



*... Transitioning Advanced  
Manufacturing Technology and  
Accelerating Capabilities for an  
Affordable Fleet*

**2020**

**Navy  
ManTech**

**Project Book**



# Contents

2020 Navy ManTech Project Book: This edition of the Navy ManTech Project Book provides brief write-ups for most of the Navy ManTech projects active in FY19. The projects are organized by platforms and highlight Navy ManTech's cost savings investment strategy, with its concentration on accelerating capabilities and transitioning affordable manufacturing technology for the key platforms and to the fleet. Please contact the points of contact listed in the project summary for additional information on any Navy ManTech project.

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**The** Navy Manufacturing Technology (ManTech) Program has been improving the affordability of Navy platforms critical to the future force. Our investments are targeted on manufacturing technologies that assist key acquisition Program Offices in their respective affordability goals – both acquisition and life cycle. For FY20, we will continue to focus on the VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), DDG 51 Class destroyer, CVN 78 Class aircraft carrier, F-35 Lightning II, and CH-53K heavy lift helicopter. Looking to FY20, Navy ManTech is broadening its investment strategy to support the FFG(X) next generation frigate as well as select manufacturing technology projects that accelerate the delivery of capabilities to the Navy.

Implementation is the end goal of our program. While the resources for implementation are provided by organizations other than ManTech, much of our effort and many of our processes are focused on ensuring that ManTech projects successfully transition to the end user and ultimately reduce the cost to manufacture Navy ships and aircraft. For example, Technology Transition Plans, which are required for every project, specify what will be accomplished with ManTech funds, the exit criteria to complete a project, and the resources that will be funded by other entities to actually implement the technology.

In addition, Navy ManTech continues to use an implementation risk assessment and management process to assess both potential future projects (those in the planning stages) as well as ongoing projects. For ongoing projects, risks are discussed during periodic program reviews to ensure ManTech is on the same page as acquisition and industry stakeholders. For projects in the planning phases, the goal is to recognize the risks to implementation upfront and, by doing so, prioritize funding of affordability projects that have the greatest probability of implementation.

Assessing the progress made to help platforms meet their affordability goals is an essential metric to measure the program's success. To do this, Navy ManTech semi-annually updates its affordability assessment information which identifies cost reduction / avoidance per project and an estimated total savings per platform. Affordability assessments on a per-platform basis, bought off by both the relevant Program Offices and industry, demonstrate the cost-reduction potential and the benefits of implementation.

The Navy ManTech Points of Contact Directory provides a comprehensive source of information on the Navy ManTech Program, its investment and execution strategies, and contact information for its key players. I hope that it is a valuable resource for members of industry, government, and academia.

I look forward to working with all of you as we continue to improve the successes of the Navy ManTech Program. It is more critical than ever to put our resources to the best use, and I am confident that the continued collaboration of ManTech, Program Executive Offices, and industry on cost-reduction opportunities will help platforms achieve both acquisition and life-cycle affordability goals.

John U. Carney  
Director, Navy ManTech

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## Navy ManTech Overview

The Navy Manufacturing Technology (ManTech) Program responds to the needs of the Navy for the production and repair of platforms, systems, and equipment. It helps reduce acquisition and total ownership costs by developing, maturing, and transitioning key manufacturing technologies and processes. Investments are focused on those that have the most benefit to the warfighter.

For over 12 years, the Navy ManTech Program has been focused on affordability improvements for key acquisition platforms. Our current investment strategy includes the VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), DDG 51 Class destroyer, CVN 78 Class aircraft carrier, F-35 Lightning II, FFG(X) next generation frigate, and CH-53K heavy lift helicopter. ManTech helps these Navy programs achieve their respective affordability goals by transitioning needed manufacturing technology which, when implemented, results in a cost reduction or cost avoidance (measured as \$ per hull or \$ per aircraft).

Navy ManTech works with defense contractors, the Naval Research Enterprise, Navy acquisition Program Offices, and academia to develop improved processes and equipment. ManTech promotes timely implementation to strengthen the defense industrial base. With their expertise in specific technology areas, the Navy ManTech Centers of Excellence (COEs) play a key role in the definition and execution of the program. Together with the Navy ManTech Program Office, representatives of the customers, and industrial entities, the COEs function as a team to define projects that address the needs of the Navy in time to make a difference. As an example, extensive interaction and cooperation among the Navy ManTech Program Office, COEs, General Dynamics Electric Boat, Huntington Ingalls Industries – Newport News Shipbuilding, Program Executive Office (PEO) Submarines, and the PMS 450 Program Office have resulted in a focused ManTech initiative for VCS. To date, technology from 57 of the portfolio's approximately 135 projects have been implemented, or are in the process of being implemented, resulting in real acquisition cost savings of approximately \$41.0M per hull, verified by our industrial partners and PMS 450.

The Navy ManTech Program is managed by Code 33, Mission Capable, Persistent and Survivable Naval Platforms, of the Office of Naval Research (ONR), with direct oversight from the Chief of Naval Research.

The directors of the ManTech programs of the Army, Navy, Air Force, Defense Logistics Agency, and Missile Defense Agency coordinate their programs through the auspices of the congressionally-chartered Joint Defense Manufacturing Technology Panel (JDMTP) with representation from the Office of the Secretary of Defense, the Department of Commerce's National Institute of Standards and Technology, the Department of Energy, the Defense Advanced Research Projects Agency, and industry. The JDMTP is organized to identify and integrate requirements, conduct joint program planning, and develop joint strategies. Department of Defense (DOD) oversight is provided by the Office of Manufacturing and Industrial Base Policy which was established by the 2011 National Defense Authorization Act to ensure that the linkage between industrial policy and manufacturing is firmly established and effectively coordinated.

## Navy ManTech Objectives

The overall objective of the Navy ManTech Program is to improve the affordability and readiness of Department of the Navy systems by engaging in manufacturing initiatives that address the entire weapon system life cycle and that enable the timely transition of technology to industry to support the fleet. More specifically, DOD Directive 4200.15 states that ManTech investments shall:

1. Aid in the economical and timely acquisition and sustainment of weapon systems and components.
2. Ensure that advanced manufacturing processes, techniques, and equipment are available for reducing DOD materiel acquisition, maintenance, and repair costs.
3. Advance the maturity of manufacturing processes to bridge the gap from research and development advances to full-scale production.
4. Promote capital investment and industrial innovation in new plants and equipment by reducing the cost and risk of advancing and applying new and improved manufacturing technology.
5. Ensure that manufacturing technologies used to produce DOD materiel are consistent with safety and environmental considerations and energy conservation objectives.
6. Provide for the dissemination of program results throughout the industrial base.
7. Sustain and enhance the skills and capabilities of the manufacturing workforce, and promote high levels of worker education and training.
8. Meet other national defense needs with investments directed toward areas of greatest need and potential benefit.



## Navy ManTech Investment Strategy

The Navy ManTech investment strategy concentrates ManTech resources on reducing both the acquisition and life-cycle costs of key Navy acquisition programs. ManTech transitions manufacturing technology which, when implemented, results in a cost reduction or cost avoidance. Platforms for investment are determined by total acquisition funding, stage in acquisition cycle, platform cost-reduction goals, cost-reduction potential for manufacturing, and other factors primarily associated with the ability of ManTech to deliver the technology when needed. ManTech investments are currently focused on affordability improvements for the VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), DDG 51 Class destroyer, CVN 78 Class aircraft carrier, F-35 Lightning II, FFG(X) next generation frigate, and CH-53K heavy lift helicopter.

**FY21 ManTech Investment Strategy**

**FY21 Investment Strategy – 2 focus areas** CNR Approved – Aug 2019

- 1. Major Acquisition Platform Affordability**
- 2. Capability Acceleration**

**1. Major Acquisition Platform Affordability**

- FFG(X) - added as new platform in FY20
- CH-53K - ramping down (no new starts in FY21)

**2. Capability Acceleration**

- Supports CNO direction to get capabilities to the fleet faster.

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**FY21 Investment Strategy**

**1. Major Acquisition Platform Affordability**

PEO (Subs) VIRGINIA Class	PEO (CLB) COLUMBIA Class	PEO (Ship) DDG 51 Class	PEO (USC) FFG(X) Class (Inflation)	PEO (Carrier) CVN 78 Class	PEO (JSE) F-35	PEO (A) CH-53K (Ramping Down)
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**2. Capability Acceleration**

- Supports CNO direction to get capabilities to the fleet faster.

Strategic planning for Navy ManTech is an ongoing effort. Navy ManTech annually analyzes acquisition scenarios and plans to determine major acquisition programs for potential investment. As the current platforms ManTech supports mature through their respective acquisition cycles, ManTech’s investment targets change.

Although different in focus, scope, and size, ManTech’s affordability initiatives function similarly. For each, ManTech has established an integrated project team or IPT with representatives from Navy ManTech, the platform Program Executive Office (PEO), and representative industry. The IPT meets regularly to coordinate and review the portfolio and ensure that projects are completed in time to meet the platform’s window of opportunity for implementation.

Individual Navy ManTech projects are developed in conjunction with industry and the acquisition Program Manager (PM). With their expertise in specific manufacturing areas, the Navy ManTech COEs play a key role in project definition. Planning for transition prior to the initiation of projects is critical for the implementation of technology on the factory floor and eventually into the fleet.

## Navy ManTech Investment Strategy

To clarify communication between program participants, Navy ManTech has established definitions for “transition” and “implementation.” For Navy ManTech purposes:

- **Transition** denotes that point at which the ManTech project is completed and the technology meets customer (Program Office / PEO / industry) criteria and goals for implementation.
- **Implementation** denotes the actual use of the ManTech results on the factory floor. (The resources for implementation are typically provided by entities other than ManTech including the Program Office / PEO and/or industry).

Agreements are reached on the degree of participation of the PEO / PM in support of the projects. The goal is for each PEO / PM to contribute resources to enable successful completion and implementation of the ManTech projects. Resources supplied may include financial support or cost share for the ManTech project itself or funding of Navy laboratory personnel to provide test, evaluation, certification, and/or other services. In addition, each PEO / PM is expected to provide personnel with technical expertise and/or management experience to assist the ManTech Program Office in project oversight. This support affords assurance that the weapon system PM is truly committed to the successful outcome of the ManTech project. In addition, this close working relationship between the parties provides ManTech with a longer-term view of implementation.

On a per-project basis, Technology Transition Plans (TTPs) document roles, responsibilities, and required resources needed to achieve transition and implementation. TTPs highlight the path from the technology development that ManTech performs to implementation on the factory floor. TTPs are signed by Navy ManTech, the relevant COE Director, a management representative of the industrial facility where implementation will occur, the Program Office / PEO, and, if appropriate, the Technical Warrant Holder. To assess progress, ManTech tracks the status of TTPs and conducts an annual assessment of transition and implementation.

In FY12, Navy ManTech formalized its focus on implementation and risks to implementation by instituting an implementation risk assessment management process to assess potential future projects (those in the planning stages) as well as ongoing projects. For ongoing projects, risks are discussed during periodic program reviews to ensure ManTech is on the same page as acquisition and industry stakeholders. For projects in the planning phases, the goal is to recognize risks to implementation upfront and, by doing so, prioritize funding of projects that have the greatest probability of implementing and have a real impact on affordability.

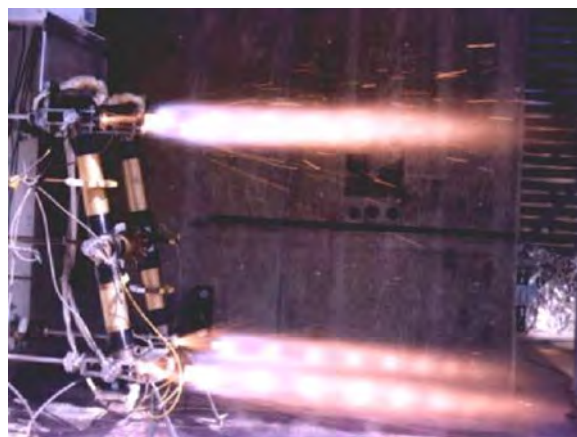
Semi-annual affordability assessments identify projected cost reduction / avoidance per project, as well as calculate an estimated total ownership cost savings per platform. These assessments, which are verified by industry and the relevant Program Offices / PEOs, provide critical information to ensure that ManTech can continue to meet both its affordability goals as well as those of the platform and are essential to ManTech’s success.

## Navy ManTech Investment Strategy

While a large majority of annual ManTech Program resources are invested in accordance with the affordability investment strategy, Navy ManTech does support smaller efforts in Energetics and Repair Technology (RepTech).

**Energetics:** ManTech projects that support energetics develop and transition process technologies for the synthesis of new or improved energetic materials, improved manufacture of propellants and explosives, and improved handling and loading of energetic materials into systems and components. Projects develop solutions to ensure the availability of safe, affordable, and quality energetics products in support of Program Executive Offices, such as Integrated Warfare Systems (PEO IWS/IWS3C) and Conventional Strike Weapons (PEO (W)/PMA-201). More information on Navy ManTech's Energetics Manufacturing Technology Center (EMTC) can be found on Page 12.

**RepTech:** While the major emphasis of Navy ManTech is on support of new production, ManTech also addresses repair, overhaul, and sustainment functions that emphasize remanufacturing processes and advancing technology. The RepTech Program focuses on fielded weapon systems and provides the process and equipment technology needed for repair and sustainment. Requirements for RepTech projects are driven by Navy depots, shipyards, Marine Corps Logistics Bases, intermediate maintenance activities, and contractor facilities responsible for overhaul and maintenance of fleet assets. In general, RepTech projects are usually shorter in duration and are funded at lower levels than standard ManTech projects. The RepTech Program is managed by the Institute for Manufacturing and Sustainment Technologies (iMAST). More information can be found on Page 12.



*Development of Energetics Manufacturing for Primary Explosives.  
Courtesy of EMTC*



*Innovative Cold Spray Repair Technology for Ships.  
Courtesy of iMAST*



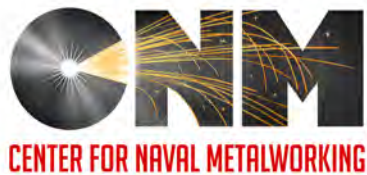
## Navy ManTech Execution

Navy ManTech projects are executed through the Navy ManTech Centers of Excellence (COEs). The COEs were established as focal points for the development and transition of new manufacturing processes and equipment in a cooperative environment with industry, academia, and the Naval Research Enterprise.

### The COEs:

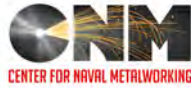
- Execute projects and manage project teams;
- Serve as a corporate expertise in technological areas;
- Collaborate with acquisition Program Offices / PEOs / industry to identify and resolve manufacturing issues;
- Develop and demonstrate manufacturing technology solutions for identified Navy requirements;
- Provide consulting services to naval industrial activities and industry; and
- Facilitate transfer of developed technologies.

Descriptions of ManTech's seven COEs are presented on the following pages.



## Navy ManTech Execution

### *Center for Naval Metalworking (CNM)*



Established in 2016, CNM develops and deploys innovative metalworking and related manufacturing technologies to reduce the cost and time to build and repair key U.S. Navy ships and weapons platforms, while also collaborating with other relevant manufacturing industries. CNM utilizes a proven approach that blends the “virtual center” model with in-house technical expertise to ensure that project teams are comprised of the best providers from industry to identify, develop, select, and execute “metals-centric” projects that support the Navy ManTech program objectives and transition to industry.

CNM is managed by Advanced Technology International (ATI) in Summerville, SC, and partners with EWI, leveraging EWI’s member-based organization that provides applied research, manufacturing support, and strategic services. CNM conducts projects that focus on metals and advanced metallic materials, metal-based composites, metal materials manufacturing processes (e.g., additive manufacturing) and joining techniques, coupled with process design control and advanced metrology and inspection technologies.

CNM web site: <http://www.navalmetalworking.org>

### *Composites Manufacturing Technology Center (CMTC)*



Established in 2000, CMTC is a virtual center that develops improved manufacturing processes for composite-based components and facilitates technology transfer to resolve manufacturing and repair issues identified and prioritized by the Navy’s Program Executive Offices, other DOD services, and industry. Operated by Advanced Technology International (ATI) in Summerville, SC, CMTC forms teams of prime contractors, composites industry suppliers, and universities to address Navy composites manufacturing technology needs and has strong in-depth knowledge and experience in composites manufacturing technology for all DOD weapon systems.

As part of CMTC’s organizational structure, all laboratories, facilities, and project labor resources are provided by project teams. This structure results in cost benefit to the Navy, with maximum funding going to project execution. CMTC’s current portfolio includes composites manufacturing projects for four major ship platforms, the F-35 Lightning II aircraft, and the CH-53K heavy lift helicopter.

CMTC web site: <http://cmtc.ati.org>

## Navy ManTech Execution

### *Electro-Optics Center (EOC)*



Since its inception in 1999, EOC has reduced acquisition, operational, and life-cycle costs while simultaneously improving the mission capability of electro-optic military hardware and enabling the transition of technology to industry and ultimately to the warfighter. Operated by the Penn State University Applied Research Laboratory in Freeport, PA, EOC is a hybrid between the best components of a university and those of private industry. This relationship enables access to the university's researchers and scientists, its state-of-the-art facilities, and leading-edge research. Application of this hybrid model enables EOC to provide its sponsors with solutions that combine leading-edge research with on-time and on-budget deliveries.

EOC and the partner members of its Electro-Optics Alliance (EOA) have completed nearly 40 Navy ManTech projects that have resulted in significant savings to the taxpayer. The EOA advances DOD critical electro-optic manufacturing science and technology and promotes U.S. preeminence in all areas of electro-optics. Alliance membership is available at no cost to all U.S. companies, government labs, and academic institutions involved in electro-optics technology. The EOA is committed to advancing the commercial viability of electro-optics technologies and promoting technology transfer to industry, as well as wide dissemination of new electro-optics-related information.

EOC web site: <http://www.eoc.psu.edu>

### *Electronics Manufacturing Productivity Facility (EMPF)*



EMPF was established in 1984 to aid the electronics industry in improving electronics manufacturing processes required in the manufacture of military systems. Today, ACI Technologies Inc. operates the Navy's electronics manufacturing COE focused on the development, application, and transfer of advanced electronics manufacturing technology. EMPF executes projects that reduce the cost and time to fabricate Navy ships, aircraft, weapon systems, and unmanned systems by partnering with industry, academia, and government centers and laboratories to maximize available research capabilities at the lowest possible cost.

EMPF operates in a modern 36,000-square-foot facility adjacent to the Philadelphia International Airport, which houses a demonstration factory containing the latest electronics manufacturing equipment, fully equipped classrooms for skill-based and professional-level technical training, and an analytical laboratory for materials and environmental testing. EMPF offers many electronics manufacturing services and capabilities to the U.S. Navy, DOD, and the U.S. electronics manufacturing industrial base and is dedicated to the advancement of environmentally safe electronics manufacturing processes, equipment, materials, and practices; flexible electronics manufacturing technologies; and workforce competency.

EMPF web site: <http://www.empf.org>

## Navy ManTech Execution

### *Energetics Manufacturing Technology Center (EMTC)*



Established in 1994 by ONR, EMTC is Navy-operated and located at the Naval Sea Systems Command's Naval Surface Warfare Center, Indian Head Division (IHD), in Indian Head, MD. IHD serves as the focal point for EMTC and, as a renowned leader in energetics, provides a full spectrum of capabilities, including energetics research, development, modeling and simulation, engineering, manufacturing technology, production, test and evaluation, and fleet / operations support.

EMTC develops solutions to manufacturing problems unique to military system / sub-system acquisition and production requirements and the energetics industry. EMTC does not own or operate any facilities or equipment but is essentially a virtual enterprise that involves government, industry, and academia in identifying requirements and executing projects. EMTC identifies weapon system and manufacturing base needs, develops and demonstrates the required manufacturing process technology solutions, and transitions successful results. EMTC understands that energetics are inherently dangerous and require special processes, equipment, facilities, environmental considerations, and safety precautions.

EMTC web site: <http://www.navsea.navy.mil/Home/WarfareCenters/NSWCIndianHead-EODTechnology/WhatWeDo/EMTC.aspx>

### *Institute for Manufacturing and Sustainment Technologies*



Established in 1995, iMAST coordinates Navy ManTech efforts at the Pennsylvania State University's Applied Research Laboratory, one of seven U.S. Navy University Affiliated Research Centers. Located in State College, PA, iMAST addresses challenges related to Navy and Marine Corps weapon system platforms in the following technical areas: materials processing, laser processing, advanced composites, manufacturing systems, repair and sustainment, and complex systems monitoring. iMAST supports the Navy and Marine Corps systems commands, as well as PEOs and Navy laboratories.

iMAST also manages the Repair Technology (RepTech) program and applies new and emerging technologies to improve the capabilities of Navy depots, shipyards, Marine Corps Logistics Bases, and lower level maintenance activities throughout the fleet. RepTech cooperates and communicates with Navy COEs, the joint depot community, DOD industrial activities, industry, PEOs, and university laboratories to improve sustainability, reliability, and system availability.

iMAST web site: <http://www.arl.psu.edu/content/institute-manufacturing-sustainment-technologies>

## Navy ManTech Execution

### *Naval Shipbuilding and Advanced Manufacturing (NSAM) Center*



Since 2003, the NSAM Center and its predecessor, the Center for Naval Shipbuilding Technology, have been operated by Advanced Technology International (ATI) in Summerville, SC. The NSAM Center develops advanced manufacturing technologies and deploys them in U.S. industrial facilities to improve manufacturing processes and ultimately reduce the cost and time required to build and repair Navy weapons platforms.

The NSAM Center works closely with the Navy's acquisition community and the defense industry to address manufacturing technology issues that negatively impact efficiency, with respect to both cost and cycle time. Projects improve construction and repair processes, such as optimizing production practices, increasing the use of robotic manufacturing methods, investigating modular / packaged units, improving accuracy control, eliminating inefficiencies in material usage, and using advanced manufacturing tools and technologies. The NSAM Center focuses on technologies that improve the affordability of current Navy acquisition programs; new projects will investigate using modern planning systems, automated fabrication technologies, supply chain improvements, streamlined unit / module flow to and within storage and construction areas, wireless data management applications, using 3D models to support production, and developing improved scheduling systems for new, aggressive build strategies.

NSAM web site: <http://www.NSAMCenter.org>



*Induction heating and straightening for ship panels will reduce rework.  
Courtesy of NSAM*



*CVN 79 Underwater Hull in Dry Dock. Courtesy of Huntington Ingalls Industries - Newport News Shipbuilding.*



*CVN 79 Lower Bow Positioned in Dry Dock. Courtesy of Huntington Ingalls Industries - Newport News Shipbuilding.*

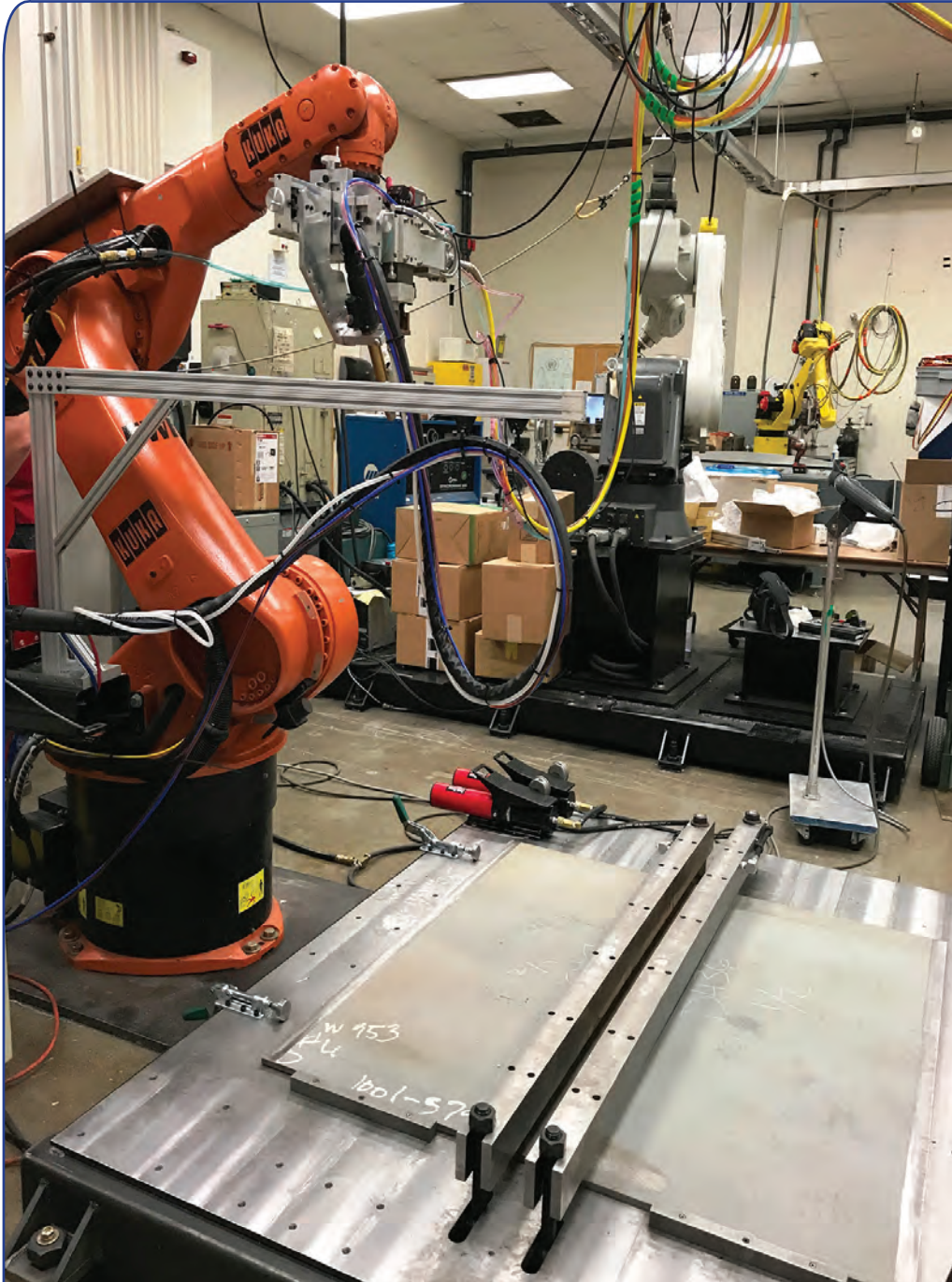
## Navy ManTech Technology Transfer

As previously indicated, the emphasis of the Navy ManTech Program is on transition of manufacturing technology that will result in tangible benefits for the fleet. To achieve transition, it is imperative that the manufacturing advances be widely disseminated to the industrial base for implementation. To foster that dissemination, Navy ManTech provides the following:

<b>Program Web site</b>	The <b>Navy ManTech Program Web site</b> can be accessed at <a href="https://www.onr.navy.mil/en/work-with-us/navy-mantech">https://www.onr.navy.mil/en/work-with-us/navy-mantech</a> . The web site is a central source to access general information about program activities and participation, developments, events, and key points of contact. The site also offers links to the annual Navy ManTech Project Book, program success stories, as well as other publications.
<b>Defense Manufacturing Conference</b>	The annual <b>Defense Manufacturing Conference (DMC)</b> is a forum for presenting and discussing initiatives aimed at addressing DOD manufacturing technology and related sustainment and readiness needs. The conference includes briefings on current and planned programs, funding, DOD initiatives, and seminars relating to the various technology thrusts currently being pursued. Further details are available at the DOD Manufacturing Technology Web site at: <a href="https://www.DODmantech.com/DMC/">https://www.DODmantech.com/DMC/</a>
<b>ShipTech</b>	The biennial event is a forum to exchange information on the manufacturing technology developments generated by Navy ManTech through its COEs, as well as the related initiatives conducted by the National Shipbuilding Research Program, industry, and academia. <b>ShipTech's</b> objective is to reduce acquisition and total ownership costs of naval ships, accelerate the delivery of capabilities to the warfighter, and enhance the competitiveness of the U.S. shipbuilding industry. The ShipTech Web site is <a href="https://www.onlineregistrationcenter.com/register/222/page1.asp?m=4269&amp;c=410">https://www.onlineregistrationcenter.com/register/222/page1.asp?m=4269&amp;c=410</a>
<b>Project Book</b>	The <b>Navy ManTech Project Book</b> , which is published annually, provides a snapshot of the Navy ManTech projects active during the previous fiscal year. Points of contact for each project are provided to facilitate technology transfer.
<b>Centers of Excellence</b>	The <b>Navy COEs</b> are focal points for specific manufacturing technology areas. The charter for each COE requires it to act as a consultant to both the Navy and industry and to facilitate the transfer of technology throughout the industrial base.

## Navy ManTech Technology Transfer

The Navy urges government activities, industry, and academia to participate in its ManTech Program as participants, advisors, consultants and, most importantly, as beneficiaries. Development and implementation of new and improved technologies are achieved only through a concerted effort by everyone connected with the design, manufacture, and repair and sustainment of naval weapon systems.



*Increasing Productivity and Reducing Distortion by Employing Hybrid Laser Arc Welding. Courtesy of Huntington Ingalls Industries - Ingalls Shipbuilding / NSAM.*





VCS



F-35



CLB



CVN



DDG 51



CH-53K

Navy ManTech – affordability improvements for key naval platforms: VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), F-35 Lightning II, CVN 78 Class aircraft carrier, DDG 51 Class destroyer, and CH-53K heavy lift helicopter. Courtesy of PEO (Subs), PEO (Columbia), PEO (JSF), PEO (Aircraft Carriers), PEO (Ships), and PEO (A).

# Navy ManTech Broadens Strategy to Accelerate

The Office of Naval Research (ONR) continues to develop cutting-edge capabilities for the warfighter, but the manufacturing processes that lead to their implementation are slowed by current practices. As a result, the technologies that would provide a distinct advantage to the warfighter are now delayed, and the impact of fielding the new technologies is diminished. ONR is committed to accelerating the transition and implementation of technology to provide the warfighter with the most advanced capabilities sooner rather than later.

ONR's Manufacturing Technology (ManTech) Program is supporting the urgent need for capabilities by developing and transitioning manufacturing best practices for targeted components and by employing design for manufacturing principles to improve specific products while shortening their fabrication durations. For FY20 and FY21, ManTech has organized its approach toward capability acceleration by supporting the following thrust areas:

**SWARM PRODUCTION** – A swarm is a group of unmanned vehicles that enable intra-vehicle communication and coordination of activities. The Navy has initiated a number of programs to develop this technology for the fleet. ManTech is evaluating and recommending improvements to the planned manufacturing process. In addition, efforts to improve the electronic communication packages, the electronic interfaces between the sensors and control algorithm, and the high-precision speed management of the drone propulsion systems are underway.

**ADVANCED RADAR AND ELECTRONICS WARFARE SYSTEMS FOR SHIPS** – ManTech is supporting the acceleration of advanced radar systems by introducing open and common architecture into radio-frequency (RF) components and working to reduce the size and weight of the high-power ship switching and power distribution system. In order to implement the advanced radar systems on future Navy ships, the weight, size, and cost of these systems must be reduced.

**HIGH ENERGY LASER WEAPONS SYSTEMS** – Future implementation of high-powered laser systems aboard Navy ships requires that power switches possess less weight and be available at a reduced cost. In addition, the quality and cost of ship-board spinel optical windows must improve. ManTech is focusing on both of these radar system attributes with the goal of producing a fieldable system at an accelerated rate. Other initiatives include the development of a rapid manufacturing process for beam expanders using emergent hybrid materials, alternate sources and methods to apply gold for reflective coatings, an advance production capability of off-axis mirrors, and easily replaceable optical assemblies for field repair.

# Accelerate Capabilities to the Warfighter

**FLEET REPAIR TECHNOLOGY** – Maintaining ships in an operational state is critical to meeting at-sea mission demands. As a result, technologies that shorten repair periods, allow for at-sea shipboard repairs, and extend the life of critical components are essential to increasing the availability of ships. ManTech continues to advance repair technologies by applying appropriate technologies to improve the capabilities of the remanufacture and repair community as well as utilizing emerging technologies to improve the process and the affordability of Navy and Marine Corps repair facilities. ManTech has long-standing relationships with private and public shipyards, aircraft repair depots, and industry and continues to work with these organizations to reduce costs and extend vehicle availabilities.

**F-35 CANOPY PRODUCTION ACCELERATION** – Aircraft canopies have high acquisition and life-cycle costs. Canopy forming and finishing require a large amount of manual labor, which results in long manufacturing periods and high labor costs. ManTech has automated labor-intensive canopy manufacturing activities. Manufacturing improvements of the canopies have been achieved, and planned efforts are focusing on automating the optical inspection of canopy quality.

**ENERGETICS PRODUCTION IMPROVEMENT** – To facilitate the more rapid production of critical energetic products and stabilize the supply of critical energetics, ManTech is supporting targeted projects at its Energetics Manufacturing Technology Center in Indian Head, Maryland. These efforts include the use of additive manufacturing to produce propellants, incorporating an advanced flow reactor to accelerate the manufacturing process for needed munitions, and the development of advanced mixing methods for igniter compounds that reduce the risk of accidental detonation and facility damage.

ManTech's targeted focus areas are expected to produce near-term successes that will shorten the time between technology development and warfighter availability, and stabilize the supply chain of critical military products. ManTech is working closely with the 6.2 and 6.3 research and development community to eliminate manufacturing inefficiencies and shorten the implementation path for critical military products and components.



# CVN 78 Class / Aircraft Carriers Projects

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## Higher Deposition Submerged Arc Welding Processes to Increase Productivity



PERIOD OF PERFORMANCE:  
June 2015 to November 2018

PLATFORM:  
CVN Class / Aircraft Carriers

CENTER OF EXCELLENCE:  
NSAM

POINT OF CONTACT:  
Mr. Marty Ryan  
(864) 646-4512  
marty.ryan@ati.org

STAKEHOLDER:  
PMS 378, 379

TOTAL MANTECH INVESTMENT:  
\$ \$1,491,000

S2595 — High Deposition Submerged Arc Welding for CVN 78 Class Aircraft Carriers

### Objective

Compared to the Nimitz Class, the Ford Class aircraft carriers have changed the thickness of plating, resulting in increased welding hours for CVN 78. To meet CVN 79 / 80 cost-reduction goals, Huntington Ingalls Industries-Newport News Shipbuilding (NNS) is actively modernizing its welding infrastructure to transition to new equipment that is more capable, and shifting to more efficient welding processes. This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project worked to identify and implement an ultra-high deposition submerged arc welding (SAW) variant and expand the use of SAW to increase productivity. The project supported NNS's welding infrastructure improvement effort by piloting and validating advanced commercial SAW technology / equipment.

This project had two distinct phases; the first phase determined baseline requirements for ultra-high SAW technology and candidate SAW processes. In collaboration with the technical warrant holders, the second phase evaluated and quantified the performance of candidate SAW processes relative to current NNS SAW processes. The project results supported the technical feasibility of implementing new SAW technology in Ford class aircraft carrier fabrication at NNS. The preferred SAW process targeted for implementation at NNS is twin wire variable wave-AC (TWVW-AC).

### Payoff

By implementing the TWVW-AC process, NNS projects savings of \$2.2M/CVN hull). The analysis focused on only the arc-on time due to traceability. The business case analysis excluded items due to the inability to provide effective metrics – lack of current usage data as well as the change created by the new process. However, these excluded items may increase the future benefits for this effort, and long-term usage may result in greater savings than reported here.

### Implementation

The Procedure Qualification submittal was developed, submitted to SUPSHIP Newport News, and routed to NAVSEA. NNS purchased equipment to implement the process, and the equipment is 100 percent deployed. Although currently being used in legacy direct current SAW process mode, the systems and the potential for TWVW-AC use is there. Implementation of this ManTech project is pending NAVSEA approval of the Procedure Qualification submittal.



# Deploying Induction Heating to Straighten Deck and Bulkhead Panels to Reduce Rework

S2664 — Induction Straightening for CVN

## Objective

Current Ford Class aircraft carrier construction employs flame-straightening to straighten deck and bulkhead panels within required tolerances. Although effective, the process is time-consuming and allows for variability in application. It requires numerous application zones across the full area of the panel and often necessitates multiple treatments. Phase 1 of this Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project determined the technical acceptability testing and is executing a test plan to develop induction-straightening parameters that do not adversely affect HSLA 65 material properties. Phase 2 will determine the effectiveness of the developed induction-heating parameters to straighten a representative mock-up of a ship structure.

## Payoff

If the process is able to achieve the threshold labor-reduction goal, Huntington Ingalls Industries - Newport News Shipbuilding (NNS) projects an estimated savings of \$8.4M per CVN hull.

## Implementation

The transition event for this project is the submission of a formal endorsement from NNS's CVN 79 Program Office to PMS 379, accompanied by the justifying business case analysis that has concurrence from NNS's cost and pricing department, and the completion of Phase 2 testing and evaluation activities. Successful completion of the testing and evaluation activities will verify that the process meets the expectations of the project team and stakeholders and is ready for implementation at NNS. Implementation is anticipated the 1st quarter of FY21.



PERIOD OF PERFORMANCE:  
June 2016 to October 2020

PLATFORM:  
CVN Class / Aircraft Carriers

CENTER OF EXCELLENCE:  
NSAM

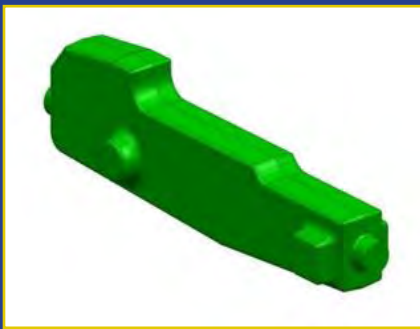
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STAKEHOLDER:  
PMS 379

TOTAL MANTECH INVESTMENT:  
\$ 2,283,000



## Improved Affordability and Producibility for EMALS Components



PERIOD OF PERFORMANCE:  
February 2016 to March 2019

PLATFORM:  
CVN Class / Aircraft Carriers

CENTER OF EXCELLENCE:  
iMAST

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STAKEHOLDER:  
PMS 378, PEO (Carriers), NAVAIR  
PMA 251 - Aircraft Launch and  
Recovery

TOTAL MANTECH INVESTMENT:  
\$540,000

S2686 — Electromagnetic Aircraft Launch System (EMALS) Armature Assembly Producibility Improvements

### Objective

The armature assembly of the Electromagnetic Aircraft Launch System (EMALS) connects to the aircraft at the tow bar interface. Electromagnetic fields accelerate the armature assembly, providing thrust to launch the aircraft. As the load transmission link between the EMALS and aircraft, the armature assembly is a critical safety item, as are each of the components comprising the armature assembly. The acquisition cost of the armature assembly was a target for ManTech affordability investment. Many of the vendors supplying armature assembly components are sole source. Sole source supply of critical components creates technical, cost, and schedule risks. At the project start, the acquisition lead time for one armature assembly was 36 months. The five armature assemblies fabricated for CVN 78 were delivered a year after the scheduled in-yard date.

The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project was to reduce the cost and lead time associated with acquisition of the EMALS armature assembly. iMAST chose to focus on the aft bogey, one of the higher-cost components having excellent manufacturing cost-reduction potential. The estimated acquisition cost of the aft bogey ranged between \$215K and \$385K, depending on the number of parts procured at a time. At approximately 23 percent of the total armature cost, reducing the cost of the aft bogey was a logical starting point to reduce the cost of the armature assembly.

### Payoff

The supplier machines aft bogeys from 4,000-pound billets of Custom 465° stainless steel. iMAST identified a forging house having the capability to produce a 1,500-lb. Custom 465° forging suitable for the aft bogey. iMAST designed the forging for ultrasonic inspection and for compatibility with 4-axis machining centers (e.g., Haas EC-1600ZT with rotary platter). The 63 percent weight reduction dramatically lowered material and machining costs. Designing for machinability reduced setup, fixturing, and jig costs, while simultaneously opening up the number of potential machine shops capable of machining the part. iMAST estimated the full-up assembled aft bogey could be produced at approximately \$150K per copy, even in small quantities.

### Implementation

The Office of Naval Research canceled this project in March 2019 due to inadequate return-on-investment (ROI). Recent EMALS procurement contracts, executed after the project start, delayed acquisition cost savings beyond 2026 (CVN 81), and near-term cost savings for spares provide insufficient ROI. Beyond ROI, implementation requirements are straightforward. Material requirements, incoming material inspection requirements, and part acceptance criteria already exist for this component.





# Industrial Modeling and Simulation Facilitating Factory Configurations and New Facility Designs

S2727— Advanced Steel Production Facility – Industrial Modeling and Simulation

## Objective

The Institute for Manufacturing and Sustainment Technologies (iMAST) developed stochastic discrete event simulation models of the entire fabrication process for the products created by Huntington Ingalls Industries - Newport News Shipbuilding's (NNS's) current and future-state Steel Production Facility. The models provide a means for NNS to assess alternatives for modifications to the current factory configuration, as well as new facility designs to obtain the productivity increases needed to support accelerated production schedules and cost-reduction initiatives for CVN construction.

NNS proposed a radical shift in manufacturing within the Advanced Steel Production Facility (ASPF). The models enable productivity changes to be assessed globally and at the station level, allowing productivity variations to be determined and technology gaps to be identified. Alternative equipment, process flow configurations, and new stations were “modeled.” Modules representing these stations will be inserted into the model to iteratively evaluate alternative scenarios which will, in turn, facilitate capital investment decision making.

## Payoff

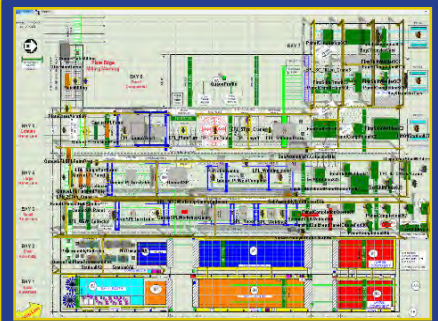
While no benefits may be estimated until the actual completion of NNS's long-term plan for steel processing, the concept itself may be assessed on a global scale. Significant savings may be obtained when:

- CVN products that are currently removed from the legacy panel line due to weight, depth, or access may be assembled on the new production line. If these products are fabricated on an assembly line, a 40 percent reduction in structural fabrication and assembly labor hours can be achieved.
- CVN products currently assembled on the panel line undergo early outfitting more effectively. This will include a more completed final product with a goal of completing the majority of hot work (i.e., welding) either on the line or in the shop. An increase in productivity can result in approximately 20 percent savings.

Expected savings are to be achieved by conducting concurrent manufacturing technology research and development, and validating these improvements using the simulation models transitioned from this project, thus providing data-driven decision support for capital investment planning at NNS.

## Implementation

Upon completion of this project and acceptance of the technology and associated business case by the acquisition Program Office (PMS 379), the models and all associated software applications and source code were transitioned to NNS. The technology was implemented at NNS to support follow-on research and development efforts expected to be funded to support the ASPF concept.



PERIOD OF PERFORMANCE:  
December 2016 to September 2019

PLATFORM:  
CVN Class / Aircraft Carriers

CENTER OF EXCELLENCE:  
iMAST

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STAKEHOLDER:  
PMS 379

TOTAL MANTECH INVESTMENT:  
\$689,000



# NNS Will Leverage ManTech Tool to Connect Digital Thread



**PERIOD OF PERFORMANCE:**  
February 2018 to March 2020

**PLATFORM:**  
CVN Class / Aircraft Carriers

**CENTER OF EXCELLENCE:**  
NSAM

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**STAKEHOLDER:**  
PMS 379

**TOTAL MANTECH INVESTMENT:**  
\$1,771,000



## S2759 — Digital Thread Shipbuilder-Supplier Interface

### Objective

Acquisition of shipboard components is entirely based on paper technical documents that are enclosed within purchase orders. Huntington Ingalls Industries - Newport News Shipbuilding (NNS) provides suppliers with 2D fabrication drawings that are developed from 3D component models. Suppliers use the 2D drawings to create their own 3D component models to produce parts using computer numerical control machines. Design and manufacturing collaboration during supplier contract execution is based on traditional spreadsheets, emails, and conference calls. Purchase orders are clouded with requirement noise, relying on the supplier to determine what is and what is not required. With this complexity and overabundance of information comes the inherent risk of supplier delays and quality failures that can have a tremendous impact on cost, quality, and schedule. In addition, there are situations where shipyard quality inspection of engineering components typically takes place after manufacturing and production is complete, eliminating any possibility of in-process corrections. Shipboard construction installation and operation issues are discovered long after the supplier has delivered the product, resulting in rework and schedule delays.

The Digital Thread Shipbuilding – Supplier Interface effort, managed by the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center, will incorporate NNS’s supply base into the company’s digital shipbuilding strategy by connecting the “digital thread” from design through production / fabrication, assembly, test, inspection, integration, and installation / operation. In addition, the digital information produced by NNS will need to be consumable downstream by fleet provisioning and sustainment activities. The project will help the supply base improve first-time quality, cycle times, schedule performance, and supplier readiness, which will lead to cost savings for the company and the Navy. When a part number is created in the parts catalog system, engineering will use computer-aided logic to assign requirements to help avoid human error and reduce the learning curve. The requirements applied will be clearer, more concise, and specific to the item, component, or assembly being purchased.

### Payoff

The project will simplify technical data packages, produce 3D design disclosures, and establish a secure exchange medium to enable efficient two-way transfer of data with suppliers. Once implemented, the process improvement could save an estimated \$10M per CVN 78 Class aircraft carrier.

### Implementation

NNS plans to deploy the solution in its target environment after initial acceptance tests are complete and will engage affected individuals, groups, and organizations to ensure the solution satisfies documented needs and expectations. Implementation into a production environment is projected start in the third quarter of FY20 on CVN 80.

# NNS Developing New Process to Resolve and Capture Growth Work

S2762 — Digital Problem Resolution

## Objective

Huntington Ingalls Industries - Newport News Shipbuilding (NNS) processes nearly all unscoped work during an execution the same way. Worker error, vendor error, material condition reports, and growth (unplanned) work are all resolved using one system. This system is not effective at separating and identifying growth work, which can be some of the costliest work performed during the execution phase of a program.

Growth work includes repair activities not identified and, therefore, not budgeted for during planning. Growth work associated with carrier programs is inconsistent and causes major disruptions to cost and schedule goals. Savings could multiply when shipyards share knowledge and best practice solutions. NNS developed a process that will reduce both immediate and future costs associated with growth work.

The Digital Problem Resolution effort, managed by the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center, developed a process for CVN to digitally capture and retain growth work items. It created a knowledge base to store identified resolutions for each growth work item. Engineering and planning personnel contributed growth work resolutions as best practice solutions to the knowledge base. NNS also developed processes to exploit the laser-scanning solutions developed under the ManTech CVN Reality Capture project to increase the fidelity of applicable growth work resolutions. Additionally, NNS evaluated other forms of digital capture technologies, including digital photographs and digital videos, to identify an appropriate level of fidelity required for specific resolutions. The project developed a process that digitally captures growth work items for use and evaluation by problem resolution teams from in-service carrier and new construction aircraft carrier contracts. These new processes are currently being piloted at NNS.

## Payoff

The project will improve work time (hours spent by personnel), response time (hours until a resolution is approved), and the incorporation (frequency converted into planned work) rate of growth work. By emphasizing digital media when capturing growth work, cost savings will multiply downstream by reducing time to review and confirm conditions at each stage. Once implemented, the process improvements are estimated to provide five-year savings of \$3.3M for the CVN 78 Class aircraft carrier across in service and new construction operations, and CVN 68 Class refueling and complex overhaul work.

## Implementation

NNS plans to deploy the solution in its target environment after initial acceptance tests are complete and will engage affected individuals, groups, and organizations to ensure the solution satisfies documented needs and expectations. Implementation into a production environment is projected for the second quarter of FY20 on CVN 79.



**PERIOD OF PERFORMANCE:**  
March 2018 to October 2019

**PLATFORM:**  
CVN Class / Aircraft Carriers

**CENTER OF EXCELLENCE:**  
NSAM

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**STAKEHOLDER:**  
PMS 379

**TOTAL MANTECH INVESTMENT:**  
\$602,000



# Leveraging Air Vehicle Technology to Inspect Tanks and Surfaces Will Reduce Time While Increasing Accuracy and Safety



PERIOD OF PERFORMANCE:  
April 2019 to July 2021

PLATFORM:  
CVN Class / Aircraft Carriers

CENTER OF EXCELLENCE:  
EOC

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STAKEHOLDER:  
PMS 379

TOTAL MANTECH INVESTMENT:  
\$1,950,000



## S2788 — Tank Inspection Using Drones

### Objective

Inspections of over 700 new tanks and enclosed areas on the CVN 78 Class aircraft carrier are currently performed manually. Manual inspections, both internal and external, are time consuming, generate opportunities for human error, and create safety concerns as personnel use ladders, scaffolding, or man-lifts to visually inspect areas for defects. This Electro-Optics Center (EOC) project will develop and test a prototype unmanned aerial vehicle (UAV) inspection system(s) and implement processes to inspect tanks and surfaces with UAVs, thereby reducing inspection time, while increasing accuracy and safety.

In the first phase, Huntington Ingalls Industries – Newport News Shipbuilding (NNS) will lead the evaluation and enumeration of all inspection processes, both internal and external, from which UAV inspection requirements and specifications will be derived. The goal is to identify the inspections which will yield the most benefit from UAV inspection and supply the requirements for performance and payload capabilities to support subsequent phases. In the second phase, EOC will lead the development and selection of the UAV platform(s), developing hardware and software modifications to commercial-off-the-shelf products, as required. In the final phase, the shipyard and EOC will work cooperatively to test the prototype system(s) in mockups and actual environments in order to validate the UAV inspection process.

### Payoff

For the initial business case, which is focused predominantly on CVN 80, savings are estimated at approximately \$4M, if fully implemented. The savings result from an estimated 50 percent reduction in labor and rework using UAVs for remote inspection of internal and external spaces. Long-term benefits of this project will be applicable well beyond new hull construction for CVN 80, and may potentially include new inspections of enclosed areas, voids, tanks, and external structures for DDG 51, LHA, LPD, and NSC platforms, as well as overhaul inspections of all platforms. Additional benefits include reduced occupational, health, and safety risks for personnel; and reduced human error when transcribing inspection data for analysis and recordkeeping, as well as the transition to digital inspection processes to reduce analysis time and maintain permanent inspection records for the life of the ship.

### Implementation

The primary focus of the project is to reduce labor costs and improve safety for the inspection of tanks and surfaces on CVN 78. Refinements to procedures and equipment will become evident as the shipyard gains experience with the system. Using the system on other platforms at other shipyards will reveal additional refinements and likely some unexpected benefits as users develop their own methods and implementation plans. NNS is acting as the transition shipyard and expects this technology to be implemented during the summer of 2021 to support the build of CVN 80. Additionally, as part of the project team, Huntington Ingalls Industries – Ingalls Shipbuilding will be implementing this technology for DDG 51 platforms. EOC will work closely with the shipyards to develop a system that produces the most benefit in reducing labor while increasing safety for inspectors. The shipyards will prioritize those areas that will benefit most from the use of such a system. One hundred percent replacement of human inspectors for all tasks is not likely at the close of this project; however, significant reduction in man-hours for setup, inspections, tear-down, and support is expected.

# Robotic Mechanized Gas Metal Arc Welding to Increase Panel Line Productivity

S2794 — Adopting GMAW for Robotic Panel Line Fillet Welding Operations

## Objective

The Navy continues to strain to meet new goals for fleet size and increased acquisition activity. An acquisition cost goal set by the Navy has been to reduce the construction costs for the CVN 78 Class aircraft carrier by 20 percent. A major portion of the strategy to achieve this goal is the use of technology insertion to reduce fabrication cost. Using the Navy ManTech program to support this endeavor addresses high-priority defense needs, aids in achieving reduced acquisition cost, and transitions improved manufacturing technology to production.

The Adopting Gas Metal Arc Welding (GMAW) for Robotic Panel Line Fillet Welding Operations project will determine the advantages of converting legacy equipment from a robotic - flux core arc welding - mechanized (R-FCAW-ME) process to a robotic - gas metal arc welding - mechanized (R-GMAW-ME) process. The Center for Naval Metalworking project team will compare the current baseline welds to the welds fabricated with the R-GMAW-ME process.

Once Huntington Ingalls Industries - Newport News Shipbuilding (NNS) evaluation activities are completed and the process has achieved successful results against project expectations, NNS can develop positive supporting documentation for implementation using capital funding.

## Payoff

For the initial business case, cost savings for the return on investment calculation purposes are estimated at approximately \$3.4M, if fully implemented.

## Implementation

The project results are anticipated to be implemented at Newport News Shipbuilding for CVN 80 and 81. Implementation is anticipated to occur between the third and fourth quarters of FY21.



PERIOD OF PERFORMANCE:  
April 2019 to April 2021

PLATFORM:  
CVN Class / Aircraft Carriers

CENTER OF EXCELLENCE:  
CNM

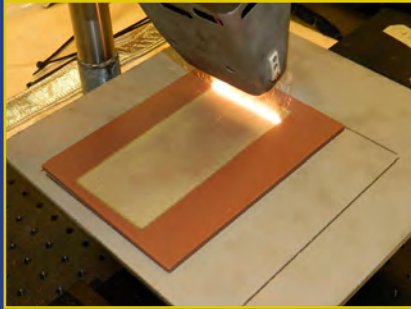
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STAKEHOLDER:  
PMS 379

TOTAL MANTECH INVESTMENT:  
\$1,600,000



# Laser Ablation to Improve NNS Preconstruction Primer Removal Operations



**PERIOD OF PERFORMANCE:**  
February 2019 to May 2021

**PLATFORM:**  
CVN Class / Aircraft Carriers

**CENTER OF EXCELLENCE:**  
iMAST

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PMS 379

**TOTAL MANTECH INVESTMENT:**  
\$1,450,000



S2823 — Laser Ablation of PCP from HSLA Steel

## Objective

Preconstruction primer (PCP) must be removed prior to welding in aircraft carrier (CVN) construction. Typically, needle guns, handheld or walk-behind grinders, and/or abrasive blast equipment are used, which are often laborious, dangerous, and detrimental to the substrates, and/or produce excessive waste materials that may be costly to dispose. At the Huntington Ingalls Industries - Newport News Shipbuilding (NNS) Steel Production Facility (SPF), a substantial percentage of CVN steel fabrication labor is consumed in PCP removal. This process inherently results in an unacceptable number of personnel injuries per year, some surface erosion of the steel substrate, and cleanup and disposal costs for blast media.

Laser ablation (LA) technology can reduce the detriments that are tied to current practices. Numerous civilian industries are implementing LA as supported by many studies showing its potential. Challenges for implementation (comprising technical, procedural, training, safety, environmental, and financial) may be overcome by appropriately identifying and carefully addressing them on an as-needed basis.

The objective of this project is to qualify and implement LA technology for the semi- or fully-automated removal of PCP from HSLA steels within the NNS steel fabrication facilities that are being prepared to support the more rapid construction schedules of CVN 80 and CVN 81.

## Payoff

The preliminary business case, based on pre-project figures provided by NNS, shows a labor reduction in excess of 20,000 hours for the first year of full LA implementation for automated PCP removal. Following full implementation of LA at NNS, the five-year return on investment is expected to be approximately 2.4:1. The figure does not include yet to be fully quantified savings in material costs (e.g., abrasives), or cost avoidances related to injuries experienced using current PCP removal methods. In the last phase of this project, NNS will provide an updated business case.

## Implementation

For full implementation to occur at the NNS SPF, technical, procedural, safety, environmental, financial, and workforce development aspects must be addressed. Early estimates for implementation costs are nearly \$3M, which include procurement of capital equipment; environmental permitting; development of standard operating procedures and safety protocols / training; and equipment installation, debugging, and training. NNS anticipates the need for three to five LA systems in the SPF and will begin transition with its final business case. The strategy for implementation has a timeline beginning in FY22 and ending in FY24.

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# Automation of Repetitive Tasks and Flexible Connector Adapter Production



PERIOD OF PERFORMANCE:  
February 2017 to November 2019

PLATFORM:  
DDG 51

CENTER OF EXCELLENCE:  
EOC

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STAKEHOLDER:  
PMS 400D, PMS 500

TOTAL MANTECH INVESTMENT:  
\$2,625,000



## S2626 — Test Adapter Efficiency Improvement

### Objective

This project builds on the theme that the complexity of electrical and optical connections in ships leads to high installation and maintenance costs. In addition to simplifying cabling designs, reducing the cost of complex cable installation and testing is a way to improve acquisition (material) and life-cycle (reliability and maintenance) costs. Previous Navy ManTech and National Shipbuilding Research Program projects have provided some methodology toward decreasing cable testing costs. This project will validate methods that reduce the cost of automatic cable testing, using the results of the previous projects, and provide electrical, radio frequency (RF), and fiber optic tests at the Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls) Pascagoula shipyard.

The project is being executed by four organizations: the Penn State Electro-Optics Center (EOC), Ingalls (providing industrial engineering and integrating the project results), DIT-MCO International (production supplier of the Integrated Link Test System), and Ultra Communications (manufacturer of optical transceivers and hardware).

### Payoff

The overall project is estimated to result in savings at the shipyard. Payback is less than four years. Task savings come from reductions in test execution time, data transcription and hookup errors, and lead times for adapter connectors; increased flexibility with the capability of producing test adapter connectors on-site; and the introduction of new test technology.

### Implementation

Transition opportunities for this project include process changes related to testing and possible engineering design changes related to cable simplification and RF cable sustainment. Process changes are anticipated to be implemented on DDG 125. Changes impacting the engineering design will be considered for implementation on a ship in FY20. Once the ManTech project achieves cost-reduction results relating to a specific task, the transition of improvements into each additional platform will take from three to six months, depending on the availability of resources and the relevance of each process improvement. Project results may also be implemented on the LHA and LPD platforms.



# Improving Manual Welding through Improved Visualization

S2628 — Augmented Visualization for Manual Welding

## Objective

Welding is the predominant joining method used in the assembly of ship structures, and each shipyard has hundreds of certified manual welders who are responsible for delivering quality welds at a reasonable speed. Even with improvements in auto-darkening weld shades, it remains a difficult art to see the weld space prior to the weld arc being struck and to allow human eyes to adjust to lower levels of light once the arc is off. The learning curve to become a proficient welder is long, and many welders give up before reaching a desired level of proficiency.

This Electro-Optics Center (EOC) project is developing and demonstrating new visualization tools for manual welding, using high dynamic range cameras and head-mounted displays. The newly built devices will be evaluated at Huntington Ingalls Industries – Ingalls Shipbuilding for improvements in quality, speed, and learning curve, against measured baseline tests from auto-darkening weld helmets.

In addition to solving problems with eye strain, learning curve, and quality, the development of a heads-up camera display for manual welding is the first step in delivering the capability for augmented reality in hot work applications at the shipyard.

## Payoff

Improved visualization in manual welding seeks cost savings from three unique positions: improvement in “arc time” productivity, shortening the learning curve to proficiency, and reduction in rework. If augmented visualization results in a 10 percent reduction of a welder’s time by implementing this technology solution with 30 percent of an organization’s welders, a positive business case could be achieved. The addition of augmented reality to the welding display could someday substantiate even higher savings.

## Implementation

The primary transition platform for this project is the DDG 51 Class destroyer. A business case for cost savings will be weighed against the cost of bringing the technology to production at an appropriate annual volume for the market. If shown to be successful, implementation will extend to other Department of Defense and dual-use applications.



**PERIOD OF PERFORMANCE:**  
February 2017 to April 2020

**PLATFORM:**  
DDG 51

**CENTER OF EXCELLENCE:**  
EOC

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**STAKEHOLDER:**  
PMS 400D

**TOTAL MANTECH INVESTMENT:**  
\$2,097,000



# Increasing Productivity and Reducing Distortion by Employing Hybrid Laser Arc Welding



PERIOD OF PERFORMANCE:  
December 2016 to January 2020

PLATFORM:  
DDG 51

CENTER OF EXCELLENCE:  
NSAM

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STAKEHOLDER:  
PMS 400D, PMS 400 (PEO (Ships))

TOTAL MANTECH INVESTMENT:  
\$2,366,000

S2697 — HLAW Process Verification and Implementation for Ship Production

## Objective

Huntington Ingalls Industries - Ingalls Shipbuilding (Ingalls) introduced a new panel line to improve productivity in ship manufacturing. A review of joining processes used in commercial shipbuilding worldwide identified that hybrid laser arc welding (HLAW) can reduce the input of welding heat used to join metals, thus minimizing distortion and, therefore, rework cost. Ingalls collaborated extensively with NAVSEA and has approval of the HLAW weld process qualification and certification test plan, supporting post-project implementation. This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project had two phases, where in Phase I the Edison Welding Institute (EWI) developed HLAW process parameters, and the team evaluated the resultant weld quality. In Phase II, the HLAW weldments and the currently qualified baseline submerged arc welding process, a similar mechanized welding process, are undergoing dynamic-load testing. Ingalls used the EWI-developed parameters on the installed Ingalls HLAW panel line to validate weld quality through testing.

## Payoff

The five-year return on investment (ROI) is 3.78:1 based on building one DDG 51 class hull per year. If other hulls and anticipated future ships are included in the ROI, the business case becomes exponentially stronger, (five-year ROI of 9.46:1). LHA 8 and NSC are poised to take full advantage of HLAW single-sided welding.

## Implementation

Ingalls implemented the process and system technology developed and refined under this project for 80 percent of the targeted applications. Implementation for the remaining 20 percent of target applications is pending the outcome of the dynamic testing. Ingalls anticipates full implementation in the second quarter of FY20.



# Ingalls Streamlines Its Methodology for Short-Term Tactical Planning

S2700 — Tactical Information Planning System (TIPS)

## Objective

Front-line supervisors, who are responsible for the safety, quality, cost, and schedule performance of their crew, have more impact on production than any other member of Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls) management. Their most laborious tasks are planning, progressing, and projecting their crew’s work responsibilities through a two-week (short-term schedule) window for the DDG 51 platform. Typically, these activities are performed away from the production area and their crew. These critical, time-consuming tasks constrict the ability to manage people, issues, and quality. The supervisors are key to optimizing productivity, as they draw on their extensive experience for solutions to most of the problems that crews face on a daily basis.

The Tactical Information Planning System (TIPS) project developed a digital process that will increase the efficiency of front-line supervisors. Ingalls is improving the work package decision-making process to enhance short-term resource planning activities. Ingalls anticipates an additional benefit of increased use and utility of mobility applications at the shop floor and deck plate levels. Mobile work capability is critical to future efficiency improvements in this area. The project team is consolidating critical information for the supervisor from the systems of record in scheduling, engineering change, material, shop status and capacity, job planning, certifications, and personnel availability. This consolidation is enabling efficiencies that allow the supervisors to manage the completion of jobs faster while reducing work stoppages and rework.

The Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project was conducted in two phases. Phase 1 assessed the present system and developed a high-level design for a new system that streamlines numerous administrative tasks necessary to achieve short-term scheduling and work assignment. Phase 2 developed the designs for the systems / processes identified in the first phase as well as pilot testing those systems in the pipe shop.

## Payoff

Once implemented, Ingalls anticipates the TIPS tool / system will provide supervisors with vital work status in a more expedited fashion, resulting in labor savings that translate into potential cost savings of \$652K per DDG 51 hull. The team expects the savings associated with this effort will have additional benefits for other platforms and have five-year savings of over \$9.8M across the Ingalls-built U.S. Navy and U.S. Coast Guard platforms.

## Implementation

The system screen design concepts were proven and upgraded during the pilot effort. The pilot enhanced the system practicality and measured the process time improvement. An implementation plan for the system was developed and the implementation process started at project completion. The project team is confident that the rollout of TIPS will be completed successfully and is currently on track to be operational with a full user base in the first quarter of 2021. However, partial implementations were realized in March 2019 on DDG 128.



PERIOD OF PERFORMANCE:  
February 2017 to January 2019

PLATFORM:  
DDG 51

CENTER OF EXCELLENCE:  
NSAM

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STAKEHOLDER:  
PMS 400D

TOTAL MANTECH INVESTMENT:  
\$581,000



# The Digital Thread is Optimizing Ingalls' Paint Management for DDG 51



**PERIOD OF PERFORMANCE:**  
January 2017 to May 2019

**PLATFORM:**  
DDG 51

**CENTER OF EXCELLENCE:**  
NSAM

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**TOTAL MANTECH INVESTMENT:**  
\$854,000

## S2701 — Digital Paint Tool and Process Optimization

### Objective

Painting in the shipyard is a major undertaking, as almost every part of a ship will go through some degree of painting during construction. Specifically designated, constrained areas in the shipyard are dedicated to performing major paintwork. This limitation, coupled with the requirement to paint most parts, can often create a bottleneck for the rest of the construction processes taking place before and after paint. At the core of this issue is the ability of the upstream engineering and planning organizations to provide the best data to the painters. Currently the paint data for engineering and planning is stored in several different places, in multiple disparate databases, and the data format / terminology varies across each ship program. This construction discipline is ripe for change: the paint 'metadata' needs to be standardized across all ship platforms, accessible as it changes, easy to maintain, and intuitive in its user interfaces and data presentation.

The Digital Paint Tool and Process Optimization project analyzed the current paint process and data to develop an optimized and consolidated method of generating, maintaining, and executing paint data for the DDG 51 Class destroyer. This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center effort created a unified data tool for paint data management, thus reducing labor costs through increased process efficiency and reduced rework. The digital paint tool will leverage the new paint data epoch by utilizing a central data management tool instead of the previous multiple federated database method. The dynamic nature of the tool allows upstream users to quickly modify, query, and provide an unprecedented ability to work with their data.

The project was conducted in two phases at Huntington Ingalls Industries - Ingalls Shipbuilding (Ingalls). Phase 1 consisted of analysis, documentation, and process development tasks to understand the current paint process and data. Phase 2 configured, tested, and validated the digital paint tool to support the modified process developed in Phase 1. The focus was on end-user engagement in testing and validation to achieve the business goals.

### Payoff

Once fully accepted, the scripted automation will be distributed to personnel extracting details for production use. This effort will reduce labor hours required to provide instruction artifacts for fabrication, which translates into potential cost savings of \$218K per DDG hull. Ingalls expects the tool to provide benefits for other platforms, resulting in estimated five-year savings of over \$2.7M across the Ingalls-built U.S. Navy and U.S. Coast Guard platforms.

### Implementation

The tool has undergone a series of trials to validate that the paint data was captured, managed, and delivered with its integrity preserved. In order to evaluate the tool's impact on efficiency and quality, metrics were collected in accordance with the effectiveness evaluation criteria. The project was successfully completed and accepted by Ingalls management. Implementation is underway and expected to be completed during the first quarter of FY20 on DDG 128.



# New Surface Ship Deck Material and Installation Process

S2723-A-B-1 — False Deck Panel Improvement Phase 1

## Objective

The Arleigh Burke DDG 51 Class guided missile destroyer and both the Ford and Nimitz Class aircraft carriers require a false deck covering throughout their electronic spaces, where inspection and access to electrical and heating, ventilating, and air conditioning systems are necessary. The current composite decking is a structural sandwich panel with a 3/16-inch honeycomb core, faced with two plies of glass fiber reinforced plastic, and covered on both upper and lower surfaces with a wear surface. To ensure a watertight seal, the panels require a multi-step edge treatment around the perimeter, and on the DDGs when cut to fit around objects such as pipes, equipment, and furnishings during installation. The process of cutting and sealing the edges is highly labor-intensive. Additionally, the wear surface is prone to cracking, chipping, and delaminating in service. To meet cost-reduction targets and to improve the supply base, General Dynamics Bath Iron Works, Huntington Ingalls Industries – Newport News Shipbuilding, and Huntington Ingalls Industries – Ingalls Shipbuilding are evaluating alternative panel solutions.

The objectives are to develop a common material architecture that meets the requirements of both platforms in order to optimize efficiencies of scale, increase the potential supply base, eliminate edge preparation work, and generally reduce the costs of acquisition and installation, while maintaining or improving performance requirements.

## Payoff

Projected cost reductions will result through increased productivity and throughput effected by eliminating time for cutting and edge treatment steps. Moving all installation activities to the ship should reduce panel fabrication time by as much as 75 percent (DDGs). Expected benefits include streamlining the installation process and reduction of maintenance burden on the ship's crew, which will translate into lower installation and sustainment costs. The total savings for 12 DDG hulls and three CVN hulls are \$6.4M. The five-year return on investment is 2.12:1, and is expected to improve when the project results are applied to other classes of ships and back-fit onto the in-service fleet.

## Implementation

NAVSEA will develop a Military Performance Specification document that will define material and performance characteristics requirements for all U.S. Navy surface ships. This project will work collaboratively with NAVSEA to ensure the proposed false deck panel alternatives meet acceptance requirements and constitute a viable solution to support false deck development and ship integration. Additionally, a full-scale prototype will be demonstrated for both DDG 51 and CVN. Implementation is anticipated to occur in production in early 2020.

This project is a joint COE effort between Composites Manufacturing Technology Center (CMTC) and Institute for Manufacturing and Sustainment Technologies (iMAST).



**PERIOD OF PERFORMANCE:**  
July 2018 to December 2019 (CMTC)  
January 2017 to December 2019 (iMAST)

**PLATFORM:**  
DDG 51  
CVN Class / Aircraft Carriers

**CENTER OF EXCELLENCE:**  
CMTC  
iMAST

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**TOTAL MANTECH INVESTMENT:**  
\$968,000 (CMTC)  
\$547,000 (iMAST)



# RFID Technology Will Improve Material Handling Processes



PERIOD OF PERFORMANCE:  
May 2018 to February 2022

PLATFORM:  
DDG 51

CENTER OF EXCELLENCE:  
NSAM

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STAKEHOLDER:  
PMS 400D

TOTAL MANTECH INVESTMENT:  
\$1,272,000



## S2737 — RFID Part Delivery Tracking and Visibility

### Objective

Material management activities are one of the key cost drivers in shipbuilding construction processes. Additionally, difficulties in capturing equipment status and the absence of real-time location information frequently lead to errors that further disrupt delivery efforts and commonly result in downstream delays in production schedules. Capturing, maintaining, and utilizing material and equipment location data is a complex process within the shipbuilding environment due to a variety of factors, including severe weather conditions, constantly shifting priorities, and limitations on vacant storage areas within the shipyard. These and other challenges frequently result in the need for the materials, planning, and production organizations to assign unplanned labor to properly status and locate material throughout the shipyard.

Through the DDG 51 Radio Frequency Identification (RFID) Part Delivery Tracking and Visibility project, which is managed by the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center, General Dynamics Bath Iron Works (BIW) expects to optimize material tracking processes and minimize key cost drivers, such as excessive paper-based documentation and ineffective statusing of materials. By integrating RFID tracking into material handling processes and incorporating material statusing and location details into the Material Resource Planning system, BIW will significantly reduce material location inefficiencies within current processes and optimize production schedules.

### Payoff

BIW will significantly reduce material tracking-related activities through the use of RFID technology. Following full implementation in early 2022, the optimized material handling process is anticipated to save approximately \$1M per DDG.

### Implementation

Following the validation of the solution technology and completion of the project, BIW expects to implement the technology into DDG 51 production during the second quarter of FY22. Activities required to implement the technology include integration of RFID hardware across the shipyard, process documentation updates, and system training.

# Improved Automation and Technology to Optimize Plate Shaping

S2753 — Shaped Plated Automation and Verification

## Objective

Legacy processes utilized by Huntington Ingalls Industries - Ingalls Shipbuilding (Ingalls) in the fabrication of 2D and 3D hull plates is a multifaceted process requiring skilled labor and strict process monitoring to ensure proper alignment of individual hull plates during downstream hull construction stages. Irregularity and inconsistency in construction material inject variability into the hull construction process that requires mitigation to ensure each hull is in accordance with critical design parameters. Additionally, manual execution of plate shaping, geometry verification sequences, and alignment during stiffener attachment frequently result in increased rework requirements. Commercial solutions capable of automating or semi-automating these complex sequences are not readily available.

Through the Shaped Plate Automation and Verification project, which is managed by the Center for Navy Metalworking, Ingalls intends to develop an automated or semi-automated system and process capable of forming shell plates and verifying the geometries of as-built plates in accordance with design data. Additionally, tooling and/or fixtures will be developed to set, align, and fabricate shell plates and shell plate assemblies, as well as to quickly and accurately check and monitor the as-built geometry to determine the adherence to tight process tolerances.

## Payoff

Ingalls anticipates this effort will enable significant reductions in labor, rework, material handling, and crane support, as well as an increase in throughput. Following implementation in the first quarter of FY21, the anticipated benefits are expected to result in five-year savings of \$4M for the DDG 51 Class destroyer and an additional \$3M across all other ship platforms constructed by Ingalls (LHA, LPD, and NSC).

## Implementation

The project results will be implemented at Ingalls' Pascagoula, MS, facility across the DDG, LHA, LPD, and NSC platforms. Implementation is anticipated to occur in the first quarter of FY21.



PERIOD OF PERFORMANCE:  
September 2018 to November 2020

PLATFORM:  
DDG 51, LHA, LPD, NSC

CENTER OF EXCELLENCE:  
CNM

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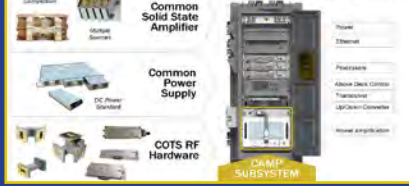
STAKEHOLDER:  
DDG PEO (Ships) PMS 400D, LHA  
PEO (Ships) PMS 377, LPD PEO  
(Ships) PMS 317

TOTAL MANTECH INVESTMENT:  
\$2,500,000



# Open and Common Modular Building Blocks Will Enable Affordable Radars

## Modular COTS Architecture for Modern Radar Systems



PERIOD OF PERFORMANCE:  
May 2018 to January 2020

PLATFORM:  
DDG 51

CENTER OF EXCELLENCE:  
EMPF

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STAKEHOLDER:  
PEO (Ships), IWS 2.0

TOTAL MANTECH INVESTMENT:  
\$5,800,000

## S2755 — Open and Common RF Modular Building Blocks Enabling Affordable Radars

### Objective

This Electronics Manufacturing Productivity Facility project will produce a prototype of a modern radar system architecture that introduces open and common radio frequency (RF) components to demonstrate the capability to implement the requirements of two significantly different radar systems. This effort represents the baseline for the Navy's Next Generation Surface Search Radar (NGSSR). The proposed open and common architecture will meet multi-mission requirements for current and next-generation surface ships. Under this project, an industry competition will be held to determine all reduction costs of identified modular RF components.

### Payoff

The benefits of this project include cost reduction through a competitive search of solid-state amplifier industry domain manufacturers, with potential acquisition cost savings estimated at 25 percent of the unit costs over 200 units for NGSSR as compared to traditional traveling-wave tube-based designs. The potential for reuse of the technology demonstrated in this project also increases the economy of scale for military procurement; NGSSR will be installed on every Navy Surface Search Ship, replacing the AN/SPS-73(V)12. In addition, the project will provide higher reliability of the power amplifier and extensive commonality among military radars through the use of modular components; the open modular approach also offers greater commonality and a more efficient technology refresh, which will have a broad economic and technical impact over several radar programs.

### Implementation

This project will provide a demonstration prototype that proves that the open building block architecture approach meets the capability to implement the requirements of modern radar systems. The effort will include the generation of a technical data package for the NGSSR that will be used for formal request for proposals, enabling an open and fair competition for full rate production and manufacture of the NGSSR prototype for field testing to demonstrate hardware and software capabilities of solid-state high-power amplifier technology.





# An Analysis of Alternatives Manufacturing Approach to Reduce Life-Cycle Costs for Deck Edge Safety Nets

S2764 — Deck Edge Safety Net Composite Frame Feasibility Assessment

## Objective

The current manufacturing process for surface ship deck edge safety net (DESN) frames is highly labor-intensive. The materials used for the frames are prone to corrosion and surface damage, resulting in frequent maintenance and replacement only a few years into their service life. When corrosion resistant (CRES) materials are used to address corrosion issues, welding represents a manufacturing challenge during frame assembly. The metallic frames currently in the fleet also pose a safety hazard, as they can be difficult for sailors to handle due to their weight.

The objective of this Composites Manufacturing Technology Center (CMTC) project is to identify a low-cost, adaptable manufacturing process aimed at producing a damage-resistant DESN frame while reducing part cost and weight. The solution needs to be implementable on the variety of ship topsides on which the DESN frames are used. This is executed through a comprehensive requirements review and an analysis of alternatives (AoA) design and manufacturing approach to decrease the life-cycle cost of surface ship DESN frames. To determine the feasibility of this endeavor, the composite DESN system trade study is focused on the following three key variables: manufacturing approach, material systems, and viable component designs. The trade study will evaluate and compare alternatives based on the requirements, as well as assess manufacturing and production readiness with considerations for factors such as material qualification, process maturity (technology readiness level /manufacturing readiness level), supply base capability, and intellectual property rights.

## Payoff

During the AoA process, members of the shipbuilding team provided data for the manufacturing and acquisition cost of current DESN frames, as well as life-cycle cost data based on repair history. This data, along with down-selected concepts and manufacturing approaches, will be used to develop a return-on-investment for the follow-on project.

## Implementation

Contingent upon successful identification of key metrics, a follow-on ONR Manufacturing Technology (ManTech) project will be initiated to develop a production-ready alternative composite surface ship DESN frame and manufacturing process. Implementation requirements will be developed in the follow-on CMTC project.



PERIOD OF PERFORMANCE:  
October 2018 to January 2020

PLATFORM:  
DDG 51

CENTER OF EXCELLENCE:  
CMTC

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PMS 501

TOTAL MANTECH INVESTMENT:  
\$194,000



# Ingalls is Developing Improved Fabrication Processes to Increase Quality and Efficiency



**PERIOD OF PERFORMANCE:**  
September 2018 to September 2020

**PLATFORM:**  
DDG 51

**CENTER OF EXCELLENCE:**  
NSAM

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**STAKEHOLDER:**  
PMS 400D

**TOTAL MANTECH INVESTMENT:**  
\$1,037,000



## S2781 — Work Cell Development

### Objective

Huntington Ingalls Industries - Ingalls Shipbuilding (Ingalls) machine shop, integrated products division (IPD) shop, and support shops fabricate and assemble a variety of repetitive parts such as louvers, covers, strainer plates, tanks, filters, vents, lifting lugs, custom bolts, lifting lug repairs, etc. The current processes have a high degree of manual operations performed at workstations in various locations of the shops. The problem is that many of these current processes are not automated and require highly skilled labor to efficiently execute. There are currently no readily available commercial-off-the-shelf (COTS) solutions to make these processes more efficient.

The Work Cell Development project, managed by the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center, will develop manufacturing solutions focused on improving process efficiency and tooling for the production of repetitive and labor-intensive products. This may consist of a work cell approach or advanced tooling and fixtures as well as modifications to current equipment and processes. The development of manufacturing work cells that automates and/or mechanizes various processes by incorporating lean manufacturing principles and advanced tooling and fixtures will reduce labor, improve quality, and increase throughput. Development of improved fabrication processes in these areas will also result in increased quality.

The project is being executed in two phases. Phase 1 baselined the current processes to fabricate labor-intensive parts and compiled part family data, including size, quantity, manufacturing process, man-hours, and re-work. Process maps were developed to document the current processes for the target parts and part families. Time studies were performed and Industrial Engineering (IE) data was gathered for cost analysis and to document the quality of the target processes. Work cell requirements were developed to identify engineering and operations constraints, processes, tolerances, etc. Phase 2 will perform the design and engineering of the prototypes and produce the prototypes by fabricating and/or modifying COTS equipment.

### Payoff

Once implemented, Ingalls anticipates the tools and processes will reduce labor in the implementing shops and quality assurance and accuracy control. Implementation of the automated / semi-automated processes and any tools or fixtures developed under this project is estimated to result in annual savings of \$830K and five-year savings of over \$4.1M, across all U.S. Navy and U.S. Coast Guard platforms constructed at Ingalls

### Implementation

Ingalls will deploy the solution in its target environment after initial acceptance tests are complete, and engage affected individuals/groups/organizations to ensure the solution satisfies documented needs and expectations. If any significant deficiencies are noted, the solution will be revised by the development team and acceptance testing will be repeated on the revised solution. Implementation into a production environment will start in the first quarter of FY21 on DDG 128, LHA 8, LPD 30 and NCS 11.

# Promoting Digital Automation and Optimization with New Non-Destructive Testing Processes

M2787— Increased Automation of NDT Tracking

## Objective

The Huntington Ingalls Industries - Ingalls Shipbuilding (Ingalls) process to request and accomplish non-destructive testing (NDT) currently requires multiple paper requests and report forms, some of which are completed in quadruplicate. Shot locations must be identified and physically marked on the test articles and should match the contents of the key plan, which are not always the case. Deviations require the key plan to be modified, which are severely disruptive and problematic for tracking in a paper-centric process. If reconciliation between the NDT requested and the key plan is not done, it can result in incorrect testing, inability to test, testing 'out of position,' or other harmful cost drivers.

The objective of the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project was to perform a thorough study and modernization of the current NDT process utilizing the latest proven techniques and technologies to do so. The primary focus was to develop parameters, identify best-fit technologies and best-practice concepts, and then incorporate them into a new electronic process. This new process will enhance and replace the current paper-centric process to request, execute, process, and archive NDT for structure. The new process and tooling addressed areas to achieve maximum cost reduction and process efficiency, and was enabled through digital automation and optimization. This coupling of process and technology has a portion of the NDT process performed in one digital tool using one repeatable process.

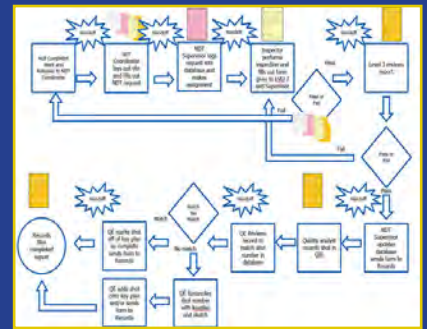
The team has identified hardware and process parameters to attack inefficiencies identified in the current structural NDT process for the Quality Assurance organization's stakeholders. The project team also identified manual touchpoints in the current process that will be candidates for automation during the development of a modified process. A transition plan that describes the implementation activities that are required for production was also developed. The resultant best-fit elements will be iteratively incorporated in to a modified process and associated tooling to gain end-user buy-in during the modification process.

## Payoff

The new process and tooling addressed areas to achieve maximum cost reduction and process efficiency and used digital automation and optimization. This symmetry of process and technology streamlines the NDT process, and once implemented, is estimated to result in potential cost savings of \$836K per DDG 51 hull. The team expects the savings to have additional benefits to other platforms and have five-year savings of over \$1.9M across Ingalls-built U.S. Navy and U.S. Coast Guard platforms.

## Implementation

Ingalls will deploy the solution in its target environment after initial acceptance tests are complete, and engage affected individuals/groups/organizations to ensure the solution satisfies documented needs and expectations. If significant deficiencies are noted, the solution will be revised by the development team, and acceptance testing will be repeated on the revised solution. Implementation in a production environment will start in the first quarter of FY20 on DDG 125, LHA-8, LPD-29, and NCS-10.



PERIOD OF PERFORMANCE:  
August 2018 to October 2019

PLATFORM:  
DDG 51

CENTER OF EXCELLENCE:  
NSAM

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STAKEHOLDER:  
PMS 400D, PMS 377, PMS 317

TOTAL MANTECH INVESTMENT:  
\$472,000



# Artificial Intelligence to Improve the Shipyard Production Planning Process



**PERIOD OF PERFORMANCE:**  
October 2018 to December 2020

**PLATFORM:**  
DDG 51

**CENTER OF EXCELLENCE:**  
iMAST

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**STAKEHOLDER:**  
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**TOTAL MANTECH INVESTMENT:**  
\$854,000



S2797— Production Bill of Material Quality Assurance using Artificial Intelligence

## Objective

The DDG 51 production bill of material (PBOM) is a hierarchical data structure used to represent the shipyard's manufacturing processes in the context of the ship's design. The conversion of the ship's various material lists into this integrated PBOM is what enables the manufacturing resource planning system to effectively back-schedule all the fabrication and procurement activities that support efficient assembly of the ship. Due to the complexity and scale of this data and the process for managing it, errors are easily introduced. The complexity and scale also make it difficult to identify these errors through basic data analysis.

In this project, the Institute for Manufacturing and Sustainment Technologies (iMAST) will develop an artificial intelligence (AI) to increase the effectiveness of PBOM quality checking while reducing the associated costs, which will result in very small, short-term savings within the planning area and more significant savings in the operations areas. Accordingly, the development and implementation of the PBOM quality assurance (PQA) software with embedded AI and machine learning at Bath Iron Works (BIW) will improve business efficiency by reducing product disruption costs due to PBOM errors without introducing large costs associated with large-scale manual checking.

## Payoff

Whenever a PBOM error is identified during construction, a Bill Change Request (BCR) is used to correct it. The BCR process is designed to ensure that material is routed back to inventory, new demand is created, work budgets are redistributed, and tasking is rescheduled. There are an average of 2,000 BCRs per DDG 51 hull at BIW. Using the AI tools will:

- reduce BCRs by 25 percent from hull-to-hull.
- result in a 50 percent reduction in PBOM errors from hull-to-hull.
- generate average savings of \$700K for 6 DDG hulls (total savings = \$4.2M); five-year return on investment = 3.5:1

## Implementation

Upon successful and timely completion of the PBOM Quality Assurance Using AI project and acceptance of the technology and associated business case by the stakeholders (PMS 400D), the resulting software and tools will be transitioned to BIW (estimated completion date for transition is FY20). It is expected that the new technologies will be implemented at BIW. Post-project technology insertion should be limited to full-scale deployment of piloted technologies / improvements during the project.

# Technology Insertion to Optimize Process for Machinery Packages

M2793 – Optimal Methods for Installing Machinery Foundations

## Objective

Equipment and machinery packages are used in shipbuilding to improve construction and outfitting processes by moving work off the ship and into less costly manufacturing environments. One of the primary challenges associated with building machinery packages off the ship in other fabrication locations is ensuring they are constructed within the tight manufacturing tolerances required by the Navy. This requires a robust accuracy control program throughout the entire process to eliminate the rework associated with foundation modifications, equipment misalignment, and pipe interface positioning both on and off the package.

This Center for Naval Metalworking project intends to reduce the labor associated with machinery package construction and installation by developing a process that incorporates improved tooling and technology to quickly and accurately identify points in space to streamline the installation process and eliminate the costly rework associated with interface misalignment during DDG, LHA, LPD, and NSC construction. Technology solutions, such as laser metrology for package layout and lifting devices for outfitting, will be investigated for potential to eliminate field fitting time and installation process labor requirements.

## Payoff

Through elimination of interface alignment errors, outfitting labor reductions, and increased automation of the quality check processes, this project is anticipated to result in five-year savings of approximately \$480K across all three Navy platforms currently constructed by Huntington Ingalls Industries - Ingalls Shipbuilding (Ingalls).

## Implementation

Ingalls will implement the technology and process improvements resulting from this project at its Pascagoula, MS, facility once initial acceptance tests are complete. Affected end users and supervisors will be engaged throughout the project to ensure the solution satisfies documented needs and expectations. If any significant deficiencies are noted, the solution will be revised by the development team and acceptance testing will be repeated on the revised solution. The solution technology and process are scheduled to be implemented during the first quarter of FY20.



PERIOD OF PERFORMANCE:  
November 2018 to September 2019

PLATFORM:  
DDG 51, LHA, LPD, NSC

CENTER OF EXCELLENCE:  
CNM

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PEO (Ships), PMS 377, LPD PEO  
(Ships), PMS 317

TOTAL MANTECH INVESTMENT:  
\$265,000





# VCS / CLB Submarines Projects

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# Development of Fire Safe Resins for Submarine Applications

Q2533-2 — Composite Manufacturing Technology for Fire Safe Resins Ph 2



**PERIOD OF PERFORMANCE:**  
April 2018 to November 2019

**PLATFORM:**  
VCS / CLB Submarines

**CENTER OF EXCELLENCE:**  
CMTC

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**STAKEHOLDER:**  
PMS 450, PMS 397

**TOTAL MANTECH INVESTMENT:**  
\$640,000

## Objective

Applications to reduce acquisition and life-cycle costs, decrease weight, and improve manufacturing lead time on submarines have predominantly been limited to the outside of the pressure hull. That is no longer the case, but in order to use composite materials internal to submarine pressure hulls, the U.S. Navy requires that they be qualified to MIL-STD-2031 (Fire and Toxicity Test Methods and Qualification Specification). While some existing composite systems have been approved for use within the submarine pressure hull, they have been unreliable due to high void content and exhibit relatively high manufacturing cost and complexity.

Phase 1 of the Composites Manufacturing Technology Center (CMTC) Fire Safe Resins project was successful in identifying and verifying a material system which met the performance requirements. In addition, an affordable manufacturing process was developed and demonstrated for the material. Phase 2 continued to identify and improve manufacturing processes that enhance design capabilities. New mechanical properties were generated to replace those that were based on the legacy phenolic material system.

## Payoff

Phase 2 of this project finalized processes, methodologies, and materials that can be used to bring composites within the pressure hull. The applications targeted will replace metal components in corrosive environments, thereby reducing the life-cycle costs of submarines. The manufacturing improvements made to phenolic core systems and phenolic laminates can be leveraged to applications industry-wide and provide far-reaching improvements to multiple Department of Defense platforms. The high quality associated with the phenolic material system is expected to provide components that are less expensive and last longer than more advanced materials, which might meet both inboard fire requirements and the needs of the selected components.

Assuming implementation on all Block V VIRGINIA Class submarines (VCS) and following ships, as well as all COLUMBIA Class submarines (CLB), total estimated acquisition savings of \$2.2M are possible for just one application currently being pursued. The estimated return on investment is 2.5:1 over the total life of both the VCS and CLB programs.

## Implementation

This project is a follow-on to Q2533-1. Fire Safe Resins Phase 2 (Q2533-2) will fabricate an actual submarine component for insertion in a VCS hull. Such implementation will open the door for future internal composite submarine components, create opportunities to demonstrate techniques that can be used for a direct replacement of internal metallic components with composite materials, and may lead to previously untapped acquisition and life-cycle savings opportunities.





# Novel Low-Cost Composite Solutions for VIRGINIA Payload Module

S2601— Low-Cost Hybrid Fairings

## Objective

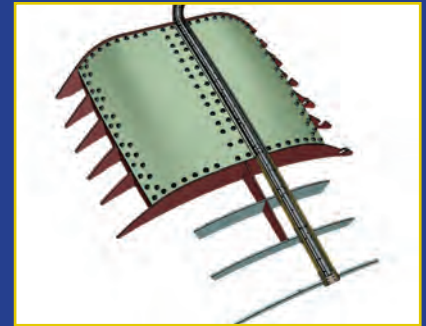
This effort further refined and developed gateway technologies, techniques, and processes that demonstrated that cost-effective design and manufacturing solutions are achievable with acceptable risk for faired structures fabricated from composite and/or hybrid material systems. Several innovative technologies used either individually or in conjunction with one another are under consideration for use in VIRGINIA Payload Module (VPM) configurations. Each employs the use of enhanced composite materials with integrated stiffness and damping, or a combination thereof, to form the fairings that make up the boundary of the VPM.

## Payoff

Successful incorporation of the project results into the VPM design has the potential to provide significant total ownership cost savings to the VIRGINIA Class submarine (VCS) for Block V and following ships. For the remaining class of VPM-enabled ships, acquisition savings are estimated to be up to \$2M, and life-cycle savings for all of the options included are estimated to be between \$18M and \$21M, depending on the implementation schedule. Potential weight savings are estimated to be approximately 7,600 lbs. with implementation of hybrid composite forward and aft fairings.

## Implementation

The Low-Cost Hybrid Fairing (LCHF) project completed a major design review which resolved stakeholder concerns from a number of disciplines. Notably, the preliminary assessments for shock indicated acceptable results for the LCHF and substructure. However, the meeting revealed additional design concerns related to the alignment of the safety track, isolation of the carbon for cathodic protection, and performance technical readiness level of the hybrid material. Testing and analysis activities were scheduled through August 2018 to resolve or mitigate performance concerns. On successful completion of the project, the technology will be available for incorporation into current redesign activities on VCS VPM. The project results will also facilitate consideration for similar technology insertion into COLUMBIA Class components and structures of comparable design / function. The implementation targets are SSN 806 and following ships with anticipated implementation to occur in FY20.



PERIOD OF PERFORMANCE:  
April 2015 to March 2019

PLATFORM:  
VCS / CLB Submarines

CENTER OF EXCELLENCE:  
CMTC

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STAKEHOLDER:  
PMS 450, PMS 397

TOTAL MANTECH INVESTMENT:  
\$2,284,000



# Alternative Coating and Surface Preparation Solutions Offer Significant Savings for Submarines



**PERIOD OF PERFORMANCE:**  
March 2016 to September 2019

**PLATFORM:**  
VCS / CLB Submarines

**CENTER OF EXCELLENCE:**  
iMAST

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**STAKEHOLDER:**  
PMS 450, PMS 397

**TOTAL MANTECH INVESTMENT:**  
\$1,466,000



S2649 – VIRGINIA Class Submarine Alternative Coating and Surface Preparation Solutions for Ball Valves

## Objective

Currently, green Teflon® coatings are used as a solid film lubricant to reduce the operating torque of the ball in the valve assemblies of the VIRGINIA Class submarine (VCS). The coating on the air system ball valves (ASBV) peels and wears after a low number of cycles, potentially causing an increase in seal wear and operating torque. Teflon® peeling of ball valves has increased the number of inspection rejections, which increased re-work and acquisition costs. The project goal was to identify, test / evaluate, and implement potential alternative coating systems, coating deposition processes, and/or surface modification processes that improve the performance and extend the life-cycle of ASBV. Finding the root cause failure mechanism helped identify the coating properties / surface modifications that meet the minimum performance requirements. The coated ASBV / seating material interaction was evaluated to serve as a baseline. Four potential solutions were evaluated: improved Teflon® coating process, improved seat / ball materials, super-finished valve balls, and a diamond-like, carbon-coated valve ball.

## Payoff

Approximately 400 Teflon®-coated valve balls are required to achieve full qualification acceptance for approximately 200 ball valve assemblies due to the high rejection rate during acquisition. An improved coating system eliminated the need to rework the ASBV and saved approximately 50 percent of the total acquisition cost. General Dynamics Electric Boat (GDEB) estimated savings of more than \$155K per boat in materials for baseline VCS and \$514K per boat due to planning / engineering, which resulted in a total acquisition savings of \$669K per boat. Over five years, at two boats per year, this correlates to \$6.9M in savings with a return on investment (ROI) of approximately 4.94:1. There are also potential acquisition savings of \$960K per VIRGINIA Payload Module (VPM) and \$2.2M per COLUMBIA Class submarine (CLB) due to the increased number of ASBV per boat. The VPM savings are for the whole submarine; therefore, the savings include the \$669K for the rest of the submarine. If additional benefits from CLB are considered, and only two CLB are assumed to be built in the same five-year period, an additional \$4.4M in savings will be realized. In addition, if two VPMs are built within the 10 VCS, an additional \$2.3M in savings will be realized, and the revised five-year ROI is 10.95:1.

## Implementation

This project will be implemented in late FY20 on new construction VCS and existing hulls on an attrition basis. GDEB and NAVSEA are committed to this project as a means of reducing acquisition total ownership costs for VCS and CLB. The project's results will significantly reduce source inspection rejections and unplanned maintenance. Implementation will be accomplished through drawing changes and will require successful coating or surface modification development by iMAST to be qualified and certified by NAVSEA technical authorities.

# Development of Hull Tile Manufacturing Improvements and Automated Preparation to Save Time and Cost

S2655-1 — Automated Manufacturing of Hull Tiles Phase 1

## Objective

Submarine hull tiles have unique compositions and configurations, which are labor and schedule intensive to manufacture and install. Larger sizes of tile configurations are also desired to improve installation efficiency. The objective of this Composites Manufacturing Technology Center (CMTC) effort was to investigate and develop an improved manufacturing technique for large and/or complexly configured hull tiles. This was accomplished through a combination of catalysis and automation, which resulted in the reduction of the manufacturing cycle time / tile and improvement of the manufacturing rate and response time to tile design changes. The effort focused on development of a catalyzed casting process, as catalyzed casting is a prerequisite for any future automation of this process. Automation of other shipyard applications, such as blasting, painting, and abrading outer hull surfaces, were evaluated and demonstrated successfully in a laboratory environment.

## Payoff

The main benefit of the improved manufacturing technique is the ability to reduce the manufacturing time and labor associated with large and/or complexly configured tiles. The other benefits to the project include, but are not limited to, the following:

- Reduced manufacturing costs by eliminating the need to utilize large-scale ovens for curing and large precise metal molds for cutting
- Reduced tooling costs as a result of programmable, reconfigurable tooling
- Reduced material waste by removing the need to cut specific tile shapes from slab stock

This project is expected to result in a catalyzed casting technique for the large and/or complexly shaped tiles. The catalysis process would reduce the time required to manufacture a set of tiles and would facilitate increased size of each tile set, as the number of tiles manufactured in the set would no longer be dependent on the oven size; therefore, the tile cycle time could potentially be reduced up to 50 percent.

## Implementation

This effort is applicable to Block V, back-fit on VIRGINIA Class submarines, and potentially Columbia Class submarines. Implementation will occur as an updated manufacturing process for hull tiles is used and is anticipated for builds starting in 2020 upon qualification



PERIOD OF PERFORMANCE:  
February 2016 to November 2018

PLATFORM:  
VCS / CLB Submarines

CENTER OF EXCELLENCE:  
CMTC

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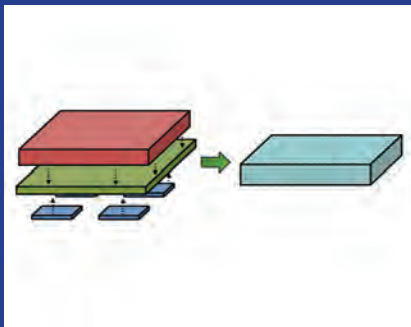
STAKEHOLDER:  
PMS 450, PMS 397

TOTAL MANTECH INVESTMENT:  
\$1,173,000



# Ready-to-Install, “Plug-and-Play” Composites Accelerates Navy Manufacturing

S2677 — Plug-and-Play Composites



PERIOD OF PERFORMANCE:  
June 2017 to June 2020

PLATFORM:  
VCS / CLB Submarines

CENTER OF EXCELLENCE:  
CMTC

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STAKEHOLDER:  
PMS 450

TOTAL MANTECH INVESTMENT:  
\$2,775,000

## Objective

External submarine hull components often require significant man-hours to apply supplemental materials in order to meet performance and functional requirements of the platform. In many cases, several different materials are employed, which require additional labor, costs, and manufacturing time. This Composites Manufacturing Technology Center (CMTC) project will develop and successfully demonstrate that a multi-functional “plug-and-play” composite part (a single part with all functional attributes of the original multi-material system) can arrive from the vendor ready for shipboard installation. The proposed technology would balance the performance of multiple materials—structural and non-structural—to enable the final manufactured part to meet the requirements without the need for supplemental materials. Many existing composite applications currently require additional coatings; therefore, potential applications could be more desirable as a result of improved business cases.

## Payoff

Successfully designed and manufactured plug-and-play composite components are anticipated to offer numerous benefits. The principal benefit involves the reduction of labor by eliminating the need to install supplemental materials for structural components post-fabrication. Receiving a ready-to-install component from the vendor also provides the following benefits:

- Reduced labor costs and scheduled installation time
- Reduced repair and replacement of the supplemental materials due to damage and loss during routine installation
- Increased opportunities to replace metal components with composite structures to enhance the material system (thus, reducing life-cycle costs through the avoidance of corrosion)
- Reduced exposure to environmental contamination during shipping and storage of multiple materials prior to installation

Combined acquisition and life-cycle savings are estimated to be approximately \$63.8M, combined across VIRGINIA Class and COLUMBIA Class submarines.

## Implementation

Additional applications are being investigated for FY22 implementation of multi-functional “plug-and-play” composites. Potential applications include non-pressure hull access covers / hatches, control surfaces, and external fairings.



# Merging Digital Data with New Technology in Component Location Improvements

S2699 — Digital Data for Next Generation Measurement / Locating Tools

## Objective

The amount of time required to locate items during outfitting and final installation is a significant contributor to shipbuilding costs. Recent studies have indicated that location activities account for up to 10 percent of touch labor costs. Opportunities to reduce location costs and labor requirements are afforded by recent advancements in projection technologies, specifically when applied to hanger stud and paint masking location identification. While shipyards commonly perform automated extractions from CAD models, manual steps are required to feed data files into the projection systems. For paint masking, drawings are manually developed with dimensions added, providing direction for areas of “no paint” marking and ultimately, masking off prior to paint.

This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project will improve the processes to locate and install paint masking and hanger stud positions by developing software that automatically queries the CAD model and planning databases for the location and work sequencing data needed to drive the projectors. The project will design and develop a mobile optical projection device and supporting software to receive and process CAD and associated product data, and integrate the location data with the appropriate technologies to validate the accuracy and repeatability of an improved process.

The application of automatically extracted location data in advanced location tools is expected to reduce the time and cost required in stud and paint masking locations.

## Payoff

This project is expected to result in estimated savings of \$510K per DDG hull and \$479K per VIRGINIA and COLUMBIA Class submarine hulls for estimated five-year savings of \$7.3M (the five-year return on investment is 2.91:1).

## Implementation

The solution technology is expected to be implemented at General Dynamic Electric Boat’s Quonset Point, RI, facility and at Bath Iron Work’s Blast and Paint facility during the fourth quarter FY20.



PERIOD OF PERFORMANCE:  
March 2019 - September 2020

PLATFORM:  
VCS / CLB Submarines  
DDG 51

CENTER OF EXCELLENCE:  
NSAM

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PMS 450D, PMS 397, PEO Subs  
PMS 400D, PEO Ships

TOTAL MANTECH INVESTMENT:  
\$1,680,000



# Optimized Sheet Metal Shop Capabilities Will Reduce Costs and Span Times



**PERIOD OF PERFORMANCE:**  
August 2017 to August 2019

**PLATFORM:**  
VCS / CLB Submarines

**CENTER OF EXCELLENCE:**  
NSAM  
iMAST

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**STAKEHOLDER:**  
PMS 450

**TOTAL MANTECH INVESTMENT:**  
\$1,427,00 NSAM  
\$390,00 iMAST



## S2702-A-B — Sheet Metal Modernization

### Objective

General Dynamics Electric Boat (GDEB) is planning for an increase in production volume for the Quonset Point sheet metal fabrication shop to accommodate the production rate increase for the VIRGINIA Class submarine (VCS), which now includes construction of the VIRGINIA Payload Module (VPM), and the upcoming construction of the COLUMBIA Class submarine (CLB). The increased production rate will affect the overall shipbuilding schedule; therefore, GDEB is evaluating the legacy sheet metal shop to modernize in preparation for the increase in work. GDEB is looking for areas that can be streamlined with the implementation of automated manufacturing engineering tools and the development of manufacturing product data from the 3D product model.

The Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project optimized the sheet metal shop by implementing capabilities and processes that maximize shop efficiency, new and proficient designs, and an error-proofing system. The first objective was to reduce the touch time required by the lofting group who assigns appropriate “sketch details” to assist in the manufacturing of parts on Build Authority data. The second objective was to make shop floor improvements that will increase efficiencies. Models and/or analysis methods to evaluate the impact of proposed changes were needed to validate the current and future states of the sheet metal shop. Lastly, machine technologies and capabilities were evaluated and compared to the existing equipment, resulting in a plan that will expand shop capabilities and reduce span time. The project focused on sheet metal assembly, cutting and punching technologies, and forming and bending capabilities.

This project was executed in two phases. Phase 1 compared the current shop capabilities to potential future changes and developed manufacturing engineering tools and a computer-aided-design application. Phase 2 designed and developed potential future state shop alternatives and included a process model-based evaluation. The project also demonstrated and delivered a prototype application.

### Payoff

The project will streamline GDEB’s sheet metal fabrication process by implementing automated manufacturing engineering tools and developing manufacturing product data from the 3D product model. This increase in efficiency is anticipated to reduce lofting and support services by 15 percent, resulting in one-time engineering rough order of magnitude (EROM) savings of \$2.7M. In addition, the project’s shop floor improvements will provide a 3 percent reduction in man-hours, resulting in EROM savings of \$460K per VCS hull and \$726K per CLB hull, resulting in five-year EROM savings of over \$9.1M.

### Implementation

Two software tools were developed and implemented during the project’s first and third quarters FY19 on SSN 801 and SSBN 826. Upon approval from management, GDEB will implement the upgraded layout of the floor and the equipment used in the shop. Full implementation is anticipated in the third quarter of FY21.

# Replacing Paper Weld Records with an Electronic System

S2703 — Electronic Weld Record System

## Objective

Welding processes at Huntington Ingalls Industries - Newport News Shipbuilding (NNS) require over 25 different forms, including non-destructive testing (NDT). These forms are manually completed and signed by hand. Information recorded on the forms must be captured and retained to meet NNS procedures and/or government requirements. This process leads to hand-written errors, difficulty interpreting hand-written data, missing data fields, misplaced records, and difficult / time-consuming tracking, reviewing, and certifying records for accuracy and completeness, which impacts NAVSEA audits and system testing.

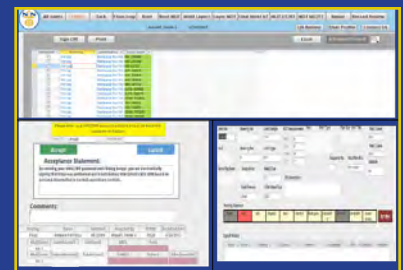
The Naval Shipbuilding and Advanced Manufacturing (NSAM) Center managed this VIRGINIA Class submarine (VCS) project to develop an Electronic Weld Record System that eliminates paper records with an electronic system. The web-based system will be accessible to all users (e.g., welders, auditors, managers, fitters, and inspectors) through the NNS network using a desktop, mobile device (e.g., tablet), or kiosk. The first phase mapped out the current state and future state processes, developed an electronic prototype, and defined the technical requirements. The electronic prototype example determined the welding, NDT, inspection, and IT software / hardware requirements. The applicable process and program owners, users, SUPSHIP, and NAVSEA reviewed the requirements to ensure all issues and technical input were being considered and met. Phase II focuses on system development, which includes coding, testing, evaluating, verifying, and validating the software, and a stakeholder demonstration of the developed system.

## Payoff

This technology, once implemented, could potentially save an estimated \$1.5M per VCS hull. The estimated savings per year are approximately \$2.9M (based on nine VCS in-process hulls per year). For five years, the savings are approximately \$14.5M.

## Implementation

Upon successful and timely completion of the project and acceptance of both the technology and associated business case by the acquisition Program Office, the results will be transitioned to the NNS facility. Implementation is anticipated late FY20.



PERIOD OF PERFORMANCE:  
November 2016 to November 2019

PLATFORM:  
VCS / CLB Submarines

CENTER OF EXCELLENCE:  
NSAM

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STAKEHOLDER:  
PMS 450, PMS 397, PEO Subs

TOTAL MANTECH INVESTMENT:  
\$965,000



# Commonality for Temperature Measurement and Control in the Shipyard



PERIOD OF PERFORMANCE:  
October 2018 to September 2020

PLATFORM:  
VCS / CLB Submarines

CENTER OF EXCELLENCE:  
EOC

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STAKEHOLDER:  
PMS 450, PMS 397, PEO Subs

TOTAL MANTECH INVESTMENT:  
\$1,083,000



## S2747— Automated Preheat Temperature Monitoring

### Objective

Many facets of submarine construction involve controlled heating of materials during welding processes to ensure the quality of welds. In submarine construction the rigid monitoring and controlling of the temperatures during the welding processes are highly manual processes. Workers continuously monitor the temperature of welded sections, and adjust the heater controls to maintain the correct temperature profiles. Weld preheat and post-welding heat treatment processes, which require manual temperature monitoring, measurement, and documentation methods, use significant amounts of labor.

This Electro-Optics Center (EOC) project follows a proven systems engineering approach to develop an automated temperature monitoring and digital reporting solution. The initial phase developed and optimized physical attachment method(s), temperature correlation, and logistics in a relevant environment. The project is defining the requirements for data processing and its integration with temperature control systems. The results of the project will be a detailed technical report and shipyard implementation plan for automated temperature monitoring in a shipyard environment.

### Payoff

There is presently a group of technicians who are responsible for manually monitoring and documenting the temperatures for critical heating processes in the shipyard. According to the shipyard, the time involved in manual temperature monitoring is roughly 9,000 hours per year, or about \$340K per VIRGINIA Class submarine hull. The vision of this project is to automate the monitoring processes so that these technicians can spend more time performing setup tasks and only address the correction of out-of-limit processes. By having access to critical material temperature data, a new level of temperature traceability could enhance weld issue diagnosis capabilities in the future

### Implementation

Because of the wide applicability of temperature monitoring scenarios and methods, this project included specific tasks that drive commonality into implementation of the methods. There is a large amount of cooperative work between EOC and shipyard engineers to ensure the resulting functional system specification will be implementable. Where development work is required at EOC laboratories, there is an accompanying transition to a non-production task at the shipyard to assure that personnel are current with the methods development. The knowledge gained during the task, in conjunction with the resulting system specification document, will be the recipe for a successful shipyard implementation.



# Predictive Facilities Maintenance and Capacity / Production Planning Systems to Reduce Costs and Meet Manufacturing Schedules

S2750 — Diagnostic and Predictive Monitoring for Facilities Equipment

## Objective

Unplanned equipment maintenance has a profound effect on the production capacity of manufacturing facilities and shipbuilding schedules for both VIRGINIA and COLUMBIA Class submarines. While many capacity and production planning tools can organize the production schedule around planned maintenance events, most cannot quickly re-plan for unexpected equipment failure. The objective of this project is to implement a predictive health monitoring system at General Dynamics Electric Boat (GDEB), and to integrate the resulting information into its production planning and scheduling systems to reduce the impact of downtime due to unplanned equipment failure.

## Payoff

This Institute for Manufacturing and Sustainment Technologies (iMAST) project is identifying, evaluating, and implementing equipment health monitoring systems to more accurately predict failure of critical equipment identified by GDEB. This predictive capability will support improved planning and scheduling. The project is expected to reduce schedule disruptions due to catastrophic breakdown of identified equipment and support improved shipyard and shipbuilding schedule performance, reduce outsourcing, and lower inventory costs. GDEB estimates annual savings of \$252K per year and five-year savings of \$1.3M for Groton, and \$787K per year and five-year savings of \$4.0M for Quonset Point; the five-year return on investment is 1.1 for Groton and 2.2 for Quonset Point.

## Implementation

This project began with a machinery evaluation, called a degrader analysis, to determine the critical failure modes that the selected health management technology can optimally support. The appropriate capacity planning tools will be enhanced to accept machinery maintenance and condition trend information and display this information to the schedulers. Phase 2 will expand the implementation of the predictive maintenance system and integrate this information with the Critical Resources Planning Tool. iMAST will provide the tools and hands-on training to GDEB. Software interfaces will be developed and implemented to connect condition information to the enhanced capacity planning tools. This will result in increased effectiveness of the diagnostic and monitoring tool and GDEB's scheduling process.



PERIOD OF PERFORMANCE:  
May 2017 to April 2020

PLATFORM:  
VCS / CLB Submarines

CENTER OF EXCELLENCE:  
iMAST

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STAKEHOLDER:  
PMS 450, PMS 397

TOTAL MANTECH INVESTMENT:  
\$900,000



# Robotics and Automation Will Improve Submarine Hull Insert Installation



**PERIOD OF PERFORMANCE:**  
May 2018 November 2020

**PLATFORM:**  
VCS / CLB Submarines

**CENTER OF EXCELLENCE:**  
CNM

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**STAKEHOLDER:**  
PMS 450, PMS 397

**TOTAL MANTECH INVESTMENT:**  
\$1,904,000



## S2751 — Robotic Process for Welding Hull Inserts

### Objective

The legacy process to install hull inserts in VIRGINIA Class submarine (VCS) hulls is an intricate sequence of events that consists of multiple manual operations, including cutting, beveling, grinding, and welding processes. The current process for installing hull inserts requires roughly 45K labor hours per hull and significantly expands the manufacturing span time for the initial outfitting phase. Since weld quality is dependent on tribal knowledge and individual skill level, additional rework is often required. Because this process is entirely manual, a robotic installation solution would improve weld quality and weld process cycle time. These welds are much more complex than linear welds in a fixed welding position. Welding parameters change multiple times as the weld torch moves along the curvature of the hull through various welding positions. Cutting and beveling holes in the hull require constant varying of the bevel angle on the hull and the insert to keep the weld joint's angle consistent as the hull curvature changes around the circumference of the weld. Because of the complexities of each individual process, there are no readily available commercial-off-the-shelf technologies capable of performing all of the integral steps of this complex process.

The objective of this Center for Navy Metalworking project is to develop a robotic system to install hull inserts on VCS and COLUMBIA Class submarines (CLB). The solution technology will leverage previous robotic and automation efforts conducted at General Dynamics Electric Boat (GDEB) to develop a hull insert installation robot capable of automating each individual step while maintaining the tight tolerances required of submarine fabrication processes.

### Payoff

Through automation and weld quality improvements, a 20 percent reduction in cutting, fitting, and welding labor is forecast. Through increased efficiencies and quality improvements enabled by the technology, GDEB anticipates savings of \$1.49M per VCS hull and \$1.86M per CLB hull for combined five-year savings of \$19.55M across both programs.

### Implementation

Based on the results of testing, GDEB will generate the data needed for process qualification packages to submit to NAVSEA, finalize the business case, and create shipyard implementation plans. The transition event for this project is GDEB's performance demonstration activities. Once those activities have been successfully completed, the process will be verified to meet the expectations of the project teams and stakeholders. Implementation at GDEB's Quonset Point, RI, facility is anticipated in the third quarter of FY22.

Implementation is expected to utilize a phased approach, where the most beneficial opportunities will be assigned a higher priority and implemented first. The results of this ManTech project will be implemented in the production of VCS and CLB. However, the schedule for implementation activities is dependent on the project results.

# Producing Savings through Portable Welding Technology

S2754 — Portable Welding Robot for VIRGINIA and COLUMBIA Class Submarines

## Objective

Fabrication of major assemblies is a highly labor-intensive, manual process that is both physically demanding and highly complicated. Major assemblies are manufactured in permanent fixtures and unable to be moved. As a result, welders are required to move over and around assemblies to complete difficult welds.

The Portable Welding Robot project will develop and implement a portable welding robot to construct the major assemblies of VIRGINIA and COLUMBIA Class submarines (VCS and CLB, respectively). Portable robotic technologies exist for commercial applications; however, the technology has not been tested and proven for submarine construction. This Center for Naval Metalworking project will improve major assembly welding for VCS and CLB by creating a portable robotic solution that increases weld quality and reduces the welding labor requirements.

Insertion of a portable robotic welding process is expected to increase productivity, decrease manufacturing costs, and potentially decrease major assembly manufacturing span time. A portable robotic welding system that can be quickly deployed and programmed to weld major assemblies will greatly expand the use of robotic welding in shipbuilding.

## Payoff

This project is expected to provide a savings of \$691K per VCS hull and \$1.04M per CLB hull for five-year savings of \$9.51M (five-year return on investment of 1.97:1).

## Implementation

The solution technology is expected to be implemented at General Dynamic Electric Boat's Quonset Point, RI, facility during the fourth quarter of FY24.



PERIOD OF PERFORMANCE:  
March 2019 to March 2022

PLATFORM:  
VCS / CLB Submarines

CENTER OF EXCELLENCE:  
CNM

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STAKEHOLDER:  
PMS 450D, PMS 397, PEO Subs,  
PEO Columbia,

TOTAL MANTECH INVESTMENT:  
\$2,100,000



## Automated Assembly Planning Software Will Improve Shipbuilding Structural Assembly and Reduce Submarine Costs



**PERIOD OF PERFORMANCE:**  
October 2017 to April 2020

**PLATFORM:**  
VCS / CLB Submarines

**CENTER OF EXCELLENCE:**  
iMAST

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**STAKEHOLDER:**  
PMS 450, PMS 397

**TOTAL MANTECH INVESTMENT:**  
\$830,000



S2758 — Automated Assembly Planning and Work Package Information Generation

### Objective

The objective of this project is to develop a process and tools that automatically generate an assembly plan for structural fabrication of the VIRGINIA Class submarine (VCS) and the COLUMBIA Class submarine (CLB). The plan will then be supplemented with additional information, converted to a digital work package, and delivered to General Dynamics Electric Boat (GDEB) tradesmen on the shop floor using the platform and processes established in the Navy ManTech S2653 Mobile Computing for Design Build project conducted by the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center.

Phase 1 focused on the documentation of assembly rules and preferences for structural fabrication of submarine assemblies and the development of the software tool to augment the build authority model. In addition, the project team developed requirements and methods for the generation of electronic work packages. The project team also developed a prototype version (an extension of tools developed by the Defense Advanced Research Projects Agency) of the assembly planning algorithms and concluded with prototype system results for test assemblies.

In Phase 2, the project team will mature the structural fabrication assembly sequencing tool based on feedback obtained from the user group prototype testing. The electronic work package data / information generation process and software will be finalized, and the two developed technologies will be integrated. The project team will also test the efficacy of auto-generated assembly sequences for candidate assemblies and demonstrate the generation of electronic work package data to obtain feedback and refine the software.

### Payoff

Savings will result from reductions in planning labor hours, production control inventory, and shop floor job planning hours. The estimated planning labor-hour reduction is 1,500 hours for VCS and 3,000 hours for CLB, which will result in \$450K savings. In-process inventory is estimated to be reduced by 2.5 percent and result in \$75K savings for both VCS and CLB. Shop floor planning hours are expected to be reduced by 1,600 labor hours and 3,200 labor hours for VCS and CLB, respectively, resulting in an estimated combined savings of \$480K. This results in total five-year savings of \$5.9M and a return on investment of 5.62:1.

### Implementation

Upon successful completion of this project, the tools and methods will be transitioned to the VCS Program at GDEB in mid-2020. Post-project technology insertion will be limited to full-scale deployment of the piloted technologies / improvements developed during the project. GDEB management has expressed its commitment to implementing these tools and methods in an effort to reduce VCS production costs for two subs per year and one CLB per year.

# Electron Beam Welding to Generate Savings for Missile Eject System Components

S2761 — Electronic Beam Welding and Cladding

## Objective

Various changes in the design of the COLUMBIA Class submarine (CLB) have improved the capability to execute its mission, while improving the manufacturability as well. In addition to its size, the CLB common missile compartment (CMC) is one key element that differentiates it from the legacy OHIO Class submarine. The Navy's need for expedited submarine delivery schedules has resulted in design and manufacturing improvements for CMC component-level construction. One such improvement addresses the methods utilized to weld CMC eject system components. Existing qualified processes to weld and clad critical CMC eject system components use conventional arc welding, which frequently result in costly rework due to weld anomalies. Opportunities to improve weld quality and cost and to reduce lead-time are anticipated by using more efficient joining processes like electron beam welding (EBW) and electron beam cladding (EBC).

Through this Center for Naval Metalworking (CNM) project, Northrop Grumman will develop and support qualification of EBW and EBC procedures for CMC system components. Since EBW and EBC provide higher quality welding and cladding than conventional arc welding and cladding, this project has the potential to provide significant savings to the CLB Program.

EBW and EBC offer many benefits to submarine eject system component construction, and Northrop Grumman anticipates the potential of significant reductions in labor and the rework required by the legacy welding processes. Following implementation in the second quarter of FY21, initial estimates forecast substantial savings per CLB hull as well as the program's life cycle.

## Payoff

Savings will result from key attributes of the electron beam process, including increased travel speeds, single pass welds, the vacuum welding environment, automatic weld execution, and minimized distortion. This project is anticipated to result in \$1.02M savings per CLB hull and five-year savings of \$3.07M.

## Implementation

The solution technology is expected to be implemented at Northrop Grumman's Sunnyvale, CA, facility during the second quarter of FY21 and benefit the lead CLB hull.



PERIOD OF PERFORMANCE:  
September 2018 to March 2022

PLATFORM:  
VCS / CLB Submarines

CENTER OF EXCELLENCE:  
CNM

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STAKEHOLDER:  
PMS 397, PEO Columbia,  
Strategic Systems Program, SP-22

TOTAL MANTECH INVESTMENT:  
\$1,400,000



## Automated System to Replace Human Skill Set



PERIOD OF PERFORMANCE:  
February 2019 to August 2020

PLATFORM:  
VCS / CLB Submarines

CENTER OF EXCELLENCE:  
NSAM

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STAKEHOLDER:  
PMS 450, PMS 397

TOTAL MANTECH INVESTMENT:  
\$1,000,000



S2784 — CNC Forming of Steel Plates for VIRGINIA and COLUMBIA Class Submarines

### Objective

Program Offices for the VIRGINIA Class (VCS), VIRGINIA Payload Module (VPM), and COLUMBIA Class (CLB) submarines have directed a reduction in construction costs. At General Dynamics Electric Boat (GDEB), plate forming is a manual process dependent on hydraulic forming equipment, annotated paper sketches, wooden templates, and “tribal knowledge” of various steel behaviors. GDEB recognizes the importance of mechanized / automated processes to reduce the cost of submarine structures and is interested in taking that mechanization to the next level with a computer numeric control (CNC) forming process.

The objective of this Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project is to utilize CNC technology to form steel to computer-generated geometry. This will allow for better throughput of the forming task, creating better formed parts. This manufacturing improvement will result in parts that are easier to fit to the requirements of the submarine, further reducing labor hours downstream from the forming process.

The effort will research, prototype, and validate the concept of utilizing commercial-off-the-shelf (COTS) CNC forming equipment to produce accurate, cold formed submarine parts using Navy required plate materials. Computer-controlled forming will be predictable and repeatable, and provide faster, first-time quality formed parts using digital data derived from the design model

### Payoff

If the project is successful and implemented, GDEB projects five-year engineering-rough-order-of-magnitude (EROM) savings of \$7.9M for VCS and \$3.1M for CLB.

### Implementation

Upon successful and timely completion of the project and acceptance of both the technology and associated business case by the acquisition Program Office, the results will be transitioned to the GDEB Quonset Point facility. Implementation is anticipated in the second quarter of FY22

# Using Virtual Reality to Inspect Piping Systems

M2792 — Virtual Reality Inspection of Piping Systems (VipeR)

## Objective

The current piping inspection processes at General Dynamics Electric Boat (GDEB) are largely manually planned and executed. The as-is process is manually intensive with significant duplication and re-work. In addition, the workforce at GDEB has an increasing number of inexperienced workers as knowledgeable veteran workers continue to retire at a fast pace. The submarine is a complicated space. In order for new workers to be familiar with inspection processes, as well as work efficiently, they need to learn the layout of the submarine, which consists of 2 million components.

The Naval Shipbuilding and Advanced Manufacturing (NSAM) Center Virtual Reality Inspection of Piping Systems project introduced a new process and innovative tool set into the business of inspecting ship's piping systems. The project replaces paper piping schematics and crayon-colored engineering drawings with model-based virtual reality (VR). In the to-be process, the inspection planner / supervisor will begin a VR session prior to assigning inspection work. VR will highlight planned inspection work in a full-scale immersive session that mocks up the piping system and all of its immediate surroundings on the ship. The planner / supervisor will decide how to allocate inspection work based on the system display of current system installation and inspection statuses.

## Payoff

The Virtual Reality Inspection of Piping Systems project eliminates the current time-consuming process of manually color-coding construction drawings to identify and assign inspection work. The new technology enables inexperienced inspectors to more quickly familiarize themselves with the submarine and its inspection requirements. As a result, rework will be reduced, inspection time will be shortened, and the work force will be better informed. The project is estimated to reduce inspection labor by 2.2 percent, resulting in total five-year, engineering-rough-order-of-magnitude (EROM) savings of \$1.69M.

## Implementation

GDEB estimates full implementation in the fourth quarter of fiscal year 2020. Implementation will take place at two location, one at Quonset and the other at Groton.



PERIOD OF PERFORMANCE:  
September 2018 to July 2019

PLATFORM:  
VCS / CLB Submarines

CENTER OF EXCELLENCE:  
NSAM

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STAKEHOLDER:  
PMS 397, PMS 450

TOTAL MANTECH INVESTMENT:  
\$255,000



## Locating Savings with Real-Time Locating Technologies



**PERIOD OF PERFORMANCE:**  
May 2019 to January 2021

**PLATFORM:**  
VCS / CLB Submarines

**CENTER OF EXCELLENCE:**  
NSAM

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**STAKEHOLDER:**  
PMS 450D, PMS 397, PEO Subs

**TOTAL MANTECH INVESTMENT:**  
\$489,000



### S2799 — Real Time Locating Systems (RTLS)

#### Objective

Production assets such as forklifts, welding units, cranes, etc. are essential components required in submarine construction. Currently at General Dynamics Electric Boat (GDEB), there are no existing systems or processes in place to easily locate these assets. Assets are allocated geographically on an as-needed basis with limited ability to track the path of the asset. This antiquated process results in underutilization of equipment, additional labor costs associated with finding assets, lost labor due to inventory efforts, and work scheduling conflicts due to an inability to effectively plan asset usage. Additionally, there are no current program or universal database to capture details on asset status availability and condition. The absence of this pertinent information often results in uninformed planning and scheduling of work as well as preventative maintenance deferrals due to the inability to locate and schedule assets.

The Real Time Locating System (RTLS) project, managed by the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center, will create an effective electronic tracking method to integrate into GDEB's existing emergent work order systems. This will allow GDEB to locate, request, and status production assets on the floor in real time. RTLS technology offers cost-effective solutions to automatically status, track, and locate assets in a shipyard environment. By inserting RTLS technologies capable of tracking assets connected to work orders, the project is expected to enable numerous improvements to equipment utilization, resource allocation, as well as a more effective in-field service program for preventive maintenance.

#### Payoff

This project is expected to result in savings of approximately \$179K per VIRGINIA Class submarine and approximately \$358K per COLUMBIA Class submarine for five-year savings of \$3.22M. The five-year return on investment is 2.13:1.

#### Implementation

The RTLS technology is expected to be implemented at GDEB's Quonset Point, RI, facility during the second quarter of FY21.



# F-35 Lightning II Projects

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# Automated Optical Inspection for Reduced Cost of EOTS Sapphire Panel Assemblies

A2620 — Optical Evaluation of Sapphire Panels



**PERIOD OF PERFORMANCE:**  
January 2015 to June 2020

**PLATFORM:**  
F-35 Lightning II

**CENTER OF EXCELLENCE:**  
EOC

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**STAKEHOLDER:**  
PEO (JSF)  
F-35 Lightning II Joint Program Office  
(JPO)

**TOTAL MANTECH INVESTMENT:**  
\$4,017,000

## Objective

This Electro-Optics Center (EOC) project is developing an automated optical inspection (AOI) system to use in pilot production for the inspection of the F-35 Electro-Optical Targeting System (EOTS) sapphire window assembly. The automated system will be able to inspect roughly 86 percent of an EOTS interior and exterior window assembly (the remaining approximately ~14 percent requires manual inspection due to installation constraints and system mechanical limitations), and analyze the data to produce results based on Mil-Spec standard criteria. This project is focusing on the inspection of gridded / coated sapphire panels assembled in frames and factory-produced aircraft structural panels; however, the technology developed here is applicable to a variety of scratch / inspection scenarios.

## Payoff

Automating the optical inspection task will greatly improve the process by producing objective and repeatable results while also providing a quality characterization more relatable to system performance over the operational life cycle. Automated inspection of panels will reduce labor, lower costs, decrease variability, and increase throughput. This technology may be extended to other optical panels with Mil-Spec scratch and dig criteria. Therefore, large potential return on investment exists to develop a flexible system that can be tailored to different optical inspection criteria for multiple applications and programs. The projected acquisition affordability savings will be over \$4M for the F-35 Program alone.

## Implementation

The development of an AOI test station is a pilot project to prove out automated inspection technology on military sensor windows. The initial (prototype) system will be validated for EOTS window production by verification of successful detection algorithms and demonstration of production cost savings. The system will be used by Lockheed Martin Missiles and Fire Control for acceptance of the EOTS sapphire window assembly beginning in 2020. EOTS production builds for airframe low-rate initial production (LRIP) 13 are delivered in 2020, one year ahead of LRIP 13 aircraft delivery in 2021. The prototype test station throughput supports all future F-35 factory production rates up to 24 units per month. The Technology Transition Plan describes how the AOI system may be replicated and adapted as necessary for additional F-35 depot and/or field support uses within three to five years.



# Process Improvements for New F-35 EOTS Detector Material

J2622 — F-35 Electro-Optical Targeting System (EOTS) Producibility Ph 4

## Objective

Leveraging the success achieved in the three phases of the F-35 Lightning II Electro-Optical Targeting System (EOTS) Producibility projects, this Electro-Optics Center (EOC) project will continue to drive down the cost and risk of key EOTS infrared components while transitioning the EOTS mid-wave infrared integrated Dewar cooler to a high operating temperature advanced detector.

## Payoff

Insertion of the new detector into the current EOTS configuration will provide multiple affordability advantages, from increased capacity and reduced focal plane array processing hours and span time to increased reliability and maintainability of the integrated Dewar cooler assembly. The focal plane arrays will also be more uniform and manufacturable, and have better yield and performance than the current focal plane arrays. Together, these tasks are expected to save over \$62M for the F-35 Lightning II Program.

## Implementation

The F-35 Lightning II EOTS is the transition platform. These producibility improvements will be implemented in a phased approach. Improvements will be applied to the current production efforts as process changes are qualified, and cut into production before completion of the project. Those manufacturing process level changes are only required to go through the normal Santa Barbara Focalplane Process Control Board. Improvements that are specific to the nBn detector material will be implemented upon successful qualification and flight testing to prove there are no adverse performance issues with the new detector material (a parallel effort is being funded outside this ManTech project).

Implementation for the airframe's low-rate initial production (LRIP) 13 delivery is in 2021, and EOTS production builds for LRIP 13 delivery are scheduled in 2020, one year ahead of aircraft delivery in 2021. This project is a joint effort with Air Force Research Lab.



PERIOD OF PERFORMANCE:  
March 2017 to April 2020

PLATFORM:  
F-35 Lightning II

CENTER OF EXCELLENCE:  
EOC

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TOTAL INVESTMENT:  
\$1,997,000 - Navy ManTech  
\$325,000 - Air Force



# OLED Helmet-Mounted Display Improves Performance and Cost for F-35



**PERIOD OF PERFORMANCE:**  
August 2017 to November 2019

**PLATFORM:**  
F-35 Lightning II

**CENTER OF EXCELLENCE:**  
EOC

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(JPO)

**TOTAL MANTECH INVESTMENT:**  
\$3,706,000

A2627 — OLED Display for F-35 HMD

## Objective

This Electro-Optics Center (EOC) project developed and demonstrated a manufacturing process to assemble an organic light-emitting diode (OLED) display into the existing optical train of the F-35 Lightning II helmet-mounted display system (HMDS). Government Accountability Office (GAO) report 18-321 (June 2018) stated that the current liquid crystal display on the F-35 exhibits a characteristic “green glow” during low-light flights, which makes it difficult for the pilot to see the full resolution of the night vision video feed. The GAO report concluded that “Organic light-emitting diode displays avoid this effect by only illuminating the active pixels.” The manufacturing challenge for ManTech was to substitute an OLED microdisplay for the existing AMLCD (active matrix liquid crystal display), without adding additional process steps or optical train elements. Further, the OLED-based HMD needs to perform sufficiently over the lifetime of the helmet without the luminance degradation known to be a problem with OLED devices.

## Payoff

In addition to HMDS performance improvements, this project demonstrated cost savings in assembly time and parts handling: part count is projected to be reduced by 27 percent, and touch time labor is projected to be reduced by 10 percent through improved tooling concepts. The projected savings for the F-35 program are \$17.4M.

## Implementation

This ManTech project is integral to the initial operational capability (IOC) for the F-35C, which was achieved in early 2019. A quantity of 62 OLED flight helmets have been ordered for IOC trials. OLED HMD production will start after the full qualification program is completed in late 2021.



# Production-Ready Plasma Treatment Device Will Prepare Composite Surfaces for Nutplate Installation

A2657 — Plasma Surface Preparation for Composite Nutplate Installation

## Objective

In order to ensure adequate bond strength and maintainability of the aircraft, surface preparation is critical. The current surface treatment method to install nutplates on the F-35 Lightning II produces variable results and involves a labor-intensive manual operation. If the surface is not prepared correctly, the physical bond between the composite surface and the adhesive can prematurely fail leading to a nutplate disbonding from the surface and becoming foreign object debris (FOD), thus, causing catastrophic damage to the aircraft. Due to potential FOD formation and the high cost associated with replacing failed nutplates, there is need to develop a method that eliminates operator variability from the preparation process, effectively providing a consistently prepared surface for nutplate adhesion. This Composites Manufacturing Technology Center (CMTC) project aims to deliver an efficient, cost-effective, and safe atmospheric plasma treatment system for the F-35 platform. The project will deliver a production-ready plasma treatment device capable of preparing composite surfaces for nutplate installation during the assembly process. This tool will be designed to meet durability, ergonomic, and safety requirements for use in the F-35 production facility.

## Payoff

Upon successfully developing a reliable and repeatable method that removes the variability of manual, mechanic-to-mechanic preparation, a plasma system that can reach at least 85 percent of the composite nutplate areas will be implemented. This system will enable savings in the following three areas:

- Eliminating scrap, rework, and repair due to poor surface preparation
- Reducing the labor associated with preparing the composite surface for bonding
- Reducing material consumption by eliminating sanding disks and a portion of the current solvent wipe process

Total cost savings resulting from implementation of a suitable plasma surface preparation process are anticipated to be on the magnitude of 2:1 for the F-35.

## Implementation

After successful demonstration, the plasma system is expected to be implemented through the F-35 Affordability and /or Change Request process. Upon evaluation and approval by the Affordability Initiative Review Board, the plasma surface preparation technology will be implemented in factory locations that bond nutplates. Implementation is anticipated to occur in 2020.



PERIOD OF PERFORMANCE:  
October 2016 to December 2019

PLATFORM:  
F-35 Lightning II

CENTER OF EXCELLENCE:  
CMTC

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STAKEHOLDER:  
PEO (JSF)  
F-35 Lightning II Joint Program Office  
(JPO)

TOTAL MANTECH INVESTMENT:  
\$2,776,000



# Automated Hybrid Manufacturing to Reduce Cost and Optimize Weight in Composite Structure Fabrication

Q2688 — AFP/ATL Hybrid Structures



PERIOD OF PERFORMANCE:  
May 2016 to May 2020

PLATFORM:  
F-35 Lightning II

CENTER OF EXCELLENCE:  
CMTC

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PEO (JSF)  
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TOTAL MANTECH INVESTMENT:  
\$2,400,000

## Objective

The Automated Tape Layup (ATL) and Automated Fiber Placement (AFP) manufacturing processes have significantly advanced over the past 30 years. However, both ATL and AFP developers have evolved within their distinct paths and optimized each process with respect to their suitable products. Therefore, the separate development paths of ATL and AFP have resulted in distinct software and hardware capabilities for each manufacturing process. With the Navy considering future systems utilizing a larger proportion of composites, such as the Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS), the need to fabricate large, complex contoured parts will increase. The ability to meet both the affordability and performance requirements of these future systems will be challenged by current manufacturing capabilities, as presently employed in the F-35 Lightning II manufacturing process. A novel hybrid-manufacturing solution that optimizes the weight of the AFP process and the affordability benefits of the ATL process is highly desired.

This Composites Manufacturing Technology Center (CMTC) project has demonstrated the technical capabilities and the potential cost and weight savings of the new hybrid AFP/ATL technology on bismaleimide (BMI) materials, and the project has recently been expanded to replicate that work on epoxy materials. Successful demonstration of this new technology enables future Navy systems to achieve the affordability benefits of ATL and the performance benefits of AFP. At the completion of this project, this will be true of both BMI and epoxy material systems.

## Payoff

Successful implementation of the novel hybrid AFP/ATL technology is anticipated to have the following benefits:

- 13 percent material cost reduction
- Reduction in manufacturing downtime
- Increased ability to manufacture parts with complex geometries
- Ability to consolidate multiple parts into a single complex part
- 15 percent improvement in material deposition rate
- Weight optimization

## Implementation

The hybrid technology resulting from this project could support acquisition programs currently in place, such as the F-35 Lightning II, as well as future acquisition programs, such as the UCLASS, TERN, and F/A-XX. Since these future programs are still in the early development phases, no specific implementation plan will be prepared.

Demonstrating this technology will enable future platforms to make informed, baseline decisions on part design and fabrication options by understanding the cost and weight implications of such decisions. With respect to current platforms, the F-35 may require additional wing part fabrication capacity depending on the full production build rates that are achieved. If the F-35 supply chain requires additional equipment, successful execution of this project will enable the part producers to make informed decisions about the proper equipment to purchase to support the increased rates. If the supply base elects to use the hybrid system, then typical F-35 implementation methodology will be followed.



# F-35 Blind Fastener Preparation System Will Provide Efficiencies and Production Savings

M2740 — Automated F-35 Blind Fastener Preparation

## Objective

Blind fasteners are manually installed into many areas of the F-35 Lightning II. The current process, which requires significant hours per unit, involves multiple mechanics in each area to clean and apply sealant to the substructure, locate the skins to the structure, and install temporary and permanent fasteners. Prior to installation, each fastener is cleaned and promoted. Due to lubrication inside the sleeve in the locking mechanism of the blind fasteners, the fasteners cannot be cleaned using a slossh method and are instead cleaned and promoted individually to ensure that the cleaner / promoter does not enter the mechanism.

Individual cleaning of blind fasteners is a labor-intensive process that requires a fine paint brush to apply the cleaner to the fastener after which the fasteners must dwell in open air for 15-plus minutes after each application to ensure sufficient drying prior to handling. The task occurs in the work area where the fasteners are used and must be installed within eight hours or the process must be repeated. This Composites Manufacturing Technology Center (CMTC) project developed an automated blind fastener preparation system to apply cleaner to large quantities of blind fasteners to eliminate the “one-at-a-time” method. The system accelerates drying time after applications to further reduce preparation time.

## Payoff

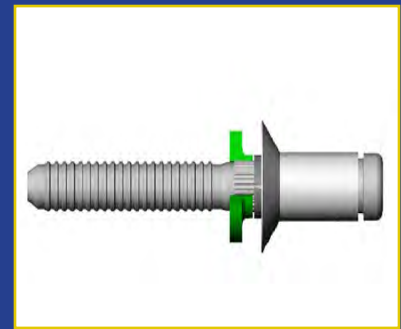
The conventional take-off and landing forward assembly contains over 790 blind fasteners and the Electronic Mate and Assembly Stations (EMAS) has 290. To clean the fasteners prior to installation takes an average of nine hours per unit and four hours per unit, respectively. Preparation time can be reduced by 56 percent in forward assembly and by 50 percent in EMAS, providing approximately \$2.2M in production savings.

Increased shelf life is critical in order to allow enough time for fasteners to be prepared and kitted for use in the automated installation system. The proposed system process will increase shelf life for the fasteners by five days. The automated skin installation system enabled by this automated fastener cleaning system is anticipated to impart 50-60 hours of savings per aircraft depending on the variant.

## Implementation

Implementation will begin with the development of a pilot system based on the technology developed under this ManTech project. The pilot system is anticipated to be placed into production in FY20. Benefits of a pilot system include quick implementation, knowledge of real production needs, and lower probability of system changes on the capital system.

After gaining experience on the pilot system in a production environment, Lockheed Martin will develop a full-scale capital system. This fastener cleaning capital system will integrate with the future automated fastener insertion system for the forward fuselage that is being funded separately. Production break-in of the capital fastener cleaning system is anticipated in FY22 to coincide with the planned break-in of the automated fastener insertion system. Other opportunities for the insertion of this technology are being investigated both on F-35 and other platforms.



PERIOD OF PERFORMANCE:  
July 2018 to June 2019

PLATFORM:  
F-35 Lightning II

CENTER OF EXCELLENCE:  
CMTC

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STAKEHOLDER:  
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F-35 Lightning II Joint Program Office  
(JPO)

TOTAL MANTECH INVESTMENT:  
\$450,000



# Automation Equipment Optimization through Prescriptive Analytics



PERIOD OF PERFORMANCE:  
December 2018 to October 2020

PLATFORM:  
F-35 Lightning II

CENTER OF EXCELLENCE:  
NSAM

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PEO (JSF)  
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(JPO)

TOTAL MANTECH INVESTMENT:  
\$2,070,000

A2785 — Rapid Automation Technology Evaluation (RATE)

## Objective

The reliability of key automated systems used in F-35 drilling and painting application is essential in achieving committed production schedules and cost targets. Predictive failure capability on critical automation assets is required to proactively manage these systems to guarantee their capacity and performance in manufacturing quality parts within program production intervals. Reactive maintenance required when an issue occurs inevitably causes delays to the production line that are costly and jeopardize delivery schedules, part quality, and best-fit assembly. With program ramp-up and product delivery rates increasing every year, these schedule delays, inefficiencies, and quality compromises are exponentially costly and unacceptable for effective program execution.

The Naval Shipbuilding and Advanced Manufacturing (NSAM) Center Rapid Automation Technology Evaluation (RATE) project will develop a system that utilizes a combination of commercial-off-the-shelf products and internally developed models and applications to predict high-impact failures or issues leading to downtime. The RATE solution will involve establishing a real-time connection to the automation equipment on a large-scale assembly line by incorporating hardware and sensing devices to reach a quality of data that is informative and actionable for maintenance and equipment operations. Additionally, the RATE effort will investigate part quality implications of unplanned automation events and utilize condition-based maintenance to optimize part quality and best-fit assembly. Corrective actions are expected to be applied with prescriptive models that take from a combination of knowledge-based, physics-based and/or data-driven modeling.

## Payoff

This project is expected to result in savings of \$23.4K per F-35 for five-year savings of \$13.67M (five-year return on investment of 4.32:1).

## Implementation

The solution technology is expected to be implemented at Northrop Grumman Corporation's Palmdale, CA, facility during the second quarter FY21.





# Upgraded and Enhanced Global Positioning System Electronics Unit for the F-35 Lightning II Aircraft

A2800 — Global Positioning System (GPS) Arrays on Commercial Timescales (ACT) Direct Digital Conversion for Electronic Protection

## Objective

The objective of this Electronics Manufacturing Productivity Facility project is to produce a prototype of an upgraded and enhanced global positioning system (GPS) electronics unit (EU) for the F-35 Lightning II aircraft. This effort represents the baseline for an advanced GPS EU configuration in support of a “Follow on Modernization” (FoM) effort. The prototype will leverage existing digital active electronically scanned array radar radio frequency (RF) processing technology and will be integrated with the current F-35 GPS antenna. The immediate potential of repurposing the existing multi-chip module RF processing technology, which stemmed from a Defense Advanced Research Projects ACT Program awarded to Northrup Grumman in 2014, will allow for the redistribution of the GPS EU function to an advanced GPS system consistent with the Arrays on Commercial Timescales (ACT) initiative. Under the present F-35 architecture, the GPS EU is facing component and manufacturing obsolescence identified as a diminishing manufacturing source and will be obsolete by F-35 Lot 17 in 2025. In addition, it is heavy, unique in design, and has become an expensive and unreliable line replacement unit (LRU) of this generation of the F-35. Mean-Time-Between-Failures (MTBF) has increased to affect availability and overall maintenance actions. There is also a need to upgrade the GPS system to include the new military-code GPS capability that provides precise service position, velocity, and time information for low Earth orbit and geostationary Earth orbit applications.

## Payoff

Expected benefits include cost reduction through re-packaging the EU of the existing RF processing technology and integration with the current GPS antenna, which lowers the LRU cost resulting in improved size, weight, and power (lower weight by 20 percent and 10 percent less power consumed), and increasing the MTBF, which results in fewer maintenance repair actions and overall life-cycle maintenance savings. It is estimated that the number of maintenance activities will decrease by 200 per aircraft over the forward fit.

## Implementation

The GPS ACT team acceptance of the final production prototype is the milestone in the implementation process. The result will be the approval of the GPS ACT prototype for final certification / qualification testing under the F-35 Program Navigation Project FoM effort for 2021 qualification. At the end of this project, the final technical data package (TDP) will ensure the implementation of the ManTech cost reductions for future acquisition procurements. The ManTech transition event will occur with the delivery of the TDP for full rate production, the approval of requirements, technical performance measures (TPM) check-off, and the assembly and acceptance test of the final production prototype. The event and platform will be determined but the final production prototype will be transferred to the F-35 Program Navigation Upgrade FoM effort for official fleet release, which is scheduled for 2023.



PERIOD OF PERFORMANCE:  
October 2018 to January 2020

PLATFORM:  
F-35 Lightning II

CENTER OF EXCELLENCE:  
EMPF

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STAKEHOLDER:  
PEO (JSF)  
F-35 Lightning II Joint Program Office  
(JPO)

TOTAL MANTECH INVESTMENT:  
\$5,747,000



# Additively Manufacturing Precision Plastic Optics to Reduce Cost and Improve Availability



PERIOD OF PERFORMANCE:  
July 2019 to July 2020

PLATFORM:  
F-35 Lightning II

CENTER OF EXCELLENCE:  
EOC

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TOTAL MANTECH INVESTMENT:  
\$644,000



## M2830 — Low-Cost Printed Optics for the F-35 HMD

### Objective

The design and manufacturing time to produce complex optics makes optic design slow and expensive. For example, the optic manufacturing method currently used to produce F-35 Helmet Mounted Display (HMD) optics, diamond turning, requires expensive machine time and post-polishing to achieve surface quality, making optics produced by this method expensive. Other manufacturing methods used for plastic optics, including injection molding, offer the ability to rapidly produce plastic optics at a cheaper price, but require expensive molds to achieve high surface quality and have inherent problems, such as shrinkage and sinks, that eliminate the method from being a viable production method for many precision optics. In addition to cost and manufacturing limitations, existing optic manufacturing technologies constrain optics engineers due to the design limits associated with conventional methods, thus limiting next-generation optic design concepts. There is a need to develop new technology and capability to reduce both cost and design time while allowing for continued advancement in optic technology by removing manufacturing limitations.

The objective of this Electro-Optics Center (EOC) project is to develop an additive manufacturing (AM) laser-printing process to manufacture precision plastic optics. In addition to printing first-order optics for demonstration, this project will define a printing process that can be leveraged for printing optics used on multiple platforms, increasing the project's impact.

This project is being supported by subcontractor, Rockwell Collins, Inc.

### Payoff

The initial proof-of-concept developed by this project will showcase the ability for AM to produce precision plastic optics at a significantly lower cost when compared to current, traditional methods. It is expected that using AM to print six of the eight required optical elements used in each F-35 HMD optics assembly, rather than the current process of diamond turning and post-polishing, will generate cost savings of 60 percent, or approximately \$10,000 per HMD unit. With a projected need of 7,500 HMDs, the total costs savings generated by using AM optics in the F-35 HMD optics assembly are estimated at \$75M.

### Implementation

This concept demonstration project will determine if this low-cost AM process can produce optics of sufficient quality to use for the F-35 HMD. Results of this project will be used / leveraged to refine an AM process to print high-quality, low-cost F-35 HMD optic assemblies. This process will significantly reduce the cost of plastic optics used in the F-35 HMD in addition to other potential platforms that could benefit from an AM solution for producing precision plastic optics.

# CH-53K Projects

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## Reliable and Cost-Effective Ice Detector System for CH-53K



PERIOD OF PERFORMANCE:  
January 2016 to April 2019

PLATFORM:  
CH-53K

CENTER OF EXCELLENCE:  
EMPF

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STAKEHOLDER:  
PMA-261

TOTAL MANTECH INVESTMENT:  
\$5,200,000

A2616 — CH-53K Ice Detection Repackaging & Affordability

### Objective

The legacy ice detector for the CH-53K utilizes a radioactive isotope that presents an environmental and safety hazard and is expensive to dispose of and replace. An Electronics Manufacturing Productivity Facility project developed the CH-53K Ice Detector System (IDS), a unique ice probe / controller system that can reliably detect ice buildup (accretion) on the new Marine Corps CH-53K Heavy Lift helicopter while in hazardous weather conditions. The low footprint probe will perform equally well in low or high accretion rate environments and will provide pilots with unambiguous feedback on icy weather conditions to facilitate optimal decision-making. IDS uses a unique probe sensor and associated algorithms developed by FBS / Guided Wave under the Small Business Innovation Research program to accurately detect and precisely quantify the cylindrical probe's outer diameter as ice accumulates on the circumference.

### Payoff

Implementing a safe, non-toxic, ice-sensing technology for future implementation on CH-53K offers major benefits in acquisition cost reduction and life-cycle support. The production cost for an equivalent commercial system that meets CH-53K requirements is estimated at \$30K per unit based on 200 units. The ManTech effort is targeting an IDS production cost of \$12K per unit, including a probe and controller, which calculates to \$2.4M for 200 CH-53K units versus \$6M for a commercial unit. Other benefits include:

- Ice-detection capability on thickness as low as 0.005 inches and capable of real-time tracking of ice accretion rate.
- Detects ice accretion in hovering and flying conditions because of its rugged probe.
- Meets or exceeds the performance of the legacy Strontium 90-based detector, eliminating the radiation hazard.
- Provides the Navy with a configurable controller that expands to include additional detection capabilities and adapts to other platforms.

### Implementation

The transition event for the project is the successful completion of the prototype IDS (passes environmental testing and the final ice tunnel test, and the test results are accepted by PMA-261) and the final update to the technical data package for the IDS design. The completed prototype for the CH-53K will transition to NAVAIR PMA-261 to undergo qualification testing and validation of airworthiness, which is expected to begin in the third quarter of 2020.



# Implementation of the Deltoid Filler Forming Tool Significantly Reduces CH-53K Composite Bulkhead Scrap Rates

M2684 — Bulkhead T-Flange Crease Elimination

## Objective

T-flanged composite parts on the CH-53K STA 315 bulkheads experience significant scrap rates as a result of autoclave curing. Recurring defects (bulges) form in low pressure zones on the bag side during the cure cycle causing creases in the radii of the T-flanges. These defects have generated a 20 percent scrap rate for the T-flanges on the bag side radii of the bulkheads. In an effort to eliminate these recurring defects and, ultimately, minimize the scrap rate, this ManTech project was developed to evaluate a deltoid filler form tool approach into the manufacturing process of the CH-53K parts with T-flanges, ensuring adequate deltoid region and bag side radius formation. The use of a formed deltoid filler shaped to match the filler region inclusive of joggles was evaluated. This was done to ensure that the exact amount of material in exactly the right shape was repeatedly applied during layup.

Several manufacturing trials were performed using the new manufacturing approach that demonstrated the ability of the formed deltoid filler to significantly reduce the occurrence of bag side radius bulging. This approach proved to be successful in reducing the scrap rate of STA 315 bulkheads from 20 percent to 6 percent.

## Payoff

After the first manufacturing trial and consultation with Sikorsky CH-53K Materials and Processing, the use of the joggle deltoid forming tool was implemented into the manufacturing process for the fabrication of STA 315 bulkheads. Currently, this process has been used to produce 17 STA 315 bulkheads with an observed scrap rate of 6 percent. This represents a scrap rate reduction from the 20 percent scrap rate observed on parts prior to the implementation of the joggled deltoid filler forming tool. Based on the remaining production, a total cost reduction to the CH-53K program will be \$814,800 as a result of the scrap rate reduction. Implementation on additional bulkheads could drive the cost savings to \$1.6M.

## Implementation

The use of the joggled deltoid filler forming tool has been fully implemented into the manufacturing process for STA 315 bulkheads as a result of its demonstrated scrap rate reduction.



PERIOD OF PERFORMANCE:  
October 2016 to April 2019

PLATFORM:  
CH-53K

CENTER OF EXCELLENCE:  
CMTC

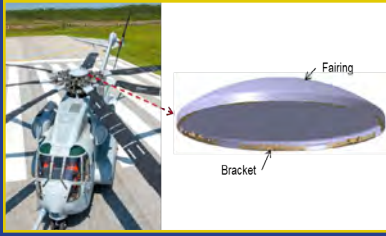
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STAKEHOLDER:  
PMA-261

TOTAL MANTECH INVESTMENT:  
\$300,000



# Innovative Manufacturing Approaches to Enable Significant CH-53K Cost Reductions



PERIOD OF PERFORMANCE:  
May 2018 to October 2018

PLATFORM:  
CH-53K

CENTER OF EXCELLENCE:  
CMTC

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STAKEHOLDER:  
PMA-261

TOTAL MANTECH INVESTMENT:  
\$147,000



## R2736 — Main Rotor Hub Fairing Phase 0

### Objective

The current fabrication approach for the main rotor hub fairing of the CH-53K heavy lift helicopter is highly expensive, labor intensive, and inefficient. The current hand layup / autoclave manufacturing process of the core-stiffened hub fairing consists of 14 major steps, which results in long lead times. The objective of the Composites Manufacturing Technology Center (CMTC) project was to identify, through conceptual design, a streamlined composite manufacturing process of the CH-53K main rotor hub fairing with substantially reduced manufacturing cost of the fairing while still maintaining the integrity of other properties, such as weight, reliability, maintainability, and structural capability. An analysis of alternatives (AoA) was conducted to determine the most efficient approach to decrease the manufacturing cost of the hub fairing with no negative impact to other part attributes. The AoA focused on three key variables: manufacturing approach, material system(s), and viable component suppliers.

### Payoff

A successful conceptual design of the CH-53K main rotor hub fairing offers numerous benefits. The principal benefit involves the reduction of cost by eliminating the multiple processing steps during fabrication. Development of an alternative composite manufacturing process also provides the following benefits:

- Reduction in lead times for the hub fairing
- Reduction in perishable material waste due to fewer long lead times
- Reduction in inventory cost due to fewer long lead times
- Maintenance or improvement of key part attributes, such as weight, reliability, maintainability, and structural integrity

Based on the results of the trade study, both compression molding and hand layup designs without core are feasible while still meeting requirements. Compression molding offers higher potential recurring cost savings at the expense of higher tooling cost, low press availability at this scale, and material development. Hand layup has slightly lower cost savings but does not add any additional risk over the baseline layup.

### Implementation

Sikorsky is currently in the process of further evaluating the results of the ManTech trade study to determine the optimum method of fabrication, taking into account factors beyond cost / technical. If development funding is available, compression molding could be very attractive due to the lowest recurring unit cost.

# Design of Experiments to Decrease Manufacturing Recurring Costs of CH-53K Honeycomb Core Sandwich Panels

M2738 — CH-53K Sandwich Panel Core Potting Optimization

## Objective

A large portion of CH-53K composite structures are designed as honeycomb core sandwich panels. The core is potted in select locations to provide reinforcement and a moisture barrier for fastener locations and internal edges. However, many of these honeycomb core sandwich panels have experienced persistent issues with inconsistent core potting quality, mainly in the form of voids, which can compromise the performance of the parts. Furthermore, these defects require Material Review Board (MRB) activities, which add cost, weight, and the potential for scrap.

The purpose of this Composites Manufacturing Technology Center (CMTC) project was to decrease the overall recurring manufacturing cost of CH-53K airframe components by delivering a uniform product, thus reducing rework, repair, and scrap without a negative effect to quality, performance, cost, and weight. This project centered on a design of experiments technology improvement plan for core densification.

## Payoff

Based on 13 core parts reviewed and their historical total MRB disposition rate of 60 percent, the projected cost of the associated MRB activity over the planned CH-53K production program of 190 aircraft amounts to just over \$1.7M. By improving the core potting process and reducing MRB activity to a maximum of 12 percent versus the current 60 percent, a savings of \$1.4M for these 13 parts would be achieved over the life of the CH-53K program. The return on investment is 2.3:1 over the life of the program.

## Implementation

Initial implementation will occur on CH-53K; however, the technology is applicable to multiple platforms where densified honeycomb core structures are prevalent. Implementation is anticipated to occur in FY20 at Aurora Flight Sciences.

Process improvements / optimization details resulting from this project will be documented in a final report as well as shared at CH-53K Airframe Supplier Program Management Reviews, TCC's bi-annual events, and industry forums, as applicable. The final report will be the basis for formal process specification updates (as applicable), a "Best Practices" document, as well as design and manufacturing operation sheet updates, if applicable.



PERIOD OF PERFORMANCE:  
July 2018 to October 2019

PLATFORM:  
CH-53K

CENTER OF EXCELLENCE:  
CMTC

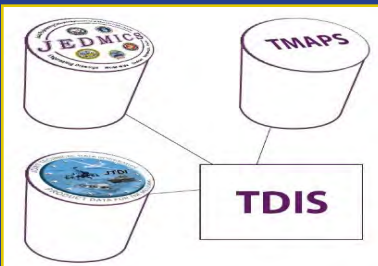
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STAKEHOLDER:  
PMA-261

TOTAL MANTECH INVESTMENT:  
\$350,000



# NAVAIR Connecting Disparate Technical Data for Engineering Support



PERIOD OF PERFORMANCE:  
November 2018 to November 2019

PLATFORM:  
CH-53K

CENTER OF EXCELLENCE:  
NSAM

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STAKEHOLDER:  
PMA-261 CH-53K, NAVAIR 4.1.9;  
PMA-231 E-2/C-2, PMA-251 EM-ALS/AAG, PMA265 F-18, PMA-290 P-8, PMA-299 H-60, PMA-275 V-22

TOTAL MANTECH INVESTMENT:  
\$694,000

M2795— Technical Data Integration and Search (TDIS)

## Objective

NAVAIR is responsible for the full life-cycle management of the weapon systems fielded in support of all naval aviation assets. This project focused on the in-service sustainment period need for engineering support activities; specifically, the ad hoc need for engineering support for depot and provisioning services. Naval air depots utilize an internal Request for Engineering Investigation (REI) ticket to elicit engineering support. Defense Logistics Agency (DLA) utilizes an external form called the 339 – Request for Engineering Support (RES). Both internal REIs and external RES categories of REIs often kickoff a series of actions to locate the pertinent technical data required to disposition the request. The Technical Data Integration and Search project focused on reducing the non-value-added time of manually searching to locate and provide this technical data to an engineer.

This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project will index multiple disparate databases and provide a single portal through which a user can search for technical data. Once this search is complete, the user can initiate a workflow that will collect the files and metadata from multiple databases, convert the computer-aided-design models to a validated neutral format (if necessary), package the information into one file, and send the package to an appropriate recipient.

## Payoff

The project developed the architecture to reduce the time to search and collect required engineering information across multiple systems, reduce potential errors and the time required to package and distribute the technical data, and increase the throughput of engineering requests, which lead to higher platform availability. The Technical Data Integration and Search project will provide an estimated savings of \$2.87M annually.

## Implementation

NAVAIR 4.1.9 plans to implement the project results starting in December 2020. Implementation is expected to take 18 months. This technology is expected to be used in other areas of NAVAIR as well.



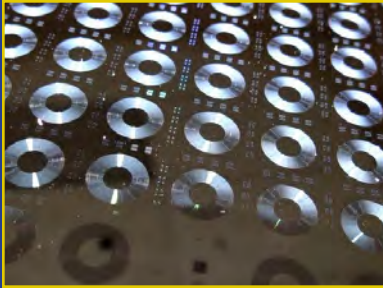


# Other Sea Platforms Projects

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S2744 — Hatchable Cold Spray Technology for Naval Shipyards and Marine Corps Depots .....	84
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## Manufacturing Process to Yield Higher Production Volumes



PERIOD OF PERFORMANCE:  
July 2015 to April 2019

PLATFORM:  
Other Sea Platforms

CENTER OF EXCELLENCE:  
EMPF

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PEO (Ships), NSWCDD

TOTAL INVESTMENT:  
\$692,000



T2710 — Manufacturing Process Optimization of Azimuth and Inertial MEMS

### Objective

There is a need for a high-performance, microelectromechanical systems (MEMS)-based inertial navigation system. The system will integrate silicon micro sensors with optimized, low-noise electronics and navigational software to deliver a miniature handheld, lightweight, affordable inertial navigation system that accurately determines azimuth in all environments, including global positioning system (GPS)-denied. The full navigation system will integrate gyroscopes, accelerometers, navigational algorithms, and electronics into a new targeting system or plug-and-play with existing targeting systems.

This Electronics Manufacturing Productivity Facility project is directed at the production of low-cost, high-quality sensors that will produce a low size, weight, power, and cost (SWaPC) replacement for the digital magnetic compass (DMC). Fabrication of the current silicon disc resonator gyroscope (SiDRG) is on 100mm-diameter wafers produced in a laboratory environment; this work successfully validated the high level of performance achievable with this device.

To lower the component cost at the operational SiDRG level, fabrication to a larger wafer size (200mm) in a production environment is necessary; this will decrease the per-die cost by reducing the per-wafer production cost as well as increasing the number of die per wafer. Wafer-scale vacuum packaging will eliminate the secondary die attach, wire bond, and vacuum packaging costs, and will allow the use of standard low-cost die singulation methods.

### Payoff

The project will enable the production of an inertial sensor that meets the Department of Defense requirements for targeting systems used by ground forces. This will allow ground forces to utilize precision munitions, resulting in improved engagement efficiency and reduced collateral damage. The warfighter will gain the ability to engage targets in all environmental conditions, including GPS-denied. The sensors will result in a drastic SWaPC reduction and meet the U.S. Marine Corps' requirements for SWaPC.

The MEMS inertial sensor will be capable of full electronic calibration, without the need for any rotational adjustment (i.e., no moving parts required). The technology is directly applicable to future low-cost, miniature, missile guidance control systems, unmanned air vehicle robotic navigation, and stabilized weapon systems.

### Implementation

The high-performance MEMS sensors developed under this project will be incorporated into the Azimuth and Inertial MEMS (AIM) Future Naval Capabilities (FNC) program sponsored by the Office of Naval Research to address azimuth error associated with the DMC. Under the FNC program, the SiDRG sensors will be enclosed in an environment-resistant package to provide ultra-stable temperature and stress isolation. The Boeing Company will assemble a 3D inertial navigation system using the packaged sensors. The navigation system will be characterized for self-calibration, thermal response, and bias stabilization. Under Phase 2 of the FNC program, this advanced navigation system will be integrated into a targeting system for test and evaluation.

# Additive Manufacturing R&D in Support of the Navy's Fight Against Corrosion

T2716 — Development of Additive Manufacturing Processes for Corrosion Resistant Alloys

## Objective

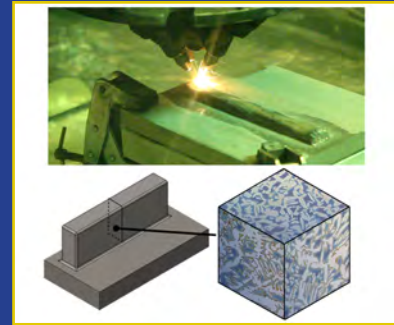
The Navy utilizes several corrosion-resistant alloys, such as Monel® K-400 and K-500 and corrosion-resistant steels (CRES), in a range of turbomachinery and structural applications. Common product forms, such as bar, plate, or rod, provided limited geometries and frequently required significant levels of post-processing to produce the desired component geometries. These limited geometries and post-processing requirements resulted in long lead times and limited availability for critical components. However, additive manufacturing (AM) offers significant promise for the on-demand fabrication of parts of varying sizes and complexities. In AM technologies, components are built in a layer-by-layer manner using either powder bed fusion or directed energy deposition processes. No concerted effort to analyze the impact of AM processes on the properties of corrosion-resistant materials of interest to the Navy had previously occurred. In this project, two categories of materials systems were investigated. These materials systems included the Ni-Cu-based Monel® and CRES alloys. Each system has unique characteristics that potentially made the AM processing of these alloys challenging.

## Payoff

The Navy will significantly benefit from the fabrication of corrosion-resistant structural components using directed energy deposition AM processes. For applications common to the Naval Sea Systems Command (NAVSEA), component size and materials of interest fall outside of the ranges typical for powder bed fusion processes. But, directed energy deposition processes can be adapted to a much wider range of material and product sizes, making it an attractive option for larger structural components. When combined with its ability to work with multiple materials, this AM process shows promise for addressing the size and diversity of components common to NAVSEA applications. This project offered the opportunity to investigate the impact of AM on these classes of materials and provide a sound scientific foundation for developing a fundamental understanding of the governing process-structure-property relationships. This project also serves as a test bed for the application of data analytics and data capture for important processing and property conditions.

## Implementation

Each of the material classes noted above has significant applicability to naval systems but also presents a range of challenges before they can be successfully processed using AM. Efforts were directed at understanding the processing challenges and building a knowledge base for how a small range of processing conditions could impact the resulting structure and properties for important naval materials. As part of the process development work, a preliminary process and property database was developed for these material systems. The technology basis developed for the AM fabrication of a range of different components using these materials systems was applied to the near-term qualification and insertion of AM components into service. The Institute for Manufacturing and Sustainment Technologies team hopes to transition this knowledge to specific part applications on ships in the near future.



**PERIOD OF PERFORMANCE:**  
April 2016 to December 2018

**PLATFORM:**  
Other Sea Platforms

**CENTER OF EXCELLENCE:**  
iMAST

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**STAKEHOLDER:**  
PEO (Ships), NSWCCD

**TOTAL INVESTMENT:**  
\$500,000



## Innovative In-Situ Repair for Ships



PERIOD OF PERFORMANCE:  
April 2017 to March 2019

PLATFORM:  
Other Sea Platforms

CENTER OF EXCELLENCE:  
iMAST

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STAKEHOLDER:  
NAVSEA 04X3, NAVSEA 04, USMC  
LOGCOM, Public Shipyards

TOTAL INVESTMENT:  
\$700,000

S2744 — Hatchable Cold Spray Technology for Naval Shipyards and Marine Corps Depots

### Objective

This Institute for Manufacturing and Sustainment Technologies (iMAST) effort developed and delivered a high-pressure, hatchable cold spray system, commensurate support equipment, and operating procedures including on board ship, and developed and validated shipboard repairs of specifically selected components.

The successful completion of the S2580 Cold Spray Proof of Procedure for Navy Shipboard Components project led to the identification of several additional components that could be repaired using cold spray technology. Repairing these components on board will result in significant time and cost savings by eliminating the need to remove them from the ship or submarine to facilitate repair. Additional components were identified that could be repaired pier side, which will also result in significant cost savings. A new high-pressure cold spray system was designed that can be transported throughout the ship to enable in-situ repair and save extensive labor hours required to remove and replace ship systems. Supporting technology, such as dust collection, personal protective equipment, operator feedback, in-process quality assurance, and motion control was developed and integrated with the cold spray system. This project leveraged other ongoing cold spray efforts and included applications for NAVSEA and the U.S. Marine Corps.

### Payoff

Benefits as a result of this project include development of a man portable high-pressure cold spray system and supporting technology that can be used to perform shipboard, pier-side, and field repairs; approved repair processes for submarine and aircraft carrier components; repairs that return components to service that previously had to be scrapped; repair costs of less than 20 percent of the cost of a new component; reduced repair times (lead times taking as long as 24 months now take one day to four weeks depending on the component); and an improved process to identify additional candidate components for repair by shipyard or depot personnel. The estimated cost avoidance for the first five years of implementation is \$8M for a return on investment of 13:1.

### Implementation

The hatchable cold spray system was demonstrated at the Intermediate Maintenance Facility Bangor and Puget Sound Naval Shipyard. Full implementation will occur in late 2020. Approved repairs are expected to be implemented in late 2019. The repair process will be governed by Uniform Industrial Process Instruction (UIPI). Information specific to the hatchable repairs will be developed as required by the UIPI. Other implementation sites include Navy shipyards and the Marine Depot at Albany, GA. The system will also be made available to NAVAIR facilities.



# Assuring that Additively Manufactured Metallic Components are Free of Detrimental Defects

T2783 – Optimizing X-ray Computed Tomography for Defect Detection

## Objective

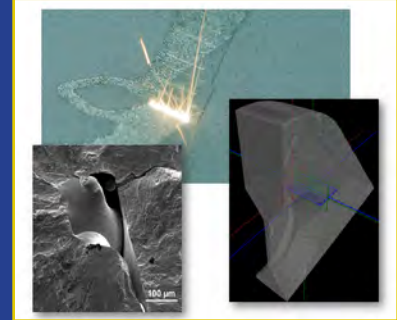
This Institute for Manufacturing and Sustainment Technologies (iMAST) project will investigate how the X-ray computed tomography (CT) analysis process and data reconstruction algorithms can be optimized for additive manufacturing (AM) metallic components. Different alloy systems that include titanium and stainless steel alloy systems were investigated. The project laid the initial foundation to better understand the critical defects that need to be identified within high-value, high-risk AM components. In AM, components are built in a layer-by-layer manner using either powder bed fusion or directed energy deposition processes. AM offers significant promise to the Navy for on-demand fabrication of parts of varying sizes and complexities. The ability to “print on demand” will have significant impact on lead times and procurement costs for new and replacement components. The Navy is currently investigating AM for the production of high-value, high-risk components. However, AM is still an emerging technology, and the process can introduce several types of defects into the build, such as lack-of-fusion porosity, gas porosity, and the entrapment of impurities. Non-destructive testing by X-ray CT has become the standard technique to qualify these high-value, high-risk components. CT can analyze and quantify internal structures (e.g., porosity) within components in three dimensions. The analysis of AM components by X-ray CT is complicated by many variables, and these complications could lead to the failure to identify defects that would be detrimental to the component during service.

## Payoff

In the coming years, the Navy is expected to significantly increase its AM footprint and the use of AM to produce both new and replacement components. This project will help validate a method of qualifying AM components prior to service and assure they perform as expected. This project will also help meet the challenges of certifying AM components for structural applications. In addition, optimizing the X-ray CT process will help streamline the non-destructive testing of AM components allowing for rapid qualification of AM components for service.

## Implementation

The alloys chosen for this investigation have significant applicability to naval systems. Efforts are directed toward better understanding the challenges of verifying that AM components are free of detrimental defects. In addition, efforts will be directed at better understanding critical defect size within a component, including establishing the groundwork to build a database of the impacts of defect size as a function of shape and the material systems investigated. The initial database of critical defect sizes, along with the optimized X-ray CT techniques, will be transferred to the Navy to help qualify AM components. The iMAST team hopes to transition this knowledge and the testing techniques developed for the Navy within the FY20–FY21 timeframe for use on specific critical components through a follow-on project designed to mature the process for specific components.



**PERIOD OF PERFORMANCE:**  
March 2018 to October 2019

**PLATFORM:**  
Other Sea Platforms

**CENTER OF EXCELLENCE:**  
iMAST

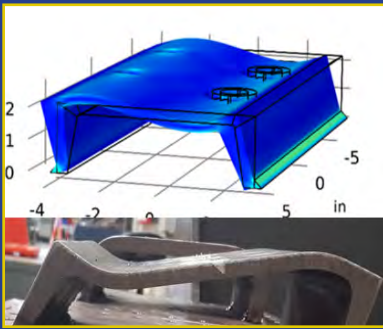
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**STAKEHOLDER:**  
NAVSEA

**TOTAL MANTECH INVESTMENT:**  
\$500,000



# Set Weld Analysis for Submarine Rescue System Ship Interface Template



**PERIOD OF PERFORMANCE:**  
September 2018 – June 2019

**PLATFORM:**  
Other Sea Platforms

**CENTER OF EXCELLENCE:**  
CNM

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**STAKEHOLDER:**  
PMS 391, NAVSEA,  
Vessel of Opportunity (VOO)

**TOTAL INVESTMENT:**  
\$400,000

Z2796 – Design Assessment of Ship Interface Template Set (SITS) Channel System for Mounting of Submarine Rescue System (SRS)

## Objective

In the event of a submarine going into distress, an international effort is undertaken to rescue the sailors on the downed vessel. With limited space and supplies on submarines, time is of the essence. The goal, when saving the trapped sailors, is to have the Submarine Rescue System (SRS) operational and searching for the submarine within 48 hours. This process includes receiving notice of the distressed submarine; mobilizing the rescue team to the nearest port, which includes procuring seven C-5s; identifying, procuring, and modifying a vessel of opportunity (VOO); installing the ship interface template set (SITS) that the SRS attaches to on the VOO; and finally mobilizing out to sea to begin the search for the downed submarine.

The purpose of the Design Assessment of Ship Interface Template Set (SITS) Channel System for Mounting of Submarine Rescue System (SRS), which was managed by the Center for Naval Metalworking (CNM), was to determine the feasibility of reducing the welding time to install the Launch and Recovery System (LARS) base and/or SITS structure. Another goal was to determine if changing the channel material from EH-36, which is a rarer and stronger steel, to a reduced grade such as AH-36, which is the same material as most ship decks. To reach these goals, extensive finite element modeling and simulation were conducted, drop tower testing on EH-36 and AH-36 was used to compare material properties and weld strength, and calculations of welding time and other production welding activities were used to determine time savings.

## Payoff

This updated welding procedure, once implemented, could potentially save a minimum of 3.2 hours. The estimated time savings are a conservative amount in which only 10 welders are able to support a submarine rescue effort.

## Implementation

The project was successfully completed and the recommendations from this project are under review by the Program Office and NAVSEA. Upon satisfactory review, the report will be submitted to the planning yard, Portsmouth Naval Shipyard, for review. The planning yard will give its recommendation to PMS 391, with implementation anticipated to occur during the first quarter of FY20.



# Energetics Projects

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# RAM Technology Provides Safer and Cheaper Manufacturing of Energetic Materials



RAM-5 and existing production mixer

PERIOD OF PERFORMANCE:  
July 2014 to December 2019

PLATFORM:  
Energetics

CENTER OF EXCELLENCE:  
EMTC

POINT OF CONTACT:  
Mr. Charles R. Painter

STAKEHOLDER:  
PEO U&W, PMA-242

TOTAL MANTECH INVESTMENT:  
\$1,840,000

A2575 — Energetics Production Utilizing Resonant Acoustic Mixing (RAM)

## Objective

A Resonant Acoustic Mixer (RAM) uses a novel mixing technology developed for the U.S. Army under a Small Business Innovation Research project that was patented in 2007. There have been subsequent laboratory-scale investigations of the technology at various labs throughout the Navy and Department of Defense (DOD). In the RAM, mixing is achieved by acoustical energy input to the material rather than mechanical mixing by moving blades. This means that, unlike current mixing, there are no moving parts in contact with the explosive material, which provides a significant safety advantage. Existing methods have the potential for friction initiation of energetic material if the blades and the bowl become off-set and make contact, or if foreign material enters the mixer and becomes lodged between the blades and bowl. This failure mechanism has resulted in past explosive incidents. Replacing mechanical mixing of energetics with resonant acoustic mixing would eliminate this safety hazard. The objective of the project is to develop and demonstrate a small munitions production process utilizing an 80-pound capacity RAM-5 to mix the explosive fill.

## Payoff

RAM technology offers a number of benefits as compared to current energetics mixing processes. PBXN-110, the explosive fill of the Mk152 warhead, is currently manufactured using planetary vertical mixers. RAM offers a number of benefits over vertical mixing.

As mentioned above, RAM provides a significant safety advantage over vertical mixing, and mixes much more quickly than conventional mixers. In addition, evaluation of the labor required for the proposed production process shows a cost reduction of about \$100 per warhead, which has a current production cost of \$1,500 each. At current production levels, this results in an annual savings of \$1M to Mk 152 production, providing a 2.5-year return on investment. Additional savings would be achieved as the newly proven technology is used for other existing programs and new work. RAM also offers reduced footprint, new capabilities, and the potential to produce materials not easily processed using current mixing methods. Materials with higher viscosities and shorter pot lives (solidification times) can be made.

## Implementation

The successful completion of this project will result in a fully operational resonant acoustic mixing production facility at NSWC IHEODTD, as well as a qualified RAM production process for the Mk 152 warhead to meet PMA-242 requirements. Direct transition to full production is anticipated following successful first article testing.

Techniques and processes developed will support RAM programs elsewhere. Multiple DOD contractors have already expressed interest in partnering with NSWC IHEODTD and utilizing the newly purchased RAM-5. Implementation is targeted for 2.75-inch IM warheads such as the Mk 152 and Mk 146. PMA-242 has signed a Technology Transition Plan to look at utilizing the RAM technology for full-scale manufacture.





# Obsolete No More: CPPD Antioxidant Manufacturing Capability

A2706 — Development of CPPD Manufacturing Process

## Objective

Many of the currently fielded air-launched and surface-launched Navy missile programs were initially developed 20-30 years ago. As such, these programs can be faced with material-related issues such as material obsolescence, discontinued products, and inconsistent quality or characteristics of material from manufacturers and diminished manufacturing sources.

The objective of this Energetics Manufacturing Technology Center (EMTC) project is to develop and scale a cost-effective method for synthesis and purification of N-Cyclohexyl-N'-Phenyl-p-Phenylene Diamine (CPPD) that meets specification MIL-A-85501(AS). CPPD is a component of the antioxidant package used in the certain propellant and rocket motors. Currently, there is no Continental United States CONUS source of CPPD. It was last sold as "Flexzone 6H" by Chemtura, but it has been discontinued. A secondary objective of this project is to modernize the standards to and methods by which CPPD is tested. The end-user of CPPD, a DOD contractor, will be consulted to develop modern test methods and specification limits to supplement MIL-A-85501.

## Payoff

The successful production of CPPD at NSWC Indian Head EOD Technology Division provides a reliable, Continental United States (CONUS) source of the antioxidant for certain propellant packages, allowing continued production of several rocket motors with the potential for use in other systems. The payoff of this project will be strategic, rather than financial: it will reduce the reliance of energetics manufacturing on internationally-sourced chemicals that may become unavailable on short notice.

## Implementation

The successful completion of this project will result in a reliable source to produce large quantities of CPPD meeting MIL-A-85501(AS). These large quantities will be required to prove out the material's performance in qualification studies for existing and future applications. Existing programs have an immediate need for CPPD. The CPPD annual demand is 50 to 100 pounds per year.

As of summer 2019, the CPPD synthesis process has reached full scale, and scaling of the purification process is ongoing. The development effort is being conducted by NSWC Indian Head EOD Technology Division, Chemical Development and Manufacturing Branch. The analytical effort is shared by NSWC Indian Head EOD Technology Division, Material Evaluation Division, and a DOD contractor. Upon completion of the process scaling, the DOD Contractor will evaluate the quality of the newly manufactured CPPD as compared to the previous manufacturer by performing small-scale propellant mixes and limited accelerated aging studies to qualify NSWC Indian Head EOD Technology Division's material for future Sidewinder and RAM production.

The contractor has contributed analytical effort to aid in the development of updated testing methods and specifications. NSWC Indian Head EOD Technology Division and the DOD contractor have agreed on a set of tests and specification limits that supplement or replace the tests and limits in MIL-A-85501.



PERIOD OF PERFORMANCE:  
February 2016 to December 2019

PLATFORM:  
Energetics

CENTER OF EXCELLENCE:  
EMTC

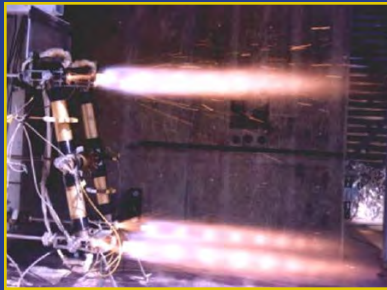
POINT OF CONTACT:  
Mr. Charles R. Painter

STAKEHOLDER:  
PEO U&W, PMA-259

TOTAL MANTECH INVESTMENT:  
\$1,423,000



## Development of Manufacturing Capability for Primary Explosives



PERIOD OF PERFORMANCE:  
October 2015 to December 2019

PLATFORM:  
Energetics

CENTER OF EXCELLENCE:  
EMTC

POINT OF CONTACT:  
Mr. Charles R. Painter

STAKEHOLDER:  
PEO U&W PMA-201

TOTAL MANTECH INVESTMENT:  
\$1,227,000

### A2708 — Primary Explosives Manufacture

#### Objective

Many currently fielded military programs were developed 20-30 years ago. As such, these programs are continually faced with material obsolescence issues where current qualified suppliers have discontinued products or product lines. In most instances, the materials that are being discontinued are not available from alternate domestic suppliers, and it is necessary for alternate materials and/or sources to be identified to perform the same or similar function as the material being replaced.

Primary explosives are required as initiators or detonators for virtually every system involving energetic materials. They are typically quite sensitive to impact, friction, and temperature, etc. and used in small quantities to initiate explosives or propellants in everything from small arms to missiles and bombs. Many of the specialized primary explosives are used in cartridge actuated devices (CADs) to transmit a signal to a remote component, sequence events during an ejection, push a piston, eject a bomb, unlock a seat belt, actuate a fire extinguisher, cut and release, etc., and propellant actuated devices (PADs), small rocket motors used for propulsion (e.g., propelling an ejection seat out of an aircraft).

The Energetics Manufacturing Technology Center (EMTC) project's objective is to develop the manufacturing capability for several critical primary explosives to ensure a continued Continental United States (CONUS) availability is being undertaken at NSWC Indian Head EOD Technology Division.

#### Payoff

Development of a manufacturing capability for critical primary explosives will ensure continued availability of these qualified materials. CONUS commercial sources for diazodinitrophenol (DDNP), lead mononitroresorcinate (LMNR), potassium dinitrobenzofuroxan (KDNBF), and barium styphnate either cannot meet the current annual requirement or no longer exist. Providing qualified sources of these materials will allow for continued sustainment of critical man-rated systems, such as those provided by the tri-service CAD / PAD Joint Program Office (JPO).

#### Implementation

The CAD / PAD JPO (PMA-201), as the single manager for CAD / PAD devices used in all DOD components, recognizes the negative impact of the inability and difficulty of procuring these materials. The CAD / PAD JPO endorses this ManTech project to advance the manufacturing methods for these primary explosives and will resource the evaluation and qualification of the new material in CAD / PAD applications.

DDNP, LMNR, KDNBF, and barium styphnate are primary explosives widely used in ordnance systems as components in explosive initiation trains. The primary applications are in cutters, squibs, and other CADs and PADs. DDNP is used in percussion caps and detonators; KDNBF is used in squib switches for missile systems; LMNR is used in Bellows motors and the MK 112 squib switch; and barium styphnate is used in semiconductor bridge ignitors for activation of thermal batteries.



# AFR Technology Provides Safer and Cheaper Manufacturing of Energetic Materials

S2719 — Advanced Flow Reactor (AFR) Energetics Manufacture

## Objective

N-alkyl-N-(2-nitroxyethyl) nitramines (NENAs) have been demonstrated to be effective energetic plasticizers in gun propellants while reducing sensitivity to unplanned stimuli relative to nitroglycerin. The use of NENAs in gun propelling charges has increased the demand for NENA materials; sustainable manufacture of NENA blends thus requires investment to demonstrate and document a safe, economical method. A fully continuous process is envisioned as the solution.

The co-nitration synthesis of Methyl/Ethyl NENA is planned as the design criteria for the Advanced Flow Reactor. Methyl/Ethyl NENA is produced via separate methyl and ethyl batch syntheses with followed on physical blending to create the 58 percent methyl / 42 percent ethyl ratio. Co-nitration of the two components provides improvements by reducing the number of reactions and has been demonstrated at the laboratory scale.

Butyl NENA synthesis is planned as a second NENA demonstration.

The scope of this project is to adapt the existing batch co-nitration chemistry to a continuous Advanced Flow Reactor (AFR).

## Payoff

Continuous nitration via the AFR offers a number of benefits as compared to batch NENA processes. Batch synthesis utilizes multiple reactors to complete the two-step synthesis, and flow on wash and separations. Through consolidation, a continuous process will provide improvements in the following areas.

- (1) Improved Safety – The actual amount of material participating in the nitration reaction at any given time is reduced from the multi-gallon batch reactor size to grams at the continuous flow reactor size. Due to the small quantity undergoing the synthesis reaction at any given time, there is a much higher contact surface area with the temperature control plates for a given reaction volume, resulting in better heat transfer, better reaction temperature control, and prevention of run away reactions.
- (2) Improved Product Quality – Reaction kinetics are more stable with consistent reaction temperatures and heat transfer. Once the continuous flow reaction has reached a steady state, material produced will have consistent quality from start to finish.
- (3) Reduced Footprint – Production rate for a G1 scale unit is anticipated at 10 to 20 lbs/hour, with an anticipated footprint of 24 square feet, compared to synthesis utilizing 50- to 500-gallon batch reactors producing 80 lbs/hour and occupying a footprint of 2,490 square feet including associated chillers and temperature control units.

## Implementation

The successful completion of this project will result in a fully operational NENA production facility at NSWC Indian Head EOD Technology Division capable of producing metric tons of material per year, as well as a demonstrated Methyl/Ethyl NENA and Butyl NENA production capability meeting existing reference quality requirements.



PERIOD OF PERFORMANCE:  
October 2016 to December 2020

PLATFORM:  
Energetics

CENTER OF EXCELLENCE:  
EMTC

POINT OF CONTACT:  
Mr. Charles R. Painter

STAKEHOLDER:  
PEO IWS 3C4

TOTAL MANTECH INVESTMENT:  
\$2,996,000



## Source of DNPD Antioxidant Manufacturing Capability



PERIOD OF PERFORMANCE:  
October 2016 to December 2019

PLATFORM:  
Energetics

CENTER OF EXCELLENCE:  
EMTC

POINT OF CONTACT:  
Mr. Charles R. Painter

STAKEHOLDER:  
PEO U&W, PMA-259

TOTAL MANTECH INVESTMENT:  
\$1,461,000

### A2720 — Development of DNPD Manufacturing Process

#### Objective

Many of the currently fielded air-launched and surface-launched Navy missile programs were initially developed 20-30 years ago. As such, these programs may experience material-related issues from material obsolescence and discontinued products to inconsistent quality or characteristics of material from manufacturers and diminished manufacturing sources.

This is the case with the antioxidant N,N'-Di-2-naphthyl-p-phenylenediamine (DNPD). DNPD is a component of the new antioxidant package used in certain air-to-air missile propellant. DNPD is considered the primary antioxidant which inhibits oxidation of the binder network with chain-terminating reactions of free radicals. With a reliable domestic source of DNPD, it could become the antioxidant of choice on future propellant development efforts.

The objective of this Energetics Manufacturing Technology Center (EMTC) project is to develop and scale up a cost-effective method for synthesis and purification of DNPD that meets the specification HS 6-0089A.

#### Payoff

The successful production of DNPD at NSWC IHEODTD provides a reliable, Continental United States (CONUS) source of the antioxidant with the potential for use in a number of propellant formulations as well.

#### Implementation

The successful results of this project will result in the capability at NSWC IHEODTD to produce large quantities of DNPD meeting specification HS 6 0089A. These large quantities will be required to prove out the material utility in final (type) qualification studies for existing as well as future applications. An existing program has an immediate need for DNPD, with potential for wider use in a variety of propellants. The DNPD annual requirement is more than 200 pounds.

The scale-up effort will be conducted by NSWC IHEODTD, Chemical Development and Manufacturing Branch. The analytical effort will be shared by NSWC IHEODTD, Material Evaluation Division, and a DOD contractor. The DOD contractor will evaluate the quality of the IHEODTD manufactured DNPD as compared to the OCONUS source by performing small-scale propellant mixes and limited accelerated aging studies.



## Enabling the Advanced Manufacture of Propellants

A2774 — Additive Manufacturing for Propellants

### Objective

The objective of this Energetics Manufacturing Technology Center (EMTC) effort is to enable the advanced manufacture of Navy / U.S. Marine Corps critical, solid propellant grains for use in cartridge actuated devices (CADs) and propulsion systems. Additive manufacturing (AM) is an advanced manufacturing technology that has the potential to produce lower cost propellant grains with little-to-no induced thermal stress / strain during cure. Under this effort, two types of AM technology will be explored for use in propellant manufacturing: material extrusion and vat photopolymerization. Adaptation of these AM technologies for energetics will enable both composite and single- and double-base forms of propellants to be manufactured using advanced techniques.

### Payoff

AM has become an attractive technology for low-volume production of specialized parts for as-needed applications. AM has flat cost per part vs. production volume curves, and would be far less sensitive to changes in product demand. While the year-to-year demand for the manufacture of new CADs containing HES-5808 is difficult to project, an advanced manufacturing technique like AM will provide increased sustainability and lower costs. Additionally, the implementation of an AM process will likely eliminate “cracking” commonly found during traditional grain manufacturing and would enable consistent CAD performance due to the potential for higher precision printed grains.

### Implementation

The initial focus will be on transitioning AM-produced HES-5808 grains into the M91 Impulse Cartridge utilized on the AV-8, F-15, F-16, and B-52 platforms. Upon completion of this project, the final formulation and technical information will be submitted to the CAD technical agent to determine energetic material qualification requirements and testing. Following this, Naval Ordnance Safety and Security Activity approval will be sought to use the AM-produced grain in the end-item application and validated by a design verification test (DVT). A critical design review (CDR) will analyze the results of the DVT prior to beginning the device qualification process. After the CDR, service release testing (SRT) will be conducted. SRT results will be reviewed to ensure all technical requirements are met, and if found acceptable, a Type III service release will be issued to allow manufacturing of the M91 with the AM grain. In order to achieve implementation of the AM-produced HES-5808 grain, the JPO technical agent (NSWC IHEODTD) will conduct the AM HES-5808 and M91 Impulse Cartridge qualification.



PERIOD OF PERFORMANCE:  
October 2017 to December 2020

PLATFORM:  
Energetics

CENTER OF EXCELLENCE:  
EMTC

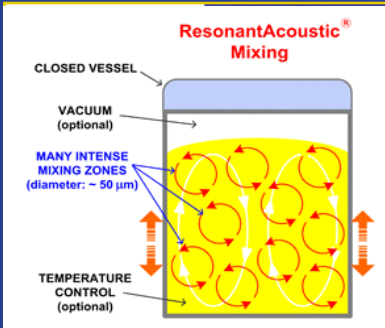
POINT OF CONTACT:  
Mr. Charles R. Painter

STAKEHOLDER:  
PEO U&W PMA-201

TOTAL MANTECH INVESTMENT:  
\$1,090,000



# Delay and Ignition Composition Manufacturing Capability via Resonance Acoustic Mixer (RAM)



The diagram illustrates the Resonant Acoustic Mixing (RAM) process. It shows a 'CLOSED VESSEL' containing a mixture. A 'VACUUM (optional)' is applied to the top. The mixture is subjected to 'MANY INTENSE MIXING ZONES (diameter: ~ 50 μm)', represented by red circular arrows indicating mixing. 'TEMPERATURE CONTROL (optional)' is also shown at the bottom of the vessel.

**PERIOD OF PERFORMANCE:**  
October 2017 to December 2019

**PLATFORM:**  
Energetics /AV-8, AV-16, A-4, B-52, FA-18, OV-10, T-38, F-5 Navy and Air Force Aircrew Escape Systems

**CENTER OF EXCELLENCE:**  
EMTC

**POINT OF CONTACT:**  
Mr. Charles R. Painter

**STAKEHOLDER:**  
PEO U&W, PMA-201

**TOTAL MANTECH INVESTMENT:**  
\$389,000

A2775 —Tungsten Delay Composition via RAM

## Objective

The Navy uses tungsten delay compositions (MIL-T-23132A) of various burn rates to manufacture cartridge actuated devices (CADs) used in Navy and Air Force applications. Transportation of tungsten delay composition introduces stratification and separation of the ingredients caused by the difference in density between ingredients, specifically the tungsten. This problem makes it difficult to verify the quality/homogeneity of compositions purchased from private contractors. For this reason, production of tungsten delay composition is recommended on-site. In 2018, NSWC IHEODTD successfully developed a production process for tungsten delay Composition using resonance acoustic mixer (RAM) technologies. After mixing and testing various compositions to achieve various delays, a burn rate curve was established to aid in future mix composition determination. From there, NSWC IHEODTD began making mixes of T-10 and zirconium-nickel delay compositions. They were tested and yielded desirable results. A1A ignition composition was then mixed and tested successfully. These mixes are projected to be First Article Tested and used for the production requirements of FY19 and forward.

## Payoff

The development of a production process of small homogenous batches of delay and ignition compositions will reduce waste, reduce personnel hazard exposure since the iterative production process is conducted at much smaller scale and streamlines formulation development with new ingredients that often come with different particle size distributions and characteristics that affect historical burn time performance. Therefore, the relationship of burn time as a function of composition can be established efficiently during the formulation effort with RAM technology. RAM technology yields homogenous products consistently and yields the lowest coefficient of variation for the burn rate. The RAM technology also significantly reduces the mixing time from hours to minutes, with highly reproducible batch results. This new production process capability will eliminate the risk of relying on private industry to supply delay compositions for aircrew escape applications and will open the door to transition the RAM manufacturing methods to other pyrotechnic composition applications.

## Implementation

This project will enable the production of tungsten, zirconium-nickel and T-10 delay compositions with various burn times and ignition compositions to meet the production needs starting in FY20. These compositions are installed in AV-8, AV-16, A-4, B-52, FA-18, OV-10, T-38, and F-5 Navy and Air Force Aircrew Escape Systems. Since the specification of the delays and ignition compositions are performance based, PMA-201 can implement use of RAM-produced material upon availability and end-item performance results.



## Source of HNS Manufacturing Capability

A2776 — Development of HNS Manufacturing Process

### Objective

Many of the currently fielded air-launched and surface-launched Navy missile programs were initially developed 20-30 years ago. As such, these programs may experience material-related issues from material obsolescence and discontinued products to inconsistent quality or characteristics of material from manufacturers and diminished manufacturing sources.

These issues make it necessary for alternate materials and/or sources to be identified to perform the same or similar function as the material being replaced. In some instances a modification of a formulation may be necessary in order to allow systems to continue to be manufactured without interruption. Any formulation modifications would need to be evaluated in advance so that the necessary change(s) can be made without program interruption. There currently exists no consistent continental United States (CONUS) source of HNS to meet the projected needs and OCONUS sources costs have risen significantly in recent years. In order to continue supporting programs using HNS, a cost-effective CONUS source of HNS must be established in the production pipeline.

The objective of this Energetics Manufacturing Technology Center (EMTC) project is to develop a scalable, cost-effective process to produce both types of HNS, Type I and Type II, that meets the material specification PEF-WS-5003K, "HNS Explosive."

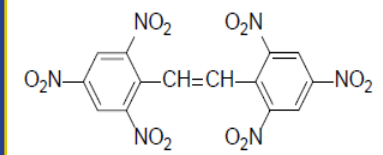
### Payoff

The successful production at NSWC IHEODTD provides a reliable, CONUS source of HNS-I and HNS-II.

### Implementation

The successful results of this ManTech project will be used to provide large quantities of HNS-I and HNS-II. These quantities will be required to prove out the material utility in final (type) qualification studies for existing as well as future applications.

The scale-up effort will be conducted by NSWC IHEODTD, Chemical Development and Manufacturing Branch. The analytical effort will be conducted by NSWC IHEODTD, Material Evaluation Division.



PERIOD OF PERFORMANCE:

November 2019 to December 2020

PLATFORM:

Energetics

CENTER OF EXCELLENCE:

EMTC

POINT OF CONTACT:

Mr. Charles R. Painter

STAKEHOLDER:

NAVAIR Precision Strike Weapons  
Program Office , PMA-201

TOTAL MANTECH INVESTMENT:

\$359,000



# Continuous Acoustic Chemical Reactor for Nitration, Oxidation, and Hydrolysis Reactions for Energetics Production



S2778— Resonant Acoustic Continuous Microreactor (RACMR)

PERIOD OF PERFORMANCE:  
September 2018 to December 2020

PLATFORM:  
Energetics

CENTER OF EXCELLENCE:  
EMTC

POINT OF CONTACT:  
Mr. Charles R. Painter

STAKEHOLDER:  
MARCORSYSCOM

TOTAL MANTECH INVESTMENT:  
\$1,450,000

## Objective

The objective of this Energetics Manufacturing Technology Center (EMTC) initiative is to develop and build a prototype Resonant Acoustic Continuous Microreactor (RACMR) for the nitration, oxidation, and hydrolysis of energetic materials and their precursors. There are many advantages associated with the continuous production of chemical compounds. Continuous flow chemistry exhibits much better heat and mass transfer, smaller footprint and enhanced safety due to much smaller quantities of potentially hazardous chemicals at a given time. However, for reactions wherein solids are precipitated or deposited during the course of the reaction, clogging is an inherent problem. RACMR technology may provide a solution to this phenomenon, and allow effective continuous production of slurries without clogging the reactor. 2,6-diaminopyrazine-1-oxide (DAPO) has been chosen as the material to be synthesized to demonstrate this capability. DAPO is the immediate precursor to the energetic compound 2,6 diamino-3,5-dinitropyrazine-1-oxide (LLM-105). DAPO is currently produced via a batch process with low yields. To improve the cost, availability, and quality consistency of DAPO, a continuous chemical reaction process that is capable of handling solids within the reaction pathway is desired. This chemical reaction process and the associated equipment will be advantageous to other chemical syntheses such as nitrations, oxidations, and hydrolysis reactions for energetic compounds.

## Payoff

LLM-105 is being evaluated as high-energy, low-sensitivity, secondary explosive material used to replace varied percentages of RDX and HMX in propellant formulations, and has found application in the development of high-performance, low-sensitivity mortar propelling charges used by the Marine Corps. Development of a continuous chemical reaction process for DAPO manufacture will ensure a reliable and lower cost supply of LLM-105.

## Implementation

The successful completion of this project will result in a fully operational continuous resonant acoustic chemical production facility at NSWC IHEODTD, capable of continuously manufacturing energetic materials and their precursors whose synthesis involves the problematic precipitation of solids during the reaction. While the RACMR will be developed to produce DAPO as part of this initiative, it will be adaptable to produce other energetic materials and their precursors as well.





# RepTech Projects

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# Innovative Repair for Legacy Missile Decoy Systems

RT2769 — Corrosion Repair of Missile Decoy Systems



PERIOD OF PERFORMANCE:  
November 2017 to June 2019

PLATFORM:  
RepTech

CENTER OF EXCELLENCE:  
iMAST

POINT OF CONTACT:  
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(814) 863-3880  
tdb14@arl.psu.edu

STAKEHOLDER:  
Naval Surface Warfare Center – Crane  
Division COM

TOTAL MANTECH INVESTMENT:  
\$156,000

## Objective

The successful completion of this project provided repair processes for Mk-36, 53, 59, and 234 decoy launching systems; the components were fabricated from Al-6061 and suffered from corrosion damage during use. Furthermore, the components were expensive to repair and required long lead times to replace. Many of the repairs had to be performed outside of the United States due to international agreement with allied nations. An efficient and economical repair process greatly reduced operating costs, increased system availability, and reduced repair times.

The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project was to develop and transition cold spray repair processes to the Department of the Navy (DoN), Naval Surface Warfare Center, Crane, and its support contractor to repair decoy launching systems.

## Payoff

Cold spray technology is rapidly growing in Department of Defense applications. DoN has been proactively and successfully implementing this technology in innovative applications as a repair for components that previously could not be returned to service. Benefits that resulted from this project include reduced repair time and cost and improved readiness, and a repair process that can be used on similar Al-6061 components. The estimated cost avoidance for the first five years of implementation is \$4.6M for a return on investment of 21:1.

## Implementation

The repair process developed through this project will be implemented through a Crane-selected cold spray vendor or the Norfolk Naval Shipyard (NNSY) in collaboration with the Mid-Atlantic Regional Maintenance Center. A cold spray system has been installed at NNSY. Detailed repair processes and qualifications have been developed following Uniform Industrial Process Instruction (UIPI) 6320-901. Implementation is expected in FY20.



# Marine Corps Depot Uses Simulation to Improve Resource Planning and Reduce Costs

RT2770 — Marine Corps Depot Workflow Modeling

## Objective

The U.S. Marine Corps depot in Albany, GA, performs maintenance on all types of Marine Corps vehicles and needs to accomplish this mission in a timely, cost-effective manner. On a regular basis, the depot has to contend with fluctuating workloads, increasing costs, resource constraints, unpredictable lead times for repair parts, and pressure to decrease costs and turnaround times for vehicles that come in for maintenance. Given these issues, the depot needs to be proficient at determining the resources required to support its workload. “Resources” at a depot consist of three things: space, equipment, and personnel. The challenge of determining the optimal combination of resources to support a forecasted workload is complicated by the variation and uncertainty that is inherent in a depot maintenance environment. Variation and uncertainty in tasks and task durations make it difficult to determine what resources are needed, when they are needed, and for how long they are needed. Additional complications include variations in workload forecasts, changing workload priorities, uncertainty in the condition of incoming vehicles, high employee turnover, long lead times for spare parts, and uncertain funding availability.

The Institute for Manufacturing and Sustainment Technologies (iMAST) developed a “Workflow Analysis & Resource Planning System” that enables the depot to quickly estimate the resource levels needed to meet specified workload levels. The software tool measures the depot’s capacity, evaluates its material flow, identifies its bottleneck operations, calculates resource utilizations, determines throughput, and assesses overall efficiency. With this tool, depot management will be able to run different experiments to test the impact of changes in operations, workload, schedules, layouts, or routings, and make strategic decisions that will improve operational performance and cost.

## Payoff

The Workflow Analysis & Resource Planning System will identify and eliminate bottlenecks in depot operations. This will reduce excess material handling and waiting, and improve the utilization of resources. These improvements are expected to result in a 2-percent decrease in annual labor costs, or \$1.4M per year. With a project cost of \$525K and an estimated implementation cost of \$100K, this yields a five-year return on investment of 10:1.

## Implementation

The Workflow Analysis & Resource Planning System software application will be implemented at the Marine Corps depot in Albany, GA, in the second quarter of 2020. The Marine Depot Maintenance Command (MDMC), supported by the Marine Corps Logistics Command (LOGCOM), will install and use the system. Preparations for implementation have already begun, with LOGCOM selecting Arena® simulation modeling software and submitting it for cybersecurity approval by the Marine Corps. iMAST has conducted several training classes on simulation modeling with Arena® for MDMC and LOGCOM personnel and has developed an Arena® User’s Guide to assist the Marine Corps engineers who will support the system.



PERIOD OF PERFORMANCE:  
December 2017 to December 2019

PLATFORM:  
RepTech

CENTER OF EXCELLENCE:  
iMAST

POINT OF CONTACT:  
Mr. Timothy D. Bair  
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tdb14@arl.psu.edu

STAKEHOLDER:  
Marine Corps Logistics Command  
(LOGCOM)

TOTAL MANTECH INVESTMENT:  
\$525,000



## Cable Installation Tool Expected to Save Approximately \$15M on First Use



PERIOD OF PERFORMANCE:  
May 2017 to June 2019

PLATFORM:  
RepTech

CENTER OF EXCELLENCE:  
iMAST

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STAKEHOLDER:  
PSNS, NAVSEA 04X3 Tactical In-  
novation Implementation Lab (TIIL),  
SEA 04X

TOTAL MANTECH INVESTMENT:  
\$120,000



### RTR2786 — Synchronized Cable Feeding System

#### Objective

Faced with a large, schedule-busting cable installation project, Portsmouth Naval Shipyard (PSNS) conceived an alternative approach to the manual “pull-loop-band-move-pull-loop-band-move” (etc.) technique. The new process reduces stress on the cable to levels below those induced during manual installation. Using multiple hand-cranked feeder-rollers and idler-rollers, PSNS demonstrated the ability to simultaneously push and pull the cable while snaking it through a series of turns. Before PSNS could use the system, it needed to figure out how to satisfy Note 1.10 of USS SEAWOLF Class DWG 6404832 which states: “Cables shall be installed taut in cableways without mechanical means such as rope or chain-falls.” Rope and chain-falls can only pull on cable, risking damage to internal conductors. The key to success was to develop a system that simultaneously pulls and pushes the cable at each drive-point and synchronizes all drive points, so the system does not stretch or compress the cable between the drive points.

The Institute for Manufacturing and Sustainment Technologies (iMAST) developed a Synchronized Cable Feeding System (SCFS) that interfaced with the PSNS drive-roller and idler-roller prototypes. iMAST designed, fabricated, demonstrated, and delivered a six-motor system in which all of the motors turned at the exact same rpm. PSNS demonstrated the system on a full-scale mockup to the technical warrant holder (TWH) nearly a year before the scheduled project date. Based on the strength of this demonstration, the TWH provided written approval for the new process, concluding the SCFS does not violate the intent of Note 1.10.

#### Payoff

PSNS estimated that the SCFS will reduce the cable installation schedule for the FY19 task by 89 working shifts, saving 790 man-days of labor and 70 days of schedule time. Including the cost avoidance associated with late undocking, the total cost savings for the FY19 cable installation task exceeded \$15M, netting a one-year return on investment of 128:1.

#### Implementation

iMAST developed (designed, fabricated, tested, and delivered) a six motor, synchronized cable feeding system that addressed PSNS’s immediate need for the July 2019 cable installation project. Providing a full technical data package was beyond the scope of this \$120K Rapid Response project.

## Radome Restoration Improves Reliability and Reduces Cost

RT2810 — AN/SPS-67(V)3/5 Radar Radome Surface Restoration

### Objective

There are 67 AN/SPS-67(V)3/5 radar systems in-service within the Navy fleet. The antennae are refurbished every four years. Refurbishing the 67's radome material has become problematic and labor-intensive due to an inability for radomes to pass radio frequency (RF) acceptance testing after refurbishment. The purchase of new radomes is prohibitively expensive due to their complex honeycomb composite structure.

The current refurbishment procedure requires hand-sanding and painting of composite radomes. These radomes are large flat panels, and the current procedure produces variations in the thickness of the radome and surface texture during each refurbishment, negatively impacting performance. This process also leads to inconsistencies in the paint thickness and ultimately damage to the radome, as hand-sanding, by nature, is inconsistent.

The Institute for Manufacturing and Sustainment Technologies (iMAST) is developing an alternative refurbishment procedure and identifying a coating system that will eliminate unnecessary iterations during refurbishment. This project is investigating alternative coating removal systems (e.g., laser ablation, soda blasting, sponge blasting, etc.) to replace inconsistent hand-sanding. The project also includes alternative coating systems that will be more uniform to achieve an increase in service life and/or improved removal without sacrificing performance.

Additionally, iMAST is investigating the potential use of a radome boot to act as the paint substrate and end the refurbishment of the radome structure for the life of the part. The clear boot will protect the coated surface from abrasion, UV, and other wear without affecting radar performance. This will further reduce refurbishment costs and help to eliminate future inconsistencies and iterations of radome testing, as radomes will be untouched during system overhaul.

### Payoff

This project will extend the life expectancy of radomes, reduce the labor costs associated with the current refurbishment procedure, and decrease the overall number of radomes that are being scrapped each year. All changes will require an engineering change proposal (ECP) II that must be approved by the stakeholder before final implementation.

### Implementation

Implementation will occur when a refined refurbishment process has been developed and successfully tested on a AN/SPS-67(V)3/5 radome. Concurrently, if the use of a radome boot is found to be transparent to radome signal without degradation of performance, a radome boot will be designed for the radar system. Once either or both of these solutions are determined to be effective without degradation of performance, the procedures and materials will be moved to implementation. This must be approved by the Program Office, Naval Surface Warfare Center-Crane. It will likely require a variance but could escalate to a Class II ECP.



PERIOD OF PERFORMANCE:  
November 2018 to June 2020

PLATFORM:  
RepTech

CENTER OF EXCELLENCE:  
iMAST

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STAKEHOLDER:  
PEO-IWS 2.0

TOTAL MANTECH INVESTMENT:  
\$259,000



# Repair of AAV Hydrostatic Steering Units Offers Five-Year Cost Avoidance of \$10.25M



**PERIOD OF PERFORMANCE:**  
December 2018 to September 2019

**PLATFORM:**  
RepTech

**CENTER OF EXCELLENCE:**  
iMAST

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**STAKEHOLDER:**  
AAV Program Office, NAVSEA Other

**TOTAL MANTECH INVESTMENT:**  
\$90,000



RTR2811 — Repair of AAV Hydrostatic Steering Units

## Objective

The successful completion of this project provided a repair for the AAV Hydrostatic Steering Units (HSUs). The HSUs are ductile cast iron and have stringent flatness requirements to achieve the pressure for operation. During extended use, the HSUs warp and cannot maintain the operating pressure. The HSUs are removed from the vehicle and shipped to the Marine Depot in Albany, GA, where the critical face is precision ground or honed to reach the required flatness. Eventually, enough material is removed from the critical surface that the HSUs no longer meet dimensional requirements and must be removed from service. The HSUs are no longer in production, and there is no approved repair process. The purchase of new units requires the vendor to set-up the manufacturing process and produce new parts, which can take up to 18 months. An efficient and economical repair process would greatly reduce operating costs, increase system availability, and reduce repair times.

The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project was to develop and transition cold spray repair processes to the Department of the Navy (DoN), Naval Surface Warfare Center-Crane, and its support contractors to repair the AAV HSUs.

## Payoff

Cold spray technology was used to repair the AAV HSUs. Cold spray technology has been implemented for many different Department of Defense applications. The DoN successfully implemented this technology for innovative additive repair of components that could not previously be returned to service. Benefits that resulted from this project include an approved process for ductile cast iron, reduced repair time and cost, and improved readiness. The estimated cost avoidance for the first five years of implementation is \$10.25M for a return on investment of 19.6:1.

## Implementation

The repair process developed through this project will be implemented through the Marine Depot Maintenance Command or an approved vendor. Detailed repair processes and qualifications will be developed following Uniform Industrial Process Instruction 6320-901. Implementation is expected in FY20.

# Investigating Laser Ablation of Aluminum Alloys for Restoration and Increased Corrosion Resistance

RT2825 — Radar System Parts Laser Ablation and Passivation

## Objective

Naval Surface Warfare Center-Crane (NSWC-Crane) uses media blasting during the overhaul of SPS-48E radar antenna to remove paint and corrosion. This process is labor-intensive and uses consumable media. Additionally, the aluminum components of the SPS-48E radar system are treated with a hexavalent chromium (Cr+6) conversion coating as a corrosion barrier and to enhance paint adhesion. Cr+6 is a health risk that requires special treatment. Consequently, consumable media must be replaced frequently and treated as hazardous waste. Media blasting can also cause warpage, damage, and pin-holing of critical components, thereby reducing life expectancy and causing inspection failures.

The Institute for Manufacturing and Sustainment Technology (iMAST) is testing and developing laser ablation and hyper-passivation processes for aluminum components utilizing commercial-off-the-shelf systems. A key benefit of laser ablation is the capability to remove multiple layers of paint efficiently with minimal waste and limited exposure to Cr+6. In addition to increasing operator safety, laser ablation can be fully automated, thus reducing labor hours and the risk of damage.

iMAST is also exploring the potential that a laser ablation process may also passivate the surface by changing the pulse length and intensity to create a thick aluminum oxide layer on the surface. This process is known as hyper-passivation. The thick oxide layer creates an excellent barrier for corrosion and would allow for the removal of the hazardous Cr+6 dip on aluminum components. By adding this processing step to current procedures, it innovatively reduces health risks while increasing corrosion resistance, enhancing paint adhesion, and removing a hazardous step from the refurbishment process.

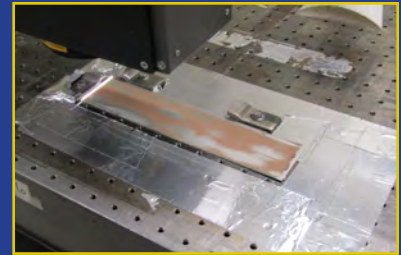
## Payoff

The benefits of this project include reduced labor, exposure to hazardous chemicals, and waste. Potential additional savings may be realized by extending life expectancy of components and increasing refurbishment periodicity. Pending successful completion of testing, the passivation effect will proliferate to numerous additional aluminum structures and components.

## Implementation

NSWC-Crane and In-Service Engineering Agent will ensure that the required metrics are achieved. This project will compare the cost of updated procedures to legacy procedures and the material properties post-laser processing to determine detrimental effects and cost savings. Both of these metrics are important to justify a business case that has both near-term cost reduction and longer-term cost avoidance implications.

This project will implement an innovative, state-of-the-art system at NSWC-Crane that will reduce cost and increase the performance and life expectancy of components. NSWC-Crane is looking to be a leading innovator in the implementation of laser ablation for the Navy fleet, and with PEO IWS's support, believes that laser ablation is part of the future of refurbishment at the depot. Expected implementation will occur in November 2020.



PERIOD OF PERFORMANCE:  
February 2019 to September 2020

PLATFORM:  
RepTech

CENTER OF EXCELLENCE:  
iMAST

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STAKEHOLDER:  
PEO-IWS 2.0

TOTAL MANTECH INVESTMENT:  
\$325,000







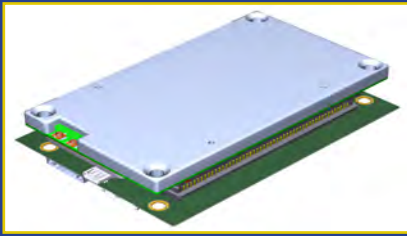
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# ManTech Supports Swarm Technology to Enhance Capability and Reduce Cost of TX2CB



**PERIOD OF PERFORMANCE:**  
February 2019 to November 2019

**PLATFORM:**  
Capability Acceleration

**CENTER OF EXCELLENCE:**  
EMPF

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**STAKEHOLDER:**  
ONR Code 35, AVMC

**TOTAL MANTECH INVESTMENT:**  
\$709,000

## M2815 — Swarm TX2CB Development Support

### Objective

Swarm is a strategic Science and Technology program funded and managed by the Office of Naval Research (ONR) Code 35, Aviation, Force Projection and Integrated Defense. Swarm is supported by the Deputy Assistant Secretary of the Navy (RDT&E), and many other government stakeholders, including significant interest by each Department of Defense service. The overarching goal of swarm is to develop required fundamental technologies to ultimately deploy groups of inexpensive, unmanned drones, i.e., swarms, that conduct operational missions such as intelligence gathering, reconnaissance, fire control designation, and strike, among many others.

The TX2 Carrier Board (TX2CB) is an electronic circuit board integrated within various swarm drones that interfaces with peripheral electronic subsystems, such as the forward looking infra-red sensor, gimbal electronics, and other drone control devices. The TX2CB contains programmable electronics, including a Tegra TX2 module and Artix-7 Field Programmable Gate Array. Code 35 has engaged the U.S. Army Aviation and Missile Center (AVMC) Precision Target Acquisition Seeker Team to design a baseline TX2CB for a designated subset of swarm drones, which will be designated government-furnished equipment.

### Payoff

The project will result in the development of an initial prototype and a subsequent production run of 10 TX2CB units to be implemented in the Code 35 swarm exercises. The project outcome will yield multiple benefits, including increased swarm performance through enhanced capabilities and the potential for a reduced unit cost at production rates.

### Implementation

The AVMC baseline TX2CB design concluded in the fourth quarter of 2018, followed by single digit production of prototype TX2CBs with initial engineering assessments. Project activities focused chiefly on planning and preparation of the TX2CB production; mitigating component procurement risks; and laying the foundation for efficient prototype design, manufacturing, and test cycles as requirements continue to evolve and mature. Electronics Manufacturing Productivity Facility (EMPF) is providing collaborative ManTech support to AVMC with the primary goals of optimizing its baseline TX2CB design for manufacturability, component supply chain, capabilities evolution, and other engineering parameters as deemed appropriate throughout the project's duration concurrent with TX2CB design completion, evaluation, prototype, and low-rate initial production (LRIP). EMPF will also research the feasibility of various material sets and printed circuit board constructions to improve operational performance and potentially reduce the cost of the TX2CB.

Ultimately, EMPF will conduct a production run of 100 TX2CB units per the AVMC baseline design schematics and engineering parameters using ACI Technologies' in-house Surface Mount Technology Manufacturing Factory resources. EMPF will provide relevant quality assessment of all finished LRIP TX2CB units.

# ManTech Supports Swarm Technology for Software Defined Radio

M2816 — Swarm Software Defined Radio (SDR) Development Support

## Objective

Swarm is a strategic Science and Technology program funded and managed by the Office of Naval Research (ONR) Code 35, Aviation, Force Projection and Integrated Defense. Swarm is supported by the Deputy Assistant Secretary of the Navy (RDT&E), and many other government stakeholders, including significant interest by each Department of Defense service. The overarching goal of swarm is to develop required fundamental technologies to ultimately deploy groups of inexpensive, unmanned drones, i.e., swarms, that conduct operational missions such as intelligence gathering, reconnaissance, fire control designation, and strike, among many others.

Code 35 has engaged Georgia Tech Research Institute (GTRI) to design a baseline software defined radio (SDR) for a subset of swarm drones, which will be designated government-furnished equipment and progress to a modular design that delineates radio frequency wireless functions from digital processing functions joined by an industry standard A/D interface. GTRI is designing the baseline SDR, which will incorporate a separate Air Force min-crypto board to accommodate the transmit and receive encryption radio requirement.

## Payoff

The 12-month Electronics Manufacturing Productivity Facility (EMPF) project will develop an initial prototype and a subsequent production run of 20 SDR units to be implemented in the Code 35 swarm exercises. The project outcome will yield multiple benefits, including increased swarm performance through enhanced capabilities and the potential for a reduced unit cost at production rates.

## Implementation

The GTRI design concluded in FY19, followed by single-digit production of prototype SDRs and initial engineering assessments. Project activities will focus chiefly on planning and preparation for the SDR production; mitigating component procurement risks; and laying the foundation for efficient prototype design, manufacturing, and test cycles as requirements continue to evolve and mature. EMPF is providing collaborative ManTech support to GTRI with the primary goals of optimizing its baseline SDR design for manufacturability, component supply chain, capabilities evolution, and other engineering parameters as deemed appropriate throughout the project duration concurrent with SDR design completion, evaluation, prototype, and low-rate initial production (LRIP).



PERIOD OF PERFORMANCE:  
February 2019 to February 2020

PLATFORM:  
Capability Acceleration

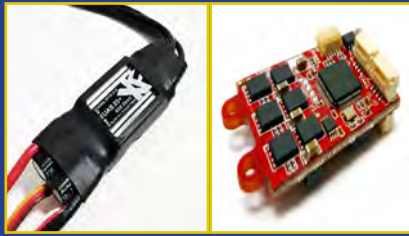
CENTER OF EXCELLENCE:  
EMPF

POINT OF CONTACT:  
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STAKEHOLDER:  
ONR Code 35, GTRI

TOTAL MANTECH INVESTMENT:  
\$733,000

# ManTech Supports Swarm Technology for Electronic Speed Controller



PERIOD OF PERFORMANCE:  
July 2019 to July 2020

PLATFORM:  
Capability Acceleration

CENTER OF EXCELLENCE:  
EMPF

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STAKEHOLDER:  
ONR Code 35

TOTAL MANTECH INVESTMENT:  
\$748,000

M2842 — Swarm Electronic Speed Controller (ESC) Development Support

## Objective

Swarm is a strategic Science and Technology program funded and managed by the Office of Naval Research (ONR) Code 35, Aviation, Force Projection and Integrated Defense. Swarm is supported by the Deputy Assistant Secretary of the Navy (RDT&E) and many other government stakeholders, including significant interest by each Department of Defense service. The overarching goal of swarm is to develop required fundamental technologies to ultimately deploy groups of inexpensive, unmanned drones, i.e., swarms, that conduct operational missions such as intelligence gathering, reconnaissance, fire control designation, and strike, among many others.

The project's primary goal is to review a commercial-off-the-shelf design to use as the foundational starting point for a domestically sourced electronic speed controller (ESC) baseline design with suitable ManTech enhancements to promote affordable high-rate manufacturing, future capabilities evolution, and well-understood, risk-mitigated component supply chains. The engineering enhancement effort will bring the design under more direct government control, eliminating the need to license intellectual property.

## Payoff

The 12-month Electronics Manufacturing Productivity Facility (EMPF) project will result in the development of six fully operational prototype ESC units and a subsequent production run of 32 ManTech-enhanced ESC units to be implemented in the ONR Code 35 swarm exercises. The project outcome will yield multiple benefits, including increased swarm performance through enhanced capabilities and the potential for a reduced unit cost at production rates.

## Implementation

Project activities will focus chiefly on planning and preparation for the ESC production; mitigating component procurement risks; and laying the foundation for efficient prototype design, manufacturing, and test cycles as requirements continue to evolve and mature. EMPF is providing collaborative ManTech support with the primary goals of optimizing the baseline ESC design for manufacturability and component supply chain, capabilities evolution, and other engineering parameters as deemed appropriate throughout the scheduled 12-month duration concurrent with ESC design completion, evaluation, prototype, and low-rate initial production. EMPF will also research the feasibility of various material sets and printed circuit board constructions to improve operational performance and potentially reduce the cost of the ESC. Feasibility research will include investigating various processing architectures to enhance future swarm capabilities.

Ultimately, EMPF will conduct a production run of 32 ManTech-enhanced ESC units using the design schematics and engineering parameters developed under the project.



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