# Defense Manufacturing Focused On Warfighter Dominance



The Department of Defense Manufacturing Technology Program December 2019



### The DoD Manufacturing Technology (ManTech) Program

### VISION

A responsive world-class manufacturing capability to affordably and rapidly meet Warfighter needs throughout the defense system life cycle.

### FOCUS

The DoD Manufacturing Technology (ManTech) program is focused on developing processes and enabling production capabilities that reduce the acquisition and sustainment cost of weapon systems and provide direct benefit to the Warfighter. Measures of effectiveness include improved mission capability, improved readiness, and reduced total ownership costs. Timely transition of the technology consistent with acquisition and operational requirements is essential.

### DOD MANTECH MISSION

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

This brochure highlights 15 ManTech program successes of the DoD Service and Agency ManTech programs.

The OSD ManTech program focuses heavily on satisfying the manufacturing technology needs for the OSD Research & Engineering modernization priorities (e.g. hypersonics, biotechnology, microelectronics). A key element of this is mission is to secure the future workforce needed to make the Warfighter's technologies for tomorrow.

Updates are also provided on the activities of the eight OSD ManTech-Lead manufacturing innovation institutes: Advanced Functional Fabrics of America (AFFOA), the American Institute for Manufacturing Integrated Photonics (AIM Photonics), Advanced Robotics Manufacturing (ARM), America Makes (the National Additive Manufacturing Innovation Institute), BioFabUSA (Advanced Regenerative Manufacturing Institute), Lightweight Innovations for Tomorrow (LIFT), Manufacturing Times Digital (MxD - National Center for Cybersecurity in Manufacturing), and NextFlex (the flexible electronics institute).



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### **ManTech Demonstrates Macrocell Receiver Conversion for Millimeter Wave (MaRCm)**

### The Challenge:

Radar warning receivers require digital processing to provide timely and accurate situational awareness and countermeasures against advanced radar technology. Since sampling at the Nyquist Rate of the highest threat millimeter wave (mmW) frequency is required, current digital processing rates must be increased. Improved manufacturing for low loss mmW frequency block conversion is a cost effective solution that maximizes the utility of existing digital receivers without the need for complete system redesign or replacement.





MaRCm Module

AH-64 Apache

#### ManTech Response:

**Reduces Size**,

Weight and

**Power of** 

**Overall System** 

- Developed production processes for millimeter wave device technologies for Radio Frequency (RF) threat warning improvements to the air platforms
- Enabled process technologies for producing macrocells with package isolation and increasing sensor sensitivity
  - Army ManTech investment was \$7.3M with a cost share from PM ASE of \$1.8M

### Impact:

- Successful technology transition to the Army's Modernized Radar Warning Receiver (MRWR) Program of Record (PoR)
- Reduced size, weight, and power of mmW detection module, which will enable integration into aircraft and all other equipment requiring mmW detection
- Reduced module complexity and increased reliability
- Reduced manufacturing and test cycle time
- Reduced millimeter wave module cost

## **ManTech Improves Infrared Sensors for Soldier Lethality and Situational Awareness**

### The Challenge:

Uncooled Long Wave Infrared (LWIR) sensors are a key technology for providing the Soldier with improved situational awareness and lethality over our adversaries. Newly developed High Definition (HD) imaging arrays provide capabilities that exceed those of our adversaries, but uncooled production and fabrication was immature with low yield, contributing significantly to increased costs.



### ManTech Response:

- Optimize key component manufacturing process of 12µm HD uncooled sensors, resulting in reduced costs and increased performance capabilities
- · Improved sensitivity, uniformity, and operability
- Successful demonstration of technology in operationally relevant environments while advancing maturation from MRL 4 to MRL 7
- Army ManTech investment was \$10M with a cost share from Project Manager, Soldier Sensors and Lasers (PM-SSL) of \$4.9M

### Impact:

- Increased sensor yields from 10% to 70%
- Reduced camera core costs by 4x
- Increased the Warfighter's lethality and situational awareness in day, night, and obscured conditions by doubling the field of view with higher sensitivity while meeting SWAP+C requirements
- Transitioned to Family of Weapon Sights Crew Served (FWS-CS) program, during Engineering & Manufacturing Development (EMD)

PARTICIPANTS

Army Combat Capabilities Development Command (CCDC) C5ISR Center, Program Manager Aircraft Survivability Equipment, Northrop Grumman

Army Combat Capabilities Development Command (CCDC) C5ISR Center, Project Manager Soldier Sensors and Lasers, BAE Systems, Leonardo DRS, Raytheon Vision Systems

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Improved Performance While Meeting Size, Weight, **Power and Cost** 



### **ManTech Modernizing the Manufacturability** for Soldier Enhanced Targeting Systems

### The Challenge:

Uncooled Shortwave Infrared (SWIR) imagers were too expensive, too large and used too much power for wide deployment in Soldier Systems. Manufacturing protocols required smaller substrates and more touch labor to yield focal plane arrays (FPAs). Increased manufacturing costs were in part due to a lack of advanced manufacturing processes.



#### ManTech Response:

- Evaluated and improved the manufacturing of high guality indium gallium arsenide (InGaAs) focal plane arrays for use in SWIR cameras
- Implemented wafer scale processes in place of die level processes
- Transitioned to 4-inch wafer processing which increased yield
  - Significantly reduced dark current and noise, enabling high sensitivity operation
  - Army ManTech investment was \$8M with a DMS&T cost share of \$4.6M

**Enables Next Generation Soldier Systems for Army Modernization** 

### Impact:

- · Enabled the direct observation of tactical laser spots for enhanced targeting
- Reduced packaging requirements and significantly matured SWIR which expanded transition paths for Soldier applications
- Transitioned to the Product Manager Soldier Precision Targeting Devices (PM-SPTD) Joint Effects Targeting System (JETS) Engineering & Manufacturing Development (EMD) phase

#### PARTICIPANTS

Army Combat Capabilities Development Command (CCDC) C5ISR Center, Product Manager Precision Targeting Devices, Collins Aerospace

# **ManTech Enables Forward Looking Infrared** (FLIR) for Ground Vehicle Modernization

### The Challenge:

The Infrared Focal Plane Array (IRFPA) is an essential but technically challenging and costly part of the 3rd Generation Forward Looking Infrared (FLIR) sensor. Innovations in III-V materials can address these challenges, but lacked manufacturing readiness for dual-band, high-performance IRFPA applications. To enable readiness, commercial domestic compound semiconductor foundries needed to establish multi-wafer production capability for starting material, and fabrication houses needed to improve yields of IRFPAs that met 3rd Generation FLIR system specifications.



### ManTech Response:

- Established multi-wafer growth capability, greatly improving the supply chain of high-quality epi-wafers to the fabrication houses at a production level
- Enabled detector batch processing for III-V Strained Layer Superlattice (SLS) materials
- Demonstrated manufacturing capability for producing FPAs that operate in day/night conditions and degraded visual/all-weather environments for Soldiers
- Army ManTech investment was \$7.5M

### Impact:

- Reduced costs over current mercury cadmium telluride IRFPAs for ground combat vehicles
- Significant operability, stability, and yield improvements

"ManTech investment in dual-band SLS is providing 3GEN FLIR additional sources of supply at an affordable unit cost per focal plane array while still not sacrificing FLIR performance to the Warfighter ... "

- LTC James A Lindh, II, Program Manager, PM Ground Sensors, PEO IEW&S

Army Combat Capabilities Development Command (CCDC) C5ISR Center, Program Manager Ground Sensors, Raytheon Vision Systems, L3Harris, HRL Laboratories, IQE, Intelligent Epitaxy Technologies

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Abrams Tank

**Enables Next** Generation **Reconnaissance**, **Targeting & Surveillance** 



ARMY

### **Navy ManTech Connects Disparate NAVAIR Technical Data**

### The Challenge:

Naval Aviation Depots and the Defense Logistics Agency (DLA) use different forms and processes to request internal and external engineering support, which often kickoffs a series of actions to locate the pertinent technical data required to disposition the request. The Technical Data Integration and Search (TDIS) project reduced the non-value-added time of manually searching to locate and deliver this technical data. Navy ManTech focused on the in-service sustainment period needed for engineering support activities; specifically, the ad hoc need for engineering support for depot and provisioning services.



### ManTech Response:

- Navy ManTech automated the indexing and connected multiple systems, including the Technical Manual Application System, Navy Joint Engineering Data Management Information and Control System, and NAVAIR's product life-cycle management software, ENOVIA
- Provided a secure portal for internal and external consumers, such as Logistics, DLA, the Naval Supply Systems Command, and CIMCO software developers, to easily search for technical data from one location
- Integrated a previous ManTech effort, the 3D Data Exchange project, to validate technical data from TDIS, generate a technical data package, and deliver it to the requesting agency
  - Navy ManTech investment of \$.69M

**TDIS Project Reduces the Amount of Time** to Search, Locate, and Deliver **NAVAIR** Technical **Data**, Saving \$2.9M Annually

### Impact:

- Estimated annual cost savings of \$2.9M
- Reduces labor hours to locate data across multiple data systems by 34%, saving \$1.7M annually
- Reduces labor by 23% to package and deliver technical data for internal Requests for Engineering Investigation, saving \$.53M annually
- Reduces labor by 34% to package and deliver technical data for external Requests for Engineering Support, saving \$0.11M annually

### PARTICIPANTS

Office of Naval Research Navy ManTech, NAVAIR 4.1.9, Naval Shipbuilding and Advanced Manufacturing Center

# **OLED Microdisplays Simplify the Manufacture** of F-35 Helmet-Mounted Displays

### The Challenge:

The F-35 Joint Program Office needed to improve the contrast ratio of the F-35 Lightning II helmetmounted display (HMD) to improve visibility during night operations. The Navy ManTech objective was to substitute an organic light-emitting diode (OLED) microdisplay for the existing active matrix liquid crystal display without adding additional process steps or optical train elements. Further, the OLED-based HMD needed to perform sufficiently over the lifetime of the aircraft without luminance degradation - a known problem with OLED devices.



### ManTech Response:

- Navy ManTech developed and demonstrated a manufacturing process to assemble an OLED display into the existing optical train of the F-35 Lightning II HMD
- · Designed, built, and transferred the OLED assembly tooling to the production contract
- Conducted OLED device life-testing and degradation modeling that demonstrated adequate luminance over the life of the product
- Designed the testing station to identify issues earlier in the manufacturing process
- Conducted manufacturing process demonstration and informal safety-of-flight testing that supported the initial operating capability designation for F-35C in February 2019
- Navy ManTech investment of \$3.7M

### Impact:

- Reduced part count by 27 percent
- Reduced assembly fixture count by 50 percent
- Reduced touch labor by 10 percent
- Reduced life-of-program costs by \$17.4M
- Rear Adm. Dale Horan, director of the F-35C Fleet Integration Office, called the OLED technology, "an elegant solution"
- Assembly and degradation modeling concepts can be transferred to other OLED applications across services

#### PARTICIPANTS

Office of Naval Research Navy ManTech, Penn State Applied Research Laboratory -Electro-Optics Center, F-35 Joint Program Office, Rockwell Collins Elbit Vision Systems, Lockheed Martin Corporation

Left: The F-35 HMD helmet © Rockwell Collins Elbit Vision Systems

Top Right: The green glow exhibited by the F-35 Lightning II helmet makes it difficult for pilots to see in low light conditions NAVAIR photo

Bottom Right: Navy ManTech developed a manufacturing process to assemble an OLED display into the existing optical train of the F-35 HMD NAVAIR photo





**Reduced HMD Parts and Labor**, Which Reduced Life-of-Program Costs by \$17.4M





# NAVY

### **Navy ManTech Increases Life Expectancy and Reduces Refurbishment Costs of Waveguides**

### The Challenge:

The U.S. Navy needed an improved process to apply new radome material on AN/SPS-48E radar antenna waveguide array slats during refurbishment without the high cost of buying replacement waveguides. Additionally, waveguides are highly vulnerable to corrosion due to trapped water. Navy ManTech developed a new procedure for radome replacement and investigated the causes of corrosion. This effort led to the successful development of a new procedure and corrosion mitigation /prevention techniques that will both lower cost and increase the life expectancy of waveguides.



SPS-48E in service (U.S. Navy photo)



Navy ManTech designed a new waveguide load-end flange to allow the antenna to better self-clean during rotation (Applied Research Laboratory Penn State photo)

### ManTech Response:

**Reduced Costs** 

and Increased

**Radar Systems** 

**Availability and** 

**Time Between** 

**Overhaul** 

- Navy ManTech successfully implemented a new refurbishment procedure that allows low-cost replacement of radomes during overhauls
- Developed a new corrosion mitigation procedure based on material changes
  - Demonstrated the need to change from stainless steel to aluminum hardware on the load-end array to prevent galvanic corrosion
  - Designed a new waveguide load-end flange to allow the antenna to better self-clean during rotation
  - Navy ManTech investment of \$319K

### Impact:

- Five-year cost savings of \$6.9M
- Five-year cost avoidance of \$6M
- Total five-year cost savings of ~\$13M with an ROI of 38.4:1
- Significant improvement in AN/SPS-48E Air-Search Radar Systems availability and mean time between overhaul
- · Additional benefits of reduction in hardware costs and extension of life expectancy have not been quantified but are impactful

### PARTICIPANTS

Office of Naval Research Navy ManTech, Naval Surface Warfare Center - Crane, PEO Integrated Warfare Systems 2.0, Tri-Star Engineering, Institute for Manufacturing and Sustainment Technologies

# **Air Force ManTech Uses Process Modeling** and Expert Elicitation to Reduce Variability in **Hypersonic Aeroshell Coatings**

### The Challenge:

The Air Force ManTech Carbon-Carbon Material Producibility (CMP) program sought to reduce thickness variability of Silicon Carbide (SiC) coatings on Carbon-Carbon (C/C) composites. Unpredictable variability in coating thickness often led to additional re-coating processing steps that added unnecessary cycle time, Material Review Board actions, cost, and schedule uncertainty.



### ManTech Response:

- A Silicon Monoxide (SiO) vapor diffusion process model was developed, and it showed coating thickness was dependent on C/C surface porosity
- Expert elicitations posited that legacy upstream cure processing methods caused variation in C/C surface porosity
- The baseline conformal tools used for curing, pyrolysis, and graphitization were replaced with several small supports to hold parts during these processing steps, providing higher quality and less-variable C/C surface porosity

### Impact:

- Coating trials with an entire aeroshell demonstrated a more uniform coating thickness that met minimum thickness requirements
- Shorter and more affordable aeroshell manufacturing cycle due to elimination of a second coating application
- Enhanced coating methodology transitioned to flight demonstration systems

#### PARTICIPANTS

Carbon-Carbon Advanced Technologies (C-CAT), University of Dayton Research Institute, Southwest Research Institute, Air Force ManTech, and Materials Research and Design

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Saved \$15K and 2 Weeks per Unit, Delaying **Significant Capital** Investment



### **Air Force ManTech Uses Digital Metrology Methodologies to Restore Damaged F-16 Vertical Tail to Flight-Ready State**

### The Challenge:

The Ogden Air Logistics Complex required assistance reassembling an F-16 vertical tail. Due to lack of datums, they were neither able to accurately machine mounting lugs to within the required tolerance, nor properly align the "doghouse" structure that houses spherical bearings for rudder and actuation assembly to the rest of the tail, rendering the tail unrepairable using traditional methods.



### ManTech Response:

- Resulted in successfully restoring a damaged F-16 vertical tail to a flight-ready state
- Showcased the different capabilities of multiple metrologies and how those metrologies can be used in coordination with one another to improve fit and function
- Demonstrated how requirements can be met without access to original designs
- Demonstrated the benefit of creating digital masters of in-service parts
- Demonstrated the capability to improve repair processes through digital data analysis by eliminating 0.16" tilt

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#### PARTICIPANTS

University of Dayton Research Institute (UDRI), Macy Consulting, U.S. Air Force, Air Force Research Lab, America Makes

# **ManTech Program Improvements in Military Subsistence Supply Chain**

### The Challenge:

The Subsistence Network (SUBNET) is a DoD Manufacturing Technology Program for logistics research and development to improve and implement innovative capabilities and processes related to military subsistence and combat ration products. Focus areas include: food equipment, combat rations, field feeding equipment, garrison feeding, packaging solutions, nutrition and health, food safety and defense, food innovations, food footprint, and water security. The program leverages government, industry and academia to improve readiness, enhance the quality of subsistence products, advance efficiencies, and reduce costs in the supply chain.



### Soldier Boost Nutrient Dense Bars

### ManTech Response:

- Supplemental nutrient bar with high nutritional and caloric value and long shelf-life to fill nutritional gaps during high OPTEMPO and/or high stress and timeconstrained missions
- Tailored nutrition content provides the warfighter with the proper caloric intake based on activity level and body weight
- Working to improve flavor and shelf-life

### Impact:

- Easy to consume nutrition bar on the move
- Individually wrapped portions are easy to stow and remain sealed until needed
- Stimulant-infused bars keep the warfighter alert during times of fatigue
- Bar provides ultra-high energy in compact form
- DLA R&D Investment \$540,000

### **Digitally Transform Class I Supply Chain to** Improve Service, Cost, Agility, and Materiel Visibility

DLA ManTech Subsistence Program, Systems & Materials Research Corporation (SMRC), North Carolina State University

**Restored** a \$1.0 -1.5M Asset With a 3-Year Lead Time



Modernization and Readiness Analysis of Joint Food Management System

### ManTech Response:

- Develop a strategic plan for digital transformation of the subsistence supply chain
- Establish a roadmap for how digital applications can improve service, cost, and inventory levels
- Develop strategic guidance to implement, and maintain a Joint Food Management System

### Impact:

- Improve day-to-day operations, strategic planning, and performance management
- Provide real-time and predictive capabilities
- Transform and modernize subsistence capabilities to deliver and sustain Warfighter readiness and lethality
- DLA R&D Investment \$841,000





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DLA ManTech Subsistence Program, Vibronyx, Atiba, and MRJ

### **ManTech Program Expands Proven Microcircuit Emulation Approach**

#### The Challenge:

Microcircuit Obsolescence has for many years had its greatest impact on digital microcircuits; logic and memory functions. With Industry's discontinuance of its last remaining 5-volt digital processes, the decreasing demand for the corresponding analog/linear microcircuits has made those microcircuits increasingly unprofitable. Microcircuit Emulation has a proven track record and is being applied to re-establish sourcing for legacy analog/linear microcircuits.



### ManTech Response:

**Microcircuit** 

**Emulation for** 

**Legacy Parts** 

Improves

Warfighter

**Readiness** 

- Adapt design approach to maintain on-demand, low-volume tenets of emulation
- Develop design library to support circuit elements of 20-volt Operational Amplifiers
  - Apply earlier process development results to base array development
  - Implement electrical performance testing capabilities and develop test program generation procedures
  - Mature manufacturing processes

### Impact:

- Establish manufacturing capability for over 100 microcircuit NSNs
- Over 500 weapon systems potentially supported
- Increased readiness
- Reduced Total Ownership Cost
- DLA R&D Investment \$5.8M

### PARTICIPANTS

DLA ManTech Advanced Microcircuit Emulation Program, SRI International, Naval Information Warfare Systems Command (NAVWARSYSCOM) Formerly Space and Naval Warfare Systems Command (SPAWAR)

# **ManTech Program Augments Radiographic Testing Protocols with Deep Neural Networks**

### The Challenge:

Current radiographic standards used in the quality inspection of steel castings are not performance based nor quantifiable. The resulting Radiographic Testing (RT) ratings are subjective. Conventional x-ray ratings of steel castings per ASTM E446 or E186 can vary by as much as 2 levels (95% Cl). In fields with similar rating systems (such as cancer detection), this is a persistent issue.





Deep Neural Network and Semi-Automated Image Processing

### ManTech Response:

- and rating decisions
- testing
- Leveraged machine learning methods (deep neural networks) to further improve the rating experience using the implemented tool
- Metrics used for automated rating should be computable and related to performance

### Impact:

- Increased consistency of RT quality level ratings
- Results from the tool include intermediate results for improved traceability and records
- Performance based metrics can be used to improve design of cast steel parts
- The tools developed for radiographs of steel castings are widely applicable to non-destructive testing tasks across testing methods and material types
- Deep Neural Networks provide a path for continual improvement as additional data is collected
- DLA R&D Investment \$100,000 with a cost share of \$50,000

#### PARTICIPANTS

DLA ManTech Metal Casting Program, University of Alabama at Birmingham, Steel Founders' Society of America, University of Iowa, Mercury Marine, Advanced Technology International

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• Designed a semi-automated image analysis pipeline to improve robustness of feature detection • Implemented the developed algorithms in readily available software for ease of distribution and

### **Machine Learning** Augmented **Non-Destructive Evaluation Improves Test Robustness**



# **ManTech Ensures Manufacturers' Technical Requirements: Access, Integration, and Sharing**

TexSpecs – Foundation for the Combat Uniform Digital Thread

### The Challenge:

**TexSpecs** 

**Supports the** 

Warfighter

by Ensuring

**Combat Uniform** 

**Requirements are** 

**Current and Met** 

Combat Uniform product requirements are captured in a complex web of thousands of documents from different Government agencies, Standards Development Organizations and industry. For example, the Army Combat Uniform coat's requirements are scattered across 5000 pages in 98 documents from 13 organizations. Today, these documents are only available in PDF format which makes it almost impossible for the DLA, the Military Services and industry partners to effectively manage the technical requirements. They are a significant burden DLA product specialists and manufacturers who are responsible for consistently meeting the manufacturing and testing requirements.



and testing requirement data. This can result in costly errors, long lead times, difficult quality control reporting and poor configuration management.



Knowledge Base for Combat Uniforms

### ManTech Response:

- Transition from electronic paper-based requirements to "model document requirements"
- Validate the process of conversion from legacy data to model-based data
- Build Application Program Interface (API) to link test requirements to commercial test lab reporting and other purpose-driven apps

### Impact:

- Higher quality combat uniforms
- Shorter production lead-times
- · Easier tracking of test results over time and manufacturers
- Foundation for Combat Uniform Digital Thread
- DLA R&D Investment \$4.5M

### PARTICIPANTS

DLA ManTech Manufacturing Unique Sustainment Technology (MUST) Program, DLA Troop Support Clothing and Textiles Directorate, DOD Textile Industrial Base, Defense Standardization Program Office, XSB Inc. and LMI

# **Lockheed Martin Leverages "One Factory"** to Deliver World Class Radar in 2020

### The Challenge:

The Long Range Discrimination Radar (LRDR) is a 60-month contract to develop and rapidly field a radar at Clear Air Force Station, AK. Given the enormous scope of the project, gated by Manufacturing Readiness Level 8 benchmarks, along with ramp to full-rate manufacturing, the strength of multiple manufacturing centers operating as one factory was required to meet a challenging schedule. Implementing factory automation was a key factor in reducing takt time.





### Lockheed Martin Response:

- Product build starts at a microscopic level with nearly weightless component parts and culminates with final integration, test and delivery of full-scale array panels
- Leverage existing factories using a "one-factory" approach to exploit site-specific commodity expertise and manufacturing technologies
- Multi-site facilities operate as "one factory"; model codified through common Material Requirements Planning (MRP) system
- Investment in existing footprint and technology insertion created a 20K sq ft open-concept work center and injected advanced manufacturing robotics for conformal coat, automated test and RF Bullet Feed Robot yielding capacity necessary to deliver

### Impact:

- LRDR contract full-rate volume required conformal coat on more than 45,000 circuit cards
- Automated Conformal Coat line, implemented in 2018, reduces coating labor hours by 75%
- RF Bullet Feed Robot, implemented in May 2019, eliminates greater than 1 million manual operations
- Fully automated insertion, test and optical inspections
- Significantly reduced employee fatigue and eliminated human error

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RF Bullet Feed Robot (Photo: Lockheed Martin)

LRDR Panel Production Line in Moorestown, N.J. (Photo: Lockheed Martin)

Lockheed Martin has Invested in **Existing Footprint** and Inserted Automation to **Yield the Capacity Needed to Deliver** in 2020



### **ManTech Drives Improvement in the THAAD Manufacturing Process**

### The Challenge:

To design a new THAAD Missile Checkout Console to replace obsolete equipment and remove unnecessary flight test instrumentation that is not needed for increased production rates required for tactical Interceptor testing and delivery.



#### ManTech Response:

- The Missile Checkout Console (MCC) was designed to test all THAAD Interceptor functionality at Troy Production Facility
- The MCC test equipment contains instrumentation for analyzing the laser output, RF output, electrical performance, as well as capturing Interceptor Bus communication
- The MCC test equipment also performs an end-to-end checkout of the interceptor, where it performs a real-time simulated flight sequence
- Missile Checkout Console Production (MCCP) was developed to replace the obsolete MCCs. while also removing flight test instrumentation that is not needed for tactical Interceptor testing

### Impact:

- **Significantly Decreased Test Duration** and Equipment **Failures While** Increasing Throughput
- 37% reduction in Missile Testing duration
- Reduced Setup & Test duration from 4 days to 2 days
- Reduced test manpower from 2 to 1 people
- Combined 4 disparate computer systems into 1 common Graphic User Interface
- Reduced THAAD Missile test equip failures by 83%
- Increased THAAD Missile test throughput by 100%
- Offset ~\$28M in capital equipment investment
- Offset ~\$640K/year in labor savings

A core tenet of the U.S. Department of Defense (DoD) strategy is combat overmatch, ensuring there is never a "fair fight" between our Service members and any potential adversary. A critical element of combat overmatch is having access to a robust and responsive U.S. industrial base armed with advanced manufacturing technologies that deliver critical products and systems affordably and rapidly. The DoD's ManTech program, including the eight Manufacturing Innovation Institutes, connects multiple organizations, programs, and activities to better enable the affordable ...the DoD Manufacturing and rapid transition and delivery of defense-essential Innovation Institutes are crucial technologies. and game-changing catalysts... The projects and activities of the DoD Manufacturing

Innovation Institutes are crucial and game-changing catalysts, acting as the connective tissue that bring

together innovative industrial ecosystems in various technology and market sectors in the U.S. They enable vibrancy and robustness that bring new technologies to U.S. warfighters using a combined over \$870 million in federal investment from the DoD and \$1.65 billion in matching funds from industry, academia, and state governments. Institute members include nearly 1,300 organizations across defense industry, commercial manufacturers of all sizes, start-ups, universities, community colleges, and both state and local economic developers in active partnership with the U.S. Federal Government.



Each institute is a public-private partnership designed to overcome the challenges faced by manufacturing innovators in a variety of technology areas. While each institute operates in its own unique ecosystem, the institutes offer common capabilities: providing access to state-of-the-art tools and equipment that are otherwise beyond the reach of most businesses, implementing targeted education and workforce development training programs, and encouraging project investments in applied research and industrially-relevant manufacturing technologies.

### PARTICIPANTS

Lockheed Martin and MDA program office

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# **DoD Manufacturing Innovation Institutes**



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# **The DoD Manufacturing Institutes**



### AFFOA: ADVANCED FUNCTIONAL FABRICS OF AMERICA

AFFOA enables a manufacturing-based revolution through the transformation of traditional fibers, yarns, and textiles into sophisticated, integrated, and networked devices and systems.



### ARM: ADVANCED ROBOTICS FOR MANUFACTURING

ARM strengthens and stabilizes the DoD manufacturing supply chain by advancing the robotic and Artificial Intelligence (AI) technologies and supporting workforce needed to efficiently supply the U.S. warfighter from domestic sources.



### BIOFAB USA: ADVANCED TISSUE BIOFABRICATION INSTITUTE

BIOFAB USA integrates innovative cell and tissue cultures with advances in biofabrication, automation, robotics, and analytical technologies to create disruptive research and development tools and Food and Drug Administration (FDA)-compliant volume manufacturing processes.



### MANUFACTURING TIMES DIGITAL (MXD): DIGITAL MANUFACTURING AND DESIGN INNOVATION INSTITUTE

MxD brings together the U.S. manufacturing industry, government, and academia around federally-funded project opportunities, a 22,000 square-foot future factory floor innovation center, workforce development tools, and workshops to advance the digital transformation of U.S. manufacturers.



### AIM PHOTONICS: AMERICAN INSTITUTE FOR MANUFACTURING INTEGRATED PHOTONICS

AIM Photonics has created a complete Photonic Integrated Chip (PIC) manufacturing ecosystem. The system provides the photonic community and DoD access to advanced technology, capabilities, and resources throughout the entire product development cycle.



### AMERICA MAKES: NATIONAL ADDITIVE MANUFACTURING INNOVATION INSTITUTE

Driven by the National Center for Defense Manufacturing and Machining (NCDMM), America Makes is the national accelerator for AM and the first of eight Manufacturing Innovation Institutes (MIIs) established and program managed by the DoD as a public-private partnership.



#### LIFT: LIGHTWEIGHT INNOVATIONS FOR TOMORROW

LIFT rapidly contracts, designs, develops, prototypes, and tests innovative technologies for the DoD to speed technology transition to the warfighter while building the future workforce of America.



### NEXTFLEX: AMERICA'S FLEXIBLE HYBRID ELECTRONICS INSTITUTE

NextFlex engages design, development, prototyping, and pilot-scale manufacturing of Flexible Hybrid Electronics aligned with multiple DoD priorities at a single International Traffic in Arms Regulations (ITAR) and FDA compliant location.



Cambridge, MA | 134 Member Organizations | go.affoa.org

### Advanced Fabric Entrepreneurship Program (AFEP)

AFFOA launched its first entrepreneurship program in partnership with Massachusetts Institute of Technology's (MIT) Venture Mentoring Service (VMS) for advanced fibers and fabrics. The 12-month program, which concluded earlier in March 2019, was unlike traditional mentoring and training programs. This unique program provided 20 teams of entrepreneurs with access to the Institute's advanced technologies, its 120+ membership network and access to equipment and facilities for prototyping.

The AFEP enables participants to acquire venture building skills, create job opportunities, and distinguish themselves in the job market. Additionally, the program expands their professional network, as participants interact with fabric technology and industry experts. The training and support is based on the MIT VMS vast experience supporting entrepreneurship and venture development.

This effort supports the institute's goals to create a domestic workforce necessary to develop and scale advanced textile products. These initiatives are critical for the next generation of workers and entrepreneurs.

### Physiological Monitoring - Rapid Prototyping

Breakthroughs in fiber materials, manufacturing processes, and system integration capabilities enable AFFOA and its National Prototyping Network to design and prototype fabrics that deliver communication services. The overarching goal of their fabric communication thrust is to revolutionize fabrics to be the new software – where information is either encoded into the design of the fabrics or transmitted by the microelectronic devices that are embedded into the advanced fibers of the fabric (i.e. active LOOks, a name created to identify products generated from the technology).

Active LOOks technology can be used within the surrounding sensor data found on Infrared (IR) strobes. The strobes are currently deployed on the battlefield for enhanced identification of friend or foe (IFF) and improve situational awareness.

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ZAZIN

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# INSTITUTES

The technology can add positive identification, sensor data, and battle tracking capabilities to ground forces and may also be used for training monitoring, field authentication, and IFF. AFFOA has demonstrated these capabilities through prototyping the technology in various form factors such as military vests, pants, caps, and composites.

In an operational demonstration, an IR Active LOOks cap was paired with an Apple watch to collect a user's physiological data and optically transmit that information to a third party. Then an app reader, functioning as the 3rd party could access the information. With this demo, AFFOA was asked to produce 100 active LOOks caps within three weeks' time. AFFOA completed this project on schedule demonstrating the ability to rapidly source, build a supply chain, and prototype at a pilot scale.

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Albany, NY | 118 Member Organizations | www.aimphotonics.com

### **Radio Frequency Over Fiber**

AIM Photonics member, Lockheed Martin has been working on a Radio Frequency (RF) over Fiber solution for future Warfighters. Current platforms communicate via electrical cabling, wiring, and electronic signals. Replacing these structures with fiber optics and integrated photonics significantly reduces weight of the fighter and reduces power consumption. This change will ultimately lead to less fuel consumption, increased mobility, speed, and performance in addition to other benefits described by Lockheed below. Lockheed has demonstrated the technology in joint projects with other AIM Photonics Members and recently presented data to the Members at the June 2019 Members Meeting. The technology is moving to the product validation phase and will be a key capability for future DoD warfighters.

"Integrated Photonics is going to give us the opportunity to be more compact in how photonics fits onto our platforms, saving size, weight, and power, and then we also get the inherent benefit of photonics which is the bandwidth capability and the scalability we need in our platforms," said Lockheed Martin Fellow, Rick Stevens. "This gives

us the ability to react to new environments and new requirements quickly without having to re-cable, because we can use the existing fiber optic cabling and add other optical wavelength resulting in multiple sources of information on one fiber using wavelength division multiplexing. Working with AIM Photonics, which Lockheed Martin has been a member of since 2017. is showing us a vision and a pathway towards realizing much more compact RF over fiber solutions for our platforms."



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### Fabless Design of Photonic Integrated Circuits within the AIM Foundry Ecosystem

AIM Academy, the education wing of AIM Phototoics, launched its first edX (provider of online course content) course April 9, 2019, "Fabless Design of Photonic Integrated Circuits within the AIM Foundry Ecosystem." Nearly 2,000 people registered for the course. The c ourse produced 136 chip design submissions. New York State contributed \$100K in funding for 25 people to process their designs, and MIT contributed \$40K to create the course. Among the survey responders, 98% said their experience in the course was very positive or somewhat positive, with 73% describing their experience as very positive. This course met a demand for training, while also introducing students to AIM's foundry capabilities.

#### QUOTES FROM ATTENDEES:

"This was a great refresher to get up to speed really fast. I will definitely be doing the other courses you offer. A serious game changer for the field."

"This course was very helpful to increase my knowledge and insight about silicon photonics and industry standard procedures to design a photonic chip."

"I have to say, this course is the best course I've ever taken during my ~20 years of study experience."



Pittsburgh, PA | 202 Member Organizations | www.arminstitute.com

### Launching Career Pathways in Robotics

### **VETERANS SERVING VETERANS:** TRAINING IN CONSTRUCTION

ARM is launching a program that will create curriculum and program materials for two veterans focused robotic systems certificates in construction, an industry ripe for automation applications. Preparing workers for this next phase will position them for future jobs embracing new technologies. The first certificate will be focused on design and manufacture. The second certification will focus on deployment, utilization, and repair skills with 3Space Makers veteran workforce. This project is led by Texas A&M University.

### **Robotic Assembly of Garments**

ARM has begun funding projects directed at solving some of the challenges of robotic sewing, most importantly the handling of a limp textile fabric. A recent project, led by Siemens Corporate Technology in partnership with University of California at Berkeley, Sewbo, and Bluewater Defense, aims to build a prototype system that leverages advanced robotics technology to assemble and sew part of a military uniform.

Despite being universally adopted throughout traditional manufacturing, industrial robots have failed to find a place in garment sewing applications. Limp textiles are difficult for robots to maneuver. This makes the global apparel industry strongly dependent on lowskilled, low-cost manual labor, leaving the U.S. at a considerable competitive disadvantage compared to less developed regions. Though growing globally, the apparel industry is suffering from extensive complexities, inefficiencies,

### **ROBOTICS WORKFORCE READINESS PROGRAM**

ARM initiated a project with Impact Washington, a Manufacturing Extension Partnership to leverage the current manufacturing and military partnerships and develops new aspects of the Center for Advanced Manufacturing Puget Sound (CAMPS) sponsored Military to Manufacturing (M2M) Career Pathways Program. New aspects of the program will align with ARM's Work and Learn educational programs for transitioning military personnel, veterans, and spouse. The modification will engage individuals in online, classroom, and internship training as a pathway to high value careers in manufacturing.



and controversies - largely derived from its dependence on low-cost manual labor. Automated sewing solutions may alleviate these issues across the global garment market.

If successful, the results of ARM's project will directly benefit the DoD by reducing the labor cost per garment and, once the technology is adopted, make garment production in the U.S. a viable reality (thereby reducing our significant trade deficit in this sector).



### OSD Invests in an In-depth Immersive Additive Training Experience for the DoD Workforce

The America Makes Advanced Curriculum in Additive Design, Engineering, and Manufacturing Innovation (ACADEMI) program is a comprehensive set of immersive training experiences with advanced additive manufacturing curriculua. The intense, hands-on training integrates skills from multiple disciplines used in Design for Additive Manufacturing (DfAM) processes. ACADEMI was created to address a DoD identified gap and subsequent requirement from the Air Force. The content aligns with the America Makes Education and Workforce Development (EWD) and DoD roadmaps. The curricula were written and delivered in collaboration with the Lanterman Group and with input from over 100 America Makes members and leaders from across DoD.

ACADEMI is continually modified to accommodate requirements in DfAM within the DoD and industry.

America Makes is currently expanding the ACADEMI program with support of OSD to all military branches. The next two ACADEMI courses are planned for this fall. Because of ACADEMI's success within the DoD, the industrial manufacturing base has also adopted the program. ACADEMI has provided rigorous, hands-on DfAM training to over 400 participants, including nearly 100 across DoD to date. The program is preparing for future growth to maximize the impact. Feedback from participants has been extremely positive.

### **New Process Reduces Weight and Lowers Cost While Maintaining Strength and Integrity**

America Makes launched the Maturation of Advanced Manufacturing for Low-cost Sustainment (MAMLS) Fairings Part Families project. Led by Boeing, in conjunction with the DoD, the objective is to develop and demonstrate a new hybrid process for creating composite sandwich panels used as fairings and other aero-surface components.

Boeing created a fly-away support tooling system using additive manufacturing along with a typical overlay process to create a full fairing and nose cone part that passed all required proof testing for strength and dynamic integrity.

This novel approach produced a full polymer part of lower weight and at lower cost. The modification replaces currently used tooling and final metallic parts as demonstrated on an active aircraft weapons pylon. Near-term and long-term benefits of this effort include improved organic capability leveraging additive manufacturing with more typical manufacturing processes, and the use of modeling and simulation to optimize design. A business case assessment of using this process shows improved turnaround time for part replacement and lower costs for part production.





Anchester, NH | 160 Member Organizations | www.armiusa.org

### **Engaging and Attracting Next Generation Talent to Biofabrication**

BIOFABUSA has developed hands-on activities related to biofabrication to educate and provide insight about tissue manufacturing processes. These activities target 6th-12th graders given evidence that career choices are being determined by students as early as middle school.

The activities were demonstrated at the 2019 For Inspiration and Recognition of Science and Technology (FIRST) Robotics Championship in April, for later integration in the secondary school curriculum. From January to July 2019, over 5,000 students participated in the exercises. They are now being produced as modules with complete instructions, teacher and student guides, and contain questions aligned to the Next Generation Science Standards, Common Core Standards, and the Framework for K-12 Science Education.

The institute's goal is to have the modules included in all science courses, regardless of varying state standards. Teachers will test the kits during workshops, giving them the opportunity to

### CGEM<sup>™</sup> Graft Production

BIOFABUSA collaborated with one of its members, Skeletal Tissues Engineering Labs (STEL) Technologies, to create a Tissue Foundry using STEL's manual automation process. STEL's first product, Cell Generated Matrix (CGEM)<sup>TM</sup>, is a tissue consisting of mineralized (bone) ends and a non-mineralized (ligament) middle region, generated by mesenchymal stem cells (MSCs). CGEM<sup>TM</sup> is intended to replace damaged ACLs. BIOFAB USA's Tissue Foundry was initially configured to produce 10 CGEM<sup>TM</sup> grafts from a single vial of MSCs without the intervention of a technician.

STEL contributed its closed tissue bioreactor, which the integration team adapted to Tissue Foundry's fluidic handling system. A rack system was developed that allowed connection of the bioreactors

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integrate the content into their course work. The activities provide opportunities to highlight essential manufacturing skills and processes. Additionally, the activity kits allow students to envision a career pathway for themselves in this emerging technology area, ultimately attracting the future workforce to the biofabrication industry.

to the Tissue Foundry's remaining modules through sterile connectors. As a result, additional racks can connect to the system to support rapid production to meet growing clinical and commercial demand.

To demonstrate the adaptability of the Tissue Foundry, it will be reconfigured to produce skeletal muscle units. This developmental technology from the University of Virginia is intended to maximize function for return to duty or civilian life following volumetric muscle loss.



### **IGNITE: Mastering Manufacturing curriculum for High School Students**

In June 2019, LIFT rolled out its new curriculum, IGNITE: Mastering Manufacturing. It is a threeyear foundational competency-based educational program for the "multi-skilled technician" needed in today's workplace. Funded through a Manufacturing Engineering Education Program (MEEP) grant, the curriculum couples learning with project-based experiences focused on real industry problems and emerging technologies. The curriculum is designed to prepare students for a 21st- century production environment, and post-secondary education leading to careers as engineering technicians, technologists, or engineers. The IGNITE program is being launched in partnership with two other DoD Manufacturing Innovation Institutes: MxD and America Makes.



### YEAR 1

#### Materials Science:

- » Introduction to Materials Science
- » Engineering Design Cycle

Introduction to Advanced Manufacturing:

- » Manufacturing Metrics
- » Plant Organization
- » Principles of Materials
- » Manufacturing Process & Technologies
- » Safety Measurement

### YEAR 2

Systems 1:

» Quality

» Materials Safety

Advanced Manufacturing

» Measurement & Control

### YEAR 3

Advanced Manufacturing Systems 2:

- » Lean Manufacturing Machine » Programmable Controllers
  - » Fluid Power
  - » Computer Aided Design
  - » Computer Aided Manufacturing

### Novel Approach to Linear Friction Welding (LFW) of Near Net Shape Titanium Aerospace Structural Components

LIFT successfully completed a program that utilized an Integrated Computational Materials Engineering Approach (ICME) to build and integrate a manufacturing simulator for linear friction welding titanium components. It was imperative that LIFT identify and develop a robust ICME- based predictive tool to model the linear friction welding process. Accelerated implementation of LFW for titanium alloys in a variety of aerospace applications is limited. An extensive qualification and certification of materials and machines, and incomplete material databases used by predictive models restrict broad and rapid implementation.

Additionally, geometric workpiece effects on process robustness, and an understanding of microstructural evolution also deter rapid implementation of LFW.

This solution enhances and elevates the maturity of ICME methods. The solution has a direct impact on the manufacturing readiness of linear friction welded titanium structures within the air framing industry.

The work also enables the DoD to lead in the race to create and deploy new materials to the Warfighter.



Chicago, IL | 291 Member Organizations | www.mxdusa.org

### Achieving a Smart Factory through Predictive Dynamic Scheduling

Problem: Unplanned machine downtime is a bane for manufacturers throughout the U.S. industrial base. When critical machines fail, parts slip and schedule and delivery to the customer is delayed. Within the defense industry, any delays in producing critical systems can be detrimental to the Warfighter on the battlefield.

Outcome: MxD is completing an advanced R&D project with Lockheed Martin, FORCAM Inc., Predictronics, and Northeastern University to supply manufacturers with the technology they need to minimize unplanned machine downtime. The team developed a predictive maintenance solution that can predict when critical computer numerical control (CNC) machine tools are going to fail. Then, using a novel algorithm, the solution can provide optimal guidance to operators for scheduling maintenance

### Defining Future Roles in Manufacturing: A Jobs Taxonomy

In partnership with staffing and workforce solutions firm ManpowerGroup, MxD released the Digital Workforce Succession in Manufacturing report. The report identifies 165 different roles in manufacturing that will be created or transformed by the introduction of digital technology to the industry. Additionally, it includes in-depth profiles for 20 of those roles and describes the type and level of educational degree associated with each position.

MxD and ManpowerGroup's research was conducted over a year-long period and was supported by more than 30 industry, academic, and government partners. The Taxonomy has been used by MxD manufacturing partners like Dow Inc. to define job roles for facilities and guide hiring decisions. Building upon the success of the Jobs Taxonomy, and addressing MxD's focus in cybersecurity, MxD will pursue a Taxonomy 2.0 that will be completed in early 2020. The updated 2.0 version will define the

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in order to minimize downtime and maximize productivity.

Impact: The team completed development and is launching a pilot at Lockheed Martin to refine the technology and mitigate further production risks so they can continue to provide the Warfighter with the tools they need, when they need it.



cybersecurity roles and positions that are emerging as a vital workforce component of advanced manufacturing industries.



### NextFlex and Army Futures Command Bring New Devices to Tactical Identity and Access Management (TIDAM) Program

NextFlex is developing and testing wearable soldier identity and authentication technologies as part of the Tactical Identity and Access Management (TIDAM) program. Collaborating with the Army Futures Command through the Combat Capability Development Command C5ISR (formerly CERDEC), NextFlex is designing and manufacturing fully functional prototype devices that allow simpler and more intuitive access methods for tactical networks. The devices use multiple secure wireless communication technologies to authenticate a soldier's identity and automatically disconnect and lock a system when the soldier physically moves away from it. This increases security while ensuring that the Army benefits from advances in the commercial electronics field.

The advances were made possible by the NextFlex Technology Hub and through the Institute's partnership with the DoD. The hub is the Institute's integrated facility that houses engineering and manufacturing capabilities for advanced Flexible Hybrid Electronics (FHE). By employing FHE



technologies and manufacturing, the authentication device is produced with a form factor that can be integrated into a uniform (e.g. in the cuff of a uniform sleeve). This project continues as NextFlex works to improve manufacturability and also ensures that the manufacturing process will transition to U.S.-based manufacturers for high-volume production.

### *The FlexFactor Outreach Program is Making an Impact in Northern Alabama*

Throughout the spring of 2019, NextFlex piloted three iterations of the FlexFactor outreach program in partnership with Boeing, the Alabama Community College System, Drake State and Calhoun Colleges, and the Huntsville Region K-12 school districts. Other industry partners involved in the pilot included Toyota and Polaris. The program served 57 students in the pilot and will expand to reach over 300 in the coming school year. This piloting activity in Alabama was completed while the existing FlexFactor programs in California and Ohio reached 1,417 students across 12 school districts. The outreach model helped to inform, inspire, attract, and recruit students into education and career pathways associated with advanced manufacturing.



The FlexFactor program also helped mobilize the workforce and economic development ecosystem in the Northern Alabama region.

## 2019 DEFENSE MANUFACTURING TECHNOLOGY ACHIVEMENT AWARD NOMINATIONS

The Defense Manufacturing Technology Achievement Award (DMTAA) is awarded to ManTech teams who demonstrate outstanding performance in executing and delivering ManTech solutions for DoD. The Joint Defense Manufacturing Technology Panel would like to recognize these teams for their hard work and congratulates the winners of this year's DMTAA, to be announced at the Defense Manufacturing Conference.

### **Technology Enabler**

The primary advancement is in software, hardware, firmware, data management, and related activities

### **Project Title**

Technical Data Integration and Search

Qualification Framework for High-Performance Low-Variability Additive Manufacturing Parts

### **Cost Reduction / Rate or Safety Improvement**

Projects where the primary objective is to reduce cost, increase rate or provide significant safety methodology for manufacturing production or sustainment

### Project Title

Advanced Engineered Coatings with Extended for Tooling

THAAD Missile Checkout Console – Production

III-V Dual Band Infrared Focal Plane Arrays

Low Cost Miniaturized Shortwave Infrared (SV Imagers

Long Range Discrimination Radar (LRDR) "On Production Expansion

Kaman SM-3 Block IB Gravity Actuated Switc Manufacturing Yield

	Service	Subpanel
	Navy	AME
e,	DSM&T	Composites

	Service	Subpanel
d Die Life	DLA	Electronics Subpanel
on and Test	MDA	
	Army	Electronics Subpanel
VIR)	Army	Electronics Subpanel
ne Factory"	MDA	
ch	MDA	

### **Enhancing Military Capability**

ManTech projects which result in system and sub-system enhancements to improve military performance

Project Title	Service	Subpanel
Additive Manufactured M1A1 Abrams Scavenge Fan Assembly, Impeller	DLA	
12um Pixel High Definition (HD) Uncooled Longwave Infrared (LWIR)	Army	Electronics Subpanel
OLED Helmet-Mounted Display Assembly for the F-35	Navy	Electronics Subpanel
Macrocell Receiver Conversion for Millimeter Wave (mmW) (MaRCm)	Army	Electronics Subpanel

### **Readiness Improvement**

Manufacturing technologies where the primary benefit is readiness

Project Title	Service	Subpanel
Maturation of Advanced Manufacturing for Low-Cost Sustainment	Air Force	

### **Supply Chain Improvement**

Develop manufacturing technologies, processes, or workforce improvements that enhance efficiency (cost) and effectiveness (quality) of the supply chain

Project Title	Service	Subpanel
Process Improvement Using Intensive Quenching	DLA	Electronics Subpanel
Increase Competition through Small Business Source Approval Request (SAR) for DLA Nuclear Enterprise Support Office (NESO) NSNs	DLA	

### **DEFENSE MANUFACTURING TECHNOLOGY ACHIEVEMENT AWARD WINNERS**

The Joint Defense Manufacturing Technology Panel (JDMTP) seeks to recognize and honor those most responsible for outstanding technical accomplishments in achieving the vision of the Department of Defense (DoD) ManTech Program. That vision is to realize:

"A responsive world-class manufacturing capability to affordably and rapidly meet Warfighter needs throughout the defense system life cycle."

To this end, the Defense Manufacturing Technology Achievement Award was established in the Fall of 1999.

### AWARDEES

- 2018 Automated Aircraft Inlet Coating
- 2018 Organic Light Emitting Diode (OLED) Microdisplays
- 2018 F-35 High Fidelity Fastener Measurement
- 2018 Lithium-Ion Replacement for TOW MGS Nickel Cadmium Battery
- 2017 Tungsten Carbide Penetrator and Assembly Cost Reduction
- 2017 Affordable Protection from Objective Threats
- 2017 Virginia Class Submarine Retractable Bow Plane System
- 2017 128 Kilobit RAM ROM Microcircuit Emulation
- 2016 High Operating Temperature Multi-Band FPA
- 2016 Digital Thread for Material Review Board
- 2016 Optical Windows ALON
- 2015 F-35 Electro-Optical Targeting System (EOTS) Producibility
- 2015 Welding of High Strength Steels
- 2015 Manufacturing Technology for High Power Vertical Cavity Surface Emitting Lasers (VCSELS)
- 2014 Chip Scale Atomic Clock (CSAC)
- 2014 F-35 Canopy Thermoforming Automation
- 2014 Low Light Level Sensor
- 2014 Large Affordable CdZnTe Substrates (LAS)
- 2014 Establishing the Production Capability for Lighter, Higher Energy Soldier Batteries
- 2013 Advanced Body Armor
- 2013 Plate Edge Preparation Improvements (PEPI)
- 2013 Restoration of Aerospace Parts by Cold Spray
- 2012 Fastener Insertion Live Link System (FILLS)
- 2012 Customer/Supplier Interoperability During Collaborative Design
- 2012 3-D Technical Data Package and Certification
- 2011 Use of Digital Radiography for Final Part Acceptance of Aerospace Casting

2011 –	Prosthetics & Orthotics Manufacturing Initiative (POMI)
2011 –	Automated Fiber Placement of Carbon Fiber Bismaleimide Materials
2010 –	High Power, High Energy Density Lithium-Ion Batteries
2010 –	Seal Extrusion Development and Demonstration (SEDD)
2010 -	Weld Seam Facing and Back Gouging
2009 -	F-35 Inlet Duct Robotic Drilling
2009 –	Low Cost Manufacturing of Materials for Improved Warfighter Protection
2008 –	Laser-Welded Corrugated-Core (LASCOR) Panel Evaluation
2008 -	Low Observable Paints for Aircraft
2007 –	Lean Battery Initiative
2007 –	Low Cost SiC-N Ceramic Tile
2007 –	Translational Friction Stir Welding
2006 -	Uncooled Focal Plane Array Producibility
2006 -	Engine Rotor Life Extension
2005 –	Large Aircraft Infrared Countermeasures
2005 -	Large Marine Composite-to-Steel Adhesive Joints

- 2004 Lean Depot Repair
- 2004 Uniform Cannon Tube Reshaping
- 2003 Laser Additive Manufacturing
- 2003 Laser Shock Peening
- 2002 Composites Affordability Initiative
- 2002 Apparel Research Network
- 2001 Enhanced Manufacturing Processes for Body Armor
- 2000 Advanced Optics Manufacturing
- 2000 Flexible Manufacturing of Microwave Vacuum Devices
- 1999 Advanced Fiber Placement















For Further Information, Visit: www.dodmantech.com

