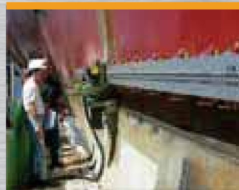
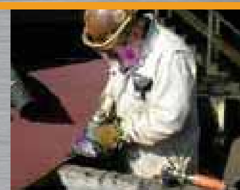
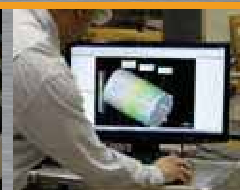
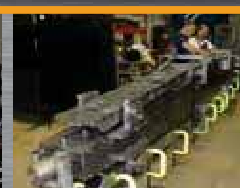
2012 Annual Report

ADVANCED METALWORKING SOLUTIONS FOR NAVAL SYSTEMS THAT GO IN HARM'S WAY





NMC Navy Metalworking Center

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **2012**	2. REPORT TYPE	3. DATES COVERED **00-00-2012 to 00-00-2012**
4. TITLE AND SUBTITLE **Advanced Metalworking Solutions For Naval Systems That Go In Harm's Way**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Navy Metalworking Center,Concurrent Technologies Corporation,100 CTC Drive,Johnstown,PA,15904**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**21**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

For 25 years, the Navy Metalworking Center (NMC) has supported the Navy's evolving needs by developing and transitioning innovative metalworking and manufacturing solutions. Currently, NMC conducts projects that improve manufacturing and shipyard processes by developing solutions that incorporate advanced metalworking, joining and coatings technologies, as well as design for manufacturability tools.

Since it was established as a ManTech Center of Excellence in 1988, NMC and its government and industry partners have driven advanced manufacturing technologies from research and development to application on Navy and other military weapon systems. Moving forward, NMC remains committed to meeting the Navy's critical need to reduce total ownership cost through advanced metalworking solutions for naval systems that go in harm's way.

NMC is operated by Concurrent Technologies Corporation, an independent, nonprofit organization located in Johnstown, PA.

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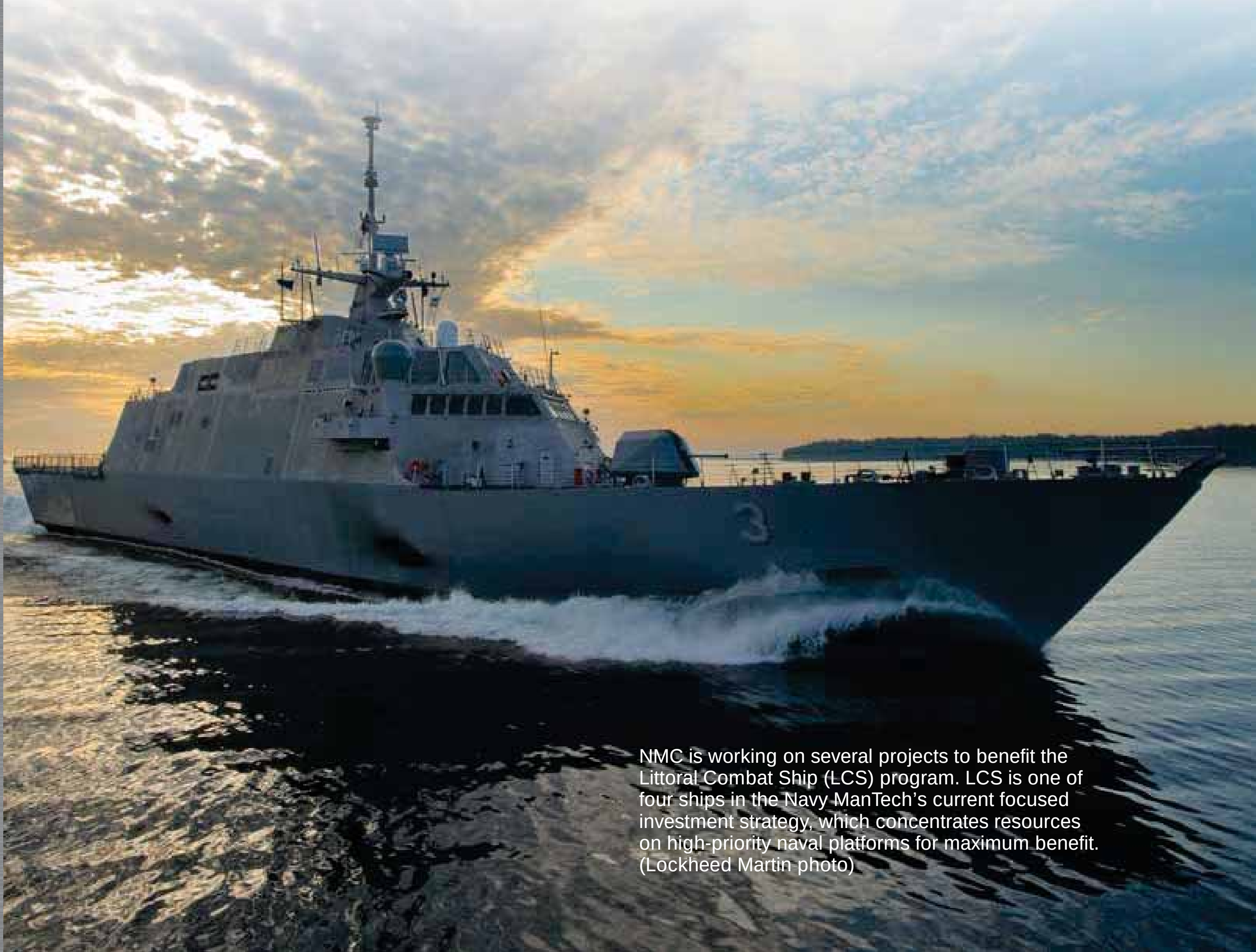
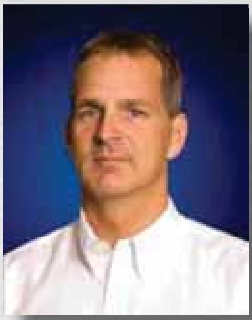


NMC is working on several projects to benefit the Littoral Combat Ship (LCS) program. LCS is one of four ships in the Navy ManTech's current focused investment strategy, which concentrates resources on high-priority naval platforms for maximum benefit. (Lockheed Martin photo)



The U.S. Navy, like other Department of Defense services, is challenged to deliver needed capability in an austere budget environment. The Navy Manufacturing Technology Program (ManTech) plays a critical role in the Navy's ability to meet its affordability and performance challenges.

The ManTech Program, including the Navy Metalworking Center (NMC), continues to execute an investment strategy that helps key acquisition Program Offices achieve their affordability goals. Our strategy includes the Virginia Class Submarine, DDG 51 Class destroyer, Littoral Combat Ship, CVN Class carrier, and the Joint Strike Fighter.

NMC's projects, which are described more fully in this report, reduce total ownership cost by addressing acquisition and life-cycle affordability. For example the Plate Edge Preparation Improvements project is developing a solution for removing surface rust and pre-construction primer from large steel plates that will save up to $7 million on the cost of a modern surface combatant and is 300% faster than the current process. Other projects like Main Propulsion Shaft Taper Inspection will save the naval shipyards $7.5 million in life-cycle refurbishment costs by eliminating the maintenance on gauges currently used and replacing them with white light scanning systems, reducing the labor to perform shaft inspections, and eliminating the need to purchase additional gauges for VCS and CVN.

NMC is making a difference, and I look forward to working with NMC on projects that further reduce total ownership cost and improve the manufacturability of Navy weapon systems.

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

It's all about balance. Weighing up-to-the-minute manufacturing innovations against considerations such as implementation likelihood, ROI, and cost share. The Navy Metalworking Center (NMC) continuously works to find the balance between the latest technology and the potential for those advances to contribute to the Navy's ultimate goal of reducing weapon system total ownership cost.

While NMC experienced a few challenges developing manufacturing advancements that achieve real-world application, in 2012, the Metals Subpanel of the Joint Defense Manufacturing Technology Panel (JDMTP) praised NMC for its high track record of project implementation. One of the implemented projects is reducing $367K per hull by improving pipe wrapping when blasting structural steel on submarines. Yet another NMC project developed an environmental control system for painting operations that is expected to save more than $200K per VCS hull.

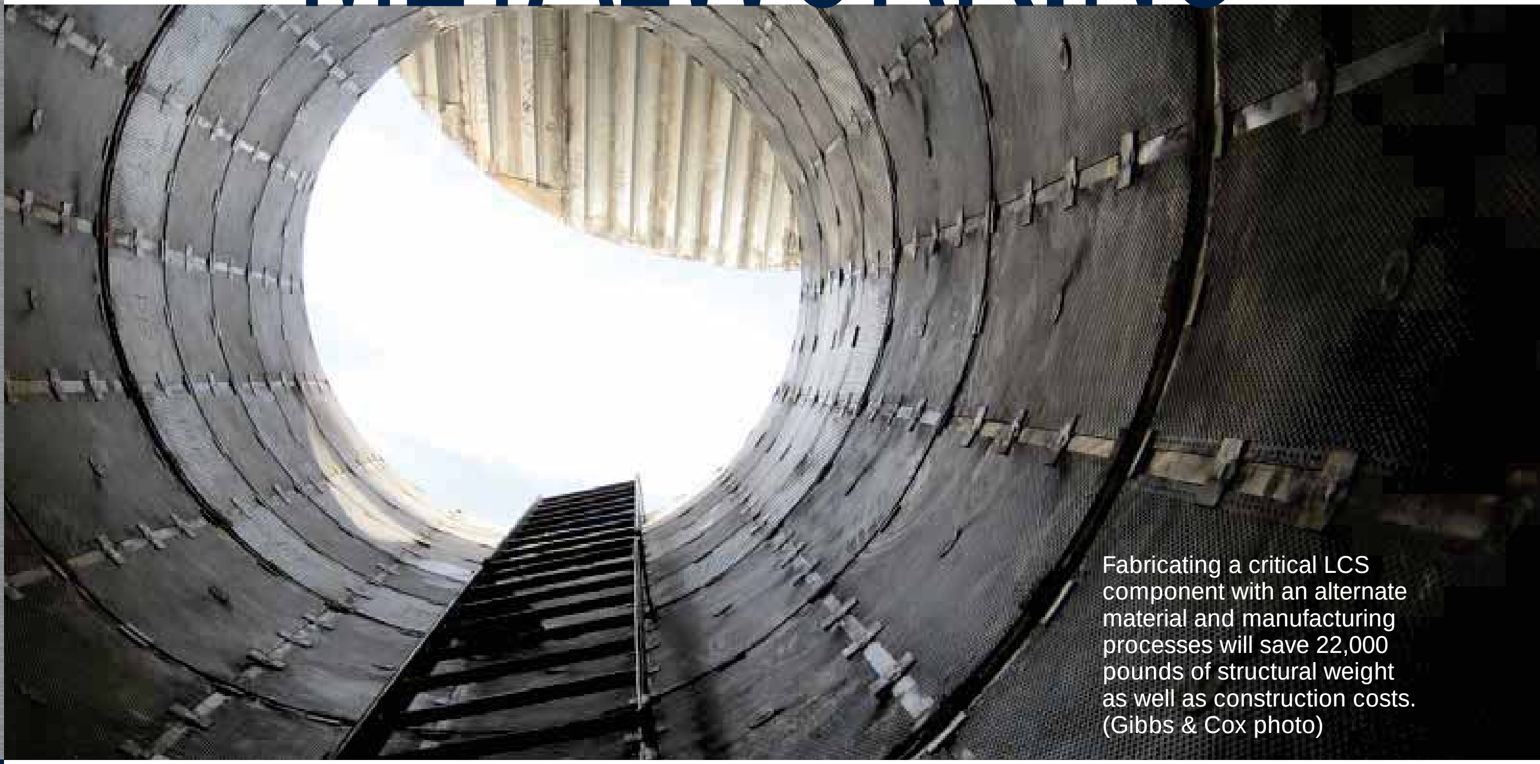
Beyond implementation, NMC's work has also earned recognition from outside agencies. The principals of the JDMTP selected our alternative brazing project as a finalist for the 2012 Defense ManTech Achievement Award. RDML Thomas J. Moore, Program Executive Officer, Aircraft Carriers, also endorsed the nomination for the project, which developed a mechanized system for brazing CVN 78 pipe fittings shipboard.

2013 presents a special opportunity to reflect on the program's past and to plan its future. In January we will begin to celebrate the NMC's 25th anniversary, and in October, I mark my 10th year as the NMC Program Director. Looking ahead, we started an innovative manufacturing project for the Joint Strike Fighter Program, which represents both a new capability area for us in additive manufacturing and a new Program Office to team with and build relationships.

One of the lessons our experience has taught us is that implementing advanced manufacturing is oftentimes challenging but equally rewarding. Albert Einstein said, "Life is like riding a bicycle. To keep your balance you must keep moving." We intend to use our momentum and continue developing advanced metalworking solutions for naval systems that go in harm's way.

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

ADVANCED METALWORKING



Fabricating a critical LCS component with an alternate material and manufacturing processes will save 22,000 pounds of structural weight as well as construction costs. (Gibbs & Cox photo)

At the naming celebration for USS Colorado in June 2012, Secretary of the Navy, the Honorable Ray Mabus, spoke about current Navy shipbuilding priorities. He used the Virginia class submarine (VCS) program to illustrate what's working: "Virginia-class attack submarines have been a tremendous success story. They have been on or ahead of schedule and on or under budget…The USS Mississippi set a record by delivering to the fleet over a year early. That kind of performance is a model for everything we're trying to do in the Navy today." At the heart of the Navy Metalworking Center's work is advancing metalworking technology to improve the affordability of the fleet, which Secretary Mabus said will grow to 300 ships by 2019, even in the current budget environment. About half of the 27 projects highlighted in this annual report support the VCS Program. The rest of the projects address the other Navy platforms in the Office of Naval Research's current Focused Investment Strategy: CVN 78, DDG 51, the Littoral Combat Ship (LCS), and the Joint Strike Fighter.

NMC's work spans a wide variety of manufacturing technologies, including advanced metalworking, design for manufacturability, shipyard processes, joining technologies, and coatings application and removal. In the advanced metalworking area, NMC is utilizing advanced metalworking technologies and/or corrosion-resistant materials to develop innovative solutions that help drive down total ownership cost for targeted Navy platforms.

A Navy Metalworking Center (NMC) Integrated Project Team (IPT) demonstrated that using an alternative material for a critical component on the Freedom-class LCS can save 22,000 pounds of structural weight. The IPT showed that by replacing the incumbent nickel-based INCONEL® Alloy 625 with a lighter-weight, corrosion-resistant alloy and simplifying construction of the exhaust ducting for the gas turbine engines (uptakes), they could reduce weight and lower manufacturing costs of the legacy uptake system. To offset the cost of the alternate material, the IPT developed high-speed, hot-wire gas tungsten arc welding procedures, along with a simpler configuration that would reduce part count and labor cost. A full-scale section of the uptake was manufactured and delivered to the Naval Surface Warfare Center, Philadelphia, for a test stand trial using a gas turbine engine. Assuming that no damage is observed in periodic inspections, the new uptake will be implemented in future LCS builds. The IPT included the LCS Program Office; Lockheed Martin Corporation; Gibbs & Cox, Inc.; Titanium Fabrication Corporation; Marinette Marine Corporation; Naval Surface Warfare Center, Carderock Division (NSWCCD); American Bureau of Shipping (ABS); and NMC.

Using improved abrasive technology in support of VCS construction could lead to a $700,000 cost savings per hull. (Bath Iron Works photo)

Another NMC project involving INCONEL® Alloy 625 will assist in removing one maintenance availability over the life of each VCS. The VCS main propulsion shafts are currently clad with Alloy 625 using an electro-slag strip process, but noticeable wear has been observed in the areas of the propulsor bearing. This project's objective is to recommend journal and bearing material options to increase the current shaft replacement cycle from 72 months to no less than 96 months. Doing that may remove one maintenance availability over the life of each VCS, thereby reducing life-cycle costs. The cost savings per shaft replacement is estimated at $4 million, which includes the material and labor costs associated with shaft replacement and refurbishment. The IPT for this effort includes the VCS Program Office, Naval Sea Systems Command (NAVSEA), General Dynamics Electric Boat (EB), and the Institute for Manufacturing and Sustainment Technologies (iMAST).

To address another issue in VCS construction, NMC is conducting a project that will lead to the use of improved abrasives that also meet the strict cleanliness and detrimental material requirements in place in nuclear shipbuilding. The use of enhanced abrasives can lead to significant savings associated with decreased labor, improved abrasive life, and reduced fatigue and injury due to less vibration. The IPT, which includes the VCS Program Office and NSWCCD, will perform technical evaluations of several commercially available enhanced abrasives. NMC will work with the manufacturers to perform any needed modifications and conduct production evaluations of the final selected abrasives. Cost savings are estimated to be $700,000 per VCS hull, which includes a 7.5 percent labor reduction in operations using improved abrasives at EB. Additional benefits may be realized for overhaul activities.

Improved construction processes involving thin plates are expected to reduce labor costs by $5 million over five years for DDG 51. (NMC photo)

In the construction of DDG 51, Ingalls Shipbuilding is experiencing distortion in thin steel plates used in hull construction, which is driving up costs associated with flattening the plates and addressing excessive weld joint gaps. An NMC project is looking into two main processes that could contribute to thin plate distortion – manufacturing and shipping of the plate and thermal cutting of shapes from parent thin plates. NMC is evaluating the current production processes at supplying steel mills and will recommend plate procurement specifications to help the mills reduce thermal-induced stress. To address thermal-cutting distortion, NMC is investigating the shipyard's plasma cutting equipment and practices and is establishing a set of guidelines for plate nesting, cutting, sequencing and equipment to improve the process. Ingalls estimates that this project's recommendations will save more than $5 million over the next five years. Initial implementation is set for 2014 during the construction of DDG 114. Contributing to this project are ArcelorMittal Burns Harbor, Ingalls, the DDG 51 Program Office, ESAB Cutting Systems, NSWCCD, and NMC.

NMC is addressing manufacturing issues involving the thin plates used in the construction of the Arleigh Burke (DDG 51) class destroyer. (U.S. Navy photo)

Addressing thin plate panel distortion is even more critical considering that the use of these panels is expected to reach 90 percent on future ship construction. In addition to the previous project, NMC is working to improve the fit-up and welding of DH-36 thin plate components to produce panels on DDG 51 class ships. The IPT is investigating ways to improve the fit up of components by improving the consistency of the weld root gaps between the inserts and the panel openings. In addition, the IPT is developing techniques and tooling to minimize distortion during the welding process. Employing these processes will reduce fit-up time and improve quality, avoid distortion mitigation costs, and improve panel line capacity for DDG 51 thin panels. Ingalls expects to save more than $2.6 million over the next five years based on this project's results. The IPT, which consists of Ingalls, DDG 51 Program Office, NSWCCD, and the University of New Orleans, is creating a scaled prototype measurement/trimming system as an implementable station that will demonstrate the capability and benefits to panel insert fit-up for as many plate sizes and weld profiles as possible. The results of the project are targeted to be integrated into DDG 117 panel lines at Ingalls in the first quarter of calendar year 2014.

In a technical area very different than the previously highlighted projects, NMC addressed High Temperature Superconducting Degaussing (HTSDG) systems that the Navy intends to use on future ship platforms. In HTSDG systems, the cryostat provides the necessary insulation to maintain a very low resistance condition in the superconducting cable. Currently, however, no U.S. supplier is capable of manufacturing flexible cryostats that meet Navy application requirements. This project's IPT developed a baseline cryostat insulation system and validated it via thermal performance testing. In addition, the team outlined a recommended manufacturing process for fabrication of the corrugated tubing that comprises the structural component of the cryostat, verifying via finite element analyses that the tubing met application requirements. While the project results were not transitioned due to high capital equipment costs, this work can be implemented when a future industry partner is identified. The IPT included the LCS Program Office, NSWCCD, NMC, Southwire Company, Oak Ridge National Laboratory, ASRC Aerospace and NASA Kennedy Space Center.

DESIGN FOR MANUFACTURABILITY

A prototype weapons cradle weldment incorporates several manufacturing improvements that will reduce costs for VCS weapons cradles that hold torpedoes on the ship. (NMC photo)

Using a design for manufacturability approach, NMC is addressing Navy weapon system manufacturing issues in order to improve producibility and reduce cost.

Manufacturing a long, thin steel structure with extensive welding and machining processes can be a challenge. The weapons cradles on VCS present such a challenge. An NMC-led project is improving the producibility of the cradles, which handle weapons shipboard prior to launch. The IPT developed and is fabricating a prototype improved cradle weldment that integrates many design for manufacturability improvements, including consolidation of multi-piece subassemblies into single-piece construction; design for mechanization to incorporate an improved opposing arc welding process; and elimination or reduction of post-process operations such as machining, pressing, and stress relief. In addition, a four-head opposing arc submerged arc welding process has been optimized to make 20-foot welds in a single pass without back gouging. Newport News Shipbuilding (NNS) has already implemented some incremental cradle process improvement recommendations, and NNS and EB are executing an engineering request to implement the major recommendations starting in 2013. In addition to NNS, EB and NMC, the IPT includes the VCS Program Office; Naval Undersea Warfare Center, Division Newport; and NSWCCD.

Various design for manufacturing improvements will reduce cost and weight for the LCS sliding doors. This photo shows a small-scale mockup that was constructed using welding procedures being investigated through this effort. (Applied Thermal Sciences photo)

The sliding doors on the Freedom-class LCS are also challenging to fabricate. The doors require several labor-intensive welds, which lead to higher cost and structural weight. An NMC project is evaluating the door configuration and manufacturing approach and will recommend improvements that can be readily implemented. Considerations being investigated include the use of metallic sandwich structures; automated or lower heat input welding; improved fixturing, part, and process consolidation and simplification; and modular assembly to reduce cost and weight. After subscale testing, the IPT's recommendations will be prototyped and demonstrated. Acquisition costs are expected to be reduced by $100,000 to $150,000 per LCS hull with the improvements. Pending favorable performance evaluations and approval by Gibbs & Cox and the LCS Program Office, the improved sliding doors will be implemented on LCS 9 in late 2013. The IPT working on this project includes Lockheed Martin, Marinette Marine Corporation, LCS Program Office, NMC, Gibbs & Cox, NSWCCD, and ABS.

NMC is addressing issues occurring in the fabrication of very different doors on another Navy ship, CVN 79. In this case, it is investigating weld distortion and fit-up issues in the manufacture of the new lighter-weight design of the weapons and stores elevator doors. Improvements will be developed and assessed in several categories: evaluating alternate materials and construction processes; optimizing current manufacturing processes; and implementing design for manufacturing and assembly recommendations. The IPT, which includes NNS, NMC, CVN 78 Class Program Office, NAVSEA 05V3, NSWCCD, and EWI, is devising improved door configurations and will conduct limited subscale trials prior to fabricating a full-scale prototype. The five-year cost savings of improving the producibility and first-time quality of the doors is $5.5 million for CVN 79. Some of the project's recommendations have already been incorporated into the CVN 79 baseline design. NNS will implement additional project results on CVN 79 as doors are fabricated in 2013; full implementation is expected in 2014. In addition to the weapons and stores elevator doors, the producibility methods and improvements can be applied to the hatches and other doors and hull closures on CVN 79, as well as on other platforms.

SHIPYARD PROCESSES

A prototype tool will replace manual grinding of plate edges for weld preparation, which is slow and physically taxing work. (NMC photo)

NMC is working several current projects that are developing mechanized systems and tools that not only save shipbuilding labor-hours, but also improve manufacturing processes over manual methods.

Removing rust and primer from a weld joint before welding can be a slow and labor-intensive process. Currently, an operator uses a pneumatic stone grinder or sander to prepare the surface during ship fabrication, which often leads to carpel tunnel and other injuries. An NMC project is developing a prototype tool that will increase the production rate and reduce injury claims. The IPT, which includes the DDG 1000 Program Office, NSWCCD, Bath Iron Works (BIW), Ingalls, and NMC, is devising innovative designs of surface preparation and manipulation equipment and integrating the two technologies into a prototype system. The team estimates that the tool could lead to a 300 percent increase in production rate and the potential of $7 million in savings on a typical surface combatant. In addition, the technology could reduce shipyard injury claims caused by edge grinding by up to 50 percent. The prototype is being demonstrated at BIW and Ingalls; commercially produced units are expected to be implemented at BIW in 2013.

Solutions are also being generated to reduce labor-hours for pipe assembly installations on VCS. An NMC project will increase installation efficiencies of on-hull pipe assemblies by using improved tooling for pipe fit-up; fixturing and positioning; and automated welding/joining processes. The IPT, comprised of EB, NNS, the VCS Program Office, NMC and NSWCCD, will assess and down-select tooling concepts and develop prototypes that will be tested at the VCS Modular Outfitting Facilities. Applying improved pipe assembly installation methods and automated technologies will reduce labor by a minimum of 20 percent and could save $600,000 per hull. The improvements will be used in the construction of SSN 788 in early 2014 at both EB and NNS. This project is building on the success of two previous NMC projects that improved VCS pipe shop assembly processes for small and large diameter pipes.

Improved construction processes for large diameter pipes in VCS, including the prototype pipe purging tool pictured, will save 8,500 labor-hours for a $590,000 savings per hull. (NMC photo)

The large diameter pipe project mentioned above involved off-hull pipe detail fabrication processes used in the construction of VCS. Excessive labor was required for various complex configurations of large diameter pipe (3" – 12" diameters). This NMC project established improved and automated construction processes that are expected to save 8,500 labor hours per hull. The labor savings translates into a projected $590,000 savings per hull. Specific areas investigated included fixturing, positioning, and fitting; automation of welding and drilling pipe bosses; pipe purging methods; and the use of internal pipe joint blending tools and applications to reduce pipe section cutting, rework, and pipe material scrap. The prototype tools developed in this project were transitioned to EB and NNS in April 2012. In addition to EB and NNS, the VCS Program Office, NSWCCD, and NMC contributed to this effort.

Also on VCS, the installation of electrical cable offers an opportunity for improvement over the current labor-intensive process. In addition to looking at possible modifications to EB's current cable routing practices, an NMC-led IPT will develop easy-to-use, small, lightweight, portable tools that can be used to pull sections of cables, as well as reduce cable friction points, thereby decreasing the overall effort required to pull and route

A white light scanning system will save the four naval shipyards significant costs in the inspection of main propulsion shaft connections on submarines and aircraft carriers. (NMC photo)

cables. The IPT, which includes EB and the VCS Program Office, will generate concepts, down-select ideas for prototype development, and evaluate the prototypes. The objective is to reduce the labor hours associated with routing cables on new VCS construction by at least 10 percent. In addition to the labor reduction, the technology has the potential to reduce injury claims and medical costs. Project results will initially be implemented on SSN 790 by December 2015.

NMC is investigating and optimizing an innovative technology that will cut significant costs in the inspection of main propulsion shaft connections on submarine and aircraft carriers. Currently, the tapered connection between the shaft and the inboard coupling is inspected using heavy and cumbersome gauges. This project is evaluating white light scanning technology as a lower cost alternative to gauges. The white light scanning system will measure components by taking a series of images and aligning them to form a single composite digital model. The system will be able to accurately measure a shaft taper, compare the taper to the nominal dimensions, identify out-of-specification areas, and project an outline of those areas onto the taper. The four naval shipyards will save more than $5 million just by eliminating the purchase of the VCS taper gauges. They'll save an additional $900,000 each year by eliminating the need to maintain the existing taper gauges. The labor to inspect the gauges will be reduced by eliminating the lifting and handling process and by reducing the time required to perform taper inspections. The prototype system will be tested at Norfolk Naval Shipyard and Portsmouth Naval Shipyard in early 2013; it is expected to be used at a naval shipyard in January 2014.

Additional systems are being planned for other naval shipyards and other facilities that manufacture or repair propulsion shafts. The IPT includes the naval shipyards, NAVSEA 05Z22, NAVSEA 04X, NSWCCD, NMC, and Steinbichler Vision Systems.

In submarine overhauls, approximately 160 labor-hours are needed to install and then remove each of the fillet-welded temporary padeyes. NMC developed and evaluated alternative designs for the padeyes in an effort to reduce both labor and material costs. Due to a change in interpretation of the requirements, the padeye devised by the NMC project will not be implemented. The IPT consisted of the four Navy shipyards, NAVSEA 04X and NMC.

NMC investigated an alternative application of a system it developed for remotely controlling the preheating of welding assemblies. Currently, an operator manually controls and monitors the temperature of the base metal, which needs to achieve a minimum preheat temperature before welding. While the system generated in this project did not meet all of the requirements for use at NNS, EB is interested in a slightly different application. The IPT for this project included the CVN 78 Class Program Office, NSWCCD, NNS, EB, and NMC.

NMC has several current projects that are improving the affordability of the Navy's aircraft carriers, including the pictured CVN 79, which is under construction. (Huntington Ingalls Industries, Inc., image)

COATINGS APPLICATION AND REMOVAL

NMC's portfolio of projects includes many efforts in support of the Virginia class submarine, which Navy leadership has cited as a shining example of the Navy's ability to cut costs and deliver ships on schedule. (U.S. Navy photo)

The materials and processes involved in coating the metal on ships is often a critical factor, considering the harsh sea environment where they operate. NMC is working on issues related to several different types of coatings on Navy ships, as well as their application and removal processes.

Grit blasting is a common shipbuilding practice to prepare structural steel for coating. NMC completed a project that not only reduces the labor needed to blast VCS surfaces at EB and NNS, but improves the process of protecting nearby piping. The IPT conducted a series of trials to optimize the grit blasting parameters, such as variations of blast media type, blast media size, nozzle angle, and nozzle type. The IPT determined that use of extra-long venturi nozzles in blast guns can reduce grit blasting labor by 29 percent.

Currently, the piping is wrapped prior to blasting, unwrapped after blasting to remove grit dust, and re-wrapped to protect it during painting. The IPT developed and evaluated several creative pipe wrapping / unwrapping methods to save labor. Portsmouth Naval Shipyard and EB have already implemented some of the approaches; full implementation is expected by the end of 2012 in the construction of SSN 787 at EB and NNS. Project results are expected to save $367,000 per VCS hull in reduced labor, materials, and disposal cost. Improved wrapping / unwrapping processes are expected to reduce labor by 60 percent.

NMC investigated alternatives to grit blasting for removing coatings from submarine propulsion shafts. Grit blasting requires moving the shafts from the machine shop to another location in the repair yards, adding construction time and cost. The IPT optimized laser ablation and mechanical removal processes that could be performed right in the machine shop. While the shipyard addressed this issue using an alternate path, this project's work can be leveraged for other applications in naval shipyards. The IPT included the naval shipyards, NAVSEA 04X, NAVSEA 05Z22, and NMC.

Laser ablation was optimized to remove coatings from submarine propulsion shafts and for other naval shipyard applications. (NMC photo)

Another NMC project is ensuring that special hull treatment (SHT) is properly bonded to the hull. Currently, shipyard personnel manually tap the SHT to ensure proper adhesion. NMC is leading a project to develop an instrumented approach. The IPT, including the VCS Program Office, NSWCCD, EB, and NMC, is investigating the use of impulse hammers to increase the accuracy of detecting debonded areas. Impulse hammers mimic manual inspection, but the force and response are measured electronically instead of by the subjective human senses. If testing is successful, impulse hammers will be implemented in mid 2013. A cost avoidance of $348,000 per VCS hull may be realized by repairing SHT debonds during construction as opposed to after delivery. This project is also being monitored by NAVSEA 04X, Portsmouth, Puget Sound, and Pearl Harbor Naval Shipyards for possible use on existing VCS.

In addition to SHT, damping tile is also installed on each VCS hull. NMC led an effort to reduce the cost of select damping tile by finding alternate materials and/or installation methods. While the down-selected pressure-sensitive adhesives would significantly lower damping costs, their performance needs to be validated. Savings could total $715,000 per hull. The VCS Program Office will perform large-scale testing and determine final acceptance of the pressure-sensitive adhesives, with implementation anticipated on SSN 792 in 2014. The IPT included the VCS Program Office, NSWCCD, EB, NNS, and NMC.

To address a coatings need in the construction of CVN 78 and DDG 51, NMC identified, evaluated, and modified temporary coatings that would protect certain components while the ships are being built. The temporary coatings would significantly reduce the labor needed to remove the corrosion or repair damage. A revised baseline cost lowered the project's expected cost avoidance, so the project's modified coatings will not be pursued at this time. The CVN 78 Program Office, NSWCCD, EB, Ingalls, and NMC contributed to this project.

JOINING TECHNOLOGIES

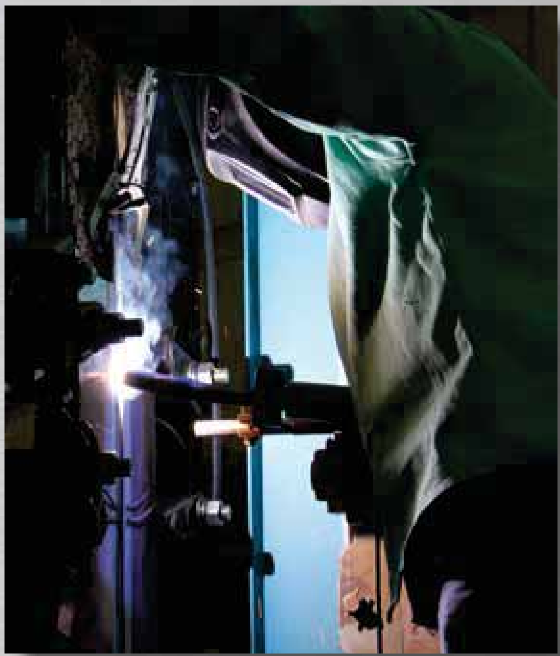
Brazing pipe joints with a small, lightweight heating system as opposed to using a hand-held torch, is reducing shipbuilding costs for CVN 78 construction. (Newport News Shipbuilding photo)

NMC is optimizing several very different metal joining technologies used in ship construction to reduce costs and address manufacturing issues.

Since June 2012, NNS has been using a prototype mechanized brazing system developed and created in an NMC-led project to braze fittings shipboard on CVN 78. The automated tool is an improvement over hand-held torches, which require more labor and are difficult to control and use to negotiate the minimal clearances surrounding fittings. In addition to the prototype tool it is using, NNS plans to procure 10 mechanized brazing systems. The new flame brazing technology uses a programmable logic controller, mass flow controllers, and a specially designed burner to surround the fitting. Using the system reduces the time required to braze each joint, the amount of rework related to manual torch brazing, and training time as well as the need for highly skilled operators due to the user-friendly operation. NNS will save an estimated $2.6 million in the construction and overhaul of CVN and VCS. In addition, this technology solution may benefit other platforms requiring flame brazing. The IPT for the project included NNS, NSWCCD, NMC, the CVN 78 Class and VCS Program Offices, and NAVSEA 05.

An NMC project evaluated a very different joining process – exothermic (thermite) welding – and its applicability on Navy ships. While the CVN 78 Class Program Office supports the use of exothermic welding for performing multi-cable, copper conductor splices for CVN 78 shipboard power applications, the process was not approved for use. The effects of shipboard environmental conditions on weld quality were not fully understood, and Navy and shipbuilder experience with the process was very limited. NMC evaluated the quality and performance of splices fabricated using the CADWELD® Exolon System from Erico Products and facilitated qualification of the proposed process for shipboard use. Testing was also performed to validate the quality and performance of the recommended 3M insulation products for these cable splices. The validated weld and insulation processes will be applied in the fall of 2013 in accordance with the project-developed installation and repair procedure during installation of the Electromagnetic Aircraft Launch System on CVN 78. The IPT consisted of the CVN 78 Class Program Office, NSWCCD, NAVSEA 05Z, NAVAIR, NNS, and NMC.

In another project addressing aircraft carrier manufacturing needs, NMC is evaluating and optimizing electrodes for use in CVN 79 structural welds and other critical applications. This project is focusing on developing improved MIL-101TM flux-cored arc welding (FCAW) electrodes as alternatives to incumbent FCAW electrodes. These electrodes have exhibited inconsistent lot-to-lot notch toughness test values and lower fracture toughness of MIL-101TM welds compared to welds made by other welding processes. The IPT's work will support the qualification of improved electrodes for CVN 79 structural welds and other critical applications. An enhanced electrode will improve survivability of Navy combatant ships and avoid up to $1.9 million in costs. The IPT, including the CVN 79 Class Program Office, NNS, NSWCCD, NAVSEA 05P24, and NMC, is also targeting a 50 percent reduction in electrode procurement costs due to the introduction of at least one additional qualified electrode source. This would reduce electrode procurement costs by $735,000 per CVN 78 class aircraft carrier. Implementation is expected when NNS begins to use the electrode in the construction of CVN 79 in the first quarter of 2014.



Improved electrodes in CVN 79 structural welds will improve survivability and avoid significant costs. (NMC photo)

For the VCS Program, NMC is developing a plasma arc backgouging system that will reduce labor-hours for new construction butt welds. The IPT, including the VCS Program Office, NSWCCD, EWI, EB, and NMC, is building upon the robotic welding technology that was successfully demonstrated in a prior ManTech project executed by EWI under the Navy Joining Center. The current effort is production hardening the backgouging system components against electromagnetic noise and physical hazards, creating a control system with teach capability, and integrating these components on a dedicated carriage. EB estimates an overall 25 percent reduction in welder hours when implementing this system in sequence with the robotic welding system. EB plans to procure two production plasma arc backgouging systems from the commercialization partner, Servo-Robot, for use in its Quonset Point assembly plant for preparing VCS hull butt joints, starting in the spring of 2014.

Another welding-related consideration in shipbuilding is the need to clean the surface to be welded. Currently, an aluminum weld joint is prepared, cleaned and tack welded and then left in that condition for a time prior to final welding. Navy procedure calls for re-cleaning the joint prior to welding because moisture and shipyard debris created during the delay could contaminate the surface and affect the quality of the weld, but the guidance for re-cleaning the tack-welded joints varies from platform to platform. The IPT, consisting of NAVSEA 05P2, NSWCCD, and NMC, better quantified the effects on the mechanical properties of aluminum between cleaning and final welding. For construction of LCS 2 class ships, project test results concluded that tack-welded joints do not need to be broken, cleaned, and re-welded in cases where the exposure time has exceeded the current requirement. New practices based on those results were implemented in early 2012.

Friction stir welding (FSW) is a joining process that offers benefits over traditional welding in many applications, but the U.S. has been slow to adopt this process because of the high cost of the equipment. NMC continued its work in this area by developing an enhanced FSW system that would reduce ship costs, improve welded joint quality, and decrease vessel weight. NMC expanded the capabilities of the low-cost machine it designed for the Freedom-class LCS for use on Joint High Speed Vessel (JHSV) product forms such as thick plate and hollow core extrusions. The IPT also devised processes and tooling for JHSV products and was prepared to assist in startup and training of the new system at Austal USA. While Austal reached a "no-go" decision for this project, the shipyard intends to re-evaluate procuring FSW equipment after requirements for the welding qualification and non-destructive testing are fully defined. The IPT for this project consisted of Austal USA, ABS, Nova Tech Engineering, Joint High Speed Vessel Program Office, and NMC.

NMC's work has included an effort to improve the affordability of the Joint High Speed Vessel, which is a Navy-led shipbuilding program intended to transport U.S. Navy and Army units and their vehicles. (U.S. Navy photo)

PROJECTS INCLUDED IN THIS REPORT:

Advanced Metalworking
S2341 Reduced Cost Lightweight Uptakes for LCS
S2368 Improved Shaft Cladding Materials and Processes
S2471 Improved Abrasive Technology
S2400 Thin Plate Distortion Mitigation
S2468 Precision Panel Inserts
S2304 Development of Long Length, Flexible, Vacuum-Jacketed Cryostats

Design for Manufacturability
S2319-2 Weapons Cradle Manufacturing Cost Reduction Phase II
S2399 Sliding Door Manufacturing Improvements
S2469 Weapons and Stores Elevator Doors Manufacturing Cost Reduction

Shipyard Processes
S2373 Plate Edge Preparation Improvements
S2397 Pipe Assembly Installation Improvement Methods
S2326 Large Diameter Pipe Process Improvements
S2472 Improved Cable Routing Tools
S2365 Main Propulsion Shaft Taper Inspection
R2457 Alternatives to Temporary Padeyes
S2291 Remote Welding Preheat Control System

Coatings Application and Removal
S2338 Optimization of Blasting Operations
S2320 Submarine Shaft Coating Removal
S2363 SHT Debond Detector
S2139-2 Damping Material Application Improvement Phase II
S2331 Temporary Protective Coatings

Joining Technologies
S2298 Alternative Brazing for Shipboard Use
S2330 Exothermic Welding for CVN
S2372 FCAW Electrodes with Improved Toughness
S2467 Hull Fabrication Improvements Phase III
R2445 Extended Delay Between Cleaning and Welding of Aluminum
S2321 Expanded Capabilities for Low-Cost Friction Stir Welding

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This report was prepared by the Navy Metalworking Center, operated by Concurrent Technologies Corporation (CTC), under Contract No. N00014-10-D-0062 to the Office of Naval Research as part of the Navy ManTech Program. Approved for public release; distribution is unlimited.