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CRADA brings device to marketplace

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In this issue

Summer is upon us. At the end of August, I will be retiring from my 40-year federal service career, which started back in 1978 after graduating from the U.S. Naval Academy. While I am looking forward to new ventures, I am truly going to miss working with the many dedicated and talented employees here at Carderock Division. The ideas and innovations I have seen from this workforce lead me to believe that Carderock will continue to move forward, on the cutting edge of science and technology. It has been my honor to serve alongside you and I am extremely proud of how you have excelled in delivering advanced technologies and enduring capability to the warfighters! Thank you!

In 2014, about a year after I started working as the technical director, we saw that we needed to come up with better ways for our scientists, engineers and other employees to bring their ideas to the surface. We accelerated Carderock's culture of innovation by starting the Technical Director's Innovation Challenge (TDIC), which allows employees to submit their ideas or projects for further funding (Page 30). It's been exciting to watch these ideas develop and progress over the course of the year timeframe the projects are presented and worked on.

Innovation is not just at the basic research level. Carderock has helped develop some really good ideas into reality, such as helping the Coast Guard develop a new Icebreaker, which is being tested in Canada now (Page 13); and the Cooperative Research and Development Agreement (CRADA) between Oceana Energy and the Navy, where our folks helped the company develop and test a new river-based energy converter (Page 22).

Showcasing Carderock's innovations and technologies to the outside world is a very important aspect of what we do. It helps us focus our attention on what is important to our stakeholders. Read about our time at the Pentagon Lab Day (Page 4), the Print-a-thon (Page 6) and the Sea-Air-Space exposition (Page 3).

Some of those outside-world stakeholders are students. It's equally important to showcase what we do to students to encourage their interest in STEM fields. The Carderock Math Contest brought hundreds of really smart kids on base (Page 38); and now many of those students have a greater appreciation for what Carderock does for the Navy.

I encourage everyone to get involved in STEM events. Everyone likes to pass on their knowledge and ideas, and how better to do that than with students. You might make a huge difference in someone's life. And In order for our own workforce to continue to grow and improve, employees should consider joining professional societies (Page 46). These are great places to network and learn from each other.

It has been my pleasure to work here at Carderock for the last four years and I look forward to seeing all the great things that will continue to come from here and all Navy Labs.

Dr. Tim Arcano
NSWCCD Technical Director

Cover

Alexander Tsarev, a team lead for the Maritime Systems Hydromechanics Branch of Naval Surface Warfare Center, Carderock Division, watches as a hydrokinetic device, developed by Oceana Energy, is tested in Carderock's David Taylor Model Basin on Aug. 5, 2014 in West Bethesda, Md. Story on Page 22. (U.S. Navy photo by Ryan Hanyok/Released)

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Carderock at the 2017 Sea-Air-Space expo

From Carderock Division Public Affairs

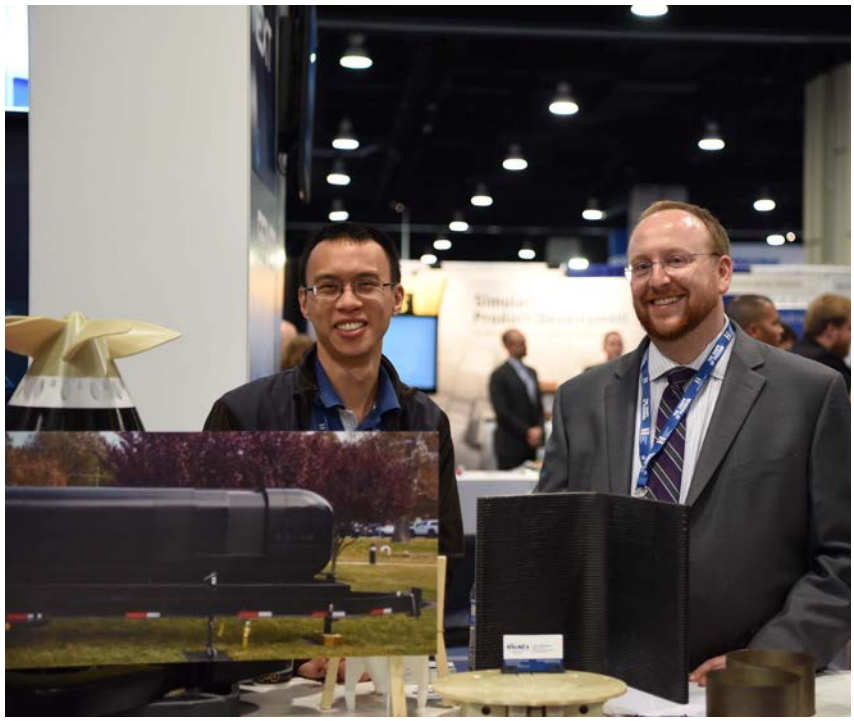
Garry Shields (right), director of Naval Surface Warfare Center, Carderock Division's Disruptive Technologies Lab, tells visitors about the Optionally Manned Technology Demonstrator during the Sea-Air-Space Exposition on April 4, 2017, at National Harbor, Md. (U.S. Navy photo by Kelley Stirling/Released)

The Navy League's 2017 Sea-Air-Space Exposition was held April 3-5 at the Gaylord National Convention Center at National Harbor in Maryland.

Naval Surface Warfare Center, Carderock Division, showcased the Optionally Manned Technology Demonstrator (OMTD) – a 30-foot demonstration vehicle built using Big Area Additive Manufacturing. The OMTD was too large to showcase in the exhibition hall, so Garry Shields, director of Carderock's Disruptive Technologies Lab, presented it on the Gaylord's terrace near the waterfront.

The OMTD has allowed the DTL the opportunity to demonstrate how augmented reality technology, such as the Microsoft HoloLens, might work for the Navy. The glasses can overlay schematics or technical information over what the viewer is seeing in the real world. Carderock displayed the HoloLens inside the exhibition hall during the Sea-Air-Space Exposition, along with other 3-D printing capabilities.

The event brings the U.S. defense industrial base, private-sector U.S. companies and military members together for an annual innovative, educational, professional maritime-based event, giving the attendees an opportunity to display, discuss and demonstrate the most current information and technology relevant to maritime policy and establish relationships that could lead to future collaborations.



Kevin Lin (left), an electrical engineer and member of Naval Surface Warfare Center (NSWC), Carderock Division's Disruptive Technologies Lab, stands with Ricky Moore from NSWC, Dahlgren Division at their booths April 4, 2017, during the Sea-Air-Space Exposition. (U.S. Navy photo by Katie Ellis-Warfield/ Released)

Carderock showcases Combatant Craft Division at DOD Lab Day 2017

By Dustin Q. Diaz, Carderock Division Public Affairs

Dr. John Burrow (right), deputy assistant secretary of the Navy for research, development, test and evaluation, talks with Combatant Craft Division's John Phillip (back to camera), Scott Petersen (left) and Dennis Danko during DOD Lab Day 2017 on May 18 at the Pentagon courtyard.The CCD team represented Naval Surface Warfare Center, Carderock Division at the biennial event. (U.S. Navy photo by Kelley Stirling/Released)

Employees from Naval Surface Warfare Center, Carderock Division's Combatant Craft Division (CCD) displayed the results of developing technologies and partnerships at the second biennial Department of Defense (DOD) Lab Day in the Pentagon center courtyard, May 18.

Lab Day showcased innovations from 63 Army, Marine Corps, Navy, Air Force and medical laboratories and engineering centers across the country, featuring more than 80 exhibits.

"It's our goal to hold this event every two years to bring in the labs and show what our government scientists and engineers are doing every day to make a difference in the fight," said Dale A. Ormond, principal director of research in the Office of the Assistant Secretary of Defense (Research and Engineering), to begin the event. "The displays here demonstrate what our defense labs do to solve problems today and design solutions for tomorrow."

Ormond introduced Mary J. Miller, acting assistant secretary of defense for research and engineering, who talked about her own history as a "lab rat" in the DOD laboratory community working on night vision for the Army early in her career and the diversity of the technologies on display and entities represented at Lab Day. She then discussed some of these in more detail, like the Soldier Weapon Exoskeleton on display by the U.S. Army Research Laboratory, advanced ordnance technologies from the Air Force and the unmanned underwater vehicles (UUV) and Stiletto Maritime Demonstration Program on display at CCD's booth.

"These labs provide a flexible in-house capability to quickly adjust to the warfighter's needs. They provide science and technology and engineering expertise to the entire Department of Defense that allows our nation to maintain a technological edge over potential adversaries," Miller said. "Through these efforts, the department has continued to be the engine of innovation that allows our military to overcome current and future challenges to our security."

DOD Lab Day was sponsored by Rep. Jim Langevin of Rhode Island, a member of the House Armed Services Committee, and open to members of Congress, STEM-participating high schools, Pentagon employees, the media and special guests. Carderock's participation in the event highlighted current and future efforts for a range of purpose-built and re-purposed manned and unmanned combatant craft contributing to future warfighting

Mary Miller, acting assistant secretary of defense for research and engineering, meets Combatant Craft Division's (from left) Scott Petersen, John Phillips and Dennis Danko during a pre-event walk-through May 17 for DOD Lab Day 2017 at the Pentagon courtyard May 18. The CCD team represented Naval Surface Warfare Center, Carderock Division at the biennial event. (U.S. Navy photo by Monica McCoy/Released)

needs for the Navy and Marine Corps, according to Scott Petersen, Combatant Craft Systems Design Branch head.

"Today we're showcasing two programs – unmanned vehicle programs and our Stiletto program. It's some of the most exciting work we're doing," Petersen said. "It's emergent, it's relevant and it's being looked at a lot to change how we do business in the Navy. We're postured, we're developing technologies, we're getting smarter, and we're here to showcase these capabilities we have."

The Stiletto maritime demonstration platform is an experimental all-carbon-fiber craft that was originally built to explore the scalability of non-mechanical dynamic lift and high-speed performance for military operations. The ship has since become a test platform that can give industry, academic and government organizations a realistic environment in which they can demonstrate emerging capabilities and technologies without paying for operating costs. Petersen told visitors more about how CCD and the Navy use Stiletto, including as a command-and-control platform for UUVs, and why UUVs will figure heavily into the Navy's future.

"Like a drone you use to remove human involvement, there are all kinds of reasons to unman a boat: you can rescue a person from a minefield without endangering others or allow a Sailor to run a harbor security mission from an air conditioned room via remote control," Petersen said. "Then you have fully autonomous UUVs. Perhaps for that, you could set a boat by an oil rig and set it to respond when a vehicle gets too close. We're improving things like obstacle avoidance to make these vehicles more robust and capable, because there are many missions where you want the man out of the environment and back on shore."

John Phillips, mechanical engineer at CCD's Systems Integration Branch, and Dennis Danko, program manager for the Stiletto program, also represented Carderock at Lab Day.

Technologies on display by other Navy entities at Lab Day included low-cost, ultra-wideband phased array antennas, transparent biometric armor and the electromagnetic railgun. Also at the event, Miller discussed the importance of STEM outreach, an endeavor Carderock is heavily involved in, and James MacStravic, performing the duties of the undersecretary of defense for acquisition, technology and logistics, recognized the DOD Service Scientists of the Year and the DOD STEM Advocates of the Year on stage in the courtyard.

CCD, based at Joint Expeditionary Base Little Creek-Fort Story, Virginia, is the Navy and DOD's center for excellence for manned and unmanned boats and combatant craft total systems engineering, providing craft technology and design, craft systems integration, science and technology, research and development, acquisition support and life-cycle engineering. CCD aims to maximize warfighter performance, minimize total ownership costs and smartly manage risk. CCD maintains expertise in naval architecture, hull, mechanical, electrical and electronics systems design and engineering, survivability, transportability, human systems integration, test and evaluation, logistics and life-cycle management. CCD supports more than 10,000 boats, craft and life rafts worldwide.

For more information on CCD, visit http://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Carderock/Who-We-Are/Norfolk-Virginia/.

Pentagon Print-a-thon highlights benefits of additive manufacturing

By Kelley Stirling,
Carderock Division Public Affairs

The Department of the Navy (DON) showcased some of its 3-D printing capabilities at a 3-D Print-a-thon at the Pentagon on March 15.

"The purpose of the event was to demonstrate the DON benefits of Additive Manufacturing (AM) while providing a forum for subject-matter experts to share lessons learned and develop future collaboration opportunities," said Ben Bouffard, an engineer at Naval Surface Warfare Center (NSWC), Carderock Division and the AM lead to the Deputy Assistant Secretary of the Navy for Research, Development, Test and Evaluation Dr. John Burrow.

Bouffard helped organize the event, along with Carrie Gonzalez from NSWC Dahlgren Division. There were 20 naval organizations, including scientists and engineers from across the Naval Research and Development Establishment (NR&DE), maintenance operations and Sailors and Marines from multiple commands presenting items that have been produced through the use of AM technology.

The two primary themes demonstrated during the Print-a-thon aligned with the DON Additive Manufacturing Implementation Plan were:

- Enhanced warfighting capability – demonstrates an innovative use of AM technology to provide enhanced

Dr. John Fiore (left), technical director for Naval Surface Warfare Center, Dahlgren Division, listens as Harry Whittaker (right), the team lead for NSWC Carderock Division's Sailor Performance Support Technology, and Kevin Lin, a member of Carderock's Disruptive Technologies Lab, demonstrate prototypes created for the Big Area Additive Manufacturing (BAAM) Test Article of the Optionally Manned Technology Demonstrator (OMTD) during the 3D Print-a-Thon, an event hosted by the Navy at the Pentagon on March 15, 2017. (U.S. Navy photo by Kelley Stirling/Released)

warfighting capabilities, such as increased lethality, light-weight components, items customized to mission or warfighter
- Readiness and sustainment – demonstrates AM to support or resolve an existing readiness, sustainment, logistical or supply problem

"As an enabling technology that cuts across warfighting domains, AM shows potential to reduce sustainment costs, increase equipment readiness, revolutionize warfighting capabilities and unshackle protracted supply chains," Bouffard said, adding that the benefits of AM are applicable to all Department of Defense communities, such as infantry, logistics, maritime, aviation, medical, etc.

Bouffard listed some of the benefits of AM:

- Eliminates traditional design constraints, creating a new design space that allows for previously impossible characteristics. Multi-component assemblies can be consolidated into a single item, lattice-like structures to yield lighter and stronger parts; advanced materials enable multi-functionality; and miniaturized sensors can be embedded into a structure – all resulting in more effective and more lethal platforms.
- Allows for mass customization at almost no additional cost, enabling tailored solutions that are specific to each mission or even each warfighter.
- Will produce components on-demand and in remote locations, enabling a new era of supply chain independence.
- Will significantly reduce obsolescence, improving sustainment costs and responsiveness.
- Accelerates capability development through rapid prototyping, which helps to address urgent needs, drive innovation at the speed of battle and deliver advanced warfighting capabilities.

Craig Hughes from Johns Hopkins Applied Physics Lab (APL) points to a piece of U.S. Marine Corps Expeditionary hardware and highlights the additive manufacturing process used to Dr. John Burrow (center), deputy assistant secretary of the Navy for research, development, test and evaluation, during the 3-D Print-a-thon hosted by the Navy at the Pentagon on March 15, 2017. Fellow project participants Steve Laderman from Carderock's Propulsor Manufacturing Office and Marine Capt. Matthew Friedell listen. (U.S. Navy photo by Kelley Stirling/Released)

Carderock engineers upgrade mine susceptibility scanning technology

By Daniel Daglis, Carderock Division Public Affairs

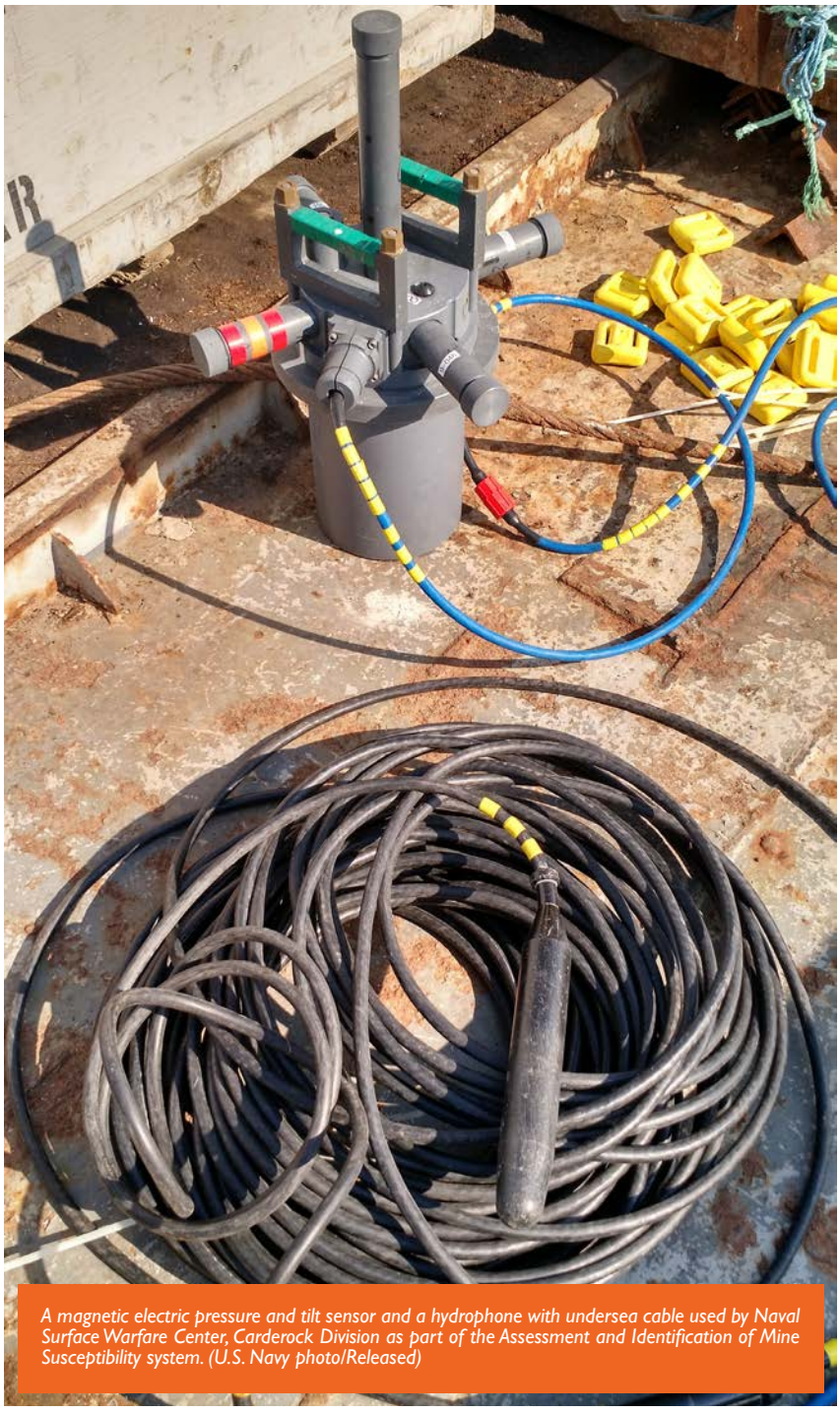
Brian Simpson had not even been out of college for two weeks before becoming an engineer in the Systems and Measurement Branch of the Underwater Electromagnetic Signatures and Technology Division of Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland.

A physics major at Washington and Lee University in Lexington, Virginia, Simpson came to Carderock with very little coding experience, but was able to overcome this learning curve to assist a team including branch head Robert Schuler and fellow engineer Jacob Kunnappally in successfully completing a technical refresh of Carderock's Assessment and Identification of Mine Susceptibility (AIMS) system developed in 2000 for identifying issues with U.S. Navy vessel magnetic and acoustic signatures.

"This is a system that is brought out to a port and does a full signature evaluation as the ship drives over it," Simpson said. "It's doing both a magnetics and acoustics signature. One of the big caveats with AIMS is that it has to be a forward-deployable system since it works with minesweepers. It measures the ship to see if the ship is susceptible to setting a mine off nearby. If we reduce their susceptibility, then we've increased their effectiveness."

According to Simpson, the ships are equipped with the technology to make adjustments based on the AIMS report which his team provides to the ship upon the completion of a full evaluation. For their technical refresh of the programming, Simpson and the team he works with received a team award at the Carderock Command Awards in March.

"It's a very interesting project because it's one of the few instances that our division and the Signatures Measurement Technologies and Systems Division are



A magnetic electric pressure and tilt sensor and a hydrophone with undersea cable used by Naval Surface Warfare Center, Carderock Division as part of the Assessment and Identification of Mine Susceptibility system. (U.S. Navy photo/Released)

Naval Surface Warfare Center, Carderock Division Assessment and Identification of Mine Susceptibility system team members and barge crew working diligently to recover sensors from the ocean floor. (U.S. Navy photo/Released)

working on the same system together."

Included in the technical refresh, Simpson said they not only upgraded software, but also were able to significantly improve the equipment in the AIMS system.

"With AIMS, there are sensors on the ocean floor that are waiting for a signal. These are all passive sensors, so when a ship comes over it, the sensors pick up the ship and we use our acquisition and analysis software to decipher the signals.

"They're called MEPTs, which stands for magnetic electric pressure and tilt. That's the four different kinds of sensing that these sensors do. Recently, or in the past few years, there only used to be an older kind of sensor, but with the tech-refresh, we've added the underwater electric detection capability. It used to just be magnetic, but now it's also underwater electric. In that upgrade, we also moved from analog to digital and upgraded a lot of the shore side components, like upgrading to the highest-level computers we could and upgrading to Windows 10."

Less than a week after Simpson started at Carderock he went on his first trip to the detachment in Fort Lauderdale, Florida, which was a recovery of the original test sensor they made for the technical refresh. Simpson said they endearingly named the sensor "Frankenstein" because it was the new body type made up of the parts of several sensors. According to Simpson, they found everything they could and made a smaller sensor just to test that the smaller body type was going to work.

Simpson said Frankenstein was the original sensor developed for the tech-fresh and was deployed at the South Florida Ocean Measurement Facility in Fort Lauderdale. This was a proof-of-concept sensor before the team moved on to produce two prototype sensors which Simpson said had the new digitization cards installed and a slightly modified, more robust layout.

"Once we validated the prototypes, then we moved on to a Low Rate Initial Production (LRIP) and those are now deployed in the field. Now, we're actually on to our fourth batch of sensors, and we're looking to procure another two batches. So far, the project's been very successful in that sense," Simpson said.

"One of the big benefits of these sensors is not only was this the first large-scale move towards digitization – which I think in and of itself is a very good thing – but it's also just a smaller, lighter, cheaper sensor than the rest of the things we produce. So a quick test where you put the sensor in a tank of water, it takes us 20 minutes with the MEPTs, but if we were to do it with one of the larger sensors it would take a full day, you'd need a crane, and it just becomes time consuming. Working with the MEPTs has really made them a lot more productive versus their counterparts."

The coding software commonly used by engineers at Carderock, and by Simpson to code to improve programs, is called LabVIEW. Simpson shared his team's success with coding the AIMS program with fellow engineers at the Carderock LabVIEW user group on April 26. The group meets monthly and is a forum for engineers to share their techniques and their go-to methods for how to write LabVIEW code effectively.

"It's a pretty useful thing here (Carderock) because so many people use LabVIEW and we're always working with a limited training budget, so anytime we can share our techniques with other people in our branch or another branch is very beneficial," Simpson said. "Someone will talk about a bit of code that they've created, and they usually try to focus on a particular interesting aspect of it. I find it a very useful tool."

Navy engineers volunteer to install solar panels for West African community in need

By Daniel Daglis, Carderock Division Public Affairs

Dr. Peter Cho, an electrical engineer in Carderock's Marine and Aviation Division, is preparing a solar panel to be installed on building to bring light to a community in the rural city of Mbour in the Republic of Senegal in West Africa. (Photo provided by Dr. Peter Cho/ Released)

In the rural city of Mbour in the Republic of Senegal in West Africa, more than 200 children go to school every day in a community with no electricity.

Several Navy engineers used their personal time to partner with The Lamps, a non-profit 501(c) organization, as part of their "Let There Be Light" campaign to bring electrical power to regions of the world with no affordable supply.

Naval Surface Warfare Center (NSWC), Carderock Division's Dr. Peter C. Cho, an electrical engineer in Carderock's Marine and Aviation Division, Dr. Bryant H. Kim from NSWC, Indian Head Division, and Dr. Sungshin Kwak from the Naval Research Laboratory dedicated their personal leave time from Feb. 10-19 to visit the city, located about two hours from the country's capital of Dakar. There they installed six solar panels, bringing a source of light to a community that had no means of electricity prior to their visit.

Mbour is just one of the many communities Cho and his fellow engineers have visited over the years. They install what Cho describes as a simple solar electric power system consisting of the panels, batteries, inverter and circuit breakers, which brings the community enough power to run indoor lights and small appliances. However, Cho noted that the communities they visit do not have the luxury of appliances of any kind.

"The need in that community, as well as all of the communities we do work in, is immense," Cho said. "Every trip I make, when I come back and arrive at the Dulles International Airport, I marvel at what a blessed country the United States truly is. One thing that always amazes me is everywhere we go the children always seem to be very happy, even in their situation. In Mbour, the children go to school but have no shoes, no sandals, and in the summertime it gets so hot – upwards of 120 degrees – they cannot wear clothes. Their happiness is not measurable with materials."

Cho, a Korean-American who emigrated

from South Korea, says that one of the main reasons he makes these trips every year is because he was lucky enough to immigrate to the U.S. and receive a good education.

"The U.S. government educated me from bachelors all the way to Ph.D. I began my career at the Naval Undersea Warfare Center in Newport, Rhode Island. I got together with some of my fellow engineers and figured out how we can pass on this great education and engineering experience to the next generation," Cho said. "One way we do this is by providing our skills and experience to the areas where there's no electricity available. If we can give students even something as simple as light in their school house and it can improve their chances of succeeding, improve their chances of a better education, then I am happy. That is our motivation."

Completed solar panels on a building in the rural city of Mbour in the Republic of Senegal in West Africa. (Photo provided by Dr. Peter Cho/Released)

Cho said that when he first started bringing solar energy to communities without electricity he worked with a team of four engineers. Today, that team has grown to 13. The engineers not only travel on their own personal leave time, but also often fund the purchasing of the solar panels with their own money. Cho said, in some cases, they have worked to subsidize funds from the U.S. Agency for International Development and SEED International, a Christian ministry out of Virginia.

"The biggest benefit to installing solar panels is they do not require a lot of maintenance. A lot of the communities we visit are close to the equator; sun is abundant. On average, two hours of sun will provide around eight hours of electricity."

Cho and his team have also installed solar panels in communities in Peru and Cambodia. Cho added that wherever they go, being able to provide something as simple as indoor lighting, they leave knowing that their work has improved the quality of life for the people of that community.

A video of the countdown to the lights coming on can be seen on You Tube: https://youtu.be/Bjqi2EnpuXs.

Local children from the rural city of Mbour in the Republic of Senegal in West Africa. (Photo provided by Dr. Peter Cho/Released)

BREAKING ICE:

The next icebreaker will be a Navy-Coast Guard partnership

By Dustin Q. Diaz, Carderock Division Public Affairs

U.S. Coast Guard photo by PO Patrick Kelley

Adm. Paul Zukunft, commandant of the U.S. Coast Guard, delivers remarks during the Sixth Symposium on the Impacts of an Ice-Diminishing Arctic on Naval and Maritime Operations at the Naval Heritage Center in Washington, D.C., in 2016. (U.S. Navy photo by John F. Williams/Released)

As global climate change occurs, the Arctic is changing with it, causing unprecedented retreat of sea ice in one of the world's last great frontiers, opening new sea lanes and with them, new opportunities for exploration, research and trade.

The U.S. Navy, in particular, the Naval Research and Development Establishment (NR&DE), will play a necessary role in this expansion, and employees at Naval Surface Warfare Center, Carderock Division (NSWCCD) are taking part in that effort, according to Dr. Tim Arcano, Carderock's technical director.

"To maintain presence and to defend our national interests in these important emerging areas, and to enforce treaties and other international laws, the U.S. Navy will need to design and build polar capabilities into its ships," Arcano said. "Capabilities such as advanced ship-design modeling tools, hydrodynamics, ship systems and ice modeling must be given priority now to ensure that the U.S. maintains relevance and presence in this critical arena."

The Navy currently does not have any polar-capable surface ships, nor does it have the ability to independently design and test them. What it does have is a roadmap of activities to pursue in the near, mid and long term, and capable partners to work with and learn from to achieve those goals. The U.S. Navy Arctic Roadmap was created by Task Force Climate Change and was most recently revised in 2014 to prepare the Navy to respond effectively to future contingencies, delineate the Navy's Arctic region leadership role within the Defense Department and articulate the Navy's support to the National Strategy for the Arctic region.

"In the near term, the focus is on training and understanding what the inherent capabilities of our existing platforms and systems are when operating in that region," said Stephen Minnich, naval architect at Carderock's West Bethesda, Maryland, headquarters. "Given what we learn about our existing platforms, we will investigate how we can enhance the capabilities of those platforms in the midterm. Far term, we are looking at the needed capabilities and platforms to support sustained presence in high latitudes. The Arctic Roadmap is guiding the research work that we're doing here at Carderock."

The Navy has the ability today to surface through ice with its submarines, with limitations. Safe-operating guidance for doing this was developed at Carderock in the 1980s and 1990s by members of the Structures and Composites Division. While the Navy accumulates more knowledge and develops technology to operate in marginal ice zones with its own ships, the need to explore Arctic regions and resupply American interests at both poles is currently met by the Coast Guard's polar icebreakers: the heavy icebreaker Coast Guard Cutter Polar Star (WAGB-10) and medium icebreaker Coast Guard Cutter Healy (WAGB-20). These massive ships have fulfilled regular commitments for decades under very arduous conditions and the effort now underway to create a new class of icebreakers will be a historic one, said Neil Meister, technical director of the Polar Icebreaker Replacement Project within the Coast Guard.

"You don't build a heavy icebreaker except once in a generation," Meister said. "These are considered national strategic assets. What we're making is essentially a steel fist that has to last for decades and be able to float, run into things and operate at 40 below zero. These ships do a lot of crazy things that most ships don't do. The capabilities we are building into the replacement reflect that."

The crew of the Coast Guard Cutter Healy plans an approach to tow the 36-foot sailboat, Altan Girl, trapped in Arctic ice approximately 40 miles northeast of Barrow, Alaska, July 12, 2014. The Healy crew broke a 12-mile path through the Arctic ice with the sailboat in tow and led it to open water. (U.S. Coast Guard photo courtesy of Coast Guard Cutter Healy)

The Coast Guard recently began the acquisition process for a new polar icebreaker and formed an Integrated Program Office with the Navy's Program Executive Office (PEO) Ships and Naval Sea Systems Command's (NAVSEA) Naval Systems Engineering Office (05) to maintain this capability by building the next generation of these unique vessels. With Polar Star reaching 40 years of age in 2016, the program intends to begin production activities for the next heavy icebreakers in the very near future. Carderock, in multiple ways, will play a key role in this acquisition.

"The Navy and Carderock are now in a position to support the Coast Guard in terms of the research and development efforts that are associated with acquiring a platform with icebreaking capability," Minnich said. "This collaboration with the Coast Guard is strategically important. It helps us to identify and quantify the challenges that we face, which will help to inform requirements. This shared knowledge and expertise will help us continue to execute the Arctic Roadmap."

The Coast Guard has its own Arctic Strategy, released in 2013, that has a lot of overlap with its Navy counterpart, according to Meister. Both services have an interest in preserving freedom of the seas, projecting Arctic sovereignty and supporting scientific research. With the Navy's Arctic reach limited to submarines for now, these icebreakers give the United States the reach it needs at the poles with the incredibly limited shore infrastructure and hazardous conditions faced when operating in these environments. Minnich said that navigation, for example, is difficult enough in open water conditions, but even more so at extreme latitudes where the functionality of some systems aboard surface ships may be degraded.

"Some of the environmental challenges faced by vessels operating in high latitudes include topside icing, extreme cold, heavy seas and limited visibility. You get spray that ices the deckhouse so you get a lot of weight up high, which has a negative impact on ship's stability," Minnich said. "Navigation in close proximity to the poles is challenging. Our understanding of the bathymetry in that area is poor, relatively speaking. Operational awareness, understanding where the ice is and how it's changing so that we can plan our operations, is a challenge."

Currently, Healy is tasked with regular science research missions to the Arctic while Polar Star conducts the annual Operation Deep Freeze deployment to resupply McMurdo Station in Antarctica. Meister said both are chartered by the National Science Foundation: Healy, to conduct arctic research, with a full research-vessel level science capability aboard; and Polar Star, to provide logistical support capability for Antarctic research. These icebreakers are uniquely qualified for the missions they perform with much of the global icebreaking fleet dedicated to commercial purposes.

"You want reach, because there is nothing up there. It's very difficult for people who have never been to the Arctic or Antarctic to understand what 'nothing' is, because they've never been exposed to it," Meister said. "Up there, it

is effectively a moonshot. There is very little infrastructure. Communications are very difficult up there. You are on your own and you need to be able to take care of yourself. Coast Guard ships are traditionally designed for independent operations."

Nathan Hagan, a naval architect and Carderock's technical point of contact for ice-structure loading assessment for naval vessels operating in the Arctic, said Carderock's involvement in the upcoming icebreaker class motivated the unification of NSWCCD's efforts in hydrodynamics and ship structures into a team that will look at all the disciplines involved in building this ship.

"Previously, both from a hydrodynamics and a structural perspective, subject-matter experts at Carderock continued research to develop polar ship design knowledge within the Navy, but it didn't quite have a clear goal, other than technical diligence," Hagan said. "And now we have an objective that really helps us identify priorities more appropriately when allocating resources."

One area that Carderock Division can't directly support at its own facilities is ice model testing. Hagan said one of Carderock's partners in this area has been the Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire, which maintains the nation's primary ice-tank facilities, and is currently collaborating with NSWCCD's structural team by looking at discrete element modeling to simulate a notional Navy ship moving through an ice field to understand how ice breaks and moves in chunks as the hull moves through it.

"Material science associated with Arctic conditions is traditionally in the swim lane of our domestic partner CRREL. Their facility has ice tanks and ice labs already, so we have a very strong working relationship with them to use their facilities when we need to do certain model tests and share simulation and modeling expertise," Hagan said. "We've provided all the structural assessment capability for the submarine platforms – which look to bend ice to break it for surfacing, unlike the icebreakers, which crush ice to go through it – as well for arctic operations."

Dr. Paul E. Hess III, of the Office of Naval Research (ONR) 331, is sponsoring this structural work between Carderock and CRREL. This is not the first work Hess has done with ice model testing, or even the first time working with Carderock and CRREL, as he worked with Carderock's Ed Devine, who is now retired, on ice impact testing using a polar icebreaker model and a conceptual Navy frigate model on a study in the early 1990s.

"Based on my past association with ice-loading experimentation, and the uptick in interest in potential Navy operations in the Arctic regions, in 2009 I started working with Ed Devine to find a way to resurrect past Navy knowledge and figure out how to move forward in development of new tools and knowledge with regard to ice loading on hulls," Hess said. "That work led to increased and renewed engagement with CRREL and coordination with the U.S. Coast Guard Surface Forces Logistics Center and Defence Research and Development Canada (DRDC), both sharing interests with the Navy in knowing how capable non-ice-strengthened ships are in ice covered waters.

"The Coast Guard and DRDC funded American Bureau of Shipping (ABS) and Memorial University of Newfoundland, Canada (MUN), to provide a spreadsheet tool for predicting ice capability of non-ice-strengthened ship hulls to assist in operator guidance in areas with floating sea ice. To leverage the Coast Guard and DRDC investments and interest, I began funding NSWCCD, ABS, MUN and CRREL to collaborate on the evaluation of existing toolsets and data to determine effectiveness for naval non-ice-strengthened hulls. ABS and MUN are taking their in-house tools, developed for ice-class ships under the IMO (International Maritime Organization) Polar Code, and exploring their use on a notional Navy combatant ship design provided by NSWCCD."

Hagan said the non-homogenous nature of ice presents unique challenges not only for ships to operate in, but also during scaled model testing. Ice, he said, adds many more variables than open water.

"There are many dependencies that determine what the strength of ice will be. It forms naturally in many different ways resulting in many different ice types. These factors play into our ability to predict the structural load that a ship will experience if it impacts ice. It makes operating more unpredictable," Hagan said.

Hess said reporting on this initial work should be complete in 2017 and will increase knowledge of the capability of current tools to support operations of existing U.S. Navy ships in areas such as the marginal ice zone in high-latitude regions.

"With increased understanding of current hull ice-resistance capacity, we can both operate our existing ships more safely and understand the value added by increased plate thickness, or other strengthening approaches, in future design," Hess said.

This need for increased naval operability is becoming more critical as Arctic ice melts and new sea lanes open, according to Arcano. He said cargo shipping volume through the Northern Sea Route has increased with the retreat of ice.

"As the Arctic opens up, commercial vessels will begin to use these northern routes for shipping, trade, exploration and more between Europe and Asia, reducing travel times between the Atlantic and Pacific oceans," Arcano said. "The U.S.'s interest includes not only shipping, but also scientific research and exploration, critical natural resources and strategic location, which could be especially beneficial to our nation."

Carderock's next step to help the new icebreakers come to fruition will be to join the Coast Guard and the Department of Homeland Security as they utilize a standing Cooperative Activity Arrangement with the Canadian government to share knowledge and begin ice-model testing of a Coast Guard-developed indicative design, with open-water testing expected to begin at Carderock in 2017, according to Meister. Hess said that he hopes the work he and others have done so far can contribute to "Naval Ship Maneuverability in Ice," a NATO Science and Technology Organization collaboration with Canada, Germany, the Netherlands and New Zealand, which starts in fall 2017 and for which he is the lead. Carderock also provides delegates to the specialist team on polar ship design and safety under the NATO Ship Design and Capability Group.

'It's not just science'

The Navy's business case for additive manufacturing

By Edward Lundquist, special correspondent for Seapower Magazine

Ben Bouffard, an engineer representing additive manufacturing (AM) technology at Naval Surface Warfare Center, Carderock Division, talks to Vice Adm. William Hilarides, commander, Naval Sea Systems Command, during Carderock Day at the Washington Navy Yard, March 23, 2016. In the foreground a 3-D printer creates a model ship. (U.S. Navy photo by Monica McCoy/ Released)

Additive manufacturing has grown beyond gimmickry and entered the mainstream of modern manufacturing. That's why the Navy is leveraging the experience and expertise of its own world-class experts and facilities at systems commands, warfare centers, research labs, shipyards and repair facilities – even on ships – to meet uniquely naval needs.

Referred to as AM and frequently thought of as 3-D printing, it's much more than that. AM is an umbrella term involving seven different processes and many materials. It involves successive layering of materials such as plastics and metals in the form of liquid, powder, paper or sheet material, and includes a variety of processes from vat photopolymerization, material jetting, binder jetting and material extrusion to sheet lamination, stereolithography, powder-bed fusion and directed-energy deposition.

The result is an ability to produce or manufacture things that could not be made with traditional subtractive methods.

Ben Bouffard, branch lead for additive manufacturing at Naval Surface Warfare Center (NSWC) Carderock Division in West Bethesda, Maryland, said AM technology is not new, and the Navy has been using it for a long time to create molds, jigs and tooling fixtures to help make existing processes more efficient. But that is changing.

"We're transitioning from those indirect applications – from printing a tool that helps you make a part – to printing the actual part itself," Bouffard said.

When it comes to making parts for submarines, ships and aircraft, the materials, processes and the result must be consistent, and the end-product certified for use on the specific platform.

Norfolk Naval Shipyard in Portsmouth, Virginia, has significant experience using AM. Maria Williams, a nuclear engineer at the shipyard and lead for the yard's additive manufacturing subcommittee, said submarines have a much higher standard than can be met with the current state of AM technology. But AM is being used to make models, prototypes and tools.

"You won't see 3-D-printed parts on the submarine we're working on, but they will be involved in what you do see," she said. "3-D parts will be used to get that ship ready for sea."

The Navy's vision is to be able to make parts that are out of stock, out of production or were made by companies that no longer exist. The cost of contracting for the manufacture of very small quantities of such items can be orders of magnitude greater than the part originally cost.

In some cases, AM could be used for urgent temporary repairs.

"We could make noncritical parts that might be good enough," Bouffard said. "They probably wouldn't last long, but it might get them through."

3-D printers and software can be inexpensive, which makes experimentation and creativity affordable. Resourceful Sailors onboard the aircraft carrier USS Harry S. Truman found that the clasps for their $600 hand-held radios were constantly breaking. They created a replacement part onboard – dubbed the "Tru Clip" – using 3-D printing that cost about 10 cents.

"When we can make parts on demand, when we need them, that will have a direct impact on readiness," Bouffard said.

"The Navy and Marine Corps envision using the technology in forward-deployed operational settings, whether that be in the desert or afloat, wherever we need to use it," he said. "So we need more robust equipment that can handle those environments."

That environment is one of the challenges. Most AM processes require clean and stable work areas. Ships operate at sea, with the salt air, moisture and pitching and rolling. So the Navy is studying how those factors affect the AM process at sea.

But the environment can be an advantage.

"Additive manufacturing allows us to come up with different ways to make some of the assets we use today," said Dr. Ryan Kincer, a materials engineer at NSWC Panama City in Florida.

Additively manufactured aviation parts rapidly produced in a first-of-its-kind response to a critical fleet need by employees at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md., May 31, 2017. (U.S. Navy photo by Dustin Q. Diaz/Released)

Panama City is experimenting with adjustments to the "recipe" to make disposable unmanned underwater vehicles that eventually dissolve in seawater.

"We can change the amount of polyhydroxylalkinate added to the material to degrade faster or slower, depending on how long we want it to last. We don't need to recover it because the cost is so reasonable," Kincer said.

Unlocking the constraints

The method by which products have traditionally been manufactured dictates how they are designed and maintained. The manufacturing processes used can limit how fast you can build and test a prototype. That, in turn, affects how a company can innovate and turn a new idea or concept into a reality that is ready for market.

Finished products that used to be made at a factory and shipped to a customer might now be more affordably printed on demand at the point of use by the customer.

"Additive manufacturing unlocks the constraints, and offers new ways to design, distribute and service products. It allows an industrial system that gives you complete process control, and allows you to connect a continuous digital thread from concept to finished part.

It's not just a toy or a tool for experimentation," said Aaron Frankel, senior director of marketing for manufacturing engineering software products at Siemens PLM Software, Plano, Texas. "But we're still learning."

Siemens, for example, offers a system that integrates design, planning and construction that is fully compliant with manufacturing operating systems.

Frankel said there are many disconnected applications for specific engineering specialties. Different computer-aided design and engineering systems, print software and printers can be made to work with each other, but something may be lost in translation.

"If we convert files from one software to another, we disconnect the digital thread and can lose fidelity, and the ability to manage the workflow," he said.

There are challenges. Parts milled from forgings have different qualities than printed parts made from metal powder.

"We're seeing deformation of printed parts based on different thermal properties. We need to compensate for that in the design," he said.

Frankel said broken or damaged parts can be digitally scanned to produce a model and then print the repaired part.

"You don't need outside tooling," he said.

Machined parts remove metal from a block to shape a part, so the part is limited by the shape of the block. AM removes that restraint allowing the manufacture of shapes that cannot be done using conventional machining techniques.

Vice Adm. Thomas Moore, commander, Naval Sea Systems Command, handles an object created through additive manufacturing during a tour Nov. 8, 2016, of the Manufacturing, Knowledge and Education (MAKE) Lab at Naval Surface Warfare Center, Carderock Division, in West Bethesda, Md. AM, also known as 3-D printing enables high-velocity learning for the Carderock workforce and helps build a culture of affordability through rapid iterative design. Through this lab, the workforce is empowered with the latest technology and access to Navy experts as they explore the use of AM for their program needs. (U.S. Navy photo by Monica McCoy/ Released)

Dr. Daniel Henkel is research manager for additive manufacturing and materials at the Commonwealth Center for Advanced Manufacturing (CCAM) near Petersburg, Virginia, an industrial applied research center. According to Henkel, some parts are so complex, such as those with very fine or non-linear internal channels for cooling or fiber connectivity, that are sometimes impossible to machine, but easy to do in AM.

"In just one build, we can make custom components or entire assemblies that can't be done any other way," he said.

CCAM works with five Virginia universities. One of the recent efforts is researching the corrosion of additive parts, an important factor for parts in a marine environment.

"It's something that really hasn't been looked at. We're working with the University of Virginia's Center for Electrochemical Science and Engineering, which is doing research with the Navy on corrosion of additive parts," Henkel said.

He said the university does not currently have the AM capability.

"We're going to do the additive manufacturing part of the project here at CCAM, and they're going to do the corrosion testing. We don't know how these materials are going to corrode," Henkel said. "It's a different grain structure and chemistry. We don't know if they will corrode similarly to conventional wrought metals."

Science and technology

Dr. Julie Christodoulou is director of the Naval Materials Science and Technology Division in the Sea Warfare and Weapons Department of the Office of Naval Research (ONR).

"We don't make widgets. We transfer technology to the widget makers," she said.

Christodoulou manages a portfolio of science and technology programs trying to solve complex problems with naval applications.

For example, she said the Navy is interested in novel conformal heat exchangers, because there's no reason, other than manufacturing limitations, to make them in rectangular blocks.

"AM opens a broader design space so we can make better use of the space available to us. It might have some benefits to us in very tight spaces that are common in military systems. The design has to be approached in a different way because we're no longer constrained by traditional manufacturing technologies and processes. Understanding what we can control and how we can control it is as important as simply building it," Christodoulou said.

ONR has also been working on very compact, high-efficiency fuel cells for a number of applications.

"When you try to demonstrate a new system in a laboratory environment you need to make your own parts. For our fuel cell, the titanium bipolar plate has a very complicated internal flow path, which was best made by additive. The team made it in a couple of different variations and generations to find what worked best and then demonstrated on the Ion Tiger small long-endurance UAV (unmanned aerial vehicle), developed by the Naval Research Lab," she said.

Additionally, Christodoulou said there is a great deal involved in qualifying the materials, processes and systems used in additive.

Christodoulou said it's important to build confidence into the process, and make it more predictable. That calls for real-time sensors and better predictive tools to ensure that during a build, the result will have the desired properties, "So that we know what it is we're going to have at the end."

According to Christodoulou, during each AM build different alloy compositions, heated to different temperatures over different amounts of time, and with different cooling rates depending on the part dimensions alter the microstructure of the finished material.

"We are conducting research on the compositional and process changes that can be made to the more well-established alloys to deliver the microstructures and properties we desire. It's not going to be used for everything," she said. "In some cases, the only way to produce something that can perform a function with the correct form and fit, and do it elegantly, is with a traditional method.

"It all comes down to the economics of the process and the properties that are needed," Christodoulou said. "Sometimes the business case is very compelling."

Not just science

"I have world-class experts in many fields, from energetics, radar propagation or missile control, to chemical and biological warfare, electronic countermeasures and naval architecture," said Rear Adm. Tom Druggan, commander of the Naval Surface Warfare Center in Washington, D.C. "We have experts working on AM at all of our centers."

Druggan sees AM as a way to make those special or otherwise unobtainable parts for deployed or remote units.

"If I had a 3-D printer, and the right technical data package that would allow me to manufacture it, I could have that part on the ship in hours instead of days or weeks. That's operationally significant, and a huge enabler," he said.

Druggan said the Navy's warfare centers are engaged with developing standards and certifying parts.

"What happens if a 3-D-printed part is installed and it fails and someone gets hurt, or pieces of equipment go bad? What are the standards that are required? NSWC Corona (California) is looking at how we characterize the requirements of the machine itself to make them eligible for Navy use. It won't be tomorrow, but eventually you'll see this start to enter the fleet ships as an operational enabler," Druggan said.

"It's not just science," he said. "It's an emerging engineering application that adds value to the Navy."

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Carderock engineers work with VMI cadets to design automated ramp for unmanned SURC

By Daniel Daglis, Carderock Division Public Affairs

(From left) Virginia Military Institute cadets Austin Roes; Tyler Corcoran; and Brandon Conley; with Jonathan Holbert, a naval architect in Naval Surface Warfare Center, Carderock Division's Center for Innovation in Ship Design, pose for a picture in front of a Small Unit Riverine Craft (SURC) at the V-47 waterfront facility at the Combatant Craft Division (CCD) in Norfolk, Virginia. (Photo provided by Jonathan Holbert)

As leaders in innovation for the U.S. Navy, Naval Surface Warfare Center, Carderock Division often brings together their workforce of scientists and engineers and partners with other government agencies, private companies and universities under Cooperative Research and Development Agreements (CRADAs). A CRADA with the Virginia Military Institute led to a design for an automated bow door for the Small Unit Riverine Craft (SURC) which was transitioned into an Unmanned Surface Vehicle (USV) by Carderock's Unmanned Maritime Mobility Group at its Combatant Craft Division in Norfolk.

As part of their senior design project, Virginia Military Institute cadets Tyler Corcoran, Brandon Conley and Austin Roe, under the mentorship of Professor Dr. Gerald "Jay" Sullivan, worked with Carderock engineers to come up with a fully functional design to automate the bow door of the unmanned SURC that originally had to be manually deployed.

According to Corcoran, Conley and

Roe's final report, the SURC bow door is required in order to transport an Unmanned Ground Vehicle (UGV) from the vessel to the beach without human intervention. Successful transportation of the UGV from the vessel to the beach also requires installation of a fully automated ramp system that spans the gap between the end of the existing bow door to the beach. UGVs could potentially play a vital part in safely clearing a path once a USV or other craft is beached, and are intended to reduce risk of potential hazards on land.

Jonathan Holbert, a naval architect in the Center for Innovation in Ship Design at Carderock's headquarters in West Bethesda, Maryland, was one of the engineers in the Unmanned Maritime Mobility Group that worked with the VMI cadets to complete the project.

"VMI usually sets up sponsors for their projects so the students can work with real-life scenarios interfacing with a real customer," Holbert said. "These projects are very beneficial in giving the student the technical interaction, as well as professional interaction. What the cadets were able to accomplish with the automation of the bow door in the short few months of a semester was very impressive."

Holbert came to Carderock in August 2015 following his participation in the Science, Mathematics and Research for Transformation (SMART) Scholarship for Service Program. His work currently focuses on the development of surface combatant concept designs, but he said that he has had the benefit of being able to go on a variety of rotations. He got involved with this project while doing a rotation at Combatant Craft Division. It was there that he joined the Unmanned Maritime Mobility Group and participated in this project. He was supported by Carderock employees Dr. Tim Coats, Scott Sampson, David Colburn, Alex Jeffrey and Vincent Thiele, who provided key insight into the design process and participated in the final project review.

As stated in the final report, the design for the automated bow door had to eliminate the need for human intervention while minimizing the changes to the existing structure. The design also had to meet military and government mechanical specifications and be able to transport the UGV, as well as a fully burdened Sailor or Marine to the beach.

"They were able to visit the SURC that we have over at the V-47 waterfront facility down at Combatant Craft," Holbert said. "They got a tour and got to see a little bit of the work that goes on down there, as well as get on the SURC itself, take measurements and kind of have a physical understanding of what the problem was.

"After that, they went back to VMI and began the design process, which started off with looking at the constraints of the problem, some of the physical dimensions that they took, what type of mechanical linkages they can design, what type of actuators, etc. They went through a few different trade studies and once they selected an actuator design they did a structural analysis. They did a finite element analysis on the model that they built in Solid Works, as well as they chose a pneumatic system. So they did a pneumatic air supply analysis, as well as an electrical controls analysis."

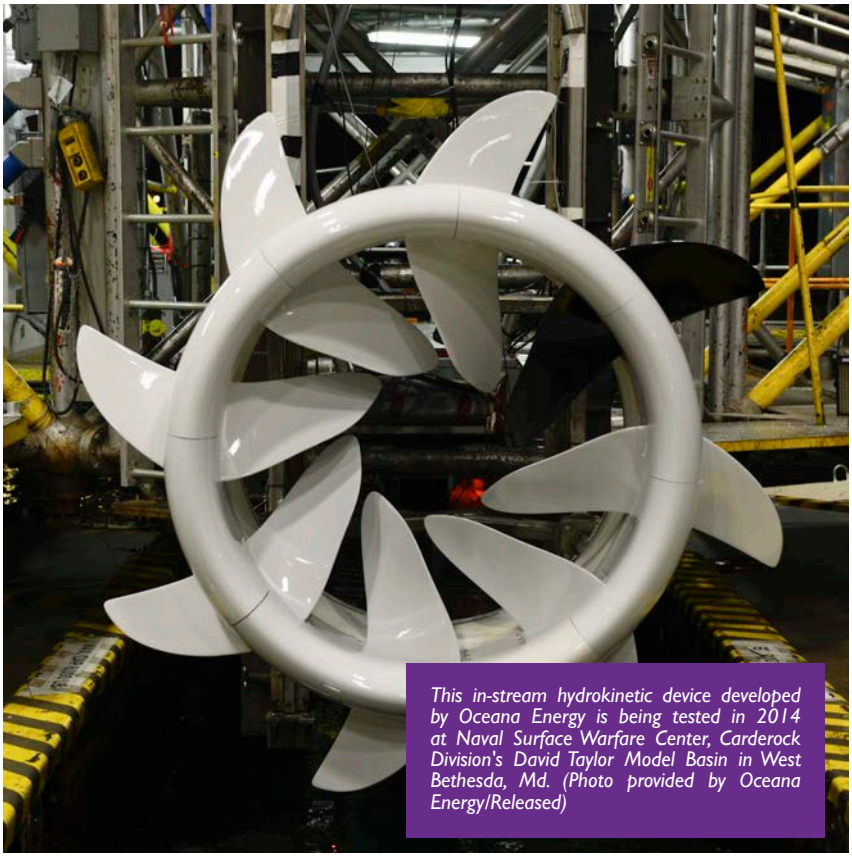
According to the final product report, the bow door automation system is capable of achieving the maximum angle of the bow door relative to the deck, and the proposed system does not require any modifications to the existing bow structure, which significantly lowers the cost of implementing the design.

"It was an awesome experience for me as a new hire within my first couple of years to be able to interface with a project group like that. That was kind of a trial, because in the future I'm sure I'll be holding a similar position in one way or another. It was good just being able to work with the students – with myself not being too far removed from the senior design process – it was nice to help them through that and to share some insights," Holbert said.

Before coming to Carderock, Holbert earned his bachelor's and master's in naval architecture and marine engineering from the University of Michigan. He said University of Michigan is one of about a dozen or so naval architecture programs in the country, and Carderock remains prevalent as the standard for naval architecture and innovation.

CRADA between Carderock and Oceana Energy brings in-stream hydrokinetic device to marketplace

By Daniel Daglis,
Carderock Division Public Affairs



This in-stream hydrokinetic device developed by Oceana Energy is being tested in 2014 at Naval Surface Warfare Center, Carderock Division's David Taylor Model Basin in West Bethesda, Md. (Photo provided by Oceana Energy/Released)

The old adage that collaboration breeds innovation holds true time and time again at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland. As leaders in innovation for the U.S. Navy, Carderock often brings together their workforce of scientists and engineers and partners with other government agencies, private companies and universities under Cooperative Research and Development Agreements (CRADAs).

Through a CRADA, both parties involved contribute and share ideas to make a bigger and better product that is mutually beneficial to the industry. According to Carderock's Director of Technology Transfer Dr. Joseph Teter, Carderock has the most cumulative CRADAs from fiscal year 1989 to fiscal year 2016 than any of the Naval Surface Warfare Center activities.

In a CRADA effort that started July 2006, Carderock teamed with Oceana Energy Company to develop and test an in-stream hydrokinetic device to be used in coastal communities to harvest ocean currents, tides or river flows. Their effort led them to concentrate on this technology's usefulness in remote communities in Alaska. According to a report released by Oceana, the remote nature of many of the communities in Alaska makes energy a critical challenge with costs that can be a factor of 5 to 10 higher than grid-connected locations. According to the Environmental Protection Agency, diesel fuel and heating costs in remote Alaskan villages such as Nenana and Kivalina can cost as much as $10 per gallon. With many of these communities close to a river, Oceana recognized the potential for river-based hydrokinetic power generation to provide a renewable source of power.

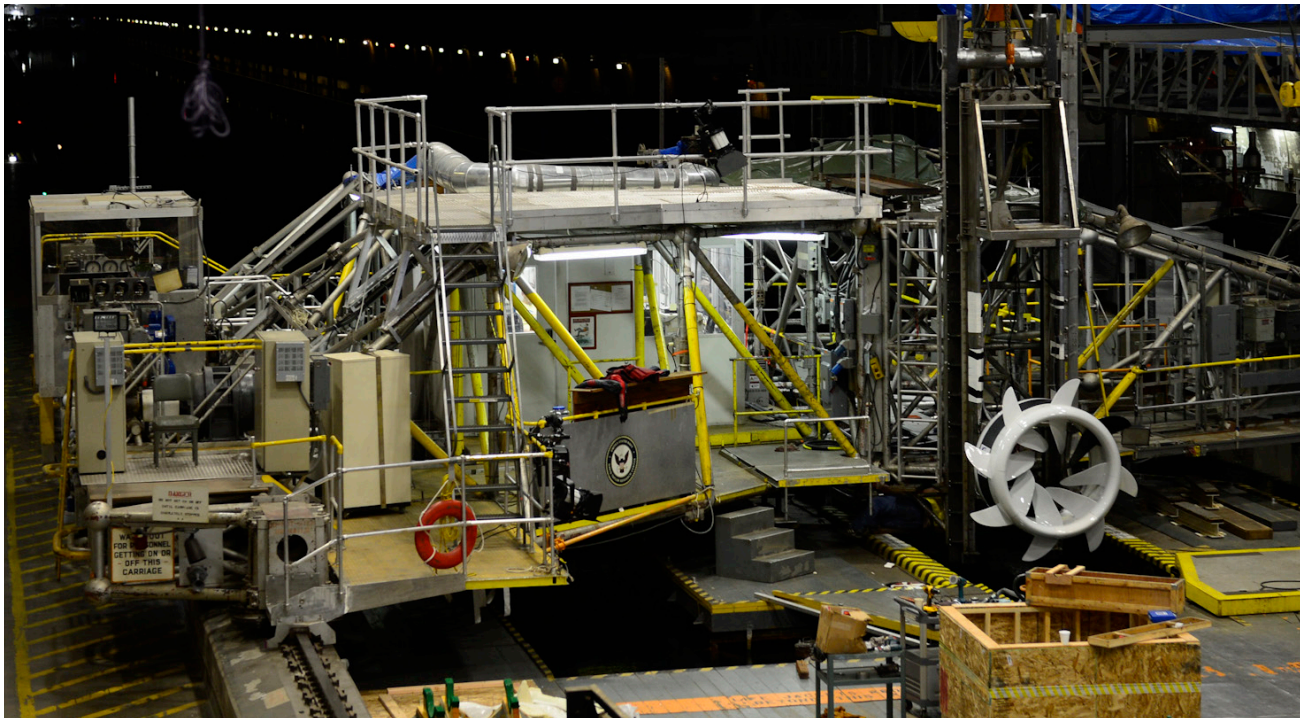
"This project is a true testament to the benefit of CRADAs for domestic industrial development," Teter said. "With this product especially, it also shows that it honestly takes approximately 10 years to get a technology from concept to the marketplace. If you're writing Google apps, obviously it's only months, but to get a real-world physical device constructed and to market – especially in the difficult environment of putting something at sea – that's a serious effort."

Carderock played an integral role in the testing and design of the device. The first phase of the Oceana device evaluation was testing the turbine in Carderock's David Taylor Model Basin tow tank. The basin is among the largest of its kind in the world, containing a shallow-water basin, a deep-water basin and a high-speed basin. Using its sophisticated combination of towing carriages, wave-makers and measuring equipment, engineers are able to determine the sea-keeping qualities and propulsion characteristics of ship and craft models up to 40 feet in length.

According to the Oceana report, the basin provided the perfect location for initial testing because the objective was to obtain performance data in a clean environment free of sediment and other contaminants before proceeding to river conditions in Alaska.

Steve Ebner, head of Carderock's Marine and Aviation Division, led a small team of Carderock engineers and worked in collaboration with Oceana and Carderock's Propulsors Branch to design and test the device. Testing in the basin was coordinated by Matthew Madalis, a mechanical engineer in Carderock's Maritime System Hydromechanics Branch.

"The rim itself is actually moving around, so there's a series of magnets in the rim that's moving and coils in the stationary section, and that's what creates the electrical power. It is simple magnetics, simple electrical generations



Oceana Energy's in-stream hydrokinetic device, designed to generate energy by leveraging natural water flow in a river, is assembled on a carriage in the David Taylor Model Basin at Naval Surface Warfare Center, Carderock Division's David Taylor Model Basin in West Bethesda, Md. for testing in 2014. During the testing the device was able to generate up to 8.15 kilowatts of power. The device's rotational rate was calculated by placing a single black fin on the device that could be tracked while viewing video playback. (Photo provided by Oceana Energy/Released)

technologies," Ebner said while discussing the design.

The Oceana device includes fins both radially outward and radially inward of the rotating duct. The goal was to build the next-generation hydrokinetic device that included an integral electrical generator, magnetic axial bearings and hydrofoils specifically designed for river environments. According to Ebner, by including blades on both the inside and outside, the reaction loads on the ring tend to be balanced and generate more power. The device can then leverage the force exerted on it by the natural water flow in a river, thus allowing the turbine to generate energy.

During the three days of testing in the model basin, the device was able to generate up to 8.15 kilowatts of power. The device's rotational rate was calculated by placing a single black fin on the device that could be tracked while viewing video playback.

In the Oceana report, the company considers Carderock to be an integral part of their team and future success. It notes that the testing facilities are unparalleled and the staff was professional and knowledgeable. Overall, the tow tank testing provided critical data to determining the performance of the device and giving engineers an idea of the device's behavior in river conditions before proceeding to the actual river testing. By thoroughly testing the device in Carderock's basin, engineers were ultimately able to determine the turbine's potential to provide an alternative energy source for Alaskan communities.

"Working with CRADAs, the engineers in my division like to collaborate for two very important reasons: first, the goals are always different, which gives them an opportunity to think outside of the box, and secondly, the technology we learn from doing this kind of work is always fresh and it aids in their professional development. It is especially beneficial when these opportunities to work with leaders in the industry lead to the use of the technology in some programs that are going on right now within the Navy," Ebner said.

Madalis said CRADAS are also beneficial to engineers because they allow the engineer to optimize resources and work together with another party to come up with solutions and conduct expanded research.

"In terms of the benefits for Carderock, this Oceana device was on the front page of the business section for the Washington Post about a year ago. It was right when they started testing up in Alaska," Madalis said. "It's refreshing to get recognized for your work as an engineer because a lot of what we do – especially with some of the technologies that are exclusively designed for the Navy – isn't available for public release. CRADAs allow for more open research."

An analysis released by Oceana Energy states that the size and location of Alaska makes it the leading potential of hydrokinetic energy in the U.S. It is estimated that Alaska has approximately 40 percent of the total river energy, 90 percent of the total tidal energy and approximately 60 percent of the total wave energy in the U.S. With this new technology, the state's geographic location and abundance of flowing water, Alaska has the potential for being the hub for hydrokinetic power generation. Through the humble start of a CRADA between Carderock and Oceana Energy, this potential is on its way to being realized.

Carderock's MAKE Lab a hit with employees

By Alisha Tyer, Carderock Division Business Support Office

Since opening its doors in March 2016, the Manufacturing, Knowledge and Education (MAKE) Lab has attracted a wide variety of employees across Naval Surface Warfare Center, Carderock Division curious about the additive manufacturing (AM) process and its application to Navy programs. AM, or 3-D printing, is a cross-cutting manufacturing technology in which parts are built by the addition of material in thin successive layers. The technology presents an ability to produce and reproduce components in a quick, cost-effective, on-demand fashion.

AM is a rapidly maturing technology and, in recent years, its benefits have gained increased recognition. The technology is of significance to the Navy, as it offers the potential to rapidly develop and improve upon systems and components crucial to supporting the fleet and its warfighters. Future projections of AM integration include all aspects of naval operations, from research and development to production, manufacturing and lifecycle maintenance support.

Within Carderock, the potential capabilities of AM technology are of particular interest to many employees, including those outside of the materials and manufacturing area. Kent Bartlett, a mechanical engineer in Carderock's Hydroacoustics and Propulsor Development Branch, is an active proponent of AM technology. He advocates the speed and flexibility that AM affords in the production of complicated parts. In support of test work in the anechoic flow facility, Bartlett utilized the MAKE Lab to additively manufacture an adapter used to connect varying diameters of Tygon, a flexible polymer tubing used to create static pressure taps.

Bartlett explained how the limitations of the pre-manufactured adapters did not allow his team to freely connect tubes of varying diameters as they are pre-fitted for specific tubing pairs.

"Well, one adapter might connect one-

Jonathan Hopkins, deputy department head for the Additive Manufacturing (AM) Project Office, shows fellow employees at Naval Surface Warfare Center, Carderock Division objects created through AM during a tour of the Manufacturing, Knowledge and Education (MAKE) Lab, which officially opened in Building 60 in West Bethesda, Md., March 24, 2016. The MAKE Lab allows training and production in AM, also known as 3-D printing, to all of Carderock's employees who desire to participate and exchange ideas. (U.S. Navy photo by Dustin Q. Diaz/Released)

eighth inch to one-quarter inch, and you can only use it for one-eighth-inch to one-quarter-inch tubing," Bartlett said. "So what I did was take this existing product, which costs about $65, I took that same design and I turned it into a 3-D print. If the part gets ruined or breaks, it's cheap and fast to remake or tweak my design as needed. Plus, creating the adapter myself means I can go to and from whatever sizes I want. That means we can use the adapters a lot more within our facility."

The MAKE Lab, managed by the Carderock's Additive Manufacturing Project Office, aims for a collaborative-style approach to the 3-D printing process, one that inspires creativity and innovation by encouraging knowledge share and providing an open-access space and resources necessary to actively test the AM process. The AM Project Office offers training to anyone who wants to explore the lab's AM capabilities and employees are not required to have a technical background to use the lab. In fact, many who take training are unfamiliar with the 3-D printing process before learning to utilize the lab's equipment, according to Jonathan Hopkins, a mechanical engineer and deputy department head of the AM Project Office.

Hopkins highly encourages all employees, technical and non-technical, to take the two-hour training which consists of a presentation, discussion of the goals of the MAKE lab, a demonstration of software and equipment and culminates with each trainee creating their own 3-D print. So far, 155 employees have participated in the training, Hopkins said.

"The MAKE lab is a pretty open place in terms of your background. You really don't need any background to join," Bartlett said when asked what advice or encouragement he would offer to others considering visiting or using the MAKE Lab. "It's very easy to get a hold of admin or supervisors in order to take the training and once you do, the lab is open and accessible. If you have time in your schedule, then the MAKE Lab is there when you need it. So I think it's very beneficial and easy to get involved. It really is awesome. You should do it."

Annual NISE technical exchange meeting at Carderock

By Kelley Stirling, Carderock Division Public Affairs

Chief of Naval Research Rear Adm. David Hahn listens as Garry Shields (left), head of Naval Surface Warfare Center, Carderock Division's Disruptive Technologies Laboratory (DTL), describes the Optionally Manned Technology Demonstrator (OMTD) Big Area Additive Manufacturing (BAAM) test article, which is a 30-foot-long, proof-of-concept hull print modeled after a SEAL delivery vehicle. Hahn was at Carderock's headquarters in West Bethesda, Md., on Feb. 28, 2017, for the annual Naval Innovative Science and Engineering (NISE) Technical Exchange Meeting (TEM). Alex Askari (right) and Ray Alexander (center), both from Carderock, work with Shields in the DTL. (U.S. Navy photo by Devin Pisner/Released)

The annual Naval Innovative Science and Engineering (NISE) Technical Exchange Meeting (TEM) was held at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland, Feb. 28-March 1.

"This TEM provided a forum for folks from across the entire Department of the Navy to share ideas and collaborate," said Dr. Tim Arcano, Carderock's technical director. The event brought together 350 scientists, engineers and decision makers. Nearly 200 research efforts were presented, as well as specific briefings on many cutting-edge research areas, including quantum computing and human-autonomy interaction.

The NISE 219 program was developed as part of the 2009 Defense Authorization Bill (section 219) for research and development of new concepts and to ultimately provide for the transition of these new concepts to the future naval force.

"The investments that we made in our 219 programs, I believe, are the underpinning of how we are going to re-start and globalize new ideas in science and technology within our Warfare Center community," Deputy Assistant Secretary of the Navy for Research, Development, Technology and Evaluation (DASN-RDT&E) Dr. John Burrow said in his opening remarks at the TEM. "These investments are more than just an opportunity for you to pursue your ideas and to see what this new technology may or may not be able to do. It's actually seeking capabilities for the future."

Burrow introduced Rear Adm. David Hahn, chief of naval research, and director of innovation, technology requirements, and test and evaluation (OPNAV N94).

Deputy Assistant Secretary of the Navy (DASN) for Research, Development, Technology and Evaluation (RDT&E) Dr. John Burrow talks to members of the Naval Research and Development Establishment on Feb. 28, 2017, at the annual Naval Innovative Science and Engineering (NISE) Technical Exchange Meeting (TEM), held at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Kelley Stirling/Released)

"He's an innovator; he's somebody that's driving change," Burrow said of Hahn.

While the TEM (under NISE 219 funding) focused on research, workforce development and initial transition, Hahn emphasized the larger picture as the entire spectrum of funding, from basic research to operational system development. From that perspective, Hahn said things need to move faster and cost less, and his discussion centered on how to get the workforce on board with initiating change.

"If you look at the competitive space we operate in, it's dictated by the adversary, it's dictated by the movement and the pace of technology that we are living in," Hahn said, adding that because of where the world is in the current commoditization of technology and information, the Navy has to figure out how to get what it needs faster and more effectively.

"We are going to have to figure out as a team how we are going to get more out of our dollars," Hahn said. "We are not going to do it the same way. And we are going to have to figure out how to work in the ever-accelerating world of technology where information, communication, data, the Internet, all that data being created is going to be unlocked by somebody."

At the warfare and system centers level, much of the NISE funding supports basic and applied research and advanced component development and prototypes. Hahn said the Navy will continue to explore these areas, but that there has to be collaboration out to the program and development level, as well as to the Sailors and Marines that have the requirements.

"We can't just throw it over to industry and ask them to figure it out, because they don't set requirements," Hahn said. "They are not connected to the Sailor and Marine like you are. They don't understand the systems the way you do."

Burrow echoed Hahn's sentiments, adding that the power of the work that the Naval Research and Development Establishment (NR&DE) does is a collective power, not an individual power. He stressed that he thinks the scientists and engineers are the most important asset to the future of the Navy and this is evident in the Department of the Navy's (DON) 30-year research and development (R&D) plan.

"The plan doesn't come and tell you 'build this.' What it tells you is what the operating environment is that we are dealing with, and here are some key science and technology areas that we need to develop." Burrow said regarding the plan, adding that the Navy needs to give the scientists and engineers the tools and facilities they need and allow them to think, innovate and run with ideas.

Two recurring themes discussed at the TEM were collaboration and rapid prototyping. Interaction among the scientists and engineers was the major

Dr. Daphne Fuentevilla, a chemical engineer and power system specialist in the Advanced Power and Energy Group at Naval Surface Warfare Center, Carderock Division, describes her NISE 219 project for determining lithium battery failure mechanisms in order to improve failure mitigation technologies, Feb. 28, 2017, to an attendee of the Naval Innovative Science and Engineering (NISE) Technical Exchange Meeting (TEM), held at Carderock's headquarters in West Bethesda, Md. (U.S. Navy photo by Kelley Stirling/Released)

goal of the TEM, facilitated by the poster session of NISE 219 projects from across the NR&DE spectrum. These ranged from laser metrology enabling additive manufacturing to liquid nitrogen spray cooling. Even the Big Area Additive Manufactured structure for the Optionally Manned Technology Demonstrator was on display outside, as the large 3-D printed vehicle did not fit inside the conference center.

The event was structured to encourage many "sidebar" meetings defined and executed by attendees. One example was the meeting between Chief Technology Officers (CTOs) from across the NR&DE to discuss their NISE 219 strategies, the importance of the program to scientific development, and how best the CTOs could aid in cross-organizational cooperation and innovation.

According to Arcano, in fiscal year 2016, NISE projects across the NR&DE produced over 754 technical publications, 176 patent actions, enabled 165 people to pursue advanced degrees with 36 being awarded, and provided technical training and mentorship to over 12,200 scientists and engineers. There were 528 different collaborations across DOD and 491 collaborations with other U.S. government organizations, industry and academia.

"It's important that you connect with each other here," Burrow said. "It's important that you establish relationships that don't last for two days, but are enduring. It's important that you understand that your ideas are worth exploring. Your ability to define the future of naval force capabilities is absolutely an imperative."

During a call for proposals for fiscal year 2018 Laboratory-Directed Research and Development at Carderock in February, Dr. Jack Price, Carderock's director of research, said there were four areas under NISE 219 funding that Carderock is looking at: division thrust areas; technology stewardship; long-range research and development plan technology and skills development; and professional development.

Carderock's principal thrust area right now is platform design tools, a topic area that crosses all technical department boundaries, but Price said there is talk of adding Arctic research in the next year or so. The thrust areas generally are funded to last about three years, though Arcano has directed the refinement of a five-year Science and Technology (S&T) roadmap, which is now in its infancy.

Another key area is professional development, which is a focus on bringing knowledge to the workforce at Carderock. Price said that if there is some technology that Carderock needs, and if anyone involved in the research of that technology needs an advanced degree, Carderock will consider paying for the labor for them to do the research and become subject-matter experts in that technology.

"All the investments that we do here should reflect the mission of Carderock," said Price, who is involved with administering the programs that oversee Carderock's discretionary investments in the people and capabilities at Carderock that will help create and build knowledge. "If your ideas or your concepts reflect the mission of Carderock Division very well, you have a home with us."

Invention Evaluation Board at Carderock

By Daniel Daglis, Carderock Division Public Affairs

The Invention Evaluation Board (IEB) brings together Naval Surface Warfare Center, Carderock Division experts in science and technology and intellectual property attorneys to discuss the potential of patenting inventions developed by Carderock engineers and scientists. The IEB most recently met at Carderock's headquarters in West Bethesda Maryland, May 18 to discuss the latest patent submissions from personnel with new ideas and inventions to help improve the U.S. Navy fleet.

Leading the council is Dr. John Barkyoumb, Carderock's director of strategic relations, and Dave Ghatt, lead intellectual property attorney in the Office of Counsel. Joining them in this meeting, and most meetings of the IEB, was Director of Technology Transfer Dr. Joseph Teter; attorney Charles Buskey; William "Dave" Sudduth, program manager for the Survivability, Structures, Materials and Environmental Department Science and Technology Office; and mechanical engineer Damien Bretall.

"The Navy has a strong history in technical excellence related to patents," Ghatt said. "The Navy is routinely listed as the No. 1 government organization in the world in terms of patent production. Locally, Carderock does extremely well in terms of producing quality patents. We have won eight Admiral Bowen awards since 1996. This is an award that is granted to the most prestigious patent from any Navy organization."

According to Barkyoumb, pursuing a patent can cost between $10,000 and $20,000, so one of the main objectives of the IEB is to decide if a patent for a particular invention is worth pursuing. The members of the board deliberate on each proposal, then fill out a score sheet ranking the invention on a scale of one to five on criteria including the invention's investment potential, degree of development and affordability impact.

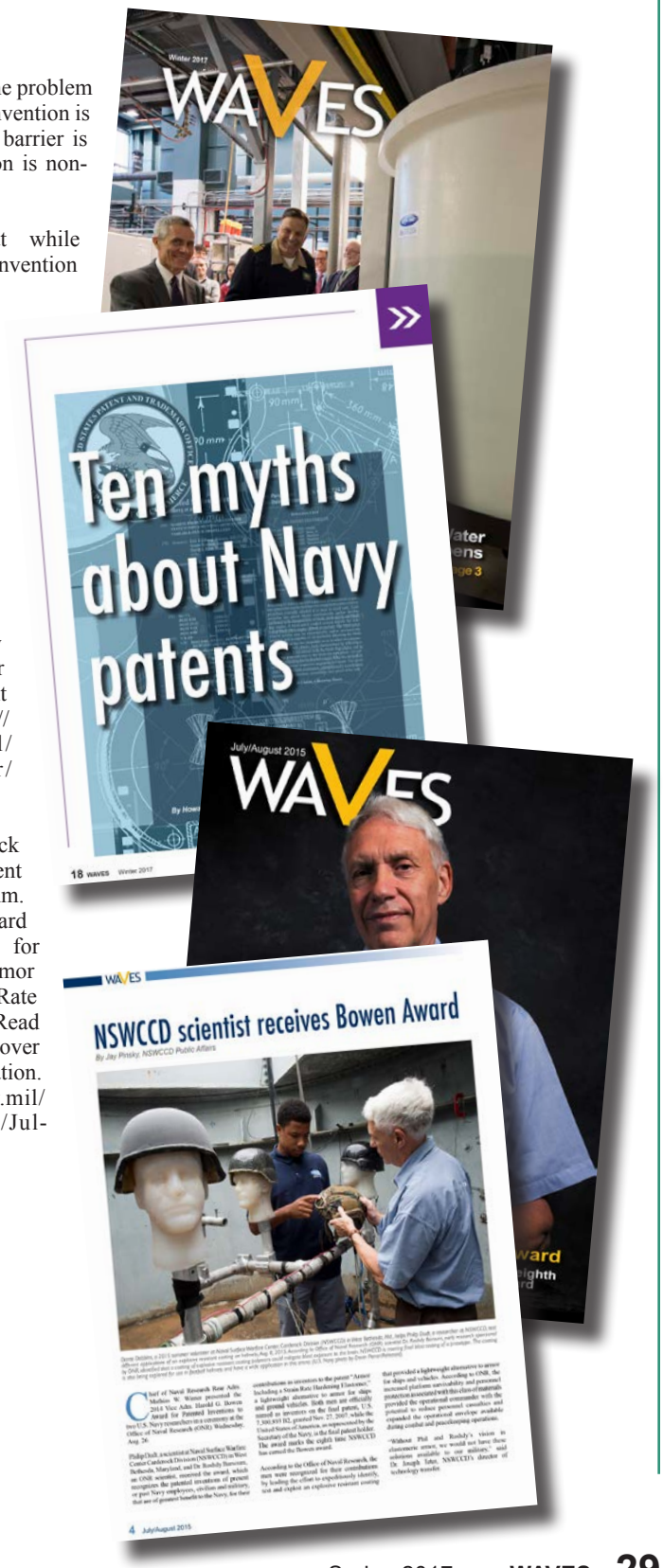
Ghatt said there are three major legal questions that need to be asked when considering an invention for a patent: Is it new? Is it useful? Is it non-obvious?

"Usually there is rarely the problem with whether or not the invention is useful; the biggest legal barrier is proving that the invention is non-obvious," Ghatt said.

Barkyoumb noted that while deliberating the invention disclosures, the board considers the potential value of the invention to the Navy and how that invention promotes the division's national image as a source of maritime science and engineering competence.

Read the Winter 2017 edition of Waves for an article written by intellectual property attorney Howard Kaiser on the "Ten Myths about Navy Patents:" https://cuthill.crdr.navy.mil/WAVES/2017/winter/winter2017_WAVES.pdf

Phil Dudt is Carderock Division's most recent recipient of the Vice Adm. Harold G. Bowen Award for Patented Inventions for his role in the patent "Armor Including a Strain Rate Hardening Elastomer." Read the Waves magazine cover story for more information. https://cuthill.crdr.navy.mil/WAVES/2015/Jul-Aug/Jul-Aug2015_WAVES.pdf



Carderock technical director challenges employees to innovate; employees accept

By Dustin Q. Diaz, Carderock Division Public Affairs

Just before the third edition of Naval Surface Warfare Center, Carderock Division's command-wide innovation contest concluded in June, the command launched its call for proposals for the fourth edition of the Technical Director's Innovation Challenge (TDIC) in May.

Carderock Technical Director Dr. Tim Arcano created the TDIC in 2014 after his initial engagements with the Carderock workforce indicated a level of anxiety over the difficulties involved with innovating and a hunger for opportunities to conduct entrepreneurial innovative activity. The aim of the challenge is to stimulate innovation across all of Carderock's technical and business areas: concept development, science and technology, research and development, test and evaluation, fleet support, in-service engineering, acquisition support, logistics research and development and business processes.

"I think every single proposal here has an application we can use, so that's great work," Arcano said after last year's TDIC final presentations. "I'm proud of the innovations that your hard work has produced through TDIC and its effect on our employees and our culture. It's been wonderful being this program's sponsor and I look forward to seeing what happens with these proposals in the future."

While the fiscal year 2018 TDIC proposals have already been submitted, Arcano said employees should be thinking about what they can submit in future years.

"Thirty years ago, who would have thought that you needed a smartphone? And now, it would be hard to imagine life without them. A TDIC proposal could be something to provide a stated need by a program office, or it could be something completely different like that," Arcano said. "Another distinguishing feature of TDIC is it's not just open to the scientists and engineers here, it's open to all employees to pursue all types of innovation. Whether it's operations,

Johnnie DeLoach, Naval Surface Warfare Center, Carderock Division Materials division head, presents his and Dave Sudduth's "Shark Tank" type approach to funding innovation during the Technical Director's Innovation Challenge (TDIC) outbriefs in West Bethesda, Md., June 1, 2017. TDIC is a command-wide innovation program that has a low barrier to entry, can be applied to any field, and operates on the premise that business process and policy innovation is just as valid as technological innovation. (U.S. Navy photo by Dustin Q. Diaz/Released)

Garth Jensen (right), Naval Surface Warfare Center, Carderock Division's director of innovation, briefs Carderock employees interested in taking part in the Technical Director's Innovation Challenge (TDIC) during a brown bag in West Bethesda, Md., May 11, 2017. The TDIC is a program created by Carderock Technical Director Dr. Tim Arcano, open to all Carderock employees working in all fields, soliciting proposals for solutions to problems for Carderock's stockholders and offering employees 20 percent of their working hours to develop their ideas if their proposals are selected. (U.S. Navy photo by Dustin Q. Diaz/Released)

management, contracting or anything else we do here, it's very important that we work on these things as one team."

TDIC is open to all federal employees at Carderock. It is modeled after Google's "20-percent"concept to provide employees time and funding for projects to address stakeholder needs, whether perceived or unperceived, with an emphasis on human-centered design.

Prospective participants from all of Carderock's technical and business areas can submit a proposal answering questions about how their idea will address the needs of Carderock's stakeholders, including but not limited to Navy and Marine Corps warfighters and maintainers, the Office of Naval Research and contract and information technology functions. These ideas are briefed to Carderock senior leaders at phases of development and they decide at each phase if the proposal will receive initial or continued funding, taken from a mix of discretionary overhead and Naval Innovative Science and Engineering (NISE) 219 money.

Garth Jensen, Carderock's director of innovation, called the TDIC projects the intersection between two forces: one, an individual at Carderock with a burning passion for a need or a problem that keeps them up at night, and the second, what he calls the force of enlightened leadership.

"Dr. Arcano, our department heads and leadership recognize that giving people space, availability of time and an opportunity to set aside some time and try to do something that may be out of the norm is a rare commodity," Jensen said. "This is one of the few places I've seen that recognizes at that level that leadership doesn't have a monopoly on the answers and they don't even have a monopoly on the questions that need to be asked. By opening it up to the workforce, it's a very explicit statement to that effect."

According to Jensen, eight to 10 new starts are typically selected each year, with one to two continuing on from the previous year. Last year's presenters out-briefed six new projects, including next-generation surface treatments (new ways of painting ships) from Allan Demmelmeier and Mike Anslow from the Combatant Craft Division; a human-centered design digital collaborative toolbox from Paul Andron and Nathan Hagan; a Shark Tank-like approach to funding innovation by Johnnie DeLoach and Dave Sudduth; voice-to-printed word applications from Ray Alexander; unmanned underwater vehicle design tools from Ben Kassel and Michael Goodman; and haptic technology for structural health monitoring from Benjamin Grisso.

Alexander said his application came about when he thought about the volume of knowledge exchanged at Carderock, in meetings and daily work, that is not recorded and thus, a lot is forgotten. He said he was resistant to smartphone technology at first, but when he finally bought one, he made frequent use of the voice-to-text functions and wondered why that couldn't be used at Carderock. Though he comes from the operational side of Carderock's work and wasn't involved in projects like TDIC before, he said he talked about his ideas to Dr. Judy Conley, Carderock's science and technology coordinator, and she helped him write a proposal for TDIC.

With the help of Conley and a few

Dr. Jenn Wolk, a program officer with the Office of Naval Research; John Carney, director of the Navy Manufacturing Technology Program; and Jason Jouet, manager of the High Energy Materials Branch at Naval Surface Warfare Center, Indian Head Division, listen to project presentations from engineers and scientists at Naval Surface Warfare Center, Carderock Division during the third phase of the Technical Director's Innovation Challenge on April 3, 2017. (U.S. Navy photo by Harry Friedman/Released)

other Carderock employees, Alexander navigated the project's logistics and ended up with a final product that exceeded his expectations. In working with different departments, getting on the phone directly with potential commercial partners and using other typically unorthodox methods to solve the challenges in delivering on his proposal, he lived up to TDIC's call to innovate processes and methods along with technological innovation.

"I know that sometimes folks can be frustrated about the difficulty of initiating change," Alexander said. "All this is brand new to me and I had help from a lot of people with it, but we managed to create a product while returning much of the funding since we were able to work cheaply. I hope more folks will get involved, from both the technical and support sides."

DeLoach came up with the idea for a Carderock Shark Tank and proposed this as part of last year's TDIC. In the television show "Shark Tank," inventors and aspiring entrepreneurs pitch their idea to a panel of experienced businessmen and women in hopes that a member of the panel will choose to share their resources and bring the idea to fruition.

DeLoach said the Carderock Shark Tank is a perfect way to support TDIC because senior leadership do not necessarily have a monopoly on the answers, or even the questions, that need to be asked when it comes to continually improving the command. Shark Tank is not only about cultivating new ideas from the workforce, but also giving those with proposals a platform.

"Shark Tank gives the staff of scientists and engineers and personnel that typically put proposals forward more visibility with the management staff of the division, which is also a good thing. The way we've executed it, we've allowed people to come in and just be audience members so other people within the division can hear these ideas if they want to take the time to do it," he said.

DeLoach held a Shark Tank within the Carderock's Survivability, Structures, Materials and Environmental Department. In the first two phases of his Shark Tank, scientists and engineers presented their independent applied research or NISE 219 funded proposals to division and department level leadership.

The third phase, held in April 2017, put these ideas in front of potential sponsors such as Danesha Gross, program manager for Cross Platform System Development (CPSD) within Naval Sea Systems Command's Chief Technology Office; John Carney, director of the Navy Manufacturing Technology Program; Dr. Jason Jouet, manager of the High Energy Materials Branch at NSWC Indian Head Division; and Dr. Jenn Wolk, a program officer with the Office of Naval Research's Naval Material Science and Technology Division. DeLoach said he wanted to choose a variety of panelists with diverse perspectives, since this event was an experiment to find out how well this format would work at Carderock and more participants would give it a greater chance of success.

"From my experience, one of the things that doesn't necessarily come naturally to people is the ability to present the value of an idea in a succinct way," DeLoach said. "It's all about quickly being able to convey your idea and what the value of that idea is to whomever it is you're

Allan Demmelmaier and Mike Anslow with Naval Surface Warfare Center, Carderock Division's Combatant Craft Division present their proposal for alternatives to dry dock paint aboard combatant craft during the Technical Director's Innovation Challenge outbriefs in West Bethesda, Md., June 1, 2017. (U.S. Navy photo by Dustin Q. Diaz/Released)

talking to. The Shark Tank approach is all about that. I felt like our work force – because it is getting progressively junior – needed a friendly atmosphere to hone those skills, and Shark Tank allows for that environment."

Shark Tank presenter Dr. Nicholas Jones, a materials scientist in Carderock's Physical Metallurgy and Fire Protection Branch, gave two presentations, one about developing a reliable real-time tension monitoring system for fastener applications using magnetostrictive materials and the other about studying the ductile-to-brittle transition temperature of iron-based alloys. He said he is accustomed to giving technical talks that are longer, sometimes much longer, than the quick format here, so he had to prepare differently to get his message out quickly and anticipate the panelists' questions, especially since they would approach the topic from their own scientific backgrounds.

"I think this format is very effective for discussing preliminary ideas and brainstorming with those at a much higher level," Jones said. "This is a great way as a researcher to keep the key funding points at the forefront and answer specific questions that panelists have about it. It was a fun time, and it was refreshing to participate in a research discussion focusing on strengthening the idea rather than judging it. This was positive in nature and focused on how to improve the idea or change its presentation to make it more understandable and fundable, which is comforting."

This completed DeLoach's entry in the TDIC and he was able to brief the results of his Shark Tank idea during the final presentations in June. He said the Shark Tank concept gives Carderock employees a platform to present their ideas in an interactive setting that is productive, as well as fun.

Over the past several years, Carderock leadership has made innovation a top priority.

"I have to give Dr. Arcano a lot of credit," DeLoach said. "His emphasis on innovation since he's been here is huge. I've been here through several technical directors and there is nobody so far that has put the emphasis on innovation in all the ways that he has."

Daniel Daglis and Kelley Stirling of NSWCCD Public Affairs contributed to this story.

Carderock showcases examples of high-velocity learning

By Kelley Stirling, NSWCCD Public Affairs

High-velocity learning has been the hot topic in the Navy and especially with Naval Sea Systems Command (NAVSEA) ever since Chief of Naval Operations Adm. John Richardson laid it out in his "Design for Maintaining Maritime Superiority" not long after taking office. But, what is high-velocity learning, who should be doing it and how does it get applied?

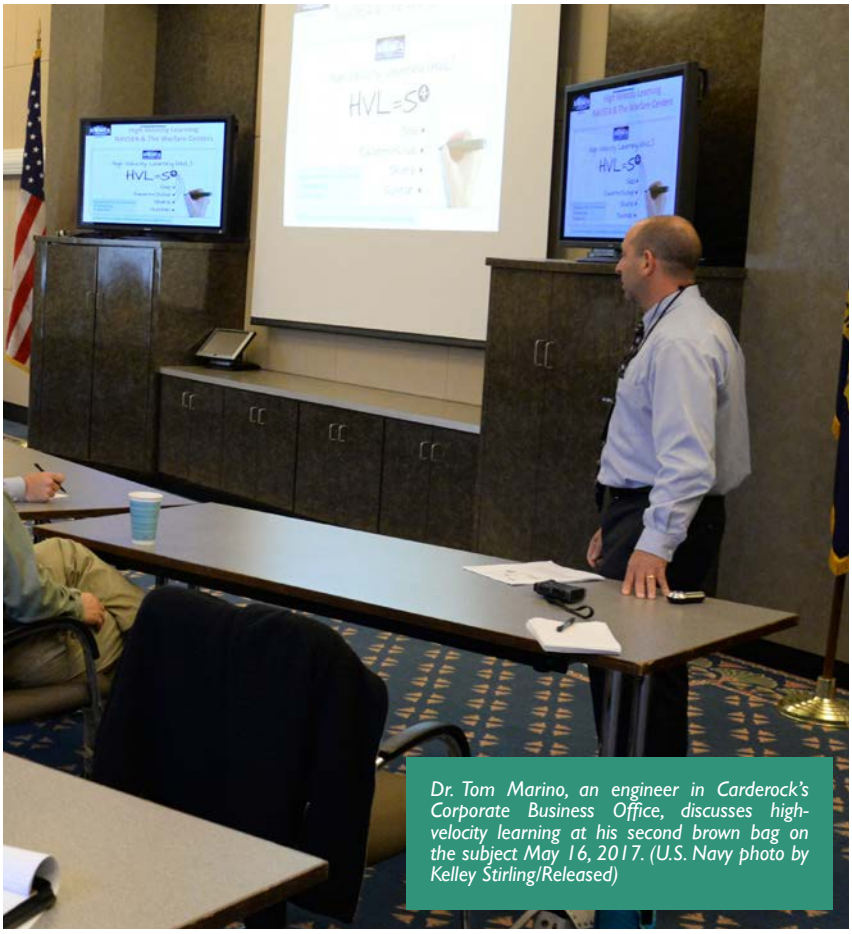
Dr. Tom Marino, an engineer working in the Corporate Business Office of Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland, has become Carderock's resident expert in high-velocity learning and has given a couple of presentations to the workforce in an effort to answer some of these questions.

Marino said the first presentation held April 18 was about educating the workforce with the goal being to not only help the workforce understand high-velocity learning, but also to have the workforce provide feedback on how they interpret high-velocity learning.

"I would venture to guess that the majority of you are doing some amount of high-velocity learning on what you do on a day-to-day basis," Carderock's Technical Director Dr. Tim Arcano said when introducing Marino. "What we want to do with this forum is showcase that folks are doing high-velocity learning around the campus."

While the CNO coined the "learning" part of high-velocity learning, the basic concept stems from a book by Dr. Steven Spear called "The High-Velocity Edge." For the book Spear researched companies, such as Toyota, that were doing exceptionally well relative to their competitors, not only in profit margin and production, but also in safety and a sustained improvement in innovation.

According to Marino, there are lots of ways to describe high-velocity learning, but despite its name, it's not about doing things faster and not about learning in traditional pipelines. Marino said people have to stop thinking about "learning" in the sense of traditional education; they should be thinking about it more in the terms of collaboration and leveraging the collective knowledge of the workforce, in their respective division and beyond.



Dr. Tom Marino, an engineer in Carderock's Corporate Business Office, discusses high-velocity learning at his second brown bag on the subject May 16, 2017. (U.S. Navy photo by Kelley Stirling/Released)

"The main thing to understand about high-velocity learning is that it's about how culture change influences the success of the organization," Marino said. "Continuously looking at the underlying structure is really one of the essences of a learning organization. The workforce has to change the way they build and share knowledge in order for high-velocity learning to be successful, and sharing not just the solutions to problems, but the processes that lead to those solutions as well. That's where the high-velocity occurs."

He said people tend to think of process improvements as events, such as a Lean Six Sigma or CPI (continuous process improvement) event, but high-velocity learning is really about continuous examination and immediately addressing normalized deviation (workarounds) when it's discovered.

Marino described the four "S's" that high-velocity learning has become known for, especially in the NAVSEA world, and they are "see, swarm (or solve), share and sustain." NAVSEA's roll out of high-velocity learning characterized the four

S's as the key to disciplined learning, according to Marino.

"This isn't really a template for solving problems, it's a template for looking at problems," Marino said in his second presentation May 17. "The 'see' part is really detecting problems as they occur, and I argue that this is probably one of the most challenging things, seeing the underlying structure of things in your processes that are typically hidden from you normally. That's basically the things that affect your processes and that lead to work-arounds and inefficiencies."

Marino talked about NAVSEA Commander Vice Adm. Thomas Moore's comments during a town hall meeting May 10, saying he addressed the NAVSEA campaign plan to expand the advantage. Moore gave the high-velocity learning community 90-day goals and said the priority is to focus on the sharing.

"He wants us to share information on how we are breaking down barriers, how we are finding ways to innovate, how we are communicating that and how we are telling people about it," Marino said. The other objective the Warfare Center divisions should be working on is pilots and examples of how high-velocity learning is being incorporated into processes, and Marino is gathering examples to meet that objective.

The common thread throughout discussions of high-velocity learning has been leveraging knowledge management. According to Marino, the online suite of social network-based communication and collaboration tools with iNFusion is a way to preserve knowledge.

"INFusion aligns very nicely with what Admiral Moore's objectives are and with the mandate for high-velocity learning," Marino said.

Marino introduced Owen McGarity, acting branch head for Carderock's Vulnerability Assessment Branch. McGarity is participating in NAVSEA's Journey Level Leadership team and for their capstone project, they are looking at iNFusion as a high-velocity learning technique that can be used to enhance the knowledge transfer between Warfare Centers and maintenance activities.

"Before these types of tools were rolled out to the fleet, what you really required was some sort of institutional tribal knowledge as far as who does what, who is really the technical expert in the specific area," McGarity said. "These iNFusion tools begin to connect people across organizations and boundaries that otherwise you would probably never bring together. This gets people interested in what you're doing and brings visibility to your own projects."

McGarity said the suite of tools allows people to broadcast what they are working on, providing a chance to connect with someone at a different Warfare Center or headquarters organization that may be interested in working on the same problem.

Marino introduced four additional speakers, each relaying an example of how high-velocity learning was used, even before high-velocity learning was a thing. This reiterates the notion that Carderock employees are already employing some of the characteristics of high-velocity learning in their everyday work, according to Marino.

One example was the Littoral Combat Ship Full-Ship Shock Trials (FSST) held last summer. Joe Venne, FSST program manager, described the problem being a pod of dolphins with calves swimming through the test area, threatening to shut down the operation. The FSST team took action to develop an avoidance plan, but this required a multitude of organizations to come together to make it happen. Once the trial was successfully completed and the dolphins were avoided, the team incorporated the lessons learned and added the new processes developed into the regular operations of FSSTs. Venne said the new processes are being updated and will be used for CVN 78 and DDG 1000 shock trails in a few years.

Some of the other examples were Carderock's Health Assessment Process presented by Brian Tammaro; the Cooperative Research and Development Agreement (CRADA) between Carderock and Oceana Energy presented by Dr. Joe Teter; CRADA and patents for elastomeric armor, also presented by Teter; and DDG 1000 scale-model testing, presented by Calvin Krishen. Dave Newborn also gave a presentation about bibliometrics, which is a statistical analysis of written publications, such as books, published articles or reports that can be used to identify trends leading indicators and innovation opportunities.

Carderock commits to expanding the advantage

Naval Surface Warfare Center, Carderock Division Commanding Officer Capt. Mark Vandroff and Technical Director Dr. Tim Arcano held an all-hands meeting to showcase Naval Sea Systems Command's Campaign Plan to Expand the Advantage on April 19 in West Bethesda, Maryland.

The campaign ties back to the Chief of Naval Operations Adm. John Richardson's "Design for Maritime Superiority" and lays out three mission priorities for NAVSEA's strategic framework which will result in expanding the advantage: on-time delivery of ships and submarines; culture of affordability; and, cybersecurity. The two pillars are people and high-velocity learning.

As part of the "one-team" vision for the Warfare Centers, Arcano said a key aspect of expanding the advantage is through collaboration. He added that Carderock is moving in the right direction, which can be seen in the command's Strategic Plan and vectors and the establishment of communities of interest (COIs) and technology application teams (TATs) that help to maintain Carderock's standard of excellence.

Arcano and Vandroff signed a poster signifying their commitment to expanding the advantage and invited other Carderock leaders and employees to do the same.

AM Technical Action Team holds kickoff at Carderock

By Daniel Daglis, Carderock Division Public Affairs

The Additive Manufacturing (AM) Technical Action Team (TAT) at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland, held a kickoff meeting March 29 in what Ben Bouffard, AM lead and mechanical engineer in the Materials and Manufacturing Technology Division, said to be the first of many.

"AM is an extremely cross-cutting and enabling technology. For that reason, a lot of us can use it in our research. It enables us to get new and better technologies out to the warfighter faster," Bouffard said.

Bouffard, along with fellow AM Technical Action Team members Jonathan Hopkins and Frank Neukam, said the goal of having these meetings is to communicate Carderock's AM capabilities to personnel across all departments and to create a forum to build the division's AM stakeholder base.

"If anyone is interested in the technology, is working with the technology or plans to work with the technology, I strongly encourage them to reach out. In the future, we want to take this input and create a comprehensive Carderock portfolio so when any of us speak about AM at Carderock, we'll be speaking about the entirety of our capabilities, not just what we're doing in our own branch or lab," Bouffard said.

AM describes technologies that build 3-D objects from digital data by adding layer upon layer of materials such as plastic, metal or concrete. According to Bouffard, AM poses many benefits to the Department of the Navy: it can increase the range, endurance or payload of our platforms; provide cost-effective solutions in regards to maintenance and sustainment; it will open the door for a new era of supply chain independence; and it gives engineers the capability of producing tailored solutions for the mission and the warfighter.

Bouffard said that AM also has other useful applications such as rapid reverse-engineering, the designing of lattice structures, multifunctional materials and training aids. In December, Marine Corps 2nd Lt. Ben Lacount came to

Naval Surface Warfare Center, Carderock Division engineers explore some projects created using additive manufacturing (AM) at the AM Technical Action Team kickoff held at Carderock's headquarters in West Bethesda, Maryland, on March 29, 2017. (U.S. Navy photo by Jake Cirksena/ Released)

Ben Bouffard (left), AM lead and mechanical engineer in the Materials and Manufacturing Technology Division, talks about Naval Surface Warfare Center, Carderock Division's additive manufacturing (AM) capabilities at the AM Technical Action Team kickoff held at Carderock's headquarters in West Bethesda, Maryland, on March 29, 2017. (U.S. Navy photo by Jake Cirksena/Released)

Carderock to produce a prototype of his idea for an expended rounds counter to be placed on the Picatinny rail of an M16 rifle as part of the Marine Corps Innovation Challenge. Lacount worked in Carderock's Manufacturing, Knowledge and Education (MAKE) Lab.

The MAKE Lab was opened at Carderock in March 2016 to cultivate a collaborative-style approach to the 3-D printing process. The lab contains several 3-D printers and other resources to enable engineers to actively learn about and test the 3-D printing process. The MAKE Lab is managed by Carderock's Additive Manufacturing Project Office, and they offer training to any employee who is interested in exploring the lab's AM capabilities.

Neukam provided insight into how AM has been, and continues to be, used to support Carderock operations on a day-to-day basis. He provided examples of test models that went through 50 design iterations and models that are made in specific ways not possible without AM technology. Neukam's team has been providing AM support to Carderock since the early 2000s; in fact, Francisco "Paco" Rodriguez, who attended the TAT event, was responsible for bringing the first Stereolithography printer to Carderock in 2000.

Disruptive Technologies Lab (DTL) Director Garry Shields gave engineers testimony on the success DTL had with printing the largest-ever AM naval asset, in collaboration with the Oak Ridge National Laboratory. The Optionally Manned Technology Demonstrator was created through the use of AM. Shields noted that building the device through AM resulted in a significantly reduced cost and was produced in a matter of days rather than weeks or months.

At the conclusion of the kickoff, engineers in attendance were invited to view some of the projects on display that had been created through AM.

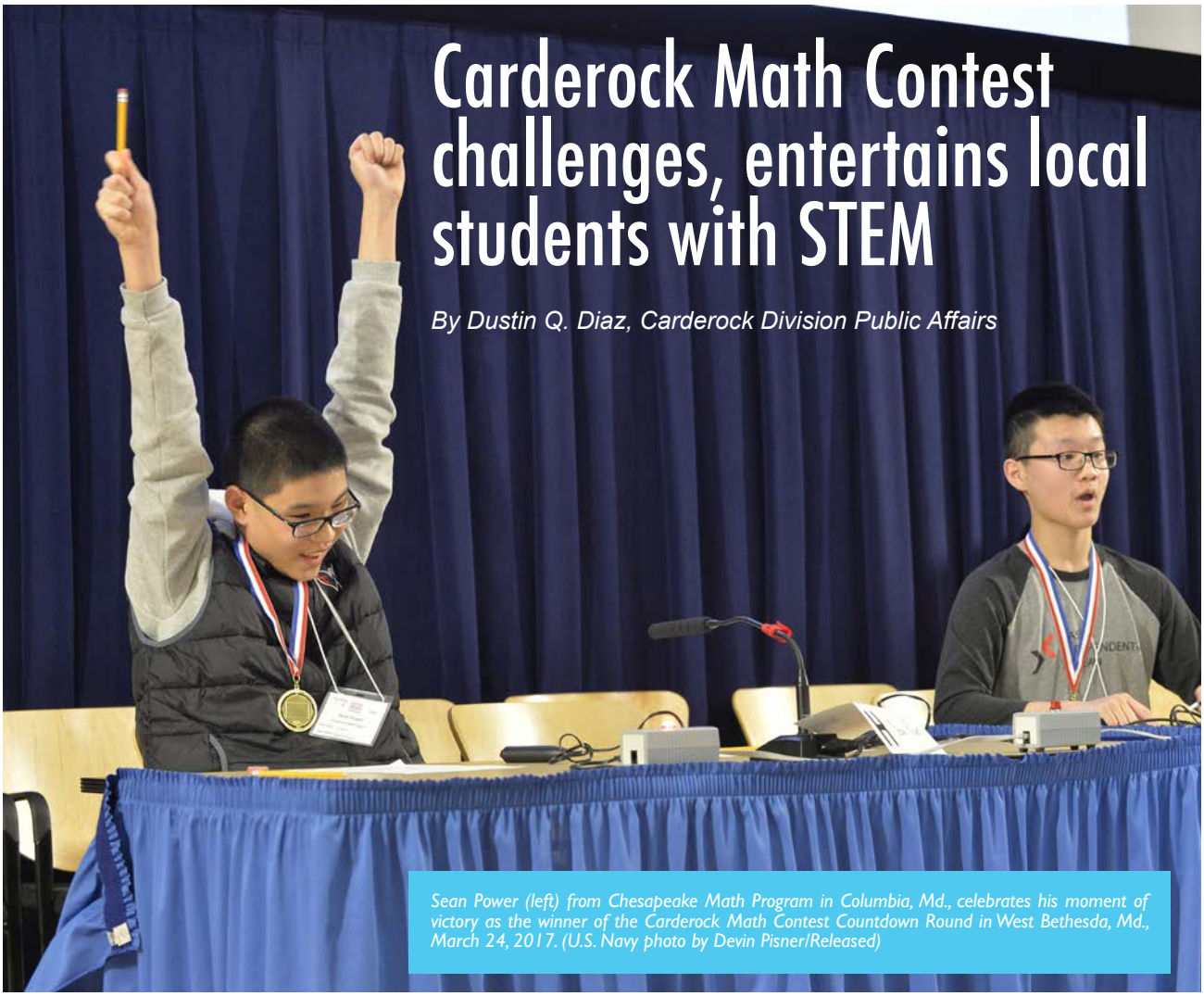
Bouffard added that engineers and even non-technical personnel at Carderock are encouraged to participate in future meetings and seek training on how to utilize the resources in the MAKE Lab. Ultimately, the goal is to have a well-versed workforce that aids the AM TAT in building a diverse portfolio that can highlight Carderock's support to the Navy and Marine Corps and inform the future of AM within the division.

To read more about the Marine Corps Innovation Challenge, read the Winter 2017 issue of Waves, Page 30: http://www.navsea.navy.mil/Portals/103/Documents/NSWC_Carderock/Waves-winter_2017_web.pdf?ver=2017-05-25-140329-493.

To read more about the Optionally Manned Technology Demonstrator, read the Fall 2016 issue of Waves, Page 24: http://www.navsea.navy.mil/Portals/103/Documents/NSWC_Carderock/Waves-fall_2016_web.pdf?ver=2017-02-03-105907-457

Carderock Math Contest challenges, entertains local students with STEM

By Dustin Q. Diaz, Carderock Division Public Affairs



Sean Power (left) from Chesapeake Math Program in Columbia, Md., celebrates his moment of victory as the winner of the Carderock Math Contest Countdown Round in West Bethesda, Md., March 24, 2017. (U.S. Navy photo by Devin Pisner/Released)

More than 200 students from 32 local middle schools came to Naval Surface Warfare Center, Carderock Division on March 24 to compete in the eighth annual Carderock Math Contest (CMC).

The contest, part of Carderock's science, technology, engineering and math (STEM) student outreach efforts, included individual and team competition in MATHCOUNTS-style tests and other activities to inform and entertain them, like tours of the West Bethesda, Maryland, facility.

"I want to ensure that students find STEM-based activities exciting; that's something I am passionate about," said Dr. Charles Fisher, CMC coordinator and materials engineer with Carderock's Welding, Processing and Nondestructive Evaluation Branch. "This contest opens up the opportunity for them to see the applications of some of the skills they're getting. During the tours, they get a chance to see how they would use that math in real life, and they see how they can learn it in school and then translate it into a job and their future careers."

The CMC began with the Target and Sprint rounds of competition, with sets of written math problems the students answered on their own, followed by the Team Round. Phil Dudt, a CMC committee member and Carderock employee since 1968, said Carderock's CMC is unique in that it offers two levels of difficulty, port and starboard, so that less-advanced students can still compete and learn about STEM.

"I'm helping at the CMC because it can introduce students to possible new options for their future," said Dudt, who added that he didn't get those opportunities himself since his middle-school science teacher said he had no future in science and thus wouldn't let him take biology class. "I think these middle-school kids are still at a formative time and introducing them to this vista is a really worthwhile endeavor."

After the morning tests, students gathered in the Maritime Information Technology Center's auditorium for a presentation from the "mathemagician," Prof. Arthur Benjamin. Benjamin is the Smallwood Family Professor of Mathematics at Harvey Mudd College in Claremont, California, and has entertained with his mental math capabilities on the Today Show, the Colbert Report and elsewhere. At Carderock, he impressed the children with his skills in combinatorics

Kevin Kimmel (right), an aerospace engineer with the Aviation and Aerospace Mechanics Branch, tells local students about the Subsonic Wind Tunnel as they tour Naval Surface Warfare Center, Carderock Division during a break between rounds at the Carderock Math Contest in West Bethesda, Maryland, March 24, 2017. (U.S. Navy photo by Devin Pisner/Released)

while involving them directly in his presentation.

From there, volunteers took the students on tours of Carderock's facilities, with the Manufacturing, Knowledge and Education Lab, the David Taylor Model Basin and the Subsonic Wind Tunnel as highlights. Ben Medina, an engineer who began working at Carderock in August, helped coordinate these volunteer efforts, with 16 Carderock employees working year-round on the committee to prepare for the event and more than 60 volunteers on the day of the event serving as chaperones and test proctors, as well as other necessary support roles. He said he relates to the students at the CMC, having taken some preliminary MATHCOUNTS tests as a student himself, and he enjoys getting the chance to tell them about Carderock's facilities.

"When I came and toured Carderock for the first time, that was what impressed me: the facilities, the physical investments and the things we do here," Medina said. "We do real laboratory work here – we're not just typing in numbers and doing equations all day, there are physical things we are doing. I definitely know how being a student and being able to come to a place like this is a special occasion for them, and I like supporting that a lot."

The top 16 scorers in the morning competitions moved on to the main event, the Countdown Round, answering advanced math questions for speed in a bracket-style tournament. Sean Power, a home-schooled student with the Chesapeake Math Program, was the overall winner in the Countdown Round, while Swanson Middle School in Arlington, Virginia, won the team competition. Garry Lee Murray, a student attending Blow Pierce Academy, said he enjoyed touring Carderock, especially the Solid Waste Lab, and had fun watching the mathemagician, but the testing was his favorite part of the day.

"It was a rough challenge – some of it was easy, but some was tough, and I didn't get to complete them all, which lets me know I need to keep studying and challenging myself," Murray said. "This place is cool. I'm definitely interested in becoming a STEM teacher or an engineer someday."

Fisher said he was grateful for the help from all the volunteers to make CMC happen and that he enjoyed putting the event on once again, thanks to the enthusiasm of the students.

"The kids make the event for us; their excitement is what makes the event go so well every year," Fisher said. "We're very happy to have them out here so they can have some fun and see real applications for the math they're learning. This is our pleasure."

Girls in Technology learn about STEM opportunities at Carderock

By Dustin Q. Diaz, Carderock Division Public Affairs

Caroline Scheck, a mechanical engineer with the Additive Manufacturing Project Office, tells middle and high school students with the Washington, D.C., Girls in Technology (GIT) program about the Manufacturing, Knowledge and Education (MAKE) Lab, Naval Surface Warfare Center, Carderock Division's 3-D printing space for workforce development and science, technology, engineering and math (STEM) outreach in West Bethesda, Md., March 29, 2017. Carderock's women engineers and other employees hosted the local GIT chapter to tell and show them about career opportunities in STEM with Carderock and the Department of the Navy. (U.S. Navy photo by Dustin Q. Diaz/Released)

Middle and high school students with the Washington, D.C, Girls in Technology (GIT) program met with their professional counterparts in science, technology, engineering and mathematics (STEM) to learn about opportunities at Naval Surface Warfare Center, Carderock Division, March 29.

The event included tours of the research facility along with presentations and networking opportunities with women engineers and scientists, in keeping with GIT's goals of inspiring girls in grades 6-12 in STEM and identifying pathways to careers in STEM, like those at Carderock.

"I couldn't think of a nicer way to celebrate Women's History Month than to acknowledge what our women do here and give an exciting experience to young women in STEM," said Odean Cameron, an administrative specialist with Carderock Division's Technology Transfer Office, who organized the event.

GIT is a global non-profit organization founded in 2007 with more than 50,000 members and focused on the engagement, education and empowerment of girls and women who are passionate about technology. On this visit to Carderock, Jenny Oh, founding chair of Washington, D.C., GIT's flagship STEM mentoring program, and other GIT staff members accompanied the students on tours of the West Bethesda, Maryland, campus, beginning with a visit to the Model Surfacing and Finishing Shop and David Taylor Model Basin, hosted by naval scientist Dr. Emily Harrison of the Hydrodynamics and Maneuvering Test Branch.

Kiree Young was visiting with her daughter Tai Rosebure, an 11th-grader at McKinley Technology High School in Washington, and said though her daughter was too shy to tell her about it, she could clearly see the excitement on her daughter's face during the tour.

"She loves water. She is a competitive

swimmer, and when we visited the basin, I saw her eyes light up," Young said. "Learning about the battery testing and other research they do here, that was fantastic as well. We are learning a lot more about pathways she can take that aren't available at the school she's attending now. I'm ecstatic that she is seeing women in these jobs, because women can do as much as men can. Young people just need to see that, and my daughter is seeing it here."

Meredith Wood, a nuclear engineer in Carderock's Radiation Technology, Environmental Occupational Safety and Health, Ship Acquisition and Systems Safety Branch, gave a presentation in Carderock's Maritime Technology Information Center (MTIC) on nuclear energy and radiation detection, including a live demonstration of the equipment she uses in her job. Wood came to Carderock in June under the Department of Defense's Science, Mathematics and Research for Transformation (SMART) Scholarship for Service program after graduating from the University of Michigan in nuclear engineering and radiological science. She is an active member of the Society of Women Engineers (SWE) and said STEM outreach events like this one are in keeping with SWE's mission statement of encouraging women to get involved in STEM.

"It's events like these that got me interested in science and engineering to begin with," Wood said. "I think radiation is something that a lot of people don't know about, but I love what I do, it's really interesting. Working with all this nuclear instrumentation is something I didn't think I'd get to work with hands-on, and today I got to do that and show it to possible future engineers too.

"The Navy is a good career path; there are so many opportunities for a civilian engineer. I can work here in Washington, D.C., I could work in California or Pearl Harbor, Hawaii; anywhere there's work, because of how flexible the Navy is with letting civilian engineers pursue their career paths. So I'm very happy to be involved in an event where I can talk both about STEM opportunities with students, but career opportunities with the Navy, too."

The students also toured the Manufacturing, Knowledge and Education (MAKE) Lab, Carderock's additive manufacturing facility for workforce development and STEM outreach, with mechanical engineers Caroline Scheck and Susan Hovanec of the Additive Manufacturing Project Office and met with Dr. Daphne Fuentevilla in the Advanced Power and Energy Branch. The students also attended presentations in the MTIC on engineering, STEM career choices and workplace roles by Dr. Judy Conley, a science and technology coordinator; Diedre Gilmer, a mechanical engineer; and Wanda Jimenez-Barkdoll, Carderock's director of diversity and inclusion. Emily Seifarth and Katherine Geisler, naval architects with the Center for Innovation in Ship Design (CISD), gave a presentation on the CISD, as well as internship opportunities at Carderock that they took advantage of and that were available to the students.

Naval Surface Warfare Center, Carderock Division's women engineers and other employees host middle and high school students with the Washington, D.C., Girls in Technology (GIT) program to show and tell them about career opportunities in STEM with Carderock and the Department of the Navy in West Bethesda, Md., March 29, 2017. (U.S. Navy photo by Dustin Q. Diaz/Released)

Rita Zhang, a 10th-grade student attending Thomas Sprigg Wootton High School in Rockville, Maryland, said her favorite part of the day was visiting the David Taylor Model Basin. She's focusing on graduating high school and studying STEM in college for now, but she said seeing the opportunities Carderock offers first-hand made her strongly consider working here in the future.

"It was a really good experience to come here and see the research they do, the 3-D printing, the materials science and everything else," Zhang said. "And I really like the people, especially Wanda. The event was very interesting, very cool. If anyone gets the chance, they should definitely come here."

Oh said the visit was great for the students and she appreciated the time Carderock's women employees took with the students to answer their questions on Carderock, STEM and the Navy.

"I was blown away," Oh said. "This exposed our girls to different fields they've never heard of or knew existed. The women of Carderock are incredibly intelligent. I think everyone here learned something new, more than one new thing, even."

Before the students departed, Jimenez-Barkdoll spoke to them about her experiences in the government as a Carderock employee and also with the Army, in which she served for 20 years. She encouraged the women to ignore any naysayers in their lives and not to let being a woman hold them back from their dreams, whatever they may be.

"Your future relies on you, so you must do your best," Jimenez-Barkdoll said. "I never forget a face, and I have a few years left until I retire, so I want to see your faces here again. I want you here again as interns in high school in the summer, I want to see you go to college in the subject you are passionate about, and I want to see you come back here as an engineer and be successful and be a part of the Carderock team. It's a stable job with good benefits and the things we work on for our Sailors and Marines who are on ships at sea, who are defending our country, are incredibly important. You can be a part of that here at Carderock as an engineer."

Elementary and middle school students build LEGO robots for Carderock competition

By Daniel Daglis, Carderock Division Public Affairs

A team of students look on as they test out their final product during Naval Surface Warfare Center, Carderock Division's LEGO Robotics Competition in West Bethesda, Maryland, on April 21, 2017. This is the fourth annual competition Carderock has hosted in which engineers assist elementary and middle school students with the designing and programming of fully-functioning autonomous LEGO robots. (U.S. Navy photo by Jake Cirksena/released)

In what has become an annual competition hosted at Naval Surface Warfare Center, Carderock Division, students from local elementary and middle schools spent the day April 21 at the command in West Bethesda, Maryland, demonstrating teamwork in an effort to design and program fully functioning autonomous LEGO robots.

This is the fourth time Carderock has hosted the LEGO Robotics Competition, "Operation Carderock," with several of Carderock's engineers volunteering to help students put the finishing touches on their robots that had been weeks in the making. Once the robots were completed, teams from the four participating schools – Wood Middle School in Bethesda, Maryland; Pyle Middle School in Rockville, Maryland; Burning Tree Elementary School in Bethesda, Maryland; and, Forest Edge Elementary School in Reston, Virginia – were assessed on their demonstration of teamwork, their ability to communicate their design decisions to the judges and the quality of their team-produced research project presentation.

To kick off the day-long event, Carderock's Technical Director Dr. Tim Arcano addressed the students during the opening ceremony, emphasizing both the importance of the competition as a fun learning activity and its importance to Carderock's future workforce by sparking students' interest in engineering careers through the science, technology, engineering and math (STEM) initiative.

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"In a few more years, we're going to need people like you doing what we do at Carderock as scientists and engineers. Someday you might decide to work at Carderock and lend your talents and expertise to helping improve the U.S. Navy's fleet," Arcano said.

Arcano added that Carderock's employee volunteers put their passion into it because not only is it the right thing to do to train students on elements of engineering and design, but also because it's something they love doing.

"We love getting students, especially at such a young age, interested in STEM so one day they can design the ships and submarines that our nation relies on," Arcano said.

Once students were finished with their breakout sessions, they toured some of Carderock's unique facilities including the David Taylor Model Basin and the Maneuvering and Seakeeping Basin.

In the afternoon, students reconvened in the Melville-Taylor Auditorium, where Carderock Chief Technology Officer Jack Templeton congratulated the students for their hard work and recognized all of Carderock's volunteers who dedicated their time to helping the students complete their robots. Engineers Jonathan Hopkins and Michael Britt-Crane acknowledged each team in attendance for their strengths in the final evaluations.

Wood Middle Team No. 3 came in first place, followed by Wood Middle Team No. 4 and Burning Tree Elementary Team No. 1 rounding out the top three. For their accomplishments, each team that placed received a 3-D printed trophy made in Carderock's Manufacturing, Knowledge and Education (MAKE) Lab.

Tracy Carole, Grant Honecker (and Nathan Hagan organized the competition and helped mentor students through weekly afterschool sessions along with Arthur Elefante, Van Lien, Li Jiang, Hua Shan and Woody Pfitsch.

Naval Surface Warfare Center, Carderock Division's Technical Director Dr. Tim Arcano shows students participating in the command's fourth annual LEGO Robotics Competition a SeaGlide glider as an example of other science, technology, engineering and math (STEM) activities the command hosts. The students are gathered in Carderock's Melville-Auditorium in West Bethesda, Maryland, for the LEGO Robotics Competition opening ceremony, April 21, 2017. (U.S. Navy photo by Jake Cirksena/Released)

Carderock partners with academic communities to cultivate future workforce

By Daniel Daglis, Carderock Division Public Affairs

Eric Silberg, activity facilitator and aerospace engineer in Naval Surface Warfare Center, Carderock Division's Sea-Based Aviation and Aeromechanics branch, looks on as sixth-graders from the Mount Washington School, launches his team's seaplane during the Seaplane Challenge STEM activity Nov. 28, 2016, in West Bethesda, Md. (U.S. Navy photo by Daniel Daglis/Released)

Naval Surface Warfare Center, Carderock Division depends on a talented workforce to come up with new and exciting innovations both for internal command processes and products, as well as for America's warfighters and the fleet. Having served the U.S. Navy and the national maritime community for nearly 80 years, Carderock emphasizes the importance of having new generations of skilled workforce recruitment pools by offering a variety of programs and activities dealing with career development in technical, operational and financial fields while supporting national interests in science, technology, engineering and math (STEM) focused initiatives.

In addition to intern programs such as the Science and Engineering Apprenticeship Program (SEAP) and the Naval Research Enterprise Intern Program (NREIP) which engage high-school and college students in summer work opportunities, many of Carderock's career-focused programs aim to reach students as early as elementary school and as late as post-graduate university level. To ensure that students and the schools they attend receive the visibility and resources they need, Carderock enters into Educational Partnership Agreements (EPA) with the university, public school or public school jurisdiction.

Currently, Carderock has 11 active EPAs with schools, ranging from K-12 public school systems including Frederick and Howard counties in Maryland, through significant college-level institutions such as the University of Nevada, Las Vegas. The term of an EPA currently spans five years.

Carderock's Chief Technology Officer Jack Templeton said that these EPAs are imperative to make sure that the universities, public schools and their students receive the opportunity for and resources required to cultivate student interest in what Carderock does, to interest them in prospective future careers working at Carderock and to learn how financial, operational, engineering and science skills impact many aspects of Carderock's business world.

"Having these formalized relationships affords Carderock the recognition among students and academics, and further promotes STEM and other prospective federal career paths. It also allows us to track our outreach," Templeton said. "We are working with academics and institutes of higher learning to ensure latest technology sharing, which postures Carderock for future healthy recruiting pools to hire from."

As stated in any official EPA that Carderock enters into, the purpose of these agreements is to aid in the educational

experience of the institution's students by providing a mechanism by which those students can benefit from both Carderock's staff expertise and unique facilities and equipment related to its science and technology ventures. Carderock's contributions to these partnerships help to encourage student interest in STEM and business vocations, and may benefit Carderock laboratories in terms of advanced training of future employees. It also benefits the country by encouraging young people to be interested in the sciences and engineering.

An EPA can also allow Carderock to loan laboratory equipment to an institution for educational purposes, make laboratory personnel available to teach science courses or to assist in the development of such course and related educational material, as well as offer visits, tours and demonstrations at its facilities for faculty and students of the partnered institution. Additionally, Carderock designates a senior scientist or engineer to be responsible for structuring the partnership program and provide support to the educational institution. EPAs do not procure funds for programs, and participating parties are responsible for their own funding.

Carderock's Director of Technology Transfer Dr. Joseph Teter said that the EPA not only protects the student's interest, but also serves as a necessary safety measure when working with young people.

"Because we are sending our people out to the school districts and they will be in the classroom interacting with kids, the agreement specifies that the school system has the right to vet these people coming through the door," Teter said. "This is something Carderock happily obliges with. While Carderock personnel have been vetted by the government, it is important that schools know who is coming into their buildings to interact with the students at all times."

Odean Cameron, an administrative specialist and acting EPA coordinator at Carderock, works closely with many of the programs and serves as the liaison between the educational institution and the command.

"The relationship between Carderock and the academic institutions is mutually beneficial. Students are learning about new things and getting to interact with neat equipment and real professionals in STEM fields, and Carderock will hopefully get more scientists and engineers in the future," Cameron said.

"The goal of the whole STEM program is to inspire, engage and educate. Currently, the United States is lacking in scientists and engineers, and in order to get that number up, we are going out to the elementary schools, middle schools and high schools, teaching students about great potential careers. Elementary-school kids may not be thinking about their careers, but the middle-school and high-school students are starting to listen and they see the opportunities. Even if they don't come to Carderock, if we can inspire them and get them thinking outside the box to pursue a STEM career, then it was all worthwhile," Cameron said.

Other STEM programs and activities that Carderock offers – in addition to the Navy-wide SEAP and NREIP programs – include SeaGlide®, LEGO Robotics, SeaPerch, Calculator-Controlled Robots, the Seaplane Challenge and Bristlebots.

Michael Britt-Crane, a mechatronics engineer in the Hydrodynamics and Maneuvering Testing Branch, talks to 10th-graders from Wootton High School's Academy of Information Technology about programming calculator-controlled robots during a science, technology, engineering and math (STEM) event at Naval Surface Warfare Center, Carderock Division Nov. 2, 2016 in West Bethesda, Md.

Templeton said Carderock is always interested in prospective, formalized relationships with academic institutions and encourages any employee who would like to discuss a prospective relationship for EPA consideration to reach out to Teter or Cameron.

Representatives at Professional Societies Day tout membership benefits for Carderock employees

By Dustin Q. Diaz, Carderock Division Public Affairs

Representatives from the American Society of Naval Engineers (ASNE) meet with employees at Naval Surface Warfare Center, Carderock Division during the command's Professional Societies Day on May 3, 2017. Representatives from different professional societies visited the command to talk about the benefits of membership for Carderock employees. (U.S. Navy photo by Dustin Q. Diaz/Released)

Representatives from four professional societies came to Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland, for panel discussions and networking with their counterparts May 3.

Dr. Tim Arcano, Carderock's technical director, began Professional Societies Day at Carderock by welcoming these visiting engineers and scientists, comprising members of the American Society of Mechanical Engineers (ASME), the Society of Naval Architects and Marine Engineers (SNAME), the American Society of Naval Engineers (ASNE) and the Marine Technology Society (MTS).

"We're here today to give you some insight into what professional society membership can do for you," Arcano said. "I joined a society myself when I was at the Naval Academy and I have stayed involved with these groups because I really believe in them. This is an investment you can make to continue

to develop throughout your career."

Arcano talked about the different professional societies that cover the range of Carderock employees' professional endeavors and hosted panel discussions with members of these societies, asking each about their own career paths, what professional societies they belong to and how they've helped in their careers, from maintenance of technical knowledge to personal mentorship. During the first panel, Erik Seither, executive director for SNAME, said they are an excellent way to maintain personal connections and stay informed in the era of new media.

"We spend a lot more time in the office on the computer, and a lot more time away from it on our phones, but when you meet with members of your society in person, you're putting the phones away, you're talking about important things, and you're establishing that personal interplay and gaining more knowledge from each other," Seither said. "I encourage you to join a society and be active in it. And if you're not interested, maybe your children would be."

Calvin Foster is a member of ASNE and the director of a private company which provides services to the Department of Defense, including Naval Sea Systems Command and its Warfare Centers like Carderock. His own reasons for participating in these organizations include a sense of duty.

"The organizations that I'm a part of really contribute to that ship or that aircraft or that submarine that's going in harm's way, to ensuring the Sailors and officers know what the capabilities and limitations of their platform is and that they'll be able to navigate that operational environment and defend our country," said Foster, who is a captain in the U.S. Navy Reserve and has deployed overseas multiple times. "That's what gets me up every morning, and I know I work with a lot of folks who share that passion in these organizations."

The second panel was focused on young professionals and hosted by Jonathan Hopkins, a mechanical engineer with Carderock's Additive Manufacturing Project Office. During this panel, Nathan Hagan, a naval architect with the Criteria and Assessment Branch at Carderock, talked about the camaraderie he shares with current and past fellow members of these societies, like Arcano. He said he turned to these societies for help in becoming a naval architect in the first place and they continue to enrich his personal and professional life.

"I knew I wanted to be a naval architect early on growing up, but any adult I would tell this to would look at me like I was crazy, so I needed to find help elsewhere," Hagan said. "A critical role of a professional society is awareness of the profession. I joined SNAME in college, as well as MTS and ASME. There was and is a value in it. It really came down to technical content and relationships. Your mentors become like your peers and you form lasting relationships you can build on over a career."

After the panels, members of all four societies, as well as the Society for the Advancement of Materials and Process Engineers, were available for networking and information in the command's Maritime Technical Information Center.

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By Sung-Eun Kim, Hua Shan, Ronald Miller, Bong Rhee, Abel Vargas, Shawn Aram and Joseph Gorski
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