Shipbuilding Prototype Tool Development

From Concept to Commercialization

Mechanizing manufacturing processes that are currently performed manually can save significant shipbuilding costs through reduced labor and associated worker injuries. In order to develop mechanized tools that effectively address shipyard manufacturing issues, the Navy Metalworking Center (NMC) employs an iterative prototype approach, leveraging internal, industry, and shipyard expertise throughout the process.

NMC's prototype capabilities span the entire process – from developing tool concepts to transitioning the final product to a commercializing partner or the shipyard. NMC and its Integrated Project Teams (IPT) explore and advance tool concepts after assessing the existing manufacturing process. IPT members perform validation tests to determine which concept and features will be used in the prototype design and then develop and test several iterations of the prototype, making improvements along the way, until the final version is ready for implementation and commercialization. The iterative approach reduces risk, as key stakeholders are involved in developing the tool, ensuring the finished product meets the needs of the shipyard.

Using this approach, NMC and its partners have developed a wide range of tools, including both non-mechanized and mechanized tools, to improve the installation of electrical cables on Virginia class submarines (VCS) and surface ships. The non-mechanized tools, such as rollers, hooks and slides on adjustable handles, and custom low-friction slides that clamp on cable hangers, coamings and wire ways, are designed to enable workers to install the cables on VCS, which have complex configurations in confined areas. Other NMC projects successfully addressed unique VCS manufacturing challenges with both small and large diameter piping systems. Several project-developed inspection and welding tools for small pipes are being used at Electric Boat Corporation and Newport News Shipbuilding (NNS). Hands-free clamps developed for the fabrication of large pipes are being used at Electric Boat and NNS.

Several of NMC's projects involving prototype tools have earned Defense Manufacturing Technology Achievement Awards, which recognize technical achievement, transition / implementation success, and benefits in terms of reduced cost, improved performance, etc. Those award-winning projects and others are detailed in this document.

NMC and its project teams develop prototype tools that reduce shipbuilding costs through reduced labor and injuries associated with manual manufacturing processes. U.S. Navy photo

Mechanized Cable Pulling Tools

Mechanized cable pulling tools will reduce labor as well as health and safety issues associated with shipboard cable pulling. Pictured are the capstan (top) and dual roller (bottom) tools. NMC photos

Background

It can take up to 25 workers to pull a single cable on a surface ship, depending on the cable size, length, and routing path. The workers grasp the cable and use verbal communication to coordinate the pulling effort, often from poor ergonomic positions due to the lack of space and cable access. NMC developed two portable, power-assisted tools that increase efficiency and greatly reduce the physical demand on tool operators. The air-powered dual roller tool weighs 26 pounds and is designed to pull cables 1.5 inches to 2.25 inches in diameter with a force up to 450 lbf. With slight modifications, this tool could be adapted for use with cable diameters as small as 0.5 inches. The electric capstan tool weighs 29 pounds and has a maximum cable pulling force of 2,000 lbf without cable size limitations.

Benefits

Ingalls Shipbuilding (Ingalls) anticipates that this project will result in a 20 percent labor savings when using the tools to install Class III and Class IV cables on LHA, LPD, DDG and National Security Cutter (NSC) class ships. This labor hour reduction equates to a total estimated cost savings of approximately $1.5 million, and is based on using the cable pulling tools on a single hull of each of the programs under construction at Ingalls. Additional cost savings are anticipated due to reduction in medical claims.

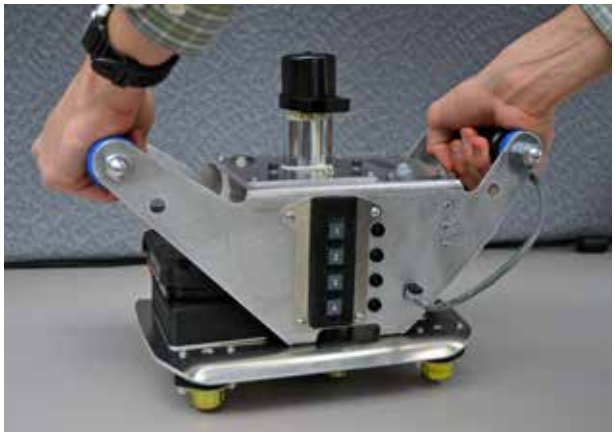
Commercialization

Quotations to fabricate the developed tools have been solicited and documented for shipyard use. Vendors will incorporate tool modifications requested by the shipyards as they gain additional experience using the tools.

Implementation

Ingalls expects to purchase six of each tool (capstan and dual roller) for use on DDG and LHA in the second quarter of FY16. Implementation is also anticipated at NNS and General Dynamics Bath Iron Works (BIW).

Debond Detector



Use of impulse hammers to identify debonded SHT areas during VCS construction is significantly less costly than correcting the problem after delivery. (NMC photo)

Background

The SHT Debond Detector project improved the accuracy of detecting debonded VCS Special Hull Treatment (SHT) by developing and transitioning impulse hammer technology into the VCS construction process. During construction, inspection of the SHT is a critical process that detects debonding from the hull, which can lead to premature failure of the system. The SHT-to-hull bond had been inspected manually, a process that is very subjective to the individual performing the inspection. If a debonded area is found after the ship is delivered, the cost associated with repairing it is greater than if it were repaired during construction.

Benefits

An estimated cost avoidance of $348K per hull may be realized by repairing SHT debonds during construction as opposed to after delivery. Cost avoidance is attributed to the additional effort required to set up the equipment and staging area and to establish the proper environment in the dry-dock. The inspection device is also expected to be used on in-service boats, which will provide additional benefits.

Commercialization

NMC provided a complete drawing package for mechanical and electric components as well as the programming to allow contract manufacturing of the device. Enterprise Venture Corporation (EVC) completed the first commercial fabrication of six units, which were delivered to NAVSEA and Portsmouth Naval Shipyard.

Implementation

NAVSEA approved the use of the debond detector as the primary tool for detecting debonds of SHT material on USS HAWAII (SSN 776) during its upcoming extended dry-docking selected restricted availability. Seven debond detectors were delivered in June 2015 to the Navy for use on future VCS availabilities. Pearl Harbor also provided funding to purchase three Debond Detectors. Additional units can be purchased from the commercialization partner, EVC.

Plate Surface Preparation Tool

Winner, 2013 Defense Manufacturing Technology Achievement Award

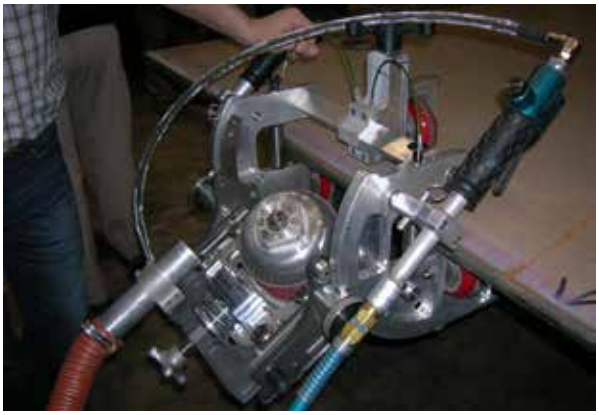


Plate surface preparation tools are reducing the labor needed to prepare plates for welding on DDG class ships. (NMC photo)

Background

Mechanized tools are increasing the production rate and reducing injury rates for workers preparing steel plates for welding at BIW. Shipyards traditionally remove rust and primer prior to welding with a pneumatic stone grinder or sander in a labor-intensive process that often results in worker injury. Considering that there are several thousand plates on a typical naval surface combatant, with several edges per plate requiring preparation, even a slight improvement in productivity can have a significant effect. The NMC IPT devised innovative designs for surface preparation and manipulation equipment and integrated them into two prototype tools – one for plate edges and one for plate surfaces – to replace manual grinding of large plates for weld preparation.

Benefits

The tools demonstrated that they can significantly increase production rates and save between $2 million and $4 million on the cost of a future surface combatant.

Commercialization

BIW tested these prototype tools on sample and production plates in order to finalize the prototype design. The plate preparation tools are commercially available through Adaptive Manufacturing Systems, EVC, and Gullco International.

Implementation

BIW has implemented the prototype tool to process at least 2,000 feet of plate edges on DDG 51 and DDG 1000 class hulls and has trained personnel on the tool's specific operating characteristics. BIW has also implemented the surface tool on the same classes. BIW ordered four edge tools and four surface tools in third quarter of FY15 from Gullco International Limited for use on DDG 1000 and DDG 51 class hulls. This technology can readily be implemented on virtually any ship type, and is not limited to surface combatants.

Flame Brazing System

Finalist, 2012 Defense Manufacturing Technology Achievement Award

This brazing tool reduces the use of hand-held torches on CVN class aircraft carriers, saving costs. (NNS photo)

Background

Flame brazing of pipe fittings is another manual shipyard process, requiring considerable labor to complete. For instance, NNS uses hand-held torches to manually flame braze small diameter pipe fittings shipboard. After the fitting is brazed, rework is occasionally needed to repair paint damage and pipe leaks that result from the difficulty in manipulating the torch in confined areas. An NMC project developed a new flame brazing tool to reduce the labor required to braze fittings on CVN class aircraft carriers and VCS. The flame brazing tool uses a specially designed burner combined with a programmable logic controller to provide automated hands-off brazing of most standard types and sizes of smaller diameter pipe fittings.

Benefits

In addition to reducing the time required to braze each joint, the user-friendly operation of the brazing tool will decrease training time and the need for highly skilled operators. Implementing this brazing tool at NNS is expected to result in an estimated cost savings of $2.6 million in the construction of three CVN and nine VCS hulls, and in the overhaul of seven CVN hulls. In addition, the proposed solution may benefit other platforms requiring flame brazing.

Commercialization

The new flame brazing system is commercially available through EVC, Gasbarre Products, and Premier Industries.

Implementation

In June 2012, NNS used the prototype brazing system to successfully braze production pipe joints in the construction of CVN 78. NNS purchased three systems in the first quarter of FY13 and requested a quote for seven more systems from EVC in the first quarter of FY15.

Track Weld Shaver

Winner, 2010 Defense Manufacturing Technology Achievement Award

The track weld shaver tool, pictured being tested at BIW on DDG 51, reduced manual grinding on DDG hulls. (BIW photo)

Background

Butt welding exterior ship panels together produces a weld reinforcement that exceeds DDG 1000 fairness requirements. As a result, approximately 23,000 feet of weld reinforcement must be hand ground flush with the hull. The manual weld removal process is slow, which increases shipbuilding costs, and the repetitive nature of hand grinding causes frequent injuries and costly medical expenses.

After an assessment at BIW and Ingalls, an NMC IPT developed mechanized tool requirements and evaluated several metal removal technologies. As a result, industry and NMC developed and presented concepts to the IPT, which included grinding, milling, and shaving. NMC generated and validated a track weld shaver (TWS) concept using commercially available hardware, which was ultimately selected by the IPT for prototype development. PushCorp was selected as the commercialization partner to support development of the tool, which was tested at BIW and Ingalls.

The IPT developed a mechanized tool that significantly reduced DDG 1000 construction costs by removing the weld reinforcement on hull panels much faster than what was achievable though hand grinding. An iterative process included alpha, beta and gamma versions of the TWS. This basic tool was subsequently adapted to perform back gouging of weld joints.

Benefits

The TWS removes 80 percent of the weld reinforcement height at well over 20 feet per hour versus the manual rate of three feet per hour. The modified version of the tool that performs weld back gouging increases the value to the shipyards.

The estimated cost savings for three DDG 1000 hulls:

- $2.77 million for weld shaving
- $1.41 million for back gouging

Commercialization

The TWS technology is commercially available through PushCorp, Inc.

Implementation

The preproduction tools were delivered to BIW and Ingalls in June 2009, and BIW used them in the construction of DDG 1000. The use of the preproduction tools allowed the shipyards to take advantage of their benefits, identify potential tool enhancements for future production tool acquisitions, and identify other processes that can leverage this technology. BIW purchased a complete TWS system from PushCorp in 2011, and Ingalls used the TWS tool first in the construction of DDG 1001 in June 2013.

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