REPORT TO CONGRESS

Fiscal Year 2019

November 2020

About This Document

This annual Report to Congress documents the progress of the Manufacturing USA program in meeting its goals and highlights accomplishments of the federal agency-sponsored manufacturing institutes that participated in the Manufacturing USA program in fiscal year 2019.

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Executive Summary

Manufacturing USA brings together nine federal agencies to collaborate with industry and academia using a "whole-of-government" approach towards the innovation and development of advanced manufacturing technologies. The federal agencies establish and support manufacturing innovation institutes aligned with national priorities, with a common foundational structure built upon the needs of industry to accelerate transformational manufacturing technologies.

In FY 2019, three federal agencies sponsored Manufacturing USA institutes: the Department of Commerce with one institute, the Department of Defense with eight institutes, and the Department of Energy with five institutes. The Advanced Manufacturing National Program Office, headquartered at NIST under the Department of Commerce, oversees the branding and coordination of Manufacturing USA.

Each institute is a public-private partnership focused on a specific technology area of critical importance to the nation's ability to establish and maintain leadership in advanced manufacturing. The institutes connect member organizations, including companies, universities, community colleges, state and local governments, and Manufacturing Extension Partnership organizations. These member organizations work together within each institute's technological field of focus, leveraging co-investment in emerging innovations and sharing capital-intensive infrastructure. Together, they develop new pre-competitive manufacturing technologies and train the workforce with skills to foster a globally competitive US manufacturing base.

Manufacturing USA continued to thrive in Fiscal Year 2019 (FY 2019). Building on years of acquired best-practices, the network of 14 institutes continued to expand the frontiers of advanced manufacturing technology in areas such as biopharmaceutical manufacturing, integrated photonics manufacturing, and wide-bandgap power electronics manufacturing. Institutes also focused on topics such as smart manufacturing and cybersecurity to improve the integration and security of advanced technologies in manufacturing. In FY 2019, the institutes:

- Conducted over **560** major applied research and development collaboration projects of high priority for broad industry sectors.
- Engaged **1,920** member organizations, an increase of nearly 50% since 2017 and more than double 2016. Sixty-one percent of members are manufacturing firms and 69% of these industry members are small and medium manufacturers, which are key to the U.S. manufacturing supply chain.
- Helped more than **39,000** workers, students, and educators through institute workforce efforts. Institutes continued their leadership in workforce training, increasing cross-institute collaborations and sharing of best practices. The result was tremendous engagement in institute-led workforce development efforts, including educator/trainer instruction and development of science, technology, engineering, and mathematics (STEM) activities. Analysis of the funding of these efforts, using new education performance measures in 2018 and 2019, showed that industry resources are not generally allocated for education and workforce training, indicating that the institutes must rely on federal and other non-corporate resources to support the training of the U.S. workforce of the future.
- Attracted **$355** million in state and private investment, leveraged $133 million in federal funds. This remarkable **2.7 to 1 investment match** vastly exceeds the program design of a 1 to 1 match and represents the catalyzing effect of matching investment. It demonstrates the importance of advanced manufacturing to manufacturers and to the future success of state and local economies.

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Introduction

American Competitiveness: Today, Tomorrow and into the Future

The federal agencies[1] participating in Manufacturing USA have established and deployed a whole-of-government innovation framework that accelerates U.S.-based technology developments to the forefront of advanced manufacturing, allowing the U.S. to remain globally competitive in the ever-expanding frontiers of manufacturing. Manufacturing USA continues to grow and thrive and, in FY 2019, three federal agencies sponsored the 14 Manufacturing USA institutes: the Department of Commerce (DOC) with one institute, the Department of Defense (DoD) with eight institutes, and the Department of Energy (DOE) with five institutes.

These institutes are public-private partnerships that connect member organizations from U.S. industry, academia, and government to collaboratively solve manufacturing changes in key technology areas. This cooperative development of strategic manufacturing technologies ensures that inventions and innovations from the United States are scaled up and produced in the United States. Each institute advances a different, specific manufacturing technology, such as biopharmaceutical manufacturing, integrated photonic manufacturing, and wide-bandgap power electronics manufacturing. Institutes also focus on topics such as smart manufacturing and cybersecurity in manufacturing to improve the integration and security of advanced technologies used in manufacturing. The institutes advance technologies through collaborative pre-competitive research by their member organizations and by providing shared access to capital-intensive infrastructure. The institutes also help educate and train the workforce with the advanced manufacturing skills needed by U.S. manufacturers.

The United States continues to face significant manufacturing challenges. The threat to U.S. leadership in advanced manufacturing technology remains high, with recognized supply chain difficulties resulting from economic downturn and fierce international competition. Despite a long history of global leadership in advanced technology products, our trade deficit in these products continues to grow. Additionally, there is a dearth of U.S. workers with the skills needed by today's manufacturers, which challenges manufacturers nationwide. Within each technology focus, the institutes provide the infrastructure and collaborative environment needed to alleviate these shortfalls.

Reporting Period

This required Report to Congress[2] describes the performance of Manufacturing USA for FY 2019.

Organization and Management

Manufacturing USA includes nine member agencies: the Departments of Commerce, Defense, and Energy, which each sponsor institutes; the Departments of Agriculture, Education, Health and Human Services, Labor; the National Aeronautics and Space Administration; and the National Science Foundation. The Advanced Manufacturing National Program Office (AMNPO), headquartered at NIST under the Department of Commerce, oversees the Manufacturing USA's branding and coordinates the Manufacturing USA interagency team.

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[1] The Departments of Commerce, Defense, Education, Energy, Health and Human Services, and Labor; the National Aeronautics and Space Administration; the National Science Foundation; and the U.S. Department of Agriculture.

[2] 15 U.S.C. § 278s(i)(2), as amended. http://uscode.house.gov/view.xhtml?req=(title:15 section:278s edition:prelim).

The DOC, DoD, and DOE coordinate with the other federal agencies through the AMNPO, enabling cooperation over a wide range of support activities. Manufacturing USA's national goals, while well aligned with each individual agency's mission, are best realized by a whole-of-government effort that focuses broadly on increasing U.S. advanced manufacturing competitiveness.

Vision, Mission, and Goals

As first articulated in the program's strategic plan, the vision of Manufacturing USA is *U.S. global leadership in advanced manufacturing*. To achieve this vision, the mission of Manufacturing USA is *connecting people, ideas, and technology to solve industry-relevant advanced manufacturing challenges, thereby enhancing industrial competitiveness and economic growth, and strengthening our national security.*[3]

Manufacturing USA's four goals are to:

- Increase the competitiveness of U.S. manufacturing;
- Facilitate the transition of innovative technologies into scalable, cost-effective, and high-performing domestic manufacturing capabilities;
- Accelerate the development of an advanced manufacturing workforce; and
- Support business models that help the institutes become stable and sustainable.

The institutes serve as core resources for meeting the Manufacturing USA goals. The DoD, DOE, and DOC established and oversee institutes that help unify the country around technology development ecosystems. The DoD Manufacturing Innovation Institutes (MIIs) have the additional mission to develop innovative technologies that will ultimately aid the warfighter. The DOE Office of Energy Efficiency & Renewable Energy, Advanced Manufacturing Office also establishes Manufacturing Innovation Institutes to bolster U.S. energy efficiency and innovation.

Department of Commerce: NIST Office of Advanced Manufacturing

The NIST Office of Advanced Manufacturing (OAM) helps to coordinate outreach in the area of advanced manufacturing. The office works in close partnership with other federal agencies to support the acceleration of U.S. innovation and to increase U.S. competitiveness in industrially relevant, cross-cutting advanced manufacturing products and resources. OAM serves as the headquarters for the interagency AMNPO, which is authorized by the Secretary of Commerce to collaborate with federal departments and agencies with missions that contribute to, or are affected by, advanced manufacturing. Within Manufacturing USA, OAM is also responsible for the National Institute for Innovation in Manufacturing Biopharmaceuticals or NIIMBL (the DOC-sponsored Manufacturing USA institute) and for AMTech (a technology roadmapping program).

Department of Defense and the Defense Manufacturing Technology Program

The U.S. Department of Defense's mission is to provide the combat-credible military forces needed to deter aggression and protect the security of our nation. To mature and transition DoD science and technology advances into production, the Department must have access to a robust and responsive U.S. industrial base equipped with advanced manufacturing technologies that deliver critical products and systems affordably and rapidly. Advanced and innovative manufacturing technologies, which enable critical capabilities, ensure that the U.S. military will prevail should the need

[3] *National Network for Manufacturing Innovation Program Strategic Plan*, Executive Office of the President, National Science and Technology Council, Advanced Manufacturing National Program Office (February 15, 2016), p. 9. https://www.manufacturingusa.com/reports/national-network-manufacturing-innovation-nnmi-program-strategic-plan.

for armed conflict arise. To help develop the technology and ecosystems needed to support the Department's mission, the DoD established eight manufacturing institutes through its Defense-wide Manufacturing Science and Technology (DMS&T) program element within the DoD Manufacturing Technology (ManTech) program. Unlike the other manufacturing institutes, the DoD-sponsored manufacturing innovation institutes have the additional mission to develop innovative technologies that will ultimately aid the warfighter.

The DoD Manufacturing Innovation Institutes (MIIs) address commercial and defense manufacturing needs within specific, defense-relevant technology areas and receive active participation and support from the military departments and defense agencies. The institutes' flexible business models and strong focus on enabling highly collaborative research and development catalyze important new organizational relationships across government, industry and academia. Under the leadership of the Under Secretary of Defense for Research and Engineering, the Department continues to foster long-term engagement with the DoD MIIs to support the DoD's modernization technology areas. Already, the institutes have shown progress in support of cybersecurity for manufacturing, micro-electronics, biotechnology, hypersonics, and autonomy, among other modernization priorities.

As a key resource for the Department, the DoD intends to continue investing in their public-private partnerships in order to further enable the development of defense-critical technologies into affordable, domestic defense products. Continued strategic and tactical engagement helps to maintain and enhance manufacturing innovation ecosystems that enable shared access to state-of-the-art equipment and facilities for small, medium, and large manufacturers alike, as well as academia. Through fostering Department engagement, these public-private partnerships help ensure domestic and defense manufacturing needs can be met while protecting intellectual property and providing overmatching technology to the warfighter first. The DoD MIIs further the Department's vision for a National Technology Innovation Base and help ensure that key advanced technologies that are invented in the United States are manufactured in the United States.

In FY 2019, the DoD began the process of establishing a ninth institute focused on bioindustrial manufacturing of non-medical materials, with an anticipated award date in late 2020.

Department of Energy: Advanced Manufacturing Office

The Advanced Manufacturing Office (AMO)—within the Department of Energy's Office of Energy Efficiency & Renewable Energy—is the only technology development office within the U.S. Government that is dedicated to improving the energy and resource efficiency of manufacturers across the industrial sector. Effective and efficient use of our energy, water, and materials resources in manufacturing is essential for the nation's energy security, economic competitiveness, and environmental stewardship.

AMO partners with manufacturers, not-for-profit entities, universities, national laboratories, and state and local governments to develop technologies that will improve energy productivity and make U.S. manufacturing operations more affordable. By addressing energy related manufacturing challenges and reducing risk through merit-based research and development, adoption of AMO-developed technologies can save energy and lower expenses for industry, while reducing emissions, industrial waste, water usage, and the life cycle energy of manufactured goods.

Functions, Governance, and Coordination

Manufacturing USA's four governance operating principles, outlined in its network charter, are:[4]

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

Collaboration is key for effective management and coordination of the Manufacturing USA network. Federal agency members meet monthly to discuss policy decisions for defining and improving the network functions. The agencies coordinate their efforts through the AMNPO in support of the program's national purposes and in recognition that those national purposes are best realized by an integrated whole-of-government effort. The federal agencies embrace this unified effort, while ensuring that the value delivered by their respective institutes remains closely aligned with their agencies' statutory requirements. Maintaining this balance between Manufacturing USA's national programmatic goals and each agency's needs helps ensure that all major stakeholder base requirements are addressed.

Collaboration is also important to the institute directors, who share best practices through their Institute Directors Council meetings. Formalized in the *Charter of the Institute Directors Council: Manufacturing USA*,[5] the council directly supports the goals of the Manufacturing USA Program. The council facilitates cooperation and collaboration among the institutes with advice, as needed, from the federal institute sponsors and other federal agencies, and from the AMNPO, which also provides the council with financial and staff support.

Manufacturing USA has developed a powerful network brand and iconic logo to foster awareness of the institutes as individual applied manufacturing technology centers that belong to a larger network. The logo helps create instant awareness when furthering the cause of advanced manufacturing to nonmember industries and academia, as well as to the media and public.

The AMNPO plays a key role in facilitating peer-to-peer collaboration and serves as an information clearinghouse for internal and external communications. The office communicates with key stakeholders through a variety of means, including Manufacturing USA's website (ManufacturingUSA.com) and social media (Facebook, LinkedIn, and Twitter). Through public materials and industry events, the office shares stories and information about the Manufacturing USA

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[4] *Network Charter: Manufacturing USA Program*, Advanced Manufacturing Series (NIST AMS) - 600-4 Revision 1, Section D, Network Operating Principles, Department of Commerce, National Institute of Standards and Technology (October 2019). https://www.manufacturingusa.com/reports/network-charter-manufacturing-usa-program-revised.

[5] *Charter of the Institute Directors Council: Manufacturing USA*, NIST Advanced Manufacturing Series (NIST AMS) - 600-1, C. Blue, L. Brown, Y. Fink, N. Justice, M. Liehr, E. Morris, p. 3 (November 2016). https://www.nist.gov/publications/charter-institute-directors-council-manufacturing-usa.

network, relevant activities of the participating Federal agencies, and the work of the institutes and their members to develop advanced manufacturing technologies and a skilled workforce.

Manufacturing USA Network Institutes

The 14 manufacturing institutes, each jointly funded by a sponsoring federal agency and private industry, are the core of Manufacturing USA. Each institute focuses on a specific technology area of critical importance to the nation's ability to establish and maintain leadership in advanced manufacturing (see Table 1). The institutes connect member organizations, including large and small private companies, major research universities, community colleges, state and local economic development entities, and Manufacturing Extension Partnership state organizations. Along with the institutes, these partners work together on research and development (R&D) collaboration projects to solve industry's toughest challenges and on training workers, students, and educators in critical advanced manufacturing skills.

Table 1. Manufacturing USA Institutes Cover a Broad Range of Critical Technology Areas

Institute Name	Technology Focus Area	Establishing Agency	Headquarter Locations	Date Established
America Makes — The National Additive Manufacturing Innovation Institute	Additive manufacturing	DoD	Youngstown, Ohio	August 2012
MxD — Manufacturing times Digital	Digital manufacturing and design/ Cybersecurity in Manufacturing	DoD	Chicago, Illinois	February 2014
LIFT — Lightweight Innovations for Tomorrow	Lightweight materials manufacturing	DoD	Detroit, Michigan	February 2014
PowerAmerica — The Next Generation Power Electronics Manufacturing Innovation Institute	Wide-bandgap power electronics manufacturing	DOE	Raleigh, North Carolina	January 2015
IACMI — Institute for Advanced Composites Manufacturing Innovation	Fiber-reinforced polymer composites manufacturing	DOE	Knoxville, Tennessee	June 2015
AIM Photonics — American Institute for Manufacturing Integrated Photonics	Integrated photonics manufacturing	DoD	Rochester and Albany, New York	July 2015
NextFlex —America's Flexible Hybrid Electronics Manufacturing Institute	Thin flexible electronics devices and sensors manufacturing	DoD	San Jose, California	August 2015
AFFOA — Advanced Functional Fabrics of America Institute	Sophisticated, integrated, and networked fibers, yarns, and fabric manufacturing	DoD	Cambridge, Massachusetts	April 2016
CESMII — Clean Energy Smart Manufacturing Innovation Institute	Smart manufacturing, advanced sensors, and process controls	DOE	Los Angeles, California	December 2016
BioFabUSA — Advanced Regenerative Manufacturing Institute	Engineered tissues and tissue-related manufacturing	DoD	Manchester, New Hampshire	February 2017
ARM — Advanced Robotics for Manufacturing Institute	Transformative robotic technologies and education for manufacturing	DoD	Pittsburgh, Pennsylvania	January 2017
NIIMBL — The National Institute for Innovation in Manufacturing Biopharmaceuticals	Biopharmaceutical manufacturing	DOC	Newark, Delaware	March 2017
RAPID — Rapid Advancement in Process Intensification Deployment Institute	Modular chemical-process intensification for manufacturing	DOE	New York, New York	March 2017
REMADE — Reducing Embodied-energy And Decreasing Emissions	Sustainable manufacturing	DOE	Rochester, New York	May 2017

Funds Expended by the Department of Commerce

Congress appropriated $15 million to DOC for Manufacturing USA for FY 2019, of which approximately $10.6 million was spent to provide financial assistance to the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL). Approximately $4.4 million was spent providing for network services supporting Manufacturing USA, operation of the National Program Office, and other legislative requirements. No waivers were requested during the fiscal year.

Manufacturing USA Program Performance

Quantitative and qualitative metrics of the performance of the manufacturing institutes were collected and assessed for FY 2019. As Manufacturing USA grows and matures, additional evaluation metrics will evolve. While this evolution may complicate the comparison of certain metrics over time, Manufacturing USA's leadership is committed to their continuous improvement so that the program can be properly assessed over the long term.

FY 2019 is the fourth year in which quantitative metrics have been reported. Twelve quantitative measures in four program categories were continued from previous years, offering opportunities to track trends. This year's report expands the program's education and workforce metrics, incorporating lessons learned from piloting these metrics with the nine DOC and DoD institutes for the FY 2018 report. The introduction of 10 new education and workforce measures, shown in Table 4, increases the total number of program performance measures to 22. Additionally, several pilot education and workforce metrics are examined using data from institutes sponsored by the DOC and DoD.

As in prior reports, qualitative outcomes from individual institutes were included to illustrate specific examples of institute performance.

As described in the strategic plan, the evaluation strategy for Manufacturing USA and its components is anchored by the following principles and best practices:[6]

- Establish or leverage existing data infrastructures that can manage information needed to address the extent to which Manufacturing USA is meeting its mission and purposes.
- Focus data collection on areas that can best provide rigorous and repeatable analysis.
- Leverage lessons learned from evaluation efforts underway within individual institutes and from other similar programs and related interagency groups.
- Provide a trusted measure of Manufacturing USA's performance that is broad enough to support process-improvement analysis for the future design and activities of Manufacturing USA.
- Leverage partnerships to improve data quality (e.g., linking Manufacturing USA to external sources where appropriate) and to build a community of practice for evaluation.

In addition, each of the lead funding agencies collects metrics for the institutes they fund relative to the agency's unique mission-specific requirements. These separate metrics inform the individual agency who are responsible for overseeing the Federal government's formal relationship with these public-private partners.

[6] *National Network for Manufacturing Innovation Program Strategic Plan*, Executive Office of the President, National Science and Technology Council, Advanced Manufacturing National Program Office (February 15, 2016), p. 27. https://www.manufacturingusa.com/reports/national-network-manufacturing-innovation-nnmi-program-strategic-plan.

Performance Metrics

FY 2019 is the first year in which all the institutes were past their first full year of growth since Congress authorized the program in 2014.[7] It is therefore the first stabilization year for the program as a whole.

In previous years, the aggregated performance metrics have reflected both the growth in activities within the institutes and growth in the number of new institutes established within the previous two years. The performance metrics for FY 2019, however, are slightly different because, while 5 new institutes were established in 2017, no new institutes were launched in either 2018 or 2019. As such, performance demonstrated in the FY 2019 metrics was similar to FY 2018 as the three sponsoring agencies continued operating the same institutes as in the prior two years. With the 14 institutes now all at least two years old and past their early expansion phase, membership numbers and percentage of key technical milestones met were stable. Financial leverage and the number of technology projects both increased significantly. Total STEM participation experienced a drop due to the spin-off of a large web-based program by one of the institutes but grew modestly for the other 13 Institutes. This large dependency on one institute for the total participation metric has been previously noted in the Manufacturing USA annual reports for FY 2017 and FY 2018.

Metrics

Effective quantitative performance metrics are tied to measuring progress toward validated goals and objectives. As seen in Table 2, each institute metric category described in Manufacturing USA's strategic plan provides information for tracking progress toward multiple high-level goals.[8] The four goals are interrelated elements of a robust strategy supporting manufacturing innovation and are based primarily on the legislative program purposes.[9]

Table 2. Manufacturing USA Quantitative Performance Metrics Categories Mapped to the Manufacturing USA Program Goals

Institute Metric Category	Goal 1: Increase the competitiveness of U.S. manufacturing	Goal 2: Facilitate the transition of innovative technologies into scalable, cost-effective, and high-performing domestic manufacturing capabilities	Goal 3: Facilitate development of an advanced manufacturing workforce	Goal 4: Support business models that help institutes become stable and sustainable
Impact to U.S. innovation ecosystem	●	●		●
Financial leverage		●		●
Development of an advanced manufacturing workforce	●		●	
Technology advancement	●	●		

[7] 15 U.S.C. § 278s. http://uscode.house.gov/view.xhtml?req=(title:15 section:278s edition:prelim).

[8] *National Network for Manufacturing Innovation Program Strategic Plan,* Executive Office of the President, National Science and Technology Council, Advanced Manufacturing National Program Office, p. 30 (February 2016). https://www.manufacturingusa.com/reports/national-network-manufacturing-innovation-nnmi-program-strategic-plan.

[9] 15 U.S.C. § 278s(b)(2). http://uscode.house.gov/view.xhtml?req=(title:15 section:278s edition:prelim).

Table 3 provides the aggregated performance metrics values for each specific metric subcategory since 2016, as well as a description of each specific metric and unit of measure.

Broad Participation

During FY 2019, the institutes had 1,920 member organizations, including large and small manufacturers, community colleges, major research universities, and state and local economic development entities. Of these, 1,174 (61%) were manufacturers (industry), and 805 (69%) of those manufacturers were small and medium-sized manufacturing companies (SMMs) with 500 or fewer employees. There were 463 (24 %) universities, community colleges, and technical training schools, and 283 (15%) were in a broad category of other organizations that included federal laboratories, regional economic development agencies, not-for-profit organizations, and state and local governments. Compared to 2018, these numbers reflect year-to-year stability in the number of institute members organizations, as all the institutes are now at least two years old and are past their early rapid growth phases.

Table 3. Aggregated Institute Performance Metrics Values

Institute Metric Category	Specific Metric	Unit(s) of Measure	FY 2016	FY 2017	FY 2018	FY 2019
Impact to U.S. innovation ecosystem	Number of partner organizations with institute membership agreements	Total number of memberships	830	1,291	1,937	1,920
	Diversity of members	Number of large manufacturers (more than 500 employees)	187	295	371	369
		Number of small manufacturers (500 or fewer employees)	361	549	858	805
		Number of academic members (universities, community colleges, etc.)	177	297	474	463
		Number of other entities (government members, government laboratories, not-for-profit organizations, etc.)	105	150	244	283
Financial leverage	Total co-investment in each fiscal year	Amount of cost share expended in each fiscal year and any federal funding not part of the base federal funding	$218.9 M	$177.8 M	$313.5 M	$355 M
Technology advancement	Number and value of active research and development projects	Number of projects ongoing in each fiscal year (projects completed, started, and spanning each fiscal year)	191	273	476	561
		Total institute expenditures in the fiscal year	$333.8 M	$298.5 M	$496.9 M	$488 M
	Percentage of key project technical objectives met in each fiscal year	Percentage of key milestones met in each fiscal year	82 %	79 %	82 %	80 %

Development of an advanced manufacturing workforce (see Table 5 for a more detailed breakdown of these activities for nine institutes)	STEM activities	Number of students participating in institute projects or institute internship programs/training	23,560	185,425	200,169	32,951*
		Number of individuals in the workforce completing a certificate, apprenticeship, or training program led by the institutes	3,386	4,302	2,630†	6,120
	Educator/trainer engagement	Number of teachers or trainers participating in institute-led training	1,023	1,299	2,455	805‡

* In FY 2017 and 2018, Lightweight Innovations for Tomorrow (LIFT), whose education and workforce initiatives have leveraged online platforms to reach students across the country, was responsible for a vast majority of participating students (93 % in 2018). In FY 2019, LIFT concluded its relationship with Learning Blade, which it had funded to develop and host online mission-focused STEM activities that introduced students to material science and lightweight metal knowledge and competencies. LIFT no longer receives usage reports from Learning Blade and, therefore, the program's students are no longer included in the participant totals. However, the online educational materials developed jointly with LIFT continue to be used nationwide.

† In FY 2018 and subsequent years, the definition of a credential was changed to a higher standard. The 2018 value does not include an additional 3,680 participants who were not pursuing an industry-recognized credential, and the 2018 total would have been 6,310 by the old definition. After FY 2018, the old definition will no longer be tracked.

‡ In FY 2019, the Educator/Trainer engagement metric was changed to a higher standard, capturing only individuals who have completed, rather than simply participated in, institute-led training programs. It also excludes training for which there was no formal recognition of completion.

Financial Leverage:

Nonfederal Institute Research and Development Co-Investment Exceeded Federal Program Funds by 2.7-to-1

Once again, in FY 2019, the institutes significantly exceeded the required target of a 1-to-1 match for their funding of institute expenditures. Total institute expenditures were $488 million, with nonprogram matching expenditures totaling $355 million and federal program funds totaling $133 million. Matches from industry, academia, and regional organizations totaled $2.7 for each $1 in base federal funding, significantly greater than even last year's 1.7-to-1 match. These matching funds were expended for technology R&D efforts, capital-intensive efforts such as facility or manufacturing equipment purchases, institute operations, and education and workforce development programs. To date, the institutes have attracted over $1 billion in co-investment support, exceeding the federal investment by more than a factor of two.

Technology Advancement: Advancing Technology and Improving the Innovation Ecosystem

During FY 2019, the institutes managed 561 technology projects that included manufacturing-process research, proof-of-concept development, early system prototyping, and manufacturing demonstrations. This represents an increase of 18% from FY 2018 and more than double the FY 2017 project totals. While R&D projects have inherent risks, an average of 80% of key technical milestones was met in FY 2019. Critical to each institute's success is a rigorous and broadly inclusive approach to selecting project topics. Stakeholders from industry, academia, regulatory agencies, and end users develop roadmaps for key technologies and manufacturing processes. The subsequent R&D projects are selected based in part on their linkage to the roadmaps' time-based technical requirements. The institutes' procedural transparency and the wide acceptance among members of the importance of the institutes' technology roadmaps have helped generate highly qualified teams of industry and academic members doing high-quality collaborative technology development.

Advanced Manufacturing Workforce:

Over 32,000 People Participated in Institute-Led Education and Workforce Development Training Programs

Workforce issues have become increasingly important to the U.S. industrial base, as evidenced by projections of a 2.4 million worker shortfall between 2018 and 2028. Worker training and availability have risen to the top of manufacturing CEO's list of needs, due to the growing mismatch between the current worker skills and the required skills for advanced manufacturing workers.[10] To address this shortfall in each institute's respective area of technical focus, the institutes have maintained a focus on education and workforce development (EWD). In 2019, over 32,000 workers and students participated in institute EWD activities that spanned a broad spectrum of needs.

Because companies need workers trained in advanced manufacturing technologies, the institutes organized programs to upskill existing workers and to create a pipeline of new skilled workers. The complexity of these new technologies requires training that extends beyond the traditional classroom and includes activities such as participation in research and development projects, technical certifications, and hand-on, field-based apprenticeships. The institutes also trained educators, helping them to incorporate information about emerging technologies and manufacturing techniques into their lessons. By teaching trainers already linked to existing educational programs, the institutes ensured that knowledge of work-relevant technologies reached larger numbers of students.

Introduction of New Education and Workforce Development Metrics

While these activities have been ongoing within the institutes since their inception, in FY 2018 additional education and workforce measures were trialed across the DOC and DoD institutes in order to gather a greater understanding of the scope of these activities. That assessment clearly demonstrated the value of these new metrics and, for FY 2019, has led to a further expansion in the metrics being monitored and to the progressive adoption of these metrics across all the institutes. In Table 4, the data obtained from the pilot study of 9 institutes in FY 2018 is shown alongside the FY 2019 data aggregated from all 14 institutes. As originally noted when examining the FY 2018 pilot data, the percentage of EWD projects and expenditures that were commercially funded is small compared to overall activity, comprising only 8% of the number of projects and 7% of the total expenditures.

Table 4. Aggregated Institute Education and Workforce Development Expanded Performance Metrics

Metric	Unit(s) of Measure	FY 2018*	FY 2019
Number of EWD projects or activities	Base-funded projects: base federal funding from the original cooperative agreement or technology investment agreement	45	96
	Commercial-funded projects: provided from industry, regardless of membership status	10	9
	Federal agency–funded projects: resourced from federal funding outside the base CA or TIA funding	9	17
	State- or locally-funded projects: resourced from state or municipal government funding	32	19
	Other funded projects: resourced from philanthropic organizations, nonprofits, foundations, or associations	10	9
	Total number of EWD projects and activities operated by institutes	106	121

[10] *2018 Deloitte and The Manufacturing Institute skills gap and future of work study*, Deloitte Development LLC, Member of Deloitte Touche Tohmatsu Limited (2018), p. 3. https://documents.deloitte.com/insights/2018DeloitteSkillsGapFoWManufacturing

Funding amount expended for EWD projects and activities	Base funding expended: resourced by institute using base federal funding from the original CA or TIA	$5,410,035	$9,418,223
	Commercial expenditures: provided from industry, regardless of membership status	$66,300	$864,942
	Federal agency expenditures: resourced from federal funding outside the base CA or TIA funding	$1,152,223	$2,130,064
	State or local funding expended: resourced from state or municipal government funding	$664,317	$458,572
	Other expenditures: resourced from philanthropic organizations, nonprofits, foundations, or associations	$1,740,003	$2,660,537
	Total expenditures for EWD projects and activities	$9,032,878	$16,662,978

* The data for FY 2018 was obtained from a pilot study of 9 DoD- and DOC-funded institutes. It is shown alongside FY 2019 data aggregated from all 14 institutes.

Refined Education and Workforce Development Metrics (FY 2018 and FY 2019)

Continuing the examination begun in FY 2018 of the three metrics focused on the development of an advanced manufacturing workforce presented each year in Table 3, this report is piloting additional sub-metrics using data from the DOC and DoD institutes. These sub-metrics for FY 2019, along with corresponding data reported by the same nine institutes engaged in the piloted analysis for the FY 2018 report, are provided in Table 5.

The FY 2019 EWD data demonstrate that the institutes have been highly effective at reaching K-12 participants, with K-12 students comprising 68% of the individuals participating in institute EWD projects or institute-led EWD activities. K-12 educators account for 89% of the teachers and trainers completing institute-led training. The institutes have been cost-effective in reaching students and teachers at these grade levels in large numbers by leveraging existing community-based educational institutions, including local public schools. By exposing K-12 students to emerging high-technology career opportunities in manufacturing before the students make formative career decisions, the institutes are strengthening the pipeline of manufacturing workers for future years. Knowledge of these career options is useful for college-bound students and for the 33.8% of high school graduates who do not immediately go to college. These students, as well as those who do not finish high school, have significantly higher unemployment rates than college graduates,[11] and advanced manufacturing provides them with better-paying job opportunities in fields where high demand is anticipated.

The refined EWD metrics for FY 2019 brought to light that the majority of the individuals completing an institute-aligned professional development certification, apprenticeship, or training program fall into the 'Other' category. This indicates that closer examination into those other types of professional development might be of interest.

[11] College Enrollment and Work Activity of Recent High School and College Graduates Summary (April 28, 2020), Bureau of Labor Statistics, https://www.bls.gov/news.release/hsgec.nr0.htm.

Table 5. Aggregated Institute Education and Workforce Development Refined Performance Metrics Assessment of Nine DOC and DoD Institutes			
Specific Metric	**Unit(s) of Measure**	**FY 2018**	**FY 2019**
Individuals participating in institute EWD projects or institute-led EWD activities	K–12 participants: students enrolled full-time in primary or secondary schools and GED candidates not employed full-time in current workforce	191,407*	22,179
	Postsecondary participants: postsecondary students (full- or part-time) not employed full-time in the current workforce (e.g., college student or worker taking a career and technical education class to prepare for a new career)	1,499	2,983
	Manufacturing workforce participants: individuals employed full- or part-time in the manufacturing workforce, whether or not their participation eventually leads to a credential	3,680	7,265
	Total individuals participating in institute EWD projects or institute-led EWD activities		32,427
Individuals completing an institute-aligned professional development certification, apprenticeship, or training program	Certification: Include substantive certifications recognized or otherwise valued by industry. Does NOT include certificates for minor courses	New categories in FY 2019	150
	Apprenticeships: Include arrangements in which someone has completed learning an art, trade, or job under another expert in that field		11
	Other Training Programs: Include other substantive training programs that would be recognized or otherwise valued by industry		4,313
	Total individuals completing an institute-aligned professional development certification, apprenticeship, or training program		4,474
Number of teachers and trainers completing institute-led training	K-12 educators who completed an institute-led training activity	New categories in FY 2019	546
	Post-Secondary educators who completed an institute-led training activity		9
	Manufacturing Workforce teachers and trainers who completed an institute-led training activity		60
	Total number of teachers and trainers completing institute-led training		615

* In FY 2017 and 2018, Lightweight Innovations for Tomorrow (LIFT) was responsible for a vast majority of participating students (93 % in 2018). In FY 2019, LIFT concluded its relationship with Learning Blade and the program's students are no longer included in the participant totals. However, the online educational materials developed jointly with LIFT continue to be used nationwide.

Assessment of New Expanded FY 2019 Education and Workforce Development Metrics

In May 2019, the Manufacturing USA Education and Workforce Development (EWD) Working Group finalized an additional EWD metric that had been developed over several meetings in 2018 and had been agreed to at the March 2019 Manufacturing USA network meeting. Complementing the other EWD metrics, which count different levels of participation equally – a one-day manufacturing facility tour is counted the same way as a two-year apprenticeship, a four-year college degree, or a six-year Ph.D - the proposed metric differentiates the "intended learning depth" of planned activities.

The data from nine institutes presented in Table 6 measures the number of participants in EWD, distinguishing shallower, shorter interactions from deeper, longer-term engagements, in order to determine if the entire spectrum of

learning is being supported. The concept of learning depth uses a depth of engagement scale, from first topical awareness through advancement of technological frontiers, to recognize the value of the attained competency or advancement. The metric is not intended to measure a participant's success towards attaining the learning objectives.

As Table 6 indicates, awareness activities had the largest number of participants. Additionally, nearly 13,000 individuals participated in concept, skills, or application learning. As would be expected given the focus of the institutes on bridging the mid-range gap in the Manufacturing Readiness Levels (MRLs), more of the institute activities are focused on applied skills learning and application activities, rather than on concept learning activities. The collection of this data from the nine institutes piloting this analysis demonstrated that the highest level of activity, creation, is either not occurring or is not being identified by the institutes, which has enabled informed discussions about the best practice for distribution of institute activities across the five levels of intended learning depth.

Table 6. Participation in Education and Workforce Development Activities by Intended Learning Depth Assessment of Nine DOC and DoD Institutes

Metric	Unit(s) of Measure	FY 2019
Individuals participating in institute-led EWD activities, in total, and by the intended learning depth of the activities	1. Awareness: Presentation of information with or without accompanying recall questions *Examples: a short class, presentation, demonstration, or event*	19,468
	2. Concept Learning: Learners understand facts and ideas by classifying, summarizing, comparing, or explaining principals, theories, or models *Example: introductory-level (101) course*	3,420
	3. Skills Learning: Practically oriented learning to apply conceptual knowledge and develop manufacturing-related procedural or process knowledge *Example: intermediate-level (201) course with significant interactive, laboratory, or hands-on components*	4,361
	4. Application: Learners solve problems, identify connections and relationships and how they apply in practical situations *Examples: long-term internship or apprenticeship, or through work-based or project-based learning*	5,178
	5. Creation: Original research or innovation activity that might advance the state of the art. Students critique and evaluate accepted procedural knowledge or create novel methods or combinations of accepted methods *Examples: graduate or post-doctoral research project, novel product design, or an R&D project*	0
	Total number of individual EWD participants for FY 2019 (aggregate of DOC and DoD institutes)	32,427

Outcomes and Activities of the Institutes within the Manufacturing Ecosystem

Department of Commerce: NIST Office of Advanced Manufacturing

The DOC OAM sponsors the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), which works to fundamentally advance U.S. competitiveness in biopharmaceutical manufacturing. NIIMBL focusses on accelerating innovation, on supporting the development of standards that enable more efficient and rapid manufacturing capabilities, and on educating and training a world-leading biopharmaceutical manufacturing workforce.

Examples of the DOC institute's impact on technology development include:

NIIMBL

- NIIMBL's efforts will enable the biopharmaceutical industry to transition from large batch production facilities to smaller, modular and continuous manufacturing operations. This more flexible manufacturing approach will allow better alignment between product demand and manufacturing scale up.

- NIIMBL members are collaborating on integrating process analytical data for quality decisions based in real-time manufacturing data, and more rapid end-product testing methods. These approaches will speed the delivery of emerging types of treatments such as cellular and gene-therapies for cancer patients, where traditional end-product test methods can cause weeks-long delays in treating patients.

Department of Defense: Manufacturing Technology Office

The DoD ManTech Program sponsors eight manufacturing innovation institutes with headquarters and hubs across the country. These institutes address game-changing initiatives that are beyond the scope of any one military department or defense agency through projects and activities that act as the connective tissue that bring together innovative industrial ecosystems in various technology and market sectors in the U.S.

Examples of the DoD institutes' impact on technology development include:

AFFOA

- In FY 2019, AFFOA launched 24 new MicroAwards through 90-day cycles with 2-week sprints for creating a "shot clock" innovation model that drives rapid innovation and prototyping. This mechanism enables the supply chain to showcase scalable, advanced manufacturing capabilities to Industry and the DoD.
- AFFOA developed the first-of-its-kind advanced functional fiber with embedded optical receivers and transmitters that enable optical communication across air-water interfaces, and between undersea assets.

AIM Photonics

- AIM Photonics opened the world's first open 300mm state-of-the-art advanced facility for integrated silicon photonics testing, assembly, and packaging in late 2019. The TAP facility is a key component in AIM Photonics' end-to-end advanced manufacturing capability for photonic integrated circuits (PIC) and is now supporting programs of several members, including Lockheed Martin, University of Rochester, and Ortho-Clinical Diagnostics.
- AIM Photonics has created a complete Photonic Integrated Chip (PIC) manufacturing ecosystem. The facility has recently produced the first-ever fully integrated quantum photonic 300mm wafer for the DoD in partnership with the Air Force Research Laboratory to help explore how integrated photonics can be used to develop future quantum computers.

America Makes

- America Makes coordinated across the DoD to create the first-ever open platform that simplifies sharing 3D model data across the military services. The platform was delivered to the Defense Logistics Agency in late 2019 and has been deployed for warfighter use.
- America Makes kicked off a series of seven additive manufacturing research projects aimed at addressing qualification and certification of additively manufactured metals. It is anticipated that knowledge gained through advancements in additive manufacturing post-processing technology will address critical factors impacting quality, readiness, and cost for a variety of DoD and USAF relevant products.

ARM

- ARM opened their Mill 19 headquarters facility in September 2019. The innovative 60,000-square-foot facility is co-located and in partnership with Carnegie Mellon University's Manufacturing Futures Initiative.
- ARM is attacking the challenges of robotic sewing, most importantly the handling of a limp textile fabric. One project, led by Siemens Corporate Technology in partnership with UC Berkeley, Sewbo, and Bluewater Defense, leverages advanced robotics technology to assemble and sew part of a military uniform, enabling garment production in the U.S. a viable reality.

BioFabUSA

- BioFabUSA demonstrated the first-ever Tissue Foundry, a scalable, modular, automated and closed tissue manufacturing system, in June 2019. The modular design allows BioFabUSA to reconfigure the Tissue Foundry to facilitate the manufacture of any type of tissue product.
- BioFabUSA developed a hands-on biofabrication experience to educate students in grades 6-12 on current and future tissue manufacturing processes. The institute piloted the activities at the 2019 FIRST Robotics Championship in April 2019 with more than 5,000 students.

LIFT

- LIFT developed Operation Next, which is an innovative, manufacturing-focused training and credentialing initiative for soldiers who are in their last six months of service but still on active duty. Of the 101 soldiers who have completed their training and earned a credential, 87% have accepted a job in advanced manufacturing.
- LIFT successfully aided Lifeline Firehose with the production of a state-of-the-art technology that makes it possible for a firehose to deliver both breathable air and water/foam simultaneously. The technology is being launched initially in Grand Ledge, Michigan, allowing firefighters to battle fires longer, as well as get critically needed air to downed personnel and victims.

MxD

- In July 2019, MxD announced their partnership with AT&T to accelerate the deployment of 5G to the U.S. manufacturing industry. AT&T installed 5G technology and Multi-access Edge Compute (MEC) services within MxD's Chicago-based Future Factory to provide an active testbed to demonstrate, prove out, and de-risk the opportunities and benefits 5G brings to manufacturing.
- In concert with MxD, Autodesk opened its Generative Design Field Lab at the facility. The Field Lab is equipped with state-of-the art machinery so that visitors and customers can see how to design, prototype and make products in real time. Generative design allows users to select their preferred manufacturing processes from the beginning, so any solution selected will be manufacturable with the equipment they have at their disposal.

NextFlex

- NextFlex's Technology Hub provides manufacturing-focused R&D, prototyping, and production capability for government and industry and in 2019 achieved compliance with FDA quality system regulations for manufacturing medical devices. The institute led DoD electronics technology transitions through flexible hybrid electronics prototypes in FY 2019, with 14 different technologies under consideration.
- NextFlex continued to grow FlexFactor, a 5-week experience-based program for high-school-aged students that combines advanced manufacturing concepts with basic business model frameworks. The program grew from an initial class of 26 in 2017 to more than 4,500 students to date. Expansion is planned to over 6,200 students per year by 2022.

Department of Energy: Advanced Manufacturing Office

The DOE AMO sponsors five institutes, each having distinct technology focus areas. These institutes facilitate the transition of innovative advanced materials, information, and process technologies to industry by enabling manufacturing scale-up and by helping to develop national capabilities that enable future global leadership and workforce development in advanced manufacturing.

Examples of the DOE institutes' impact on technology development include:

CESMII

- CESMII's Factory 4.0 Toolkit Brings Smart Manufacturing (SM) Education to the Classroom – Penn State University and the Massachusetts Institute of Technology partnered with CESMII to develop an instrumented, small-scale

fiber extrusion kit that models real-world practical manufacturing scenarios along with SM software applications and supporting educational modules. This tool lets students work with SM use cases and makes SM education immediately adoptable in a broad range of engineering, non-engineering, and cross-disciplinary educational programs.

- CESMII Launches Its first Smart Manufacturing Innovation Center – The integrated demonstration facility is located at the Biomanufacturing Training and Education Center (BTEC) at North Carolina State University. BTEC-led project team members integrated CESMII-developed technology (the CESMII SM Innovation Platform™, or SMIP) onto biomanufacturing assets to manage applications from multiple vendors in a way not previously possible in industry.

IACMI

- 42 Students Receive Composites Research and Innovation Opportunities – In 2019, IACMI sponsored 42 students to participate in composites research and innovation at 17 member and partner locations across the country. The students, who presented their research at the Summer 2019 IACMI Members Meeting, engaged in hands-on learning at IACMI member companies, national laboratories, and universities.
- Novel Thermal Composites Recycling – The IACMI-sponsored New Recycled Mixed-Stream Composites project created a novel thermal composites recycling technology based on pyrolysis that uses the inherent energy in composites for fuel and preserves the structural value of glass fiber and carbon fiber for reuse.

PowerAmerica

- Launching a New Independent Testing Facility – Texas Tech University (Lubbock, TX) and Group NIRE (Lubbock, TX) have established an independent, confidential, third party testing facility, demonstrating long-term performance and enhancing end-user confidence in the reliability of wide bandgap devices and accelerating the adoption of these technologies.
- Foundry Access – PowerAmerica members X-FAB Texas and SiCamore Semi provide foundry access to other institute member companies that lack their own manufacturing facilities. In addition, university members, such as SUNY Polytechnic Institute and North Carolina State University, provide research fabrication capability.

RAPID

- Conversion of Waste Biomass to Sugars and other Bioproducts –Iowa State University (Ames, IA) is developing an autothermal process for thermochemical conversion of woody and agricultural biomass to fermentable sugars and other value-added products. The new process uses less process heat than existing processes, is expected to double energy productivity, and is well suited for distributed processing in modular units designed to fit in standard shipping containers.
- Virtual Internship Program – In this structured, 10-week virtual program, engineering student interns at RAPID member organizations join a virtual community and receive online safety, technical, and leadership training, as well as professional development and mentorship. The program helps smaller organizations by giving them access to interns nationwide and by allowing their student interns to become part of a broad virtual network across the U.S.

REMADE

- Scalable High Shear Catalyzed Depolymerization of Multilayer Plastic Packaging - Approximately 12 billion pounds of flexible packaging and plastic wraps is introduced into the U.S. market each year; however, just 1% is collected for post-consumer recycling. The University of Massachusetts-Lowell, Michigan State, Unilever, National Renewable Energy Laboratory, and the American Chemistry Council are investigating whether combining high-speed twin screw extrusion (TSE) and catalytic depolymerization can cost-effectively process these films into higher value products.

- Partnered with New York State Economic Development to deliver workshops in 2020 focused on education and training for small and medium sized businesses. One hundred and seventy (170) people have attended technology workshops geared towards engineers and technicians including Introduction to Plastic Recycling and Remanufacturing, Repair and Reuse. A newly launched Remanufacturing Bootcamp has been converted to an online format and includes a five-part workshop series covering design for remanufacturing, condition assessment, additive repair, cleaning technologies, and more.

The National Science Foundation Support of Collaborative Projects with Manufacturing USA Institutes

In FY 2019, as part of Manufacturing USA's whole-of-government approach, the NSF provided $3.2 million in funding for projects stimulated by three Dear Colleague Letters (DCLs)[12] that encourage researchers and educators to submit proposals that foster collaboration with the institutes. This support brought cumulative NSF funding in support of Manufacturing USA to more than $12.7 million.

[12] *Dear Colleague Letter: Advanced Technological Education (ATE) Program Support for Manufacturing Innovation Institutes and Investing in Manufacturing Communities Partnerships (IMCPs)*, National Science Foundation (NSF 16-007), Susan R. Singer (October 9, 2015). https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf16007; *Dear Colleague Letter: Supporting Fundamental Research to Enable Innovation in Advanced Manufacturing at Manufacturing USA Institutes*, National Science Foundation (NSF 17-088), Barry Johnson (May 25, 2017). https://www.nsf.gov/pubs/2017/nsf17088/nsf17088.pdf; and *Dear Colleague Letter: Research on Integrated Photonics Utilizing AIM Photonics Capabilities*, National Science Foundation (NSF 18-095), Dawn M. Tilbury (July 20, 2018). https://www.nsf.gov/pubs/2018/nsf18095/nsf18095.jsp.

Summary and Assessment of the NIIMBL Report to the Secretary of Commerce

The National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) is the only institute funded under Manufacturing USA's legal authority. NIIMBL is therefore required to submit an annual report to the Secretary of Commerce. A summary and assessment of that report must be included in the Manufacturing USA annual report to Congress.[13] This is a summary and assessment of the NIIMBL 2019 Annual Report to the Secretary of Commerce.

NIIMBL launched operations on March 1, 2017. Its annual report, submitted to the Secretary of Commerce in 2019, covers its second year of performance, and describes the institute's financial standing, key performance metrics, and accomplishments as of February 28, 2019. A public version of this report was published for the NIIMBL National Meeting in June 2019.[14]

NIIMBL's seeks to promote U.S. global leadership in biopharmaceutical manufacturing innovation and to ensure that U.S. inventions become products made in America. The institute's success will promote economic development, with additional impacts on national security and public health, by strengthening the domestic supply chain and advancing the rapid scale-up of bio-manufactured therapies.

NIIMBL's mission is "to accelerate biopharmaceutical manufacturing 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."[15] In alignment with this mission, NIIMBL's report maps their startup activities, goals, plans, and accomplishments to the statutory purposes of the Manufacturing USA program.

NIIMBL reports that, in its second year, the institute:

- Expanded its technical and workforce portfolio to more than 40 projects with a cumulative value approaching $50M;
- Grew its membership to 100+ members including the addition of large industry leaders Genentech, Celgene,
- Merck & Co, Inc., MilliporeSigma/EMD Serono, AstraZeneca, Pfizer, and Sartorius as well as several Small-to-Medium Manufacturers (SMMs);
- Synthesized the collective expertise of the biopharmaceutical community to publish technology roadmaps for gene therapy, antibody-drug conjugates and bispecific antibodies, and vaccines;
- Introduced the NIIMBL eXperience, a hands-on program designed to give underrepresented students a look into career possibilities in the biopharmaceutical industry;
- Announced the Global Health Fund to support cost-saving manufacturing technology development for vaccines;
- Promoted partnerships and idea exchange through our technology workshops, Global Health Fund activities, project call summits, and the annual National Meeting.

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[13] 15 U.S.C. § 278s(i). http://uscode.house.gov/view.xhtml?req=(title:15 section:278s edition:prelim).
[14] *NIIMBL 2018/2019 Annual Report*, The National Institute for Innovation in Manufacturing BioPharmaceuticals (2019). https://niimbl.org/Downloads/NIIMBL2019AnnualReport.pdf, Accessed 06-10-2020

[15] Ibid., p. ii.

Assessment of NIIMBL's Performance

The NIST assessment of NIIMBL's report on its second year of performance, on behalf of the Secretary of Commerce, addresses the institute's financial standing, key performance metrics, and accomplishments. The assessment is positive as indicated in the impacts summarized in Table 7. It is evident that Manufacturing USA's statutory purposes[16] form an important guide to institute decision-making and activities and that the institute showed progress in all areas.

Table 7. NIIMBL FY2018-2019 Performance Snapshot

Manufacturing USA Statutory Purpose	Strategic Objective	Institute Performance Goals	Performance Measures	Performance Indicators	Explanation (data as of February 28, 2019)	Value or Descriptor
A) Improve the competitiveness of U.S. manufacturing and to increase the production of goods manufactured predominately within the United States	Foster diverse membership base to facilitate an end-to-end advanced manufacturing ecosystem	Secure partnerships with critical US stakeholders	Growth in membership	Number of members	Total members	114
				Growth over fiscal year	Yearly Increase	38%
			Membership diversity evident (size, type, and geographic distribution)	Percentage of members signed in each key stakeholder group	Industry members	36%
					Academic members	46%
					State and local non-profit entities	18%
				Geographic diversity	Number of states with NIIMBL members	21
B) Stimulate U.S. leadership in advanced manufacturing research, innovation, and technology	Provide leadership in activities that require industry sector-wide engagement to support advanced biomanufacturing	Convene and lead an ecosystem to industrialize advanced manufacturing technology	Prioritization and project call execution for technical investments	Roadmapping initiatives led	Number of NIIMBL roadmaps published in fiscal year	3
				Technical workshops convened	Number of technology workshops since institute launch	25
C) Facilitate the transition of innovative technologies into scalable, cost-effective, and high-performing manufacturing capabilities	Establish and support a robust technical portfolio to advance biomanufacturing capabilities	Demonstrate capabilities for establishing and maintaining a robust technology portfolio	Technology portfolio growth	Project calls designed and executed	Total number of technology project calls completed since institute launch	4
				Number of technical projects awarded	Total number of technical projects awarded since institute launch	28
				Value of technology portfolio	Total value of technology portfolio investment	$35.1 M

[16] 15 U.S.C. § 278s(b)(2). http://uscode.house.gov/view.xhtml?req=(title:15 section:278s edition:prelim).

D) Facilitate access by manufacturing enterprises to capital-intensive infrastructure	Develop a shared facilities network of biomanufacturing pilot facilities for testbeds and training	Establishment of NIIMBL HQ facility (non-federal funding)	NIIMBL HQ construction and planning on track for Q1 2020 occupancy	Planning and construction timelines met	(Met or unmet)	Met
E) Accelerate the development of an advanced manufacturing workforce; and H) Create and preserve jobs	Establish a robust and industrially relevant workforce development portfolio to increase pipeline and skills	Demonstrate capabilities for establishing and maintaining a robust WFD portfolio	WFD portfolio growth	Number of WFD project calls executed	Total WFD project calls executed since institute launch	4
				Number of WFD projects awarded	Total number of WFD projects awarded since institute launch	15
				Value of WFD portfolio	Total value of WFD portfolio	$9.5 M
F) Facilitate peer exchange of the documentation of best practices in addressing advanced manufacturing challenges	Facilitate sharing and documentation of best practices for addressing advanced biomanufacturing challenges	Develop substantive mechanisms to foster knowledge sharing among ecosystem	Establishment and maintenance NIIMBL website and community portal	Public and member-only access to complete project portfolio	(Met or unmet)	Met
			Ecosystem participation in technical activities	Individuals participating in technology and roadmapping workshops	Total number of individuals participating in NIIMBL technology and roadmapping workshops since institute launch	776
				Unique organizations participating in technology and roadmapping workshops	Total number of unique organizations (member and non-member) participating in NIIMBL technology and roadmapping workshops since launch	192
G) Leverage non-federal sources of support to promote a stable and sustainable business model without the need for long-term Federal funding	Support membership structures that promote sustainable cost-sharing towards institute activities	Demonstrate non-federal leverage to fund institute activities	Meet and exceed Federal award requirements for NIIMBL non-federal cost-share	Non-Federal cost-share	Ratio of non-Federal to Federal cost-match reported for fiscal year ending February 28, 2019	3.13 to 1

It is also evident that industry is embracing this institute through membership and participation in NIIMBL technical activities such as workshops and roadmapping. The high financial leverage indicates a strong commitment by partners even in this early operations phase. NIIMBL fully accomplished the activities and actions identified to NIST in its Year 2 Operating Plan. The report to the Secretary of Commerce is an accurate reflection of the institute's accomplishments for the reporting period.

NIIMBL is the sole institute established under the Manufacturing USA authority given to the DOC. As such, the alignment of NIIMBL's mission and activities is more intentionally governed by the statutory purposes of the Manufacturing USA program than the Manufacturing USA institutes established by the DoD and the DOE under different authorities. The Secretary of Commerce has determined that NIIMBL's standing after its second-year positions NIIMBL to create the impacts for the U.S. economy intended by Congress for Manufacturing USA institutes and that NIIMBL could serve as a model for any future institute funded under the same authority.

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