NAVY MANTECH

Manufacturing Technology Program

Office of Naval Research Science & Technology

Transitioning advanced manufacturing technology and accelerating capabilities for an affordable fleet

FY2023 – FY2024 Navy Manufacturing Technology Project Book

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On the front cover — PHILIPPINE SEA (Sept. 25, 2020) From left, USNS Sacagawea (T-AKE 2), USS Germantown (LSD 42), USNS John Ericsson (T-AO 194), USS Antietam (CG 54), USS Ronald Reagan (CVN 76), USS America (LHA 6), USS Shiloh (CG 67), USS New Orleans (LPD 18) and USS Comstock (LSD 45) steam in formation while E/A-18G Growlers, FA-18E Super Hornets and an E-2D Hawkeye from Carrier Air Wing (CVW) 5 fly over in support of Valiant Shield 2020. Valiant Shield is a U.S. only, biennial field training exercise (FTX) with a focus on integration of joint training in a blue-water environment among U.S. forces. This training enables real-world proficiency in sustaining joint forces through detecting, locating, tracking and engaging units at sea, in the air, on land and in cyberspace in response to a range of mission areas. (U.S. Navy photo by Lt. Lauren Chatmas)

Contents

FY2023-FY2024 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 FY2023-FY2024. 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.

Projects by Platform:

Index:

There have been many changes to the ManTech Program since the last publication of the ManTech Points of Contact Directory. We have welcomed new faces to the ManTech community as well as said fond farewells to others. What has not changed, however, is ManTech's commitment to its mission: transitioning affordable technologies and accelerating capabilities to the fleet. FY2025 brings continued emphasis on the two key components of the ManTech investment strategy: major acquisition platform affordability and capability acceleration to get capabilities to the fleet faster.

ManTech will continue to play a significant role in providing cost savings to the VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), DDG 51 Class destroyer, CVN 78 Class aircraft carrier, FFG 62 Class frigate and the F-35 Lightning II aircraft and help these platforms meet their affordability goals. Navy ManTech will also focus efforts on PEO IWS weapon systems that support the ship platforms in our investment strategy. ManTech affordability highlights for this year include developing a system integrating automated machine learning and schedule optimization which was implemented at Newport News Shipbuilding and Ingalls in FY2024 resulting in a savings of nearly $21.0M over the initial five years of use and supplementing conventional predictive maintenance with advanced Industrial Internet of Things technology to automatically communicate impending faults and failures of critical assets for near-continuous health monitoring of critical path VIRGINA and COUMBIA Class manufacturing equipment, saving the Navy over $7.0M over five years after implementation at General Dynamics Electric Boat in FY2025.

ManTech's capability acceleration efforts will continue to support the Chief of Naval Operations' direction to get capabilities to the fleet faster. Our primary thrust areas include sustainment technology, energetics production support, advanced submarine fabrication technology, unmanned / autonomous vehicle production, directed energy, hypersonics fabrication and other ONR manufacturing maturation.

For more information about Navy ManTech's sustainment focus and three sustainment highlights, please read pages 18-19 in this directory.

I am excited about Navy ManTech's future and our ability to help major Navy platforms meet their affordability goals for acquisition, maintenance and sustainment. I look forward to working with all of you as we continue to improve manufacturing technologies and provide great benefit to the Navy and the DoD.

Neil A. Graf
Manufacturing Technology (ManTech) Lead / Program Officer
ONR Navy ManTech Program

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.

The Navy ManTech Program is managed by Code 33, Sea Warfare and Weapons Department, of the Office of Naval Research (ONR).

Since FY07, the Navy ManTech Program has been focused on affordability improvements for key acquisition platforms. In addition, Navy ManTech has recently supported efforts to accelerate the delivery of capabilities to the fleet.

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 our Navy customers and our industry partners, 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 68 of the portfolio's projects have been implemented, or are in the process of being implemented, resulting in real acquisition cost savings of approximately $45.5M per hull, verified by our industrial partners and PMS 450.

The directors of the ManTech programs of the Army, Navy, Air Force, Defense Logistics Agency, Missile Defense Agency and Office of the Secretary of Defense (OSD) coordinate their programs through the auspices of the congressionally chartered Joint Defense Manufacturing Technology Panel (JDMTP) with ex-officio representation from agencies such as the Department of Commerce and the Department of Energy. The JDMTP is organized to identify and integrate requirements, conduct joint program planning and develop joint strategies. Although the JDMTP has a shared strategic vision, technical projects and initiatives are selected, executed and managed separately through each service or agency ManTech program.

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 aircraft and FFG 62 Class frigate, as well as PEO Integrated Warfare Systems (IWS) weapon systems for the ship classes.

Navy ManTech also supports select manufacturing technology projects that accelerate the delivery of capabilities to the Navy. Our eight primary thrust areas include sustainment technology, energetics production support, advanced submarine technology fabrication, future (major) acquisition platform support, unmanned / autonomous vehicle production, directed energy, hypersonics fabrication and other ONR manufacturing maturation.

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 Office and representative industry. The IPT meets regularly to coordinate and review the portfolio and to 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 / industry) criteria and goals for implementation and is available for use at industrial / naval organic facilities.
- **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 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 long-term view of implementation.

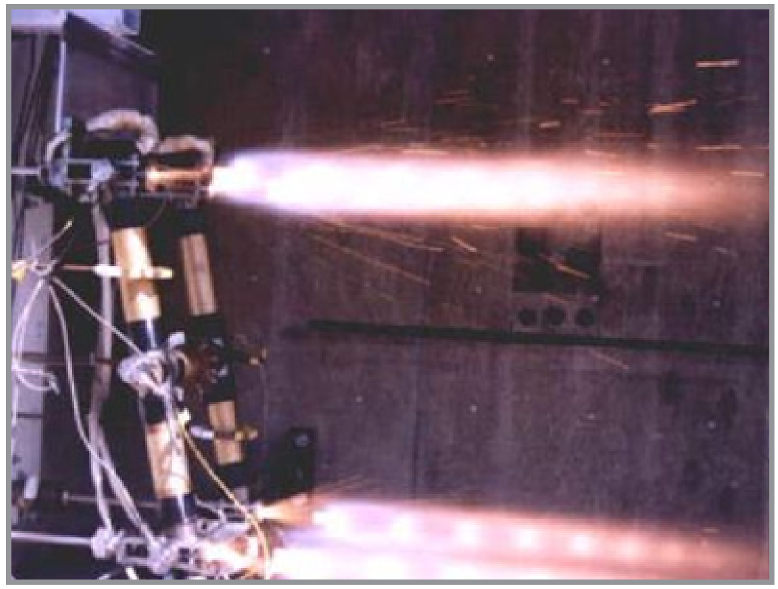
On a per-project basis, Technology Transition Plans (TTPs) document roles, responsibilities and required resources needed to achieve transition and implementation. TTPs highlight the path from the technology development that ManTech performs to implementation on the factory floor. TTPs are signed by Navy ManTech, the relevant COE Director, a management representative of the industrial facility where implementation will occur, the Program Office 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 scheduled 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 the 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. These assessments, which are verified by industry and the relevant Program Offices, 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. 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 the Energetics Manufacturing Technology Center (EMTC) can be found on Page 12.



Development of energetics manufacturing for primary explosives. *Courtesy of EMTC.*

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 on iMAST can be found on Page 12.

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 / 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
- 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 weapon platforms, while also collaborating with other relevant manufacturing industries. CNM utilizes a proven approach that blends a 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. 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: 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, Navy platform Program 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 active or in development for the VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), DDG 51 Class destroyer, CVN 78 Class aircraft carrier, FFG 62 Class frigate, F-35 Lightning II aircraft, MQ-25 Stingray unmanned aircraft and the XLUUV unmanned undersea vehicle.
CMTC web site: www.cmtc.ati.org

Navy ManTech Execution

Electronics Manufacturing Center (EMC)

Established in 2021, EMC is the ONR electronics COE located within the Penn State Applied Research Laboratory (ARL) in Freeport, PA. The core mission and function of the EMC are to identify, develop and facilitate the transition of electronics manufacturing technologies to reduce the cost and time to deploy electrical and electronic (digital and analog) systems as well as the supporting power storage and distribution infrastructure to naval ships, aircraft, submarines and unmanned systems. EMC personnel and technical contributors are experienced in most facets of electronics manufacturing and include experts from ARL, Pennsylvania State University and collaborators in the electronics manufacturing industry. The EMC facility has multiple laboratories dedicated to technology research and development, offices and meeting rooms and spaces to perform DoD-specified work.

EMC web site: www.arl.psu.edu/emc/

Electro-Optics Center (EOC)

The Electro-Optics Center (EOC) operates within the Penn State Applied Research Laboratory (ARL) and has served as Navy ManTech's COE for electro-optics since 1999. EOC's mission is to transition new electro-optics technologies and applications to Navy-selected focus platforms, through strong technical interactions with DoD and its industrial base, demonstrating acquisition cost and/or life-cycle cost savings and accelerating capabilities to the warfighter. EOC generally focuses its projects in one of three technical areas: manufacturing of electro-optics, manufacturing using electro-optics and electro-optics manufacturing systems.

EOC is comprised primarily of former industry and DoD personnel and maintains technical competencies in laser systems, imaging sensors and systems, fiber optics and photonics and electro-optics manufacturing technology. Located in Freeport, PA, EOC collaborates with electro-optics companies throughout the United States. EOC also supports important DoD technology thrusts and programs of national interest, such as the design, analysis and testing of advanced laser weapons systems. As a University Affiliated Research Center, Penn State's ARL maintains essential research, development and engineering core capabilities; maintains long-term strategic relationships with DoD sponsors; and operates in the public interest, free from real or perceived conflicts of interest.

EOC web site: www.eoc.psu.edu

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 / subsystem acquisition and production requirements and the energetics industry. EMTC has a full understanding of the inherent dangers of energetics and the need for special processes, equipment, facilities, environmental considerations and safety precautions required for manufacturing.

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-based needs, develops and demonstrates the required manufacturing process technology solutions and transitions successful results that ultimately benefit the warfighter.
EMTC web site: go.usa.gov/xMBqg

Institute for Manufacturing and Sustainment Technologies (iMAST)

Established in 1995, iMAST executes and oversees the Navy ManTech mission 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, metals and polymer additive manufacturing, advanced composites, digital manufacturing, coatings removal and surface preparation, complex systems monitoring and repair / sustainment.

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: https://www.arl.psu.edu/imast

Navy ManTech Execution

Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

Established in 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 weapon platforms. The NSAM Center works closely with the Navy's acquisition and sustainment 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: https://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:

Program Web site

The **Navy ManTech Program web site** can be accessed at https://www.onr.navy.mil/work-with-us/navy-mantech. The web site is a central source to access general information about program activities and participation, developments 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.

Defense Manufacturing Conference

The annual **Defense Manufacturing Conference (DMC)** is a forum to present and discuss initiatives that address DoD manufacturing technology and related sustainment and readiness needs. The conference includes briefings on current and planned programs, funding, DoD initiatives and seminars related to the various technology thrusts currently being pursued.

ShipTech

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. **ShipTech's** 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.

Project Book

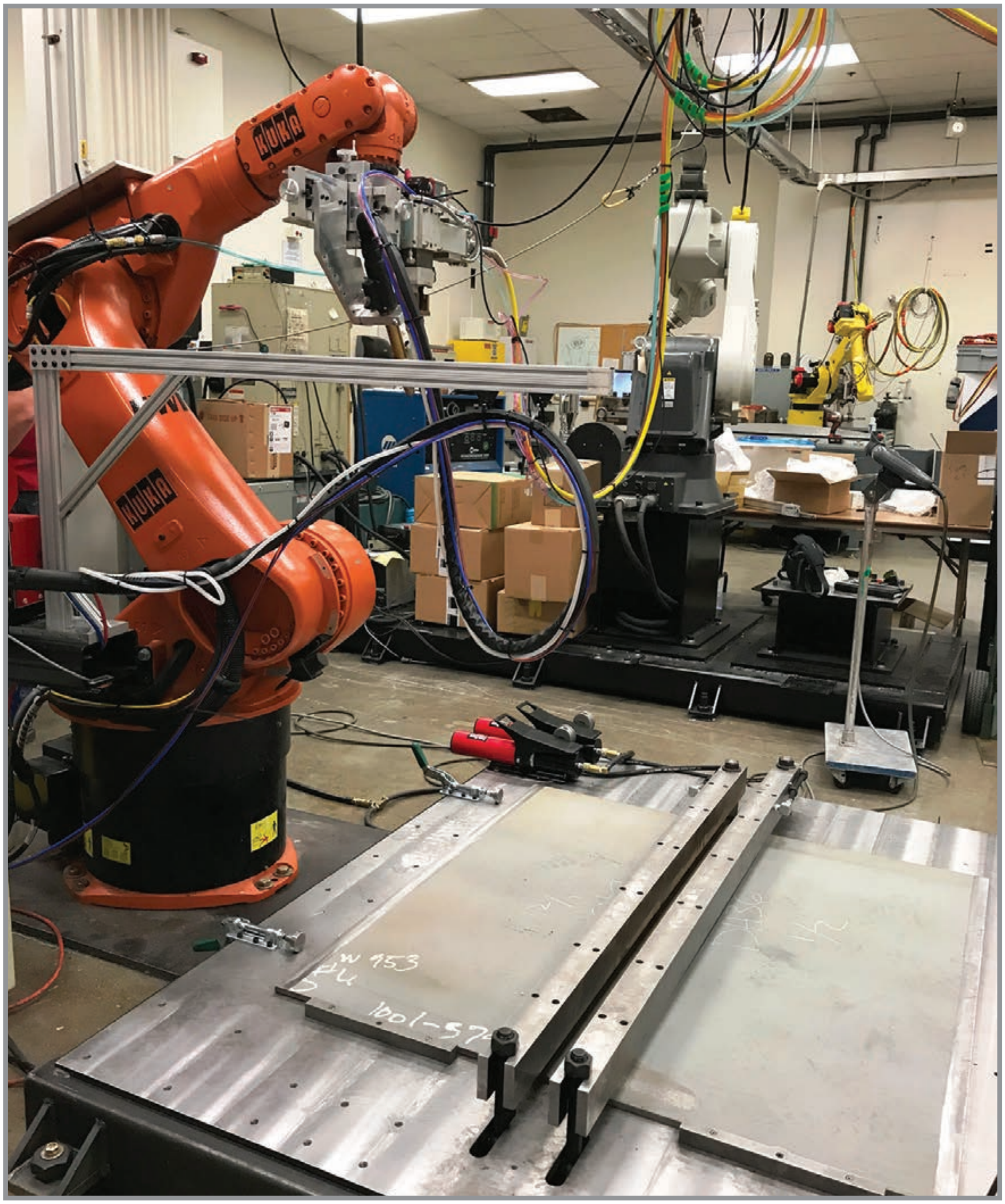
The **Navy ManTech Project Book**, which is published annually, provides a snapshot of Navy ManTech projects active during the previous fiscal year. Points of contact for each project are provided to facilitate technology transfer.

Centers of Excellence

Navy ManTech COEs 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 is 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.

Navy ManTech's S

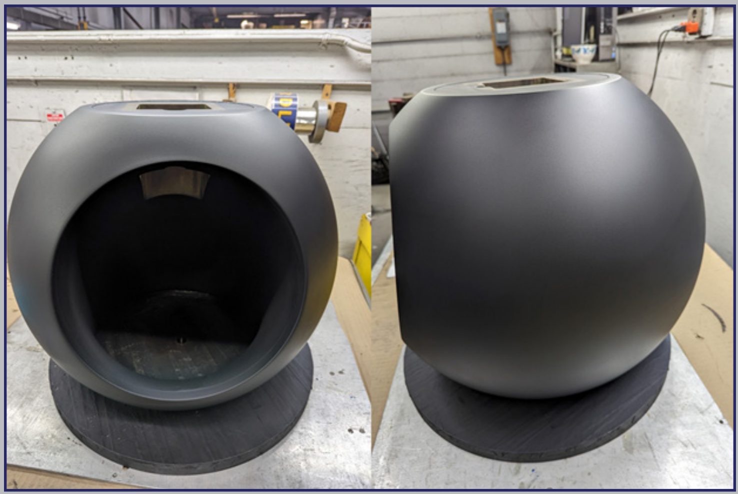
Mission Statement

ManTech's sustainment efforts focus on advancing cutting-edge repair and sustainment technologies to maximize the readiness and resilience of Navy systems. In alignment with Navy priorities, ManTech focuses on delivering adaptable, affordable, and high-performance sustainment solutions that directly support the Navy's warfighting edge. Through innovations in manufacturing processes, data-driven sustainment, and strategic partnerships, ManTech helps ensure the fleet remains fully prepared for distributed maritime and air operations, providing warfighters with mission-ready, reliable assets in support of the Navy's strategic goals. Navy ManTech prioritizes flexibility to ensure responsiveness to critical needs as they arise.

ManTech executes its sustainment strategy on a number of fronts – through ManTech Centers of Excellence both on the affordability platforms supported by the ManTech Investment Strategy and through Capability Acceleration efforts which aim to deliver capability to the warfighter more rapidly as well as through its Repair Technology (RepTech) program located at the Institute for Manufacturing and Sustainment Technologies (iMAST).

Two recent ManTech sustainment efforts include:

RT2837 Large Diamater Ball Valve Improvements



The current coating on large diameter submarine seawater valve balls is failing prematurely, resulting in calcareous deposits from marine growth, high operating torque conditions, and emergent repairs at significant cost. This iMAST RepTech project has developed and is testing / evaluating a potential replacement coating system and application process that improves the performance and life-cycle of seawater-system ball valves.

The ceramic coating application process has been optimized, tested under extreme conditions, and is expected to result in a Navy-owned solution that has life-of-boat reliability that can be applied to in-service 688 submarines, VIRGINIA Class submarines (VCS), ships, submersibles, ballistic, nuclear (SSBN) as well as new submarine construction (VCS and COLUMBIA Class submarine [CLB]). The total estimated life-cycle cost savings for VCS is approximately $80.6M. Additional cost savings can be realized with CLB at a minimum of $22.4M depending on the number of seawater ball valves.

Powder Blown Laser Directed Energy Deposition Repair

Knife-edge seal features on multiple Naval Air Systems Command (NAVAIR) engine platform components experience excessive wear during service, and repair options for these worn seal features are limited, leading to component scrap and replacement at high cost and long lead time.

This project is developing a qualified repair process using powder blown Laser Directed Energy Deposition (L-DED) for rotating engine components with knife edge seal features. iMAST, working with Naval Air Warfare Center Aircraft Division (NAWCAD) and Fleet Readiness Center East (FRCE), is developing and testing the powder blown L-DED process, integrating advanced in-situ monitoring to drive deposition standoff and adaptive path planning, and conducting full mechanical testing to provide the objective quality evidence needed for a qualified repair process.

The primary project benefit is the cost saving associated with approval of a repair process that can restore traditionally scrapped components in lieu of full part replacement. A Five-year cost savings of $2.3M are expected, resulting in a return on investment of nearly 2:1, with opportunity for significant growth if able to apply to other NAVAIR platforms and components. In addition, the repair process is expected to reduce lead time for component availability by 75 percent, thus increasing weapon system mission capability.

Navy ManTech – affordability improvements for key naval platforms: VIRGINIA Class submarine (VCS), F-35 Lightning II aircraft, COLUMBIA Class submarine (CLB), CVN 78 Class aircraft carrier, DDG 51 Class destroyer and FFG 62 Class frigate. *(Courtesy of PEO (Subs), PEO (JSF), PEO (Columbia), PEO (Aircraft Carriers), PEO (Ships) and ES3DStudios.)*

CVN 78 Class Aircraft Carriers Projects

CVN 78 Class Aircraft Carrier
(U.S. Navy image.)

Laser Ablation to Improve NNS Preconstruction Primer Removal Operations

PERIOD OF PERFORMANCE:
February FY2019
to September FY2024

PLATFORM:
CVN 78 Class aircraft carrier

CENTER OF EXCELLENCE:
Institute for Manufacturing
and Sustainment Technologies
(iMAST)

POINT OF CONTACT:
Mr. Ligetti
(814) 865-6531
iMAST@arl.psu.edu

STAKEHOLDER:
PMS 379

S2823 — Laser Ablation of PCP from HSLA Steel

Objective

In CVN 78 Class aircraft carrier construction, preconstruction primer (PCP) must be removed prior to welding. Needle guns, handheld or walk-behind grinders and abrasive blast equipment typically are used. These are dangerous, laborious processes that can be detrimental to the substrates and produce excessive waste materials. A substantial percentage of CVN 78 Class aircraft carrier steel fabrication labor is consumed in PCP removal at Huntington Ingalls Industries - Newport News Shipbuilding (NNS) in the Steel Production Facility (SPF). An unacceptable number of personnel injuries are experienced each year, surface erosion of the steel substrate is prevalent and cleanup and disposal costs for blast media are rising. Laser ablation can reduce these concerns, and widely supporting studies have led many defense and commercial industries to implement the technology already. For shipyards, implementation challenges (e.g., technical, procedural, training, safety, environmental and financial) may be overcome by appropriately identifying and carefully addressing application needs individually.

The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project is to develop and test a laser ablation removal process that will reduce the time to strip PCP, limit impact to the steel substrate and reduce labor and consumable costs. iMAST, working with NNS, has developed, tested and optimized a 1kW, pulsed fiber laser by IPG Photonics to remove PCP in various conditions (weathered and unweathered). Testing, per Technical Warrant Holder guidance, is underway to assist NNS with laser ablation qualification and implementation for semi- or fully-automated SPF applications in order to help support the rapid CVN 78 Class aircraft carrier construction schedule.

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 laser ablation implementation for automated PCP removal. Following full implementation of laser ablation at NNS, the five-year return on investment is expected to be approximately 2.0:1. This figure does not include quantified savings in material costs (e.g., abrasives) or cost avoidances related to injuries experienced using current PCP removal methods. Near the end of this project, NNS will provide an updated business case.

Implementation

Early estimates for implementation costs are nearly $3.0M, which include procurement of capital equipment; development of standard operating procedures and safety protocols / training; and equipment installation, debugging, and training. NNS anticipates the need for three to five laser ablation systems in the SPF and will begin transition with TWH approval for use and a positive final business case. The strategy for implementation has a timeline beginning in mid-FY2025.

Improved Weapons Elevator Manufacturing Will Increase Efficiency and Throughput

S2894 — Advanced Weapons Elevator – Modular Hatch Assembly

Objective

Huntington Ingalls Industries — Newport News Shipbuilding (NNS) has been constructing Ford Class aircraft carriers for over 10 years. An essential component of these carriers is the advanced weapons elevators (AWEs). These elevators are used to carry munitions and other mission critical items from deep within the carrier to the upper decks. The total build time for the elevators is five to six years with 130 milestones to build, outfit, groom and test. Each Ford Class aircraft carrier has 11 total AWEs.

This Center for Naval Metalworking (CNM) project is developing a method to build AWE doors and hatches modularly to reduce alignment issues and schedule delays. Building large modules in a shipboard environment presents many manufacturing challenges, including environmental factors and space constraints. Manufacturing the elevator modules in a shop environment, versus onboard the ship, will typically reduce labor costs by a factor of eight to one. Included in the deliverables for this project is a new process for manufacturing AWE modules, improved fixturing and jigs, a new manufacturing cell concept and new build plans. This effort will be accomplished in three phases. Phase I consists of requirements definition and concept summary. Phase II will perform design and engineering activities. Finally, Phase III will encompass construction and testing activities.

Payoff

By moving the build of the AWE modules to an earlier stage of construction, the projected five-year savings for CVN 78 Class Aircraft Carrier is $5.1M.

Implementation

The results of this project will be implemented partially on CVN 80 and CVN 81 in 2026. Preliminary plans indicate that full implementation of the equipment and methods will occur within 18 months of project completion in 1Q FY2026.

PERIOD OF PERFORMANCE:
September FY2022 to December FY2026

PLATFORM:
CVN 78 Class aircraft carrier

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

POINT OF CONTACT:
Mark Snider
(843) 760-3239
mark.snider@ati.org

STAKEHOLDER:
PMS 379

Thermal Insulating Coatings for Anti-Sweat Thermal Applications

PERIOD OF PERFORMANCE:
October FY2022 to March FY2025

PLATFORM:
CVN 78 Class aircraft carrier

CENTER OF EXCELLENCE:
Composite Manufacturing Technology Center (CMTC)

POINT OF CONTACT:
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STAKEHOLDER:
PMS 379

S2944 — Thermal Insulating Coatings (TIC)

Objective

The installation of traditionally formed insulation is labor-intensive, requiring manual application of adhesives and fitting each insulation piece individually. Approximately 210,000 linear feet of insulation is required for CVN 78 Class aircraft carrier non-nuclear piping systems alone. Over 1.5 million labor-hours were spent hand fitting pipe and ventilation insulation on CVN 78 Class aircraft carriers. Hand labor consumes 95 percent of the cost to install insulation.

The purpose of this Composites Manufacturing Technology Center (CMTC) project is to test and validate the service properties of thermal insulation products for insulation applications. Additionally, the project will develop new implementation requirements, including facility and equipment specifications, build strategies and in-service testing plans.

Payoff

The anticipated labor cost savings of a sprayable thermal insulating coating, as opposed to the current hand-fitted process, is approximately $25.0M per CVN, assuming a 50 percent replacement of formed insulation. Approved TIC will offer naval shipbuilding insulators that are currently unavailable, addressing the widespread chronic issues present in the fleet today.

Implementation

The primary challenge for successful implementation is reallocating labor resources from hand-applying insulation to applying coatings. This will include the need for new designated facilities, equipment, defined process lanes and the associated procedures governing the applications. Coating application is a standard practice in shipbuilding. The main focus of the training will be on the successful application of the new product to achieve the specified thicknesses and determining the optimal environment for this process. The target implementation platform will be CVN 80 / 81. The opportunity for implementation on CVN 80 will be dependent on when a thermal insulating coating may reach the approval stage. As a result, there may be a partial opportunity for CVN 80, along with a full opportunity for CVN 81 and other surface ship platforms in Q1 FY2025.

Integrate Automated Schedule Optimization and Machine Learning into Shipyard Artificial Intelligence

S2959 — Machine Learning (ML) and Schedule Optimization

Objective

The objective of this project is to integrate automated schedule optimization and machine learning (ML) into Shipyard Artificial Intelligence (AI) to create more robust construction schedules. This approach aims to shorten overall time spans for vessel blocks, improve communication with internal supply chain management and enhance considerations for efficiency and safety concerns. The technology developed within this project will not be limited to a single yard, but could be deployed, with the underlying Shipyard Artificial Intelligence software to other locations supporting Navy vessel production.

Long lead time items and vendor-supplied components have always played a critical role in vessel production and schedule adherence. Any effort to optimize schedule and production must include links that will inform both internal and external supply chain of construction need-by dates (CND) and, alternately, allow Supply Chain to inform Production Planning of changes in availability dates. The ability for Production Planning and Supply Chain to rapidly inform each other of CNDs, availability dates and subsequent changes will greatly work to reduce risk to schedule compliance.

The key objective of this Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project is for Optimization and Machine Learning (ML) to become a standard capability in support of CVN 78 Class aircraft carrier, VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), DDG 51 Class destroyer, Amphibious Assault Ship (LHA), National Security Cutter (NSC) and Amphibious Transport Dock (LPD) programs. Successful operation of the feature should not require a user to be an IT professional, but rather a typical shipyard planner. Bringing AI and ML into everyday use by shipyard personnel will be a major accomplishment for Newport News Shipbuilding (NNS), Huntington Ingalls Industries - Ingalls Shipbuilding (Ingalls), Naval Air Systems Command (NAVSEA) and the Navy ManTech Program.

Payoff

This project will have multiple avenues of return on investment (ROI), both quantitative and qualitative for NNS and Ingalls.

Total five-year savings at NNS are expected to be $7.3M for CVN, $5.0M for VCS and $3.4M for CLB for a total of $15.6M. For Ingalls, five-year savings for DDG 51 Class destroyer are expected to be $2.0M. The combined total five-year savings are expected to be $17.6M and a return on investment (ROI) of 6.56:1.

Implementation

This project was conducted in two phases and was successfully completed in 3Q FY2024. The solution developed though this project is anticipated to be implemented at Newport News Shipbuilding and Ingalls Shipbuilding facilities in Newport News, VA, and Pascagoula, MS, in 4Q FY2024.

PERIOD OF PERFORMANCE:
December FY2021 to April FY2024

PLATFORMS:
CVN Class aircraft carrier
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

POINT OF CONTACT:
Daniel Reed
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STAKEHOLDERS:
PMS 450
PMS 378
PMS 397
PEO Ships

Streamlining Abrasive Recovery with Autonomous Technology

PERIOD OF PERFORMANCE:
November FY2023 to November FY2026

PLATFORM:
CVN 78 Class aircraft carrier
VIRGINIA Class submarine (VCS)
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDERS:
PMS 378
PMS 450
PMS 400D

S3005 — Autonomous Abrasive Collection

Objective

Blasting processes are required in support of new construction shipbuilding efforts. Currently, spent blast abrasive is collected manually and placed into collection troughs, dumpsters, waste bins, barrels, drums, or bags for recycling / disposal. Huntington Ingalls Industries — Newport News Shipbuilding (NNS) tracked over 53,000 labor hours spent in 2021 on abrasive recovery in its Blast and Coat Facilities and estimates that over 4.8 million pounds of blast abrasive are collected each year throughout the shipyard. The objective of this project is to develop and deliver a prototype autonomous abrasive collection system to reduce the labor associated with this physically demanding, dirty and sometimes hazardous activity. The purpose of this Center for Naval Metalworking (CNM) project is to develop the prototype autonomous abrasive collection system into a commercial-off-the-shelf item that NNS or any shipyard will purchase and implement into their individual blast processes.

Payoff

The anticipated labor cost savings of an autonomous abrasive collection system, as opposed to the current manual process, is approximately $5.7M per CVN 78 Class aircraft carrier, $800K per VIRGINIA Class submarine (VCS) and $436K per DDG 51 Class destroyer hull.

Implementation

This project includes tasks to develop operational systems based on end use requirements defined by shipyards. The individual systems will be integrated into the final autonomous blast abrasive collection system. The integrated project team will develop the project test plan, which will highlight the activities necessary to execute the implementation plan. The executed test plan will validate that the autonomous abrasive collection system satisfies all defined requirements. The target implementation platforms for NNS are CVN 78 Class aircraft carrier and VCS hull 806 in 4Q FY2027. The target implementation platform at Huntington Ingalls Industries — Ingalls Shipbuilding is DDG 51 Class destroyer in 2Q FY2027.

DDG 51 Class Destroyer Projects

Enterprise Tool to Facilitate Electronic Diagram Usage

PERIOD OF PERFORMANCE:
May FY2019 to January FY2023

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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STAKEHOLDER:
PMS 400

S2802 — Advanced Diagram Development and Management

Objective

This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project was created to increase the quality of shipbuilding functional diagrams while decreasing the associated development labor. The project evaluates computer-aided design (CAD) software packages that are capable of mitigating labor-intensive aspects of functional diagram creation. The project consisted of two phases. The first phase included the identification of beneficial changes that are possible in the existing diagram development and maintenance processes, a summarization of hardware and software required to support these changes and research into commercial products to accomplish these changes. The second phase of the project included acquiring or developing the new software, then performing a pilot to validate the new process and demonstrate the new software.

In the first phase, current and future state functional diagram development and maintenance processes were mapped and analyzed to determine where process changes would be beneficial. From these proposed process changes, high-level project requirements were derived. Commercial product vendors and an internal software development group were interviewed and graded against the high-level requirements without consideration of cost in order to determine the best technical solution options. A field of over 100 external vendors was evaluated in a multiple stage process, eventually culminating in the detailed review of two external vendors.

In the second phase, software design, development and testing were performed to create the internally developed solution. The phase started by defining the software definition and development plan. A process and development plan were created. Software development efforts began with the support of an external subcontractor and completed with General Dynamics Bath Iron Works (BIW) engineering development. Testing was performed as development occurred and User Acceptance Testing was held as development completed. BIW held several meetings to validate the business case and implementation plan.

Payoff

The project team estimates a yearly savings of $1.1M. The current shipbuilding rate is 1.1 ships/year, which corresponds to a per hull savings of $1.0M. The five-year savings estimate is $5.5M. Savings are currently applied for DDG 51 class ships; however, the tool could be used to support other ship programs at BIW. The primary savings for BIW will occur during the lead yard services activities. These benefits will flow down to new construction through improved drawing quality and change processing.

Implementation

Implementation activities initiated in the 1Q FY2023 and are anticipated to complete in the 4Q FY2025.

Drone-Based Targetless Photogrammetry for High-Accuracy Inspection

S2828 — Automated Metrology for Structural Assembly

Objective

The objective of this Electro-Optics Center (EOC) project was to develop an automated metrology system for use during structural assembly of DDG 51 Class destroyers to conduct in-process accuracy checks. The system was designed with the needs of the shipbuilding industry at the forefront to accommodate the specific manufacturing hurdles that exist, including inverted builds and the joining of large structural assemblies into a single unit. The solution is minimally targeted, or targetless, to reduce labor and human error and includes automated software scripting that conducts comparative measurements of as-built conditions against the computer-aided design (CAD) model. The project has demonstrated a trade-friendly automated solution that rapidly generates a visual and numerical output to display deviations of the as-built condition against the model with minimal user interaction using an autonomous drone.

Payoff

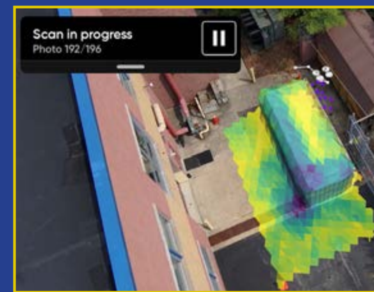
This project will greatly improve the shipbuilding process by reducing costs and increasing manufacturing throughput. Additionally, this new metrology technique will provide more accurate surveys at a faster rate, leading to a reduction in rework, less risk of operator error and greater accuracy control.

General Dynamics Bath Iron Works (BIW) estimates total savings of $1.2M per hull, which generates a five-year return on investment (ROI) of 1.2:1, after full implementation. Additional ROI is expected to be captured through additional use cases by BIW and the Navy, which will increase the project's impact.

Additionally, the project has garnered significant interest from across the DoD, and the project team continues to investigate additional use cases for the technology for a variety of applications.

Implementation

The system developed by this project was tested on mock structures during the final task of the project. This demonstration triggers the initiation of transition to BIW. Initial implementation of the technology into the shipbuilding process at BIW is anticipated in the second quarter of FY25. Implementation will require a capital investment from BIW, and this investment is supported through its internal capital expenditures. The EOC team continues to work with BIW and other Navy partners to execute on-ship demonstrations. It is expected the results of these demonstrations will be used to justify implementation of the metrology system at BIW and within the Navy by leveraging the ROI documentation generated by the project. Following successful demonstration, this technology will have application at other similar facilities, expanding the impact of the system beyond BIW.



PERIOD OF PERFORMANCE:
February FY2020 to August FY2023

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Electro-Optics Center (EOC)

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STAKEHOLDER:
PMS 400D

Automation to Optimize Hull Access Hole Cutting and Welding

PERIOD OF PERFORMANCE:
December FY2020 to February FY2025

PLATFORMS:
DDG 51 Class destroyer
Amphibious Assault Ship (LHA)
Amphibious Transport Dock (LPD)
National Security Cutter (NSC)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDER:
PMS 400

S2855 — Automated Hull Access Welding and Cutting Applications

Objective

All Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls) programs require manual cutting and welding of temporary accesses (cut-out holes) along the exterior of the ship's hull to allow for blasting, painting and ventilation. These manual efforts involve precisely defining and cutting access areas on site, as well as removing material to create a temporary manhole. This manual labor is intensive and requires a highly skilled workforce to cut, remove and weld to re-install the access cut-out plate. Even with such skilled workers, the working environment lends itself to various scenarios that promote poor cut quality and weld inconsistency. These scenarios, in turn, have direct impact on the ability of the operator to produce first-time quality welds to close-out the access, as validated by ultrasonic non-destructive evaluation. Significant rework is performed by re-welding and repeated inspections to achieve acceptable quality requirements. This redundancy has impact upon productivity, schedule and cost for ship fabrication. The objective of this Center for Naval Metalworking (CNM) project is to improve the productivity and increase the first-time quality acceptance for hull access cut-out processing by developing an automated or semi-automated solution. Market research was performed to help leverage solutions, including new commercial-off-the-shelf technology, as well as other industrial users who work with similar processes amenable for shipyard use.

Payoff

Automated processes can produce consistent quality at generally higher speeds and for greater "duty cycles" than manual or semi-automatic processes. Thus, implementation will reduce rework by providing better first-time quality. This will aid in reducing the overall build time for the areas in which this project will be implemented.

Ingalls anticipates this effort will enable significant reductions in labor, rework and material handling, as well as an increase in throughput. Implementation of the automated / semi-automated processes for welding applications developed under this CNM project is estimated to result in savings of $452.0K per DDG 51 Class destroyer hull or $1.1M for the combined platforms of DDG 51 Class destroyer, Amphibious Assault Ship (LHA), Amphibious Transport Dock (LPD) and National Security Cutter (NSC). This results in potential five-year savings of $2.3M for DDG or $5.8M for Ingalls' combined platforms.

Implementation

The project results will be implemented at Ingalls' Pascagoula, MS, facility across the DDG 51 Class destroyer, LHA, LPD and NSC platforms. Implementation is anticipated to occur in the 2Q FY2026.

Transforming Deep Hole Drilling

S2869 — Deep Hole Tight Tolerance Drilling

Objective

Alignment of precision Grade A shock machinery components requires very close tolerances and installation of long fasteners. Additionally, due to the size (diameter/depth) of the holes, they are drilled multiple times to adhere to the required final size. Clearance for the current portable drilling equipment and length of drill bits prevent the use of a standard set-up. The use of current assets is inefficient, and the equipment is outdated. The drills currently available are not maintenance-friendly. If the tool breaks, it is sent to a clean environment for full disassembly and repair, rather than allowing a mechanic to repair the drill at the job site. Although there have been previous efforts by Huntington Ingalls Industries – Newport News Shipbuilding (NNS) to address this issue, no commercial-off-the-shelf drills are robust, compact or maintenance-friendly enough to replace current drilling tools. The Center for Naval Metalworking (CNM), NNS and General Dynamics Bath Iron Works (BIW) developed a solution that resulted in a robust, compact and maintenance-friendly deep-hole drill. The project team developed a prototype that can be used in confined spaces to drill through at least 6.5-inches of high strength steel to fill an unmet need in shipbuilding. A rigorous vendor down-selection process was completed to partner with Hougen Manufacturing for the development of a prototype compact annular cutter with a magnetic base that was designed to have increased bit life that can handle the depth and tolerance requirements of Grade A shock machinery holes.

Payoff

The project concluded in November 2022 with great success in reducing the time to drill one hole from two days down to just two hours for a finished hole. It established a new process for deep-hole drilling, resulting in improved first-time quality, tool reliability and operator safety. Hougen Manufacturing is expected to have the drill commercially available by December 2023 for implementation beyond NNS and BIW.

By reducing the amount of labor hours and drill set-up time, NNS and BIW estimate this CNM effort to provide savings of $1.8M per CVN and $366K per DDG 51 Class destroyer. Over the next five years, this equates to a combined estimate of $4.6M with a return on investment for the project of 3.6:1.

Implementation

Tool quality and performance was evaluated and accepted through user testing and demonstration at BIW and NNS. Upon acceptance of both the technology and associated business case by the acquisition Program Offices, the results will transition to NNS and BIW facilities. NNS anticipates the initial implementation of the system in 3Q FY2025 on CVN 80. BIW anticipates initial implementation in 2Q FY2025 on DDG 51 Class destroyer. The drill was presented at Defense Manufacturing Conference (DMC) 2022 to the broader Department of Defense (DOD) industrial base and was received well. Multiple demonstration days were held at both BIW and NNS with Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls) and General Dynamics Electric Boat (GDEB) expressing interest for potential implementation in their yards.

PERIOD OF PERFORMANCE:
June FY2020 to November FY2022

PLATFORMS:
CVN Class aircraft carrier
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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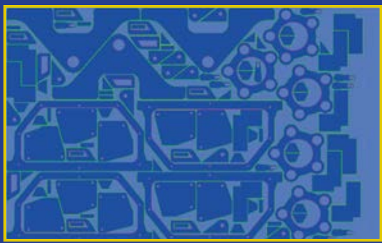
STAKEHOLDERS:
PMS 379
PMS 400

Streamlining Processes for Pipes, Plates and Shapes



PERIOD OF PERFORMANCE:
August FY2020 to February FY2022

PLATFORMS:
DDG 51, LHA, LPD, NSC

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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STAKEHOLDER:
PMS 400D

S2886 — Dynamic Rules-Based Material Process

Objective

The current manufacturing process for nesting plates, cutting plates and cutting pipe at Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls) results in excessive material waste. Additionally, internal administrative constraints limit the fluid nature of production (e.g., nesting that addresses just-in-time schedule requirements across contracts, hulls, units, material types / sizes). This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project investigated how to make these processes more efficient.

This project created a rules-based process for effective consumption of whole material while reducing overall scrap. A dynamic nesting solution was evaluated with the goal of eliminating risk associated with cross-nesting (nesting across multiple bills, hulls or contracts) while decreasing material handling cost. A formal rules-based program was established that addressed the handling of excess material. These approaches add versatility to the processes and minimize manual nesting, touch cost and material waste. Additionally, the project addressed physical marking for material allocation (cost collection), tracking and locating.

This project also examined whether the opportunity exists to connect results automatically, via a digital solution with other ManTech projects to leverage existing technology like the S2160 VIRGINIA Class submarine (VCS) Material Management and S2107 Nested Material Manufacturing Technology Improvement projects.

Payoff

Once implemented, Ingalls anticipates this project will create a reduction in plate and pipe material waste, as well as a reduction in engineering labor hours associated with touch labor, material handling and nesting process. Implementation of new technologies / products developed under this project is estimated to result in annual savings of $5.7M for the DDG 51 Class destroyer and $16.5M for all platforms combined, creating a five-year return on investment (ROI) of 8.4:1.

Implementation

Ingalls completed implementation into their production environment in the 1Q FY2024 on multiple ship platforms, including in the construction of Amphibious Assault Ship (LHA) 9, Amphibious Transport Dock (LPD) 33, DDG 137 and Naval Safety Command (NSC) 12.

Content-Based Search Will Optimize Parts Lookup

S2889 — Visual Search Engine

Objective

A surface combatant such as the DDG 51 Class destroyer is built from hundreds of thousands of parts, each of which is selected by Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls) engineering, sourced and purchased by Ingalls supply chain and installed by Ingalls operations in accordance with ship design requirements. Engineers must perform extensive research to identify and select required parts meeting ship design specifications. During this identification and selection phase, engineers unknowingly identify and select parts believed to be new to the ship's design when, in fact, the parts have already been used in other areas of the ship or on other vessels that have been built. The primary objective of this project was to reduce the time it takes to research, identify and select parts and to reduce the number of parts duplicated each year, thereby reducing the engineering, supply chain and associated labor with respect to new part creation.

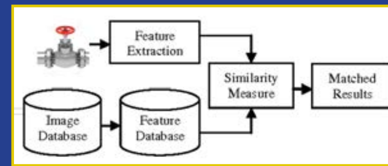
The Visual Search Engine project, managed by the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center, investigated the employment of new technologies enabling component searches across all libraries and databases used in the design process for parts that have appropriate or similar fit, form and function. The anticipated solution space is expected to utilize content-based image retrieval (CBIR), also known as query by image content (QBIC) and content-based visual information retrieval (CBVIR). CBIR is the application of computer vision techniques to image retrieval problems. To accomplish this, Ingalls will index parts catalogs using "visual fingerprinting" (e.g., the attachment of image data to components in text-based libraries). Engineers and supply chain technicians will only need to provide a shape input to the search engine to locate parts of similar shapes, fits, forms and functions. "Content-based" means that the search analyzes the contents of the image rather than the metadata, such as keywords, tags or descriptions associated with the image, which is the "long pole in the tent" with respect to performing parts searches in Ingalls' parts libraries. The term "content" in this context might refer to colors, shapes, textures or other information that can be derived from the image itself. CBIR is desirable because searches that rely purely on metadata are dependent on annotation quality and completeness, and often are very time-consuming to complete.

Payoff

This project is expected to result in savings of approximately $7.6M over five years across all platforms. Five-year savings of $3.3M for DDG 51 Class destroyer are anticipated.

Implementation

The Visual Search Engine technology was fully implemented at Ingalls during the 4Q FY2023.



PERIOD OF PERFORMANCE:
August FY2020 to December FY2022

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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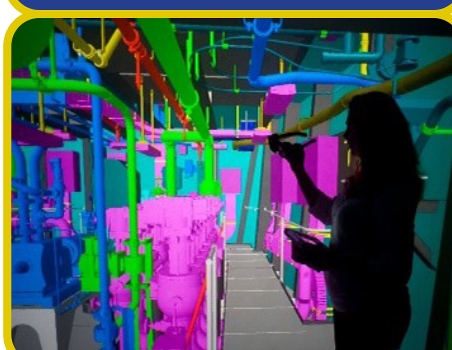
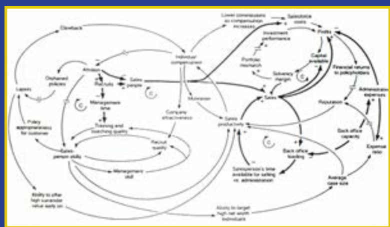
STAKEHOLDER:
PMS 400D4



Dynamic Simulation Capability Brought In-House, Yard-Wide



PERIOD OF PERFORMANCE:
January FY2021 to October FY2023

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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STAKEHOLDER:
PMS 400D4

S2891 — Shipyard-Wide Simulation Platform

Objective

Since the 1980s, yard-wide dynamic simulation modeling has proven highly effective in dealing with complex manufacturing issues, as demonstrated in system dynamics applications on numerous naval shipbuilding and other defense-industry programs. However, these models were built and owned or controlled by outside consultants with deep simulation expertise and could not be operated or employed continuously by naval shipbuilders themselves. This project will change that by adapting software proven in other industries to deliver and test a whole-yard simulator that naval shipbuilders can operate in-house, without system dynamics expertise. This analysis capability will reveal new ways of increasing manufacturing performance and help to ensure the success of improvement initiatives, as seen in increased delivery rates and reduced labor costs.

This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project adapted existing system dynamics technology and software for naval shipbuilding and created a Yard-Wide Simulation Platform (YWSP) to guide strategic decision-making at General Dynamics Bath Iron Works (BIW). BIW utilized 4Sight Solutions to adapt existing system dynamics model content and simulation software to reflect the shipyard's current programs, capabilities and conditions. The ability to incorporate the impacts of future programs will also be added to the simulator. Auto-calibration functions were added to the system to permit periodic updates to the model. Moving forward, BIW will manage and maintain this asset internally. The model and software used to operate the simulator can be adapted for use in other naval shipyards as well.

Payoff

This project is anticipated to deliver approximately $29.0M in total savings over five years, along with a 0.6 equivalent DDG increase in five-year cumulative manufacturing throughput and deliveries.

Implementation

The YWSP technology is anticipated to initiate implementation activities at the BIW Bath, ME, facility in the 1Q FY2024 and achieve full availability by the 3Q FY2025.

Revolutionizing Temporary Attachment Removal

S2892 — Cold-Cutting Steel

Objective

When building steel ships, it is a common practice to employ "hot work" methods for cutting steel. This is true not only to fabricate the ship components, such as plate and shape products, but also to remove temporary attachments or other welded components that may need to be relocated later in the construction cycle. Hot work methods often employ the use of handheld burning torches and arc gouging equipment, which are prone to imprecision. Imprecise cuts can result in wasting lifting pads by cutting too much material and cause rework due to damage on finished areas of the hull. Currently, there are no commercial-off-the-shelf options for a safe, handheld "cold-cutting" device to remove large lifting pads. This Center for Naval Metalworking (CNM) project developed a safe, cold-cutting device capable of removing lifting pads with a precise cut line. General Dynamics Bath Iron Works (BIW) and CNM have finished all project tasking, which included baselining, developing a use case and down-selecting to Claxton Engineering to develop and adapt its current offering to make precise cuts along the ship hull. The latter half of the project effort provided BIW with a viable alternative to removing lifting pads without damaging the hull integrity while resulting in a safer process that extends the life of lifting pads.

Payoff

By utilizing the new "cold" work method, BIW will reduce the need for rework caused by late-stage construction damage from the hot work cutting process, which damaged the paint and sensitive components on the interior of the hull, resulting in accelerated ship construction.

By eliminating the use of hot work and manual cutting from the lifting pad removal process and replacing with a "cold" cutting approach, BIW estimates five-year savings of $1.7M and labor reduction of 3,005 hours for DDG 51 Class destroyer.

Implementation

Implementation will begin with DDG 132. The results will be implemented primarily in the Outfitting Halls and Land Level Transfer Facility. BIW anticipates initial implementation in the 1Q FY2026.

PERIOD OF PERFORMANCE:
September FY2020 to January FY2023

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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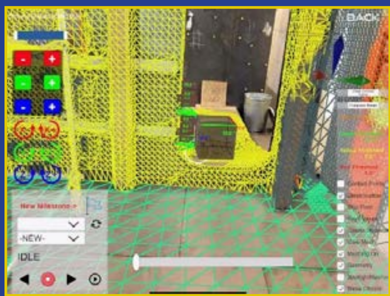
STAKEHOLDER:
PMS 400

Integration of Augmented Reality for Equipment Installation and Removal



PERIOD OF PERFORMANCE:
January FY2021 to March FY2023

PLATFORMS:
DDG 51 Class destroyer
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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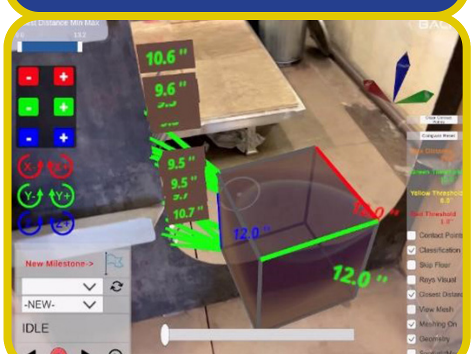
STAKEHOLDERS:
PMS 400D4
PMS 397
PMS 450D



S2899 — Virtual Load Out Interference Detection

Objective

During the shipbuilding process, there are numerous planned and unplanned "load outs" entailing the installation or removal of Customer Furnished Equipment (CFE), Government Furnished Equipment (GFE) and fabricated subsystems during some of the later stages of construction. In many cases, load outs involve the rip-out of surrounding structure, grating and other potential interfering objects in the way of load out activities. Planned load outs take place at a specific stage of construction. They follow a pre-determined path and approach for rigging and landing the component, so that potential interferences between the component and any objects within that path are already known. Ideally, the designed travel path for each component correctly identifies possible interferences ahead of time, and only those objects are removed. However, the differences in as-built configurations of the ship often cause additional interferences within the load out or removal path that were unaccounted for in the design. Unplanned load outs and removals entail movement of major equipment unforeseen in the build plan or out-of-sequence according to the plan. These can include removal of defective equipment or delayed deliveries. If equipment has no requirement for removal and maintenance, then no removal route is built into the design. Both planned and unplanned load outs require a travel path to be determined, and all interferences identified.

The Virtual Load Out Interference Detection project, managed by the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center, developed an augmented-reality (AR) application that will be used to identify interferences in the load out path in real time, on the deck plates prior to the load out process. The application utilized a virtual object based on CAD models or a 3D scan that corresponds to the shape of the equipment. At General Dynamics Bath Iron Works (BIW), the mechanic using the application will move the virtual object through the load out path to identify and verify interferences to minimize unnecessary rip out. General Dynamics Electric Boat (GDEB) will use this tool to allow the riggers to be able to walk a component out of the ship directly. There would be no need to run the time-consuming simulations because the trades will be able to load the component into the AR session and see the interferences directly related to the as-built conditions of the ship.

Payoff

This project is expected to save approximately $283.0K per VIRGINIA Class submarine, approximately $314.0K per COLUMBIA Class submarine and approximately $268.0K per DDG 51 Class destroyer for combined five-year savings of $5.2M and return on investments (ROI) 4:0:1.

Implementation

The Virtual Load Out Interference Detection technology is implemented at BIW and pending hardware technology rollout at GDEB facilities, which is anticipated to occur in 1Q FY2025.

Enhanced Efficiency by Structurally Welding Aircraft and Vehicle Stowage Deck Tie-Down Sockets on Just One Side

S2933 — One-Sided Deck Tie-Down Welding Inspection

Objective

All Navy ships currently built at Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls) require the installation of aircraft tie downs on the deck that have to be structurally welded on both sides. This is a labor-intensive process, and if defects are found during the process, the deck panel assembly has to be flipped multiple times for re-work and re-inspection. The objective of this Center for Naval Metalworking (CNM) project is to increase efficiencies in the aircraft tie-down and heavy weather tie-down installation processes by structurally welding the tie-downs from one side on DDG 51 Class destroyer, Amphibious Assault Ship (LHA) ships and Amphibious Transport Dock (LPD) vessels versus the current process of structurally welding the tie-downs from both sides. This project will perform the required testing and obtain Naval Sea Systems Command (NAVSEA) technical warrant holder approval to weld and inspect aircraft and heavy weather tie-downs from one side with the use of a permanent backing bar; this would eliminate the need to back gouge and weld the opposite side as well as eliminate the magnetic particle testing inspection on the opposite side and flip the panel multiple times.

This effort will be accomplished in two phases. Phase I will consist of requirements definition and test plan development. Phase II will perform one-sided deck tie-down welding tests and functionality demonstrations.

Payoff

By structurally welding deck tie-downs from only one side, the initial estimate for five-year cost savings is $2.9M for all Ingalls platforms and $1.3M for the DDG 51 Class destroyer.

Implementation

The results of this project will be implemented at Ingalls in support of multiple ship platforms, including the construction of LHA 10; LPD 32, 33 and 34; and DDG 141,143,147, and 149 in 2Q FY2026. Preliminary plans indicate that full implementation of the equipment and methods will occur within 12 months of project completion.

PERIOD OF PERFORMANCE:
January FY2023 to March FY2025

PLATFORMS:
DDG 51 Class destroyer
Amphibious Assault Ship (LHA)
Amphibious Transport Dock (LPD)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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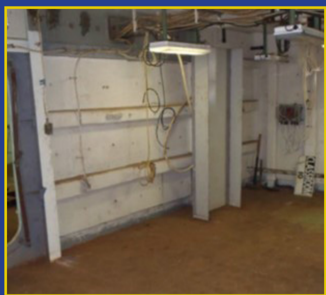
STAKEHOLDER:
PMS 400D

Using Adhesive Bonding Solutions Instead of Welding



PERIOD OF PERFORMANCE:
October FY2022 to April FY2024

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Composite Manufacturing Technology Center (CMTC)

POINT OF CONTACT:
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STAKEHOLDER:
PMS 400D

S2939 — Bonded Joiner Bulkheads for U.S. Navy Vessels

Objective

Non-structural joiner bulkheads on Navy surface ships require welding at the connections to the deck above and below, despite being defined as non-structural. The time to prepare, weld out, repair, coat and finish these bulkheads is significant. Bulkhead hot work also requires a fire watch on the opposite side of the bulkhead. The purpose of this Composites Manufacturing Technology Center (CMTC) project is to test and validate the use of various adhesives to install joiner bulkheads on U.S. Navy vessels in lieu of traditional welding.

Payoff

The projected labor hours to install joiner bulkheads were expected to decrease significantly. However, due to the necessary cure time for the specified adhesives, the overall work duration increased considerably compared to the existing installation method. Testing of the identified adhesives was conducted in order to obtain data that may prove useful in other shipbuilding applications.

Implementation

The use of adhesives to install joiner bulkheads on U.S. Navy vessels will not be implemented at this time.

Leveraging Advancements in Commercially Available Insulation Technologies to Improve Shipbuilding

S2940-1 — High Performance Insulation Materials and Processes (Phase 1)

Objective

Advances in insulation material and installation technology provide an opportunity to reduce material cost, storage cost, installation labor, rework, craft scheduling flexibility and improve the quality of ship insulation while staying within ship specifications. This project identified and evaluated new insulation technologies including new materials, tooling and installation processes.

The purpose of this Composites Manufacturing Technology Center (CMTC) project was to focus on improvement opportunities for three of the primary applications of high-temperature insulation used on Navy ships: high-temperature equipment, N30 fire insulation and removable valve covers. The first phase of the project provided an evaluation of existing materials, tools and processes, along with identification of problem areas. Alternative products were identified and screened against requirements.

Information from this review was used to consolidate insulation products. New materials were recommended as options to reduce material cost and initial / rework labor costs. Insulation installation processes were compared, examined and upgraded. New tools were studied and recommended to reduce installation labor and rework. Storage strategies were examined and upgraded, and more efficient insulation delivery to the job site should result. This effort should increase craft productivity, reduce rework and improve scheduling flexibility. Candidate products identified in Phase 1 were piloted in Phase 2 for final selection and approval for implementation onboard ships.

Payoff

The anticipated labor savings of utilizing selected insulations for numerous applications, including fire insulation, high-temperature insulation and valve body insulation, were approximately $1.7M per DDG 51 Class destroyer with an anticipated $10.0M savings over five years.

Implementation

Transition of the insulations, tools and processes to implementation occurred soon after piloting and final approval in Phase 2. Implementation was accomplished initially where no conflict exists with the existing design. This involved replacing insulation materials, utilizing tools and implementing new processes in current ship construction practices. However, some of the materials, tools and processes have to be phased into use with future ships.

PERIOD OF PERFORMANCE:
October FY2022 to September FY2024

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Composite Manufacturing Technology Center (CMTC)

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STAKEHOLDER:
PMS 400D

Optimizing Warehousing Processes and Space Utilization

PERIOD OF PERFORMANCE:
September FY2023 to January FY2026

PLATFORMS:
DDG 51 Class destroyer
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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STAKEHOLDERS:
PMS 400D
PMS 397
PMS 450

S2973 — Improved Warehouse Efficiency

Objective

The warehousing processes at Ingalls Shipbuilding (Ingalls) and General Dynamics Electric Boat (GDEB) are labor intensive, time consuming and prone to errors causing a negative impact to overall production schedule and cost performance. The objective of this project is to investigate and test true process improvement solutions for antiquated warehouse processes and tools. Process improvements to investigate include streamlining recordkeeping processes and optimizing rack designs. While resolving the ineffective process concerns, the team will identify technology insertion solutions that could be leveraged to gain further benefit. Technology insertions to be investigated include improved storage racks, automated picking technology and improved warehouse software tools.

Based on the investigation into these technologies, the project team will define a path forward that will improve warehouse space utilization, while providing a reduction in processing time needed for warehouse processes. Ingalls' primary focus is to streamline paper-based processes, which encompass picking and retrieval, efficient material handling and transactions such as receipts, issues, transfers, adjustments, relocations, cycle counts and returns to the storehouse across multiple warehouse sites. The highest priority for GDEB is process improvement through technology insertion, including both software and storage automation improvements. However, both objectives will be leveraged at both shipyards to maximize the benefit gained through project efforts.

Payoff

The return on investment (ROI) for Ingalls over five years would be 1.83:1 for DDG 51 Class destroyer and 3.79:1 when including DDG 51 Class destroyer, Amphibious Assault Ship (LHA) and Amphibious Transport Dock (LPD). For GDEB, the five-year ROI would be 3.63:1 for VIRGINIA Class submarine (VCS) and COLUMBIA Class submarine (CLB).

Implementation

Ingalls and GDEB plan to implement the solution in a production warehouse environment beginning in the 2Q FY2026 for all platforms at Ingalls and VCS and CLB platforms at GDEB.

Ingalls Shipbuilding Leverages Latest Technology in Augmented Reality and Materials to Advance Electrical Cable Installations and Testing

S2975 — Improved Cable Installation and Testing

Objective

The objective of this Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project is to improve performance of shipboard cable plant manufacturing and installation. This project will improve First Time Yield (FTY) of cable plant fabrication and focus on improvements to sensitive cable media, including coaxial and optical cable types. Improvements to the cable media, cableway design, planning and installation and testing activities will be included.

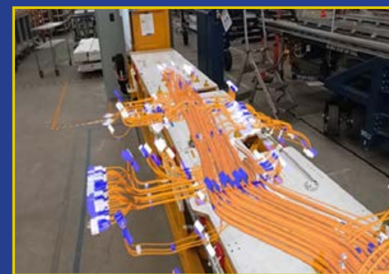
The project began with a survey of current installation process and identification of failure modes. The initial phase of the project included specific focus on cableway design, planning activities, cable materials, installation and testing processes. An evaluation of augmented reality technology and its application to shipyard cable installations will be performed. Proposed solutions will be developed and reviewed with shipyard management teams. Options will be down selected to address areas with the highest potential of impact within the project scope. The project team will work with Ingalls Shipbuilding teams on proposed options that address internal shipyard processes. The team will work with cable manufacturers on items that require material / product changes. New materials will be identified and evaluated for impact to installation performance. In phase two, a trial installation will be conducted on a ship or representative environment.

Payoff

By enhancing the FTY of cable installations and reducing labor and material costs, the projected five-year cost savings are estimated at $7.6M across all Ingalls platforms and $3.0M for DDG 51 Class destroyer specifically. This corresponds to a return on investment of 5.3:1 and 1.5:1.

Implementation

Cable system options identified and evaluated through this project will be reviewed with the applicable Navy Technical Authorities for Navy acceptance and subsequently implemented at Ingalls on the DDG 51 Class destroyer, Amphibious Assault Ship (LHA), Amphibious Transport Dock (LPD) and/or National Security Cutter (NSC) platforms in the 4Q FY2026. Preliminary plans indicate full implementation of the equipment and methods will occur within 12 months of project completion.



PERIOD OF PERFORMANCE:
June FY2023 to March FY2025

PLATFORMS:
DDG, LHA, LPD

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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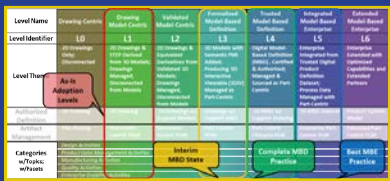
STAKEHOLDER:
PMS 400D

Advancing Model Based Enterprise Maturity



PERIOD OF PERFORMANCE:
August FY2023 to April FY2025

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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STAKEHOLDERS:
PMS 400D4

S2976 — MBE Maturity Index Update

Objective

Based on the broad acceptance and adoption of the Model Based Enterprise (MBE) Maturity Index in the manufacturing industry, Navy ManTech has recognized this tool as the preferred method for quantifying the specific needs and benefits of MBE projects, making it a key consideration for future Navy ManTech efforts. Navy ManTech leadership anticipates this project will enable key Navy shipbuilders to evaluate and identify recommended updates to the existing MBE Maturity Index that will ensure effective and efficient use of the tool in future Navy ManTech projects and related activities.

The MBE Maturity Index has been developed and refined over the past several years, equipping organizations to identify requirements, constraints, gaps and priorities, and to ultimately formulate initiatives and strategies that advance their MBE Maturity efforts and achieve their desired goals. While the MBE Maturity Index has evolved, it still contains significant gaps that the need to be addressed to increase applicability across the entire manufacturing industry. This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project will evaluate the current MBE Maturity Index and Assessment by identifying gaps in the existing MBE Maturity Index, establishing recommendation to optimize the MBE Maturity Index for broader use, and supplement the MBE Maturity Index documentation with a guidebook aligned to the contents of an updated version. By taking this action, the project will establish and demonstrate applicability of the MBE Maturity Index to Navy ManTech shipyards, related Department of Defense (DoD) manufacturing programs and broader industry applications.

As a result of this project, the improved MBE Maturity Index will aid Navy ManTech and partner organizations in strategy development and advancement of excellence in the Digital Enterprise domain.

Payoff

The project will benefit the ONR ManTech community by identifying tools, updating and tailoring best practices and adapting them for ManTech projects. With an updated MBE Maturity Index in place, Navy ManTech will be better equipped to evaluate the capabilities of its original equipment manufacturers to take on a complex model-based enterprise project. The updated MBE Maturity Index is intended to better enable utilization across a wide range of manufacturing entities and enable improved strategy development and advancement of excellence in the digital enterprise domain. Expected efficiency will be gained by ONR along with potential wider adoption in the DoD community and its industrial base.

Implementation

The MBE Maturity Index Update is expected to be implemented at Ingalls Shipbuilding and General Dynamics Bath Iron Works during the 4Q FY2025.

Automated Conversion of Point Cloud Data to 3D Solid Objects

S2978 — Point Cloud Conversion to Detailed Design

Objective

Although fully detailed 3D models allow the Planning Yard to utilize 3D visualization and automated interference detection methods, very few are available for the DDG 51 Class destroyer fleet. For the few that do exist, they likely do not reflect the current in-service conditions of the ship or provide a reliable baseline for supporting SHIPALT design activity. Manually reproducing these as-configured shipboard conditions is time consuming and may not be cost effective to support Planning Yard design activities for upcoming availabilities. Light Detection and Ranging (LiDAR) scanning for ship-checked compartments does provide information which is useful for Planning Yard design purposes. However, LiDAR scan data is not 3D CAD graphical or geometric data in the traditional sense, and it cannot be directly edited or manipulated beyond basic cropping and orientation.

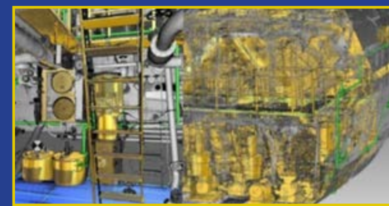
This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project intends to develop software tools to automate the creation of 3D CAD models from point cloud data. This can be manipulated, attributed, used for interference checking and subsequent development of 2D technical drawings. Processes and tools will be employed to convert digital point cloud data into virtual scenes via digital auditing and model retrieval, and reconstruction can be used across sites. This will produce neutral format 3D CAD models to be importable into various CAD software platforms.

Payoff

This project is projected to achieve total savings of around $7.2M over five years, with return on investment (ROI) of 2.39:1.

Implementation

The technology is expected to begin implementation at the Bath Iron Works, ME, facility in the 1Q FY2025 and reach full availability by the 4Q FY2025.



PERIOD OF PERFORMANCE:
February FY2021 to February FY2025

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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STAKEHOLDER:
PMS 400D4

Planning and Coordinating Temporary Services

PERIOD OF PERFORMANCE:
May FY2023 to May FY2025

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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STAKEHOLDERS:
PMS 400D4

S2980 — Temporary Services Call Board

Objective

Temporary services, such as hot work, ventilation, welding lines, electric lighting, power, compressed air, scaffolding and various other services are essential in construction of all Navy ship platforms. The scheduling of temporary services within the Ingalls Shipbuilding (Ingalls) shipyard is a manual process where shipboard requests for such services are tracked with a pen and a clipboard. All too often in the construction of a ship, the lack of essential temporary services like power and internet services when needed has impacted execution of the complex shipbuilding schedule. Temporary services such as forklifts, hot work, ladders, lines and power are currently scheduled through a manual paper process. This introduces inefficiencies in planning and scheduling, potentially affecting the timely execution of individual work packages and overall adherence to the construction schedule. The manual temporary services management process is slow, inconsistent and enables user error, and drives schedule delays. The antiquated paper process and insufficient tracking system are driving errors and schedule delays, which are primed for improvement through the incorporation of an improved digital toolset that permits visibility of interdependencies across work packages and platform construction programs, priorities and constraints.

This Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project is developing an automated management toolset to provide immediate visibility of the location and performance of key service resources, thus reducing labor costs through increased process efficiency. The improved process will enable timely fulfillment of temporary services requests while also minimizing travel distances of relocatable temporary services to the workstation and maximizing temporary service availability at the workstations. This will improve visibility of real-time status and location of equipment by superintendents, supervisors and other process owners.

Payoff

This project is expected to result in combined five-year savings of approximately $2.6M.

Implementation

The Temporary Services Call Board is expected to be implemented at the Ingalls facility during the 1Q FY2026.

Using Robots for Visual Pipe Inspection

S2981 — Portable Shipyard Pipe Inspection

Objective

To complete a visual pipe cleanliness inspection, inspectors for Huntington Ingalls Industries - Ingalls Shipbuilding (Ingalls) frequently have to crawl on their hands and knees with a flashlight to inspect each pipe and make notes on paper. They must inspect the pipe system based on what can be seen from their vantage point outside the pipe. The goal of this Center for Naval Metalworking (CNM) project is to create and test a robotic system to visually inspect ferrous and non-ferrous pipe systems with a diameter ranging from 4” to 8”. This system should be able to capture and store inspection videos, have live streaming capability and retrieve any foreign debris found during the inspection.

This project will be completed in two phases. Phase I will define the baseline requirements for the prototype. Afterward, a robotic vendor will design a prototype system based on those requirements. In Phase II, the robotic vendor will build and test the prototype system in a mock-up test environment.

Payoff

Ingalls anticipates this effort will enable significant reductions in labor and rework. This CNM project is expected to provide an estimated savings of $703.0K per hull or $1.9M for the combined platforms of the DDG 51 Class destroyer, Amphibious Assault Ship (LHA) and Amphibious Transport Dock (LPD) ship. This results in potential five-year savings of $3.5M for DDG 51 Class destroyer or $5.9M for Ingalls’ combined platforms.

Implementation

The project results will be implemented at Ingalls’ Pascagoula, MS, facility across the DDG 51 Class destroyer, LHA and LPD platforms. Implementation is anticipated to occur in 3Q FY2027.

PERIOD OF PERFORMANCE:
April FY2024 to February FY2026

PLATFORM:
DDG 51 Class destroyer
Amphibious Assault Ship (LHA)
Amphibious Transport Dock (LPD)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDER:
PMS 400D

Advanced Data Analytics and Modeling to Forecast Unplanned Materials

PERIOD OF PERFORMANCE:
March FY2023 to September FY2025

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDER:
PMS 400D

S2986 — Data Analytics for Slump Management

Objective

General Dynamics Bath Iron Works (BIW) uses the term 'slump' to describe material not explicitly listed in production bills of material – generally low-dollar, high-volume items. Slump material is stored in bins located in designated areas throughout the shipyard, allowing mechanics easy access to the slump materials needed to complete their assigned work. The current method for managing slump material, including consumption, restocking, and procurement, is a manual process that relies on lagging indicators (i.e., empty or low bins), oftentimes resulting in schedule disruption.

The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project is to develop a predictive analytics and forecasting software tool to perform material and schedule analyses. This tool will enable BIW to determine appropriate reorder points and reorder quantities to eliminate production delays associated with slump material availability issues. This will result in savings for both the procurement and production operations at BIW.

After collaborating with BIW to establish requirements, iMAST conducted a thorough review of data modeling and forecasting techniques for slump materials. This review encompasses conventional univariate forecasting models commonly used in enterprise resource planning software, as well as more sophisticated deep learning models. These advanced models take into account various factors that could influence slump material usage, such as schedule, work type, and material lead time. The forecasting methods will be incorporated into a software application that will assist BIW Procurement in determining reorder points and quantities of unplanned material that will prevent production delays.

Payoff

Implementation of the Slump Material Management and Planning tool will reduce the time buyers spend monitoring and calculating slump, leading to decreased expediting fees, fewer labor hours for mechanics waiting on slump materials, less supervision time spent reprioritizing work, reduced time managing slump bin stock outs, and decreased time spent replenishing slump bins. BIW has estimated that this project will save $836K per year with total savings of $4.2M and result in a five-year return on investment (ROI) of 2.1:1.

Implementation

Upon successful and timely completion of the Slump Material Management and Planning tool and acceptance of the technology and associated business case by the stakeholder (PMS 400D), the resulting software will be transitioned to BIW (estimated transition date 4Q FY2025). It is expected that the new technologies will be implemented at BIW under the cognizance of the Procurement, Planning, and IT departments. Post-project technology insertion should be limited to full-scale deployment of piloted technologies / improvements during the project.

Transceiver Affordability Improvements to Reduce Cost, Improve Performance and Enable Technology Insertion

S2987 — SEWIP Block 3 Transceiver Affordability

Objective

Surface Electronic Warfare Improvement Program (SEWIP) Block 3 is the third in a series of evolutionary block upgrades to the AN/SLQ-32(V) electronic warfare system (EWS). SEWIP Block 3 substantially upgrades the AN/SLQ-32(V) EWS by providing Electronic Attack (EA) capability against anti-ship missiles. The SEWIP Block 3 transceiver subsystem enables both transmit and receive functionality. This Electronics Manufacturing Center (EMC) project will develop and transition a new transceiver solution and combine the functionality of various line replaceable units (LRUs) in the EA rack to reduce cost, improve performance and enable future technology insertion techniques, including fiber winding and joining technologies that will need to be explored.

Payoff

The technical approach for this project includes updating the EA signal processor backplane and chassis to replace the current transceiver with an upgraded transceiver (and associated cables, cable supports and rack mounts); re-architecting and porting of the firmware to the new transceiver; combining some lower level components; conducting design verification test; and creating new drawings.

Together, these tasks are expected to provide space and weight reduction (eliminates multiple LRUs reducing weight and maintaining spare backplane slots for technology refresh / insertion cycles); enhance performance and provide $1.3M cost savings per shipset with integration onto at least 50 surface combatants (DDG 51 initial platform).

Implementation

The DDG 51 is the initial transition platform. The results of this ManTech project will transition to the Program Office. The Program Office intends to fund the additional development, qualification test, engineering change proposal development and processing to implement these affordability improvements into the SEWIP Block 3 production line. Implementation is expected 2Q FY2026. Retrofit is planned for previously fielded systems.

PERIOD OF PERFORMANCE:
November FY2022 to November FY2025

PLATFORMS:
DDG 51 Class destroyer
CVN 78 Class aircraft carrier
Landing Helicopter Dock (LHD)

CENTER OF EXCELLENCE:
Electronics Manufacturing Center (EMC)

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John Mazurowski
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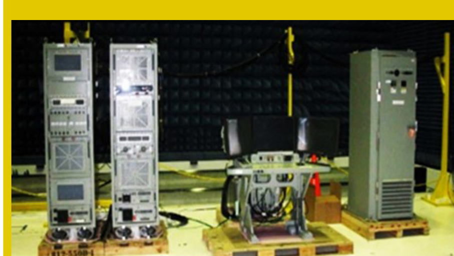
jsm23@arl.psu.edu

STAKEHOLDER:
PEO IWS 2.0 Above Water Sensors and Lasers



Improved Cryocooler Life Reduces Optical Sensor Life Cycle Costs

PERIOD OF PERFORMANCE:
October FY2024 to October FY2027

PLATFORMS:
DDG 51 Class destroyer
FFG 62 Class frigate
CVN 78 Class aircraft carrier

CENTER OF EXCELLENCE:
Electro-Optics Center (EOC)

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STAKEHOLDER:
PEO-IWS 2.0

S2999 — Cryocooler Reliability Improvements

Objective

Current cryocooler limitations in operating life and reliability for tactical applications, including the Shipboard Panoramic Electro-Optic Infrared (SPEIR) system, present a risk to the surface fleet and negatively impact the life-cycle cost of the system. Surface fleets rely upon optical sensors in these systems for critical situational awareness capability and to support the "detect-to-engage" sequence to address threats. Tactical sensor packages utilize cryocoolers to cool the focal plane array to cryogenic temperatures in order to achieve the sensor performance required for the mid-wave infrared (IR) detection of threats.

This Electro-Optics Center (EOC) project with L3Harris will improve the life of tactical cryocoolers by demonstrating the production of cryocoolers with life extending technologies and characterizing the performance through life testing. A life prediction model, based on life test data will also be developed to provide guidance to the fleet best operating practices with respect to cryocooler life. The manufacturing technology demonstration, performed by L3Harris, leverages recent internal research and development projects for life-extending product improvements. EOC will perform life testing on both improved and baseline cryocooler units in an environmental chamber configured to represent the operating conditions for SPEIR. The simulated loads and cycling rates applied to the cryocoolers will represent the SPEIR operating conditions. A condition-based monitoring approach will be developed by EOC as part of the life-testing effort, for future detection of early failures and predictions for remaining life of units in the field. The project will also provide information needed by the fleet and sustainment planners on Mean Time to Failure (MTTF) for the improved units.

Payoff

This affordability project is expected to reduce life-cycle costs by extending the MTTF of cryocooler by 2x to 3x of the current unit. Savings beyond the value of the cryocooler will be realized, since the life extension applies to an integrated sensor unit of much higher value with significant logistical and spares cost for the program. Longer replacement intervals and early detection of failure indicators will also benefit system availability.

Implementation

The primary transition platforms for this project are the DDG 51 Class destroyer, FFG 62 frigate, and CVN platforms. The first implementation is expected to be to be the DDG 51 and shore-based systems for SPEIR Block I.

Optimizing Component Layout in Shipbuilding

S3008 — Optimized Layout Process

Objective

At Ingalls Shipbuilding (Ingalls), outfitting currently consists of a series of very labor-intensive process steps required to accurately install components in accordance with ship specifications. The process begins with manually measuring from reference points, marking the location, installing the component and finally welding. Adding to the complexity of the process, early-stage construction is performed with the products inverted, whereas computer-aided design (CAD) drawings are generated in the "upright" position. Translating the drawing information to match the physical layout can be challenging. In addition to time and labor, inconsistency and inaccuracy can drive rework at later construction phases and may cause outfitting to be pushed to later stages creating environmental issues and other obstacles, leading to further rework.

The Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project is developing a digital location mapping layout process to improve the legacy process that historically depends on manual, hands-on measurements to arrange components layouts. This will be achieved through the development and validation of an integrated technology solution that enables creation and utilization of digital layout data, digitizes the layout process through data capture and visualization and accommodates various environmental challenges such as plate distortion and lighting variations.

Payoff

This project is expected to result in combined five-year savings of approximately $3.0M.

Implementation

The Optimized Layout Process is expected to be implemented at Ingalls during the 4Q FY2026.

PERIOD OF PERFORMANCE:
January FY2021 to March FY2023

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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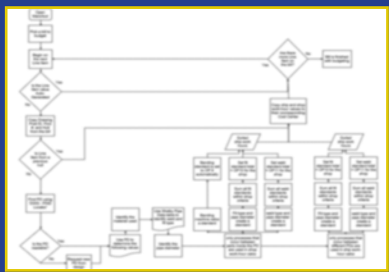
STAKEHOLDER:
PMS 400D4

Work Package Planning System for Production Engineers and Engineering Planning Organizations



PERIOD OF PERFORMANCE:
August FY2023 to August FY2026

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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STAKEHOLDER:
PMS 400D

S3009 — Production Engineering Efficiency

Objective

The process of production planning in shipbuilding is a very laborious process involving many different departments. The process requires data integration from various data sources including paper forms, material data, detail drawings and construction schedules. This process involves data coordination between multiple organizations and end users (Engineering, Planning, Industrial Engineering, Programs and Operations).

The goal of this Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project is to investigate the steps necessary to reach a level of automation for production planning by integrating the engineering data directly into the processes of scoping, billing and work package release. Ingalls Shipbuilding's (Ingalls') goal is to begin the process with ship design data from Engineering and have seamless integration throughout the entire process used by Industrial Engineering and Production Planning.

This project started with an analysis of current processes used to generate work packages, developed budgeting and scoping guidance and planned material consumption. The resulting opportunities and needs for enhancement and automation will drive definition of performance, capability and evaluation criteria to begin development of a solution. During development, Ingalls' Industrial Engineering and Production Planning personnel will be intimately involved in system definition to properly envision the functionality goals of the system and guide creation of the system.

Payoff

Once implemented, Ingalls anticipates a reduction in the total number of labor-hours needed to analyze and scope work packages and create Manufacturing Bill of Materials (MBOMs). Implementation at Ingalls is estimated to result in five-year savings of $5.7M for DDG 51 Class destroyer.

Implementation

Ingalls will implement the solution in a production environment beginning in the 2Q FY2027 for DDG 51 Class destroyer and all other ship platforms at Ingalls.

Radio Frequency Head Manufacturing Improvements to Reduce Cost, Increase Throughput and Improve Performance

S3020 — AN/SPY 6 (V) Radio Frequency Head Manufacturing Improvements

Objective

The AN/SPY 6 (V) is a U.S. Navy family of active electronically scanned array radars that performs air and missile defense and will be deployed to almost every combatant ship class. This radar enhances ships' abilities to detect, track and discriminate air surface. The ballistic missile targets and provides 360-degree integrated air and missile defense. The radar is designed upon an architecture that is modular at the array face (radar modular assemblies (RMA)) and, therefore, scalable to meet the needs of each ship class. Each RMA contains transmit and receive integrated microwave modules (TRIMM) (common building block of the radar) and the Radio Frequency (RF) Head is contained within the TRIMM. This Electronics Manufacturing Center (EMC) project will focus on developing and implementing new materials, enhancing automation and introducing innovative manufacturing processes to lower costs, boost throughput, and enhance performance.

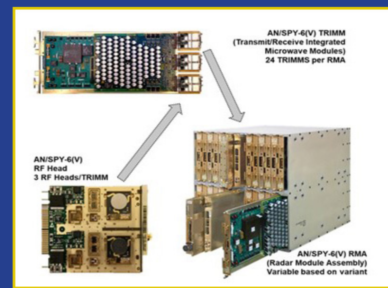
Payoff

The technical approach for this project includes several key initiatives: optimizing vent seal materials and implementing semi-automated or fully automated dispensing; enhancing inspection processes for RF Head Monolithic Microwave Integrated Circuit (MMIC) subassemblies with a new automated inspection tool; improving RF and thermal pathways using cost-effective materials; and refining gallium nitride (GaN) via etch and plating processes.

Together, these tasks are expected to provide automation of manual inspection steps that not only reduce cost, but improve defect detection accuracy and repeatability; reduce material costs and eliminate hazardous materials; and provide over $50M cost savings for the SPY-6 program. The common processes developed and transitioned under this Navy ManTech program also have direct benefit to other Navy and Department of Defense (DoD) programs with monolithic microwave integrated circuit/RF Head content.

Implementation

Transition of the manufacturing improvements developed under this ManTech project is accomplished when the individual processes are approved (Raytheon internal configuration control board), the relevant process control documentation for the production line is updated and the new processes are introduced into the AN/SPY 6 (V) production line. Implementation is expected to occur 2Q FY2027.



PERIOD OF PERFORMANCE:
March FY2024 to March FY2027

PLATFORMS:
DDG 51 Class destroyer
FFG 62 Class frigate
CVN 78 Class aircraft carrier
Amphibious Assault Ship (LHA)
Amphibious Transport Dock (LPD)

CENTER OF EXCELLENCE:
Electronics Manufacturing Center (EMC)

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STAKEHOLDER:
PEO IWS 2.0 Above Water Sensors and Lasers

Cost-Effective Paint and Corrosion Removal Tools for Shipyard Use

PERIOD OF PERFORMANCE:
April FY2024 to March FY2026

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDER:
PMS 400D

S3021 — Clean Alternative Paint Removal

Objective

Shipyards use grinding, blasting, needle-guns, etc. to remove paint or rust during late-stage manufacturing, which are typically out-of-sequence paint and rust removal activities. For the phase in which these activities occur and the processes that are currently used to conduct the removal, a significant amount of set-up / clean-up is needed. This causes significant workflow disruptions, may require items be removed from the ship, is very labor intensive, must be segregated from other work, contributes to ergonomic injuries and can expose mechanics to health hazards. The objectives of this Institute for Manufacturing and Sustainment Technologies (iMAST) project are to identify and evaluate potential Clean Alternative Paint Removal (CAPR) solutions to be used for out-of-sequence paint (and rust) removal and develop the solutions that best fit typical shipyard needs.

iMAST, working with General Dynamics Bath Iron Works (BIW), will evaluate alternative portable paint removal / cleaning technologies, conduct testing for identified use cases and perform demonstrations, not only for BIW stakeholders, but for the U.S. Navy shipbuilding and sustainment community. Removal use cases involve different applications (such as back-side paint removal, tank touchup and repair, hardware used during paint application, in-situ parts, etc.), different coating systems (ultra-high solids, powder coating, etc.), and various substrates (e.g., steels, soft metals, rubber mounts and flexible hoses). Alternative methods for consideration include laser ablation, plasma blast, dry ice blasting, etc. Selection of appropriate technology is dependent upon the ability to efficiently remove paint / corrosion across broad use cases at the shipyard.

Payoff

Significant labor savings are anticipated as a result of this project, primarily in the reduction of setup time, more efficient paint removal methods and limited disruption to other production work. In addition, implementation of clean alternative paint removal technologies will reduce the consumable media required for conventional removal methods, the costly disposal of media waste and worker injuries. BIW estimates five-year savings of nearly $10.0M for DDG 51 Class destroyer production. Results of this project can be leveraged by multiple shipyards and other government contractors for rapid adoption and application to many different platforms across the Department of Defense.

Implementation

Implementation at BIW will consist of initial deployment of CAPR solutions to be used for the most beneficial use case(s) that are the most technically feasible and economically viable. Implementation is expected in 4Q FY2026. The results of this project will also provide guidance for applications beyond BIW through the comparison of available technologies and best value applications to address common shipyard paint and corrosion removal issues.

Permanent Monuments Support Accuracy Control throughout a Ship's Life-Cycle

S3022 — Permanent Accuracy Control Monuments

Objective

U.S. Navy vessel Accuracy Control (AC) assessments consist of measurements taken during construction, life-cycle support and if damage is sustained while a ship is active in the fleet. During construction, measurements are assessed relative to the digital model for accurate ship construction. Post-delivery, measurements are assessed relative to both the digital model (twin) and the as-is physical ship condition, to develop an upgrade / repair design. Throughout all, measurements are taken to support alignment of critical ship systems, including combat systems, propulsion and ship structure. While a few monuments currently exist in the ship model that are installed during construction, lack of an extensive monument system provides limited ability for AC personnel to tie into the ship's coordinate system quickly and only serve as a reference location.

The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project is to perform a Phase 1 study and requirements definition to assess the feasibility to place permanent, agnostic AC monuments in Navy vessels that can be integrated with existing metrology systems and source digital data. If the Phase 1 study is deemed feasible, iMAST and General Dynamics Bath Iron Works (BIW) will conduct a Phase 2 proof-of-concept initiative on an in-construction DDG 51 Class destroyer. At the end of the project, an action plan will have been developed outlining the location and numbers of monuments required to achieve the goals / metrics outlined during the project, with the ultimate goal of supporting future ship platforms such as DDG(X).

Payoff

At this time, quantifiable benefits are difficult to capture, as number, design and cost are unknown; however, monument and installation costs are expected to be low. The inclusion of an agnostic, robust monument / receptor network tied back to the ship's coordinate system is expected to greatly reduce setup and measurement time in new construction and sustainment (goal – 40 percent reduction). iMAST and BIW aim to develop an initial cost benefit analysis during Phase 1 and update that cost benefit analysis for inclusion in the implementation plan.

Implementation

This project ultimately targets the Next-Generation Guided Missile Destroyer (DDG(X)) as the implementation target platform, as this presents the greatest opportunity for design consideration of permanent monuments well before construction begins. While DDG(X) is the targeted platform due to the ability to include it in future new construction designs, the applicability of the project extends across all platforms, including existing platforms (e.g., DDG 51 Class destroyer) with a retrofit, with implementation expected in 2Q FY2026.

PERIOD OF PERFORMANCE:
March FY2024 to December FY2025

PLATFORMS:
Next Generation Guided Missile destroyer (DDG(X))
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDERS:
PMS 460
PMS 400D

Transition Planning and Risk Reduction Maximize Benefits of Carbon Nanotubes for the Navy

PERIOD OF PERFORMANCE:
April FY2024 to September FY2024

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Electronics Manufacturing Center (EMC)

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STAKEHOLDER:
Navy

SP3024 — Carbon Nanotube Cathode Applications and Risks

Objective

The cathode technologies commonly used in commercial and Department of Defense (DoD) vacuum electronic devices are difficult to manufacture and can have performance challenges in high emission environments. The cathode technology typically used for High Power Microwave (HPM) sources is made by a time-consuming manufacturing process that results in long lead times. These are measured in months not weeks. The resulting cathode product also has some operating characteristics that are not optimal for the vacuum environment. Cathodes produced from Carbon Nanotube (CNT) fibers have shown promise as the next-generation technology in electron emission. Previous Air Force Research Laboratory (AFRL) led development efforts have produced test results showing superior performance in emission efficiency and repeatability through uniform field emission. CNT fiber cathode development to date has been limited to laboratory testing and focused on HPM sources. This effort seeks to explore the potential benefit of CNT fiber cathodes to the broader DoD vacuum electronics industry.

This Electronics Manufacturing Center (EMC) special project will create a roadmap of DoD applications for the CNT fiber cathode / emitter technology. This project will provide the application information needed for adjacent ManTech efforts, including the upcoming Office of the Secretary of Defense (OSD) Manufacturing Science and Technology Program (MSTP) project "Carbon Nanotube Fiber Cathodes for High Power Microwave," to develop high-performance CNT fiber cathodes. The project team will obtain device-specific cathode requirements from various DoD vacuum electronic applications. This will be accomplished through engagements of industry and government subject matter experts. Additionally, site visits will also be conducted with various laboratories, industries and manufacturing sites to understand the testing / implementation requirements. Other emerging technologies related to CNT cathode manufacturing will be investigated in order to reduce the risk of implementation into these devices. Adjacent CNT cathode manufacturing techniques, including fiber winding and joining technologies will need to be explored.

Payoff

This special project is expected to provide information that facilitates efficient transition and implementation of the CNT fiber cathode technology into broader Navy applications. EMC will provide a clear assessment of the potential benefits, cathode requirements and implementation barriers for each application in various areas, such as electronic warfare, communication and directed energy. A variety of devices are used in these systems, each with unique cathode geometries and requirements that will be matched up with emerging CNT fiber cathode manufacturing techniques for cylinders, discs and rings. These findings will assist in prioritizing future efforts to achieve a better return on investment to the warfighter while minimizing risk.

Implementation

Many Navy platforms utilize vacuum electronic devices, including directed energy, electronic warfare, radar and communications systems. The application map for CNT fiber cathodes developed under this project will provide preliminary requirements information for implementation into the various devices for these systems. Input from the vacuum electronic device manufacturers will be used for initial transition and implementation plans. Several DoD vacuum electronic devices have been identified for implementation opportunities, but these will require additional application-specific development for transition and implementation. Implementation for high power microwave sources is expected in 2Q FY2028 after completion of the OSD MSTP project.

FFG 62 Class Frigate Projects

Rendering of the FFG 62 Frigate.
(NAVSUP Weapon Systems Support image.)

Optimizing Ship Module Weight and Center of Gravity Accuracy with Automated Parts and Completion Status

PERIOD OF PERFORMANCE:
August FY2021 to October FY2023

PLATFORM:
FFG 62

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDER:
PMS 515

S2957 — Automated Product and Asset Tracking for FFG 62

Objective

During ship construction, modules and units must be lifted and moved throughout the shipyard. An accurate estimate of the weight and center-of-gravity (CG) is needed to ensure that the lifts and moves are safe and within the capabilities of the resources. The current process for calculating weight and CG is to add a designated outfitting factor to the steel weight. This process resulted in inefficiencies and potential safety issues (overweight) or inefficiencies (underweight). Additionally, the current process limits the ability to accurately estimate the weight and CG dynamically as potential outfitting work can move from one stage of construction to another. The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project was to develop and transition a tool that more accurately estimates the weight and CG of a module as it moves throughout the stages of construction. The tool was developed as an improved tracking and information management tool that can accurately integrate with existing processes and information-management software.

iMAST, working with Fincantieri Marinette Marine (FMM), investigated technology that can provide a more accurate calculation of weight and CG estimates, offers earlier outfitting due to more precise weight and CG information, provides automated updates to the shipyard's space planning software system, improves crane reliability, and avoids rental crane costs and lift re-planning. The project team evaluated alternative asset and item tracking tools (e.g., radio frequency identification (RFID), lidar scan and cartridge-actuated device (CAD) comparison), but determined that the best approach was to develop a software tool that integrates design information with the planning and execution system to provide near-real-time status of completed work to inform the weight and CG calculations.

Payoff

Due to the uncertainty of the weight and CG, a significant amount of extra time is required to prepare and conduct lift procedures, which adds safety and cost risk. The ability to reduce the unexpected downtime due to re-planning crane lifts will reduce the costs associated with production delays. Additionally, providing the ability to maximize outfitting prior to a lift results in increased manufacturing efficiencies and cost savings. This newly transitioned calculator application improved the accuracy of weight and CG estimates, ultimately improving lift planning and providing the ability for earlier outfitting. FMM estimates annual savings of $708K per hull and five-year savings of $5.6M. The five-year return on investment (ROI) is 4.4:1.

Implementation

The prototype weight and CG calculator application was transitioned to FMM at the completion of the project in 1Q FY2023. After testing on production module moves and validation by the FMM Methods department, the software application was implemented at FMM in 3Q FY2024.

VCS / CLB Submarines Projects

Robotics and Automation Will Improve Installation of Submarine Hull Inserts

PERIOD OF PERFORMANCE:
May FY2018 to March FY2024

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDERS:
PMS 450
PMS 397

S2751 — Automated Welding of Hull Inserts for VIRGINIA and COLUMBIA Class Submarines

Objective

The legacy process to install hull inserts in submarine pressure hulls is an intricate sequence of events consisting of multiple manual operations, including cutting, beveling, grinding and welding processes. The process requires extensive labor in excess of 45,000 hours per hull, and installing hull inserts significantly increases the manufacturing span time for the initial outfitting phase. Weld quality is dependent on tribal knowledge and individual skill level, thus additional rework is often required. Because this process is entirely manual, a robotic installation solution would improve weld quality and has the potential to reduce the labor required for submarine build schedules. 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 associated with this complex process.

The objective of this Center for Naval Metalworking (CNM) project was to develop robotic cutting and welding prototypes to demonstrate the hull-insert and hull-penetration process on VIRGINIA and COLUMBIA Class submarines (VCS and CLB, respectively). The project team developed a hull-insert and hull-penetration process by leveraging previous robotic and automated technologies currently implemented at General Dynamics Electric Boat (GDEB). The solution, achieved robotically, could cut and bevel the pressure hull for placement of the insert and penetration and will weld the insert or penetration into the pressure hull. This project investigated the use of large industrial welding and cutting robotic systems in conjunction with collaborative robots for smaller inserts and penetrations, but ultimately, it was decided to implement the Fanuc Cobot.

Payoff

Through automation and weld quality improvements, an estimated 20 percent reduction in cutting, fitting and welding labor is forecast because of this CNM project. Through increased efficiencies enabled by the technology, GDEB will save $1.9M per VCS / Virginia Payload Module (VPM) hull and $1.4M per CLB hull for combined five-year savings of $17.7M across all programs with a return on investment (ROI) of 1.9:1.

Implementation

The transition event for this project is GDEB's performance demonstration activities. Once those activities have been successfully completed, the process will have been verified to meet the expectations of the project teams and stakeholders and will be ready for implementation efforts at GDEB. Implementation is anticipated in 3Q FY2025. Implementation is utilizing a phased approach, in which the most beneficial opportunities will be assigned a higher priority and implemented first in the production of VCS, VPM and CLB. 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 are 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 developed and implemented a portable welding robot to aid in the construction of major assemblies of VIRGINIA and COLUMBIA Class submarines (VCS and CLB, respectively). Portable robotic technologies exist for commercial applications; however, the technology was not tested and proven for submarine construction. This Center for Naval Metalworking (CNM) project improved major assembly welding for VCS and CLB by creating a portable robotic solution that increased weld quality and reduced the welding labor requirements.

Payoff

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 has greatly expanded the use of robotic welding in shipbuilding.

This CNM project provided an estimated savings of $863.0K per VCS hull with the VIRGINIA Payload Module (VPM) and $919.0K per CLB hull for five-year savings of $13.2M.

Implementation

The solution technology was implemented at General Dynamic Electric Boat (GDEB) Quonset Point, RI, facility during 3Q FY2025.

PERIOD OF PERFORMANCE:
March FY2019 to January FY2023

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDERS:
PMS 450
PMS 397

Increasing Efficiency of Steel Processing through Robotic Advancements

PERIOD OF PERFORMANCE:
July FY2020 to December FY2022

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDERS:
PMS 450
PMS 397

S2812 — Beveling and Tapering Cell

Objective

General Dynamics Electric Boat (GDEB) currently uses labor-intensive operations and processes to bevel and taper structural steel. This includes hull plating and hull frames. Plate beveling and tapering is a manual process dependent on annotated paper sketches, manual burning equipment and tribal knowledge of various steel behaviors. Currently, beveled and tapered plate parts are manually laid out and then beveled and tapered by using manually operated torches or grinding equipment.

Robotic capability has advanced enough to replace these manual functions, eliminating production delays from operator availability and producing bevels and tapers of consistently high quality. Similar proven technologies from the heavy steel fabrication industry were evaluated and leveraged as the starting point for development under this project.

The objective of this Center for Naval Metalworking (CNM) project was to utilize state-of-the-art bevel and tapering equipment to increase throughput in steel processing to meet the demands of the VIRGINIA Class submarine (VCS), VIRGINIA Payload Module (VPM) and COLUMBIA Class submarine (CLB). Project results enabled automation of steel plate beveling processes, improved accuracy and reduced labor / time costs.

Payoff

This CNM project is expected to provide an estimated savings of $410.0K per VCS hull, $1.22M per VCS hull with VPM and $661.0K per CLB hull for five-year savings of $13.5M.

Implementation

The solution technology is expected to be implemented at GDEB Quonset Point, RI, during the 1Q FY2025.

Automating Surface Treatments on Tank Interiors

S2817 — Automated Interior Scanning, Blasting and Painting

Objective

General Dynamics Electric Boat (GDEB) and General Dynamics Bath Iron Works (BIW) are faced with several issues when it comes to blasting and painting the interiors of tanks. Access to these areas is highly limited and requires substantial personal protective equipment to ensure safety in confined spaces. Additionally, there is a substantial amount of labor required during the process due to the complex shapes of the tanks and lack of visibility in the confined blasting environment.

The goal of this Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project was to develop and demonstrate a robotic system to scan, blast and paint a complex surface similar to that of the interior of the tank. The system will aid in reducing cycle time for the process and labor hours required to complete the entire evolution. In addition, the proposed system will create more uniform quality while maintaining safety.

This project included two demonstrations. A small-scale demonstration was conducted at a robotic integrator's facility based on specifications provided by the integrated project team (IPT). After further refinement, a large-scale demonstration was conducted at a robotic integrator's facility.

Due to complexity of developing and refining the ability to robotically paint the interiors of tanks within the remaining project period of performance, the IPT eliminated painting from the final development and demonstration.

Payoff

Once implemented, GDEB and BIW anticipate that this project will reduce the hours needed to perform blasting interior tank surfaces by 50 percent. Implementation of new technologies / products developed under this project at BIW is estimated to result in five-year savings of $2.4M for the DDG 51 Class destroyer. Implementation at GDEB is estimated to save $3.5M for the combined VIRGINA Class submarine (VCS), VIRGINA Payload Module (VPM) and COLUMBIA Class submarine (CLB) platforms.

Implementation

GDEB and BIW will implement the solution in a production environment beginning in the 4Q FY2025 on multiple ship platforms, including construction of DDG 51, VCS, VPM and CLB.

PERIOD OF PERFORMANCE:
March FY2020 to August FY2024

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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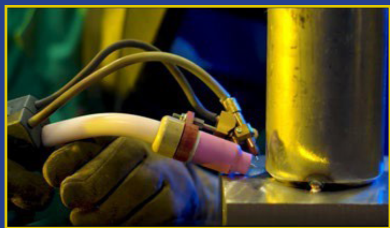
STAKEHOLDERS:
PMS 397
PMS 400D
PMS 450

General Dynamics Electric Boat Uses GTAW to Increase Productivity



PERIOD OF PERFORMANCE:
June FY2020 to February FY2023

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDERS:
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PMS 397

S2831 — Semi-Automatic GTAW Welding Process

Objective

For the VIRGINIA Class submarine (VCS), General Dynamics Electric Boat (GDEB) currently uses labor-intensive manual gas tungsten arc welding (GTAW) operations and processes for cladding, welding pipe, welding tanks with difficult to weld alloys and some structural welds. Manual GTAW is very slow, particularly for large-diameter circumferential welds. Additionally, it requires a high level of skill, due to the dexterity required in using both hands independently (i.e., one hand to move the welding arc along the joint and the other to feed the filler metal).

This Center for Naval Metalworking (CNM) project used semi-automatic GTAW equipment to increase throughput for pipe welding, cladding and other applications to meet the demands of the VIRGINIA Payload Module (VPM) and COLUMBIA Class submarine (CLB). This project assessed and selected a semi-automatic GTAW system by EWM TIG Speed. This system was used to evaluate various shipyard applications, including tank welds, cladding inside of tanks, pipe welding and other applications.

The capabilities of welding equipment have advanced enough to replace manual GTAW with semi-automatic GTAW, thus eliminating production delays by producing welds of consistently higher quality. The semi-automatic GTAW process is more productive than conventional (manual) GTAW and produces higher quality welds with the potential for fewer defects, such as lack of fusion. As a result, the new process will improve precision, reduce labor costs and improve schedule performance.

Phase 1 defined the requirements and developed welding parameters. In Phase 2, a test plan was created and executed to determine the acceptability of the semi-automatic GTAW process in the shipyard environment.

Payoff

Semi-automatic GTAW will enable better quality welds at higher deposition rates compared to manual GTAW. It has the potential to be two-to-five times faster than manual GTAW and requires less skilled welders. GDEB projects that this effort will result in estimated five-year savings of $801.0K for VCS, $9.4M for VPM and $4.2M for CLB. This equates to total five-year cost savings of $14.4M for all platforms and a return on investment (ROI) of 4.46:1.

Implementation

The Semi-Automatic GTAW Welding Process ManTech project has successfully completed, and the results have transitioned to the GDEB facility. First production use was in 2Q FY2024, and GDEB is currently working on scaling and performing additional training.

Improving the Valve Cladding Process for COLUMBIA and VIRGINIA Payload Module

S2832 — Robotic Valve Cladding Cell

Objective

The Robotic Valve Cladding Cell project is investigating opportunities with General Dynamics Electric Boat (GDEB) to develop a prototype that will demonstrate proof-of-concept robotic capabilities aimed at enhancing production quality and throughput for valve-cladding processes. This innovative robotic system has the potential to significantly boost the efficiency and workflow of valve production. With increased efficiency and versatility, the system will help meet the anticipated demand for critical schedules. Traditional cladding processes involve long setup times and extensive labor and require large amounts of shop space. To achieve the required clad thickness for shipping, components must be precisely positioned for welding, necessitating multiple fixtures, optical tool checks and manual adjustments for each configuration. With the start of VIRGINIA Payload Module (VPM) and COLUMBIA Class submarine (CLB) construction, GDEB must produce almost double the number of cladded valves to meet shipping requirements.

This two-phased Naval Shipbuilding and Advanced Manufacturing (NSAM) Center effort developed a prototype to demonstrate proof-of-concept robotic cladding capabilities that improve production quality and increase throughput. GDEB has defined the desired system functionality and developed the system requirements and functional specifications. The project team worked with equipment integrators to modify existing robotic cladding systems to specific GDEB applications and demonstrate the desired functionality of a prototype system at the selected robot integrator facility. The team legacy cladding processes with those demonstrated by the prototype system, which will guide decisions on procurement and implementation, if the prototype proves successful.

Payoff

Once implemented, this technology is projected to deliver combined five-year savings of $13.6M for VCS and CLB.

Implementation

Upon successful and timely completion of the Robotic Valve Cladding Cell project and approval of both the technology and associated business case by the acquisition Program Offices, the results will be transitioned to the GDEB facility. GDEB expects to implement the technology in the 4Q FY2024.

PERIOD OF PERFORMANCE:
February FY2020 to July FY2023

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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PMS 450
PMS 397

Optimizing Organizational Capabilities by Accessing and Sharing Research and Development Project Data

PERIOD OF PERFORMANCE:
November FY2022 to November FY2023

PLATFORMS:
Office of Naval Research (ONR)
Navy ManTech

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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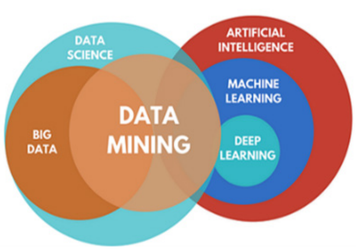

M2850-2 — Automated Portfolio Data Mining Analysis II

Objective

The Automated Portfolio Data Mining Analysis Phase 2 project, conducted by the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center, evaluated and tested commercial-off-the-shelf (COTS) software that was identified in the first phase of the project. The team assessed the products' capabilities to connect disparate data sources and provide a central location where users can search, obtain and display the portfolio data.

The project team conducted proof-of-concept demonstrations with the chosen software packages intent to verify their ability to connect various data sources, including SharePoint instances, networked file repositories and external sources such as public websites or sites behind firewalls. Additionally, the team evaluated and ranked the capabilities and security risks of each application based on a requirements document and criteria established during the initial project phase.

Payoff

The primary goal of this project was to allow for end users such as Navy ManTech and other Department of Defense (DoD) Program Officers to search and find relevant project and technical information in an efficient manner. The software tools evaluated demonstrated the ability to parse various data types and provided data modeling capabilities that could allow for automation and categorization of the target data while generating useful result reports. However, in the Project Final Report, ATI recommended that neither of the final solutions were ready for implementation at this time and additional analysis needed to be conducted for an effective solution that meets the Navy ManTech project objectives.

Implementation

Based on the results of this project, no final solution was chosen and deemed acceptable for implementation to meet Navy ManTech needs. Further evaluation and a follow-on project may be assessed in the future, but there are no current plans to pursue at this time.

Renovating Temporary Fitting Attachment Technology

S2870 — Development of Fitting Aid Tools

Objective

General Dynamics Electric Boat (GDEB) used labor-intensive operations and processes to fit steel components (e.g., egg crates, stiffeners and panels) when creating assemblies. This highly manual process required the fabrication of temporary fitting attachments, which were welded to the assembly for fit-up and then cut and ground off once fit-up is completed. The objective of this Center for Naval Metalworking (CNM) project was to eliminate or minimize the need to fabricate, weld, cut and grind these numerous temporary fitting attachments. Other commercial industries used temporary and reusable fitting aids for a variety of manufacturing applications. Discussions with a few vendors indicated that such existing technologies could be modified for submarine applications. This project verified that the tools can be modified for unique submarine applications and were robust enough to handle the work required for submarine construction. This project utilized state-of-the-art fitting aids to increase throughput in the fabrication of steel components to meet the demands of the submarine platforms fabricated at GDEB. This project researched and validated commercial-off-the-shelf fitting aids as well as designed, prototyped and evaluated custom fitting aids to produce accurate submarine components using Navy required plate materials.

Payoff

GDEB expected the results of this project would reduce the labor hours required in the fabrication process, improving accuracy and reducing labor / time costs. The project's final business case analysis savings of $395.0K per VIRGINIA Payload Module (VPM) hull and $556.0K per COLUMBIA Class submarine hull for combined five-year savings of $6.7M across all platforms delivering a return on investments (ROI) of 5.85:1.

Implementation

The results of this project have were implemented at the GDEB facility in 2Q FY2024.

PERIOD OF PERFORMANCE:
July FY2020 to June FY2023

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDERS:
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PMS 450

Common Datums and Inspection Tools Overcome Inconsistencies

PERIOD OF PERFORMANCE:
May FY2020 to September FY2023

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)
CVN Class aircraft carrier

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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S2874 — Digital Common Layout and Inspection Process

Objective

Many of the components and assemblies that are manufactured at Huntington Ingalls Industries – Newport News Shipbuilding (NNS) have historically been inspected using manual methods. In this manufacturing state, efforts are often duplicated as multiple stakeholders perform independent inspections and variations in inspection methods present false-positive or -negative findings, which create production delays. These variations are due to the time-intensive process to ensure the part is level, which becomes increasingly difficult when inspecting large parts. Even though common datums and inspection standards exist, slightly different interpretations of the standards and complex geometries often create different results and add non-value-added rework to the process.

The objective of this Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project was to develop common reference datum targets on components based on the analysis of survey data of key features. The monument systems allow technicians to tie an instrument back into the digital datum coordinate system by resurveying these monuments – with a laser tracker, laser scanning and probing metrology tools – and performing a transformation analysis. This capability means that any technician can obtain a monument, tie into the component and perform dimensional surveys or layoffs. This capability persists through a build schedule and can be independent of component relocation.

Payoff

By reducing the labor hours associated with rework and providing timely and efficient dimensional process control data, the project team anticipates a reduction in non-value-added work. Increased efficiencies and quality improvements enabled by the technology are anticipated to result in five-year savings of $5.0M and a five-year return on investment (ROI) of 1.99:1.

Implementation

Based on the results of testing, NNS generated the data needed for internal process verification and validation, finalized the business case analysis and created shipyard implementation plans. The transition event for this project was the successful execution of NNS' performance demonstration activities, verifying the improved process met the expectations of the project team and stakeholders. Initial implementation efforts have initiated and are to complete in 4Q FY2025.

Implementation will utilize a phased approach, where the most beneficial opportunities will be assigned a higher priority and implemented first. The results of this ManTech project may be implemented in the production of CVN 78 Class aircraft carrier, VIRGINIA Class submarine (VCS) and COLUMBIA Class submarine (CLB).

End-to-End Process Using Intelligent Data Reduces Time, Effort and Cost

S2903 — Model to Manufacturing

Objective

Huntington Ingalls Industries – Newport News Shipbuilding (NNS) is developing increasingly intelligent 3D computer models for its products in support of design activities. However, it is not able to adequately leverage these models downstream to support component and assembly manufacturing. During the design phase of a product, models are created in computer-aided design (CAD) software that aids significantly in the development of design products, including traditional drawings (most common). Unfortunately, the usefulness of the 3D model often ends in design as the 3D model does not persist to downstream stakeholders and often lacks the detail necessary for manufacturing. This poses a significant problem as manufacturing equipment is becoming increasingly intelligent and is driven more by computer programs than traditional manual operations.

The Model to Manufacturing project, managed by the Naval Shipbuilding and Advanced Manufacturing (NSAM) Center, established an end-to-end process where data flows seamlessly from the design agent or technical authority to the build authority, including manufacturing entities (internal and external), without losing any of its intelligence or integrity. Stated differently, the authoritative source model is connected and preserved (its integrity is maintained) to each downstream stakeholder, including both external suppliers who may need different neutral formats (e.g. STEP, JT, etc.) and internal manufacturers.

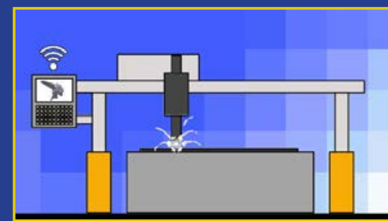
Establishing an end-to-end process that includes configuration management of manufacturing by-products reduces the duplication of effort, saves time, reduces cost and improves first-time quality not just locally (in a shop), but also between businesses and suppliers. Manufacturing groups can use a pre-produced product as the baseline for their manufacturing work, utilizing basic attributes such as size, shape, form, material type, etc. This information, coupled with manufacturing details, can then be associated with the technical authority design model (authoritative source) and fed to the appropriate machines. Any engineering or design changes are captured by the system, and new features and details will automatically become available to the manufacturing team, greatly improving the overall configuration management of a given component.

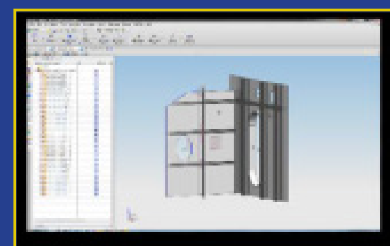
Payoff

This project is expected to result in five-year savings of approximately $10.0M with a return on investments (ROI) of 1.7:1.

Implementation

The Model to Manufacturing technology is expected to be implemented at NNS during the 4Q FY2027.





PERIOD OF PERFORMANCE:
January FY2021 to July FY2023

PLATFORMS:
VCS, CLB, CVN

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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Pipecrawler to Repair Internal Weld Defects

PERIOD OF PERFORMANCE:
July FY2021 to May FY2025

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class Submarine (CLB)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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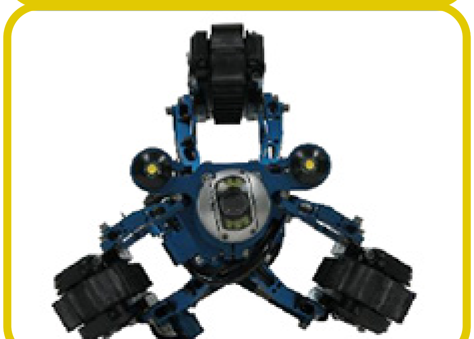

S2911 — Robotic Blending of Large Diameter Internal Piping

Objective

Final installation of large diameter shipboard pipe assemblies presents a scenario known as "closure joints," where welding technicians complete the last weld assemblies in a pipe system. Weld joints completed before closure preserve a degree of access to the interior diameter (ID) of the pipe, allowing shipbuilders to perform rework – if warranted by inspection – on the ID of pipe joints. By contrast, closure joints eliminate the usual access. If rework is required, the lack of access results in numerous delays and additional labor costs to complete the joint to acceptable quality standards. The combination of material type, application, closure joint scenario and required quality make this situation unique to submarine construction at General Dynamics Electric Boat (GDEB).

The objective of this Center for Naval Metalworking (CNM) project is to utilize robotic and video technology to provide access to internal pipe locations to perform work typically conducted when access is available. GDEB seeks to develop a means for a small device to enter small access points, expand to the working pipe diameter, navigate to the intended work location and perform minor blending and grinding operations. A high degree of system cleanliness must be maintained throughout the operation. This solution would provide an alternative to the current practice of removing critical equipment by making smaller access points associated with valves / bosses viable entry points. The solution would also provide a means to enter non-closure joints in the event ID access is still problematic due to configuration or length.

Payoff

GDEB expects the results of this project will reduce the labor-hours required to repair weld defects and reduce the overall number of internal piping weld defects. This CNM project is expected to provide estimated savings of $400.0K per VIRGINIA Class submarine (VCS), $493.0K per VIRGINIA Payload Module (VPM) and $789.0K per COLUMBIA Class submarine (CLB) for combined five-year estimated savings of $6.8M across all platforms.

Implementation

Upon successful and timely completion of the CNM project, the results will be implemented at the GDEB facility. GDEB anticipates implementation in 3Q FY2026.

Investigating Drone Operations for Submarine Hull Inspections

S2919 — Drone Photogrammetry

Objective

Currently, major modules for submarines are moved into the aisle to perform circularity surveys using JLG man lifts. This process displaced workers, required the module be moved twice, involved disconnecting and reconnecting utilities and disrupts the outfitting schedule on average five to seven working days. In addition, there was growing interest in the shipbuilding industry to introduce the use of drones in industrial environments to improve the efficiency from use cases such as these dimensional inspections. The objective of the Institute for Manufacturing and Sustainment Technologies (iMAST) project, working with General Dynamics Electric Boat (GDEB), was to outfit a drone with a photogrammetry camera and active gimbal system that can pan and tilt the camera to successfully accomplish approved surveys in tight production surroundings, eliminate the need to operate a vertical man lift and manually take photographs. The gimbal system needed to be adaptable to existing photogrammetry cameras currently used and approved for handheld photogrammetry, and the system needed to adhere to Blue UAS, IT, Cyber, and Facility policies.

Working with well-defined requirements, including line-of-sight clearance, drone pathway clearance, camera payload, flight time and security, the project team conducted an extensive market survey to identify technologies, platforms and partners for drone-related research. iMAST developed a drone and gimbal system that enables the operator to tilt and pan the camera, while at the same time, provide real-time live feedback of the camera's line of sight. The drone was equipped with collision-detection technology and designed with flight controls suitable for indoor use in GPS-denied environments. Risk-reduction activities, such as analysis of vibration effects on the photogrammetry camera, downdraft studies (dust and grit) and radiofrequency emission, were completed to ensure successful transition. During early demonstration activities, additional use cases for labor-intensive or unsafe activities, such as crane rail inspections, were identified as prime opportunities for additional industrial use of drones. iMAST provided extensive training, both outdoors and indoors, to shipyard drone pilots in preparation for a final demonstration and evaluation of the drone technologies in November 2023.

Payoff

The main benefits of this project are in the areas of reduced labor and construction schedule. Drone photogrammetry should reduce the set-up and break-down times associated with moving sections to the aisle for JLG man lift access. Secondary benefits are expected from the introduction of drones into the manufacturing, overhaul and repair and operational inspection requirement situations, including inspection of high-reach critical assets such as cranes. Total five-year savings for crane inspections alone are expected to exceed $2.1M.

Implementation

At this time, GDEB is committed to implementation of a smaller drone platform to conduct crane rail inspections, and this implementation is expected to take place in 4Q FY2024. Further investigation, training and drone pilot commitment is still required for full implementation of the larger Freefly Alta X drone system to perform dimensional inspections.

PERIOD OF PERFORMANCE:
March 2021 to December 2022

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDERS:
PMS 450
PMS 397

Invigorating the Additive Manufacturing (AM) Supply Base and Shipyards

PERIOD OF PERFORMANCE:
September FY2021 to September FY2024

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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PMS 450

S2924 — Modern Shipbuilding Manufacturing to Support VCS and CLB Submarines Additive Manufacturing Supply Chain and Shipyard Readiness

Objective

General Dynamics Electric Boat (GDEB) and its vendor base must be prepared to meet the increased construction demands of two VIRGINIA Class submarines (VCS) and one COLUMBIA Class submarine (CLB) per year.

The objective of this Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project is to invigorate the additive manufacturing vendor base to prepare for increased shipbuilding production and sustainment. This includes advancing the technology readiness level (TRL) of additive manufacturing (AM) and establishing a framework for GDEB and Connecticut Center for Advanced Technologies vendors to accept AM as a potential manufacturing technique for tools / components, which would then benefit the rest of the AM community. This project is organized into three main tasks that will be executed in two phases. The first task will focus on creating processes for designing future components with AM as an option and creating databases that will capture information on materials, processes, machines and vendor capabilities for future AM design projects. The second task will identify the business cases where use of advanced manufacturing technologies and processes makes business sense, specifically for non-shipboard components, and will result in the creation and testing of prototype tooling and fixtures. Finally, the third task will focus on advancing the TRL and the manufacturing readiness level (MRL) from 4 to 5 for applying directed energy deposition (DED) AM for a shipboard component part build or repair.

Payoff

This project will improve the readiness of the submarine manufacturing supply base through advancing AM technologies and capabilities, as well as developing a database of relevant suppliers. The direct benefits of this project, as they apply to cost savings are difficult to quantify. However, all aspects of the potential benefits of this project will continue to be investigated and refined throughout the project's life-cycle. Preliminary anecdotal benefits of the project include a functional AM vendor database, AM design tenets and an improved TRL — all expected to contribute to decreased acquisition costs and more rapid repairs.

Implementation

The implementation plan is contingent on successful creation of a functioning vendor database, successful design and manufacturing path for AM tooling / fixtures and successful execution of DED build or repair for a shipboard component. It is expected that a functioning AM vendor database, AM design tenets and an improved TRL will result in lower acquisition costs and more rapid repairs.

Improving Efficiency and Safety in Lead Bay Packing

S2926 — Improved Lead Bay Packing

Objective

Current classes of U.S. submarines ships use lead for ballast and balancing. The lead packing process begins with the delivery of painted lead bricks, weighing between 34 and 56 pounds each, to the shop floor. These bricks are then transported to the hull section using an overhead lift and manually placed into position within the hull. Painted lead bricks are hazardous materials which require handling by specially qualified lead workers. The physical demand upon the individual necessitates increasing the number of qualified lead workers needed to support lead packing. Qualified lead workers require specialized training and periodic medical surveillance tests and physical exams, must suit-up in cumbersome full-body protective personal equipment including respirators, and require decontamination at the end of each shift. This adds to the activity's span time with extra tasks for setup, breakdown and clean-up. Inadvertent mishandling of heavy bricks poses both a serious injury hazard, not only to lead packing personnel, but also to any non- lead packing personnel working near lead handling. Damaging the painted lead brick surface could result in exposing the work environment to lead. Specialized training, medical surveillance testing and physical exams reduce the availability of highly skilled trades. Supervisor manually collects and reports the weight of lead packed into each bin, which is non-value added and time consuming. The manual calculations must be checked by Naval Architecture.

This project is expected to reduce cycle time for lead bay packing processes by approximately 30 percent and, where feasible, replace manual weight logging with an integrated digital weight collection and reporting interface. It is also expected to minimize human exposure to lead and physically demanding activities (manual lifting and repetitive motion – such as bending and twisting) – this is an ancillary goal that will not be quantitatively measurable but is an important aspect of this project.

Payoff

Once implemented, General Dynamics Electric Boat (GDEB) anticipates that this project will improve efficiency and safety in the lead bay packing process. Implementation of new technologies / products developed under this project is estimated to result in savings of $713K per VIRGINIA hull and $1.65M per COLUMBIA hull, creating a combined five-year return on investment (ROI) of 8.96:1.

Implementation

GDEB will implement the solution in a production environment beginning in the 2Q FY2027 on multiple ship platforms, including the construction of VIRGINIA Class submarine (VCS) and COLUMBIA Class submarine.

PERIOD OF PERFORMANCE:
January FY2022 to December FY2024

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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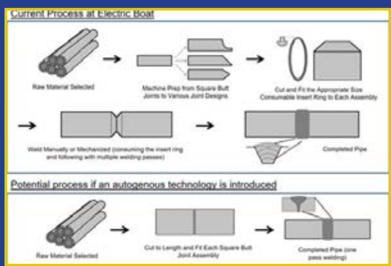
Simplified Pipe Joint Welding via Single Pass Welding Process



PERIOD OF PERFORMANCE:
May FY2023 to October FY2025

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class Submarine (CLB)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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S2928 — Next Generation Autogenous Welding Process and Equipment Development

Objective

At General Dynamics Electric Boat (GDEB), to go from raw pipe material to a welded joint involves a number of steps. The process begins by selecting the raw material and cutting the piece to length specified by the application. The application will call out the technical specification to which the joint needs to be prepared and welded, setting the tolerances and dimensions for the bevel geometry. These pipe pieces are machined either by hand or by machine. This can be time consuming based on the design and/or the application. Once pieces are verified to meet the specification-required dimensions, the pipe pieces are fit-up using a consumable insert ring. Consumable insert rings need to be cut and filed to accurately fit around the pipe's inner diameters. Any spaces or gaps left between the pipe pieces or the insert and a pipe, increase the likelihood for defects to occur within the weld. Once ensuring a quality fit, the pipe moves on to welding. The number of weld passes for a joint increases as the pipe thickness increases. Additionally, interpass temperature and cleaning between beads will increase the number of hours spent to complete each joint.

With each step, the potential for workmanship-type defects increases. These defects are undesirable and may lead to rework of the joint. In some cases, removing the joint entirely and starting from scratch may be required. In order to maximize the amount of time saved per application, the steps to complete a pipe joint need to be made more efficient or eliminated altogether. Welding can be enhanced by potentially reducing the number of passes needed to complete the joint.

This Center for Naval Metalworking (CNM) project is investigating the use of autogenous gas tungsten arc welding (GTAW) technology to reduce the necessary steps involved to weld thin-walled, horizontally rolled pipe joints. The autogenous process can complete welds within a single pass without the use of filler material or inserts. The team is executing a research plan to investigate potentially eliminating / minimizing bevel machining of each piece for pipe applications, insert ring prep and fit up, initial tack welding (due to the square prep that is required), multiple weld passes, filler material and additional rework based on the outcome of the weld.

Payoff

By reducing the number of labor hours associated with machining, fitting and welding, GDEB is projecting savings of $1.3M per VIRGINIA Class submarine (VCS) and $2.8M per COLUMBIA Class submarine (CLB) for a combined savings estimate of $27.1M and a five-year return on investment (ROI) estimate of 6.7:1.

Implementation

Upon successful and timely completion of the CNM project, the results will be implemented at the GDEB facility. GDEB anticipates implementation in the 4Q FY2026. Project results will be shared with additional Navy stakeholders via technology transfer events with a goal of improving application visibility across all platforms.

Efficiency Gains in Void Filling Applications

S2936 — Foam Fill Transformation Analysis

Objective

The objective of this Composites Manufacturing Technology Center (CMTC) project was to evaluate alternative concepts for foam filling appendages for COLUMBIA Class submarines (CLB). Because the current process for filling appendages is labor intensive and ergonomically challenging on VIRGINIA Class submarines (VCS), and the CLB is expected to significantly exacerbate these issues due to its increased size, a new approach is sought. This was accomplished by identifying the system requirements, consulting with industry experts, brainstorming alternative solutions and presenting alternatives based on cost, schedule, performance and safety measures. A demonstration test article was also built during this project, so that promising foam alternatives or process changes can be tested in a simulated environment.

Existing salient requirements were identified. Once these were documented, potential solutions were identified and categorized. Finally, the solutions were compared to the baseline, and choices were made based on cost, schedule and safety performance, as well as any other requirements determined by, and agreed to, by the project team.

Payoff

The project provided data for manufacturing and acquisition cost of current syntactic foam processes and foam pouring techniques. This data, along with down-selected concepts and manufacturing approaches, were used to achieve a 30 percent reduction in cycle time.

Implementation

It is anticipated that the project results will be implemented in Newport News Shipbuilding's production facility. Updated manufacturing processes developed under this project were documented for incorporation into build instructions. After securing all certifications, the material and process are anticipated to be incorporated on future builds of CLB. Implementation on new builds is expected to occur in FY2026, once the procedure has been approved through Naval Sea Systems Command (NAVSEA).

PERIOD OF PERFORMANCE:
September FY2022 to February FY2024

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Composite Manufacturing Technology Center (CMTC)

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STAKEHOLDERS:
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Advancing Health Monitoring of Critical Manufacturing Assets

PERIOD OF PERFORMANCE:
January FY2022 to May FY2024

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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S2963 — Predictive Maintenance II — Industrial Internet of Things (IIoT)

Objective

General Dynamics Electric Boat (GDEB) has critical path manufacturing assets that have the potential to experience catastrophic failure despite preventative maintenance programs, directly resulting in unnecessary asset repair costs, lost production time and rework. Manual health monitoring systems (HMS) have proven to be very successful, but many assets have accessibility challenges that require wireless interrogation for health monitoring.

Implementing advanced machinery health monitoring technologies i.e., those that make use of the Industrial Internet of Things (IIoT) for inaccessible, critical equipment will improve production of U.S. Navy submarines by ensuring proper operation when needed while avoiding critical failure and production delay. The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project was to use reliability-centered maintenance analysis to identify the most suitable critical path VIRGINIA (VCS) and COLUMBIA (CLB) Class submarine manufacturing equipment candidates and to develop and demonstrate an optimum state-of-the-art, wireless predictive maintenance system to measure vibration and temperature on critical legacy and modern shipbuilding equipment.

iMAST, working with GDEB, conducted a Failure Modes and Effects Analysis to identify equipment most suitable for IIOT HMS technology. A thorough investigation of wireless sensing technologies was conducted and down selected to the only vendor that met critical cybersecurity requirements at GDEB. iMAST developed various courses of action to implement the IIOT HMS technology on GDEB assets. The one course of action that would not affect the active GDEB production network was selected, and a pilot was conducted, collecting data from wireless accelerometers, liquid level and current sensors. Demonstrations were provided to internal GDEB management as well as participants from the broader Navy shipbuilding and repair community in 3Q FY2024.

Payoff

This project will help to mitigate construction down-time due to manufacturing asset failure by circumventing catastrophic failures, which often cause costly replacement. Some assets are unique, essential systems for submarine manufacturing; avoiding catastrophic failure will also avoid unexpected and unnecessarily extended downtimes and costs for full asset repair, lost production time and rework. This project's anticipated savings are in excess of $7.0M. The estimated five-year return on investment (ROI) for this project is 1.9:1.

Implementation

Initial technology transition took place during the pilot use and demonstration of the wireless sensors HMS software on GDEB production assets. The technology was demonstrated on two critical assets identified by GDEB that have large potential benefit from the avoidance of a catastrophic failure at the GDEB Quonset Point facility. GDEB reliability engineers then worked with GDEB Applied Electrical Technologies, IT, and cybersecurity to expand the use of the IIoT HMS throughout VCS and CLB manufacturing at GDEB. Implementation at other shipyards may expand this project's impact and savings to the Navy. The iMAST team has conducted a site survey at another yard to identify similar assets to those identified at GDEB, which may also benefit from IIoT HMS technologies to reduce schedule slip and maintain or improve costs.

Advanced Surface Treatments for Adhesion Promotion in Shipbuilding

S2968-1 — Improved Surface Preparation Processes Phase 1

Objective

When bonding a polymeric material to a substrate, preparing the surface of the substrate to receive the applied material is a critical step. Improper surface preparation often leads to poor coating performance and/or delamination. In most cases, surface preparation entails removing undesirable materials (i.e., cleaning) and imparting surface roughness. Abrasive blasting of steel prior to applying the first coat of a polymeric paint system is a very common example of surface preparation in the shipbuilding and ship repair industries. However, when multiple polymeric layers are stacked to create a coating system, preparation of prior polymeric layers is more complex and typically involves at least one time-dependent element.

The objective of this Composites Manufacturing Technology Center (CMTC) project is to evaluate alternate manufacturing processes to prepare a polymeric surface (e.g., paint) against incumbent processes and requirements necessary for implementation. Two generalized use cases will be explored in this project. First, the interface between the submarine exterior hull anti-corrosion paint system and a subsequently applied hull treatment material will be explored. Second, paint repair process improvements for surface ships will be investigated. The final deliverable of this effort will be a trade study that identifies the most promising technologies to develop further to improve surface preparation processes in shipyards. The processes of interest will be readily repeatable, amenable to automation, able to be quantitatively evaluated and produce surfaces that accept the next process material (e.g., coating, adhesive, or hull treatment) with equivalent (or improved) adhesion. The future processes ideally would be able to be performed well outside of typical recoat windows, which can enable additional shipbuilder flexibility and reduce rework.

Payoff

Labor savings will be the driver for the return on investments (ROI), with an expectation to improve both shipyard construction / maintenance schedules and Naval Sea Systems Command (NAVSEA) life-cycle costs as a result of more flexible surface preparation requirements and more consistent polymeric adhesion. Data and information obtained from several sources (i.e., historical government-furnished information (GFI), baseline process test data and the Request for Information (RFI) tasking in Phase 1, etc.) will be used to develop the business case, which will be defined in the Project Planning Document (PPD) for Phase 2 of this effort.

Implementation

Implementation will not occur as a result of Phase 1 of this effort. An Implementation Plan will be defined in the PPD for Phase 2 of this effort.

PERIOD OF PERFORMANCE:
Octobrer FY2024 to November FY2025

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Composite Manufacturing Technology Center (CMTC)

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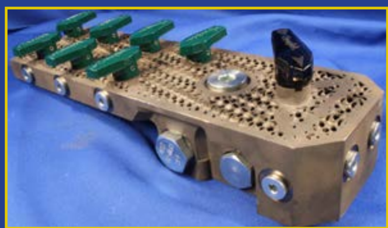
STAKEHOLDERS:
PMS 450
PMS 397
PMS 400D4
PMS 378

Additive Manufacturing of Critical Component to Resolve Supply Chain Deficiencies



PERIOD OF PERFORMANCE:
November FY2022 to June FY2024

PLATFORM:
Submarine Rescue Diving and Recompression System Pressurized Rescue Module

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDERS:
PMS 390
Naval Undersea Warfare Center (NUWC) Keyport
Naval Surface Warfare Center (NSWC) Carderock

S2996-2 — Additively Manufactured Submarine Rescue Vehicle Manifold

Objective

The U.S. Navy Submarine Rescue Diving and Recompression System (SRDRS) performs rescue operations on submerged, disabled submarines of the U.S. Navy or foreign navies. The SRDRS Pressurized Rescue Module (PRM) contains complex, application-specific components that are not readily available from established supply chains when replacement components are required. One example of these components is the Jettison-Hatch Control Manifold, which enables control of several safety-critical functions. There are currently no spare manifold components and no readily available method of procuring additional components. Powder bed fusion (PBF) additive manufacturing (AM) has the potential to enable rapid production of this component by a qualified Navy-owned process and machine. The overall objective of this pathfinder project is to exercise—for the first time—the entire AM development, qualification and deployment cycle for a safety-critical Scope of Certification (SOC) subsea component. This involves redesign-for-AM, developing and coordinating process and part qualification and supporting transition to Naval Undersea Warfare Center (NUWC) Keyport for production and PMS 390 for installation.

The PMS 390 Phase 1 effort involved redesign-for-AM, risk reduction, and defining the overall qualification strategy. The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) Phase 2 project was to help coordinate and formally document a Navy-owned qualification procedure for this PRM SOC manifold fabricated via PBF AM.

iMAST, working closely with PMS 390, Portsmouth Naval Shipyard (PNSY), NUWC Keyport and Naval Surface Warfare Center (NSWC) Carderock, supported PBF procedure qualification by coordinating and completing nondestructive and destructive testing and analysis of material properties, microstructure, mechanical properties and machining of test specimens and representative parts. iMAST and NUWC Keyport completed a series of part verification builds and follow-on, post-process procedures and tests (including stress relief, heat treatment, electrical discharge machining, machining and hydrostatic testing) in support of Qualification Package 2 that will enable a production build at NUWC Keyport.

Payoff

Inability to rapidly procure or fabricate these components can result in costly downtime or delays implementing on additional components and vehicles. This pathfinder project creates a qualified procedure and process to fabricate replacement and spare SOC components, giving the Navy the ability to alleviate emergent replacement delays and costs and reduce lead times. Having a qualified procedure and system within the Navy will enable more rapid qualification for other SOC and safety-critical subsea components in the future.

Implementation

iMAST provided inputs to the draft Production Certification Package documentation and transitioned these deliverables to PMS 390, PNSY, and NUWC Keyport. Finalization of the Qualification Package 2 continued through 1Q FY2025, where Naval Sea Systems Command Technical Warrant Holder (TWH) approval is expected shortly afterward. Part verification builds completed by NUWC Keyport in 1Q FY2025 will be non-destructive and hydrostatically tested. After submission and TWH approval of Qualification Package 3 (Certificate of Conformance), the manifold will be installed on the PRM in 3Q FY2025.

Sensor Assembly Improvement Reduces Sensor Cost and Allows for Use in Other Submarine Acoustic Systems

S3003 — Manufacturing of Advanced Textured Ceramic Sensor Elements for a Navigational Sonar System (NSS)

Objective

The objective of this Electronics Manufacturing Center project is to improve the assembly process for the acoustic sensor device used in an existing sensor array. With manufacturing improvements to this sensor, it can be used to create a modern, flexible and sustainable sensor for use in designing navigational sonar systems.

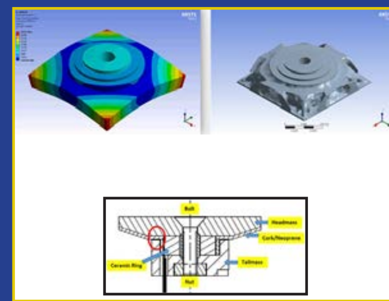
Payoff

Columbia Platform Benefits: Improved manufacturing for NSS-type sensors will improve the sustainability of the NSS system by using a simple to manufacture ceramic element coupled with a sensor that is well understood and commonly used across the submarine fleet, including Virginia platforms. This should also result in improved availability of the Ship, Submersible, Ballistic, Nuclear (SSBN) platform by improving system reliability. Success of the program may also enable pier-side replacement or repair of the NSS, which is currently not possible.

Virginia Platform Benefits: While the primary platform benefit is for Columbia platforms, any manufacturing improvements developed under this effort will be backward compatible to the sensor arrays used on all Virginia class platforms.

Implementation

Following the conclusion of this program, Naval Surface Warfare Centers (NSWC) Crane, as the manufacturing partner, will implement the results of the effort on its existing NSS sensor manufacturing line. NSWC Crane will also implement the results of this effort as part of its depot activity on related systems using a similar sensor. The ManTech effort is expected to culminate in the testing of prototype elements and creation of a data set that allows the pursuit of qualification of the revised devices for system insertion. Implementation is expected to occur 3Q FY2026.



PERIOD OF PERFORMANCE:
May FY2023 to May FY2025

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Electronics Manufacturing Center (EMC)

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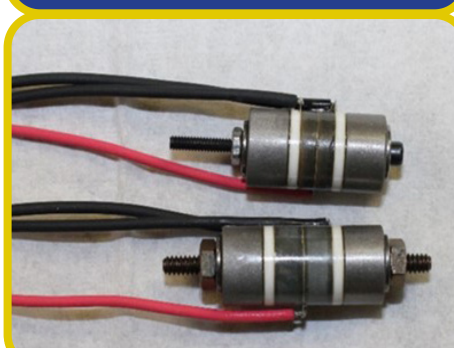
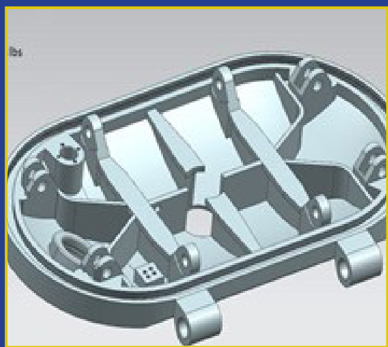
Naval Surface Warfare Center - Crane
PMS-401
SP-24



Pursing Monolithic Machining to Reduce Manual Welding Operations



PERIOD OF PERFORMANCE:
April FY2024 to May FY2027

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDERS:
PMS 397
PMS 450

S3006 — Large Scale Monolithic Machining

Objective

Structural assembly in shipbuilding is facing growing challenges due to dependence on heavily manual welding operations. An expanding workforce and new products force a steep learning curve to contend with the material property challenges and limitations of this fabrication process. With roughly 18 percent of all submarine manufacturing hours spent welding, deficiencies in the process can become a bottleneck for all downstream customers. Variation due to human factors, long set up times and extensive testing requirements often lead to cost overruns on small volume production of complicated subassemblies. With growing demands as a result of COLUMBIA Class submarine (CLB) and VIRGINIA Payload Module (VPM) reaching full production, new methods need to be proven to accelerate production and meet first-time quality demands.

The objective of this Center for Naval Metalworking (CNM) project is twofold: prove feasibility for monolithic machining principles in shipbuilding and provide design tenets for future monolithic manufactured parts. Due to the large variety of potential candidates, a representative sample of parts must be chosen that can demonstrate future capabilities. The final deliverable will include monolithically machined prototypes of varying size, geometry and material properties. Success will be measured by the ability to reduce cycle times, distortion and other key performance indicators.

Payoff

By investigating historic data, utilizing subject matter experts and absorbing industry best practices, the selected articles will be redesigned, tested and proven to enhance future manufacturing decisions as it relates to cost and schedule considerations. This proposed solution aims to reduce labor hours associated with welding and fitting, install cycle time and open new opportunities for novel article design for the monolithic machining process resulting in estimated combined five-year savings of $7.9M across the VIRGINIA Class submarine (VCS), CLB and VPM platforms.

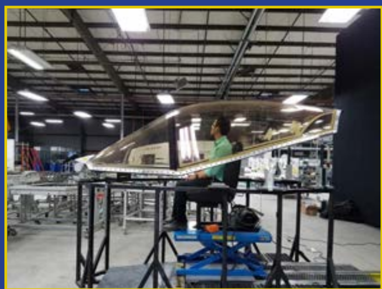
Implementation

General Dynamics Electric Boat (GDEB) will provide an implementation plan incorporating all design tenets, production parts and recommendations for future machine requirements discovered over the course of the project. This will include revisiting the component selection matrix and determining all necessary capital, facility and IT improvements to scale the application of monolithic machining across Groton, Quonset Point and Focus Factory sites. Implementation is estimated at 3Q FY2026.

F-35 Lightning II Projects

F-35 Lightning II Aircraft. *(U.S. Navy image.)*

Automated Optical Measurement System to Save Millions of Dollars on F-35 Transparencies



PERIOD OF PERFORMANCE:
September FY2019 to August FY2022

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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

A2765 — F-35 Automated Optical Measurement System

Objective

Inspecting transparencies for optical defects to strict specifications is both time consuming and prone to error. The Automated Optical Measurement System project sought to replace manual inspectors with highly specialized optical measurement equipment coupled with advanced analytical algorithms.

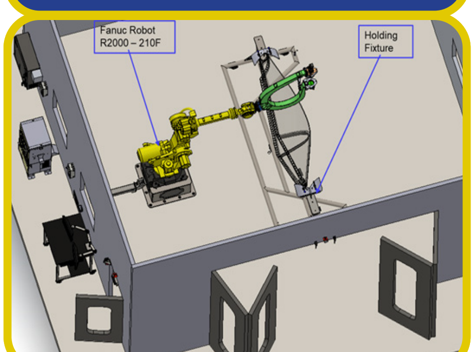
This Composites Manufacturing Technology Center (CMTC) project had two primary technical goals. The first was to develop and demonstrate equipment and methods that would reliably detect and characterize all categories of minor optical defects. This includes the tooling and fixturing required to accurately position the F-35 transparency such that inspection is reliable, repeatable and safe. The second technical goal was to develop and demonstrate programming capable of processing and applying accept / reject criteria based on the acceptance criteria in the acceptance test plan. The system is required to operate at a confidence level such that GKN, Lockheed Martin, the F-35 Lightning II Joint Program Office and Defense Contract Management Agency (DCMA) all are willing to rely on the inspection cell for part acceptance.

Payoff

By implementing an automated optical measurement system, significant labor hours could be saved by reducing manual inspection and documentation for the appropriate application. Capabilities of the system in its current configuration include repeatable and reproducible inspection results; reliable detection of opaque and semi-transparent foreign object defects (nicks / cuts, runs, disturbances, etc.); documentation of inspection results including a detailed summary, a defect map showing defect locations and a table summarizing defect size and location; inspection results stored in database (electronic format) and available for back-up / archiving; elimination of inspector-to-inspector measurement variability; and minimal inspector training required to perform inspection with vision system compared to manual inspection.

Implementation

There are no future plans to implement the Automated Optical Measurement System into the GKN Garden Grove facility or the F-35 Transparency production line due to system gaps to the objectives outlined above. These system gaps include its inability to detect no / low contrast defects; evaluate and size defects from pilot's eye; detect and identify the defect layer of outer mold line, inner mold line, interlayer or acrylic; and determine whether a defect is visible under NEST (Natural, Environment, Sky Terrain) conditions.



DISTRIBUTION STATEMENT A. Approved for public release; distribution unlimited DCN# 2025-7-28-1209, 22 Sep 2025

Advanced Mixing Method for Infrared Countermeasures Project to Reduce Solvent Usage and Improve Worker Safety

J2777-A-B — Advanced Mixing Method for Infrared Countermeasures

Objective

The current method for mixing magnesium, Teflon™, Viton™ (MTV)-based infrared countermeasure energetics involves the use of mixing technology that has been in production for many years. These mixing methods, namely the Mix Muller and Cowles mixing systems, while effective, have seen significant optimization over the years. Further optimization is not anticipated to yield the cost savings desired by the countermeasure's procurement community. In addition, the current mixing technologies do not accommodate automation. Handling MTV materials is very dangerous and has led to many serious injuries and death. Automation is particularly critical to removing personnel from the hazardous environments. New mixing technology, Resonant Acoustic Mixing (RAM) by Resodyn, has been introduced to the market and has seen significant success in mixing other energetic materials due to improved safety and reduced mixing times. Additionally, RAM lends itself to automation and has been demonstrated to mix MTV at Naval Surface Warfare Center (NSWC) Crane Division. Additionally, NSWC Indian Head Explosive Ordinance Division Technology Division (IHEODTD) has scaled the mixing of other types of energetic materials.

This joint project with the Composites Manufacturing Technology (CMTC), Energetics Manufacturing Technology Center (EMTC) and Office of the Secretary of Defense (OSD) Manufacturing Science and Technology Program (MSTP) was leveraging lessons learned from both NSWC Crane and NSWC IHEODTD to demonstrate the ability to scale-up production of MTV utilizing the RAM technology suitable for production operations. Furthermore, Chemring Countermeasures' Kilgore operation will develop the mixing process so that it is compatible with both downstream processing requirements and newly developed automation processes. Franklin Engineering will develop the automation system to add constituent materials and transfer mixed material through various stages and bowl clean-up procedures.

Payoff

The expected benefits anticipated to be achieved under this project, the most significant payoff will be the removal of personnel from a very hazardous manufacturing process through implementation of automation. Secondary to this is reduced cost as a result of decreased mixing times with the RAM mixer and reduced labor through automation. MTV-based flares are used on nearly every combat aircraft in the Department of Defense (DoD) inventory. Cost savings at Chemring Countermeasures' Kilgore facility for ignition composition alone are estimated to be as much as $150K per year.

Implementation

The mixing process and automation system developed under the CMTC and EMTC project are anticipated to be capable of small-scale production suitable for ignition composition. This system may be transferred to a contract for production use. Implementation of the mixing process for ignition composition is expected to begin in FY2025.

PERIOD OF PERFORMANCE:
May FY2020 to December FY2024

PLATFORM:
F-35 Lightning II

CENTERS OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)
Energetics Manufacturing Technology Center (EMTC)

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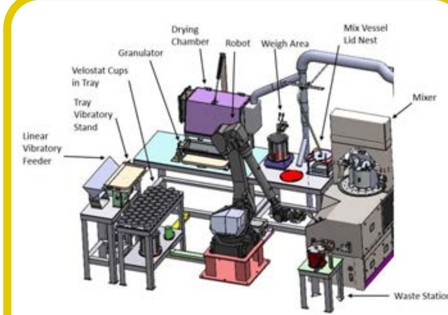
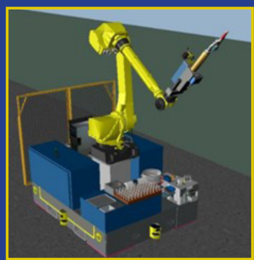


Automated Fillet and Cap Sealing to Save Millions of Dollars and Enable Increased Weight Margin



PERIOD OF PERFORMANCE:
March FY2021 to October FY2022

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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

A2818 — Automated Fillet & Cap Seal

Objective

Fillet and Cap Sealing for F-35 is currently a labor-intensive process in which assemblers manually apply sealant to the aircraft using a variety of disposable tips and hand-smooth the material to final shape. This process was very time-consuming and had multiple application issues such as material overflow leading to slump, dripping, voids, and excessive material usage, which increased cost and subsequently increased aircraft weight. This sealant was utilized on a variety of grooves requiring fillet seals and hardware requiring cap sealing on Eddie-Bolts®. An automated sealant dispensing system had significant potential to reduce labor costs and increase uniformity of fillet and cap seal, which minimized aircraft weight. This Composites Manufacturing Technology Center (CMTC) project, which included Lockheed Martin and Encore Automation, implemented a phased approach to develop and demonstrate an automated application system capable of transitioning to production.

Payoff

The benefits of developing an automated solution for fillet and cap seal have a major payoff in process savings alone, with the additional benefit of potential material and quality savings. Total cost savings for the left / right F-35 wings only were estimated at over $7.0M. A follow-on implementation was expected on center wing, resulting in total F-35 cost savings of over $13.7M. In addition, the automation led to decreased variability in total wing weight, which was expected to provide additional weight margin for incorporating new potential capabilities into the aircraft.

Implementation

Initial implementation is expected at the chosen Lockheed Martin facility in FY2025 with a follow-on implementation at an additional Lockheed Martin facility. Implementation is expected to include procurement of the capital system, performing qualification testing, and any necessary changes to procedures, work instructions, and drawings.

Enhancing Manufacturing and Producibility Improvement for CIAM Assembly to Reduce Total Life-Cycle Costs

A2827-2 — CIAM Manufacturing and Producibility Improvement Phase 2

Objective

The objective of this Composites Manufacturing Technology Center (CMTC) effort is to redesign and manufacture improvements to the CIAM components. This phase will encompass redesign of components, manufacture of hardware for testing, component-level testing, assembly testing and detailed design approval of a solution ready for production verification and validation testing. The primary goal of the project is to implement a solution that lowers non-quality costs by minimizing rework hours and scrap rates, reducing weight and decreasing recurring fabrication costs.

Payoff

This effort is estimated to deliver savings to both per-unit and total life-cycle cost-savings. This value encompasses the reduction in production life-cycle labor costs achieved through enhanced erosion coating and adhesive performance, which helps mitigate the increased costs and delivery delays associated with teardown, rebuilding and retesting. Further, the proposed design will eliminate a significant amount of rework by the hardware supplier. This will contribute to cost reduction and aid in cycle time reduction and delivery reliability. The resulting return on investment (ROI) is 5.8:1.

Implementation

Upon approval of the detailed design and successful completion of Phase 2, work is anticipated to commence on Phase 3: Production Implementation. Phase 3 is outside the scope of this effort. The estimated duration of Phase 3 is a total of 37 months, which includes all engineering labor, test hardware, test activities, material qualification, production process validation and production tooling to achieve production implementation. The key to successful production implementation lies in effective system-level strain gauge testing of the new hardware, approval of materials that are new to Rolls-Royce and the establishment of a standardized manufacturing process for the new design hardware.

PERIOD OF PERFORMANCE:
July FY2021 to December FY2024

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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

Polymer Additive Manufacturing to Replace Traditional Manufacturing Methods and Materials for F-35 Lightning II Non-Flight-Critical Parts

PERIOD OF PERFORMANCE:
July FY2020 to February FY2024

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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

A2849 — PEKK Additive Manufacturing for F-35

Objective

The F-35 Lightning II Program continues to work toward successful full rate production. As part of that effort, the Program is seeking to leverage advanced technologies that will control or reduce costs to the platform while maintaining or improving overall weight and performance of the aircraft. Most F-35 Lightning II components were designed prior to additive manufacturing (AM) technologies being considered a viable method for low load, non-flight critical parts. Due to advancements made in AM processes and materials, traditional fabrication methods may no longer be the most cost effective. This Composites Manufacturing Technology Center (CMTC) project leveraged and built upon previous data to validate HexPEKK® material and demonstrated performance against F-35 Lightning II specifications for non-flight critical parts.

Payoff

The benefit to production, which is based on work currently in progress, is estimated at total potential cost savings over $16.0M for the program. This project developed an alternative method to fabricate non-flight critical parts that will support F-35 Lightning II production.

Implementation

Candidate parts developed and tested during this CMTC project are targeted to implement on aircraft in FY2025. Follow-on implementation efforts will consist of re-design and approval of additional parts utilizing the Design Guide and Qualification Guide deliverables.

Automated In-Process Inspection for Composite Lamination: Consistent Qualification for Consistent Quality Results

A2853 — Automated In-Process Inspection for Automated Composite Lamination

Objective

The demanding performance requirements of modern composite structures are predicated on tightly controlling the tolerances of the as-built part. This duteous approach ensures that the as-designed part is manufactured within the established design limits. Defects that cause the part to deviate from the design can come from a wide variety of sources. One of the defining strengths of automated composite layup and forming is that it removes a considerable degree of the variability introduced by manual layup. Although automated layup and forming technologies provide a significantly more robust and repeatable process, automated manufacturing equipment is still susceptible to producing a part that violates specification tolerances. To detect, correct and control these deviations, some form of inspection system is required.

The current industry standard for inspection of composite parts is manual ply-by-ply inspection of the composite layup. This approach has a number of limitations and drawbacks that result in costly rework, excessive material consumption and reduced production rates. An automated in-process inspection system has significant potential to mitigate and eliminate these aforementioned drawbacks of the current industry standard. This Composite Manufacturing Technology Center (CMTC) project, which includes Northrop Grumman and FIVES, used a phased approach to develop and demonstrate an automated in-process inspection system capable of transitioning to production.

Payoff

The benefits of developing an automated solution for composite laminate inspection have a major payoff in process savings. Potential production rate increases, quality savings and reduction in production material waste enable these possible process savings. Specific benefits were shown in inspection time on wing skin structures and human levels of detection accuracy for splices, twists and missing tow defects. There are additional opportunities on current and future platforms, with larger benefits realized when the technology is applied at program start-up.

Implementation

The implementation of automated inspection technology on the F-35 program will require input from the Joint Program Office (JPO), Lockheed Martin Aeronautics (LMA), Northrop Grumman and Fives. The initial intent was to pursue the transition of the technology onto automated fiber placement (AFP) machines used to produce nacelles on the F-35 Lightning II program. Due to program delays the system has only been demonstrated on wing skins on Fives Viper 6000 machines. The below updated strategy addresses the revised two-phase implementation strategy that is anticipated to start in FY2025:

1. Qualification and validation on FPM-5 for wings.
2. Qualification and validation on nacelles.

PERIOD OF PERFORMANCE:
May FY2021 to April FY2024

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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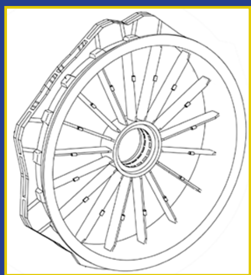
STAKEHOLDER:
F-35 Lightning II Joint Program Office (JPO)

Achieving Increased Throughput and Reduced Cost for the F135 Fan Inlet Case



PERIOD OF PERFORMANCE:
November FY2021 to December FY2024

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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

A2868 — Preform Consolidation for F135 Fan Inlet Case

Objective

As the F-35 program continues to work toward full rate production, opportunities to reduce cost and improve throughput are being investigated, including efforts focused on the delivery of the F-135 engine. The F-135 Fan Inlet Case is the front-frame for the engine, which includes the front engine mounts and main shaft bearing support in addition to other functions. The complexity of the design for the Fan Inlet Case resulted in a manufacturing method with numerous preforms that must be joined together, creating opportunity for defects. The objective of this Composites Manufacturing Technology Center (CMTC) project is to optimize the preform count and improve joint design of candidate preforms to improve quality, reduce labor and improve rate. These objectives will be accomplished by advancements in manufacturing technology related to modified tooling, assembly aids and automated preform layup.

Payoff

The business case will be updated periodically throughout execution of the project. Five-year savings are currently estimated to be over $6.0M. Savings for the total life of this specific program could be between $13.0M and $22.0M.

Implementation

Upon successful completion of this project, there will be sufficient justification to incorporate the validated changes into the production definition, which requires completion of quality system requirements and program approvals. This process could begin in early FY2026.

Assessing Hole Rifling on the F-35 Lightning II Aircraft Production Line

A2893 — Rifled Hole Assessment

Objective

Currently characterization of F-35 Lightning II hole quality is a subjective task utilizing legacy measurement instruments and methods. In the event of a defect, production inspectors do not have an adequate method to quickly and accurately measure and quantify defects inside a fastener hole at the aircraft to determine acceptability. Characterization of defects currently requires several steps and reviews requiring final approval away from the aircraft.

The objective of this Center for Naval Metalworking (CNM) project is to develop and implement a handheld measurement device and inspection process that will eliminate existing inaccurate and costly inspection processes to characterize hole features, enable inspectors to quickly assess metallic and composite hole features on-aircraft and accurately measure hole features. This project also aims to reduce costly rework by means of accurate, repeatable data so that not only are "acceptable" readings quickly defined, but the necessary amount of rework is quickly agreed upon and completed by collecting 360-degree hole surface data for external systems. Completion of this effort will result in a handheld measurement system capable of accurately and reliably measuring the entire internal surface of metallic and composite fastener holes with a tolerance threshold of 0.001" and objective of 0.0001".

Payoff

By enabling inspectors to quickly and accurately assess metallic and composite fastener hole features on-aircraft, the proposed solution aims to reduce inspection labor hours by 10 percent per aircraft equating a to program lifetime savings of approximately $16.7M.

Implementation

Based on the results of testing, the team will generate the data needed for internal process verification and validation, finalize the business case analyses and create production floor implementation plans. The transition event for this project is final performance demonstration on-aircraft. Once those activities have been successfully completed, the process will have been verified to meet the expectations of the project team, and stakeholders and will be ready for implementation at Lockheed Martin Aeronautics (LM-Aero). Implementation is anticipated in the 3Q FY2025.

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 are expected be implemented in the production of F-35 Lightning II.

PERIOD OF PERFORMANCE:
September FY2021 to May FY2025

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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

Abradable Coating Improvement for Production and Sustainment Cost Benefits

PERIOD OF PERFORMANCE:
May FY2021 to April FY2023

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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

A2908 — LiftFan Fan Case – Abradable Coating Improvement

Objective

The objective of this Composites Manufacturing Technology Center (CMTC) project was to deliver improvements to the manufacturing process that reduce the size and distribution of voids remaining in cured attrition liner material and eliminate rework to fill voids exposed after machining the abradable material. Target improvement opportunities included the automated mixing program, the attrition material pot-life and cure characteristics, attrition material application methods and alternate attrition liner fabrication / installation methods using the same material system. These areas were investigated to improve quality, cost and delivery of the fan case.

Payoff

The team was unable to achieve the originally defined project goals described above. However, there were still significant process improvements that were implemented that will improve producibility of the fan case in the future. These improvements include improved safety due to decreased material handling temperature; repeatable application process; and validation of new tooling for material application.

Implementation

Partial project implementation occurred in 3Q FY2023 on the F-35B and implementation funding was provided by general Rolls-Royce Purchasing maintenance funds.

Advanced Protection for the Heart of the F-35

A2929 — Enhanced Wear Coating of F135 Engine Parts

Objective

The Center for Naval Metalworking (CNM) in partnership with Pratt & Whitney (P&W) is seeking a viable alternative wear coating to the current electroless nickel-B coating (PWA 259) to improve wear performance in F135 engines on wear-sensitive parts. With a lower cost, low internal stress and columnar structure, electroless nickel-P coating could offer a significantly greater process control. PWA 259 coating is today's preferred coating solution for its high hardness, wear resistance, low internal stress and low fatigue debit.

The project team will develop a new chemistry and procedure to disseminate to industry and increase the U.S. wear coating supply base to mitigate schedule delays, reduce cost and improve performance on the current wear coating for nickel- and titanium-based aerospace alloys.

Payoff

By reducing the total coating cost by approximately $60 per part, P&W estimates that this CNM effort may result in five-year savings of $6.6M and a life-of-program savings of $16.8M. The five-year return on investment (ROI) for the project is anticipated to be 2.5:1, with a total program ROI of ~7.2:1.

Implementation

Assuming all performance metrics meet P&W product requirements and cost savings are confirmed, the new coating will be applied to every part possible on the F135. Initial estimates predict 220+ parts will be affected by this new coating. Upon successful and timely completion of the Enhanced Wear Coating project and acceptance of both the technology and associated business case by the acquisition Program Offices, P&W will begin the process of qualifying multiple coating and chemistry suppliers to develop a larger industrial base expediting the coating process. P&W anticipate partial implementation in 1Q FY2025.

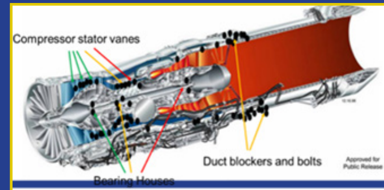

Figure 1: Map of PWA259 coated parts on an F135 engine. Black dots represent part locations where the wear coating is applied.

PERIOD OF PERFORMANCE:
January FY2023 to July FY2025

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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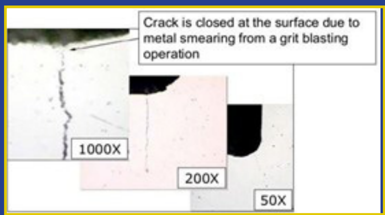
STAKEHOLDER:
F-35 Lightning II Joint Program Office (JPO)

Etch Pit Removal via Novel Peening Process



PERIOD OF PERFORMANCE:
July FY2024 to July FY2026

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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

A2931 — Aluminum Etch Pit Removal Advancement

Objective

This Center for Naval Metalworking (CNM) initiative aims to develop and implement a material peening solution to mitigate the effects of etch pits on various F-35 components resulting from the anodization process. Some F-35 Lightning II flight-critical structures exhibit reduced fatigue life due to the anodizing process applied to aluminum during manufacturing. This process includes three key steps prior to assembly: fluorescent penetrant inspection (with a pre-penetrant etch to remove potential smeared metal), chemical conversion coating application and anodization. These steps have resulted in etch pitting, increasing the likelihood of crack initiation sites and subsequently reducing fatigue life. These pits manifest over time after the aircraft has accrued flight hours. Initially, pits are not noticeable during production, as a certain level of stress is required for their formation. Etch pit removal must be conducted on the aircraft (e.g., metallic structure, bulkheads) and will be carried out as a depot modification/retrofit task within sustainment. Current removal methods employ a combination of mechanical and hand sanding, which are neither reliable nor repeatable. Early investigations into commercial-off-the-shelf (COTS) solutions are steering the integrated project team (IPT) toward a needle peening approach.

Payoff

This project is expected to result in five-year savings of approximately $1.0M.

Implementation

The Aluminum Etch Pit Removal Advancement project is expected to be implemented at Lockheed Martin Aeronautics (LM-Aero) during 1Q FY2027.

Manufacturing Technologies and Inspection Techniques for Boot Disbond Process Improvement

A2947 — Boot Disbond Improvement

Objective

The objective of this Composites Manufacturing Technology Center (CMTC) effort was to address two of the high drivers for boot disbonds and liquid epoxy process improvements. The Lockheed Martin team developed two manufacturing technologies to address these drivers. The selected technologies that were developed for complicated boots were Liquid Epoxy Mix on Demand and Vacuum Bagging Tools.

In addition to the technologies to support boot bonding process improvements and boot disbonds, Lockheed Martin collaborated with the Electro-Optics Center (EOC) managed by Pennsylvania State University's Applied Research Lab (ARL) to develop an inspection system capable of identifying and quantifying boot disbonds.

Payoff

For this effort, Lockheed Martin developed the following technologies for complex boots to provide boot disbond improvements: boot disbond inspection system; liquid epoxy mix on demand system; and custom-molded boot vacuum bagging tools. Following the completion, Lockheed Martin made recommendations to transition the manufacturing and inspection technologies to be implemented within the F-35 production line to reduce boot disbonds and provide improved liquid epoxy mixing and boot inspection. The successful development of these proposed technologies has the potential to provide $9.7M in production savings for the program.

Implementation

Lockheed Martin is in the process of seeking both F-35 Affordability and Program Non-Recurring funding for implementation. If this effort is approved for implementation through the Affordability program, all cost and savings data will be tracked through the Affordability program. Each fiscal year, all projects are evaluated based on progress, established technology gates and/or Kaizen events to ensure projects meet floating requirements, such as benefit to the program, return on investment and savings. If this effort does not require Affordability funding for implementation, then other LM Aero internal investments (e.g., Internal R&D, Capital, Contract funds) will be used to support implementation outside the scope of Affordability.

PERIOD OF PERFORMANCE:
August FY2021 to February FY2023

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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

Improving F-35 Scuff and Recoating Operations Using Laser Technology

PERIOD OF PERFORMANCE:
April FY2023 to April FY2026

PLATFORMS:
F-35 Lightning II
V-22
CH-53K

CENTERS OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center
Institute for Manufacturing and Sustainment Technologies (iMAST)

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

A2960 — Automated Laser Coating Removal

Objective

The objective of this joint project that includes the Institute for Manufacturing and Sustainment Technologies (iMAST), Naval Shipbuilding and Advanced Manufacturing (NSAM) Center and Air Force Life Cycle Management Center Rapid Sustainment Office is to develop an automated coating refurbishment system to replace the current labor-intensive, hand-sanding process used to remove a very prescribed thickness paint layer in a scuff and refresh effort. The extensive removal time reduces platform (aircraft and part) availability and increases costs associated with refurbishment. In addition, errors in hand-sanding on complex geometries can lead to damage of the composite substrate, which can further increase costs, extend downtimes and reduce mission readiness.

The joint project team is leveraging the existing F-16 laser coating removal system as a baseline system to be modified to accommodate all F-35 aircraft variants. The Navy team, comprised of the F-35 Joint Program Office (JPO), Fleet Readiness Centers (FRC), Penn State Applied Research Laboratory, Advanced Technology International, Titan Robotics and Lockheed Martin Corporation (LMCO), is developing technology and transitioning an automated process for measuring and removing F-35 coatings across tight tolerances and contours. Specific objectives include reducing the time to measure and remove coating by 30 percent and validating the accuracy of the measurement system for in-process requirements as well as remaining coatings.

Payoff

The cost benefit of this project arises from a significant reduction in coating removal time (including preparation and cleanup) and inspection. For the first aircraft, this process took about 1,000 hours, with 30 percent of the time spent on masking and measuring and 70 percent on stripping and repainting. Using conservative estimates to account for the future learning curve of the alternative process, the team assumed a total objective time savings of 300 hours per jet. DoD is estimating coating refurbishment activities over the span of five years to equate to $13.5M in savings.

Implementation

Implementation is planned for sustainment operations at Air Force and Navy depots. The Air Force is funding all investigations related to the F-35 variant, including any modifications required to the existing full aircraft stripping system currently at Ogden Air Logistics Center. The Navy is working with Commander Fleet Readiness Center (COMFRC) and JPO to help fund prototype equipment fabrication and installation at an F-35 maintenance facility such as a Fleet Readiness Center (FRC) upon completion of this project. FRC coordination has been an ongoing activity throughout project development and execution, where project support has been confirmed as a means to reduce future sustainment costs for F-35. Implementation of this project requires successful and precise partial coating removal, accurate measurements of coating thickness and the ability to expand surface coverage. Qualification and certification approvals by LMCO and JPO authorities are necessary for implementation.

Improving Composite Curing through Heat Application

A2969 — Accelerated Cure for Manufacturing and Sustainment

Objective

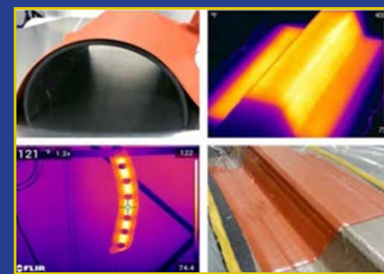
As production of the F-35 continues, Lockheed Martin Aeronautics seeks to improve manufacturing processes. The Wing-to-Body (WTB) fairing has a complex shape and unique design for each F-35 variant. The part installation is extensive and a major time constraint for wing structures production due to the required material cure times. The WTB curing process accounts for a quarter, and in some cases more, of the total wing structure assembly time. During cure, no other tasks are completed. The objective of this effort is to develop and implement an accelerated cure method to significantly reduce the span time for WTB fairing installation on the F-35.

Payoff

The expected benefits of this project include total potential cost savings of over $11.0M for the life of the program. The Composites Manufacturing Technology Center (CMTC) project will develop a method to accelerate cure times of the WTB fairing on the F-35 Program, resulting in reduced manufacturing time and increased throughput.

Implementation

Upon successful completion of this project, Lockheed Martin Aeronautics anticipates implementing the solutions developed from this project in FY2027 and continuing to use through the life of the F-35 program.



PERIOD OF PERFORMANCE:
August FY2024 to November FY2027

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Composites Manufacturing
Technology Center (CMTC)

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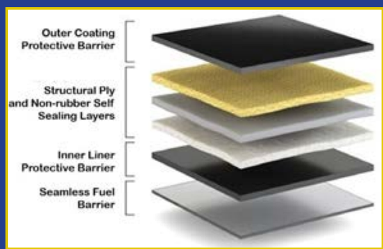
STAKEHOLDER:
F-35 Lightning II Joint Program Office (JPO)

V-22 Fuel Bladder Readiness Effort Offers $87.0M in Savings



PERIOD OF PERFORMANCE:
July FY2024 to January FY202

PLATFORM:
V-22

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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STAKEHOLDER:
V-22 Joint Program Office (PMA-275)

A2971 — Advanced Crashworthy Self-Sealing (ACWSS) Fuel Bladder

Objective

The objective of this Composites Manufacturing Technology Center (CMTC) project is to develop new crashworthy, self-sealing fuel bladders using modern manufacturing methods for production. The focus is on material development of an advanced composite construction to enhance low fuel permeability and resistance, structural toughness and self-sealing performance, while reducing weight and susceptibility to damage during handling / installation.

Payoff

Fuel bladders resulting from this effort are anticipated to improve availability, affordability and maintainability. Response Technology's advanced manufacturing processes, improvements in automation and seamless bladder designs will reduce defects and reworks in the end-product. Projected cost savings per bladder are approximately 25 percent due to efficiencies gained in material and manufacturing. Lead and cycle times will be improved over legacy fuel bladder manufacturing from 6 to 8 weeks to under 10 days.

These improvements are expected to reduce weight of fuel bladders by up to 40 percent compared with the current design. Response Technology's new bladders are anticipated to meet the full life expectancy, which will help reduce the number of non-mission capable aircraft and general aircraft downtime due to early failures of fuel bladders. From a maintenance and installation perspective, the resulting fuel bladders will be lighter, more flexible and less prone to damage, which will allow the maintainers to more easily maneuver the fuel bladders into the fuel cavity for installation. The anticipated reduction in fuel cell replacement costs is ~60 percent.

The total anticipated savings for the V-22 Osprey platform in production costs and maintenance are expected to be $22.0K per unit, which equates to $87.0M in program savings.

Implementation

After successful completion of all qualification testing for each bladder position, the Naval Air Warfare Center, Aircraft Division (NAWCAD) Technical Warrant Holder for Mechanical Systems, will issue a letter to the Defense Logistics Agency (DLA) and/or the Naval Supply Systems Command (NAVSUP) authorizing Response Technologies as an approved supplier of U.S Navy / Marine Corps aviation fuel bladders.

The V-22 Program Office will execute a Production Readiness Review with Response Technology to confirm readiness / ability to manufacture their specific fuel bladder designs. Implementation is anticipated in FY2027.

Improving Leak Detection without Bubbles

A2979 — Improved Leak Detection

Objective

Throughout F-35 production, pressure tests are performed on structures and systems to ensure there are no leaks as a part of the aircraft assembly process. For fuel, pressure leak checks occur within the wing systems, final assembly, on the flight line and throughout aircraft sustainment. These pressure checks occur periodically for every aircraft to ensure internal fuel tanks and systems that traverse these fuel tank cavities meet integrity specification prior to aircraft fueling.

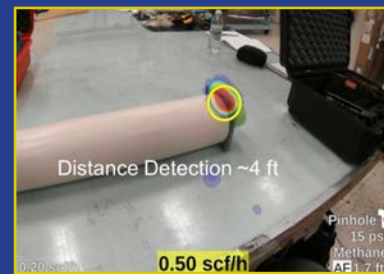
The objectives of this Naval Shipbuilding and Advanced Manufacturing (NSAM) Center project are to investigate and improve methods to detect and isolate leaks from F-35 tanks within the production and sustainment phases. The project will enable mechanics to quickly and accurately identify and troubleshoot leaks on aircraft by investigating relevant technologies, modifying and evaluating leak detection systems in a production and sustainment environment and then developing and demonstrating a prototype detection system. The resulting technology is anticipated to enable aircraft technicians to quickly identify and troubleshoot leaks on aircraft (production and sustainment), improve leak detection accuracy and further increase confidence in leak detection technology to potentially allow for application beyond F-35 production.

Payoff

Once implemented, it is anticipated that this project will reduce the hours needed to perform leak detection tests by ~20 hours for each aircraft in production (baseline is 27 hours) and ~17 hours in sustainment. Implementation of new technologies and processes developed under this project is estimated to result in five-year savings of $1.4M for the F-35 Program. Additional benefits include increased fleet readiness, reduction in required maintenance time at maintenance depots, flight safety and airworthiness and elimination of a subjective process indicators.

Implementation

The anticipated first year of implementation is FY2026, with the final year of implementation being FY2031. The technology will be implemented at Lockheed Martin Aeronautics on the F-35, with 413 aircraft being built during the implementation period. The technology will also be implemented at Cherry Point on the F-35, with 400 aircraft being serviced during the implementation period.



PERIOD OF PERFORMANCE:
February FY2024 to December FY2025

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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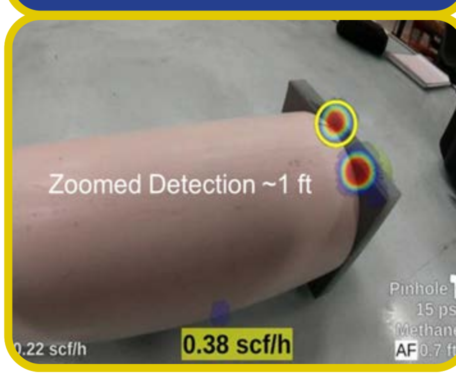
STAKEHOLDER:
F-35 Lightning II Joint Program Office (JPO)



Aluminum Tube Welding Made Easy

PERIOD OF PERFORMANCE:
April FY2023 to September FY2025

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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

A2983 — Orbital Welding for Aluminum Tubes

Objective

The Lockheed Martin Aeronautics (LM-Aero) F-35 Lightning II Production Tube Shop welds a wide variety of aluminum alloy tubes that are safety critical to the performance of the aircraft. These aluminum tubes have "Class A" type welds, the failure of which would endanger personnel and systems. They also have a high scrap rate from weld inspection failures due to porosity, cracking, burn-through, etc. Currently, mechanics manually gas tungsten arc weld (GTAW) aluminum tubes using rotating fixtures while they manually feed filler metal into the arc. There is high variability between individual mechanics depending on their skill level. To reduce high scrap rates, an automated orbital welding process could reduce variation seen in production between mechanics and increase first-time weld quality. A repeatable and accurate solution to make "Class A" type welds is needed to reduce high scrap rates for aluminum tube welding production. To efficiently support production, an automated (or mechanized) orbital solution is required to increase first pass yield and eliminate process waste. This Center for Naval Metalworking project seeks to identify and develop an orbital welding solution to replace manual "Class A" welding of aluminum tubes in F-35 Lightning II production.

Payoff

This project is expected to result in five-year cost savings of $7K per aircraft and a return on investment (ROI) of 1.0:1.

Implementation

The Orbital Welding for Aluminum Tubes project is expected to be implemented at LM-Aero facility during the 2Q FY2026.

Utilizing Nano-Particles for Rapid Aluminum Welding Repair Operations

T2991 — Nano-Particle Weld Wire Advancement for Rapid AL Repair

Objective

Currently, there are many Navy aircraft parts that have minor damage and cannot be repaired due to the lack of an approved method of repair. These may be large parts with long lead times or lack of a source at all. An approved repair process would allow these parts to be repaired and used to maintain readiness of aircraft that may be parked due to lack of replacement parts. Aluminum alloy 2024 and 7075 are two alloys commonly used for aviation structural components across multiple platforms. These alloys are used by Naval Air Systems Command (NAVAIR) for highly stressed structural applications while providing an excellent strength-to-weight ratio. Damage to AA2024 and AA7075 parts is often due to wear and corrosion. Repair approaches require bolted mechanical fittings or part replacement, which is slow and costly, may add weight and a fleet readiness degrader. Recent research conducted at UCLA identified a possible approach to enhance weld ability of high-strength aluminum alloys through the addition of nanoparticles in the weld filler metal to control of the secondary microstructural phase to reduce hot cracking susceptibility.

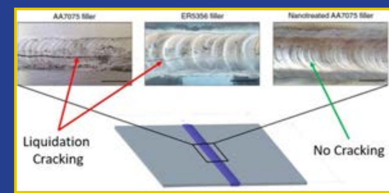
This Center for Naval Metalworking (CNM) project supports weld development with the use of advanced nanoparticle enhanced aluminum weld filler alloys to enable repair of high-strength, difficult-to-weld aluminum alloys such as AA2024 and AA7075. The development activity will be limited in nature to explore the feasibility of using the nanoparticle rod as an enablement for maintenance, repair and operations. Positive results can increase capabilities and reduce cost and schedule for delivery of parts to improve NAVAIR fleet readiness.

Payoff

Fleet Readiness Center East (FRC-E) anticipates this effort will enable significant reductions in labor, rework and material handling, as well as an increase in throughput and overall level of fleet readiness.

Implementation

The identification of implementation application areas for the welding processes developed under this project will be an ongoing effort that is not a core deliverable of this project. Project results will be shared with additional Navy stakeholders via technology transfer events with a goal of improving application visibility across all platforms. As applications are identified, opportunities for follow-on projects will be evaluated for specific savings.



PERIOD OF PERFORMANCE:
November FY2019 to May FY2023

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDER:
Fleet Readiness Center East (FRC-E)

Alternative Method of Permanent Fastener Removal

PERIOD OF PERFORMANCE:
September FY2024 to September FY2026

PLATFORM:
F-35 Lightning II

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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

A3007 — Alternative Permanent Fastener Removal Advancement

Objective

Removing permanent fasteners from aircraft is a necessary, yet time consuming requirement that often results in damage to the surrounding structure. Lockheed Martin (LM) and Joint Program Office (JPO) have recently qualified an electric discharge drill (EDM fastener removal system) to aid in the removal of permanently installed fasteners on limited composite substrates with special permission required each time. Gaps still exist for process development and impact assessment on composite and metallic substrates due to lack of a standardized procedure in the event the EDM fastener removal system is misaligned during operation. While the EDM fastener removal system is authorized for use in production to support a Material Review Board (MRB) task, it requires assistance from engineering in each instance. The system has yet to be used extensively within a sustainment environment due to variability of operators to repeatedly use the system on-aircraft. While this technology is best suited to benefit sustainment where a significant number of permanent fasteners may be removed during maintenance and modifications, LM is planning to deploy the technology on the production floor where fastener removal is needed. Challenges exist with highly contoured areas, having accurate offset / alignment tools and utilizing on horizontal / inverted scenarios. The objective of this Composites Manufacturing Technology Center (CMTC) project is to develop an improved process and capability to support transition of the EDM fastener removal system to sustainment for improved fastener removal.

Payoff

This project is expected to result in a five-year return on investment (ROI) of 2.0:1.

Implementation

The Alternative Permanent Fastener Removal Advancement project is expected to be implemented at LM during the 2Q FY2026

CH-53K Projects

CH-53K Heavy Lift Helicopter.
(U.S. Navy image.)

Development of Automated Flexbeam Manufacturing Cell Decreases Inefficiencies

PERIOD OF PERFORMANCE:
November FY2019 to May FY2023

PLATFORM:
CH-53K

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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STAKEHOLDER:
PMA-261

A2739 — CH-53K Flexbeam Automation

Objective

CH-53K tail rotor blade flexbeams are expensive to manufacture and are predominately built using a manual lay-up process. Each flexbeam consists of several hundred individual plies that are manually laid up. Current process inefficiencies include significant labor for manual debulking, raw material waste, ply kitting / interim kit storage and transfer and manual layup. The purpose of this Composites Manufacturing Technology Center (CMTC) project was to develop, build and validate a fully automated manufacturing cell to cut, laminate and debulk the plies necessary to layup a complete flexbeam.

Payoff

The anticipated labor cost savings of an automated fabrication approach for the tail rotor flexbeam as opposed to the current hand layup process are approximately $78.3M over 155 aircraft and 2,352 spares.

Implementation

Contingent upon successful installation and validation of the flexbeam manufacturing cell, Sikorsky and the CH-53K program will productionize this process. This will include limited fatigue testing, teardown and first article inspection. Automated production is targeted for insertion in 1Q FY2025.

Sikorsky worked with PMA-261 through the Project Cost and Affordability Tracker (PCAT) process to secure the funding required to develop the full-scale, production-ready, automated flexbeam manufacturing cell that was proposed in the project plan. Follow-on funding for the validation testing noted above has been coordinated with PMA-261 through the PCAT process as well.

In addition, Sikorsky worked internally to ensure adequate facilities were planned for and funded appropriately to productionize the automated flexbeam manufacturing cell. Items considered included clean-room availability and ensuring that suitable facility requirements are met and proper utilities are in place for the manufacturing cell. Upon successful demonstration of the technology and once the business case is verified, Sikorsky will submit the project int

Energetics Projects

A RIM-161 Standard Missile (SM-3) is Launched from the Aegis Cruiser USS Lake Erie.
(U.S. Navy image.)

RAM Technology Provides Safer and Cheaper Manufacturing of Energetic Materials

PERIOD OF PERFORMANCE:
July FY2014 to July FY2024

PLATFORM:
Energetics / Mk 152

CENTER OF EXCELLENCE:
Energetics Manufacturing
Technology Center (EMTC)

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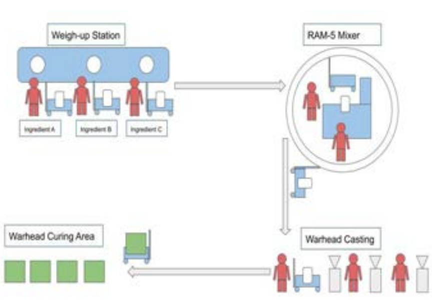
STAKEHOLDERS:
PEO (U&W)
PMA-242



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, 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 RAM would eliminate this safety hazard. The objective of the project was to develop and demonstrate a small munitions production process utilizing 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 polymer-bonded 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 that, at current production levels, results in annual savings of $1M to Mk152 production, providing a 2.5 return on investment (ROI). Additional savings would be achieved when 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-life (solidification times) can be made.

Implementation

This Energetics Manufacturing Technology Center (EMTC) project resulted in a fully operational RAM production facility at the Naval Surface Warfare Center Indian Head Division (NSWC IHD), as well as a qualified RAM production process for the Mk152 warhead to meet PMA-242 requirements. Direct transition to full production is anticipated following successful first article testing (FAT) in FY2025.

Techniques and processes developed will support RAM programs elsewhere. Multiple DoD contractors have already expressed interest in partnering with NSWC IHD and utilizing the newly purchased RAM-5. Implementation is targeted for 2.75-inch insensitive munitions warheads, such as the Mk152 and Mk146. PMA-242 has signed a Technology Transition Plan to look at utilizing the RAM technology for full-scale manufacture. In FY2024, PMA-242 provided $400K to NSWC IHD to support RAM PBXN-110 mixing and Mk152 casting to support the FAT of Mk152 in FY2025.

Enabling the Advanced Manufacturing of Propellants

A2774 — Additive Manufacturing for Propellants

Objective

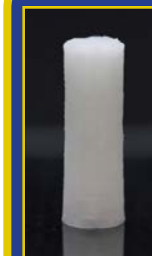
The objective of this Energetics Manufacturing Technology Center (EMTC) effort was to enable the advanced manufacture of U.S. Navy / U.S. Marine Corps critical, solid propellant grains for use in cartridge actuated devices (CADs) and propulsion systems. Additive manufacturing (AM) is an advanced manufacturing 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 were explored for use in propellant manufacturing: material extrusion and vat photo-polymerization. Adaptation of these AM technologies for energetics will enable 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 greatly diminish "cracking" commonly found during traditional grain manufacturing and favor improved CAD performance consistency due to the potential for higher precision printed grains.

Implementation

The initial focus was 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. Current needs have shifted the selection to placement in the M73 Impulse Cartridge utilized on the WB-57 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 (NOSSA) 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 or M73 with the AM grain. In order to implement the AM-produced HES-5808 grain, the JPO technical agent Naval Surface Warfare Center Indian Head Division (NSWC IHD) will conduct the AM HES-5808 and M73 Impulse Cartridge qualification. The preliminary qualification test of the improved printing of higher density grains, reached completion in 2Q providing results at the end of FY2023. NOSSA requirements were set to be hashed out in 2Q FY2024, opening the door for safety reviews to ensue 3Q FY2024. Current design implementations of the improved, higher production Direct-Ink-Writing printer were set to be test ready in 2Q FY2024, and currently estimated to be in place to commence DVT of grains by 4Q FY2024.



PERIOD OF PERFORMANCE:
October FY2017 to July FY2023

PLATFORMS:
Energetics / M91 Impulse Cartridge utilized on the AV-8, F-5, F-16 and T-38

CENTER OF EXCELLENCE:
Energetics Manufacturing Technology Center (EMTC)

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STAKEHOLDERS:
PEO (U&W)
PMA-201

RAM Enhances Manufacturing of Time Delay Formulations

PERIOD OF PERFORMANCE:
October FY2017 to December FY2025

PLATFORMS:
Energetics / Aircrew Escape Systems
F/A-18, T-34C and AV-8

CENTER OF EXCELLENCE:
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Technology Center (EMTC)

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STAKEHOLDERS:
PEO (U&W)
PMA-201

A2775 — Tungsten and T-10 Delay Compositions via Resonant Acoustic Mixing (RAM)

Objective

Pyrotechnic delay compositions are carefully engineered energetic materials that function to burn at a specific, known and consistent rate. The delay compositions are pressed into a delay column, which is the primary component of delay cartridge actuated devices (CADs) that are critical components of U.S. Navy aircrew escape systems. Delay cartridges allow for and provide timing between various sequencing of system components to ensure that all the functions of the aircrew escape system have sufficient time to occur and that the timing of events is correct for a safe, successful emergency egress event.

There are three main delay compositions used in CADs for escape systems and ejection seats: tungsten, T-10 and Z-1. This project focuses on tungsten and T-10 specifically due to the considerations related to safety, manufacturing challenges and production demand. The most important and compelling consideration with respect to this investigation of the feasibility of manufacturing tungsten and T-10 delays via RAM is personnel safety. All three CAD / propellant actuated devices (PAD) delay compositions are manufactured through an attended mixing process due to the current lack of capability to support remote mixing. Implementing a RAM manufacturing process will eliminate the use of attended mixing for CAD / PAD delay compositions and will benefit all three of the delay compositions and the associated end-items and platforms.

Payoff

This Energetics Manufacturing Technology Center (EMTC) project will improve delay composition manufacturing capability, update mixing technology (safety advancement – remote mixing), improve mixing controls, reduce processing equipment footprint and provide a better product due to time, cost and quality improvements. The use of RAM technology allows for fast delivery of delay compositions through removal of ingredient preparation processes normally required when mixing and can be mixed much faster. If an urgent need arises, it can easily be accomplished with RAM.

This project also has the potential to be the first Naval Surface Warfare Center Indian Head Division (NSWC IHD) manufactured application to use RAM-manufactured material in man-rated devices, with the goal of using RAM technology to manufacture all CAD / PAD delay compositions and secondary ignition compositions.

Implementation

Qualification of T-10 delay composition will provide the ability to produce T-10 using RAM instead of the conventional mixer. Completion of a successful first article test in a cartridge application is required prior to full-scale production use of the RAM-manufactured delay compositions. These compositions are used to manufacture delay cartridges that are components of aircrew escape systems on F/A-18, T-34C and AV-8 aircraft. First article testing will be completed after qualification of T-10 is complete.

A CONUS Manufacturing Source for Critical Chemical HNS

A2776 — Development of HNS Manufacturing Process

Objective

Many of the currently fielded air- and surface-launched Navy missile programs were initially developed decades ago. These programs may experience material obsolescence, discontinued products, inconsistent quality of material from the manufacturers and diminished manufacturing sources.

Hexanitrostilbene (HNS) is a thermally stable explosive. It is identified as a critical chemical by the Department of Defense (DoD). It has application in 47 weapon systems such as AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM), Hellfire, Guided multiple launch rocket system (GMLRS), Sidewinder, cartridge actuated devices (CAD) / propellant actuated devices (PAD) Air Crew Escape System, etc. Currently, there is no continental United States (CONUS) source of HNS to meet the projected needs of DoD.

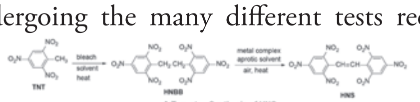
The established process for the production of HNS is the classic one-step Shipp procedure. This process typically produces a crude yield of 30-50 weight percent that requires further purification and results in substantially lower overall yield. A two-step process (Modified Shipp Process) for small-scale synthesis of HNS is also reported in open literature. The first step is the synthesis of the intermediate hexanitrobibenzyl (HNBB) and the second step is the oxidation of HNBB to HNS. The objective of this Energetics Manufacturing Technology (EMTC) project is to make the two-step process feasible at kilogram quantities and to obtain HNS at a higher yield and purity than the regular Shipp process. By making HNS in large scale at higher yield and purity, the production cost will decrease. This will provide the Navy and DoD with a reliable and cost-effective CONUS source of HNS.

Payoff

Successful production of HNS at Naval Surface Warfare Center Indian Head Division (NSWC IHD) will provide the DoD with a reliable and cost-effective CONUS source of this critical energetic material.

Implementation

The successful results of this ManTech project will be used to provide multi-pound quantities of HNS-I and HNS-II. These quantities will be used to validate the material utility in final (type) qualification studies for existing as well as future applications. A two-step synthesis of HNS at multi-liter scale has been developed at NSWC IHD; each step was optimized for high yield, safety and ease of production. The first step of the process (i.e., production of HNBB) has been performed in multi-pound scales and has been optimized. The second step of the process (i.e., production of HNS) in pound quantity is the target of the current project. Additionally, the currently produced HNS is undergoing the many different tests required by the military specification.



A Two-step Synthesis of HNS

PERIOD OF PERFORMANCE:
November FY018 to December FY2026

PLATFORMS:
Energetics /
cartridge actuated devices (CAD) /
propellant actuated devices (PAD)

CENTER OF EXCELLENCE:
Energetics Manufacturing Technology Center (EMTC)

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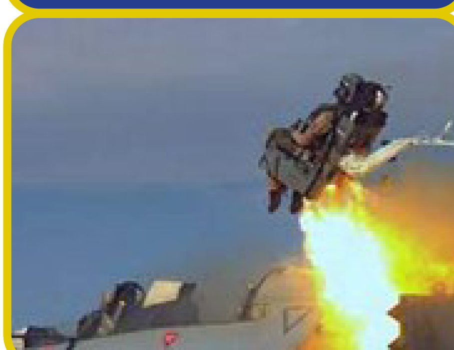
STAKEHOLDERS:
PEO (U&W)
PMA-201



Continuous Acoustic Chemical Reactor Enables Flexible Support for Energetics Production

PERIOD OF PERFORMANCE:
September FY2018 to January FY2023

PLATFORMS:
Energetics / Low-sensitivity mortar propelling charges used by United States Marine Corps (USMC)

CENTER OF EXCELLENCE:
Energetics Manufacturing Technology Center (EMTC)

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STAKEHOLDER:
Marine Corps Systems Command (MARCORSYSCOM)

S2778 — Resonant Acoustic Continuous Microreactor (RACMR)

Objective

The objective of this Energetics Manufacturing Technology Center (EMTC) initiative was 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 significantly 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 can provide a solution to this phenomenon and allow effective continuous production of slurries without clogging the reactor.

The material 2, 6-diaminopyrazine-1-oxide (DAPO) was synthesized to demonstrate this capability. DAPO is the immediate precursor to the energetic compound 2, 6 diamino-3, and 5-dinitropyrazine-1-oxide (LLM-105) and 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 was desired. This chemical reaction process and the associated equipment are advantageous to other chemical syntheses, such as nitrations, oxidations and hydrolysis reactions for energetic compounds.

Payoff

LLM-105 was evaluated as a high-energy, low-sensitivity, secondary explosive material to replace varied percentages of Research Department eXplosive (RDX) and High Melting eXplosive (HMX) in propellant formulations. It is also applicable to the development of high-performance, low-sensitivity, mortar-propelling charges used by the U.S. Marine Corps. Development of a continuous chemical reaction process to manufacture DAPO will ensure a reliable and lower cost supply of LLM-105.

Implementation

The successful completion of this EMTC project resulted in a fully operational continuous resonant acoustic chemical reactor prototype for the Naval Surface Warfare Center Indian Head Division (NSWC IHD) that is capable of continuously manufacturing energetic materials and their precursors whose synthesis involves the problematic precipitation of solids during the reaction. This was demonstrated at Resodyne by producing DAPO at kilogram throughput in high yield and purity with significant improvements over the existing batch process. While the RACMR was developed to produce DAPO as part of this initiative, it can also be adapted to produce other energetic materials and their precursors as well.

DISTRIBUTION STATEMENT A. Approved for public release; distribution unlimited DCN# 2025-7-28-1209, 22 Sep 2025

Development of the Next Generation of Demolition Explosive

S2900 — Fastpack Demolition Explosive (FPEX)

Objective

The U.S. Army and U.S. Marine Corps have documented operational deficiencies of M112 C-4 Demolition Block (DODIC M023), the most widely used plastic explosive demolition charge. The deficiencies are related to the hardness and brittleness in cold weather environments, which affects every aspect of explosive ordnance and disposal (EOD) operations, as well as pliability issues, which lead to the restriction of the use of C-4 for demolition operations. The Joint Service Explosive Ordnance Disposal (JSEOD) Notional Concept 17-004, "Advanced Explosive Ordnance Disposal Energetics," documents the need to update the field of disposal energetics with a new demolition energetic that overcomes C-4 (MIL-C-45010) operational limitations and allows for low-temperature flexibility and high-temperature stability that matches or exceeds C-4 detonation characteristics, and a green and cost-effective manufacturing process. This Energetics Manufacturing Technology Center (EMTC) effort developed the next generation of malleable energetics, referred to as Fastpack Demolition Explosive (FPEX). FPEX is an all-weather, moldable, easily compacted demolition explosive that matches or exceeds C-4 explosive performance. The FPEX manufacturing process will use state-of-the-art Resonant Acoustic Mixing (RAM) technology to deliver a one-unit, solvent-free, green and cost-effective manufacturing process.

Payoff

The Composition C-4 manufacturing process was developed in 1948. At the time, cheap labor and lower energy costs and environmental protection standards enabled the use of the multi-step water slurry process. The process produces a large quantity of waste and requires large quantities of energy, including heating and cooling, distilled water, wastewater treatment and solvent recovery systems. The process spans several production plants and requires at least six consecutive labor shifts to complete a batch. FPEX RAM-based manufacturing process decreases processing time from days to minutes, reduces / eliminates processing solvents, eliminates process wastewater, provides a biologically inert binder system that reduces health-related hazards and reduces manufacturing hazards associated with the use of mechanical mixers by performing high-speed mixing through vibration. In addition, this new demolition energetic material will help address the current operational limitations encountered by C-4 under extreme climates. FPEX will enable warfighters to perform demolition tactics, techniques and procedures under all-weather / environmental conditions.

Implementation

The FY2021 effort focused on developing FPEX formulation and the manufacturing process via Lab RAM and acquiring the preliminary performance data. In FY2022, the formulation was scaled up to the RAM5 to simulate a small-scale manufacturing process. During FY2023, ManTech efforts conducted EOD and demolition operations with FPEX and C-4. FPEX is currently undergoing explosive qualification during FY2023 to FY2027 as it transitions to the Insensitive Munition Advanced Development (IMAD) Program. FPEX is expected to be available to the end-users between FY2028 to FY2029.

PERIOD OF PERFORMANCE:
June FY2020 to July FY2023

PLATFORM:
Energetics / Composition C-4

CENTER OF EXCELLENCE:
Energetics Manufacturing
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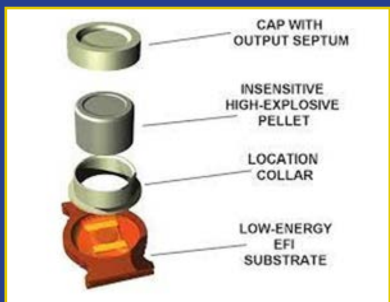
STAKEHOLDERS:
PEO USC
PMS 408

Novel Initiating Explosive Provides Warfighter with Safe, Lightweight and Reliable Weapon System Initiation



PERIOD OF PERFORMANCE:
January FY2021 to September FY2025

PLATFORM:
Energetics / Special Purpose Munitions Initiation System

CENTER OF EXCELLENCE:
Energetics Manufacturing Technology Center (EMTC)

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STAKEHOLDER:
Naval Surface Warfare Center (NSWC) Crane

S2920 — Industrialization of Submicron Explosive for Ultra-Low Energy Initiator (µLEEFI)

Objective

The objectives of this Energetics Manufacturing Technology Center (EMTC) project are to demonstrate and qualify a novel initiating explosive for use in ultra-low energy exploding foil initiators (µLEEFI) and then demonstrate and qualify the first µLEEFI. The warfighter needs lightweight, safe and reliable initiation systems. This technology is an enabler for future smart weapons when employed in multi-point configurations that facilitate directional, deformable and tailorable effects warheads, as well as inclusion in smaller smart munitions that may currently employ out-of-line devices and hot wire detonators. Future in-line safe initiation systems must consume less energy, volume and weight. This state-of-the-art explosive technology can meet the requirement for smaller, less energy-intensive systems.

The LEEFI is a qualified in-line initiator (ILI) permitted for use without interruption. Advancements in ILI technology is required to enable much smaller initiation systems with lower energy demands.

Payoff

Successful completion of this project will provide important benefits to the U.S. Navy in several areas, including improved cycle time, reduced cost and improved reliability.

In addition to the substantial reduction in process steps, handling and material movement, it is highly probable that this project will result in improved reliability by eliminating the current requirement for wetting and drying small particle size nitramines. Finely ground nitramines, typically agglomerate to some degree during drying. Eliminating the need for drying after shipment will result in a more consistent starting material for the mixing process.

The first program to receive this technology is unable to achieve reliable firing or consistent lot-to-lot performance using the state-of-the-art, normal LEEFI. The new µ-LEEFI technology is enabling technology that increases firing margin, allows the use of smaller and lower cost components and reduces supply chain risks. At a minimum, it is expected to save ~ $2.0M over the next five years by enabling the use of less expensive components and by guaranteeing a consistent future supply of enhanced explosives. This continental United States (CONUS) source will produce the required enhanced explosives using industrial processes with increased repeatability of quality, decreasing the material cost.

Implementation

After successful demonstration of the reproducible benefits of using the novel u-LEEFI, Naval Surface Warfare Center Crane will assess the performance of the parts produced in the EMTC project in the end application. The measures of performance include an acceptable reliability at tactical all fire based on both threshold testing and functional testing after exposure to tactically representative environments. If the device demonstrates reliable performance across those environments, the data will be compiled and submitted to the program manager for review and approval for immediate implementation into the production pipeline.

RAM Technology for Energetics Synthesis and Crystallization

S+2993 — CACR / CAC Manufacturing Technology Scale-Up

Objective

The objective of this Energetics Manufacturing Technology Center (EMTC) project is to provide a modular agile system for the synthesis and crystallization of energetic materials called the Continuous Acoustic Reactor / Continuous Acoustic Crystallizer (CACR / CAC). The design work will be predicated on the synthesis and crystallization of 2.6-diaminopyrazine-1-oxide (DAPO), a precursor to LLM-105 from N-nitrosodi (cyanomethyl) amine (IDAN-NO). The ultimate objectives are to design, build and install a system capable of producing a variety of energetic materials.

Payoff

Successful completion of this project will reduce preparation time by allowing for rapid re-configuration to produce a variety of materials. For example, the project will allow for the feed vessels to be reused for other raw materials. Also, the design will be such that taps and fittings are provided to add additional materials or to replace downstream components (for example, filters) with other equipment simply by disconnecting hoses and installing the new equipment. Similarly, the reactor product stream can be routed to a filter, a future liquid-liquid extraction, or the crystallizer module easily and quickly.

Multiple energetic materials may be synthesized and/or crystallized. The actual materials, apart from the designed bases DAPO and IDAN-NO, are yet to be determined. The CACR / CAC has the ability to process solid materials up to 200 microns in size in a liquid stream. This is a feature that is an improvement over alternatives such as an Advanced Flow Reactor (AFR). Solid precipitates form during energetics synthesis and plug the flow path of an AFR. Additionally, tunable crystallization allows control of particle size and distribution to desired parameters.

Implementation

Resodyn will design and build the prototype for the CACR / CAC as well as assist in installing the equipment at Naval Surface Warfare Center Indian Head Division (NSWC IHD). They will also provide initial start-up / operational verification of their equipment and train NSWC IHD personnel. Delivery and commissioning for both the CACR and CAC at NSWC IHD is targeted for completion in 3Q FY2026.

PERIOD OF PERFORMANCE:
October FY2022 to May FY2026

PLATFORMS:
Low sensitivity mortar propellent charges used by the U.S. Marine Corps
Potential replacement for TATB in Trident II nuclear warheads

CENTER OF EXCELLENCE:
Energetics Manufacturing Technology Center (EMTC)

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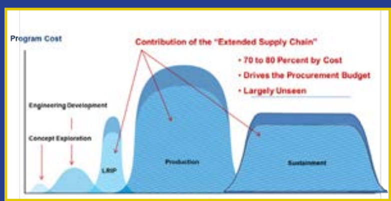
STAKEHOLDER:
United States Marine Corps (USMC)
PM AMMO

Supply Chain Resilience = Mission Readiness



PERIOD OF PERFORMANCE:
October FY2022 to September FY2024

PLATFORMS:
All naval weapons

CENTER OF EXCELLENCE:
Energetics Manufacturing Technology Center (EMTC)

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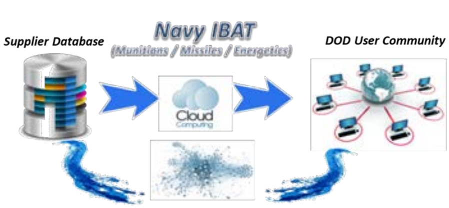
STAKEHOLDERS:
ASN RD&A
DASN Sustainment
OASD for Industrial Base Policy, OUSD (A&S)/PWPW/SW
All PEOs and PMs
Department of the Army Joint Munitions Command
Defense Industrial Base



S+2994 — Navy Energetics Supply Chain Vulnerability Study

Objective

The availability of energetic materials (explosives, propellants and pyrotechnics) and the constituents required to make them is a major readiness issue for the Navy. Aging manufacturing infrastructure, foreign dependency, fragile supply chains, diminishing domestic suppliers, increasing environmental regulations, unique material specifications and reduced demand increase the risk within the Navy acquisition community for the development and procurement of weapon systems. Mitigation of these issues makes it necessary to identify alternate materials and suppliers or to create an organic manufacturing capability to produce the critical materials. In many cases, new manufacturing technology is required to make the process viable, affordable and sustainable.

The Energetics Manufacturing Technology Center (EMTC) conducted an in-depth assessment of the criticality and fragility of the current Naval supply chain for energetic materials and their constituents, precursors and chemical reagents in order to identify risks and manufacturing technology gaps.

Payoff

This study provided multiple benefits for the Navy as well as directly impacted the future EMTC investments. By providing an increased awareness of Navy supply chain issues, this study identified opportunities to eliminate dependency on foreign or adversarial sources, evaluate capacity and surge requirements and implement process recommendations for improved transition of new materials into acquisition programs. It established a proof-of-concept supply chain management tool that allowed for data-driven decision-making for project selection and future Navy capital investments. This tool facilitated future supply chain risk management and participation in DoD energetics supply chain risk mitigation efforts, effective leveraging of other DoD and service investments and improved acquisition planning to ensure defense industrial base health / sustainment, replenishment and surge capacity.

Implementation

The EMTC is using the tools and results of this study to develop a ManTech investment strategy for rapidly maturing novel energetics manufacturing technologies. Additionally, the EMTC is using results of this study to develop an overarching critical energetic materials roadmap to support capital investments for new manufacturing capabilities and to modernize existing capacities. EMTC is identifying Navy critical materials for mitigation (through EMTC or Defense Production Act Title III) and to transition the N-IBAT proof-of-concept tool for further development and maturation.

Purification of Energetic Materials

S2995 — Continuous Post Processing for Methyl / Ethyl NENA

Objective

The objective of this Energetics Manufacturing Technology Center (EMTC) project is to provide a system that will permit the continuous post-treatment of energetic materials from a Corning G1 Advanced Flow Reactor (AFR). The system will be designed to quench and purify methyl / ethyl nitratoethylnitramine (NENA) but will be suitable for use with a variety of liquid energetic materials.

Payoff

The Navy requires an on-demand capability for production and purification of liquid energetic plasticizers (NENAs) that are more stable and less sensitive than nitroglycerin. This project aims to develop a post-processor that will meet that need. The design will be based on the synthesis and purification of methyl / ethyl NENA, although other energetics materials may be synthesized. The use of the Corning G1 AFR for upstream production (developed under a previous EMTC effort with Nalas Engineering) in combination with an automated downstream quench, neutralization and separation unit (this effort, with Synthio Chemicals), allows for continuous production of NENAs. This approach offers improved heat transfer, finer control over product quality and a smaller energetics footprint (less energetic material in one physical processing unit) as compared to a Continuously Stirred Tank Reactor (CSTR). Multiple liquid energetic materials may be purified and processed through this system. While the equipment configuration is based on the synthesis of methyl / ethyl NENA, other energetic materials may be synthesized using the post-processor with agile modular design.

Implementation

Delivery of the post-processing unit by Synthio Chemicals at Naval Surface Warfare Center Indian Head Division (NSWC IHD) is targeted for 3Q FY2025, pending availability of Building 1054. Onsite support for initial commissioning and support / training is targeted for completion in 4Q FY2025. The upstream Corning G1 AFR and related equipment are currently on site at NSWC IHD.

PERIOD OF PERFORMANCE:
October FY2022 to August FY2025

PLATFORMs:
5-inch HVP/GLGP projectile
HELM7 mortar propellant

CENTER OF EXCELLENCE:
Energetics Manufacturing
Technology Center (EMTC)

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STAKEHOLDERS:
Naval Surface Warfare Center Indian Head Division (NSWC IHD)
PEO IWS 3C

Optimization of a CONUS Source of DNPD

PERIOD OF PERFORMANCE:
December FY2022 to December FY2024

PLATFORM:
AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM)

CENTER OF EXCELLENCE:
Energetics Manufacturing Technology Center (EMTC)

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STAKEHOLDER:
NAVAIR Air-to-Air Missiles Program (PMA-259)

A3002 — DNPD Optimized Scale-Up

Objective

Many Navy missile programs are encountering material obsolescence issues due to lack of a primary or secondary continental United States (CONUS) manufacturing source. A secondary CONUS source for critical materials becomes especially important during times of world conflict to ensure that these impacted programs experience no interruptions to their preparedness to defend the nation. N, N'-(di-2-naphthyl)-para-phenylenediamine (DNPD) is an antioxidant in the MG-844 propellant formulation used in the AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM) program. DNPD is one critical propellant component encountering obsolescence issues due to lack of a CONUS manufacturing source, and the current stockpile maintained by the AMRAAM program can only support two-to-three years of production at anticipated rates.

The objective of this Energetics Manufacturing Technology Center (EMTC) project is to optimize the DNPD manufacturing process at Naval Surface Warfare Center Indian Head Division (NSWC IHD). This will validate that NSWC IHD can produce DPND that meets customer material specification HS 6-0089A and can serve as a CONUS source of DNPD. Previous projects have developed and optimized a process for the synthesis and purification of DNPD that meets the required specifications; this project takes that knowledge and seeks to implement and optimize this process at a scale large enough to fulfill the AMRAAM program's estimated demand. Successful development and optimization of this capability would establish NSWC IHD as a qualified source for this critical propellant component.

Payoff

Successful completion of this project will establish a reliable CONUS source of DNPD product to support the Navy's AIM-120 AMRAAM program. DNPD is also a candidate for qualification in other propellant formulations and could be beneficial to other programs in the future.

Implementation

This project is a follow-on to A2720 — Development of a DNPD Manufacturing Process. The process that was developed during the previous effort will be scaled to a 50-gallon reactor in order to make quantities sufficient to meet the estimated demand. Some minor process design changes were made when scaling to the 50-gallon reactor, but none significant enough to change the predicted product quality.

The details of the optimized process will be outlined in an internal NSWC IHD technical report once three 50-gallon batches of DNPD that pass specification have been manufactured successfully.

Defending the Supply Chain – Energetics Vulnerabilities Uncovered

S+3026 — Navy Industrial Base Assessment Tool (N-IBAT) for Critical Chemicals

Objective

Energetics are among the longest lead items for munition production, which significantly delays their delivery to the warfighter. Lack of supply chain transparency from materials procurement interferes with Energetics Manufacturing Technology Center's (EMTC's) ability to mitigate critical energetic material issues. The project objective is to refine and expand the proof-of-concept Navy Industrial Base Assessment Tool (N-IBAT) into a functional prototype and demonstrate its capabilities, which will help EMTC improve acquisition readiness, meet sustainment requirements and meet emerging performance requirements for PEO / PM / prime contractor transition.

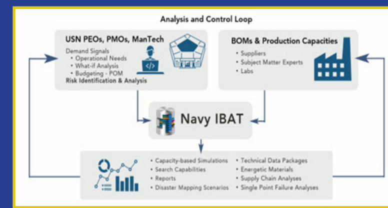
Iterative testing of N-IBAT will be done in close collaboration with Decision Sciences Incorporated to develop the N-IBAT into a functional tool with data storage, analysis, retention, update and retrieval capabilities for tracking Navy energetic supply chains. Data will continue to be organized and added into the N-IBAT database so that periodic updates can be performed to monitor changes in the supply chain and identify future needed efforts.

Payoff

The N-IBAT has benefactors across several levels. It will aid EMTC in tracking manufacturing data and developing investment strategies for critical chemicals. Stakeholders, such as Assistant Secretary of the Navy for Research, Development, and Acquisition, Deputy Assistant Secretary of Sustainment, and Navy PEOs and PMs benefit from the database because it will improve their supply chain risk planning and provide increased awareness of Navy supply chain issues. By integrating the N-IBAT with other DoD supply chain management systems, DoD can then use the joint IBAT to perform supply chain risk planning across all DoD weapons acquisitions. It is possible that the N-IBAT will improve the effectiveness of leveraging DoD investments, including Innovation, Capability, and Modernization (ICAM), the Defense Production Act Title III and the Manufacturing Science and Technology Program. This tool can maintain a more robust industrial base to support future energetic material (EM) requirements because it can provide insights that will help suppliers better address government needs and facilitate planning for efficient incorporation of novel manufacturing technologies into the supply chain.

Implementation

Transition and implementation of the prototype N-IBAT will help improve acquisition readiness and meet sustainment and emerging performance requirements for PEO / PM / prime contractor transition. Transition will occur when DoD and Navy leadership adopt and maintain N-IBAT for monitoring Navy energetics supply chains. Accurate, detailed supply chain mapping of EM will be implemented by various Navy and DoD stakeholders. Activities include EMTC to provide insight on EM acquisition and performance requirements, Navy leadership to develop a plan to integrate N-IBAT with existing DoD supply chain risk management systems and Office of the Secretary of Defense to develop DoD energetics supply chain risk mitigation efforts.



PERIOD OF PERFORMANCE:
February FY2024 to September FY2028

PLATFORMS:
All naval weapons

CENTER OF EXCELLENCE:
Energetics Manufacturing Technology Center (EMTC)

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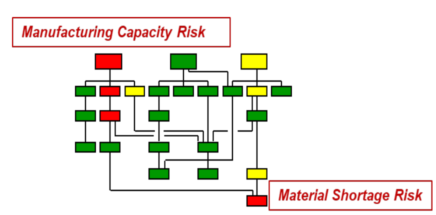
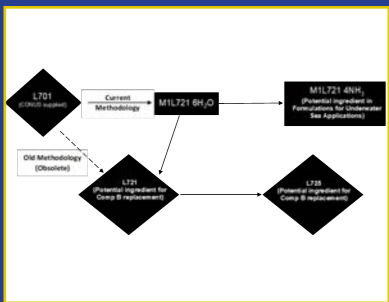
STAKEHOLDERS:
ASN RD&A
DASN Sustainment
OASD for Industrial Base Policy, OUSD (A&S)
All PEOs and PMs
Defense Industrial Base



Scale-Up of L-Series Materials for CONUS Explosive Fills



PERIOD OF PERFORMANCE:
February FY2024 to December FY2026

PLATFORMS:
Clandestine Delivered Mine (CDM)
MK 68 MOD2
Long Range Aerial Delivered Maritime Mine (LRADMM)

CENTER OF EXCELLENCE:
Energetics Manufacturing Technology Center (EMTC)

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STAKEHOLDER:
N957 for PMS 495

S3027 — L-Series Process Development and Scale-Up

Objective

Many of the currently fielded naval underwater weapons programs require materials that do not have reliable continental United States (CONUS) sources and the underwater explosive (UNDEX) formulations for those systems are in need of updating. These programs are continually faced with material-related issues due to: 1) material obsolescence – current qualified supplier(s) have discontinued products or product lines; 2) the quality or characteristics of material coming from current manufacturers is inconsistent; and/or 3) critical materials only have a sole-source point of domestic manufacture. In many instances the materials that are being discontinued are no longer available from alternate domestic manufacturers.

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. The updating of these UNDEX formulations will be aided by the production of these L-series products at Naval Surface Warfare Center Indian Head Division (NSWC IHD).

The Energetics Manufacturing Technology Center (EMTC) will support the chemical scale-up team at NSWC IHD with the manufacturing of the L-series energetic products: L721, M1L721*6H2O, M1L721*4NH3 and L725 . Although a certified lab-scale process from the inert precursor, L701 to L721 has been submitted before, prior attempts at scale-up of the process proved difficult and inefficient. In collaboration with the Naval Research Laboratory and Combat Capabilities Development Command Armaments Center, EMTC is designing and executing modern scalable processes for these selected L-series materials that can be fitted for pilot-scale production.

Payoff

This effort will establish a reliable CONUS source for the production of selected L-series materials to be utilized in naval UNDEX. The L725 product will be a key gateway material to an extensive line of other L-series materials.

Implementation

This effort benefits the Navy, as well as the defense industry community, by establishing a CONUS source of a critical energetic material for use in naval underwater weapon systems. Due to a limited source of material, NSWC IHD has proposed a method to demonstrate the scalability of the L-series products that are highly significant and can potentially resolve an ongoing issue related to the product sourcing. Under this effort, NWSC IHD will work with Defense Threat Reduction Agency and Office of the Chief of Naval Operations N957 for PMS 495 to establish a process to produce reliable L721, L725, M1L721*6H2O and M1L721*6NH3.

Industrialization of “Printed Propellant” Improving Industrial Base Efficiency, Flexability and Adaptability

S3028 — Additive Manufacturing of Igniter Grains

Objective

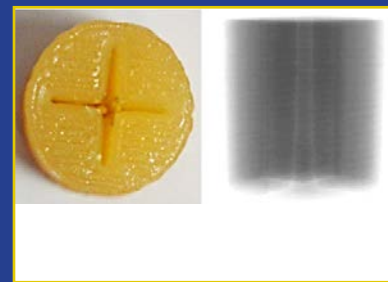
This objective of this project is to demonstrate and qualify a printable composite propellant and its use as a pyrogen igniter. Igniter grains – small propellant grains with complex geometries – have long lead times contributing to schedule delays and cost overruns. During development, lead times for casting tooling are often several months, including for each rework necessary. In production, many cast grains are rejected due to defects introduced during the removal from tooling. 3D printing grains eliminates these issues; the propellant may be mixed in the morning and printed in the afternoon without the need for any tooling. This results in reduced development time, which helps systems reach the fleet sooner, reduced part rejection, which improves manufacturing reliability and reduced resource demand, which enables industry to react more quickly during production surges.

Payoff

This Energetics Manufacturing Technology Center (EMTC) project represents a classic tech-pull and additive manufacturing (AM) business case supporting critical path schedule compression, more rapid fleet availability and system sustainment. Printing igniter grains is expected to eliminate the typical lead-time of one year associated with tooling, $100-200K in recurring tooling costs during development and the need to retool between production runs. It is also anticipated to increase production yield through a reduction of rejected parts while simultaneously eliminating machining requirements and associated energetic waste, thereby reducing component acquisition cost. With the ability to produce multiple assets or designs concurrently, the technology supports a more agile industrial base by freeing plant labor for other needs. Importantly, the technology may be utilized by any tri-service solid rocket motor or missile system for additional applications, such as launch motor grains or solid divert and attitude control grains. In the long-term, it is expected to support the testing and production of functionally graded propellant grains targeting range goals.

Implementation

Composite propellant additive manufacturing technology will be industrialized by transitioning materials and methods developed by the Navy to industry. An acrylate polybutadiene will be commercialized to supply production plants, government labs and igniter grain articles produced under this EMTC effort. The performance of the igniter grains will be assessed and a qualification plan implemented. Performance metrics include density, burning rate, maximum stress and strain at ambient, peak pressure and rise time. Upon completion of the qualification plan, the igniter grain will be implemented into the production pipeline and the basic technology will be utilized.



PERIOD OF PERFORMANCE:
February FY2024 to December FY2027

PLATFORMS:
Pyrogen igniters. D5 (demonstration article), SM6, PAC3, MPBD, OpFires, MRBM

CENTER OF EXCELLENCE:
Energetics Manufacturing Technology Center (EMTC)

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STAKEHOLDERS:
Navy Strategic Systems Programs (SSP)

RepTech Projects

Hull Maintenance Technician 3rd Class Jesse Belfi Strikes a Welding Rod to Mend the Hinge of a Quick-Acting Watertight Door Handle Aboard the USS Bonhomme Richard (LHD 6).
(U.S. Navy image.)

Optimized Ceramic Coating Improves Wear and Prevents Calcareous Deposit on Large Diameter Submarine Ball Valves

RT2837 — Submarine Large Diameter Ball Valve Improvement

Objective

The coating on large diameter submarine seawater valve balls is failing prematurely, resulting in emergent repairs at significant cost. Causes of increased torque attribute to swelling of valve seats, loss of lubricity between the surface of the valve ball and seat due to the loss of the green coating and calcareous deposits from marine growth. Damage to the surface finish of the valve ball coatings requires a full restoration. The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) Repair Technology (RepTech) project is to identify, test-evaluate and implement a potential coating manufacturing system and/or process that improves the performance and life-cycle of seawater-system ball valves.

iMAST is evaluating ceramic coatings with an overcoat for hydraulically actuated valves with high torque output. The project has identified the contributing coating system deficiencies (porosity, density, uniformity, adhesion, microstructure, friction, etc.) and the failure mechanism of the ceramic-coated and Teflon™-coated titanium valve balls and their repair processing parameters. The ceramic coating application process, deposition parameters and coating microstructure will be evaluated and optimized to provide the ultimate ceramic coating solution. Initial testing of a coated large diameter valve ball, tested to the anticipated total number of lifetime cycles in a dry condition (i.e., friction test), has indicated no failures to the ceramic-xylan coating system, indicating potential life-of- boat reliability. Additional durability wet testing is being conducted at General Dynamics Electric Boat (GDEB) in 4Q FY2024 / 1Q FY2025 to verify valve ball coating performance. If successful, this Navy-owned coating process can be applied to both in-service 688 submarines, VIRGINIA Class submarines (VCS), ships, submersibles, ballistic, nuclear (SSBN) as well as new submarine construction (VCS and COLUMBIA Class submarine [CLB]).

Payoff

An improved ceramic-coated ball valve system would eliminate a month-long honing operation and result in significant cost savings and increased mean-time-between-overhaul, resulting in improved availability, less rework and reduced delays in complex repairs. The coating can be applied to large and small diameter seawater valve balls further increasing the cost savings. The total life-cycle cost savings for VCS is approximately $80.6M. Additional cost savings can be realized with CLB at a minimum of $22.4M depending on the number of seawater ball valves.

Implementation

The seminal transition event will be the satisfactory completion of laboratory validation testing of a 12-inch seawater ball valve assembly coated with an effective ceramic coating that improves wear and prevents calcareous deposit. This iMAST project will be completed in Q1 FY25 and will be available for implementation in the seawater-system's ball valves on new construction submarines and back-fit on operational hulls on an attrition basis.

PERIOD OF PERFORMANCE:
April FY2020 to December FY2024

PLATFORMS:
VIRGINIA Class submarines (VCS)
COLUMBIA Class submarines (CLB)

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDERS:
PMS 450
PMS 397

Modern Shop Floor Control and Enterprise Resource Planning Application Integration for USMC Vehicle Repair and Overhaul

PERIOD OF PERFORMANCE:
October FY2020 to June FY2023

PLATFORMS:
Light Armored Vehicles (LAV)
Joint Light Tactical Vehicle (JLTV)
Other USMC ground vehicles

CENTER OF EXCELLENCE:
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STAKEHOLDERS:
Marine Depot Maintenance Command
Production Plant Albany
USMC Logistics Command

RT2914 — Shop Floor Control at USMC MDMC

Objective

The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project was to improve the efficiency of the depot maintenance operations at the Marine Depot Maintenance Command (MDMC) by providing a modern Shop Floor Control (SFC) capability utilizing the new Navy Enterprise Resource Planning (ERP) system and supplementing it with the additional tools necessary to meet all their shop floor control requirements. A SFC system can transform the way manufacturing products are tracked, controlled and recorded. It will provide the MDMC re-manufacturing depot transparency of production information, lower downtime, flexible production operations and reduced quality costs with thorough traceability.

The main benefit of this project was the foundation of an ERP system implementing via a SFC system for the United States Marine Corps (USMC). The benefits and cost-savings in the marketplace were documented in the open market of up to 50 percent reduction in inventory, management, production and logistics costs. Specifically for USMC MDMC, cost-avoidance was initially determined in reduced refurbishment cost as enabled by less labor and more accurate construction schedules. In the long term, the benefit will be direct communication of vehicle information by the USMC MDMC depot of fleet vehicle maintenance records for analysis and improvement.

Payoff

The improvements of implementing a fully robust SFC system were estimated to reduce refurbishment costs by $2.0M a year for Operational Logistics Command (LOGCOM). It will improve depot production throughput, reduce required production expeditor meetings seeking lost components and lay the foundation to integrate an ERP system.

Implementation

A specific migration plan has been developed and briefed to USMC LOGCOM senior management. This plan includes the USMC ERP training integration efforts that were accomplished and defines the attributes of a supportive SFC system. USMC LOGCOM is responsible for implementation. The detailed integration plan includes confirmation of USMC LOGCOM sponsorship, implementation schedule that matches ERP integration and initial development of procedures for integration into USMC operations.

Improving Stripping Operations for Off-Aircraft Parts

RT2923 — Laser Ablation for NAVAIR Applications

Objective

Aircraft coatings removal at Naval Air Systems Command (NAVAIR) Fleet Readiness Centers (FRCs) is performed using chemical, manual (hand sanding) and blasting methods. Many coatings contain hazardous chemicals targeted for elimination by Department of Defense; these create occupational exposure and hazardous waste disposal issues. The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) Repair Technology (RepTech) project is to test and transition a laser ablation (LA) process to remove coatings from Navy aircraft parts in order to reduce coatings removal costs, eliminate occupational exposure to hazardous chemicals and airborne dust and reduce damage to substrates and/or rework as a result of legacy processes.

iMAST is working with FRC Southeast (FRCSE) to develop and execute a comprehensive test matrix to evaluate LA for complete paint removal from thin aluminum aircraft. iMAST identified several candidate LA technologies, developed suitable process parameters and optimized settings using LA for coatings removal. LA samples have passed several critical tests, including depaint efficiency, hardness, conductivity, surface roughness, cadmium embrittlement and tensile testing. Fatigue, adhesion and corrosion testing are expected to be completed in 1Q FY2025.

Payoff

The business case was based on cost avoidance for the sustainment of T-6 Trainer aircraft. FY2021 production data (hazardous waste costs, material costs and depaint labor costs) was extrapolated to FY2022 and FY2023 production quantities and labor rates were updated to establish baseline coatings removal costs. The Navy estimated LA reduces labor depaint time by 70 percent and materials usage and hazardous waste generation by 90 percent, as compared to conventional coatings removal technologies for the T-6 Trainer aircraft alone (flight controls and fuselage body). This resulted in five-year savings of $8.4M.

Implementation

Implementation in sustainment operations at FRCSE will be pursued initially for T-6 aircraft parts; expansion to other NAVAIR aircraft such as the F-5 is anticipated. The data generated will be provided to the United States Air Force to pursue joint service applications and will be reviewed for wider applications in aerospace maintenance, repair and overhaul (MRO) operations. NAVAIR Commander, Fleet Readiness Centers (COMFRC) is committed to this project as a means to reduce sustainment costs and improve process flow in MRO operations at the FRCs. Additional fatigue qualification testing is anticipated to be required for full implementation to occur with the T-6 and other aircraft at FRCSE. Implementation is expected to be funded by COMFRC/FRCSE and is anticipated for4Q FY2027

PERIOD OF PERFORMANCE:
January FY2021 to September FY2024

PLATFORM:
T-6 (Air Force and Navy)

CENTER OF EXCELLENCE:
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STAKEHOLDERS:
Naval Air Systems Command (NAVAIR) Commander, Fleet Readiness Centers (COMFRC)
Fleet Readiness Centers Southeast (FRCSE)

Improved Repair Process for CVN Components Yields Lower Costs and Faster Repair Times

PERIOD OF PERFORMANCE:
July FY2021 to December FY2022

PLATFORM:
CVN 78 Class aircraft carrier

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDER:
PMS 378

RT2935 — Cold Spray for CVN Sustainment

Objective

The objectives of this Institute for Manufacturing and Sustainment Technologies (iMAST) project were to identify opportunities for cold spray repair technology for CVN 78 Class Aircraft Carriers Refueling and Complex Overhaul, develop qualified spray procedures (QSPs) for candidate components and guide implementation of cold spray for CVN 78 Class aircraft carriers at Huntington Ingalls Industries - Newport News Shipbuilding (NNS) or a qualified site with organic capability.

Existing repair methods are troublesome for dimensional restorations due to the complex jigs-fixtures, which must be designed and built to mitigate weld distortion. Specialty jigs and fixtures are not always successful in preventing distortion on the first try, resulting in several iterations of weld repair, machining and distortion correction. Cold spray repair is not only more cost effective than the cyclic process described above (i.e., acceptable results in a single iteration) but also results in fewer significant schedule delay.

iMAST and NNS identified candidate components for cold spray repair, settling on the CVN 78 Class aircraft carriers shaft rotating coupling covers (RCCs) for repair process development. Two QSPs to repair the RCCs were then developed by iMAST, following Uniform Industrial Process Instruction 6320-901 – Cold Spray, Processes and Quality Control of Limited Use Approvals – allowing for flexibility in the spray material selection. Finally, test data was provided to Naval Sea Systems Command (NAVSEA) 05 for review, who officially approved the QSP and authorized the repair at the NAVSEA Pop-up Cell in Chesapeake, VA.

Payoff

Preliminary cost avoidance for a CVN 78 Class aircraft carriers Refueling and Complex Overhaul (RCOH) was estimated to be $5.0M based on the first identified application related to weld distortion and extrapolated to four, high-value applications during an overhaul. Cost avoidance will increase as more repair opportunities are identified. Finally, cold spray implementation of component repair may have a direct impact on RCOH cycle time; however, the quantification of this benefit is difficult to ascertain due to the complexity of the overhaul.

Implementation

Currently, NNS does not have an organic cold spray repair capability. Therefore, the NAVSEA Pop-up Cell in Chesapeake, VA, was identified as the implementation site for the RCC repairs. NAVSEA approval of the QSPs and NNS authorization and repairs of RCCs began to take place in 2Q FY2023. Two sets of couple covers were repaired, reinstalled onto CVN 74 and are now waterborne. NNS continues to identify additional component repairs, and QSPs are in development.

Optimizing Motor Generator Remanufacturing Tooling and Processes

RT2964 — Motor Generator Rewind Optimization

Objective

The Puget Sound Naval Shipyard (PSNSY) Shop 51 (S51) plays a crucial role in rewinding alternator components for a wide range of motors, motor generators and fire pumps used across naval platforms. Currently, the process of rewinding these generators is predominantly manual, resulting in an alarming 80 percent failure rate during qualification testing. This high failure rate necessitates an average of 3.1 rebuilds per motor / motor generator before they can be deployed back to the fleet. These frequent failures and repetitive work have led to significant cost overruns and availability issues.

During the exploratory phase of this project, the Institute for Manufacturing and Sustainment Technologies (iMAST) identified that excessive manipulation of the windings due to challenging installation requirements is the primary cause of motor rewind failures. The objective of this Phase 2 iMAST Repair Technology project is to address these failure issues by developing processes and tooling that reduce the time and failure rate associated with the rewinding process. The goals are to minimize manipulation and the risk of component damage during installation.

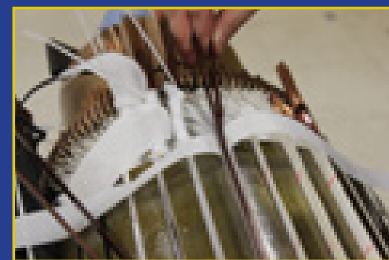
iMAST has identified and tested various process improvements, including winding material replacement, alternative Dacron slot filling, coil protection using Mylar and new tooling for custom winding forming. iMAST has conducted onsite training at PSNSY and will facilitate additional training by industry professionals at a commercial motor rewinding vendor.

Payoff

Based on data provided by S51, the initial business case estimates five-year savings of over $1.9M due to direct reduction in labor hours as well as a significant reduction in the rewinding failure rate, resulting in a return on investment of 2.3:1. A final business case will be presented once refined tooling and processes are directly compared to the existing installation methods, further substantiating the potential benefits.

Implementation

Process and material modifications have been reviewed and approved by Code 270. The implementation of new solutions will be executed in a progressive phased approach, with each solution evaluated and adopted at floor-level workmanship practices. Full implementation will occur once the entire rewind process has been successfully completed and the resulting savings are validated. Implementation at PSNS S51 is anticipated to start in 4Q FY2024.



PERIOD OF PERFORMANCE:
September FY2023 to October FY2024

PLATFORMS:
CVN 78 Class aircraft carriers
Los Angeles Class (688) submarine
Guided Missile submarine (SSGN)
VIRGINIA Class submarine (VCS)

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDERS:
Naval Sea Systems Command (NAVSEA) 04
Puget Sound Naval Shipyard (PSNSY)

Additive Manufacturing Repair for Critical Engine Components Reduces Fleet Maintenance Costs and Improves Operational Availability

PERIOD OF PERFORMANCE:
May FY2023 to April FY2025

PLATFORMS:
T-64 (CH-53E)
T408 (CH-53K)

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDERS:
Naval Air Warfare Center Aircraft Division (NAWCAD)
Naval Air Systems Command (NAVAIR) Fleet Readiness Center East (FRCE)

RT2992 — Powder Blown Laser Directed Energy Deposition (L-DED) Repair

Objective

Knife-edge seal features on multiple Naval Air Systems Command (NAVAIR) engine platforms experience wear during service, and repair options for these worn seal features are limited. Currently, the T64 (CH-53E) Rear Air Seal experiences excessive in-service wear on the knife-edge seal teeth features, resulting in a loss in engine performance. Traditionally, these components are scrapped and replaced, but for some legacy systems, there is not a sufficient supply for full part replacement due to the aging fleet and a decreased vendor base. Arc welding and thermal spray have been used to rebuild feature geometries on some components such as the T64 Rear Air Seal, but these processes are not suitable for many parts that are sensitive to excessive heat input. Repairing with a powder blown laser directed energy deposition (L-DED) process has many functional benefits that make this process a leading contender for developing a qualified repair method on knife-edge seal features. Powder blown L-DED repairs have been demonstrated to exhibit significantly decreased heat affected zones of the repaired region and decreased thermal distortion of the repaired component when compared to traditional welding processes. The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project is to develop a qualified repair process using powder blown L-DED for knife-edge seal teeth features on rotating engine components.

iMAST, working with Naval Air Warfare Center Aircraft Division (NAWCAD) and Fleet Readiness Center East (FRCE), is developing and testing the powder blown L-DED process, integrating advanced in-situ monitoring to drive deposition standoff and path planning and conducting full mechanical testing to provide the objective quality evidence needed for a qualified repair process. Development has been successful on linear coupons at the Penn State Applied Research Laboratory and NAWCAD, and the project team continued to develop and test the repair process on scrapped seal rings in late FY2024 and early FY2025.

Payoff

The primary project benefit is cost savings associated with approval of a repair process that can restore traditionally scrapped components in lieu of full part replacement. It is estimated that the repair process will only cost 10 percent of a component replacement. Assuming 10 rear air seal repairs per year, five-year cost savings of $2.3M are expected, resulting in a return on investment of nearly 2:1. In addition, the repair process is expected to reduce lead time for component availability by 75 percent, thus increasing mission capability.

Implementation

Upon successful completion of this project, it is anticipated that a repair process will be approved and ready for implementation at FRCE. FRCE has already acquired a powder blown L-DED machine; therefore, implementation costs should be modest and limited to final repair process approval, procedure development, operator training and equipment training along with a maintenance contract.

Cold Spray Additive Manufacturing Can Support Rapid Component Fabrication to Support Navy Sustainment Needs

RT2998 — SPEE3D for Rapid, Low-Cost Additive Manufacturing of Navy Components

Objective

The casting supply chain continues to shrink, which increases the lead time and cost for castings used by the Navy and other Department of Defense organizations. The long lead times can cause delays in meeting tight refurbishment schedules when replacement components are required. Cold spray additive manufacturing, a process capability of the SPEE3D system, can quickly and economically produce near-net-shape parts from aluminum alloys, brass, bronze and stainless steel. Other alloys, such as 70/30 copper nickel (CuNi) and nickel aluminum bronze (NAB) that are of particular interest to the Navy, need to be developed for use on the SPEE3D system. In addition, there is a potential need to produce replacement components in the field or at forward maintenance facilities to maintain readiness, and a qualified process, proven for use in continental United States repair and fabrication sites, is first needed to justify that forward-based capability. The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project is to develop the additive manufacturing process for three different material / components using the SPEE3D Cold Spray system and transition the process to the Navy or supporting industry for costing in both submarine repair and new construction.

iMAST, working closely with Naval Sea Systems Command (NAVSEA) 05T1 and SPEE3D, is selecting candidate naval amphibious base (NAB) and CuNi components, developing and optimizing process parameters – not only for component build, but also post heat treatment, conducting extensive material characterization and testing in order to provide the Navy with the objective quality evidence for more accelerated repair approval, and developing technical data packages for specific repairs. Once SPEE3D-fabricated components meet the performance requirements, they will be delivered to NAVSEA or Norfolk Naval Shipyard for additional evaluation and potential installation onto active Navy vessels.

Payoff

The primary project benefit is the cost savings associated with an approved cold spray additive manufacturing process as a replacement for castings procurement and is estimated to save $4.3M over five years, a return on investment of 2.4:1. Additionally, cold spray additive manufacturing can produce parts at orders of magnitude faster than conventional casting procurement, days versus months of lead time, therefore, improving weapon system availability and potentially reducing costly dry-docking times.

Implementation

Implementation of the cold spray additive manufacturing process is expected to occur at industrial facilities that already have the organic capability in 4Q FY2025 (e.g., HAMR Industries), therefore, reducing implementation cost. Post-project implementation may require Navy investment in full process qualification; however, the repair processes developed in this project will be applicable to a large range of components of similar alloys, specifications, etc., therefore, preventing the need for component-specific qualification for every repair need.

PERIOD OF PERFORMANCE:
May FY2023 to May FY2025

PLATFORMS:
VIRGINIA Class submarine (VCS)
COLUMBIA Class submarine (CLB)
CVN 78 Class aircraft carrier

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDERS:
PMS 450
PMS 397
PMS 379
Naval Sea Systems Command (NAVSEA) 05T1

Rapid Response to Improve Critical Path Submarine Repair Overhaul and Repair

PERIOD OF PERFORMANCE:
May FY2023 to November FY2023

PLATFORMS:
VIRGINIA Class submarine (VCS)
LOS ANGELES Class submarine (688)

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDERS:
Naval Sea Systems Command (NAVSEA) 04
Portsmouth Naval Shipyard

RTR3019 — SHT Hole Removal and Plug Replacement Improvement

Objective

Removal of special hull treatment (SHT) in the way of handling gear for the bow dome-lifting fixture is a unique operation that is a physically exhausting, labor-intensive process that is in the critical path to start work in the forward most area during a major overhaul / availability. Underlying glass-reinforced plastic (GRP) substrate may be damaged during the process, resulting in costly and delicate rework that further increases schedule. Puget Sound Naval Shipyard (PSNS) led an initiative in 2009 that utilized high-pressure waterjet removal of minimal material, only exposing the structural hardware, on SEAWOLF Class submarines. This method resulted in damage to the underlying GRP substrate while also resulting in variability in the quality of the holes, thus never replacing the conventional, manual method of SHT removal and replacement. This confirmed the lingering need for a low-cost, safe, slightly modified commercial-off-the-shelf (COTS) tool system for selective bow dome SHT removal.

This Rapid Response Repair Technology project, led by the Institute for Manufacturing and Sustainment Technologies (iMAST), developed a minimally modified COTS vacuum-mounted drilling system capable of removing a cylinder of SHT material at a precision depth and location without causing damage to the GRP substrate. Various hole saw designs were considered, including sharp, shallow angle saws (shaving) as well as abrasive grinding, which was found to produce higher quality surfaces and longer tool life with less heat generation. iMAST optimized the drilling process to allow for vacuum removal of material using a peck drilling approach.

Hole saw training was conducted at Portsmouth Naval Shipyard (PNSY) with Shop 76 in 4Q FY2023 and included an on-hull demonstration, coordinated by Naval Surface Warfare Center Carderock Division (NSWCCD), for cylindrical core sample extractions. PNSY-trained mechanics conducted extractions over steel hull with oversight by PNSY Code 250, Code 106, NSWCCD technical manager and iMAST onsite to verify equipment operation was safe and effective for operators without damaging the underlying hull material.

Payoff

Shipyard Process Improvement and Engineering departments estimated that a fully developed procedure, utilizing the hole saw plug removal technology transitioned to standard shipyard use for well adherent dome and faring areas, would result in an estimated reduction of 1,000 labor hours, $100,000 in material use, and three weeks schedule reduction of dome-related work on each side of the dome critical path (i.e., removal and reassembly) for each hull.

Implementation

Based on successful training, the hole saw technology transitioned to PNSY, who implemented the drill and hole saw for production use on a VCS availability in 1Q FY2023, where no deficiencies were found in the current state of the technology. PNSY may lead efforts for future equipment modification to further reduce cycle times and increase safety. Expanded implementation to other SEA04 shipyards is possible and will be explored.

Streamlined Automated Paint Removal Process Increases Repair Throughput for USMC Armored Vehicles

RT3025 — Laser Ablation of Armored Vehicles

Objective

The current process to remove paint and corrosion from U.S. Marine Corps (USMC) armored vehicles is conducted manually via grit blasting, which is labor-intensive, causes worker fatigue and exposure to hazardous materials and results in significant blast media consumption and disposal costs. Marine Depot Maintenance Command (MDMC), Production Plant Albany has worked with Titan Robotics to integrate the Adapt Laser System into an automated laser coating removal system for armored vehicles; however, USMC requires objective quality evidence that the laser stripping process will not result in degradation of the armored steel substrates. The objectives of this Institute for Manufacturing and Sustainment Technologies (iMAST) project are to develop and optimize laser stripping process parameters for integration with the Titan Robotics system, obtain approval to use through testing that will support qualification and ease transition to MDMC Albany operations.

Phase 1 of the project focuses on development of processing requirements and a test matrix for the Light Armored Vehicle (LAV) and Joint Light Tactical Vehicle (JLTV), optimization of processing conditions and testing in support of qualification. This phase will establish baseline processing parameters for stripping of LAV and JLTV paint systems, and the results from this phase will support full qualification testing by MDMC. These results will be leveraged in Phase 2, which focuses on modifying and optimizing processing conditions for the Amphibious Combat Vehicle (ACV) The results from the combined phases will be used to support USMC in funding the remaining testing needed for qualification and technical authority approval to use the procured equipment.

Payoff

The primary benefit is anticipated labor savings associated with vehicle / hull paint removal and is expected to exceed $5.3M over five years, resulting in a return on investment (ROI) of 6.9:1. Additional labor savings (not included in the ROI) are expected to be yielded for the ACV and, potentially, the High Mobility Multipurpose Wheeled Vehicle (HMMWV). Uncaptured, soft savings will be achieved in areas of reduced consumable use and waste disposal, improved ergonomics and fewer injury hazards, reduced schedule disruptions and delays, improved workplace cleanliness and improved employee morale.

Implementation

MDMC has already procured the Titan Robotics laser decoating system, which is expected to be delivered and installed in 1Q FY2025 at Production Plant Albany. It will enable process development and testing on the actual system during this ManTech project. Implementation for laser stripping of LAV and JLTV is anticipated in 4Q FY2025. Implementation for use on the ACV is anticipated to occur in 2Q FY2026.

PERIOD OF PERFORMANCE:
April FY2024 to April FY2026

PLATFORMS:
Light Armored Vehicle (LAV)
Joint Light Tactical Vehicle (JLTV)
Amphibious Combat Vehicle (ACV)

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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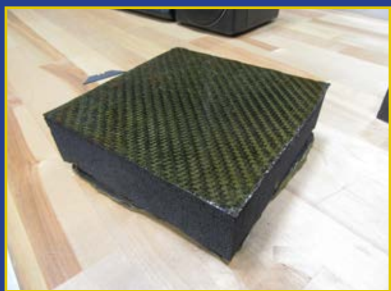
STAKEHOLDERS:
Marine Depot Maintenance Command Production Plant Albany

Low-Cost, Minimal-Use Tooling Supports NAVAIR Repair and Sustainment



PERIOD OF PERFORMANCE:
March FY2024 to September FY2024

PLATFORM:
CH-53K

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

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STAKEHOLDERS:
Naval Air Systems Command (NAVAIR)
Fleet Readiness Centers (FRC) East

RTR3029 — CFOAM Tooling for Aviation Composites

Objective

Naval Air Systems Command (NAVAIR) and other Department of Defense organizations have a need to rapidly fabricate complex composite parts to repair aircraft. Composite structures found in military aircraft consist of carbon-fiber / epoxy-matrix or carbon / bismaleimide cured at 350°-450°. These cure temperatures necessitate high-temperature molds or tooling, which also have a low coefficient of thermal expansion to closely match the fiber-reinforced article and maintain dimensional precision of the part. Typically, nickel-iron alloy (Invar) or carbon composite tooling are used in these applications. However, Invar is expensive and heavy, and carbon / epoxy tooling is expensive and difficult to fabricate. Carbon foam (CFOAM) is a new tooling material derived from coal that may offer advantages in schedule and cost saving compared to traditional Invar and composite tooling. CFOAM has not yet been adopted by NAVAIR, so fabrication procedures and best practices are not well understood. The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project is to further investigate the CFOAM material for tooling fabrication, develop procedures and document best practices and present a business case for broad adoption across the Fleet Readiness Centers (FRC).

This Rapid Response Repair Technology project, led by the Institute for Manufacturing and Sustainment Technologies (iMAST) and working with Fleet Readiness Center East (FRCE), is conducting a study and testing carbon foam adhesives, surface sealants and application method and machinability of resultant tooling. iMAST intends to deliver a Navy-owned process for temporary tooling fabrication that can withstand up to 10 thermal fabrication cycles.

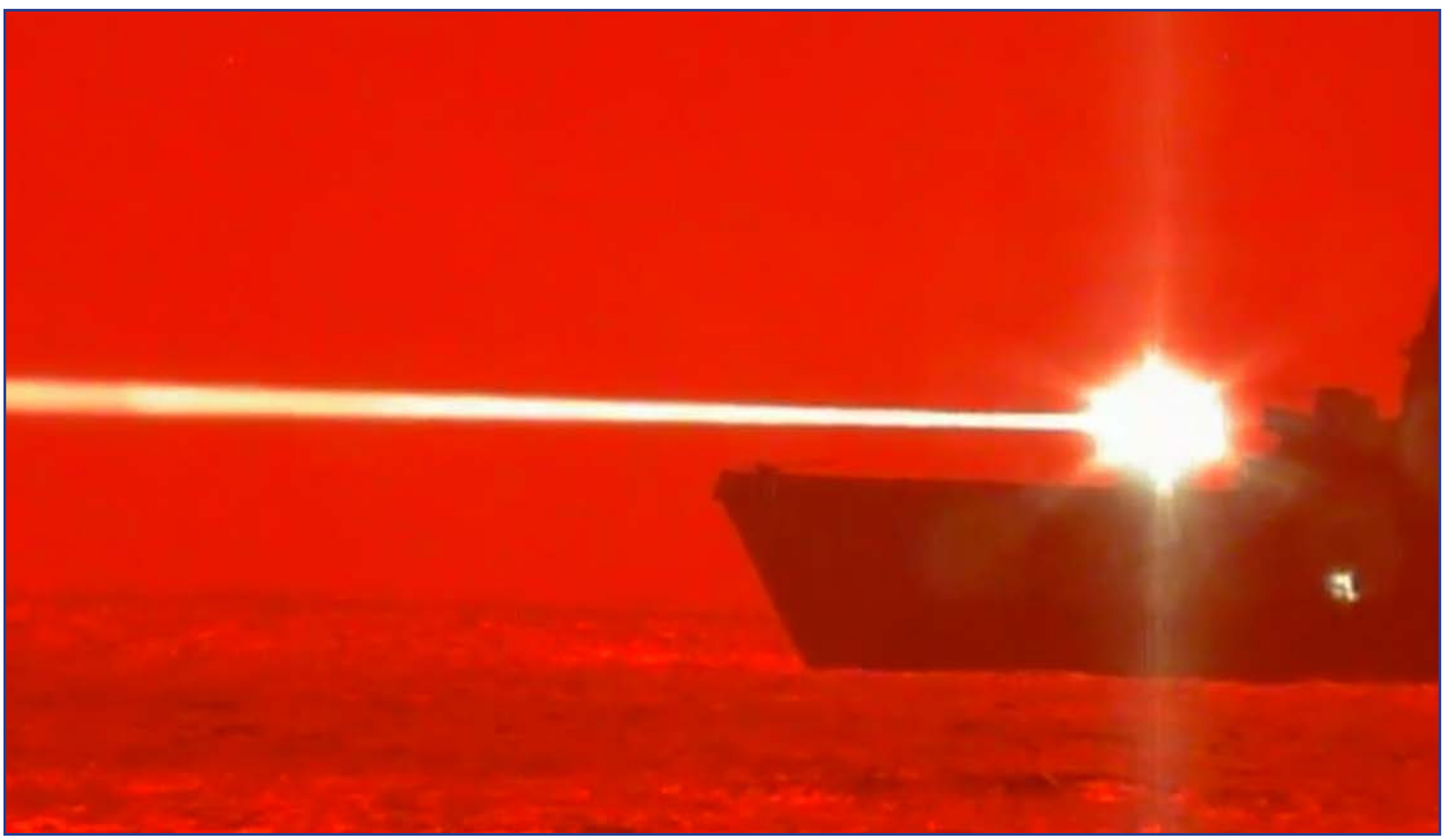
Payoff

CFOAM is lightweight and reportedly easy to machine, bond and repair. Unlike Invar, CFOAM requires no welding, forming or heat treatment. High-volume pricing on CFOAM is $300/3ft, compared to $4,000/3ft for Invar. Implementation of CFOAM tooling could help reduce repair backlog and repair costs for Navy aircraft.

Implementation

All findings, test results and procedures will be shared with FRCE, as the primary initial implementation organization as well as other NAVAIR FRCs. FRCE is committed to implementation, pending CFOAM tooling evaluation and successful test results from the RepTech project, where transition is anticipated in 1Q FY2025 and full implementation will follow in mid-FY2025. Additional transition opportunities at NAVAIR aircraft original equipment manufacturers are also being explored.

Capability Acceleration Projects



USS Portland (LPD 27) Successfully Disabled an Unmanned Aerial Vehicle with a Solid State Laser.
(U.S. Navy image.)

Improving Optical Quality and Reducing Cost of High-Quality Spinel Optics

PERIOD OF PERFORMANCE:
October FY2019 to October FY2023

PLATFORM:
HEL Weapons Systems

CENTER OF EXCELLENCE:
Electro-Optics Center (EOC)

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STAKEHOLDER(S):
TBD

Q2790 — Laser Quality Spinel Optics

Objective

The objective of this Electro-Optics Center (EOC) project was to develop a low-cost powder purification technique that would allow for the production of low-cost, high-optical quality and rugged spinel optics. While small, lab-scale optics have been produced using powder that has been processed through a purification technique, large-scale production of both ultra-high purity powder and laser-quality optics has yet to be achieved. The final objective was to demonstrate the capabilities developed by this project by producing a large diameter optic that met or exceeded the requirements for high energy laser weapons and other system applications.

Payoff

A current limitation of spinel development is the high cost and low availability of commercial ultra-high purity powders. Developing a low-cost, high-volume powder purification technique for commercial-grade powders would increase the supply chain, reduce the cost for ultra-high purity powder and increase interest in the inclusion of spinel in Navy systems. The accomplishments of this project set the stage for the development of a production-scale purification technique and product demonstrations, such that Navy and other Department of Defense systems may take advantage of spinel's unique combination of strength and optical performance in the mid-wave infrared bands.

Implementation

The subcontractor CeraNova Corporation has developed a defined process for producing laser-quality spinel optics using the powder purification technique developed by this project. This process can be leveraged for the development of optics and elements, both flat and conformal, for use on Navy systems in need of a rugged alternative material that has increased capability over other materials including fused silica and sapphire.

Improved Gold Coating Process for High Energy Laser Applications

S2845 — High Energy Laser (HEL) Weapons System Gold Coating

Objective

High Energy Laser (HEL) weapons systems, including the High Energy Laser Beam Expander Telescope (HELBET), require a thin gold coating to provide broadband protection from reflected energy or beam bounce back. Only one vendor in the U.S. (Epner Technology) is capable of gold coating HEL capable surfaces. The current coating system is not meeting performance and reliability requirements. In addition, the coating supplier has limited throughput capabilities, which significantly limits the Navy's ability to acquire gold coated surfaces. The objective of the Institute for Manufacturing and Sustainment Technologies (iMAST) were to review the current gold coating system, identify alternative vendors to expand the current supply chain, develop Navy-owned technical processes, and establish standardized testing and evaluation procedures to qualify HEL gold coatings. The project also identified potential gold coating vendors and alternative processes, tested and evaluated coating system performance, and scaled the manufacturing process to allow uniform, consistent gold coatings on aluminum, titanium, and composite substrate materials to meet HELBET performance requirements.

Gold coating performance and durability was critical when evaluating multiple plating vendors. iMAST developed, documented, and delivered to the Navy a comprehensive test methodology and procedure specifically for HEL gold coatings. This reduced vendor-to-vendor variability and increased confidence of the performance of procured coating systems. iMAST successfully identified alternative vendors who had the current capability to gold plate HEL capable surfaces. Utilization of those vendors eased the supply chain constraints currently faced in weapon acquisition. In addition, iMAST assisted Epner in improving its gold coating process in order to increase performance and reliability of currently deployed gold coating systems.

Payoff

The Navy anticipated increasing the rate of production and integration of HEL weapons systems on various platforms. The technical data provided by this project enabled gold coatings to be more readily procured by the Navy and increase performance and reliability of HEL weapon surfaces. A preliminary business case, based on pre-project figures provided by L3 Harris shows a reduction in acquisition affordability from $250,000 per HELBET system to approximately $125,000; a reduction in life-cycle affordability from the current cost of $250,000 per HELBET system to approximately $100,000 was also expected. Finally, a reduction of three months in lead time scheduled savings was expected after implementation, which addressed high-priority defense / Navy needs for the High Energy Laser and Integrated Optical-dazzler with Surveillance (HELIOS).

Implementation

The Navy-owned process for gold plating has been transitioned to the Navy and HELBET original equipment manufacturer and can be implemented at ongoing shipyard / depot plating operations or other industrial partner for use in future Department of Defense (DoD) programs. Any transition program will likely require certification and performance evaluation to ensure that the final coating vendor can meet system specifications.

PERIOD OF PERFORMANCE:
April FY2020 to December FY2023

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

POINT OF CONTACT:
Mr. Ligetti
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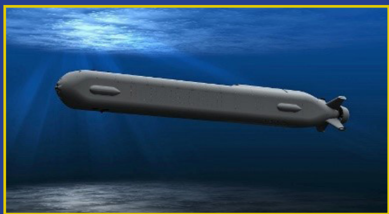
iMAST@arl.psu.edu

STAKEHOLDER:
PEO IWS 2.0

Improving Manufacture Readiness



PERIOD OF PERFORMANCE:
October FY2023 to November FY2025

PLATFORM:
ORCA Extra Large Unmanned Undersea Vehicle (XLUUV)

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

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STAKEHOLDER:
PMS 406 Unmanned Maritime Systems

S2895 — ORCA XLUUV Bulkhead Improvements

Objective

The vast majority of the primary structure bulkheads in the Extra Large Unmanned Undersea Vehicle (XLUUV) are made from billet material. Long lead times for material procurement, long processing times for bulkhead fabrication and limitations in capacity to fabricate these large items present obstacles to accelerating XLUUV production. Single-piece designs constrain fabrication options since there is a limited supply base of companies with the capability to process and machine components this large. In addition, lead times to obtain the large billets are long. This situation increases the risk of production delays, and the throughput of the limited supply base presents potential bottlenecks in production. This Center for Naval Metalworking (CNM) project is establishing the technical feasibility and benefits of implementing a new XLUUV bulkhead design that accelerates capability by solving the problems of manufacturing inflexibility, long lead times and high material cost.

Payoff

The primary benefits resulting from this project are a bulkhead lead time reduction of up to 33 percent and a cost reduction over the baseline material.

Implementation

Implementation activity consists of detailed design of the remaining sections and testing, details of which will be defined in the Technology Transition Plan. It is anticipated that design activity could occur in parallel to this Navy ManTech project to accelerate technology insertion, which is expected to be as early as FY2026.

Navy ManTech Increases MQ-25A Mission Capability

A2896 — MQ-25A Lightweight Composite / Hybrid Nozzle

Objective

The unmanned MQ-25 flight vehicle enables extended combat range of deployed F/A-18 Super Hornet, EA-18G Growler and F-35C fighters through its refueling capability and opens up additional mission readiness opportunities for tactical aircraft, which were previously encumbered with refueling missions. The current focus is on identifying and maturing manufacturing technologies and design concepts to reduce the MQ-25 airframe weight, enabling additional fuel available for offload to maximize this capability. One key piece of structure identified with significant weight-savings opportunities is the exhaust nozzle. The objective of this Composites Manufacturing Technology Center (CMTC) project is to develop and validate a lightweight exhaust nozzle through investigation and analysis of alternate materials and designs, concluding with a full-scale demonstration. The full-scale demonstration will occur on the most complex section to reduce risk for remaining design and implementation activity.

Payoff

The primary benefit resulting from a material change and associated redesign of the exhaust nozzle is the airframe weight reduction, allowing for increased mission capability. Additional benefits include the potential for a reduction in lead time, which will be quantified during project execution, and estimated savings of $400K per aircraft.

Implementation

Implementation activity consists of detailed design of the remaining nozzle sections and testing, details of which will be defined in the Technology Transition Plan. It is anticipated that design activity could occur in parallel to this Navy ManTech project to accelerate technology insertion, which is expected to be as early as FY2026.

PERIOD OF PERFORMANCE:
June FY2022 to December FY2024

PLATFORM:
MQ-25A

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

POINT OF CONTACT:
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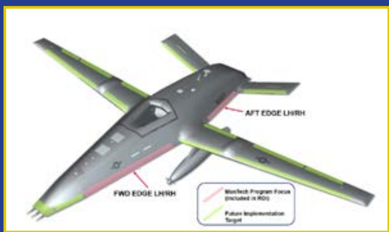
STAKEHOLDER:
PMA-268 Unmanned Carrier Aviation Program

Stronger, Lighter and Faster: Induction Welding for Composite Joining



PERIOD OF PERFORMANCE:
June FY2022 to December FY2024

PLATFORM:
MQ-25A

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

POINT OF CONTACT:
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STAKEHOLDER:
PMA-268 Unmanned Carrier Aviation Program

J2917 — Thermoplastic Composite Welded Assemblies

Objective

Structural composite assemblies require bonding or mechanical fastening to join the individual components. After initial manufacture of the composite components, both joining methods require extensive and expensive preparation of the components for assembly, either through surface preparation and bonding or hole machining and fastener installation. Thermoplastic composite components can be adhesively bonded or mechanically fastened to form structural assemblies, but the chemical nature of the thermoplastic matrix also enables local re-melting and opportunities to “weld” these components as a means of joining. This Composites Manufacturing Technology Center (CMTC) project aims to build upon previous thermoplastic induction welding efforts to develop an induction welding process for assembly of structures. The significant curvatures that represent the chines of aircraft fuselages, as well as the leading

Payoff

Reduced material handling, supply chain simplification and automation of assembly contribute to cost savings for the platform, which is currently estimated to be $100K per MQ-25A. This is conservative and only considers the forward and aft chine assemblies; additional candidates will only increase savings. Supplemental to platform savings is the weight-reduction associated with eliminating fasteners, which will also be realized with the implementation of this technology.

Implementation

Implementation of the fuselage chine on the MQ-25A requires detailed design, analysis,and testing, details of which will be defined during project execution. The results of this Navy ManTech project may be implemented in production of MQ-25A aircraft as early as FY2026. Additional fuselage chine structures not targeted in this project have been identified as additional candidates for conversion.

Driving Efficient Beam Director Optical Manufacturing

S2956 — Beam Director Manufacturing

Objective

Laser weapon systems offer warfighters unique solutions to particular challenges and Navy ManTech designates directed energy laser weapon systems for capability acceleration to the fleet. The beam director assembly (BDA) subsystem in the beam control system is an essential subassembly of every high energy laser (HEL) weapon system. To date, the Navy has integrated prototype directed energy weapons and HEL into DDG 51 Class destroyers. Additional platforms will be considered as the technology evolves and fleet needs are established.

Several aspects of beam director manufacturing combine to create a complex manufacturing challenge. The beam director is a precision assembly of many different optical, mechanical and electrical components. The optics are large, high-value items with substantial lead times, require special handling procedures to avoid damage and originate from several different manufacturers. A poorly planned or poorly executed beam director manufacturing process results in a system with serious performance degradation and inefficiencies that significantly increase system acquisition cost and limit production capacity.

The Navy has made several successful investments to improve manufacture of the beam director optical components. This project complements the prior components investments to address the manufacturing challenges of the integrated beam director assembly by defining a process for the interface, build and test of the beam director optical assembly.

Payoff

Capability acceleration is achieved by developing manufacturing aspects of these laser directed energy solutions concurrent with technology development to optimize the delivery schedule of this capability. The project will yield both manufacturing capacity expansion across providers and cost savings through a reduction in assembly and test labor for beam expander and the use of defined processes for improved efficiency with minimization of tooling, training and process development costs through use of common assembly and test methods for new and existing systems.

Implementation

The project transition point for this effort is a demonstration covering the most complex aspects of the beam director manufacturing process using a full-size, high-fidelity hardware demonstrator of a laser beam director optical system. Project transition and implementation partners from DoD and industry will participate in the demonstration event and review of the manufacturing process documentation. The project final report and process documentation package capture results for the transition partners to employ on new projects. Program Offices that will benefit from this project include both Army and Navy.

PERIOD OF PERFORMANCE:
June FY2022 to October FY2025

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Electro-Optics Center (EOC)

POINT OF CONTACT:
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eoea@arl.psu.edu

STAKEHOLDER:
PEO IWS 2.0

Providing Rapid Green Parts with Additive and Casting Manufacturing

PERIOD OF PERFORMANCE:
April FY2022 to April FY2024

PLATFORMS:
Multiple United States Marine Corps (USMC) systems (LAV, AAV, ammunitions)

CENTER OF EXCELLENCE:
Institute for Manufacturing and Sustainment Technologies (iMAST)

POINT OF CONTACT:
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STAKEHOLDERS:
Assault Amphibian School (Camp Pendleton), Advanced Manufacturing Operations Cell (Quantico)

SP2965 — Print Plastic to Make Metal

Objective

Deployed United States Marine Corps (USMC) ground vehicles frequently require replacement of metal parts to sustain operations. In expeditionary settings, ready access to the supply chain is not guaranteed, often resulting in delays in returning vehicles to mission-capable condition. Deployed USMC units are now fielding rapid repair sites that are equipped with polymer-based 3D printing capability, presenting an opportunity for rapid, low-cost manufacturing of green box parts (i.e., non-critical) for limited or temporary use. The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) Capability Acceleration project was to use a Print Plastic to Make Metal (P2M2) approach to enable USMC and other services to create needed metal parts using well-known, approved materials with well-characterized material properties that can be larger in size than direct-metal printed parts at orders of magnitude lower cost.

iMAST developed standardized tools and processes to create a P2M2 technical data set and associated process documentation sufficient to rapidly create metal parts using the P2M2 process (low-cost desktop printers coupled with casting techniques). This project specifically addressed the obstacles to fielding this capability, which include design capture and conversion to P2M2 suitability, approved and standardized equipment and methods to execute P2M2, and training for USMC personnel to execute when forward deployed. iMAST addressed these challenges by developing an expert system for design conversion and standardizing processes and equipment. They also experimented with procedures, providing examples of how to implement the P2M2 process, and developed training programs for USMC maintenance trainers.

Payoff

Improving operational availability of vehicles in forward locations requires a method for rapid part production of non-critical components. Additive manufacturing processes offer some capabilities but require a significant investment in resources and training in addition to a stable manufacturing environment. The proposed P2M2 process offers greater flexibility than additive-manufacturing processes by combining the design freedom of material extrusion additive with approved materials and well-known characteristics. Additionally, the parts made using this process can be larger than direct-metal, 3D printed parts at orders-of-magnitude lower cost.

Implementation

This project's implementation plan covers the steps required for the initial acquisition of facilities, technical data set, part definitions and implementation details of the P2M2 process. The plan also outlines all training, documentation and hands-on evaluation necessary to instantiate the capability for USMC personnel. The P2M2 technical data set, tools, process and training materials will be primarily implemented with the support and development of USMC amphibious and expeditionary organizations.

An Improved Understanding of Beam Director Costs

SP2966 — Beam Director Manufactured Cost Analysis

Objective

Laser weapon systems offer warfighters unique solutions to particular challenges, and Navy ManTech designates directed energy laser weapon systems for capability acceleration to the fleet. The beam director assembly subsystem in the beam control system is an essential subassembly of every high energy laser (HEL) weapon system and a significant portion of the recurring manufacturing costs. The Navy is considering placement of laser weapon systems on DDG 51 Class destroyers.

As demand for laser weapons increases production cost estimates and affordability become a greater concern. Analysis of a limited number of demonstrator laser weapon systems provides some insight into production costs but can be an unreliable extrapolation for a production cost estimate. Furthermore, the complexity of a beam director subsystem poses a challenge to identify top cost drivers. This ManTech special project benchmarking effort has two objectives: Promote affordable beam director acquisition by determining the cost drivers and considering typical production cost factors. Develop manufacturing investment recommendations with cross-service applicability affecting multiple systems in collaboration with industry to reduce the costs in the beam director top cost components.

The Navy has made several successful investments to improve manufacturing efficiency and capacity of the beam director components. This project complements these investments and guides future investments.

Payoff

Capability acceleration is achieved by developing a beam director cost baseline for acquisition planning and identifying specific target areas for ManTech affordability improvement projects. Manufacturing improvements and associated cost savings were identified in composite operations, tolerances, and leveraging industry provider skill sets. This study forecasts total manufacturing savings of 6 percent cost reduction on the high-cost BoM components. Additional benefits include schedule reduction on long lead components and schedule reduction on critical path of the beam director build.

Implementation

The project final report with cost analysis and manufacturing investment recommendations transitions to new projects. Program Offices that will benefit from this project include both Army and Navy in a variety of missions and beam director architectures. Investment recommendations from this project first transition to manufacturing technology development organization then to an industry partner. Implementation of the recommended investments occurs at industry partners. Given the need for precision optical gimbals and telescopes in intelligence, surveillance and reconnaissance (ISR) applications the project expects transition of results and benefits to these Program Offices.

PERIOD OF PERFORMANCE:
August FY2022 to February FY2023

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Electro-Optics Center (EOC)

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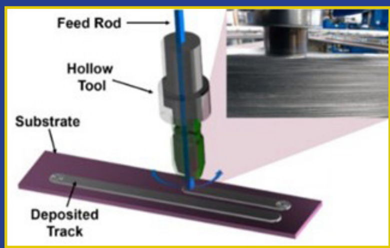
STAKEHOLDER:
PMS 400D

Point-of-Need Repair and Manufacturing through A



PERIOD OF PERFORMANCE:
March FY2024 to April FY2027

PLATFORMS:
Various Army and Navy platforms and Army infrastructure

CENTER OF EXCELLENCE:
Center for Naval Metalworking (CNM)

POINT OF CONTACT:
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mark.snider@ati.org

STAKEHOLDERS:
Naval Surface Warfare Center Carderock Division (NSWC CRD)
Naval Air Systems Command (NAVSEA)
U.S. Army Combat Capabilitries Development Command (DEVCOM)
U.S. Army Engineer Research and Development Center (ERDC)

J2967 — Mobile Fabrication and Repair

Objective

The goal of this Center for Naval Metalworking (CNM) project is to develop portable, solid-state additive/ joining processes for insertion in theater repair for multiple Army and Navy platforms. Parallel paths will be followed for the development of a man-portable friction-stir welding (PFSW) system and a portable containerized system with both additive friction stir deposition (AFSD) and Friction-Stir Welding (FSW) capabilities. These processes will provide new alternatives for sustainment and reduction of obsolescence issues for equipment and materials, as well as create higher fidelity repairs of components due to the robust material capability for a variety of alloys and metals, wherein dissimilar joining / cladding can be readily achieved. This project will work to advance the current state and develop the required data for qualification of these two sustainment and repair capabilities.

Payoff

This project is expected to result in a five-year return on investment (ROI) of 10.1:1.

Implementation

The results will be leveraged for a full transition to PMS 443, Navy shipyards, Project Manager Mounted Armor Vehicles, Project Manager Next Generation Combat Vehicle and Project Manager Sets, Kits, Outfits, and Tools for the development of a final prototype.

Meeting Manufacturing Challenges for Large Integrated HEL Optics

S2989 — Manufacturing Integrated Large Optics

Objective

Laser weapon systems offer warfighters unique solutions to particular challenges and Navy ManTech designates directed energy laser weapon systems for capability acceleration to the fleet. The large optics in the beam director assembly subsystem of the beam control system play an essential role in determining the combat mission performance of every high energy laser (HEL) weapon system. To date, the Navy has integrated prototype directed energy weapons and HEL into DDG 51 Class destroyers. Additional platforms will be considered as the technology evolves and fleet needs are established.

The integrated large optic of the beam director manufacturing presents several related manufacturing challenges. The optic itself requires special handling and precision tolerances to meet the demanding optical performance specification. This optic must then be integrated into a robust optical system to maintain performance across a wide variety of combat environments. Improper manufacturing integration of the optic into the optical system can significantly degrade the optical performance of the entire system. Achieving this high level integrated optic performance has proven to a cost and schedule driver in beam director manufacturing. Furthermore, optimizing a single aspect of the manufacturing process may not yield the best result for the integrated optical performance, cost or schedule. This ManTech project researches the manufacture of an integrated optic that meets performance and provides a flexible process to produce cost and schedule improvements over a range of laser weapon systems.

The Navy has made several successful investments to improve manufacture of the optical components, but future systems require manufacturing methods that scale to meet future requirements. This project complements the prior ManTech investments and builds upon these proven manufacturing advances, then addresses the coming manufacturing challenges of the large integrated optic by defining a process for the interface and build.

Payoff

Capability acceleration is achieved by developing manufacturing aspects of the laser directed energy solutions concurrent with technology development thereby compressing the delivery of the laser weapon systems to the warfighters. The project expects both manufacturing efficiency improvements to drive an affordable cost and responsive delivery as well as technical innovations to meet more demanding performance requirements.

Implementation

The project transition point for this effort is a full-size demonstration of an integrated optic produced with the new manufacturing process. Project transition and implementation partners from DoD and industry will participate in the demonstration event. The project final report captures manufacturing innovations and test results for the transition partners to employ on new projects. Program Offices that will benefit from this project include both Army and Navy.

PERIOD OF PERFORMANCE:
February FY2023 to August FY2025

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Naval Shipbuilding and Advanced Manufacturing (NSAM) Center

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STAKEHOLDER:
PEO-IWS 2.0

Comparison of Materials at Elevated Temperatures

PERIOD OF PERFORMANCE:
February FY2023 to February FY2025

PLATFORM:
High Temperature Applications

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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STAKEHOLDER:
Naval Air Systems Command (NAVAIR)

T2990 — Low-Cost Ceramic Matrix Composite Material Evaluation

Objective

A growing number of Navy systems have been shown to benefit from structurally efficient, low-weight and high-temperature-resistant materials to achieve optimum performance. Examples include engine applications, hypersonic systems and engine exhaust areas affected on both manned and unmanned rotary and fixed-wing aircraft, as well as potentially ships, for high-temperature applications that require flame, smoke and toxicity requirements. These heat sensitive areas traditionally use high-temperature metallic alloys (titanium / Inconel®, etc.) or Ceramic Matrix Composites (CMC) for temperature resistance. Metallic solutions have excellent temperature resistance but are expensive to manufacture and incur significant weight penalties. CMCs (such as carbon-carbon and carbon-silicon carbon) deliver exceptional performance at very high temperatures, but their complex processing and associated high costs have limited their widespread use. New material systems are becoming available which are proprietary as inorganic polymers that could potentially fill the needed material requirements. These inorganic polymers are derived from alumino-silicate-based geopolymer systems and differ significantly from both organic polymers and conventional ceramic matrices. With this technology, these composites bring a lightweight and convenient alternative to metals and other materials for heat shields, ducts, etc.

To evaluate the performance of the system, the current state will be baselined. This Composites Manufacturing Technology Center (CMTC) project will identify, mature and demonstrate a composite material and associated processing capable of high-temperature usage for Navy applications.

Payoff

Upon successful completion of the project, it is anticipated that a material system would be identified, characterized and demonstrated that could withstand elevated temperatures and be processed into parts economically with straightforward manufacturing. With this technology, these composites bring a lightweight and convenient alternative to metals and other materials for heat shields, ducts and other components. These materials are also used when superior fire, smoke and toxicity properties are required.

Implementation

With successful project outcomes, it is anticipated that, a 6.3 Navy ManTech program will be established to facilitate technology transition to a Navy application.

An Improved Understanding of Beam Director Costs

J2997 — Focal Plane Array Photonic Output

Objective

High-performance infrared (IR) imagers are used in land, sea, air and space domains to provide our forces with overmatch capability. Previous IR imagers were typically smaller format with modest frame-rates. Higher frame-rates were available only in reduced formats or windowed areas of large imagers. Image bit depth was limited to the needs of human operators. Conventional means of electrical data transmission satisfied the needs for such systems. However, increasingly challenging threats call for imaging systems with much larger focal plane sizes, higher scene refresh rates and increasing bit depth designed for automated machine processing such as aided target recognition (AiTR). Data transmission rates required for these systems exceed the capability of the conventional electrical transmission solutions.

Recent cross-service research has matured several solutions to meet these emergent data transmission needs based on photonics, but an efficient and scalable manufacturing process for the photonic solution does not exist for military sensor systems. This project seeks to establish government-owned manufacturing processes for photonic data transmission from the cryogenic IR sensor environment.

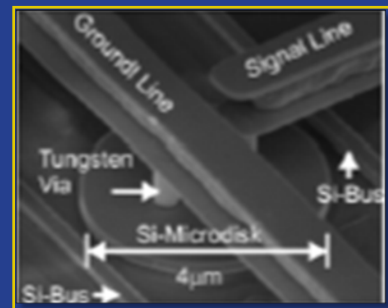
Payoff

Improvements in the manufacture of IR system data transmission complements manufacturing technology investments for high resolution, wide field of view and high update rate IR sensor systems. The ManTech capability acceleration project enables maximum imaging performance in a combat environment while increasing production capacity and affordability by reducing human labor in the manufacturing process. The ultimate benefit is accelerated delivery of advanced imaging capability to warfighters.

Implementation

The project transition point for this effort is a full signal chain demonstration of the manufacturing approach. The project final report and demonstration hardware can transition to inform additional research projects in this topic area.

Transition pathways include target platforms across services with intelligence, surveillance and reconnaissance (ISR), fire control and navigation applications. Program Offices that will benefit from this project include Navy PEO IWS 2, Army PM TS, and Army PM Apache Helicopter as well as ONR FNC efforts and other DoD research efforts.



PERIOD OF PERFORMANCE:
April FY2024 to October FY2027

PLATFORM:
DDG 51 Class destroyer

CENTER OF EXCELLENCE:
Electro-Optics Center (EOC)

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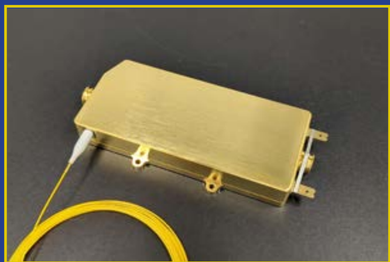
STAKEHOLDERS:
Navy PEO-IWS 2.0
Office of Naval Research, Code 31
Army PM TS
Army PM Apache Helicopter

Maturing High Operating Temperature Diodes for HEL Systems



PERIOD OF PERFORMANCE:
June FY2023 to December FY2026

PLATFORM:
High Energy Laser (HEL) Weapons Systems

CENTER OF EXCELLENCE:
Electro-Optics Center (EOC)

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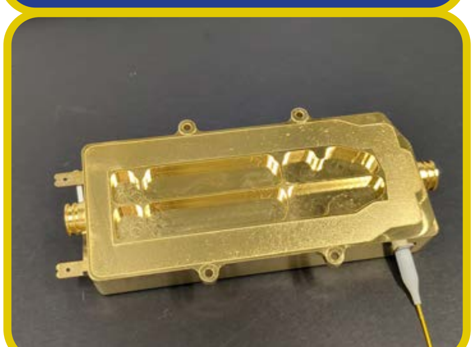
STAKEHOLDER:
PEO IWS 2.0



S3000 — High Operating Temperature Pump Diodes

Objective

The primary objective of this project is to improve the manufacturing of High Operating Temperature (HOT) diodes (50C +/-8) and develop subsequent packaging that can achieve a 1,000-hour lifetime expectancy. By accomplishing this goal, a SWaP reduction in system Thermal Management Systems (TMS) may be achieved, when compared to a conventional 25C fiber diode amplifier system, without reduction in the amplifier beam quality. During the course of the project, the diodes will be characterized for their reliability (metric >1,000 hours) and their efficiency. By leveraging previous Department of Defense) DoD-funded ManTech efforts and integrating their results, this project will develop and verify a scalable manufacturing process for a HOT-based fiber amplifier assembly.

Payoff

This capability acceleration project will advance the TRL/MRL of HOT diodes for future incorporation into High Energy Laser (HEL) systems. Through leveraging previous Army ManTech and JTO funding, rapid acceleration of the manufacturing capability and yield of HOT diodes will be realized for faster adoption by the fleet. While the goal of this project focuses on advancing the TRL/MRL, utilization of these diodes will enable more widespread adoption of HEL systems on ground, air, and sea platforms as the cooling requirements will be reduced. This benefit is especially important for installing HEL systems on legacy platforms, as chilled water availability is often problematic.

For Navy sea platforms specifically, incorporation of a 50C HOT diode allows a significant reduction in retro-fit (pipe size changes) and thermal management system cost by using sea water and a heat exchanger instead of a chilled water system. This saves power, weight, and space on the platform thus enabling higher power systems.

Implementation

Demonstration at the end of the project will be conducted on a prototype brass board amplifier that will showcase the package's ability to meet the outlined project requirements for life expectancy, power, and efficiency at elevated operating temperatures. Once the project has completed this demonstration, these diodes and their packaging will be ready for installation into future-designed HOT fiber amplifiers for utilization by all DoD platforms.

$15.6M Savings Utilizing High Yield Maching

J3001 — High Yield Machining of Thermal Protection Systems

Objective

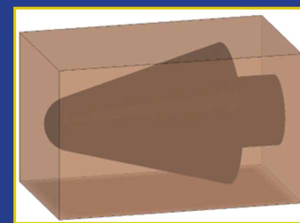
Recently, basic feasibility of a robotic solution was investigated on a Lockheed Martin Hypersonic Engineering and Accelerated Technologies (HEAT) Independent Research and Development (IRAD) program. The IRAD project successfully demonstrated the ability to attach a head with a diamond-coated wire saw to a robot for automated material processing of graphite billets. The demonstration equipment was not large enough to cut actual flight shapes. Combining existing technologies with the Lockheed Martin HEAT team's knowledge of composite machining and robotics, the objective of this project is to scale up the IRAD technology to develop a prototype robotic wire saw cutting system and demonstrate more efficient processing of flight shapes from raw 3DCC billets.

Payoff

The wire saw process will benefit multiple hypersonic strike systems to increase yield from billets. As a secondary effect, we expect even increased yield and reduced overall raw material costs by working with 2D and 3DCC suppliers to modify their sizes and optimize around the wire saw capability. Material and labor savings amounts to a total program savings of $15.55M resulting in a return of investment (ROI) of 3.3:1.

Implementation

Upon meeting Lockheed Martin's HEAT product requirements and confirmation of a positive business case, the project shall allocate the wire saw setup for U.S. Navy and Rapid Capabilities and Critical Technologies Office (RCCTO) Conventional Prompt Strike (CPS) production as required. Information from this project will be utilized to formally approve the new process for production.



PERIOD OF PERFORMANCE:
May FY2024 to May FY2026

PLATFORM:
Conventional Prompt Strike (CPS)

CENTER OF EXCELLENCE:
Composites Manufacturing Technology Center (CMTC)

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STAKEHOLDER:
Conventional Prompt Strike (CPS)

Developing Common Core Transformer Manufacturing for Navy Transducers

PERIOD OF PERFORMANCE:
May FY2023 to January FY2026

PLATFORMS:
DDG 51 Class destroyer
Aircraft Carrier Attack (CVA)
VIRGINIA Class submarine (VCS)
FFG 62 Class frigate

CENTERS OF EXCELLENCE:
Electronics Manufacturing Center (EMC)

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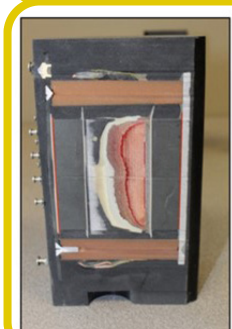
STAKEHOLDER:
Submarine Acoustic Systems Program Office (PMS-4013)



S3004 — Improving Common Sonar Transformer Manufacturability

Objective

The primary objective of this project is to develop a common transformer core type (preferably in a single transformer design) using modern, non-hazardous materials for increased volume, performance and ease of manufacture by a domestic supplier. By utilizing modern manufacturing methods and materials, current program risk related to sole-source procurement of core materials from foreign suppliers will be eliminated.

Payoff

By developing a domestic manufacturing method and supplier, procurement of these critical transformers may be stabilized and cost avoidance realized a reduction per unit cost. An estimated return on investment (ROI) of 1.3:1 over five years may be realized with a project ROI of 10.3:1.

Additional benefits potentially include the ability to incorporate design features that have commonality between the transformers used in the TR-317 and TR-343 and the inclusion of increased capability. Additionally, current TR-317 and TR-343 transformers suffer from degraded tuning capability due to limited functionality (low inductance range) which impacts the transducer's ability to meet their performance specifications after the piezoelectric ring stacks have aged. This project will investigate materials and methods to improve inductance range to help reduce attrition loss and failure.

Implementation

Transition of the project's results will occur after successful screening testing and demonstration by NSWC Crane. Once this testing has completed satisfactorily, NSWC Crane, with the support of PMS-4013, will complete first article testing and an Engineering Change Proposal to initiate implementation into the fleet. Implementation is expected to occur 4Q FY2026.

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