

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.



Table of Contents

- Executive Summary**2
- The Why:** The U.S. Manufacturing Comeback Is Generating High-Quality Jobs That Are Going Unfilled4
- The How:** An All-of-Manufacturing Approach to Workforce Development6
- The Path Forward:** Manufacturing USA National Education and Workforce Development Roadmap.....10
 - Priority 1: Equip the advanced manufacturing workforce with evolving skills*.....14
 - Priority 2: Broaden access to advanced manufacturing career pathways*.....16
 - Priority 3: Spark interest in advanced manufacturing careers to secure a steady workforce talent pool*18
- Call to Act**.....26
- References**28

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

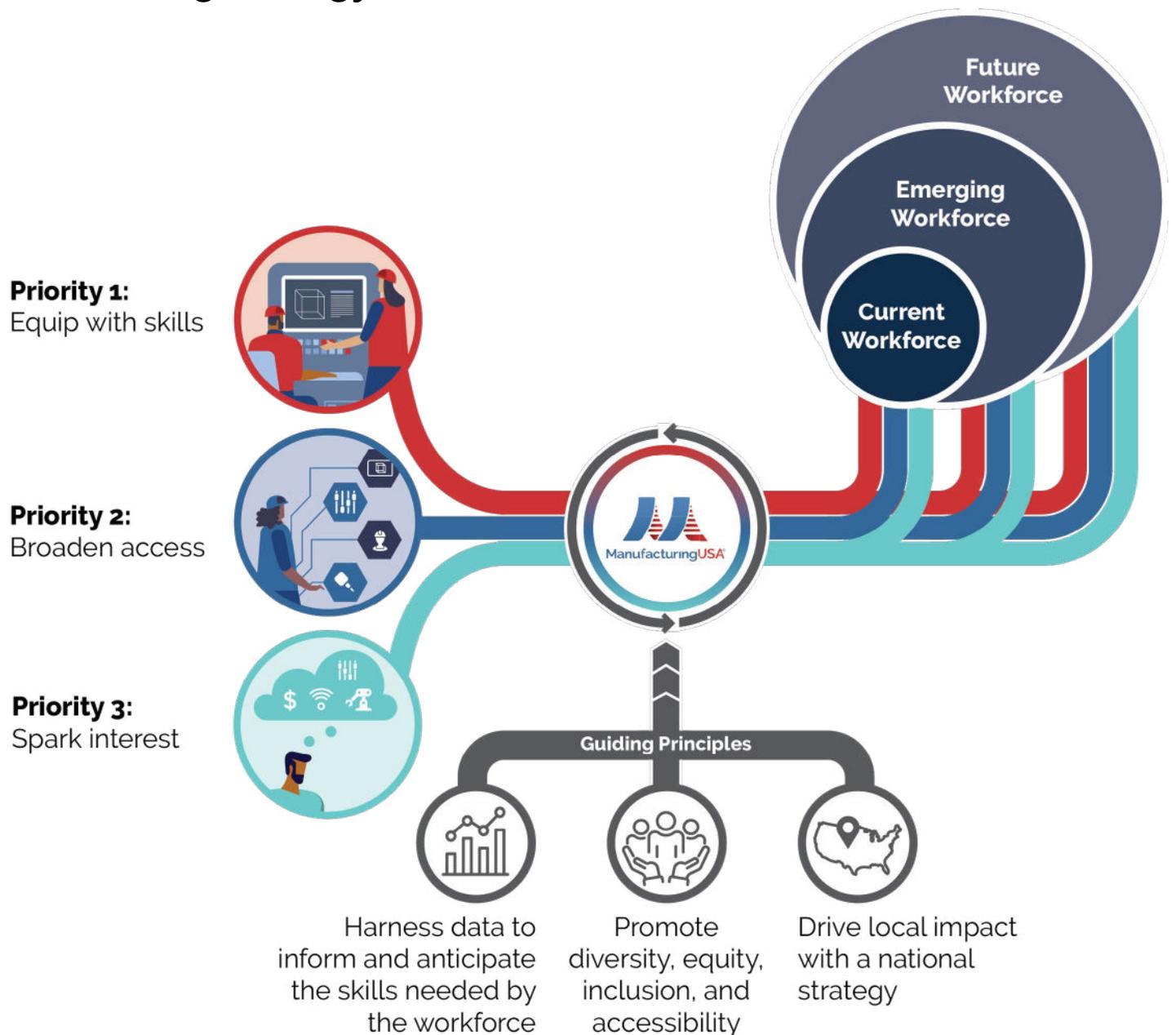


Priority 3: Spark interest

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.

Advanced manufacturing jobs are often considered to be good jobs (as defined by the Good Jobs Initiative), which are the foundation of an equitable economy that lifts up workers and manufacturers, making the United States competitive globally.¹²

Estimates predict an additional 4 million manufacturing jobs will be created by 2030.¹³

However, more than half of those jobs could remain unfilled for two reasons: employers can neither hire a sufficient number of entry-level employees nor enough qualified talent to fill “middle-skill” jobs often requiring some level of technical training or applied skills.¹⁴

The predicted workforce shortage could cost the U.S. economy up to \$1 trillion in lost economic activity.¹⁵

Alleviating a manufacturing workforce shortage with economic and national security implications **requires an all-of-manufacturing approach**. A nationwide convening of manufacturers where educational institutions prepare the current, emerging, and future workforce can drive progress towards:

1. Manufacturers (small, medium, and large) having access to a steady talent pool of workers with up-to-date, industry-relevant skills.
2. Equitable access to education and career pathways to prepare more individuals for high-quality jobs in manufacturing and create a more representative workforce.
3. Improved perceptions of the manufacturing sector and consideration of manufacturing careers as a top choice, in part by improving job quality and wages.¹⁶

To support a U.S. ramp-up in manufacturing capacity and infrastructure, commensurate investments in building an advanced workforce must be made.

Now is the time for significant action to revitalize America's manufacturing workforce.

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

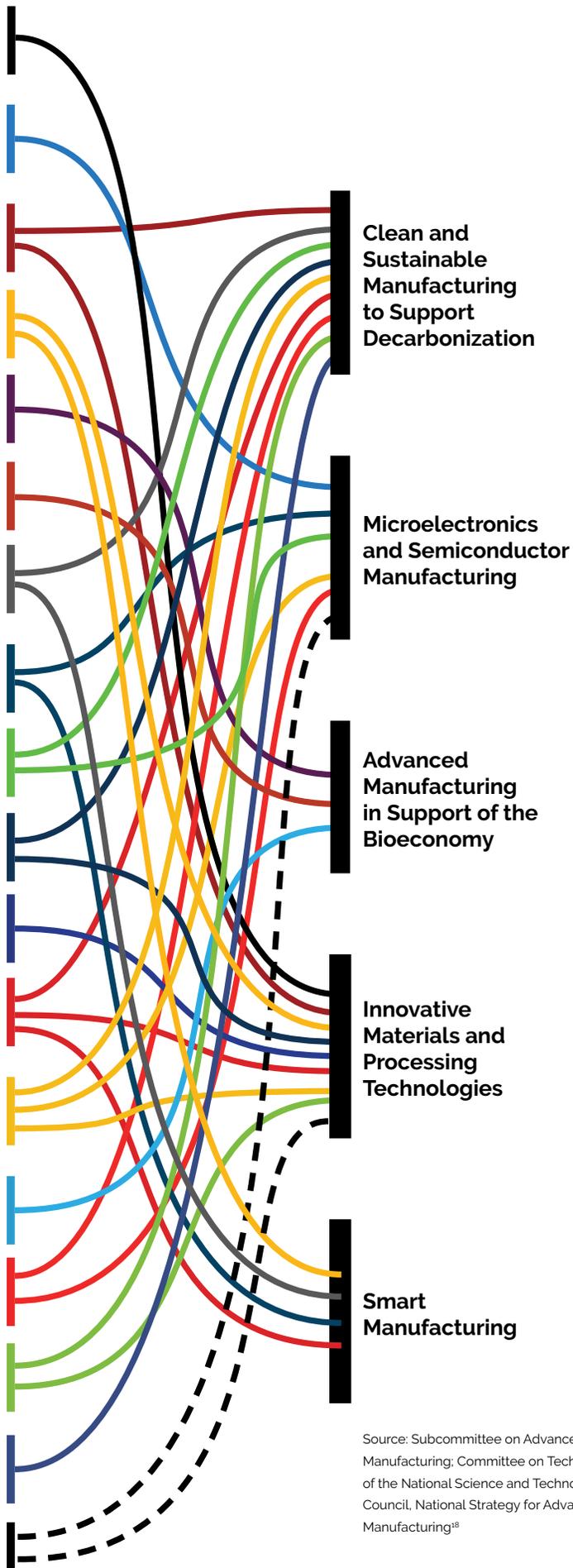
106,000+

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.



Promote diversity, equity, inclusion, and accessibility

A continued, coordinated commitment to driving diversity, equity, inclusion, and accessibility (DEIA) will broaden the U.S. workforce and encourage the future and emerging workforce to consider roles in advanced manufacturing. DEIA approaches will help bring new ideas into the workforce, and the continuous development of DEIA principles 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**

Recent Examples of Cross-Institute Collaboration

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

HI-TEC Conference

July 2023

Engaged and strengthened advanced manufacturing collaborations with the NSF Advanced Technological Education community



Modern Makers Outreach Campaign

May 2023

Highlighted inspirational and worker-centric stories and elevated students, aspiring workers, and industry leaders



Rapid Assistance - Coronavirus Economic Response (RACER) Grant Program

2022-2023

Awarded 13 projects with student research components and supported 3 workforce training milestones to increase the national pipeline



Girl Scouts Collaboration

July 2023

Supported the launch of the Manufacturing in a Box program at the 56th National Girl Scout Convention. The box includes 4 innovative kits where Girl Scouts earn badges in:

- Automotive Manufacturing
- Mechanical Engineering: Fling Flyer
- Designing Robots
- STEM Career Exploration



International Manufacturing Technology Show

September 2022

Supported Manufacturing USA focused sessions and podcasts on Advanced Manufacturing and the Smartforce Student Summit. Sponsored the Miles for Manufacturing 5K race (a fundraiser that supports students/classrooms at disadvantaged schools; also sponsored the race at The Association for Manufacturing Technology's 2023 meeting) and the Women Make Manufacturing Move program



2022 National Strategy for Advanced Manufacturing Implementation Committee

Ongoing

Supporting the National Strategy for Advanced Manufacturing Implementation Committee in developing and implementing advanced manufacturing technologies, growing the advanced manufacturing workforce, and building resilience into manufacturing supply chains



Manufacturing USA Workforce, Education, and Vibrant Ecosystems (WEAVE)

Ongoing

Distributing 11 million dollars in public service awards to projects intended to build vibrant and diverse ecosystems and transition institute-developed technologies into commercial use



Network-wide support resources

Ongoing

Fostering information sharing and coordinated outreach by developing a central repository of institute programming, distributing outreach kits, promoting Manufacturing Day, and creating manufacturing workforce-related stories and videos



THE PATH FORWARD:

Manufacturing USA National Education and Workforce Development Roadmap

Roadmap Priorities

To maximize the full potential of the U.S. manufacturing resurgence and ensure the nation's manufacturers have access to a skilled, diverse, and steady talent pool, this roadmap establishes three key priorities for an all-of-manufacturing approach to workforce development:



Priority 1: Equip an advanced manufacturing workforce with evolving skills

The advanced manufacturing workforce of today and tomorrow requires the necessary skills to develop, deploy, and operate innovative technology. Growing and continually updating skillsets to meet industry needs requires technical learning content, curricula, and training opportunities. As technology continues to advance, initiatives must be in place to equip the workforce with the skills they need to acquire and succeed in high-quality jobs and advance the sector.



Priority 2: Broaden access to advanced manufacturing career pathways

Removing barriers to education and career pathways for groups that have historically been left out of advanced manufacturing careers (e.g., disadvantaged communities, women, underrepresented minorities, individuals with disabilities) not only broadens the manufacturing talent pool but also promotes more inclusive workplaces, which help improve worker retention and increase career progression opportunities.



Priority 3: Spark interest in advanced manufacturing careers to secure a steady workforce talent pool

Improved perceptions and greater awareness of roles in the advanced manufacturing industry will help exponentially grow the size the industry' talent pool.

Manufacturing Workforce Categories



Current Workforce:

Individuals currently employed in an advanced manufacturing job

These workers require learning and development opportunities to grow and evolve their skillsets and keep up with technology transformations.

This can include:

- Current workers advancing their careers
- Upskilling workers
- Managers
- Technicians
- Workers maintaining industry-relevant skillsets

Emerging Workforce:

Those actively pursuing pathways to careers in advanced manufacturing, with a likelihood of joining the workforce in about 0-4 years

This category can include individuals:

- Pursuing industry-recognized credentials or certificates
- Enrolled in post-secondary academic institutes (2-year or 4-year)
- Working as apprentices

These individuals need their schools or credential programs to provide them with the right skills and preparation for a career in the advanced manufacturing sector. They also need to connect with high-quality job opportunities that leverage their skillsets.

Future Workforce:

Individuals who may or may not have decided on a science, technology, engineering, and mathematics (STEM) or manufacturing career path or are considering alternative career paths, with a likelihood of joining the workforce in about 5-15 years

This can include:

- K-12 students
- Veterans
- Displaced workers, underemployed workers, or workers in other sectors

To encourage the future workforce to pursue careers in advanced manufacturing, these individuals (and those who support them) need to understand the requirements and pathways to high-quality jobs.

To maximize the full potential of the U.S manufacturing resurgence and ensure the nation's manufacturers have access to a skilled, diverse, and steady talent pool, **this roadmap outlines three priorities and serves as a guide for an all-of-manufacturing approach to workforce development.**



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	●	●	●
U.S. Manufacturer's Guide to Diversity, Equity, Inclusion, and Accessibility	●	●	

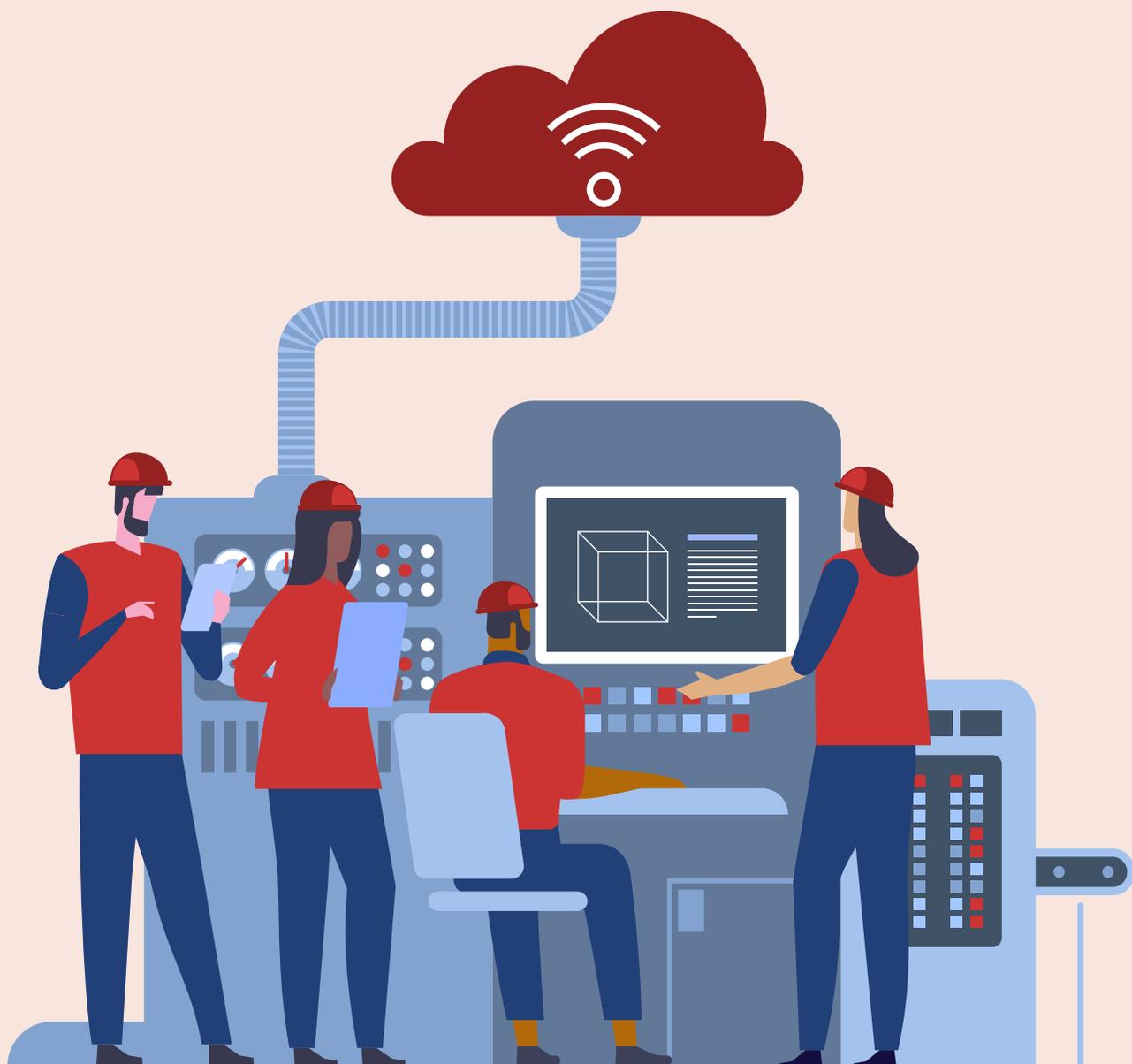
Priority 3: Spark interest in advanced manufacturing careers

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.



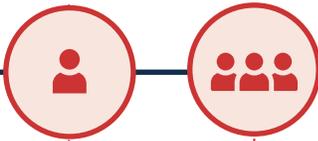
Potential Initiatives



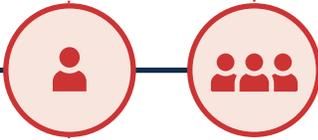
Manufacturing the Future: Hands-On, Standards-Based Experiment Kits Connecting STEM to Careers in Manufacturing
 Leveraging technical expertise and the vast professional connections across the institutes in the Manufacturing USA network, develop a new initiative that ships hands-on STEM experiments at 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



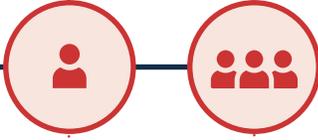
Manufacturing USA Academy
 A one-stop-shop website for individuals and manufacturers to access advanced manufacturing learning and development content across the manufacturing institutes and manufacturing sectors. Includes national, virtual opportunities as well as local and regional in-person opportunities



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

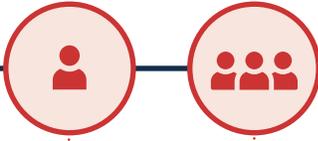


Manufacturing USA Institutes x NSF ATE Centers
 Support the ongoing development of entry-level technicians with skills needed by industry on an evolving basis with a strategic collaboration between the Manufacturing USA network and the National Science Foundation's Advanced Technological Education (ATE)

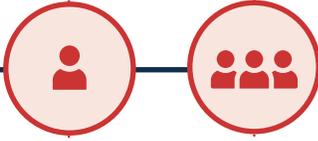


Industry-Recognized National Manufacturing Credential Program
 A cross-network program to assess, validate, and standardize industry-recognized credentials

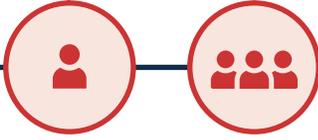
 See Page 22 for more information on REMADE Academy



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

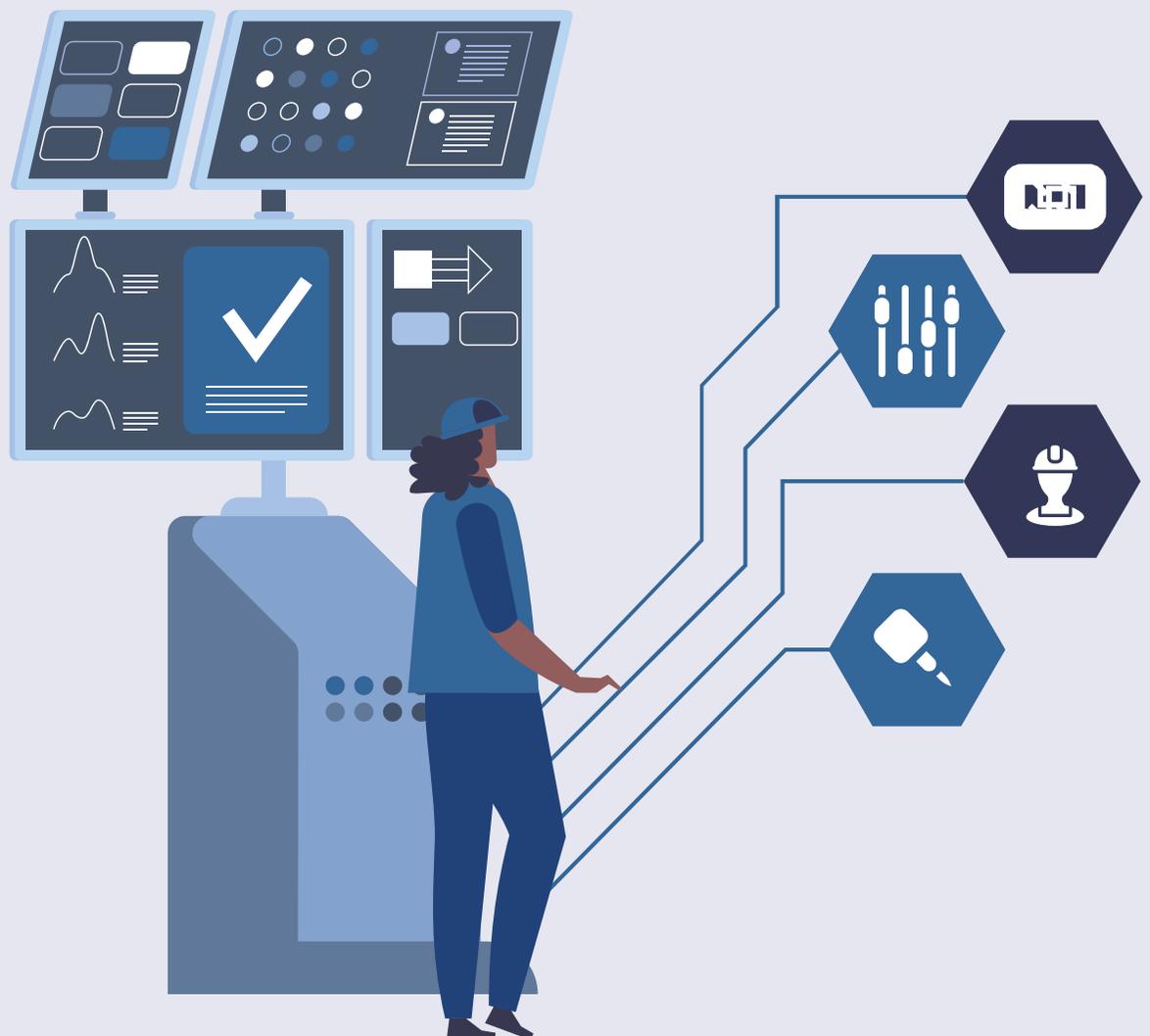


 = Ready-to-Scale Model

Priority 2: Broaden access to advanced manufacturing career pathways

By leveraging a broad network of members, partners, and regional connections, like community-based organizations, the institutes in the Manufacturing USA network will work together to expand the manufacturing talent pool and broaden the workforce by creating more opportunities for historically underrepresented groups to access education and career pathways that lead to high-quality careers.

- As workforce shortages persist in the manufacturing industry, it is imperative that employers diversify their talent pool to ensure that they can find, hire, and retain their needed workforce.
- By removing historic barriers (biased hiring practices, language and communication barriers, childcare needs, lack of accessibility and transportation, lack of regional learning opportunities, and more) that prevent individuals from joining the manufacturing workforce, the sector can dramatically broaden and increase its talent pool and provide more individuals with access to high-quality jobs.
- Additionally, an increasingly inclusive working environment within advanced manufacturing encourages and improves employee retention by providing long-term career growth with family-supporting salaries, allowing workers to stay rather than search for these opportunities elsewhere.



Potential Initiatives

Current Workers

Emerging Workforce (0-4 years)

Future Workforce (5-15 years)

Manufacturing USA Pre-Apprenticeship & Apprenticeship Program

With a focus on disadvantaged communities, this cross-network approach to pre-apprenticeships and apprenticeships creates standard, sector-based training curricula and a centralized/standard approach to collaboration across Institute industry members



Manufacturing USA x Career and Technical Education (CTE)

Promote advanced manufacturing technical skill development through a cross-institute collaboration with the Career & Technical Education Program



Manufacturing USA x Manufacturing Extension Partnerships (MEP)

A cross-network approach to developing and scaling technical education and development efforts with priority on disadvantaged communities and small- to medium-sized enterprises, including wraparound and accessibility services



Manufacturing Career Website

A website for individuals to learn about pathways to high-quality careers in advanced manufacturing and match skills and interest to education pathways/opportunities and job openings in their area. The ARM Institute's RoboticsCareer.org is an existing Institute-specific example and best practice



See Page 22 for more information on RoboticsCareer.org



U.S. Manufacturer's Guide to Diversity, Equity, Inclusion, and Accessibility (DEIA)

An online resource for U.S. manufacturers and institute members with resources and guidance on promoting DEIA throughout recruitment, hiring, and retention processes and recommendations for community-based organizations for partnership at the local and regional levels

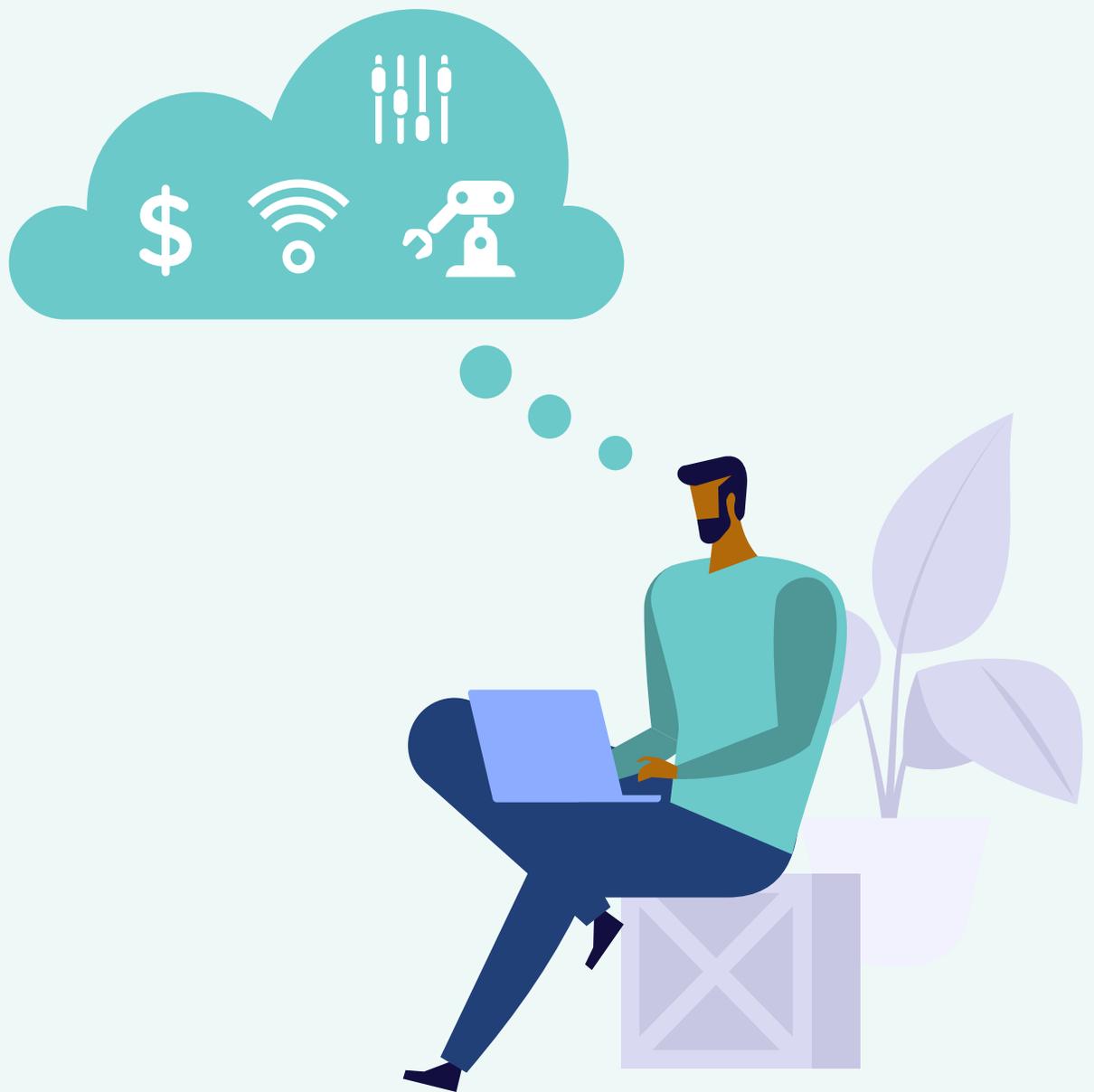


= Ready-to-Scale Model

Priority 3: Spark interest in advanced manufacturing careers to secure a steady workforce talent pool

The advanced manufacturing industry will need a steady stream of incoming talent as the industry expands and current workers leave the field to retire. However, the industry has struggled to combat negative perceptions of manufacturing jobs and increase awareness of the plentiful opportunities for fulfilling careers.

By leveraging its brand and championing the efforts of the network and its partners, Manufacturing USA will improve perceptions of manufacturing jobs and create awareness of the opportunities for high-quality, fulfilling careers in advanced manufacturing, particularly among young people.



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	—



Ready-to-Scale Examples

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



READY-TO-SCALE MODEL:

CyManII's Industrial Control Systems (ICS) Operational Technology (OT) Cybersecurity Bootcamp Will Prepare Students for Industry 4.0

OVERVIEW

CyManII is developing an Industrial Control Systems (ICS) Operational Technology (OT) Cybersecurity bootcamp designed to **help enable employees of small to medium manufacturers to protect, operate, manage, and address risks in their own OT equipment** by understanding relevant threats to their company, their unique exposure levels, and methods for patching and managing exposures.

Designed with the end user in mind, this modular bootcamp will feature mini bootcamps that will allow employees at varying levels the opportunity to upskill in a specific area or reskill by completing the entire bootcamp. Additionally, the cybersecurity bootcamp will further enhance the skills needed to become an OT cyber security analyst or OT cybersecurity engineer by teaching skills like networking, system administration, threat management, governance, risk, and compliance.

NATIONWIDE IMPACT



2 minority-serving institutions and 4 community colleges will deliver the live version of this bootcamp to traditional and non-traditional students



Full on-demand bootcamps will be available for the incumbent workforce and other non-traditional students



READY-TO-SCALE MODEL:

FlexFactor Familiarizes Students with Pathways to STEM Careers

OVERVIEW

FlexFactor is an outreach, recruitment, and STEM education program designed to **familiarize K-12 students with advanced manufacturing technology, entrepreneurship, and the education and career pathways** that can lead to a STEM career. By taking part in the FlexFactor program, students discover the promise of these careers and develop the critical thinking, creative reasoning, and problem-solving skills needed for future success.

The program challenges students to identify a problem, develop a product, create a business model, and pitch the concept to renowned industry experts.

NATIONWIDE IMPACT



83% of students are more aware of the career opportunities in advanced manufacturing



67% of students are more interested in a career in STEM, business and entrepreneurship, or advanced manufacturing



15,048 students from 13 states have graduated from the FlexFactor program



83% of students have a better understanding of the educational pathways available to them



Ready-to-Scale Examples

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



READY-TO-SCALE MODEL:

NIIMBL eXperience Broadens Awareness of Biopharmaceutical Careers

OVERVIEW

Geared toward African American/Black, Latinx, and Native American freshmen and sophomores in a STEM-based major, the NIIMBL eXperience is an exclusive week-long immersion program **designed to introduce students to biopharmaceutical careers.**

Through hands-on learning and personal interactions, students will take away a deep understanding of how the industry and federal agencies work together to develop and manufacture life-saving medicines. In addition, students gain direct insight into education and training pathways that help them reach their career goals.

NATIONWIDE IMPACT



80
total students served



41
industry, federal, non-profit hosts



58
student institutions including 16 historically black colleges and universities (HBCUs) and 10 community colleges

"Learning about all these biopharmaceutical companies was really helpful for me to get exposure of what STEM fields/paths are out there and how we can make a difference in the world."

— Participant of NIIMBL eXperience @ Raritan Valley Community College (RVCC)



READY-TO-SCALE MODEL:

ChemE Cube™ Encourages Students to Think Outside the Box to Build an Innovative and Viable Mini-Manufacturing Plant

OVERVIEW

ChemE Cube™ is an annual student competition that **convenes undergraduate university teams to design, build, and demonstrate a 1-cubic foot plant**, with the product changing each year. Recent competition challenges have included modular water purification and direct air capture (DAC). The program aims to promote teamwork, creativity and innovation, sustainable development, diversity, and inclusion.

Teams compete on cube performance via a head-to-head duel and promote their technology through a 1-minute ad, poster, and 20-minute "shark-tank" style pitch to a panel of mock investors.

NATIONWIDE IMPACT



76 teams of students across the globe have pitched their ideas to ChemE Cube



21 teams will have competed in ChemE Cube through 2023



175+ students have participated in ChemE Cube



17 organizations within the manufacturing ecosystem have participated in sponsoring or judging the competition



Ready-to-Scale Examples



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

READY-TO-SCALE MODEL:

REMADE Academy Trains the Next Generation of Circular Economy Technologists

OVERVIEW

REMADE Academy **trains the incumbent workforce and next-generation engineers** to leverage cutting-edge technologies that accelerates the circular economy in U.S. manufacturing. Working in parallel with the REMADE Institute's R&D activities, REMADE Academy coordinates top subject matter experts from across the nation to deliver in-person and online training in design for re-use, remanufacturing, and recycling and recovery.

Whether through three-tiered certificate training and bootcamps, R&D project participation, or technology conference workshops, REMADE Academy offers numerous avenues for students to increase their circular economy knowledge.

NATIONWIDE IMPACT



Over **100** students supporting REMADE R&D projects each year



80 hours of training available online, on-demand to U.S. workforce

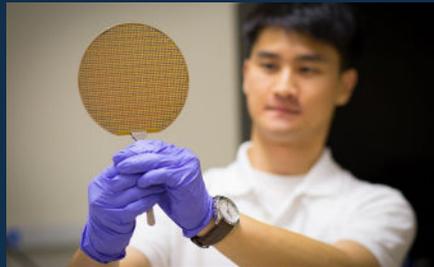


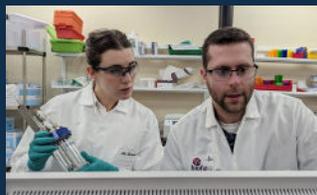
Annual scholarships available for students and early-career faculty to attend REMADE technology conference



Integrating knowledge from advanced circular economy R&D activities to develop training not available in the marketplace

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

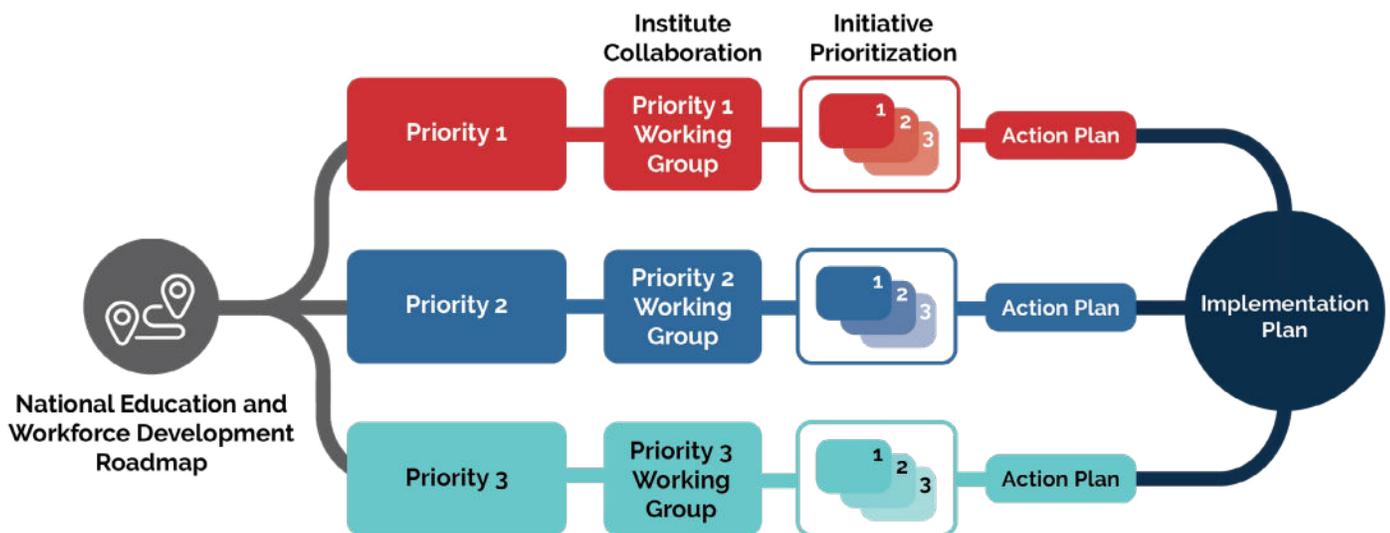




Call to Act

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



References

1. The U.S. Departments of Commerce and Labor, "Good Jobs Principles," n.d., <https://www.dol.gov/general/good-jobs/principles>.
2. "Creating Pathways for Tomorrow's Workforce Today: Beyond Reskilling in Manufacturing," Deloitte and the Manufacturing Institute, May 2021, <https://www.themanufacturinginstitute.org/research/creating-pathways-for-tomorrows-workforce-today-beyond-reskilling-in-manufacturing>.
3. CHIPS and Science Act of 2022, H.R. 4346, 117th Congress (2022), [https://www.congress.gov/bill/117th-congress/house-bill/4346/text/Inflation Reduction Act, H.R. 5376, 117th Congress \(2022\)](https://www.congress.gov/bill/117th-congress/house-bill/4346/text/Inflation%20Reduction%20Act,%20H.R.%205376,%20117th%20Congress%20(2022)), <https://www.congress.gov/bill/117th-congress/house-bill/5376/text>; Infrastructure Investment and Jobs Act, H.R. 3684, 117th Congress (2021), <https://www.congress.gov/bill/117th-congress/house-bill/3684/text>.
4. U.S. Census Bureau, "Total Construction Spending: Manufacturing in the United States [TLMFGCONS]," retrieved from FRED, Federal Reserve Bank of St. Louis, <https://fred.stlouisfed.org/series/TLMFGCONS>, accessed September 1, 2023.
5. The White House, "Bidenomics Is Working: The President's Plan Grows the Economy from the Middle Out and Bottom Up—Not the Top Down," June 28, 2023, <https://www.whitehouse.gov/briefing-room/statements-releases/2023/06/28/bidenomics-is-working-the-presidents-plan-grows-the-economy-from-the-middle-out-and-bottom-up-not-the-top-down/>.
6. The White House, "FACT SHEET: Bidenomics is Boosting Clean Energy Manufacturing for Offshore Wind and Creating Good-Paying American Union Jobs," July 20, 2023, <https://www.whitehouse.gov/briefing-room/statements-releases/2023/07/20/fact-sheet-bidenomics-is-boosting-clean-energy-manufacturing-for-offshore-wind-and-creating-good-paying-american-union-jobs/>.
7. Michael Ettlinger and Kate Gordon, "The Importance and Promise of American Manufacturing," The Center for American Progress, April 7, 2011, <https://www.americanprogress.org/article/the-importance-and-promise-of-american-manufacturing/>.
8. The National Association of Manufacturers (NAM), "Manufacturers Concerned of Recession Threat in 2023," January 5, 2023, <https://nam.org/manufacturers-concerned-of-recession-threat-in-2023-20054/?stream=series-press-releases>.
9. Steve Nielsen, "TSMC needs more specialized workers as it's behind schedule by about 6 months," FOX 10 Phoenix, July 24, 2023, <https://www.fox10phoenix.com/news/tsmc-needs-more-specialized-workers-as-its-behind-schedule-by-about-6-months>.
10. Jim Tankersley, Alan Rappeport and Ana Swanson, "Factory Jobs Are Booming Like It's the 1970s," The New York Times, September 26, 2022, <https://www.nytimes.com/2022/09/26/business/factory-jobs-workers-rebound.html>.
11. Mark Muro, Lavea Brachman, and Yang You, "With high-tech manufacturing plants promising good jobs in Ohio, workforce developers race to get ready," Brookings Institution, January 24, 2023, <https://www.brookings.edu/articles/with-high-tech-manufacturing-plants-promising-good-jobs-in-ohio-workforce-developers-race-to-get-ready/>.
12. The U.S. Departments of Commerce and Labor, "Good Jobs Principles," n.d., <https://www.dol.gov/general/good-jobs/principles>.
13. "2.1 Million Manufacturing Jobs Could Go Unfilled by 2030," National Association of Manufacturers, May 4, 2021, <https://www.nam.org/2-1-million-manufacturing-jobs-could-go-unfilled-by-2030-13743/>.
14. "2.1 Million Manufacturing Jobs Could Go Unfilled by 2030," National Association of Manufacturers, May 4, 2021, <https://www.nam.org/2-1-million-manufacturing-jobs-could-go-unfilled-by-2030-13743/>.
15. "2.1 Million Manufacturing Jobs Could Go Unfilled by 2030," National Association of Manufacturers, May 4, 2021, <https://www.nam.org/2-1-million-manufacturing-jobs-could-go-unfilled-by-2030-13743/>.
16. "National Strategy for Advanced Manufacturing," Subcommittee on Advanced Manufacturing and Committee on Technology of the National Science and Technology Council, October 2022, <https://www.whitehouse.gov/wp-content/uploads/2022/10/National-Strategy-for-Advanced-Manufacturing-10072022.pdf>, pg. C11; The U.S. Departments of Commerce and Labor, "Good Jobs Principles," n.d., <https://www.dol.gov/general/good-jobs/principles>.
17. "National Strategy for Advanced Manufacturing," Subcommittee on Advanced Manufacturing and Committee on Technology of the National Science and Technology Council, October 2022, <https://www.whitehouse.gov/wp-content/uploads/2022/10/National-Strategy-for-Advanced-Manufacturing-10072022.pdf>.
18. "National Strategy for Advanced Manufacturing," Subcommittee on Advanced Manufacturing and Committee on Technology of the National Science and Technology Council, October 2022, <https://www.whitehouse.gov/wp-content/uploads/2022/10/National-Strategy-for-Advanced-Manufacturing-10072022.pdf>.
19. The U.S. Departments of Commerce and Labor, "Good Jobs Principles," n.d., <https://www.dol.gov/general/good-jobs/principles>.

Learn more about how to support by visiting
[ManufacturingUSA.com](https://www.ManufacturingUSA.com)