

Revitalizing America's Manufacturing Workforce

A Manufacturing USA National Roadmap



NOVEMBER 2023



About this Roadmap

This roadmap was commissioned by the Office of Advanced Manufacturing at NIST and prepared by Nexight Group through the engagement of key institute, government, and industry stakeholders. This 2023 Education and Workforce Development roadmap aims to guide and coordinate the efforts of the Office of Advanced Manufacturing and to frame our support of scale-up and coordination efforts across the Manufacturing USA network. By outlining the network's priorities and shared interests, we can drive initiatives to grow the manufacturing workforce and connect workers to good jobs¹ in advanced manufacturing.

About Manufacturing USA

Manufacturing USA[®] is a national network created to secure U.S. global leadership in advanced manufacturing through large-scale public-private collaboration on technology, supply chain, and education and workforce development. The network comprises the U.S. Departments of Commerce, Energy, and Defense; their sponsored manufacturing innovation institutes; and six additional federal agency partners, creating a whole-of-government, national effort to drive innovation in manufacturing.

Each institute includes members from industry, academia, and state and federal governments with a shared interest in advancing manufacturing. In 2022, then 16 institutes collectively worked with over 2,500 member organizations to collaborate on more than 670 applied research and development technology projects of high priority to industry and engaged over 106,000 people in building workforce knowledge and skills in advanced manufacturing. The institutes attracted \$307M from state, federal, and private funds in addition to \$109M in base federal funding.

[Join us and learn more](#) about how we can impact advanced manufacturing in the United States.



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Executive Summary

The Why

Thanks to advances in technology and unprecedented investments in domestic manufacturing and infrastructure improvements, the U.S. manufacturing sector is on track to again become the global leader in manufacturing. While promising, this success cannot be achieved without first addressing a key barrier: **the manufacturing industry's ongoing challenge in attracting and retaining workers.**

4 million

manufacturing jobs—across diverse sectors—will need to be filled by 2030

Source: Deloitte & The Manufacturing Institute²

The How

The Manufacturing USA network of innovation institutes has been working hard since its inception in 2014 to grow and build the advanced manufacturing technologies driving the sector's resurgence. Working with their members, the institutes have made significant progress in both developing education and workforce programming and laying the groundwork needed to engage and prepare workers for future advanced manufacturing jobs in their respective industries. This roadmap identifies the core priorities and guiding principles by which we can support the institutes in developing advanced manufacturing technologies and growing the advanced manufacturing workforce.

The Path Forward

Securing and growing the manufacturing workforce needed at the national scale requires a significant expansion of Manufacturing USA's Education and Workforce Development efforts through coordination across all of the public and private stakeholders within the workforce landscape. Manufacturing USA supports the efforts of its institutes and Agency partners as they work **together** to prepare workers for the technical, high-quality jobs being created in advanced manufacturing nationwide.

By focusing on shared and common workforce development activities, often through regional and sectoral partnerships, we can support U.S. manufacturing by equipping workers with advanced manufacturing skills, while broadening access to and sparking interest in advanced manufacturing careers.



Priority 1: Equip with skills

Providing opportunities for individuals to develop advanced manufacturing skills and succeed in today's evolving manufacturing ecosystem



Priority 2: Broaden access

Removing barriers to career pathways to expand the advanced manufacturing workforce

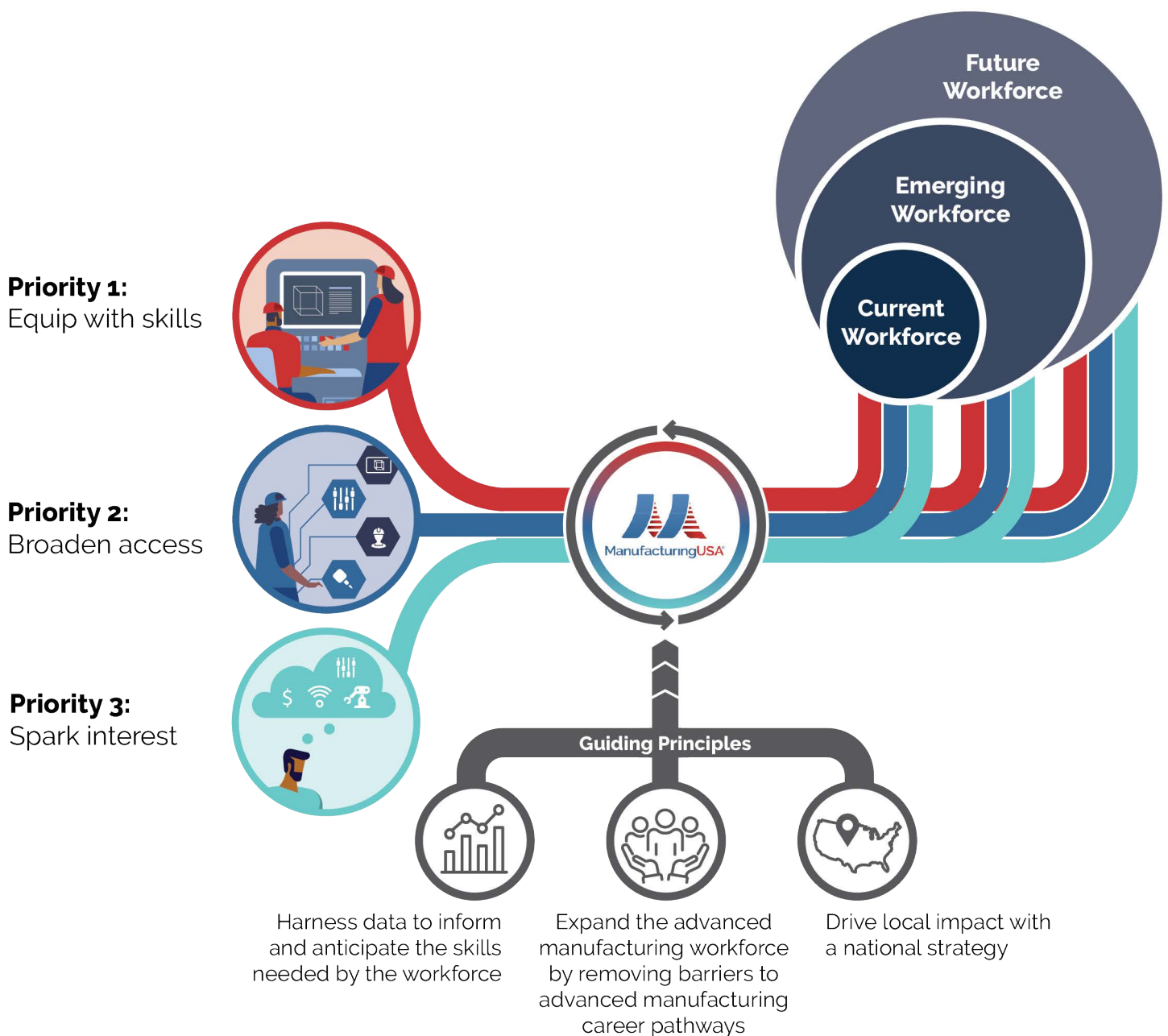


Priority 3: Spark interest

Improving perceptions of today's manufacturing careers to encourage the future workforce to pursue pathways to advanced manufacturing careers

Each institute in the Manufacturing USA network is successfully working to tackle these needs for their respective technology area. However, a network-wide expansion and coordination effort of education and workforce development efforts can drive impact across the U.S. manufacturing landscape. **This roadmap aims to guide this process and provide ideas for initiatives that could have the greatest impact on addressing these gaps and securing a manufacturing workforce for decades to come.**

Overarching Strategy



THE WHY:

The U.S. Manufacturing Comeback Is Generating High-Quality Jobs That Are Going Unfilled

After decades of decline, manufacturing in the United States is on the rise. Post-pandemic production growth and unprecedented investments in domestic manufacturing and infrastructure improvements³ have:

- sparked a surge in total manufacturing construction spending (Figure 1)⁴
- created more than 800,000 jobs⁵
- catalyzed more than \$500 billion in private sector manufacturing and clean energy investment.⁶

Manufacturing is poised to once again become a foundation for the American economy and a platform for the growing middle class,⁷ yet realizing the full potential of this resurgence hinges on one major challenge: identifying, engaging, hiring, and retaining workers. While financing, technology innovations, and supply chain resilience are key to a growing American manufacturing industry, the inability to fill jobs remains the industry's top concern.⁸ For example, the opening of a semiconductor plant under construction in 2023 near Phoenix, Arizona, was delayed by six months because of its inability to fill key, specialized, roles.⁹

Figure 1. Real Total Manufacturing Construction Spending

Billions of 2022 U.S. Dollars



Note: Value of Private Construction Put in Place for Manufacturing. U.S. Census Bureau. Monthly at a seasonally adjusted, annualized rate. Nominal spending deflated by the Producer Price Index for Intermediate Demand Materials and Components for Construction, Bureau of Labor Statistics.

U.S. manufacturing jobs grew at a higher pace than expected from June 2020 through 2022, with the addition of an average of 30,000 jobs per month.¹⁰ Despite global economic cooling in 2023, manufacturers are predicted to generate thousands more tech-related, accessible blue-collar and "new-collar" jobs, many of which will not require a traditional four-year college degree.¹¹

Realizing the full potential of this manufacturing resurgence hinges on our ability to grow the advanced manufacturing workforce to access the high-quality jobs being created.

THE HOW:

An All-of-Manufacturing Approach to Workforce Development

Revitalizing the nation's advanced manufacturing workforce is a multifaceted goal that requires innovative, cross-sector solutions. By engaging key stakeholders, the manufacturing sector can work to collectively identify near-term workforce solutions while enacting forward-facing, data-informed initiatives that forecast anticipated needs and prepare workers for the high-quality jobs of the future. This all-of-manufacturing approach brings to the table those who can enact real change.

Fortunately, over the last decade, the United States **has established a growing national network of manufacturing innovation institutes** (17 and counting) known as Manufacturing USA. The network of institutes brings together entire ecosystems (industry, government, education institutions, research labs) across the manufacturing sector to advance technology, supply chain, and workforce development.

The institutes in the Manufacturing USA network work to advance education and workforce development for the industry sectors they support. As a network, they represent a unique opportunity to significantly grow and equip U.S. manufacturing across sectors through:

1.

Innovation Infrastructure

In the last decade, the institutes have become an infrastructure of innovation, leveraging federal support to **generate additional investments and advance U.S. manufacturing.**

2.

Industry Engagement

The institutes have regular, direct **engagement with manufacturing companies** across the five key sectors critical to the National Strategy of Advanced Manufacturing.¹⁷

3.

Workforce Development

Across the advanced manufacturing ecosystem, the institutes leverage technical expertise, engage industry stakeholders, and generate workforce data to **prepare the nation now for future needs of the manufacturing sector.**

4.

Effective Impacts

A **vast network of members** representing all of manufacturing provides a platform to engage a variety of stakeholders to **drive impact quickly and effectively.**

2022 Impact

Worked with over

2,500

partner member organizations

63% are manufacturers and 72% of those are small companies with 500 employees or fewer

17

institutes across all 50 states

The 17th institute was added in May 2023 and there are more to come

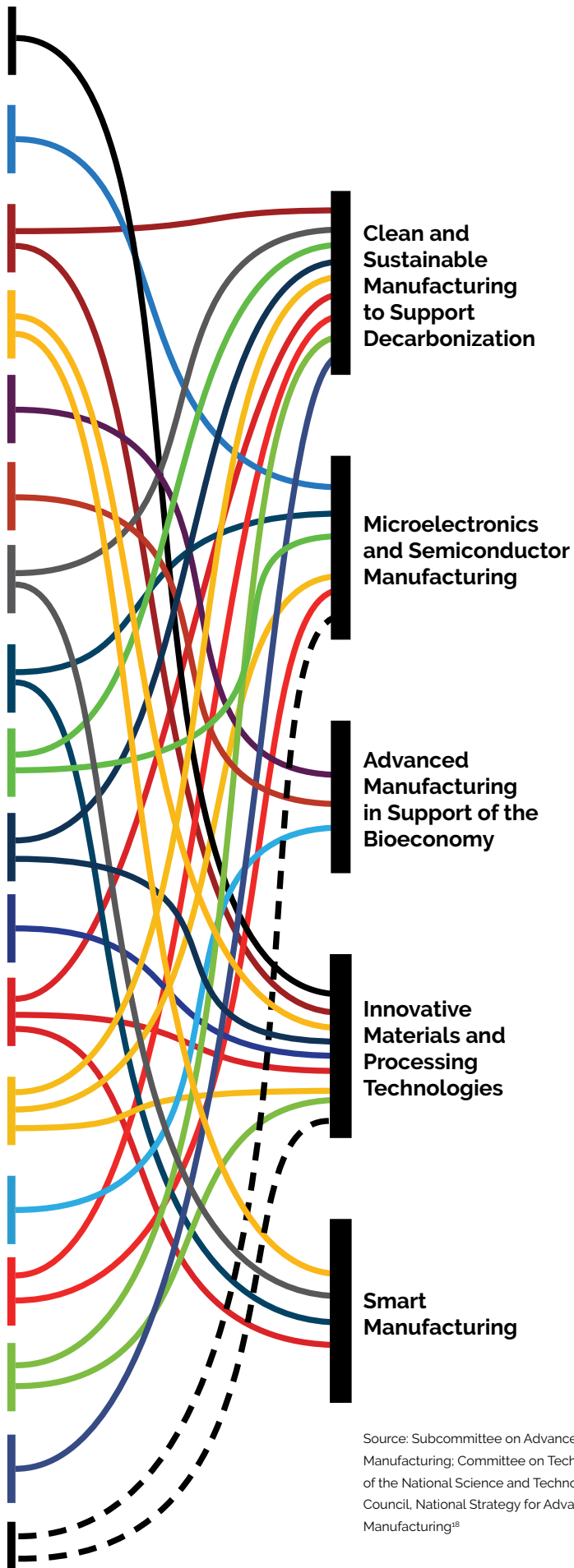
106,000+

workers, students, and teachers

were supported

	AFFOA Advanced Functional Fabrics of America Institute
	AIM Photonics American Institute for Manufacturing Integrated Photonics
	AmericaMakes The National Additive Manufacturing Innovation Institute
	ARM Advanced Robotics for Manufacturing
	BioFabUSA Advanced Regenerative Manufacturing Institute
	BioMADE Bioindustrial Manufacturing and Design Ecosystem
	CESMII Clean Energy Smart Manufacturing Institute
	CyManII Cybersecurity Manufacturing Innovation Institute
	EPIX Electrified Processes for Industry Without Carbon
	IACMI The Institute for Advanced Composites Manufacturing Innovation
	LIFT Advanced Lightweight Metals
	MxD The Digital Manufacturing & Cybersecurity Institute
	NextFlex America's Flexible Hybrid Electronics Manufacturing Institute
	NIIMBL National Institute for Innovation in Manufacturing Biopharmaceuticals
	PowerAmerica Next Gen Power Electronics
	RAPID Rapid Advancement in Process Intensification Deployment Institute
	REMADE Reducing EMBodied-Energy and Decreasing Emissions
	Future Institute(s)

Institutes



National Strategy for Advanced Manufacturing: Technology Objectives

Source: Subcommittee on Advanced Manufacturing; Committee on Technology of the National Science and Technology Council, National Strategy for Advanced Manufacturing¹⁸

Manufacturing USA Education and Workforce Development Guiding Principles

Across these priorities, workforce categories, and manufacturing sectors, **three guiding principles** drive the Manufacturing USA network's education and workforce development efforts:



Harness data to inform and anticipate the skills needed by the workforce

Through the power of technical expertise across the network, coupled with data and data tools, efforts can be focused to meet and anticipate manufacturing workforce needs at a national, regional, and local level. Innovative manufacturing technology development efforts taking place at each Institute and across the Manufacturing USA network inform future workforce needs and ensure the United States can anticipate the skills needed for future jobs and proactively work to align curriculum and learning programs with industry needs.



Expand the advanced manufacturing workforce by removing barriers to advanced manufacturing career pathways

A continued, coordinated commitment to removing barriers to advanced manufacturing will expand the U.S. workforce and encourage the future and emerging workforce to consider roles in advanced manufacturing. This will help bring new ideas into the workforce, and the continuous development of novel career pathways and education opportunities can also create an industry environment in which workers want to stay and pursue long-term career progression.¹⁸



Drive local impact with a national strategy

Success of this roadmap will depend on the network's ability to drive large-scale, national initiatives to generate community and regional impact and support good jobs for the economy. Institutes can initiate collaboration with homegrown community organizations to customize programs for the differing needs of different communities. This grassroots engagement will help accelerate programming in both the near and long term.

The institutes in the Manufacturing USA network stand ready to:

- **Deploy the technology, education, and workforce development infrastructure** they have built over the last decade
- **Leverage tested and piloted education and workforce development initiatives** for scale up across the U.S.
- **Work together** to tackle the biggest challenge facing U.S. manufacturers: **finding, hiring, and retaining workers**

Potential Initiatives

Current
Workers
(Current Jobs)

Emerging
Workforce
(For Jobs in
0-4 Years)

Future
Workforce
(For Jobs in
5-15 Years)

Priority 1: Equip the advanced manufacturing workforce with evolving skills

Manufacturing the Future: Hands-On, Standards-Based Experiment Kits Connecting STEM to Careers in Manufacturing			●
Manufacturing USA Academy	●	●	
Curriculum to Careers: Manufacturing	●	●	
Manufacturing USA institutes x NSF ATE Centers	●	●	
Industry-Recognized National Manufacturing Credential Program	●	●	
National Network of Regional Innovative Learning Hubs	●	●	
Manufacturing USA Endorsement Program	●	●	

Priority 2: Broaden access to advanced manufacturing career pathways

Manufacturing USA Pre-Apprenticeship & Apprenticeship Program	●	●	●
Manufacturing USA x Career and Technical Education (CTE)			●
Manufacturing USA x Manufacturing Extension Partnerships (MEP)	●	●	●
Manufacturing Career Website	●	●	●

Priority 3: Spark interest in advanced manufacturing careers

National Manufacturing Career Pathway Outreach Program			●
Manufacturing USA x Youth Organizations			●
Manufacturing USA x Educator Organizations		●	●
Careers in Manufacturing Outreach Campaign	●	●	●
Modern Makers Outreach Campaign	●	●	●
Manufacturing Day	●	●	●

Priority 1: Equip the advanced manufacturing workforce with evolving skills

Leveraging cross-network advanced manufacturing expertise and existing workforce development program portfolios, the institutes in the Manufacturing USA network will work together to develop and rapidly scale learning and development opportunities. These opportunities will be designed to equip the current, emerging, and future workforce with the skills needed to succeed in the increasingly technical manufacturing sector and fill current and anticipated job openings.

- With a technically skilled workforce, manufacturers will be better able to hire and retain employees with the right industry-relevant skillsets needed for today's highly technical jobs.
- Emerging and future workers will be prepared, often without needing a 4-year degree, for quality, family-supporting manufacturing jobs.
- Current workers will have better opportunities to grow their skillsets to keep pace with evolving technologies and advance their careers.



Potential Initiatives

Current Workers

Emerging Workforce (0-4 years)

Future Workforce (5-15 years)

Manufacturing the Future: Hands-On, Standards-Based Experiment Kits Connecting STEM to Careers in Manufacturing

Leveraging technical expertise and the vast professional connections across the institutes in the Manufacturing USA network, develop a new initiative that ships hands-on STEM experiments at no cost to schools. The kits include standards-based lesson plans and FAQs for parents and guidance counselors, while connecting students in the classroom to real people working in manufacturing via a virtual meeting platform



Manufacturing USA Academy

A one-stop-shop website for individuals and manufacturers to access advanced manufacturing learning and development content across the manufacturing institutes and manufacturing sectors. Includes national, virtual opportunities as well as local and regional in-person opportunities



Curriculum to Careers: Manufacturing

A data-driven mechanism/program to align (and continue to align) the workforce skills needed by manufacturers nationwide with curriculum at 4-year and 2-year technical educational institutions. This ensures graduates from academic institutions are equipped with job-ready skills



Manufacturing USA Institutes x NSF ATE Centers

Support the ongoing development of entry-level technicians with skills needed by industry on an evolving basis with a strategic collaboration between the Manufacturing USA network and the National Science Foundation's Advanced Technological Education (ATE)



Industry-Recognized National Manufacturing Credential Program

A cross-network program to assess, validate, and standardize industry-recognized credentials



See Page 22 for more information on REMADE Academy



National Network of Regional Innovative Learning Hubs

Leverage existing and develop new regional learning labs and innovation hubs to facilitate in-person, hands-on training for high-demand jobs. IACMI's America's Cutting Edge (ACE) program is an Institute-specific example/best practice



Manufacturing USA Endorsement Program

A cross-network program to establish industry standards and endorse learning programs across educational institutions, non-profit organizations, and other learning organizations that prepare and equip the manufacturing workforce



= Ready-to-Scale Model

Potential Initiatives

Current Workers

Emerging Workforce (0-4 years)

Future Workforce (5-15 years)

National Manufacturing Career Pathway Outreach Program

Continued scaling and regional expansion of a student outreach program. NextFlex's FlexFactor® program is an institute-specific example and best practice, and a model that expanded to other institutes



See Page 21 for more information on NextFlex



Manufacturing USA x Community-Based Organizations

Develop strategic partnerships, sponsorships, and joint strategies with youth organizations involved in K-12 outreach. Examples include FIRST Robotics, Girl Scouts, Scouts BSA, Junior Achievement, and others



Manufacturing USA x Educator Organizations

Develop strategic partnerships with teacher unions, teacher associations, and career counselor associations; connect to resources developed under Priority #1



Careers in Manufacturing Outreach Campaign

Leverage digital communication tools such as social media (e.g., LinkedIn), Manufacturing USA's website, and more to promote awareness of manufacturing careers and career pathways



Modern Makers Outreach Campaign

Continue highlighting inspiration and worker-focused stories and supporting students, aspiring workers, and industry leaders



Manufacturing Day

Continue to share and promote information and events hosted by Manufacturing USA institutes that can help broaden awareness of advanced manufacturing and its opportunities



= Ready-to-Scale Model



Ready-to-Scale Examples

- PRIORITY 1: Equip with skills
- PRIORITY 2: Broaden access
- PRIORITY 3: Spark interest



READY-TO-SCALE MODEL:

RoboticsCareer.org Connects Students and Existing Workers with Robotics Training

OVERVIEW

RoboticsCareer.org, powered by the ARM (Advanced Robotics for Manufacturing) Institute, is the only national capability that **highlights robotics training that has been vetted by industry experts** and connects education seekers—both students and existing workers—with training in their region or nationally that is aligned to their desired career pathway.

The free, online platform maps advanced manufacturing robotic competencies to career pathways and education programs and job opportunities. Additionally, the ARM Institute identifies and endorses the best robotics programs with a seal of approval following an audit and evaluation process.

NATIONWIDE IMPACT



16,700+
training programs
from 2,500 organizations
featured on the platform



Over **3,000**
job opportunities
in robotics in
manufacturing



24 programs
recognized by the ARM
Institute as a top-tier training
program for robotics careers
in manufacturing



READY-TO-SCALE MODEL:

BioTrek Introduces Students to Developing Lifesaving Biotechnology Concepts and Career Pathways in Regenerative Medicine

OVERVIEW

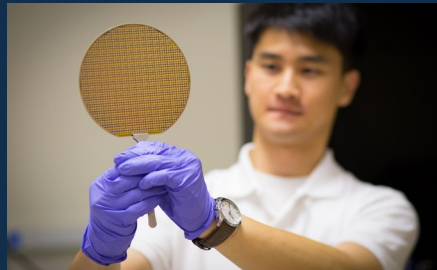
BioTrek is a problem-based learning program to **inform, attract, inspire, and recruit students to engage with biofabrication and regenerative medicine**. It incorporates teaching students about the science and technology of tissue engineering, the need for cells, tissues and organs for transplant patients and people with chronic diseases, and provides information on the myriad of career pathways that the industry has in store for them.

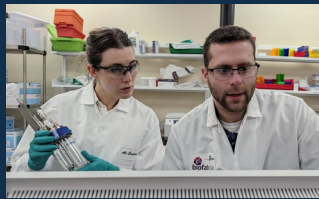
Following NextFlex's FlexFactor template, students have proposed many different ideas, such as skin for burn victims, islet cells for diabetes patients, replacement ligaments for knee surgery, and more.

NATIONWIDE IMPACT

School Year	Total Schools Supported	Total Students
2020–2021	1	78
2021–2022	5	452
2022–2023	9+	575
2023–2024	20+ planned 4 schools served as of Nov. 1	—

Every day, Manufacturing USA institutes bring together industry, academia, and government to fuel the development of a skilled U.S. workforce.

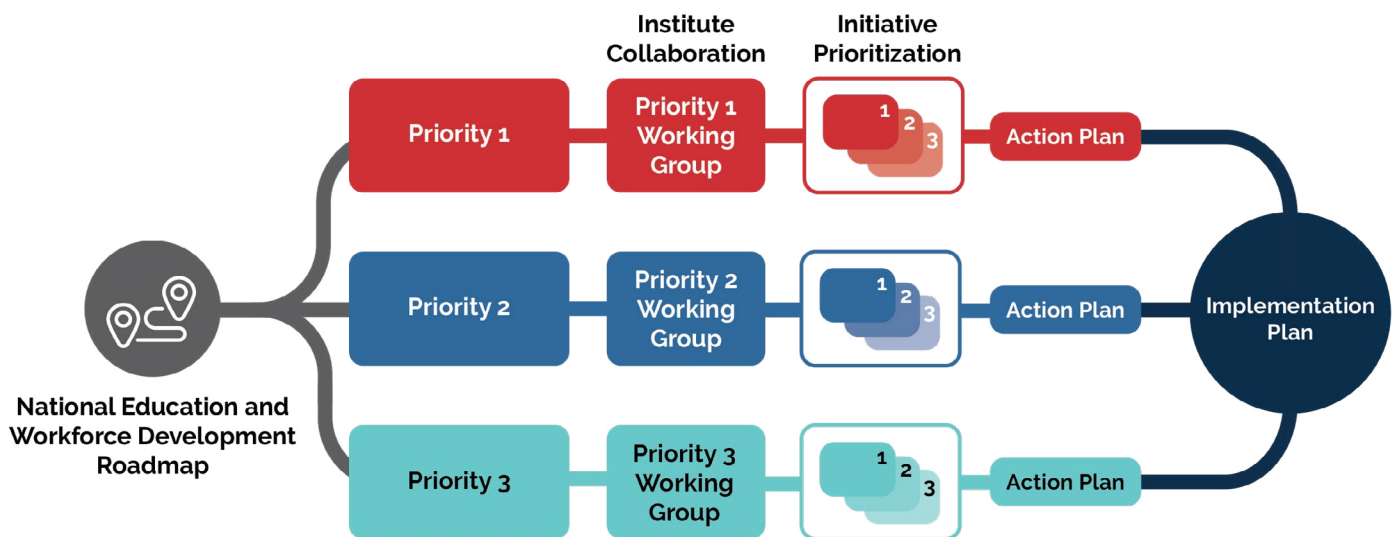




Call to Act

With heightened innovation and unprecedented resources bringing more advanced manufacturing technologies online than ever before, the time is now for us all to collectively invest in U.S. manufacturing education and workforce development.

Manufacturing USA institutes stand ready to leverage the groundwork they have already laid and the experts they already have in place to undertake some of the initiatives in this roadmap:



But securing and growing the manufacturing workforce at the national scale needed will require a significant scale-up of the institutes' efforts through support from all the public and private stakeholders in the workforce landscape. In the coming months, using this roadmap as a guide, we will tap into our networks, leverage progress already made, and ramp up collective efforts to grow the workforce to fill good, quality advanced manufacturing jobs now, and for years to come.

Join us in supporting the innovation revolution.



ManufacturingUSA.com



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