United States Government Accountability Office

Report to Congressional Committees

December 2021

ADVANCED MANUFACTURING

Innovation Institutes Report Technology Progress and Members Report Satisfaction with Their Involvement

GAO@100
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GAO-22-103979

GAO@100 Highlights

Highlights of GAO-22-103979, a report to congressional committees

December 2021

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Innovation Institutes Report Technology Progress and Members Report Satisfaction with Their Involvement

Why GAO Did This Study

In recent decades, the U.S. trade balance in advanced technology products declined, resulting in a $130 billion deficit as of 2018. The Manufacturing USA institutes seek to stimulate leadership in advanced manufacturing innovation. Members include companies, nonprofits, academic institutions, and state and local governments. Members receive benefits such as access to shared facilities, equipment, and intellectual property. As of August 2021, Commerce, DOD, and DOE have provided $1.7 billion to the institutes.

The Revitalize American Manufacturing and Innovation Act of 2014, as amended, includes a provision for GAO to assess the Manufacturing USA program. This third report examines institutes' progress toward technology goals, smaller manufacturers' engagement with the institutes, and implementation of prior recommendations, among other things.

GAO collected institute information via a questionnaire, surveyed a generalizable sample of institute members, and interviewed agency officials and institute representatives.

What GAO Recommends

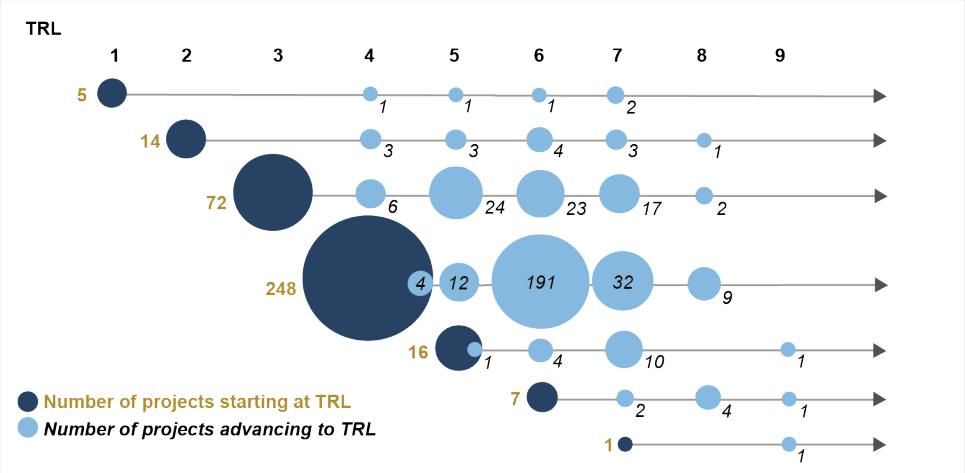
In prior work, GAO recommended that Commerce develop network-wide performance goals with measurable targets and time frames and align performance measures with goals. Commerce partially concurred and worked with DOD and DOE to develop some measures, but has not fully implemented the recommendations. GAO maintains that the recommendations still warrant action.

View GAO-22-103979. For more information, contact Candice Wright at (202) 512-6888 or wrightc@gao.gov.

What GAO Found

The Departments of Commerce, Defense (DOD), and Energy (DOE) have established a network of innovation institutes—known as Manufacturing USA institutes—to promote research, development, and commercialization of advanced manufacturing technologies. Manufacturing USA institutes reported making progress toward achieving their technology goals. Progress on institute projects is often tracked using technology readiness levels (TRL), a standardized scale for assessing maturity and risk. GAO's analysis of institute information found that projects moved through a range of TRLs (see figure). Many moved from TRL 4 to 6, taking a manufacturing technology from a point where it could be demonstrated in a lab to a point where a prototype system could be created in a simulated production environment.

Advancement of Technology Readiness Level (TRL) for Completed Manufacturing USA Institute Projects, as of March 2021



Source: GAO analysis of data provided by Manufacturing USA institutes. | GAO-22-103979

Note: Circle size illustrates the number of projects (but is not in direct proportion).

Results from a survey administered by GAO to institute members found that smaller manufacturers (those with fewer than 500 employees) were generally engaged and satisfied with their institutes' activities, such as collaborating on projects and providing input on institute priorities. Larger businesses and academic institutions reported similar levels of satisfaction. Officials noted that some factors, such as cost of membership, may limit smaller manufacturer engagement, and identified initiatives to help offset the cost.

Commerce, DOD, and DOE have implemented GAO's prior recommendations on interagency collaboration and developing sustainability criteria. However, Commerce has not fully implemented two of GAO's prior recommendations related to network-wide performance goals for the Manufacturing USA program. By not implementing these recommendations, Commerce is missing an opportunity to better observe and report on progress made toward achieving the purposes of the Manufacturing USA program.

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Abbreviations

AFFOA	Advanced Functional Fabrics of America Institute
AIM Photonics	American Institute for Manufacturing Integrated Photonics
America Makes	National Additive Manufacturing Innovation Institute
AMNPO	Advanced Manufacturing National Program Office
ARM	Advanced Robotics for Manufacturing Institute
BioFabUSA	Advanced Regenerative Manufacturing Institute
BioMADE	Bioindustrial Manufacturing and Design Ecosystem
CESMII	Clean Energy Smart Manufacturing Innovation Institute
CyManII	Cybersecurity Manufacturing Innovation Institute
DOD	Department of Defense
DOE	Department of Energy
EPA 2005	Energy Policy Act of 2005
IACMI	Institute for Advanced Composites Manufacturing Innovation
JDMC	Joint Defense Manufacturing Council
LIFT	Lightweight Innovations for Tomorrow
MEP	Hollings Manufacturing Extension Partnership
MRL	Manufacturing Readiness Level
MxD	The Digital and Cyber Manufacturing Institute
NDAA	National Defense Authorization Act

NextFlex	America's Flexible Hybrid Electronics Manufacturing Institute
NIIMBL	National Institute for Innovation in Manufacturing Biopharmaceuticals
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
NSTC	National Science and Technology Council
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 Institute
REMADE	Reducing Embodied-energy And Decreasing Emissions Institute
TRL	Technology Readiness Level
USDA	U.S. Department of Agriculture

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December 16, 2021

Congressional Committees

Advanced manufacturing—including both new manufacturing methods and the production of new products enabled by innovation—has shown the potential to promote economic growth. New technologies and innovations can increase productivity and create entirely new industries. However, the U.S. trade balance in advanced technology has declined in recent decades, resulting in a $130 billion trade deficit in advanced technology products as of 2018.[1] In addition, between 2010 and 2019, U.S. manufacturing productivity fell, ending a decades-long growth trend.[2] These changes have accompanied a long decline in U.S. manufacturing jobs and increased competition from other countries. These trends raise concerns about the strength of U.S. manufacturing, particularly for advanced technology products.

Over the past decade, the federal government has taken steps to help promote advanced manufacturing. Beginning in June 2011, the President's Council of Advisors on Science and Technology (PCAST) issued a series of reports that recommended a number of steps to increase U.S. competitiveness in advanced manufacturing.[3] Among other things, PCAST recommended that the federal government establish a national network of manufacturing innovation institutes to create a manufacturing research infrastructure. According to PCAST, such a network could help increase U.S. competitiveness by bridging the "Valley of Death"—the gap that frequently occurs between the early stages of research and development (R&D) for a technology and the later stages of

[1]Department of Commerce, National Institute of Standards and Technology, *Manufacturing USA Annual Report, FY2018* (September 2019).

[2]Shawn Sprague, "The U.S. productivity slowdown: an economy-wide and industry-level analysis," *Monthly Labor Review*, U.S. Bureau of Labor Statistics, April 2021, accessed October 1, 2021, https://doi.org/10.21916/mlr.2021.4.

[3]Executive 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). Also, see Executive 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); and Executive 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).

commercialization of that technology by industry. In response to this recommendation and at the request of the President, the Department of Defense (DOD) established a pilot manufacturing innovation institute in 2012 (America Makes) with a focus on additive manufacturing technology.[4]

In January 2013, the National Science and Technology Council (NSTC) proposed a preliminary design for a national manufacturing innovation network.[5] In December 2014, this preliminary design was formalized under the Revitalize American Manufacturing and Innovation (RAMI) Act of 2014. The RAMI Act required the Secretary of Commerce to establish a manufacturing innovation program within the Department of Commerce's National Institute of Standards and Technology (NIST), and provided that GAO assess the operation of the program not less frequently than once every two years.[6] The program's original eight purposes identified by the RAMI Act included stimulating leadership in advanced manufacturing research, innovation, and technology; accelerating development of an advanced manufacturing workforce; and

[4]DOD established the pilot institute with financial assistance and participation from the Department of Energy and other agencies. Additive manufacturing (also called 3D printing) refers to a suite of technologies used to fabricate metallic, plastic, ceramic, and electronic parts by precisely adding layers of material. The process is controlled electronically. For more information, see GAO, *3D Printing: Opportunities, Challenges, and Policy Implications of Additive Manufacturing*, GAO-15-505SP (Washington, D.C.: June 24, 2015).

[5]Executive 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 policymaking process and ensuring science and technology policy decisions and programs are consistent with the President's goals.

[6]The Revitalize American Manufacturing and Innovation (RAMI) Act was enacted as part of the Consolidated and Further Continuing Appropriations Act, 2015, Pub. L. No. 113-235, div. B, title VII, § 703(2), 128 Stat. 2220, 2221, and 2228 (2014) (codified as amended at 15 U.S.C. § 278s (b) and (i). The mandate for GAO was subsequently amended, as we discuss later in this report.

creating and preserving jobs.[7] The RAMI Act was reauthorized and amended in December 2019.[8]

There are two types of institutes: those that, under the RAMI Act,[9] receive financial assistance from Commerce and those that do not.[10] Commerce sponsors the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL). The remaining institutes were established by DOD and the Department of Energy (DOE), using their existing statutory authorities.[11] Specifically, DOD-sponsored institutes were established under authorities provided to its Manufacturing Technology

[7]RAMI Act, Pub. L. No. 113-235, div. B, title VII, § 703(2), 128 Stat. 2220, 2221 (2014) (codified as amended at 15 U.S.C. § 278s (b)(2)(B), (E), and (H)).

[8]The RAMI Act was reauthorized and amended as part of the National Defense Authorization Act for Fiscal Year 2020, Pub. L. No. 116-92, div. A, title XVII, §1741, 133 Stat. 1198, 1826 (2019) (codified at 15 U.S.C. § 278s).

[9]The RAMI Act, as amended by the National Defense Authorization Act for Fiscal Year 2020, authorizes the Secretary of Commerce to award financial assistance to assist in planning, establishing, or supporting centers for manufacturing innovation. 15 U.S.C. § 278s (e)(1).

[10]Under 15 U.S.C. § 278s (d)(3)(A)-(B), institutes that do not receive financial assistance from Commerce under the RAMI Act are either (1) considered institutes because they were formally recognized as manufacturing innovation centers under law or executive actions prior to the RAMI Act's enactment, or (2) recognized by the Secretary of Commerce, at the institute's request, as an institute for the purposes of participating in the network and are substantially similar to those established by Commerce under the RAMI Act. The RAMI Act, as amended, recognizes DOD's National Additive Manufacturing Innovation Institute (America Makes) as a Manufacturing USA institute. 15 U.S.C. § 278s (d)(3)(A). See also 15 U.S.C. § 278s (d)(3)(C) for additional applicability requirements.

[11]To date, the agencies tell us that no other institute except NIIMBL is governed by the requirements under the RAMI Act, or is being "treated as a Manufacturing USA institute under this section." 15 U.S.C. § 278s (d)(3)(C). DOD told us that America Makes, which is recognized by statute as a Manufacturing USA institute, is also not subject to the RAMI Act requirements.15 U.S.C. § 278s (d)(3)(A).

Program, and DOE-sponsored institutes were established under the Energy Policy Act of 2005.[12]

Each institute in the network is a public-private partnership between a federal agency sponsor and a nonfederal entity in charge of day-to-day operations. Each institute focuses on a particular technology area such as biopharmaceuticals, robotics, or advanced fibers. The institutes include members such as private companies, nonprofit organizations, academic institutions, federal laboratories, and state and local governments. Institute members receive a variety of benefits, such as access to shared facilities, equipment, and intellectual property. The network also provides opportunities to network and collaborate on research projects related to an institute's area of focus. As of October 2021, the network consisted of 16 operational institutes, one sponsored by Commerce, nine by DOD, and six by DOE. As of August 2021, federal financial assistance for the institutes totaled approximately $1.7 billion; financial assistance from nonfederal entities, including institute members and state and local governments, totaled approximately $2.6 billion.

The RAMI Act also requires the Secretary of Commerce to establish a national program office within NIST to oversee and carry out the program; this office is known as the Advanced Manufacturing National Program Office (AMNPO).[13] The RAMI Act specifies a number of functions for the national program office, and the Secretary of Commerce is to report annually to Congress on the performance of the program.[14] One function of AMNPO is to establish procedures, processes, and criteria, as necessary and appropriate, to maximize cooperation and coordination between the program and those of other federal departments and agencies whose missions contribute to or are affected by advanced

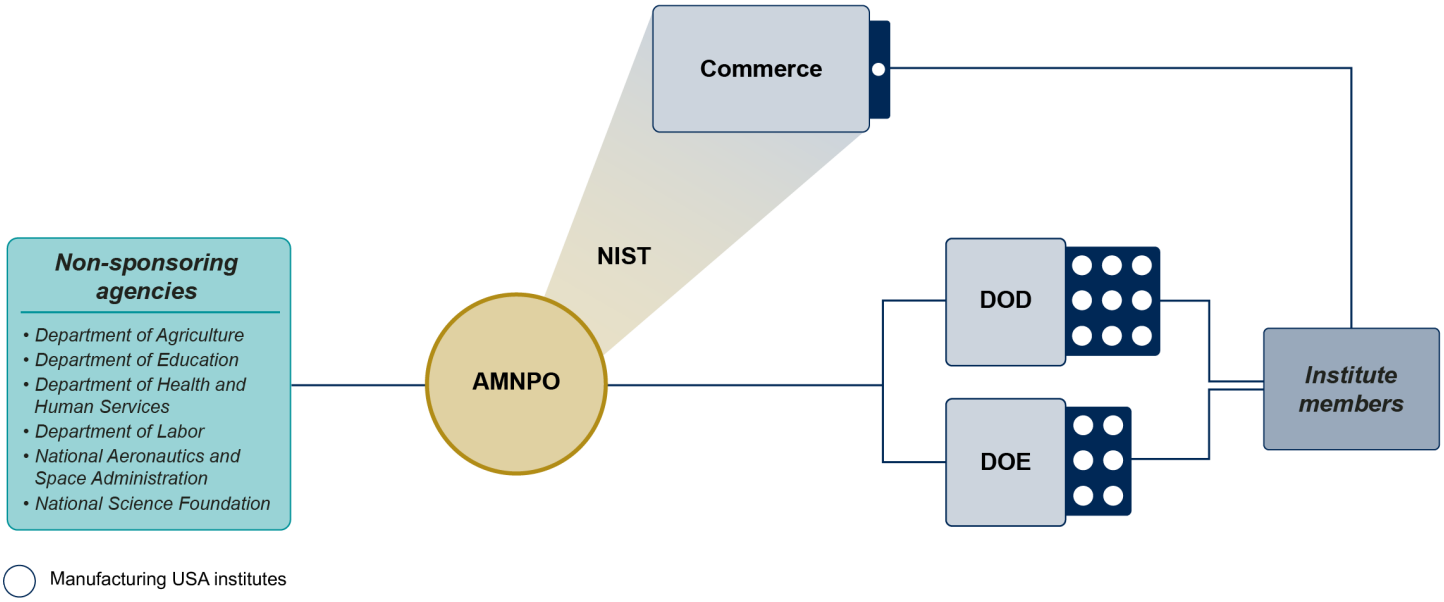
[12]The authorities for establishing DOD and DOE-sponsored institutes are 10 U.S.C. § 2521 (effective Jan. 1, 2022, this section will be renumbered 10 U.S.C. § 4841, pursuant to William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021 (NDAA FY2021), Pub. L. No. 116-283, div. A, title XVIII, §§ 1801(d), 1869(b)(1), 134 Stat. 3388, 4151, 4284, (2021)), and Pub. L. No. 109-58, § 911, 119 Stat. 594 (2005) (codified at 42 U.S.C. § 16191 (a)(2)(C)), respectively. DOD's initial authority and funding were under the Industrial Preparedness Manufacturing Technology Program in the National Defense Authorization Act for Fiscal Year 1994, Pub. L. No. 103-160, div. A, title VIII, § 801(a)(a), 107 Stat. 1547, 1700 (1993).

[13]15 U.S.C. § 278s (h)(1). In 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.

[14]15 U.S.C. § 278s (i)(2).

manufacturing. In carrying out this function, AMNPO brings together sponsoring and non-sponsoring federal agencies into an interagency team.[15] The entire effort is known collectively as Manufacturing USA. Figure 1 shows the entities that make up the Manufacturing USA program, including AMNPO and the network of institutes.

Figure 1: Manufacturing USA Program and Its Network of Institutes



AMNPO = Advanced Manufacturing National Program Office
Commerce = Department of Commerce
DOD = Department of Defense
DOE = Department of Energy
NIST = National Institute of Standards and Technology

Source: GAO analysis of agency documents. | GAO-22-103979

When the RAMI Act was reauthorized and amended by section 1741 of the National Defense Authorization Act for Fiscal Year 2020 (FY2020 NDAA), a range of provisions changed the Manufacturing USA program. This included the addition of a ninth purpose of the program: to contribute to the development of regional innovation initiatives across the United

[15]In this report, the term "non-sponsoring agencies" refers to federal agencies that participate in the Manufacturing USA program because they are agencies whose missions contribute to, or are affected by, advanced manufacturing, but do not sponsor Manufacturing USA institutes. See, 15 U.S.C. § 278s (j)(7).

States.[16] The FY2020 NDAA also specified additional functions for AMNPO, such as to work with federal agencies that are not sponsoring or supporting a Manufacturing USA institute to explore and develop options for doing so.[17] Further, the FY2020 NDAA adjusted the RAMI Act provision for GAO to assess the operation of the program not less frequently than once every 3 years, and provide a final assessment by December 31, 2030.[18] Each assessment by GAO is to include a review of the management, coordination, and industry use of the program. The RAMI Act, as amended, also has a new provision that GAO assess the program's progress toward achieving the goals specified in the national strategic plan for advanced manufacturing. As of September 2021, the current national strategic plan is the October 2018 Strategy for American Leadership in Advanced Manufacturing.[19]

This is our third report on the Manufacturing USA program. In our first report, issued in April 2017, we found that opportunities existed to strengthen interagency collaboration and recommended that Commerce work with all relevant federal agencies to fully identify roles and responsibilities for how agencies that do not sponsor institutes (i.e., non-sponsoring agencies) could contribute to the Manufacturing USA program.[20] Commerce agreed with our recommendation.

In our second report, issued in May 2019, we found that Commerce had taken some steps to address our prior recommendation, but had not fully identified the roles and responsibilities of relevant non-sponsoring

[16]National Defense Authorization Act for Fiscal Year 2020, Pub L. No. 116-92, § 1741(a), 133 Stat. 1198, 1835 (2019) as codified at 15 U.S.C. § 278s (b)(2)(I).

[17]National Defense Authorization Act for Fiscal Year 2020, Pub L. No. 116-92, § 1741(a), 133 Stat. 1198, 1835 (2019) as codified at 15 U.S.C. § 278s (h)(2)(G).

[18]National Defense Authorization Act for Fiscal Year 2020, Pub L. No. 116-92, § 1741(a), 133 Stat. 1198, 1835 (2019) as codified at 15 U.S.C. § 278s (i)(3).

[19]National Science and Technology Council, Committee on Technology, Subcommittee on Advanced Manufacturing, *Strategy for American Leadership in Advanced Manufacturing* (Washington, D.C.: October 2018). This updated the first strategic plan. See National Science and Technology Council, Executive Office of the President, *A National Strategic Plan for Advanced Manufacturing* (Washington, D.C.: February 2012).

[20]GAO, *Advanced Manufacturing: Commerce Could Strengthen Collaboration with Other Agencies on Innovation Institutes*, GAO-17-320 (Washington, D.C.: Apr. 6, 2017).

agencies.[21] We also found that opportunities existed to evaluate the financial sustainability of the institutes and strengthen performance measurement of the program. Specifically, we recommended that Commerce, DOD, and DOE develop criteria to evaluate whether institutes can sustain their operations without additional federal financial assistance after their initial agreements expire. We also recommended that Commerce enhance performance measurement by working with other sponsoring agencies to develop and implement network-wide performance goals with measurable targets and timeframes. Lastly, we recommended that such goals be aligned with the network-wide performance measures, program goals and objectives, and the statutory purposes of the RAMI Act. Commerce, DOD, and DOE generally agreed with the sustainability criteria recommendations, and Commerce partially agreed with the performance measurement recommendations.

This report examines:

- the extent to which the Manufacturing USA program addresses the goals of the national strategic plan for advanced manufacturing;
- the extent to which agencies have addressed prior GAO recommendations;
- the progress that institutes have reported toward achieving their technology goals;
- how small and medium-sized institute members have engaged with Manufacturing USA institutes and steps that sponsoring agencies and institutes have taken to ensure these members can leverage the work of the institutes; and
- the sponsoring agencies' plans for institutes.

To address all of our objectives, we interviewed agency and institute officials. To examine the extent to which the Manufacturing USA network addresses the goals of the national strategic plan, we analyzed the 2019 Manufacturing USA strategic plan in relation to the goals and objectives of the national strategic plan. We also collected information on institute activities that support the national strategic plan's goals and objectives

[21]GAO, *Advanced Manufacturing: Innovation Institutes Have Demonstrated Initial Accomplishments, but Challenges Remain in Measuring Performance and Ensuring Sustainability*, GAO-19-409 (Washington, D.C.: May 23, 2019).

through a questionnaire we administered to the 14 Manufacturing USA institutes operating as of November 2019.[22]

To examine the extent to which agencies have made efforts to implement prior GAO recommendations, we analyzed agency documents and interviewed agency officials. To examine progress toward achieving institute technology goals, we collected information and data related to institute technology goals and projects through the questionnaire administered to the institutes. We assessed the reliability of project data provided by the institutes by checking for missing data or errors; we found the data to be sufficiently reliable for the purposes of our analysis.

To examine small and medium-sized manufacturers' engagement with the institutes, we administered a survey to a generalizable sample of institute members from the 14 Manufacturing USA institutes operating as of November 2019.[23] We also interviewed officials from a nongeneralizable sample of 13 NIST Hollings Manufacturing Extension Partnership (MEP) centers to obtain their perspectives on small and medium-sized manufacturer engagement with institutes.[24]

To examine agency plans for institutes, we reviewed agency documentation and interviewed agency officials. For more information about our objectives, scope, and methodology, see appendix I.

We conducted this performance audit from November 2019 through December 2021 in accordance with generally accepted 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

[22]We did not administer the questionnaire to the two institutes that were established during the course of our work.

[23]Our generalizable sample included 615 institute members across the following categories: large manufacturers (500 or more employees), small and medium-sized manufacturers (fewer than 500 employees), and academic members (colleges and universities). We received 239 completed survey responses for a response rate of 39 percent. We did not administer the survey to members of the two institutes that were established during the course of our work.

[24]Under the Hollings MEP program, NIST provides funding on a cost share basis to 51 nonfederal organizations located in all 50 states and Puerto Rico. The MEP centers provide assistance to manufacturers, either directly or through third parties, to help them improve their processes and productivity, expand their capacity, adopt new technologies, use best management practices, and accelerate company growth. The program generally focuses on helping small and medium-sized manufacturers.

that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Advanced Manufacturing Strategic Plans

The national strategic plan and the Manufacturing USA strategic plan are aimed at improving the competitiveness of U.S. manufacturing through accelerating innovation and developing advanced manufacturing capabilities. While the plans address similar issues, they do not have to align.

- *National strategic plan.* Under Section 102 of the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Reauthorization Act of 2010, as amended, the NSTC Committee on Technology is responsible for developing a national strategic plan for advanced manufacturing, and updating the plan on a quadrennial basis.[25] The national strategic plan outlines goals and objectives intended to promote American leadership in advanced manufacturing across industrial sectors to ensure national security and economic prosperity.

  The committee updated the February 2012 plan in October 2018.[26] This current plan has three goals: (1) develop and transition new manufacturing technologies; (2) educate, train, and connect the manufacturing workforce; and (3) expand the capabilities of the domestic manufacturing supply chain. These three goals include 13 strategic objectives (e.g., increase the role of small and medium-sized manufacturers in advanced manufacturing) and 35 technical and program priorities (e.g., cybersecurity outreach and awareness).

[25]America COMPETES Reauthorization Act of 2010, Pub. L. No. 111-358, § 102, 124 Stat. 3982, 3985 (2011), (codified as amended at 42 U.S.C. § 6622(b)(7), and (c).

[26]National Science and Technology Council, Executive Office of the President, *Strategy for American Leadership in Advanced Manufacturing (Washington*, D.C.: October 2018). In a March 2017 report, we reviewed the 2012 plan and found that information needed to evaluate progress in achieving the plan's objectives had not been identified. We recommended that the Director of the Office of Science and Technology Policy work through the National Science and Technology Council and agencies, as appropriate, to identify the information they would need to collect from federal agencies to determine the extent to which the plan's objectives were being achieved. This recommendation has not yet been implemented. See GAO, *U.S. Manufacturing: Federal Programs Reported Providing Support and Addressing Trends*, GAO-17-240 (Washington, D.C.: Mar. 28, 2017).

Program priorities include specific outcomes or actions to be accomplished during the subsequent 4 years.

The national strategic plan cites the Manufacturing USA program as an important contributor in helping meet the plan's goals. It describes Manufacturing USA institute efforts, such as manufacturing education and workforce development, as playing a role in achieving its priorities.

- *Manufacturing USA strategic plan.* The Manufacturing USA strategic plan communicates a set of program goals to support manufacturing innovation. The first Manufacturing USA strategic plan was released in February 2016 and contained four goals and 10 associated objectives based on the initial eight statutory purposes of the RAMI Act.[27] In January 2021, AMNPO published an updated plan (dated November 2019).[28] The current plan retains the same program goals: (1) increase competitiveness of U.S. manufacturing; (2) facilitate the transition of innovative technologies into scalable, cost-effective, and high performing domestic manufacturing capabilities; (3) accelerate the development of an advanced manufacturing workforce; and (4) support business models that help institutes become stable and sustainable.

Manufacturing USA Network and Institutes

According to the NSTC's January 2013 report outlining the design of what would later become the Manufacturing USA network, the institutes would be designed to strengthen support for R&D after the beginning stages of innovation but before commercialization. Each Manufacturing USA institute is established and managed through a cooperative agreement or a technology investment agreement between the sponsoring federal agency and the nonfederal entity in charge of the institute's operations.[29] The agreement outlines the technology focus area and associated goals, which may change over time as institutes periodically review goals and work with sponsoring agencies to make mutually agreed upon updates if

[27]Executive 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).

[28]National Science and Technology Council, Advanced Manufacturing National Program Office, *Manufacturing USA Strategic Plan* (Washington, D.C.: November 2019). According to the RAMI Act, AMNPO is to update the Manufacturing USA strategic plan at least once every 3 years. 15 U.S.C. § 278s (h)(2)(C).

[29]DOD entered into technology investment agreements with the entities responsible for managing three institutes. The other 13 institutes were established with cooperative agreements.

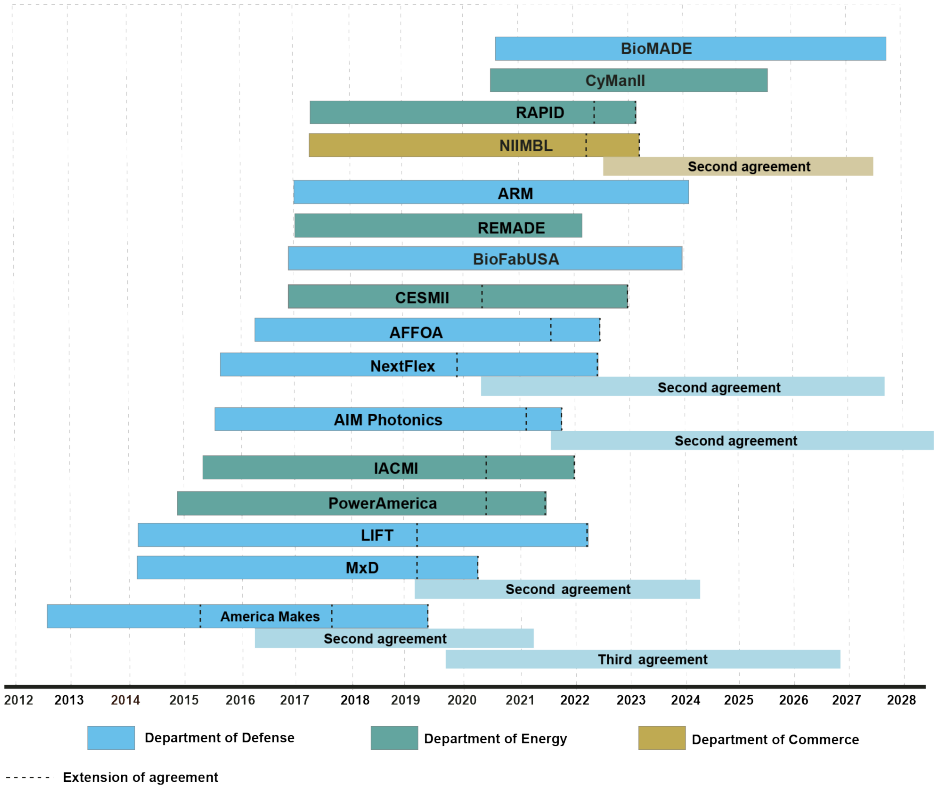
necessary. (Appendix II provides an overview of technology focus areas and goals for the 16 Manufacturing USA institutes operating as of September 2021.) Institute membership is open to all U.S. industrial organizations, academic institutions, nonprofit organizations, and government agencies interested in advancing technology and education in a certain focus area.

The NSTC's design envisioned each institute becoming self-sustaining within 7 years of its launch through income-generating activities such as member fees, intellectual property licenses, contract research, and fee-for-service activities. The agreements specify a total amount of baseline federal financial assistance and a minimum level of matching financial assistance to be provided by the institutes. The federal investment provides institutes with financial assistance that institutes can use to sponsor projects and support general operations.

According to the institutes' agreements and agency documentation, the planned federal baseline investments range from approximately $55 million to approximately $300 million per institute over the agreement performance periods, including follow-on agreements. The institutes' planned co-investments range from approximately $40 million to approximately $500 million per institute over the same time period. The co-investments include, for example, institute members' dues, state support, and any other federal support not part of the federal baseline investment, such as project-specific funding.

As of September 2021, 16 Manufacturing USA institutes were operational and implementing activities in their technology areas. Figure 2 describes the planned dates for each institute's financial assistance agreement with its sponsoring agency, including extensions and follow-on agreements.

Figure 2: Planned Start and End Dates for Institute Federal Financial Assistance Periods as of September 2021



AFFOA – Advanced Functional Fabrics of America Institute

AIM Photonics – American Institute for Manufacturing Integrated Photonics

America Makes – The National Additive Manufacturing Innovation Institute

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BioFabUSA – Advanced Regenerative Manufacturing Institute

BioMADE – Bioindustrial Manufacturing and Design Ecosystem

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PowerAmerica – The Next Generation Power Electronics Manufacturing Innovation Institute

RAPID – Rapid Advancement in Process Intensification Deployment Institute

REMADE – Reducting EMbodied-energy And Decreasing Emission Institute

Source: GAO analysis of institute agreements and agency information. | GAO-22-103979

Two of the institutes in the figure above were established after we issued our May 2019 report.

- **Bioindustrial Manufacturing and Design Ecosystem (BioMADE) Institute.** Launched in April 2021, this DOD-sponsored institute focuses on enabling bioindustrial manufacturing at all scales.[30] As of August 2021, BioMADE has formally signed on 60 institute members and expects to have a total of about 100 members by the end of 2021. BioMADE started with two initial institute projects and one directed research project with DOD, and issued a request for technology and education and workforce development project proposals. The institute is currently exploring a partnership with the National Science Foundation (NSF) to improve connections with community and technical colleges in the bioindustrial sector. BioMADE is working with its members on financial sustainability issues beyond its initial 7-year performance period.
- **Cybersecurity Manufacturing Innovation Institute (CyManII).** Launched in September 2020, this DOE-sponsored institute focuses on energy efficient, cyber-secure manufacturing. CyManII started with 59 potential member organizations and expects the number of members to increase. CyManII issued its first request for project proposals in May 2021, and funding for approved member projects was made available in September 2021. The institute's activities include technology road mapping, baselining to help measure institute progress, and increasing cybersecurity awareness. To achieve financial sustainability after its initial 5-year performance period, the institute has established a for-profit entity that will offer services to advance cybersecurity in manufacturing, including training, workforce development, and helping manufacturers improve energy efficiency and equipment productivity while implementing cybersecurity solutions.

As described in the Manufacturing USA 2019 strategic plan, small and medium-sized manufacturers are an important component of institutes' memberships because they promote a broader reach across all U.S. manufacturing sectors. To ensure that the programs reach smaller manufacturers, AMNPO and NIST MEP began a pilot program in September 2016 to connect these smaller prospective members to technologies available in Manufacturing USA institutes and, at the same time, help the institutes establish relationships with smaller manufacturers

[30]Bioindustrial manufacturing, according to BioMADE representatives, uses biology to make industrial products such as renewable fuels, chemicals, nutrients, and other materials.

throughout the United States.[31] The aim was to engage small and medium-sized manufacturers in the technology focus areas of Manufacturing USA institutes and help institutes better understand their needs. NIST MEP awarded funding to each institute in operation at the time for 2-year projects that embedded MEP center staff at each institute. The program concluded in August 2020. See table 1 for more details.

Table 1: Pilot Program Matching Manufacturing USA Institutes with Hollings Manufacturing Extension Partnership (MEP) Centers, 2016 through 2020

Manufacturing USA institute	Lead MEP center
AFFOA: Advanced Functional Fabrics of America Institute	Massachusetts MEP
AIM Photonics: American Institute for Manufacturing Integrated Photonics	New York State Department of Economic Development
America Makes: National Additive Manufacturing Innovation Institute	Pennsylvania MEP
ARM: Advanced Robotics for Manufacturing Institute	Pennsylvania MEP
BioFabUSA: Advanced Regenerative Manufacturing Institute	Massachusetts MEP
CESMII: Clean Energy Smart Manufacturing Innovation Institute	California Manufacturing Technology Center
IACMI: Institute for Advanced Composites Manufacturing Innovation	The University of Tennessee Center for Industrial Services
LIFT: Lightweight Innovations for Tomorrow	Michigan Manufacturing Technology Center
MxD: The Digital and Cyber Manufacturing Institute	Illinois Manufacturing Excellence Center
NextFlex: America's Flexible Hybrid Electronics Manufacturing Institute	California Manufacturing Technology Center
NIIMBL: The National Institute for Innovation in Manufacturing Biopharmaceuticals	Delaware MEP
PowerAmerica: The Next Generation Power Electronics Manufacturing Innovation Institute	North Carolina State University
RAPID: Rapid Advancement in Process Intensification Deployment Institute	Oregon MEP
REMADE: Reducing EMbodied-energy and Decreasing Emissions Institute	New York State Department of Economic Development

Source: GAO analysis of National Institute of Standards and Technology documentation. | GAO-22-103979

Among the activities that institutes undertake to achieve their technology goals are projects supported by an institute that involve at least one member organization, such as a company. For the purposes of this report, we refer to these projects as consortium projects. The progress of consortium projects is a major contributor to an institute's progress toward its overall technology goals.

[31] 15 U.S.C. § 278s (h)(5).

Institutes measure the progress of their consortium projects in two ways. Most institutes use Technology Readiness Levels (TRL) or Manufacturing Readiness Levels (MRL), which are common measures and vocabulary for assessing and discussing maturity and risk for technologies or manufacturing capabilities, respectively. TRLs fall on a 9-point scale, starting with paper studies of a basic concept and ending with a technology that has proven itself in operation. MRLs fall on a 10-point scale beginning with the identification and study of basic manufacturing shortfalls and opportunities, and ending with full-rate production. TRLs and MRLs are distinct, and both enable consistent comparison of maturity between different types of technologies or manufacturing capabilities.

Because Manufacturing USA institutes were designed to strengthen support for R&D in the gap between early stages of innovation and commercialization, consortium projects focus on technologies in the TRL or MRL ranges of 4 to 7, as shown in figure 3. Advancing along each scale represents the various stages of maturity needed to advance manufacturing from the conceptual stage of processes proven in a lab to a production-ready environment. For other projects, institutes measure progress by tracking the number or percentage of milestones or deliverables achieved.

Figure 3: Technology Readiness Levels (TRL) and Manufacturing Readiness Levels (MRL) Used by Manufacturing USA Institutes

	TRL 1:	Basic principles observed and reported	MRL 1:	Basic manufacturing implications identified
	TRL 2:	Technology concept and/or application formulated	MRL 2:	Manufacturing concepts identified
	TRL 3:	Analytical and experimental critical function and/or characteristic proof of concept	MRL 3:	Manufacturing proof of concept developed
Manufacturing USA Target	TRL 4:	Component and/or breadboard validation in a laboratory environment	MRL 4:	Capability to produce prototype component in a laboratory environment
Manufacturing USA Target	TRL 5:	Component or breadboard validation in a relevant environment	MRL 5:	Capability to produce prototype components in a production relevant environment
Manufacturing USA Target	TRL 6:	System/subsystem model or prototype demonstration in a relevant environment	MRL 6:	Capability to produce a prototype system or subsystem in a production relevant environment
Manufacturing USA Target	TRL 7:	System prototype demonstration in an operational environment	MRL 7:	Capability to produce systems, subsystems, or components in a production representative environment
	TRL 8:	Actual system completed and qualified through test and demonstrated	MRL 8:	Pilot line capability demonstrated; ready to begin low-rate initial production
	TRL 9:	Actual system proven through successful mission operations	MRL 9:	Low rate production demonstrated; capability in place to begin full rate production
			MRL 10:	Full rate production demonstrated and lean production practices in place

Source: GAO, Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects, GAO-20-48G (Washington, D.C.: 2020). | GAO-22-103979

The National Strategic Plan's Goals and Objectives Are Generally Supported

The Manufacturing USA strategic plan and institutes generally support the goals and objectives of the national strategic plan. Specifically, the goals of the Manufacturing USA strategic plan align with the goals of the national strategic plan, although some variation exists between the objectives of each plan. Moreover, Manufacturing USA institute representatives and sponsoring agency officials reported that institutes have conducted activities that support the national strategic plan's goals and objectives.

The Manufacturing USA and National Strategic Plans' Goals Generally Align, While Some Objectives Vary

We found general alignment between the goals of the Manufacturing USA strategic plan and those of the national strategic plan. While no official requirement exists for the plans to align, the Manufacturing USA strategic plan's goals align with all three goals of the national strategic plan. The Manufacturing USA strategic plan also includes one additional goal, as shown in table 2.

Table 2: Alignment between the National Strategic Plan and Manufacturing USA Strategic Plan Goals

National strategic plan goals	Corresponding Manufacturing USA strategic plan goals
Develop and transition new manufacturing technologies	Facilitate the transition of innovative technologies into scalable, cost-effective, and high-performing domestic manufacturing capabilities
Educate, train, and connect the manufacturing workforce	Accelerate the development of an advanced manufacturing workforce
Expand the capabilities of the domestic manufacturing supply chain	Increase the competitiveness of U.S. manufacturing[a]
N/A	Support institute business models that help institutes become stable and sustainable

Legend: N/A = not applicable

Source: GAO analysis of Manufacturing USA and national strategic plans. | GAO-22-103979

[a]The Manufacturing USA strategic plan states that, "altogether, Manufacturing USA encourages the creation of stronger domestic supply chain networks that in turn encourage U.S. manufacturers to produce more products in the U.S."

While the goals of the strategic plans generally align, the Manufacturing USA strategic plan does not address all of the national strategic plan's objectives and program priorities. Overall, the Manufacturing USA strategic plan corresponds to five of 13 national strategic plan objectives, and nine of 35 program priorities.[32] For example, both plans have an objective on expanding career and technical education pathways. However, the national strategic plan includes an objective on strengthening opportunities for food and agricultural manufacturing that does not appear in the Manufacturing USA strategic plan.[33] For more details on our analysis of the alignment between the goals and objectives

[32]Our analysis compared the objectives of the 2016 Manufacturing USA strategic plan with the national strategic plan. NIST officials told us that while they did not include objectives in the most recent update, the objectives still apply to the 2019 plan. Supporting content, including written text of the strategic plan, was also considered from the 2019 Manufacturing USA strategic plan as part of our analysis.

[33]We previously reported that the U.S. Department of Agriculture (USDA) was considering establishing a Manufacturing USA institute that would focus on biomanufacturing and renewable performance materials from forest and agricultural feedstock. However, during the course of our work, Commerce officials told us that they have not received any information from USDA about sponsoring a new institute. GAO-19-409.

of the Manufacturing USA strategic plan and national strategic plan, see appendix III.

Institute Activities Generally Support National Strategic Plan Goals and Objectives

According to our analyses of information provided by sponsoring agencies and institute questionnaire responses, Manufacturing USA institutes' activities generally support the national strategic plan's three goals and 13 objectives.

Commerce, DOD, and DOE officials said the institutes they sponsor broadly support the goals and objectives in the national strategic plan. Commerce officials stated that NIIMBL directly supports two of the national strategic plan goals—developing and transitioning new manufacturing technologies, and educating, training, and connecting the manufacturing workforce[34]—and indirectly supports the third goal of expanding the capabilities of the domestic manufacturing supply chain. DOE officials stated that its six institutes support all of the goals of the national strategic plan and six of the 13 objectives are supported by all six institutes.[35] According to DOD officials, the missions of the institutes they sponsor directly align with all of the national strategic plan's goals.[36]

According to institute questionnaire responses, all 14 institutes support the following objectives in the national strategic plan:

[34]NIST officials reported that NIIMBL's technology portfolio invests $60 million in technical projects to accelerate industrialization of innovative technology. Also, NIIMBL's workforce development portfolio invests $15 million in training and professional development programs at partnering organizations.

[35]The six objectives all DOE institutes support are: attracting and growing tomorrow's manufacturing workforce, updating and expanding career and technical education pathways, promoting apprenticeships and access to industry-recognized credentials, matching skilled workers with the industries that need them, increasing the role of small and medium-sized manufacturers in advanced manufacturing, and encouraging ecosystems for manufacturing innovation. DOE officials reported that other agency programs also support the national strategic plan goals.

[36]For example, for goal 1, which is related to developing and transitioning new manufacturing technologies, each DOD-sponsored institute has a specific technology focus area and distinct membership model designed to focus research and development on manufacturing challenges shared by the DOD and industry. For goal 2, each DOD-sponsored institute has its own unique education and workforce development strategy and programs to increase workforce preparedness for advanced manufacturing jobs. Lastly, for goal 3, DOD officials said the institutes they sponsor work on the development of a vibrant, domestic ecosystem that relies upon assuring access for start-ups and small and medium manufacturers to develop prototyping, engineering, and manufacturing capabilities.

- Attract and grow tomorrow's manufacturing workforce
- Update and expand career and technical education pathways
- Increase the role of small and medium-sized manufacturers in advanced manufacturing

In addition, each of the plan's objectives is supported by over half of the institutes, as shown in table 3. We also found that each of the institutes supported at least one objective under each goal.[37]

Table 3: Manufacturing USA Institutes Questionnaire Responses on Support of National Strategic Plan Goals and Objectives

National strategic plan goals and objectives	Number of institutes supporting national strategic plan objectives
Goal 1: Develop and Transition New Manufacturing Technologies	
Objective 1.1: Capture the future of intelligent manufacturing systems	11 of 14
Objective 1.2: Develop world-leading materials and processing technologies	13 of 14
Objective 1.3: Assure access to medical products through domestic manufacturing	12 of 14
Objective 1.4: Maintain leadership in electronics design and fabrication	9 of 14
Objective 1.5: Strengthen opportunities for food and agricultural manufacturing	8 of 14
Goal 2: Educate, Train, and Connect the Manufacturing Workforce	
Objective 2.1: Attract and grow tomorrow's manufacturing workforce	14 of 14
Objective 2.2: Update and expand career and technical education pathways	14 of 14
Objective 2.3: Promote apprenticeship and access to industry-recognized credentials	10 of 14
Objective 2.4: Match skilled workers with the industries that need them	12 of 14
Goal 3: Expand the Capabilities of the Domestic Manufacturing Supply Chain	
Objective 3.1: Increase the role of small and medium-sized manufacturers in advanced manufacturing	14 of 14
Objective 3.2: Encourage ecosystems for manufacturing innovation	13 of 14
Objective 3.3: Strengthen the defense manufacturing base	12 of 14
Objective 3.4: Strengthen advanced manufacturing for rural communities	10 of 14

Source: GAO analysis of Manufacturing USA institute questionnaire responses. | GAO-22-103979

Manufacturing USA institute representatives identified a variety of institute activities that demonstrate their efforts in supporting the national strategic plan objectives. For example:

- **Objective 1.2 - Developing world-leading materials and processing technologies.** The Digital and Cyber Manufacturing Institute (MxD)

[37]BioMade and CyManII were established during the period of our work and thus were not included in the questionnaire.

representatives described their efforts to develop, test, and validate new materials through process improvements advanced through digital engineering, machine learning, and other technologies. Also in support of this objective, Reducing Embodied Energy and Decreasing Emissions Institute (REMADE) representatives described their work developing cost-effective and cost-competitive manufacturing, remanufacturing, and recycling technologies to increase the use of secondary metals, plastics, fibers, and electronic waste.

- **Objective 1.5 - Strengthening opportunities for food and agricultural manufacturing.** Clean Energy Smart Manufacturing Innovation Institute (CESMII) representatives stated they have developed a member group related to food, beverage, and consumer goods that meets to discuss industry wide challenges and best practices for smart manufacturing relating to food and agriculture.
- **Objective 2.2 - Updating and expanding career technical education pathways.** CESMII's Smart Manufacturing education plan includes development and licensing of knowledge and education resources for both eLearning and instructor-led education, through a knowledge sharing portal, learning management system, and repository of educational resources for the national network of educators. In addition, the Institute for Advanced Composites Manufacturing Innovation (IACMI) has an advanced composites career pathways program that establishes partnerships with community and technical colleges to create technician training, certifications, and degree programs aligned with local industry needs.
- **Objective 2.3 - Promoting apprenticeship and access to industry-recognized credentials.** America's Flexible Hybrid Electronics Manufacturing Institute (NextFlex) developed a work-based learning program designed to support apprenticeship, internship, co-op, and employment skills development programs across the nation.
- **Objective 3.2 - Encouraging ecosystems for manufacturing innovation.** REMADE institute representatives described that the 25 affiliate organizations included in REMADE's membership, such as trade associations, allow the institute to extend its research to an additional 5,000 companies that are members of these affiliate organizations. In addition, Advanced Regenerative Manufacturing Institute (BioFabUSA) representatives described efforts to support this objective by creating a local ecosystem in the Massachusetts and New Hampshire area that allows companies to share facilities and equipment.
- **Objective 3.4 - Strengthening advanced manufacturing for rural communities.** IACMI representatives reported conducting outreach and

workforce training events held in partnership with regional host partners, serving more than 2,000 participants at locations more accessible to rural communities.

Agencies Have Implemented GAO's Prior Recommendations, Except for Those on Network-Wide Performance Goals

Commerce has implemented our prior recommendation from 2017 related to interagency collaboration with non-sponsoring agencies. In addition, DOD, DOE, and Commerce have implemented our prior recommendations related to institute sustainability. However, Commerce has not fully implemented two of our prior recommendations related to network-wide performance goals with measurable targets and time frames. See table 4.

Table 4: Status of Implementation of Prior GAO Recommendations to the Manufacturing USA Program

GAO report	Recommendation	Status of implementation
GAO-17-320 *(Advanced Manufacturing: Commerce Could Strengthen Collaboration with Other Agencies on Innovation Institutes)*	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.	Implemented
GAO-19-409 *(Advanced Manufacturing: Innovation Institutes Have Demonstrated Initial Accomplishments, but Challenges Remain in Measuring Performance and Ensuring Sustainability)*	The Secretary of Defense should direct the Director of DOD's Manufacturing USA institutes to develop criteria to evaluate whether DOD-sponsored institutes can sustain their operations without additional federal financial assistance after their initial agreements.	Implemented
	The Secretary of Energy should direct the Director of DOE's Manufacturing USA institutes to develop criteria to evaluate whether DOE-sponsored institutes can sustain their operations without additional federal financial assistance after their initial agreements.	Implemented
	The Secretary of Commerce should direct the NIST Director to develop criteria to evaluate whether the Commerce-sponsored institute can sustain its operations without additional federal financial assistance after its initial agreement. If an analysis based on such criteria indicates that additional federal financial assistance is needed to help the institute sustain its operations, then the Secretary of Commerce should consider a legislative proposal to amend relevant provisions of the RAMI Act.	Implemented
	The Secretary of Commerce should direct the NIST Director to work with other sponsoring federal agencies to develop and implement network-wide performance goals for the Manufacturing USA program with measurable targets and time frames.	Not implemented

GAO report	Recommendation	Status of implementation
	The Secretary of Commerce should direct the NIST Director to work with other sponsoring federal agencies to ensure that the Manufacturing USA network-wide performance measures are directly aligned with the network-wide performance goals, the Manufacturing USA strategic objectives and program goals, and the statutory purposes of the RAMI Act as amended.	Not implemented

Source: GAO. | GAO-22-103979

Interagency Collaboration

Example of Collaboration between a Manufacturing USA Institute and a Non-Sponsoring Agency

The Food and Drug Administration (FDA) does not sponsor a Manufacturing USA institute, but regularly collaborates with the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), sponsored by Commerce.

FDA holds a weekly meeting with NIIMBL, FDA's Office of the Chief Scientist, and NIST's Office of Advanced Manufacturing. Commerce officials said these regular meetings have helped NIIMBL staff align their technical work with regulatory science needs and submit proposals to address FDA's advanced manufacturing priorities.

Source: GAO analysis of agency information. | GAO-22-103979

Commerce implemented our prior recommendation from April 2017 to improve interagency collaboration with non-sponsoring agencies. Commerce officials said they worked with sponsoring and non-sponsoring agencies to revise the Manufacturing USA governance document in October 2019 to clarify how non-sponsoring agencies are expected to contribute to the network.[38] The interagency team agreed to add a function that gives non-sponsoring agencies the responsibility for facilitating information sharing about federal programs and funding opportunities relevant to institutes (see text box).

Commerce officials said they convene a monthly meeting with an interagency team comprising sponsoring and non-sponsoring agencies during which agencies can share information on programs, activities, and interagency collaboration opportunities relevant to Manufacturing USA. For example, according to Commerce officials, if a non-sponsoring agency such as NSF started a new collaboration with a Manufacturing USA institute to fund early-stage research in that institute's technology focus area, the agency would be responsible for informing the interagency team about that collaboration, and sponsoring agencies would inform the other institutes to keep them aware of such opportunities.

Additionally, as discussed in our May 2019 report, outreach and informational briefings that AMNPO conducted with the Departments of Labor and Health and Human Services resulted in those departments

[38]The Manufacturing USA governance document was originally created in 2016, and identifies different network functions and associated sub-functions or tasks. For example, one function is "to sustain, strengthen, and grow the network," and this function includes sub-functions such as identifying and helping to establish long-term nonfinancial support mechanisms for the Manufacturing USA program. For each sub-function, the governance document identifies a role for AMNPO, sponsoring agencies, institutes, and other stakeholders as being accountable, responsible, consulted, or informed. See Department of Commerce, National Institute of Standards and Technology, *NIST Advanced Manufacturing Series 600-4: Network Charter Manufacturing USA Program* (October 2019).

naming representatives to the Manufacturing USA interagency team to attend meetings. For example, Department of Labor representatives provided a presentation on the workforce development system at an October 2017 Manufacturing USA interagency meeting that included information on the role of different entities, along with information on Department of Labor programs and resources related to advanced manufacturing.

Institute Sustainability

DOD, DOE, and Commerce implemented our recommendations from May 2019 to develop criteria to evaluate whether institutes can sustain their operations without additional federal financial assistance after their initial agreements expire. As discussed earlier, the National Science and Technology Council's preliminary design for the Manufacturing USA network envisioned that an institute would become self-sustaining and fully independent of federal financial assistance within 7 years of its launch through income-generating activities such as member fees, intellectual property licenses, contract research, and fee-for-service activities.

DOD incorporated sustainability criteria into its long-term planning for institutes. DOD officials said they worked with their institutes to develop an updated set of metrics that would better evaluate institute progress. Finalized in June 2019, the updated metrics include categories of education and workforce, operations, ecosystem development, and financial management. Specifically, the financial metrics include institute membership revenue, project funding, and cash reserves. DOD first collected the updated metrics in September 2019, and now collects these metrics on a quarterly basis. DOD officials said they use these metrics to track institute progress, aid with program management, and as inputs in a new institute evaluation process.

Accepted in September 2020, the new evaluation process is designed to determine whether there is a continuing need for the institute, if the institute is the appropriate solution, if the institute is performing well, and if the governance and management of the institute are effective. This process uses a DOD senior-level panel called the Joint Defense Manufacturing Council (JDMC), which is separate from DOD's Manufacturing Technology program, to make recommendations about DOD's continued partnership and financial assistance for its institutes. According to DOD officials, the JDMC assesses the relevance of the institute technical area to DOD and the nation, the effectiveness of the institute and its management, and the importance and effectiveness of the institute in meeting the needs of its members. DOD officials said that

starting in FY2021, each DOD institute will be evaluated by the JDMC panel every 5 years. DOD officials said that they plan to establish follow-on agreements with its institutes, contingent on the results of these assessments.

DOE developed a set of financial sustainability metrics to assess its institutes, and DOE-sponsored institutes began reporting on them in early 2020. According to DOE officials, the metrics address the institute's ability to cover management and operation expenses as well as the value of the institute to its members and its manufacturing sector. For example, the metrics include the ratio of institute expenses to membership fees, member participation in institute meetings, the number of patents and journal articles stemming from institute efforts, and the number of projects funded by nonfederal sources.

DOE officials said implementation of these financial sustainability metrics has resulted in a consistent and quantitative approach to reporting and evaluating institute progress, and has helped institutes refine their sustainability plans. For example, DOE officials said the ratio of institute expenses to membership fees metric helped one institute refine its management approach. Specifically, when anticipating a reduced budget after the end of the initial cooperative agreement, the institute used this metric to identify activities it could sustain and to reduce planned management expenses to better match expected income.

Commerce developed sustainability criteria to evaluate whether NIIMBL can sustain its operations without federal financial assistance.[39] Agency officials said they developed and implemented sustainability criteria in October 2020, and NIIMBL revised its sustainability plan in December 2020 in response. In January 2021, Commerce completed its assessment of NIIMBL's sustainability plan and found it to be sufficient (i.e., meets or exceeds the performance criterion that the institute can support 25 percent or more of steady-state operations for an additional 3 years without federal financial assistance). Commerce officials said their future

[39]The original recommendation for Commerce in GAO-19-409 included an additional component: "If an analysis based on such criteria indicates that additional federal financial assistance is needed to help the institute sustain its operations, then the Secretary of Commerce should consider a legislative proposal to amend relevant provisions of the RAMI Act." This recommendation is no longer relevant because the RAMI Act, as amended, allows Commerce to provide federal financial assistance beyond the original 5-to-7 year period. 15 U.S.C. § 278s (e)(2)(B).

assessments of NIIMBL's overall performance will include the sustainability criteria.

Network-Wide Performance Goals

Commerce has not fully implemented two of our prior recommendations from May 2019 on performance management that we believe are still valid: (1) work with other sponsoring agencies to develop and implement network-wide performance goals for the Manufacturing USA program with measurable targets and time frames and (2) ensure that the Manufacturing USA network-wide performance measures are directly aligned with the network-wide performance goals, the Manufacturing USA strategic objectives and program goals, and the statutory purposes of the RAMI Act. We previously found that systems of performance measures benefit from certain key practices, such as creating a hierarchy that breaks down broad, long-term goals and objectives into more specific, near-term performance goals with measurable targets and time frames.[40] Additionally, the December 2019 amendments to the RAMI Act added a function for AMNPO to work with sponsoring and supporting agencies to develop and implement network-wide performance goals.[41]

Commerce officials said recommendations related to network-wide performance goals have not been implemented to date because the range of maturity, technology focus areas, and diversity of projects among institutes make it challenging to set network-wide performance goals with measurable targets and time frames. Commerce, DOD, and DOE officials said they have discussed network-wide performance goals at their regular coordination meetings, but they have not developed or implemented any network-wide performance goals or targets given such challenges. Additionally, DOD and DOE officials expressed concern that establishing network-wide performance goals could lead to negative outcomes, such as institutes increasing international membership solely for the purpose of meeting a performance target. However, DOD officials said that they encourage network-wide performance goals that evaluate the success of the Manufacturing USA network as a whole, and suggested such goals be set in coordination with the National Science and Technology Council's Subcommittee on Advanced Manufacturing to ensure alignment with national science and technology priorities. DOD officials said that measuring what agencies and institutes are

[40]GAO, *Managing for Results: Practices for Effective Agency Strategic Reviews,* GAO-15-602 (Washington, D.C.: July 29, 2015).

[41]15 U.S.C. § 278s (h)(2)(H).

accomplishing together toward national manufacturing priorities could help grow the network.

Commerce's annual reporting still does not specify performance goals or measurable targets for network-wide performance measures.[42] In our April 2017 and May 2019 reports, we described AMNPO's plans to develop revised network-wide performance measures. In its fiscal year 2019 Manufacturing USA Annual Report, Commerce reported on the same set of network-wide performance measures as in previous years, (e.g., total number of institute memberships and total institute expenditures during the fiscal year). Further, Commerce, DOD, and DOE officials said they agreed to new performance measures on education and workforce development activities, which are included in the fiscal year 2019 Manufacturing USA Annual Report (e.g., the number and value of education and workforce projects across various funding sources). However, neither the new performance measures nor the existing measures have associated performance goals or measurable targets with time frames. Without measurable goals or targets for the performance measures, it remains unclear how Commerce and sponsoring agencies can determine if the Manufacturing USA network is making sufficient progress towards long-term program goals.

We continue to believe that Commerce should work with DOD and DOE to develop and implement network-wide performance goals with measurable targets and time frames. We recognize that Commerce does not have the authority to develop performance requirements for DOD- or DOE-sponsored institutes; however, these three agencies have worked collaboratively to agree upon the Manufacturing USA strategic plan and its program goals, and could build upon that collaboration to develop network-wide performance goals. By not fully implementing our prior recommendation to work with the other sponsoring and supporting agencies to develop performance goals with measurable targets and time frames, Commerce is missing an opportunity to better observe and report

[42]The fiscal year 2019 Manufacturing USA Annual Report did not have network-wide performance goals with measurable targets or timeframes. Commerce stated that, in response to our 2019 recommendations, NIST developed and implemented performance goals and measures for current and future Commerce-sponsored institutes that align with the statutory purposes and strategic goals of Manufacturing USA. NIST piloted these institute-level performance goals and associated measures for its one institute, NIIMBL. NIST has not developed targets or time frames for these institute-level performance goals and measures but said it planned to do so if the number of institutes sponsored by Commerce increases.

on progress made toward achieving the statutory purposes of the Manufacturing USA program.

Institutes Reported Progress toward Achieving Technology Goals

The 14 Manufacturing USA institutes we analyzed reported making progress toward achieving their technology goals.[43] Most institute consortium projects track progress using MRLs or TRLs, and institutes reported increases in those values. Institutes also reported that consortium projects where progress was measured by milestones or deliverables have met some or all of these milestones or deliverables.[44] In addition, institute representatives reported that their institutes have carried out other activities contributing to progress achieving their technology goals. Most institute representatives, however, noted challenges associated with measuring such progress.

Institutes Reported Most of Their Projects Increased Readiness Levels or Achieved Milestones

As of March 2021, the 14 institutes we collected data from via the questionnaire reported a total of 981 ongoing or completed consortium projects since the first Manufacturing USA institute, America Makes, began operations in 2012.[45] Of these projects, 967 were tracked by institutes using TRLs, MRLs, or project-specific milestones and deliverables.[46]

Institute representatives told us they used different methods of measuring project progress because no single method is suitable for evaluating all projects. In particular, MRLs have definitions written in broad language that can be difficult to translate for use in specific fields. Some fields have developed domain-specific language that enables manufacturers to adapt and use MRLs. Institutes may use a combination of methods to evaluate the progress of their projects, using MRLs or TRLs for some projects and milestones or deliverables for others. Institutes may also use a combination of methods for an individual project. Across all institute projects, the progress of 54 percent of projects was measured primarily or only by TRL. The progress of 14 percent of projects was measured

[43]BioMADE and CyManII were established too recently for inclusion in our analysis.

[44]Analyzing project progress is not the only way to measure institute progress toward achieving goals. However, we focused on analyzing project progress for purposes of this report.

[45]Across all institutes, there were 356 ongoing and 625 completed projects.

[46]For the remaining 14 projects, institutes either did not specify a method for measuring progress or indicated that no method was used.

primarily or only by MRL. Institutes used milestones or deliverables as the primary or only measure of progress for 31 percent of projects.[47]

For institutes that used MRLs or TRLs to measure the progress of projects, we found that technology or manufacturing readiness levels for projects increased, according to institute reported data. We found that ongoing and completed consortium projects across the institutes that use these measures had increased the readiness levels of manufacturing technologies or processes, on average, from about 4 to about 6 on either the MRL or TRL scale. This means that, on average, projects have taken manufacturing technologies or processes from a point where they can be produced or demonstrated in a lab to a point where a prototype system or subsystem can be created in a simulated production environment.[48]

Also, for projects where milestones or deliverables were the primary method used to track progress, our analysis of data on completion of milestones or deliverables for those projects showed progress toward their goals.[49] Among such projects, including both ongoing and completed projects, the average of milestones or deliverables met was about 77 percent. For example, one institute stated that a project reached 100 percent completion by successfully creating a retrofit kit for military high-mobility multi-purpose wheeled vehicles that will reduce rollover accidents. Another institute described completion of all deliverables for its cybersecurity for 3D printers project (two guides and a risk assessment report).

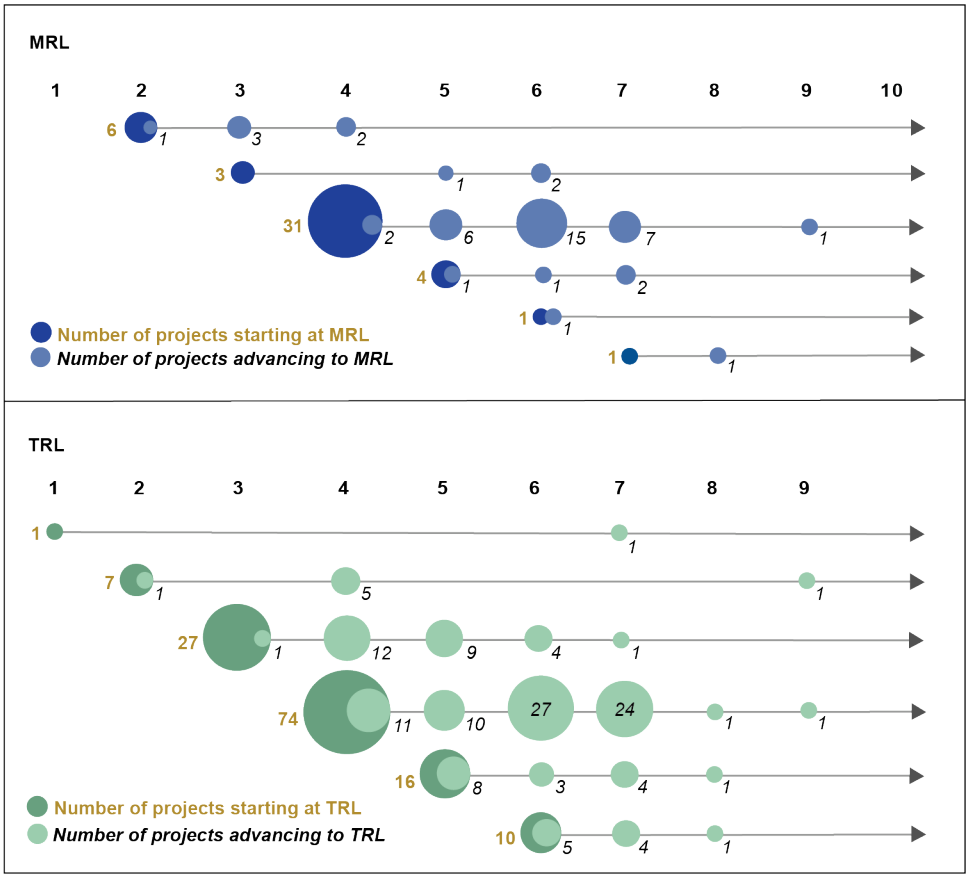
[47]Institutes either did not specify a method for measuring progress or indicated that no method was used for the remaining 1 percent of projects.

[48]For ongoing projects, starting MRLs ranged from 2 to 7, while current MRLs ranged from 2 to 9. For completed projects, starting MRLs ranged from 1 to 7, while final MRLs ranged from 4 to 9. For ongoing projects, starting TRLs ranged from 1 to 6, while current TRLs ranged from 2 to 9. For completed projects, starting TRLs ranged from 1 to 7, while final TRLs ranged from 4 to 9.

[49]In April and May 2021, we received data from nine of the 14 institutes included in this review on the percent of milestones or deliverables completed by projects for which these were the primary measurement method. Three institutes did not provide any data on the percent of milestones or deliverables completed, and two institutes indicated that they did not have any projects for which milestones or deliverables were the primary method of tracking project progress. Of the 301 projects for which institutes specified that they measured progress primarily by milestones or deliverables, the institutes supplied data for 178 projects.

Figures 4 and 5 show the extent of advancement of MRLs and TRLs by ongoing and completed projects as of March 2021 across the 14 institutes we collected data from.

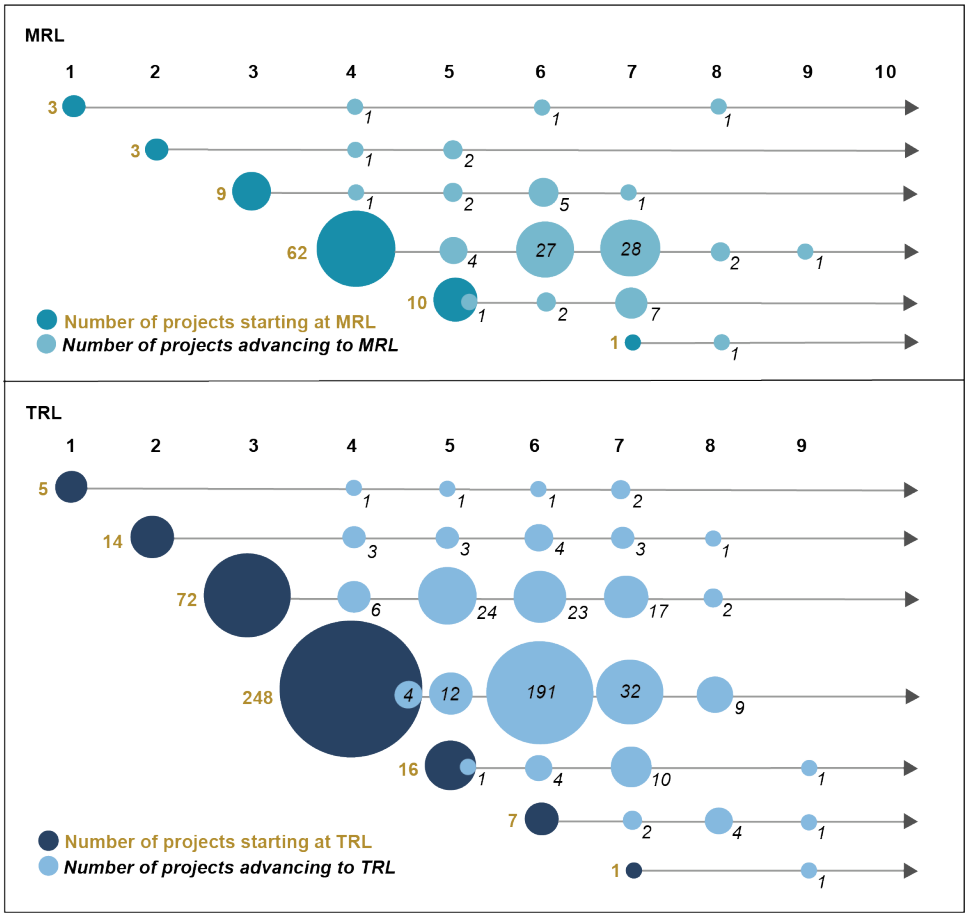
Figure 4: Extent of Advancement of MRL and TRL in Ongoing Projects at Manufacturing USA Institutes, as of March 2021



Source: GAO analysis of data provided by Manufacturing USA institutes. | GAO-22-103979

Note: In figure 4, the darker-colored circle at the left end of each line represents the total number of projects that started at a given Manufacturing Readiness Level (MRL) or Technology Readiness Level (TRL). Each lighter colored circle to the right along the same line represents the number of projects from that group that have advanced to a given MRL or TRL. Projects for which the MRL or TRL remains at the same level as when the project began are represented by a smaller circle within the circle representing the number of projects at a given starting level. Circle size illustrates the number of projects (but is not in direct proportion). For projects measured by TRL, institutes provided starting and current/final TRL data for 498 projects. For 34 projects, institutes did not provide starting and/or current/final TRL data. This figure does not include projects for which institutes did not provide complete data.

Figure 5: Extent of Advancement of MRL and TRL in Completed Projects at Manufacturing USA Institutes, as of March 2021



Source: GAO analysis of data provided by Manufacturing USA institutes. | GAO-22-103979

Note: In figure 5, the darker-colored circle at the left end of each line represents the total number of projects that started at a given Manufacturing Readiness Level (MRL) or Technology Readiness Level (TRL). Each lighter colored circle to the right along the same line represents the number of projects from that group that advanced to a given MRL or TRL. Projects that began and ended at the same MRL or TRL are represented by a smaller circle within the circle representing the number of projects at a given starting level. Circle size illustrates the number of projects (but is not in direct proportion). For projects measured by TRL, institutes provided starting and current/final TRL data for 498 projects. For 34 projects, institutes did not provide starting and/or current/final TRL data. This figure does not include projects for which institutes did not provide complete data.

Institutes Also Reported Other Kinds of Progress toward Meeting Technology Goals

While consortium projects are the main way institutes reported progress toward meeting their technology goals, institute representatives said that other activities also contribute. These activities fall into three categories.

- **Developing and implementing education, training, and workforce recruitment courses, materials, and programs.** One example is a sabbatical program for faculty in academia that is intended to help academic researchers connect with industry stakeholders and identify potential commercial applications for their research. Representatives from another institute told us they had established a program aimed at preparing military members to transition to civilian careers in manufacturing.
- **Developing new technologies, innovative methodologies, and improved practices for integrating and expanding supply chains.** For example, one institute is developing a database that captures site and equipment details related to the pharmaceutical manufacturing supply chain. Representatives from another institute told us that they hosted a series of technology-focused events where members could showcase technologies developed through previous projects. This effort is intended to support the technology ecosystem by allowing members to identify synergies between their efforts and helping teams bid on future projects.
- **Developing or encouraging shared state-of-the-art facilities and infrastructure to reduce the cost and risk of commercializing new technologies and to address relevant manufacturing challenges on a production-level scale.** One example is an institute's 22,000-square-foot facility where members can test and demonstrate technologies. Another institute manages a facility intended to support members with education and resources in the institute's technology focus area.

Institutes Reported Challenges in Measuring Progress toward Meeting Technology Goals

While institute representatives reported making progress toward meeting their technology goals, 10 of the 14 institutes reported challenges with measuring progress in some cases. Of these, three said that they can lack visibility into whether the projects that they lead or sponsor result in the transition of a technology to production, making it difficult to accurately assess the contribution of those projects to the institute's overall technology goals. As discussed earlier, while the Manufacturing USA institutes are designed to focus on technologies with MRL or TRL values of between 4 and 7, technologies transition to a production environment when the MRL reaches a level of 8 or higher. For institutes whose goals include the commercialization of technologies in their focus areas, it can be difficult to evaluate progress toward this goal when members do not inform the institute that a technology has transitioned to production.

Institute representatives also described challenges related to assessing the progress of specific projects. For example, one institute reported that existing methods for evaluating the progress of a project, such as using MRLs or TRLs, may not be well-suited to the target technology. Representatives from this institute commented on efforts to develop a readiness scale tailored specifically to its technology focus area. Institute representatives also told us that industry and government partners may restrict business-proprietary information about certain R&D projects. One institute reported having to rely on published information to measure the progress of some projects, and having to disclose project progress data confidentially.

Smaller Manufacturers Are Engaged and Generally Satisfied with Institutes, but Several Factors May Limit Their Engagement

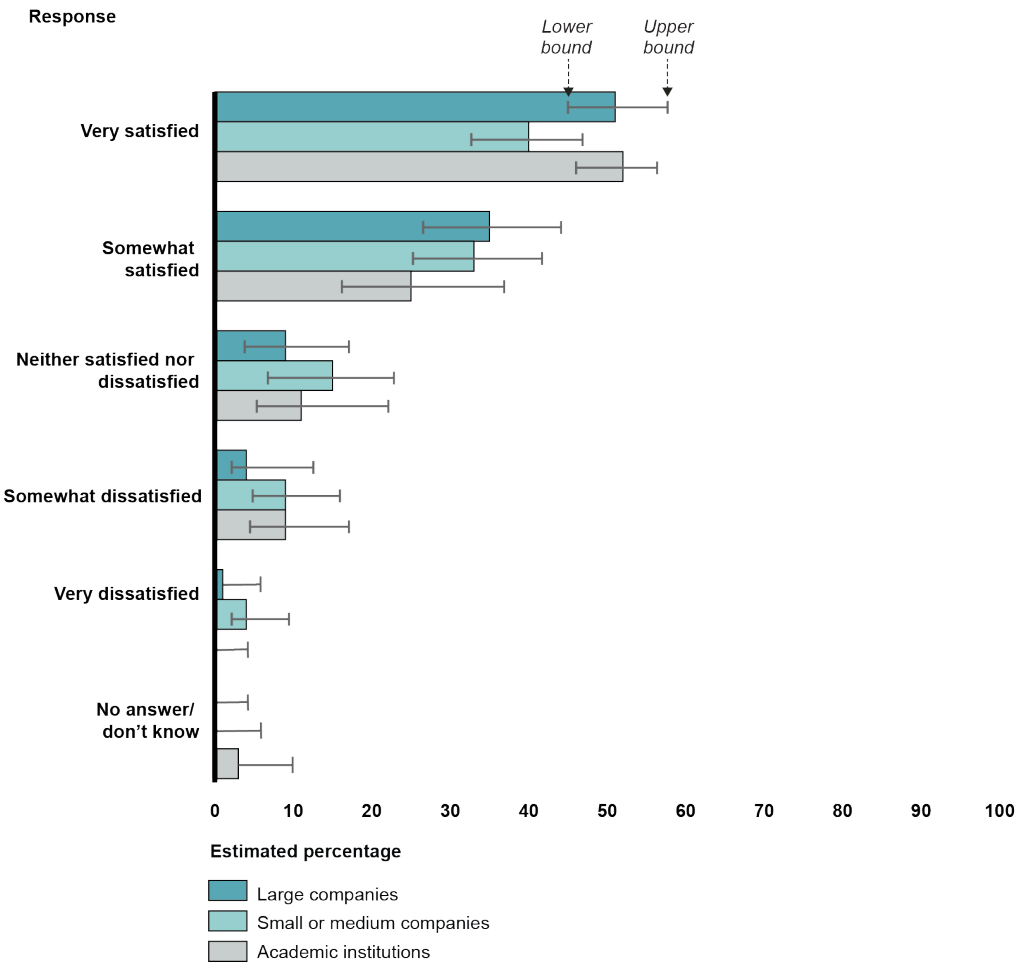
Results from our survey indicate that small and medium-sized manufacturer members are engaged in and satisfied with their institutes at levels similar to those reported by large manufacturers and academic institutions. However, Hollings Manufacturing Extension Partnership (MEP) officials we interviewed said that several factors may limit small and medium-sized manufacturers' engagement with their institutes. We found that Commerce and institutes are addressing some of the factors, but other factors fall outside the scope of the Manufacturing USA program, according to officials.

Small and Medium-Sized Manufacturers Reported Levels of Engagement and Satisfaction Similar to Those of Other Members

According to our survey of institute members, small and medium-sized manufacturers were engaged in and satisfied with various institute activities at levels comparable to those of large manufacturers and academic institutions. Based on survey responses, we estimate that a majority of all members are very or somewhat satisfied with the institutes overall (fig. 6).[50]

[50]The 95 percent confidence interval for the percentage of members who were very or somewhat satisfied with the institutes overall is (62, 81) for small or medium-sized manufacturers, (76, 93) for large manufacturers, and (66, 87) for academic institutions. A 95 percent confidence interval is the range that is 95 percent likely to contain the true percentage.

Figure 6: Estimated Percentages of Manufacturing USA Members' Overall Satisfaction with the Institutes



Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: Range bars display confidence intervals for the estimates at the 95 percent confidence level (the range that is 95 percent likely to contain the true percentage).

Small Company on Overall Satisfaction with an Institute

"The [institute] offers opportunities to network and consult with various industry stakeholders and offers relevant information and data regarding industry requirements, priorities, developments, and opportunities. This is a useful input to my organization's market research and product/services planning, technology road-map and investment decisions."

Source: Institute member survey data. | GAO-22-103979

Small Company on Overall Satisfaction with an Institute

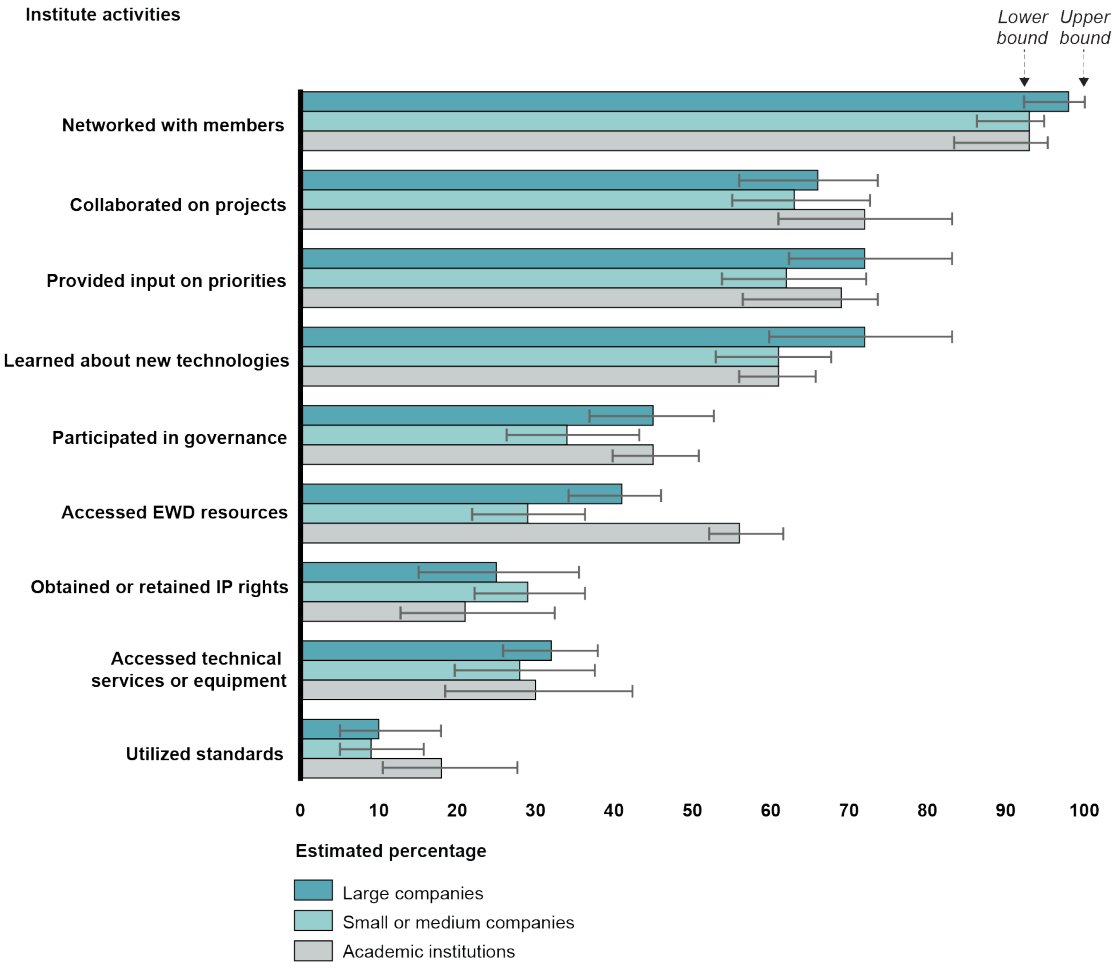
"[The institute] has provided funding and a framework for us to participate in a project with significant potential. Without [the institute], the project would probably not have proceeded."

Source: Institute member survey data. | GAO-22-103979

Based on our survey, many of the members that were satisfied overall cited satisfaction with the network and ecosystem, as well as with technologies and projects developed by the institute. For example, a large company said the institute provides access to a large U.S. network of suppliers and research organizations, and a small company said that access to the institute ecosystem was "invaluable." Additionally, some companies said institute membership has enabled them to develop potential new products or applications.

The three most common institute activities that members engaged in were networking with other members, collaborating on projects, and providing input on institute priorities (fig. 7).

Figure 7: Estimated Percentages of Manufacturing USA Members That Engaged in Institute Activities, 2018-2021

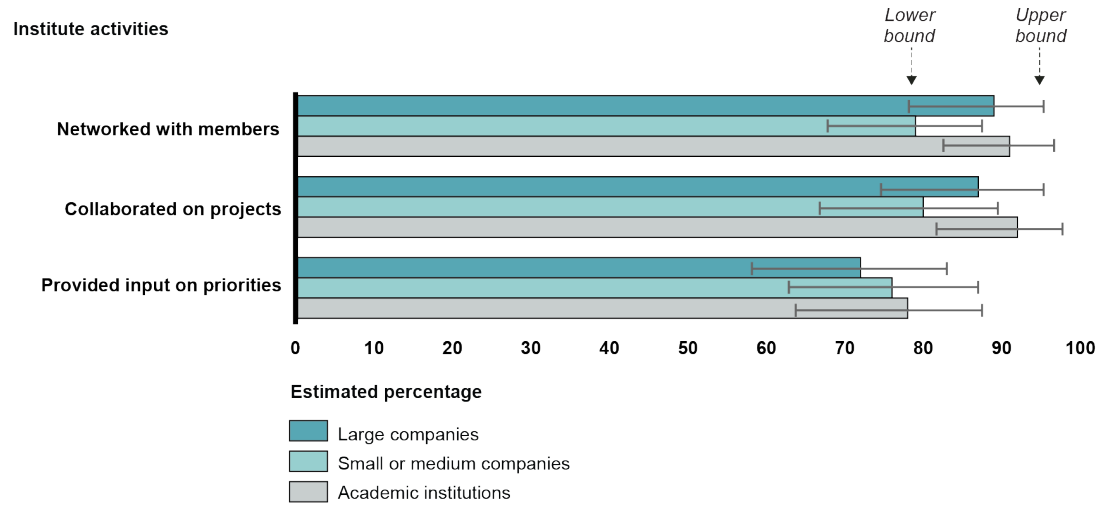


Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: Range bars display confidence intervals for the estimates at the 95 percent confidence level (the range that is 95 percent likely to contain the true percentage). EWD = education and workforce development. IP = intellectual property.

For the three most common institute activities that members reported engaging in, we estimate that small and medium-sized manufacturers reported similar levels of satisfaction as large manufacturers and academic institutions (fig. 8).

Figure 8: Estimated Percentages of Manufacturing USA Members That Were Very or Somewhat Satisfied with the Three Most Common Institute Activities



Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: Range bars display confidence intervals for the estimates at the 95 percent confidence level (the range that is 95 percent likely to contain the true percentage).

Small Company on Overall Dissatisfaction with an Institute

"The institute struggles to find a path to move relevant technologies and more important real world applications forward..."

Source: Institute member survey data. | GAO-22-103979

However, our survey results show that some members are generally dissatisfied with the institutes overall. Specifically, we estimate that 12 percent of small or medium-sized manufacturers, 5 percent of large manufacturers, and 9 percent of academic institutions are somewhat or very dissatisfied with the institutes overall.[51] Among those that were dissatisfied, respondents cited concerns such as a lack of progress in institute projects and cost of membership. One company member said that its institute is too focused on "basic/academic" research.

Several Factors May Limit Smaller Manufacturer Engagement with Institutes

According to interviews with officials from selected MEP centers, several factors may limit engagement of small and medium-sized manufacturers with institutes. Commerce and institutes have taken steps to address some of these factors, but others fall outside the scope of the Manufacturing USA program, according to officials.

- **Lack of awareness or understanding of new technology.** Small and medium-sized manufacturers may not be aware of or understand how

[51]The 95 percent confidence interval for the percentage of members who were very or somewhat dissatisfied with the institutes overall is (6, 21) for small or medium-sized manufacturers, (1, 13) for large manufacturers, and (3, 18) for academic institutions.

advanced manufacturing technologies could improve their business or affect their industries. For example, officials from one MEP center said that smaller manufacturers in their state that work on building submarines could fall behind competitively in the future if they do not adopt additive manufacturing technology. However, according to some MEP officials, institutes may be too technical or academic for some small and medium-sized manufacturers to understand how they could engage or benefit from using advanced manufacturing technologies available at the institutes.

Steps taken: NIST MEP and AMNPO collaborated on a pilot program from 2016 to 2020 to embed MEP center staff at institutes, as discussed earlier in this report. MEP officials said the pilot helped institutes better address small and medium-sized manufacturers' needs in various ways, including raising awareness and providing technology demonstrations. However, some MEP officials said the timing of the pilot program may have been too early because institutes were still standing up their operations and were not yet ready to fully engage with small and medium-sized manufacturers. The RAMI Act, as amended, included expanded language that AMNPO is to leverage the capabilities of the MEP program and ensure institute engagement with small and medium-sized manufacturers.[52] In addition, NIST MEP has made awards to support technology transfer from institutes to small and medium-sized manufacturers. For example, the MEP Advanced Technology Team project is a collaboration between the Tennessee, New York, and Washington MEP centers to create a framework and processes to facilitate technology transfer to small and medium-sized manufacturers from Manufacturing USA institutes, as well as national labs, universities, and other research centers. NIST MEP officials said the project seeks to generate standard operating procedures that could be shared with other MEP centers; the project is in its early stages and is expected to conclude in August 2022.

- **Workforce needed to implement technology.** For smaller manufacturers to implement advanced manufacturing technologies, they

[52]The RAMI Act amendments also authorized AMNPO to provide financial support to MEP centers to ensure that the program results reach small and medium-sized manufacturers. According to a senior Commerce official, the RAMI Act amendments authorized, but did not require, AMNPO to provide such financial support. As of September 2021, Congress has not provided appropriations supporting these activities. 15 U.S.C. §§ 278s (h)(5)(A)(i) and (h)(5)(B).

need trained workers. However, it can be difficult for smaller manufacturers to find and retain a qualified workforce that can operate and integrate new technology into manufacturing operations. For example, officials from one MEP center said a small manufacturer had purchased a robotics unit, but the equipment was unused because the company lacked staff trained on the technology.

Steps taken: All institutes have education and workforce development activities, such as developing curricula for training programs, supporting internships and apprenticeships, and collaborating on programs to train military veterans. Additionally, the Manufacturing USA Education and Workforce Development Working Group, which includes participation of NIST MEP officials, coordinates on initiatives across multiple institutes and agencies. For example, the group developed and piloted a set of network-wide performance measures to report on education and workforce development activities at institutes.

- **Cost of membership.** MEP officials said the cost of institute membership can be prohibitive for small and medium-sized manufacturers that are focused on having adequate funds to pay their workers. It may be difficult for these smaller companies to see the value of membership without an immediate or clear return on investment.

  Steps taken: Some institute officials said they have structured their membership fees so that small and medium-sized manufacturers can afford to participate in institutes. For example, some institutes have created "observer" membership tiers, and others have fees based on company size or revenue. MEP officials said they worked with institutes during the NIST MEP and AMNPO pilot program to help refine membership tiers that are more accessible to smaller manufacturers.

Other factors that may limit small and medium-sized manufacturer engagement with institutes fall outside the scope of the Manufacturing USA program, according to officials.

- **Technologies not ready for commercialization.** According to MEP officials, small and medium-sized manufacturers generally need "off-the-shelf" technologies that can be readily adopted to address the problems they face today. However, institutes generally focus on technology development in the range of TRL or MRL 4 to 7, before the technologies are ready for commercialization. MEP officials said it could be difficult for smaller manufacturers to engage with institutes on early stage research.

- **Lack of capital to invest in new technologies.** MEP officials said implementing advanced manufacturing technologies can require significant capital investment, which small and medium-sized manufacturers may lack. For example, officials from one MEP center said it could cost $100,000 or more to install, integrate, and configure a single robotic arm. In another example, MEP officials said implementing cybersecurity solutions could cost $20,000 to $40,000. According to DOD officials, it is not part of the institutes' mission to provide capital investments to small companies.

Sponsoring Agencies Have Differing Plans for Existing and Future Institutes

The agencies sponsoring Manufacturing USA institutes are taking different approaches to their sponsorship of existing institutes and their plans for future institutes. Commerce, for example, used new authority under the amended RAMI Act to develop an institute renewal process. DOD updated its institute strategy and its evaluation process for making decisions about whether to renew financial assistance for its institutes. DOE has not decided if it will renew agreements with existing institutes.

Commerce Used New RAMI Act Authority to Develop an Institute Renewal Process

Commerce officials told us they operate NIIMBL under the authority of the RAMI Act, as amended, and have implemented the amendments as applicable to NIIMBL. For example, they used amended RAMI Act authority to renew financial assistance to NIIMBL. Commerce officials said they used this authority to develop an institute renewal process outlined in a July 2021 report that identified performance standards for its sponsored institutes. (As of September 2021, Commerce's only institute is NIIMBL.)

Under its renewal process, an external panel assesses the extent to which NIIMBL activities are making progress to accomplish the statutory purposes of the Manufacturing USA program.[53] This panel's input helps inform agency decisions about renewing financial assistance. NIST officials said the agency used the process to help make its decision to provide financial assistance for a second performance period of 5 years for NIIMBL.

[53]According to a Commerce document, the evaluation panel is made up of stakeholders from across the innovation ecosystem for biopharmaceutical manufacturing, including large and small to medium-size companies, academia, and federal agencies not directly involved with NIIMBL oversight or operations. Department of Commerce, National Institute of Standards and Technology, *Manufacturing USA Institute Evaluation: Renewal Process and Performance Standards*, NIST AMS 600-8 (July 2021).

Commerce's new process is based on the RAMI Act amendment that authorizes agencies to renew financial assistance to institutes for additional periods, subject to a rigorous merit review[54] that involves developing metrics and performance standards to assess an institute's progress in addressing the purposes of the program.[55] Prior to the amendments to the RAMI Act, once an award's initial 7-year period expired, agencies could not provide additional financial assistance or renew their awards.

Commerce officials reported that any future sponsored institutes would also operate under the authority of the RAMI Act, as amended. As of September 2021, Commerce officials said they do not have appropriations for additional institutes. However, in Commerce's FY2022 budget request, it asked for an increase of about $150 million from the FY2021 enacted funding level to establish two additional Manufacturing USA institutes. In addition, although the FY2021 NDAA included a provision that NIST may establish a Manufacturing USA institute focused on semiconductor manufacturing, Commerce officials said that appropriations have not been authorized for such an institute.[56]

DOD Updated Its Strategy and Evaluation Process for Renewing Institute Agreements

DOD officials said they have modified their strategic approach to managing and evaluating institutes as they have seen the continued need to invest in the institutes to help ensure their effectiveness in advancing DOD and national manufacturing objectives. DOD's modified strategy focuses more on growing the value of strategic partnerships through increasing awareness of the institutes across DOD and the nation. Specifically, this would support integration with the military services to facilitate the transition of advanced manufacturing capabilities into the field. This stronger integration would also help DOD continue to engage with its institutes after the stand-up phase, which DOD characterized as the 5-to-7 year initial financial assistance period.

DOD's planned approach includes targeting institute investments to advance DOD modernization priorities, supporting interagency initiatives, addressing national manufacturing ecosystem needs, and maintaining active contracts with institutes to have some involvement in decision-

[54]15 U.S.C. § 278s (e)(2)(B).

[55]15 U.S.C. § 278s (e)(5).

[56]William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, Pub. L. No. 116-283, div. H, title XCIX, § 9906(f), 134 Stat. 3388, 4859, (2021).

making. Further, DOD officials said they have worked with its institutes to create a communications and outreach strategy to help communicate, define, and describe responsibilities for DOD and its institutes, and will use findings from a recent National Academy of Sciences study to improve institute engagement.[57] In addition, DOD officials said they are working with institutes to define and implement a more self-sustaining financial model in which financial assistance levels in the sustaining phase are anticipated to be lower than in the stand-up phase.

DOD officials said a significant modification to DOD's approach is the addition of formal institute evaluations by a DOD senior-level panel separate from DOD's Manufacturing Technology program. The panel is called the Joint Defense Manufacturing Council (JDMC). This updated evaluation process came in response to amendments to the Manufacturing Technology program authority, included in the FY2020 NDAA, which amended the authority DOD used to establish its institutes.[58] The Manufacturing Technology amendments call for DOD to perform comprehensive program management evaluations to determine the DOD's long-term strategy for its institutes.[59]

According to DOD officials, starting in FY2021, each DOD institute will be evaluated by the JDMC panel every 5 years.[60] DOD officials said they plan to complete their first two institute reviews (Advanced Functional

[57]National Academies of Sciences, Engineering, and Medicine 2021. *DoD Engagement with Its Manufacturing Innovation Institutes: Phase 2 Study Interim Report* (Washington, D.C.: June 2021). This prepublication interim report includes strategic guidance on protocols for conducting long-term engagement assessments of DOD-sponsored institutes, and development of strategies for better connecting institutes to the broader DOD community.

[58]The authority for establishing DOD-sponsored institutes is 10 U.S.C. § 2521 (effective Jan. 1, 2022, this section will be renumbered 10 U.S.C. § 4841, pursuant to NDAA FY2021, Pub. L. No. 116-283, div. A, title XVIII, §§ 1801(d), 1869(b)(1), 134 Stat. 3388, 4151, 4284, (2021)). DOD's initial authority and funding were under the Industrial Preparedness Manufacturing Technology Program in the National Defense Authorization Act for Fiscal Year 1994, Pub. L. No. 103-160, div. A, title VIII, § 801(a), 107 Stat. 1547, 1700 (1993).

[59]National Defense Authorization Act for Fiscal Year 2020, Pub. L. No. 116-92, § 227(a), 133 Stat. 1270 (2019).

[60]According to DOD officials, the JDMC evaluation includes assessing the relevance of the institute technical area to DOD and the nation, the effectiveness of the institute and its management, and the importance and effectiveness of the institute in meeting the needs of members.

Fabrics of America Institute, or AFFOA, and BioFabUSA) using this new process in 2021 and complete evaluations for two institutes each year thereafter. DOD officials said that they plan to establish follow-on agreements with its institutes, contingent on the results of these assessments.

DOD officials said participation in the Manufacturing USA program is a collaborative partnership of choice in light of a common purpose and that they interpreted the FY2020 NDAA as maintaining DOD's separate and distinct authority to operate its institutes. DOD has not substantively changed its future institute plans. As of September 2021, DOD officials said they do not have plans for additional DOD-sponsored institutes and that future institutes would be subject to appropriations.

DOE Has Not Decided If It Will Renew Agreements with Existing Institutes

DOE officials said that the agency has not yet made decisions regarding its plans for potential renewals of its existing institutes. DOE officials said they do not have appropriations to provide financial assistance to institutes beyond the initial agreement periods.[61] However, DOE officials said the technology areas of its institutes will continue to be important priorities for DOE beyond their initial performance periods. For example, DOE officials said an institute could compete for DOE project funding after their initial agreement ends.

DOE officials said the agency is still considering whether any potential renewals of current institutes, depending on the basis of future appropriations, would be established under the authority of the RAMI Act, as amended, or DOE's original authority under the Energy Policy Act of 2005. Officials said these multiple statutory provisions made potential authority "somewhat ambiguous" to them. The officials also said that higher nonfederal cost-share requirements under the RAMI Act as compared with cost-share requirements under DOE's original authority could be a factor if DOE were to decide to not use the RAMI Act authority to renew agreements with its existing institutes. Under the RAMI Act, as amended, institutes must contribute at least 50 percent cost share.[62] In contrast, under the Energy Policy Act of 2005, an institute must contribute

[61]Neither the President's FY2022 budget request, nor DOE's FY2022 budget request justification, includes renewal financial assistance for any of DOE's existing institutes.

[62]15 U.S.C. § 278s(e)(7)(A).

at least 20 percent cost share.[63] According to DOE officials, nonfederal institute sponsors may be unwilling to renew agreements with DOE if required to meet the higher cost share requirements under the RAMI Act.[64] However, representatives from one DOE-sponsored institute said they did not anticipate the higher cost share requirement under the RAMI Act would hinder their institute's willingness to renew its agreement. Other than the cost sharing obligation, DOE officials told us that DOE institutes largely align with the RAMI Act amendments.

DOE is planning a new institute focused on reducing domestic manufacturing emissions. On July 27, 2021, DOE announced a request for information to inform the creation of a new Clean Energy Manufacturing Institute focused on technological advances for widespread industrial decarbonization, with the goal of achieving a carbon-neutral economy by 2050. In addition, DOE's Chief Financial Officer's FY2022 Congressional Budget Request includes a request for appropriations to support two additional institutes. As of September 2021, DOE has not yet published a funding opportunity announcement for any additional institutes. DOE officials said their intent was that any new institutes, if appropriations were available, would likely be funded under the RAMI Act, as amended, provided that they made a determination in the future that it was more appropriate than their authority under the Energy Policy Act of 2005.

Agency Comments, Third-Party Views, and Our Evaluation

We provided a draft of this report to Commerce, DOD, and DOE for review and comment. A DOD official stated via email that DOD had no comments on the report.

We received written comments from Commerce that are reproduced in appendix V. Commerce's comments were generally focused on our evaluation of the extent of its implementation of two recommendations related to measuring network-wide performance included in our May 2019 report. Commerce stated that NIST will work with its partner agencies to

[63]Energy Policy Act of 2005, Pub. L. No. 109-58, § 911, and § 988, 119 Stat. 594 (2005) (authority codified at 42 U.S.C. § 16191(a)(2)(C)), and 42 U.S.C. § 16352(b)(1) (cost share provision).

[64]DOE's newest institute, CyManII, was established under the authority of the Energy Policy Act of 2005, soon after the RAMI Act was amended, and will continue to operate with the 20 percent cost sharing requirement set forth in the terms and conditions for the financial assistance agreement that was entered into prior to the amendments to the RAMI Act. DOE's other five institutes were established with institute cost-share requirements greater than 50 percent.

develop and implement network-wide performance goals for the Manufacturing USA program; and will work with its partners to align network-wide performance measures with the network-wide performance goals, the Manufacturing USA strategic objectives and program goals, and the statutory purposes of the RAMI Act. Commerce also stated that NIST will work with agencies that are sponsoring or supporting a Manufacturing USA institute to develop and implement network-wide performance goals with measurable targets and time frames.

Commerce noted some potential challenges to these efforts—specifically related to setting targets or time frames or aligning goals and measures for institutes that are not sponsored by Commerce. As discussed in our May 2019 report and reiterated in this report, we recognize that Commerce does not have management authority over the other agencies' programs or the institutes they sponsor. Our prior recommendations were intended to better enable a data-driven understanding of the collective effect of the Manufacturing USA institutes. Our recommendations did not call for alignment in how each agency manages and oversees the institutes it sponsors.

In its agency comment letter, Commerce also discussed an enclosure containing comments that it said reflected views of Commerce, DOD, and DOE concerning an earlier version of our report. Because these comments were not focused on the final draft of the report that we sent the agencies for formal comment, and because DOD and DOE did not also provide these comments to us separately, this enclosure is not reproduced in appendix V.

In an email from a DOE official with the Office of the Chief Financial Officer, DOE provided a comment of a more general nature. Specifically, DOE expressed the view that the draft report was equating TRLs with MRLs. DOE stated that, while the readiness concepts have similarities, TRLs and MRLs are distinct and should not be referred to interchangeably. We agree that TRLs and MRLs are distinct and did not intend for our report to be understood as using these terms interchangeably. Accordingly, we made several adjustments to our final report to further emphasize that these measures are distinct.

In addition, Commerce and DOE provided technical comments, which we incorporated as appropriate.

We also offered an opportunity to review a draft of this report to representatives of the Manufacturing USA institutes from which we

collected information. Representatives of 12 of the 16 institutes asked to receive a copy of the draft report. Of the 12 institutes:

- One institute's representatives provided a technical comment, which we incorporated as appropriate.
- Four institutes' representatives stated via email that they had no comments on the report.
- Seven institutes' representatives did not provide comments.

We are sending copies of this report to the appropriate congressional committees; the Secretaries of Commerce, Defense, and Energy; 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 have any questions about this report, please contact me at (202) 512-6888 or wrightc@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 VI.

Candice N. Wright
Director, Science, Technology Assessment, and Analytics

List of Committees

The Honorable Maria Cantwell
Chair
The Honorable Roger Wicker
Ranking Member
Committee on Commerce, Science, and Transportation
United States Senate

The Honorable Jeanne Shaheen
Chair
The Honorable Jerry Moran
Ranking Member
Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
United States Senate

The Honorable Jon Tester
Chair
The Honorable Richard Shelby
Ranking Member
Subcommittee on Defense
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United States Senate

The Honorable Dianne Feinstein
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The Honorable John Kennedy
Ranking Member
Subcommittee on Energy and Water Development
Committee on Appropriations
United States Senate

The Honorable Eddie Bernice Johnson
Chairwoman
The Honorable Frank Lucas
Ranking Member
Committee on Science, Space, and Technology
House of Representatives

The Honorable Matt Cartwright
Chairman
The Honorable Robert B. Aderholt
Ranking Member
Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
House of Representatives

The Honorable Betty McCollum
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The Honorable Ken Calvert
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Subcommittee on Defense
Committee on Appropriations
House of Representatives

The Honorable Marcy Kaptur
Chairwoman
The Honorable Mike Simpson
Ranking Member
Subcommittee on Energy and Water Development, and Related Agencies
Committee on Appropriations
House of Representatives

Appendix I: Objectives, Scope, and Methodology

Our objectives for this report were to examine (1) the extent to which the Manufacturing USA program addresses the goals of the national strategic plan for advanced manufacturing; (2) the extent to which agencies have addressed prior GAO recommendations; (3) the progress that institutes have reported toward achieving their technology goals; (4) how small and medium-sized institute members have engaged with Manufacturing USA institutes, and steps that sponsoring agencies and institutes have taken to ensure these members can leverage the work of the institutes; and (5) the sponsoring agencies' plans for institutes.

For objective 1, we analyzed the goals, objectives, and program priorities of the 2018 national strategic plan for advanced manufacturing in relation to the 2019 and 2016 Manufacturing USA strategic plans.[1] We also administered a three-part questionnaire to 14 of the Manufacturing USA institutes in operation. We did not administer the questionnaire to the two newest institutes, Bioindustrial Manufacturing and Design Ecosystem (BioMADE) and Cybersecurity Manufacturing Innovation Institute (CyManII), because they were established during the course of our review. The third part of the questionnaire collected information on institute activities that support national strategic plan goals and objectives. In addition, we interviewed sponsoring agency officials about the extent to which the institutes they sponsor support the goals and objectives in the national strategic plan.

For objective 2, we reviewed documents and interviewed agency officials on steps taken to address prior recommendations from our April 2017 and May 2019 reports on the Manufacturing USA program.[2]

For objective 3, we administered a three-part questionnaire to 14 of the Manufacturing USA institutes in operation as of November 2019, as

[1]The 2016 Manufacturing USA strategic plan contained 10 objectives that were not included in the 2019 update. According to NIST officials, while not in the 2019 Manufacturing USA strategic plan, the objectives included in the 2016 Manufacturing USA strategic plan are still in effect. For purposes of our analysis, we reviewed both the 2016 and 2019 Manufacturing USA strategic plans.

[2]GAO, *Advanced Manufacturing: Commerce Could Strengthen Collaboration with Other Agencies on Innovation Institutes,* GAO-17-320 (Washington, D.C.: Apr. 6, 2017) and GAO, *Advanced Manufacturing: Innovation Institutes Have Demonstrated Initial Accomplishments, but Challenges Remain in Measuring Performance and Ensuring Sustainability,* GAO-19-409 (Washington, D.C.: May 23, 2019).

mentioned above.[3] The first two parts of the questionnaire collected information related to institute technology goals and data on project status and progress. Specifically, we collected data on how the institute measured project progress (such as manufacturing readiness levels and technology readiness levels), project duration, and focus area for all ongoing and completed projects since the institute began operating. For the purposes of our analysis, we defined projects as those supported by an institute and involving at least one member organization (e.g., a company), and which generally require a cost share between the institute and the project team. We did not collect data from institutes on projects that were solely supported by nonfederal funding sources. We conducted pretests of the questionnaire with three institutes, selected to achieve variation in sponsoring agency: the Departments of Commerce, Defense (DOD), and Energy (DOE). The pretests of the questionnaire were conducted to ensure that questions were clear and to obtain any suggestions for clarification. We also requested and received follow-up responses and technical clarifications on institute questionnaire responses, and incorporated them as appropriate. We assessed the reliability of project data provided by the institutes by checking for missing data or errors; we found the data to be sufficiently reliable for the purposes of our analysis.

For objective 4, we administered a web-based survey to a statistically representative sample of Manufacturing USA institute members. In the survey, we asked members about their overall satisfaction with the institutes; engagement and satisfaction with specific institute activities; and views on the effectiveness of the institutes. We administered the survey from January 2021 to April 2021, and collected information for the 3-year period prior to survey administration, 2018 to 2021. Appendix IV contains information on the survey results.

To identify the universe of institute members, we obtained data on membership rosters from the same 14 Manufacturing USA institutes. For the purposes of our survey, we collected information on all members that had a signed institute membership agreement as of March 31, 2020. We

[3]In April and May 2021, we received data from nine of the 14 institutes included in this review on the percentage of milestones or deliverables completed by projects for which these were the primary measurement method. Three institutes did not provide any data on the percentage of milestones or deliverables completed, and two institutes indicated that they did not have any projects by which milestones or deliverables were the primary method of tracking project progress. Of the 301 projects for which institutes specified that they measured progress primarily by milestones or deliverables, the institutes supplied data for 178 projects.

did not include pending members, members that joined after March 31, 2020, or organizations whose membership agreements expired prior to March 31, 2020 and were not renewed. We manually reviewed the institute member rosters for errors and inconsistencies, and followed up with institutes to verify information as needed. After addressing these items, we found the data to be sufficiently reliable for the purposes of our analysis. We also reviewed the membership rosters to identify multi-institute members, or organizations that had a current membership with more than one institute.

Our initial population contained 1,611 member organizations as of March 31, 2020. We stratified the population into three sampling strata and used a stratified random sample: (1) large companies, 500 or more employees; (2) small or medium companies, fewer than 500 employees; and (3) academic institutions, colleges, or universities. Other organizations, such as nonprofits or state and local governments, were not included in the survey population. For multi-institute members, we structured our sample such that an organization could only be selected once based on its membership with a particular institute, and then would not be able to be selected for the sample again. This ensured that no one organization's views were overrepresented in the analysis.

Our initial sample size allocation was designed to achieve a stratum-level margin of error no greater than plus or minus 10 percentage points for an attribute-level measure at the 95 percent level of confidence. Based upon prior surveys of nonfederal entities, and to adjust for expected nonresponse given the COVID-19 pandemic, we assumed a response rate of 50 percent to determine the sample size for the strata. During the administration of our survey, we identified seven organizations that were out of scope for various reasons, including companies that were out of

business or acquired by another company. This reduced our sample size to 615. We obtained a weighted survey response rate of 38.9 percent.[4]

Because we followed a probability procedure based on random selections, our sample is only one of a large number of samples that we might have drawn. Since each sample could have provided different estimates, we express our confidence in the precision of our particular sample's results as a 95 percent confidence interval (for example, plus or minus 7 percentage points). This is the interval that would contain the actual population value for 95 percent of the samples we could have drawn. Confidence intervals are provided along with each sample estimate in the report. All survey results presented in the body of this report are generalizable to the estimated population of in-scope institute members, except where otherwise noted.

The practical difficulties of conducting any survey may introduce errors, commonly referred to as nonsampling errors. For example, difficulties in interpreting a particular question or sources of information available to respondents can introduce unwanted variability into the survey results. We took steps in developing the questionnaire, collecting the data, and analyzing the results to minimize such nonsampling error. To inform our methodology approach and our survey development, we conducted interviews with representatives from 13 of the 14 Manufacturing USA institutes described above.[5] From these interviews, we gathered information on the specific activities that organizations may engage in as part of their membership with institutes. Additionally, we conducted pretests of the survey with five institute members. We selected these members to achieve variation in member type (large company, small or medium company, academic institution) and institute. The pretests of the

[4]To encourage survey participation, we conducted pre-administration notification and followed up with members. Before administering the survey, we obtained contact information (e-mail addresses and phone numbers) for the sample of members from eight of the institutes; six of the institutes did not provide us with contact information, due to privacy concerns, and instead administered the survey on GAO's behalf. Notification e-mails were sent to the sampled members, by GAO and institutes. For those whose e-mails were undeliverable, we followed up with institutes to correct the e-mail addresses and confirm the points of contact. Institute leaders also encouraged survey participation by sending pre-administration e-mails to their members. During survey administration, we called sampled members that had not completed the survey (non-respondents) to encourage them to complete the survey and answer any questions or concerns they had. Emails were also sent, by GAO and institutes, with reminders and instructions for the taking the web-based survey.

[5]Representatives from one institute were unavailable for our survey development interview due to COVID-19 pandemic response work.

survey were conducted to ensure that survey questions were clear, to obtain any suggestions for clarification, and to determine whether members would be able to provide responses to questions with minimal burden. We also provided the 14 institutes and the three sponsoring agencies with the draft survey instrument for review, and we incorporated their comments accordingly.

In addition, for objective 4, we interviewed officials from a nongeneralizable sample of NIST Hollings Manufacturing Extension Partnership (MEP) centers. In the semi-structured interviews, we asked officials about their views on the Manufacturing USA program, including their experiences collaborating with institutes as well as institute engagement with small and medium-sized manufacturers. We judgmentally selected 13 MEP centers based on four criteria: geographic diversity; MEP center size, based on the number of manufacturers in the MEP center's respective market; institute affiliation, including MEP centers with and without known affiliations to institutes; and participation in the MEP-Manufacturing USA pilot program as the lead awardee, including MEP centers that did and did not participate in the pilot program. Although the results of these interviews are not representative of all MEP centers, they provide valuable insights on MEP centers' experiences with a range of Manufacturing USA institutes.

For objective 5, we reviewed agency documents and interviewed agency officials about institute strategies, including evaluations of institute performance, and any plans for additional institutes. We also reviewed relevant laws, legislative history, and documents related to the FY2020 National Defense Authorization Act changes to the Revitalize American Manufacturing and Innovation Act of 2014, DOD's Manufacturing Technology program, and DOE's authority under the Energy Policy Act of 2005.

We conducted this performance audit from November 2019 to December 2021 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.

Appendix II: Manufacturing USA Institute Technology Focus Areas and Key Goals

Table 5 provides an overview of the technology focus areas, and the key manufacturing technology-related goals, of the 16 Manufacturing USA institutes as of September 2021.

Table 5: Manufacturing USA Institute Technology Focus Areas and Key Goals as of September 2021

Institute	Technology focus area	Key technology goal(s)
Advanced Functional Fabrics of America (AFFOA)	Sophisticated, integrated and networked fibers, yarns, and fabric manufacturing	Advance the ability to manufacture functional fiber and fabric technology, enabling revolutionary system capabilities for national security and commercial markets such as body-worn sensing and communications products.
American Institute for Manufacturing Integrated Photonics (AIM Photonics)	Integrated photonics manufacturing	Advance U.S. leadership in photonic integration manufacturing technology by creating an unprecedented capability, and catalyze synergistic cooperation in market-driven investments to both enrich and mature the manufacturing ecosystem.
National Additive Manufacturing Innovation Institute (America Makes)	Additive manufacturing	Drive technological advancements that improve additive manufacturing machines, enable step change improvements in the end-to-end value chain for additive manufacturing-produced products, and accelerate technological advancements in materials for additive manufacturing.
Advanced Robotics for Manufacturing (ARM)	Transformative robotic technologies and education for manufacturing	Lower the barriers to the adoption and expansion of robotics for manufacturing.
Advanced Regenerative Manufacturing Institute (BioFabUSA)	Engineered tissues and tissue-related manufacturing	Enable scalable, consistent, and cost-effective manufacturing of human cells and tissue engineered medical products (TEMPs) for the warfighter and the nation to provide access to sufficient numbers of safe, efficacious, and affordable cell and TEMP technologies.
Bioindustrial Manufacturing and Design Ecosystem (BioMADE)	Bioindustrial manufacturing	Enable domestic bioindustrial manufacturing at all scales, develop technologies to enhance U.S. bioindustrial competitiveness, de-risk investment in relevant infrastructure, and expand the biomanufacturing workforce to realize the economic promise of industrial biotechnology.
Clean Energy Smart Manufacturing Innovation Institute (CESMII)	Smart manufacturing	Develop and demonstrate smart manufacturing technologies that include sensing, control, analytics, and modeling, as well as platform technologies that move information from the devices and sensors that generate data to the applications that consume it.
Cybersecurity Manufacturing Innovation Institute (CyManII)	Cybersecurity for manufacturing	Research, develop, and implement manufacturing cybersecurity that enables energy-efficient manufacturing and secures manufacturing operations and supply chains.
Institute for Advanced Composites Manufacturing Innovation (IACMI)	Fiber-reinforced polymer composites manufacturing	Reduce production costs of carbon fiber composites by 25 percent in 5 years, on the path to over 50 percent in 10 years. Demonstrate production of fiber-reinforced polymer composites with performance and cost parity to today's glass fiber reinforced polymer in 5 years. Demonstrate technologies that reduce production-related energy use and greenhouse gas emissions of carbon fiber by 50 percent, on the path to 75 percent in 10 years. Demonstrate technologies for >80 percent recyclability or reusability of fiber-reinforced polymer composites in 5 years, on the path to >95 percent in 10 years.

Institute	Technology focus area	Key technology goal(s)
Lightweight Innovations for Tomorrow (LIFT)	Lightweight materials manufacturing	Integrate computational materials and computational engineering, agile and smarter manufacturing, advanced alloy and process development, and multi-material joining.
The Digital and Cyber Manufacturing Institute (MxD)	Digital manufacturing and design/cybersecurity in manufacturing	Equip U.S. manufacturers with the digital manufacturing tools, technologies, cybersecurity, and expertise they need to begin building every part better than the previous part.
America's Flexible Hybrid Electronics Manufacturing Institute (NextFlex)	Thin flexible electronics devices and sensors manufacturing	Enhance, improve, and drive the manufacturing maturity of flexible hybrid electronics across the United States.
National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL)	Biopharmaceutical manufacturing	Accelerate biopharmaceutical innovation, support the development of standards that enable more efficient and rapid manufacturing capabilities, and educate and train a world-leading biopharmaceutical manufacturing workforce, fundamentally advancing U.S. competitiveness in this industry.
Next Generation Power Electronics Manufacturing Innovation Institute (PowerAmerica)	Wide bandgap power electronics manufacturing	Accelerate the commercialization of wide bandgap power semiconductor technology.
Rapid Advancement in Process Intensification Deployment Institute (RAPID)	Modular chemical process intensification for manufacturing	Build and educate a technical community around the concepts of modular chemical process intensification.
Reducing Embodied Energy and Decreasing Emissions Institute (REMADE)	Sustainable manufacturing with clean energy and carbon-emission reduction	Conduct R&D that will enable increased remanufacturing and materials recycling across the domestic manufacturing supply chain.

Source: GAO analysis of the November 2020 Manufacturing USA program annual report and institute responses to GAO's questionnaire. | GAO-22-103979

Appendix III: Comparison of the Manufacturing USA Strategic Plan to the National Strategic Plan for Advanced Manufacturing

Table 6 summarizes our analysis of the alignment between the Manufacturing USA strategic plan and the national strategic plan for advanced manufacturing.

Table 6: Alignment of the Manufacturing USA and National Strategic Plans

2018 national strategic plan goals, objectives, and program priorities	Corresponding Manufacturing USA strategic plan goals and objectives[a]
Goal 1: Develop and transition new manufacturing technologies	**Goal 2: Facilitate the transition of innovative technologies into scalable, cost-effective, and high-performing domestic manufacturing capabilities**
Objective 1.1. Capture the future of intelligent manufacturing systems	None identified
Priority 1.1.a. Smart and digital manufacturing	None identified
Priority 1.1.b. Advanced industrial robotics	None identified
Priority 1.1.c. Infrastructure for artificial intelligence	None identified
Priority 1.1.d. Cybersecurity in manufacturing	None identified
Objective 1.2. Develop world-leading materials and processing technologies	None identified
Priority 1.2.a. High-performance materials	None Identified
Priority 1.2.b. Additive manufacturing	None identified
Priority 1.2.c. Critical materials	None identified
Objective 1.3. Assure access to medical products through domestic manufacturing	None identified
Priority 1.3.a. Low-cost, distributed manufacturing	None identified
Priority 1.3.b. Continuous manufacturing	None identified
Priority 1.3.c. Biofabrication of tissue and organs	None identified
Objective 1.4. Maintain leadership in electronics design and fabrication	None identified
Priority 1.4.a. Semiconductor design tools and fabrication	None identified
Priority 1.4.b. New materials, devices, and architectures	None identified
Objective 1.5. Strengthen opportunities for food and agricultural manufacturing	None identified
Priority 1.5.a. Processing, testing, and traceability in food safety	None identified
Priority 1.5.b. Production and supply chain for food security	None identified
Priority 1.5.c. Improved cost and functionality of bio-based products	None identified
Goal 2: Educate, train, and connect the manufacturing workforce	**Goal 3: Accelerate the development of an advanced manufacturing workforce**
Objective 2.1. Attract and grow tomorrow's manufacturing workforce	Objective 3.5. Identify the competencies needed by the next generation of workers

2018 national strategic plan goals, objectives, and program priorities	Corresponding Manufacturing USA strategic plan goals and objectives[a]
Priority 2.1.a. Manufacturing-focused foundational Science, Technology, Engineering and Mathematics (STEM) education	Objective 3.1. Nurture future workers for STEM-related work
Priority 2.1.b. Manufacturing engineering education	“Institutes are increasingly attending to the quality and alignment of secondary and postsecondary career and technical education programs, in regions in which institutes are active, to help assure that technician education programs are established at scale, based on a realistic analysis of future skill demands.”
Priority 2.1.c. Industry and academia partnerships	“Partnerships with academia and workforce development programs provide a critical pipeline of skilled and knowledgeable workers for U.S. manufacturers.”
Objective 2.2. Update and expand career and technical education pathways	Objective 3.2. Support, expand, and communicate relevant secondary and post-secondary pathways, including credentialing and certifications
Priority 2.2.a. Career and technical education	“Increasing an early sense of excitement about STEM will widen the pipeline of students available for more specialized training and education. Part of the strategy for communications about program and institute activities includes outreach efforts, such as participation in Manufacturing Day, is to improve the image of manufacturing careers and to correct inaccurate negative stereotypes about manufacturing employment.”
Priority 2.2.b. Training a skilled technical workforce	Objective 3.3. Support the coordination of state and local education and training curricula with advanced manufacturing skill-set requirements
Objective 2.3. Promote apprenticeship and access to industry-recognized credentials	Objective 3.4. Advanced-knowledge workers: researchers and engineers
Priority 2.3.a. Manufacturing apprenticeships	“These programs and initiatives support a coherent sequence of secondary to postsecondary courses while connecting students to registered and industry-recognized apprenticeship programs and other work-based learning and cooperative education opportunities.”
Priority 2.3.b. Registry of apprenticeship and credentialing programs	None identified
Objective 2.4. Match skilled workers with the industries that need them	None identified
Priority 2.4.a. Workforce diversity	None identified
Priority 2.4.b. Workforce assessment	None identified
Goal 3: Expand the capabilities of the domestic manufacturing supply chain	**Goal 1: Increase the competitiveness of U.S. manufacturing[b]**
Objective 3.1. Increase the role of small and medium-sized manufacturers in advanced manufacturing	Objective 2.1 Enable access by U.S. manufacturers to proven manufacturing capabilities and capital-intensive infrastructure
Priority 3.1.a. Supply chain growth	Objective 1.1. Support the increased production of goods manufactured predominantly within the United States
Priority 3.1.b. Cybersecurity outreach and awareness	None identified
Priority 3.1.c. Public-private partnerships	Objective 2.2. Facilitate sharing and documentation of best practices for addressing advanced manufacturing challenges

2018 national strategic plan goals, objectives, and program priorities	Corresponding Manufacturing USA strategic plan goals and objectives[a]
Objective 3.2 Encourage ecosystems of manufacturing innovation	"Strengthening domestic innovation ecosystems is critical to national competitiveness."
Priority 3.2.a. Manufacturing innovation ecosystems	"During this period, institutes conduct pre-competitive applied research to advance the manufacturing processes and systems associated with their specific technology areas and work towards creating manufacturing innovation ecosystems."
Priority 3.2.b. New business formation and growth	None Identified
Priority 3.2.c. R&D transition	None Identified
Objective 3.3. Strengthen the defense manufacturing base	None identified
Priority 3.3.a. Disruptive dual-use capabilities	None identified
Priority 3.3.b. Buy American	None identified
Priority 3.3.c. Leveraging existing authorities	None identified
Objective 3.4. Strengthen advanced manufacturing for rural communities	None identified
Priority 3.4.a. Advanced manufacturing for rural prosperity	None identified
Priority 3.4.b. Capital access, investment, and business assistance	None identified
None identified	Goal 4: Support business models that help institutes to become stable and sustainable

Source: GAO analysis of Manufacturing USA and national strategic plans. | GAO-22-103979

[a]GAO's comparison of the strategic plans involved comparing the goals, objectives, and program priorities of the national strategic plan with the Manufacturing USA strategic plan's goals and objectives. According to NIST officials, while not included in the 2019 Manufacturing USA strategic plan, the objectives in the February 2016 Manufacturing USA strategic plan are still relevant. Thus, GAO reviewed both the 2016 and 2019 Manufacturing USA strategic plans. Supporting content, including written text of the strategic plan, was also considered from the 2019 Manufacturing USA strategic plan as part of our analysis.

[b]The Manufacturing USA strategic plan states that, "altogether, Manufacturing USA encourages the creation of stronger domestic supply chain networks that in turn encourage U.S. manufacturers to produce more products in the U.S."

Appendix IV: Responses to Selected Questions from GAO's Survey of Manufacturing USA Institute Members

From January 2021 to April 2021, we administered a web-based survey to a statistically representative sample of Manufacturing USA institute members.[1] In the survey, we asked members about their overall satisfaction with the institutes, engagement and satisfaction with specific institute activities, and views on the effectiveness of the institutes. We collected information for the 3-year time period prior to survey administration, 2018 to 2021.

All survey results presented in this appendix are generalizable to the population of institute members, except where otherwise noted. We obtained a weighted survey response rate of 39.9 percent.[2] Because our estimates are from a generalizable sample, we express our confidence in the precision of our particular estimates as 95 percent confidence intervals. Responses to selected questions we asked in our survey are shown in tables 7 through 30 below. Survey results presented in this appendix are categorized into four groups: (1) all institute members, (2) large companies, (3) small or medium companies, and (4) academic institutions, unless otherwise noted.[3] Our survey consisted of closed- and open-ended questions. In this appendix, we provide information only on responses to the closed-ended questions. For a more detailed discussion of our survey methodology, see appendix I.

[1]Institute members were defined as an organization with a signed membership agreement, as of March 31, 2020, with one or more of the 14 Manufacturing USA institutes in operation. The sample did not include organizations that joined after March 31, 2020.

[2]We used a weighted response rate because our survey sample incorporates strata with different probabilities of selection. A weighted response rate may more accurately reflect the level of participation. For example, large units that contribute more to the estimate of a total would have a larger "weight" on the response rate.

[3]All institute members include all members in the survey population. Large companies are those with 500 or more employees. Small or medium companies are those with fewer than 500 employees. Academic institutions are colleges or universities. Other organizations, such as nonprofits or state and local governments, were not included in the survey population.

Table 7: In the last 3 years, has your organization networked with institute members?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Yes	94.0	90.2	96.7
	No	5.3	2.8	8.9
	No answer/ Don't know	0.7	0.1	2.8
Large companies	Yes	97.5	90.9	99.7
	No	1.2	0.0	7.3
	No answer/ Don't know	1.2	0.0	7.3
Small or medium companies	Yes	93.0	85.7	97.3
	No	7.0	2.7	14.3
	No answer/ Don't know	0.0	0.0	3.2
Academic institutions	Yes	93.0	84.3	97.7
	No	4.2	0.9	11.9
	No answer/ Don't know	2.8	0.3	9.8

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 8: How satisfied is your organization with networking with institute members?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very satisfied	46.4	40.6	52.3
	Somewhat satisfied	36.2	30.4	42.0
	Neither satisfied nor dissatisfied	11.0	7.2	15.8
	Somewhat dissatisfied	4.5	2.2	8.1
	Very dissatisfied	1.9	0.5	4.8
	No answer/ Don't know	0.0	0.0	1.3
Large companies	Very satisfied	51.2	43.4	58.9
	Somewhat satisfied	37.4	29.4	45.4
	Neither satisfied nor dissatisfied	7.6	2.7	16.4
	Somewhat dissatisfied	3.8	0.7	11.2
	Very dissatisfied	0.0	0.0	4.1
	No answer/ Don't know	0.0	0.0	4.1
Small or medium companies	Very satisfied	39.8	30.9	48.7
	Somewhat satisfied	39.4	30.5	48.3

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
	Neither satisfied nor dissatisfied	12.8	6.5	21.9
	Somewhat dissatisfied	5.3	1.6	12.5
	Very dissatisfied	2.7	0.4	8.8
	No answer/ Don't know	0.0	0.0	3.5
Academic institutions	Very satisfied	65.2	60.1	70.2
	Somewhat satisfied	25.8	15.8	38.0
	Neither satisfied nor dissatisfied	4.5	0.9	12.7
	Somewhat dissatisfied	3.0	0.4	10.5
	Very dissatisfied	1.5	0.0	8.2
	No answer/ Don't know	0.0	0.0	4.4

Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: This question was only asked of members that answered yes to networking with institute members.

Table 9: In the last 3 years, has your organization collaborated on institute projects with institute members?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Yes	65.2	59.7	70.8
	No	32.3	26.8	37.9
	No answer/ Don't know	2.4	0.9	5.3
Large companies	Yes	66.0	58.1	74.0
	No	29.0	19.0	40.7
	No answer/ Don't know	5.0	1.3	12.7
Small or medium companies	Yes	63.4	54.9	71.8
	No	35.4	27.0	43.8
	No answer/ Don't know	1.2	0.0	6.2
Academic institutions	Yes	71.8	59.9	81.9
	No	23.9	14.6	35.5
	No answer/ Don't know	4.2	0.9	11.9

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 10: How satisfied is your organization with collaborating on institute projects with institute members?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very satisfied	55.7	48.9	62.6
	Somewhat satisfied	28.5	22.5	34.5
	Neither satisfied nor dissatisfied	7.3	3.8	12.4
	Somewhat dissatisfied	8.5	4.6	14.1
	Very dissatisfied	0.0	0.0	1.8
	No answer/ Don't know	0.0	0.0	1.8
Large companies	Very satisfied	58.6	50.9	66.4
	Somewhat satisfied	28.2	16.5	42.5
	Neither satisfied nor dissatisfied	9.4	3.0	20.9
	Somewhat dissatisfied	3.8	0.4	13.2
	Very dissatisfied	0.0	0.0	5.7
	No answer/ Don't know	0.0	0.0	5.7
Small or medium companies	Very satisfied	53.3	42.4	64.2
	Somewhat satisfied	27.1	16.3	40.4
	Neither satisfied nor dissatisfied	7.8	2.4	17.9
	Somewhat dissatisfied	11.7	4.8	22.9
	Very dissatisfied	0.0	0.0	5.0
	No answer/ Don't know	0.0	0.0	5.0
Academic institutions	Very satisfied	58.8	52.9	64.7
	Somewhat satisfied	33.3	20.8	47.9
	Neither satisfied nor dissatisfied	3.9	0.5	13.5
	Somewhat dissatisfied	3.9	0.5	13.5
	Very dissatisfied	0.0	0.0	5.7
	No answer/ Don't know	0.0	0.0	5.7

Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: This question was only asked of members that answered yes to collaborating on institute projects with institute members.

Table 11: In the last 3 years, has your organization accessed technical services supplied by the institute, such as equipment, shared facilities, or consulting services?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Yes	29.6	24.5	34.8
	No	65.7	60.3	71.0
	No answer/ Don't know	4.7	2.4	8.2
Large companies	Yes	32.3	26.1	38.5
	No	61.5	54.8	68.2
	No answer/ Don't know	6.2	1.9	14.3
Small or medium companies	Yes	28.4	19.5	38.8
	No	69.1	61.0	77.2
	No answer/ Don't know	2.5	0.4	8.1
Academic institutions	Yes	29.6	19.3	41.6
	No	63.4	58.5	68.3
	No answer/ Don't know	7.0	2.3	15.7

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 12: How satisfied is your organization with accessing technical services supplied by the institute, such as equipment, shared facilities, or consulting services?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very satisfied	51.2	40.8	61.5
	Somewhat satisfied	18.3	10.2	29.1
	Neither satisfied nor dissatisfied	20.4	11.8	31.4
	Somewhat dissatisfied	6.8	2.2	15.2
	Very dissatisfied	0.0	0.0	4.0
	No answer/ Don't know	3.4	0.6	10.5
Large companies	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	n/r	n/r	n/r
	Very dissatisfied	0.0	0.0	10.9
	No answer/ Don't know	n/r	n/r	n/r
	Very satisfied	n/r	n/r	n/r

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
Small or medium companies	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	n/r	n/r	n/r
	Very dissatisfied	0.0	0.0	11.3
	No answer/ Don't know	n/r	n/r	n/r
Academic institutions	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	0.0	0.0	13.3
	Very dissatisfied	0.0	0.0	13.3
	No answer/ Don't know	0.0	0.0	13.3

Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: n/r indicates that we are not reporting the estimate because the maximum half-width of the confidence interval is greater than 15 percentage points. This question was only asked of members that answered yes to accessing technical services supplied by the institute, such as equipment, shared facilities, or consulting services.

Table 13: In the last 3 years, has your organization accessed education, training, or workforce development resources provided by the institute?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Yes	35.9	30.6	41.1
	No	57.6	52.1	63.1
	No answer/ Don't know	6.5	3.7	10.4
Large companies	Yes	41.0	34.1	47.9
	No	50.3	42.8	57.9
	No answer/ Don't know	8.7	3.4	17.6
Small or medium companies	Yes	29.3	21.3	37.3
	No	64.5	56.1	72.9
	No answer/ Don't know	6.2	2.2	13.3
Academic institutions	Yes	56.3	51.3	61.4
	No	38.0	33.1	43.0
	No answer/ Don't know	5.6	1.6	13.8

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 14: How satisfied is your organization with accessing education, training, or workforce development resources provided by the institute?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very satisfied	53.8	45.1	62.4
	Somewhat satisfied	33.0	25.0	41.1
	Neither satisfied nor dissatisfied	10.4	5.2	18.2
	Somewhat dissatisfied	0.7	0.0	5.5
	Very dissatisfied	0.0	0.0	3.0
	No answer/ Don't know	2.1	0.2	8.8
Large companies	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	0.0	0.0	8.7
	Very dissatisfied	0.0	0.0	8.7
	No answer/ Don't know	0.0	0.0	8.7
Small or medium companies	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	0.0	0.0	11.3
	Very dissatisfied	0.0	0.0	11.3
	No answer/ Don't know	n/r	n/r	n/r
Academic institutions	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	7.5	1.6	20.4
	Somewhat dissatisfied	2.5	0.1	13.2
	Very dissatisfied	0.0	0.0	7.2
	No answer/ Don't know	0.0	0.0	7.2

Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: n/r indicates that we are not reporting the estimate because the maximum half-width of the confidence interval is greater than 15 percentage points. This question was only asked of members that answered yes to accessing education, training, or workforce development resources provided by the institute.

Table 15: In the last 3 years, has your organization engaged in activities related to obtaining or retaining intellectual property rights associated with an institute project?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Yes	26.5	21.4	31.7
	No	67.3	61.9	72.7
	No answer/ Don't know	6.2	3.5	10.0
Large companies	Yes	24.8	15.5	36.2
	No	69.0	57.1	79.2
	No answer/ Don't know	6.2	1.9	14.3
Small or medium companies	Yes	29.3	21.3	37.3
	No	65.0	56.6	73.3
	No answer/ Don't know	5.7	1.9	12.7
Academic institutions	Yes	21.1	12.3	32.4
	No	70.4	58.4	80.7
	No answer/ Don't know	8.5	3.2	17.5

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 16: How satisfied is your organization with engaging in activities related to obtaining or retaining intellectual property rights associated with an institute project?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very satisfied	37.8	26.6	49.0
	Somewhat satisfied	29.0	18.0	42.1
	Neither satisfied nor dissatisfied	12.3	5.2	23.3
	Somewhat dissatisfied	5.6	1.3	14.8
	Very dissatisfied	5.8	1.2	15.9
	No answer/ Don't know	9.6	3.4	20.3
Large companies	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	n/r	n/r	n/r
	Very dissatisfied	0.0	0.0	13.9
	No answer/ Don't know	n/r	n/r	n/r
	Very satisfied	n/r	n/r	n/r

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
Small or medium companies	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	n/r	n/r	n/r
	Very dissatisfied	n/r	n/r	n/r
	No answer/ Don't know	n/r	n/r	n/r
Academic institutions	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	n/r	n/r	n/r
	Very dissatisfied	n/r	n/r	n/r
	No answer/ Don't know	n/r	n/r	n/r

Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: n/r indicates that we are not reporting the estimate because the maximum half-width of the confidence interval is greater than 15 percentage points. This question was only asked of members that answered yes to engaging in activities related to obtaining or retaining intellectual property rights associated with an institute project.

Table 17: In the last 3 years, has your organization learned about new technologies, prototyping, or manufacturing processes for possible commercialization?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Yes	63.4	57.8	69.0
	No	29.3	24.0	34.7
	No answer/ Don't know	7.2	4.3	11.3
Large companies	Yes	72.0	60.4	81.8
	No	17.8	9.9	28.5
	No answer/ Don't know	10.2	4.3	19.4
Small or medium companies	Yes	60.5	52.0	69.0
	No	32.9	24.7	41.1
	No answer/ Don't know	6.6	2.5	13.8
Academic institutions	Yes	60.6	55.6	65.5
	No	32.4	21.8	44.5
	No answer/ Don't know	7.0	2.3	15.7

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 18: How satisfied is your organization with learning about new technologies, prototyping, or manufacturing processes for possible commercialization?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very satisfied	39.9	33.1	46.6
	Somewhat satisfied	38.9	32.0	45.8
	Neither satisfied nor dissatisfied	12.9	8.1	19.2
	Somewhat dissatisfied	5.1	2.3	9.8
	Very dissatisfied	2.8	0.8	7.0
	No answer/ Don't know	0.4	0.0	3.5
Large companies	Very satisfied	43.1	36.6	49.6
	Somewhat satisfied	37.9	31.5	44.3
	Neither satisfied nor dissatisfied	12.1	5.0	23.3
	Somewhat dissatisfied	5.2	1.1	14.4
	Very dissatisfied	1.7	0.0	9.2
	No answer/ Don't know	0.0	0.0	5.0
Small or medium companies	Very satisfied	34.7	22.4	48.7
	Somewhat satisfied	42.2	31.1	53.4
	Neither satisfied nor dissatisfied	12.2	4.9	23.8
	Somewhat dissatisfied	6.8	1.8	16.9
	Very dissatisfied	4.1	0.6	13.2
	No answer/ Don't know	0.0	0.0	5.3
Academic institutions	Very satisfied	53.5	47.0	60.0
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	11.6	3.9	25.1
	Somewhat dissatisfied	0.0	0.0	6.7
	Very dissatisfied	0.0	0.0	6.7
	No answer/ Don't know	2.3	0.1	12.3

Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: n/r indicates that we are not reporting the estimate because the maximum half-width of the confidence interval is greater than 15 percentage points. This question was only asked of members that answered yes to learning about new technologies, prototyping, or manufacturing processes for possible commercialization.

Table 19: In the last 3 years, has your organization utilized standards, certifications, or qualification of new materials or processes developed by the institute?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Yes	10.7	7.0	15.3
	No	83.2	77.8	87.7
	No answer/ Don't know	6.2	3.5	10.0
Large companies	Yes	9.9	4.2	19.1
	No	81.4	70.6	89.5
	No answer/ Don't know	8.7	3.4	17.6
Small or medium companies	Yes	9.1	4.1	16.9
	No	86.0	77.1	92.4
	No answer/ Don't know	5.0	1.5	11.6
Academic institutions	Yes	18.3	10.1	29.3
	No	73.2	61.4	83.1
	No answer/ Don't know	8.5	3.2	17.5

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 20: How satisfied is your organization with utilizing standards, certifications, or qualification of new materials or processes developed by the institute?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	0.0	0.0	9.8
	Very dissatisfied	0.0	0.0	9.8
	No answer/ Don't know	0.0	0.0	9.8
Large companies	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	n/r	n/r	n/r
	Very dissatisfied	n/r	n/r	n/r
	No answer/ Don't know	n/r	n/r	n/r
	Very satisfied	n/r	n/r	n/r

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
Small or medium companies	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	n/r	n/r	n/r
	Very dissatisfied	n/r	n/r	n/r
	No answer/ Don't know	n/r	n/r	n/r
Academic institutions	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	n/r	n/r	n/r
	Very dissatisfied	n/r	n/r	n/r
	No answer/ Don't know	n/r	n/r	n/r

Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: n/r indicates that we are not reporting the estimate because the maximum half-width of the confidence interval is greater than 15 percentage points. This question was only asked of members that answered yes to utilizing standards, certifications, or qualification of new materials or processes developed by the institute.

Table 21: In the last 3 years, has your organization provided input on institute priorities or projects?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Yes	65.0	59.4	70.5
	No	29.3	23.9	34.6
	No answer/ Don't know	5.8	3.2	9.5
Large companies	Yes	72.2	60.6	82.0
	No	18.9	10.7	29.6
	No answer/ Don't know	8.9	3.5	17.8
Small or medium companies	Yes	62.2	53.8	70.6
	No	32.8	24.7	41.0
	No answer/ Don't know	5.0	1.5	11.6
Academic institutions	Yes	69.0	56.9	79.5
	No	25.4	15.8	37.1
	No answer/ Don't know	5.6	1.6	13.8

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 22: How satisfied is your organization with providing input on institute priorities or projects?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very satisfied	44.0	37.1	50.9
	Somewhat satisfied	31.4	25.0	37.9
	Neither satisfied nor dissatisfied	16.5	11.1	23.1
	Somewhat dissatisfied	3.5	1.2	7.6
	Very dissatisfied	3.5	1.1	8.4
	No answer/ Don't know	1.1	0.1	4.2
Large companies	Very satisfied	46.4	38.8	54.0
	Somewhat satisfied	25.8	15.0	39.2
	Neither satisfied nor dissatisfied	24.4	13.9	37.7
	Somewhat dissatisfied	1.7	0.0	9.6
	Very dissatisfied	0.0	0.0	5.2
	No answer/ Don't know	1.7	0.0	9.6
Small or medium companies	Very satisfied	41.1	30.1	52.1
	Somewhat satisfied	34.4	22.1	48.4
	Neither satisfied nor dissatisfied	14.6	6.5	26.7
	Somewhat dissatisfied	4.0	0.6	13.0
	Very dissatisfied	6.0	1.4	15.8
	No answer/ Don't know	0.0	0.0	5.3
Academic institutions	Very satisfied	46.9	40.8	53.0
	Somewhat satisfied	30.6	18.3	45.4
	Neither satisfied nor dissatisfied	14.3	5.9	27.2
	Somewhat dissatisfied	4.1	0.5	14.0
	Very dissatisfied	0.0	0.0	5.9
	No answer/ Don't know	4.1	0.5	14.0

Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: This question was only asked of members that answered yes to providing input on institute priorities or projects.

Table 23: In the last 3 years, has your organization participated in institute governance or advisory groups?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Yes	37.5	32.1	42.9
	No	56.3	50.7	61.9
	No answer/ Don't know	6.2	3.5	10.0
Large companies	Yes	44.7	37.5	51.9
	No	46.6	38.8	54.4
	No answer/ Don't know	8.7	3.4	17.6
Small or medium companies	Yes	34.2	25.9	42.6
	No	60.4	51.8	69.0
	No answer/ Don't know	5.3	1.7	12.2
Academic institutions	Yes	45.1	40.0	50.1
	No	47.9	42.8	53.0
	No answer/ Don't know	7.0	2.3	15.7

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 24: How satisfied is your organization with participating in institute governance or advisory groups?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very satisfied	48.2	39.3	57.1
	Somewhat satisfied	27.8	19.1	37.8
	Neither satisfied nor dissatisfied	13.3	7.2	21.7
	Somewhat dissatisfied	8.7	3.9	16.2
	Very dissatisfied	2.0	0.1	8.5
	No answer/ Don't know	0.0	0.0	3.0
Large companies	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	0.0	0.0	8.0
	Very dissatisfied	0.0	0.0	8.0
	No answer/ Don't know	0.0	0.0	8.0
Small or medium companies	Very satisfied	n/r	n/r	n/r
	Somewhat satisfied	n/r	n/r	n/r

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
	Neither satisfied nor dissatisfied	n/r	n/r	n/r
	Somewhat dissatisfied	n/r	n/r	n/r
	Very dissatisfied	3.6	0.1	18.0
	No answer/ Don't know	0.0	0.0	9.8
Academic institutions	Very satisfied	50.0	42.4	57.6
	Somewhat satisfied	n/r	n/r	n/r
	Neither satisfied nor dissatisfied	6.3	0.8	20.8
	Somewhat dissatisfied	n/r	n/r	n/r
	Very dissatisfied	0.0	0.0	8.9
	No answer/ Don't know	0.0	0.0	8.9

Source: GAO analysis of institute member survey data. | GAO-22-103979

Note: n/r indicates that we are not reporting the estimate because the maximum half-width of the confidence interval is greater than 15 percentage points. This question was only asked of members that answered yes to participating in institute governance or advisory groups.

Table 25: Overall, how satisfied is your organization with <<institute name>>?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very satisfied	44.0	38.4	49.6
	Somewhat satisfied	31.7	26.3	37.0
	Neither satisfied nor dissatisfied	13.6	9.5	18.6
	Somewhat dissatisfied	7.5	4.5	11.6
	Very dissatisfied	2.5	0.9	5.7
	No answer/ Don't know	0.7	0.1	2.8
Large companies	Very satisfied	51.1	43.5	58.8
	Somewhat satisfied	35.2	27.3	43.1
	Neither satisfied nor dissatisfied	8.7	3.4	17.6
	Somewhat dissatisfied	3.7	0.7	10.9
	Very dissatisfied	1.2	0.0	7.3
	No answer/ Don't know	0.0	0.0	4.0
Small or medium companies	Very satisfied	39.5	31.0	48.0
	Somewhat satisfied	32.8	24.7	41.0

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
	Neither satisfied nor dissatisfied	14.9	8.3	23.9
	Somewhat dissatisfied	8.7	3.8	16.4
	Very dissatisfied	3.7	0.9	9.9
	No answer/ Don't know	0.4	0.0	6.0
Academic institutions	Very satisfied	52.1	47.0	57.2
	Somewhat satisfied	25.4	15.8	37.1
	Neither satisfied nor dissatisfied	11.3	5.0	21.0
	Somewhat dissatisfied	8.5	3.2	17.5
	Very dissatisfied	0.0	0.0	4.1
	No answer/ Don't know	2.8	0.3	9.8

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 26: In your opinion, how effective or ineffective is <<institute name>> at strengthening the potential for the U.S. to be competitive in <<institute name>>'s technology focus area(s)?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very effective	44.8	39.1	50.4
	Somewhat effective	37.8	32.2	43.4
	Neither effective nor ineffective	5.7	3.0	9.5
	Somewhat ineffective	4.6	2.3	8.3
	Very ineffective	1.8	0.5	4.6
	No answer/ Don't know	5.3	2.8	9.0
Large companies	Very effective	50.5	42.8	58.2
	Somewhat effective	39.2	31.8	46.6
	Neither effective nor ineffective	1.3	0.0	7.4
	Somewhat ineffective	1.3	0.0	7.4
	Very ineffective	1.3	0.0	7.4
	No answer/ Don't know	6.5	1.7	16.1
Small or medium companies	Very effective	40.8	32.2	49.4
	Somewhat effective	38.0	29.4	46.5
	Neither effective nor ineffective	7.9	3.3	15.6
	Somewhat ineffective	6.3	2.2	13.4

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
	Very ineffective	2.5	0.4	8.2
	No answer/ Don't know	4.6	1.3	11.1
Academic institutions	Very effective	50.7	45.6	55.8
	Somewhat effective	36.6	31.7	41.5
	Neither effective nor ineffective	2.8	0.3	9.8
	Somewhat ineffective	2.8	0.3	9.8
	Very ineffective	0.0	0.0	4.1
	No answer/ Don't know	7.0	2.3	15.7

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 27: In your opinion, how would a reduction or elimination of baseline federal financial assistance for <<institute name>> affect the institute's ability to enhance U.S. competitiveness in <<institute name>>'s technology focus area(s)?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	A very positive effect on U.S. competitiveness	2.7	1.1	5.7
	A somewhat positive effect on U.S. competitiveness	2.0	0.6	4.7
	Neither a positive nor negative effect on U.S. competitiveness	7.1	4.1	11.3
	A somewhat negative effect on U.S. competitiveness	31.3	26.1	36.5
	A very negative effect on U.S. competitiveness	48.2	42.5	53.9
	No answer/ Don't know	8.7	5.4	13.0
Large companies	A very positive effect on U.S. competitiveness	1.2	0.0	7.3
	A somewhat positive effect on U.S. competitiveness	1.2	0.0	7.3
	Neither a positive nor negative effect on U.S. competitiveness	2.5	0.3	9.1
	A somewhat negative effect on U.S. competitiveness	42.7	34.9	50.4
	A very negative effect on U.S. competitiveness	38.5	31.8	45.2
	No answer/ Don't know	13.9	6.9	23.9
Small or medium companies	A very positive effect on U.S. competitiveness	2.5	0.4	8.1

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
	A somewhat positive effect on U.S. competitiveness	2.5	0.4	8.1
	Neither a positive nor negative effect on U.S. competitiveness	9.9	4.6	18.0
	A somewhat negative effect on U.S. competitiveness	29.5	21.7	37.4
	A very negative effect on U.S. competitiveness	50.3	41.5	59.0
	No answer/ Don't know	5.3	1.7	12.2
Academic institutions	A very positive effect on U.S. competitiveness	5.6	1.6	13.8
	A somewhat positive effect on U.S. competitiveness	1.4	0.0	7.6
	Neither a positive nor negative effect on U.S. competitiveness	2.8	0.3	9.8
	A somewhat negative effect on U.S. competitiveness	26.8	16.9	38.6
	A very negative effect on U.S. competitiveness	52.1	47.0	57.2
	No answer/ Don't know	11.3	5.0	21.0

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 28: If baseline federal financial assistance were reduced or eliminated for <<institute name>>, how likely would your organization be to maintain membership with <<institute name>>?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very likely to maintain membership	7.8	4.7	11.9
	Somewhat likely to maintain membership	24.4	19.6	29.2
	Not likely to maintain membership	44.2	38.5	50.0
	No longer a member	11.0	7.3	15.7
	No answer/ Don't know	12.6	8.7	17.5
Large companies	Very likely to maintain membership	8.9	3.5	17.8
	Somewhat likely to maintain membership	23.6	14.5	34.9
	Not likely to maintain membership	35.0	27.8	42.2

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
	No longer a member	11.2	5.0	20.6
	No answer/ Don't know	21.3	12.7	32.4
Small or medium companies	Very likely to maintain membership	7.8	3.2	15.4
	Somewhat likely to maintain membership	23.9	15.5	33.9
	Not likely to maintain membership	48.1	39.4	56.8
	No longer a member	12.4	6.4	21.0
	No answer/ Don't know	7.8	3.2	15.4
Academic institutions	Very likely to maintain membership	7.0	2.3	15.7
	Somewhat likely to maintain membership	29.6	19.3	41.6
	Not likely to maintain membership	40.8	35.9	45.8
	No longer a member	5.6	1.6	13.8
	No answer/ Don't know	16.9	9.0	27.7

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 29: How has the COVID-19 pandemic affected U.S. competitiveness in <<institute name>>'s technology focus area(s)?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Large positive effect	6.2	3.5	10.1
	Moderate positive effect	10.6	7.0	15.2
	Neither positive nor negative effect	30.2	24.9	35.6
	Moderate negative effect	26.0	21.2	30.8
	Large negative effect	7.3	4.4	11.4
	No answer/ Don't know	19.6	15.0	24.2
Large companies	Large positive effect	5.0	1.3	12.7
	Moderate positive effect	6.2	1.9	14.3
	Neither positive nor negative effect	32.7	24.8	40.7
	Moderate negative effect	31.0	20.8	42.9
	Large negative effect	2.5	0.3	9.1
	No answer/ Don't know	22.6	13.7	33.8

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
Small or medium companies	Large positive effect	5.3	1.7	12.2
	Moderate positive effect	10.7	5.2	18.9
	Neither positive nor negative effect	31.7	23.6	39.8
	Moderate negative effect	23.9	15.5	33.9
	Large negative effect	8.7	3.8	16.4
	No answer/ Don't know	19.8	12.1	29.4
Academic institutions	Large positive effect	11.3	5.0	21.0
	Moderate positive effect	11.3	5.0	21.0
	Neither positive nor negative effect	23.9	14.6	35.5
	Moderate negative effect	29.6	19.3	41.6
	Large negative effect	8.5	3.2	17.5
	No answer/ Don't know	15.5	8.0	26.0

Source: GAO analysis of institute member survey data. | GAO-22-103979

Table 30: How likely is your organization to maintain membership with <<institute name>> in response to the effects (if any) of the COVID-19 pandemic on your organization?

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
All institute members	Very likely to maintain membership	51.7	46.0	57.5
	Somewhat likely to maintain membership	25.7	20.6	30.8
	Not likely to maintain membership	3.8	1.7	7.0
	No longer a member	7.8	4.7	11.9
	No answer/ Don't know	11.0	7.3	15.7
Large companies	Very likely to maintain membership	52.6	45.0	60.1
	Somewhat likely to maintain membership	19.9	11.5	30.8
	Not likely to maintain membership	2.5	0.3	9.1
	No longer a member	8.7	3.4	17.6
	No answer/ Don't know	16.4	8.8	26.8
Small or medium companies	Very likely to maintain membership	50.6	41.8	59.3

Group	Response	Estimated percentage	95 percent confidence interval—lower bound (percentage)	95 percent confidence interval—upper bound (percentage)
	Somewhat likely to maintain membership	27.3	18.4	37.6
	Not likely to maintain membership	4.5	1.3	11.0
	No longer a member	7.4	3.0	14.9
	No answer/ Don't know	10.2	4.9	18.4
Academic institutions	Very likely to maintain membership	53.5	48.5	58.6
	Somewhat likely to maintain membership	28.2	18.1	40.1
	Not likely to maintain membership	2.8	0.3	9.8
	No longer a member	7.0	2.3	15.7
	No answer/ Don't know	8.5	3.2	17.5

Source: GAO analysis of institute member survey data. | GAO-22-103979

Appendix V: Comments from the Department of Commerce

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-0001

Candice Wright
Director, Science, Technology Assessment, and Analytics
U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

Dear Ms. Wright:

Thank you for the opportunity to review and comment on the Government Accountability Office's draft report entitled *Advanced Manufacturing: Innovation Institutes Report Technology Progress and Members Report Satisfaction with Their Involvement* (GAO-22-103979).

On behalf of the National Institute of Standards and Technology (NIST), I have enclosed our comments on the draft report.

In addition, we are enclosing a joint statement developed by NIST, the Department of Defense, and the Department of Energy regarding the concerns raised in the GAO Statement of Facts and Draft report on network-wide performance goals and measures. In the Joint Statement, the agencies request that their common understandings of performance goals also be reflected in GAO's final report.

If you have any questions, please contact Amy Egan, NIST Audit Liaison, at 301-975-2819.

Sincerely,

JAMES OLTHOFF

Digitally signed by JAMES OLTHOFF
Date: 2021.12.08 15:31:38 -05'00'

James K. Olthoff, Ph.D.
Performing the Non-Exclusive Functions and Duties of the
Under Secretary of Commerce for Standards and Technology &
Director, National Institute of Standards and Technology

Enclosures

NIST Comments on
GAO Draft Report entitled *ADVANCED MANUFACTURING: Innovation Institutes Report Technology Progress and Members Report Satisfaction with Their Involvement*
(GAO-103979)

The National Institute of Standards and Technology (NIST) has reviewed the draft report and thanks GAO for its careful study of institutes participating in the Manufacturing USA network. NIST offers the following comments for GAO's consideration.

1. In response to 2019 GAO recommendations, NIST developed and implemented performance goals and measures aligned with the statutory purposes and strategic goals of Manufacturing USA for current and future Commerce-sponsored institutes and piloted them with the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL). NIST commits to implementing targets and timelines for the planned network of Commerce-sponsored institutes.

2. The NIST Office of Advanced Manufacturing, the DoD ManTech Office, and the DOE Advanced Manufacturing Office jointly developed a request for clarification of the GAO's earlier *GAO Statement of Facts, Manufacturing USA - Third Review, Job Code 103979*. The separately submitted joint request asked for text revisions to the *GAO Statement of Facts* and asked that the shared perspective of the three sponsoring agencies be incorporated into the GAO's final report.

   NIST reiterates its commitment in the jointly developed request that it will work with its partner agencies to develop and implement network-wide performance goals for the Manufacturing USA program. NIST also agrees to work with its partners towards aligning network-wide performance measures with network-wide performance goals. strategic objectives, program goals, and the statutory program purposes in 15 U.S.C. § 278s (b)(2), as amended.

   However, NIST notes that there may be limits to that network-wide alignment of performance goals and measures for institutes sponsored by other agencies. As the DoD ManTech Office and the DOE Advanced Manufacturing Office have stated, *"the alignment of any network-wide performance measures and performance goals to Manufacturing USA goals, strategic objectives, and the statutory purposes may be limited to the extent to which those goals, objectives, and statutory purposes align with the purposes for which DoD and DOE sponsor their institutes."*

3. NIST will work with Federal agencies that are sponsoring or supporting a Manufacturing USA institute to develop and implement network-wide performance goals with measurable targets and timelines.

   While as outlined above NIST will continue to work to develop and implement network-wide performance goals, NIST does not commit to setting targets and timeframes for the network-wide performance measures. For reasons noted in the submitted joint request, the DoD ManTech Office and the DOE Advanced Manufacturing Office, *"Do not agree that network-wide performance goals based on aggregate institute performance should have measurable targets and time frames,"* and have stated that, *"the use of network-wide targets and time frames as applied to DoD and DOE-sponsored institutes [is] inappropriate."*

Appendix VI: GAO Contact and Staff Acknowledgments

GAO Contact

Candice N. Wright at (202) 512-6888 or wrightc@gao.gov

Staff Acknowledgments

In addition to the contact named above, Christopher Murray (Assistant Director), Aaron Shiffrin (Analyst-in-Charge), Maggie Bryson, Rah Cantatore, Jehan Chase, Louise Fickel, Rebecca Gertler, and Monique Williams made key contributions to this report. Also contributing to this report were Blake Ainsworth, Carl Barden, Christina Bixby, Brian Bothwell, Cheron Brooks, Jenny Chanley, Thomas Lombardi, Kirsten Lauber, and Sarah Veale.

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