



National Defense Industrial Association Manufacturing Division Meeting

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Why the Manufacturing Technology Program?

- Manufacturing dominance is mandatory for DoD technology dominance and force projection
- Manufacturing Technology transforms emerging & disruptive technologies into disruptive capabilities
- Increasing need for federal R&D investments to address manufacturing technology challenges that are beyond the risk of industry
- Weapon system cost overruns mainly result from entry of immature technologies into production

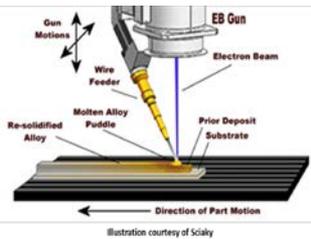
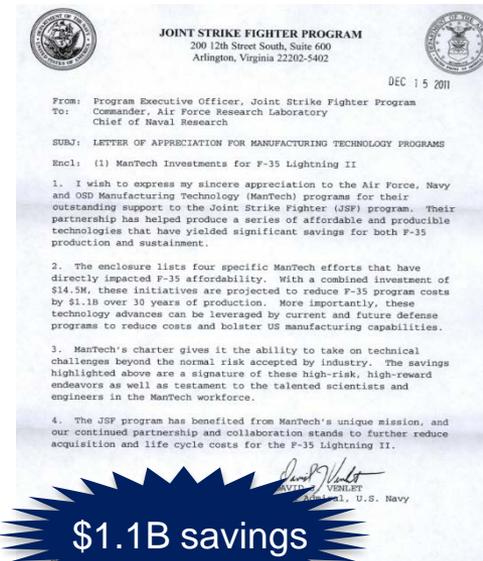


Illustration courtesy of Sciaky



If you can't build it reliably, affordably, and in a timely manner, then you don't have it.



DoD ManTech Program Foundation and Purpose



- ***Congressionally Mandated Mission***

- Crucial transition between technology development and manufacturing implementation to establish capability
- Focus is to develop capabilities that are beyond the risk of industry
- Key to affordable and timely acquisition and sustainment of weapon systems and components
- Broad R&D investment portfolio focused on cross-cutting, multi-system benefit to Defense Industrial Base

- ***Key Metrics***

- Increased affordability, producibility, reliability, and predictability of performance
- Decreased cycle time, manufacturing cost, system life cycle cost

ManTech Mission:

ManTech anticipates and closes gaps in manufacturing capabilities for affordable, timely, and low-risk development, production, and sustainment of defense systems.

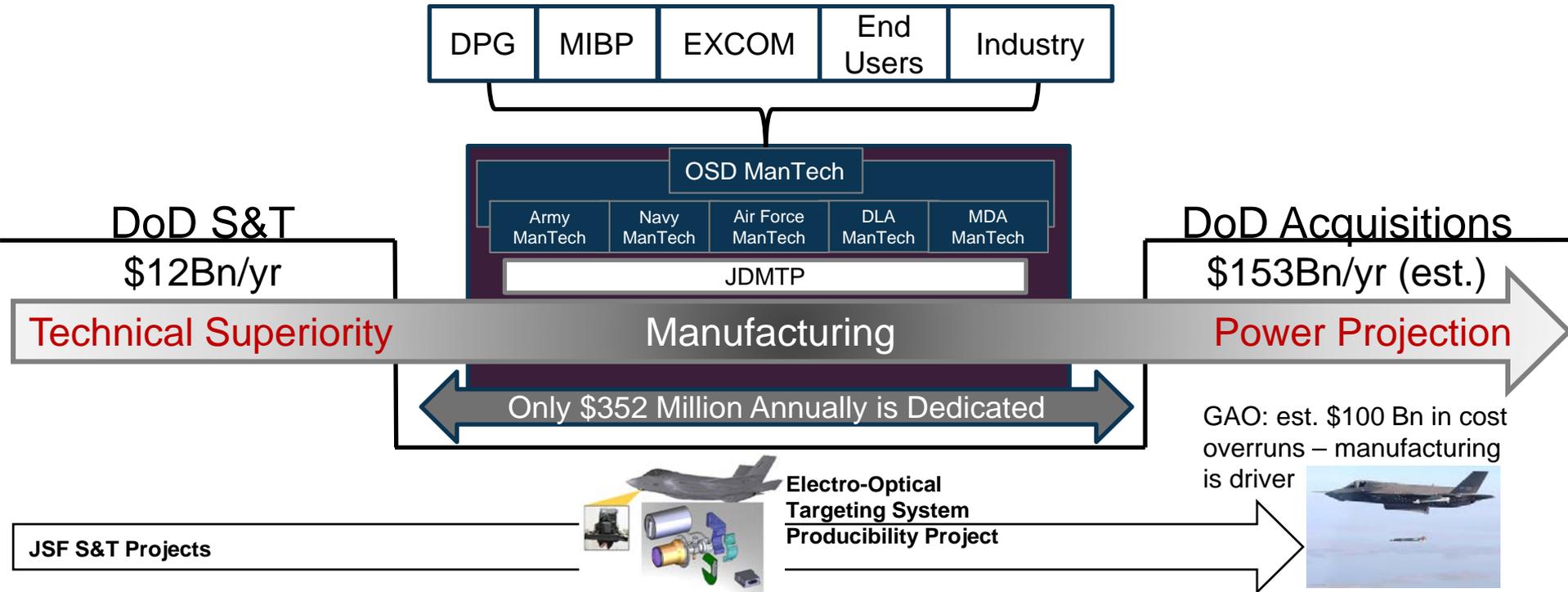
ManTech carries out its mission through programs in the Military Departments, participating Defense Agencies, and OSD





OSD ManTech Program: The Power to Connect and Coordinate

- OSD ManTech is positioned to operate across and coordinate the manufacturing enterprise.
- Manufacturing Dominance enables the transition of \$12B in DoD S&T investments to Force Projection.
- OSD ManTech is a highly leveraged program that maximizes resources to improve capability and reduce cost.
- OSD ManTech is the convening for DoD ManTech strategic planning.



OSD ManTech focuses S&T Priorities and Operational Shortfalls to create Warfighter Capabilities



OSD ManTech Tenets



- Development of enabling technologies for advanced capabilities that ensure warfighter technical dominance
- Address cross-cutting, defense-critical manufacturing needs beyond the ability of a single service or agency to address
- Reducing cost to acquire and maintain critical technologies supporting warfighter needs
- Maintain a balanced portfolio of near-term, critical defense needs and long term, higher-risk, potentially 'game-changing' technologies



OSD ManTech Portfolio



• Advanced Electronics Manufacturing (\$6.8M):

- Sensors
- Power generation
- Switches
- Optics
- *Radar Affordability and Electronic Warfare Initiatives*

• Advanced Materials Manufacturing (\$7.7M):

- Composites
- Metals
- Ceramics
- *Transparent Ceramics Initiative*
- *Propulsion Initiatives*
- *Advanced Energetics*

• Enterprise & Emerging Manufacturing (\$2.0M):

- Additive manufacturing
- Advanced manufacturing enterprise
- Digital Design
- Machining, robotics, assembly, and joining
- *Cyber Initiative – “Shop Floor”*



CAPABILITIES REALIZED BECAUSE OF MANTECH



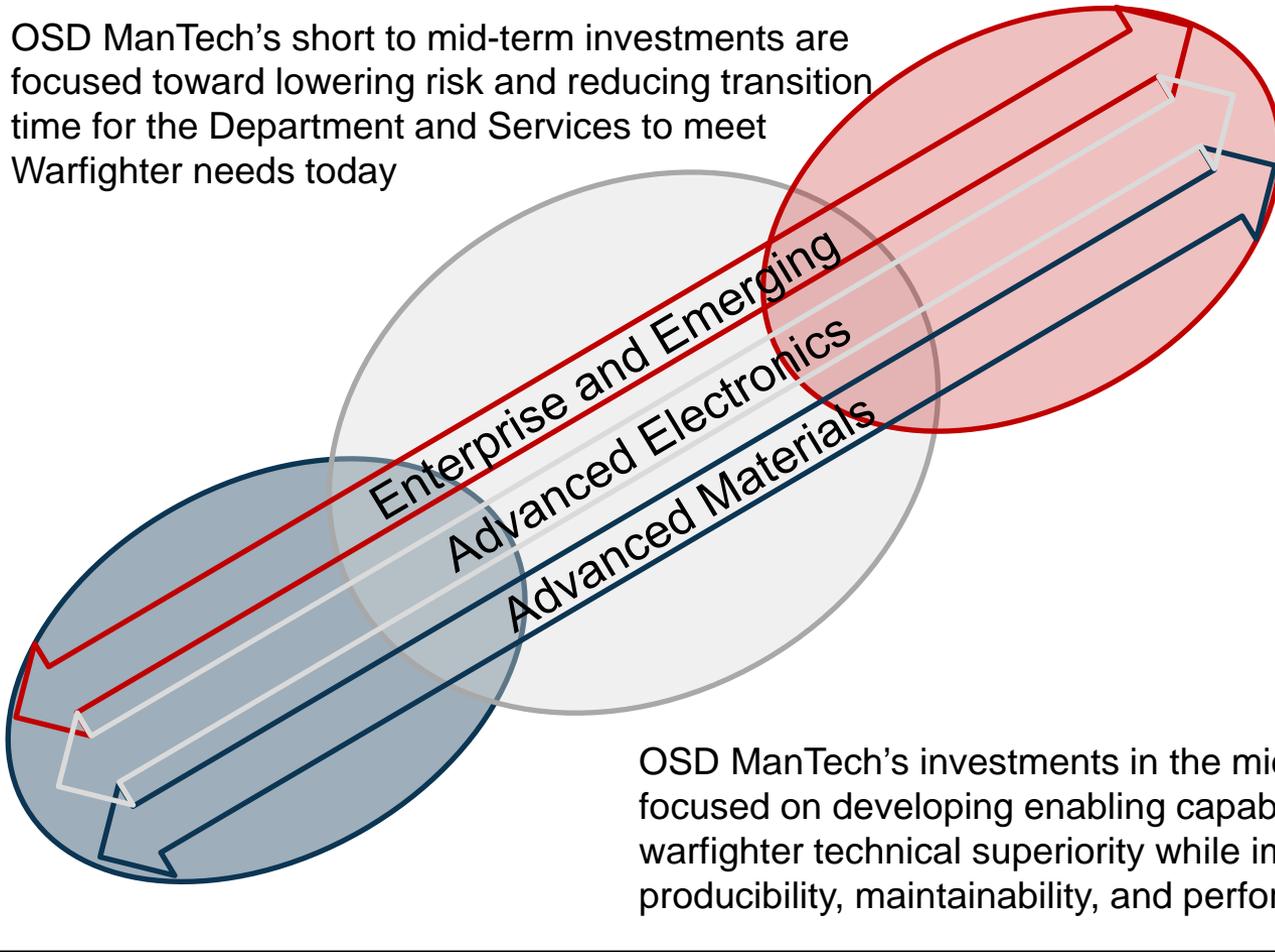
OSD ManTech Portfolio Management

Balancing Time Horizon, Risk & Strategic Impact



OSD ManTech's short to mid-term investments are focused toward lowering risk and reducing transition time for the Department and Services to meet Warfighter needs today

Strategic Impact



OSD ManTech's investments in the mid-long term are focused on developing enabling capabilities to ensure warfighter technical superiority while improving producibility, maintainability, and performance

< 5yrs

5-10 yrs.

> 15 yrs.

Time Horizon



OSD ManTech Portfolio Management

Balancing Time Horizon, Risk & Strategic Impact

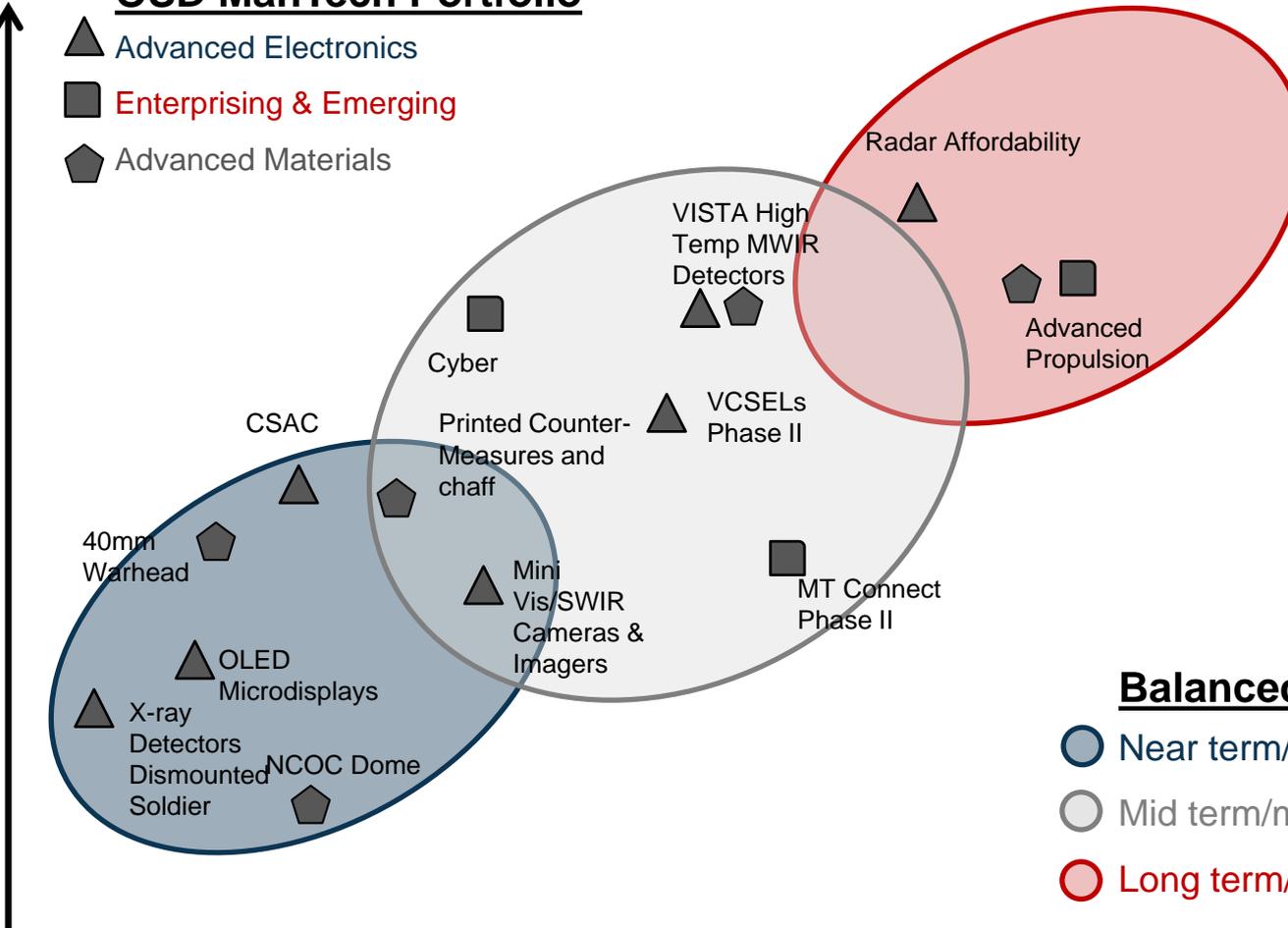


OSD ManTech Portfolio

- ▲ Advanced Electronics
- Enterprising & Emerging
- ⬠ Advanced Materials

Sample Project within current portfolio

Strategic Impact



Balanced Portfolio

- Near term/low risk
- Mid term/mid risk
- Long term/high risk/high reward

< 5yrs

5-10 yrs.

> 15 yrs.

Time Horizon



Potential Future Investment Areas



- Advanced Energetic Materials and Systems
- Hydrogen Storage Technologies
- Next Generation Sensor Technologies
- Energy Harvesting Technologies
- Batteries
- Materials for Hypersonics



Success Stories



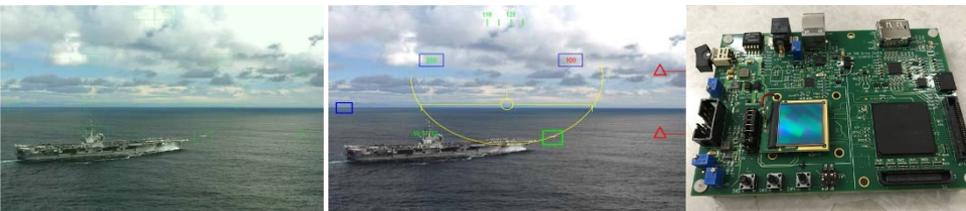
Organic Light Emitting Diode (OLED) Microdisplays

- Warfighters require displays that operate in bright ambient environments
- High Brightness Color OLED microdisplays satisfy military requirements, but are too expensive and have low yield to be a feasible alternative.
- Overall scrap/repair rate reduced by 86% for circuit board assembly; 47% for fully assembled packs.
- Established new on-shore manufacturing capability – bulk Si and SOI backplanes
- Improved lifetime and lower power consumption.
- Yield: 5X improvement
- Cost: 5X improvement (\$10k to \$2k for HD High Brightness Color)
- Cycle times: 45% improvement of final component yield

Implementation and Technology Transfer:

F-35 Head Mounted Display System (F-35 HMDS Program Office);
 Enhanced Visual Acuity (EVA) Goggles (NAVAIR PMA 202);
 Multispectral Digital Fusion Goggles (SOCOM); Joint Helmet Mounted Cueing System (JHMCS) Display Unit (JHMCS Joint Program Office);
 and Enhanced Night Vision Goggles (ENVG) and Army Family of Weapon Sights (FWS) (PM Soldiers Sensors and Lasers).

OSD ManTech	\$4.95M
(PMA 202, NVESD)	\$2.24M
Industry cost share (eMagin)	\$4.75M



Manufacturability of Vertical-Cavity Surface Emitting Lasers (VCSELs) - Phase I

- VCSELs are semiconductor diode lasers that emit radiation normal to the wafer surface; unique structure leads to inherent strength for high power laser applications
- USA-based manufacturing enables VCSEL technology
- Estimated production: 77,000 units
- Systems impacted
 - NAVAIR UAVs, AFSOC CP3, AngelFire, 670th Aeronautical Systems Squadron
 - 10X cost reduction for VCEL Arrays
 - Thermal Management: reduce systems cost by 70%
- ROI: 4:1
 - Per unit savings range from \$45 - \$9K; total 5 yr. savings expected to be \$15M
 - OSD ManTech Investment: \$4.2M
 - \$15M/\$4.2M = 3.6



VCSEL Technology
 Very low speckle
 Brightest illumination

Edge-emitting Laser Technology
 Large scale speckle noise

Small scale speckle noise
 Diagonal, non-circular beam
 Artifacts from optics

LED Technology
 Dim illumination
 (low power = reduced range)
 No speckle

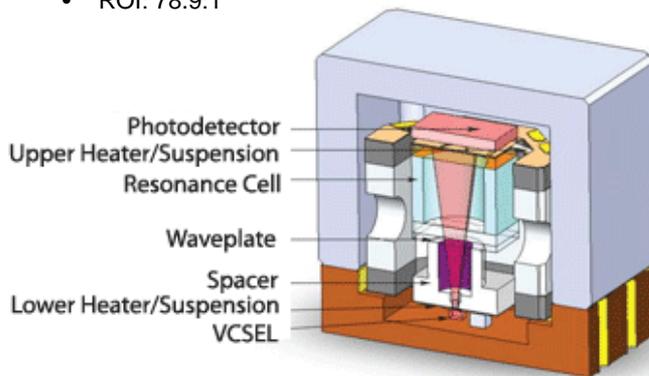


Success Stories



Chip Scale Atomic Clock Phase I & II

- C4ISR systems derive synchronization from GPS; GPS downtime is an issue
- Chip-Scale Atomic Clock (CSAC) is a frequency source which provides the accuracy needed for operation, regardless of GPS availability
- CSAC's high cost (\$8,700/unit) and low production rate (100/yr.) precluded large-scale fielding
- Leveraged a DARPA CSAC investment to reduce operational costs and transition beyond custom fabrication
- 29X improved cost: reduced from \$8,700 to \$300
- Increased manufacturability from 100/yr. to 20,000/yr.
- Systems impacted: Military GPS user equipment, Joint Counter Radio Controlled Improvised Explosive Device Electronic Warfare (JCREW), C4ISR systems requiring synchronization: WIN-T, JTRS, SIGINT geolocation
- ROI: 78.9:1



5 yr procurement of 20,000 units x 5 = 100,000 units
Savings: \$8,700/unit - \$300/unit = \$8,400/unit
Total OSD ManTech investment: \$10.66M
 $(100,000 \times 8,400) / 10,660,000 = 78.8$

Cold Spray Repair & Rebuild Phase I

- Create a production ready supply chain that will cost effectively deliver transmission housings and other high cost, high failure rate components repaired with cold spray technology
- Reclaim parts that are unserviceable due to corrosion, wear, chafing, or other damage; Impacts Army, Navy and Air Force
- OEM, AMRDEC, NAVSEA & AFMC have authority to implement CS
- Technology transition to Industry (CS Supplier and Depots)
- Systems impacted:
 - F-18 AMAD Gearbox
 - F-16 Air Inlet Housing
 - B-1 FEB Panel
 - UH-60 Sump Housing
- ROI: 4:1
 - 5 yr savings: \$16.9M; OSD ManTech investment: \$4.7M; $16.9/4.7=3.6$
 - \$3.4M/yr savings on four systems noted above

F-18 Mechanical Damage

Before



After

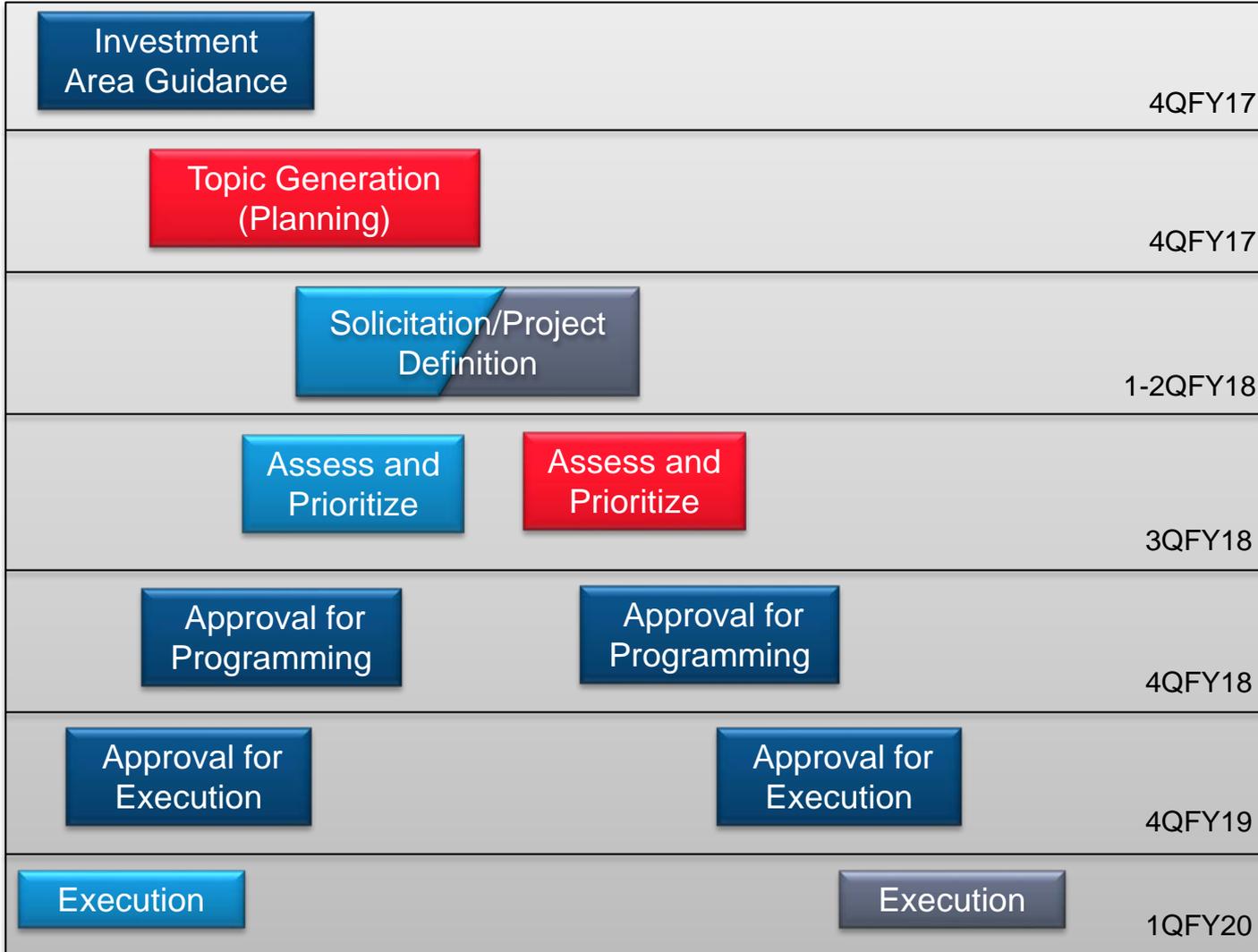




OSD ManTech PPB&E Process



-  OSD ManTech
-  Program Stakeholders*
-  S&T & Acq Orgs, Organic & Defense Industrial Base
-  Manufacturing Institutes



- *Stakeholders include:
- OSD ManTech
 - JDMTP JTPAs
 - MII Gov't CTOs
 - DoD S&T EXCOM Deputies
 - OSD DPA Title III



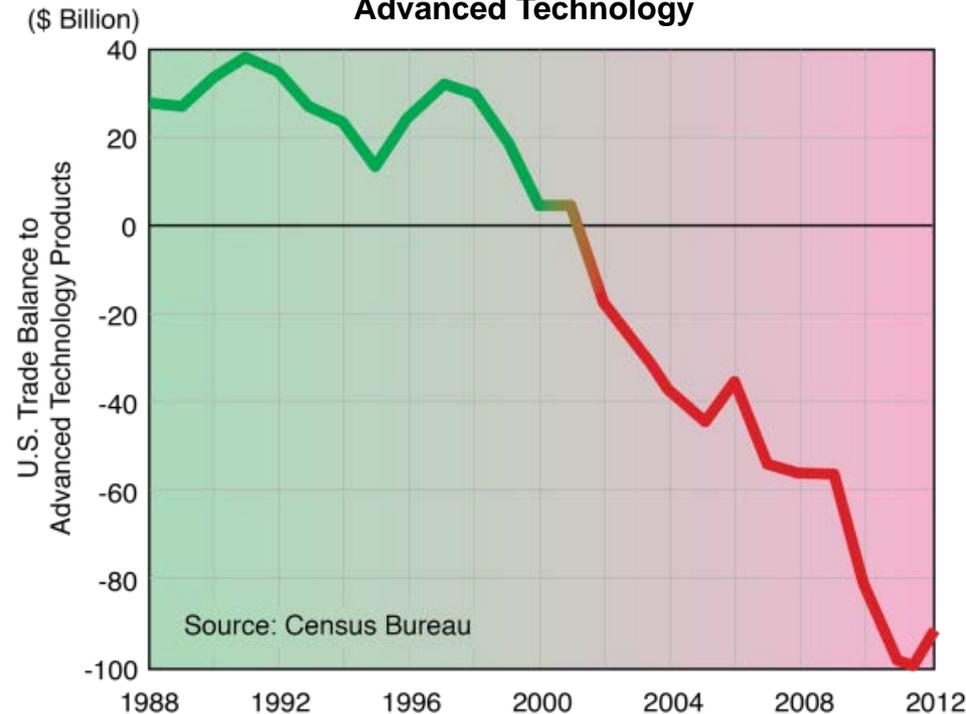
Manufacturing USA Program Genesis



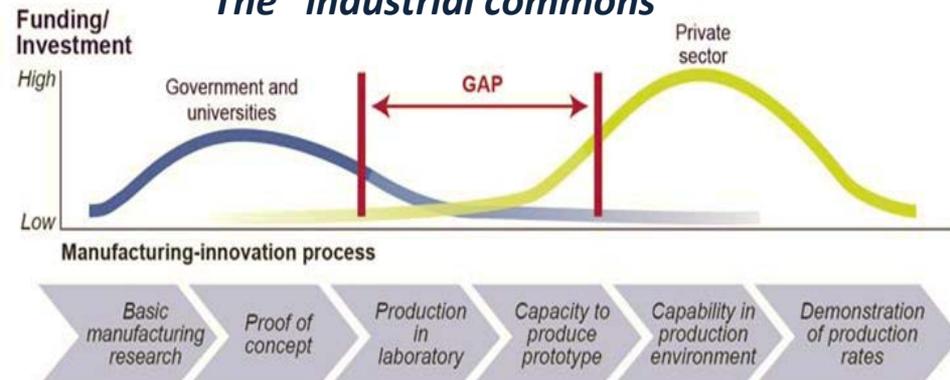
Compelling national need to address market failures in pre-competitive applied manufacturing R&D

- **U.S. Trade Balance swung to historic deficit, lost 1/3rd of workforce**
- **High value products invented here, now made elsewhere**

U.S. Trade Balance of Advanced Technology



The “valley of death”
The “missing Bell Labs”
The “industrial commons”



The requirement: A framework for government, industry and academia to intensely collaborate on industry-relevant manufacturing problems

- Address the market failure of industry underinvestment in “pre-competitive” applied R&D
- Focus on “de-risking” new technologies and materials to scale-up for U.S. manufacturers



Manufacturing USA's Expanding National Network

Since Launching in 2012:

- Over \$1 billion Federal funding matched by over \$2 billion non-Federal funding
- 1,300+ companies, universities, and non-profits involved
- 41 states participating

America Makes
Additive Manufacturing
Youngstown, OH

aim
Advanced Robotics Manufacturing Institute
Robotics Manufacturing
Pittsburgh, PA

AIM
photonics
Integrated Photonics
Albany, NY

REMADE
INSTITUTE
Recycling Materials
Rochester, NY

armi
Tissue Biofabrication
Manchester, NH

affva
Fibers and Textiles
Cambridge, MA

RAPID
Process Intensification
New York, NY

NIMBL
Biopharma Manufacturing
Newark, DE

POWERAMERICA
Wide Bandgap Semiconductors
Raleigh, NC

iacmi
Advanced Composites
Oak Ridge, TN

lift
Lightweight Metals
Detroit, MI

DMDII
Digital Manufacturing and Design
Chicago, IL

CLEAN ENERGY SMART MANUFACTURING INNOVATION INSTITUTE
Clean Energy
Los Angeles, CA

NEXTFLEX
Flexible Hybrid Electronics
San Jose, CA

DoD		8 Institutes
DoE		5 Institutes
DoC		1 Institute



*States in purple have major participants in Manufacturing USA Institutes



DoD's Manufacturing USA Institutes are Demonstrating Growing, Tangible Impact



DoD's Manufacturing USA Institutes are creating new, highly collaborative environments that are spurring innovation, performance, and competitiveness across the U.S. manufacturing base.

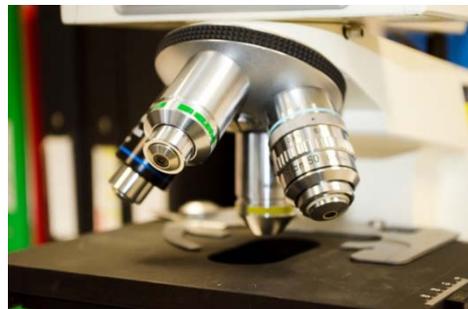
- ✓ Helping to bridge the current gap between basic research and product development/fielding
- ✓ Providing the Department with access to key, domestic enabling technologies that can enhance the performance and capabilities of future defense systems
- ✓ Advancing manufacturing innovation for specific, focused technology area manufacturing ecosystems
- ✓ Ensuring a strong ecosystem of companies and organizations capable of manufacturing components needed by the DoD
- ✓ Maintaining close manufacturing partnering relationships with certain industries when the right factors are in place
- ✓ Sharing assets among MII member organizations to help companies, particularly small and medium enterprises, gain access to cutting-edge capabilities and equipment
- ✓ Creating an environment to develop the skills and educate and train the workforce for advanced manufacturing implementation



Established: December 2016
Hub Location: Manchester, New Hampshire
Lead: ARMI
Federal Funding: \$80 Million
Industry cost share: \$214 Million

Focus Areas:

- Cell & Material Selection & Sourcing: The ATB-MII will use industrial manufacturing practices to reliably and reproducibly generate cells and biomaterials.
- Biofabrication Platforms: Integrated biofabrication platforms will be developed to transform these standardized starting materials into novel and evolving tissue and tissue-related end-products.
- Process Design and Automation: Process design and automation will need to be used to improve the rate and reproducibility of multi-step manufacturing processes.
- Tissue Finishing and Testing Technologies: The ATB-MII will assist in developing the successful commercialization of tissue-based products and non-destructive validation tools.



Biofabrication: An innovative manufacturing industry segment is *creating state-of-the-art manufacturing innovations in **biomaterial and cell processing, bioprinting, automation and non-destructive testing technologies** for critical Department of Defense and novel commercial use.*



Established: January 2017
Hub Location: Pittsburg, PA
Lead: American Robotics
Federal Funding: \$80 Million
Industry cost share: \$173 Million

Technologies ripe for significant evolution within the RIME institute include:

- Robot control (learning, adaptation, & repurposing)
- Collaborative robotics
- Dexterous manipulation
- Autonomous navigation and mobility
- Perception and sensing
- Testing, verification, and validation (TV&V)



Problem: The use of robotics is becoming widespread in manufacturing environments but the robots are typically **expensive, singularly purposed, challenging to reprogram,** and require **isolation from humans for safety.**

Need: Robotics are increasingly necessary to achieve **the level of precision necessary for defense and other industrial manufacturing requirements.** Capable affordable robots, which can be repurposed expeditiously will improve participation of mid-size to small manufacturers so far excluded due to capital cost and complexity of use constraints.

Solution: ARM will integrate industry practices and institutional knowledge across many disciplines to **realize the promises of a robust manufacturing innovation ecosystem.**



DOC and DOE Institutes



NIIMBL

Established: December 2016
Hub Location: Newark, DE
Lead: University of Delaware
Federal Funding: \$70 Million
Industry cost share: \$129 Million



RAPID

Established: December 2016
Hub Location: New York, NY
Lead: American Institute of Chemical Engineers
Federal Funding: \$70 Million
Industry cost share: \$140 Million



REMADE INSTITUTE

Established: January 2017
Hub Location: Rochester, NY
Lead: Rochester Institute of Technology
Federal Funding: \$70 Million
Industry cost share: \$70 Million





Third Party Assessment (Deloitte) Commissioned by DoD, Now Completed



Deloitte studied key areas in order to evaluate and assess Manufacturing USA's national-level impacts, including:

- Program Theory and Structure
 - Is the program doing the right things?
 - Is the program meeting objectives / impacts?
- Program progress
 - How is the program performing, achieving its objectives, and creating impact?
 - Qualitatively, what are case studies / examples of impact?
 - Quantitatively, what does the data tell us about impact?
- Recommendations
 - What can be improved?





Third Party Assessment (continued)



Report Extract:



9,424

Relationships between organizations

1,174

Organizations involved with the program

753

Organizations with formal membership

203

Organizations have relationships with multiple institutes

120

Organizations are members of more than one institute

Together, the Institutes' convene **nearly 1,200 organizations** in an inter-industry network comprised of **9,000+ organization relationships**



DMDII Facility in Chicago, Illinois



PowerAmerica Institute member facility.



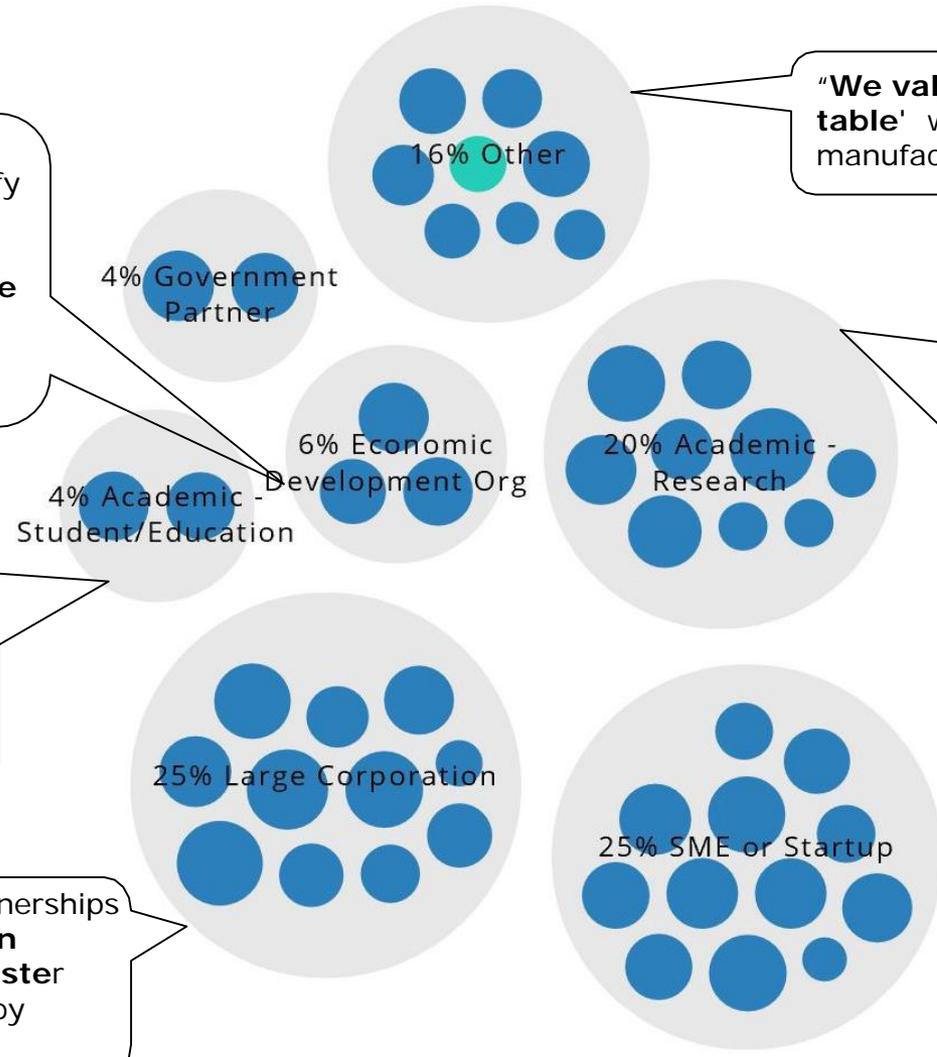
Third Party Assessment (cont.): Extracted Quotes

Report Extract:

"We receive great value working with the [Institute] staff to identify new programs and capabilities to deploy in the community. **They understand the technology; we understand economic development processes. It's a good partnership.**"

"The **Manufacturing USA program helps us serve as a resource to our local employer base**, promoting how the Institutes can benefit them and advance their growth strategies."

"Broad public private partnerships enable new **technology in manufacturing much faster** than if addressed solely by individual corporations."



"We value being '**at the table**' when the future of manufacturing is discussed."

"My affiliation provides me with an outstanding opportunity to see **basic science and technology discoveries translated into real-world applications** and products. It also provides **unique training opportunities** for my students."

"There is **amazing collaboration** in a large grouping of companies advancing science in cutting edge technology."



Third Party Assessment (cont.)

Results/Conclusions



Key Conclusion: “Manufacturing USA is convening U.S. advanced manufacturers, spurring R&D Innovation, and laying the groundwork for workforce progress.” (pg. 48)

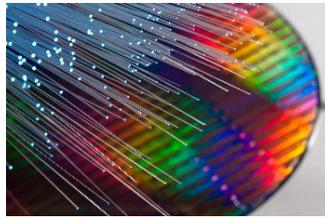
Report Extracts:



- ✓ The Program is a highly effective ecosystem convener
- ✓ Institutes are demonstrating the potential to deliver 5x leveraged value for members
- ✓ Institutes are successfully planning for sustainability independent of U.S. government influence
- ✓ Workforce efforts should be coordinated for greater effectiveness
- ✓ Manufacturing USA should adopt phased metrics
 - Long-term results such as innovative processes and products or company ROI will not be observable for several years after the formation of the Institutes.
 - Initially, the Program should track Institute metrics around start-up activities as well as preliminary R&D results.



Delivering Value: Innovation Ecosystem Growth



Integrated Photonics Foundry Access

AIM Photonics has foundries on both coasts to support the entire domestic supply chain for integrated photonics. This includes silicon photonics design in Massachusetts, a silicon photonics foundry in Albany, NY, a packaging, assembly, and test center in Rochester, NY, and an Indium Phosphide fabrication and novel laser research design center in California.



Reinvigorating Communities

LIFT, housed in a 100,000 sq. ft. abandoned former factory of an auto parts supplier that went bankrupt during the wave of offshoring in the early 2000s, is breathing new life into historic Corktown, one of Detroit's oldest neighborhoods.



The Digital Manufacturing Commons

DMDII in collaboration with General Electric and MIT will help increase the competitiveness of American manufacturing by providing a next-generation web platform that fosters supplier interoperability and creates a marketplace for connecting, analyzing, and distributing people and solutions.

Involving Small Business

America Makes member and close partner, Youngstown Business Incubator, is incubating nine small businesses involved in the 3D Printing industry.





Delivering Value: Innovation Ecosystem Growth (cont.)



Revolutionizing Standards

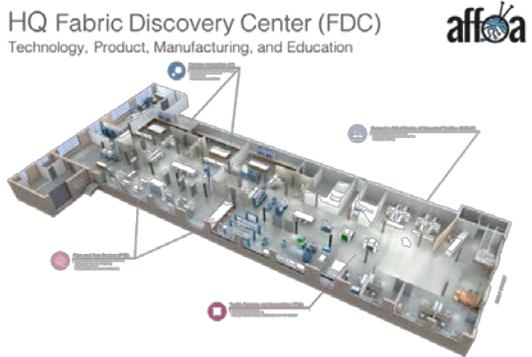
ATB will revolutionize the standardization of starting materials, post-delivery assurance of tissue identity, viability, function and efficacy while improving the scale, throughput, automation, and reproducibility of engineered tissues

Regional and Technology Nodes

NextFlex has technology specific nodes focused on complementary technologies, and regionally focused nodes that assist with workforce development initiatives.

Fabric Discovery Centers

AFFOA is working with a number of universities including NC State and University of Delaware to discuss the potential for them to become a Fabric Discovery Centers.



ARM – Regional Robotics Innovation Collaboratives

Eight (8) Regional Robotics Innovation Collaboratives (RRIC's) with common and specialized services offered. ARM is currently analyzing best architecture to leverage RRICs.



Delivering Value: Technical Innovations

Fast Facts (as of September 2016)*

Non-Federal Pledges: **Over \$1.x billion**

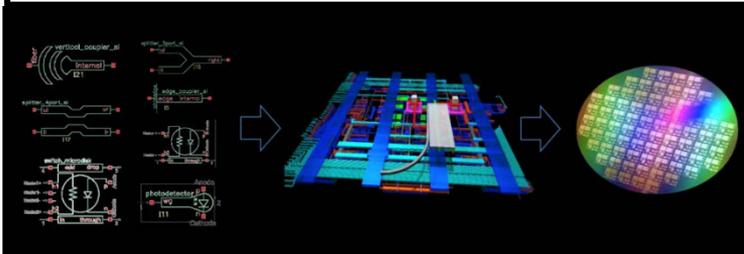
Technology Profile: **XXX projects**

*This includes only the first 6 DoD Manufacturing USA institutes.



Future Factory Platform

DMDII has embarked on its Future Factory Platform, an operating manufacturing sandbox at its Chicago Innovation Center where digital manufacturing technologies can be integrated into real world production.



3D Printing Metal Castings

Through **America Makes**, a team including Youngstown Business Incubator, Caterpillar, the American Foundry Society, and nine industry partners developed a method for using additive manufacturing to make sand molds for metal casting. A demonstration on a commercial air brake core consolidated eight parts into one, increased yield from 12% up to 99%, and reduced lead time from 12 weeks down to 3 weeks. A 3D printed sand casting of a fuel pump system for a major aerospace platform was awarded *#2 Casting of the Year* by the American Foundry Society.

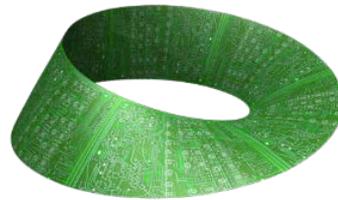
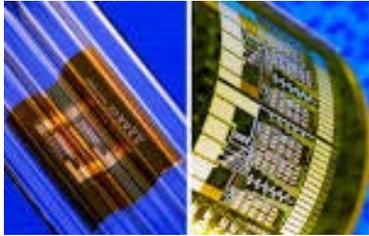
State-of-the-Art Prototyping Process

AIM Photonics members can now rapidly design photonic circuits to be fabricated in the Institute's state-of-the-art silicon photonics foundry service using AIM's Photonics Design Kit, giving their researchers the ability to have prototypes fabricated that can address applications including data communications, sensors, and other related processes that will enable their technology development more efficiently and cost-effectively.





Delivering Value: Technical Innovations (cont.)



Light weighting for Energy Savings

LIFT has successfully reduced the weight of a core metal part found in cars and trucks by 40%, helping improve fuel efficiency and save consumers dollars at the pump.

Biomarkers that Help Save Lives

NextFlex, as part of a DoD wearables community engagement, is creating a revolutionary human and soldier monitoring patch, using flexible hybrid electronic manufacturing processes, which will sense stress through biomarkers in sweat that can monitor soldier cognitive and stress during training and identify stressed premature babies without drawing precious quantities of blood.



Spearheading a Fabric Revolution

AFFOA is spearheading a fabric revolution through innovative fabrics and textiles that protect firefighters from the hottest flames, will replicate the sensing capabilities of a smart watch into a lightweight fabric, and will detect when a wounded soldier needs treatment.

Advancing Medical Capabilities

ATB is rapidly advancing state-of-the-art medical capabilities for warfighter readiness and care by developing scale up technologies for any material based on cells and creating/defining new in-process testing technologies used in three-dimensional printing and manufacturing of living cells



Delivering Value: Workforce Development

Supporting Veterans

America Makes launched a 3D Printing for Veterans pilot program in partnership with the Veterans Administration, google.org, Autodesk, and 3D Veterans (a small business in San Antonio, TX). The 90-day boot camp trained veterans in the digital skills needed to design and 3D print personalized, assistive technologies for veterans with disabilities. These 21st century skills will help the veterans obtain future job opportunities and re-integrate into their community.



Developing Course Curriculums

DMDII and its partners at the University at Buffalo have developed an online course series on digital manufacturing and design with Coursera, the world's largest provider of massive online open courses. The first courses was launched in January 2017 for students and engineers across the country wanting to upgrade their knowledge and factories with the latest digital technology.

Credentialing the Workforce

LIFT partnered with the National Institute for Metalworking Skills and 125 industry, education and workforce experts to roll-out a new national training and credentialing program to fill those jobs.

Training Future Experts

AIM Photonics is training tomorrow's photonics experts through Research Undergraduate Apprenticeships at UC Santa Barbara, providing community college and UCSB undergraduate students with the technical and professional development in the next generation of telecommunications.

Reaching High School Students

NextFlex is conducting the Flex Factor project based learning program for high school students. This education initiative blends technology and entrepreneurship learning objectives with familiarization of flexible hybrid electronics (FHE) and broader advanced manufacturing education and career pathways. With help from the city of San Jose and Santa Clara County, NextFlex is planning to significantly scale the program throughout the Bay Area in the fall of 2017.





MIBP Function - Manufacturing



Manufacturing USA Institutes: Strategic Impact is Growing

- Now a whole-of-government effort, in strong partnership with industry
 - **Strong, bi-partisan Congressional support, in concert with Executive Branch**
 - **Revitalize American Manufacturing and Innovation (RAMI) Act of 2014—118 RAMI Bill sponsors**
- Building a true national network of public-private partnerships, creating an industrial commons for manufacturing R&D and workforce education and development
 - **Nearly 1,000 partners, 40+ states, \$1.4 Billion in cost share**
- Marshalling best talent across industry to both lead and participate
 - **100's of years of experience at every level**
- Strategically aligning resources to address technology space
 - **States and companies aligning funds and people to close gaps**
- Catalyzing ecosystems across the Nation
 - **Galvanizing communities – springboard for broader activity**
 - **Satellites enabling recruit AND retain**
- Accelerating trust in supply chain development with diversified risks
 - **Small and large companies gain exposure to each other in safe, collaborative environment**
 - **Institutes establish manufacturing capacities that were beyond the reach of even the largest companies**