Advanced Manufacturing at NIST

Hollings Manufacturing Extension Partnership (MEP)

MISSION **To strengthen and empower U.S. Manufacturers.**

Carroll Thomas, Director, MEP

VCAT Meeting

June 6, 2018

MEP • MANUFACTURING EXTENSION PARTNERSHIP
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

MEP National Network Advancing U.S. Manufacturing

- Today's Manufacturing in Brief
- All About MEP
- MEP Strategy and Priorities
- Connecting with NIST Labs- Highlighting Automation
- Connecting with MFG USA institutes
- MEP Initiatives- Supply Chain, Cybersecurity, Defense Industrial Base and Workforce

Today's Manufacturing

Facts about Manufacturing:

- 99% of all manufacturing firms have less than 500 employees and 75% of small manufacturing firms have less than 20 employees
- Employ about 8.2 million people – 73% of all manufacturing employment, and account for about 62% of the total value-added by all U.S. manufacturers

Challenges for Small Manufacturers:

- Productivity per employee in large establishments was 63% higher than productivity in small establishments. In 1967, productivity per employee was "only" 26% higher
- Over the last 10 years, productivity across smaller firms grew at a slightly faster rate than large firms (39% vs. 34%)

Sources: U.S. Census of Manufacturing & the Bureau of Economic Analysis

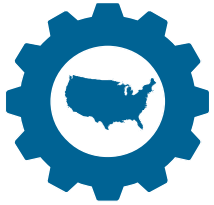
Key Legislation

Congress passes Omnibus Trade and Competitiveness Act 1988 (P.L. 100-418), creating a program geared to help U.S. manufacturers.

The Consolidated Appropriations Act of 2005 (P.L. 108-447) renamed the program to Hollings Manufacturing Extension Partnership (MEP) - in honor of Senator Ernest Hollings who introduced the Omnibus Trade and Competitive Act.

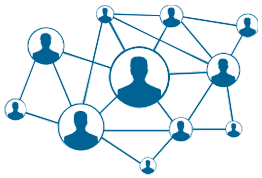
The American Innovation and Competitiveness Act of 2017 (P.L. 114-329) made the 1:1 cost share permanent and formalized recompetition for centers after 10 years of consecutive funding.

MEP Program in Short



Started in 1988

A Center in all 50 states and Puerto Rico by 1996



National Network

51 Centers with over 400 field locations. More than 1,300 non-federal trusted advisors and experts for manufacturers nationwide, with nearly 2,100 partners

Partnership Model

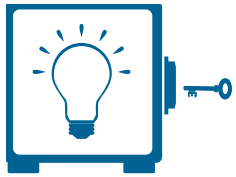
Federal, State, University, and Industry

MEP Network Budget

$140 Million Federal Budget with Cost Share Requirements for Centers

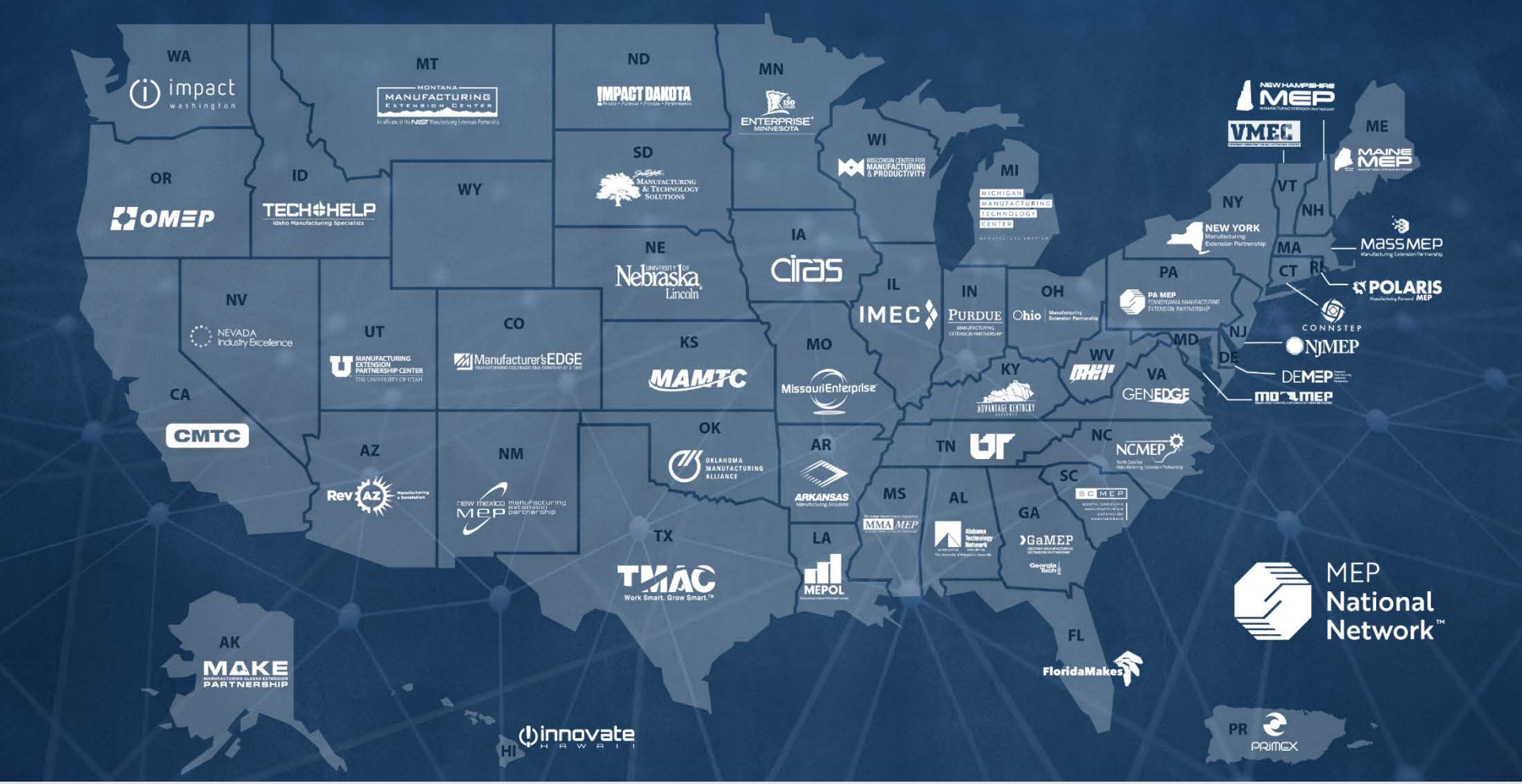
Global Competitiveness

Program created in 1988 and reauthorized by the American Innovation and Competitiveness Act in 2017



Evolving Role

Program continues to evolve in order to support manufacturers during changing economic situations



The Go-To Experts For Advancing U.S. Manufacturing

National Network
One Center in Every State & Puerto Rico

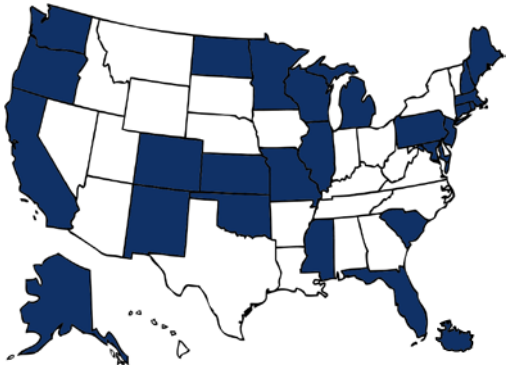
Over **1,300**
Manufacturing Experts

Over **400** Service Locations

Nearly **2,100**
Service Providers & Partners

Interacted with **26,313**
Manufacturers

MEP Centers Organizational Structure



501(c)(3) - 24

California
Colorado
Connecticut
Florida
Illinois
Kansas
Massachusetts
Maryland
Maine
Michigan
Minnesota
Missouri
North Dakota
New Hampshire
New Jersey
New Mexico
Oklahoma
Oregon
Pennsylvania
Puerto Rico
Rhode Island
South Carolina
Washington
Wisconsin

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Mississippi

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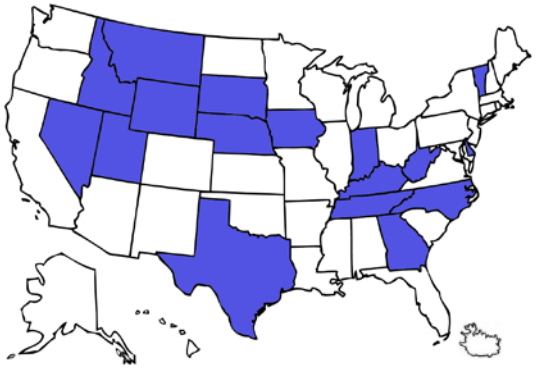
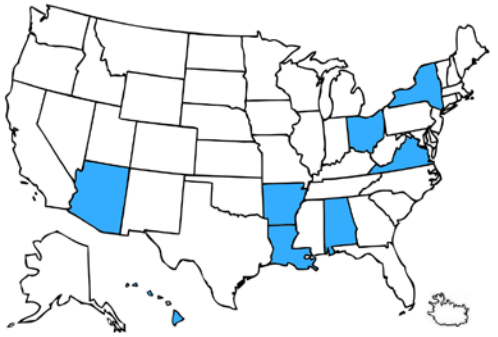
Alaska



University - 17

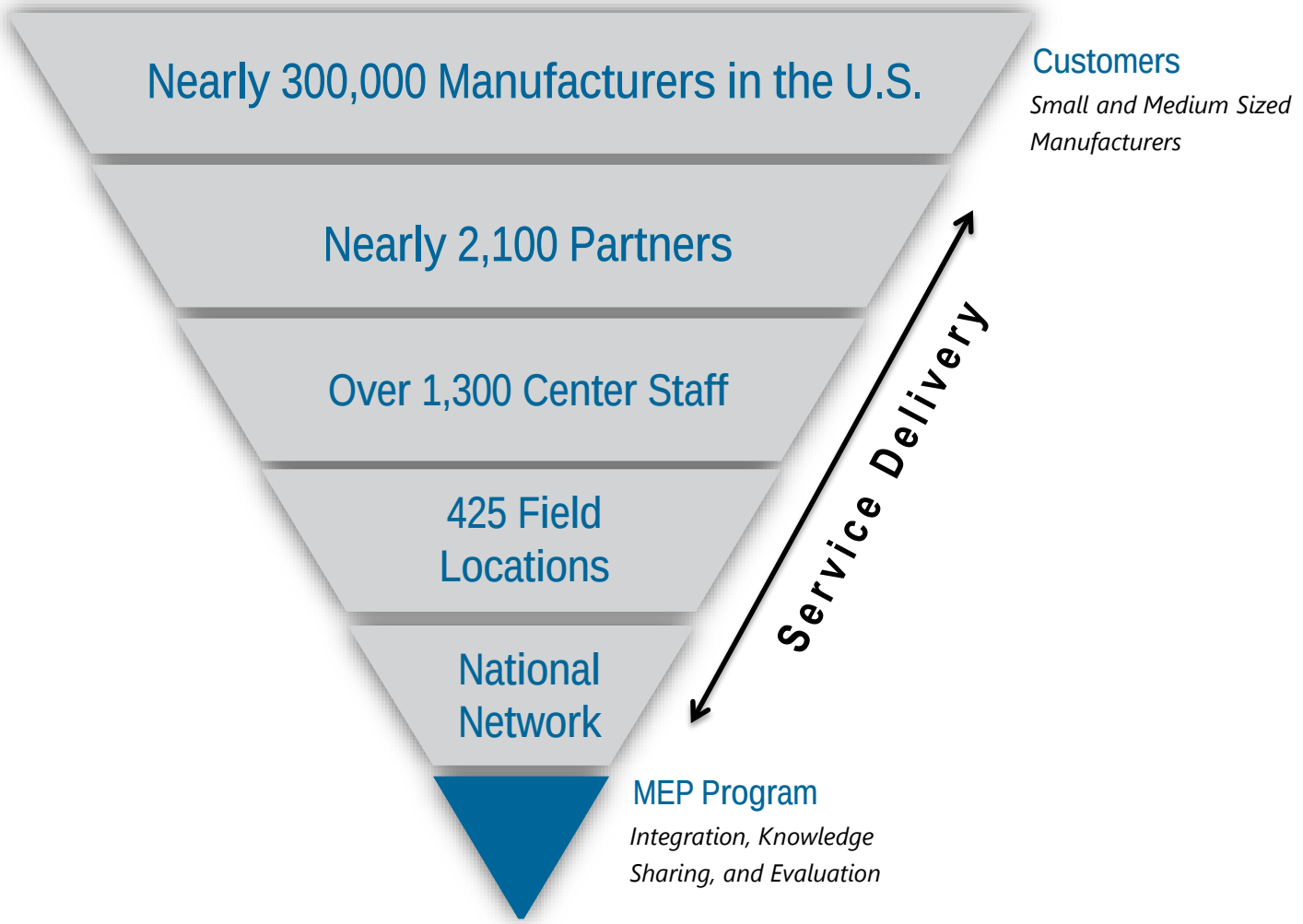
Delaware
Georgia
Iowa
Idaho
Indiana
Kentucky
Montana
North Carolina
Nebraska
Nevada
South Dakota
Tennessee
Texas
Utah
Vermont
West Virginia
Wyoming



State - 8

Alabama
Arkansas
Arizona
Hawaii
New York
Ohio MEP
Virginia
Louisiana

Partnering to Drive a National Program



How Centers Work with Manufacturers

Initial Contact

Group sessions, referral

Assessment

Informal walk-through, detailed company analysis

Identify

Find potential issues, define proposed project and approach for solving it

Negotiate

Consult with company and sign project contract with fee paid to center

Project Execution

Center staff, partner organization, and/or third party consultants

Follow-Up

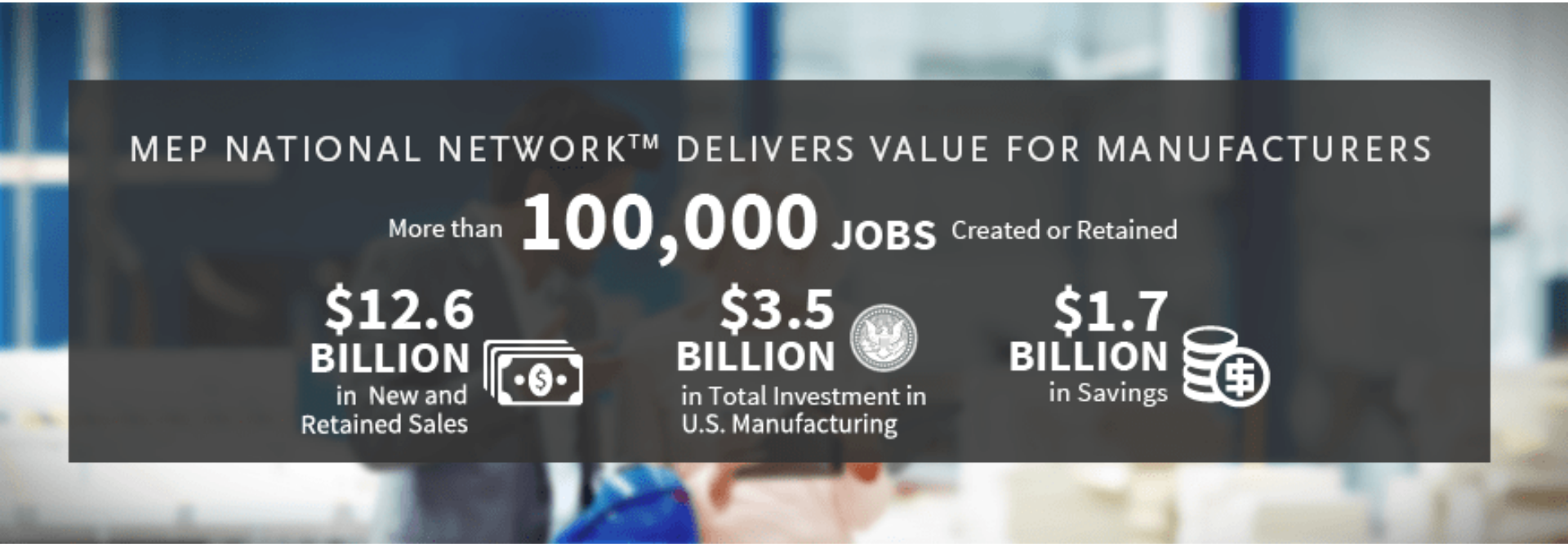
After completion, project follow-up by center to assure customer satisfaction and explore further project opportunities

Project impact data collected by contractor for NIST approximately 6-12 months after project completion

Program Evaluation

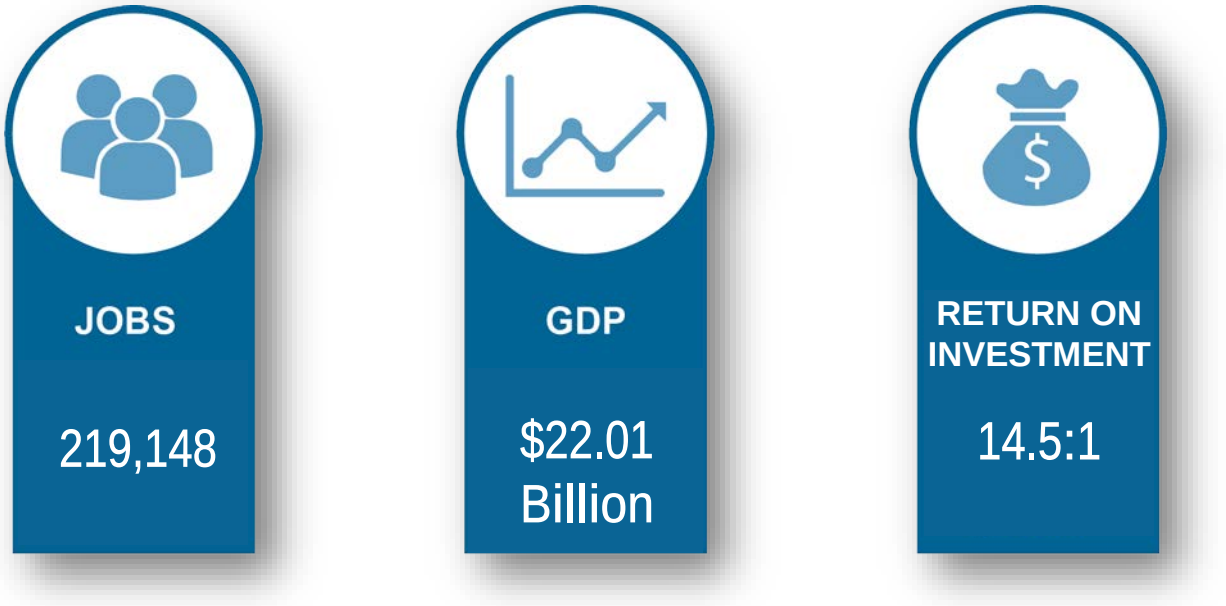
- NIST MEP has a two-pronged approach:
  - Help manufacturers in the United States lower costs – i.e., make products the right way
  - Help manufacturers in the United States increase revenues – i.e., make the right products for the right customers
- MEP Performance and Evaluation Portfolio
  - Impact Data from Third Party Client Impact Survey: New sales, cost-savings, investments, & jobs attributed to MEP services. Used in part to develop center performance metrics. Since 1999. Survey all clients. @ 8-9K clients annually
  - Quasi-Experimental/Longitudinal Studies: Focus on assessing the comparative performance of MEP clients relative to similar firms that did not receive MEP services. Episodic studies done over time
  - Case Studies: Focus on successful and pilot MEP projects to gain insight into variables at both the firm and industry-level that impact technology adoption and business transformation. Examples include process evaluation of the B2B pilot
  - Impact Studies: Economic impact analysis of Client Impacts using models such as REMI. Examples include the Upjohn study

MEP National Network connected with **26,313** manufacturers in FY17



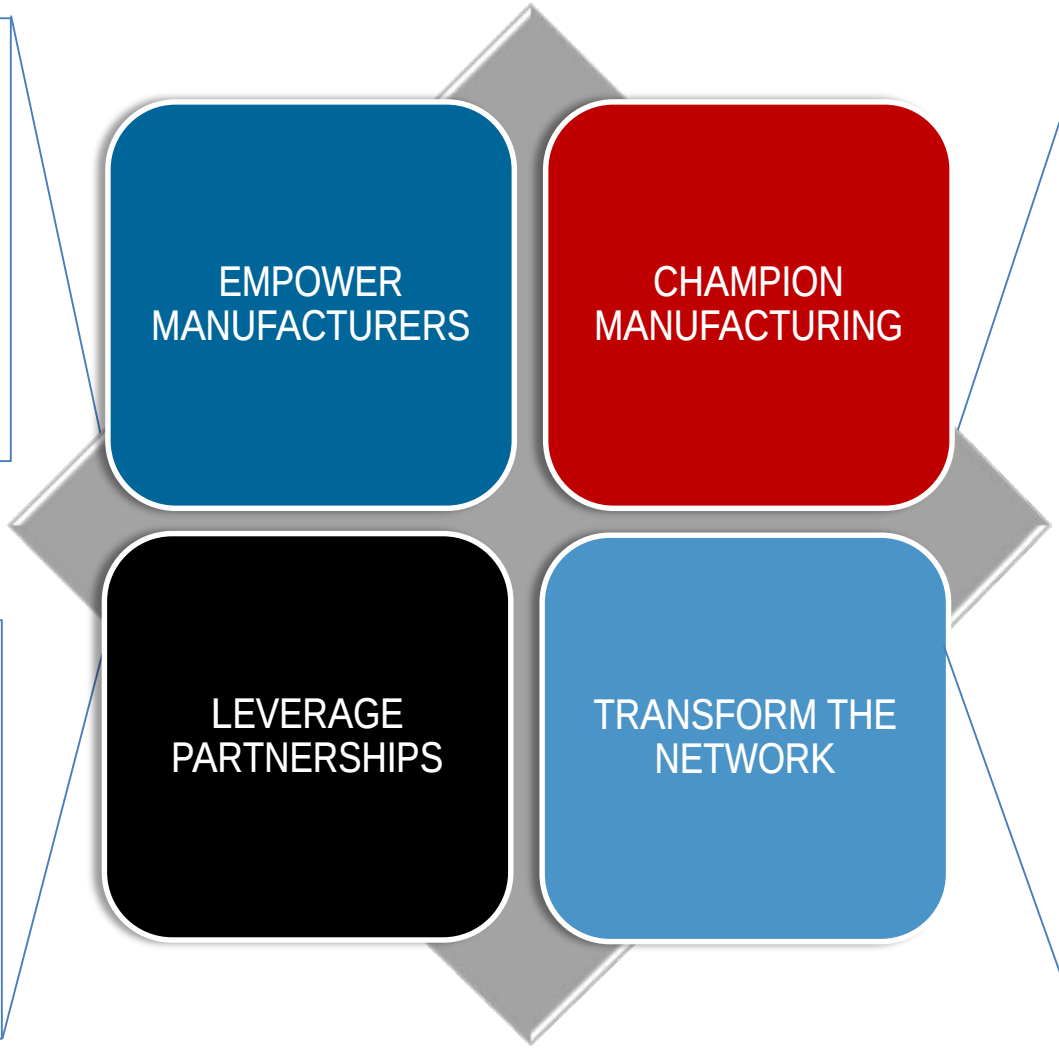
MEP Economic Impact Analysis

In April 2018, the *W.E. Upjohn Institute for Employment Research* published a study that found the MEP Program generated a substantial return on investment of nearly **14.5:1** for the $128.0 million invested by the federal government.



MEP National Network™ 2017-2022 Strategic Goals

Objective— to assist U.S. manufacturers in embracing productivity-enhancing innovative manufacturing technologies, navigate advanced technology solutions and recruit and retain a skilled and diverse workforce.



Objective— to actively promote the importance of a strong manufacturing base as key to a robust U.S. economy and for the protection of national security interests; create awareness of innovations in manufacturing; create workforce development partnerships to build a stronger and diverse workforce pipeline; and maximize market awareness of the MEP National Network.

Objective— to leverage national, regional, state and local partnerships to gain substantial increase in market penetration; identify mission-complementary advocates to help MEP become a recognized manufacturing resource brand; build an expanded service delivery model to support manufacturing technology advances.

Objective— to maximize National Network knowledge and experience to operate as an integrated national network; increase efficiency and effectiveness by employing a Learning Organization platform; and create a resilient and adaptive MEP National Network to support a resilient and adaptive U.S. manufacturing base.

Empower Manufacturers- Network Priorities

Assist U.S. manufacturers in adopting productivity-enhancing innovative manufacturing technologies, help inform and navigate advanced technology solutions…

DEFINED AREAS OF FOCUS FOR MANUFACTURING TECHNOLOGY ADVANCES

- Cybersecurity - National Network implementation and current assessment/future trends
- Digital manufacturing - National Network implementation and current assessment in industry and National Network/future trends
- *Automation and robotics - current assessment in industry and National Network/future trends*
- Additive manufacturing - current assessment in industry and National Network/ future trends
- IoT - future trends for small and medium-sized manufacturers in advanced manufacturing
- National and regional service portfolio coordination
- National Network workforce development plan

NIST MEP Connects with the Engineering Lab

Date: 2015 – present
Project/Topic: Collaborative Robotics for Small & Medium-Sized Manufacturers

- NIST MEP & Maryland MEP facilitated a connection between NIST EL Intelligent Systems Division robotics researchers and several MEP Centers in the mid-Atlantic Region
- MD MEP conducted technical workshop in October 2015 for NIST EL to allow robotic end users from broad cross section of U.S. small and medium-sized manufacturers (SMMs) to communicate challenges and barriers they encounter when integrating and using robotics in their factories
  - Event attended by 29 representatives of manufacturing companies and systems integrators located in MD, NY, OH, PA, TX, VA, and WV
  - Workshop also attended by 12 representatives from 9 MEP Centers located in 7 different states, 4 NIST MEP representatives, and 8 researchers from NIST EL
- Report delivered to NIST EL from NIST MEP in 2016 highlighting workshop findings and next step recommendations
- Ongoing activities in 2018 include: improving SMM awareness of Cobot technologies through MEP National Network; providing SMM use cases to NIST Cobot research programs; improving SMM standards participation through MEP Centers
  - South Dakota MEP Center participating on ASTM Cobot Standards Committee with NIST EL and also operating program to prove out cobot technology prior to small manufacturer implementation

Elena Messina
Group Leader, Manipulation and Mobility Systems, Engineering Laboratory

Al Wavering
Division Chief, Intelligent Systems, Engineering Laboratory

NIST MEP Connects with the Engineering Lab

Start Date: Spring 2018

Project/Topic: Metal Additive Manufacturing

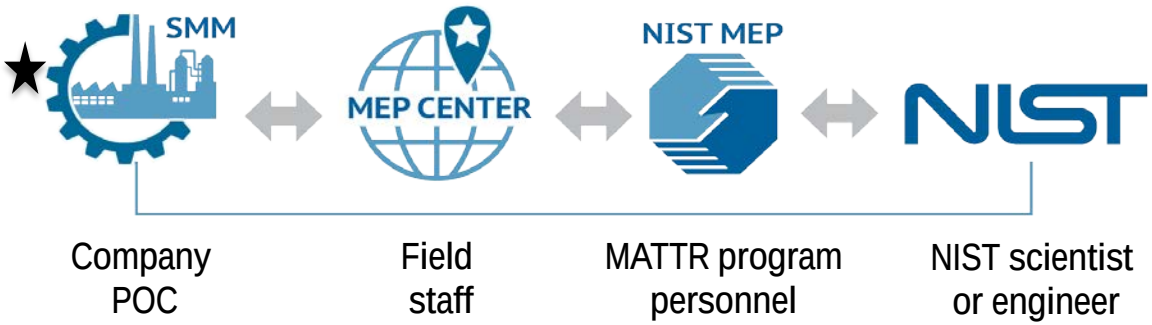
- NIST MEP coordinated a one day workshop at NIST in March 2018 involving MEP National Network additive manufacturing practitioners from 11 MEP Centers around the country, and research staff from the NIST Intelligent Systems Division, with a focus on:
  - Having MEP practitioners share SMM practices and needs with NIST researchers
  - Having NIST EL researchers share leading-edge resources, such as technologies, reference materials and databases, with MEP practitioners
- NIST MEP Blog on workshop published in April 2018
- Resulting activities include ongoing dialogue between participants to connect SMMs with NIST metal additive research through MEP Centers and NIST MEP
- Co-authored blog: *Five Surprising Factoids About Metal Additive Manufacturing*
  - Published April 20, 2018 by Tab Wilkins and Marlon Walker

Al Wavering
Division Chief, Intelligent Systems,
Engineering Laboratory

Alkan Donmez
Group Leader, Production Systems,
Engineering Laboratory

MEP-Assisted Technology and Technical Resource Program (MATTR)

SMM-Initiated Inquiry: Connection to NIST through MEP Center and NIST MEP



NIST staff can also inquire through the MEP National Network if there are technical areas in which standards, calibrations, or innovative measurement science techniques are needed

In this way, the manufacturing community can help identify research priorities for NIST

NIST Initiated Inquiry: Connection through NIST MEP and MEP Centers

MATTR proved in pilot - will now receive $500k to pay for NIST Labs expertise and user facilities for SMEs

MATTR Connections

- There have been 22 submissions from 12 centers from 12 states
  - + ~5 in progress / about to be submitted
- There have been 4 information "pushes" from NIST scientists to MEP Center staff through NIST MEP, several requests from MEP Center staff for dialogue with a NIST professional, and numerous occurrences of information disclosure about the MATTR program to NIST staff
- Practitioner workshop conducted with participation from several MEP centers, NIST MEP, and NIST labs was held on metal additive manufacturing at NIST MEP

Plus Several Lab Tours…

- NCNR
- PML, Mass and Force Group Labs (Force Lab)
- EL, Manipulation and Mobility Systems Group Labs (Robotics)
- EL, Production Systems Group Labs (Metal Additive Manufacturing)
- MML, Mechanical Performance Group Labs (NCAL)
- EL, Systems Engineering Group Labs (Digital Thread)
- EL, Net Zero House
- EL, Networked Control Systems Group Labs (Industrial Control Systems Cybersecurity)
- CNST

Manufacturing USA
Regional Hubs with National Impact

Embedding MEP into the Manufacturing USA Institutes: SUMMARY

- MEP investing ~$17M over 2 years to embed MEP National Network staff in residence at all 14 Manufacturing USA Institutes
- Embedding projects focused on engaging U.S. SMMs in technology focus areas of Institutes via MEP National Network service mechanisms and assistance
  - Institute technology focus areas generally not well known among U.S. SMMs
  - Engagements can include deploying technologies into products and processes, as well as capitalizing on supply chain opportunities
- Projects working to create nationwide expertise in Institute technology focus areas across MEP National Network to scale U.S. SMM engagement to large, impactful, national level

Embedding MEP into Manufacturing USA Institutes

14 NIST MEP-funded **Embedding Projects** operating with MEP National Network and all 14 Manufacturing USA Institutes

Focused on creating sustainable business models aligned with needs of U.S. SMMs, Institutes, and MEP Centers

LEAD MEP CENTER	MFG USA INSTITUTE
CA MEP	CESMII
CA MEP	Next Flex
DE MEP	NIIMBL
Illinois Mfg Excellence Center	DMDII
Mass MEP	AFFOA
Mass MEP	BioFab USA
Michigan Mfg Technology Center	LIFT
NC MEP	Power America
NY MEP	AIM Photonics
NY MEP	REMADE
OMEP	RAPID
PA MEP	Advanced Robotics
PA MEP	America Makes
TN MEP	IACMI

Embedding Project Sample Results: MMTC / LIFT, TN MEP / IACMI

Multiple Partners Create and Debut New Lightweight Specialty Car Frames

- The Michigan Manufacturing Technology Center (MEP Center) and industry partners embarked on a collaborative project in 2017, leading to the invention of a **lightweight aftermarket car frame**
  - Lightweight alternative ideal for replacing car frames on nearly any specialty vehicle
  - Offers affordable, stiffer and safer car frame option
  - Requires no welding, reducing material cost; uses morphing software to allow lightweight frame to fit virtually any body and length

C2 Corvette (1963 to 1967) lightweight alternative frame

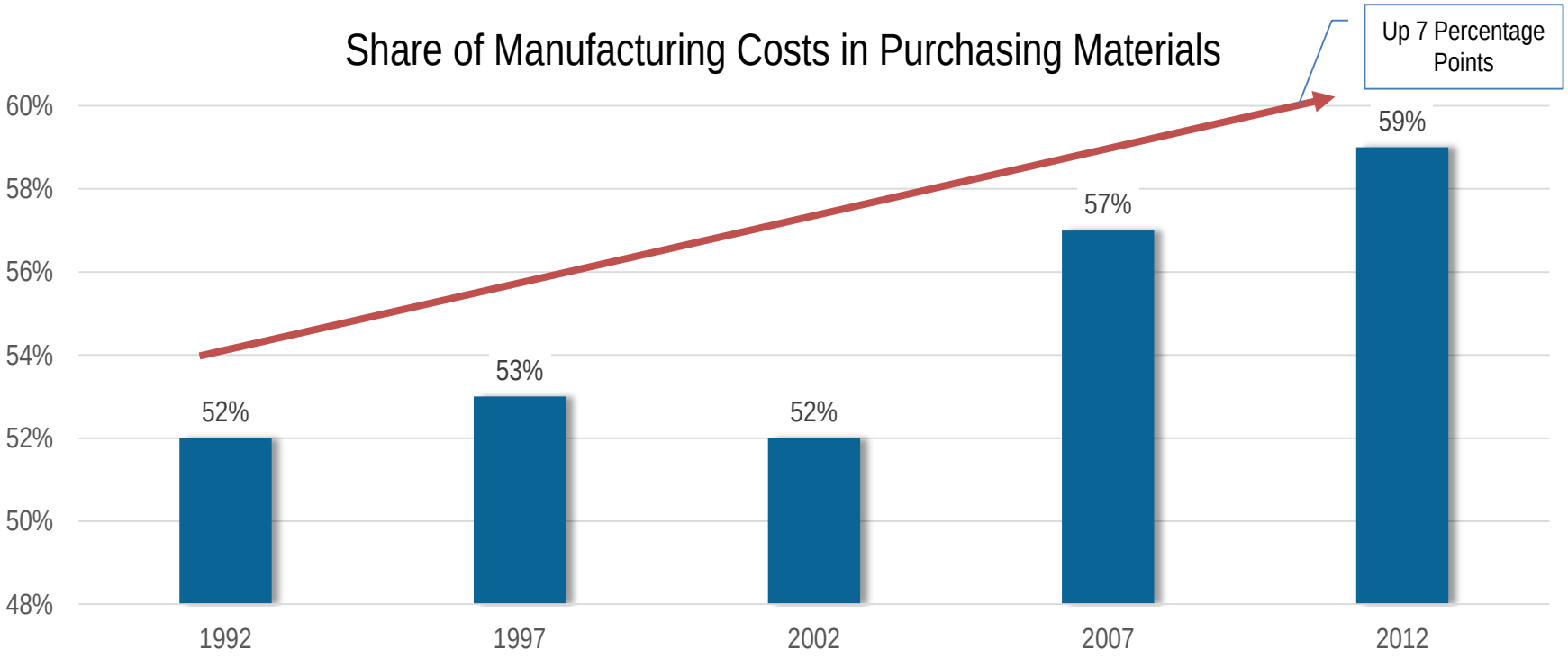
- Lead engineer from MMTC worked with software developer and trusted OEM consultant Detroit Engineered Products (DEP) and LIFT, IACMI, and TN MEP
- In response to multiple requests for purchase, Michigan's MEP Center now pursuing investments to fund low-volume production of frames, including tooling and testing
- Forward-looking engineering offers a great opportunity for innovation across numerous industries, and project leads are gauging interest outside the arena of car restoration

MEP Embedding Project at NIIMBL

NIIMBL — National Institute for Innovation in Manufacturing Biopharmaceuticals
Newark, DE

- DE MEP staff member embedded full-time at NIIMBL
  - Project also includes participation from NC MEP, Mass MEP
    - Centers located in high density areas for biopharmaceutical manufacturing
    - States with NIIMBL-university partnerships (MIT, NCSU)
  - NJ MEP recently became NIIMBL member
- Project mapping geographic locations of U.S. biopharmaceutical industry
  - Clusters in MA, NC, TX, CA, mid-Atlantic
  - Supply chain for equipment is more geographically diverse
    - "Traditional MEP services" needed in equipment supply chain
- Project delivering understanding of biopharmaceutical industry to MEP National Network
  - Biopharmaceutical industry is new to MEP
  - In the past 5 years, MEP Centers have done 130 projects with companies in biopharmaceutical NAICS

A Majority of Manufacturing Costs Are in the Supply Chain



Source: Executive Office of the President and the Dept of Commerce (March 2015)
Supply Chain Innovation: Strengthening America's Small Manufacturers.

MEP National Network & Supply Chains

- Extensive, decades-long experience providing direct, hands-on assistance with manufacturing supply chains
- Targets whole supply chains, plus individual manufacturer assistance to OEMs, lower tier suppliers
- Centers provide localized assistance on national scale to maximize impacts at micro (individual supplier) and macro (overall supply chain) levels

MEP National Network Supply Chain supports:

- Supply Chain Optimization
- Supplier Improvement
- Supplier Scouting
- Supply Chain Technology Acceleration
- Supply Chain Sustainability

Supply Chain Services

Supply Chain Optimization - approaches supply chains from a systems perspective and helps manufacturers build dynamic supply chains through the use of strategy, risk management, total cost of ownership, supplier communication, and supplier assessments.

Supplier Improvement - works with individual suppliers to improve their position in supply chains.

Supplier Scouting - leverages MEP's knowledge of local manufacturing capabilities and capacities to connect U.S. manufacturers with business opportunities tied to specific supply chain needs from OEMs and government agencies. This also includes supply chain re-shoring efforts.

Supply Chain Sustainability - includes multi-agency initiatives such as the Green Suppliers network, E3 (Economy, Energy, and Environment), and Energy Efficient Buildings Hub – to help reduce supplier impacts on the environment, provide manufacturers with sustainability assessments of production processes, and assist with the implementation of energy-saving projects.

Supply Chain Optimization

Equips manufacturers with tools to integrate strategy into collaboration across the multiple tiers of their supply chains.

MEP helps manufacturers use a strategic approach to develop a synchronized plan optimized across the value and supply chains.

- Reduces risk and volatility
- Increases collaboration with suppliers
- Reveals the true total cost of the supply chain
- Increases capability to develop and distribute products

Success Story:

Sync Strand of South Carolina gained more than **$2 Million increased sales** and **retained 8 jobs** as a result of the program.

Supplier Scouting

15

Participating Government Agencies

199

Items Scouted

Over $163 Million

New Business Opportunities

- Connects the capabilities, capacities, and business interests of U.S. manufacturers with the needs and business opportunities of various manufacturing supply chains.
- Connects government agencies that have Buy American provision requirements to U.S. manufacturers.
- Supplier Scouting has identified and connected domestic manufacturers with business opportunities for supply chains in the following industry sectors:

  - Energy products
  - Passenger rail cars
  - Rail locomotives
  - Railroad track and physical infrastructure
  - Highway systems
  - Waterborne transportation systems
  - Laboratory instruments

MEP & DoD Supply Chain

MEP National Network routinely works
with manufacturers that supply products to DoD

- Since 2013 MEP Centers have completed over **2,500 projects** with **1,650 companies** that are prime suppliers to DoD
- From 2014-2017 MEP Centers in 23 States worked with DoD's **Office of Economic Adjustment (OEA) Defense Industry Adjustment** program to help communities and companies diversify their capabilities and products
- **MilTech** Partnership Intermediary organization leveraging MEP Centers to provide technical assistance to U.S. manufacturers to transition critical technology into products needed for DoD warfighter
- **Supplier Scouting and Development** for various DoD needs

MEP & DoD Supply Chain: Cybersecurity

- In 2017, MEP National Network focused on assisting defense manufacturers to comply with acquisition related (DFARS) cybersecurity requirements for manufacturing supply chains
  - Ensure adequate security to protect controlled unclassified information (CUI) relevant to defense manufacturing supply chains
  - Cyber security requirements call for defense suppliers to implement security requirements contained in NIST Special Publication 800-171 rev 1, “Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations”
  - MEP Centers, working in collaboration with DoD’s Procurement Technical Assistance Centers (PTACs) and with guidance from NIST MEP, more than 60 cybersecurity awareness events conducted by MEP Centers overall, reaching more than 1,700 small U.S. manufacturers
- NIST MEP published Cybersecurity Self-Assessment Handbook, NIST Handbook 162, to assist small manufacturers with NIST SP 800-171 and DFARS compliance
  - NIST Handbook 162 downloaded from NIST MEP webpages >15,000 times since November 2017
  - NIST MEP has trained manufacturing specialists operating in roughly 38 of 51 MEP Centers

Additional MEP Cybersecurity DoD and Industry Efforts

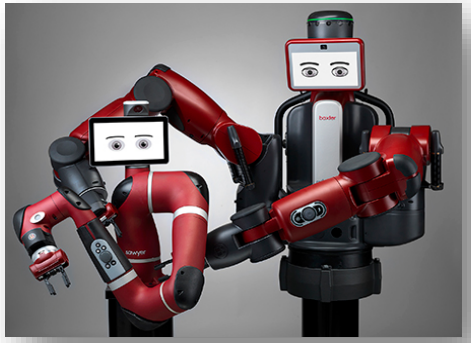
- MEP closely monitors DoD acquisition requirements, works with them to define compliance, holds events for SMMs, trains MEP Centers staff to deploy assessments and implementation of 800-171 controls for DoD suppliers
- NIST MEP led Interagency WG on Cybersecurity for Manufacturing responding to 2017 Executive Order 13806 analyzing Defense Industrial Base
- Signed MOU with DoD funded Procurement Technical Assistance Centers (PTACs)
  - National pilot collaboration w/PTACs in multiple states to assist SMMs w/DFARS compliance by end of December 2017
  - CO, CT, GA, MI, RI, VT, WA initial pilot states, with other events in other states
- MEP Centers offer assistance to small manufacturers implementing 800-171
  - Training, Web-based resources, FAQs, 3rd Party Service Providers, Guidance and Tools: basic to advanced
  - 150 cybersecurity assistance projects conducted by MEP Centers
- MEP collaborated with ITL to develop 800-171A, “Building Effective Assessment Plans”
- Baldrige Quality Excellence Program created Cyber Security Excellence Builder
  - Voluntary self-assessment tool that enables organizations to better understand effectiveness of their cybersecurity risk management efforts
  - Blends systems perspective of Baldrige Excellence Framework with Cybersecurity Framework
  - Incorporates content outlined in Cybersecurity Framework into 6 elements of Baldrige approach

MEP National Network Engaged in Workforce Solutions

- MEP centers are involved in a wide variety of activities to help build the workforce development eco-system for manufacturing.
- Essential components of these efforts include:
  - Ensuring access to career ladders
  - Reviewing competitive wages and benefits
  - Identifying training opportunities and skill certifications
  - Assisting companies with work-based learning mentorships, internships, apprenticeships
  - Talent planning
  - Customized training opportunities

Workforce Development and Automation

- MEP Centers help SMMs gain competitive edge via automation:
  - PA MEP and Advanced Robotics Manufacturing Institute (ARM) create Southwestern PA Advanced Robotics (SWPA AR) working group for local manufacturers, suppliers and integrators, to be accompanied by education and training materials to facilitate industry adoption and expansion of robotics practice areas throughout the MEP National Network
  - South Dakota MEP Center participating on ASTM Cobot Standards Committee with NIST EL and also operating program to prove out cobot technology prior to small manufacturer implementation
  - New Mexico MEP partners with *Build With Robots* to introduce New Mexico SMMs to cobots and show how they're used to automate quickly and cost-effectively
  - MEP Center blog- *Robots, Cobots & Human Labor* debunk myths about automation and workforce to educate SMMs
  - MEP Centers *support robotics competition* involving partnerships between high schools and manufacturers



Workcred Research Project

Examining the Quality, Market Value, and Effectiveness of Manufacturing Credentials
Sponsored by MEP, in coordination with NIST SCO, we have engaged Workcred, an affiliate of ANSI

The report on the study will be ready in early June. A draft shows:

- **Significant lack of independent research** regarding the quality, market value, and effectiveness of manufacturing specific credentials
- Report **contributes to body of knowledge** for manufacturing related skill credentials
- Identifies gaps that could be filled by **creating new credentials and replacing existing ones** that are ineffective; identifies credentials being used by manufacturers representative of the industry
- **Evaluates the quality** of the credentials against national and/or international standards
- Determines **the market value** of credentials based on data from the credential issuer
- Determines **how the credential is being used** and how the effectiveness of the credential is being determined in work settings
- Identifies the **need for new credentials**, the scope and outcomes needed of the credentials, and what organizations might be willing and capable of creating the credential

MAKE IT IN AMERICA
MANUFACTURING EXTENSION PARTNERSHIP

Thank You!

MEP National Network™