Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Office of the Secretary Of Defense	Date: May 2021
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603680D8Z *I Defense Wide Manufacturing Science and Technology Program*

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
Total Program Element	939.113	251.516	245.757	134.022	-	134.022	-	-	-	-	-	-
680: *Manufacturing Science and Technology Program*	197.258	112.033	82.340	32.318	-	32.318	-	-	-	-	-	-
350: *Manufacturing Innovation Institutes*	741.855	139.483	163.417	97.704	-	97.704	-	-	-	-	-	-
351: *Manufacturing Education and Workforce Development*	-	0.000	0.000	4.000	-	4.000	-	-	-	-	-	-

Note

COVID-19 (i.e., CARES Act) Comptroller Add of $60.780 million in FY 2020 was incorrectly aligned to Project Code 680 when it was rolled into the Defense Wide Manufacturing Science and Technology (DMS&T) Program in late CY 2020. Budget lock prevents alignment correction, as part of the President's Budget FY 2022 submission. The full COVID-19 funding should have been aligned to Project Code 350.

FY 2020 $101.000 million Congressional Adds also must be aligned as managed (Project Code 680 = $22.000 million and P350 = $79.000 million).

Because COVID-19 funds are primarily executed via the Manufacturing Innovation Institutes, the correct breakout of the Total Program Element of $251.516 million, in FY 2020, is:
FY 2020 Project Code 680 = $57.162 million
FY 2020 Project Code 350 = $194.354 million ($201.015 million less SBIR/STTR Transfer of $6.661 million)

A. Mission Description and Budget Item Justification

The Defense-wide Manufacturing Science and Technology (DMS&T) program is the joint, defense-wide component of the DoD Manufacturing Technology (ManTech) Program directed in Title 10 U.S.C. Section 2521. DMS&T addresses joint, cross-cutting, and high-risk/high payoff technologies; manufacturing challenges within the DoD Modernization Priorities areas; and many of the recommendations in the Executive Order Report “Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States” September 2018.

The DMS&T program objective is to increase the speed at which innovation, inventions, and scientific discoveries are turned into equipment and capabilities through advances in manufacturing technologies and processes. The DMS&T program created and is sustaining a manufacturing innovation ecosystem via activities within three Program Element (PE) Project Codes: 680, Manufacturing Science and Technology Program (MSTP), 350, DoD Manufacturing Innovation Institutes (MIIs), and 351, Manufacturing Education and Workforce Development (M-EWD).

Project Code 680, Manufacturing Science and Technology Program (MSTP):

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The MSTP focuses on cross-cutting defense manufacturing advancements and stimulates early development of manufacturing processes and enterprise business practices.

Project Code 350, DoD MIIs:
This project supports nine DoD-led MIIs within the national Manufacturing USA network, in accordance with mission requirements. MII technology domain focus areas are: (1) additive manufacturing; (2) digital manufacturing, design, and manufacturing cybersecurity; (3) lightweight materials; (4) integrated photonics; (5) flexible hybrid electronics; (6) smart fibers and textiles; (7) advanced tissue biofabrication; (8) advanced robots for manufacturing; and (9) bioindustrial manufacturing. Each MII is a public/private partnership with members from industry, academia, and federal and state governments that together mature manufacturing processes, build out a supporting ecosystem, and provide manufacturing education and workforce development. The consortia match DoD funding at a one to one ratio (or greater). They include small and medium as well as large manufacturers and state-of-the-art pilot facilities.

Project Code 351, Manufacturing Education and Workforce Development (M-EWD):
M-EWD provides strategic leadership of advanced manufacturing talent development within the Defense Industrial Base (DIB) with three mission objectives: (1) invest in strategic education and workforce development capabilities, (2) expand the talent acquisition pool to promote diversity equity and inclusion, (3) modernize manufacturing EWD by driving action within DIB-critical regional economies with a focus on Career & Technical Education (CTE).

B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	197.397	93.817	96.042	-	96.042
Current President's Budget	251.516	245.757	134.022	-	134.022
Total Adjustments	54.119	151.940	37.980	-	37.980
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	152.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-6.661	-			
• Program Adjustment	60.780	-0.060	37.980	-	37.980

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: 680: *Manufacturing Science and Technology Program*		
Congressional Add: *High Temperature Carbon Composites Manufacturing*	-	7.000
Congressional Add: *Advanced Structural Manufacturing (FY20 title was "Advanced Manufacturing")*	-	7.500
Congressional Add: *Carbon Hypersonics Materials Industrial Base*	-	5.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Office of the Secretary Of Defense	Date: May 2021
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603680D8Z *I Defense Wide Manufacturing Science and Technology Program*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Congressional Add: *HPC enabled advanced manufacturing*	17.000	17.000
Congressional Add: *Hypersonics Advanced Manufacturing Technology Center*	-	25.000
Congressional Add Subtotals for Project: 680	17.000	61.500
Project: 350: *Manufacturing Innovation Institutes*		
Congressional Add: *Program Increase*	20.000	26.000
Congressional Add: *Manufacturing Engineering Programs*	5.000	-
Congressional Add: *Flexible Hybrid Electronics (FHE) (FY20 title was "Manufacturing Innovation Institutes")*	10.000	10.000
Congressional Add: *Advanced Manufacturing*	10.000	14.000
Congressional Add: *Manufacturing Cybersecurity*	14.000	-
Congressional Add: *Silicon Based Lasers*	25.000	-
Congressional Add: *Cyber Initiatives*	-	3.000
Congressional Add: *Digital Manufacturing*	-	7.000
Congressional Add: *Additive Manufacturing Training Insertion*	-	2.000
Congressional Add: *Hypersonics Enabling Additive Manufacturing*	-	10.000
Congressional Add: *5G Manufacturing Testbed*	-	5.000
Congressional Add: *Manufacturing USA Institutes*	-	5.000
Congressional Add: *Hypersonics and Thermal Management*	-	5.000
Congressional Add: *Arsenal Supply Chain Security Proof of Concept*	-	3.500
Congressional Add Subtotals for Project: 350	84.000	90.500
Congressional Add Totals for all Projects	101.000	152.000

Change Summary Explanation

The increase in FY 2022 supports Manufacturing Education and Workforce Development and Manufacturing Innovation Institutes.
The increase in FY 2021 supports the Bioindustrial Manufacturing Innovation Institute, BioMADE.
The increase in FY 2020 is for CARES Act Funding, executed through Manufacturing Innovation Institutes to conduct diagnostics and medical research, devise medical countermeasures, develop personal protective equipment, and improve medical care.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense			Date: May 2021
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	Project (Number/Name) 680 / *Manufacturing Science and Technology Program*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
680: *Manufacturing Science and Technology Program*	197.258	112.033	82.340	32.318	-	32.318	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

Note

COVID-19 (i.e., CARES Act) Comptroller Add of $60.780 million in FY 2020 was incorrectly aligned to Project Code 680 when it was rolled into the Defense Wide Manufacturing Science and Technology (DMS&T) program in late CY 2020. Budget lock prevents alignment correction. The full COVID-19 funding should have been aligned to Project Code 350.

Project Code 680 also manages $22.000 million of the FY 2020 $101.000 million Congressional Adds. The correct FY 2020 total amount for Project Code 680 is $ 57.162 million.

A. Mission Description and Budget Item Justification

The Office of the Secretary Defense (OSD) Manufacturing Science and Technology Program (MSTP) concentrates on cross-cutting defense manufacturing needs that are beyond the ability of a single service to address. The MSTP invests in broad technology initiatives within Advanced Electronics and Optics, Advanced Materials and Composites, Advanced and Emerging Manufacturing Processes, and Advanced Energetics Manufacturing.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Advanced Electronics and Optics	10.443	7.750	8.750
Description: Advanced Electronics and Optics is a series of efforts addressing advanced manufacturing technologies for a wide range of applications such as sensors, radars, power generation, switches, and optics for defense applications. Focal points are productivity and efficiency gains in the defense manufacturing base to accelerate delivery of technical capabilities to impact current warfighting operations, and manufacturing technologies to reduce the cost, acquisition time and risk to our major defense acquisition programs. Future efforts will focus on advances in fuel cells, lasers, enhanced acuity micro-displays, and transparent ceramics for opto-mechanical and armor applications.			
FY 2021 Plans: The Gradient Index Lenses, Portable X-Ray Detectors for the Dismounted Solider, Automated Assembly of Laser-Welded Fiber Optics and Circular Polarizes for Color Day Camera projects will be entering the final year of funding to carry them through the remainder of their efforts. Continue projects that are addressing manufacturing needs for electronic and optics related technologies. Initiate the Low-Cost Chip Scale Atomic Clock and Improved Photovoltaic Power for Space projects in FY 2021.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Fund the final year of the Low-Cost Chip Scale Atomic Clock project and Year 2 of 4 of the Improved Photovoltaic Power for Space project. Utilize the annual project call to select and initiate projects that support the National Defense Strategy and DoD modernization priorities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Changes reflect minor budget fluctuations.			
Title: Advanced Materials and Composites ***Description:*** Advanced Materials and Composites is a series of efforts addressing advanced manufacturing technologies for a wide range of materials such as composites, metals, ceramics, nanomaterials, and metamaterials. Through productivity and efficiency gains, these manufacturing technologies will accelerate delivery of technical capabilities to impact current warfighting operations, while reducing the cost, acquisition time and risk of our major defense acquisition programs. Advanced materials manufacturing technologies undergoing development include materials for ballistic survivability and ballistic protection, survivability and rapid fabrication of structural components. ***FY 2021 Plans:*** Fund the Manufacturing of Carbon/Carbon Composites for Hypersonic Applications (MOC3HA) initiative for Year 4 of 6 and issue additional Task Orders to advance manufacturing capabilities. Additionally, the Hypersonic RF Seeker Window Manufacturing Development project will enter Year 2 of 3 and the Thermoplastic Composites project will be initiated. ***FY 2022 Plans:*** Fund the MOC3HA initiative for Year 5 of 6 and the Hypersonic RF Seeker Window and Thermoplastic Composites projects will enter their final year of funding. Utilize the annual project call to select and initiate projects that support the National Defense Strategy and DoD modernization priorities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Increase reflects anticipated investments in a critical technology sector for Modernization Priorities to enable advanced manufacturing of published requirements.	11.490	5.870	12.900
Title: Advanced and Emerging Manufacturing Processes ***Description:*** Advanced and Emerging Manufacturing addresses advanced manufacturing technologies and business practices for defense applications. Key focus areas include direct digital (or additive) manufacturing, advanced manufacturing enterprise, machining, robotics, assembly, and joining. Projects selected will accelerate delivery of technical capabilities to impact current warfighting operations while reducing cost, acquisition time, and risk of major defense acquisition programs. ***FY 2021 Plans:***	6.010	4.010	6.550

Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
The Magnesium-Oxide Binder for Thermal Batteries and Foamable Celluloid Materials will receive their final allotments of funding in FY 2021 to carry them through to project completion. The Lightweight Hydrogen Fuel Cell project will enter Year 2 of 3 and the Deformable Mirrors for High Energy Laser project will be initiated. ***FY 2022 Plans:*** Lightweight Hydrogen Fuel Cell project will enter the final year of funding and Deformable Mirrors for High Energy Lasers will enter funding Year 2 of 3. Utilize the annual project call to select and initiate projects that support the National Defense Strategy and DoD modernization priorities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Increase is due to the balance of projects within the portfolio (i.e., as old projects retire and new projects are initiated among the technology focus areas within the portfolio).			
Title: Advanced Energetics Manufacturing ***Description:*** Advanced Energetics Manufacturing develops improved manufacturing capabilities for safer, low cost, high quality production of existing and newly developed ingredients and composites used in energetic materials production. Develops techniques such as additive manufacturing, microfluidics, continuous processing, resonant acoustic mixing, robotics, etc. for production of critical energetics and supporting ingredients to ensure Department access to these materials and enable development of new, highly advanced energetic systems for improved range and performance. ***FY 2021 Plans:*** The High Density Reactive Material (HDRM) project will receive the final funding allotment in FY 2021. The Advanced Mixing for Infrared Countermeasures will enter funding Year 2 of 3. ***FY 2022 Plans:*** The Infrared Countermeasures project will be in the final year of execution in FY 2022. Utilize the annual project call to select and initiate projects that support the National Defense Strategy and DoD modernization priorities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The funding level in FY 2022 is consistent with funding needed to incrementally fund existing projects and begin new advanced energetic manufacturing efforts.	6.310	3.210	4.118
Title: COVID-19 (CARES Act) Initiatives ***Description:*** Originally accounted for separately under line of accounting USRE_030603680D8Z_COVID19, the COVID-19 (CARES Act) Initiatives leveraged federal, state, commercial, and academic members of the DoD Manufacturing Innovation Institute (MII) national ecosystem to begin execution of 13 projects through seven DoD MIIs in response to COVID-19. These projects support manufacture of antibody and antiviral diagnostics technologies, rapid deployment of medical devices and	60.780	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
instrumentation, development of a range of medical countermeasures, and coordination of national efforts to accelerate secure U.S. manufacture and acceptance of critical medical supplies. Medical countermeasure projects include viral deactivation surface treatments, novel drug delivery systems, rapid production of personal protective equipment, manufacture of Natural Killer (NK) cells and virus-free red blood cells from stem cells, demand forecasting for allocation of critical medical supplies, and improving pharmaceutical industry capacity to optimize scale-up production using digital technology.			
Accomplishments/Planned Programs Subtotals	95.033	20.840	32.318

	FY 2020	FY 2021
Congressional Add: High Temperature Carbon Composites Manufacturing	-	7.000
FY 2021 Plans: Reduce the cost of preform construction and densification processes for Carbon/Carbon and Carbon/Silicon Carbide materials through process automation including densification automation, pitch crush automation, and weaving automation. Reduce the cost of inspection through digital x-ray and automated x-ray reading and advancements to computer tomography (CT) scanning capabilities as well as incorporate vision systems and automated inspection techniques.		
Congressional Add: Advanced Structural Manufacturing (FY20 title was "Advanced Manufacturing")	-	7.500
FY 2021 Plans: Continue development of advanced powder supply for cold-spray specific applications. Create a DoD-wide framework for qualification data sets to facilitate accelerated cold-spray approvals within DoD. Streamline site-installation approvals for cold spray capabilities at organic repair facilities throughout DoD.		
Congressional Add: Carbon Hypersonics Materials Industrial Base	-	5.000
FY 2021 Plans: Reduce the cost and process variability of 3D Polar weaving through full automation of the weaving process. Hypersonic boosters and thermal protection system (TPS) systems require a polar weave due to the size and pressures. Currently this is a manual weaving process.		
Congressional Add: HPC enabled advanced manufacturing	17.000	17.000
FY 2020 Accomplishments: Worked with The U.S. Army Engineer Research and Development Center's (ERDC), the Oak Ridge National Labs, and the University of Maine's Advanced Structures and Composites Center to productionize large scale 3-D manufacturing process utilizing bio-based feedstocks to fabricate prototypes and manufactures shelters, vehicles and other large systems for the Army and other military customers.		
FY 2021 Plans: Cyber-harden the High-Performance Computing (HPC) on the edge devices to reduce vulnerability to attacks. Investigate non-intrusive acoustic or electromagnetic (XRAY, CT) technologies during		

Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense		Date: May 2021
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	FY 2020	FY 2021
the print process to detect voids, bubbles, etc. Finite element model analysis with respect to the physics differences involved as prints move from small scale to large scale.		
Congressional Add: Hypersonics Advanced Manufacturing Technology Center	-	25.000
FY 2021 Plans: Establish a large-scale classified manufacturing space to demonstrate scalability of manufacturing capabilities & capacity within the hypersonics ecosystem, and reduce risk for transition to production with design for manufacturing. Naval Surface Warfare Center Crane will manage a coordinated effort that leverages Purdue University facilities (e.g., wind tunnels) to engage in development activities to advance materials and manufacturing processes required to meet hypersonics needs. Requirements include flow & design optimization of multi-material systems, additive manufacturing of disparate material systems, joining of multi-material systems and components, and sub-assembly performance testing.		
Congressional Adds Subtotals	17.000	61.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

ManTech projects are awarded competitively through the DoD Service Laboratories. Approximately 1/3 of the total active topics are awarded to new initiatives annually.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense			Date: May 2021
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	Project (Number/Name) 350 / *Manufacturing Innovation Institutes*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
350: *Manufacturing Innovation Institutes*	741.855	139.483	163.417	97.704	-	97.704	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

Note

The COVID-19 (i.e., CARES Act) Comptroller Add of $60.780 million in FY 2020 was incorrectly aligned to Project Code 680 when it was rolled into the Defense Wide Manufacturing Science and Technology Program (DMS&T) program in late CY 2020. Budget lock prevents alignment correction. The full COVID-19 funding, in the amount of $60.780 million, should have been aligned to Project Code 350.

Additionally, Project Code 350 manages only $79.000 million of the FY 2020 $101.000 million Congressional Adds. Because COVID-19 funds are executed primarily via the Manufacturing Innovation Institutes, the correct FY 2020 amount for Project Code 350 is $194.354 million ($201.015 million less SBIR/STTR Transfer of $6.661 million).

A. Mission Description and Budget Item Justification

The Department of Defense (DoD) supports nine Manufacturing Innovation Institutes (MIIs), public/private partnerships that address both commercial and defense manufacturing needs within specific, defense-relevant technology areas. MIIs receive active participation and support from the military departments and defense agencies and their members. The MIIs' flexible business models and strong focus on enabling highly collaborative research and development (R&D) are catalyzing important new organizational relationships across government, industry, and academia. MIIs bring together both traditional defense and non-traditional sectors to accelerate key innovation cycles, expand U.S. industrial capability, and assist in creating resilient supply chains that will support innovative defense products.

DoD's nine MIIs are: (1) America Makes (for additive manufacturing); (2) MxD (Manufacturing times Digital, for digital manufacturing, design and cybersecurity); (3) LIFT (Lightweight Innovations For Tomorrow, for innovative processes to lightweight materials); (4) AIM Photonics (American Institute for Manufacturing Integrated Photonics, for photonic device manufacturing and packaging); (5) NextFlex (for flexible hybrid electronics manufacturing); (6) AFFOA (Advanced Functional Fabrics of America, for smart fibers and textiles); (7) BioFabUSA (for regenerative tissue manufacturing); (8) ARM (Advanced Robotics Manufacturing, for smart collaborative robotics for manufacturing); and (9) BioMADE (for biomanufacturing of non-medical materials and products).

MII funding is focused on:
- Conducting pre-competitive applied research and development projects to reduce the cost, time, and technical uncertainty related to new manufacturing technologies and to improve existing technologies, processes, and products.
- Developing and implementing education, training, and workforce recruitment courses, materials, and programs.
- Developing innovative methodologies and practices for supply chain integration and introduction of new technologies into supply chains.
- Engaging with small and mid-sized manufacturers, including women and minority-owned manufacturing enterprises, and larger-sized manufacturing firms.

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Each MII has a different model, with the following core tenets:
• Each MII is a public/private partnership with representatives from industry, academia, state and local governments, and the DoD that co-invest in world-leading technologies and capabilities.
• Each MII provides facilities to allow collaborative, precompetitive development of promising technologies and to promote the creation of stable and sustainable innovation ecosystems for advanced manufacturing.
• The partnership forming the MII must commit non-federal resources that equal or exceed the federal commitment.
• Each institute participates in the national Manufacturing USA network.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: America Makes (Additive Manufacturing)	4.806	7.674	7.800
Description: America Makes' mission is to accelerate the adoption of additive manufacturing in the United States industrial base. Additive manufacturing (i.e., 3D printing) is a process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies such as traditional machining. Additive manufacturing benefits the DoD by enabling lifecycle cost savings and enhanced capabilities including: distributing supply chains to enable the right part in the right place at the right time; improving mission readiness by producing work aids for DoD depots; replacing long-lead time and out of production spares, and enhancing lethality through production of lighter weight and higher performing parts than could otherwise be achieved with traditional manufacturing. ***FY 2021 Plans:*** Initiate a new long-term agreement between America Makes and the DoD to accelerate adoption of additive manufacturing within industry and government, resulting in revamped staffing and increased stakeholder engagement. Enhance the model of technical excellence through projects by synthesizing project outcomes and deliverables with industry trends and other outside information sources to become a strategic leader in the additive manufacturing community. ***FY 2022 Plans:*** Continue the strategic partnership with the DoD to include additional project calls with America Makes members; education and workforce development activities, and support to DoD joint additive manufacturing activities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Increased funding slightly to support current industry cost-matched initiatives for new projects in FY 2022.			
Title: MxD – Manufacturing times Digital (Digital Manufacturing, Design and Cybersecurity)	4.804	8.323	8.624
Description: MxD focuses on implementation of the Digital Thread; the unencumbered flow of data across the lifecycle of a manufactured product encompassing data from design, production, supply, sourcing, inventory, assembly, quality, maintenance, and sustainment. It includes analysis of data to reduce the time and cost of bringing new products to market. MxD eliminates			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
barriers between design, manufacturing, and sustainment by using both product data and process data in a way that is seamless and transparent. ***FY 2021 Plans:*** Continue MxD focus on: (1) future factory, 2) agile and resilient supply chain, 3) cybersecurity for manufacturing, and 4) design, product development, and system engineering. ***FY 2022 Plans:*** Continue recently awarded FY 2021 projects with the goal of advancing the cybersecurity of the manufacturing supply chain and driving new digital manufacturing technologies and capabilities across the U.S. manufacturing base. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Change reflects few new start initiatives with limited continued investment in current efforts.			
Title: LIFT – Lightweight Innovations for Tomorrow (Lightweight Innovations – materials and processes) ***Description:*** Advanced lightweight material retain properties comparable to heavier, traditional materials, and can enable weight reduction in a variety of components and products with significant energy savings and increased payloads. Scale-up research across multiple areas to accelerate market expansion by applying an integrated materials and manufacturing approach, addressing a lack of design guides and certifications as well as affordability and scale-up challenges. The goal is to catalyze the development of an advanced lightweight material U.S. supplier base and to enable DoD to realize greater speed and agility of manned, unmanned, and Warfighter systems as well as benefits for commercial applications. ***FY 2021 Plans:*** Plans include funding projects to support DOD and the commercial industrial base to benefit the warfighter, to expand smart manufacturing capabilities, and to develop and advance hypersonic and other DoD modernization priority capabilities, and continuing to develop education and workforce programs that will benefit the DoD and defense industrial base workforce. ***FY 2022 Plans:*** Continue executing FY 2021 initiatives such as Hypersonics and Cold Spray work. Accelerate deployment of advanced manufacturing technologies such as linear friction welding; design and manufacturing methods for promising high strength alloys; optimized ultra-fast heat treatment and quenching techniques for thin-walled casting applied to components for military vehicles. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Change reflects little to no new start initiatives with limited continued investment in current efforts.	4.804	14.493	8.928
Title: AIM – American Institute for Manufacturing Photonics (Integrated Photonics Device Manufacturing and Packaging)	4.804	6.144	14.166

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Description: Integrated photonics manufacturing advances the promise of unprecedented interconnection between electronics and photonics that will deliver world-class performance in speed, density, and power consumption. Photonics provides differentiating benefits for defense applications such as high-speed signal processing; electronic warfare; position, navigation, and timing; information transport and computation; sensing; imaging; and targeting. AIM Photonics has established an end-to-end U.S. 'ecosystem' for advancing domestic integrated photonics manufacturing, including access to a responsive integrated photonics fabrication foundry. AIM Photonics provides the world's only 300 mm silicon photonics multi-project wafer service, state-of-the-art photonics-electronics integrated design tools, and a highly advanced packaging, assembly, and testing user facility. ***FY 2021 Plans:*** Continue developing and maturing the U.S. photonics ecosystem. Collaborate with other DoD customers to leverage the AIM Photonics MII to address specific program problems. Develop an acquisition strategy to allow the institute to produce prototypes for DoD customers. Solicit, evaluate, and award a follow-on agreement for an integrated photonics institute. ***FY 2022 Plans:*** Develop new sets of components targeted at non-standard wavelengths, which are of particular interest to the DoD. Align capabilities with other special DoD needs such as chemical/ biological sensors. Continue to support efforts aligned to OUSD(R&E) modernization priorities. Maintain a robust education and workforce development program for integrated photonics. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2020 funding completed the DoD commitment of $110.000 million to AIM Photonics in the first Cooperative Agreement. FY 2022 funding reflects anticipated 'steady- state' funding that meets threshold requirements of this technology ecosystem as part of the follow-on Cooperative Agreement.			
Title: NextFlex Manufacturing Innovation Institute (Flexible Hybrid Electronics Manufacturing)	4.804	7.837	7.900
Description: Flexible hybrid electronics manufacturing involves highly tailorable devices on non-traditional, compliant substrates that combine thinned components manufactured from traditional processes with components added via "printing" processes. NextFlex invests in prototyping and scale-up of manufacturing processes for high speed pick-and-place, printed circuits, and hybrid fabrication to enable defense and commercial applications in wearable electronics, unattended sensors, integrated array antennas, medical devices, and soft robotics devices. NextFlex is also committed to continuous improvement in SWAPC (Size, Weight And Power plus Cost) for electronic systems. ***FY 2021 Plans:*** FY 2021 is the first full year of the NextFlex follow-on Cooperative Agreement, awarded in July 2020. New RD&D awards will begin in response to pending project calls. NextFlex goals include transition of at least two prototypes into defense systems in			

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Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 350 / *Manufacturing Innovation Institutes*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
partnership with industry member teams, and continued deployment and transition of its FlexFactor manufacturing education program from a regional to a national program. ***FY 2022 Plans:*** NextFlex will continue to mature flexible, stretchable hybrid electronics including advanced packaging and additive manufacturing technologies within their world-class pilot manufacturing line. Several RD&D projects initiated in FY 2021 will continue execution in FY 2022. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Change reflects little to no new start initiatives with limited continued investment in current efforts.			
Title: Advanced Functional Fabrics of America (Smart Fibers and Textiles) (AFFOA) ***Description:*** AFFOA accelerates transformation of the manufacture of traditional fibers, yarns, and textiles into highly sophisticated, integrated, and networked devices and systems. It is helping to convert the domestic textile industry into one differentiated by Intellectual Property (IP) and value-added technology. AFFOA mission outcomes will lead to highly functional fabrics that provide valuable services: fabrics that see, hear, sense, communicate, store and convert energy, regulate temperature, monitor health, and change color. AFFOA is translating these outcomes into new and improved textiles that benefit the warfighter as well as the commercial consumer. ***FY 2021 Plans:*** AFFOA plans to scale light-emitting diode (LED) and energy fibers, at low-rate production lengths, and incorporate them into full garment/product prototypes for monitoring physiological performance, stress, strain, and other parameters. Work with DoD Program Executive Offices (PEO) and Program Managers (e.g., PEO Soldier) to build insertion paths into programs of record. Demonstrate secure communications in an Identification Friend or Foe (IFF) application for PM Soldier Clothing Individual Equipment. Initiate a Wearable Sensors prototyping effort utilizing the Other Transaction Authority (OTA) for Prototyping vehicle. ***FY 2022 Plans:*** Enter into a new follow-on 5-7 years Assistance Instrument with the DoD. This agreement will involve a reduced but still significant strategic investment of federal funds in recognition of the 'steady-state' of AFFOA's maturity and the value it provides to the DoD. DoD Modernization Priority 'Quick Start' projects are likely to be part of the FY 2022 award. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The funding in FY 2021 completes the DoD funding commitment of $75.000 million to AFFOA. Decreased FY 2022 funding provides limited funding for a new agreement to continue DoD strategic engagement in the public/private partnership with AFFOA.	7.154	8.646	6.200
Title: BioFabUSA Manufacturing Innovation Institute (regenerative tissue manufacturing)	12.152	0.000	16.300

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Description: BioFabUSA advances state-of-the-art human tissue manufacturing innovations in cell and biomaterial processing, bioprinting, automation, and non-destructive testing technologies. BioFabUSA is establishing a collaboration to mature tissue-related technology across manufacturing readiness levels (MRL) 4-7, enabling post-delivery assurance of tissue identity, viability, function, and efficacy. This MII is assembling a diverse and currently fragmented collection of industry practices and institutional knowledge across many disciplines (e.g., cell biology, bioengineering, materials science, analytical chemistry, robotics, and quality assurance). ***FY 2021 Plans:*** Technical focus at a minimum is comprised of five thrust areas: (1) Cell Selection, Culture, and Scale-up, (2) Biomaterial Selection and Scale-up; (3) Tissue Process Automation and Monitoring; (4) Tissue Maturing Technologies; and (5) Tissue Preservation and Transport. ***FY 2022 Plans:*** BioFabUSA will continue to improve the tissue foundry prototype line. As BioFabUSA develops supported tools and enabling technologies through institute projects, they will begin to replace off-the-shelf tools used to establish the initial prototype line with the newly developed technologies. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Increase restores the government's original intent, and funding profile, for the initial standup phase agreement for this institute.			
Title: Advanced Robotics Manufacturing (Smart Collaborative Robotics for Manufacturing) ***Description:*** Improve U.S. manufacturing competitiveness through advancements in the smart collaborative robotics field. Technologies developed via Advanced Robotics Manufacturing (ARM) support advanced robotics capabilities to address DoD requirements and improve U.S. manufacturer competitiveness with robotics. ARM is focusing on technologies enabling human robot interaction, and perfecting robotic adaption, learning, manipulation, autonomy, mobility, and perception. ***FY 2021 Plans:*** ARM will continue to accelerate technology in the following areas: (1) risk reduction for transition to the factory floor; (2) human-robot interaction; (3) interoperability; (4) reconfigurable, agile, and flexible robotic systems and, (5) intelligent robotic systems. ***FY 2022 Plans:*** Develop (1) methods and tools for adoption, integration, and readiness to include virtual modeling and simulation and testing; (2) user-friendly interfaces, natural language communication, and human-robot trust/safety; (3)Plug-and-play hardware and software,	12.155	5.800	10.786

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
utilizing open source and open architectures; (4) Modular designs, smart flexible end-effectors and sensors, automated path planning/mobility; and (5) collaborative, self-aware, machine learning/artificial intelligence techniques, and advanced computing. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Increase restores the government's original intent, and funding profile, for the initial standup phase agreement for this institute.			
Title: BioMADE Manufacturing Innovation Institute ***Description:*** The BioMADE MII promises to deliver a new class of manufacturing with domestic capabilities to manufacture critical resources with increased supply chain security. Bioindustrial manufacturing also has the potential to create entirely new classes of products with primary defense applications, such as chemicals and materials with advanced properties for use in austere environments. Bioindustrial manufacturing addresses defense priorities and offers commercial potential for innovations in food, agriculture, fuel, pharmaceuticals, and other consumer products that will create new opportunities for U.S. manufacturers. ***FY 2021 Plans:*** Establish the BioMADE MII to foster an end-to-end U.S. ecosystem for bioindustrial technologies including cohesive scale-up manufacturing and downstream processing capabilities, integrated test & evaluation capacity, and data operationalized for design for manufacturing, all coupled with workforce development and guided by a focus on ethics and biosecurity. The MII will be structured to address DoD and commercial applications. DoD will establish a strategic partnership with the BioMADE MII to define the strategic investment plan, establish initial MII membership, initiate a bioindustrial technology road mapping process for all technical focus areas, and launch projects. The MII will take steps to bring together government, industry, and academic bioindustrial capabilities to better position the U.S. relative to global competition. The BioMADE MII will also include universities and small to medium enterprises to allow them to participate in and benefit from bioindustrial manufacturing advances. ***FY 2022 Plans:*** Mature the emerging manufacturing innovation ecosystem for bioindustrial technologies. Establish pilot lines for downstream processing. Conduct road-mapping activities to inform and initiate the first project calls. Make subrecipient awards for each cost-shared project. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Increase establishes the second full increment of the government's funding profile to invest in the standup phase of this institute.	-	14.000	17.000
Accomplishments/Planned Programs Subtotals	55.483	72.917	97.704

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	FY 2020	FY 2021
Congressional Add: Program Increase	20.000	26.000
FY 2020 Accomplishments: Addressed a range of manufacturing challenges and gaps for DoD systems and modernization priorities. Accelerated ongoing efforts to provide earlier transition of technologies to the warfighter. Maintained DoD's strategic relationships with its nine MIIs and supported development and protection of associated supply chains. Initiated projects in auto-tuning RF filters, hypersonics challenges, wearable sensors, Joint Metal Additive Database Definition, and other specific MII-related research, design, and development (RD&D). ***FY 2021 Plans:*** Initiate projects supporting manufacturing requirements for DoD modernization priorities including 5G, microelectronics, hypersonics, directed energy, and fully networked command, control, and communications (FNC3). Enable additive manufacturing decision-making and life cycle data management. Increase the DoD strategic investment in the MIIs to improve their ability to advance research and technology, expand associated manufacturing ecosystems, and secure human capital through technology-related education and workforce development activities.		
Congressional Add: Manufacturing Engineering Programs	5.000	-
FY 2020 Accomplishments: Supported competitive grants and awards with community colleges, technical schools, and the DoD institutes that support manufacturing education and workforce development (EWD) objectives. Expanded the coalition of manufacturing EWD partners across all levels of government, industry, and academia with the MIIs at the hub. Drove change in the systems needed to accelerate development of a highly skilled advanced manufacturing workforce for the defense industrial base and the DoD.		
Congressional Add: Flexible Hybrid Electronics (FHE) (FY20 title was "Manufacturing Innovation Institutes")	10.000	10.000
FY 2020 Accomplishments: Continued technology development, technology transition, and education and workforce development (EWD) support at the NextFlex Manufacturing Innovation Institute to address DoD modernization priorities advanced through flexible hybrid electronics. ***FY 2021 Plans:*** Conduct open calls for FHE manufacturing projects relevant to commercial and DoD modernization priorities. Address FHE manufacturing, reliability, and scale-up for Connected Soldier Devices (C3), Human Monitoring, Harsh Environments (Hypersonics and Munitions), Autonomy and Communications for Unmanned Aerial Vehicles (UAVs). Improve NextFlex hub tools and capabilities to support prototyping of increasingly sophisticated FHE systems. Expand collaboration to address manufacturing development and supply chain bottlenecks. Create workforce education digital technical training course/modules.		
Congressional Add: Advanced Manufacturing	10.000	14.000

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	FY 2020	FY 2021
FY 2020 Accomplishments: (1) Advanced cold spray technologies through the Lightweight Innovations for Tomorrow (LIFT) Manufacturing Innovation Institute (MII); and (2) Conducted additive manufacturing training for departing veterans and other students via the America Makes MII. ***FY 2021 Plans:*** Extend University of Texas at El Paso (UTEP) Driving Research, Innovation, and Value through the (Driving Research, Innovation, and Value through Education in Additive Manufacturing) DRIVE AM program to produce a superior additive manufacturing educated military, domestic manufacturing workforce, and defense supply chain. Provide a K-PhD science, technology, engineering, and mathematics (STEM) education pipeline and business creation ecosystem using a holistic approach for developing proficiency in AM while growing local and national economies.		
Congressional Add: Manufacturing Cybersecurity ***FY 2020 Accomplishments:*** Funded core MxD activities that increased awareness of cybersecurity in manufacturing, provided small and medium manufacturers with necessary tools and technologies, and increased the number of participants in the cyber-skilled manufacturing workforce. Began a project with the Defense Logistics Agency that provided cybersecurity support to the defense manufacturing base.	14.000	-
Congressional Add: Silicon Based Lasers ***FY 2020 Accomplishments:*** Began execution against the AIM Photonics MII Cooperative Agreement. Developed high quality lasers on silicon to enable the next generation integrated photonics.	25.000	-
Congressional Add: Cyber Initiatives ***FY 2021 Plans:*** Issue a competitive call for cyber manufacturing research to develop self-adapting, resilient Operational Technology (OT) threat analysis technologies to recognize, in real-time, new threat vectors and craft novel security responses. Mature OT cyber resilience analytics leveraging high-performance data analytics resources while maintaining functional and security assurances. Perform reverse engineering of network protocols and controllers to expand the adaptability of OT threat analysis technologies.	-	3.000
Congressional Add: Digital Manufacturing ***FY 2021 Plans:*** Support the DoD Digital Engineering Strategy and use of digital representations of systems and components and digital artifacts to design and sustain national defense systems.	-	7.000
Congressional Add: Additive Manufacturing Training Insertion ***FY 2021 Plans:*** Continue the University of Texas at El Paso (UTEP) – America Makes Driving Research, Innovation, and Value through Education in Additive Manufacturing ("DRIVE AM") program to develop and	-	2.000

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	FY 2020	FY 2021
deliver additive manufacturing training to service members. Training includes virtual interactive, hands on implementation of 3D printers for high impact training opportunities at the Foundational, Specialty, and Authority levels.		
Congressional Add: Hypersonics Enabling Additive Manufacturing ***FY 2021 Plans:*** Conduct research on candidate geometries/ applications and materials for development of air breathing hypersonic systems. Enable additive manufacturing (AM) development efforts anchored by Ursa Major, a part of the hypersonics industrial base, which is establishing a manufacturing presence at the America Makes Youngstown campus. Focus on AM for rocket motors / propulsion components, with lines of effort in active cooling and high temperature sensor integration; modified AM machines capable of larger build volumes to reduce/eliminate joining; and collaboration with University of Texas at El Paso (UTEP) heat flux modeling and sensor integration. Efforts will expand training opportunities in connection with DRIVE AM. Articles to be prototyped with outside vendors with testing in partnership with NASA Glenn.	-	10.000
Congressional Add: 5G Manufacturing Testbed ***FY 2021 Plans:*** Expand existing MxD Manufacturing Innovation Institute dual-use testbed with additional 5G infrastructure using an open call for RD&D manufacturing use project(s) relevant to commercial and DoD modernization priorities, including Real-Time 5G Logistics with In-Transit Visibility and Manufacturing Cognitive Readiness Training and Skills Capture. Conduct programming/training to educate manufacturers, industry, and government and demonstrate 5G Future Factory Connectivity.	-	5.000
Congressional Add: Manufacturing USA Institutes ***FY 2021 Plans:*** Increase the DoD strategic investment in the MIIs to improve their ability to advance research and technology, expand associated manufacturing ecosystems, and secure human capital through technology-related education and workforce development activities.	-	5.000
Congressional Add: Hypersonics and Thermal Management ***FY 2021 Plans:*** Build on results of the LIFT Manufacturing Innovation Institute FY 2020 Hypersonics Challenge investment to increase development of hypersonic powders for manufacturing to meet DoD requirements for cross-platform system development. Coordinate requirements with the Hypersonics Working Group.	-	5.000
Congressional Add: Arsenal Supply Chain Security Proof of Concept ***FY 2021 Plans:*** Engage Army arsenals (e.g., Rock Island) to establish supply chain security pilot(s) to improve DoD Organic Industrial base supply chain resiliency. The MxD Manufacturing Innovation Institute will conduct	-	3.500

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	FY 2020	FY 2021
outreach activities (e.g., workshops, roadshows, assessments) to determine priorities for pilots, then issue an open call for projects to establish pilots to address the priorities identified.		
Congressional Adds Subtotals	84.000	90.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Each Manufacturing USA institute is established through a competitive selection process. The executing military department or agency, in close and continuous coordination with OSD ManTech, publishes a formal solicitation (funding opportunity announcement) for proposals describing the scope of required activities and extensive proposal evaluation criteria. Non-Profit Organizations (including universities) are eligible to bid, and each bidder forms a broad consortium of industry and academic partners. The executing military department or agency, in close coordination with OSD, uses a team of government experts to evaluate each proposal against the evaluation criteria and selects a winning consortium. The final terms of the cooperative agreement/technology investment agreement between the selectee and the federal government are then negotiated and the CA or TIA is signed. Throughout and after completion of this process, the federal government makes clear that members of non-selected teams are encouraged to join the selected consortium as conditions permit.

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COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
351: *Manufacturing Education and Workforce Development*	-	0.000	0.000	4.000	-	4.000	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Office of the Secretary Defense (OSD) promotes equity and inclusion in manufacturing careers, drives regional action to modernize manufacturing Career & Technical Education (CTE) for the U.S. industrial base, invests in strategic education and workforce development capabilities, and expands strategic leadership of advanced manufacturing human capital development.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Manufacturing Innovation Institutes	-	-	4.000
Description: The Manufacturing Education and Workforce Development (M-EWD) program builds on activities from FY 2019-2021 resourced by Project Code 350 and congressional interest items including the Manufacturing Engineering Program. Key M-EWD accomplishments include development of a strategic framework for DoD leadership of advanced manufacturing talent development, eight MII-led regional initiatives informed by labor market data profiles of regional economies, start of a pilot effort to develop an automated real-time labor market data portal, and launch of ManufacturingWorkforce.org, a dual-use digital learning platform with advanced manufacturing course offerings. ***FY 2022 Plans:*** The primary M-EWD effort will be a pilot project to expand the pool of talent and promote equity and inclusion in manufacturing careers by building upon Minority-Serving Institution (MSI) and Historically Black Colleges and Universities (HBCU) partnerships developed beginning in FY 2021. The secondary effort is a pilot project to build regional economic and talent development alliances. The initial alliance project will address skill shortages and gaps in the shipbuilding industry in southeast Virginia. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** New Project Code 351 established with $4.000 million in FY 2022 and additional out-year funding to promote a diverse and inclusive manufacturing workforce.			
Accomplishments/Planned Programs Subtotals	-	-	4.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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D. Acquisition Strategy

N/A