

CTMA CONNECTOR

WINTER 2022



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About NCMS

The National Center for Manufacturing Sciences (NCMS) is a cross-industry technology development consortium, dedicated to improving the competitiveness and strength of the US industrial base. As a member-based organization, it leverages its network of industry, government, and academic partners to develop, demonstrate, and transition innovative technologies efficiently, with less risk and lower cost.

About CTMA

The CTMA Program offers a unique contracting vehicle for industry, academia, and the DOD sustainment community to work collaboratively. Through these efforts they promote the demonstration, evaluation, and validation of new and innovative technologies that enhance warfighter readiness at optimal value and lowest risk. This non-FAR based contracting vehicle is the only DOD-wide program focused solely on maintenance and sustainment.

UPCOMING EVENTS

January 18-20, 2023

[NCMS Technology Showcase: Pearl Harbor Naval Shipyard](#)

Spring 2023

[Airfield Autonomy Initiative](#)

Burlington, NJ

June 6-8, 2023

[CTMA Partners Meeting](#)

New Orleans, LA

June 20-21, 2023

[Cold Spray Action Team \(CSAT\) 2023](#)

Worcester, MA

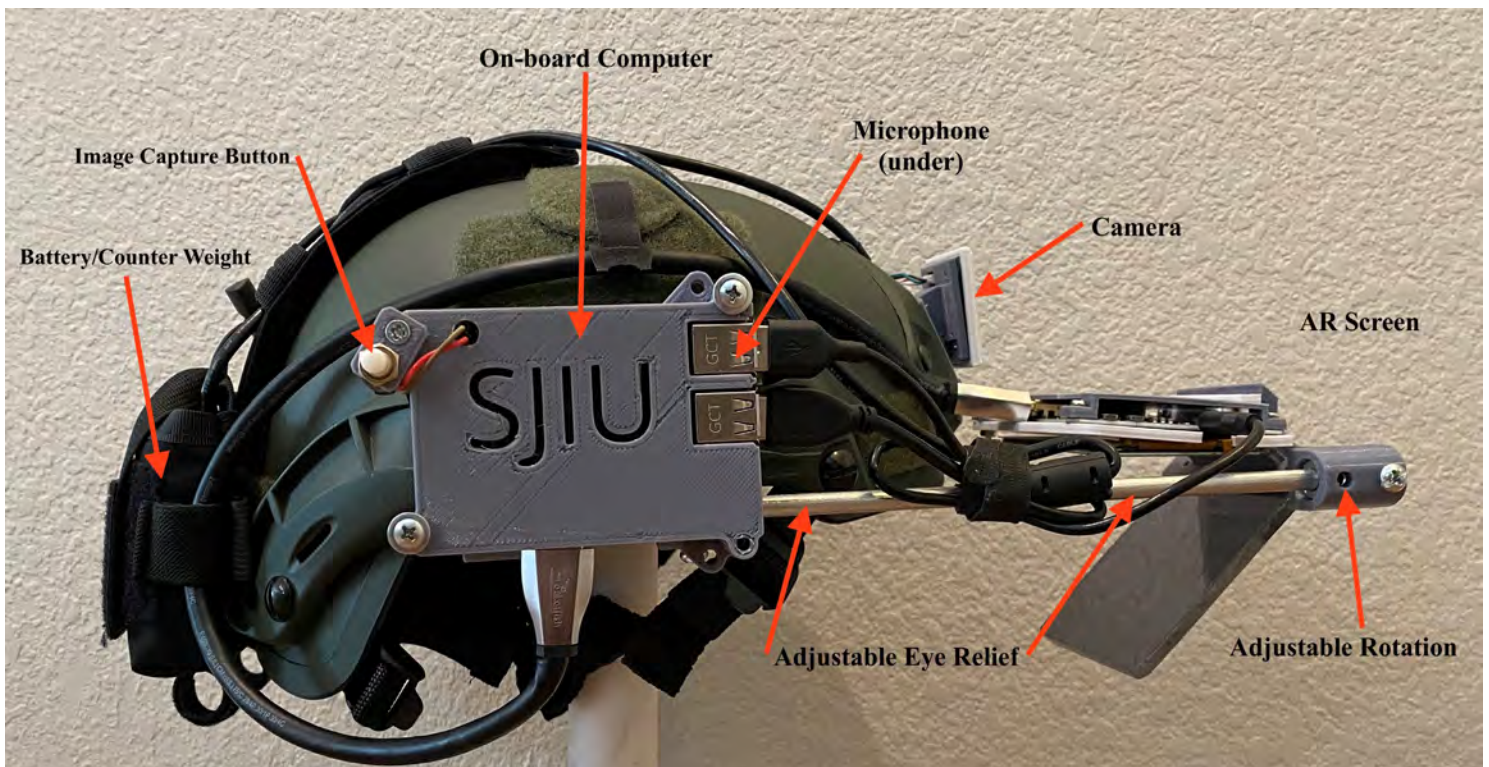
June 22, 2023

[Large Scale Additive Action Team \(LSAAT\) 2023](#)

Worcester, MA

Due to ongoing travel uncertainties, some NCMS events might be rescheduled. Please check the NCMS events page linked below for the latest updates. Don't hesitate to email eventsupport@ncms.org with any questions.

View all upcoming events at: www.ncms.org/events



The T-Glass, developed through a CTMA project, offers USMC maintenance personnel a wearable eyepiece with audible, hands-free search functions and data-gathering capabilities. The system allows access to needed data while they continue working. (Photo courtesy of USMC.)

“T-Glass” Wearable Eyepiece Supports Maintainers

Imagine having the ability to instantly access needed technical manuals and part data without having to stop your work to search through heavy hardcovers or scroll through a digital text.

That’s the goal of a current CTMA project that is producing the T-Glass, a wearable eyepiece with audible, hands-free search functions and data-gathering capabilities. While wearing the T-Glass, maintainers will be able to access needed data, in the periphery of their line of sight, so they can continue their work.

Yet it’s not only maintainers who will benefit from the T-Glass; it will also be a useful tool for electricians working on-site, miners working underground, field technicians installing cable TV and Internet, mechanics repairing vehicles, and even astronauts working on satellites or the International Space Station.

Launched in 2020, the first phase of the project, called Augmented Reality for Streamlined Equipment Maintenance, brought together the expertise of the US Marine Corps (USMC), NAVSEA, NAVAIR, and the

Joint Technology Exchange Group (JTEG). The project team used the Marine Corp’s data and processes as a surrogate for industry to demonstrate how the T-Glass could improve commercial inspection and maintenance operations.

“The goal of this project was to create a maintenance-focused augmented reality/virtual reality (AR/VR) system called the T-Glass that can facilitate acquiring and storing supply chain metrics,” said Lt. Col. AJ Scotti, who managed the project for the USMC. “The scope of work was initiated by Marine Corps reservists, attached to the 4th Marine Logistics Group. They wanted to find a way to manage supply chain metrics in real time. Normally, Marines have to keystroke all our metrics into a computer. This project’s T-Glass can focus on an item so that it can be recognized, counted, archived, and sent to the Global Combat Support System-Marine Corps (GCSS-MC) portal.”

The team began by developing the T-Glass hardware interface to complete a minimum viable product (MVP).

“As we started building the T-Glass, we realized that the most important thing was to find out what the end user wants,” said Scotti. “There’s a lot of AR/VR commercial-off-the-shelf (COTS) technology, but that technology is not necessarily always focused on the needs of maintainers. The T-Glass is unique because it’s built specifically for maintenance professionals.”

NCMS supplied the team with the resources needed to purchase COTS equipment such as small cameras and Raspberry Pi units—computers that run Linux and provide a set of general-purpose input/output (GPIO) pins. The Raspberry Pi devices enable the user to control electronic components for computing and explore the Internet of Things (IoT). Some of the Marines on the project team are electricians by trade, so they were able to integrate the components into a system to be mounted on a Marine’s head with a transparent visor.

Next, the team worked on the software, testing item recognition accuracy and categorizing items within the database configuration. The team of reservists included software developers who coded for tasks such as detecting a specific type of item (e.g., a rifle) and differentiating that item from other types in the same category (e.g., an M27 or a SCAR-L).

“The project team worked like a start-up company using the Silicon Valley business model,” said Scotti. “We built the prototype, did some showcases, demonstrated our capabilities, and got feedback from customers.”

The project is preparing for a second phase, which is intended to complete the software and data integration. The goal is to not only produce the T-Glass, but also a variety of other necessary components including private, secure servers set up to analyze data; informatics on military data for projections; and an informatics engine that is easily usable or adaptable for commercial use.

Although most of the tasks and deliverables of this project will be completed by the Marine Corps, NAVSEA and NAVAIR are interested in being the

next organizations to adopt the T-Glass technology. Moreover, the analytics developed in this initiative could be used to identify fault clusters for all DOD equipment. For example, logs of military aircraft maintenance could be analyzed for fault patterns, which could help the DOD optimize its equipment management in the areas of maintenance, parts purchase, and best practices.

Expectations for the T-Glass suggest that it could bring major innovations in data analysis. As a platform for a scalable data pipeline, the T-Glass has the potential to transform the whole logistics infrastructure by providing a rapid way to gather and analyze existing data on maintenance activities and deliver it to maintainers so they can work more efficiently.

The T-Glass, once fully developed, would also benefit commercial industries by providing a new way to increase the operational efficiency of inspection and maintenance technicians, reduce errors, improve equipment readiness, and lower repair turnaround time. Moreover, the technology’s general data analytics engine for maintenance analysis could be used in civilian maintenance sectors to optimize a vast range of daily commercial or general public operations. One directly transferable application could allow manufacturers/machine operators to follow prompts on their T-Glass to increase their output. The T-Glass could also benefit workers who perform inspection and maintenance in dangerous locations or environments not conducive to reading instructions.

“This project’s T-Glass can focus on an item so that it can be recognized, counted, archived, and sent to the Global Combat Support System-Marine Corps (GCSS-MC) portal.”

– Lt. Col. AJ Scotti, USMC

“What has been most impressive about this project is the depth of the talent and skill set inherent in the USMC reserves, especially the junior Marines as we move toward Force Design 2030,” said Col. Mike Wendler, the contracts manager for the project who also provided program oversight.

Lt. Col. Scotti agreed. “We focused on cultivating an ecosystem of STEM Marines,” he said. “The reservists have experience working in the commercial sector and we were able to inject those capabilities into the Marines.” Currently, the team is actively seeking funding to DOD as well as commercial industry. ■



Members of the 175th Cyberspace Operations Group provide cyber threat updates at Warfield Air National Guard Base, Middle River, MD. (US Air Force photo by J.M. Eddins Jr.)

Air Force Collaboration Advances US Cybersecurity

Last year's ransomware attacks on the Colonial gas pipeline and JBS, a global leader in meat distribution, have exposed the need for commercial and government industries to prioritize their cybersecurity. To help this process, in November 2021 NCMS launched a collaboration between the US Air Force and BigBear.ai. This collaboration—Digital Transformation of Cyber Operations for Acquisition and Sustainment Operation—is using the US Air Force as a test bed to ensure that legacy acquisition and procurement processes have robust cybersecurity protections.

“The objective is to take the traditional acquisition and development process that the government uses and transform it into a Lean-Agile enterprise that can independently sustain the delivery of high quality,

secure, and valued capability at the speed of need for their customers to protect the US and its resources from cyberattacks,” said Tom Tschuor, Senior Vice President of Defense Service Solutions at BigBear.ai.

BigBear.ai and the Air Force collaborated to develop a training program that combines Lean and Agile approaches. Put simply, “Lean” is a quality improvement and management philosophy focused on reducing waste and improving workplaces. The term “Agile” has multiple definitions and, in this case, applies to a framework that allows flexibility, minimizes risk, and adapts to emerging requirements while maintaining and sustaining current operations. Combining Lean and Agile approaches promotes a single strategy for continuous innovation and development.

The initiative is applying the Lean-Agile approach to the US Air Force's Cryptologic and Cyber Systems Division and demonstrating their solution using the Air Force's Unified Platform (UP), a software platform designed to consolidate cyber capabilities across the DOD for joint cyber warfighters. The goal is to ensure successful execution by rapidly fielding secure, fully integrated, interoperable cyberspace capabilities.

The project began in February 2022 with an agility assessment report to identify organizational challenges and improvements needed for responding to urgent and emergent cyberwarfare operations. After assessing these needs, the team delivered customized training in Lean-Agile principles and methodologies, including Jira software (an Agile project management tool), Kanban/Sprint boards, metric reports, risk management, planning, collaboration, and continuous improvement. By conducting "train-the-trainer" instruction on Agile processes, the initiative also established an initial cadre of Agile coaches to sustain the Lean-Agile cyber operations workforce pipeline. This training breaks down legacy acquisition organizational silos through the instantiation of "DevSecOps"—the harmonized combination of development, application security, and operations.

The Lean-Agile framework ensures that the cyber unit is adaptable to the dynamic nature of offensive and defensive cyber operations and rapidly responsive to adversarial attacks. Beyond the Air Force, this initiative directly supports the senior DOD's strategy of cultivating, expanding, and enabling a foundational cyber workforce trained to conduct decentralized development and experimentation in cyberspace while remaining a dominant power in global cybersecurity operations. The collaboration has completed the first two phases and is working on the third one.

"Phase three focuses on taking the solutions we developed in the first two phases and building on those capabilities to deliver a larger-scaled solution," said Tschuor. "This will provide insight into how the defensive

cyber applications can support commercial and business operations."

The project, scheduled to wrap up in 2023, will enable a stronger global defense industrial base and allow for the delivery of high-quality cybersecurity for both government and commercial enterprises. From integrating Lean-Agile approaches into their systems, processes will be adaptable across the spectrum of business sectors. With this advancement, businesses will be equipped with an ability to rapidly produce high-quality, innovative, digitally enabled products and services. These advances will enable a continuous

delivery pipeline of software and tools embedded with DevSecOps practices and compliances to reduce the cyber vulnerabilities faced by the general public today.

"If we can't evolve and create defensive tools quickly enough, then we're vulnerable to cyberattacks," said Tschuor. "Without effective cybersecurity measures in place, a lot of systems potentially can be compromised, such as power infrastructure, the internet, and even the food supply."

Along with improving cybersecurity, this initiative will enable better efficiencies in complex, software-intensive transformations. As results from this project have shown, the transformation plan employed is capable of creating and maturing an adaptive, cadence-based release system design that supports the growing software infrastructure. Additionally, this initiative will demonstrate how alternative scaling frameworks can be used for software development and sustainment. These scaling frameworks could help businesses leap from rigid hierarchies and infrastructure models to a more collaborative approach capable of rapid responses to emerging requirements.

"I'm very excited about the government program offices being able to deliver value much more quickly to their customers," said Tschuor. "Delivering that value continuously and as quickly as things change in the cyber areas is critical to keep ahead of the threats." ■

“If we can't evolve and create defensive tools quickly enough, then we're vulnerable.... Without effective cybersecurity measures in place, a lot of systems potentially can be compromised, such as power infrastructure, the internet, and even the food supply.”

- Tom Tschuor, BigBear.ai



Two hull maintenance technicians of the Navy's Surge Maintenance program listen as EWI Cold Spray Research Engineer Sam Bedard briefs them on the use of the Centerline SST low-pressure cold spray system aboard the Self Defense Test Ship while underway off the coast of Naval Surface Warfare Center, Port Hueneme Division, during the 2022 REPTX. (US Navy photo by Eric Parsons.)

Tele-manufacturing Goes to Sea: Bringing Remote and Automated Processes onto Deployed Vessels

By Connie LaMorte, Howard Marotto, and Lindsey Lindamood

In August 2022, EWI was selected by NCMS to attend the inaugural Repair Technology Engagement Exercise (REPTX) to demonstrate our technologies aboard the Navy's Self-Defense Test Ship (SDTS). This event, held at Naval Base Ventura County in Port Hueneme, CA, was sponsored by the NAVSEA Technology Office and provided an opportunity to showcase technologies that can solve fleet expeditionary maintenance and battle-related support requirements. EWI was able to demonstrate and evaluate the viability and efficacy of two newly developed technologies, cold spray and tele-NDE for corrosion repair and assessment — both at port and at sea on the SDTS (ex-US Paul F. Foster, DD 964). The REPTX event is a tool to help the Navy evaluate prospective technologies that may expand its ability to perform expeditionary maintenance and sustainment.

Corrosion on ships causes immense damage and is a constant challenge. It can degrade structural integrity, lead to parts failure, and decrease material readiness. Furthermore, corrosion remediation requires countless hours of additional labor, costing millions of dollars and diverting sailors from more important tasks. Cold spray technology deployed on a ship in service can mitigate or stop localized corrosion. During REPTX, EWI demonstrated that a sailor can employ a portable cold spray system to treat corrosion with very little training and potentially prevent it from affecting the treated area again.

Cold spray has been an established solution to treat localized corrosion and provide dimensional restoration on ships for many years. It has been employed at the Navy shipyards in applications such as non-sealing or non-bearing surface restoration, sealing or bearing

surface restoration, and dimension repair in non-load bearing areas. Some commercial entities have considered using cold spray for propeller repair as well.

While adopting cold spray processes can save the Navy millions of dollars and increase material readiness, the ability to assess the damage, determine the repair required, and evaluate the quality of the repair are also important to saving time and money. However, this evaluation is a complex task that requires an engineer's insight, and is not currently possible on ships while deployed. EWI has developed a remote technology that can do this evaluation on a ship underway and demonstrated this during REPTX.

Tele-NDE is a system that can conduct nondestructive evaluation (NDE) of surfaces from a distance through automated technology. Remote control of repair and inspection processes allows an operator to be onshore and communicate with process and inspection equipment located on the ship. Alternatively, the operator can be in one location on the ship and the operating equipment can be in another.

Both remote visual monitoring and automated NDE have been used in commercial applications for some time. Tele-robotics has enabled doctors to perform remote surgery successfully in medicine for over a decade. Over the past two years, EWI has been active in developing tele-robotic systems for welding, gouging and inspection using both phased array ultrasonic testing and eddy current. A combined cold spray and tele-NDE solution—a technological first—was demonstrated on actual corrosion-damaged areas on the SDTS in-port, with access to shore power and connectivity to validate the solution in that regime. At-sea demonstrations later validated that the solution could also be employed while underway.

Navy leadership has stated the need for dynamic visualization and inspection methods to “see” themselves and the world surrounding them. Tele-inspection technology can help meet that goal by providing real-time visualization of a surface and subsurface features to a remote operator. During REPTX, EWI demonstrated that eddy current could be used to

assess the results of a cold-spray repair of a corroded area on or off the ship.

The Navy also reports the need to perform maintenance operations underway and in forward locations to improve ships material condition and build battle damage repair competencies. EWI's cold spray technology can complete this type of repair as demonstrated on the SDTS. For our cold spray solution, only one sailor would be required to move, operate, and maintain the system. Meanwhile,

EWI's tele-NDE method allows the NDE technician the ability to remotely access the machine for moving the probe into a desired inspection location and interpreting the results. Pairing our cold spray solution with our tele-NDE solution ensures that the quality of work performed by the sailor can be quickly assessed, allowing for adjustments, corrections, and assurance.

Finally, the Navy is challenged by “the tyranny of distance” for supply chains, particularly in contested environments. Forward manufacturing hubs, including additive manufacturing, can enable greater ship readiness in theatre. Tele-presence inspection methods, like those developed by EWI and

demonstrated during REPTX could be used for inspection and remote assessment of additively manufactured parts, further building confidence in forward-manufactured components and ensuring quality at the point of need.

Tele-NDE and cold spray can be deployed individually or in coordination, for repair or inspection applications in all industries. EWI continues to develop solutions in tele-manufacturing for our customers and continues to push the advancement of cold spray into industry.

Authors Connie LaMorte, Principal Engineer, Howard “Howie” Marotto, Business Director for AM, and Lindsey Lindamood, Applications Engineer, work for EWI.

Note: Any reference to specific equipment and/or materials is for informational purposes only. Any reference made to a specific product does not constitute or imply an endorsement by EWI of the product or its producer or provider. ■

A combined cold spray and tele-NDE solution—a technological first—was demonstrated on actual corrosion-damaged areas on the Self-Defense Test Ship in-port, with access to shore power and connectivity to validate the solution in that regime.



Exhibitor Keyence Corp. demonstrates its Laser Marker/Engraver to attendees of the NCMS Technology Showcase at Puget Sound Naval Shipyard & Intermediate Maintenance Facility in September, 2022. (Photo by NCMS Staff.)

2022 Year in Review: Live Events Return

CTMA Partners Meeting

After a two-year hiatus due to the coronavirus pandemic, nearly two hundred leaders from government, industry, and academia gathered at NCMS's 2022 CTMA Partners Meeting, held May 3-5 in Virginia Beach, VA. Focused on advancing the development and adoption of key maintenance and sustainment (M&S) technologies, the Partners Meeting provided a forum for experts to exchange information about successful projects and to address challenges.

Keynote speakers included Steve Morani, who at the time served as Acting Assistant Secretary of Defense for Sustainment, and Col. Howard K. Marotto, AM Business Director for EW. Mr. Morani shared details about the DOD's Logistics and Materiel Readiness Strategic Plan 2022-28, and spoke enthusiastically about CTMA collaborations: "The DOD can't do it alone—we need our industry and academic partners to be successful." Col. Marotto, during his keynote address, discussed lessons learned during the Marine Corps' NEXLOG project. Panel topics included the Sustainment Technology Program, Modernizing the Organic Industrial Base (OIB), CBM+/Predictive Maintenance, Advanced Manufacturing/Additive Manufacturing, Energy/Environmental Health and Safety, NavalX and the Tech Bridge Network, Sustainable Modernization of Weapons Systems, and Improved Business Operations. Additionally, the event featured tabletop demonstrations by 25 industry

innovators. For more information about the event, visit: tinyurl.com/CTMA2022PM.

JROBOT Summit V

JROBOT Summit V took place June 6-9 in Detroit at the Automate Show, North America's largest automation and robotics exhibition, which is held every two years. The JROBOT Summit was an invitation-only event focused on assessing the latest solutions using robotic capabilities within the Automate Exhibit Hall and identifying the policy elements needed to maximize asset availability across the DOD and Allied Partners.

Participants included maintainers and researchers from the DOD, NASA, and the DOE, along with industry and academic partners via the Advanced Robotics for Manufacturing (ARM) Institute and NCMS. During the event, over twenty-five volunteers interviewed 230+ exhibitors (suppliers, integrators, and OEMs). An additional survey available by QR code was provided to 500 exhibitors. These surveys identified robotics-focused companies that are interested in assisting the DOD to meet maintenance needs.

Additive Manufacturing Workshop

The seventh annual Additive Manufacturing (AM) Workshop, held June 28-29, 2022, gathered over one hundred leaders and stakeholders with an interest in AM



The Sustainment Technology Program Panel, moderated by Steve McKee, Director of Enterprise Maintenance Technologies with the Office of the Deputy Assistant Secretary of Defense for Materiel Readiness (at left) discusses the DOD’s new Logistics and Materiel Readiness Strategic Plan during the 2022 CTMA Partners Meeting, held in May in Virginia Beach, VA. (Photo by NCMS Staff.)

from government, industry, academia, and nonprofits. Attendees collaborated on advancing foundational aspects of AM necessary for the DOD’s wide adoption of this game-changing capability.

The event organized working groups focused on five important AM areas: standardization prioritization, cybersecurity, assessing additive manufacturing crisis response, AM portal for education (AMPED), and agile inspection and testing. To learn more about the event, visit tinyurl.com/2022AMworkshop.

NCMS Technology Showcase at Corpus Christi Army Depot (CCAD)

NCMS’s July Technology Showcase at Corpus Christi Army Depot (CCAD)—the first showcase NCMS has held at this depot—was a huge success, attracting nearly 50 world-class exhibitors to demonstrate their maintenance and sustainment technologies.

This event gave industry and academia a special opportunity to display and demonstrate novel capabilities at the Army’s premier helicopter overhaul and repair facility. DOD leadership, maintenance managers, and artisans met face-to-face with industry and academic experts to learn about the latest processes and technologies that can best solve their maintenance and sustainment (M&S) challenges.

A unique feature of this showcase was that both Army and Navy representatives were able to attend, because CCAD is located on the site of the Corpus Christi Naval Air Station (NAS). Corpus Christi NAS serves primarily as an aviator training facility, and provides pilot training for the Navy, Marines, and Coast Guard. To learn more about the event, visit: tinyurl.com/2022CCADshowcase.

REPTX

The wildly successful, first-ever Repair Technology Exercise (REPTX), a US Navy demonstration event, took place from August 22 through September 2. More than 60 technology providers substantiated their products’ capacity to tackle real-world fleet maintenance challenges, including assessing and repairing potential battle damage aboard the Navy’s Self Defense Test Ship, an asset of Naval Surface Warfare Center, Port Hueneme Division (NSWC PHD).

REPTX participants addressed four focus areas: visualization, command and control aids, forward manufacturing, and expeditionary maintenance. NCMS was pleased to assist the US Navy with identifying and vetting industry and academic participants via its network of hundreds of innovative technology solutions providers. For more information about the event, visit: tinyurl.com/2022REPTX.

NCMS Technology Showcase at Puget Sound Naval Shipyard

In partnership with innovation leadership at Puget Sound Naval Shipyard (PSNSY), NCMS organized, facilitated, and co-hosted a Technology Showcase to help fast-track relevant maintenance, repair, and overhaul (MRO) innovations. Working closely with the innovation leads at PSNSY, NCMS identified best-in-class technologies aligned to nine key MRO functional areas: Advanced/Additive Manufacturing, Business IT and Analytics, CBM+/Predictive Maintenance, Coatings and Corrosion Prevention, Energy/Environmental/Health & Safety, Enhanced Inspection, Facilities and Industrial Process Modernization, Hardware Reliability Improvement, and Workforce Development and Visualization.

Forty-four companies participated in the showcase from September 14-15. Personnel from key PSNSY production shops, Command leadership, NAVSEA engineering and sustainment, and representatives from the Navy's Repair Technologies (REPTech) working group collaborated and shared ideas at the event. Visit tinyurl.com/2022PSNSYshowcase to see more information about the event.

Airfield Autonomy Initiative (AAI)

The first-ever AAI is a US Air Force (USAF) development, integration, and test demonstration initiative that is enabling industry and academia participants to partner with the USAF to advance airfield automation and command and control (C2) systems. For this initiative, the USAF is focusing on automation for the simple tasks of lawn mowing, Foreign Object/Debris (FOD) detection, and perimeter patrols (for both security and wildlife management).

In order to advance toward AAI consortium demonstrations, a preliminary group of applicants took part in a collaborative information exchange session on October 13-14. During this session, the participants engaged with DOD and FAA organizers to learn the detailed rules for operating autonomous vehicles on active airfields, the nature of airfield layouts, existing obstacles, and how the step-by-step demonstration plan will be executed. The collaborative team also provided introductions to the FAA

advanced technology airport engineers who will ultimately decide on the future of Smart Commercial Airports (including automated vehicles). The exchange session created a venue for discussions with other government officials considering automation of the maintenance of large open areas. Participating companies are slated to perform initial demonstrations beginning in early 2023. For more information about the initiative, visit the AAI web page: tinyurl.com/2022AAIevents.

During REPTX, more than 60 technology providers substantiated their products' capacity to tackle real-world fleet maintenance challenges, including assessing and repairing potential battle damage aboard the Navy's Self Defense Test Ship, an asset of Naval Surface Warfare Center, Port Hueneme Division.

DOD Maintenance Symposium

NCMS recently took part in the DOD Maintenance Symposium, held December 12-15, 2022, in Orlando, FL. In our exhibit hall booth, we showcased seven outstanding industry partners: AMETEK/Spectro Scientific; Automated Precision Inc. (API); Atmospheric Plasma Solutions (APS); Boston Engineering; DAES Group; Ricardo Defense; and Siemens Industry Software. These companies embodied the theme of the symposium, "Next Generation Materiel Readiness Forged through Data Advantage, Technology, and Innovation."

Of equal importance, NCMS facilitated a breakout session during which the six Maintenance Innovation Challenge (MIC) finalists presented their entries and competed for awards. The Overall MIC Award Winners are Jim Becker, Perfect Point EDM, and Jared Wright,

Naval Air Systems Command and their entry, E-Drill: A New Way to Remove Aircraft Fasteners. The winning entry was selected by the DOD's senior maintenance leaders from the Maintenance Executive Steering Committee, the Joint Group on Depot Maintenance, and the Industrial Base Commanders. The People's Choice Award winners are Brett Jordan, Air Force Research Laboratory, and Tech. Sgt. William Kesler, Aircraft Battle Damage Repair Technical Support Office, Air Force Sustainment Center, for their entry Fiber Optic Fusion Splice Repair. It was selected by the breakout session's attendees. For more information about the MIC winners, visit: tinyurl.com/2022MICwin. ■



A PPG scientist coats out NMP-free cathode slurry onto aluminum foil. These films are then cured and calender-pressed to create a cathode before electrochemical testing. (Photo courtesy of PPG Industries, Inc.)

Advances in Lithium-Ion Battery Materials Expected to Lower US Electric Vehicle Costs

While a variety of commercial electric vehicles (EVs) are available on the US market, there are several barriers to address before they achieve widespread adoption. Consumers are cost-conscious, averse to long charge times, and concerned about vehicle safety. A current CTMA collaboration is addressing these issues, aiming to increase the public's adoption of electric vehicles and reduce the country's petroleum dependence.

"If you think about what's going to stop somebody from buying an electric vehicle, the two main things are high cost and concerns about safety," said Sam Esarey, Ph.D., Senior Research Chemist at PPG. "We're working to help reduce the manufacturing cost of batteries for electric vehicles, along with making thermal management coatings for battery fire protection."

The initiative, Advanced Materials for Lithium-Ion Batteries, brings together experts from PPG, US Army Ground Vehicle Systems Center (GVSC), and North Dakota State University. The team is researching new coating technologies and thermal management systems for improved lithium-ion battery energy density, life,

and safety, particularly to provide protection against temperature extremes that can lead to catastrophic battery failure. Results will lead to cheaper, longer-lasting batteries that would be usable for consumer products, industrial use, and electric vehicles.

"The battery pack is the most expensive component of an electric vehicle," said John DiMeglio, Research Chemist at PPG. "Any technology that can help with improving batteries, realizing economies of scale or a cheaper, more efficient manufacturing process, will decrease the cost of EVs. With our system, we've found a five to six percent cost savings from the cathode coating process."

The team is working on improving lithium-ion batteries for ground vehicles. Lithium-ion battery cells are composed of an anode and cathode, layered with a separator, surrounded by electrolyte and capped with two current collectors (i.e., electrodes). A chemical process allows ions to separate from electrons, delivering negatively charged electrons to an electrical circuit and allowing positively charged ions to travel through the electrolyte. Cathodes are made by coating active materials, frequently lithium iron

phosphate (LFP) or lithium nickel manganese cobalt oxide (NMC), onto an aluminum foil current collector. Anodes are typically graphite or other carbon materials coated onto copper foil. During charging, lithium ions are driven through the separator to intercalate into the graphite, building up a negative charge at the anode's electrode and a positive charge at the cathode's electrode. During discharge, the electrons carry current from the negative electrode into an electrical circuit, and the ions travel back through the separator from the negative to positive electrode. The binder or the binder system is essentially the polymers that hold all the other components of the battery together.

"The chemistry that we use in our binder system ultimately helps with increasing the cycle life of our batteries," said Esarey. "Our binder system contains components that are better at distributing the cathode coating to yield better results over time, over many cycles, compared to traditional binder systems. We're incorporating particular binders in our system that help with the ultimate performance of cathode, such as better carbon dispersion, active material dispersion, adhesion to the current collector, and better flexibility so that during processing, you don't have any cracks."

In Phase I, the team focused on improving cathodes to improve the batteries' energy density and power density. The novel cathode coating formulas can deliver a balance of power and energy so batteries can store enough power to fuel a vehicle over long distances, all while providing a high-enough power draw to support the onboard electrical equipment. In addition, they worked to reduce the batteries' environmental impact by creating and successfully demonstrating a cathode coating formula that eliminated N-methyl pyrrolidine (NMP).

"NMP is being regulated out in Europe and will eventually be phased out elsewhere, so we seek an alternative for battery manufacturing that does not contain NMP," said Esarey. "The new system that we have developed is an NMP-free solvent binder system that actually allows us to use less solvent overall compared to traditional NMP-

containing cathode formulations, and that allows us then to use less heat to evaporate less solvent and cure the cathode coatings faster. Ultimately, lowering the amount of energy required to coat and dry cathode materials will lower the overall cost."

The new formulation brings other improvements that reduce the batteries' environmental impact.

"One consideration we have is that batteries are made in a sustainable way so that there are not a lot of emissions associated with the production of the raw materials that go into the battery and the battery itself," said DiMeglio. "We've done some life cycle analyses for our NMP-free solvent that have shown that the PPG binder system and the PPG NMP-free solvent emits 39 percent less CO₂ when compared to standard NMP systems."

In the second phase, the team shifted their attention to improving anodes.

"In Phase II, we designed some new binders for the anode, which is carbon-based material that can allow the active materials to be more well distributed throughout the coating, and which we found to significantly improve the performance of the anode," said DiMeglio.

Currently, the project team is concurrently working on the third and fourth phases to leverage research benefits between efforts and maximize information-sharing of technical knowledge. In Phase III, the team is incorporating the advanced high-energy-density cathodes and anodes demonstrated in the previous phases into single-layer pouch cells to assess performance. The anticipated results will bring new levels of both power and energy capacity compared to current energy storage technology.

"The first three phases focused on making cells that will ultimately go into a 6-T battery," said Esarey. "We looked at the cell level, rather than the pack level. We weren't testing 6-T batteries. Rather, we're looking to build pouch cells that will be tested at the cell level to meet 6-T specifications. In phase three, we're trying new formulations to further improve energy density and power, particularly by looking at anode formulations."

“The battery pack is the most expensive component of an electric vehicle.... Any technology that can help with improving batteries, realizing economies of scale or a more efficient manufacturing process, will decrease the cost of EVs.”

- John DiMeglio, PPG

The team is also working on the fourth phase, which is focused on developing solid-state battery capabilities, and on high-power supercapacitor cells that are meant to complement a Li-ion battery electrode with decreased flammability and size versus traditional supercapacitors. As complementary technology to a battery, a supercapacitor can take the extreme load off the Li-ion battery during high power applications such as turning over an engine, extending the lifetime of the Li-ion 6T battery.

“We’re working to make these devices smaller and safer so they can be used more readily in mobility applications,” said Esarey.

The project is scheduled to be completed in September 2023, when the team will perform a manufacturability study to determine if there are any roadblocks to making a 6T battery at scale. Results will be of interest to the entire Department of Defense (DOD), since the DOD, as the largest federal government consumer of fossil fuel, has identified vehicle electrification as an area of high priority. In the long road to full electrification, the ability to utilize a lithium-ion 6T battery in place of lead-acid batteries would allow the DOD to begin reaping benefits much sooner. Lithium-ion batteries are lighter weight and can last five times as long as lead acid-based batteries.

This project’s improvements to the performance, efficiency, energy density, safety, charging speed, and cost of lithium-ion batteries will lead to more affordable EVs and possibly more widespread public adoption of EVs.

“Working in the alternative energy battery space is a really exciting opportunity,” said DiMeglio. “After working on this project over the past few years, I’ve seen the real-world positive impact.”

“I went into science to work on renewable energy,” said Esarey. “It’s been really motivating to work with the military to help convert their vehicles to something that are more hybrid, not purely run on fossil fuels. I think this project will have an impact on improving lithium-ion batteries.” ■

MEMBER SPOTLIGHT



Meet AR SOME Technology

As many schools, companies, and organizations pivoted to online school and work during the pandemic, investments in digital and immersive programs skyrocketed. While most organizations have returned to in-person or hybrid environments, there is still a strong and growing market for digital programs, systems, and applications. AR SOME Technology (AR SOME) provides full-service augmented, virtual, and mixed reality (AR/VR/XR) software development, working with companies and organizations to develop digital programs, systems, and applications to better educate and train employees and personnel on workforce activities and development.

Furthermore, AR SOME Technology develops personalized AR/VR training and education programs for workforce personnel. AR SOME’s AR/VR training programs and products include training simulations for occupations that are dangerous, dirty, or complicated. Through simulation, gamification, and storytelling, these programs help to improve employee engagement, reduce employee error, and better prepare employees for on-the-job workforce activities.

In addition to developing AR/VR training and education programs, AR SOME develops virtual worlds and the metaverse for workforce personnel to communicate and learn in an interconnected, safe environment. To meet their clients’ objectives, AR SOME executes a four-phase project management process: storyboard, development, testing, and deployment. Additionally, AR SOME collaborates with subject-matter-experts (SMEs) to develop digital programs, systems, and applications that achieve their clients’ goals.

AR SOME’s team of entrepreneurs, engineers, investors, partners, and experts have worked with companies and organizations such as Harvard University, MIT Media Lab, *The Wall Street Journal*, Connecticut Children’s Hospital, and more. For more information, please visit:

www.arsome.com. ■