Newsletter 2014 No.3

iMAST

Institute for Manufacturing and Sustainment Technologies

IN THIS ISSUE

DIRECTOR'S CORNER

Change is in the wind here and it's not just the seasons, as you can read within. The new director, VADM (ret) Sullivan, brings a wealth of Navy expertise and a fresh approach to keeping ARL relevant for years to come. Our staff is very much looking forward to his tutelage and support as we seek to serve the Navy-Marine Corps team in the years ahead. Second to the appointment of a new director, iMAST is deep into the changes that a new fiscal year brings, as well as plans for FY16. At the same time we're working to justify our FY15 budget as we kick-off FY15 new starts (new projects).

Timothy D. Bair

Every summer the ONR ManTech program begins the process of identifying potential ManTech projects that may help reduce the cost of acquisition of the Navy's major Category 1 programs. RAdm Klunder, Chief of Naval Research, announced that the FY16 supported

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Sullivan Takes Helm at ARL

On 1 September 2014, VADM Paul E. Sullivan USN (Ret) assumed the helm of Penn State University's Applied Research Laboratory (ARL), becoming its 9th director. Admiral Sullivan succeeds Edward Liszka, who has retired.

Admiral Sullivan inherits a robust laboratory that has contributed markedly to the success of the U.S. Navy for over 69 years. A DoD University Affiliated Research Center (UARC) in naval science, with preeminence in undersea missions and related areas, ARL Penn State provides solutions to challenges in national security, economic competitiveness, and quality of life. Its motto: Discover, Develop and Deploy applies and is incorporated into the support ARL provides to the U.S. Navy-Marine Corps Team.

Holding a bachelor's degree in mathematics from the U.S. Naval Academy, and dual degrees of Master of Science (Naval Architecture and Marine Engineering and Ocean Engineer) from the Massachusetts Institute of Technology, Admiral Sullivan brings a wealth of experience from both the military and industry. Serving a distinguished 31-year career (1974-2005) in the U.S. Navy, as both a surface and submarine warfare officer, Admiral Sullivan completed service as Commander of the Naval Sea Systems Command (NAVSEA). Additional career Navy highlights include service as program manager of the Seawolf-class Submarine Program (PMS 350) and the Virginia-class Submarine Program (PMS 450). Upon selection to flag rank, VADM Sullivan served as Deputy Commander for Ship Design Integration and Engineering, Naval Sea Systems Command.

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PENNSTATE
iMAST
Applied Research Laboratory
Institute for Manufacturing and Sustainment Technologies

DIRECTOR, iMAST & NAVY/MARINE CORPS REPAIR TECHNOLOGIES
Timothy D. Bair
(814) 863-3880 tdb14@arl.psu.edu

MATERIALS PROCESSING TECHNOLOGIES
Timothy J. Eden, Ph.D.
(814) 865-5880 tje1@arl.psu.edu

LASER PROCESSING TECHNOLOGIES
Richard P. Martukanitz, Ph.D.
(814) 863-7282 rxm44@arl.psu.edu

COMPOSITES MATERIALS TECHNOLOGIES
Kevin L. Koudela, Ph.D.
(814) 863-4351 klk121@arl.psu.edu

MANUFACTURING SYSTEMS TECHNOLOGIES
Mark T. Traband, Ph.D.
(814) 865-3608 mtt1@arl.psu.edu

SYSTEMS OPERATIONS AND AUTOMATION/ COMPLEX SYSTEMS MONITORING
Eddie C. Crow
(814) 863-9887 ecc1@arl.psu.edu

DRIVETRAIN TECHNOLOGIES
Nagesh Sonti, Ph.D.
(814) 865-6283 nxs7@arl.psu.edu

iMAST ADMINISTRATION and EDITOR
Gregory J. Johnson
(814) 865-8207 gjj1@arl.psu.edu

FINANCIAL COORDINATOR
Brenda E. Kephart
(814) 865-3264 bew3@arl.psu.edu

WORLD WIDE WEB
www.arl.psu.edu/imast.htm

NAVY PROGRAM MANAGER
Gregory D. Woods
gregory.woods1@navy.mil

DIRECTOR'S CORNER

programs will continue to include the CVN, DDG, VCS (with ORP being a sister beneficiary) and F-35 programs. He is also adding the new heavy lift helicopter program, the CH-53K. This is the first time two NAVAIR systems have been included in the ManTech funding portfolio in ten years. The common denominator is the Navy's push to get as much bang for its acquisition dollar as possible, through the investment of small dollars into numerous projects aimed at helping shipyards and weapons systems manufacturers become more efficient. We'll keep you appraised in future issues on what projects iMAST will support, as well as potential spin-off opportunities to compound the payback through additional applications.

While I remain optimistic, not all the news is encouraging. The new fiscal year is going to be lean. The ONR ManTech program took its share of sequestration cuts this year—which equates to fewer projects. I estimate about three less projects starting this year. I am confident, however, we'll weather the storm. iMAST's track record, like the ONR ManTech program in general, has been one of successful implementations and program funds saved that will equate to more affordable systems in acquisition and operations.

On a good note, iMAST is kicking off 5 new projects this fiscal year. In the acquisition cost saving category we're working to start a new project with Electric Boat and the Naval Shipbuilding and Advanced Manufacturing COE (CNST renamed) that will take another bite out of the digital thread challenge to move shipbuilding plans to 3D—putting them into the hands of tradesmen. Additionally, we are starting a turbine wheel grinding project with Pratt & Whitney and developing technology to measure primer thickness in-process with Lockheed Martin (F-35). Finally, in the RepTech world, we're working towards a new start implementing Additive Manufacturing in the Naval Air Depot enterprise and working to down-select one of three projects in the public shipyard and Marine Corps depot arenas. It's a great year when we can support all three systems commands with new starts!

One of the things we love about our jobs is the dynamics related to executing the ManTech mission.

Tim Bair

PROFILE

Dan Finke is a Research Associate at Penn State's Applied Research Laboratory. Dr. Finke has experience in applied research and development within the U.S. Navy shipbuilding domain. This experience includes supporting and leading projects that fill technology gaps inherent in large legacy planning and execution systems by developing and implementing custom software tools and specialized manufacturing system analyses supporting the U.S. Navy shipbuilding community, as well as the Joint Strike Fighter (JSF) program.

Dr. Finke received his B.S. degree in Industrial Engineering from New Mexico State University. His earned graduate degrees include an M.S. in Industrial Engineering and Operations Research, and a Ph.D. in Industrial Engineering—both from The Pennsylvania State University. Dr. Finke's current research interests include simulation-based decision support, planning and scheduling, heuristic algorithm development and implementation, agent-based simulation and modeling, and process improvement. He can be reached at (814) 865-5178, or by email at <daf903@arl.psu.edu>.

★ MATERIALS PROCESSING TECHNOLOGIES ★ MECHANICAL DRIVE TRANSMISSION TECHNOLOGIES ★ LASER PROCESSING TECHNOLOGIES ★ COMPLEX SYSTEMS MONITORING TECHNOLOGIES ★ COMPOSITES MATERIALS TECHNOLOGIES ★ NAVY/MARINE CORPS REPAIR TECHNOLOGIES ★ MANUFACTURING SYSTEMS TECHNOLOGIES

Improved Welder Productivity

by Daniel A. Finke, Ph.D.

U.S. Navy released photo

INTRODUCTION

Welding at shipyards remains a large cost-driver in the construction of US Navy ships. This is particularly evident with the VIRGINIA Class Submarine (VCS), where there are hundreds of thousands of structural weld joints per boat. Process improvements in this area have the potential for significant cost savings. Several past and current efforts have focused on the welding process itself, implementing technologies such as mechanized welding, improved work packages, etc. However, these efforts have failed to address the inefficient daily welder startup process, which often takes up to an hour before a welder actually starts welding material. This article discusses an approach used to reduce the welder startup process time using a combination of commercial off the shelf and custom integration software in addition to traditional process mapping and process improvement strategies.

This project was a cooperative effort between General Dynamics Electric Boat (GDEB), the Center for Naval Shipbuilding Technologies (CNST) and the Institute for Manufacturing and Sustainment Technologies (iMAST) at the Applied Research Laboratory at the Pennsylvania State University (ARL Penn State), sponsored by the Office of Naval Research Manufacturing Technology (ManTech) Program under project number S2454 Improved Welder Productivity.

BACKGROUND

To ensure quality and accountability of each weld on the boat, shipyard welders must complete a thorough series of checks at the start of their daily shifts prior to actually performing welds. This shift startup includes getting proper assignments from shop supervision, checking out the correct weld wire, verifying their qualifications and setting up the work to be completed. Because these activities often require supervisor approval prior to starting work, and supervisors are responsible for several welders per work area, there are potentially significant delays prior to a welder actually beginning to weld.

There have been many technological advancements in welding power supplies in the recent past. The increased processing capability now available on welding power supplies enables GDEB machines to capture and analyze significantly more data about the welding parameters in near real-time. Network connectivity enables the machines to store the volumes of welding data on the enterprise data systems. Using these enterprise data systems, GDEB management can monitor welding machine health, welder productivity, evaluate weld quality and other relevant statistics. Additionally, this will allow GDEB to automate the start-up process with input from the shop floor.

The technology developed and demonstrated in this project represents the first step in developing a more connected digital interface from welding management systems to welding power supplies.

OBJECTIVE

The objective of this project was to reduce the time required to initiate the daily welding processes at GDEB while using the same technology to mitigate potential Wrong Weld Wire (WWW) violations. The project team focused on leveraging state-of-the-art welding equipment technology as well as enabling electronic access to information required by the welders to develop and test a prototype "Smart Welder" system. This system will help to reduce the time it takes welders to begin their work shift tasks, while still meeting strict "Zero Tolerance" policies for weld completion and quality.

APPROACH

The project was executed similar to other standard process improvement efforts where a comprehensive investigation of current welder startup processes were first conducted to identify the time drivers to get a welder fully prepared to execute welds at the start of their shifts. The project team focused on both the physical requirements as well as the information requirements to prepare a welder to perform their work.

Once the initial investigation and documentation of the system and data requirements were completed, the project team developed a small-scale pilot test to demonstrate the integrated process improvements and welding power

Continued from Page 3

supply technology. Initially, this transition and implementation consisted of the rapid-response initiatives (primarily developed by the GDEB team) that aimed to reduce inefficiencies in current welder startup procedures (e.g., pre-loaded and validated weld wire). In addition, the project team developed a pilot "Smart Welder" system that leveraged state of the art technologies in welding equipment, including advancements in machine networking and communication. Specifically, the Smart Welder system consisted of a weld machine and computing hardware capable of providing the necessary information to the welder to actually begin welding, as well as the required software and data interfaces to extract that data from existing systems at GDEB. The team developed two demonstration environments: one in a lab environment at ARL Penn State and a larger system at GDEB in two separate production areas.

Process Mapping

The initial phase of the project focused on an investigation of the current welder startup process that provided insight into the current state and future vision at GDEB. An improved process flow was developed using the information from the initial investigation.

iMAST and process engineers from GDEB sought to identify how welders acquire the proper tools to begin work (e.g., power supplies, torches, etc.) and the right support material (e.g., weld wire). On the data side, the project team documented the specific aspects of the work package that are critical to a welder starting their work, including part information, joint specification (e.g., required weld wire, edge prep, etc.), weld procedure information, welder machine settings, as well as the sign-off approval from shop supervision.

iMAST and GDEB performed a thorough review of the welder startup process to establish a baseline average startup time. Five (5) welders and five (5) supervisors were shadowed during their setup process at the beginning of the shift and their actions were recorded. The resulting current state process map included a detailed listing of each process step and included average process times. Additional process time information was collected by simply monitoring work centers at the start of the shift and recording times when welders in the area struck an arc for the first time during the shift. Time studies indicated welder starts average 56 minutes from the start of the shift. Welders and welding supervisors validated the current state process map to ensure that it accurately describes the current state welding startup process including average times for each process step. The diagram in Figure 1 shows an abridged version of the overall process flow. The full version of the current state process map has over 75 process steps and includes dependencies on the status of the startup process.

Notice that there are up to 4 checks in the process flow that include a check at the wire room, a manual self-check, a colleague check, and a supervisor check. In addition, the travel time from the work area to the wire room and back is a significant amount of time. In many cases, this time is often extended by the waiting time at the wire room as the welders and wire room attendants perform the physical checks against the weld assignment.

During the process investigation task, welders and supervisors also actively participated in helping to develop the "to-be" process map. This map (Figure 2) shows the welder startup

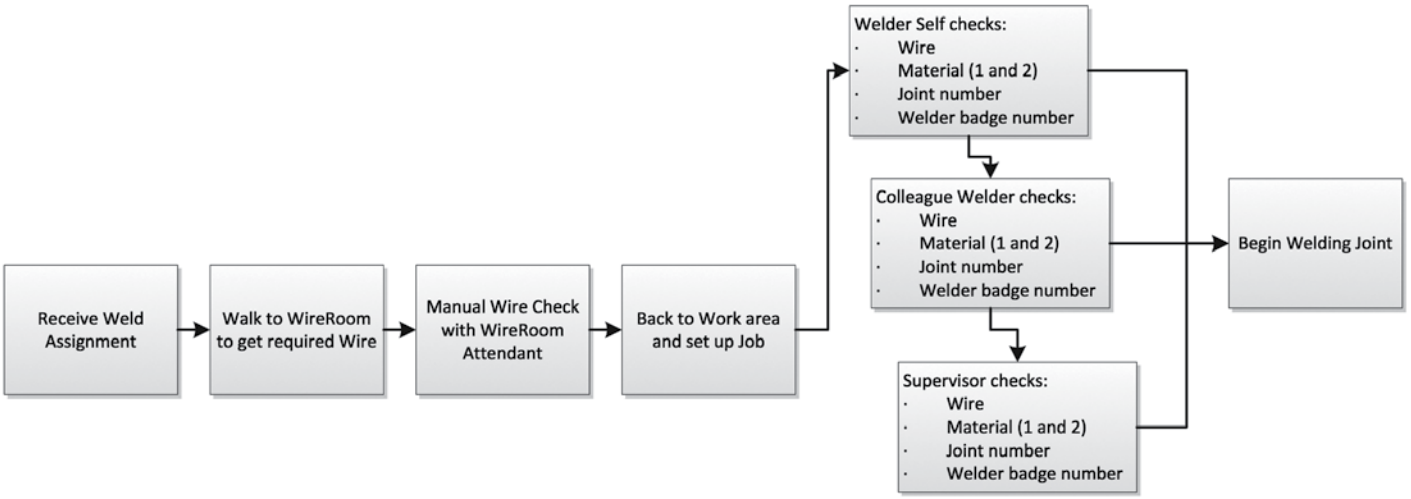

Figure 1. Basic Welder Startup Process Flow

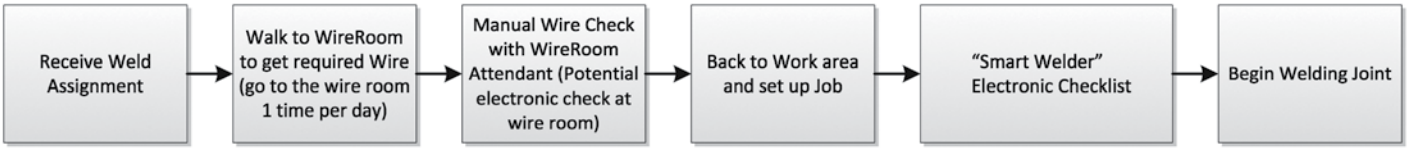

Figure 2. To-Be Welder Startup Process Flow

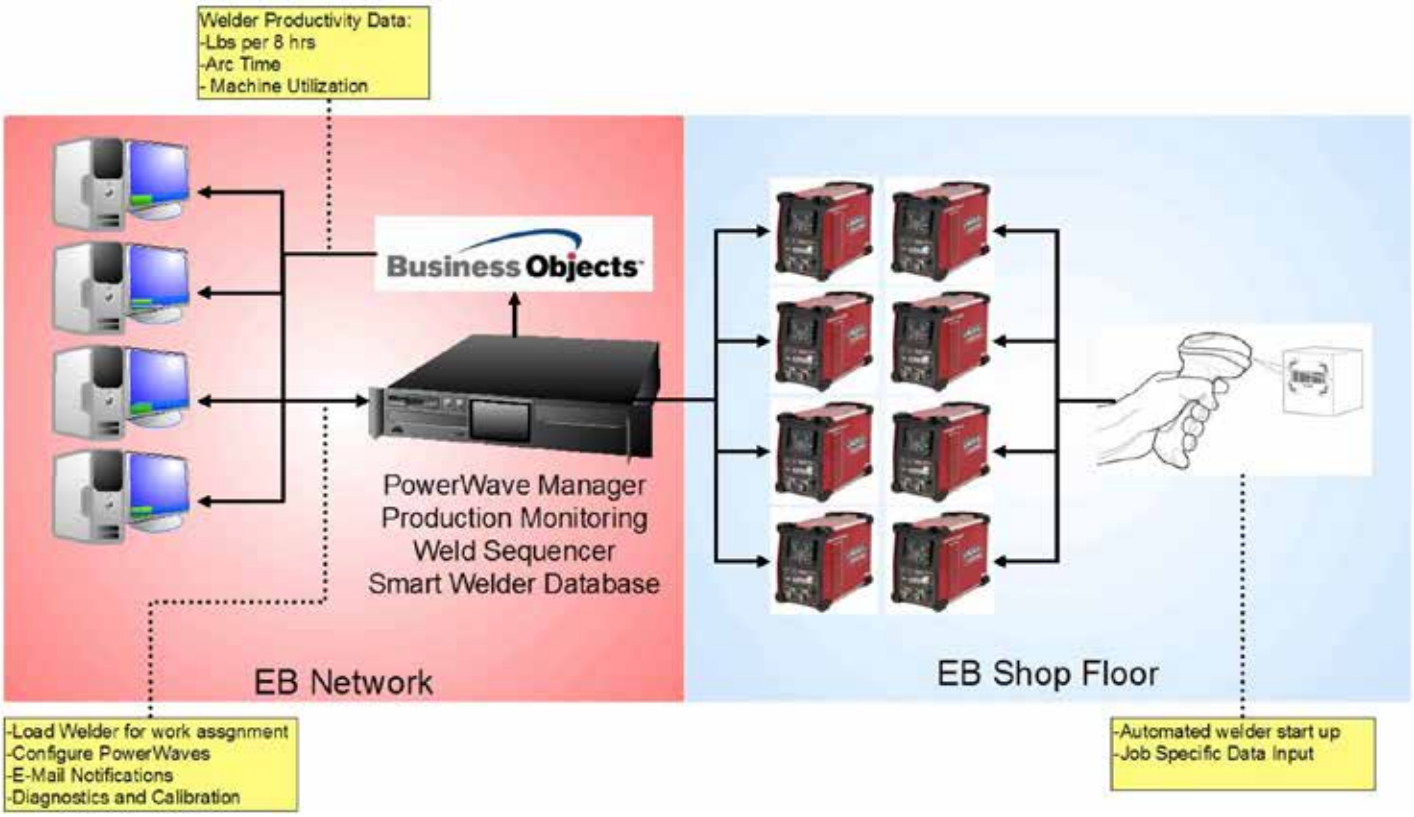

Figure 3. Final "Smart Welder" System Architecture

process with the non-value added process steps removed wherever feasible, as well as additional procedural changes that could be made to streamline the startup process.

The electronic checklist provided by the "Smart Welder" system allows the wire to be checked out once per day (or even multiple days) and eliminates the need for double checks by the peer welder and supervisor.

Market Study

The iMAST project team conducted a thorough study of state-of-the-art welding equipment at leading equipment providers. The intent of the market study was to identify the commercial-off-the-shelf capabilities of the various welding management informational database systems and compare these capabilities with the requirements established by GDEB. The market study began with an internet search of welder companies that included network and software capabilities. The team found 4 welding power supply manufacturers that have the capability to connect to a network and have software interface capabilities: ESAB, Fronius, Lincoln Electric Co., and Miller Electric Co.

Once the initial search for commercial systems was completed, iMAST conducted evaluations of the solutions offered by each of the welding equipment companies. During this phase of the study, iMAST and GDEB met with the companies and described the type of system that was required. The vendors, in turn, described and demonstrated their tools first through telecom discussions and then through webinar demonstrations. This two-phased approach enabled the vendors to tailor their online demonstrations to the needs of the project.

Following the interview/webinar phase of the study, each of the vendors was invited to demonstrate their respective system's capabilities at the Pennsylvania College of Technology (Penn College) where they have an extensive array of welding hardware and welders.

To help guide the down-selection process, the project team developed an attribute matrix that was used to compare many alternative solutions that have similar, but not identical capabilities. The majority of the attributes parallel the system requirements, e.g. network capability, weld data collection, etc. Other attributes include hardware and software cost, maintenance, and training, for example.

Using the attribute matrix, two vendors, Miller Electric and Lincoln Electric, were able to meet the majority of the requirements and the GDEB project team down selected to the Lincoln Electric system citing an acquisition strategy. In addition, Lincoln Electric performed custom development of their tools to better fit the requirements. This custom development enabled a successful demonstration of the prototype system developed during this project.

Prototype Development

The Smart Welder prototype integrates several data and hardware systems to move data from GDEB legacy systems to the welding machines for the electronic checklist. A sketch of the demonstrated Smart Welder system is given in Figure 3.

Welding work orders are assigned by the

Continued from Page 5

welding supervisor in a legacy system that ensures that the assigned welder is qualified to perform the weld. The legacy system also defines the filler material, base materials, and welding process that are used for the startup checklist. For the prototype system, this information is manually loaded into the Weld Information Database. The user (a welding supervisor is envisioned) then interfaces with the custom Java interface to "assign" the welds to a specific welding machine by pushing information to the respective Welding Power Supply Databases. The Lincoln Electric Weld Sequencer software reads the data from the database and invokes the electronic checklist that the assigned welder completes. Once all of the requisite information is scanned in using a bar code scanner and is confirmed, according to the information for the particular weld joint, the power supply is enabled and the welder can perform the specified weld. During the welding process, data is collected by the power supply and pushed to the Production Monitoring Database. The Production Monitoring software is used to view and analyze the performance of the welder and the quality of the weld. iMAST wrote custom software to extract the data/information from the Production Monitoring Database to enable the capability to push the data back into the legacy systems for further analysis and permanent storage. In the prototype system, this push back into the legacy systems is performed manually, however the software interfaces are available, and have been provided to GDEB, to programmatically interface with these systems.

CONCLUSIONS

The results demonstrated in both the lab and production environment prototypes have proven the proposed "Smart Welder" System is technically feasible and moreover that it is capable of preventing Wrong Weld Wire occurrences on the shop floor. This will enable a step change in the current weld wire distribution process at Electric Boat and thus make the potential savings estimated in this project attainable.

The work required for implementation of the "Smart Welder" system can be broken into three high-level categories, each with distinct tasks under them. These categories include updating/retrofitting/replacing existing GDEB hardware (power supplies); network infrastructure modifications; and Lincoln's commercial-off-the-shelf software and hardware modifications. The existing Lincoln Electric Co. Production Monitoring system can be implemented for the power supplies that are currently on the GDEB network to push information to the legacy data systems for performance measurement purposes in the near future, effectively accelerating the implementation and associated savings.

U.S. Navy released photo

U.S. Navy released photo

ACKNOWLEDGEMENT

The author would like to express appreciation for support of this effort by the Institute for Manufacturing and Sustainment Technologies (iMAST), a U.S. Navy Center for Excellence under contract by the U.S. Navy Manufacturing Technology (ManTech) Program, Office of Naval Research. This project also received special contributions from Paul Cournoyer and Joseph Hadfield of General Dynamics Electric Boat (Quonset Point). Additionally, commercialization partners of ESAB Welding Company, Fronius USA LLC, Miller Electric Manufacturing Company, and especially Lincoln Electric Corporation (specifically Harry Sadler and Joe Daniel) provided input and guidance from a commercial technology vendor's perspective regarding welding information processes. Any opinions, findings, conclusions and recommendations expressed in this article are those of the author and do not necessarily reflect the views of the U.S. Navy.

COVER STORY

Continued from Page 1

Following retirement from the U.S. Navy, Admiral Sullivan joined USEC Inc, a global energy corporation, where he served as Vice President and Chief Engineer of the American Centrifuge Project, which is the only centrifuge uranium enrichment technology program based in America. Paul Sullivan has also served as Vice President of the American Society of Naval Engineers (ASNE).

The appointment of Admiral Sullivan marks the end of Dr. Ed Liszka's distinguished 12-year career as director of the Applied Research Laboratory. Under Dr. Liszka's able leadership the lab has grown in capabilities, external visibility and productivity. ARL Penn State will continue to provide the Navy, Marine Corps, and the Department of Defense with superior technical support as the laboratory and Penn State move further into the challenging 21st Century. ARL will continue to promote technology transfer through industry for economic competiveness. This focus will support congressional and DoD mandates that technology from federally-funded research and development be put to dual-use by being transitioned to the nation's commercial sector.

For more information about Penn State's Applied Research Laboratory and its role in supporting the U.S. Navy Manufacturing Technology Program, check our web site out at: <http://www.arl.psu.edu/>.

INSTITUTE NOTES

Fleet Maintenance & Modernization Symposium 2014

Members of iMAST participated in the recent annual American Society of Naval Engineers (ASNE) Fleet Maintenance & Modernization Symposium held recently in Virginia Beach. This year's theme "Delivering Readiness in Austere Times" brought together the entire maintenance and modernization community. Panelists and paper presentations from the Navy, industry and academia participated—providing unique opportunities to interact military and civil service decision-makers, ship operators and maintainers, maintenance personnel, designers, builders, planners, engineers, program managers, life cycle engineers, equipment suppliers and other technical experts. Issues addressed at the symposium included:

*Improving Material Condition Assessments
*New ways, processes, and/or materials to reduce cost while improving readiness
*Modernization for Reduced Maintenance
*New approaches to scheduling and executing required maintenance

iMAST's exhibited artifacts representing numerous project activities. iMAST also exhibited its full scale lightweight shipboard watertight door and prototype non-skid removal device. Penn State research engineer Jeff Banks was invited to give a presentation titled: "Total Ownership Cost Reduction for Complex Systems through the Design and Application of Condition Based Maintenance".

ARL Penn State released photo

Modern Day Marine Exposition 2014

The Modern Day Marine (MDM) Expo continues to provide an outstanding forum for iMAST and its outreach effort to the U.S. Marine Corps at the annual event held at Marine Corps Base Quantico. Showcasing current activities supporting the Marine Corps Systems Command, MDM 2014 remains a focal point where iMAST projects supporting the Marine Corps can be highlighted. Quantico is the heart of the Marine Corps' research, development and acquisition efforts. The Marine Corps' requirements, procurement and professional school activities take place among the various tenet commands at Quantico—to include the Marine Corps Warfighting Laboratory. iMAST's Navy ManTech program has contributed to Marine Corps operational readiness enhancements within its sphere of repair and refurbishment, logistics and modernization through spares program efforts.

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PENNSTATE
Applied Research Laboratory
P.O. Box 30
State College, PA 16804–0030

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"When the Waters were dried an' the Earth did appear
The Lord He created the Engineer."
—Ruyard Kipling

CALENDAR of EVENTS

2014

13–15 Oct	AUSA Expo	Washington, D.C.
19–22 Oct	Logistics Officer Association	** Crystal City, VA
17–20 Nov	DoD Maintenance Conference	Birmingham, AL
1–4 Dec	Defense Manufacturing Conference	** San Antonio, TX

2015

13–15 Jan	Surface Navy Association Symposium	** Crystal City, VA
4–5 Feb	ASNE Naval Future Force S&T Expo	** Washington, D.C.
13–15 Apr	Navy League Sea-Air-Space Expo	** National Harbor, MD
5–7 May	AHS Forum 71	** Virginia Beach, VA
23–25 Jun	Mega Rust	Newport News, VA
TBA Sep	FMMS	** San Diego, CA
22–24 Sep	Modern Day Marine	** Quantico, VA
TBA Oct	AUSA Expo	Washington, D.C.
TBA Dec	ASNE Combat Systems Symposium	TBA

** Visit iMAST booth