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Carderock's Ballast Water Research Laboratory opens

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Naval Surface Warfare Center, Carderock Division Technical Director Dr. Tim Arcano (left) and Commanding Officer Capt. Mark Vandroff officially open the Ballast Water Research Laboratory on Dec. 5, 2016, in West Bethesda, Md. This new facility provides the Navy with the capability to research, develop, test and evaluate solutions to eliminate or remove aquatic nuisance species from residual water and sedimentation that remain inside ships' ballast water-treatment components and sensors. (U.S. Navy photo by Monica McCoy/ Released)

In this issue

At Carderock Division, we place enormous importance on technical excellence. It is core to all of our technical work. When it comes to technical excellence, Carderock shines. But we must always be vigilant, which is why I am so very proud of the scientists, engineers and all our staff who not just maintain, but build upon the technical excellence that defines us. This issue of Waves highlights a few areas of technical excellence.

Our Disruptive Technology Lab (DTL) is a prime example. In the last edition of Waves, you read about the Big Area Additive Manufacturing's test article, the Optionally Manned Technology Demonstrator. The DTL's director, Garry Shields, has not missed an opportunity to showcase that test article and other products resulting from the DTL. He brought Microsoft on board to test their HoloLens (Page 22) and held a brown bag in December (Page 28).

In the literal sense of disruptive technology, our engineers in the Anechoic Flow Facility have added an active turbulence grid to disrupt airflow to measure unsteady lift due to large-scale turbulence (Page 6). And some of our environmentally conscious and forward-thinking, engineers and scientists have developed a Ballast Water Research Lab to find ways to eliminate the problem of transporting non-native species to other parts of the world through ballast water (Page 3).

Dr. Caroline Scheck partnered with other Warfare Centers for an article about additive manufacturing that originally appeared in the December 2016 issue of Defense AT&L magazine (reprinted in Waves, page 9). Speaking of partnering, read how Carderock made an appearance at this year's Super Bowl! Well… outside in the park (Page 14); helped the Coast Guard look for ways to stop hoax calls on the emergency channel (Page 16); and trademarked the name SeaGlide, which is a popular STEM education product developed by Carderock employees (Page 12).

Back to technical excellence, a sure-fire way to establish and maintain technical excellence is to patent our inventions. One of Carderock's esteemed patent attorneys, Howard Kaiser, wants our engineers and scientists to know the importance of patents and has drawn up 10 myths about patents (Page 18).

Carderock is on the cutting edge of new design methods, including using set-based design (Page 24), which is a perfect example of high-velocity learning, a priority of CNO John Richardson.

The way to maintaining our technical excellence lies with the people who work here, and I'm forever impressed with the quality I see from Carderock. I hope you enjoy this issue of Waves.

Dr. Tim Arcano
NSWCCD Technical Director

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Carderock answers the call to protect marine life with newly commissioned Ballast Water Research Laboratory

By Daniel Daglis, Carderock Division Public Affairs

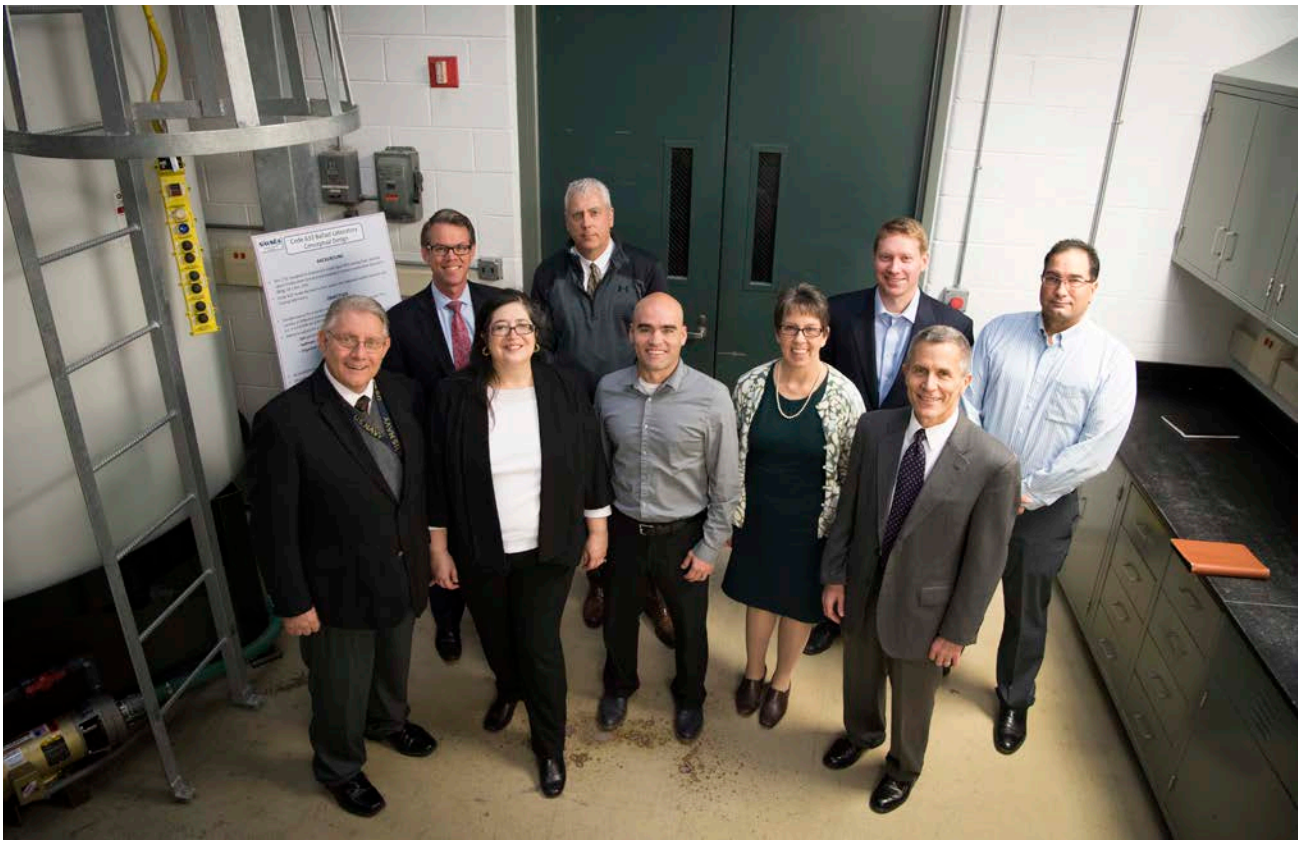
Naval Surface Warfare Center, Carderock Division Carderock Division Commanding Officer Capt. Mark Vandroff (right) speaks to employees as Carderock officially opens the Ballast Water Research Laboratory in West Bethesda, Md., Dec. 5, 2016.(U.S. Navy photo by Monica McCoy/Released)

Traveling across the globe from port to port, the U.S. Navy fleet transports Sailors and Marines, aircraft and supplies. Unfortunately, ships can also unintentionally transport stowaways, small organisms that live in ballast water. Most people would not look at small organisms like mitten crabs or zebra mussels and think they are a major threat to the environment – and in their natural habitats they pose no threat. But what happens when these organisms are introduced into a new ecosystem?

According to Rachel Jacobs, a chemical engineer in the Wastewater Management Branch at Naval Surface Warfare Center, Carderock Division, the results of introducing non-native species into a new environment can be disastrous for the ecosystem, for industry and for the marine life that already inhabit that environment. These small creatures, as well as many other organisms, can be transported through a vessel's intake and release of ballast water from one body of water to another.

Ballast water is taken in by a ship to maintain its position in the water using sea valves or pumps. The ship's stability depends on ballast water being taken in or discharged when cargo is loaded or unloaded, when the ship is traveling into different depths of water or to adjust trim or list for some other reason.

From an environmental standpoint, the problem with ballast water is that it is a means to transport aquatic nuisance species. To address and study this issue, Carderock commissioned a brand new



Team members from the Survivability, Structures, Materials and Environmental Department who helped bring the Ballast Water Research Laboratory to Naval Surface Warfare Center, Carderock Division are (from left): Dave Sudduth, director of science and technology; James Higgins, head for the Environmental and Energy Division; Rachel Jacobs, a chemical engineer in the Wastewater Management Branch; Mike Brown, department head; Toby Cole, deputy head for the Environmental and Energy Division; Rita Schuh, technical area leader for the Wastewater Management Branch; Ross Hempel, deputy department head; Dr. Tim Arcano, Carderock's technical director; and Steve Verosto, head of the Wastewater Management Branch. (U.S. Navy photo by Monica McCoy/Released)

Ballast Water Research Laboratory on Dec. 5 at the headquarters in West Bethesda, Maryland.

Through the use of the new lab, engineers and scientists at Carderock will be able to study ways to treat ballast water so that by the time ballast water is discharged at a ship's final destination, those organisms that lurk in the water will not be released to live and damage the ecosystem. The new lab gives researchers the capability to replicate the salinity and sediment profile of any body of water in the world. Jacobs is also looking forward to the addition of the nursery, which will give researchers the ability to grow and culture their own organisms.

"The issue of introducing non-indigenous species via ballast water has come more to the forefront internationally these days due to the incredible environmental and economic repercussions that have occurred," Jacobs said. "Ships can transport a lot of organisms in ballast water because what you're doing is bringing in thousands – sometimes millions – of gallons of ballast water onto a ship, and you're delivering them to a new locale when you go to your next port of call.

"It's the sort of situation where you had power plants being horrendously impacted by zebra mussels; you had total biological ecosystems being devastated in California with mitten crabs; and in the Chesapeake Bay we've had the rapa whelk attacking oysters, which are one of the big economic drivers for Maryland and the watermen."

Jacobs, a graduate of the University of Maryland with degrees in chemical engineering and marine biology and a master's degree in environmental engineering from Johns Hopkins University, is a member of the team that facilitated the designing of the Ballast Water Research Laboratory. She and Toby Cole, a chemical engineer who was a team member and is now the deputy division head of Carderock's Environment and Energy Division, were the principal investigators for the project lab.

"There's been an incredible global push for years to reduce the introductions of aquatic nuisance species that has been headed up by the International Maritime Organization; and that's how parameters were developed for ballast water treatment," Jacobs said.

The Ballast Water Research Laboratory's setup spans two levels. Water is pumped from the salt-control tank and the sediment-control tanks on the ground floor to the mix tank on the mezzanine level. Eventually, the nursery tanks will be housed on the mezzanine level where organisms can be added in the mix tank and then fed into systems under

evaluation. Engineers and scientists can then test the status of the organisms and other parameters in a sample tank on the ground floor.

"We are working with the (Carderock's) Naval Architecture and Engineering Department using virtual computational fluid dynamics to actually see how water flows within specific ballast tanks in specific ship classes. We will be able to take that and then turn that into physical scaled models and test those models in the lab," Jacobs said.

Carderock Director of Research Dr. Jack Price committed the funds for the laboratory – which was four years in the making – after a proposal modeled from a concept Jacobs and the wastewater management team were able to come up with in just over 24 hours. The need and enthusiasm for such a lab was evident, Price said.

"There was a lot of research that was involved in doing the computational fluid dynamics calculations by our hydrodynamics people," Price said. "There's also all the parts that the wastewater management folks were bringing to bear in the knowledge of the types of species you're going to want to deal with, what their densities are, sizes and weights, etc. So it's a complicated problem, and I think we built a unique lab to appropriately simulate that.

"With the fact the lab consists of lightweight nalgene, or plastic tanks, you can set the lab up in new configurations if you have to so you can simulate the different configurations you might encounter in different ship classes. That makes it an easy module-type approach so that we can do good, accurate testing."

Carderock Commanding Officer Capt. Mark Vandroff and Technical Director Dr. Tim Arcano commissioned the lab in a ribbon-cutting ceremony by pouring water from the Chesapeake Bay into one of the tanks.

"I am extremely proud to have a Ballast Water Research Lab here at Carderock because this is good for the environment," Vandroff said. "With our ships going all over the world, we have to be able to comply with such environmental demands or we're not going to have the access we need to fulfill our mission. The addition of this lab is really going to enhance our fleet."

Naval Surface Warfare Center, Carderock Division Carderock Division Commanding Officer Capt. Mark Vandroff speaks to employees about the importance of Carderock's new Ballast Water Research Lab at the ribbon-cutting ceremony in West Bethesda, Md., Dec. 5, 2016. This new facility provides the Navy with the capability to research, develop, test and evaluate solutions to eliminate or remove aquatic nuisance species from residual water and sedimentation that remain inside ships' ballast tanks. The lab can also be used to investigate various ballast water-treatment components and sensors to evaluate their suitability for Navy-specific integration. (U.S. Navy photo by Monica McCoy/Released)

Rita Schuh, the ballast water management technical area leader and environmental engineer in the Wastewater Management Branch, said the new Ballast Water Research Lab will provide tools necessary to continue to study and innovate ways of treating ballast water and meeting various regulations.

"Unlike major commercial transport ships that have dedicated transit lanes, the U.S. Navy goes all over the ocean," Schuh said. "Navy vessels are not always going to be in the same kind of water in the same part of the world and are not held to the same limitations. So we need to be able to ballast everywhere – in all conditions, all salinities and all temperatures. It is important to find a really robust treatment of ballast water that doesn't limit our operations."

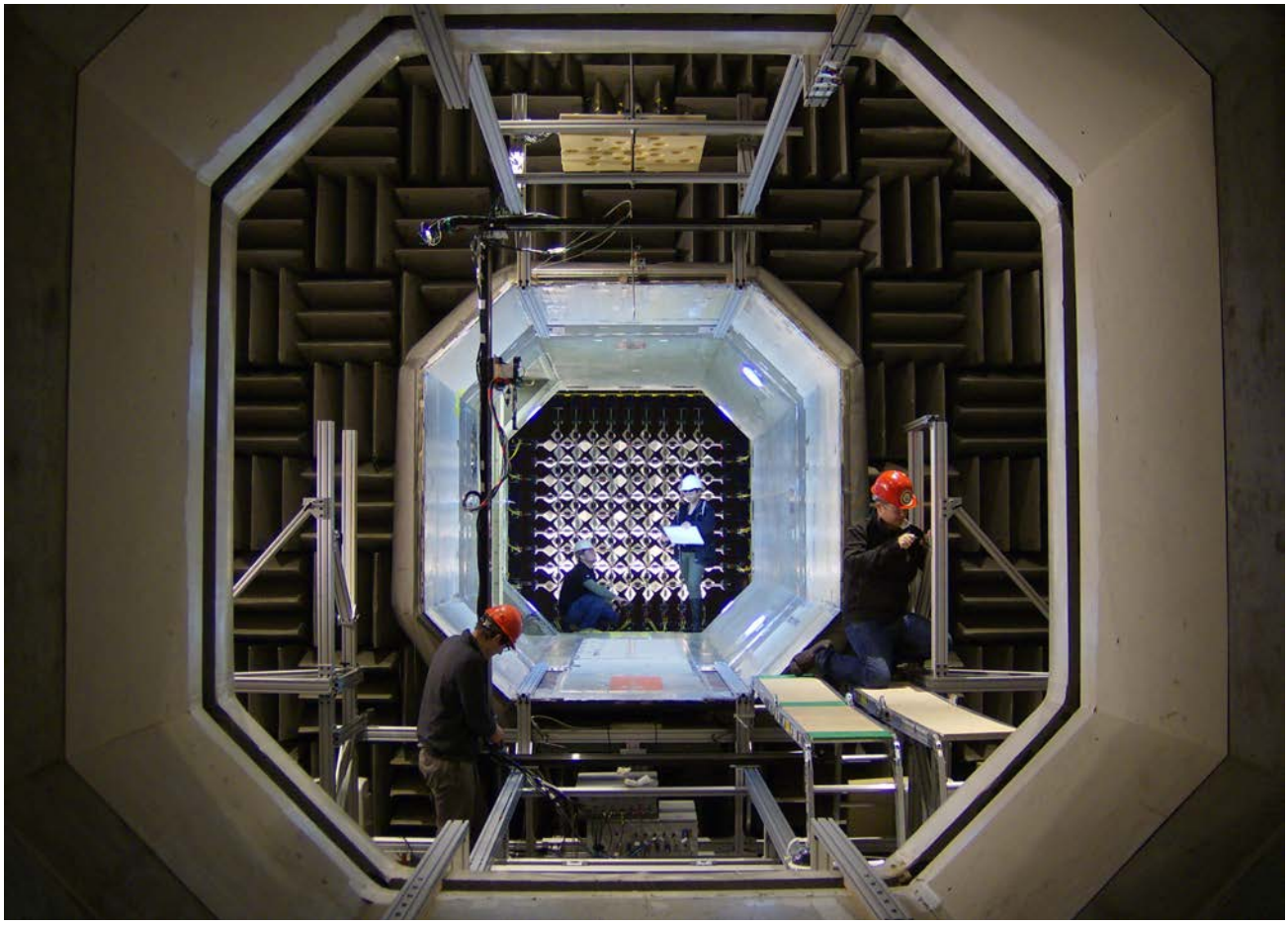
According to Jacobs and Schuh, different treatment options have been tested in the past, but the goal is to come up with a way to ensure that no live organisms are being dumped into bodies of water to interfere with the ecosystem of native species.

"Ultraviolet radiation (UV) is one set of treatment technology that has been tested, although there have been issues in terms of how effective it is at killing the organisms versus deactivating. The whole point of UV is to basically inactivate the DNA in the organism so it's unable to replicate. It's not an official kill as compared to an inactivation, but then we have to figure out how to test for that," Jacobs said. "There are other treatment technologies in terms of chlorine dioxide and deoxygenation and all sorts of different things that have the potentiality for use."

Schuh and Jacobs said they are glad to have a lab like the Ballast Water Research Lab that provides them the versatility to do proper testing of ballast water solutions, and they are enthusiastic about the opportunity to do their part to help protect the environment by solving the problems associated with the transport of ballast water.

Anechoic Flow Facility experiences unprecedented turbulence

By Dustin Q. Diaz, Carderock Division Public Affairs



From left: Jason Joiner, Kent Bartlett, Emilia Kawashima and Jonathan Forest prepare the Anechoic Flow Facility for a test Nov. 20, 2016, at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Steven Garafalo/Released)

Years of work by engineers at Naval Surface Warfare Center, Carderock Division's Anechoic Flow Facility (AFF) to revitalize the facility are paying off today with unprecedented research now underway thanks to new gear.

The AFF is a quiet, closed-loop, low-speed air-flow facility with low turbulence levels, built in the 1960s to conduct flow-generated noise studies. According to Jonathan Forest, a research engineer in Carderock's Hydroacoustics and Propulsor Development Branch, the facility's new Active Turbulence Grid (ATG), will now allow it to fulfill a different function, one completely new to the facility.

"When this tunnel was first designed, the intention was to measure things like mean flow and acoustic phenomena under very low turbulence intensities," Forest said. "This upgrade allows us to create a very different flow field with a lot of turbulence and be able to control that. There really aren't any studies out there that have done a comprehensive measurement of unsteady lift due to large-scale turbulence because there aren't a lot of places that can create turbulence this large."

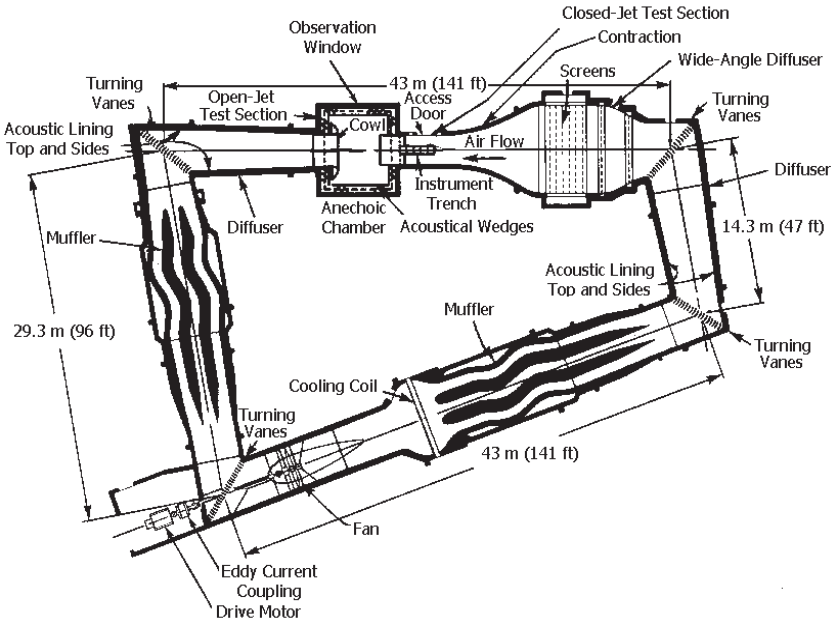
The ATG, or as the team calls it, the "meat grinder," is a mechanically agitated turbulence generator measuring four square meters and comprising nine intersecting horizontal and vertical bars, each individually controlled by a servo-

motor. Each shaft has 10 diamond-shaped spoilers designed to create large vortical structures when rotated in an oncoming flow, and it can randomize the behavior of those spoilers, according to Emilia Kawashima, another research engineer at Carderock.

"We can rotate them at different speeds at different times and create various turbulence flow fields for testing," Kawashima said. "The ATG was installed specifically so we can conduct testing to create a large data set for the acoustic community – not only government facilities, but also for academia and industry."

Kawashima said this testing paradigm, new to the AFF, came about because while the physics of basic foil turbulence are well-known within the community, data to validate prediction models for unsteady lift due to high Reynold's number turbulent flows are scarce. The Navy and Marine Corps commonly work with airfoils like propellers, wind turbines and aircraft engines, and unsteady loading on these foils operating in turbulent flow fields is known to lead to undesirable structural loading, vibration and sound. Carderock's engineers have traditionally used the AFF's closed-jet test section or the anechoic chamber to gather data by mounting and testing models that can be up to 20 feet in length. The AFF's 2,140-horsepower, 300 rpm fan feeds air through the system at a maximum of 118 knots for testing.

"We use the wind tunnel to introduce a flow over a structure and use microphones to listen to all the sources of noise radiating from that structure," said Kent Bartlett, AFF tunnel engineer. "We can sample the flow-generated noise coming off of a structure to isolate areas that need further design considerations. We've done tests for surface panels of submarines, landing gear associated with NASA aircrafts, and motorcycles to see where noise is generated. The testing we do could be done in a water tunnel, as well, but doing it in an air tunnel makes it much easier to manipulate and work on the model affording us the ability to try multiple configurations in quick succession. After testing, we can then scale the results to accurately predict how the structure would react in other fluids such as water."



Pictured above is an overhead schematic of the Anechoic Flow Facility at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (Courtesy illustration provided)

The AFF was built on a foundation of crushed gravel on top of solid bedrock to reduce background noise and isolate the chambers from structural vibrations. Other features built into the facility to that end include custom acoustic mufflers located upstream and downstream of the flow-generating fan, acoustic treating on prominent surfaces and isolation joints to separate sections of the wind tunnel, among others. Testing flow-generated noise on ships and submarines was done on full-scale ships or in wind or water tunnel test facilities before it was done at the AFF, but these all had drawbacks. Full-scale ship testing was too expensive and hurt operational readiness, while water tunnel testing was less flexible and more expensive than wind tunnels that produced too much noise to collect valuable data, according to Bartlett.

While the AFF's function until now was to test under low turbulence, Naval Sea Systems Command (NAVSEA) with the help of the Office of Naval Research (ONR) is now sponsoring a multi-year project to expand the acoustic community's database of comprehensive validation data for foil-turbulence unsteady force models that account for chordwise thickness and camber. The ATG was installed in August and Forest, Kawashima and their colleagues then got to work doing initial tests in the anechoic chamber to characterize the flow under these new conditions. Forest said the triple-component hotwire data they gathered was a vindication for the team after years of persistent work to reach that point.

"It's been almost three years since we put in our first purchase request for this project," Forest said. "Procurement took some time. Now that we have all the equipment and have started tests, we're really excited. We started taking data and the flow was very spatially uniform. We were able to achieve length scales and turbulence intensities above what we were hoping for. The data we've gotten thus far, while limited, has been fantastic."

Forest said the team is set to begin airfoil testing with the ATG under the NAVSEA and ONR project soon, with other testing under discussion. Dr. Jason Anderson, senior scientist and propulsor technical specialist; Devin Stewart, project manager; Zachary Kaler, Ryan Catlett, Jason Joiner and other members of Carderock's Hydroacoustics and Propulsor Development Branch have also contributed to the project.

Additive manufacturing: Ensuring a safe technological revolution

By William E. Frazier, Ph.D., Elizabeth L. McMichael, Jennifer Wolk, Ph.D., Caroline Scheck

In an era of increasing global hostilities, the Department of Defense (DOD) faces increasing fiscal constraints. Maritime security challenges continue while the defense industrial base shrinks, platforms and systems age and readiness declines. To help confront these challenges and meet the needs of defense missions, new enabling technologies must be identified and integrated into the DOD.

Additive manufacturing (AM), commonly referred to as 3-D printing, is an identified enabling technology with the potential to radically change how the DOD, the Department of the Navy, and their partners and allies develop, manufacture and support their platforms and systems. In the last decade, AM technology has moved beyond simple plastic prototypes to printing metal, integrated circuits, biomaterials and compound materials. Reports of AM's technology advancement can seem to approach the realm of science fiction, with demonstrations of 3-D printing of various body parts such as customized bone and joint implants.

The naval community has successfully used AM technology in its facilities since the early 1990s. Polymer AM systems have become commonplace in enabling unique production tooling, rapid prototyping, training aids and customized repair part development. The flexibility and digital aspects of AM, which enable parts to rapidly move through design iterations, have opened additional options in production tooling that would be costly and time-consuming to set up through traditional manufacturing. The types of parts producible by AM increase every day. AM systems that "print" metals are maturing to the point where direct manufacture of certain safety-critical parts is on the horizon.

AM creates opportunities that range from designing parts for increased capabilities and reliability to re-imagining naval logistics and supply chains. A digital supply chain can enable "stock[ing] the data, not the part" and fabricating parts when and where they are needed. This supply chain resiliency, coupled with manufacturing agility for increased innovation and performance capabilities, is the cusp of the AM technology revolution.

AM provides the opportunity to truly reduce costs, minimize obsolescence issues and improve both capability and readiness across the entire lifespan of naval systems—including both the new developments and systems of today. But it will require a common vision across the DOD and industry to address not only AM's technical challenges, but also include the policy, business and acquisition changes necessary to realize its potential.

Barriers to AM implementation

Qualification and certification: The ability to qualify and certify AM parts, including safety-critical metallic parts is a fundamental barrier to its more extensive use in Navy platforms. Safety-critical parts are "head hurters"—difficult to produce, made only of well understood and characterized materials, with very specific manufacturing processes and rigorous testing requirements. A "qualified" process is capable of consistently turning out a product that has acceptable proper¬ties. A "certified" part can perform properly in its operating environment. The conventional qualification and certification building-block approach used today requires that a single pro¬cess be standardized and characterized and that statistically substantiated data be generated. Significant cost and time are associated with this conventional process. Given the large number of AM processes, vendors, equipment models and potential material options, the Navy is examining methods to enable rapid qualification over the long term as the traditional qualification and certification processes will make it impossible to achieve the flexibility that AM offers. To enable the innovative designs, customization and improved performance promised by AM, qualification and certification processes must be accelerated by an order of magnitude.

The naval community has adopted a three-pronged approach to overcoming the barriers to qualification and certification. Because of the complexity of the AM processes, the long-term strategic approach is to use Integrated Computational Material Engineering (ICME) to inform qualification and certification. ICME links the AM process, part geometry, material microstructure and properties together to understand these relationships for end use. In the near term, the traditional approach to qualification and certification is being utilized on a case-by-case basis. These point solutions are parts demonstrations that help accelerate AM qualification by generating sufficient engineering confidence to field critical demonstration parts. The understanding and knowledge gained through multiple demonstrations and case-by-case certifications allow engineers to design parts that are optimized for AM production and begin to define the necessary naval requirements for AM specifications and standards.

The data gathered from demonstrations support the goal of an "ICME-informed" approach to qualification. When implemented, ICME-informed qualification will reduce the required testing and facilitate the building of parts using different AM processes, manufacturers and equipment. The naval plan's final step links the ICME

models that allow selection of the right AM process, materials and component design to a suite of sensors and controls for monitoring the AM manufacturing process. This provides real-time understanding of any manufacturing issues that will affect quality and inspection and that can significantly reduce testing requirements—depending on the part's criticality and operating environment.

Another critical aspect of qualification and certification is nondestructive inspection (NDI). Basic work is still needed on identifying anomalies in AM processes and materials, the relationship of these anomalies to processing parameters and their effects on part performance. The material variability that is observed and must be understood through modeling and simulation also poses challenges to NDI. Specific issues include variable microstructures, complex geometries and adaptation of new and existing inspection methods for AM.

Polymer and composite AM materials for use in naval applications also require qualification and certification. A current hurdle to usage of polymeric materials aboard ship is the inability of currently tested AM polymer materials to comply with standards regarding flammability, smoke or emissions and toxicity. Polymeric AM materials have been used in nonstructural aviation applications.

The vision of parts on demand, which are made available when and where they are needed, will be achieved by lowering the cost and enhancing the operational availability of naval weapon systems. The Navy is actively engaging its various communities to align needs and ensure that AM can be safely accelerated and used to meet critical needs.

The data problem: AM is a digital process, from design through printing. The digital process depends on a significant quantity of data. The amount, type and methodology for managing the data associated with an AM part are readily amenable to existing government methods for managing technical data. While the DOD as a whole is beginning to move toward digital 3-D data for new systems, addressing obsolescence and repair issues for legacy platforms and systems that use standard two-dimensional drawings requires significant analysis and reverse engineering to enable adaptation for AM. This data migration has occurred in defense prime contractors and major suppliers that have gone digital in their design and production infrastructures. These suppliers have migrated to a 3-D model-based environment that uses product life-cycle management software to ensure every element of a product is managed—from design work done in computer-aided design, to analysis, qualification and certification, computer-aided manufacturing, configuration management and supply. The infrastructure and tools needed to support the digital technical data required for AM are the standard in defense industry and commercial manufacturing companies. The Navy will need to implement the same infrastructure and standards to make AM achievable.

Business, acquisition and policy: It is difficult to develop an AM use cost model that captures the associated savings and cost avoidance. This is particularly true in defense, where most cost models are based on actual cost history for similar programs.

Because it is a technology in which shorter production runs for complex parts can actually prove more cost-effective than long production runs, AM presents a unique costing challenge. While material and design costs are higher for AM parts production, the specialized tooling costs and "touch labor" costs are much lower, and the performance gained can dramatically reduce life-cycle costs. Validated cost data are scarce; and accurate AM cost models need to be assigned a high priority.

Contracting with AM in mind (buying adequate data rights, enabling a wider supply base and moving toward shorter acquisition cycles) will require a different approach to acquisition planning. While only a limited number of suppliers can produce an airplane, the entrance cost to AM is significantly lower, and over the next decade there will be many suppliers that can make safety-critical parts. In that future, defense policy may be the biggest impediment to broad adoption of AM. Specialty metals restrictions for defense contracts may limit options in expanding our industrial base for complex parts, and impact the level of cost sharing we achieve with our NATO partners.

Accelerating AM for defense

How does the Navy leverage the huge AM investments by commercial industry, while ensuring that AM can safely be used for carrier aviation and on nuclear submarines? If AM is to mature for defense applications, and if it is ever going to be used in the future, the Navy needs to start now.

Every platform or system in the naval inventory includes parts that are hard to get. These parts are difficult to produce and are made with materials that require long lead times. They have limited supply bases and suboptimal designs; the DOD has hundreds of thousands of "problem children" parts. The ability to produce a subset of these parts through AM will dramatically increase readiness and reduce costs. If committed to making parts through AM, the Navy can mature the qualification and certification, data management and business processes for AM much more quickly.

There are other steps needed in order to accelerate AM use:

- Increase collaboration opportunities across the AM community.
- Develop an AM data architecture that will allow the DOD to tie all the AM data together across the defense enterprise.
- Work with suppliers, the Defense Logistics Agency and the Naval Supply Systems Command to source AM parts.
- Validate DOD cost models and manage the data rights for maximum reuse.

If the Navy wants to use AM, there's no time like the present.

This article is reprinted from the November-December 2016 issue of Defense AT&L magazine. *The authors can be contacted at william.frazier@navy.mil; elizabeth.mcmichael@navy.mil;jennifer.wolk@navy.mil and caroline.scheck@navy.mil.*

Capt. Vandroff represents Carderock at 29th SNA National Symposium

By Daniel Daglis, Carderock Division Public Affairs

Capt. Mark Vandroff, commanding officer, Naval Surface Warfare Center, Carderock Division speaks during the Surface Navy Association's 29th National Symposium in Arlington, Va., Jan. 10, 2017. (U.S. Navy Photo by Daniel Daglis/Released)

For the past 29 years, the Surface Navy Association (SNA) has hosted an annual national symposium that provides the opportunity for discussions on a broad range of professional and career issues for the U.S. Navy's surface community. During the 2017 symposium, held Jan. 10-12 at the Hyatt Regency hotel in Arlington, Virginia, Naval Surface Warfare Center, Carderock Division Commanding Officer Capt. Mark Vandroff gave an update on the work Carderock is doing.

SNA holds this three-day event to bring together leaders in Navy innovation and industry to showcase contributions to the advancement of America's fleet. Following a presentation from Capt. Jon Rucker, program manager for unmanned maritime systems in the Littoral Combat Ship (LCS) program executive office, Vandroff spoke to exhibit visitors from the Naval Sea Systems Command (NAVSEA) booth about the importance of current Carderock projects such as ballast water research, corrosion control and the facility's extensive modeling and testing capabilities.

"Carderock has three major technical departments: survivability, structures, materials and environmental; signatures, including work with acoustic radar; and naval architecture engineering," Vandroff said. "We support both the surface and submarine fleet.

"We run like a business, but we are part business, part government organization. There are NAVSEA program offices, different program offices outside NAVSEA and public parts of the Department of Defense or other parts of the federal government paying us to do engineering."

Keeping ships deployed and carrying out their mission was the message Vandroff presented as Carderock's No. 1 priority, highlighting its role within the Naval Research and Development Establishment (NR&DE).

Vandroff went on to tell a group of NAVSEA booth visitors some of the

From left: Naval Surface Warfare Center, Carderock Division's William Golumbfskie, materials science engineer in the Physical Metallurgy and Fire Branch of the Materials and Manufacturing Technology Division, Daniel Hart, aerospace engineer in Carderock's Survivability and Weapons Effects M&S Program Office, and Daniel Stiles, materials engineer, attend the Surface Navy Association's 29th National Symposium in Arlington, Va., Jan. 10, 2017. (U.S. Navy Photo by Daniel Daglis/Released)

things Carderock is doing today to support the surface fleet, starting with its study of ballast water. A brand new Ballast Water Research Laboratory was commissioned Dec. 5, 2016, at Carderock to research different treatments for ballast water. The new lab is addressing the environmental issue of transporting aquatic nuisance species in the ships intake and discharge of ballast water, introducing these species to new ecosystems as a vessel sails to various bodies of water.

"This isn't just a unique problem for the U.S. Navy, but the transfer of ballast water is becoming such a problem now it's getting more difficult to get access to certain environmentally sensitive ports around the world," Vandroff said. "So we talk about global access, and we talk about having the U.S. Navy being able to deploy worldwide and be able to deploy all the places we want to deploy; being able to treat and understand what you're putting out in your ballast water is a very big deal. That's one of the things this past year that Carderock has taken a leadership role on."

He also related some of the work Carderock is doing in regards to corrosion control. He discussed the role of corrosion control assistance teams which can now treat the flight decks of vessels with nonskid surfaces. According to Vandroff, in the past, flight decks would have to be completely resurfaced, which would cost a lot of money and keep the ship out of commission for a long period of time. Now, there are machines – which Vandroff compares to a Zamboni – that can roll over the flight deck to repair it while the ship is deployed without interrupting the mission.

Additionally, Carderock is testing 5000-series aluminum to use for ship repairs. Vandroff said it has many benefits, specifically its high-relative strength that allows it to be welded without compromising its strength.

Vandroff concluded his presentation by inviting spectators to Carderock's annual International Submarine Races June 26-30, 2017, sponsored by the Foundation for Underwater Research and Education. According to Vandroff, the event provides a platform for teams at all grade levels to develop a one- or two-person "wet" submarine. Crew members breathe using self-contained underwater breathing apparatus from the air supply carried aboard the submarine and propel the submarine over an underwater course which will be located in Carderock's David Taylor Model Basin. Each submarine is unique, designed from "scratch," and relies upon novel techniques for propulsion and guidance. This activity is in support of the Department of Defense science, technology, engineering and math (STEM) initiative.

According to the mission of SNA, the organization was incorporated in 1985 to promote greater coordination and communication among those in the military, business and academic communities who share a common interest in naval surface warfare and to support the activities of surface naval forces.

In addition to NAVSEA, there were dozens of naval organizations in attendance including the Missile Defense Agency, Military Sealift Command and the Naval History and Heritage Command, as well as leaders in industry ,including Lockheed Martin and Northrop Grumman.

U.S. Navy registers trademarks for Carderock's SeaGlide

By Daniel Daglis,
Carderock Division Public Affairs

A SeaGlide, or small-scale underwater glider, maneuvers in a tank at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. The SeaGlide is a non-tethered, autonomous robot that helps collect data through sensors. Carderock hosts SeaGlide workshops each year geared toward educators to teach skills they can take to the classroom, such as coding, building and basic electronics. (U.S. Navy photo by Daniel Daglis/Released)

As the world becomes more technologically advanced, so grows the need for experts to deal with its complexities. Today, there is a shortage of American students pursuing careers in science, technology, engineering and math (STEM). In response, the U.S. Department of Education began a STEM initiative to cultivate student interest in these fields by implementing STEM activities into school curriculums across the country.

Naval Surface Warfare Center, Carderock Division, in West Bethesda, Maryland, supports the STEM initiative through several STEM outreach programs. Carderock has had significant success with their latest and fast-growing SeaGlide activity.

With the popularity of SeaGlide and its quick expansion to schools throughout the Washington, D.C., area, and amid recent interest from school programs all over the country, and even internationally in places including Beijing, Carderock's Director of Technology Transfer Dr. Joseph Teter (Code 00T) said it was time to protect SeaGlide with a trademark to preserve the integrity of the program as a U.S. Navy brand.

"We had just started producing glider kits a few years ago for STEM classes. Michael Britt-Crane was the lead person at Carderock that developed the sea glider as a STEM teaching aid. We wanted to make them widely available because SeaGlide is garnering more and more interest from schools and organizations wanting to participate," Teter said.

"The trademarks – which to my knowledge are Carderock's first two ever – give us sort of quality control over future kits that are developed. In particular, and thinking forward for Carderock, if we go down the road of trademarking some of

our software products, this gives us the same protection whereas we can control the versions that come out and make sure that they're good and they satisfy and represent what we wanted to do with that software package. Trademarks prevent people from creating an inferior product and passing it off as belonging to Carderock and the Navy."

SeaGlide was started under a three-party Cooperative Research and Development Agreement between Carderock, the Naval Undersea Warfare Center and a foundation called the Association for Unmanned Vehicle Systems International (AUVSI). According to Teter, AUVSI is making the kits, essentially assembling all the parts to prevent schools from having to go out and source each part from several different locations. He said that being able to provide instructors and the student with everything they need to build their glider is part of the appeal.

The Department of the Navy now holds trademarks for the term "SEAGLIDE" without claim to any particular font style, size or color; and a branding logo which is a mark that consists of the term "cglide" with a line through the middle of the working "glide" above a swirl line that leads to a glider. The latter is the logo placed on the underwater glider kits that are assembled and distributed by AUVSI.

Dr. Teter worked closely with Michael Badagliacca, an intellectual patent attorney with the Office of Naval Research, to register the trademarks through the United States Patent and Trademark Office. A former engineer who made a career move to focus on the legal aspect of research and invention, Badagliacca is responsible for several of the Navy's trademarks including "Navy SEALs," the "America's Navy" slogan, unit and command insignias and aircraft names like the more recent EA-18G "Growler."

"A trademark is like a brand name. For this product we want the word to get out that there's a neat underwater glider and now people know to ask for SeaGlide," Badagliacca said. "When people request the Carderock underwater glider they know it's called SeaGlide, they know where to go, and they know exactly what product we're talking about instead of someone else's, which might not be as good as the one we have."

Britt-Crane, a mechatronics engineer with Carderock's Hydrodynamics and Maneuvering Simulation Branch, pioneered SeaGlide with a handful of his fellow engineers at Carderock who volunteer part-time to work with students and educate instructors on bringing SeaGlide to their schools.

Although building an underwater glider containing a circuit board for soldering and programming, buoyancy engines with syringes and moveable mass to manage buoyancy and pitch, and ballast gliders for proper underwater flight may seem too complex for learning basic electronics and physics, Britt-Crane said SeaGlide is the perfect STEM program.

"As an intro-level robotics activity where kids can get out of their books and get their hands dirty as kind of a starting point for building bigger and better robots in the future, it's a perfect entry point to get broad-based understanding of how these systems work at a fundamental level," Britt-Crane said.

Britt-Crane's parents were engineers, and he said that when he was in elementary school he would always say he wanted to be an inventor because he didn't know the term engineer.

"That's changed since then, but I think that's illustrative of the kind of disconnect between the public knowledge of science and engineering and those of us who are in the profession, and that's what we're really working to try to improve," Britt-Crane said.

While SeaGlide is designed for high-school students, Britt-Crane and his team have worked with instructors teaching students as young as sixth graders and even had higher-level education organizations like the Marine Robotics Team at the Massachusetts Institute of Technology build gliders.

Besides being an activity for students, Britt-Crane points out that there are many ways the SeaGlide gliders align with the Navy's interest when it comes to unmanned vehicles and unmanned vehicle systems. According to Britt-Crane, the completed gliders are fully functional as unmanned vehicles and have reached depths of 25 feet in Carderock's basin. He said he is confident that they could go deeper, having done some pressure testing with the structure in super deep depths, but they have not yet tested the motor at deep depths.

Britt-Crane said these small, cost-effective gliders, which consist of additive-manufactured parts, can serve as test modules for the larger, more expensive drones that cross entire ocean floors.

"I think SeaGlide would be an ideal platform to train operators of these drones. We can do the basic build in two days and we can do training for Navy personnel to really understand how these things work, and that's really important.

"Our primary mission in regards to SeaGlide is reaching as many schools and having plenty of exposure so that as many kids as possible are at least – even if they don't go into STEM fields – getting a better understanding of engineering. It's useful for us to have a well-educated public that understands science and engineering."

As SeaGlide continues to expand, Britt-Crane emphasizes that the program continues to look for new partners and work with as many Department of Defense labs as possible. He said the goal is to continue to reach as many kids as they can because STEM education in schools through programs like SeaGlide will help inspire future engineers to secure the future of innovation.

Piece of Carderock displayed in Houston week of Super Bowl

By Daniel Daglis, Carderock Division Public Affairs

As part of the official festivities leading up to the 2017 Super Bowl, patrons of the game had the chance to see a model of the Orion space capsule which was built and tested at Naval Surface Warfare Center, Carderock Division.

In Discovery Green, a park near NRG Stadium in downtown Houston, NASA's 18,000-pound model capsule was on display throughout the week leading up to the Big Game Feb. 5. The full-scale model, measuring 16.5 feet in diameter, was built collaboratively by Carderock's Surface Ship Hydromechanics and Marine and Aviation Divisions.

The stainless-steel model capsule was briefly on display outside of the National Air and Space Museum in Washington, D.C., and was on temporary display in Houston for football fans and space and engineering enthusiasts alike to view during Super Bowl LIVE, a week-long event featuring performances and interactive exhibits counting down to what became a historic – yet improbable – comeback when the New England Patriots rallied to beat the Atlanta Falcons in overtime.

The NASA team conducted initial post-landing Orion recovery test operations in the explosive pond at Carderock headquarters in West Bethesda, Maryland, in 2009. Carderock engineers and NASA personnel were able to test the environmental conditions astronauts and recovery crews would be dealing with upon an ocean landing. These tested ballast conditions reflected a range of splashdown scenarios, from potential aborted missions just after initial launch to full successful mission completion.

This capsule is the first of two that were designed and fabricated at Carderock under the supervision and direction of Richard Banko, an engineer in Carderock's Marine and Aviation Division.

"NASA came to us in March 2008, and they wanted to get some performance trials with their capsules in actual waves. They wanted to test the action of whether or not the astronauts were going to be able to survive the wave action until somebody could actually come and rescue them from the capsule after landing," Banko said.

NASA's Post-landing Orion Recovery Tests (PORT) capsule is seen on display at the Super Bowl LIVE festival in Houston. The full-scale model, weighing 18,000 pounds and measuring 16.5 feet in diameter, was built collaboratively by Naval Surface Warfare Center, Carderock Division's Surface Ship Hydromechanics and Marine and Aviation Divisions. The NASA team conducted initial post-landing Orion recovery test operations in the explosive pond at Carderock headquarters in West Bethesda, Md., in 2009. The stainless-steel capsule, which briefly had been on display outside of the National Air and Space Museum in Washington, D.C., was part of a NASA-themed pavilion featuring space artifacts and interactive displays in Discovery Green, a park near NRG Stadium, where Super Bowl LI was played Feb. 5, 2017. (Photo courtesy of collectSPACE.com/Robert Pearlman)

"This was a new vehicle based on the Apollo capsules, which they did a lot of sea testing with, and they wanted to see how this capsule interacted with the waves in various seas' states and try to get indices on the safety of the astronauts as the capsule bobbed on the ocean's surface."

Banko said that Carderock was an appealing option for NASA because not only does Carderock have the means to design and fabricate models, but they also have the facilities to test the models on site.

Before Orion, NASA's last ocean landing was in 1975 when Apollo splashed down in the Pacific. According to Banko, the renewed interest in ocean landings came after NASA initially looked at deploying bags for land-based landings, but it turned out that the equipment that was needed for such landings could be rather excessive.

"They wanted a very high-fidelity test, so we had to model not only the external structure, but also the internal structure to see how water moved around on the inside and any obstructions to the water flow inside the heat shield," Banko said.

Banko and his team were able to fabricate an exact replica of the actual Orion capsule that was being designed by Lockheed Martin Space Systems in Colorado at the time.

Banko said the testing on the capsule was very thorough. Air Force Para Jumpers were brought in to practice putting the collar on the capsule, synching it up and opening the capsule door at various ballast conditions to see exactly what needed to be done before the capsule was taken to Cape Canaveral, Florida, for ocean trials.

After the Orion model capsule completes its stint in Houston, Banko said his dream is that it will one day be on permanent display in the National Air and Space Museum for all to enjoy.

Demonstration of SOFC Hybrid Power System held at Carderock

By Daniel Daglis, Carderock Division Public Affairs

Lt. Col. William P. Dobbins, an engineer for U.S. Marine Corps Forces Command, watches a demonstration and test kickoff of the first logistics fuel (JP-8) compatible renewable-hybrid Solid Oxide Fuel Cell (SOFC) system Jan. 26, 2017, at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Jacob Cirksena/Released)

Naval Surface Warfare Center, Carderock Division is playing a significant role in the Office of Naval Research (ONR) Renewable Sustainable Expeditionary Power (RSEP) initiative.

Carderock's Advanced Power and Energy Branch hosted the demonstration and test kickoff of the first logistics fuel (JP-8) compatible renewable-hybrid Solid Oxide Fuel Cell (SOFC) system Jan. 26 in West Bethesda, Maryland. The SOFC was developed under an ONR Future Naval Capability (FNC).

Evan Rule, a mechanical engineer, served as the test lead on the project. Rule came to Carderock as the result of an internship he completed at the command while attending York College in Pennsylvania.

"At Carderock, we've been testing hybrid-power systems for the past four or five years for the Marine Corps," Rule said. "We were brought into the RSEP program as subject-matter experts on traditional hybrid technologies. These systems are typically powered by diesel generators and renewables such as photovoltaics which are hybridized with energy storage."

According to Rule, the SOFC technology developed under this FNC addresses the challenge of processing high-sulfur content logistics fuels such as JP-8 so that it can be safely reformed and consumed by the fuel cell. During the demonstration, the system was able to support three different simulated load profiles showing the system's ability to replace a traditional diesel generator while providing the added benefits of fuel savings, silent operation and reduced maintenance. Fuel cells have to heat up to function, and as the first hybrid fuel cell that uses military fuels; it can rely on solar power and Li-ion batteries while the heating takes place in the field.

"The goal of this particular effort was to make efficiency gains over traditional hybrid power systems by using a fuel cell – which has a higher efficiency throughout its operating range – but the technical challenge was that they needed to use a military logistics fuel, in this case it was F-24 or JP-8. Reforming F-24 and JP-8, because of its high sulfur content, is difficult, so there are a lot of complex processes going on within the system," Rule said.

Rule said currently the military just uses diesel generators which range in size from three kilowatts up to 100 kilowatts wherever they need power. Military personnel currently have to make frequent fuel convoy deliveries, which are not always safe and can put the warfighter at risk, added Rule.

"The idea is that we can reduce that logistics burden with hybrid power systems. The initial step was hybrid power systems with generators – which is currently in the acquisition process for the Marine Corps – and now ONR is looking at technologies of the future. The RSEP effort looked at many alternative power sources but due to the high level of power assurance required by the Marines, the RSEP program chose to hybridize a fuel cell with less reliable sources such as photovoltaics."

When it comes to Carderock's role as subject-matter experts with the hybrid power systems, Rule said they are also aiming to help the industry improve their knowledge base on what the military's needs are because sometimes it can be a challenge for industry to understand what the military actually needs and wants, and it is not always something that can be conveyed through performance specifications.

Further testing will be conducted at Carderock to verify the system's compliance with all Technology Transition Agreement requirements.

U.S. Coast Guard uses Stiletto to test direction finding systems and UAVs

By Kelley Stirling,
Carderock Division Public Affairs

Stiletto (pictured) is an experimental craft providing personnel, physical and program infrastructure to industry, government and academic system developers to evaluate their systems in the realistic military maritime environment. Naval Surface Warfare Center, Carderock Division's Combatant Craft Division at Joint Expeditionary Base Little Creek-Fort Story in Virginia Beach, Virginia, manages and executes the Stiletto Maritime Technology Program for the Department of Defense's Rapid Reaction Technology Office. (U.S. Navy photo/Released)

The U.S. Coast Guard Research and Development Center collaborated with the Stiletto Maritime Demonstration Program to find potential direction-finding and unmanned aerial vehicle (UAV) technologies to enhance search and rescue mission capabilities and reduce the amount of hoax rescue calls the Coast Guard receives on the marine radio VHF channel 16, the primary channel for distress calls.

The Coast Guard team and vendors spent Nov. 17 at Naval Surface Warfare Center, Carderock Division, in West Bethesda, Maryland, to discuss the results of a recent capabilities demonstration using Stiletto, an experimental Navy craft for demonstrating emerging capabilities and technologies developed by industry, academia and government.

"Stiletto works out great for us because they can very quickly put together this kind of capability demonstration," said Jay Spalding, a project manager for the Coast Guard's Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) Branch. Spalding initiated this demonstration event with the Navy using Stiletto.

Carderock's Combatant Craft Division at Joint Expeditionary Base Little Creek-Fort Story in Virginia Beach, Virginia, manages and executes the Stiletto Maritime Technology Program for the Department of Defense's Rapid Reaction Technology Office. Stiletto provides personnel, physical and program infrastructure to industry and government

Donald Decker (right), a program manager with the U.S. Coast Guard's Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) Branch, speaks with Mike Mackiewicz, director, Defense Technology Operations, Physical Sciences Inc., during a distinguished visitor day Nov. 17, 2016, at Naval Surface Warfare Center, Carderock Division, in West Bethesda, Md. Vendors displayed the direction-finding technologies and unmanned aerial vehicles they tested during the capabilities demonstration the Coast Guard and the Navy held in September using Stiletto, an experimental craft for demonstrating emerging capabilities and technologies developed by industry, academia and government. Carderock's Combatant Craft Division at Joint Expeditionary Base Little Creek-Fort Story in Virginia Beach, Virginia manages and executes the Stiletto Maritime Technology Program for the Department of Defense's Rapid Reaction Technology Office`. (U.S. Navy photo by Kelley Stirling/Released)

and academic system developers to evaluate their systems in the realistic military maritime environment.

"The purpose of any capabilities demonstration is to bring together the systems developers or the vendors and the end users, in this case the Coast Guard, to learn about what the operators or the end users need and at the same time, end users are learning what type of technologies are out there," said Dennis Danko, the Stiletto Maritime Technology Program manager in Carderock's Special Projects Branch (Code 833). "It's a continuous circle of learning and improving or refining the systems and the requirements."

This particular capabilities demonstration took place Sept. 26-Oct. 7 in a Navy-controlled area of the Potomac River off St. Inigoes, Maryland.

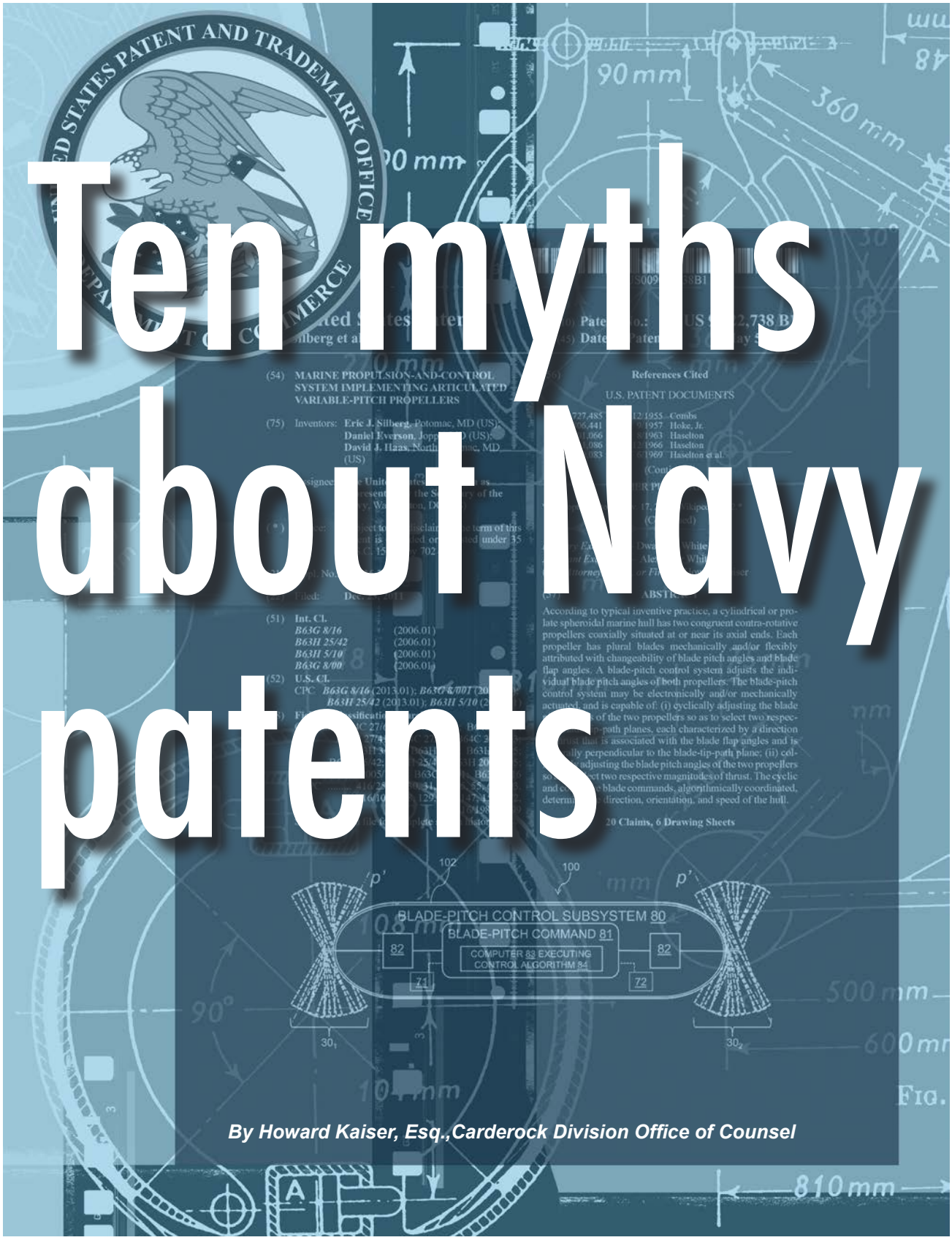
The demonstration paired the Coast Guard and Stiletto for the purpose of testing direction-finding technologies, unmanned aerial systems and intelligence, surveillance and reconnaissance systems.

"We are looking at people exploiting VHF marine band radio channel 16, specifically," said Ensign Gianfranco Palomba, a project manager for the Coast Guard's C4ISR. "Our hope is to keep advancing the DF capability through rescue 21." Rescue 21 is the Coast Guard's DF communications system to help locate distressed mariners.

Don Decker, a program manager in the Aviation Branch of C4ISR, said his role there is to see how to integrate aviation and surface systems.

"How do we put all this stuff together, as opposed to doing some stand-alone projects, and how do we transition the results to a Coast Guard tactical user onboard a cutter somewhere?" Decker asked, adding that his goal with Stiletto was to bring small UAVs and direction-finding payloads together to improve the Coast Guard's capability to pinpoint sources of the hoax calls.

During the demonstrations, vendors of both direction-finding systems and unmanned aerial systems came together to showcase the technologies they have to offer. Carderock's Stiletto team provided the Stiletto craft, as well as another small boat and land-based sources to work through possibilities. In addition to fitting Stiletto with direction-finding technologies, the Stiletto program operators assisted the unmanned aerial systems vendors in loading their UAVs with direction-finding systems and demonstrated those capabilities by launching the UAVs from Stiletto. The demonstration at Carderock compared each of the vendor demonstrations, and the Coast Guard will use the information gained from the capabilities demonstration to further their direction finding and UAV capabilities.



Ten myths about Navy patents

By Howard Kaiser, Esq., Carderock Division Office of Counsel

Patents are not important to the Navy

Among all government organizations, the Institute of Electrical and Electronics Engineers (IEEE) "Patent Power Scorecard" ranks the Navy first in the United States and fifth in the world in patents among all government organizations.

The patenting of Navy inventions greatly benefits the United States and the Navy in many ways. For instance, Navy patents promote the morale of Navy employees in terms of prestige, achievement and monetary gain. Navy patents enhance the technical image of the Navy. Navy patents preclude non-Navy persons from asserting their "inventorship" of devices, methods, products and compositions that were actually invented by Navy persons. In accordance with federal technology transfer law, many patented Navy inventions are subjects of licensing agreements or Cooperative Research and Development Agreements (CRADAs) with U.S. companies or universities.

A Navy patent affords no benefit to a Navy employee-inventor

A Navy employee might muse, "Sure, patents are extremely important to the Navy. But the Navy owns the patent, so what's in it for me?" Well, the answer is "Plenty!" When a Navy employee-inventor submits an invention disclosure, he or she can benefit in terms of money, prestige, accomplishment and career advancement.

Under federal law, a Navy employee-inventor receives a set sum of money, plus a percentage of the Navy's royalties from a Navy-owned invention that is licensed by the Navy. For instance, if the Navy licenses an invention to a company and receives royalties of $50,000, a sole inventor may receive $2,000 plus 20 percent of $48,000, for a total of $11,600. The maximum amount per year that an inventor may receive from Navy royalties on an invention is $150,000. In addition, monetary incentives may be awarded to Navy inventors at various stages of the patenting process.

The value of a patent to a Navy employee is not merely financial. Navy inventors are honored at awards ceremonies. Patents are impressive resume items, sure to garner the attention of high-ranking people in professional offices and organizations. A patent in and of itself represents an outstanding attainment by an inventor.

The Navy automatically owns any invention by a Navy employee

The Navy indeed owns a high percentage of inventions by Navy employees. However, there are situations in which ownership of a Navy invention is retained by a Navy employee-inventor.

Federal law establishes criteria for determining who has rights to a government invention. These criteria include: whether the invention was made by the government employee during working hours; whether the government contributed facilities, equipment, materials, funds, information or time or services of other government employees on official duty; whether the invention bears a direct relation to or is made in consequence of the official duties of the inventor. Federal statute also takes into consideration whether the inventor is employed by the government in connection with or in furtherance of research and development (R&D).

In most cases, the Navy's contribution to the making of an invention warrants assignment, by the employee-inventors, of invention title to the Navy. Occasionally, the just result is for invention title to be retained by the employee-inventors, because the Navy's contribution under the federal criteria is insufficient to justify assignment of title to the Navy. Sometimes the Navy merits invention title under the criteria, but the Navy is not interested in filing a patent application and chooses to leave invention title with the inventors. When employee-inventors retain invention title, the Navy typically obtains a nonexclusive, irrevocable, royalty-free license in the invention.

The Navy seeks patents only for inventions having licensing potential

Every Warfare Center has its own standards and procedures for assessing invention disclosures. At Naval Surface Warfare Center (NSWC), Carderock Division, the Invention Evaluation Board (IEB) evaluates inventions disclosed to the NSWC Carderock Division Office of Counsel and decides, as to each invention, whether the Navy patent attorneys should file a patent application. The IEB considers eight invention evaluation factors: (1) Navy needs/requirements; (2) technical image; (3) dual use; (4) technological advancement; (5) degree of development; (6) affordability impact; (7) investment potential; and (8) environmental impact.

The term "dual use" describes technology that can be used for both military and commercial purposes. Technology transfer from the government to the private sector remains an

imperative of federal legislation dating back to 1980, and the Navy is strongly motivated to bring Navy technology to the marketplace. The IEB is especially interested in obtaining Navy patents for inventions having real licensing potential to U.S. companies and businesses. Inventions that are expected to be owned, and hence licensable, by the Navy are more likely to gain IEB approval for pursuing patent protection.

Another significant evaluation factor is "Navy needs/ requirements." The Navy is continually seeking to improve Navy technologies in furtherance of Navy missions.

A Navy invention may be on the one hand impractical, but on the other hand brilliant. An impressed IEB may approve the invention simply because it represents "great science" or "great engineering." Regardless of its immediate usefulness, an invention may be "pioneering." The invention may be so new, structurally and/or functionally, that there is a dearth of pertinent prior art. The value of a pioneer invention may be uncertain, but its potential may be vast because nothing like it has ever been seen before.

A Navy employee's boss should be listed as co-inventor on an invention disclosure

An inventor of an invention is anyone who contributed in a significant way to the conception of the invention. A person is not an inventor by virtue of being a relative, a friend, a colleague or a supervisor. Nor is someone an inventor who merely exercises ordinary skill in the art in fabricating a prototype of an invention that has already been completely conceived. Nor is someone an inventor who merely suggests ornamental touches or other insignificant variations.

All inventors should be indicated when disclosing inventions, regardless of whether they are government, contractor or university employees. Inventorship can consist of a sole inventor, or two or more joint inventors. The question of inventorship may be unclear for a given invention. When in doubt as to whether a particular person qualifies as an inventor, list that person as an inventor in the invention disclosure and allow the Navy patent attorney to resolve all inventorship issues.

Every invention has a "Eureka!" moment

There is an amusing stereotype of a mad scientist feverishly manipulating electromechanical parts or chemical flasks or mathematical formulae, and suddenly exclaiming, "Eureka, I've got it!" Some inventions come to inventors as a "flash of genius." However, many inventions are progressive results of painstaking efforts over long periods of time.

The most celebrated inventor of all, Thomas A. Edison, epitomized the "hard worker" inventor. Inventiveness, Edison-style, is an outgrowth of nonstop labor and ardor. Famous quotations from Edison convey his assiduousness. Edison said: "Genius is 1 percent inspiration, 99 percent perspiration" and "I have not failed. I've just found 10,000 ways that won't work."

Most inventions build upon that which has been done before. Edison also said: "Through all the years of experimenting and research, I never once made a discovery. I start where the last man left off. All my work was deductive, and the results I achieved were those of invention pure and simple."

An invention must be tested or prototyped in order to obtain a patent

An invention need not be reduced to practice in order to obtain a United States patent. A patentable invention can be strictly conceptual. Many patents describe inventions in purely conceptual terms. A Navy employee should submit an invention disclosure regardless of whether the concepts of the invention have been tested or prototyped.

Many inventions are "works in progress" by the inventors, and more than one invention disclosure may be submitted along the way as significant improvements are conceived by the inventors. The inventor should consult a Navy patent attorney, who will advise the inventor to add the information to the original invention disclosure and/or submit an additional invention disclosure containing the information.

Once you publish a description of your invention, you cannot obtain a patent

U.S. patent law provides for a "one-year grace period" from initial public disclosure. If an invention is publicly disclosed anywhere in the world in any of various ways (e.g., printed publication, conference visual presentation, Internet, public use, public sale, public offer of sale), a patent application must be filed in the U.S. Patent and Trademark Office within one year from the date of the public disclosure; otherwise, the inventor(s) will be forever barred from obtaining a U.S. patent for the invention. This one-year statutory bar is absolute and is rigidly enforced.

This is not the case in most foreign countries, where public disclosure immediately acts to bar the obtaining of a patent.

Under U.S. patent law, a public disclosure by or attributable to a U.S. patent applicant may even benefit a U.S. patent applicant, so long as the patent application is filed within one year after the public disclosure. A publication date that precedes a U.S. patent application filing date by one year or less can constitute, in legal effect, an earlier U.S. patent application filing date. Nevertheless, an inventor should keep in mind that a public disclosure will have the immediate effect of precluding patent protection in most foreign jurisdictions.

Any technological innovation will be granted a patent

Some inventions are patentable, some are not. The U.S. patent system is not a "registration" system. A patent applicant does not receive a patent just for the asking. To be granted a U.S. patent, an invention must meet the following substantive criteria: An invention must be useful, new and non-obvious.

Generally speaking, the usefulness criterion for patentability is the easiest hurdle for a patent applicant to overcome. The U.S. Patent and Trademark Office is inclined to find usefulness or utility in an invention. To be deemed non-useful, an invention must be found to be totally devoid of a useful result.

Novelty (newness) and non-obviousness are the two legal standards that go to the very heart of patentability. Patent examiners conduct a thorough patent search for "prior art" that is pertinent to a patent applicant's "claimed" invention. In most patent examinations, the examiner will initially reject at least some of the applicant's "claims" on at least one of the two prior art bases. The first prior art basis for a rejection is that the claimed invention is not novel. The second prior art basis for a rejection is that the claimed invention, though novel, is obvious. An underlying principle for a prior art rejection is that an inventor does not deserve a patent for an invention if, prior to the effective filing date of the inventor's patent application, someone else (who neither directly nor indirectly obtained the subject matter of the invention from the applying inventor) publicly disclosed the invention, made the invention available to the public or described the invention in a patent application.

It takes forever to obtain a patent

An inventor who submits an invention disclosure should not expect instantaneous granting of a patent. A significant period of processing and legal effort ensues before a patent application is filed.

The duration of patent pendency in the U.S. Patent and Trademark Office can vary. There are two kinds of U.S. patent applications: provisional patent application and non-provisional patent application. A provisional patent application describes an invention and attains a filing date; it is particularly useful when a patent application must be filed by a certain date to avoid a statutory bar. A non-provisional patent application is a more refined document; it is the kind of patent application that is examined by a patent examiner and may lead to a patent. In order to obtain the benefit of the filing date of a provisional patent application, a non-provisional patent application must be filed within one year after the provisional patent application filing date. Generally, most non-provisional patent applications that issue as patents will do so within two to three years after the application filing date.

The "ping-pong game" of patent prosecution may involve a shorter or longer exchange of volleys. Sometimes a patent examiner will take some time to return the ball to the patent applicant's court. Sometimes the attorney and the examiner are at loggerheads, and the attorney therefore files an appeal, which can take a long time before a decision is rendered.

Most inventors who become patentees feel that the patent is worth the wait.

Carderock, Microsoft and Johns Hopkins representatives meet to discuss augmented reality opportunities

By Dustin Q. Diaz,
Carderock Division Public Affairs

Members of Naval Surface Warfare Center, Carderock Division's Disruptive Technology Laboratory (DTL) met with representatives from Microsoft and Johns Hopkins University to discuss collaboration on naval applications for augmented reality technology Jan. 13.

Garry Shields, DTL director, talked about how they can work together to bring new uses for Microsoft's HoloLens all-in-one augmented reality face-mounted computer to the Navy and Marine Corps.

"What we are trying to do is pull partners – the Warfare Centers, the Office of Naval Research, the Department of Energy, the Defense Advanced Research Projects Agency, the Advanced Research Projects Agency-Energy – into a common project to demonstrate multiple interfaces for platforms and simulations on a common system, potentially using the HoloLens," Shields said.

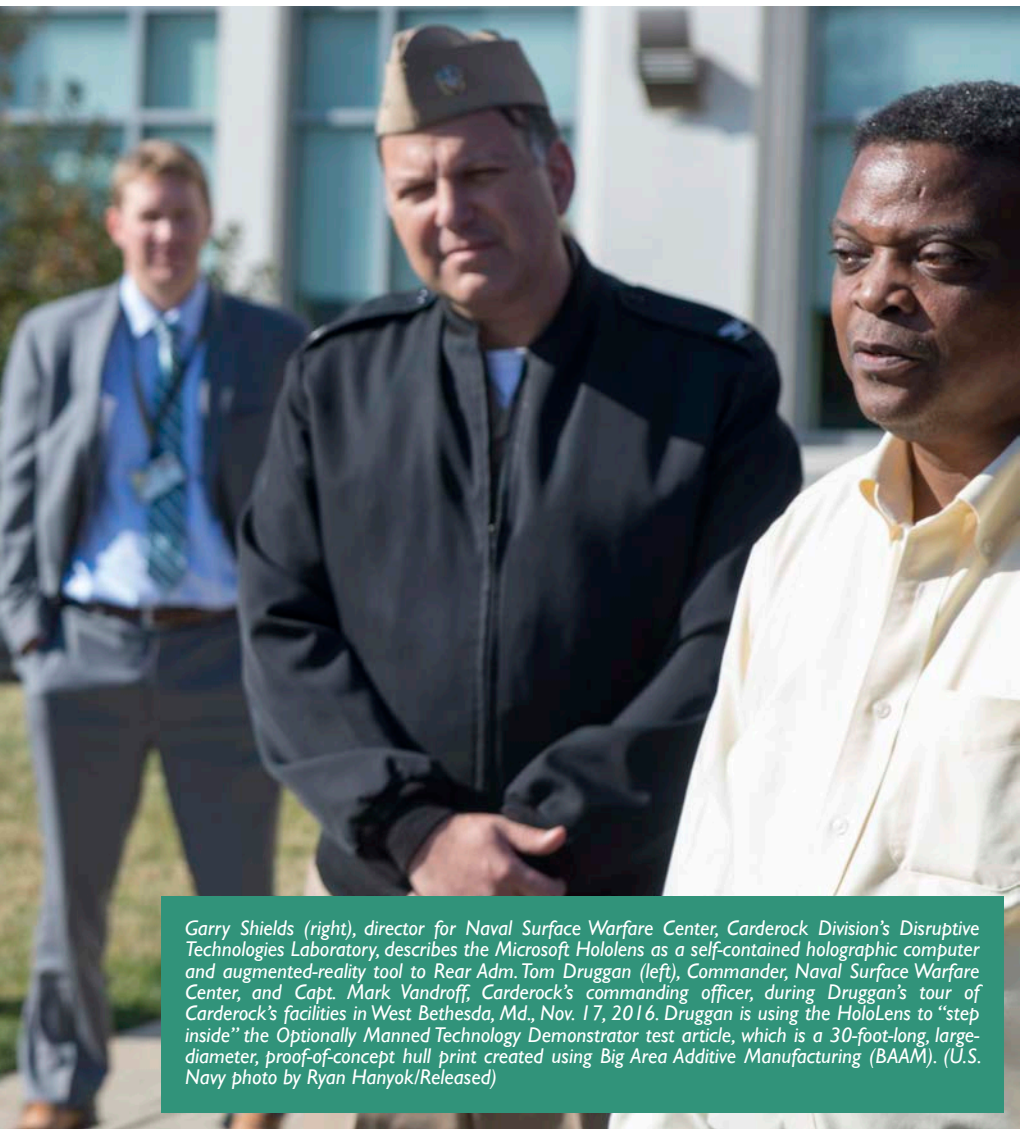
David Marra, a member of the Microsoft HoloLens group, told the DTL members about the development of HoloLens, and Microsoft's commitment to innovation through the "More Personal Computing" strategy. He explained the difference between virtual reality and mixed reality, referencing the HoloLens device's unique components, from sophisticated sensors that understand the user's environment to translucent displays.

"We're committed to this platform," Marra said. "With HoloLens and Windows Holographic, we are fundamentally evolving the personal computing paradigm."

Shields explained the DTL's role in fostering innovation for the Navy. As one of Carderock's "innovation engines," the members of the DTL work with members of other Warfare Centers, government agencies, private industry and academia to incubate new ideas, develop them and bring them as mature technologies to the fleet.

"We democratize innovation and make sure everyone has a voice and their ideas are treated the same," Shields said. "We build networks to bridge gaps between funding sources and organizations at the beginning. We find ideas, we find who finds value in the ideas, and they'll pick it up. When I deal with the private sector, it's a matter of showing them what the market is for their ideas. Through this vessel, they get a reach to all these other organizations. We do a lot of stuff out here very cheaply, very efficiently, to demonstrate capabilities. There's no overhead in this organization, but we've delivered roughly $120 million of direct funding for projects."

The DTL members and their partners in the Army, Navy, Marine Corps and the Department of Energy recently created the largest object ever additively manufactured by the Department of Defense. The Optionally Manned Technology Demonstrator (OMTD) Big Area Additive Manufacturing (BAAM)



Garry Shields (right), director for Naval Surface Warfare Center, Carderock Division's Disruptive Technologies Laboratory, describes the Microsoft Hololens as a self-contained holographic computer and augmented-reality tool to Rear Adm. Tom Druggan (left), Commander, Naval Surface Warfare Center, and Capt. Mark Vandroff, Carderock's commanding officer, during Druggan's tour of Carderock's facilities in West Bethesda, Md., Nov. 17, 2016. Druggan is using the HoloLens to "step inside" the Optionally Manned Technology Demonstrator test article, which is a 30-foot-long, large-diameter, proof-of-concept hull print created using Big Area Additive Manufacturing (BAAM). (U.S. Navy photo by Ryan Hanyok/Released)

Test Article is a 30-foot-long, proof-of-concept hull print modeled after the Mk. 8 Mod 1 SEAL Delivery Vehicle (SDV). It provided a platform for engineers at Johns Hopkins University's Applied Physics Laboratory (APL) to create a digital interface in HoloLens that can control or simulate control of the vehicle.

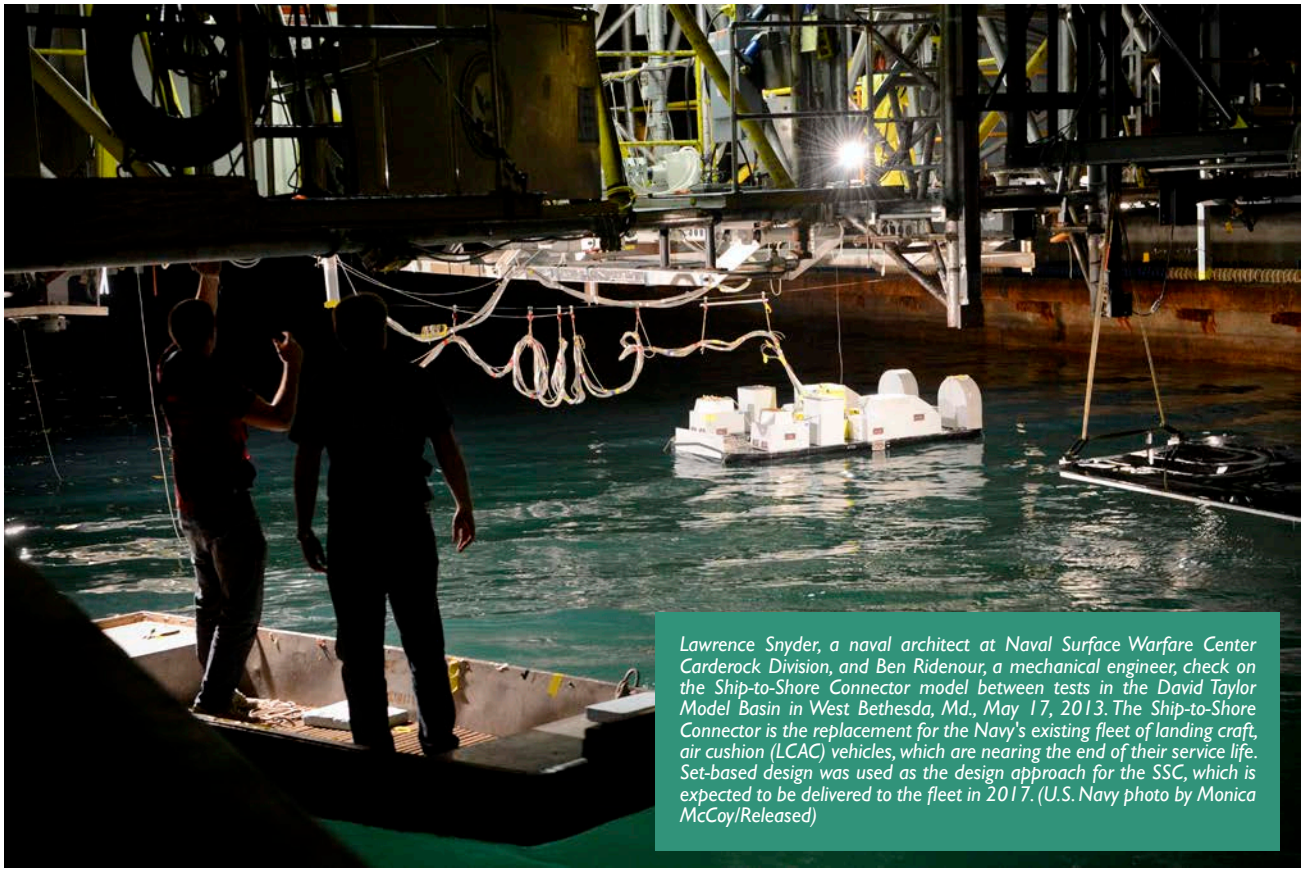
"When you touch a key on your cell phone, '3' for example, the phone goes in and manipulates the actual hardware function that is the number 3. Using the HoloLens headset with this simulator, we've created software that works in a similar way, allowing us to flip switches and move sliders on the heads-up display to impact the physical controls of the device," said Harry Whittaker, DTL member. "We partnered with APL, who saw the value in continuing this, and we have demonstrated it to other organizations who see the value in it. This not only works on the trainer, but we've also been able to use it for basic control functions on the actual mechanical systems (the previous OMTD device) NOMAD (Non-Penetrating Optionally Manned Demonstrator)."

Whittaker said they were able to demonstrate the simulation software on HoloLens for the Microsoft representatives and showed them the BAAM test article, on display at Carderock's headquarters in West Bethesda, Maryland.

Shields said this concept of using augmented reality on ships and in ships' systems for physical and cognitive augmentation is the natural result of work that started years ago in the DTL when they began working with exoskeletons. He envisions a new paradigm in ship design called the human-centric ship, where the primary role of humans aboard ship is decision making. Hardware controls like the HoloLens simulator, which could replace physical control stations on bridges of ships by making access to controls available throughout the ship via the device, comprise this physical augmentation, but Shields has ideas for cognitive augmentation, too. Both could be facilitated through the uniform with intelligent textile technology, which could be used to monitor biometrics in Sailors, and accessed with gear like HoloLens.

"We took the perspective that the uniform is the most important interface of the ship's system now that you can embed it with sensors, communication and power," Shields said. "Now that you have knowledge systems like augmented reality that can give you a heads-up display in the uniform, it creates the possibility of things like situational awareness of the location, health and performance status of all the humans on the ship, provided they are wearing that uniform. You could access a historical database of the training status of your Sailors, or access all their knowledge, or how to carry out certain tasks. A future Sailor might be able to train with augmented reality from the day they enter boot camp, and all they would have to do is register to the ship and log in to interface with all the ship's systems."

Whittaker said the DTL is currently working with Mike Alban, a naval architect with Carderock's Center for Innovation in Ship Design, to design the next version of the Optionally Manned Technology Demonstrator, which will include additional capabilities and systems that can be controlled via HoloLens in another interface developed by APL. They are collaborating on sharing gear and information with other members of the Navy Augmented Reality Consortium and also assisted with a Naval Innovative Science and Engineering/Section 219 proposal to explore augmented reality applications aboard naval platforms.



Lawrence Snyder, a naval architect at Naval Surface Warfare Center Carderock Division, and Ben Ridenour, a mechanical engineer, check on the Ship-to-Shore Connector model between tests in the David Taylor Model Basin in West Bethesda, Md., May 17, 2013. The Ship-to-Shore Connector is the replacement for the Navy's existing fleet of landing craft, air cushion (LCAC) vehicles, which are nearing the end of their service life. Set-based design was used as the design approach for the SSC, which is expected to be delivered to the fleet in 2017. (U.S. Navy photo by Monica McCoy/Released)

Set-based design ushers in 21st century approach to ship design

The Navy is working toward a common language for set-based design

By Kelley Stirling, Carderock Division Public Affairs

Set-based design has become the preferred approach for early-stage ship design at Naval Surface Warfare Center (NSWC), Carderock Division, according to engineers working on the Navy's future ships and submarines.

Dr. Jason Strickland and Jeff Hough invited engineers and academics to Carderock to learn more about set-based design and how Navy engineers and designers can work together using this approach during a summit at Carderock Division's headquarters in West Bethesda, Maryland, in August.

"We wanted to start to have a really honest conversation about what is set-based design, what's not set-based design, how it's different than what we've done and how we start to apply it with a common language," said Strickland, a senior naval architect from Carderock's Future Ship and Submarine Concepts Branch. The summit was, in part, sponsored by the Office of Naval Research (ONR), and included engineers and designers from all the different Navy Warfare Centers, Naval Sea Systems Command (NAVSEA), Naval Air Systems Command (NAVAIR), and Space and Warfare Systems Command (SPAWAR).

Two University of Michigan professors, Dr. Matthew Collette and Dr. David Singer, spoke to the group about the evolution of design and what set-based design is. Several Navy engineers presentated examples how set-based design has already been used for the Navy and how it could work for other naval design efforts.

Point-based design is the traditional approach to designing ships and other vehicles, meaning there are decisions being made at iterative points during the process. Singer said traditional design approaches may mean re-design for design failures or late changes in requirements.

"The core principle for set-based design

is delaying the design decisions until trade-offs are fully understood," Singer said. "In set-based design, we want to establish feasibility before commitment."

This process allows for a diversity of solutions, especially if requirements change at some point in the process. If the requirements change during the design process, the designers can easily evaluate the new requirements against the sets of designs and systems they have already established for feasibility. In general, Singer said that both design approaches are successful and that point-based design makes sense when the requirement is only a modification on an existing ship, vehicle or system. But for more complex designs, set-based design could make more sense. Point-based design also functions best with a highly experienced workforce that has developed the engineering intuitions needed to make critical design decisions early on.

"Traditional design is done in stages," said Collette, who spoke about the evolution of design. "Complexity is addressed by not dealing with all aspects of the design at each stage." He added that this is often called "over-the-wall" design, where each stage gets thrown over the wall to the next stage and the stages are not communicating throughout the process.

Collette explained that, in some ways, set-based design is similar to concurrent engineering, where there is communication back and forth throughout the process. Concurrent engineering occurs when different stages of the design process are being worked at the same time. Set-based design allows the customer the opportunity to be part of the decision process, as well.

"The reason we developed set-based ship design is to try to maximize your chance of success," Collette said. "It allows people to make more decisions later in the process."

Dr. John Burrow, keynote speaker at the summit and deputy assistant secretary of the Navy for research, development, test and evaluation, is very passionate about the benefits of set-based design.

"I lived it, I breathed it, I practiced it, I demonstrated it and I briefed it to the most senior people," Burrow said of his role in designing an amphibious combat vehicle (ACV) for the Marines. He added that set-based design allowed the designers and the customers and everyone in between to have healthy discussions about the requirements.

Dr. Matthew Collette, a professor from the University of Michigan, speaks to engineers and architects from across the Navy about the evolution of design at a seminar focusing on set-based design Aug. 23, 2016, at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Kelley Stirling/released)

There may be hundreds of thousands of possible sets of designs when initial requirements are put into a design tool to help process the information. As more design and analysis data is added to the design space, the sets can be reduced in size, and infeasible solutions removed. In the end, there still may be more than one design option, whereas in point-based design, the experienced engineers may already know at what point to start their design and will ultimately end up with one design to present to the customer early on in the process.

Tools

Set-based design has become a more viable option with the host of technology that is available or becoming available. Singer said in the 1950s when ships were being designed, there was a lack of information and so the design space only included a small number of possibilities. By the 1980s, the design space was on information overload. But the ability to process the information was limited.

The Department of Defense's High Performance Computing Modernization Program Office (HPCMO) sponsored and Carderock developed the Computational Research and Engineering Acquisition Tools and Environments (CREATE)-Ships tools to help process design options. Within CREATE-Ships, there are several design tools, such as Rapid Ship Design Environment (RSDE), Integrated Hydrodynamics Design Environment (IHDE) and Navy Enhanced Sierra Mechanics (NESM).

Dr. Alex Gray, a naval architect and set-based design expert with Carderock's Future Ship and Submarine Design Tools Branch, said as set-based design becomes more widely accepted, these tools are the key to making it a viable design methodology.

"When we have hundreds to thousands of points, how do you narrow that set?" Gray asked. "And how do you cross-analyze?"

The tools available allow Navy ship designers to add additional analysis beyond just the basic ship stability. Right now, the RSDE tool helps ship designers to generate concept points that are architecturally feasible for a naval vessel. Is the ship floating upright, is there enough displacement, is it structurally

sound? The information gained can then be inputted into other tools that aren't in the RSDE environment, such as the IHDE tool, which can then provide a resistance and seakeeping analysis. Carderock developed the Leading Edge Architecture for Prototyping Systems (LEAPS) data environment as the means to supply common engineering data between different engineering tools.

As the tools are being developed within the Navy, the idea is to integrate them all so that these computations on different levels become automatic, generating concepts within minutes.

Amy Markowich, a member of the Senior Executive Service, is the director of NAVAIR's Battlespace Simulation Department and is also the Department of the Navy's modeling and simulation executive. She wants to help the Navy's Warfare Centers develop and share the tools necessary to make set-based design usable across the Navy.

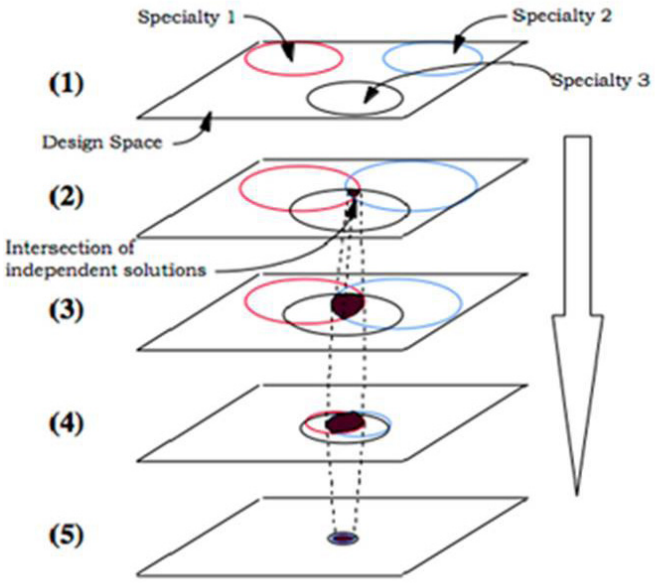
"We want a continuum, a computational prototyping environment or a common modeling environment, where we can assess designs early, make choices, start building the prototype, but then have all our capabilities tied together to be able to evaluate a prototype. That means tying our labs, our models and simulations together in a common environment," Markowich said during the Carderock summit. "How can we collectively take this to the next level?"

Education

In most cases of ship or submarine design, engineers and architects have used a point-based approach, because this is what they learned in school.

"We as engineers were not trained to do set-based design in school," said Jeff Hough, the Navy Warfare Center Distinguished Engineer for Ship and Platform Design and Integration. "Ultimately, if the Navy is using set-based design, we have to get the universities to start teaching set-based design as an approach."

Singer said students receive lectures on set-based design in graduate school, and it is mentioned in undergraduate classes, but the majority of design that is taught is point-based design. In some cases, doctoral students have focused their dissertations on set-based design. Strickland is one of four Ph.D.s in Carderock's Future Ship and Submarine Concepts Branch who studied set-based design under Singer at the University of Michigan.



Set-based design – The set-based design approach to designing ships allows for communication throughout the process and across multiple specialties repeatedly before deciding on a viable design or designs. (Courtesy illustration provided)

Strickland said Singer is recognized as the person who developed set-based design as it applies to ship design, noting that Toyota gets the credit for creating the design approach originally. Singer trained the Ship-to-Shore Connector (SSC) design team on set-based design and worked out the process for using set-based design on the amphibious landing craft. The SSC is being built as a replacement for the Navy's landing craft, air cushion class of vehicles.

Part of the problem is that the schools don't have the tools necessary to use set-based design, such as LEAPS, RSDE and IHDE.

"They don't have these tools at the universities right now," Gray said. "But I think it's possible, if they had a group of engineering students that were interested in doing a naval vessel, they could teach a set-based process for that."

From an "on-the-job-training" aspect, Hough said one of the benefits of set-based design that the Navy didn't really anticipate was that it provides a means to do design with inexperienced engineers and architects. In point-based design, there generally needs to be someone with experience in ship design to offer up the first design that fits the requirements. On the other hand, as inexperienced designers work in the set-based process, they are looking at a multitude of options within the design space which allows them to gain knowledge on something they had never done before.

"To be able to develop and train, in stride, inexperienced people so they can support design is a huge benefit," Hough said, adding that most engineers and architects will design one or two ships in their career, so everyone coming in to the ship-design workforce is inexperienced, including some that have been there for a decade.

For Burrow, set-based design is a must for the Navy. "It's not about the textbook. It's not about how they teach you to do it," he said. "It's about how you make sense of large, complex systems and make informed decisions and make them right. It's not about giving me a requirement

and swearing to it. It's about working with me to develop the requirement."

In practice

There have been several designs that have been developed within the Navy using set-based design, the SSC being one of the first where Singer provided the framework for the Navy to use set-based design for that vehicle, as well as future vehicles. The SSC is set to be delivered to the fleet in 2017.

To help foster the idea that set-based design is the best option, Carderock held a demonstration project on early ship design in 2012. Two design teams were established: one using set-based design and the other using point-based design. Both teams were given the same requirements, as well as the same design tools, with the exception of the set-based design team also having the RSDE design tool. On the set-based design team, the engineers were mostly inexperienced and the point-based design team had one team member who was experienced in ship design.

The point-based design team came to a solution quickly, whereas the set-based team needed a little more time to build the sets before coming to a set of options they could provide the customer.

Most engineers recognize that there are more costs up front using the set-based design approach, but that the costs balance out, and in some cases, will be less overall at the completion of a new ship being built. The costs usually come in the form of more engineers working on the project and taking more time to develop the sets of possibilities based on the requirements from the customer. But the savings come from less time being spent on finding the right design when a requirement changes; for example, the customer now wants the ship's minimum speed to be 30 knots instead of 28 knots, and on finding more affordable designs with lower risk. The set-based design team will be able to go to their set of designs and find that ship without having to redesign.

This is what happened in the design demonstration project. The teams were given a requirement change late in the design process.

"The point-based team had to pretty much start over. They had experience, there was a learning curve, so they were able to do it quicker the second time, but they came up with another point design," Hough said. "The set-based design team was able to plug it into the design space and come up with a design much quicker."

For the future

Gray said that the Navy is looking at using the set-based design process to look at technology insertion studies. As an example, if set-based design is being used to develop a combat system, the design space will include parameters such as area, volume, power and cooling requirements. When designing for a particular combat system, minimum and maximum ranges of the requirements are assigned.

"Taking the set-based approach, we are going to look at that minimum and maximum and everywhere in between," Gray said. This will generate sets that don't necessarily have real-life combat systems in them, but the design sets may still be useful in developing an understanding of how the ship behaves when toggling between different power and cooling requirements. "When someone comes to you from the outside, maybe someone from NSWC Dahlgren Division, and says 'We think this future weapon is going to have these properties,' we can just pull from the set we've already developed and say 'I have a ship design that more or less has those exact physical properties.'"

Technology insertion studies like this may also provide a resource for determining if it makes sense to invest money, research and development for a particular technology in the long run, Gray said.

A community of practice

"A community of practice for designers and practitioners is critical," Singer said of implementing set-based design across the Navy Warfare Centers. He added that academia doesn't have the benefit of communities of practice.

Strickland and Hough hope the August summit, which was directed to naval engineers and architects who may actually be responsible for executing set-based design in their engineering organizations, was the first stepping stone for creating a community of practice which will help to establish a common language on how to use set-based design.

"This is a self-organizing community of practice," Strickland said, speaking of the group attending the summit. "I would like to see it become more formal and a more regular thing, maybe a larger quarterly meeting or monthly for project-specific things. But I think it needs to grow in that fashion."

"We are trying to inform people so that when you hear the term set-based design, you actually know what it is and you can apply it when it's appropriate, and you can become champions of it as I have," Burrow said.

To further the community of practice, Hough and Strickland established a Navy set-based design community of practice page on the DoD milSuite site at https://www.milsuite.mil/book/groups/navy-set-based-design-community-of-practices/activity.

Disruptive technology leader discusses DTL's expansion, history of innovation

By Dustin Q. Diaz, Carderock Division Public Affairs

Joseph Curran (right), an ocean engineer with the Welding, Processing and NDE Branch at Naval Surface Warfare Center Carderock, Division, explains how to use the HoloLens to Henry Molintas, a mechanical engineer in Carderock's Propulsor Manufacturing Office, on Dec. 5, 2016, after a brown bag held by Garry Shields in West Bethesda, Md. The Microsoft HoloLens is an augmented reality device that allows the user to still see the real world with an overlay of something else, like a schematic. Shields brought this technology to Carderock through his Disruptive Technology Lab in order to find applied uses for the Navy. (U.S. Navy photo by Kelley Stirling/Released)

Naval Surface Warfare Center, Carderock Division's technical director hosted a brown bag Dec. 5 in West Bethesda, Maryland, for its employees to discuss disruptive technology and how the command transitions ideas to the marketplace.

Dr. Tim Arcano introduced "Disruptive Garry Shields," head of the Disruptive Technology Laboratory (DTL), calling him an out-of-the-box thinker and encouraging the assembly to take on his ideas.

"When I first met Garry, I thought, 'This all sounds like a bunch of talk,' but Garry delivers," Arcano said. "He's really made a difference in innovation."

Shields said the DTL began five years ago when he met in a basement office with eight employees from Carderock's different technical codes to examine the role of robots on ships.

"We got together and we exposed ourselves to new ideas about what robotics meant and how we would integrate them aboard ship, and the reality was that we found that integrating robots on existing ships today was hard," Shields said. "So then we talked

about integrating humans and robots and putting them on ships and we went through the process of investigating those technologies. We found out that's hard, too. But we stumbled on a place where robots and exoskeletons could be integrated into the naval enterprise. And that was shipyards."

By brainstorming, taking in new information and bringing the right people into the process, the DTL's opening effort led to the first exoskeleton commercially integrated into existing naval shipyards. Shields said the DTL has met 185 times since, leading to 65 new projects and about $120 million in direct funding. He said he brings his experience from previous jobs, especially community organizer and encyclopedia salesman, to this effort to assemble these communities. He also talked about his experience as a celebrity photographer when he struggled with self-belief. This self-belief was a key topic during his discussion, as he said good ideas won't go anywhere without it.

"A lot of times, what might happen is I'll write a patent or a quad chart and I'll submit it up the chain and expect the world to say 'This is a wonderful idea!' and that's not necessarily how it works," Shields said. "You have to talk to people about what you're doing. I'm doing this constantly. It's a 24/7 practice that I do. And when you talk to people about your ideas, those people are talking to other people asking what they think of it. This is how we vet and validate ideas."

This network covering the DTL was expanded over time to academia, all the Warfare Centers, multiple branches of the military and other government agencies like the Department of Energy and the Office of Naval Research.

Shields said there are often individuals and organizations involved in these processes that can be resistant to change. Persistence, he said, is necessary to break down cultural barriers and get ideas to the marketplace. He uses the five stages of grief (denial, anger, bargaining, depression, acceptance) to respectfully deal with people's grief over change.

"The process of convincing someone means you have to have the idea, you have to have self-belief in the idea, you have to be able to deal with and manage risk," Shields said. "And you have to understand you're going through this process with each and every individual. We take information that is out of your paradigm of understanding and put it before you so you can put it in your context of understanding your business space.

Garry Shields, director of Naval Surface Warfare Center, Carderock Division's Disruptive Technology Lab speaks to Carderock employees about the role of the DTL and importance of introducing out-of-the box ideas at a brown bag Dec. 5, 2016, in West Bethesda, Md. (U.S. Navy photo by Kelley Stirling/Released)

"It's not a mystery what's happening in the DTL. It's shoe leather. You have to take your ideas into the marketplace and have them socialized. Each person in this room represents an idea that's competing for attention. You have to go to these people to validate these ideas in their mind in order to make the transition happen. We have high flow rates of information going over many minds to percolate ideas. I call this the encyclopedia salesman approach to innovation."

Shields discussed the DTL's role in developing the idea for a SEAL Delivery Vehicle, which led them to create the most recent printed version of the Optionally Manned Technology Demonstrator using Big Area Additive Manufacturing (BAAM). Representatives from Carderock and their partners created a 30-foot proof-of-concept hull print that was on display at the West Bethesda site. Shields said this project incorporated many different areas of the DTL's work so far, including AM, human augmentation and exoskeleton technology, and serves as an example of the DTL's forward thinking.

"Because we've been exposed to all this technology, we have a different perspective of what a naval vessel can be," Shields said. "We think about things like disposability of ships as assets. We don't think ships should last 30 years; they should last just so long as they prosecute the problem they're trying to solve, then you grind them up and print another one that has different characteristics.

"A lot of the things we are talking about in the DTL aren't going to happen for 65 years. It takes a lot of energy and a lot of money to make these things happen. It's a process of getting others to think like you. One part was building BAAM. Another is to show HoloLens (augmented reality tool) to (Naval Surface Warfare Center Commander) Rear Adm. (Tom) Druggan. What the DTL is doing is showing our engineers what the process is. They're not taught this in school, but every idea man has ever had has gone through this process. We built an architecture of trust that says we won't criticize one another's ideas, even if we think they're stupid, we'll talk about them. And that gets you to the product that goes into the marketplace."

Shields also took questions from the audience about the DTL's current work and future plans. He encouraged attendees to come to the DTL's weekly Wednesday meeting at West Bethesda and help fuel the command's innovation engine as it charges on.

MAKE Lab hosts Marine Corps Innovation Challenge winners

By Daniel Daglis, Carderock Division Public Affairs

U.S. Marine Corps 2nd Lt. Ben Lacount works on an ammunition rounds counter in the Manufacturing, Knowledge and Education (MAKE) Lab at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. Carderock's Additive Manufacturing Project Office, along with the Corrosion and Coatings Engineering Branch, have partnered to provide support for the Marine Corps Innovation Challenge. (U.S. Navy photo by Daniel Daglis/released)

Sometimes the best ideas come from within. At least this is the concept behind the Marine Corps Innovation Challenge, which empowers Marines and Sailors to come up with fresh ideas to increase safety and efficiency for their unit or mission.

Three of the winners of this past year's challenge have been given the opportunity to visit Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland, to work alongside Carderock scientists and engineers in the Manufacturing, Knowledge and Education (MAKE) Lab. Using their time in the lab, Innovation Challenge winners are able to prototype their ideas using the MAKE Lab's 3-D printers and additional resources. Carderock's Additive Manufacturing Project Office, along with the Corrosion and Coatings Engineering Branch, have partnered to provide support for the competition.

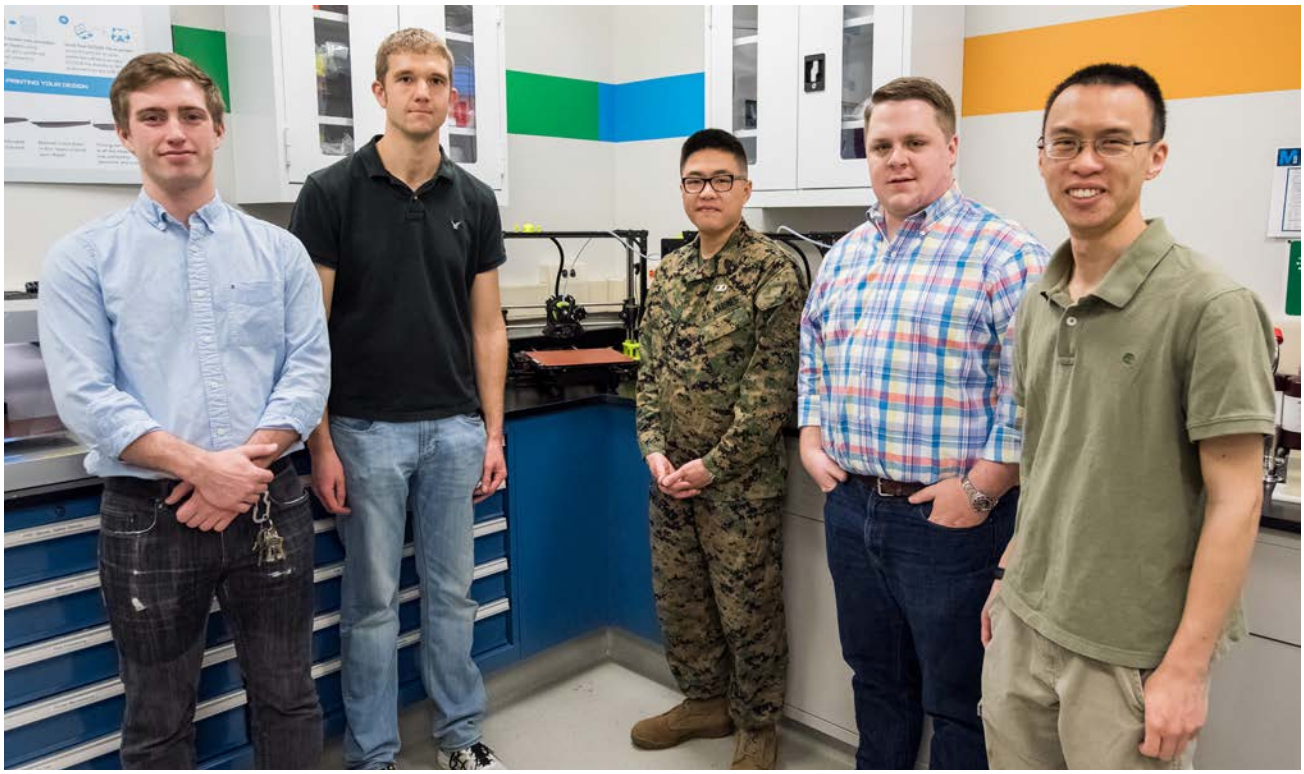
With this support, the winners will move forward with field testing back at their respective units and finally present their innovations to senior leaders with the goal of implementing their solutions across the Marine Corps.

Marine Corps 2nd Lt. Ben Lacount, currently stationed at the Marine Corps Air Ground Command Center in California, was the first winner to visit the MAKE Lab to prototype his idea for an expended rounds counter in December. The counter is a device that is designed to be attached to the Picatinny rail, specifically for the M16 rifle.

"You're supposed to keep track mentally of how many shots you have taken, but if you're in a firefight that might not be one of your priorities," Lacount said. "Having a counter there to instantly and accurately provide you a display with that number can be of great benefit for the operator."

Lacount worked with Carderock's Bryan Kessel, an engineer from the Additive Manufacturing Project Office, along with a team of fellow engineers to create the lever-action design.

"Bryan designed it for the left side, which is great because on the left side there's not really anything to worry about other than the firearm's fire rate selector. We



From left: Bryan Kessel, an engineer from Naval Surface Warfare Center (NSWC), Carderock Division's Welding, Processing and Nondestructive Evaluation Branch, Alex Punzi, a mechanical engineer from NSWC, Dahlgren Division; U.S. Marine Corps Staff Sgt. Daniel Diep, Sam Pratt, an engineer in Kessel's branch; and Kevin Lin, an electrical engineer with Carderock's Advanced Pwer and Energy Branch gather in Carderock's Manufacturing, Knowledge and Education (MAKE) Lab, Feb. 8, 2017, in West Bethesda, Md. Diep is one of three of last year's winners of the Marine Innovation Challenge visiting Carderock to prototype their innovation. (U.S. Navy Photo by Jake Cirksena/Released)

have it on a low profile so that it should be able to fit underneath the scope or anything on the top of the Picatinny rail. By using the Picatinny rail system, we can add a swivel and allow the counter to be adapted to either side of the weapon system. It is the same concept with scopes in that the placement of the counter can be adjusted based on user preference," Lacount said.

Lacount said the counter is designed to react to the recoil of the rifle upon being fired, giving the operator an accurate one-to-one ratio no matter what direction the weapon is fired.

Innovating firearms is not the only concept that benefits the warfighter. Staff Sgt. Daniel Diep visited Carderock's MAKE Lab Jan. 23-Feb. 10 to work on a prototype of a rather practical device: a cable cap.

"We have a piece of artillery known as the M777 howitzer, and it has a component on it called the Chief of Section Display (CSD) used for aiming navigation," Diep said. "There's a cable on there that runs from the M777 to the CSD, and this cable tends to get damaged a lot because the cap is not properly replaced. The way the cap is designed, it's a female head encased around a male head, so there's pins inside of this female head and when it gets dropped to the deck it will collect sand and debris. When you try to put the cap back on it'll get pancaked, the pins will get damaged or they'll take the cable itself and stick it in the CSD and it'll get damaged that way as well."

Diep, who is currently working on a master's degree in computer engineering from the University of Maryland, said that he has tried to repair the cables in the past, but it is a daunting task that requires a week of work per cable. According to Diep, the cables are usually thrown out because it is not cost effective to repair them. Diep estimates that it costs the Marine Corps $3,000 per cable. The newly designed cap to protect the cables would cost about $10, which would greatly remedy the financial burden.

"Ultimately we're trying to maximize the Marine Corps' dollars. The less money we have to use on parts for cables and things like that, we can use it on other things like gear and food and something that actually benefits the warfighter," Diep said.

The third winner of the challenge, Capt. Kyle McCarley, will be visiting Carderock in May to work on a prototype for a modification to field backpacks, enabling the warfighter to easily carry Bangalores, explosive charges used by combat engineers to clear obstacles in the field.

Seaplane Challenge teaches students STEM skills

By Daniel Daglis, Carderock Division Public Affairs

Eric Silberg (left), activity creator and aerospace engineer in Naval Surface Warfare Center, Carderock Division's Sea-Based Aviation and Aeromechanics Branch, looks on as Alex Cromwell, a sixth-grader from Baltimore's 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)

Seaplanes were flying high in West Bethesda, Maryland, in the auditorium of Naval Surface Warfare Center, Carderock Division while sixth-grade students from the Mount Washington School in Baltimore participated in the Seaplane Challenge on Nov. 28. The Challenge is one of the many activities Carderock hosts to promote science, technology, engineering and math (STEM).

Using paper, tape, drinking straws and some 3-D printed parts, students built their seaplanes modeled after Carderock's founding father Rear Adm. David Taylor's design for the U.S. Navy's NC (Navy Curtiss) flying boats, the first aircraft to cross the ocean.

Before the challenge began Eric Silberg, activity creator and aerospace engineer in Carderock's Sea-Based Aviation and Aeromechanics Branch, explained to the students, "That's why this particular design and model that you built for this project is so special for Carderock, because it comes from the guy who is responsible, whose name is on our great facilities here."

Students were divided into teams of two to build and fly their seaplanes. Planes were launched from the end of the stage of the 400-person auditorium to see how many rows of seats the seaplane could clear as a measure of distance. Each team was given five attempts to fly their planes, with one student throwing the plane while the other members of

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Eric Silberg gives a tour of Carderock's Maneuvering and Seakeeping (MASK) basin to students from Baltimore's Mount Washington School on Nov. 28, 2016, in West Bethesda, Md. (U.S. Navy photo by Ryan Hanyok/Released)

the team observed its flight pattern so adjustments could be made accordingly to improve on each attempt.

"Today on your tour you've learned about testing; your goal now is to take what you learned and apply it to your airplanes. Observe what your airplane does when you test it, and decide what to change in order to make it fly better," Silberg said to the participants. "You will be engineering and testing like we do at Carderock."

Team Bullet topped the leaderboard on their fifth and final throw of their seaplane by clearing seven and half rows in the auditorium, besting the Blaze Maker's longest attempt of seven rows.

The purpose of the exercise, while also promoting skills and interest in STEM, was to give the students hands-on experience doing what the men and women of Carderock come into work and do every day: solve problems and create a stronger, more efficient fleet for the Navy.

"Every little change, every improvement you make to your design can help it fly straighter and farther," Silberg reminded students during their flying attempts.

To emphasize the importance of innovation in design, Carderock Commanding Officer Capt. Mark Vandroff told the students a story of being on USS Arleigh Burke (DDG 51) in a storm in 1993. The violent storm produced 60-foot waves and the ship pulled through the storm undamaged and with no injured personnel.

"I'm alive today to tell you about it because as the ship was being designed by the men and women at Carderock using all the cool stuff you saw today, they made sure the ship would be able to withstand storms like that," Vandroff said.

In addition to building and testing their own model seaplanes, during their visit students were able to tour some of the testing facilities, including the David Taylor Model Basin and the Maneuvering and Seakeeping (MASK) Basin. Students were given the opportunity to see how Carderock works to improve U.S. Navy ships to make the fleet safer and stronger, allowing Sailors to complete their mission.

Carderock has an active STEM outreach program with approximately 65 tours each school year, with students coming from Maryland, Virginia and the District of Columbia, according to Melanie Zajic, Carderock's acting STEM coordinator.

"The overall goal of our STEM outreach is to build a future STEM workforce," Zajic said. "But our outreach has different specific goals at different age levels. The first step is to convince kids to give science a try, then encourage them to stick with science and become a scientist or engineer, then convince them to be a Navy scientist or engineer."

Bristlebots come to life on Halloween at Carderock

By Daniel Daglis,
Carderock Division Public Affairs

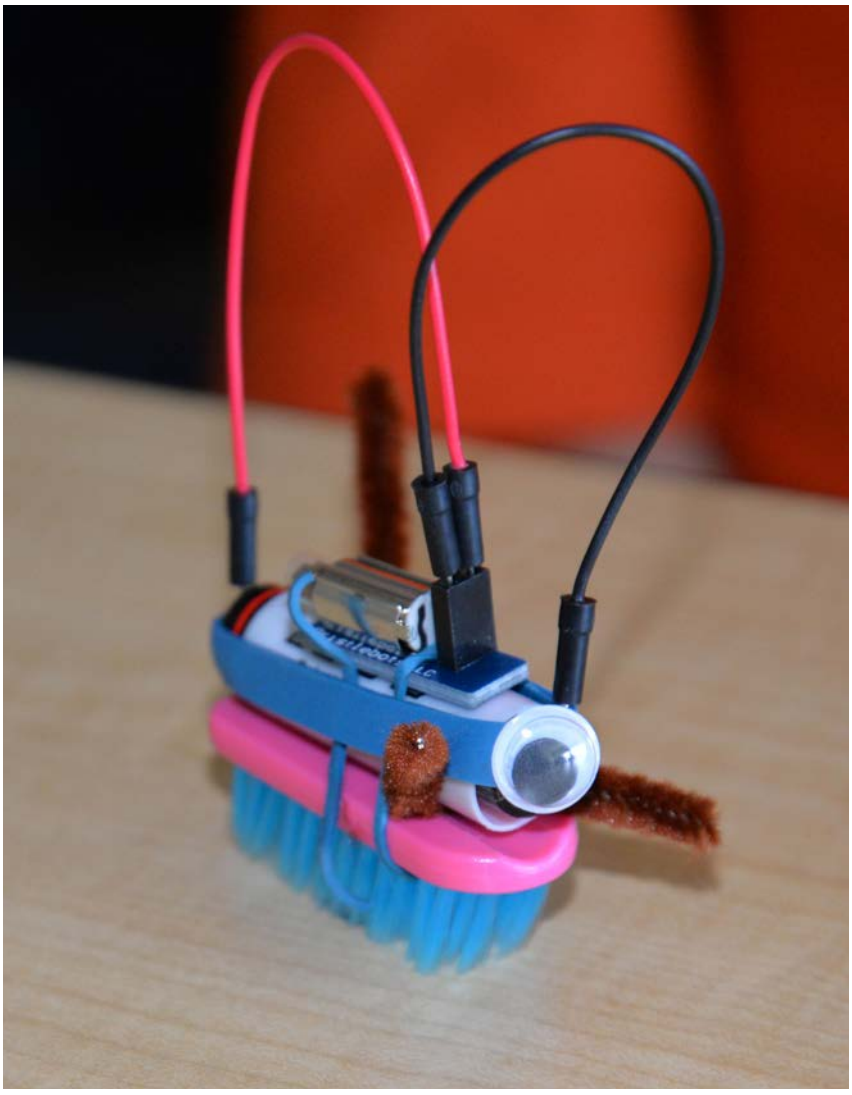
Visiting third-grade students from Lucy V. Barnsley Elementary School in Montgomery County, Maryland, were able to bring Bristlebots to life at Naval Service Warfare Center, Carderock Division on Oct. 31.

Bristlebots are simple-to-assemble robots which incorporate a small brush, a battery and a very small motor to create an electrical circuit allowing the Bristlebot to "walk" using vibrations. Students were able to customize their miniature robots with little plastic eyeballs and pieces of colored pipe cleaner to bring the Bristlebot to life.

Melanie Zajic, a chemical engineer specializing in environmental protection with Carderock's Solid Waste, Pollution Prevention (P2) and Hazardous Material Management Branch, greeted the students with a short introduction on circuits and walked the students through the different parts of the Bristlebot.

Students learned about electricity being a circuit and that not all circuits are necessarily electrical. But Zajic explained that an electrical circuit is what powers their Bristlebot. The circuit was completed when the students used the wires provided in their assembly kits to attach to the battery.

Some students put their Bristlebot to the test and challenged their classmates to a Bristlebot race on a small track put together in the back of their conference room at the Maritime Technology Information Center at Carderock's headquarters in West Bethesda, Maryland.



A completed Bristlebot assembled by a student at a science, technology, engineering and math (STEM) event on Oct. 31, 2016, at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. The students, from Lucy V. Barnsley Elementary School in Montgomery County, Md., learned to assemble the robots, which incorporate a small brush, a battery and a very small motor to create an electrical circuit allowing the Bristlebot to "walk" using vibrations. U.S. Navy photo by Daniel Daglis (Released)

In support of the Department of Defense initiative to promote science, technology, engineering and math (STEM), students were able to assemble their Bristlebot following simple directions and using problem-solving skills to make adjustments if their Bristlebot would not move or would fall over.

"Part of my job here at Carderock is to solve problems," Zajic told the students, encouraging them to brainstorm and think of ways they may be able to use a Bristlebot after building one.

The students were also shown how they can make adjustments to make their Bristlebot move in a certain direction.

Once students finished bringing their Bristlebots to life, groups were taken on a tour of some of the Carderock facilities including the David Taylor Model Basin, the Maneuvering and Seakeeping Basin and the Woodworking Shop.

Wootton High School students tour Carderock, race robots

By Kelley Stirling, Carderock Division Public Affairs

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.

Students from Wootton High School in Rockville, Maryland, visited Naval Surface Warfare Center, Carderock Division on Nov. 1-2 to experience a fun way to use a Texas Instrument (TI) calculator.

The 10th-graders were part of the high school's Academy of Information Technology (AOIT), class of 2019. The AOIT takes about 50 students each year who focus all four years of high school on technology. This is the third year the AIT class has visited Carderock headquarters in West Bethesda, Maryland, as part of a science, technology, engineering and math (STEM) outreach program, which sees about 65 of these tours each school year. The students toured the Carderock facilities and also had a lesson in programming a TI calculator to operate a robot.

"The calculator-controlled robots class was just a taste of a larger curriculum available to schools," said Tyson Tuchscherer, a contractor with Carderock's Submarine Maneuvering and Control Division. Tuchscherer originally created the class, and its complete technology-focused curriculum, when he was a middle-school math teacher. He said that TI supported the class with equipment and then eventually, the National Aeronautics and Space Administration (NASA) worked with Tuchscherer to roll the curriculum out to schools.

"These classes provide hands-on math activities, but the kids don't realize they are doing math," Tuchscherer said.

During the class, Michael Britt-Crane, a mechatronics engineer in Carderock's Hydrodynamics and Maneuvering Testing Branch, taught the students how to calibrate and program their calculator-controlled robot so that they go forward, backward, turn or spin and even how it stops. The students then held a relay race with their newly calibrated and programmed robots.

Britt-Crane said that these classes teach students how robotics are used in space vehicles, like the Mars Exploration Rover, as well as automobiles, which are becoming more and more autonomous, giving the students a real-word connection to what they are learning in school.

"The kids really enjoyed themselves," said Barbara Barry, a computer science teacher at Wootton High School, adding that the AOIT students are already technology savvy and exposing them to places like Carderock reinforces the possibility of a career in a technology field.

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