2008 Annual Report

Advanced Metalworking Solutions

For Naval Systems That Go in Harm's Way

NMC Navy Metalworking Center

DIRECTORS' LETTERS

RADM Landay is a champion of the Navy ManTech Program. Prior to his reassignment to Program Executive Officer for Ships from his position as Chief of Naval Research, he stated, "ManTech is making excellent progress, but don't get complacent. Continue looking for new opportunities." The Navy Metalworking Center (NMC) is making headway in realizing his challenge.

For example, HSLA-115—a high-strength steel that exhibits improved performance—is being incorporated into the design of the USS Gerald R. Ford, the lead ship in the Navy's new class of aircraft carriers. Because of the solid technical work, project management and perseverance of NMC and its team members, an alternate material has been qualified for use on the CVN 78 flight deck that will reduce weight by an estimated 100–200 long tons. The success of this project provided the weight savings needed for this ship class without adding cost, a noteworthy technical achievement.

HSLA 115 is just one example of NMC looking for opportunities to help the Navy meet both its performance and cost acquisition goals. Navy ManTech and NMC are playing an increasingly more decisive role in helping the Navy improve the affordability of its platforms. The 2008 NMC Annual Report provides an excellent opportunity to learn more about NMC; its projects in support of Virginia Class Submarines, CVN 21, DDG 1000 and Littoral Combat Ship; as well as ManTech's Shipbuilding Affordability initiative.

ManTech efforts have high visibility, and the ManTech Program is being recognized for work that is being implemented and making a difference, in part, because of projects like HSLA-115. I thank Dan Winterscheidt and his team for their excellent work and look forward to the Navy Metalworking Center's continued success.

John U. Carney
Director, Manufacturing Technology Program
Office of Naval Research

Legendary basketball coach John Wooden once said, "… real competitors relish the challenge, the bigger the better. The more difficult the game, the more they improve… The difficult challenge provides the rare opportunity to do their best." Like Wooden, I believe that a bit of adversity brings out the best in our people. In recent years, NMC and its staff have demonstrated the capacity to embrace challenge.

NMC has made considerable progress executing projects that will have a significant positive impact on the Navy. For example, as a result of our HSLA-115 project, a higher-strength steel that provides improved performance and reduced weight has been approved for use and incorporated into the design of CVN 78. For the LCS Program, we developed a transportable, low-cost friction stir welding prototype that produces stiffened aluminum panels, results in lower capital and operating costs and soon will be transitioned to an LCS production facility. On another project, NMC and its team members advanced the technical maturity of LASCOR metallic sandwich panels to the point where the technology is being used to manufacture Deck Edge Safety Berms and Personnel Safety Barrier Panels for DDG 1000. LASCOR offers a lower-cost solution, higher strength relative to weight, corrosion resistance and less distortion.

All of these projects encountered significant challenges. All were successful because of the dedicated people managing and supporting them. The success of these projects is directly attributable to NMC staff and their technical competence, strong work ethic, ability to build and cultivate strong teams, unwavering commitment to the customer, and flexibility in adapting and responding to change. NMC did not yield to the challenge but rather honed its game and advanced to a higher level of competition.

The Navy faces a significant challenge to meet its goal of increasing the number of ships in the fleet to 313 by the year 2020. The affordability competition will be fierce, but the rewards will be great. I am confident that the people of the Navy Metalworking Center are prepared for the Navy's 21st century challenges and will continue to implement advanced metalworking solutions for naval systems that go in harm's way.

Daniel L. Winterscheidt, Ph.D.
Program Director, Navy Metalworking Center

SUBMARINES

Virginia Class Submarine, GDEB photo

Sand casting, *CTC* photo

The Office of Naval Research has estimated that the Navy ManTech Program will reduce the cost of Virginia Class Submarines (VCS) by at least $30 million per hull. The Navy Metalworking Center (NMC) is one of nine Navy ManTech Centers of Excellence developing improved manufacturing processes and equipment for VCS, the Navy's newest nuclear-powered submarine designed to excel in a wide range of war-fighting missions.

NMC is working on 10 projects aimed at decreasing costs for the VCS Program. Areas of focus include improved welding, pipe fitting, casting, forming and other processes. In addition, a recently completed VCS project resulted in the implementation of refined manufacturing methods for pipe welding.

Improving Manufacturing Processes to Reduce Cost of VCS

NMC's newest VCS project will reduce the cost of each submarine by improving the producibility of the submarine's weapons cradles, which are used to secure weapons from the time they are loaded onto the ship until just prior to launch. Because a large amount of welding is used to fabricate the long, thin assemblies, it is difficult to construct them to meet the precise dimensional tolerances. NMC is analyzing the manufacturing processes used to fabricate the cradle and make recommendations for improvement. This will result in a decrease in the rejection rate and subsequent rework of weapons cradles, along with an improvement in production costs and lead time. The recommendations of this rapid response project will be incorporated into the manufacturing process by Northrop Grumman Shipbuilding-Newport News (NGSB-NN) and General Dynamics Electric Boat (GDEB). In addition to these shipyards, NMC is working with the Virginia Class Submarine Program Office and Naval Undersea Warfare Center.

Increasing efficiency and throughput in the GDEB machine shops is the goal of another NMC-led effort. The Integrated Project Team, including the VCS Program Office, Naval Sea Systems Command (NAVSEA) and Penn State Applied Research Laboratory, will develop simulation models of two GDEB machine shops that manufacture VCS to determine the best approach to address expected and proposed changes, e.g., increased production, new equipment, etc. The information gathered and technologies recommended will streamline production and better manage resources at GDEB's machine shops in Groton, Connecticut, and Quonset Point, Rhode Island. Manufacturing savings will result from reduced labor hours, as well as improved process flow, allocation of work load resources, work efficiency and throughput.

In an effort to reduce casting process costs, NMC is leading a project that is assessing current VCS casting issues such as inclusions and entrapped gas. Process improvements will be identified and NGSB-NN will prepare test castings to validate these improvements. Benefits include improved machining and delivery time, which are expected to reduce process costs by 10,000 labor hours per year. The Integrated Project Team also includes the VCS Program Office, NAVSEA, Naval Surface Warfare Center Carderock Division (NSWCCD) and GDEB.

Addressing Manufacturing Issues Unique to Piping Systems

Lowering the manufacturing costs of VCS piping systems is the focus of an NMC project demonstrating a newly identified forming technique. The cost to produce seamless Alloy 625 large-bore elbows and tees is high due to expensive raw material and forming costs. NMC and the Integrated Project Team will validate that a closed die, cold forming technique can be economically and successfully applied to manufacture large bore, seamless elbows made of Alloy 625, a nickel-based alloy. The estimated total cost savings per shipset is $660K. The manufacturing process involved is applicable to new construction, overhaul and repair, and can be further extended to Alloy 625 piping systems on all Navy platforms. The project team includes the Virginia Class Submarine Program Office, NAVSEA, GDEB, Nuflo Inc. and NGSB-NN.

NMC has initiated a project that will reduce the number of production labor hours needed to prepare and weld small diameter (<3") pipes, which require complex configurations for set-up, positioning, fixturing and joint preparations on VCS. By applying improved joint preparation tools and methods, automation techniques and work cell optimizations, the number of pipe construction labor hours will be reduced by as much as 20 percent. Managed by NMC, an Integrated Project Team consisting of the VCS Program Office, GDEB, NGSB-NN, NAVSEA and NSWCCD will identify, develop, demonstrate and validate pipe welding process improvements for this VCS application. The automated manufacturing methods can also be applied to other ship systems.

New Hampshire (SSN 778)
GDEB photo

GDEB recently implemented the results of a project that addressed deficiencies in the welds of large diameter, thin-walled Alloy 625 pipe on VCS. The initial goal of the project was to identify new welding techniques, but NMC and the Integrated Project Team discovered that improving the fit-up of the piping components would reduce the weld rejection rate. The project provided evidence that currently used practices and techniques, when followed meticulously, and the implementation of "better than specification" fit-up tolerances result in acceptable welded joints. GDEB implemented these improved processes in the summer of 2007 on re-welding of shipboard welds for SSN 778 and will use them for initial welding applications at both the Groton and Quonset Point facilities. Also included in this effort were the VCS Program Office, NAVSEA, NSWCCD, NGSB-NN and the Navy Joining Center.

Clean steel technology will be incorporated into NGSB-NN foundry standard operating procedures for hull insert castings; it is applicable to other VCS components and marine structures. NGSB-NN photo

Optimizing Surface Treatment Technologies

NMC is working to identify and evaluate alternative damping materials that can be applied more efficiently, reducing the total cost of damping material by 20 percent for VCS. The application process for the damping tiles, which reduce vibration, is labor-intensive and has significant potential for reduction. The project, which involves the VCS Program Office, GDEB, NGSB-NN and NSWCCD, is focusing on materials that have more efficient application rates and meet military requirements for damping characteristics, adhesion strengths in peel and shock, toxicity, flame retardancy and others.

New Hampshire (SSN 778) in GDEB main building shed, GDEB photo

Alternate cladding techniques are being investigated in another NMC project that will reduce the production cost and timeframe for VCS. GDEB currently uses hot wire gas tungsten arc welding, which produces a high-quality clad overlay but at a low deposition rate relative to other cladding processes. NMC and the project team will evaluate up to three alternate processes—plasma transferred arc welding, gas metal arc welding and submerged arc welding—in an effort to increase deposition rates from 6 lbs/hour to 10 lbs/hour while maintaining stringent quality requirements. This work is being conducted in conjunction with a cladding work cell project being carried out by the Institute for Manufacturing and Sustainment Technologies (iMAST). The down-selected cladding process technology will be implemented at GDEB's Quonset Point and Groton shipyards. Other team members are the VCS Program Office and NSWCCD.

AIRCRAFT CARRIERS

Alloy 625 testing, *CTC* photo

CVN 78, U.S. Navy image

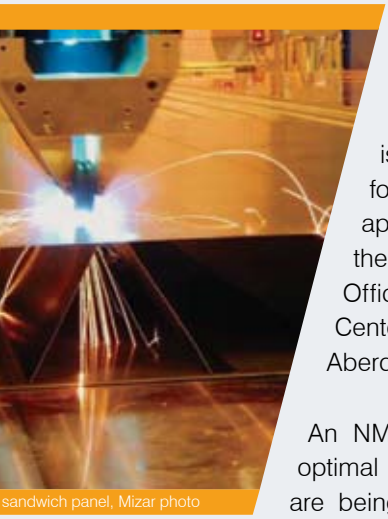
Laser-welded metallic

The USS Gerald R. Ford (CVN 78) represents the Navy's first major investment in aircraft carrier design since the 1960s Nimitz class. The USS Gerald R. Ford is the first ship in the CVN 21 Program, a class that will provide early, decisive striking power in major combat operations. The keel on CVN 78 is scheduled to be laid in late 2009, with delivery scheduled for 2015. The Navy plans to build 11 Ford-class aircraft carriers, and the Navy Metalworking Center (NMC) is involved in projects that support the early stages of development and ensure the best possible cost for the fleet.

Developing Innovative Material Solutions for CVN 78

NMC is leading an effort to support the transition of LASer-welded corrugated-CORe (LASCOR) metallic sandwich panels to future Navy applications. LASCOR is a stiff, lightweight steel structure that offers corrosion resistance, reduced weight and less distortion. While optimizing the LASCOR design for materials, manufacturability, joining, structural and protection performance and cost, this project successfully manufactured large (78 x 240-inch) LASCOR panels of CRES 2003, a lean duplex stainless steel from Allegheny Ludlum. Testing has shown that these panels provide enhanced strength, protection and corrosion resistance. Contributors to this effort are Applied Thermal Sciences, Inc; Future Aircraft Carriers Program Office; NAVSEA; NSWCCD; NGSB-NN; and iMAST. Because of the superior technical performance and the competitive cost of this technology, LASCOR is currently being used to develop DDG 1000 Deck Edge Safety Berms and Personnel Safety Barriers for Bath Iron Works (BIW). Other potential LASCOR applications being investigated for implementation include decks, bulkheads, covers, doors, ramps and other structural applications.

A creative material processing innovation developed through an NMC project has been incorporated into the design of CVN 78. The goal was to reduce top-side weight and lower the center of gravity on the ship. An initial solution using 10Ni steel did not produce the intended results. Instead of ending the project, the Integrated Project Team pursued an alternate path—increasing the performance and strength of HSLA-100 steel through heat treatment so that it could be used at reduced thicknesses, and thus, reduced weight, while meeting performance requirements. By improving the processing and heat treatment of HSLA-115 (named for its increased minimum yield strength of 115 ksi), the team increased the yield strength without compromising toughness, survivability, weldability and formability. Based upon the results of this project, the Future Aircraft Carriers Program has incorporated HSLA-115 into the CVN 78 ship design. Ship construction is expected to begin in 2009, but the project will continue through 2010, first certifying

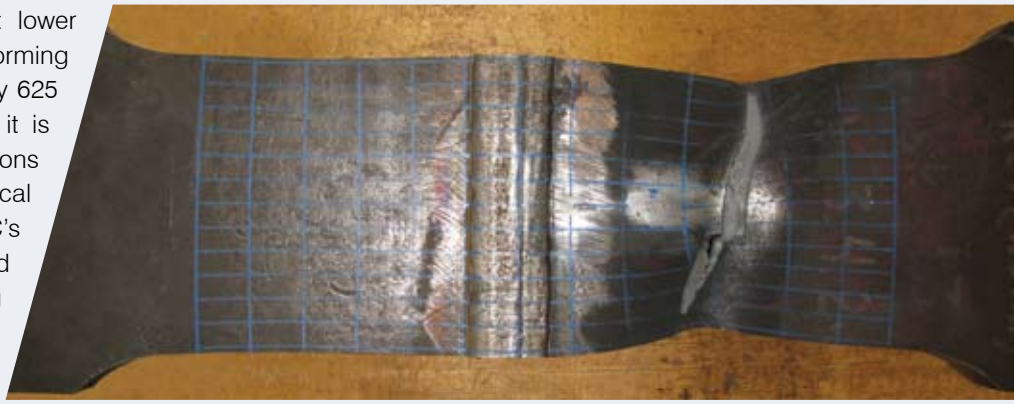

sandwich panel, Mizar photo

a vendor that can consistently and reliably produce the large HSLA-115 plates needed, then providing relevant data on further evaluation that is required for life-cycle management for CVN 78 and future HSLA-115 applications. Team members include the Future Aircraft Carriers Program Office, NAVSEA, NSWCCD, Navy Joining Center, NGSB-NN, Mittal Steel USA and Aberdeen Test Center.

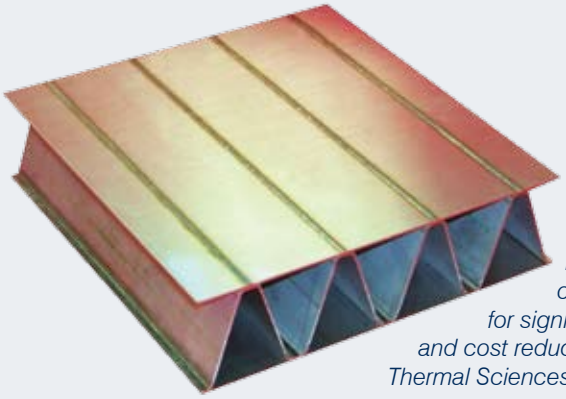
An NMC project was initiated to identify optimal Alloy 625 forming practices, which are being implemented into the fabrication of several critical components on CVN 78, preventing potentially significant schedule delays. Alloy 625 is difficult to form, particularly at lower temperatures. This project identified optimal forming practices and maximum forming limits for Alloy 625 on CVN 78 applications, demonstrating that it is possible to achieve very large cold deformations without impairing the mechanical/physical properties. Tests were conducted on NMC's 850-ton forming press using tooling fabricated specifically for these tests. The implementing shipyard, NGSB-NN, is incorporating the lessons learned from this project, including forming limits, welding preparation, drawing improvements and preparation for blast and coat. Other Integrated Project Team members include NAVSEA and the Future Aircraft Carriers Program Office.

Reducing Shipbuilding Process Costs

The Navy's requirements for qualification of welding procedures and welder performance can make it difficult for inexperienced vendors to develop the required documentation. NMC is managing a project that will continue the development of a Web-based welding procedure system intended to reduce the rejection rate of vendors' submitted procedures, along with the resulting additional costs. The goal is to reduce the rejection rate from above 90 percent to less than 20 percent. Estimated annual savings are approximately $2.6 million from vendor and shipyard labor savings alone. Additional savings could result from reduced production delays, increased competition among vendors, better vendor retention and increased availability of welding engineers to focus on other process improvements. The software system is planned for implementation during the construction of CVN 78, and is applicable to most non-nuclear-related welding on CVN 79, VCS, DDG 1000, Littoral Combat Ship, Amphibious Transport Dock (LPD) and Auxiliary Dry Cargo Carrier (T-AKE). Weld QC is developing this system, with contributions from NGSB-NN, GDEB, the Future Aircraft Carriers Program Office and NSWCCD.



HSLA-115 plate was successfully evaluated for acceptable under-matched production welding performance with breakage occurring in base material. NMC photo



LASCOR panels offer the potential for significant weight and cost reductions. Applied Thermal Sciences, Inc. photo

NMC worked to reduce the cost of surface preparation of tanks and voids. This was accomplished by two parallel efforts. The first involved soluble salt contamination and the expected rework associated with removing it during the surface preparation process. NMC investigated soluble salt contaminant sources, including where they entered the production process, and recommended efficient mitigation methods, which were validated through an on-site demonstration. The second involved recommending efficient environmental control of the tanks and voids from blasting through cure of the coating system. This involved a comprehensive study of current operations at the shipyard and investigation of equipment through a variety of energy consumption analysis. The project team provided detailed recommendations for the equipment and set-up necessary for efficient operation. This project was accomplished through efforts of an Integrated Project Team consisting of the Future Aircraft Carriers Program Office, NAVSEA and NGSB-NN.

SHIPS

DDG 1000, U.S. Navy image

Littoral Combat Ship, Lockheed Martin photo

Weld Seam

As the honorable Donald C. Winter, Secretary of the Navy, points out in his FY09 Posture Statement, 70 percent of the earth is covered by water, 80 percent of the world's population lives in close proximity to the coast and 90 percent of the world's international commerce is transported via the sea. It's not surprising, then, that the U.S. Navy plays such a critical role in our national security and in our ability to defend and promote our interests.

The FY 2009 Navy shipbuilding budget provides for seven new ships, including one DDG 1000 Destroyer and two Littoral Combat Ships. NMC is advancing technology that will improve those platforms, especially with regard to cost reduction.

Developing Manufacturing Solutions for the Littoral Combat Ship (LCS)

NMC is leading a project to develop a transportable, low-cost friction stir welding (FSW) system to support construction of the next Lockheed Martin LCS, a platform designed to operate quickly in shallow water to counter challenging threats such as mines, submarines and fast surface craft. One of this new FSW system's major benefits is that it can be located right at the shipyard, streamlining the entire production process of near-net shape panels and enabling the welding of panels that are not limited to a size that can be transported by truck. The machine's simplified design also offers lower capital and operating costs. The prototype system is currently undergoing demonstration testing at NMC facilities in Johnstown, Pennsylvania, and is scheduled to be delivered to the LM team construction yard in December 2008. The design of this system will be made available to companies interested in procuring duplicate systems, expanding the benefit of the project to multiple DoD applications. The project also includes contributions from the LCS Program Office, NAVSEA, NSWCCD, American Bureau of Shipping (ABS), Lockheed Martin Maritime Systems and Sensors (LM MS2), Advanced Joining Technologies, Friction Stir Link and Nova-Tech Engineering.

In another project for LCS, NMC is managing an Integrated Project Team that is developing a low-cost bow casting component that provides a much simpler connection between the adjoining hull plate and stem bar, greatly reducing both the costs and duration of shipyard construction and inspection, as well as potentially saving weight. The end result of this project will be a replacement solution for the construction of the stem bar detail. The project team includes the LCS Program Office, LM MS2, NSWCCD, Marinette Marine Corporation, Bollinger Shipyards, ABS, Gibbs & Cox and the Newport News Foundry.


Facing tool, NMC photo

Reducing Costs through Novel Solutions for DDG 1000 and Future Platforms

NMC has several projects in support of DDG 1000 that are also applicable to other platforms and future ships, such as CG(X) Cruiser.

NMC is leading a project to develop a prototype weld seam facing tool that will increase productivity and reduce production costs on DDG 1000. These Zumalt-class destroyers require that hull plating butt welds be ground flush with the hull. Mechanizing the grinding process will avoid damaging the surfaces adjacent to the welds, as well as reduce workforce hazards, such as ergonomic strain, eye injuries, particulate and gaseous emissions and high-decibel noise levels. A total savings of $723,000 per hull is projected from productivity improvements and reduction in safety and health costs associated with manual grinding of welds. BIW and Northrop Grumman Shipbuilding-Gulf Coast (NGSB-GC) will evaluate the prototype, which will be implemented at both shipyards. Also included in the Integrated Project Team are NSWCCD and GDEB.

Another project for DDG 1000 is determining optimum parameters to hybrid laser arc weld HSLA-80 T-Beams, which will reduce production and assembly costs as well as improve T-Beam quality. Laser-welded beams offer less distortion and higher weld travel speeds, resulting in less rework and lower beam production costs. In addition, the improved beam quality provides better fit-up during shipyard construction, which reduces assembly costs. A 25 percent total cost reduction is expected. This project will develop a weld qualification document for beams laser-welded with HSLA-80. The document will be submitted to ABS and the DDG 1000 Program Office for approval prior to BIW using laser-welded beams for ship construction. Also involved in this effort are NAVSEA; NSWCCD; Applied Thermal Sciences, Inc.; NGSB-NN; and NGSB-GC.

The Advanced Gun System (AGS) pallets on DDG 1000 are the focus of an NMC project advancing various production, manufacturing, processing and material enhancements. As a result of this effort, 20 percent reductions in weight and/or cost of the AGS pallets are anticipated. The additional margin on weight will allow for potential safety and survivability improvements, as well as enhancements in the ability to handle the pallet throughout the logistic channel. NMC is reviewing the manufacturing approach and identifying opportunities for reduced manufacturing time, enhanced material selections, alternate manufacturing approaches—such as friction stir welding or near-net-shape casting—and weight and cost reductions. Proposed production methods will focus on decreasing the time and cost to manufacture the pallets, while maintaining the tight tolerances needed for the pallets to function properly. Included in this work are PEO IWS-3C, Naval Surface Warfare Center Dahlgren and Port Hueneme Divisions, and BAE Systems.

Current and future Navy ships will benefit from work on a comprehensive R&D project that is improving the performance of a variety of manufacturing materials and processes. Among the positive developments are a lightweight fire insulation material that can offer equivalent fire protection to existing Navy ships at 20 to 30 percent less weight; a novel dual aluminum casting technology that can be used to reduce life-cycle costs and stress corrosion cracking failures; unique processes using compacted titanium powders that are subsequently flowformed into piping, thereby providing a lower cost piping solution to the Navy; constitutive models that can be used to predict the structural response of ships to various loading scenarios; and fasteners that offer equivalent performance to conventional marine fasteners at a lower cost. The project is receiving technical support from NAVSEA and NSWCCD and involves participation from various shipyards, design agents, and materials and process suppliers.

Prototype friction stir welding machine undergoing demonstration testing at NMC facility in Johnstown, Pennsylvania. NMC photo

AIRCRAFT

N-UCAS, DARPA image

Laser peening system, Metal Improvement Company photo

U.S. Navy aircraft are an integral component of a balanced force needed as our country fights the global war on terror, as well as responds to humanitarian needs around the world. NMC is engaged in several projects that are aimed at improving Navy air weapons systems.

Improving Performance and Reducing Life-Cycle Costs

An NMC project has successfully demonstrated advanced metalworking technologies that will reduce the weight and cost of airframe components on the Navy-Unmanned Combat Air System (N-UCAS). A full-scale significant structural test article consisting of both metal and composite parts was built and tested to demonstrate the applicability of two processes—advanced High Speed Machining to manufacture ultra-thin aluminum spars and Electron Beam Free Form Fabrication to produce lower-cost titanium components. The project demonstrated significant acquisition cost avoidance and a 16 to 35 percent weight reduction of the affected parts. The full-scale test article met or exceeded all requirements established by the Naval Air Systems Command (NAVAIR). The next opportunity to transition the advanced metalworking technologies into the N-UCAS Production Vehicle will be the System Design and Development program in 2012. By inserting ManTech solutions early in the design process, this project will reduce life-cycle costs, preserve development schedules and promote timely transition to the N-UCAS Platform. In addition to NAVAIR and the N-UCAS Advanced Development Program Office, members of the Integrated Project Team were Boeing Phantom Works, Sciaky and the National Institute for Aviation Research.

NMC is working with Metal Improvement Company on a NAVAIR-sponsored project that is testing the potential benefits of laser peening to improve the strength and extend the life of critical aircraft structural, turbine engine and drive train components in the Navy inventory. Laser peening is similar in concept to shot peening but imparts compressive stresses much deeper into components with minimal surface deformation. This project is developing and optimizing the laser peening process for specific Navy components through material evaluation, demonstration and validation tasks.

The Air Vehicle Systems Analysis project is addressing design and maintenance enhancements for the MH-60R maritime helicopter for NAVAIR. NMC is working with Sikorsky; Cherry Point In-Service Support Team; and North Island, Mayport and Norfolk Naval Air Stations on this effort. NMC is providing design, analysis, material expertise, structural analysis and maintenance improvements for the MH-60R's antenna gasket systems, tail section stabilator bushing update, Forward Looking Infrared / Hand-Control Unit and shimming updates of production drawings. The technology in this project will result in reduced fleet support cost, improved maintenance and higher mission availability for the war fighter.

Through these projects, as well as past efforts, the Navy Metalworking Center is developing and implementing advanced technologies for metalworking products and processes. NMC applies these technologies to reduce cost and improve weapon system performance in support of Navy and Department of Defense needs. NMC is committed to continuing its focus on quality, stakeholder needs, customer satisfaction and integrated team building among industry, military and weapon system manufacturers.

The Navy Metalworking Center (NMC) was established in 1988 as one of the Centers of Excellence of the Office of Naval Research's Manufacturing Technology (ManTech) program.

NMC is a national resource for the development and transition of advanced metalworking and manufacturing technologies, materials and related processes. NMC works in partnership with government, industry, weapon system prime contractors and Program Offices to develop and apply advanced metalworking and manufacturing technologies, materials and related processes. NMC drives new technologies from research and development to weapon systems application with two objectives:

- To implement new technologies that will improve weapon system performance
- To develop new production means for weapon system prime contractors and suppliers that lower the production cost of naval and other DoD weapon systems.

NMC has supported the U.S. Navy with affordable new metalworking technologies and capabilities that have responded to increasingly stringent requirements for greater agility, survivability and lethality.

NMC is operated by Concurrent Technologies Corporation, an independent, nonprofit organization located in Johnstown, Pennsylvania. For more information on NMC, visit www.nmc.ctc.com.

Littoral Combat Ship, Lockheed Martin photo

A ManTech Center of Excellence

www.nmc.ctc.com

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