transitioning affordable manufacturing technology to the Fleet
Contents

2018 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 FY17. To highlight Navy ManTech's Cost Savings Investment Strategy, with its concentration on development of manufacturing technology for the key platforms, the projects are organized by platform status. Please contact the Points of Contact listed in the project summary for additional information on any Navy ManTech project.

4 Overview
5 Objectives
6 Investment Strategy
9 Execution
15 Technology Transfer
18 Highlight

*Navy ManTech Extends Affordability Focus To COLUMBIA Class*

Projects by Platform:
21 CVN 78 Class / Aircraft Carriers
33 DDG 51 Class
51 Littoral Combat Ship (LCS)
53 VCS/CLB/ Submarines
71 F-35 Joint Strike Fighter
87 CH-53K
91 Other Sea Platforms
97 Energetics
101 RepTech

Index:
106 By Project Title
109 By Project Number
112 By COE
The Navy ManTech Program has been making a difference improving the affordability of Navy platforms critical to the future force. We have targeted our investments on manufacturing technologies to assist key acquisition Program Offices in achieving their respective affordability goals - both acquisition and life-cycle affordability. As we look to the future, we will continue our focus on key Navy platforms: VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), DDG 51 Class Destroyer, CVN 78 Class Aircraft Carrier, F-35 Joint Strike Fighter (JSF), and the CH-53K Heavy Lift Helicopter.

Transition remains the guiding principal of our program. For Navy ManTech, transition occurs when the ManTech project has been successfully completed, meeting the defined goals and objectives of both the relevant industry and the Program Office, in time to support implementation. Technology Transition Plans, required for each project, specify clearly and succinctly what will be accomplished with ManTech funds, the basis on which transition will be declared complete, and the resources that will be provided by other entities in order to actually implement the technology. The resources for implementation are typically provided by entities other than ManTech, such as the acquisition Program Office or industry. Hence, although ManTech understands the importance of implementation and is exerting its resources to track implementation, it is recognized that ManTech can transition needed manufacturing technology but cannot control actual implementation.

The Navy ManTech Implementation Risk Assessment and Management Process is being used both to assess potential future projects (those in the planning stages) as well as ongoing projects. For ongoing projects, risks are discussed during periodic Program Reviews to ensure ManTech is on the same page as the acquisition and industry stakeholders. For projects in the planning phases, the goal is to recognize risks to implementation upfront and, by doing so, prioritize funding of affordability projects that have the greatest probability of implementation.

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

The purpose of this publication is to provide a readily accessible source of information on the Navy ManTech Program, our investment and execution strategies, and contact information for our key players. We hope that this will be a valuable resource for members of industry, government, and academia.

I look forward to continuing to work with all of you to improve on the successes of the Navy ManTech Program. It is even more critical in the current budgetary environment to put our resources to the best use, and I am confident that the continued collaboration of ManTech, Program Offices, and industry on cost-reduction opportunities can and will help platforms achieve both acquisition and life-cycle affordability goals.

John U. Carney
Director, Affordability Initiatives Division and Navy ManTech Program

DISTRIBUTION STATEMENT A:
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED
The Navy Manufacturing Technology (ManTech) Program responds to the needs of the Navy for the production and repair of platforms, systems, and equipment. It aids in achieving reduced acquisition and total ownership costs by developing, maturing, and transitioning key manufacturing technologies and processes. Investments are focused on those that have the most benefit to the Warfighter.

For over ten years, the Navy ManTech Program has been focused on affordability improvements for key acquisition platforms. Our current focus is on: the VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), DDG 51 Class Destroyer, CVN 78 Class Aircraft Carrier, F-35 Joint Strike Fighter (JSF), and CH-53K Heavy Lift Helicopter. ManTech helps these Navy programs achieve their respective affordability goals by transitioning needed manufacturing technology which, when implemented, results in a cost reduction or cost avoidance (measured as $/hull or $/aircraft).

Navy ManTech works with defense contractors, the Naval Research Enterprise, Navy acquisition Program Offices, and academia to develop improved processes and equipment. The Program is structured to promote timely implementation to strengthen the defense industrial base. With their expertise in specific technology areas, the Navy ManTech Centers of Excellence (COEs) play a key role in the definition and execution of the Program.

Together with the Navy ManTech Program Office, representatives of the customers, industrial entities, and 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 between Navy ManTech, Navy ManTech COEs, General Dynamics Electric Boat, Huntington Ingalls Industries – Newport News, PEO (Subs), and the PMS 450 Program Office has resulted in a focused ManTech initiative for the VIRGINIA Class submarine (VCS). To date, technology from 41 of the portfolio’s approximately 139 projects have been implemented, or in the process of being implemented, for a resulting real acquisition cost savings of approximately $36.0M per hull, verified by our industrial partners and PMS 450.

The Navy ManTech Program is managed by the Office of Affordability Initiatives within the Technology Directorate of the Office of Naval Research (ONR), with direct oversight from the Chief of Naval Research. With the transition of technologies to the Fleet and acquisition as top priorities, ONR’s Technology Directorate is composed of transition-centric programs including ManTech, Future Naval Capabilities (FNCs), the Small Business Innovation Research (SBIR) / Small Business Technology Transfer (STTR), and other transition initiatives.

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

The overall objective of the Navy ManTech Program is to improve the affordability and readiness of Department of the Navy (DON) 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: Transitioning affordable manufacturing technology to the Fleet by ...

• Focusing resources on key, high priority acquisition platforms
• Targeting cost reduction as the primary benefit
• Developing critical manufacturing and repair / sustainment solutions
• Engaging relevant industry partners upfront and throughout the process
• Targeting ManTech transition and platform implementation as the key measures of success
Navy ManTech Investment Strategy

The Navy ManTech Investment Strategy concentrates ManTech investments 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: VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), DDG 51 Class Destroyer, CVN 78 Class Aircraft Carrier, and, in a portfolio coordinated with the DOD and Air Force ManTech Programs, F-35 Joint Strike Fighter (JSF) and CH-53K Heavy Lift Helicopter.

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 process 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 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 / goals for implementation.

- **Implementation** denotes the actual use on the factory floor of ManTech results. (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 longer-term view of implementation.

On a per-project basis, Technology Transition Plans (TTPs) document roles, responsibilities, and required resources needed to achieve transition and implementation. TTPs highlight the path from the technology development that ManTech performs to implementation on the factory floor. TTPs are signed by Navy ManTech, the relevant COE Director, a management representative of the industrial facility where implementation will occur, the Program Office, 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 expanded and formalized its focus on implementation and risks to implementation by instituting an Implementation Risk Assessment Management Process to assess potential future projects (those in the planning stages) as well as ongoing projects. For ongoing projects, risks are discussed during periodic Program Reviews to ensure ManTech is on the same page as the acquisition and industry stakeholders. For projects in the planning phases, the goal is to recognize risks to implementation upfront and, by doing so, prioritize funding of projects that have the greatest probability of implementing and have a real impact on affordability.

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

While the 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: Energetics ManTech projects 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. Concentration is on developing solutions to ensure the availability of safe, affordable, and quality energetic products in support of Program Executive Offices such as Integrated Warfare Systems (PEO IWS/IWS3C) and Conventional Strike Weapons (PEO (W)/PMA 201). More information on Navy ManTech’s Energetics Manufacturing Technology Center (EMTC) can be found on Page 12.

RepTech: While the major emphasis of the 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 run by the Institute for Manufacturing and Sustainment Technologies (iMAST). More information can be found on Page 13.
Navy ManTech Execution

The 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; and
- Facilitate transfer of developed technologies.

Descriptions of ManTech’s seven COEs are presented on the following pages.
Navy ManTech Execution

Center for Naval Metalworking

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

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

CNM Web site:  http://www.navalmetalworking.org

Composites Manufacturing Technology Center

The Composites Manufacturing Technology Center (CMTC), established in 2000, is located in Summerville, SC, and is operated by Advanced Technology International (ATI). The CMTC is a virtual center, providing expertise from across the defense industrial base to address all Navy composites manufacturing technology needs.

CMTC forms teams of prime contractors, composites industry suppliers, and universities and has strong in-depth knowledge and experience in composites manufacturing technology for all modern DOD weapon systems. As part of CMTC’s organizational structure, all laboratories, facilities, and project labor resources are provided by project teams. This unique structure results in cost benefit to the Navy, with maximum funding going to project execution. CMTC’s current portfolio includes composites manufacturing projects for four major ship platforms, CH-53K and the F-35 Joint Strike Fighter.

CMTC Web site:  http://cmtc.ati.org
Navy ManTech Execution

Electro-Optics Center

Since 1999, the Electro-Optics Center (EOC) has served as the ONR Manufacturing Technology Center of Excellence for Electro-Optics. The EOC’s goals are to reduce acquisition costs, operational costs, and life-cycle costs while simultaneously improving mission capability of electro-optic military hardware and enabling transition of technology to industry and ultimately to the Warfighter. Since its inception, the EOC and the partner members of its Electro-Optics Alliance (EOA) have completed over 37 ManTech projects which have resulted in significant savings to the taxpayer. The purpose of the EOA is to advance DOD critical E-O Manufacturing Science and Technology and to promote U.S. preeminence in all areas of E-O. Alliance membership is available at no cost to all U.S. companies, government labs, and academic institutions involved in E-O technology. The EOA is committed to advancing the commercial viability of E-O technologies and promoting technology transfer to industry, as well as wide dissemination of new E-O related information.

The EOC, a proud part of The Pennsylvania State University, is a hybrid between the best components of a university and those of private industry. This relationship enables access to the university’s researchers and scientists, its state-of-the-art facilities, and leading-edge research. EOC staff, comprised primarily of former industry and DOD personnel, brings experience in exceeding sponsor and corporate expectations. Through the application of this hybrid model, the EOC is able to provide its sponsors with solutions that combine leading edge research with on-time and on-budget deliveries.

EOC Web site:  http://www.eoc.psu.edu

Electronics Manufacturing Productivity Facility

The Electronics Manufacturing Productivity Facility (EMPF) was established in 1984 to aid the electronics industry in improving electronics manufacturing processes required in the manufacture of military systems. Today, the EMPF operates as a national electronics manufacturing COE focused on the development, application, and transfer of new electronics manufacturing technology by partnering with industry, academia, and government centers and laboratories to maximize available research capabilities at the lowest possible cost. The EMPF serves as a corporate residence of expertise in electronics manufacturing. The EMPF’s principal goals are to; improve responsiveness to the needs of DOD electronics systems; ensure that deliverables make a significant impact in the electronics manufacturing industry; facilitate the development and transition of technology to the factory floor; and expand the customer base to a national level.
Navy ManTech Execution

The EMPF operates in a modern 36,000 square foot facility adjacent to the Philadelphia International Airport. The facility houses a demonstration factory containing the latest electronics manufacturing equipment, fully equipped classrooms for skill-based and professional level technical training, and an analytical laboratory for materials and environmental testing. The EMPF offers many electronics manufacturing services and capabilities to the U.S. Navy, DOD, and the U.S. electronics manufacturing industrial base. The EMPF's resident technical staff consists of the nation's leading electrical engineers, mechanical engineers, materials scientists, chemists, physicists, instructors, and technicians. The EMPF staff is dedicated to the advancement of environmentally safe electronics manufacturing processes, equipment, materials, and practices; flexible electronics manufacturing technologies; and workforce competency.

EMPF Web site:  http://www.empf.org

Energetics Manufacturing Technology Center

The Energetics Manufacturing Technology Center (EMTC), established in 1994 by the Office of Naval Research (ONR), is Navy-operated and located at the Naval Sea Systems Command's Naval Surface Warfare Center, Indian Head EOD Technology Division (NSWC IHEODTD), Indian Head, MD. NSWC IHEODTD serves as the focal point for the Center and as a renowned leader in energetics, provides a full spectrum of capabilities. These include energetics research, development, modeling and simulation, engineering, manufacturing technology, production, test and evaluation, and fleet / operations support.

Energetic materials (reactive chemicals), formulations (propellants, explosives, pyrotechnics), and subsystem components (fuzes, detonators, boosters, igniters, safe & arm devices) are critical to the performance and reliability of weapon systems and thus to our Nation's defense. Applications include missile, rocket, and gun propulsion; stores or ordnance separation; warheads and munitions; obstacle and mine clearance; flares; decoys; fire suppression; and aircrew escape. Energetics, inherently dangerous, require special processes, equipment, facilities, environmental considerations, and safety precautions. At EMTC, this is kept in mind while ensuring the availability of safe, affordable, and quality products. The Center develops solutions to manufacturing problems unique to military system / subsystem acquisition and production requirements and the energetics industry. The Center does not own or operate any facilities and equipment but is essentially a virtual enterprise that involves government, industry, and academia in identifying requirements and executing projects. EMTC objectives are to identify weapon system and manufacturing base needs, develop and demonstrate the required manufacturing process technology solutions, and transition successful results.

EMTC Website:  http://www.navsea.navy.mil/Home/WarfareCenters/NSWCIndianHeadEODTechnology/WhatWeDo/EMTC.aspx
Navy ManTech Execution

Institute for Manufacturing and Sustainment Technologies

The Institute for Manufacturing and Sustainment Technologies (iMAST), established in 1995, coordinates Navy ManTech efforts at The Pennsylvania State University's Applied Research Laboratory (ARL), one of five U.S. Navy University Affiliated Research Centers (UARCs). Located in State College, PA, iMAST’s primary objective is to address challenges related to Navy and Marine Corps weapon system platforms in the following technical areas: materials processing, laser processing, advanced composites, manufacturing systems, repair and sustainment, and complex systems monitoring. iMAST supports the Navy and Marine Corps systems commands, as well as PEOs and Navy laboratories.

RepTech applies new and emerging technologies to improve capabilities of Navy depots, shipyards, Marine Depot Maintenance Command and lower level maintenance activities throughout the Fleet. RepTech cooperates and communicates with other Navy COEs, the joint depot community, DOD industrial activities, industry, PEOs, and university laboratories.

iMAST Web site: http://www.arl.psu.edu/centers_imast.php

Navy Metalworking Center

Since its inception in 1988, the Navy Metalworking Center (NMC) has supported the Navy's evolving needs by developing and transitioning innovative metalworking and manufacturing solutions. To support the Navy's mission to reduce total ownership cost, NMC works with government and industry to develop and optimize metalworking and manufacturing processes and to implement the solutions in the U.S. industrial base. Currently, NMC conducts ship and air projects that incorporate advanced metalworking technologies, additive manufacturing, joining technologies, manufacturing process optimization, manufacturing tool development, advanced metrology and inspection technologies, and coatings application and removal.

NMC is operated by Concurrent Technologies Corporation, an independent, nonprofit, applied scientific research and development professional services organization located in Johnstown, PA.

NMC Web site: http://www.nmc.ctc.com
Navy ManTech Execution

Naval Shipbuilding and Advanced Manufacturing Center

Center develops advanced manufacturing technologies and deploys them in U.S. shipyards and other industrial facilities to improve manufacturing processes and ultimately reduce the cost and time required to build and repair Navy ships and other weapons platforms. This Center works closely with the Navy’s acquisition community and the defense industry to address manufacturing technology issues that negatively impact efficiency, with respect to both cost and cycle time. NSAM solicits, selects, unds, and manages projects to address these critical and costly issues. The projects are focused on improving construction and repair processes, such as optimizing production practices, increasing the use of robotic manufacturing methods, investigating modular/ackaged units, improving accuracy control, eliminating inefficiencies in material usage, and using advanced manufacturing tools and technologies across the full range of DOD platforms.

NSAM and its predecessor, the Center for Naval Shipbuilding Technology (CNST), have been operated and managed by Advanced Technology International (ATI) since 2003. NSAM will continue to pursue technologies focused on improving the affordability of current Navy acquisition programs. New projects being considered 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 product models to support production, and developing improved scheduling systems for new, aggressive build strategies.

NSAM Web site: http://www.NSAMCenter.org

Induction Straightening for Ship Panels – Courtesy of NSAM
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 [http://www.onr.navy.mil/mantech/](http://www.onr.navy.mil/mantech/). The Web site is a central source for accessing general information about the program activities and participation, developments and events, and key points of contact. The site also offers links to the online annual Navy ManTech Project Book, program success stories, as well as other publications and reports.

**Defense Manufacturing Conference**

The annual **Defense Manufacturing Conference (DMC)** is a forum for presenting and discussing initiatives aimed at addressing DOD manufacturing technology and related sustainment and readiness needs. The conference includes briefings on current and planned programs, funding, DOD initiatives, and seminars relating to the various technology thrusts currently being pursued. Further details are available at the DOD Manufacturing Technology Web site at: [https://www.DODmantech.com](https://www.DODmantech.com).

**ShipTech**

The 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 while enhancing the competitiveness of the U.S. shipbuilding industry. Details are available at [http://www.nmc.crc.com/index.cfm?fuseaction=events.details&eventID=85](http://www.nmc.crc.com/index.cfm?fuseaction=events.details&eventID=85).

**Project Book**

The **Navy ManTech Project Book**, published annually and available through the Navy ManTech Web site, is a snapshot of Navy ManTech projects active during that particular fiscal year. Points of Contact for each project are provided to facilitate technology transfer.

**Centers of Excellence**

The **Navy 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.

For additional information on participation in the Navy’s effort to strengthen the U.S. industrial base, impact platform affordability, and increase Navy readiness, contact any of the Navy ManTech Points of Contact listed on Pages 21-31.
Navy ManTech – affordability improvements for key naval platforms: VIRGINIA Class submarine (VCS), COLUMBIA Class submarine (CLB), F-35 Joint Strike Fighter (JSF), CVN 78 Class Aircraft Carrier, DDG 51 Class Destroyer, and CH-53K Helicopter. Courtesy of PEO (Subs), PEO (JSF), PEO (Carriers), PEO (Ships), and PEO A (CH-53K).
In FY06, Navy ManTech embraced a platform-centric investment strategy that addressed the acquisition affordability goals of key weapon systems, including the VIRGINIA Class Submarine (VCS). Over the past decade, Navy ManTech has made a significant impact to VCS affordability by successfully transitioning and implementing technology that helps reduce the cost of each VCS from $2.4 billion to $2 billion (in FY05 dollars) and enables the construction of two submarines per year starting in 2012. ManTech’s VCS portfolio contains approximately 139 projects on a Navy ManTech investment of approximately $92 million and has a potential cost savings of approximately $55 million per hull. As of October 2017, General Dynamics Electric Boat (GDEB) reported that 41 of the ManTech affordability projects had completed and had either been implemented or were in some phase of implementation. These total approximately $36.0 million per hull of recognized cost savings by the Program Office and GDEB. With two submarines procured every year, the annual recognized VCS cost savings are greater than the annual ManTech budget.

In FY14, ManTech added the COLUMBIA Class submarine (CLB) to its investment strategy to further aid the Program Executive Office for Submarines, PEO (Subs), in its affordability goals. The Navy plans to build 12 CLBs to replace the aging OHIO Class ballistic missile submarines, which will begin decommissioning in 2027.

GDEB is leading the CLB detailed design phase with Huntington Ingalls Industries – Newport News Shipbuilding (NNS) providing assistance. Construction is scheduled to begin in FY21. Because design and technical specifications and early prototyping are underway, Navy ManTech has been working with both shipyards, PEO (Subs), and the CLB Program Office to identify and execute projects that will reduce acquisition cost.

Where possible, the CLB design will incorporate technology and components from both the OHIO and VIRGINIA Class submarines as a cost-saving measure. As a result, many ManTech efforts for VCS have direct applicability to CLB, such as the Trade Friendly Locating Dimensional Techniques project, which identified a dimensional locating metrology technology that can be cost-effectively incorporated into VCS manufacturing processes by tradesmen and engineers who do not specialize in metrology. GDEB purchased and implemented the first system for VCS in FY16. The metrology technology also offers opportunities to improve CLB manufacturing processes, and GDEB estimates that the system will save $869K per VCS hull and per CLB hull by replacing or enhancing common mechanical measurement tooling.
Another ManTech project that will deliver recognized savings for CLB is the Self-Locating/Self-Fixtured (SLSF) Structures project, which developed a novel way to fit and join deck structures using notched beams that interlock and are continuous in both directions. The SLSF construction method offers reduced part count, simplified fit-up and inspection, a lowered skill set required for fit-up, reduced labor and duration for setup and fabrication, and the elimination of post-weld distortion remediation. GDEB estimates that $2.19M can be saved on the first CLB hull. The SLSF method has been incorporated into the design of SSBN 826, the lead ship of the COLUMBIA Class, on 16 deck sections and 26 decks on follow-on ships. Construction is expected to commence in FY19. The construction method is relevant to many platforms, including surface ships and the VIRGINIA Payload Module.

Other Navy ManTech projects that automate the processing of steel shapes and use additive manufacturing to fabricate tools to improve shipbuilding processes will also increase efficiency and decrease the acquisition cost of CLB.

“The ONR ManTech program has a strong history of successful cost-reduction efforts, and we are very excited about working with them in our efforts to deliver COLUMBIA Class submarines on time and within budget.”

Matt Sermon, Deputy Program Manager
COLUMBIA Class Submarine Program, September 2017
CVN 78 Class / Aircraft Carriers
Projects

S2532 — Composite Hybrid Rotating Coupling Covers .......................................................... 22
S2571 — Synchronizing Material Logistics with CVN Pier & Dry Dock Build Strategies .......................................................... 23
S2595 — High Deposition Submerged Arc Welding for Ford Class Aircraft Carriers .......................................................... 24
S2606 — Efficient Identification of Plate Defects .................................................................. 25
S2643 — Acoustic Sensing Through Energized Electrical Enclosures ................................. 26
S2662 — Non-Contact Metrology in Shipbuilding ................................................................. 27
S2664 — Induction Straightening for CVN ............................................................................ 28
S2686 — Electromagnetic Aircraft Launch System (EMALS) Armature Assembly Producibility Improvements .......................................................... 29
M2726 — Geospatial Component Location, Identification and Condition (GeoCLIC) .......... 30
S2727 — Advanced Steel Production Facility - Industrial Modeling & Simulation .................. 31
Composite Hybrid Rotating Coupling Covers to Provide Acquisition and Life-Cycle Cost Savings for Aircraft Carriers

S2532 — Composite Hybrid Rotating Coupling Covers

Objective
Rotating Coupling Covers (RCC) enclose shaft flanges on waterborne shafting on aircraft carriers. The existing fairings are doubly curved copper-nickel (Cu-Ni) with tight dimensional tolerances, which makes them difficult and expensive to fabricate. In addition, they have a history of leaking, as evidenced by extensive corrosion of the flanges. The Composites Manufacturing Technology Center is working to replace the metallic RCC with a composite RCC. The functions, shape, and arrangement of the individual components are being determined during execution of the project, with a focus on optimizing manufacturing processes and reducing costs. As the primary structure, the composite shells of the RCCs will be fabricated using methods including male molding with oven vacuum bag prepreg. A decoupled design is desired to eliminate the need for a watertight fairing seal.

Payoff
Offering both acquisition and life-cycle savings, the project is estimated to save up to $19M in total, resulting in an ROI of 7:1. The fabrication approach will also reduce production time.

Implementation
This project will be demonstrated with PMS 312C funding on the earliest availability of a CVN 68 Class aircraft carrier. A RCC will be installed and checked after a limited time at sea. If successful, the composite RCC will be approved for use on all back-fits and future construction.
Creating the Ability to Quickly and Easily Analyze Material Impact on Build Strategy Decisions

S2571 — Synchronizing Material Logistics with CVN Pier & Dry Dock Build Strategies

Objective

Naval ship construction is an immensely complex logistical activity involving large quantities of highly specialized material, equipment, and personnel. All material that ultimately resides in an aircraft carrier (CVN) must be pulled from inventory, staged within a limited footprint, and moved to the mechanic’s work site along predetermined material paths. Material availability in the right job site at the right time is a key element in the Huntington Ingalls Industries - Newport News Shipbuilding (NNS) drive to reduce CVN construction costs. Unnecessary movement of material, delays due to material unavailability or blocked material paths, or space consumed by unneeded material translated to schedule delays and increased costs.

The project delivered a tool that allowed the material logistic controllers to manage the adjacent lay down areas in an optimal manner. The lay down areas next to the work areas needed to be synchronized with the type of work currently underway with respect to required square footage and location. This project provided an adaptive simulation tool capable of adjusting the material lay down and delivery path to the existing build strategies.

Phase 1 of the project addressed data and information collection and quantitatively defined the problems. Phase 2 developed and tested the simulation tool. The initiative was led by the Material Distribution Department and was supported by planning personnel representing all trades involved in the dry dock construction of CVN 79.

Payoff

The project team delivered the CVN Construction Material Logistical Planning Tool that allows the material logistic controllers to optimize the adjacent lay down areas. The tool illustrates by reports how a specific build (construction or outfitting) strategy will impact material resources, thus allowing NNS management to determine the optimum plan from several potential alternative plans, each having been analyzed using the simulation tool. This technology will reduce lost trade time and CVN acquisition cost by an estimated $3.08M per hull, resulting in a five-year ROI of 3.4:1.

Implementation

NNS developed a prototype simulation-based tool that employs discrete event simulation techniques to create a library-based, re-usable application to optimize material logistic scenarios and to improve the efficiency of CVN construction. The simulation tool permits Ship Construction Production Control to quickly link a proposed build strategy to those material delivery logistics associated with their involved tasks. Implementation started in late 2016 and is still underway.
Using Higher Deposition Submerged Arc Welding Processes to Increase Productivity

S2595 — High Deposition Submerged Arc Welding for FORD-Class Aircraft Carriers

Objective

Compared to the previous class, FORD-Class aircraft carriers are designed with larger quantities of thick and thin plate. These changes in plate thicknesses have negatively impacted fabrication costs by increasing welding hours and distortion, respectively. To achieve CVN 79/80 cost-reduction goals, Huntington Ingalls Industries - Newport News Shipbuilding (NNS) is actively working to improve its welding infrastructure. This project is determining an optimal advanced submerged-arc-welding (SAW) technology/equipment to fabricate the FORD-Class aircraft carrier that increases process productivity and reduces costs. Supporting the NNS welding infrastructure improvement effort, the project is evaluating and recommending advanced commercial off-the-shelf (COTS) SAW technology/equipment and developing recommendations that will allow NNS to acquire new equipment that is capable of higher welding deposition rates for the FORD-Class aircraft carrier.

Phase 1 activities determined the baseline performance of legacy SAW at NNS and developed the technical requirements and productivity criteria for new candidate SAW technologies. Test plans were developed to evaluate identified candidate processes and to determine process robustness for future NNS implementation. Phase 2 will continue to evaluate and quantify the performance of the recommended and selected candidate SAW processes. The candidate process will be subject to additional testing that conducts shipyard evaluations to determine the robustness and technical feasibility of the process in a shipyard (application) environment.

Payoff

The interim business case, which is based on work currently underway, is positive with estimated savings of $1.9M to $2.4M per CVN projected. At the conclusion of the project, NNS will submit a final business case report breaking down the collection of data and the process. The estimated five-year ROI is 0.73 to 0.57:1.

Implementation

Implementation is expected to utilize a phased approach, where the most beneficial opportunities will be assigned higher priority and implemented first. The results of this ManTech project may be implemented in production of CVN hulls as early as the third quarter of FY18. However, the schedule for implementation activities is dependent on the project results.
Implementing 3-D Inspection of Steel Plates Will Save Shipbuilding Costs

S2606 — Efficient Identification of Plate Defects

**Objective**

Visual inspection of large steel plate surfaces to reliably detect critical surface flaws is a challenging task. Identifying defects as early as possible in the construction process has the greatest opportunity for cost savings. The Navy Metalworking Center (NMC) is conducting a project that will develop suitable three-dimensional (3-D) inspection technologies to reliably and repeatedly identify surface defects so they can be corrected to meet surface quality requirements before being fabricated. The Integrated Project Team (IPT) is focused on creating an inspection tool with speed, accuracy, repeatability, and durability for a production plate processing environment.

**Payoff**

By implementing an inspection system at the plate processing line prior to painting, Newport News Shipbuilding (NNS) is expected to reduce inspection and repair costs by $3.5M over a five-year period for the construction of CVN 78 Class Aircraft Carriers.

**Implementation**

The IPT is working with a metrology service provider and a custom laser manufacturer to develop a prototype automated visual inspection system that will be demonstrated in a production environment for expected use on CVN 80. Implementation is planned in January 2018 at Structural Coatings, a subcontractor to NNS, in Cofield, North Carolina.
Acoustical Sensing Provides Safe, Cost Effective, and Early Fault Warning Inspection of Energized Electrical Enclosures

S2643 — Acoustical Sensing through Energized Electrical Enclosures

Objective

An electrical fault diagnostic technology has been identified for energized shipboard electrical equipment and distribution panels. Early detection of electrical faults (e.g., loose connections inside the panels) will allow corrective actions prior to catastrophic failure (i.e., arcing, explosion, fire, etc.). Existing inspection procedures using Infrared Imaging Thermographic cameras require direct line-of-sight of energized components and electrical connections. This inspection technique presents electrical safety hazards to personnel as typical distribution panels operate at voltages of 450 VAC up to 13,800 VAC. Even if the enclosures are opened, obstructions and internal structures may block visual direct line-of-sight inspection of all energized components. A reliable, non-intrusive inspection technology is desired to provide electrical fault sensing of all energized equipment through closed panels. High frequency acoustic inspection technology can provide a means of early electrical fault detection and location, enabling planning of corrective maintenance actions, improved sailor safety, and increased asset availability. The objective of this Navy ManTech project, performed by the Institute for Manufacturing and Sustainment Technologies (iMAST) at the Applied Research Laboratory at The Pennsylvania State University, was to evaluate and establish the feasibility of using high frequency acoustic sensing technology for application to shipboard electrical panel connections monitoring and maintenance. The technology has already been successfully implemented in land-based power systems distribution systems and networks.

Payoff

The new inspection technology allows for easy and frequent inspections that can be performed through closed panels and under operational power loading thus enabling the early detection of electrical faults. This inspection technology allows for proactive planning of corrective maintenance actions. Many electrical faults (loose connections/replaceable components) can be corrected with minor maintenance and minimal mission interruption. Acoustic inspection technology is applicable to all electrical distribution panels on all ship classes. This project is expected to result in an estimated $10M per year cost avoidance.

Implementation

Evaluation of the hand-held acoustic sensing device has been completed on laboratory scale components and shore-based, full-scale switch-gear panels (KEMA Labs.). Follow-on ship-board trials have been performed on numerous electrical distribution components to provide an initial acoustic signature database. Findings will be presented to the Technical Warrant Holder for review; and implementation will be funded through platform maintenance activities. Trial introduction of this new technology is anticipated by late 2017.
Targeting Cost Savings through Improved Metrology Standards

S2662 — Non-Contact Metrology in Shipbuilding

Objective
At Huntington Ingalls Industries - Newport News Shipbuilding (NNS), optimization of the shipbuilding process is not only a focus, it is a requirement. If designing, constructing and providing worldwide fleet support for the VIRGINIA Class Submarine (VCS) program was not enough of an undertaking, NNS is also the sole designer and builder for U.S. Navy aircraft carrier programs as well. To keep up with the high demands of both the VCS and the aircraft carrier programs, NNS is improving the efficiency of traditional practices which provides opportunities for substantial cost reduction of both programs as well. One of the many methods to improve efficiency and reduce cost is by shifting much of the workload to earlier in the construction process. This will allow the construction and fabrication of key components to happen in the shop, where modifications can easily be made, rather than in the difficult work environment onboard the ship. To facilitate this type of workload adjustment, precise measurements are required to ensure that the components fabricated in the shop meet the stringent specifications of the ship. Though the industry has been able to produce high-quality vessels utilizing traditional metrology methods, constantly changing build plans contribute to the need to maintain and utilize top-of-the-line metrology equipment.

This project, led by NNS, identified standards to integrate laser-scanning and projection technologies into product lines and provided Standard Operation Procedures for their utilization. By providing a clearly defined integration process and detailed procedures of how to best apply the emerging technologies, NNS will ensure the efficiency and accuracy of each metrology, and ultimately each construction process. The project was conducted in two phases, with Phase 1 identifying and defining the process requirements, developing an initial pilot of the legacy process for gap identification, and identifying suitable applications for non-contact equipment. Phase 2 developed the various standards used to govern the use and application of various non-contact metrology equipment and tested a final pilot to verify the applicability of those standards.

Payoff
The improved guidance provided by the new standards is anticipated to result in an estimated $691K savings per CVN hull and $233K savings per VCS hull. Additional savings are anticipated by implementing the standards during the construction of the first COLUMBIA Class Submarine in 2019. The estimated five-year ROI is 8.6:1.

Implementation
The project developed standards to govern the use and integration of noncontact metrology technology to the ensure efficiency and accuracy of non-contact metrology evolutions. Initial implementation of the standards occurred during the project’s execution. NNS expects full implementation of the formal standards on CVN 79 during FY18.
Deploying Induction Heating to Straighten Deck andBulkhead Panels to Reduce Re-work

S2664 — Induction Straightening for CVN

**Objective**

Current CVN construction employs flame straightening to straighten deck and bulkhead panels within required tolerances. Although effective, the process is time consuming and allows for variability in application. It requires numerous application zones across the full area of the panel and often necessitates multiple treatments. Phase 1 will determine technical acceptability testing and execute a test plan to develop induction-straightening parameters that do not adversely affect HSLA 65 material properties. The second phase will determine the effectiveness of the developed induction-heating parameters to straighten a representative mock-up of a ship structure.

**Payoff**

If the process is able to achieve a labor-reduction goal of 50 percent, Huntington Ingalls Industries - Newport News Shipbuilding (NNS) projects estimated savings of $7.9M per FORD-Class aircraft carrier (CVN) hull, with an estimated five-year ROI of 2.97:1.

**Implementation**

The transition event in this project is the submission of a formal endorsement from NNS’s CVN 79 Program Office to PMS 379, accompanied by the justifying business case analysis that has concurrence from NNS’s cost and pricing department, and the completion of Phase 2 testing and evaluation activities. Successful completion of the testing and evaluation activities will verify that the process meets the expectations of the project team and stakeholders and is ready for implementation at NNS. Implementation is anticipated the third quarter of FY19.
Improved Affordability and Producibility for EMALS Components.

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

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

The objective of this project is to reduce cost and lead time associated with acquisition of the EMALS armature assembly and is focusing on one high cost component, the Aft Bogey. The estimated Aft Bogey acquisition cost is $215K. At approximately 23 percent of the total armature cost, reducing acquisition cost of the Aft Bogey is a logical starting point to reduce cost of the armature assembly.

Payoff
Applied Research Laboratory (ARL) obtained a quote for $175K for a 4,000 billet of Custom 465 stainless steel — large enough to machine an Aft Bogey. ARL identified a forging house and received quotes for Custom 465 stainless steel forgings of $93K each. This will reduce raw material cost by approximately $80K per Aft Bogey. Starting with a near-net-shape forging that weighs approximately 500 lbs. (vice a 4,000-lb. billet) will also reduce machining costs. Cost reduction of other armature assembly parts will further improve the ROI and contribute to a successful project.

Implementation
Implementation hinges on successful cost reduction of the EMALS Aft Bogey. Implementation requirements are straightforward – material requirements, incoming material inspection requirements, and part acceptance criteria already exist for this component. Potential vendors will adhere to all relevant material and first-part inspection requirements. ARL will work with vendors to ensure the necessary vendor certifications and registrations are in place. The implementation target date is January 2018.
Replacing a Manual Tracking Process with an Electronic System for Staged Shipboard Equipment

M2726 — Geospatial Component Location, Identification and Condition (GeoCLIC)

Objective

The Geospatial Component Location, Identification and Condition (GeoCLIC) will address both Navy and Huntington Ingalls – Newport News Shipbuilding (NNS) needs by replacing the current paper-based manual process with a more efficient electronic location process that saves time and money. Data provided by the system will supplement the existing SAP inventory location information with the necessary level of detail to efficiently identify components. The system’s process improvements will complement existing databases with tracking and status reporting completed in the field using location/identification hardware and software.

Payoff

The ability to work remotely with real-time information and electronic on-demand support information significantly increases efficiency and improves record-keeping accuracy. The projected cost savings are $2.6M over five years per FORD-Class aircraft carrier (CVN) hull and $342K over two years per VIRGINIA Class submarine hull, with an estimated five-year ROI of 5.48:1. Savings are based on developing an infrastructure of GPS / grid location information embedded in RFID tags and readers located throughout the yard that will reduce the search time for components requiring preventive maintenance.

Implementation

NNS will deploy the solution in its target environment after initial acceptance tests are completed and will engage affected individuals/groups/organizations to ensure the solution satisfies documented needs and expectations. The Geospatial Component Location, Identification and Condition (GeoCLIC) technology will be implemented at NNS upon receipt of approval from the Vice Presidents of Engineering and Design and Manufacturing and Supply Chain Management, authorizing the process changes. Implementation is anticipated second quarter FY19.
Industrial Modeling and Simulation Allow Modifications in Current Factory Configuration

S2727 — Advanced Steel Production Facility – Industrial Modeling and Simulation

Objective
The Institute for Manufacturing and Sustainment Technology (iMAST) at the Penn State Applied Research Laboratory (ARL) will develop a stochastic Discrete Event Simulation model of the entire fabrication process for the products created by Newport News Shipbuilding’s (NNS) Steel Production Facility. The model, with included front-end user interface, shall provide a means that will allow NNS to assess alternatives and modifications in the current factory configuration to obtain productivity increases.

NNS is proposing a radical shift in manufacturing of these products in the Advanced Steel Production Facility (ASPF). This model will allow productivity changes to be assessed globally and down to the station-level, which allows departures and variants in productivity to be determined and, by extension, technology gaps to be identified. In follow-on efforts, alternative equipment, process flow configurations, and new manufacturing stations will be “modeled.” Modules representing these stations are to be inserted into this baseline model, creating new models of alternative scenarios. New analytical results will allow analysis of concepts to be conducted and evaluated.

Payoff
While no benefits may be estimated until the actual completion of the ASPF concept, the concept itself may be assessed on a global scale. The following EROM savings (based on ASPF model only) may be obtained:

• Products that are currently removed from the legacy panel line due to weight, depth, or access may be assembled on a new production line. This may include items currently statically built and have a high level of manual operations. Currently this potential is estimated at approximately 400,000 labor-hours per hull. If this can be fabricated using an assembly line method, it is estimated that 40 percent reduction can be achieved (approximately $17.2M savings per CVN).

• Products currently assembled on the panel line are to be assembled, joined, and undergo early outfitting more effectively. This is to include a more completed final product with a goal of completing the majority of hot work either on the line or in the shop. It has been estimated that an increase in productivity can be achieved resulting in approximately 20 percent savings. With 1.8M labor-hours assigned per hull to ASPF for panel line completion, this equates to a savings of 360,000 labor-hours per hull (approximately $38.6M per CVN).

Implementation
Upon completion of this project, and acceptance of the technology and associated business case by the acquisition Program Office (PMS 379), the model and all associated software applications and source code will be transitioned to NNS. The technology will be implemented at NNS through use in follow-on research and development efforts expected to be funded to support the ASPF concept. Post-project technology insertion should be limited to full-scale deployment of piloted technologies / improvements during the project; however, implementation investments are expected to be minimal given NNS’s cost share commitments throughout the model development phase.
## DDG 51 Class Projects

<table>
<thead>
<tr>
<th>Project ID</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2385</td>
<td>Continuous Wave Illuminator Transmitter Upgrade</td>
<td>34</td>
</tr>
<tr>
<td>S2489</td>
<td>SiC High-Efficiency Power Switches Wafer Process Improvement</td>
<td>35</td>
</tr>
<tr>
<td>S2594</td>
<td>Dynamic Change Awareness</td>
<td>36</td>
</tr>
<tr>
<td>S2600</td>
<td>Shipyard Capacity Planning Tools at BIW</td>
<td>37</td>
</tr>
<tr>
<td>S2604</td>
<td>Shape Cutting and Welding Automation</td>
<td>38</td>
</tr>
<tr>
<td>S2612</td>
<td>Automated Manufacturing Cell for Small Repetitive Assemblies</td>
<td>39</td>
</tr>
<tr>
<td>S2626</td>
<td>Test Adapter Efficiency Improvement</td>
<td>40</td>
</tr>
<tr>
<td>S2628</td>
<td>Augmented Visualization for Manual Welding</td>
<td>41</td>
</tr>
<tr>
<td>S2636</td>
<td>Robotic Welding of Complex Structures</td>
<td>42</td>
</tr>
<tr>
<td>S2652</td>
<td>Optimized Lifting and Handling</td>
<td>43</td>
</tr>
<tr>
<td>S2660</td>
<td>Resource Availability</td>
<td>44</td>
</tr>
<tr>
<td>S2667</td>
<td>Enhanced Task Assignment Progressing</td>
<td>45</td>
</tr>
<tr>
<td>S2690</td>
<td>Unit Family Construction Optimization</td>
<td>46</td>
</tr>
<tr>
<td>S2697</td>
<td>HLAW Process Verification and Implementation for Ship Production</td>
<td>47</td>
</tr>
<tr>
<td>S2700</td>
<td>Tactical Information Planning System (TIPS)</td>
<td>48</td>
</tr>
<tr>
<td>S2701</td>
<td>Digital Paint Tools &amp; Process Optimization</td>
<td>49</td>
</tr>
<tr>
<td>R2722</td>
<td>Automated Part Detail Extraction</td>
<td>50</td>
</tr>
</tbody>
</table>
MK-99 CW Illuminator Transmitter Upgrade Meets Navy’s Need for Reliable, Affordable Solid-State Replacement for Tube-Based System

**Objective**

The Radar Transmitter used in the AEGIS MARK 99 Fire Control System operates in conjunction with other components within the system to provide radiated energy for semi-active homing of the assigned missile. The transmitter contains equipment to generate and amplify the stable Continuous Wave (CW) microwave signal to the required output power level. The current design for this transmitter is based on traveling wave tube technology, and has resulted in an unacceptably low mean time between failure which has adversely affected both combat readiness and support costs for the Arleigh Burke (DDG 51) class of AEGIS destroyers.

The objective of this ManTech project is threefold. The first objective is to develop a solid-state transmitter that will provide the Navy with a higher availability, lower cost-of-ownership open architecture MK 99 Illuminator Transmitter that allows upgrades for new technologies and capabilities over the lifetime of a naval program. The second objective is to develop and implement new manufacturing technologies in critical subassemblies to reduce system cost. The third objective is to ensure continued production cost affordability to the Navy.

**Payoff**

Benefits include: (1) Improved Acquisition and Life-Cycle Costs: Analysis of the design associated with this ManTech effort concludes that the backfit-compatible GaN-based MK 99 transmitter upgrade will result in a 50 percent reduction in acquisition cost ($2M target) and greater than 39 times improvement in mean time between critical failure; (2) Reduced Time to Field: Open Architecture accommodates the easy spiral insertion of evolving solid state power amplifier (SSPA) and power supply technology. Open software and hardware architecture supports the rapid technology refresh and increased performance. This supports future cutting-edge commercial-off-the-shelf (COTS) technologies including analog devices, processors, accelerators, etc.; and (3) Reduced Risk and Affordability Assurance: Evaluation of potential alternate COTS devices through simulation of the SSPA will reduce the risk associated with a single source of supply for the GaN-based X-band power amplifier monolithic microwave integrated circuit contained in the SSPA modules and ensure continued production cost affordability to the Navy.

**Implementation**

The ManTech transition event will occur with the successful completion of design verification testing of the engineering design model (EDM) at the Raytheon facility and the delivery of the EDM hardware, software, associated special test equipment and the Technical Data Package. The completion will also demonstrate the operational success of the upgraded CW Illuminator Transmitter. At this point, the decision will be made by IWS-1 to proceed with the separately-funded Qualification Test and Limited Rate Initial Production phases of the program.
Improving the Yield of SiC High-Efficiency Power Switches

S2489 — SiC High-Efficiency Power Switches Wafer Process Improvement

Objective

Navy platforms continue to improve their performance and capabilities by insertion of new technologies, which ultimately require additional energy. High-efficiency power switching devices provide higher energy densities, thereby providing additional power without requiring ever larger footprints. Under this five-year effort, the production yield of 6.5kV and 10kV SiC metal-oxide-semiconductor field-effect transistors (MOSFET) will be increased by transitioning from production on 100mm SiC wafers to 150mm wafers and design optimization. Eight design iterations will be completed under this effort to optimize doping levels and dimensions of critical features of the device. Device yield is expected to improve from 20 percent to greater than 60 percent, and the acceptable amount of power that can be switched is expected to double.

Payoff

There are many current and future Navy platforms that will be able to take advantage of this technology. At the start of this project, switching costs were in the range of $100 per amp. It is expected that costs will be reduced to approximately $20 per amp at the end of this project. Navy personnel are engaged to estimate the number of switching devices the Navy will consume in the near future once this technology is transitioned to a commercial product and to identify platforms that will be first users of this technology.

Implementation

Wolfspeed, a Cree company, has demonstrated the ability to implement its technology into a commercial device by commercializing 1.2kV SiC MOSFETs. Wolfspeed continually performs market research to determine the power needs of both commercial and Department of Defense sectors. Using previous trends in power requirements, Wolfspeed believes the market will require a commercial product in 6-18 months. At that time, Wolfspeed will lock down a design with specific power ratings and begin the transition from prototypes to commercial products.
**Ingalls Pursues a Real-Time Process for Seamless Communication with Dynamic Change Awareness**

**S2594 — Dynamic Change Awareness**

**Objective**

Lack of visibility and knowledge of forthcoming changes to design or planned work increases engineering and planning labor as well as re-work in production. Foremen at Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls) spend hours generating plans, confirming location of materials, and training crew on the scope of the job. However, by the time the work is planned by foremen and ready to begin, engineering or planning may have changed details and impacted the foreman’s plan without his or her knowledge. When changes make it to the shop floor, most often a step in the process is missed and the craftsmen spend more time locating missing materials, removing items already installed, and/or repairing before the change can be executed. Inefficient processes among engineering, planning, and supply chain management cause excessive man-hours which increases the cost of fabricating the DDG class.

The Dynamic Change Awareness project created dashboard views from the Aras Product Lifecycle Management (PLM) and developed a real-time process for seamless communication among the engineering, planning, supply chain management, and production control organizations. The two-phased project established functional process and data traceability requirements, revised the real-time process, created PLM dashboards, piloted the real-time process with dashboards, and developed the implementation plan.

**Payoff**

A real-time process and PLM dashboards reduce duplication of efforts and material ordering errors, which decrease the number of full-time equivalents per DDG by five. The project enables the following capabilities for the organizations: product data change management and change information aggregation; 3D visualization of change data; and collaboration on change development, administration, validation, and approval. This implemented technology reduces the number of hours associated with engineering rework by more than 29,000 hours and the amount of incorrectly ordered materials by 2.5 percent, which equates to cost savings of $2.3M for LHA-8 and more than $3.3M per DDG hull. The estimated five-year ROI of 9.65:1.

**Implementation**

Ingalls began testing processes in Aras Innovator in April 2016 and has been using this PLM in production since September 2016 on the LHA-8 program. Implementation of all PLM attributes will occur on DDG 127 by the fourth quarter of 2018. Each organization has implemented process changes outside of the PLM per the developed future process map across all current hulls. Engineering, planning and supply chain management have been actively using and improving the processes in the PLM production environment.
Capacity Planning Tools Transitioned to BIW

S2600 — Shipyard Capacity Planning Tools at BIW

Objective

Capacity planning is the process of ensuring that production capacity is matched to demand. Capacity planning enables facilities to meet critical delivery schedules. Bath Iron Works (BIW) has legacy production information systems that can be used to facilitate more robust capacity planning analyses. However, the capabilities of these tools are not fully exercised. The tools analysis capabilities are limited due to significant upfront customization of the systems to meet initial implementation requirements. In addition, planners often employ a plethora of “tools” (spreadsheets, databases, etc.) to understand the demands on resources such as labor, machines, fixtures, or space under their control. Therefore, there are increased chances of disparate plans being developed that are not efficiently synchronized to the master production schedule.

The objective of this Navy ManTech Institute for Manufacturing and Sustainment Technologies (iMAST) project was to develop a shipyard-wide capacity planning system that enables the BIW planning organization and construction management personnel to conduct both long-term, shipyard-wide and short-term, shop-level capacity planning for critical shipyard resources in support of their DDG 51 and DDG 1000 shipbuilding programs. Specifically, this project developed a central data system, long-range and shop-level capacity planning tools, and integrated the previously transitioned Spatial Scheduling Tool into the system.

Payoff

The implementation of the capacity planning tools at BIW is expected to result in a reduction of overtime trade-labor hours and a reduction of labor hours for production planning and control personnel. The Capacity Planning System speeds up the time to develop capacity plans enabling rapid mitigation when existing plans require modification. BIW projects the savings for production and planning personnel to be an estimated $921K per hull (5 hulls), resulting in a five-year ROI of 6.36:1.

In addition to the quantitative benefits, qualitative benefits are expected to include improved visibility of potential space conflicts in advance of production, reduced non-value-added product movement, and completion of work in preferred work locations.

Implementation

The Spatial Scheduling, Long-Range, and Shop-Level Capacity Planning tools were transitioned and implemented in production at BIW; where immediate savings in planning development time and improvements in planning fidelity have been anecdotally reported by the planning organization. The final full-scale Capacity Planning System software that was released in spring 2017 included the Shop-Level Capacity Planning Tool, which has been undergoing early implementation testing at BIW.
Improvements in Ship Stiffener Manufacturing to Reduce Shipbuilding Labor Costs

S2604 — Shape Cutting and Welding Automation

Objective

The Navy Metalworking Center (NMC) led a project to improve the stiffener fabrication process for several surface ships. Ship frames are comprised of stiffeners that are manually cut and welded to various shapes, lengths, and geometries, according to the ship design. Workers manually lay out the stiffeners, cut them with oxy-fuel torches, and then fit and weld attachments and protrusions to them. An NMC-led Integrated Project Team (IPT) characterized the current causes of inaccuracies and inconsistent quality of these fabricated stiffeners; developed process improvements; and developed tooling and prototype equipment to improve the stiffener manufacturing process, including improved forming processes to increase part accuracy and consistency.

Payoff

The project's solutions are expected to reduce labor and rework, and increase accuracy and throughput, significantly lowering costs and improving the production schedule for this operation. The automated technologies used to improve stiffener fabrication will be implemented at Ingalls Shipbuilding (Ingalls) and are expected to save $5.4M in labor and material savings during a five-year period across several platforms.

Implementation

The IPT successfully developed and pilot tested a prototype system and tooling for functionality and efficiency at the Ingalls stiffener fabrication area. Implementation of the project results began at Ingalls in support of LHA, LPD, and DDG 51, as well as the Coast Guard’s NSC, in the second quarter of FY17.

PERIOD OF PERFORMANCE:
July 2014 to December 2016

PLATFORM:
DDG 51

CENTER OF EXCELLENCE:
NMC

POINT OF CONTACT:
Mr. Robert E. Akans
(571) 261-9441
akansr@ctc.com

STAKEHOLDER:
PMS 500, PMS 400D

TOTAL MANTECH INVESTMENT:
$1,311,000
Work Cell Principles and Work-Flow Improvements Will Reduce Ingalls’ Shipbuilding Costs

S2612 — Automated Manufacturing Cell for Small Repetitive Assemblies

Objective
The Navy Metalworking Center (NMC) conducted a ManTech project that will improve efficiency at the Ingalls Shipbuilding (Ingalls) Industrial Products Division (IPD) shop which fabricates hundreds of relatively small, high-volume parts per ship, mostly through manual labor at individual stations throughout the facility. The Integrated Project Team (IPT) developed and implemented automated or mechanized technologies supporting a work cell approach that will result in improved efficiencies and reduced shipbuilding costs.

Payoff
The anticipated savings will be realized by a significant reduction in the manual labor to produce these assemblies, along with improved material handling and ergonomics, and the reduced rework associated with implementing mechanized / automated manufacturing technologies that support a work cell approach. Implementation of the project results is estimated to result in a projected five-year savings of $7.2M across all platforms constructed at Ingalls, i.e., DDG 51, LHA, LPD, and NSC.

Implementation
The Integrated Project Team (IPT) assessed the fabrication processes and down-selected part families and target areas for mechanization and / or automation of processes in the Ingalls IPD shop. Using that information, NMC and Ingalls developed several concepts and generated a business case analysis to implement a work cell approach and manufacturing improvements for the selected target areas. Specifically, the IPT developed work cells for robotic welding of padeyes, stair tread, and ladder assemblies. Additionally, the team mechanized manhole fabrication processes by developing a stud welding station that features a mechanical arm and a hole-punching die that places 26 holes at once to increase efficiency and reduce rework. Each of the technologies was functionality tested at NMC and pilot tested at Ingalls to confirm that the potential savings were met to support fully implementing the developed and identified technologies. Implementation of the project results began in the second quarter of FY17. Full implementation is expected in FY18.
Automation of Repetitive Tasks and Flexible Connector Adapter Production

S2626 — Test Adapter Efficiency Improvement

Objective

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

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

Payoff

The overall project is estimated to result in savings in excess of $700K per year at the shipyard. Since DDG 51 hulls are delivered at the approximate rate of one per year, estimated cost savings are also in excess of $700K per hull. Individual task savings come from reductions in test execution time, data transcription and test hookups, and acquisition lead times for adapter connectors; increased flexibility with the capability of producing test adapter connectors on site; and the introduction of new test technology.

Implementation

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

S2628 — Augmented Visualization for Manual Welding

Objective

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

This project will develop and demonstrate a new visualization tool for manual welding, using head-mounted cameras and stereo displays. The newly built devices will be evaluated at the shipyard for improvements in quality, speed, and learning curve, against measured baseline tests from auto-darkening weld helmets.

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

Payoff

Improved visualization in manual welding seeks cost savings from three unique positions: improvement in "arc time" productivity, shortening the learning curve to proficiency, and reduction in rework. If augmented visualization has a 10 percent benefit for just 30 percent of the welders, a single shipyard with 1,000 welding positions could save over $4M annually. The addition of augmented reality to the welding display could someday substantiate even higher savings.

Implementation

The primary transition platform for this project is the DDG 51 Arleigh Burke Class Destroyer. A business case for cost savings will be weighed against the cost of bringing the technology to production at an appropriate annual volume for the market. If shown to be successful, implementation will extend to other Department of Defense and dual-use applications.
Adapting Existing Robotic Welding Systems Will Save Costs to Fabricate Large, Complex Structures

Objective
Traditional manual welding processes used to fabricate large complex ship structures are labor intensive and ergonomically challenging. The Navy Metalworking Center led a ManTech Integrated Project Team (IPT) to develop a system to semi-autonomously define weld paths based on varying complex structure geometries that will then utilize existing welding robots to execute weld operations. The IPT defined weld paths that do not require high-level skill sets and developed a parametric weld program that will automatically program robot manipulation. The IPT demonstrated a prototype system that integrates the necessary hardware and software to semi-autonomously locate the weld seam, position and orient the welding head, and execute a suitable weld.

Payoff
Large-scale implementation of robotic welding at the DDG 1000 peripheral vertical launch system (PVLS) cell is estimated to produce $5.6M savings for the DDG 51 Class at Bath Iron Works (BIW) over five years as a result of labor and material savings and schedule compression.

Implementation
Initial implementation consisted of modifying the DDG 1000 PVLS cell in support of the large-scale demonstration trial conducted on an approved DDG 51 production component. Full-scale implementation will occur once the PVLS cell has been fully incorporated with the required hardware and software and personnel at BIW have been fully trained and approved to use the cell. Full-scale implementation is expected to take place at the DDG 1000 PVLS cell in the Aluminum Shop at BIW in the second quarter of FY18 in production of DDG 120.
Lifting Strategy Improvements with the Optimized Lifting and Handling Project

S2652 — Optimized Lifting and Handling

Objective
The lifting and handling processes, procedures and equipment currently utilized by Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls) evolved to address the specific requirements of each step, without regard for the entire process as a whole. Controlling documentation for each organization is not coordinated, is inconsistently applied, does not clearly delineate roles and responsibilities, and frequently conflicts. As a result, costs have risen sharply as ship complexity and process steps increase.

The Optimized Lifting and Handling project studies the lifting and handling process across all Ingalls organizations and platforms to understand the key cost drivers that need to be addressed to reduce costs. The project is developing organizational and technical solutions that target the cost drivers and preparing a lifting and handling handbook that serves as a decision matrix guide for modifying lifting and handling processes. The handbook provides coordinated guidance and any relevant lessons learned to all involved organizations and establishes methods of lifting and handling units that are optimized for the entire construction and erection process. The handbook will be published digitally and available in the Ingalls Command Media system. The handbook will provide methods and procedures to reduce man hours and material costs by optimizing the lifting and handling of materials in the shipyard, i.e., reduction of the number of moves and maneuvers.

The two-phased project defines the current process and inefficiencies, investigates alternative methods and equipment to address the major cost drivers of the lifting and handling process, develops potential solutions, and develops and prototypes the opportunities deemed promising for implementation. The opportunities are being piloted, the lifting and handling metrics can be tracked, the impact on cost and schedule can be evaluated, and a lifting and handling decision making matrix will be issued and stored in the Command Media system.

Payoff
This implemented technology reduces the cost associated with lifting and handling, which translates into potential five-year cost savings of $454K per DDG hull, $1.04M per LHA, $1.09M per LPD. More specifically, the team expects five-year savings of $5.24M for other platforms built across the Ingalls shipyard, resulting in an overall five-year ROI of 3.01:1.

Implementation
Upon successful completion of the project, Ingalls will update all outstanding process documents and provide training to operations and engineering personnel to accurately utilize and maintain the Command Media files for Lifting and Handling. Ingalls’ quality management system process owners will initiate and approve all changes to the current process documentation, and will subsequently supervise any new training necessary for the process users. Implementation in a production environment is expected in the first quarter of FY18 on DDG 122.
Creation of a Centralized Data Management Tool for Lifting and Handling

**Objective**

During ship construction, it is necessary to move large objects frequently, using varied combinations of heavy lifting resources, such as gantry cranes, forklifts, manlifts, fixtures, and more. These lifting resources also often require personnel and support from other resources in order to operate. Historically, it had been extremely challenging for Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls) to coordinate and manage all of the lifting resources since they operated concurrently in the shipyard. There was no "real-time" situational awareness to locate resources or to evaluate resource performance, which hindered scheduling projections and caused reactive instead of proactive tasking.

The Resource Availability project created an automated management toolset that provides immediate visibility of the location and performance of lifting/transportation resources, thus reducing labor costs through increased process efficiency. The tool streamlined the activities of the Manufacturing Services controller by providing a graphical overview of the shipyard that displayed the locations of each resource as well as pertinent information on the resource.

The two-phased project enhanced the new Ingalls Heavy Lift Team ‘Command Center’ by creating a central data management tool for lifting and transportation activities. The dynamic nature of the tool supports informed decision-making and promotes streamlined forecasting.

**Payoff**

This resource management tool allows controllers to rapidly assess multiple changes from the current lift plan while considering resource availability, largely mitigating the inefficiencies of the old manual analysis method. In addition to situational awareness, the tool analyzes and forecasts lifts, maximizing the efficiency of future lift/transport activities. This implemented technology reduces suboptimal lifts and improves the efficiency of the Manufacturing Services planning process. The project benefits translate into potential cost savings of $849K per DDG-51 hull, $557K per LHA hull, $421K per LPD hull and $113K per NSC hull. This equates to an Ingalls savings of $5.17M over five years.

**Implementation**

The project’s success can be attributed to working directly with the Heavy Lift Team, Capacity Planning, ProModel, and other contributing organizations during the entire process. This collaboration helped define the needs effectively, and using an iterative development approach kept the tool in line with expectations. Implementation has begun and the team envisions full implementation in production by the fourth quarter of 2017 on DDG 123, after successful completion of the internal supportability, failover, and other technical reviews.
Automated Work Assignment and Status Progress Increases Productivity

S2667 — Enhanced Task Assignment and Progressing

Objective

Coordinating the daily tasks of ship construction for thousands of tradecraft personnel is a challenging responsibility for the shipyard foremen. At Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls), the amount of effort required to coordinate, scope, assign, and record completion progress is extremely time-consuming, and currently performed in a manner that alternates between electronic record and paper. A significant portion of an individual foreman’s week is dedicated to just assigning and progressing work. This manual process is time-consuming, limiting the foremen’s availability to their crews in production areas.

The Enhanced Task Assignment and Progressing (eTAP) project developed a tool for supervisors (foremen) that automates and tracks task assignment and progress. This technology streamlines work assignments by presenting a user interface where work bills can be viewed and selected, providing access to the specific bill line items, and displaying the time-to-complete estimate for each line item. The individual task assignments are then printed or transmitted to become part of the craftsman’s normal work package (operations order, drawing, etc.). When the work is performed and a supervisor needs to assess the progress made, the eTAP tool provides a separate screen of in-process bills, where the progress of individual line items can be captured with a simple, fast, one-click interaction. The eTAP tool automatically calculates the completion percentage for each line item of the bill. This composite progress report is then transmitted to update the Enterprise Resource Planning system, providing a detailed, current-state status of the platform under construction.

Payoff

Automation of these processes reduces administrative burdens for the foremen and provides the ability to assign discrete tasks, expedite progress reconciliation, and reduce progress reporting errors. The reduction of administrative effort increases the foremen’s availability to their crews, as well as the accuracy of performance. This translates into potential cost savings of $731K per DDG-51 hull, $2.9M per LHA hull, $1.99M per LPD hull, and $575K per NSC hull. The estimated five-year ROI is 11.75:1.

Implementation

The portion of the eTAP system that is used to capture work package progress is the Progressing Tool (ProTo). The tool was activated in the production environment in April 2017, using actual data generated from a select set of supervisors. Ingalls rapidly expanded the tool’s users. Although initially targeted for use on the DDG-51 Program, Ingalls initiated wide use of eTAP and it is currently managing data for all of the ship classes under construction at Ingalls. The eTAP process is now used largely in place of the legacy manual process of assigning work and progressing for foremen in the shipyard.
Objective
The Navy Metalworking Center led a Navy ManTech Integrated Project Team (IPT) to improve unit assembly, pre-outfitting, and kitting of components within the Ingalls Shipbuilding (Ingalls) unit construction areas. In the Covered Slab Area, units are constructed from panels and bulkheads that are fabricated upstream in process areas such as the Panel Line and Shell Shop. Fit-up and assembly of these units are performed manually and require a significant amount of labor and transportation time. The IPT developed and implemented fixturing and material handling solutions to improve unit assembly efficiencies within the CSA. Technologies developed will support a work cell approach to unit construction by pre-outfitting, resulting in fewer costly unit moves during the module construction process. Specifically, the team investigated modular unit fixturing to improve access and efficient leveling; deployable cranes for efficient material placement; utility line control management to increase access and utilization and to reduce safety concerns; along with laser projection technologies to improve fit-up operations. In addition, upstream and downstream process areas, such as the Outfitting Hall and outdoor unit construction, were evaluated and could benefit from the solutions developed by this project. The down-selected concept(s) were demonstrated at Ingalls on unit assemblies to support full-scale implementation. Additionally, solutions developed as a result of this project will supplement Ingalls’ shipyard modernization plans.

Payoff
Implementation of manufacturing technology solutions to construct unit assemblies is estimated to produce an annual savings of $1.4M across all platforms currently constructed at Ingalls (DDG, LHA, LPD, and NSC) as well as future platforms. The total projected five-year process savings for all hulls is $7.2M.

Implementation
Pilot testing will enable the IPT to validate the expected process savings, which Ingalls will use to support capital expenditure requests for full-scale implementation. Implementation will occur on the first available hull at Ingalls starting in January 2018.
HLAW Increases Productivity and Reduces Distortion

S2697 — H LAW Process Verification and Implementation for Ship Production

Objective

Huntington Ingalls Industries-Ingalls Shipbuilding (Ingalls) is introducing a new panel line to improve productivity in ship manufacturing. A review of joining processes used in commercial shipbuilding worldwide has revealed that Hybrid Laser Arc Welding (HLAW) can reduce the welding heat input used to join metals, minimizing distortion and the cost of rework. The HLAW project is team developing HLAW process parameters and evaluating the resulting weld quality. Ingalls will refine the initial business case based on historical production data and test results. The team will also perform fatigue and dynamic load testing for the HLAW weldments and the currently qualified baseline submerged arc welding process, a similar mechanized welding process. Ingalls will use the developed parameters on the HLAW panel line and will validate weld quality through testing.

Payoff

This technology, once implemented, could potentially save an estimated $1.6M per DDG-51 hull, $1M per NSC hull, $1.7M per LPD hull, and $6M per LHA hull, with an estimated five-year ROI of 6.9:1 for all hulls.

Implementation

The process and system technology that will be developed and refined under this project is expected to be implemented at Ingalls and is directly applicable to other major shipyards supporting the Department of Defense. The project has been structured to provide all of the necessary data and information after project completion to make a clear decision concerning implementation. Ingalls is determined to invest in the latest HLAW technology to address thin panel ship construction issues for hull quality control and production cost efficiency. Implementation is anticipated in the second quarter of FY18.
Ingalls Shipbuilding Works to Streamline Its Methodology for Short-Term Tactical Planning

S2700 — Tactical Information Planning System

**Objective**

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

The Tactical Information Planning System (TIPS) project is developing a digital process that will increase the front-line foreman’s efficiency at Huntington Ingalls Industries – Ingalls Shipbuilding (Ingalls). With its shops in mind, the Ingalls team is developing an improved work package decision-making process to enhance short-term resource planning activities. Ingalls anticipates an additional benefit of increased use and utility of mobility applications at the shop floor and deck plate levels. Mobile work capability is critical to future efficiency improvements in this arena. The project team will accomplish these objectives by consolidating critical information from the systems of record in scheduling, engineering change, material, shop status and capacity, job planning, certifications, and personnel availability. This consolidation enables efficiencies that allow the foremen to manage completion of jobs faster while reducing work stoppages and rework.

The project will help understand the present system, develop a high-level design for a new system, and develop and test the system with a pilot test in the pipe shop.

**Payoff**

Once implemented, Ingalls anticipates that TIPS will provide the status of short-term schedule and engineering changes, job packages, material, personnel, and personnel certification in a more expedited fashion. Ingalls estimates that the labor savings will translate into potential cost savings of $1.28M per DDG 51 hull, with an estimated ROI of 4.41:1.

**Implementation**

The system will be proved and upgraded as needed with a pilot effort. The pilot will enhance the system practicality and measure the improvement in process time. An implementation plan for the system will be developed that targets DDG 125 in the third quarter of FY18. This application will likely achieve cost savings across all platforms manufactured at Ingalls.
Ingalls Using Digital Thread to Optimize Paint Management

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

The Digital Paint Tool and Process Optimization project is analyzing Ingalls’ current paint process and data, and developing an optimized and consolidated method of generating, maintaining, and executing paint data. This system will create a unified data tool to support a new optimized process developed for paint data management, thus reducing labor costs through increased process efficiency and the reduction of rework. The digital paint tool proposes to leverage the new paint data epoch by creating a central data management tool instead of the current multiple federated database method. The dynamic nature of the tool will allow upstream users to quickly modify, query, and have unprecedented ability to work with their data.

The project will analyze, document, and undertake process development tasks to gain a comprehensive understanding of the current paint process and data. In addition, the project will configure, test, and validate the digital paint tool to support the modified process. The focus will be on end-user engagement, especially for testing and validation, to achieve the business goals.

Payoff
Once accepted, the digital paint tool will be distributed to personnel and used to extract details for production use. This effort will reduce the labor hours required to provide instruction artifacts for fabrication, which translates into potential cost savings of $367K per DDG hull, $471K per LHA, $450K per LPD, and $157K per NSC, resulting in a five-year ROI of 2.76:1.

Implementation
The tool will undergo a series of trials to validate that the paint data is captured, worked, and delivered with its integrity preserved. In order to evaluate the tool’s impact on efficiency and quality, metrics will be collected in accordance with the effectiveness evaluation criteria. Upon successful completion and testing and acceptance of the technology by Ingalls management, the results will be implemented third quarter FY18 on DDG 125.

PERIOD OF PERFORMANCE:
January 2017 to July 2018

PLATFORM:
DDG 51

CENTER OF EXCELLENCE:
NSAM

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

STAKEHOLDER:
PMS 400

TOTAL MANTECH INVESTMENT:
$695,000
Objective

Once a digital product model is completed, 2D detail drawings and other construction aids must be extracted. They are used directly for construction and as deliverables. The details are the work instructions for machinists and other craftsmen, and each unique part has its own detail. The detail generation process in ShipConstructor required significant manual “post processing” to develop the format desired by craft and to match the material to the augmented Huntington Ingalls Industries-Ingalls Shipbuilding (Ingalls) current design tool with scripted functionality capable of automating activities necessary for equipment used.

The Automated Part Detail Extraction tool extracting pipe detail drawings. The functionality package streamlined the way designers perform the extraction, drastically reducing the manual effort when assigning labels, arranging, and formatting. The project team previously developed a standard which was the template used by the automated functions to build detail drawings. The functionality developed in this project brought in the historically disconnected DNC data and channeled much of the data in the design tool to significantly expedite the process of formatting, arranging, and validating the detail drawings during extraction.

Payoff

By automating the manual entry, placement, and retrieval of the data element, Ingalls demonstrated a 35-percent reduction in labor hours associated with those tasks. These savings are expected to change as the learning curve (process change adaption) decreases with continued use. This translates into cost savings of $270K per DDG-51 hull, $675K per LHA hull, $900K per LPD hull, and $157K per NSC hull, resulting in an estimated five-year ROI of 82.07:1.

Implementation

The Automated Part Detail Extraction tool successfully passed the functional review conducted by the Ingalls’ IT organization. Implementation of the functionality package was accelerated to have as much direct benefit as possible during detail extraction for the LHA program. The functionality package is now in production use at Ingalls. Although initially targeted for use on the DDG 51 Program, Ingalls initiated wide use of Automated Part Detail Extraction tool, and it is currently being used on all of the ship classes under construction at Ingalls.
LCS Projects

S2558-1-2 — Manufacturing Cost Reduction for LCS Scalable Electronic Warfare (EW) System
Electronic Warfare (EW) Improved Reliability through Open Architecture

S2558-1-2—Manufacturing Cost Reduction for LCS Scalable Electronic Warfare (EW) System Phase 1 and 2

Objective

There is an urgent need for a high-reliability, above-deck power supply for the Surface Electronics Warfare Improvement Program (SEWIP) AN/SLQ-32(V)6. The project includes two objectives: to develop a Common Modular Power Supply (CMPS) and to investigate advanced manufacturing techniques for a common open architecture downconverter.

The current power supply exhibits high failure rates. Taking advantage of advancements in power supply design and manufacturing methods and the trend toward open architecture and commercial-off-the-shelf components, this project will develop an open modular power supply architecture that maximizes the use of readily available commercial components and adapt them for military environments. To achieve very high efficiency (thereby reducing heat and improving reliability), a silicon carbide conversion module is being developed. The architecture provides redundancy along with continuous monitoring of critical performance measures to create a highly reliable, battleshort-capable power supply with low mean time to repair. The open architecture allows any competent power supply vendor to provide modules for the CMPS, increasing competition and a path for technology insertion as the state of the art progresses. A complete Technical Data Package (TDP) will be provided for future production. The downconverters provide an opportunity to reduce cost through commonality of design and improved manufacturing methods. The current downconverters will be characterized, and alternate manufacturing methods will be explored.

Payoff

The CMPS will provide the SEWIP system with reliable power to improve overall availability. Its open architecture will permit improvements in power supply technology to be transitioned without the need to upgrade or replace the basic unit, and will increase competition, thereby lowering acquisition costs. This will lower lifecycle costs and provide significantly improved up time. Being modular, the CMPS can be adapted to other systems that require multiple output voltages. By changing or adapting the input module, various input voltages can be accommodated. Further savings can then be achieved through the commonality of design and shared sparing costs.

The downconverter studies will provide a path for a lower-cost alternate source if the current supplier can no longer provide the downconverters.

Implementation

PEO IWS 2.0 will establish the schedule to implement the results of the EW Expanded Scope project for SLQ-32(V)6 through the Program of Record acquisition change process. The EMPF will provide a prototype CMPS and complete the TDP for evaluation and qualification. A detailed report on the downconverter study will be provided for potential future use.
VCS / CLB Submarines Projects

Q2533 — Composite Manufacturing Technology for Fire Safe Resins ................................................................. 54
S2547 — Improved Cable Lay and Sequencing for VIRGINIA Class and COLUMBIA Class Submarine Programs ........................................... 55
S2559-2 — Fiber Optic Measurement and Shape Sensing Phase 2 ............................................................................................................................... 56
Q2596 — Enabling Technologies for Integrated Manufacturing of Submarine Components .................................... 58
S2601 — Low-Cost Hybrid Fairings .............................................................................................................................................. 59
S2602 — Weld Sequence Planning for Major Assemblies .................................................................................. 60
S2633 — Self-Locating / Self-Fixtured Structures .................................................................................................................. 61
S2634 — Automated Hanger Manufacturing .................................................................................................................. 62
S2649 — VIRGINIA Class Submarine Alternative Coating and Surface Preparation Solutions for Ball Valves ........................................ 63
S2653 — Mobile Computing for Design Build .................................................................................................................. 64
S2655 — Automated Manufacturing of Hull Tiles Phase 1 ................................................................................................. 65
S2676 — Back-fit Composite Flood Grates .................................................................................................................. 66
S2677 — Plug-and-Play Composites .............................................................................................................................................. 67
S2691 — Pipe Cutting Machine Technology .................................................................................................................. 68
Q2711 — Inspection Under SHT Phase 1 .................................................................................................................. 69
S2714 — PSNS&IMF Submarine Factory Simulation and Capacity Planning ............................................................ 70
Development of Fire Safe Resins for Submarine Applications

Q2533 — Composite Manufacturing Technology for Fire Safe Resins Ph 1

Objective

Significant research has been performed to bring the benefits of composite materials to the submarine community, and numerous projects have transitioned to submarines that have reduced acquisition and life-cycle costs, decreased weight, and improved manufacturing lead time. However, until now, these applications have been limited to outside the pressure hull. Components internal to the pressure hull require Fire, Smoke, and Toxicity (FST)-safe material systems. While some existing phenolic systems have been approved for use within the submarine pressure hull, they have been unreliable due to high void content, relatively high manufacturing cost, and complexity.

The objective of phase 1 was to identify materials and develop fabrication processes to manufacture submarine components, and to demonstrate the ability for these materials to meet a FST requirement. This project identified improved manufacturing processes that reduced the phenolic void content and improved the design allowables. Mechanical properties were generated to replace the outdated design information based on the legacy phenolic resin process. This effort also identified affordable, novel, and commercially available materials and approaches to bring composites within the pressure hull.

Payoff

This project identified the processes, methodologies, and materials that can be used to bring composites within the pressure hull. The applications will remove metal components in highly corrosive environments, thereby reducing the life-cycle costs of the submarines. The manufacturing improvements made to phenolic core systems and phenolic laminates can be leveraged to applications industry-wide and provide far-reaching improvements to multiple DoD platforms.

Phase 1 successfully completed the following key activities:

- Identified new FST-safe materials that satisfy the requirements for internal use to the pressure hull.
- Developed a novel integrated breather, manufacturing process that results in low void content and high-performance phenolic laminates.
- Created a mechanical property database for a FST-safe material that can be used for design.
- Demonstrated the manufacturability and affordability of a representative FST-safe article.
- Passed ISO 9705 Room Corner Fire Testing of a fiberglass/phenolic material system, demonstrating that it will satisfy the requirements for internal submarine applications.

Implementation

This project will transition to a follow-on project, Q2533-2 Fire Safe Resins Phase 2, which will fabricate an actual submarine component for insertion in a VCS hull. Phase 2 is anticipated to begin FY18 for initial insertion in late FY18.
Incorporation of 3D CAD Modeling Processes for Submarine Cable Installation

S2547—Improved Cable Lay and Sequencing for VIRGINIA Class and COLUMBIA Class Submarine Programs

Objective

The VIRGINIA Class (VCS) and COLUMBIA Class (CLB) Submarine programs have identified opportunities for significant and recurring savings generated from process improvements to cable installation. The complex and exacting processes of designing, planning, and installing each of the 15,000 to 20,000 cables on a nuclear submarine were challenging and laborious, a prime target for efficiency improvements. For example, typical work orders focus on small compartment size areas while cables can span through multiple compartments or even the entire length of the ship. Due to the modular design of many of the ship’s compartments, numerous cable-installation work orders could not be processed until each compartment was ready, which resulted in warehousing excessive amounts of cable for prolonged periods until the ship construction could support cable installation.

The typical cable installation process proceeds in standard phases: logical design, component physical design, cableway design, cable routing, cable lay, and cable sequencing. This project focused on optimizing the final two phases of the typical cable installation process by re-engineering the cable lay and sequencing methods. The re-engineered processes will assist planners in the selection of smaller work packages, resulting in savings in material ordering, warehousing of cable, associated footprint reductions in outfitting areas, and more timely installation of cables in modules and on board the ship.

Payoff

The tool is being implemented at General Dynamics Electric Boat (GDEB), and once fully implemented GDEB anticipates this effort will provide the best method to reduce the cost of cable lay and cable sequencing by 10 percent. The combined improvements to material ordering, cable warehousing, clutter reduction, and installation scheduling contribute to potential savings of $2.7M per CLB hull and $274K per VCS hull, resulting in a five-year ROI of 9.33:1.

Implementation

GDEB created and is currently deploying a cable lay and sequencing tool that allows electrical designers to create 3D computer-aided design (CAD) models of designated cable lays for particular cables across their routes. Once fully implemented, this will verify that designated Electro-Magnetic Interference rules have been strictly followed. Secondly, the tool provides the capability to sequence cable installation based on the status of the ship. It typically begins in the early stage of design where functionally related equipment, systems, tanks, etc. are located to reduce the distributed system footage and to maximize the standardization potential. The new tool is being implemented on the lead ship for VCS Block V (VIRGINIA Payload Module [VPM], SSN 802) and the lead ship for the CLB construction program.
Novel Non-Line-of-Sight Dimensional Metrology for Shipbuilder Applications: Fiber Optic Measurement and Shape Sensing

**Objective**

Fiber Optic Measurement and Shape-Sensing (FOMSS) technology provides accurate, real-time 3D position registration with a single free-moving cable attached to a single reference point. This flexible, non-line-of-sight cable is easy to deploy and use and is particularly effective in cramped/confined, close-range layout and verification applications. This project provided a user-friendly, adaptable, and ruggedized measurement tool that relieves the man-hour investment in set-up, rework, and downtime associated with dimensional control applications. The FOMSS system demonstrated the ability to locate points in 3D space with an accuracy of 0.06” (RMS), facilitating implementation for shipbuilder applications requiring a 2-sigma accuracy of 1/8”. The result is a robust, field-portable, highly accurate measurement system, which provides improved performance and substantial cost savings with applicability to a variety of Department of Defense (DOD) manufacturing processes and operational conditions.

**Payoff**

As it currently stands, the FOMSS beta unit, matured throughout this project, can be tied into ship’s coordinates and accurately determine point location in 3D-space in real time. The cost avoidance for VIRGINIA Class submarine (VCS) and CVN applications was estimated at $650K–$1.15M per VCS hull and approximately $400K per CVN hull. Huntington Ingalls Industries - Newport News Shipbuilding (NNS) determined that FOMSS repeatability must be of a certain value to be useful for its identified applications. Feedback from DMC 2015 and ShipTech 2016 suggested there were other potential shipbuilder applications that could benefit from this tool with its current performance. The Penn State Electro-Optics Center (EOC), in conjunction with Luna, investigated additional transition opportunities for the FOMSS system. This included FOMSS improvements for demonstration purposes as well as site visits to determine if the FOMSS system could benefit existing DoD production scenarios.

**Implementation**

This project refurbished, upgraded, ruggedized, and optimized the prototype FOMSS system developed under a previous ManTech project. The system was piloted at NNS to characterize the utility in VCS and CVN manufacturing applications. NNS verified FOMSS accuracy and repeatability values through numerous manufacturing scenarios that represented “in-field” applications. The repeatability of the FOMSS beta unit was equivalent to its accuracy. NNS determined that repeatability was an issue with better performance needed for practical shipbuilder utility for the identified applications, and, therefore, the FOMSS system was not implemented during this phase of the project. With its current accuracy and repeatability, the system could be used by NNS on applications with tolerances around 1.000” or greater. One potential application that fits this criterion involves stud gun integration for both CVN and VCS. NNS remains very interested in the technology, will implement the system provided it can meet the identified requirements, and will develop an implementation plan at that time. Luna developed a white paper that addressed additional system improvements.
Providing Accurate Information Regarding the Use and Availability of Critical Resources for Planning

Objective

A tool is needed to monitor and forecast the use of critical construction resources (e.g., support/transportation equipment) at General Dynamics Electric Boat (GDEB). The focus of this project is to develop a software-based tool that is capable of providing accurate information to Planning regarding the use and availability of critical resources at GDEB and its partners. The tool will be capable of providing statistical data to Planning regarding the downstream effects of schedule changes, added work, or changes in a manufacturing assembly plan. The data generated within the tool can then be used to estimate the total cost of a planned/unplanned change event or evaluate the total cost of a proposed plan. The tool will track information beyond the capabilities of current spatial and capacity planning tools and ensure that sufficient quantities of each critical resource exist at all phases of construction.

Phase 1 investigated and included a thorough requirements gathering from potential end users and GDEB management, development of recommendations and the design of a prototype critical resource planning tool graphical user interface, and the inventory and prioritization of all Electric Boat critical resources. Phase 2 focuses on the development or extension of the data table to feed the critical resource planning tool, the development of a prototype graphical user interface that processes planning data and incorporates requirements as defined in Phase 1, and the development of specific use cases to be tested with initial deployments of the critical resource planning software. A thorough testing procedure will be developed and executed. After verifying full functionality of the critical resource planning software, the project team will demonstrate the tool to GDEB stakeholders as well as project sponsors.

Payoff

This technology could potentially save an estimated $478K per VIRGINIA Class submarine (VCS) hull and estimated cost avoidance not less than $1.808M for the COLUMBIA Class resulting in an estimated five-year ROI of 2.56:1.

Implementation

Implementation is expected to utilize a phased approach, where the most beneficial opportunities will be assigned higher priority and implemented first. The results of this ManTech project may be implemented in production of VCS hulls as early as 2Q FY18. However, the schedule for implementation activities is dependent on project results.

This project is a joint COE effort between Naval Shipbuilding and Advanced Manufacturing (NSAM) Center and Institute for Manufacturing and Sustainment Technologies (iMAST).
Development of Enabling Composites Technology for Submarine Applications

Q2596 — Enabling Technologies for Integrated Manufacturing of Submarine Components

Objective

Like other programs in the Department of Defense, submarine programs face substantial financial challenges due to the current fiscal environment. New classes of submarine are additionally challenged because of the considerable procurement cost for the lead ship and target costs for future ships in the class. Reaching the target procurement costs for future ships is only attainable through cost-effective designs that save money over the entire life of the submarine and manufacturing approaches that reduce acquisition costs. The objective of this project is to develop and validate innovative composite material manufacturing approaches, and their associated cost and weight impacts, for submarine applications. The project used a systems-engineering approach to determine groups of components with similar requirements that can be mapped to enabling technologies and/or combinations of technologies. Enabling technologies and manufacturing approaches considered under this effort include: out-of-autoclave (OOA) processing to enable efficient use of carbon fiber; multi-material (glass/carbon hybrid) solutions for cost and weight reduction; and integrated manufacturing of laminates with structural damping treatments and integrated manufacturing of laminates with polymer coatings. This year’s efforts focused on developing alternative repair procedures and methodologies for in-service and future submarine hybrid composites.

Payoff

Historically, significant cost and weight savings have been achieved for naval platforms by replacing conventional metallic and/or traditional glass reinforced plastic (GRP) components with state-of-the-art composite structures. While innovative composite materials, and the integrated manufacturing opportunities that they afford, offer cost and weight reduction, a platform-wide analysis of the systems and components that can benefit from these technologies is required to define the technology (or combination of technologies) that result in the largest payoff. Understanding the technical and cost relationships between innovative composites and the spectrum of components that they can improve offers alternative design and manufacturing approaches for groups (families) of components currently manufactured using GRP or steel on a broader level. This approach affords a comprehensive impact to cost- and weight-reduction initiatives compared to historical single component analysis. The deliverables developed provide valuable data that can be used by both the government and defense contractors to perform design trades and component pricing estimates.

Implementation

The techniques and processes developed in this project were leveraged to composites currently on the submarine and to future efforts. This project demonstrated a production-ready composite article that could transition at the end of this effort. Initial implementation of these technologies is planned to occur with insertion of an access hatch in FY18.
**Objective**

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

**Payoff**

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

**Implementation**

A Low-Cost Hybrid Fairing (LCHF) ManTech Project Go/No-Go and Review meeting was held in May 2017, which resolved stakeholder concerns from a number of disciplines. Notably, the preliminary assessments for shock indicated acceptable results for the LCHF and substructure. However, the meeting revealed additional design concerns related to ensuring alignment of the safety track, isolation of the carbon from cathodic protection, and performance technical readiness level of the hybrid material. Testing and design activities are scheduled through September of 2017 to resolve or mitigate these remaining concerns. Demonstration articles of the hybrid materials are being built and tested to resolve or reduce concerns with the performance of hybrid materials. Current complementary efforts include compiling the estimate of hours needed to support insertion if selected by the VPM Program. After successful completion of the project, technology will be available for incorporation into the design of the VCS VPM. The project results will also facilitate consideration for similar technology insertion into COLUMBIA Class components and structures of comparable design/function. The implementation targets are SSN 803 and following ships with anticipated implementation to occur FY20.
User-Friendly Weld Sequencing Tool to Save Labor Costs and Improve Schedule for Navy Submarines

**Objective**

Weld-induced distortion on major ship assemblies creates a significant manufacturing challenge and affects both cost and schedule. This Navy Metalworking Center project developed a user-friendly weld sequence-planning tool that allows the shipbuilder to quickly determine the optimal weld sequence and best practices to improve acquisition affordability for VIRGINIA Class submarine (VCS) and COLUMBIA Class submarine (CLB) platforms. Typically, weld-induced distortion on major VCS assemblies, such as foundation tanks, is addressed by trial and error and the application of trade experience during the fabrication process. This methodology results in substantial labor hours, rework, and a lack of repeatability hull to hull. This project enhanced a commercially available software tool so that it can quickly and easily help develop weld sequence build plans for tank structures. The Weld Sequence Planning (WSP) Tool (available for purchase from the ESI Group) uses a CAD-neutral approach for geometry and associated joint data; reduces time to set-up, run, and obtain results by over five times the baseline analysis; and allows for optimization of weld sequencing and clamping considerations. It can be used by manufacturing planners to provide best practice fixture and weld sequence recommendations to the shop floor to minimize distortion and obtain critical structure tolerances with reduced rework.

**Payoff**

General Dynamics Electric Boat (GDEB) estimates a $3.87M cost savings over five years for VCS and $580K per CLB hull through reduced trial-and-error weld sequencing, mitigation of weld-induced distortion in the final product, and improved throughput. This solution also has the potential to impact all platforms that experience weld distortion (CVN, LHA, DDG, LPD, etc.), which could result in significant long-term cost savings.

**Implementation**

The Integrated Project Team (IPT) evaluated multiple commercialization partners to develop an enhanced weld sequence-planning tool. The IPT selected ESI Group as the weld sequence planning tool developer based on development proposals and sample results. The final tool was validated on a common major VCS/CLB assembly at GDEB. The tool is expected to be implemented at GDEB on SSN 796 starting in the first quarter of FY18.
New Manufacturing Process to Simplify Design and Construction of Complex Submarine Deck Structures

S2633 — Self-Locating / Self-Fixtured Structure

Objective

This Navy Metalworking Center (NMC) project developed an innovative manufacturing process for a new concept of fitting and joining deck structures for the COLUMBIA Class Submarine (CLB) and the VIRGINIA Payload Module (VPM). Deck structures on submarines are typically constructed of many short, fitted pieces (intercostals) between continuous beams. Enabled by a new shape-cutting capability, the self-locating, self-fixtured (SLSF) method utilizes construction with notched beams that interlock and are continuous in both directions. The project investigated cutting, weld joint methods, fixturing, and temporary bracing requirements both with finite element analysis and trial fabrications and determined the most efficient means of building these structures with the minimum amount of distortion and shrinkage. While the construction method is relevant to many platforms, including surface ships, CLB and VPM were of particular interest for this technology.

Payoff

Numerous benefits will be derived by implementing the SLSF construction method, including reduced part count, simplified fit-up and inspection, a lowered skill set required for fit-up, and less labor and duration required for setup and fabrication. Analysis of trial structures completed at NMC and at General Dynamics Electric Boat (GDEB) confirmed that post-weld distortion remediation, which is common under the baseline construction process, should be nearly eliminated under SLSF construction. Elimination of overall part shrinkage also will facilitate direct part layout on deck plating prior to deck construction, which will benefit all trades in construction of the ship. GDEB estimates that $2.19M can be saved on the first CLB hull, and $107K on each of the eight VPM sections in the first five years following completion of the project, for a total five-year benefit of $5.24M. The life of program savings are $27.7M based on 12 CLB hulls and 16 VPM sections.

Implementation

SLSF design has been incorporated in the design of the lead ship (SSBN 826) of the COLUMBIA Class on 16 deck sections, and 26 decks on the follow-on ships. Additional implementation on follow-on ships is under consideration. Both decks of the VPM are designed to utilize SLSF construction. Construction on both platforms is expected to commence in FY19.
Applying Work Cell Principles will Reduce the Cost to Manufacture Thousands of Hangers on Navy Submarines

S2634 – Automated Hanger Manufacturing

Objective

Shipboard systems use several thousand hangers to install and route pipe, ventilation, and electrical cable throughout the ship. The Navy Metalworking Center conducted a Navy ManTech project that will streamline the production of hangers used in the construction of submarines at General Dynamics Electric Boat (GDEB). Manufacturing processes currently used at the GDEB hanger shop rely heavily on manual operation in a congested work environment. The Integrated Project Team (IPT) developed and implemented automated or mechanized technologies that support a work cell approach, which will improve efficiencies and add throughput within the hanger shop. Implementation of the project results will directly impact construction of the VIRGINIA Class submarine (VCS) and COLUMBIA Class submarine (CLB).

Payoff

Implementation of mechanized or automated processes to manufacture shipboard hanger assemblies is anticipated to save $730K per VCS hull and $1.2M per CLB hull. The savings estimate is derived from an anticipated cost reduction to manufacture 20,000 hangers per VCS hull and 30,000 hangers per CLB hull. The savings will be realized through a reduction in rework and material handling as well as an increase in throughput, resulting in a potential five-year savings of $9.7M. The savings realized through the project results allow for additional hanger throughput required for CLB construction.

Implementation

The IPT assessed the fabrication processes and down-selected part families and target areas for mechanization and/or automation of GDEB hanger shop processes. NMC and GDEB then developed several concepts and generated a business case analysis to implement a work cell approach and manufacturing improvements for the selected target areas. Specifically, the IPT developed an improved shop layout featuring dedicated work cells using ergonomic technologies and optimized flow. The IPT improved the hanger clamp production process by implementing a horizontal press primarily for hanger clamp forming. The IPT also investigated robotic welding of standard hanger configurations to automate the welding process. NMC developed several flexible fixtures to fit, tack, and weld hangers that accommodate the varying configurations of each weldment. Additionally, the team developed and implemented a hanger stud welding station that features a mechanical arm and a hydraulic lift table that provides an improved, more accurate stud installation process. The technologies were tested at NMC and are being pilot tested at GDEB. The project results will be implemented at GDEB in support of the VCS and CLB platforms, beginning in the first quarter of FY18.
Alternative Coating and Surface Preparation Solutions for Teflon®-Coated Ball Valves

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

Objective

Currently, green Teflon® coatings are used as a solid film lubricant to reduce the operating torque of the ball in the valve assemblies. The coating on the air-system ball valves (ASBV) peels and wears after a low number of cycles (new production testing), potentially causing an increase in seal wear and operating torque. Teflon® peeling in ball valves has increased inspection rejections, which increases re-work costs.

The project is identifying, testing / evaluating, and implementing potential alternative coating systems, coating deposition processes, and / or surface modification processes that improve the performance and extend the life cycle of ASBV. The project will identify the root cause failure mechanism. This will assist in identifying coating properties / surface modifications that meet the minimum performance requirements. The coated ASBV/seating material interaction will also be evaluated as a system. Currently, four potential solution sets exist: improvements in the Teflon® coating manufacturing process, improved seat/ball materials, superfinishing, and advanced coating materials.

Payoff

There is almost a 100 percent rejection rate of the Teflon®-coated ball valves (size dependent) during acquisition. An improved coating system will eliminate the need to rework the ASBV and save approximately 50 percent of the total acquisition cost. Material savings of $100K per ship and planning and engineering savings of $334K per ship are anticipated for a total acquisition savings of $434K per ship. Over five years, at two ships per year, this correlates to $4,340K in savings, which gives a ROI of approximately 3.85:1. There is a potential acquisition savings of $755K per VIRGINIA Payload Module and $2,127K per COLUMBIA Class ship due to the increased number of ASBV assemblies. Reduced life-cycle costs are anticipated that will benefit other submarine and ships classes.

Implementation

This project will be implemented in late FY 2019 on new construction VIRGINIA Class submarines and existing hulls on an attrition basis. Electric Boat and NAVSEA are committed to this project as a means to reduce acquisition costs and total ownership costs for the VIRGINIA and COLUMBIA Class submarines. The project’s results will significantly reduce source inspection rejections and unplanned maintenance. Implementation will be accomplished through drawing changes and will require successful coating or surface modification development by iMAST to be qualified and certified by NAVSEA technical authorities.
Mobile Computing Design-Build Process Will Create Lean Tablet-Based Work Packages

S2653 — Mobile Computing for Design Build

Objective

VIRGINIA Class Submarine (VCS) Program’s legacy work instructions come with traditional engineering drawings that contain much more information than is needed for any particular task. One of the principal savings from this project will be the lean paperless work package with graphics geared only to the work at hand. Conversion of the legacy VCS design data will allow for the creation of Build Authority (BA) views and models. BA models will provide graphical views that represent build (as opposed to design) geometry.

The project creates a lean paperless work package from the legacy VCS product model. The project will create tools and processes to enhance GDEB’s lean work package, structural fabrication, and outfitting system. These tools and processes, will support shift- level work instructions, delivered on a tablet in PDF form (including PDF + 3D JT), for the GDEB Quonset Point facility using legacy VCS data. The Mobile Computing project will focus primarily on work instructions for structural fabrication. However, the project results are applicable to other disciplines.

The two-phased project defines the requirements for a lean paperless work package and the associated BA data and models needed, develops a Build Plan Editor, and integrates the data and models with the NX delivery work instruction. This integration is followed by the development of a prototype lean paperless work package. The project will conclude with a tool demonstration to all stakeholders.

Payoff

This implemented technology will provide a 2.5 percent improvement of 30 percent of the employees / trades personnel at their daily activities. These savings would be distributed across multiple functional areas such as operations, planning and through automated processes with an estimated cost savings of $367K per VCS hull, resulting in an estimated five-year ROI of 2.44:1.

Implementation

Management buy-in is the first stage to integrate the Build Plan Editor into the production environment. Demonstration of the utility and cost-saving features of the tool to upper-level management will be necessary to obtain approval for the use of company assets in deploying the Build Plan Editor. Following that, coordination with GDEB IT technicians will enable the transition from test software to select deployment across the company’s computer network. The IT Department will handle distribution as well as data integration with other GDEB data sources such as the Artemis Project Management and Team Center Product Life Cycle Management systems. Expected implementation in a production environment is the third quarter of FY18 on SSN 798.
Development Hull Tile Manufacturing Improvements and Automated Preparation to Save Time and Cost

S2655 -1 - Automated Manufacturing of Hull Tiles Phase 1

Objective
The objective of this effort was to investigate and develop an improved manufacturing technique for large and/or complexly configured tiles through a combination of catalysis and automation, thus reducing the cycle time and improving the manufacturing rate and response time to tile design and formulation changes. The effort focused on development of a catalyzed casting process reducing labor, need for ovens, and other equipment. Catalyzed casting is a prerequisite for any potential future automation of this process. Additionally, automation of other shipyard applications, such as blasting, painting, and abrading outer hull surfaces, is being evaluated. This effort is applicable to Block V, back-fit on VIRGINIA Class submarines (VCS), and potentially Columbia Class submarines (CLB).

Payoff
The primary benefit of this project is the ability to reduce the manufacturing time and labor associated with large and/or complexly configured tiles using existing treatment material formulations. This project is expected to result in a catalyzed casting technique for the large and/or complexly shaped tiles. This would result in a reduction of time/man hours required to manufacture the tiles as well as the removal of the cost of a large oven to cure the tiles at elevated temperature. The catalysis process would reduce the time required to manufacture a set of tiles and would increase the size of each tile set, as the number of tiles manufactured in the set would no longer be dependent on the oven size. This could reduce the tile cycle time from 4 days to as short as 2 days.

Implementation
The implementation of this effort will occur in an updated manufacturing process for hull tiles and upon qualification will be implemented in future builds starting in 2018.
M2676 — Back-fit Composite Flood Grates

Objective

The existing steel sail flood grates for Block I through III VIRGINIA Class submarines (VCS) incorporate perforated steel plates with coated vulcanized rubber. While the service life of VCS is relatively early, available maintenance data to date has shown that the baseline flood grates are corroding to an extent that requires reapplication of the rubber. Original application of the vulcanized rubber adds to the acquisition cost, and reapplication during maintenance periods adds to life-cycle costs. Furthermore, de-bonding of the coating can cause performance and drainage issues. This ManTech project developed and manufactured affordable composite flood grate replacements that meet all requirements and have lower life-cycle maintenance costs for VCS Block I-III submarines.

The project demonstrated that one fabrication tool and one machining fixture can be used to obtain eight unique geometries. These include seven 27-hole grates and one 23-hole grate that also account for various design changes between the Block I-III hulls.

Payoff

Composite flood grates will reduce the amount of maintenance required per scheduled maintenance interval and decrease the periodicity of maintenance over the life of the ship. Acquisition savings are also expected if new sail flood grates are required because of failed inspections during shipyard availabilities.

This ManTech project has provided an approximate 40 percent weight reduction (234 lbs.) over the steel baseline, which may result in improved ship stability. The acquisition cost of composite flood grates is expected to be cost neutral or less expensive than the steel variants. A savings of approximately $223K per ship is estimated from reduced life-cycle maintenance by replacing the existing steel/rubber flood grates with composite versions. Assuming implementation on all Block I through III VCS, a total savings of $3.1M is possible.

Implementation

The project has developed manufacturing processes and drawings to prepare GRP flood grates for installation activities. The project team collected preliminary engineering assessments which show the 27-hole flood grates, accounting for seven of eight of a shipset of flood grates, meet all requirements and are acceptable for insertion. Preparations are underway for initial implementation of the seven 27-hole flood grates on a Block I VCS during an upcoming maintenance availability. Implementation of the 23-hole configuration is under consideration pending possible additional design refinement and testing.
Development of Multi-Functional “Plug-and-Play” Composites for Submarine Applications

S2677 – Plug-and-Play Composites

Objective
Components exterior to a submarine hull often require significant man-hours to apply supplemental, non-structural materials in order to meet a multitude of requirements. In many cases, several different materials are required to meet this need. The project will develop and successfully demonstrate that a multi-functional “plug-and-play” composite part (a single part with all functional attributes of the original multi-material system) can arrive ready for shipboard installation from the vendor. Many existing composite applications currently require supplemental/transitional coating applications, which could be eliminated or facilitated by the development of the proposed technology. In addition, potential applications could be more attractive because of improved business cases.

Payoff
Successfully designed and manufactured plug-and-play composite components are anticipated to offer both acquisition and life-cycle benefits. The principal benefit from the acquisition side involves the reduction of labor associated with installing supplemental materials to structural components post-fabrication. In addition to lower labor costs, the reduction of schedule time associated with installation will also be realized by the shipyard receiving a component from the vendor ready for installation.

Additional benefits are expected from reduced life-cycle maintenance. Savings will be realized from reduced repair and replacement of the supplemental materials due to damage and loss during normal operations over the life of the submarine. Replacement of steel components with plug-and-play composite versions is also expected as a result of this project and will reduce life-cycle costs through the avoidance of corrosion.

Combined acquisition and life-cycle savings are estimated to be approximately $63.8M combined across 30 VIRGINIA Class and 12 COLUMBIA Class submarines.

Implementation
Numerous applications are being investigated for implementation of this technology. Applications could include, but are not limited to, non-pressure hull access covers/hatches, control surfaces and external fairings.
Objective

The Navy Metalworking Center (NMC) led a Navy ManTech project with Newport News Shipbuilding (NNS) and Ingalls Shipbuilding (Ingalls) to develop an improved onboard pipe cutting and beveling process that will result in reduced labor requirements and safer working conditions. NNS and Ingalls are currently using large, heavy, portable equipment not suited for the confined working conditions onboard Navy vessels and handheld cutting/beveling tools for large, thick-walled piping (3-inch diameter or greater, schedule 40 or 80). Both of these methods place a physical burden and/or ergonomic strain that could result in worker injuries and down time. Additionally, these operations require non-value-added labor and/or inefficient operational conditions, resulting in increased construction costs and outfitting schedule. The NMC-led Integrated Project Team identified and developed improved equipment/tooling to facilitate efficient onboard pipe end preparations. Prototype tools and fixtures were developed and evaluated in a simulated mock-up, and the most promising solutions were optimized for demonstration and implementation in the shipyard. Additionally, a final design package was created and business case analyses were performed to support Ingalls’ and NNS’ capital expenditure requests.

Payoff

The total projected five-year savings are $3.5M as a result of reduced labor for all hulls affected at both shipyards.

Implementation

Multiple fully functioning prototypes were transitioned to NNS and Ingalls to begin initial implementation. Additionally, using the final design package, associated vendor quotes, and shipyard capital funding, orders will be issued for multiple systems. Once obtained, these will be inserted into the work schedule on the first available ship classes. Implementation of the project results is expected on VCS and CVN new construction as well as CVN Refueling and Complex Overhaul at NNS; and on DDG 51, LHA, LPD, and NSC new construction at Ingalls in the first quarter of FY18.
Improved Inspection Techniques for Submarine Pressure Hulls will Save Construction Costs

Q2711 - Inspection Under SHT Phase 1

Objective
The Navy Metalworking Center (NMC) is conducting a Navy ManTech project that will reduce the cost of the periodic inspection of submarine pressure hulls. The current processes, including visual and ultrasonic inspection, require the removal of significant amounts of special hull treatment (SHT) to access the hull structure underneath, followed by reinstallation of SHT after the inspection. SHT removal, inspection and reinstallation are on the critical path for the schedule of a submarine availability. Technologies that can inspect directly through SHT, or minimize the amount of SHT that needs to be removed, will significantly reduce the cost of hull inspection. Technologies of significant interest include the use of ultra-wide band radar, phased array ultrasonic with reduced contact area, and terahertz imaging. In Phase I of this project, NMC is evaluating the feasibility of these advanced inspection technologies for use in this application. Should one or more of these technologies prove to be feasible, their use could reduce the burden of SHT removal and reinstallation as well as the cost of the overall process.

Payoff
Reducing the amount of SHT that must be removed and reinstalled to accommodate hull integrity inspection during availability of the VIRGINIA Class submarine has the opportunity to reduce cost by as much as $1.2M per hull per inspection cycle, or $6M over a five-year period.

Implementation
Phase 2 of this project will develop a prototype system to demonstrate / validate the technology. Successful project results will be transitioned to NAVSEA 05U7 for implementation at the Navy shipyards, including Norfolk Naval Shipyard, Pearl Harbor Naval Shipyard & Intermediate Maintenance Facility, Portsmouth Naval Shipyard, and Puget Sound Naval Shipyard & Intermediate Maintenance Facility.
Computer Simulation Improves Workload Planning in the Submarine Factory at Puget Sound Naval Shipyard

S2714 – PSNS&IMF Submarine Factory Simulation and Capacity Planning

Objective

The Submarine Factory at Puget Sound Naval Shipyard (PSNS) is responsible for operating the Navy’s Inactivation, Reactor Compartment Disposal, Recycle (IRR) Program on SSN 688 class submarines. Because of resource constraints and inefficiencies in the current workload planning process, the Submarine Factory has had trouble managing the workload of 688 class submarines that have come into the shipyard for IRR. PSNS has limited space available to store submarines that are waiting in the queue for IRR. At the current submarine arrival rate and IRR processing rate, the shipyard will reach its storage limit of 30 submarines by the year 2030. Managing the allocation of manpower is also a problem in the Submarine Factory. Resources are sometimes reassigned to higher priority work at the shipyard, causing disruptions to the Submarine Factory’s schedule and making it necessary to replan and reschedule. Scheduled work cannot be completed on time if the resources that were allocated to the work become unavailable. The shipyard would like to make targeted investments in planning resources and processes to mitigate these disruptions, but do not have a good tool for identifying the most cost-effective investments and changes.

This project will develop a simulation-based capacity planning system to improve the PSNS Submarine Factory’s ability to schedule its IRR workload and to allocate resources while minimizing costs. The capacity planning interface will have an underlying simulation model that accurately and statistically represents the tasks and resources that comprise the Submarine Factory’s IRR process. The capacity planning system will be integrated with the simulation model so that shipyard personnel can effectively use it without modeling experience.

Payoff

The system is expected to improve the utilization of resources and increase the throughput of dismantled / recycled submarines. PSNS expects a savings of $3.9M per submarine resulting from a 15 percent decrease in the total cost to dismantle and recycle a submarine. With an expected workload of two submarines per year, the savings over five years (10 submarines) would be $39M. The return on investment for the project over the five-year period would be 64:1.

Implementation

The simulation-based capacity planning system will be implemented in the Submarine Factory at Puget Sound Naval Shipyard in April 2018. At that time the capacity planning system, along with its integrated simulation model, will be handed off to PSNS personnel for use at the shipyard. PSNS will also take over responsibility for maintenance of the software and updates to the model. Applied Research Laboratory Penn State / iMAST will provide training and user documentation to PSNS personnel at the time the software transitions to PSNS ownership.
Joint Strike Fighter Projects

A2513 — F-35 Automated and Rapid Boot Installation Phase 1 ............................................................ 72
A2583 — Smart Processing Manufacturing Technology ........................................................................ 73
A2609 — Primer Thickness Measurement for Seam Validation & Supply Base Quality .................. 74
A2620 — Optical Evaluation of Sapphire Panels ................................................................................ 75
J2622 — Advanced Electro-Optical Targeting System (AEOTS) Producibility Improvements .......... 76
A2623 — Nodule Defect Mitigation in Wafer Processing / EODAS Nodule Defect Reduction .......... 77
A2624 — F35-EOTS Producibility Phase 2 .......................................................................................... 78
A2632 — Automated Turbine Airfoil Trailing Edge Rounding ............................................................. 79
A2644 — Powder Metal Advanced Grinding ....................................................................................... 80
A2656 — F-35 Assembly Metadata Integration .................................................................................... 81
A2657 — Plasma Surface Preparation for Composite Nutplate Installation ........................................ 82
Q2688 — AFP/ATL Hybrid Structures ................................................................................................. 83
A2689 — Grinding Swarf Reclamation and Reversion ..................................................................... 84
A2704 — F-35 Transparency Clean-up Automation - Pad Changing .................................................... 85
Improved Seal System to Save F-35 Joint Strike Fighter Millions of Dollars

A2513 — F-35 Automated and Rapid Seal Installation

Objective

Complex shaped and contoured F-35 Joint Strike Fighter (JSF) doors and panels tend to require a larger number of seal details to properly conform to the part. The objective of this Composites Manufacturing Technology Center project is threefold: (1) develop technologies to reduce seal details required per door / panel; (2) develop an Ultrasonic Seal Hole Cutting device; and (3) develop an improved seal adhesive application system.

Payoff

The project will significantly reduce the cost to fabricate and install seals on F-35 doors and panels. Technologies developed on this project are expected to save millions of dollars in material and labor costs. The cost savings will largely result from reducing the labor associated with fabricating seals, applying and cleaning up the seal adhesive, and cutting holes in the seals once installed.

Implementation

Once the individual development efforts are successfully demonstrated, the changes will be implemented through the F-35 Affordability and/or the Change Request process. The project will return to the Affordability Initiative Review Board for evaluation and approval for implementation funding. The Ultrasonic Seal Hole Cutting System has been implemented; the complex seal fabrication portion has been implemented on some doors / panels with implementation on the remainder on-going and the adhesive application development effort is expected to complete in time for a 2018 implementation.
Technology to Reduce the Occurrence of Out of Contour Waviness Defects

A2583 — Smart Processing Manufacturing Technology

Objective

Fighter jet wing and nacelle skins are complex layups produced from carbon bismaleimide prepreg material using the fiber placement process. Highly tailored layups resulting in numerous steep contour changes have resulted in a defect condition called Out of Contour Waviness (OCW). OCW results in costly Material Review Board (MRB) activity, and significant effort has gone into determining the root cause of OCW without success. To date, no root cause of OCW has been determined. This Navy ManTech Composites Manufacturing Technology Center (CMTC) project collected the thousands of data points available from each part fabrication and applied pattern recognition and Bayesian methods to identify and understand the variables that affect OCW. Variables identified from this early analysis were used to develop a design of experiment (DOE) in which numerous panels were fabricated and inspected for OCW. Data gathered from the first DOE shaped a follow-on DOE, which will be used to narrow in on the root cause of OCW in the components, and to develop improved fabrication process parameters that yield OCW-free parts.

Payoff

The project identified the variables that contribute to OCW in wing skins and nacelles. If the identification of variables is successful and OCW can be eliminated without impact to production costs, the cost savings for the F-35 Joint Strike Fighter (JSF) program could be approximately $20M. The cost savings are a combination of reduced MRB activity and the elimination of costly steps taken to mitigate the number of OCW occurrences on current production parts.

Implementation

The expected path to transition would consist of the identification of a series of process variables that needed to be controlled more tightly but within the current process specification. The level of approval required for this type of change would be minimal though the cost to implement would be highly dependent upon the identified variables. The implementation is targeted for 2018.
Process Improvements to Meet Strict F-35 Primer Thickness Requirements

A2609 -A-B — Primer Thickness Measurement for Seam Validation & Supply Base Quality

Objective

Various fundamental elements contribute to the establishment of the F-35 as the single most advanced warfighter in aviation history. Several factors, such as an integrated airframe design and the incorporation of innovative materials, contribute to the effectiveness of the F-35. Every detail counts toward achieving the advanced performance capabilities, and tight tolerances are held at every stage of the aircraft assembly. Meeting these tight tolerances has proven to be challenging in terms of manufacturing time and cost, and finding accurate measurement technology has proven to be just as difficult. For the F-35, the combination of overly thick primer application and the absence of accurate measurement technology commonly results in failures that require many hours of unplanned rework.

This project aims to develop a method to provide painters with the ability to reduce the costs of rework caused from deficient panels. The project team will investigate multiple tools/methods capable of proving the thickness measurements of the primer coating over composite panels without damaging the primer surface or requiring additional rework. Following a down select, the preferred technology will then be further developed for implementation into F-35 production.

Payoff

Early estimates forecast a 20-percent reduction in rework activities related to primer thickness. Assuming a low-rate initial production (LRIP) 11 implementation during the first quarter of FY18, the estimated reduction correlates to a per-aircraft savings of $30.5K and total program savings of over $60.5M per F-35 JSF program. The project is anticipated to reduce the labor and costs associated with rework, improve first-pass quality, and decrease process span time. A five-year ROI of 3:1 is expected.

Implementation

This technology will be disseminated to individual part suppliers, enabling the suppliers to accurately apply and assess the primer coating on their parts prior to shipment, eliminating tedious rework during later stages of the production process. Accurate measurements of the primer coating thickness will improve first-pass quality and eliminate the mandatory rework required for out-of-tolerance panels. If the technology proves successful, Lockheed Martin anticipates implementation of the primer thickness measurement technology in FY18 during LRIP 11.

This project is a joint COE effort between Naval Shipbuilding & Advanced Manufacturing (NSAM) and the Institute for Manufacturing and Sustainment Technologies (iMAST).
Automated Optical Inspection for Reduced Cost of EOTS Sapphire Panel Assemblies

A2620 — Optical Evaluation of Sapphire Panels

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

The inspection approach allows for the evaluation of critical functional defects and analysis of their impact on the performance of the entire optical system. This includes functional defects that diminish the infrared transmission and reduce the sensor imaging performance, and defects that reduce the mechanical strength of the sapphire panel, potentially causing early system failure over the operational lifecycle.

Payoff
Automating the optical inspection task will greatly improve the process by producing objective and repeatable results while also providing a quality characterization more relatable to system performance over the operational life cycle. Automated inspection of panels will reduce labor, lower costs, decrease variability, and increase throughput. This technology may be extended to other optical panels with Mil-Spec scratch and dig criteria. Therefore, there is a large potential return on investment to develop a flexible system that can be tailored to different optical inspection criteria for multiple applications and programs. There is broad applicability to multi-faceted and conformal sensor windows, regardless of substrate material, and to existing programs (e.g., F-35) by extending the inspection capability to include bare “as-manufactured” panels and assemblies returned from the field for depot-level evaluation and repair. Potential future applications may include EOTS enhancements and the Unmanned Carrier Launched Airborne Surveillance and Strike (UCLASS) sensor windows. The projected acquisition affordability savings will be over $4M for the F-35 Program alone.

Implementation
The development of an AOI test station is a pilot project to prove out automated inspection technology on military sensor windows. The initial (prototype) system will be validated for EOTS window production by verification of successful detection algorithms and demonstration of production cost savings. The system will be used by Lockheed Martin Missiles and Fire Control for acceptance of the EOTS sapphire window assembly beginning in early 2018. EOTS production builds for airframe LRIP 11 are delivered in 2018, one year ahead of LRIP 11 aircraft delivery in 2019. The prototype test station throughput supports all future F-35 factory production rates up to 24 units per month. The Technology Transition Plan describes how the AOI system may be replicated and adapted as necessary for additional F-35 depot and/or field support uses within three to five years.

Hardware and software developed under this effort will have a continuing benefit to the U.S. Government by extension of the automated inspection technology to new opportunities. The basic technology can be beneficial wherever scratch/dig inspection is required. AOI algorithms are flexible and easily adapted to the evolving inspection criteria often encountered in new designs. EOC will identify cost-saving projections for candidate applications explored as part of this project, such as single panel and new program window designs. Potential programs that will benefit include Lockheed Martin’s Sniper (Advanced Targeting Pod) system, currently in production.
Process Improvements for New F-35 EOTS Detector Material

**Objective**

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

**Payoff**

Insertion of the new detector into the current EOTS configuration will provide multiple affordability advantages, from increased capacity and reduced focal plane array processing hours and span time to increased reliability and maintainability of the integrated dewar cooler assembly. The focal plane arrays will also be more uniform and manufacturable, and have better yield and performance than the current focal plane arrays. Together, these tasks are expected to save over $91M for the F-35 Program.

**Implementation**

The F-35 EOTS is the transition platform. These producibility improvements will be implemented as process changes are qualified, and cut into production before completion of the project. The manufacturing process level changes are only required to go through the normal Santa Barbara Focalplane Process Control Board. A sufficient number of production runs will be completed to obtain statistical evidence that the cost and capacity goals can be maintained over long production runs. This analysis and validation will be executed within the confines of the project schedule and will be documented in the project final report.

Implementation for the airframe’s low-rate initial production (LRIP) 13 delivery is in 2021, and EOTS production builds for LRIP 13 delivery are in 2020, one year ahead of aircraft delivery in 2021. This is a joint effort with Air Force Research Lab.
Improving Imaging Systems by Reducing Coating Defects

A2623 — EODAS Nodule Defect Reduction

**Objective**

Multilayer vapor deposition coatings are used in imaging systems to reduce reflection and increase transmission of light into the detector. Small defects in coatings can create a scatter site for entering light, or completely block one or more detector elements. Coating defects can arise from several sources. Imbedded particles which have been over-coated will result in a spherical cap nodule defect on the surface of the wafer. Debris on the surface of the wafer may result from improper handling, storage, or tooling.

Preventing or removing nodule defects and debris on coatings could significantly help improve the yield of detector systems. This project has a dual-methods approach: (1) reduce the formation of nodule defects through an improved coating process, and (2) develop a laser ablation process to efficiently remove nodule defects without damaging the remainder of the wafer.

**Payoff**

When nodule defects occur, focal plane array (FPA) performance can be degraded, often through the creation of cluster defects (several adjacent non-functioning pixels). The current mitigation strategy of polishing flatness into the filter wafer can result in scuffing, which can degrade all or most of the FPA wafer.

The project is significantly reducing the potential for imaging systems malfunctioning due to multilayer coating issues. The payoff will be measured as improved yield of FPAs. For F-35, estimated cost savings of $3,864 per aircraft are being implemented in 2017 from yielded improvements in filter wafers, reduced labor for wafer repair, and improved yield in FPA downstream processing.

**Implementation**

The primary transition platform for this project is the F-35 EO/DAS (Electro-Optical Distributed Aperture System) sensor system. The EO/DAS consists of six infrared sensors mounted around the F-35 structure. The infrared sensors are one of the primary cost drivers for the EO/DAS. Coating process improvements demonstrated on this project have been communicated to the supply chain and implemented in 2017.

The technique of laser ablation for nodule defect mitigation was demonstrated as a viable and cost-effective option for nodule defect mitigation. This process can be implemented in the future on F-35 with a capital investment, if needed, or on any multilayer coating.
Continuing to Reduce Costs and Improve Producibility of Infrared Imaging Systems

A2624 — F-35 EOTS Producibility Phase 2

Objective
Continuing the success achieved in the first phase of this Navy ManTech project, the Pennsylvania State University Electro-Optics Center (EOC) and Santa Barbara Focalplane worked to improve the producibility of the infrared components comprising the F-35 Joint Strike Fighter (JSF) Electro-Optical Targeting System (EOTS). Phase 2, the follow-on effort to the Z2495 JSF EOTS Productivity Task, consisted of two tasks: The Focal Plane Array (FPA) Quick Test and Improved Dewar Final Vacuum Bake. These tasks will result in further cost reductions through process improvements that were qualified and implemented into production before completion of the project.

Payoff
The FPA Quick Test reduces handling and scrap while automation of the Dewar vacuum bake station reduces labor and span time. Benefits include a six-percent reduction in cost per unit with improved yields and throughput facilitating F-35 production rates and cost targets. Affordability savings of over $30M are projected for the F-35 program.

Implementation
The F-35 EOTS is the transition platform. These producibility improvements were implemented as process changes are qualified, and cut into production before completion of the project. The manufacturing process level changes are only required to go through the normal Santa Barbara Focalplane Process Control Board. A sufficient number of production runs were completed to obtain statistical evidence that the cost and capacity goals can be maintained over long production runs. This analysis and validation was executed within the confines of the project schedule and was documented in the project final report.

Implementation for the airframe’s low-rate initial production (LRIP) 11 delivery is in 2019, and EOTS production builds for LRIP 11 delivery are in 2018, one year ahead of aircraft delivery in 2019.
Automated Manufacturing Solutions for JSF Engine Part to Save Costs and Improve Quality

A2632 - Automated Turbine Airfoil Trailing Edge Rounding

Objective
A Navy Metalworking Center (NMC)-led Integrated Project Team (IPT) is focusing on the F135 engine turbine airfoil trailing edges, which are typically manually ground to obtain the desired contour. The current process results in high labor costs, as well as deviations in the trailing edge profile that cause both yield and quality concerns. Previous development efforts by Pratt & Whitney (P&W) have demonstrated the capability of a force- and vision-adaptive robotic system to profile grind the blade trailing edges; however, other adaptive grinding processes are potentially viable. The cooling air discharge holes on the trailing edge pose another challenge, as technologies to identify holes and inspect airfoil edges exist, but have not been integrated with adaptive-control methodology. The IPT, comprised of the F-35 Joint Program Office, P&W, Arconic, and NMC, will develop and demonstrate an automated system to establish the required turbine airfoil trailing edge profiles.

Payoff
The project will reduce acquisition costs by an estimated $14K per engine set based solely on reduced scrap; additional labor savings will be quantified during the project through evaluation/validation of the preferred adaptive grinding solution. This equates to a five-year savings of $16.6M (1,188 engine sets). Additional savings from improved engine performance, reduced fuel burn, and repair are not included. Further benefits may include supporting repair processes and strengthening the industrial base for commercial engines.

Implementation
NMC and industry are developing and evaluating several prototype airfoil profiling systems that integrate metrology and adaptive grinding or machining technologies. From those, P&W and Arconic will determine the preferred automated airfoil rounding solution. NMC will lead the development of the final specification for the full-scale system, as well as the corresponding tooling/fixturing drawings. P&W and Arconic will implement the chosen automated, adaptive grinding or machining solution in FY20.

PERIOD OF PERFORMANCE:
July 2015 to October 2018

PLATFORM:
F-35 Joint Strike Fighter (JSF)

CENTER OF EXCELLENCE:
NMC

POINT OF CONTACT:
Mr. Robert E. Akans
(571) 261-9441
akansr@ctc.com

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

TOTAL MANTECH INVESTMENT:
$2,344,000
Advanced Grinding Process Improves Machining of Powder Metal Forgings

Objective

Components for the Joint Strike Fighter F-135 engine are produced by machining powder metal forgings. The forgings are difficult and expensive to machine using conventional tools and processes. Hand work and hand polishing are required after the machining process to achieve the required surface finish. Preliminary work has shown that high-speed grinding has the potential to increase the material removal rate by a factor of four while meeting the required surface finish and microstructure. High-speed grinding can be applied to several different components. Additional work is needed to select the grinding wheel, develop the optimal grinding parameters, and qualify the process. Both creep and peel grinding are being evaluated during this project.

This effort is developing cost-effective grinding processes for powder metal and forged turbine components that meet all part quality requirements. To realize this objective, 10 different grinding wheels are being evaluated to determine the material removal rate, the wheel wear rate, and the quality of the grinding surface. After completing the same tests on all 10 wheels, the best one to two grinding wheels for each grinding process will be selected for optimization testing. An optimal set of parameters yielding the best combination of cost and performance will be developed and validated through laboratory testing. These grinding parameters will be transferred to Pratt & Whitney (P&W) for implementation within its F-135 production line.

Payoff

Implementation of high-speed grinding processes with increased material removal rates and improved surface finish will greatly reduce the time and cost to produce F-135 engine components. The process can be used on several different engine components. Cost savings will be identified based on reduced fabrication time and handwork. A faster production process will provide a higher throughput for the existing grinding cells and will help meet the production schedule without purchasing additional grinding cells. The ROI is 3.3:1.

Implementation

The results of this effort will be transitioned to P&W in March of 2018. P&W will evaluate the technical performance of each wheel and implement the grinding process into its component manufacturing enterprise. The design of the experimental systems is intended to be a facsimile of P&W’s manufacturing cell, thereby ensuring direct scalability and ease of implementation to the P&W production process.
Improving F-35 Quality and Reducing Cost through Integration and Automation

A2656 — F-35 Assembly Metadata Integration

Objective

The Integrated Assembly Line (IAL) at Northrop Grumman’s Palmdale, CA, facility contains numerous integrated systems utilized in the production of the F-35 center fuselage. Each system performs a specific function and occasionally, one of the machines will detect a process that is out of its standard specification and will designate this occurrence as a quality issue. These quality issues are currently generated into hard copy reports and require a significant amount of labor to review, address, and disposition corrective actions for the item. Each report requires significant manual review and coordination, resulting in a high volume of man-hours per report to resolve the associated quality issues.

The F-35 program is implementing production rate step increases resulting in a center fuselage production process interval reduction of 25 percent. This ramp in deliverable requirements will continue until the current four-day-per-unit rate is reduced down to a maximum throughput of one day per unit in 2019. This escalating production rate will only add to the congestion that is currently present in areas where support functions must allocate a significant percentage of their time addressing quality challenges.

The primary focus of this project was to design an integrated process to extract quality data from key machines on the IAL, which will automate and eliminate tedious review and disposition activities required of current quality processes. This project will also provide sufficient visibility to end users for improvements and gradually reduce the occurrence and oversight of non-critical quality non-conformances. To facilitate end user visibility, the improved system will be accompanied by a visualization tool that displays a variety of information based on individual needs.

Payoff

The integrated process is anticipated to reduce the number of man-hours currently utilized to address quality issues by 46 percent, resulting in per-aircraft savings of $10.5K per aircraft which equates to $4.85M (436 aircraft). Following a scheduled implementation in 2018, this significant per-aircraft labor reduction will result in JSF Program savings of more than $28M with an estimated five-year ROI of 1:1.

Implementation

The project is anticipated to automate and eliminate tedious review and disposition activities required of current quality processes. Northrop Grumman Aerospace Systems expects to implement the improved process into the production environment in LRIP-11 during FY18.
**Objective**

The current plasma treatment system for installation of the F-35 nutplate is inconsistent and involves a labor-intensive hand sanding and wiping operation. This effort will deliver an efficient, cost-effective, and safe atmospheric plasma treatment system, including processing parameters, which will produce reliable bonds and prepare composite substrates on the F-35 for nutplate installation in a measurable, repeatable manner.

**Payoff**

A plasma system, which can reach at least 85 percent of the composite nutplate areas will be developed. This system will enable savings in four areas by: (1) eliminating the push-off test requirement in production, (2) eliminating scrap, rework and repair due to poor surface preparation, (3) reducing the labor associated with preparing the composite surface for bonding, and (4) reducing the material consumption by eliminating sanding disks and a portion of the current solvent wipe process.

**Implementation**

After successful demonstration, the plasma system will be implemented through the F-35 Affordability and/or the Change Request process. Upon evaluation and approval by the Affordability Initiative Review Board, the plasma surface preparation technology will be implemented in factory locations that perform bonding of nutplates. This implementation is scheduled to occur in 2019.
Automated Hybrid Manufacturing Processing to Reduce Cost of Composite Structure Fabrication

Q2688 – AFP/ATL Hybrid Structures

Objective

The ability to fabricate complex parts that are both more affordable and minimize weight is challenged by today's manufacturing offerings, as currently utilized in F-35 production. The Navy is currently contemplating future systems, such as the Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS), Tactically Exploited Reconnaissance Node (TERN), and the next-generation fighter aircraft (F/A-XX). While these platforms are still in the early concept development stages, it is probable that large, complex-contoured skins will be part of any offering. Prime contractors’ ability to meet both the affordability and performance goals of these platforms will be challenged. A novel hybrid-manufacturing solution that could offer the affordability benefits of the Automated Tape Layup (ATL) process and the weight optimization abilities of the Automated Fiber Placement (AFP) process is highly desired.

This ManTech project will demonstrate the technical capabilities and the potential cost and weight savings of the new hybrid AFP/ATL technology. Orbital ATK and Fives have worked to develop a dockable Gantry System (DGS) with interchangeable AFP and ATL heads that have the entire fiber path and fiber delivery system located on the dockable head itself. The premise is to combine the strengths of both AFP and ATL and to minimize the weaknesses by optimizing the use of the two technologies to fabricate composite structures. Currently, composite part fabricators typically have equipment that is capable of either only ATL or only AFP. Deciding which process to use to fabricate a specific part is simple. If the geometry of a small area of a part exceeds the capabilities of the ATL equipment, the entire part is then fabricated with AFP, or the entire part may go to hand lay-up. Successful demonstration of this new technology will enable future Navy systems to achieve the affordability benefits of ATL and the performance benefits of AFP.

Payoff

Preliminary simulations comparing the hybrid AFP/ATL process to traditional AFP on an F-35 CTOL upper wing skin show the potential for as much as a 13 percent reduction in materials cost and a 17 percent increase in material deposition rate. As such, it is important to do the initial work, build the test articles as outlined above, and present the results to the industry.

Implementation

The results of this project could support both current acquisition programs like F-35 as well as future acquisition programs, such as the UCLASS, TERN and F/A-XX. For future programs, since these projects are still in the early development phases, no specific implementation plan will be prepared. Demonstrating this technology in the 2018 timeframe will enable future platforms to make informed, baseline decisions on part design and fabrication options by understanding the cost and weight implications of such decisions. With respect to current platforms, the F-35 may require additional wing part fabrication capacity dependent on the full production build rates that are achieved. If the F-35 supply chain requires additional equipment, successful execution of this project would enable the part producers to make informed decisions about the proper equipment to purchase to support the increased rates. If the supply base elects to use the DGS system, the typical F-35 implementation methodology will be followed.
Process Will Reclaim High-Cost Metal By-Product in JSF Engine Components

**Objective**

The Joint Strike Fighter (JSF) F135 engine turbine disks are made from very expensive virgin nickel superalloy forgings. When the turbine disks are ground during fabrication, the swarf (material filings) that is generated contains the nickel alloy as well as cutting oil and media from the grinding disk. Today, this contaminated by-product cannot be reverted into a new forged billet and must be sold as scrap. The Navy Metalworking Center (NMC) is leading a Navy ManTech project that is developing a process to separate and recover the nickel alloy from the grinding swarf, enabling Pratt & Whitney (P&W) to revert the nickel alloy back into new forged billets. This will reduce the amount of virgin nickel material that needs to be procured, resulting in significant material cost savings for the F135 components.

The Integrated Project Team (IPT), consisting of the JSF Program Office, P&W, and NMC, will characterize the various constituents in the grinding swarf generated during the fabrication of the F135 turbine disks. The IPT will also identify the target specifications for the recovered nickel that will result in acceptable metal billets for reuse. The IPT will then conduct an industry survey of waste separation processes used to reclaim various materials, and NMC will lead lab-scale separation trials to develop a process to separate the nickel superalloy from the grinding swarf. With industry support, the IPT will expand on the results from these trials to develop a grinding swarf separation process for use on a production scale.

**Payoff**

The project is expected to save at least $5.2K per engine, which equates to a five-year savings of $6.18M (1,188 engine sets). P&W further anticipates using the developed reversion process to recover material from other grinding swarf waste streams. This results in a total projected savings of $7.6M over five years, and $13.2M over the life of the program.

**Implementation**

Once the production separation process has been successfully demonstrated, the team will produce a forged billet using the reclaimed nickel superalloy. The billet will be tested for compliance with the applicable material specifications for the turbine disks. Implementation is planned during fabrication of F135 nickel components at P&W in FY20.
**Enhancements to F-35 Canopy Clean-up Automation Cell to Save F-35 Joint Strike Fighter Millions of Dollars**

A2704 — F-35 Canopy Clean-up Automation – Pad Changing

**Objective**

A Navy ManTech Center of Excellence, the Composites Manufacturing Technology Center (CMTC), successfully developed an automated canopy sanding system for the transparency of the F-35 under a previous ManTech project that will yield significant savings. However, because the sanding pads require changing every 5-10 minutes, significant operator intervention is still necessary. The project will develop the equipment, processes, and methods to implement a system improvement that is fully capable of autonomously changing adhesive-backed sanding pads.

**Payoff**

When the automated pad changing system is incorporated with the automated canopy sanding system, further savings will be achieved and the complexity of production will be reduced by virtually eliminating the need for an operator during the sanding operations. Total savings of millions of dollars are anticipated over the life of the F-35 program.

**Implementation**

After the pad changing system is successfully demonstrated, it will be implemented at the canopy manufacturer on existing and future automated canopy sanding systems. The ManTech-developed automated canopy sanding system in place at the canopy manufacturer will be modified to accommodate the newly developed pad changing system to demonstrate system operation and to validate the anticipated cost savings. Future canopy sanding systems will be procured with the pad changing system. Implementation is expected to initiate in 2018.
## CH-53K Projects

<table>
<thead>
<tr>
<th>Project Code</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2616</td>
<td>CH-53K Detection Repackaging &amp; Affordability</td>
<td>88</td>
</tr>
<tr>
<td>A2687</td>
<td>CH-53K Frame Machining Distortion Mitigation</td>
<td>89</td>
</tr>
<tr>
<td>A2692</td>
<td>Very-Low-Cost Radar for CH-53K DVE</td>
<td>90</td>
</tr>
</tbody>
</table>
Reliable and Cost-Effective Ice Detector System for CH-53K Rotorcraft

Objective
The legacy ice detector for the CH-53 utilizes a radioactive isotope that presents an environmental and safety hazard that is expensive to dispose and replace. The objective of this project is to apply advanced manufacturing and packaging techniques and technology advancements to provide PMA-261 a safe, reliable, and cost-effective means of detecting ice accretion on the CH-53K. The Ice Detector System (IDS) will leverage guided wave technology advancements developed under a Small Business Innovation Research program. The prototype sensor will be packaged into a ruggedized probe using an air-worthy adhesive system. The electronics pulser, receiver, and microprocessor will be re-packaged into a compact, air-worthy, commercial-off-the-shelf (COTS)-based, mountable housing that can be adapted for multiple future aircraft platforms.

Payoff
A major benefit in acquisition cost reduction and life-cycle support will be derived for this effort, with the implementation of a safe, non-toxic, ice sensing technology for future implementation on the CH-53K. Benefits can also be realized in other rotorcraft or fixed wing platforms for multiple DoD and commercial applications that are subjected to in-flight icing conditions. By implementing COTS packaging and applying advanced manufacturing techniques, the re-packaging of icing sensor prototype will enable a potential acquisition cost savings of $12,000/aircraft for CH-53K for 200 aircraft = $2.4 M. Cost savings could be extended to additional platforms and services such as CH-53E with 180+ aircraft (+$2.2 M). An ROI of greater than 2.0 is expected for the CH-53.

Implementation
After reviewing the relevant design requirements for CH-53K, the existing ice detection technologies will be evaluated, including a new guided wave technology developed by FBS Inc. /Guidedwave. This trade study will buy down the risk associated with the reliance on the Guidedwave technology by investigating alternative approaches. ACI will use advanced manufacturing packaging to develop the ice detector probe into a form factor designed for CH-53K. The IDS controller will replace the legacy system utilizing advanced manufacturing and miniaturization techniques with a full technical data package (TDP) to allow competitive bidding for manufacturing in the future. The transition event for the project will be the successful completion of the prototype IDS (passes environmental testing, the final ice tunnel test, and the test results accepted by PMA-261) and the final update to the TDP for the IDS design. The completed prototype for the CH-53K will transition to NAVAIR PMA-261 to undergo qualification testing and validation of airworthiness.
Objective
Distortion that results from manufacturing processes such as machining and heat treating is a challenge for many industries, including the construction of naval weapons systems. The Navy Metalworking Center (NMC) is working to reduce distortion of the side cabin frames on the CH-53K Heavy Lift helicopter. NMC is leading a Navy ManTech project team that will characterize potential causes of distortion in these parts and then evaluate various technologies to mitigate this distortion. Since distortion is a universal issue, the mitigation technologies developed in this project will potentially benefit other Navy platforms as well. This project will develop and demonstrate mitigation technologies that will reduce a majority of the distortion during manufacturing stages, including machining and quenching.

Payoff
The project will provide direct cost savings by reducing manufacturing errors and improving assembly costs. Industry has reported that reducing or eliminating distortion in the side cabin machine frames is expected to save $87K in rework and cost of quality per airframe, with a five-year savings of $6M over 70 units. The anticipated life-of-program savings are projected to be $16M based on 197 CH-53K cabin frames.

Implementation
After successful demonstration, the down-selected technology(ies) will be integrated into the standard manufacturing process at the cabin manufacturer, Spirit AeroSystems. Implementation is expected during low-rate initial production of the CH-53K Heavy Lift helicopter program in 2018 and full-rate production starting in 2019.
Low-Cost and Modular Concept for See-Through Technologies in USMC Rotorcraft Degraded Visual Environments

Objective

There is a need to reduce the cost of Degraded Visual Environment (DVE) see-through systems across the spectrum of military systems. ACI Technologies/Electronics Manufacturing Productivity Facility and The Penn State University Electro-Optics Center (Navy ManTech Centers of Excellence) are collaborating to develop a trade study of the integrated sensor technology that currently exists in industry. The trade study includes a Request for Information (RFI) eliciting technical concepts to integrate a low-cost, scalable open systems architecture (i.e., layered structure), see-through capability in a DVE for CH-53K. The RFI process and subsequent evaluation will assess current industry capabilities to meet the DVE requirement to allow safe aircraft operations for a rotorcraft landing. Evaluation of the RFI responses will include the development of trade study criteria that is based on the information listed in the Product Description Criteria table included in the RFI. Once the trade study is completed, PMA-261 will be provided with a joint recommendation based on the technical evaluation of the qualitative and quantitative data.

Payoff

The study will develop a set of requirements and white paper proposals for a realistic, affordable concept for a DVE sensor solution for the CH-53K landing function. The specifications and the white papers solicited from industry will identify technology that is currently available and will be used to solicit system design and cost proposals from the radar industry. In addition, cost reduction will be enabled due to manufacturing process upgrades.

Implementation

By developing new manufacturing processes for the development and construction of DVE sensor systems, opportunities for cost reduction to propagate throughout the DoD rotary aircraft industry are increased. The set of system/subsystem requirements developed from this ManTech project will immediately transition and implement to a technology demonstration prototype for U.S. Marine Corps CH-53K heavy-lift helicopter DVE evaluation testing. This will be a Phase 2 effort.

A2692 — Very-Low-Cost Radar for CH-53K DVE
Other Sea Platforms Projects

S2487 — SPS-48E Radome Replacement ................................................................. 92
T2710 — Manufacturing Process Optimization of Azimuth and Inertial MEMS ... 93
T2716 — Development of Additive Manufacturing Processes for Corrosion Resistant Alloys ................................................................. 94
S2744 — Hatchable Cold Spray Technology for Naval Shipyards and Marine Corps Depots ................................................................. 95
S2487 — SPS-48E Radome Replacement

Objective
Due to Environmental Protection Agency restrictions, legacy radomes used on the SPS-48E antenna are no longer available due to their Teflon matrix containing perfluorooctanoic acid (PFOA). The goal of this project was to acquire and test the gray, color-matched radome materials from Emerson & Cuming that were found to be potential replacements under a previous project supported by PEO-IWS 2.0. These radomes were evaluated based on their dielectric performance, environmental resistances, and color match. Along with the radomes, mounting adhesives were evaluated to ensure minimal interference and suitable bond strengths under an array of environmental conditions. After testing was completed and a radome was found that was directly comparable to the current PFOA-containing painted radomes, a production-scale test was performed on a complete SPS-48E antenna.

Payoff
A new radome manufacturer was identified, allowing continued refurbishment of the SPS-48E. Without successful execution of this project, refurbishment of the SPS-48E antenna potentially may have ceased due to a lack of available legacy radome materials that are used to replace damaged or worn-out materials. The new material is also color-matched to the antenna, which reduces the overall cost of refurbishment and removes a hazardous etch step that is necessary to prepare legacy materials for paint.

The total five-year cost saving per system is approximately $157K. With 25 systems currently in service, the cost savings are projected to reach $3.9M for one complete refurbishment cycle, assuming a full radome replacement. Since the antenna will be in service until at least 2050, additional cost savings will be realized over the next 30 years.

Implementation
The new material was vetted and tested on a full SPS-48E antenna ready to return to the fleet. Since the material had passed a complete qualification-level test set, including both performance and environmental evaluations, the material was ready for transition and implementation at the project’s end. Since the project’s end, further testing has been conducted and the 24 array-slats built under this project are set for implementation into the fleet on a refurbished SPS-48E antenna in 2017. Additionally, a revised drawing and Acceptance Test Procedure have been completed allowing for the generation of a part number for future orders of the new color-matched radome material.
Manufacturing Process to Yield Higher Production Volumes

T2710 — Manufacturing Process Optimization of Azimuth and Inertial MEMS

Objective

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

This project is directed at the production of low-cost, high-quality sensors that will produce a low size, weight, power and cost (SWaPC) replacement for the Digital Magnetic Compass (DMC). Fabrication of the current Silicon Disc Resonator Gyroscope (SiDRG) is on 100mm-diameter wafers produced in a laboratory environment; this work successfully validated the high level of performance achievable with this device.

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

Payoff

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

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

Implementation

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

T2716 — Development of Additive Manufacturing Processes for Corrosion Resistant Alloys

Objective

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

Payoff

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

Implementation

Each of the materials classes noted above have significant applicability to naval systems but also present a range of challenges before they can be successfully processed using AM. Efforts will be directed at understanding the processing challenges and building a knowledge base for how a small range of processing conditions can impact the resulting structure and properties for important naval materials. As part of the process development work, a preliminary process and property database will be developed for these material systems. At the completion of the project, the technology basis for the AM fabrication of a range of different components using these materials systems will be developed and applicable to the near-term qualification and insertion of AM components into service. The iMAST team hopes to transition this knowledge to specific parts applications on ships within the FY19-FY20 time frame.
Innovative In-Situ Repair for Ships

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

Objective

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

The objectives of this effort are to develop and deliver a high-pressure hatchable cold spray system, commensurate support equipment and operation procedures, to include on-board ship, and develop and validate shipboard repairs of specifically selected components.

Payoff

Benefits that will result from this project are: (1) development of a man portable high pressure cold spray system and supporting technology that can be used to perform shipboard, pier side and field repairs; (2) approved repair processes for submarine and aircraft carrier components; (3) repairs that return components to service that previously had to be scrapped; (4) repair costs of less than 20 percent of the cost of a new component; (5) reduced repair times (lead times taking as long as 24 months will now take one day to four weeks - depending on the component); and (6) an improved process to identify additional candidate components for repair by the shipyard or depot personnel. The estimated cost voidance for the first five years of implementation is $8M for a ROI of 13:1.

Implementation

The hatchable cold spray systems will be implemented first at IMF Bangor and Puget Sound Naval Shipyard in late 2018. Approved repairs are expected to be implemented early 2018. The repair process will be governed by Uniform Industrial Process Instruction (UIPI). Information specific to the hatchable repairs will be developed as required by the UIPI. Other implementation sites include Navy shipyards, (IMFs) and the Marine Depot at Albany, GA. The system will also be made available to NAVAIR facilities.
Energetics Projects

S2214 — Flexible Manufacturing of Novel Energetic Materials (Flex NEM) ................................................................. 98
A2575 — Energetics Production Utilizing Resonant Acoustic Mixing (RAM) ................................................................. 99
Real-Time Analytical Tools Allow Optimized Process Scale-up of Energetic Materials

S2214 — Flexible Manufacturing of Novel Energetic Materials (Flex NEM)

Objective

Novel energetic compounds have been the focus of the Navy in order to meet the growing demands of its future high performance weapons systems. Some of the work already conducted focused on the development of viable burning rate modifiers. However, in addition to achieving higher performance objectives, insensitive munitions (IM) requirements, as well as compatibility and life-cycle requirements, other concerns needed to be addressed in the development of new energetic ingredients. Several newly synthesized energetic ingredients show great promise as ingredients for explosive or propellant formulations. The objective of this project is to develop a process to produce large-scale quantities of these new ingredients for explosive and propellant formulations.

Payoff

Design and installation of a process using existing 500-gallon reactors will afford significant cost reductions surrounding the processing of the novel energetic ingredients. The scale-up of the chemical processes from previously demonstrated pilot-scales (50 and 100-liter reactors) to the 500-gallon scale will result in 50 percent overall cost reduction per pound for these ingredients and make them available at a scale for formulation and production of explosives and propellants. Process design of a reactor train at the 500-gallon scale will further reduce the manufacturing labor by 85 percent.

Implementation

NSWC IHEODTD has completed site preparation to support manufacture of novel energetic ingredients such as LLM-105, BNFF, and DAFF at a 500-gallon scale. Once process-specific programming and controls are completed, the capability of producing LLM-105, BNFF, and DAFF, and other novel energetic ingredients at the 500-gallon scale for Department of Defense (DOD) weapon systems will exist. This flexible manufacturing capability will have the ability to provide a variety of new energetic material ingredients for use in propellants and explosives.
RAM Technology Provides Safer and Cheaper Manufacturing of Energetic Materials

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

Payoff
RAM technology offers a number of benefits as compared to current energetics mixing processes. PBXN-110, the explosive fill of the Mk152 Warhead, is currently manufactured using planetary vertical mixers. For example, for PBXN-110, benefits of RAM over vertical mixing include:
(1) safety – as mentioned above, RAM provides a significant safety advantage over vertical mixing; (2) faster production – RAM mixes much more quickly than conventional mixers; (3) reduced footprint, (4) the potential to produce materials not easily processed using current mixing methods (such as materials with higher viscosities and shorter pot lives (solidification times); and (5) reduced costs - evaluation of the labor required for the proposed production process shows a cost reduction of about $100 per warhead at a current production cost of $1500 each. At current production levels, this results in an annual savings of $1M for Mk 152 production, providing a 2.5 year ROI. Additional savings would be achieved as the newly proven technology is used for other existing programs and new work.

Implementation
The successful completion of this project will result in a fully operational resonant acoustic mixing production facility at NSWC IHEODTD, as well as a qualified RAM production process for the Mk 152 warhead to meet PMA 242 requirements. Direct transition to full production is anticipated following successful FAT results. Techniques and processes developed will support RAM programs elsewhere. Defense contractors have already expressed interest in partnering with NSWC IHEODTD and utilizing the newly purchased RAM-5. Implementation is targeted for 2.75” IM warheads such as the Mk 152 and Mk 146. PMA 242 has signed a TTP to look at utilizing the RAM technology for full-scale manufacture.
RepTech Projects

S2599 — UHP SHT / MIP Removal Using Dual-Track Crawler System .........................................................................................................................................................102
A2647 — Additive Manufacturing Repair of AV-8 LPC Seal .........................................................................................................................................................................................103
S2682 — Low Loss Launch Valve (LLLV) Plug Maintainability Improvement ............................................................................................................................................................................................104
Objective

Removal of Special Hull Treatment (SHT) and mold in place (MIP) coatings from submarine hulls is performed using ultra-high pressure (UHP) water jet blasting. Currently, shipyards use UHP hand-lances to remove SHT. SHT removal using UHP hand-lances is slow and is a safety hazard for operators. The objective of this Institute for Manufacturing and Sustainment Technologies (iMAST) project is to design, fabricate, test, and deliver a dual-track UHP SHT removal system. The dual-track SHT removal system will be a semi-automated process. The dual-track crawler system will use higher pressure and flow rates than can be used with hand-lances. For these reasons, the dual-track crawler system will improve removal efficiency, improve safety, and reduce labor in both the blasting and waste cleanup processes.

Payoff

According to Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNSY&IMF), an estimated 1000 person-hours were expended from April 2013 through April 2014 for SHT removal from submarines using the standard hand-lancing technique. PSNSY&IMF subject matter experts (SMEs) estimate a labor reduction of approximately 35 percent through elimination of the 60-minute operator blast-time restriction (safety requirement) and from elimination of ‘trigger-off’ associated with operator fatigue and poor visibility.

Vacuum collection is not currently feasible due to the tendency of removed SHT material to clog the vacuum collection equipment. The use of a dual-track system will enable precise control of particle size, enabling vacuum collection at point of generation. Shipyard SMEs estimate 50 percent labor reduction for cleanup. Lastly, Shipyard SMEs estimate ~35 percent labor reduction associated with edge cleanup prior to reinstallation of new tiles.

The estimated total cost savings per hull is $120K per year per yard. The estimated total annual cost savings to the Navy is $360K per year. The return on investment over five years is 3.5:1.

Implementation

The Institute for Manufacturing and Sustainment Technologies (iMAST) first demonstrated the system at PSNSY&IMF in July of 2016. iMAST conducted pre-production trials at the PSNSY&IMF July 10th – 14th at the PSNSY&IMF. PSNSY&IMF full-scale on-boat production trials occurred in August 2017. The transition path is direct technology insertion at the submarine-supporting shipyards. Implementation target is for submarine hull-coating repair and maintenance operations.
Repair of AV-8B Engine Part by Additive Manufacturing Process

A2647 — Additive Manufacturing Repair of AV-8 LPC Seal

Objective
Additive Manufacturing (AM) is recognized by NAVAIR as a means to bring “…a revolution in how we sustain our systems” (VADM David Dunaway). This technology has clear potential to benefit Navy sustainment activities, including direct part replacement, repair parts fabrication, and refurbishment of worn or corroded parts. The U.S. Navy must develop and demonstrate qualification and certification procedures for targeted components before this potential can be realized for aviation components.

This project will advance AM technology for both new manufacture and repair by developing a qualification test plan, a suitable repair process, and a technical data package to support the qualification, repair, and implementation of AM repair procedures at Fleet Readiness Center (FRC) East. These procedures will address a high-priority repair need within the AV-8B F402 engine—unacceptable surface/frettng wear on the Low Pressure Compressor (LPC) 2nd Stage Rear Seal Ring at bolted contact points to the 3rd Stage Rear Seal Ring.

Payoff
A key payoff will be the reduction in time associated with placing components and systems back into service, resulting in concomitant reductions in cost and improvements in readiness. A Supply Snapshot provided by FRC East suggested that the projected number of surplus seal rings was expected to drop below an acceptable level, which could adversely affect their ability to sustain the fleet. Moreover, lead time to get a new part manufactured or to qualify a new vendor were expected to be two years and cost approximately $100K.

The cost avoidance and operational benefit associated with the cyclical availability of resources was stressed to the project team from FRC East as motivation to aggressively pursue suitable AM repair options. The knowledge gained through this project will be leveraged by follow-on efforts to apply the benefits of AM technologies to other Navy applications.

Implementation
Transition will be achieved when: (1) a qualification test plan has been approved by the Navy (completed), (2) a repair process has been developed that enables successful execution of the qualification test plan (completed), and (3) a technical data package with information to reproduce the qualified repair process by FRC East or their designee. Other progress toward implementation includes the approval by FRC East of internal Capital Investment Plan funding to procure special equipment to produce these AM repairs in-house, as well as repairs to other components, e.g., T64 air seals (the target of anticipated next efforts) and/or identification and qualification of a private/commercial provider. Implementation is expected to occur in FY18.
**Low Loss Launch Valve Improvement**

**Objective**

The improved Low Loss Launch Valve (LLLV) is a component within the steam catapults and are deployed on CVN 68 through CVN 77. Each catapult has a LLLV which precisely meters the proper flow of steam to the power cylinders for aircraft launch. The plug-type valve rotates to control the flow of steam. The LLLV plug is exposed to high temperature steam, condensate, graphite, and grease. A coating is applied to the area on the plug shaft just below the steam plug valve to increase wear and corrosion resistance. The coating system has a bond coat that provides adhesion to the plug and a ceramic top coating that provides wear resistance. During refurbishment of the LLLV, the coating and a thin layer of base metal must be machined from the shaft to remove any material affected by the coating process. This process can remove enough material to reduce the diameter of the shaft to below the minimum acceptable diameter. Increasing the thickness of the bond coat can restore the LLLV shaft to the required diameter. There is occasionally, some evidence of corrosion in the damaged coatings. Therefore, an alternative sealant with higher temperature capabilities is being examined to improve the corrosion performance.

The objective of this Navy ManTech Institute for Manufacturing and Sustainment Technologies (iMAST) effort was to increase the thickness of the coating system while meeting the adhesion strength requirements and to improve the corrosion resistance. Initial efforts have shown that the adhesion strength decreases with increasing bond coat thickness. However, doubling of the bond coat thickness resulted in an adhesion strength that was still above the required adhesion strength. Adhesion, microstructural analysis, and corrosion tests were performed. A high temperature sealant was produced and evaluated and other coating systems and processes were examined as needed. Representative hardware will be developed to validate the repairs. Improvements to the plasma spray process will also be investigated.

**Payoff**

The payoff includes a process that can be used to restore undersized LLLV plug shafts to the required diameter, increased corrosion and wear resistance, and improved the plasma spray process for applying the coatings. The cost of a new LLLV plug is $100K. Eight plugs are repaired annually. The cost savings for repairing the shafts over purchasing new plugs and for increasing the life of the LLLV plug shaft is $500K per year. An additional benefit includes extended time between repairs. An improved plasma spray process could be used on other Navy platforms as well.

**Implementation**

Implementation of the repair processes will be through Naval Air Warfare Center Aircraft Division - Lakehurst and the plasma spray vendor. Implementation will include test methods to validate the performance of the thicker plasma coatings. Final implementation is expected to occur in FY18.
# INDEX

## By Project Title

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Project #</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustic Sensing Through Energized Electrical Enclosures</td>
<td>S2643</td>
<td>26</td>
</tr>
<tr>
<td>Additive Manufacturing Repair of AV-8 LPC Seal</td>
<td>A2647</td>
<td>103</td>
</tr>
<tr>
<td>Advanced Steel Production Facility - Industrial Modeling &amp; Simulation</td>
<td>S2727</td>
<td>31</td>
</tr>
<tr>
<td>AFP/ATL Hybrid Structures</td>
<td>Q2688</td>
<td>83</td>
</tr>
<tr>
<td>Augmented Visualization for Manual Welding</td>
<td>S2628</td>
<td>41</td>
</tr>
<tr>
<td>Automated Hanger Manufacturing</td>
<td>S2634</td>
<td>62</td>
</tr>
<tr>
<td>Automated Manufacturing Cell for Small Repetitive Assemblies</td>
<td>S2612</td>
<td>39</td>
</tr>
<tr>
<td>Automated Manufacturing of Hull Tiles Phase 1</td>
<td>S2655-1</td>
<td>65</td>
</tr>
<tr>
<td>Automated Part Detail Extraction</td>
<td>R2722</td>
<td>50</td>
</tr>
<tr>
<td>Automated Turbine Airfoil Trailing Edge Rounding</td>
<td>A2632</td>
<td>79</td>
</tr>
<tr>
<td>Back-fit /composite Flood Grates</td>
<td>M2676</td>
<td>66</td>
</tr>
<tr>
<td>Bulkhead T-Flange Crease Elimination</td>
<td>A2684</td>
<td>36</td>
</tr>
<tr>
<td>CH-53K Frame Machining Distortion Mitigation</td>
<td>A2687</td>
<td>89</td>
</tr>
<tr>
<td>CH-53K Ice Detection Repackaging &amp; Affordability</td>
<td>A2616</td>
<td>88</td>
</tr>
<tr>
<td>Composite Hybrid Rotating Coupling Covers</td>
<td>S2532</td>
<td>22</td>
</tr>
<tr>
<td>Composite Manufacturing Technology for Fire Safe Resins</td>
<td>Q2533</td>
<td>54</td>
</tr>
<tr>
<td>Continuous Wave Illuminator Transmitter Upgrade</td>
<td>S2385</td>
<td>34</td>
</tr>
<tr>
<td>Critical Resource Planning</td>
<td>S2593-A-B</td>
<td>57</td>
</tr>
<tr>
<td>Development of Additive Manufacturing Processes for Corrosion Resistant Alloys</td>
<td>T2716</td>
<td>94</td>
</tr>
<tr>
<td>Digital Paint Tools &amp; Process Optimization</td>
<td>S2701</td>
<td>49</td>
</tr>
<tr>
<td>Dynamic Change Awareness</td>
<td>S2594</td>
<td>36</td>
</tr>
<tr>
<td>Efficient Identification of Plate Defects</td>
<td>S2606</td>
<td>25</td>
</tr>
<tr>
<td>Electromagnetic Aircraft Launch System (EMALS) Armature Assembly Productibil-</td>
<td>S2686</td>
<td>29</td>
</tr>
<tr>
<td>ty Improvements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enablers for Integrated Manufacturing of Submarine Components</td>
<td>Q2596</td>
<td>58</td>
</tr>
<tr>
<td>Energetics Production Utilizing Resonant Acoustic Mixing (RAM)</td>
<td>A2575</td>
<td>99</td>
</tr>
<tr>
<td>Enhanced Task Assignment Progressing</td>
<td>S2667</td>
<td>45</td>
</tr>
<tr>
<td>EODAS Node Defect Reduction</td>
<td>A2623</td>
<td>77</td>
</tr>
<tr>
<td>F-35 Assembly Metadata Integration</td>
<td>A2656</td>
<td>81</td>
</tr>
<tr>
<td>F-35 Automated and Rapid Boot Installation Phase 1</td>
<td>A2513</td>
<td>72</td>
</tr>
<tr>
<td>F-35 Electro-Optical Targeting System (EOTS) Producibility Phase 4</td>
<td>J2622</td>
<td>76</td>
</tr>
<tr>
<td>F-35 EOTS Producibility Phase 2</td>
<td>A2624</td>
<td>78</td>
</tr>
<tr>
<td>F-35 Primer Thickness Control</td>
<td>A2609-A-B</td>
<td>74</td>
</tr>
</tbody>
</table>
## INDEX
### By Project Title

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Project #</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-35 Transparency Clean-up Automation - Pad Changing</td>
<td>A2704</td>
<td>85</td>
</tr>
<tr>
<td>Fiber Optic Measurement and Shape Sensing Phase 2</td>
<td>S2559-2</td>
<td>56</td>
</tr>
<tr>
<td>Flexible Manufacturing of Novel Energetic Materials (Flex NEM)</td>
<td>S2214</td>
<td>98</td>
</tr>
<tr>
<td>Geospatial Component Location, Identification and Condition</td>
<td>M2726</td>
<td>30</td>
</tr>
<tr>
<td>Grinding Swarf Reclamation and Reversion</td>
<td>A2689</td>
<td>84</td>
</tr>
<tr>
<td>High Deposition Submerged Arc Welding for Ford-Class Aircraft Carriers</td>
<td>S2595</td>
<td>24</td>
</tr>
<tr>
<td>HLAW Process Verification and Implementation for Ship Production</td>
<td>S2697</td>
<td>47</td>
</tr>
<tr>
<td>Improved Cable Lay and Sequencing for VIRGINIA Class (VCS) and COLUMBIA Class (CLB) Submarine Programs</td>
<td>S2547</td>
<td>55</td>
</tr>
<tr>
<td>Induction Straightening for CVN</td>
<td>S2664</td>
<td>28</td>
</tr>
<tr>
<td>Inspection Under SHT Phase 1</td>
<td>Q2711</td>
<td>69</td>
</tr>
<tr>
<td>Low-Cost Hybrid Fairings</td>
<td>S2601</td>
<td>59</td>
</tr>
<tr>
<td>Low-Loss Launch Valve (LLLV) Plug Maintainability Improvement</td>
<td>S2682</td>
<td>104</td>
</tr>
<tr>
<td>Manufacturing Cost Reduction for LCS Scalable Electronic Warfare (EW) System</td>
<td>S2558</td>
<td>52</td>
</tr>
<tr>
<td>Manufacturing Process Optimization of Azimuth and Inertial MEMS</td>
<td>T2710</td>
<td>93</td>
</tr>
<tr>
<td>Mobile Computing for Design Build</td>
<td>S2653</td>
<td>64</td>
</tr>
<tr>
<td>Non-Contact Metrology in Shipbuilding</td>
<td>S2662</td>
<td>27</td>
</tr>
<tr>
<td>Optical Evaluation of Sapphire Panels</td>
<td>A2620</td>
<td>75</td>
</tr>
<tr>
<td>Optimized Lifting and Handling</td>
<td>S2652</td>
<td>43</td>
</tr>
<tr>
<td>Pipe Cutting Machine Technology</td>
<td>S2691</td>
<td>68</td>
</tr>
<tr>
<td>Plasma Surface Preparation for Composite Nutplate Installation</td>
<td>A2657</td>
<td>82</td>
</tr>
<tr>
<td>Plug-and-Play Composites</td>
<td>S2677</td>
<td>67</td>
</tr>
<tr>
<td>Powder Metal Advanced Grinding</td>
<td>A2644</td>
<td>80</td>
</tr>
<tr>
<td>PSNS&amp;IMF Submarine Factory Simulation and Capacity Planning</td>
<td>S2714</td>
<td>70</td>
</tr>
<tr>
<td>Resource Availability</td>
<td>S2660</td>
<td>44</td>
</tr>
<tr>
<td>Robotic Welding of Complex Structures</td>
<td>S2636</td>
<td>42</td>
</tr>
<tr>
<td>Shape Cutting and Welding Automation</td>
<td>S2604</td>
<td>38</td>
</tr>
<tr>
<td>Shipyard Capacity Planning Tools</td>
<td>S2600</td>
<td>37</td>
</tr>
<tr>
<td>SiC High-Efficiency Power Switches Wafer Process Improvement</td>
<td>S2489</td>
<td>35</td>
</tr>
<tr>
<td>Smart Processing Manufacturing Technology</td>
<td>A2583</td>
<td>73</td>
</tr>
<tr>
<td>SPS-48E Radome Replacement</td>
<td>S2487</td>
<td>92</td>
</tr>
<tr>
<td>Synchronizing Material Logistics with CVN Pier &amp; Dry Dock Build Strategies</td>
<td>S2571</td>
<td>23</td>
</tr>
</tbody>
</table>
## INDEX

By Project Title

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Project #</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tactical Information Planning System (TIPS)</td>
<td>S2700</td>
<td>48</td>
</tr>
<tr>
<td>Test Adapter Efficiency Improvement</td>
<td>S2626</td>
<td>40</td>
</tr>
<tr>
<td>UHP SHT / MIP Removal Using Dual-Track Crawler System</td>
<td>S2599</td>
<td>102</td>
</tr>
<tr>
<td>Unit Family Construction Optimization</td>
<td>S2690</td>
<td>46</td>
</tr>
<tr>
<td>Very Low-Cost Radar for CH-53K DVE</td>
<td>A2692</td>
<td>90</td>
</tr>
<tr>
<td>VIRGINIA Class Submarine Alternative Coating and Surface Preparation Solutions for Ball Valves</td>
<td>S2649</td>
<td>63</td>
</tr>
<tr>
<td>Weld Sequence Planning for Major Assemblies</td>
<td>S2602</td>
<td>60</td>
</tr>
</tbody>
</table>
## INDEX

By Project Number

<table>
<thead>
<tr>
<th>Project #</th>
<th>Project Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2214</td>
<td>Flexible Manufacturing of Novel Energetic Materials (Flex NEM)</td>
<td>98</td>
</tr>
<tr>
<td>S2385</td>
<td>Continuous Wave Illuminator Transmitter Upgrade</td>
<td>34</td>
</tr>
<tr>
<td>S2487</td>
<td>SPS-48E Radome Replacement</td>
<td>92</td>
</tr>
<tr>
<td>S2489</td>
<td>SiC High-Efficiency Power Switches Wafer Process Improvement</td>
<td>35</td>
</tr>
<tr>
<td>A2513</td>
<td>F-35 Automated and Rapid Boot Installation Phase 1</td>
<td>72</td>
</tr>
<tr>
<td>S2532</td>
<td>Composite Hybrid Rotating Coupling Covers</td>
<td>22</td>
</tr>
<tr>
<td>Q2533</td>
<td>Composite Manufacturing Technology for Fire Safe Resin</td>
<td>54</td>
</tr>
<tr>
<td>S2547</td>
<td>Improved Cable Lay and Sequencing for VIRGINIA Class (VCS) and COLUMBIA Class (CLB) Submarine Programs</td>
<td>55</td>
</tr>
<tr>
<td>S2558</td>
<td>Manufacturing Cost Reduction for LCS Scalable Electronic Warfare (EW) System</td>
<td>52</td>
</tr>
<tr>
<td>S2559-2</td>
<td>Fiber Optic Measurement and Shape Sensing Phase 2</td>
<td>56</td>
</tr>
<tr>
<td>S2571</td>
<td>Synchronizing Material Logistics with CVN Pier &amp; Dry Dock Build Strategies</td>
<td>23</td>
</tr>
<tr>
<td>A2575</td>
<td>Energetics Production Utilizing Resonant Acoustic Mixing (RAM)</td>
<td>99</td>
</tr>
<tr>
<td>A2583</td>
<td>Smart Processing Manufacturing Technology</td>
<td>73</td>
</tr>
<tr>
<td>S2593-A-B</td>
<td>Critical Resource Planning</td>
<td>57</td>
</tr>
<tr>
<td>S2594</td>
<td>Dynamic Change Awareness</td>
<td>36</td>
</tr>
<tr>
<td>S2595</td>
<td>High Deposition Submerged Arc Welding for Ford-Class Aircraft Carriers</td>
<td>24</td>
</tr>
<tr>
<td>Q2596</td>
<td>Enabling Technologies for Integrated Manufacturing of Submarine Components</td>
<td>58</td>
</tr>
<tr>
<td>S2599</td>
<td>UHP SHT / MIP Removal Using Dual-Track Crawler System</td>
<td>102</td>
</tr>
<tr>
<td>S2600</td>
<td>Shipyard Capacity Planning Tools at BIW</td>
<td>37</td>
</tr>
<tr>
<td>S2601</td>
<td>Low-Cost Hybrid Fairings</td>
<td>59</td>
</tr>
<tr>
<td>S2602</td>
<td>Weld Sequence Planning for Major Assemblies</td>
<td>60</td>
</tr>
<tr>
<td>S2604</td>
<td>Shape Cutting and Welding Automation</td>
<td>38</td>
</tr>
<tr>
<td>S2606</td>
<td>Efficient Identification of Plate Defects</td>
<td>25</td>
</tr>
<tr>
<td>A2609-A-B</td>
<td>F-35 Primer Thickness Control</td>
<td>74</td>
</tr>
<tr>
<td>S2612</td>
<td>Automated Manufacturing Cell for Small Repetitive Assemblies</td>
<td>39</td>
</tr>
<tr>
<td>A2616</td>
<td>CH-53K Ice Detection Repackaging &amp; Affordability</td>
<td>88</td>
</tr>
<tr>
<td>A2620</td>
<td>Optical Evaluation of Sapphire Panels</td>
<td>75</td>
</tr>
<tr>
<td>J2622</td>
<td>F-35 Electro-Optical Targeting System (EOTS) Producibility Phase 4</td>
<td>76</td>
</tr>
<tr>
<td>A2623</td>
<td>EODAS Nodule Defect Reduction</td>
<td>77</td>
</tr>
<tr>
<td>A2624</td>
<td>F-35 EOTS Producibility Phase 2</td>
<td>78</td>
</tr>
<tr>
<td>S2626</td>
<td>Test Adapter Efficiency Improvement</td>
<td>40</td>
</tr>
<tr>
<td>S2628</td>
<td>Augmented Visualization for Manual Welding</td>
<td>41</td>
</tr>
<tr>
<td>A2632</td>
<td>Automated Turbine Airfoil Trailing Edge Rounding</td>
<td>79</td>
</tr>
<tr>
<td>S2633</td>
<td>Self-Locating / Self-Fixture Structures</td>
<td>61</td>
</tr>
</tbody>
</table>
## INDEX
### By Project Number

<table>
<thead>
<tr>
<th>Project #</th>
<th>Project Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2634</td>
<td>Automated Hanger Manufacturing</td>
<td>62</td>
</tr>
<tr>
<td>S2636</td>
<td>Robotic Welding of Complex Structures</td>
<td>42</td>
</tr>
<tr>
<td>S2633</td>
<td>Acoustic Sensing Through Energized Electrical Enclosures</td>
<td>26</td>
</tr>
<tr>
<td>A2644</td>
<td>Powder Metal Advanced Grinding</td>
<td>80</td>
</tr>
<tr>
<td>A2647</td>
<td>Additive Manufacturing Repair of AV-8 LPC Seal</td>
<td>103</td>
</tr>
<tr>
<td>S2649</td>
<td>VIRGINIA Class Submarine Alternative Coating and Surface Preparation Solutions for Ball Valves</td>
<td>63</td>
</tr>
<tr>
<td>S2652</td>
<td>Optimized Lifting and Handling</td>
<td>43</td>
</tr>
<tr>
<td>S2653</td>
<td>Mobile Computing for Design Build</td>
<td>64</td>
</tr>
<tr>
<td>S2655-1</td>
<td>Automated Manufacturing of Hull Tiles Phase 1</td>
<td>65</td>
</tr>
<tr>
<td>A2656</td>
<td>F-35 Assembly Metadata Integration</td>
<td>81</td>
</tr>
<tr>
<td>A2657</td>
<td>Plasma Surface Preparation for Composite Nutplate Installation</td>
<td>82</td>
</tr>
<tr>
<td>S2660</td>
<td>Resource Availability</td>
<td>44</td>
</tr>
<tr>
<td>S2662</td>
<td>Non-Contact Metrology in Shipbuilding</td>
<td>27</td>
</tr>
<tr>
<td>S2664</td>
<td>Induction Straightening for CVN</td>
<td>28</td>
</tr>
<tr>
<td>S2667</td>
<td>Enhanced Task Assignment Progressing</td>
<td>45</td>
</tr>
<tr>
<td>M2676</td>
<td>Back-fit Composite Flood Grates</td>
<td>66</td>
</tr>
<tr>
<td>S2677</td>
<td>Plug-and-Play Composites</td>
<td>67</td>
</tr>
<tr>
<td>S2682</td>
<td>Low Loss Launch Valve (LLLV) Plug Maintainability Improvement</td>
<td>104</td>
</tr>
<tr>
<td>S2686</td>
<td>Electromagnetic Aircraft Launch System (EMALS) Armature Assembly Producibility Improvements</td>
<td>29</td>
</tr>
<tr>
<td>A2687</td>
<td>CH-53K Frame Machining Distortion Mitigation</td>
<td>89</td>
</tr>
<tr>
<td>Q2688</td>
<td>AFP/ATL Hybrid Structures</td>
<td>83</td>
</tr>
<tr>
<td>A2689</td>
<td>Grinding Swarf Reclamation and Reversion</td>
<td>84</td>
</tr>
<tr>
<td>S2690</td>
<td>Unit Family Construction Optimization</td>
<td>46</td>
</tr>
<tr>
<td>S2691</td>
<td>Pipe Cutting Machine Technology</td>
<td>68</td>
</tr>
<tr>
<td>A2692</td>
<td>Very Low-Cost Radar for CH-53K DVE</td>
<td>90</td>
</tr>
<tr>
<td>S2697</td>
<td>HLAW Process Verification and Implementation for Ship Production</td>
<td>47</td>
</tr>
<tr>
<td>S2700</td>
<td>Tactical Information Planning System (TIPS)</td>
<td>48</td>
</tr>
<tr>
<td>S2701</td>
<td>Digital Paint Tools &amp; Process Optimization</td>
<td>49</td>
</tr>
<tr>
<td>A2704</td>
<td>F-35 Transparency Clean-up Automation - Pad Changing</td>
<td>85</td>
</tr>
<tr>
<td>T2710</td>
<td>Manufacturing Process Optimization of Azimuth and Inertial MEMS</td>
<td>93</td>
</tr>
<tr>
<td>Q2711</td>
<td>Inspection Under SHT Phase 1</td>
<td>69</td>
</tr>
<tr>
<td>S2714</td>
<td>PSNS&amp;IMF Submarine Factory Simulation and Capacity Planning</td>
<td>70</td>
</tr>
<tr>
<td>T2716</td>
<td>Development of Additive Manufacturing Processes for Corrosion Resistant Alloys</td>
<td>94</td>
</tr>
<tr>
<td>R2722</td>
<td>Automated Part Detail Extraction</td>
<td>50</td>
</tr>
</tbody>
</table>
## INDEX

By Project Number

<table>
<thead>
<tr>
<th>Project #</th>
<th>Project Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2726</td>
<td>Geospatial Component Location, Identification and Condition</td>
<td>30</td>
</tr>
<tr>
<td>S2727</td>
<td>Advanced Steel Production Facility - Industrial Modeling &amp; Simulation</td>
<td>31</td>
</tr>
<tr>
<td>S2744</td>
<td>Hatchable Cold Spray Technology for Naval Shipyards and Marine Corps Depots</td>
<td>95</td>
</tr>
</tbody>
</table>
## INDEX

**By COE**

<table>
<thead>
<tr>
<th>COE</th>
<th>Project #</th>
<th>Project Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMTC</td>
<td>A2513</td>
<td>F-35 Automated and Rapid Boot Installation Phase 1</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>S2532</td>
<td>Composite Hybrid Rotating Coupling Covers</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Q2533</td>
<td>Composite Manufacturing Technology for Fire Safe Resins</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>A2583</td>
<td>Smart Processing Manufacturing Technology</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Q2596</td>
<td>Enabling Technologies for Integrated Manufacturing of Submarine Components</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>S2601</td>
<td>Low-Cost Hybrid Fairings</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>S2655-1</td>
<td>Automated Manufacturing of Hull Tiles Phase 1</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>A2657</td>
<td>Plasma Surface Preparation for Composite Nutplate Installation</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>M2676</td>
<td>Back-fit Composite Flood Grates</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>S2677</td>
<td>Plug-and-Play Composites</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Q2688</td>
<td>AFP/ATL Hybrid Structures</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>A2704</td>
<td>F-35 Transparency Clean-up Automation - Pad Changing</td>
<td>85</td>
</tr>
<tr>
<td>EMPF</td>
<td>S2385</td>
<td>Continuous Wave Illuminator Transmitter Upgrade</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>S2558-1-2</td>
<td>Manufacturing Cost Reduction for LCS Scalable Electronic Warfare (EW) System</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>A2616</td>
<td>CH-53K Ice Detection Repackaging &amp; Affordability</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>A2692</td>
<td>Very Low-Cost Radar for CH-53K DVE</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>T2710</td>
<td>Manufacturing Process Optimization of Azimuth and Inertial MEMS</td>
<td>93</td>
</tr>
<tr>
<td>EMTC</td>
<td>S2214</td>
<td>Flexible Manufacturing of Novel Energetic Materials (Flex NEM)</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>A2575</td>
<td>Energetics Production Utilizing Resonant Acoustic Mixing (RAM)</td>
<td>99</td>
</tr>
<tr>
<td>EOC</td>
<td>S2487</td>
<td>SPS-48E Radome Replacement</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>S2489</td>
<td>SiC High-Efficiency Power Switches Wafer Process Improvement</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>S2559-2</td>
<td>Fiber Optic Measurement and Shape Sensing Phase 2</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>A2620</td>
<td>Optical Evaluation of Sapphire Panels</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>J2622</td>
<td>F35- Electro-Optical Targeting System (EOTS) Productibility</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>A2623</td>
<td>EODAS Nodule Defect Reduction</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>A2624</td>
<td>F-35 EOTS Productibility Phase 2</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>S2626</td>
<td>Test Adapter Efficiency Improvement</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>S2628</td>
<td>Augmented Visualization for Manual Welding</td>
<td>41</td>
</tr>
</tbody>
</table>
## INDEX

### By COE

<table>
<thead>
<tr>
<th>COE</th>
<th>Project #</th>
<th>Project Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>iMAST</td>
<td>S2593-A-B</td>
<td>Critical Resource Planning</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>S2599</td>
<td>UHP SHT / MIP Removal Using Dual-Track Crawler System</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>S2600</td>
<td>Shipyard Capacity Planning Tools at BIW</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>A2609-A-B</td>
<td>F-35 Primer Thickness Control</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>S2643</td>
<td>Acoustic Sensing Through Energized Electrical Enclosures</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>A2644</td>
<td>Powder Metal Advanced Grinding</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>A2647</td>
<td>Additive Manufacturing Repair of AV-8 LPC Seal</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>S2649</td>
<td>VIRGINIA Class Submarine Alternative Coating and Surface Preparation Solutions</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>S2682</td>
<td>Low Loss Launch Valve (LLLV) Plug Maintainability Improvement</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>S2686</td>
<td>Electromagnetic Aircraft Launch System (EMALS) Armature Assembly Productivity</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>S2714</td>
<td>PSNS&amp;IMF Submarine Factory Simulation and Capacity Planning</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>T2716</td>
<td>Development of Additive Manufacturing Processes for Corrosion Resistant Alloys</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>S2727</td>
<td>Advanced Steel Production Facility - Industrial Modeling &amp; Simulation</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>S2744</td>
<td>Hatchable Cold Spray Technology for Naval Shipyards and Marine Corps Depots</td>
<td>95</td>
</tr>
<tr>
<td>NMC</td>
<td>S2602</td>
<td>Weld Sequence Planning for Major Assemblies</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>S2604</td>
<td>Shape Cutting and Welding Automation</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>S2606</td>
<td>Efficient Identification of Plate Defects</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>S2612</td>
<td>Automated Manufacturing Cell for Small Repetitive Assemblies</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>A2632</td>
<td>Automated Turbine Airfoil Trailing Edge Rounding</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>S2633</td>
<td>Self-Locating / Self-Fixtureed Structures</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>S2634</td>
<td>Automated Hanger Manufacturing</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>S2636</td>
<td>Robotic Welding of Complex Structures</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>A2687</td>
<td>CH-53K Frame Machining Distortion Mitigation</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>A2689</td>
<td>Grinding Swarf Reclamation and Reversion</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>S2690</td>
<td>Unit Family Construction Optimization</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>S2691</td>
<td>Pipe Cutting Machine Technology</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Q2711</td>
<td>Inspection Under SHT Phase 1</td>
<td>69</td>
</tr>
</tbody>
</table>
## INDEX
### By COE

<table>
<thead>
<tr>
<th>COE</th>
<th>Project #</th>
<th>Project Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSAM</td>
<td>S2547</td>
<td>Improved Cable Lay and Sequencing for VIRGINIA Class (VCS) and COLUMBIA Class Programs</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>S2571</td>
<td>Synchronizing Material Logistics with CVN Pier &amp; Dry Dock Build Strategies</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>S2593-A-B</td>
<td>Critical Resource Planning</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>S2594</td>
<td>Dynamic Change Awareness</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>S2595</td>
<td>High Deposition Submerged Arc Welding for Ford-Class Aircraft Carriers</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>A2609-A-B</td>
<td>F-35 Primer Thickness Control</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>S2652</td>
<td>Optimized Lifting and Handling</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>S2653</td>
<td>Mobile Computing for Design Build</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>A2656</td>
<td>F-35 Assembly Metadata Integration</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>S2660</td>
<td>Resource Availability</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>S2662</td>
<td>Non-Contact Metrology in Shipbuilding</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>S2664</td>
<td>Induction Straightening for CVN</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>S2667</td>
<td>Enhanced Task Assignment Progressing</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>S2697</td>
<td>HLAW Process Verification and Implementation for Ship Production</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>S2700</td>
<td>Tactical Information Planning System (TIPS)</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>S2701</td>
<td>Digital Paint Tools &amp; Process Optimization</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>R2722</td>
<td>Automated Part Detail Extraction</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>M2726</td>
<td>Geospatial Component Location, Identification and Condition</td>
<td>30</td>
</tr>
</tbody>
</table>