Cover: The High Energy Laser Tactical Vehicle Demonstrator is a pre-prototype Science and Technology effort to demonstrate High Energy Laser Technologies for Indirect Fire Protection Capability Increment 2-Intercept Block 2 (IFPC 2-I BLK 2) C-RAM Requirements.
The U.S. Army’s top priority is to ensure the total Army is ready to deploy, fight and win across the entire spectrum of conflict, with an immediate focus on preparing for a high-end fight against a near-peer adversary. To achieve this objective, the Army will advance its operational capabilities, in every domain, to be more lethal and resilient than those of our adversaries. On Oct. 3, 2017, the Secretary and Chief of Staff of the Army published a Modernization Strategy with one simple focus: make Soldiers and units more lethal. This fundamental imperative provides for six modernization priorities: Long-Range Precision Fires, Next Generation Combat Vehicle, Future Vertical Lift, Army Network, Air and Missile Defense, and Soldier Lethality. By modernizing our forces with the most advanced weapons and equipment available, our Soldiers will maintain the requisite ability to fight and win any battle. Improving readiness and maintaining a decisive overmatch in capability is essential for ensuring our Soldiers are the best equipped global force.

Accordingly, the Army Manufacturing Technology (ManTech) program exists to solve the technological challenges associated with affordably producing advanced capabilities for the Warfighter. The ManTech program is executed by the Army’s science and technology (S&T) and acquisition communities in collaboration with the defense industrial base and is focused on solving challenging manufacturing problems. Informed by stakeholders within the Army, joint services, the Office of the Secretary of Defense, and the Joint Defense ManTech Panel, the program pursues manufacturing opportunities for increased cooperation both within the Government and with private industry.

The Army ManTech projects featured in this brochure illustrate the program’s impact on systems and technologies used by our Soldiers. These competitively awarded projects are coordinated with partners across the Army acquisition and greater Department of Defense communities to maximize manufacturing capability investments.

ManTech affirms its commitment to fulfilling the needs of the Army by coordinating S&T investments with acquisition programs that facilitate the affordable transition of new and improved manufacturing technologies. The objectives of Army ManTech remain focused on increasing mission capability, reducing life-cycle costs, and providing Soldiers with cutting-edge technologies that dominate the battlespace.

Dr. Thomas P. Russell
Army Chief Scientist
Deputy Assistant Secretary of the Army
(Research and Technology)

Cedric T. Wins
Major General, U.S. Army
Commanding U.S. Army Combat Capabilities Development Command
# TABLE OF CONTENTS

## Long Range Precision Fires

- Manufacturing Technology for Complex Missile Seekers
- Advanced Phenolic Prepreg Manufacturing for Reduced Cost Rocket Nozzle Insulation
- Smart Machining (an Integrated Virtual Reality) Solution
- Waterjet Rifling of Large Caliber Cannon Tubes
- High Strength Steel for Armament Manufacturing
- Electrochemical Machining for Armament Manufacturing
- Advanced Mixing Technology for Solid Rocket Propellants

## Next Generation Combat Vehicle

- AM for New Build, Remanufacturing and Life Extension of Critical Weapon Systems Components
- High Energy Safe 5V Li-Ion Battery
- Weight Sensitive Armor Protection for Future Threats
- Agile Manufacturing Cell with High Energy Buried Arc Welding
- High Volume Automated Manufacturing for Military 6T Li-Ion Batteries
- Structural Repairs for Weapon System Components Using Cold Spray
- Advanced Combat Engine Path to Production
- Composite Rubber Track for Heavy Combat Vehicles
- Advanced Combat Transmission

## Future Vertical Lift

- Manufacturing Technology for Ballistically Tolerant Aviation Fuel Bladders
- Direct Digital Manufacturing for Helicopter Engines & other DoD Warfighter Platforms
- AH-64 Composite Sump
- Process Automation Development for Oxide Ceramic Matrix Composite
- High Density Staring Targeting Sensor Manufacturing
### Networks/C3I
- RF Metaferrite Devices 22
- Advanced Manufacturing for Digital Sensors (Digital Pilotage FPA) 23
- Durable Dual-Band High Performance Optical Coatings 24
- High-Dynamic-Range Large Format Digital Pixel Imagers for Aviation 25
- Navigation-Grade Inertial Measurement Unit 26

### Air & Missile Defense
- Fiber-Coupled Pump Diode Manufacturing for High Energy Lasers 27
- Gyroscope Manufacturing Improvements 28
- Manufacturing Improvements for EMI Mitigation Devices 29
- Production Optimization of High Energy Laser Optics 30

### Soldier Lethality
- Battery-Free Programmable Initiators for Scatterable Munitions Reserve Power 31
- Manufacturing Technology Critical for the Next Generation Hand Grenade 32
- Low Cost Freeform Prism Eyepieces 33
- Power and Energy Manufacturing for Medium Caliber Liquid Reserve Battery 34
- Lightweight Small Caliber Ammo 35
- Advanced Filters for Chemical-Biological-Radiological-Nuclear Protection 36
- Advanced Low Light Level Imagers 37
U.S. ARMY MANTECH PROGRAM

Overview
The mission of the U.S. Army’s Manufacturing Technology (ManTech) Program is to support Army readiness and modernization priorities by improving and maturing manufacturing technologies to ensure an overmatch in capability and the fulfillment of our national security objectives. ManTech projects provide affordable and timely manufacturing solutions that address the highest priority needs of the Army. The goal of the program is to improve end-item affordability by addressing manufacturing and producibility risks, thereby facilitating the maturation and transition of critical technologies to weapon system platforms. Critical technology maturation and transition is accomplished by coordinating efforts between Army program offices, the Army Science and Technology (S&T) community and the defense industrial base to demonstrate effective, efficient, affordable and adaptable manufacturing processes.

Organization
The U.S. Army Combat Capabilities Development Command (CCDC) provides program management for the Army ManTech program on behalf of the Deputy Assistant Secretary of the Army (Research and Technology (DASA(R&T))). The Deputy Assistant Secretary of the Army for Research and Technology (DASA(R&T)) provides oversight of the program.

Projects within the DASA(R&T) investment priorities are competitively awarded to the Army S&T and Program Executive Office/Program Manager (PEO/PM) organizations with manufacturing technology related missions. These executing organizations are responsible for coordinating capability goals, deliverables, projected cost/benefit data and conducting transition and implementation planning for the execution of ManTech projects. The Army ManTech process provides a balanced portfolio aligned with S&T, PEO/PM and Department of the Army priorities. Additionally, it allows the Army to maximize technology transition by leveraging both technical and acquisition subject matter expertise for specific weapon systems.
Army Futures Command

A ceremony was held at APG on Jan. 31, 2019 to officially transition the U.S. Army Research, Development and Engineering Command (RDECOM) from the Army Materiel Command (AMC) to the Army Futures Command (AFC). RDECOM is now the Combat Capabilities Development Command (CCDC).

“The United States Army has been focused on the near-term for the last 18 years, and rightfully so. But as we wind down and come out of the conflicts in Iraq and Afghanistan the message is very, very clear; we need to re-focus on large-scale, ground combat, and we need to re-focus on the future,” said Gen. John M. Murray, commanding general, AFC.

The CCDC comprises eight major and three international centers and laboratories including: Data & Analysis Center; Armaments Center; Army Research Laboratory; Aviation & Missile Center; Chemical Biological Center; Command, Control, Computers, Communications, Cyber, Intelligence, Surveillance and Reconnaissance Center; Ground Vehicle Systems Center; and Soldier Center.

The CCDC will focus on fundamental scientific research, technology development, engineering, and analysis to support the Army’s six modernization priorities: Long-Range Precision Fires, Next-Generation Combat Vehicle, Future Vertical Lift, the Network, Air & Missile Defense, and Soldier Lethality. Key tenants of the CCDC’s mission are speed of delivery and integrating technology into existing weapon systems.

This reorganization is the next step in the Army’s effort to transform its approach to modernize critical core capabilities that will give Soldiers and allies a decisive edge in battle. As the modernization strategy focuses on delivering capabilities to support Multi-Domain Operations by 2028, CCDC will maintain a balance between scientific research to support MDO and technology that may not be developed until 2050 or beyond.

To prepare for the move to AFC, CCDC Science and Technology (S&T) advisors engaged with the Modernization Task Force, which became the AFC Headquarters, and the Cross Functional Teams to help drive the modernization process. The CFTs are composed of subject matter experts from the requirements, acquisition, science and technology, test and evaluation, resourcing, contracting, cost, and sustainment communities.

CCDC collaborates with hundreds of international and domestic academic and industry partners to maintain a steady stream of world-class technology. Becoming part of AFC will enable CCDC to partner in new ways and provide greater clarity and focus for all of the Army’s major commands.
Focus on Modernization Priorities and Cross Functional Teams

In support of the U.S. Army’s modernization objectives, the ManTech Program execution strategy is to invest in projects that focus on the six Army Modernization Priorities. Investment guidance is provided by the Army’s Cross Functional Teams, charted to reduce the time to deliver new weapon systems, and other Army stakeholders including the Army S&T community, PE0s, PMs, and industry. The six Army Modernization Priorities are:

- **Long-Range Precision Fires** – Platforms, capabilities, munitions and formations that improve range, lethality, mobility, precision and target acquisition.

- **Next Generation Combat Vehicles** – Combat vehicles that integrate other close combat capabilities in manned, unmanned, and optionally-manned teaming that leverages semi-autonomous and autonomous platforms in conjunction with improved firepower, protection, mobility, and power generation capabilities.

- **Future of Vertical Lift** – Manned, unmanned, and optionally-manned platforms that can execute attack, lift, and reconnaissance missions at greater range, altitude, lethality, and payload.

- **Army Network** – An integrated system of hardware, software, and infrastructure that is sufficiently mobile, reliable, user-friendly, discreet in signature, expeditionary and appropriate for any environment where the electromagnetic spectrum is denied or degraded.

- **Air and Missile Defense** – Mobile integrated platforms, capabilities, munitions, and formations that ensure our future combat formations are protected from modern and advanced air and missile delivered fires including drones.

- **Soldier Lethality** – Capabilities, equipment, training, and enhancements that span all fundamentals of combat including; shooting, moving, communicating, protecting, and sustainment.
2019 Successes

The following success stories are recently completed projects nominated for a 2019 Defense Manufacturing Achievement Award in recognition of their outstanding results.

The III-V Dual-Band Infrared Focal Plane Array (IRFPA) project improved production-readiness of III-V Strained Layer Superlattice dual-band high-definition mid/long-wavelength IRFPAs for the 3rd Generation Forward Looking Infrared sensor systems used on armored vehicles. Manufacturing advances resulting from this project provided yield improvements that translated into cost savings and enhancements for reconnaissance, surveillance, target acquisition, pilotage, and IR search and track systems for various sensor payloads.

The Macrocell Receiver Conversion for Millimeter Wave (mmW) (MaRCm) project leveraged advancements in silicon germanium manufacturing technology enabling the design and manufacture of a highly integrated mmW converter assembly that meet the performance, size, weight, power and cost targets for rotary wing survivability applications. In collaboration with industry, this project matured the readiness of critical manufacturing processes for high-rate production. This joint partnership facilitated assembly integration onto U.S. Army helicopters as part of the Modernized Radar Warning Receiver program and also encouraged investment in the development of technology required to convert mmW signals improving aircraft survivability.

The 12um Pixel High-Definition (HD) Uncooled Longwave Infrared (LWIR) project optimized manufacturing process of 12μm HD uncooled sensor components, resulting in reduced costs and increased performance capabilities, including an increase in range and field-of-view while meeting size, weight, power, and cost requirements. The project involved three industry partners, strengthening the industrial base to provide multiple high-quality sensor sources for Army programs. This project directly supported PEO-Soldier’s Family of Weapon Sights – Crew Served (FWS-CS) program by providing high quality HD sensors with a reduced camera core cost and as a result of the ubiquitous nature of the manufacturing capability developed, will enable many other programs to realize the lower cost benefits in the years to come.

The low-cost miniaturized shortwave infrared (SWIR) imager project reduced the production cost of SWIR imager cores through improvements in the manufacturing process. In collaboration with industry partners, these improvements also yielded an improved quality of sensors produced. The reduced cost of the imagers has allowed for the technology to begin to transition to Army platforms. This technology is currently fielded as part of the PM-SPTD JETS program.

Joint Defense Manufacturing Technology Panel (JDMTP)

The U.S. Army also actively participates in the Department of Defense JDMTP to coordinate Army ManTech efforts and maximize leveraged funding across the services and the Defense Logistics Agency (DLA). The panel is comprised of leaders from the Army, Navy, Air Force, DLA, Office of the Secretary of Defense and Missile Defense Agency ManTech Programs. The mission of the JDMTP is to define how DoD components coordinate technical projects to optimize manufacturing process funding.

Going Forward

The Army ManTech program will continue to support Army modernization priorities by executing projects with sound processes, affordability, producibility, align with DoD strategic goals, and can efficiently transition critical manufacturing technologies. Additional details about the Army ManTech Program can be found at: www.armymantech.com
Objective
The Manufacturing Technology for Complex Missile Seekers project will focus on implementing more efficient production methods and procedures to reduce labor costs associated with the assembly of multi-mode seekers. Specific areas of study will include cost, performance, interfaces, production methods, and materials. Once the manufacturing technologies for multimode seeker assemblies are matured, the results will be implemented by the Joint Air-to-Ground Missile (JAGM).

Benefits:
- Enables all-weather, passive, fire and forget technology
- Complete understanding of seeker performance/cost tradeoffs
- Reduced manufacturing cost for seekers

Deliverables:
- Multi-mode seekers
- Interface solutions for seeker heads

Transition and Implementation:
- Transitions to Program Manager Joint Attack Munition Systems (PM JAMS)

The Joint Air-to-Ground Missile (JAGM) System provides improved fire-and-forget air-to-ground missile capability for rotary wing aircraft and unmanned aerial systems. (Army Photo: 2018 Test firing at Yuma Proving Ground)

U.S. Army Combat Capabilities Development Command, Aviation & Missile Center, Redstone Arsenal, Alabama
Objective
The Advanced Phenolic Prepreg Manufacturing for Reduced Cost Rocket Nozzle Insulation project will advance phenolic resin manufacturing technology to production scale prepreg capability. This project will demonstrate a lower cost material manufacturing process. Additionally, this project will demonstrate superior material performance as insulation for rocket nozzles by developing full-scale prepreg production capability for new, improved benzoxazine (BXA) based phenolic materials.

Transition and Implementation:
• Transitions to the Precision Fires Rocket and Missile Systems Project Office and GMLRS
• May also be implemented on other rocket motor systems with similar nozzle designs, e.g. Low-Cost Tactical Extended Range Missile (LC-TERM)

Benefits:
• 20 percent reduction in labor required to produce nozzles
• Commercial availability of superior phenolic composites to be used for rocket nozzle production and other high temperature/ablative insulation applications
• Matures an alternate resin system for silica cloth phenolic components

Deliverables:
• Full-scale prepreg production capability developed for new, improved benzoxazine (BXA)-based phenolic materials
• Complete thermal and mechanical characterization of prepreg vs. BXA-based material
• Demonstrated processes for reduced cost nozzle insulation manufacturing
• Demonstrated performance utilizing new material for Guided Multiple Launch Rocket System (GMLRS) nozzle insulators

Guided Multiple Launch Rocket System (GMLRS) is a surface-to-surface missile system used to attack, neutralize, suppress and destroy targets using Indirect precision fires (Army photo)

U.S. Army Combat Capabilities Development Command, Aviation & Missile Center, Redstone Arsenal, Alabama
Objective

The Smart Machining Solution (SMS) project will develop and demonstrate a network enabled manufacturing - digital manufacturing consultant for the optimization of subtractive manufacturing processes. The SMS will consist of multiple modules integrated into an organic cloud for the automated selection of optimal machining process and parameters. Ultimately, the SMS will provide a mechanism for the standardization of and best value subtractive manufacturing processes while aiding the production engineer in the “first part correct” philosophy.

Benefits:

• SMS will provide a foundation for improved realization of weapon system manufacturability and sustainability across its lifecycle. Soldier operational benefits include: lower cost, on time delivery, and quality material solutions
• The SMS is a cloud based semi-automated intelligence-based manufacturing advisor set of tools that will:
  – Standardized subtractive manufacturing process across the organization
  – Reduce the cost of subtractive component production time for materiel solutions
  – Increase the quality of subtractive component production costs for materiel solutions
  – Reduce subtractive component planning time for materiel solutions
  – Reduce the time to choose tooling and material specific speeds and feeds

Deliverables:

• Technologies that integrate the designer with the manufacturer (closing the digital thread between design and manufacturing) in a paperless environment allowing for the capture and reuse of knowledge (best practices) and the standardization of tooling and manufacturing processes
• SMS technology will be demonstrated on select components for both Vehicle (Stryker and Abrams) and large caliber solutions. Candidates include; XM35, M20, M256, M284 and Extended Range Cannon Artillery major components (Breech Ring, Breech Block, Carriage, and Housing) and 81mm mortar bipod components

Transition and Implementation:

• A prototype SMS will be established and demonstrated at Benét labs and Watervliet Arsenal

U.S. Army Combat Capabilities Development Command, Armaments Center, Picatinny Arsenal, New Jersey
Objective
The Waterjet Rifling of Large Caliber Cannon Barrels project will develop a waterjet milling capability to produce rifling in large caliber cannon tubes as an alternative to the traditional broach cutting process. Waterjet milling can also be used to strip conventional chrome plating from cannon tubes.

Benefits:
• Eliminates the environmental hazards associated with traditional broaching, such as super-alloys, chlorinated oils and cyanide treatment baths
• Eliminates the long-lead times and expense associated with making new or repairing used broaches, which are highly specialized, single-purpose tools
• Rifling profiles are changed with adjustments to software
• Waterjet milling is a highly responsive, lower cost, and multi-purpose technology for performing multiple tasks in the manufacture and refurbishment of large caliber cannon tubes

Deliverables:
• Validation and qualification of waterjet processes for rifling and stripping of large caliber cannon tubes
• Optical inspection system to adjust waterjet milling process in real-time
• Automated production system using waterjet technology to manufacture rifling grooves and strip chrome coatings in 155mm and 120mm cannon tubes, respectively

Transition and Implementation:
• M109A7 Paladin Integrated Management (PIM) program (M284 cannon)
• M777 towed howitzer (M776 cannon)
• Stryker M1128 Mobile Gun System (M68A1 cannon)

Internal view of waterjet-rifled, medium-caliber barrel (Army photo)
Objective
The High Strength Steel (HSS) for Armament Manufacturing project will develop and demonstrate a production-scale manufacturing processes for large caliber lightweight extended range armament systems. Currently no HSS domestic production capable manufacturing processes exist for extended range lightweight large caliber weapon systems. Systems in design need the high strength in order to achieve the design goals for pressure and range.

Benefits:
- HSS enables extended ranges and higher rates of fire
- Facilitates domestic production of HSS
- The HSS project has applicability to all current and future direct and indirect large caliber armament systems

Deliverables:
- A manufacturing process for domestic high strength steel heat-treated forging
- Production scale manufacturing processes for cannons
- Prototype heat treated tube forgings for system testing

Transition and Implementation:
- The HSS technology is anticipated to transition to Program Executive Office – Ground Combat Systems, Program Manager – Armored Fighting Vehicle, Product Manager Self Propelled Howitzer Systems for use on the XM907 cannon for the XM199 artillery system
- The technology is also anticipated to transition to the extended range M777A2 demonstrator program run by Program Executive Office – Ammunition, Program Manager - Towed Artillery Systems and Lightweight XM3600
Objective
The Electrochemical Machining (ECM) for Armament Manufacturing project will develop a manufacturing capability to bore and rifle large caliber cannons with an electrochemical dissolution process. Electrochemical boring and rifling will improve manufacturing quality, reduce tooling costs, and improve the ability to machine difficult to machine materials for advanced cannon applications. Use of ECM will allow manufacturing centers to meet the demand for systems with improved material property performance, while addressing the complexities associated with materials difficult to machine.

Benefits:
• Improved surface finish (no residual machining marks) facilitating improved non-destructive test inspections and reduced stress induced bore cracking
• Reduced cost, manufacturing cycle time, and scrap, increased throughput and yield with a 50 percent reduction in processing time
• Replaces the necessity for multiple tools with single tool operation
• Extends tool life to over 100 machined units

Deliverables:
• Pilot Electrochemical Machining cell to produce:
  – 60mm, 81mm, and 120mm mortars
  – Rifle, bore and hone 155mm cannons
• Process technical data package for technology transition to the industrial base

Transition and Implementation:
• Transition is to the Watervliet Arsenal
• Systems anticipated to use this technology:
  – XM907 – Extended Range Cannon
  – M109A6 – 155mm 39 caliber Artillery
  – M777 – 155mm 39 Caliber Towed Artillery
  – M119A3 – 105mm Towed Artillery
  – M225A1 – 60mm Mortar
  – M253A1 – 81mm Mortar
  – M120A1 – 120mm Mortar
Objective
The Advanced Mixing Technology for Manufacturing Cost Reduction of Solid Rocket Propellants project will improve the manufacturing process associated with producing minimum smoke tactical rocket motor propellant, to benefit both extruded and castable versions. This effort will replace the current multi-day, multi-step, and multi-equipment processes while maintaining the missile/rocket propellants current performance.

Benefits:
• Reduced batch to batch variability of propellant paste
• Reduced costs with less processing time
• Improved safety and environmental impact

Deliverables:
• Kilogram-scale double-base propellant paste production
• Process for rapid analyses of propellant to improve quality control at smaller scale

Transition and Implementation:
• Implementation will be performed at Radford Army Ammunition Plant

Double-base extruded propellant grains will benefit from improved manufacturing processes (Army photo)
Objective

The Additive Manufacturing (AM) for New Build, Remanufacturing and Life Extension of Critical Weapon System Components project seeks to develop and qualify additive fabrication and repair additive manufacturing processes as viable methods for repair and build of weapons systems components. This project focuses on 3 distinct additive technology thrust areas that are critical to this effort: Cold Spray (CS), Laser Engineered Net Shaping (LENS) and Direct Metal Laser Sintering (DMLS).

Benefits:

• 10 to 50 percent cost savings and up to 50 percent reduction in lead time for component repairs vs new purchase
• Transition to depots of AM processes applicable to manufacture/repair high-value and hard-to-source components
• Additive Manufacturing capability for weapons systems component fabrication for developmental cycle acceleration
• Increased in-theater readiness and reduction of logistical footprint through provision of new and repaired components
• In-process inspection and qualification system for rapid and cost effective component verification

Deliverables:

• Depot Maintenance Work Requirements (DMWR) defining Cold Spray and LENS repair procedures for:
  – AGT1500 Components
  – Bradley Gun Mount
  – M88/M60 Components
  – Apache Rotor Hub
  – M1 Road Arms
• Knowledge base enhancements for repeatable and reliable new build manufacturing processes demonstrated on candidate components:
  – M134 Mini-gun Components
  – M2 Barrel Extension/Support
  – Abrams Impeller
  – M240 Guide

Transition and Implementation:

• CS DMWRs for aviation components to PM Apache via Corpus Christi Army Depot
• LENS and CS DMWRs to Anniston Army Depot
• Program Executive Office/Program Manager endorsements for DMLS new build technology
Objective
The objective of the High Energy Safe Li-ion Batteries project is to scale up ARL research success in 5 V Li-ion to produce high-energy density safe Li-ion batteries by developing the manufacturing process for the 5 V materials & prototyping Li-ion batteries that are tolerant to abuse and of higher energy density than currently available.

Benefits:
• 40 percent greater energy density than safe LiFePO4 Li-ion battery chemistry with uncompromised safety
• 30 percent greater energy density unsafe LiCoO2 Li-ion battery chemistry
• High voltage electrolyte can enable multiple high energy dense cathodes
• Availability of high energy and safe Li-ion cell chemistry can be used across multiple Army platforms including combat vehicles, Soldier power, aircraft, communications and other electronic devices
• Improved performance across all platforms where Li-ion is used upon transition to Li-ion cell manufacturers, including combat vehicles, Soldier power, and aircraft

Deliverables:
• Low cost, scaled-up manufacturing process for energy dense abuse tolerant cathode material
• High voltage stable electrolyte
• High energy safe Li-ion cells

Transition and Implementation:
• Joint Light Tactical Vehicle (JLTV) and conformable wearable battery
• Joint DoD platforms that use Li-ion batteries
Weight Sensitive Armor Protection for Future Threats

Objective
The Weight Sensitive Armor Protection project aims to mature innovative, affordable manufacturing technologies to enable future protection solutions in support of vehicle protection for PEO GCS, the Next Generation Combat Vehicle and Soldier protection for PEO Soldier. Manufacturing processes to reduce cost, improve ballistic performance, lower weight are being matured for advanced aluminum and steel armor alloys and armor components including novel composite armor. The Small Target Interceptor Next Generation project is maturing active protection system (APS) component technologies to provide domestic sources, multi-functionality and reduced costs. And finally, the project is scaling up manufacturing and processing of B6O ceramic powders for next generation body armor.

Benefits:
- Reduce cost of applique aluminum armor alloys by 20 percent via increase competition
- Mature manufacturing processes for thick aluminum armor plate to enable cost efficient, machined armor vehicle components with no welds
- Develop a U.S. Government design 3D-TTR B-kit armor that demonstrates improved ballistic protection, durability and reduced cost when compared with Stryker’s existing solution
- Reduce APS component technology costs
- Reduced costs of B6O powder

Deliverables:
- Processing methods for lightweight armor alloys for both A-Kit and B-Kit applications
- Thick plate manufacturing processes and prototype machined hull components
- Manufacturing processes for 3D TTR composite armor applique
- Manufacturing processes for components that demonstrate performance of alternate lightweight ceramic materials approaches for protection
- Manufacturing solutions for domestic low space, weight, power and cost active protection system component technologies

Transition and Implementation:
- Armored Multi-Purpose Vehicle
- Stryker
- Modular Active Protection System
- Joint Light Tactical Vehicle

U.S. Army Combat Capabilities Development Command, Army Research Laboratory, Aberdeen Proving Ground, Maryland
Objective
The Agile Manufacturing Cell with High Energy Buried Arc Welding for Vehicle Structures project will develop an autonomous robotic welding cell equipped with High Energy Buried Arc Welding (HEBAW) technology that is capable of producing thick armor plate weldments at high welding rates and quality for the construction of combat vehicle hulls and subsections. HEBAW has been proven against underbody blast threats and provides increased vehicle protection over traditional welding processes.

Benefits:
- Improved welding rate versus traditionally manual processes
- Improved blast protection in thick-plate structures
- Improved weld quality with reduced post-weld repair

Deliverables:
- Robotic welder equipped with HEBAW technology for high quality thick plate welds in minimal passes
- High-capacity positioning system to manipulate vehicle structures for in-position welding
- Flexible vehicle mounting fixtures for fast and easy part change out
- Suite of sensors capable of monitoring and adapting welding parameters in real-time to compensate for part variations

Transition and Implementation:
- Armored Multi-Purpose Vehicle
- Paladin Integrated Management vehicle

The AMPV provides significant capability improvement in force protection, survivability, mobility and power generation to incorporate the Army’s inbound network and other future technologies (Army photo)
Objective
The High Volume Automated Manufacturing for Military 6T Li-ion Batteries project will develop manufacturing capabilities that address the relatively high costs and reliability issues associated with producing Li-ion 6T batteries in current low-volume production. This project will optimize design and manufacturing processes and develop automated systems to improved quality and reliability of assembled battery modules while reducing costs. These batteries are anticipated to transition to Army fielded vehicles and support 90 percent of ground vehicles that use the 6T form factor battery.

Benefits:
- Mature supplier automated manufacturing capabilities to reduce the cost of manufacturing by improving efficiency and productivity
- 6T Li-ion benefits over lead acid 6T batteries:
  - Reduced weight and volume
  - Improved power and energy density (3X improvement in silent watch duration)
  - Increased cycle life (3X to 5X improvement in cycle life duration) reducing the logistic footprint and life-cycle costs
  - Integrated battery management system for cell balancing and health status reporting
  - Capable of charging from 0 percent to 90 percent SOC within 30 minutes

Deliverables:
- Manufacturing processes that produce:
  - 6T Li-ion batteries that meet MIL-PRF-32565A
  - 6T Li-ion batteries available/delivered at a rate that can meet the anticipated demand
- Manufacturing processes that incorporate lean manufacturing principles to improve quality and increase battery reliability/availability more than 20 percent

Transition and Implementation:
- Program Manager (PM) Abrams
- PM Bradley
- PM Stryker
- PM JLTV

U.S. Army Combat Capabilities Development Command, Ground Vehicle Systems Center, Detroit Arsenal, Warren, Michigan
Objective
The Structural Repairs for Weapon System Components Using Cold Spray (CS) project aims to develop an armor repair process that can be performed at remote locations (field or war zone). The Army currently replaces pitted armor by removing the entire panel and welding in a new panel. CS, however, can be performed in the field without removing the armor. This reduces the cost of sustainment and the logistics tail for Army weapon systems. The matured CS process and material predictive models will contribute to the process “analytics.” Transitions to Depots and Original Equipment Manufacturers (OEMs) for repair, reclamation and production of armor.

Benefits:
• Higher readiness and availability of armored weapon systems at lower cost and improved performance over high hard armor
• Increased capability of vehicle repair by reducing overall weld repair hours
• Repairing a coating’s corrosion resistance will reduce future sustainment costs associated with pitting and corrosion

Deliverables:
• Ballistic test data showing effectiveness of repair
• Approved structural repair procedures for multiple weapon systems
• Approved repairs procedures transitioned to the depots and OEM’s as they are approved for each application

Transition and Implementation:
• Armored vehicles using High Hard and/or Rolled Homogeneous armor
• Cold spray system implemented at Anniston Army Depot

U.S. Army Combat Capabilities Development Command, Army Research Laboratory, Aberdeen Proving Ground, Maryland
Objective
The objective of the Advanced Combat Engine (ACE) project is to design and develop a new military engine to improve combat vehicle mobility. The new lighter weight smaller form factor engine design will enhance Army ground vehicle survivability by offsetting increasing combat vehicle weights, augmenting the ability to generate electrical power, improving fuel economy and range, and reducing the systems cooling burden. This project will mature and demonstrate the manufacturing techniques and procedures for producing an opposed piston engine prototype.

Benefits:
- Provides a 10x improvement in energy efficiency
- Provides up to a 50% increase in power density
- Provides up to a 25% improvement in fuel efficiency
- Reduces the cooling systems burden with improved ratio of heat rejection to coolant
- Provides a scalable and modular design that can support a family of combat engines for different ground vehicles

Deliverables:
- Precision 3D printed sand core technology to produce unique castings and improved machining
- Additively manufactured engine components, e.g. injectors, turbocharger housing, brackets, etc.
- Injector body with laser drilled nozzle orifices
- Forward- and reverse-rotation turbochargers
- Two-piece piston joining a high temperature alloy steel piston crown with a cast iron steel piston skirt

Transition and Implementation:
- The Advanced Combat Engine is a candidate for transition to Next Generation Combat Vehicle and potential retrofit for the PEO GCS fleet that include:
  - PM AFV (Bradley & Self-Propelled Howitzer)
  - PM AMFV (Armored Multi-Purpose Vehicle)
  - PD MBTS (Abrams & M88) Upgrades

U.S. Army Combat Capabilities Development Command, Ground Vehicle Systems Center, Detroit Arsenal, Warren, Michigan
Objective

The objective of the Composite Rubber Track (CRT) project is to mature and validate manufacturing processes required for production of composite rubber track applicable to heavy, e.g. 50-ton, ground combat vehicles in support of Program Manager Armored Fighting Vehicles (PM AFV), PM Armored Multi-Purpose Vehicle (AMPV) and PM Self Propelled Howitzer Systems (SPHS).

Benefits:
- 33% increase in CRT throughput
- 60% reduction in manpower
- 50% reduction in rejection rate
- Reduced weight (up to 50%) as compared to steel track
- Reduced fuel consumption (up to 24%), resulting in increased range (up to 30%)
- Significantly reduced vibration (up to 75%)
- Reduced track maintenance with improved durability

Deliverables:
- CRT curing processes for 1700T press
- CRT process / performance validation
- Automated pre-assembly and handling equipment

Transition and Implementation:
- Transitions to vehicles in the PM AFV portfolio, to include AMPV and M109A7
Objective

The Advanced Combat Transmission is a family of high power density transmissions that employ a new 32-speed cross drive design. This new transmission design removes or replaces the most inefficient elements of a conventional cross-drive transmission with very precise, extremely tight tolerance replacement components. The objective of this project is to meet production needs by maturing the manufacturing capabilities for the family of advanced transmissions by improving the efficiency and affordability of the technology to meet current needs.

Benefits:

• 10% to 15% Improved fuel economy
• 15% improved thermal efficiency
• 20% lower heat rejection
• Reduce acquisition cost
• Improves various areas of the transmission production, including design, facilities, materials, supply chain, and quality management to ensure reliability and reproducibility of the assembly
• Improves transition potential for future tracked vehicles in addition to the currently anticipated transition partners

Deliverables:

• Manufacturing process to support low rate initial production of cross-drive transmissions for a family of combat vehicles
• Informs transition partners on hardware costs and lead times to plan full rate production

Transition and Implementation:

• The Advanced Combat Transmission is a candidate for transition to Next Generation Combat Vehicle and potential retrofit for the PEO GCS fleet that include:
  – PM AFV (Bradley & Self-Propelled Howitzer)
  – PM AMFV (Armored Multi-Purpose Vehicle)
  – PD MBTS (Abrams & M88) Upgrades
Objective
The Manufacturing Technology for Ballistically Tolerant Aviation Fuel Bladders project aims to improve upon 50-year-old legacy materials and manufacturing processes for aviation fuel bladders. These legacy processes are incapable of meeting the performance requirements of modern combat aircraft. This project will utilize advanced materials such as improved fibers, adhesives and self-sealing materials to enhance fuel bladder performance. The project will also utilize advanced modeling and simulation techniques to improve the processes used to manufacture aviation fuel bladders.

Benefits:
• 8 percent per aircraft reduction in cost
• 15 percent per aircraft reduction in weight
• Reduced lead time of 3 to 5 months
• Improved aircraft readiness
• Environmentally acceptable/approved materials

Deliverables:
• MIL-DTL-27422F compliant fuel bladders of reduced weight and improved sealing capability, which meet more stringent environmental manufacturing restrictions
• Manufacturing process improvements developed under this program will mature advanced dynamic modeling techniques such as LS-Dyna, enabling use on legacy and future platforms

Transition and Implementation:
• CH-47 Block II
• Candidate for Future Vertical Lift, medium and heavy lift platforms, and joint service platforms

The CH-47F Block II program provides additional capability to the field with greater reach, increased payload capacity and an increase in maximum gross weight (Army photo)
Objective

The Direct Digital Manufacturing for Helicopter Engines project aims to improve manufacturing capabilities and affordability of component production using Direct Digital Manufacturing (DDM). This additive manufacturing technology enables the defense industrial base to supplement traditional component fabrication and enhance performance for both legacy and future critical gas turbine engine components. This program will accelerate the implementation of DDM for advanced engine platforms.

Benefits:
- Validated method for DDM of component(s) used in aviation propulsion and power generation gas turbine engines
- Enables operational, flexible, reconfigurable factory infrastructure model with reduced logistical requirements and compressed supply chain
- Surface Finish vs. Throughput Enhancement
- 926 manufacturing steps eliminated
- 147 parts reduced to 25
- Reduced part co-infrastructure model with reduced logistical requirements and compressed supply chain

Deliverables:
- Validated method for DD Manufactured component(s) used in aviation propulsion and power generation gas turbine engines
- Assemble target part(s) into GE-operated T-700/CT-7 turboshaft test engine and perform static testing at GE Global Research Center; Niskayuna, NY
- T700 DDM manufactured component(s)

Transition and Implementation:
- Transitions to T700-GE-701D equipped Apaches and Black Hawks
- Additional transition opportunities include: Improved Turbine Engine (ITE), Future Affordable Turbine Engine (FATE), Joint Heavy Lift (JHL) Advanced Turboshaft Demonstrators, and GE-38 for Navy CH-53K Advanced Heavy Lift Helicopter

Example of direct digital manufacturing used to create aircraft engine components (Army photo)
AH-64 Composite Sump

Objective
The current AH-64 Apache sump is cast magnesium and experiences a high manufacturing rejection rate and heat transfer/corrosion issues. The AH-64 Composite Sump project aims to manufacture a light weight main transmission Composite Sump System (CSS) to replace the metal EV31A-T6 magnesium alloy sand cast sump. Advanced Resin Transfer Mold (RTM) compounds, wear resistant materials, tooling concepts and cooling methods will be applied to the manufacturing process to improve manufacturing efficiency and reduce component costs and weight.

Benefits:
- Improved reliability via improved wear resistance, enhanced structural integrity and mechanical properties, and corrosion elimination:
  - Supports 3400 (E model) and future 3850 Hp capability
  - Reduced manufacturing cost by 14 percent
  - Reduced component weight by 31 percent
  - Reduced manufacturing processing steps by 31 percent
  - Reduced manufacturing cycle time by 45 percent
  - Reduce parts count by 24 percent

Deliverables:
- Production-representative prototype of light weight composite Apache Sump test article
- Advanced RTM tooling technology for aviation applications
- Airworthiness Qualification Specification

Transition and Implementation:
- The light weight composite sump transitions to the AH-64E, along with applicable technology transfer to FVL

The Apache AH-64D/E is the Army’s attack helicopter and is capable of destroying armor, personnel and materiel targets in obscured battlefield conditions (Army photo)

U.S. Army Combat Capabilities Development Command, Aviation & Missile Center, Redstone Arsenal, Alabama
Objective

Oxide Ceramic Matrix Composite (CMC) exhaust duct integration will enable reduced weight and increased payload/range while reducing cost, lead time, maintenance requirements and MTBF, which ensures the relevance of CH-47 and AH-64 platforms beyond the 2020 timeframe. Oxide CMCs can provide fatigue resistant, field repairable hot structure solutions with significant weight savings relative to metal alternatives.

Benefits:

• Reduced weight for CH-47 and AH-64 E
• Less prone to fatigue (material change) and field repairable
• Potential for enhanced infrared (IR) suppression due to material change
• Reduce part cost for CH-47 by more than 5 percent and AH-64 E by more than 45 percent
• Improved thermal performance and Rotorcraft Structural Integrity Program (RSIP) damage tolerance
• Directly applicable to exhaust ducts/components and IR suppressors on both legacy and future aircraft (CH-47, AH-64, Special Forces Little Bird (A/MH-6H MELB) UH-60, CH-53K and V-22) and Future Vertical Lift (FVL) - Medium/Heavy

Deliverables:

• Automated, streamlined oxide CMC manufacturing process for higher quality, more cost-effective CMC components
• Demonstrated prototype CMC exhaust ducts for CH-47F/ BLKII & AH-64 E through component level testing
• Affordability assessments and transition plans for CH-47F/ BLKII & AH-64 E

Transition and Implementation:

• PM Cargo and PM Apache for completion of the Airworthiness Qualification Plan (AQP) to enable qualification testing and ECP for the CH-47 Block II and AH-64E
Objective
The objective of the High Density Staring Targeting Sensor Manufacturing project is to mature manufacturing processes and production readiness of affordable large-format, small-pitch III-V strained layer superlattice infrared focal plane arrays at long wavelengths for airborne targeting applications.

Benefits:
• Replaces three optical field-of-view (FOV) scanned linear array assemblies with a single wide FOV sensor, which is much smaller and has less complex optics.
• Digital image processing for improved targeting operations with high dynamic range and electronic magnification.
• More pixels to increase the range, resolution and field of regard for targeting.
• Low-cost, high-yield III-V strained layer superlattice infrared detectors allow for affordability.

Deliverables:
• 6Kx4K III-V Strained Layer Superlattice 8 to 10-um pitch infrared focal plane arrays mated on digital readout integrated circuits.
• Integrated dewar cooler assembly.

Transition and Implementation:
• Transitions to PEO Aviation & PM Apache Sensors.

Lower cost and complexity: three optical field of view (FOV) scanned linear array assemblies are replaced with one single wide FOV sensor (Army photo).
RF Metaferrite Devices

Objective
Evolving Army systems require wideband and ultra-thin antennas to reduce the protrusion of antennas on ground-based platforms, as well as reduce drag on airborne platforms. MetaFerrites are a unique class of materials that enable the design of wideband and extremely low-profile antennas. The RF MetaFerrite Devices program is maturing a specialized manufacturing process to create MetaFerrites for use in RF devices – a process for which the Army has government rights.

Benefits:
• Roll-to-roll sputtering utilizing Mylar as opposed to Kapton, resulting in a 50 percent cost reduction for the host substrate
• Projected cost per antenna designed to be unit cost comparable to presently-available commercial off-the-shelf (COTS) antennas. “META” MetaFerrite TACSAT/MUOS outperforms COTS antennas in field tests and laboratory tests with 91 percent reduction in profile
• RF device performance matches, or exceeds, that of COTS antennas while maintaining a non-obvious visible signature
• MetaFerrite material benefits extend beyond communications applications to ultra-wideband scanning apertures affording dramatic reductions in profile

Deliverables:
• Manufacturing process for the development of anisotropic materials with prescribed constitutive parameters
• Ultra-thin antennas suitable for conformal application to Army platforms

Transition and Implementation:
• TACTSAT/MUOS antenna for SOCOM vehicle platforms
• TACTSAT/MUOS antenna for PEO Rotary Wing airborne platforms
• Future Vertical Lift aircraft
• Ultra-wideband, conformal, low profile antenna prototypes to the Army Aviation Integration Directorate (AID)

MEC-V1 Antenna (middle) Showing Reduced Profile vs Trivec X-wing and TACSAT Antennas (Army photo)
Advanced Manufacturing for Digital Sensors
(Digital Pilotage FPA)

Objective
The Advanced Manufacturing for Digital Sensors project develops a highly affordable domestic production process for high dynamic range (HDR) digital readout integrated circuits (ROICs), utilizing U.S. commercial foundries to develop processes for digital counter in pixel integration and high density Through Silicon Vias (TSVs) for stacked integration capacitors. The ROICs developed in this effort will be compatible with a wide range of single- and dual-band infrared detector materials and wavebands.

Deliverables:
• High-density TSV manufacturing processes for cryogenic infrared ROICs
• Affordable, large format small pitch DROICs with low noise, low power, high frame rate, and exceptional dynamic range compatible with a wide range of detector materials and wavebands
• DROIC integrated with longwave infrared material in an all-weather and obscurant pilotage system

Benefits:
• Multifunction dual-band digital imaging sensors revolutionize tactical infrared imaging, enabling sensor multifunctionality (simultaneous targeting, hostile fire indication, DVE mitigation, UAS detection, and other urgent Soldier needs) in all environments to ensure that the Soldier maintains sensor overmatch on an all-digital battlefield
• Increases in-scene dynamic range by over 3x
• Increases sensitivity by over 70 percent
• Establishes domestic source of affordable processes available to U.S. industry for 3-D connectivity and backend processing
• Eliminates the need for single-use sensors and decreases total system size, weight, power and cost

Transition and Implementation:
• PEO IEW&S PM TS PM GS -3rd Generation Forward Looking Infrared and Common Sensor Payload for Gray Eagle
• PEO Aviation – Apache and Future Vertical Lift
• Digital sensor enabler for all rotary and ground vehicle targeting systems

Digital ROICs will increase the performance of current and future Army sensors (Army photos)
Objective
Dual-band infrared (IR) focal plane arrays (FPAs) increase the performance of targeting and reconnaissance sensor systems, including 3rd Generation (3GEN) IR sensors on current platforms, e.g., M1 Abrams, M2/M3 Bradley, LRAS3 Scout Sensor, etc. Electro-Optical (EO) component requirements become increasingly complex to capture these advantages. The Durable Dual-Band High-Performance Optical Coatings project will develop high-yield, high-transmission optical coating processes for dual-band IR anti-reflective coatings through Highly Accelerated Life Testing (HALT) to significantly reduce overall system cost.

Benefits:
• Increased Soldier lethality and survivability; negates adversary ability to detect Blue forces
• Increase in yield of dual-band coatings, reducing the cost of ownership for all current and future 3GEN IR imaging sensors
• Increase in optical transmission, resulting in a significant improvement in nominal identification range and enhancement to poor weather range for multi-function dual-band IR sensors
• Coating improvements which increase FPA durability and reduce the number of system failures in the field

Deliverables:
• Matured manufacturing technology for low-cost, high-yield, dual-band coatings for all current and future tactical 3GEN IR sensors
• Highly durable, low cost high performance dual-band optical coatings for all 3GEN IR sensor systems as well as future Aviation, Fires, and Ground Maneuver platforms

Transition and Implementation:
• 3GEN FLIR (M1 Abrams, M2/M3 Bradley, LRAS3 Scout Sensor) – Program Executive Officer (PEO) Intelligence, Electronic Warfare & Sensors (IEW&S) Project Manager, Terrestrial Sensor (PM TS), Manager Ground Sensors (PdM GS)
• Grey Eagle Common Sensor Payload – PEO IEW&S PM TS PdM EO/IR Payloads
• Apache Modernized Target Acquisition Designation Sight/ Pilot Night Vision Sensor– PEO Aviation

Improving sensor coating manufacturing processes will make Next Generation Combat Vehicle tactical imaging sensors difficult to detect, difficult to dazzle, and difficult to damage by proliferating laser threats (Army photos)
**High-Dynamic-Range Large Format Digital Pixel Imagers for Aviation**

**Objective**
This project improves the manufacturability of emerging sensor technologies required to achieve situational awareness (SA) overmatch in complex threat conditions. The project includes the use of III-V strained layer superlattice infrared detectors, which are expected to increase production yield and lower the cost of large format, small pitch long-wave infrared (LWIR) and LWIR/mid-wave infrared (MWIR) dual-band compact staring imagers.

**Benefits:**
- High dynamic range, long range targeting, reconnaissance, and pilotage
- Maintains thermal sensitivity in all environments, resulting in improved Pilotage and SA
- Enables 360-degree situational awareness, high speed flight, obstacle avoidance in all-weather degraded visual environments, and rapid reaction to long-range targets possible
- Added high frame rate MWIR for threat detection and identification
- Affordable cost through III-V infrared detectors
- Digital large-format facilitates enhanced functionality including electronic zooming, picture-in-a-picture capability allowing target detection while maintaining SA

**Deliverables:**
- Production capability at multiple domestic sources for high dynamic range, large-format, (1) LWIR DPI (2) Dualband MW/LW multi-functional imagers using in-pixel digital readouts and commercially based III-V strained layer superlattice material systems

**Transition and Implementation:**
- M-TADS/PNVS – PEO Aviation PM Apache
- Future Vertical Lift – Multi-Function Imager and Full Spectrum Targeting (PEO Aviation and PEO IEW&S) - PEO Aviation and PEO IEW&S

High-performance affordable infrared detector technology will provide significant improvements for pilotage and situational awareness overmatch (Army photo)
Objective

The objective of the Navigation-Grade Inertial Measurement Unit (NGIMU) project is to develop automated, precision, high volume Micro Electro Mechanical Systems (MEMS) manufacturing, packaging and assembly processes to realize small size, weight, power, and cost (SWAP-C) navigation-grade inertial measurement units (IMUs).

The prototype IMUs resulting from this project will enable an order of magnitude improvement in navigation accuracy over currently available sensors with similar size, power, and cost.

Ultimately, this effort will produce a pilot production capability that maintains SWAP-C in order to meet the Army’s need for non-GPS Assured PNT (APNT) solutions.

Benefits:

- Order of magnitude better navigation accuracy versus off-the-shelf sensors of similar size, weight, power and cost (SWAP-C)
- GPS Independent source of Assured PNT which extends mission duration and effectiveness in challenged environments
- Volume production to supply Assured PNT capabilities to all Army platforms and priorities

Deliverables:

- Prototype navigation-grade IMUs built using automated fabrication, packaging, assembly, and test processes such as:
  - Sensor selection methods using in-situ, wafer-level testing
  - Sensor block assembly and installation processes meeting strict alignment tolerances
  - Automated IMU test procedures for calibration and verification

Transition and Implementation:

- Aligns with APNT Cross Functional Team PNT Line of Effort
- Transitions to multiple CCDC Center S&T programs
- Supports Project Manager, Positioning, Navigation and Timing (PM PNT) and Project Manager Combat Ammunition Systems (PM CAS) programs of record

Honeywell prototype sensors (left) and NGIMU (right) (Photo courtesy of Honeywell)

Northrup Grumman prototype HGIMU assembly (Photo courtesy of Northrop Grunman)
Objective
The Fiber-Coupled Pump Diode Manufacturing for High Energy Lasers project aims to reduce the manufacturing cost of High Energy Laser (HEL) fiber-coupled pump diode production by reducing the package bill-of-material cost and the amount of touch labor required to fabricate semiconductor laser, die-attach & electrical contacts, burn-in devices, perform acceptance testing and perform optical component alignment of fiber-coupled diode pump package.

Benefits:
• Economical HEL weapon systems for the Warfighter
• Reduction in fiber-coupled pump diode supply chain costs
• 70-80 percent reduction in fiber-coupled diode manufacturing costs
• Provides engagement capability against rockets, artillery, mortars and UAVs

Deliverables:
• Automated fiber-coupled diode module manufacturing and test equipment and processes with lower cost materials

Transition and Implementation:
• Transitions to PEO Missiles and Space (PEO MS) Cruise Missile Defense System (CMDS) Project Office
• Supports Indirect Fire Protection Capability Increment 2 - Intercept (IFPC 2-I), Block 2 and mobile short-range air defense system (M-SHORAD) directed energy system milestone decisions

Fiber-Coupled Pump Diode (Photo courtesy of nLight)
Objective
The objective of the Gyroscope Manufacturing Improvements project is to study, design and develop a critical manufacturing capability for the labor intensive fabrication of the Silicon Optical Bench (SiOB) for the Micro Inertial Navigator (MiNav). This project will demonstrate advanced automation techniques for key manufacturing processes to develop the SiOB, which will result in much quicker assembly and fabrication times.

Benefits:
• Reduces cost to produce product by 98 percent
• Provides a reduced SWaP-C alternative, enabling precision effects in GPS-denied environments across multiple platforms
• Reduces touch labor (~99 percent reduction) and assembly lead time (~99 percent reduction) per component

Deliverables:
• 50 prototype SiOBs designed for low cost volume production
• Documented portable manufacturing process

Transition and Implementation:
• Transitions to the Lower Tier Project Office and the PATRIOT Missile System
• Transitions to the Precision Fires Rocket and Missile Systems Project Office and the Precision Strike Missile
• Transitions to Close Combat Weapon Systems Project Office and the Javelin Missile System and/or the Tube-launched, Optically tracked, Wireless-guided, (TOW) Improved Target Acquisition System (ITAS) Missile System
Objective
To improve the manufacturing process to produce innovative frequency-selective limiter technology that rapidly and dynamically adapts to eliminate co-site, jamming and other electromagnetic spectrum threats to radar, electronic counter-measures and communications systems. The Autotune Filter (AtF) is one of these innovative technologies; the relatively immature manufacturing technology and processes creates challenges for immediate transition to Army and other DoD programs.

Benefits:
- Increase production yield by more than 20 percent
- Increase throughput 100 percent
- Decrease cycle time by 52 percent
- Decrease lead time by 47 percent

Deliverables:
- 12 Prototype AtFs to demo
- Manufacturing metrics and process report
- Government owned manufacturing processes for AtFs

Transition and Implementation:
- Manufacturing technology transition to PM Cruise Missile Defense Systems for Sentinel A3
Objective
The Production Optimization of High Energy Laser Optics project aims to develop and demonstrate a reduced manufacturing schedule through a deterministic and optimized production process to manufacture large precision optics required for High Energy Laser systems.

Benefits:
- Reduces lead time to first article from 12 to 6 months
- Reduces takt time (rate of production) from 6 to 2 months
- Reduces cost by 20 percent

Deliverables:
- Process for precision optics manufacturing
- Virtual factory model

Transition and Implementation:
- Transitions to PEO Missiles and Space Cruise Missile Defense System Project Office
- Supports Indirect Fire Protection Capability Increment 2 – Intercept (IFPC 2-I), Block 2 and mobile short-range air defense system (M-SHORAD) directed energy system milestone decisions

The High Energy Laser Mobile Demonstrator is being developed to demonstrate directed energy force protection capabilities against rockets, artillery, mortars, unmanned aerial vehicles and cruise missiles (Army photo)
Battery-Free Programmable Initiators for Scatterable Munitions Reserve Power

Objective
Scatterable munitions are essential for force protection and maneuverability to be deployed for 30 days with the ability to provide high energy pulses for stimulus recognition and/or main charge detonation. No technology currently exists to meet these energy needs. The Battery-Free Programmable Initiators for Scatterable Munitions Reserve Power project aims to develop the scaled-up manufacture of a new, self-powered, programmable thermal battery initiator. Used in conjunction with lithium reserve batteries, the new reserve system architecture will satisfy power requirements for Family of SCAtterable Munitions (FASCAM) replacements.

Benefits:
- Product required to augment thermal batteries to meet scatterable munitions energy requirements. Alternative reserve power solutions do not currently exist to meet needs
- Pervasive novel initiator technology to support a wide variety of emplaced munitions and thermal battery applications
- Meets 30 day mission requirements and Ottawa Treaty compliance
- Initiator technology can be integrated with an array of sensors to increase environmental/situational awareness

Deliverables:
- Enhanced design and automated manufacturing process for a new, programmable, self-powered igniter, composed of a piezoelectric generator with energetic porous silicon, compatible with standard thermal battery reserve systems
- High manufacturing throughput and thermal battery cost reductions

Transition and Implementation:
- Thermal battery industry collaborations
- FASCAM replacements
- Gator Land Mine Replacement Program

Initiator manufacturing process (Army photo)
Objective
In order to enable the next generation of hand grenades and advanced munitions, this project seeks to develop the manufacturing technologies required to achieve reliable miniaturization of a power source that meets the performance, cost, reliability, safety and space requirements for multiple applications. The Next Generation Hand Grenade and other Small to Medium Smart Round Applications project aims to develop the first dual purpose grenade for Soldiers called the Enhanced Tactical Multipurpose (ET-MP) hand grenade and the M67 Insensitive Electro-Mechanical (IEM) Fuze as well as other advanced munitions applications.

Benefits:
• Enable the first dual-purpose grenade for Soldiers
• Reduce cost and weight while improving the safety and performance of the next generation grenades
• Micro power source that meets the performance, cost, reliability, safety and space requirements for multiple applications
• Enhanced capabilities for small-to-medium smart rounds including guidance and fuzing
• Enable innovative designs for future munitions

Deliverables:
• Micro power source (e.g. micro dynamo) that meets the performance, cost, reliability, safety and space requirements for multiple applications

Transition and Implementation:
• Enhanced Tactical Multi-Purpose hand grenade
• M67 IM hand grenade
• Explosive Ordnance Disposal applications
• Future small-to-medium smart munitions

With the new ET-MP multi-purpose grenade, designed for ambidextrous use, provides Soldiers the ability to choose either fragmentation or concussive effects (Army illustration)
Low Cost Freeform Prism Eyepieces

Objective
Augmented reality devices provide overlays of information for Soldiers before, during and after operations. The Low Cost Freeform Prism Eyepieces project aims to develop processes for low cost freeform prism eyepieces, which provide high brightness and full high definition color images for an augmented reality display. It will mature manufacturing technology for a low-cost augmented reality eyepiece.

Benefits:
- 15X reduction in the cost of the current units
- Greater adoption across air and ground platforms, dismounted Soldiers and training and simulation applications
- Increased situational awareness through wide field-of-view and high resolution imagery
- Improved training effectiveness
- Reduced cycle time – from 6 to 1.5 weeks
- Enhanced Domestic Industrial Base - increased supplier base for freeform prism optics
- Scalable technology across DoD systems with numerous opportunities for transition

Deliverables:
- Precision machining of injection molds for freeform prism eyepieces
- Hard, durable coatings on optical polymers
- Repeatable, precision optical bonding of freeform surfaces
- Low cost molding of a glass field lens
- Snap-in assembly of optics

Transition and Implementation:
- PEO Soldier – Future Vision Mobility Device (FVMD) and Family of Weapon Sights (FWS)
- PEO Aviation - Air Warrior 1b

Low-cost, wide field of view, high brightness and high resolution eyepieces enable increased situational awareness for augmented reality applications across multiple platforms (Army photos)
Objective
The Power and Energy Manufacturing for Medium Caliber Liquid Reserve Battery project will improve the manufacturing capability of the domestic industrial base for small form factor liquid reserve batteries by designing and fabricating production rate manufacturing equipment to meet medium caliber production rates. Meeting production rates is not possible with current domestic capabilities. This project will enable manufacturing fuze technologies that are needed for future medium caliber munitions.

Benefits:
• Reduced unit cost with improved availability
• Improved reliability
• Establishment of a domestic pilot production line for liquid reserve batteries
• Establishment of an industrial base production capability that can support future government acquisitions program such as 30mm and 40mm ammo and potentially both hand grenades and cluster munitions

Deliverables:
• Demonstration of a reliable ampoule fill and seal machine for small form factor batteries
• A pilot liquid reserve battery production line for medium caliber liquid reserve batteries that can demonstrate viable throughputs and yield efficiencies

Transition and Implementation:
• 30mm x 113mm Point Detonating/Proximity Sensor Program
• 40mm Airburst Non-Lethal Munition
• 40mm Low Velocity XM1166 High Explosive Air Burst
Objective
The Lightweight Small Caliber Ammo (LSCA) project aims to manufacture 7.62mm cases using the Metal Injection Molding (MIM) technology to improve previous LSCA manufacturing and quality issues. Previous manufacturing techniques for lightweight cartridge cases required the assembly of sub-components, which increased the complexity, the potential for nonconforming material, manufacturing time and cost.

Benefits:
- Reduce the weight of 7.62mm cartridge by more than 10 percent
- Increase the production cycle rate more than 100 percent by producing one case per cycle to four cases per cycle

Deliverables:
- Demonstrate production representative manufacturing of lightweight 7.62mm cases
- Demonstrate case production processes that use the MIM process
- 7.62mm lightweight MIM cases in M80A1 and M62A1 configurations that maintain the same performance as current brass cases

Transition and Implementation:
- Transition to Project Manager Maneuver Ammunition Systems
- Transition to all 7.62mm weapons (primarily M240 machine guns) and other compatible 7.62mm weapons

The 7.62mm MIM Case will offer a lower weight alternative over conventional brass cases (Army photo)
Objective
Metal-Organic Frameworks (MOFs) are a filtering and chemical conversion technology that are effective against a broader range of threats than traditional activated carbon. MOFs show promise of protecting against chemical warfare agents (CWAs) and toxic industrial chemicals (TICs). The Advanced Filters for Chemical, Biological, Radiological and Nuclear (CBRN) Protection project will improve Soldier protection by maturing a high-rate manufacturing process for MOFs. The increased availability of MOFs at a reduced unit cost will enable affordable incorporation of MOFs into CBRN filters and other ancillary CBRN protection products.

Benefits:
- Increased Warfighter protection across a wide range of CBRN threats
- Improved life-cycle sustainment performance with improved stability in long-term storage
- MOF enhanced fibers can be incorporated into decontamination wipes or personnel protective equipment technology such as a suit, undergarment, or balaclava providing protection against CWAs and TICs

Deliverables:
- Demonstration of high-rate production quantities of MOF filtration materials
- Manufacturing Technical Data Package
- CBRN protective filters with enhanced toxic industrial chemical protection
- CBRN protective fabrics

Transition and Implementation:
- Initial use projected for the M-61 canister filter used in the M-50 Joint Service General Purpose Mask and the M-51 Combat Vehicle Mask
- Transitions to Joint Program Executive Officer for Chemical, Biological, Radiological, and Nuclear Defense

The Joint Service General Purpose Mask provides the Soldier with face, eye and respiratory protection from battlefield concentrations of chemical and biological agents, toxins, toxic industrial materials and radiological particulate matter (Army photo)
Advanced Low Light Level Imagers

Objective
Warfighters require an affordable low light sensor solution with digital capabilities for enhanced nighttime situational awareness and future augmented reality efforts. Advanced Low Light Level Imagers will develop manufacturing capabilities enabling production of low cost, high performance digital visible/near-infrared sensors (VNIR) capable of being digitally fused with low-power long wave IR (LWIR) sensors for target identification, marking and handoff.

Benefits:
- Enhance manufacturing capabilities to produce low cost, low power, high performance digital VNIR sensors
- Enhance manufacturing capabilities to produce low cost, low power LWIR sensors
- VNIR sensors with digital capabilities available with applications for Soldier Lethality, Future Vertical Lift and Next Generation Combat Vehicles modernization priorities

Deliverables:
- Low power digital VNIR and LWIR sensors
- Back-side illuminated digital low light detector arrays with high quantum efficiency and sub-electron noise levels
- Prototype fused VNIR & LWIR system

Transition and Implementation:
- Transition to PM-Soldier Maneuver Sensors for Enhanced Night Vision Goggle
- Transition to heads up display sensor suite for PM-Integrated Visual Augmentation System
- Transition to PM-Soldier Maneuver Sensors for P3I into Family of Weapon Sights – Crew Served

The future digital Soldier requires lightweight, low power, networked Soldier-borne weapon and helmet mounted sensors to enable overmatch in all environments (Army photo)
**U.S. Army 2018 Defense Manufacturing Technology Achievement Award Nominations**

**Enhanced Military Capability**

**High Energy Safe Li Ion Batteries (ARL)**

The High Energy Safe Li-ion Battery ManTech effort developed a manufacturing method to bring a lab scale innovation of a 5V Li-ion cathode material to a commercial scale. The U.S. Army Combat Capabilities Development Command Army Research Laboratory and its industry partner, Hydro-Quebec, developed a transition approach to license this material to battery producers for test, validation and commercial use.

**Macrocell Receiver Conversion for Millimeter Wave (MaRCm) (C5ISR Center)**

The MaRCm program leveraged advancements in silicon germanium manufacturing technology to design and manufacture a highly integrated, cost effective, converter assembly that meets the performance, size, weight, power and cost targets for rotary wing applications. The project transitioned to PM ASE (Aircraft Survivability Equipment) as part of the APR-39D(V)2 Modernized Radar Warning Receiver program.

**Organic Light Emitting Diode (OLED) Microdisplays (C5ISR Center)**

This Defense-Wide Manufacturing Science and Technology-Army and U.S. Army Combat Capabilities Development Command, Control, Computers, Communications, Cyber, Intelligence, Surveillance and Reconnaissance Center funded effort directly patterned Organic Light Emitting Diode (OLED) emitters onto advanced silicon backplanes, eliminating the need for color filters and increasing the efficiency and brightness by more than 15X. The technology transitioned to the Apache Integrated Helmet and Display Sight System, Soldier Visual Interface Technology, NetWarrior and test programs within the Navy (EVA goggles) and Air Force (F-35 visor).

**Cost Reduction / Rate or Safety Improvement**

**Ground Vehicle Coating System (Ground Vehicle Systems Center and ARL)**

This effort demonstrated manufacturing capability leveraged CARC-Z coating replacement, which resulted in 40 percent cost avoidance to the government; the project transitioned to acquisition programs of record for implementation.
“The Army ManTech program has enabled sensors for next generation Soldier systems and cross-modernization priorities through affordable high performance short-wave IR (SWIR) camera cores which are being implemented in the Joint Effects Targeting System, Electro-Optics IR payloads, future weapons sights and Apache helicopter upgrades that include SWIR”.

- LTG Paul Ostrowski, Deputy Commanding General for Combat Systems, Army Futures Command

“As the Armored Multi-Purpose Vehicle Product Manager in charge of Engineering and Manufacturing Development, I would not have achieved success and launch of low-rate-initial-production without the Army’s ManTech program.”

- LTC Ryan Howell, PdM AMPV Platforms

“This ManTech project [III-V Dual-Band Infrared Focal Plane Arrays] played a pivotal role, improving production capability at numerous fabrication houses and epitaxial material growth foundries around the Nation…”

- Mr. John Notte, Deputy PM Ground Sensors, PEO IEW&S.