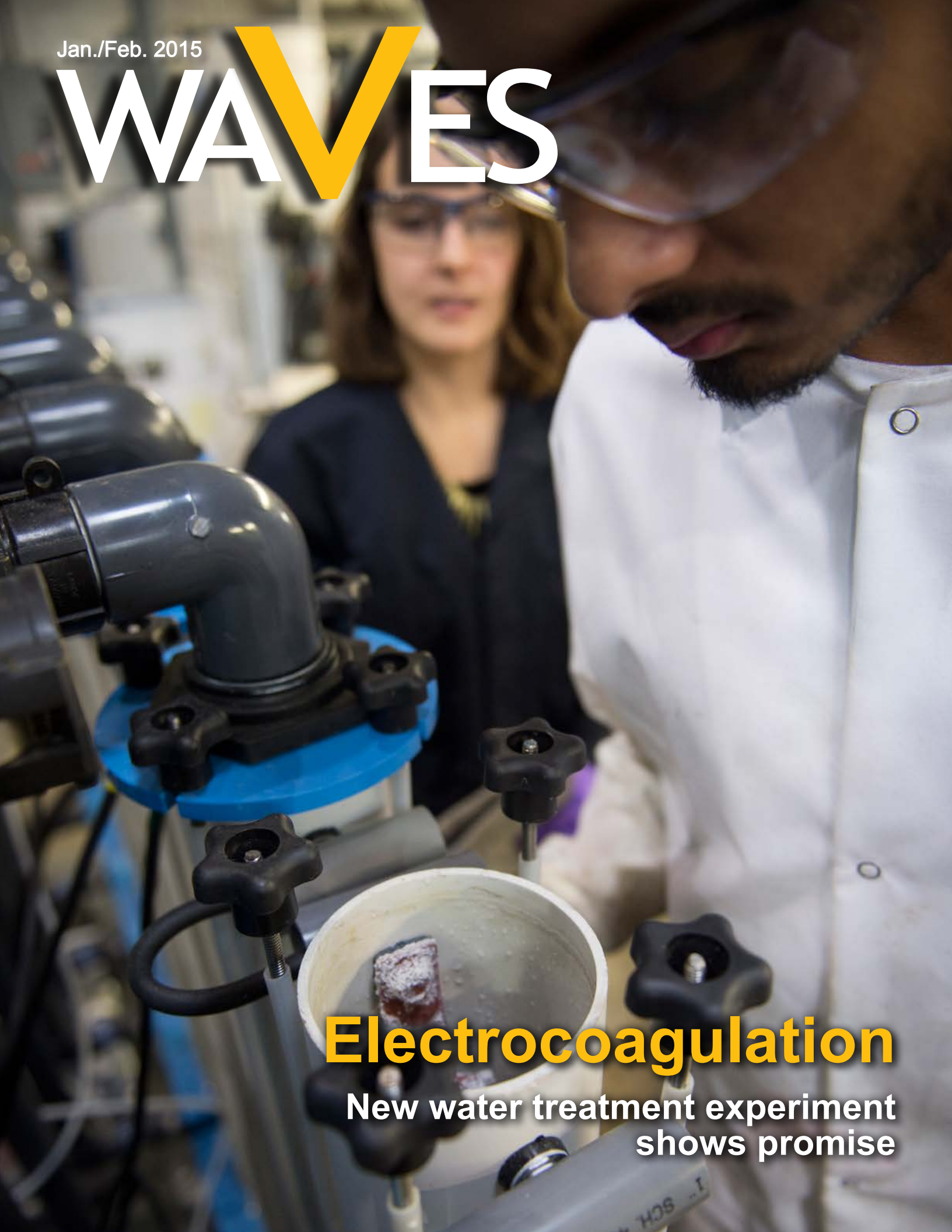
Jan./Feb. 2015

WAVES



Electrocoagulation

New water treatment experiment shows promise

Jan./Feb. 2015

WAVES

INSIDE PAGE 7

Sailors practice repairing leaks in the "wet trainer" on board the Submarine Training Facility (SUBTRAFAC) in Norfolk, March 8, 2004. (U.S. Navy photo/Released)

TEAM

COVER

From left: Danielle Paynter and Syed Shamin in the Survivability, Structures and Materials Department at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md., examine the electrodes of an electrocoagulation chamber Jan. 14, 2015. The chamber is part of a full-scale mockup being used for experimental testing of a chemical injection process. This process is aimed at increasing the efficiency of a combined electrocoagulation/ mechanical oily wastewater treatment system. (U.S. Navy photo by Ryan Hanyok/Released)

TECHNICAL DIRECTOR'S CORNER

Dr. Joseph T. (Tim) Arcano Jr.
NSWC Carderock Division Technical Director

Topic: Knowledge transfer and MMOWGLIs

Throughout my time here at Carderock I have talked about the ways we can use mentoring to facilitate the process of capturing what we know so our new team members do not have to "reinvent the wheel." To continue the conversation, this time I would like to talk about an innovative problem-solving exercise named Massive Multiplayer Online War Game Leveraging the Internet - MMOWGLI for the acronym lovers among us.

We all read peer journals, take classes, work with colleagues at other sites or universities when time permits, but how do we break out of the old thinking and dig out knowledge we didn't know was actually very relevant and important to pass on?

One new method that I believe has great promise is called "Black Swan MMOWGLI." What is this? Simply put, it is a game we play together. The game presents the players with a scenario and they work together to solve the problem. The problem presented is a broad one, requiring solutions that require working across several areas of knowledge to come up with viable solutions.

The end results of games such as this are threefold.

First, there is a cross-pollination of knowledge between seemingly unrelated areas that can lead to new ideas, techniques and solutions. Playing any open-ended game like MMOWGLI allows players to think outside the box in ways that problems encountered in the real world do not normally require. It is here where we gain new ideas and knowledge as I referred to earlier. Finding the answers would push a team to look not only inward, but also outward to find new information and consider solutions the team members might not normally consider.

The second captures the existing knowledge base through discussions and applications of what is currently known. Solving any problem requires and uses existing experience and knowledge. Obviously, this requires that both senior and junior members be assigned to a team for a true transfer of knowledge to happen. Here is another opportunity for senior team members to add to their "legacy," as I've mentioned in earlier columns.

Third, and perhaps most important, is building teamwork and relationships that will produce organically created mentoring relationships that will endure after the game is complete. It is another way to bring people together that is more interactive and personal. There are plenty of examples of this. Look to any team sport to see the result. More effective communication and less encumbered sharing and support happens naturally.

The idea of using a game to help us do our work more effectively may seem frivolous on the surface, regardless of the context. Calling something a game reminds us of time spent that was often not productive in the sense of accomplishing something larger and more meaningful. Answering more trivia questions than the other guy or playing cards for bragging rights is fun, but work is serious stuff. It must be directed in a serious effort to create something "real" in the minds of many.

Ok, point taken, but let me ask you; why can't a game produce something real, useful and important? My contention is that it can. It has been proven in other contexts, so I believe it can be done for the problems we are working on here at Carderock.

Office of Naval Research launched their first widely publicized event in spring 2011 where 2,700 players contributed 20,000 ideas across three game events. The events were an interesting mix. The first event involved finding ways to avert Somali piracy. The second worked on how to build an agile Navy for the 21st century. The most recent sought ways to reinvent the military's relationship to energy consumption.

Now having said earlier that there were three beneficial results found with playing a game like a MMWOGLI, permit me to cheat a little. I would like to add a fourth positive result: You have a chance to have some fun while working on something that provides a real, usable result.

What does having fun accomplish? Fun equals frivolity, right? Well, not always. Some of our most creative thinking occurs when we're having a good time. Pressures are removed and ideas we might not normally take seriously come out into the light. You actually take the time to consider them rather than toss them aside as frivolous.

Ask yourself; do you find the idea of playing a game a waste of your time? Ask yourself why. Are you stuck in a groove? How many of us turn to play a quick game of solitaire on the computer or make a pot of coffee? A momentary diversion has value to clear our heads. What value would a focused, shared game have?

Years ago a movie was released called WarGames. In the story a young man was pitted against a supercomputer that began its challenge to the young man with "Do you want to play a game?" The game ended up as serious business, not just for the young man, but for the world. Exciting stuff, and relevant in this case to us. The problems we solve have implications on a similar scale, if not with the same immediacy.

So here we are, having come full circle. Do you want to play a game? I believe it might be good for us to play one together.

"You have a chance to have some fun while working on something that provides a real, usable result."

Middle-school mathletes compete at sixth annual Carderock Math Contest

By Nicholas Malay, NSWCCD Public Affairs

Middle-school students participate in the Countdown Round portion of the sixth annual Carderock Math Contest in West Bethesda, Md., Jan. 23, 2015. Tom Luo (second from right in back) from the Chesapeake Math Program in Columbia, Md., was the winner of the overall competition. (U.S. Navy photo by Katie Ellis-Warfield/Released)

More than 230 middle-school students from 30 schools across the region gathered at Naval Surface Warfare Center, Carderock Division (NSWCCD) in West Bethesda, Maryland, for the sixth annual Carderock Math Contest (CMC), Jan. 23.

This National Defense Education Program (NDEP) outreach event is a unique opportunity to inspire students to pursue careers in math and science while they showcase their talent for math in a series of MathCOUNTS style tests, providing encouragement to today's students to pursue a foundation for success in science, technology, engineering and math (STEM) careers.

Testing commenced in the morning, followed by presentations from NSWCCD Commanding Officer Capt. Richard Blank and NSWCCD Technical Director Dr. Tim Arcano about the importance of math in the real world of engineering and science in support of the warfighter. "Carderock is a place where science, math and engineering come to life, where people of various disciplines and backgrounds join forces to solve real problems and develop new ideas," Blank said.

The event included facility tours throughout the warfare center for the middle-school students to gain a better understanding of what Navy engineers and scientists do every day.

"I didn't think math was fun before, but now I feel like math is the most amazing and the most important thing in your lifetime," said Khulan Erdenedalai, a sixth-grade student at H-B Woodlawn in Arlington, Virginia. "The things surrounding me, it's all math."

NSWCCD scientists and engineers helped proctor and score the tests, lead tours of the electromagnetic laboratory, the Maneuvering and Seakeeping Basin and the tow basin, and speak with the students about their careers.

"The Carderock Math Contest provides the extra incentive and the perfect atmosphere for students to push themselves to achieve more in mathematics," NSWCCD mechanical engineer and CMC executive board member Alyssa Littlestone said. "We have fun and creative problems that promote critical-thinking and problem-solving skills."

The Carderock Math Contest consists of written and oral rounds, as well as individual and team components. Though challenging and non-routine, the competition problems focus on the sixth-through-eighth grade standards of the National Council of Teachers in Mathematics.

"This math event is different from other contests because of the unique facilities at Carderock," NSWCCD materials engineer and CMC executive board member Charles Fisher said. "The chance to show middle-school students how math is used in real-life applications, specifically to advance U.S. Navy technology, is unparalleled."

The competition consisted of four different rounds. The Sprint Round (40 minutes) consisted of 30 problems. This round tested accuracy, with time being such that only the most capable students would complete all of the problems. Calculators were not permitted.

The Target Round (24 minutes) consisted of eight problems for which the competitors were permitted to use calculators. This round featured multistep problems that engaged mathletes in mathematical reasoning and problem-solving processes. Because calculators were allowed, the problems were generally more challenging than the Sprint Round.

The Team Round (20 minutes) consisted of 10 problems that team members worked together to solve. Team member interaction was permitted and encouraged. Calculators were allowed.

The Countdown Round was a fast-paced, oral competition for top-scoring individuals (based on scores in the Sprint and Target Rounds). In this round, pairs of mathletes competed against each other and the clock to solve problems.

The day was not all tests. There were also fun scientific demonstrations – prompting some students to get out of their seats several times to peer closer – in the Maritime Technology Information Center auditorium by the Science Brothers, Bill Porter and Daniel Flisek, two NSWC Panama City employees. They conducted several scientific demonstrations, including explaining how a Tesla coil works and conducting a combustion reaction demonstration called the "Barking Dog."

"We want to introduce students to career fields in STEM that they may not have known about or considered before," Flisek said. "Our goal is to get kids interested in science and technology at an early age, before they might have decided that science 'isn't cool.'"

Michelle Meehan, a math teacher at H-B Woodlawn, said that Carderock Division engineers and scientists going into her school and working with her students helps add validity to what she and her colleagues are teaching in the classroom. "They can answer the question 'when are we ever going to use this?' with real examples of how they actually use the math which is much cooler than because a math teacher says so."

"The Naval Surface Warfare Center, Carderock Division is really cool," said Dalton Yu, an eighth-grader at Pyle Middle School in Montgomery County, Maryland. "Everything at Carderock is so interesting and this area is such an important center for America."

The Science Brothers, Naval Surface Warfare Center, Panama City employees Bill Porter and Daniel Flisek, conduct scientific demonstrations for middle-school students as part of the sixth annual Carderock Math Contest in West Bethesda, Md., Jan. 23, 2015. (U.S. Navy photo by Katie Ellis-Warfield/Released)

Middle-school students prepare to start the Target Round portion of the sixth annual Carderock Math Contest in West Bethesda, Md., Jan. 23, 2015. (U.S. Navy photo by Neubar Kamalian/Released)

"The truth is math isn't my best subject, but that doesn't mean I don't like it," said H-B Woodlawn sixth-grader Akila Islam. "I find challenging math problems fun even though I don't get the right answer most of the time, but I like being right, too. I'm totally doing this again next year."

Tom Luo, an eighth-grade student from the Chesapeake Math Program in Columbia, Maryland won the overall competition.

Middle-school students take a tour of the model fabrication shop as part of the sixth annual Carderock Math Contest in West Bethesda, Md., Jan. 23, 2015. (U.S. Navy photo by Neubar Kamalian/Released)

Team winners

Most creative team name: Gee I'm a Tree ☺– Congressional School of Virginia
People's choice art award: Math Clock – Queen of Apostles Catholic School
Captain's choice art award: The Tank –St. Andrew's Episcopal School

Starboard Division team winners:

First place: Purple Chickens – Lemon Road Middle School
Second place: Пgers from Chesapeake Math and IT Academy-North
Third place: 3 Bang-2 Bang Couldn't Come Up with a Nang – Montgomery County Home School

Port Division team winners:

First place: Nylknarf-Poisened Barley – Longfellow Middle School
Second place: Vocabulcrioi Grammatical en Context –Takoma Park Middle School
Third place: Technidium Head Gear – Roberto Clemente Middle School

Individual winners

Starboard Division written competition winners:

First place: Benjamin Yam from Lemon Road Elementary School
Second place: Allie Amerman from Montgomery County Home School
Third place: Christopher Kan from Lemon Road Elementary School

Port Division written competition winners:

First place: Kevin Qian from Takoma Park Middle School
Second place: Aaditya Singh from Longfellow Middle School
Third place: Jason Lee from Roberto Clemente Middle School

Countdown round

First place: Tom Luo from Chesapeake Math Program
Second place: Jason Lee from Roberto Clemente Middle School
Third place: Andrew Wu from St. Albans School

HIT software field tested

Timothy E. Hunt, NSWCCD Public Affairs

Sailors assigned to Basic Enlisted Submarine School (BESS) battle a simulated fire in the firefighting trainer on board Naval Submarine School, Groton, Conn. (U.S. Navy photo by Marion Snipes/Released)

From Oct. 24-27, 2014, David McArdle and Kevin Rankin of the Vulnerability Assessment Branch (VAB) at Naval Surface Warfare Center, Carderock Division (NSWCCD) in West Bethesda, Maryland, visited the Applied Research Associates' (ARA) Rocky Mountain Division in Denver, Colorado, to oversee a field test of the Human Injury Treatment (HIT) software under development for VAB. The HIT program started in fiscal year 2008 and is currently in transition for use and distribution NSWCCD.

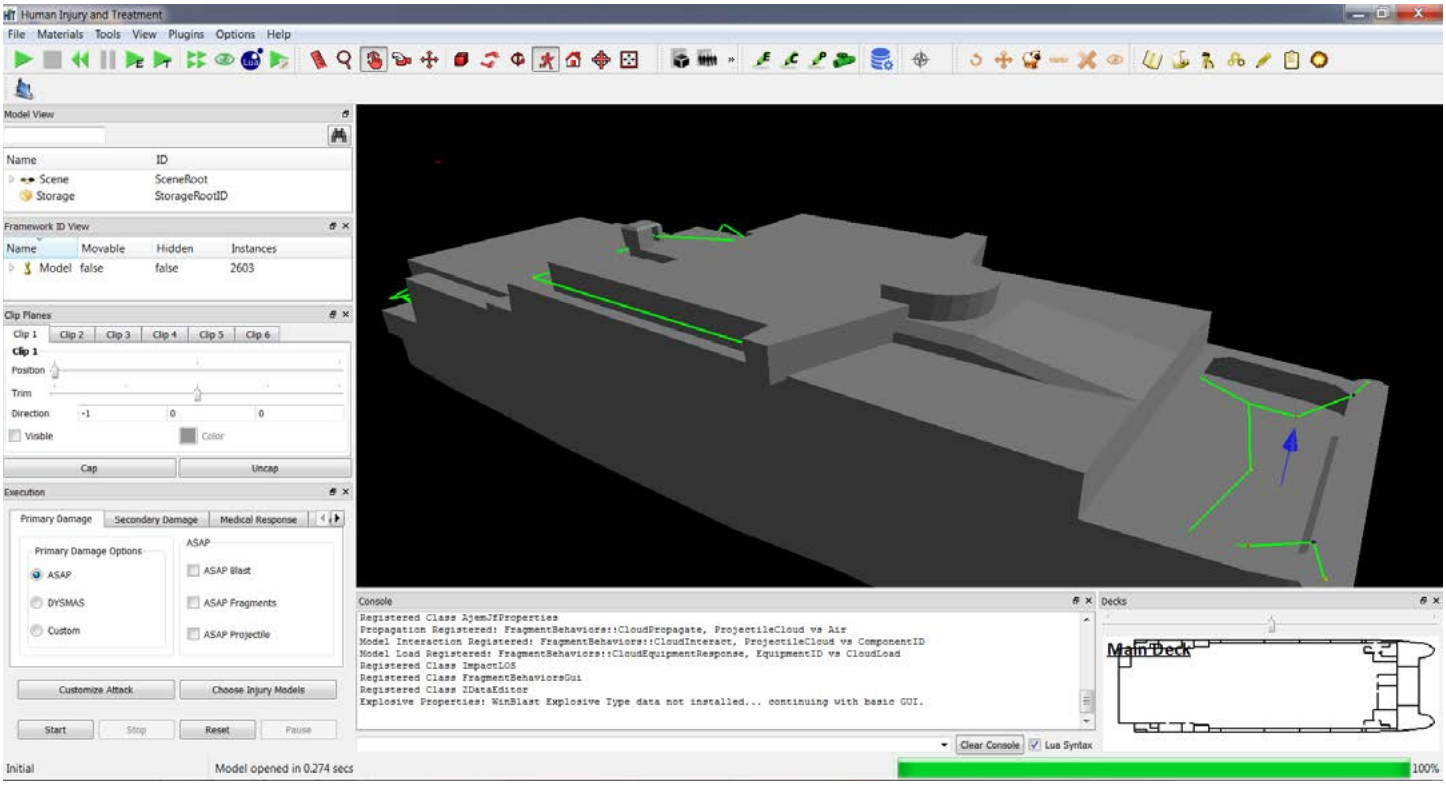
HIT is a computer modeling tool for predicting human injury, incapacitation, medical response requirements and patient outcome associated with weapon engagements in shipboard environments. NSWCCD and ARA are currently in the final stages of debugging the software before the transition to NSWCCD.

HIT is an achievement on many levels, not only with the complexity of code but also in the detail the resulting data provide. The HIT program processes and identifies the types of injuries all crewmembers would sustain, their severity and the impact on a ship's state of readiness the following an attack.

The level of detail the HIT data models create for assessment are impressive in their complexity. Injury models assign severity predictions according to the HIT-developed Military Combat Injury Score (MCIS) and cover the locations of every Sailor on the ship. The MCIS is a new, simpler severity scale with 269 codes and five severity levels that specifically characterize and distinguish the many unique injuries encountered in combat. It was developed by a panel of military and civilian subject-matter experts and leverages 35 years of injury coding/modeling experience.

The data generated are further processed to create capability assessments that are calculated based on the functions performed by each Sailor and an injury's impact on the crewmember's capability to perform their assigned duties. Developed in conjunction with the MCIS, the Military Functional Incapacity Scale (MFIS) correlates MCIS injury severity with the associated loss of combat effectiveness.

HIT's first phase of development centered on predicting human injury, incapacitation and medical response requirements based on both the MCIS, the locations of every Sailor on the ship and MFIS scales. These requirements were developed to equip and provision medical supplies and medical personnel to provide adequate care in line with expected patient outcome associated with the selected weapon engagement.



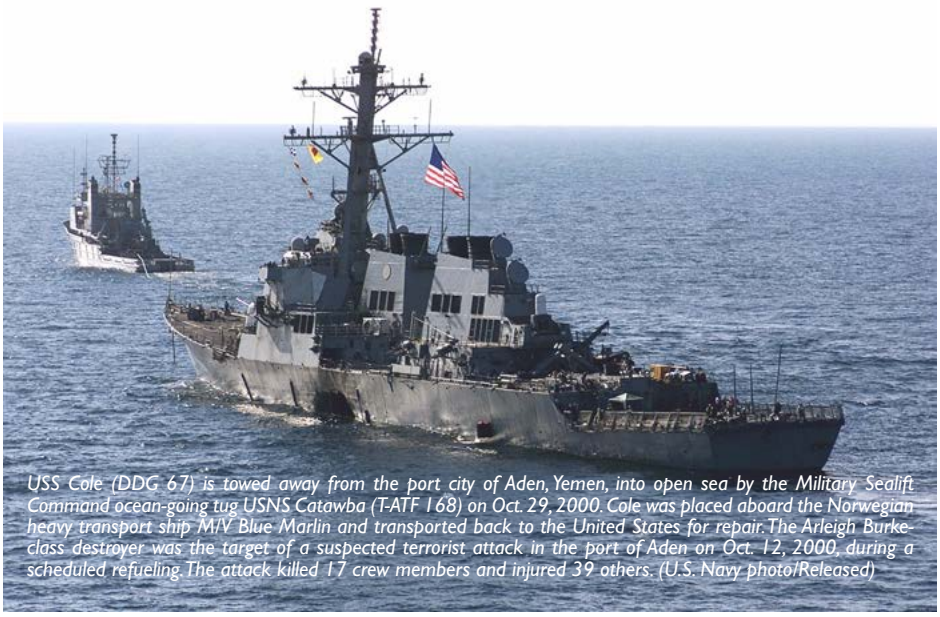
The HIT program provides both visual and text-based results. The graphic above depicts the external deck structure of a ship. The virtual models used are complex. In addition to the external deck views, the models show both crew locations and a ship's internal arrangement.

The next phase allows HIT to interact seamlessly with NSWCCD damage assessment tools. The HIT code can accept damage outputs from various Navy damage algorithms including the Advanced Survivability Assessment Program, Dynamic System Mechanics Advanced Simulation and Navy Enhanced Sierra Mechanics. These various damage simulations produce damage data files which are read directly into HIT.

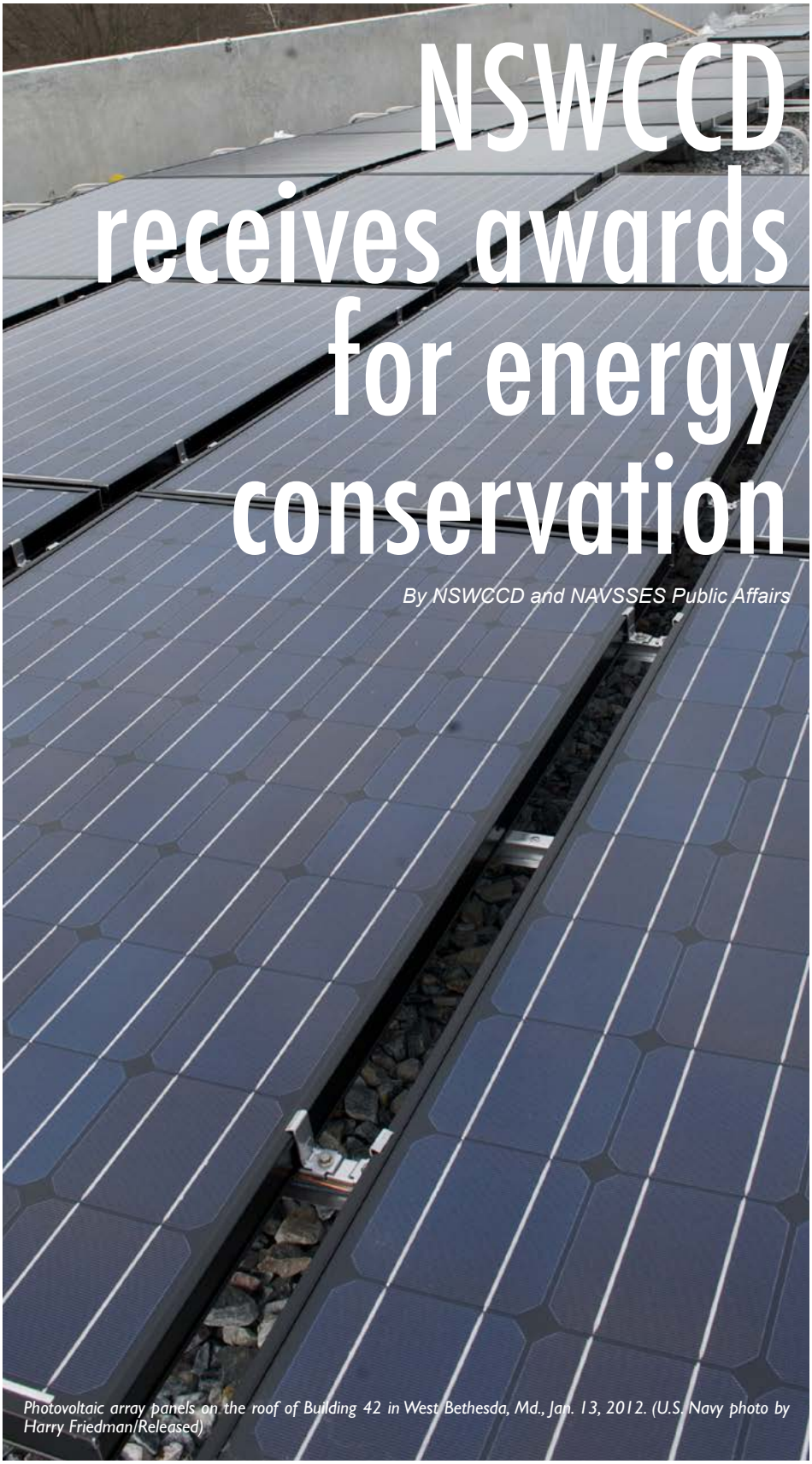
The current phase is aimed at refining the various ship models for HIT use, entering manning profiles and validating injury response functions specific to the ships being used to conduct software tests.

The HIT software provides the NSWCCD Vulnerability Assessment Branch with an improved analysis capability and by extension, improved damage control capabilities and readiness for the fleet. The software has potential impact on various areas of ship readiness. The results of Live Fire Test and Evaluation (LFT&E) studies will be significantly improved; Program Executive Office acquisition programs will have a new tool to optimize ship manning and design for shipboard medical treatment configurations. The improved data will also improve cost-benefit assessments for medical capabilities and manning requirements to save money while improving available facilities and medical response for the ship's crew.

The Office of Naval Research (ONR) sponsored and funded the HIT program under its Force Health Protection Future Naval Capability (FNC) Program. Delivery of the final version is expected in March.



USS Cole (DDG 67) is towed away from the port city of Aden, Yemen, into open sea by the Military Sealift Command ocean-going tug USNS Catawba (T-ATF 168) on Oct. 29, 2000. Cole was placed aboard the Norwegian heavy transport ship M/V Blue Marlin and transported back to the United States for repair. The Arleigh Burke-class destroyer was the target of a suspected terrorist attack in the port of Aden on Oct. 12, 2000, during a scheduled refueling. The attack killed 17 crew members and injured 39 others. (U.S. Navy photo/Released)



NSWCCD receives awards for energy conservation

By NSWCCD and NAVSSES Public Affairs

Photovoltaic array panels on the roof of Building 42 in West Bethesda, Md., Jan. 13, 2012. (U.S. Navy photo by Harry Friedman/Released)

For the 12th consecutive year, Naval Surface Warfare Center, Carderock Division (NSWCCD) has been recognized by SECNAV for its achievements in energy conservation. The division's West Bethesda, Maryland, and Memphis, Tennessee, locations were named as "gold level," and Naval Ship Systems Engineering Station (NAVSSES) in Philadelphia was named as "blue level" for its energy program.

The annual SECNAV Navy's Energy and Water Management Awards program rates commands based on multiple criteria including energy conservation efforts, energy and water management practices, energy awareness and training, project execution and progress toward meeting mandated energy and water reduction levels. The sustained success of NSWCCD in this program is a testament to the level of importance placed on efficient and effective management of command utilities.

"We can attribute much of our command's success in energy conservation to well-planned and well-executed energy projects, and an overall emphasis on being good stewards of the resources required to support the Navy's mission," said NSWCCD Technical Director Dr. Tim Arcano.

The NSWCCD energy management program is a comprehensive program with the overall goal of reduction in energy consumption and costs. With sites located in eight states, the NSWCCD energy management program is corporately managed, with resource sharing and best practices utilized across all sites. This is achieved through usage monitoring, development and application of efficient energy processes in routine operations, installation of energy-efficient equipment and systems, and the implementation of sustainable and green energy technologies. Since NSWCCD directly reimburses utility providers, any reduction in energy consumption results in avoided energy costs.

Emphasis on energy savings and cost avoidance is a key tenet of SECNAV, and, as such, a high priority within the Naval Sea Systems Command and the Warfare Centers. As energy commodity costs continue to rise, NSWCCD has placed an even greater importance on minimizing energy consumption and limiting wasteful practices across the board. Warfare Centers are tracking energy consumption and implementing strategies to meet a target goal of a 30 percent reduction by 2015, Naval Sea Systems Command (NAVSEA) Executive Director Donald McCormack wrote in an all-hands email to NAVSEA employees this

summer. Carderock Division is on pace to exceed the 30 percent reduction goal from the baseline set in 2003.

"We all play a part in energy conservation efforts for the command," said Greg Cancila, an electrical engineer with NSWCCD Infrastructure Division, who works to track, measure and reduce Carderock's energy footprint. "We try to be good stewards of the resources we're entrusted to manage."

Of the projects that demonstrate the command's commitment to energy efficiency, Cancila said the design and construction of Building 42 in West Bethesda is a great example of where energy conservation objectives were evaluated and implemented. Through the inclusion of energy enhancement elements, the building was awarded a Leadership in Energy and Environment Design (LEED) GOLD certification – a prestigious certification for building construction and renovation projects. Other energy related features included a 21-kilowatt photovoltaic array, solar domestic hot water and a green roof.

In addition to the renewable energy features in Building 42, several other systems are part of the NSWCCD renewable energy portfolio. Building 4E in West Bethesda is equipped with photovoltaic array, buildings 9 and 19 have solar walls which preheat intake air and Building 68 has a solar domestic hot water system. Cancila said that if it is cost effective, and funding allows, the Infrastructure Division hopes to develop additional renewable energy projects.

Last year Philadelphia completed the decentralization of the inefficient steam-heating system and replaced the central steam system with new distributed natural gas-heating systems. The project allowed the Navy to avoid the line-losses and maintenance problems associated with the old centralized system.

Another energy management tool NSWCCD uses extensively throughout the command is Direct Digital Controls (DDC) to schedule, monitor and control heating, ventilation, air conditioning (HVAC) and lighting systems at major buildings. Currently, over 2,600 per 1,000 square feet of space is equipped with DDC. The DDC systems are programmed for night and weekend temperature and lighting setbacks, resulting in substantial energy savings. Several systems are equipped with day-lighting features, which cycle building lights off based on ambient lighting levels. In certain lab areas, DDC systems have been programmed to lower supply cubic feet per minute and static pressure. Through the use of DDC, the Infrastructure Division is able to better monitor and efficiently control lighting and HVAC systems.

Secretary of the Navy Ray Mabus committed the Navy and Marine Corps to meet five ambitious energy targets by 2020. In his 2009 message highlighting October as Energy Awareness Month, he reiterated to the fleet that energy reform and energy conservation are more than ideas to think about only one month out of the year. Cancila notes he, along with all Infrastructure Division employees, keep energy conservation goals in mind as they go about their duties for the command.

Future efforts include an Energy Conservation Investment Project in Philadelphia to construct a 60 megawatt energy recirculation system at Building 633, several building envelope repairs, HVAC repairs and DDC enhancement projects. "We try to do whatever we can to reduce our operational costs," Cancila said.

Secretary of the Navy Ray Mabus' Energy Targets:

Target 1: By 2020, half of our total energy consumption, ashore and afloat, will come from alternative sources.

Target 2: By 2020, we will make half of our installations net-zero energy consumers, using solar, wind, ocean and geothermal power generated on base.

Target 3: By 2016, the Navy will sail the Great Green Fleet, a carrier strike group composed of nuclear ships, hybrid electric ships running biofuel and aircraft flying on biofuel.

Target 4: By 2015, the Department of the Navy will cut in half the amount of petroleum we use in our commercial vehicle fleet through phased adoption of hybrid, electric, and flex fuel vehicles.

Target 5: Effective immediately, the Navy and Marine Corps will change the way contracts are awarded. Industry will be held contractually accountable for meeting energy efficiency targets.

New water treatment experiment shows promise

Timothy E Hunt, NSWCCD Public Affairs

From left: Syed Shamim, Danielle Paynter and Adam Grossman with the Survivability, Structures and Materials Department at Naval Surface Warfare Center, Carderock Division pose in front of an electrocoagulation (EC) system in West Bethesda, Md., Jan. 14, 2015. The EC research team has achieved a significant milestone in recent water treatment experiments sponsored by Naval Sea Systems Command. The experiments were performed in November 2014 by researchers as a proof of concept for using the EC process as a pretreatment to typical oily water separators. (U.S. Navy photo by Ryan Hanyok/Released)

Recently, the Survivability, Structures and Materials Department, Naval Surface Warfare Center, Carderock Division (NSWCCD) in West Bethesda, Md., achieved a significant milestone in recent water treatment experiments sponsored by Naval Sea Systems Command (NAVSEA). The experiments were performed in November by researchers Danielle Paynter, Adam Grossman and Syed Shamim as a proof of concept for using electrocoagulation (EC) process as a pretreatment to typical oily water separators (OWS), which can only remove oil-based pollutants based on gravity differences with water. The experiments conducted by the team are aimed to increase the efficiency of the EC process by adding the capability to inject a chemical additive. This additive is an organic polymer that reduces the amount of chemical emulsions in the water.

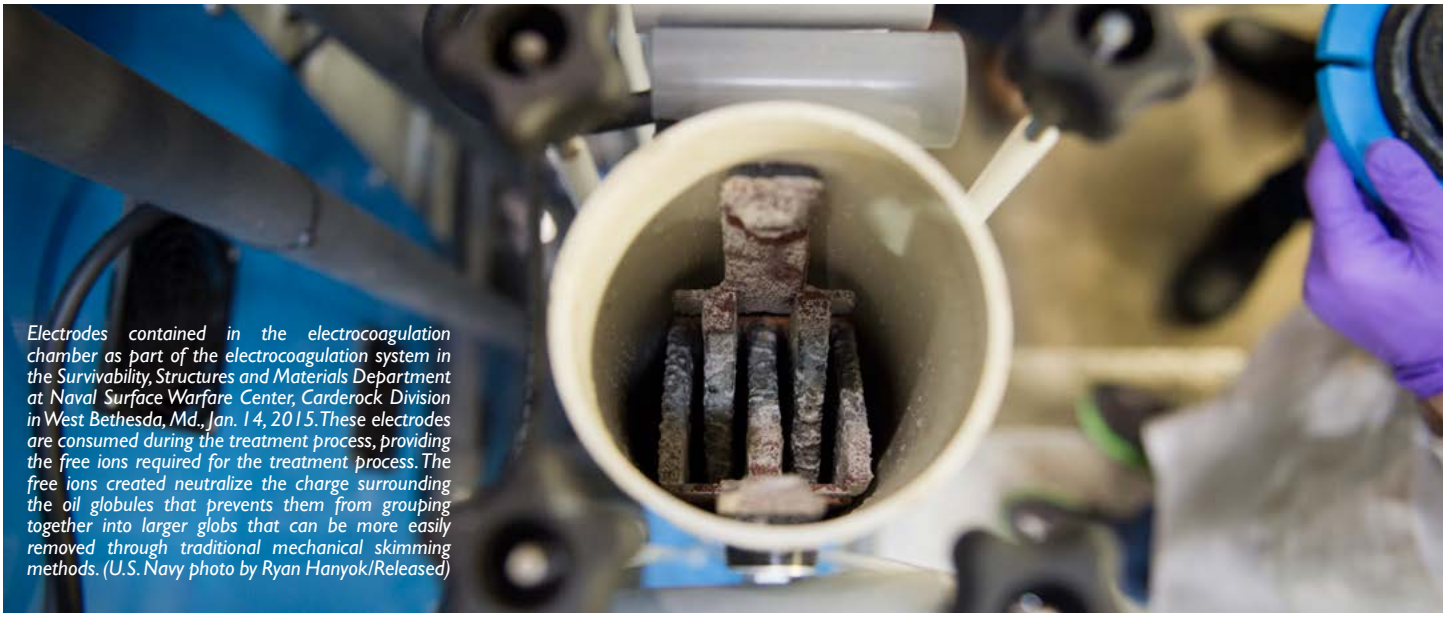
Emulsions are produced when oils and water are mixed together by shaking and stirring, in a manner similar to how oil and water are mixed together to make salad dressing. The result is a solution of smaller, evenly distributed oil droplets that are harder to remove from water than the current physical oil/water separating equipment is capable of treating effectively.

Physical separation has been the primary method of oil removal from bilgewater on naval ships since the 1930s. While this method has been satisfactory to meet current regulations, the allowable amounts of oil permitted continue to be tightened. Cost is also a concern. "Emulsion treatment and removal is a ubiquitous issue across the Navy which can incur high-pier side disposal costs or pose a risk to Navy missions. A tremendous amount of hard work and diligence goes into investigating treatment systems and technologies to reduce costs while maintaining high treatment performance," Paynter said.

This is why the team began their experiments using a commercially available EC system. Commercial treatment of wastewater by EC has been practiced for most of the 20th century. The systems are effective, reliable and relatively inexpensive to operate. The process is typically very effective for removing contaminants such as emulsified oil, petroleum hydrocarbons, suspended solids and heavy metals.

However, EC systems are created to treat water with a very specific mixture of pollutants. This is why these systems have not been used for naval vessels. Bilgewater has a unique combination of contaminants continually mixed by the motion of the ship. This unique mix of emulsions and conditions reduces the effectiveness of the EC process. These contaminants, particularly the detergents, break down oils into even smaller droplets that form highly stable oil/water emulsions which are more difficult to treat. These smaller droplets are where the treatment problem resides.

EC removes contaminants using an electrical process to help bring smaller droplets together.



Electrodes contained in the electrocoagulation chamber as part of the electrocoagulation system in the Survivability, Structures and Materials Department at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md., Jan. 14, 2015. These electrodes are consumed during the treatment process, providing the free ions required for the treatment process. The free ions created neutralize the charge surrounding the oil globules that prevents them from grouping together into larger globs that can be more easily removed through traditional mechanical skimming methods. (U.S. Navy photo by Ryan Hanyok/Released)

The process changes the electrical charges of each droplet to make them more attractive to each other. Because of the other contaminants the larger globules are harder to form and make it difficult to remove the oily globules using the physical separation process provided by existing Navy OWS equipment.

So while EC helps to address the issue to a degree, it is not consistently effective at causing oil droplets to gather together, or coagulate, into larger globules. This loss of coagulation efficiency is why the team began experimenting with chemical additives in an effort to kickstart the coagulation process. What they have found is that the addition of an organic polymer increases the amount of coagulation that occurs, increasing the size of the globules so they can be separated from the water more easily.

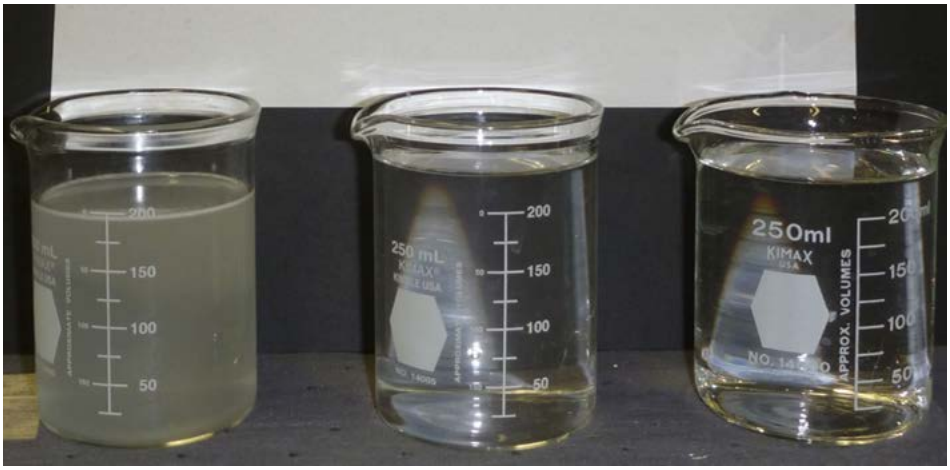
The results show the test system is capable of producing discharge water that consistently meets the Environmental Protection Agency's requirements that the oil content of ship water discharge is no more than 15 parts per million. The results are particularly noteworthy since the EC system is able to maintain the required quality while matching the flow rate of the existing 10 gallons per minute OWS currently in wide use by the Navy. Another appealing aspect of the additive injection process is the minimal impact on a ship's installation and maintenance requirements; the amount of the dry chemical additive required for an entire six-month deployment is only about the size of a shoebox.

The team's promising findings demonstrate the process being investigated warrants continued research. If built, the resulting system could have a significant impact on the Navy's ongoing efforts to improve the cleanliness of bilgewater discharges from fleet ships.

"Being able to test and evaluate a technology which shows this level of promise in breaking emulsions is not only exciting, but also very rewarding since the knowledge gained helps us to better serve the warfighter, environment and taxpayer" Paynter said.

The tests were performed on a full-size mock-up of the combined OWS/EC system. Each test lasted 10 hours and included optimization studies of the electrode cell bank and injection rate of the treatment chemicals into the system.

According to Paynter, the next step in their research is to conduct studies of electrode life and treatment performance with varying chemical mixtures to confirm the system effectiveness under varying conditions.



This photograph illustrates the effectiveness of the new treatment process. From left: Contaminated water sample prior to treatment, sample after electrocoagulation/chemical treatment, but prior to model 10NP parallel plate oily water separator processing and sample of final result after model 10NP parallel plate oily water separator treatment. (U.S. Navy photo by Danielle Paynter/Released)

Demonstration of Oily Wastewater System Membrane Verification Test conducted aboard USS Arlington (LPD 24)

Timothy E. Hunt, NSWCCD Public Affairs

The amphibious transport dock ship USS Arlington (LPD 24) participates in training exercises with the amphibious assault ship USS Iwo Jima (LHD 7) in the Atlantic Ocean, Aug. 9, 2014. (U.S. Navy photo by Mass Communication Specialist Seaman Shelby M. Tucker/Released)

Naval Surface Warfare Center, Carderock Division (NSWCCD) in West Bethesda, Maryland, recently demonstrated a method developed to test the integrity of filtering membranes found in oily waste processing systems used on fleet ships. The demonstration team, consisting of Syed Shamim, mechanical engineer, and Danielle Paynter, chemical engineer, successfully conducted the demonstration aboard USS Arlington (LPD 24). The demonstration addresses a long-standing need for a reliable and noninvasive method to test membrane integrity.

The need for a process such as this is driven by the nature of the membranes used in the system. The membranes are made of ceramic material that is delicate and prone to breakage during installation or removal for cleaning. The current cost of each membrane is approximately $19,100 for the system currently deployed on LPD 24. The system uses three membranes for a total cost of $57,300. According the team's report, cost and the fragile nature of the membranes are the main factors that drive the need for a procedure that does not require filter disassembly to perform the inspections and tests to effectively maintain the membranes.

This particular test was conducted as a proof of concept for the testing process. The version of the process the team demonstrated is intended to detect the presence of defects in the filter membrane following installation. The procedure uses the "pressure decay" method to determine the condition of the membrane.

The test procedure follows guidelines established by the American Society for Testing and Materials – an independent organization that sets international standards for product quality and safety. It begins by injecting air on one side of a wetted-filter membrane. The amount of pressure applied is predetermined with a known start value. After the one side is pressurized, the other side of the membrane is opened to atmospheric pressure. The resulting

pressure loss from the pressurized side is measured over a specified time interval. If the pressure changes more rapidly than is expected for an intact membrane, the filter membrane is damaged. This test is done without removing the membrane from the system, therefore not risking damaging membranes that are in working condition.

The results of this demonstration will be used in development of standard testing procedures for oily wastewater processing systems containing membranes like those contained in the system currently deployed on LPD 24.

The Navy's efforts in this area of pollution abatement started over 20 years ago in order to comply with new international pollution regulations regarding waste discharge from ships in international waters. Department of Defense, Navy and Naval Sea Systems Command regulations were written to ensure compliance with these regulations and to guide all ongoing research and development. Shamim and Paynter's paper (see sidebar at end of story) notes that through these instructions and the effectiveness of the current wastewater processing systems, the Navy has been very successful in meeting and even exceeding the current regulations.

Shamim expressed his satisfaction by saying, "We're really very proud of our success. Working on solutions in this area may seem to be of interest only due to environmental regulations, but it has real impact on our mission readiness. We wouldn't be able to operate in many areas where the Navy needs to be without our efforts in this area of research. The fact that we directly affect the fleet's ability to process wastewater during deployment and also to protect the environment makes what we do doubly satisfying."

The Navy is also looking ahead in anticipation of new, more stringent limits on discharge pollution imposed through the Uniform National Discharge Standards Act, the Clean Water Act, as well as increasing international restrictions. These restrictions will become especially critical when considering the limitations on naval operations created by an inability to comply with the more stringent regulations and as the nature of naval warfare changes.

Shown above, the oily waste processing systems currently installed on USS Arlington (LPD 24). It uses three ceramic membranes to process the wastewater. The costs, as well as the fragile nature of the membranes, drive the need for a procedure that does not require filter disassembly. (U.S. Navy photo by Syed Shamim/Released)

The demonstration team has published two follow-up reports documenting the results of the event. The first is titled "Shipboard Demonstration of Air Pressure Decay Testing on Membranes in the Leidos Model UF-1001 10-GPM Oily Waste Membrane Systems aboard USS Arlington (LPD 24)." The reference number for the report is NSWCCD-63-TM-2014/83. The second report, "Shipboard Demonstration of Air Pressure Decay Testing as a method for Determining Membrane Integrity" (Report No. NSWCCD-63-TM-2014/82) is more comprehensive. It documents the overall results of this particular research and includes the results for the tests performed on LPD 24 and USS Forrest Sherman (DDG 98), as well as on the membrane system in Carderock's oily wastewater laboratory. Both reports can be found in the SEA 05P25 Corporate Documents Management System Technical Library.

Secretary of Defense approves Navy small surface combatant proposal

NSWCCD Public Affairs

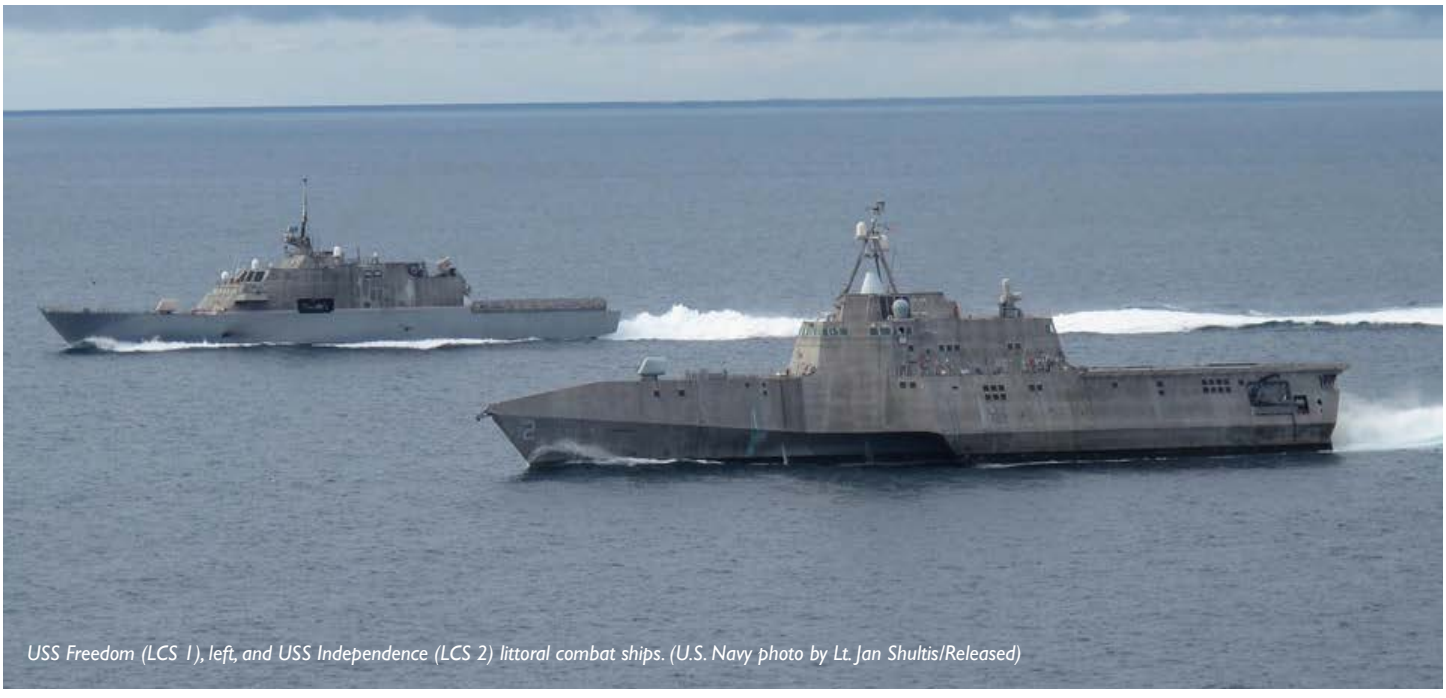
On Dec. 11, 2014, Secretary of Defense Chuck Hagel approved the Navy's proposal to "procure a new small surface combatant based on an upgraded Flight 0+ LCS." This approval is the final step in an ongoing procurement process that began in February 2014 when Secretary Hagel directed that the Navy procure up to 32 Littoral Combat Ships (LCS). At that time, Secretary Hagel also tasked the Navy to submit alternative proposals for a "capable and lethal small surface combatant generally consistent with the capabilities of a frigate" in time to inform the President's Budget 2016 deliberations.

In response to Secretary Hagel's direction, Chief of Naval Operations Adm. Jonathan Greenert and Assistant Secretary of the Navy for Research, Development and Acquisition Sean Stackley chartered the Small Surface Combatant Task Force (SSCTF) on March 13, 2014. The SSCTF mission was to develop alternative design proposals for a small surface combatant. Specific tasks assigned to the Task Force included establishing the requirements of a small surface combatant, translating requirements into design concepts and providing top-level system attribute (including sensors, weapons, combat systems requirements) cost and schedule information for each concept.

Consistent with the fleet's views on the most valued capabilities delivered by a small surface combatant, the modified LCS ship will be more lethal and survivable. It will provide multi-mission anti-surface warfare (SUW) and anti-submarine warfare capabilities (ASW), as well as continuous and effective air, surface and underwater self defense.

The proposed platform will modify the current LCS configuration, which now includes the 57mm gun and SeaRAM missile system. To increase the defensive and offensive capabilities, the new version of the ship will be equipped with an impressive array of weapon systems covering the full spectrum of warfare threats.

Modularity design features will also be retained to augment SUW and ASW capabilities. Currently available mission modules include Longbow Surface-to-Surface Missiles (Hellfire), two MK46 30mm guns,



USS Freedom (LCS 1), left, and USS Independence (LCS 2) littoral combat ships. (U.S. Navy photo by Lt. Jan Shultis/Released)

Secretary of the Navy Ray Mabus, Chief of Naval Operations (CNO) Adm. Jonathan Greenert, and Commandant of the Marine Corps Gen. James F. Amos appear before the House Armed Services Committee in February 2012 to provide testimony and answer questions regarding the fiscal year 2013 budget submission from the Department of Defense. The future of the LCS was a frequent topic of discussion at that time. (U.S. Navy photo/Released)

and two 11M Rigid Hull Inflatable Boats for surface warfare, or a variable depth sonar for submarine warfare that make this LCS variant an extremely effective anti-submarine warfare platform when combined with the ship's organic multi-function towed array and embarked helicopter.

In addition to the improved weapon systems capabilities for this ship, modifications will also include improved passive measures – measures that will reduce the ship's signature against mine threats, and measures that will harden certain vital spaces and systems against potential damage caused by weapon impact – to further enhance its overall survivability.

From an operational perspective, the sum of these improvements will increase the ship's capability and availability to participate in SUW Surface Action Groups, ASW Search and Attack Units, escort of High Value Units, and support of Carrier Strike Group (CSG) SUW and ASW operations.

This decision allows the Navy to add organic multi-mission capabilities to the small surface combatant force while leveraging the benefits and affordability of the LCS program. The 32 LCS ships currently planned or in service, with their full modular capability, will allow the Navy to deploy assets adequate to meeting the Navy's mine warfare, SUW and ASW demands, while the modified LCS ships will add the capability to cover a wider range of mission areas. The resulting 52 ship Small Surface Combatant Fleet will then be more in line with the Navy's Force Structure Analysis, which calls for a larger number of smaller ships to deal with cost issues and continuing changes in mission requirements.

Proposed LCS weapon system additions:

- Over-the-horizon surface-to-surface missiles
- Air defense upgrades (sensors and weapons)
- An advanced electronic warfare system
- Advanced decoys
- Towed array system for submarine detection and torpedo defense
- Two 25mm guns
- An armed helicopter capable of engaging with either Hellfire missiles or MK-54 torpedoes
- An unmanned FireScout helicopter for surveillance, reconnaissance and targeting

The Remote Multi-Mission Vehicle (RMMV) tows an advanced Variable Depth Sensor (AQS-20A) that supports mine-hunting sensors as part of the Remote Minehunting System (RMS). The RMS is part of the Mine Countermeasures (MCM) Mission Package which provides the primary mine reconnaissance capability for the Navy's Littoral Combat Ship (LCS). (U.S. Navy photo/Released)

Carderock Division signs Educational Partnership Agreement

By Nicholas Malay and Rebecca Grapsy, NSWCCD Public Affairs

NSWCCD Commanding Officer Capt. Richard Blank signs an Educational Partnership Agreement with Maryland's Frederick County Public Schools (FCPS) in West Bethesda, Md., on Dec. 2, 2014. Front: Capt. Blank and FCPS Career and Technology Education (CTE) Supervisor Kristine Pearl. Back: NSWCCD's Alyssa Littlestone, Toby Ratcliffe and Dr. Joseph Teter; FCPS CTE Specialist Norm McGaughery; and FCPS CTE Coordinator Eric Haines. (U.S. Navy photo by Harry Friedman/ Released)

Naval Surface Warfare Center, Carderock Division (NSWCCD) Commanding Officer Capt. Richard Blank and Frederick County Public Schools Career and Technology Education Supervisor Kristine Pearl finalized an Educational Partnership Agreement between Carderock Division and Frederick County Public Schools in West Bethesda, Maryland, Dec. 2, 2014.

Educational Partnership Agreements are the mechanism through which the division can provide assistance to grade schools, colleges and universities. The agreement with Frederick County Public Schools will allow Carderock Division to impact science, technology, engineering and math (STEM) programs being offered to K-12 students throughout Frederick County.

"You never know what experiences can spark an interest in a young person and help them start down a career path," Blank said. "STEM programs are getting students and faculty excited. Frederick County Public Schools can benefit from the staff expertise, unique facilities and equipment related to surface warfare science and technology available from Carderock Division through this Educational Partnership Agreement."

Frederick County is adjacent to Montgomery County, where the division is headquartered.

"There are numerous Carderock Division engineers and scientists who call Frederick County home and are willing to volunteer time to work, using Carderock-developed STEM programs, to enhance STEM educational opportunities," said Dr. Joseph Teter, Carderock Division director of technology transfer.

The agreement specifically outlines the ability to have volunteers work with students during and after school, to train teachers to incorporate STEM curriculum into the classroom and to loan equipment to the teachers to enhance learning.

Carderock Division currently has 18 active Educational Partnership Agreements with four universities and eight K-12 school systems.

"Finalizing the partnership between Carderock Division and Frederick County Public Schools opens the door for future collaborations and Educational Partnership Agreements," said Toby Ratcliffe, Carderock Division educational outreach coordinator. "The opportunity provides students a chance to learn about a career that they might not have otherwise considered for themselves and shows them what scientists and engineers do and the exciting and important STEM work they could be a part of."

At the signing ceremony, Frederick County Public Schools representatives and Carderock personnel discussed STEM programs that Carderock currently offers to students and faculty, such as curriculum-enhanced field trips to the base.

"One facility we showcase to students is our electromagnetic facility, where they learn about magnetism in physics," said Alyssa Littlestone, a Carderock Division mechanical engineer. "We explain to them how our scientists and engineers use physics in their everyday work.

"We have had numerous professional developments through the years where our folks have had the opportunity to directly work with Carderock engineers to learn from, become more comfortable in delivering the curriculum and bring real-world experiences to share with kids," Pearl said.

Navy engineer assigned as science advisor to U.S. Ambassador to South Korea

By Joseph Battista, NAVSSES Public Affairs

Dr. Peter Cho, electrical engineer with Electric Power Research and Development Branch at Naval Ship Systems Engineering Station, Naval Surface Warfare Center Carderock Division (NAVSSES), began a three-month assignment in early November 2014 as the U.S. Embassy Science Fellow, Power and Energy specialist at the U.S. Embassy in Seoul, Republic of Korea.

Cho, who received the Department of the Navy Meritorious Civilian Service Award in April 2014 for his coordination of numerous international science and technology projects, was selected for this position to help establish a smart micro-grid technology project with his South Korean counterparts and support the U.S. Embassy's Environment, Science, Technology and Energy team. He will work with representatives from the Office of the Deputy Assistant Secretary of the Navy (DASN) Energy Office, the Navy's Pacific Command (PACOM), Naval Facilities Command (NAVFAC), and the Navy International Program Office (NIPO), as well as the U.S. Department of Energy.

"It is a great honor to be selected to the ESF program," said Cho, who earned his doctorate in systems engineering from the University of New Hampshire. "I am more than excited to make a significant contribution to the U.S. Navy's future capabilities."

Cho is one of 1.7 million Korean-American descendants in the United States. He said he has a strong cultural knowledge of Korea and speaks the language fluently – two things he attributes to why he may have been selected for the job. He also worked with South Korea on an $80 million joint project while assigned to Office of Naval Research Global (ONRG) from 2007-2011.

"Given Dr. Cho's technical background and experience as an ONR Global associate director, I thought the ESF in (South) Korea was a perfect fit for him," said Dr. Patricia Gruber, ONRG technical director. "Power and energy is a key technology area for both the United States and Republic of Korea. ONR will benefit from his fellowship by continuing to strengthen our relationships with the Republic of Korea science and technology community."

"As a NAVSSES engineer working on power and energy, this position is a great opportunity to make a significant technical contribution to the U.S. Navy," said Cho, whose federal career spans 23 years. "Smart micro-grid technology is a key for energy security, mission enhancement, combat effectiveness and readiness through use of energy, increased use of renewable and alternative energy, integration of smart energy technologies and reduction in our dependence of foreign oil."

U.S. Secretary of State John Kerry greets Mark Lippert before swearing him in as the new U.S. ambassador to the Republic of Korea, at the U.S. Department of State in Washington, D.C., on Oct. 24, 2014. (State Department photo/ Public Domain)

Cho, who holds 29 patents and published more than 60 technical papers, said U.S. Embassy's need strong technical expertise to develop policy and technical collaboration with host governments, universities and other organizations because most embassy personnel do not have a science background.

"The benefits of collaboration are access to unique facilities and equipment, the opportunity to share techniques and skills, increase knowledge capacity, and share costs and risks while strengthening areas of weakness," said Cho, who earned bachelor's and master's degrees in electrical engineering from the University of Massachusetts and a second master's in business administration from Anderson University.

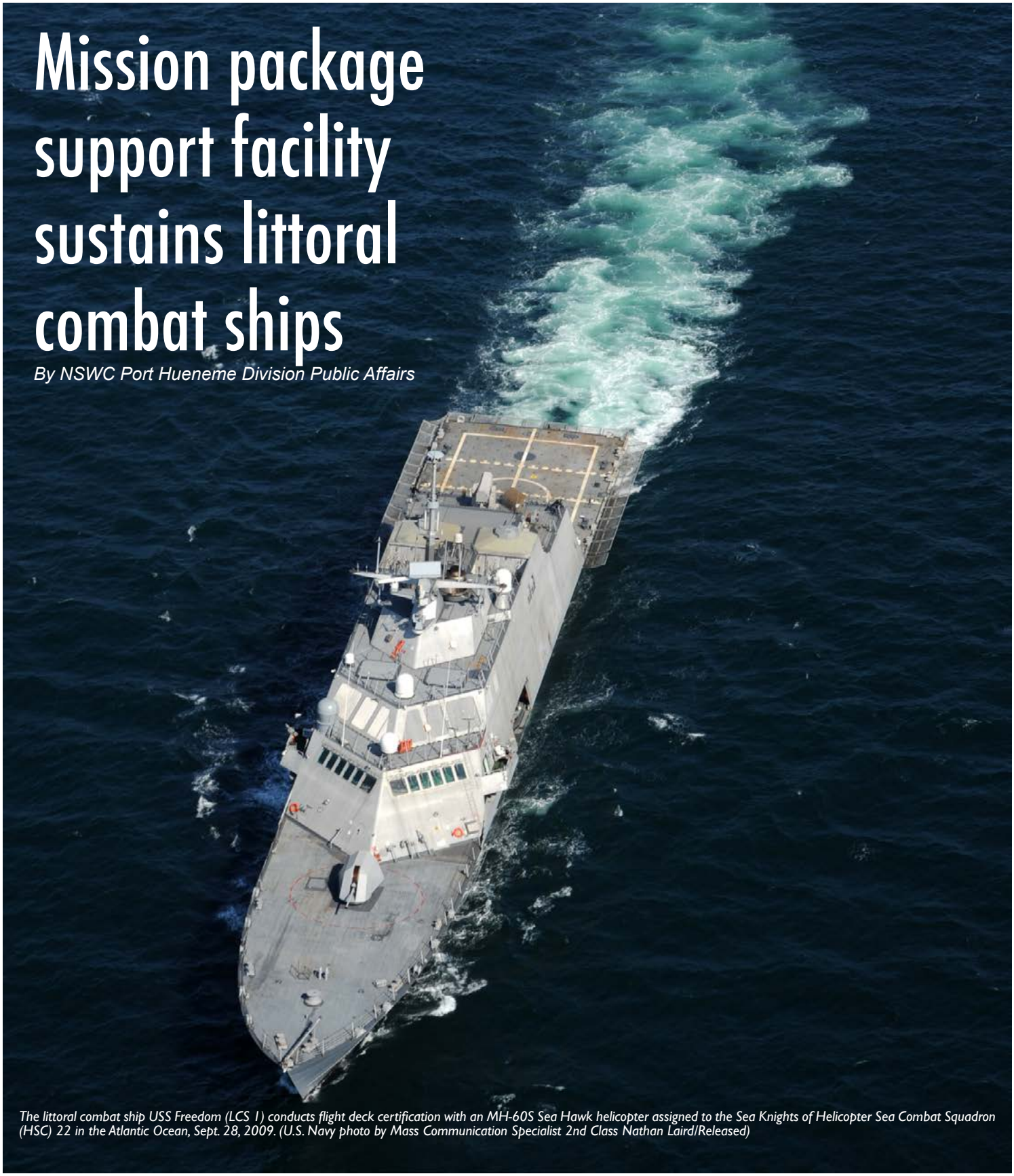
Before the assignment in South Korea, Cho was detailed from NAVSSES to the Office of Naval Research as a program officer where he manages discovery and invention (D&I) and science and technology (S&T) projects with academic professors, industries and government labs. He also provided oversight and guidance for approving, monitoring and ensuring accountability with both domestic and international grants and contracts of up to $3.5 million.

"Personally the ESF program is a great career development tool that will increase my technical capability when I return to NAVSSES," said Cho, who began working at NAVSSES in 2004. "But, more importantly, it will enhance the Navy's relationship with our allies through joint projects."

Cho completes his assignment in January 2015, but said it could be extended depending on funding.

Mission package support facility sustains littoral combat ships

By NSWC Port Hueneme Division Public Affairs



The littoral combat ship USS Freedom (LCS 1) conducts flight deck certification with an MH-60S Sea Hawk helicopter assigned to the Sea Knights of Helicopter Sea Combat Squadron (HSC) 22 in the Atlantic Ocean, Sept. 28, 2009. (U.S. Navy photo by Mass Communication Specialist 2nd Class Nathan Laird/Released)

Naval Surface Warfare Center, Port Hueneme Division (NSWC PHD) is the home of the Mission Package Support Facility (MPSF) – the central sustainment "hub" for Littoral Combat Ship (LCS) Mission Modules (MM).

Within the Naval Sea Systems Command (NAVSEA) Warfare Centers, NSWC PHD specializes in fleet support for in-service surface ship combat and weapon systems. In this capacity, NSWC PHD supports Program Executive Office Littoral Combat Ships (PEO LCS) PMS 505 to maintain, install, remove and replenish MM systems and equipment. PMS 505 operates the Mission Package Support Facility as well as Mission Module Repair Sites to execute MM requirements. MM sustainment includes: maintenance management of organizational, intermediate and depot (O, I and D) level maintenance; asset management and visibility; embark and debark execution including Ready For Use (RFU) / System Operational Verification Test (SOVT); configuration management of installed hardware and software; distance support, troubleshooting and repair; spares and consumables replenishment; and shipping, transportation and pier services.

"Where Mission Package Support Facility is the sustainment hub for mission modules, other Divisions like Dahlgren, Panama City, and Newport support the research, development, test, and evaluation of the Surface Warfare, Mine Countermeasures (MCM), and Anti-Submarine Warfare (ASW) Mission Modules," said Gene Scampone, MPSF deputy site manager. "The Mission Package Support Facility is intended to have a level of organic capability to execute its sustainment responsibilities, but it relies on established engineering and logistics support from our partner divisions to accomplish more integrated and complex tasks."

There are several examples of how the NAVSEA Warfare Centers are collaborating to provide integrated technical solutions in support of PEO LCS. NSWC Dahlgren designed and developed the MK50 Gun Mission Module (GMM), a part of the Surface Warfare Mission Package (SUW MP), to provide the Navy with warfighting capability against small boats. Within the NAVSEA Warfare Centers, NSWC Dahlgren Division specializes in systems engineering and integration of warfare systems. As the GMMs went through developmental and operational testing, Dahlgren engineers provided Port Hueneme's MPSF engineers GMM familiarization training, including how to install and remove the guns within the required 96-hour embark/debark time. NSWC PHD is transitioning to the In-Service Engineering Agent (ISEA) role for the GMM, thereby expanding PHD's role beyond SUW Integrated Logistics Support (ILS).

Another example of collaboration is the partnership between NSWC Port Hueneme and NSWC Carderock Divisions in support of the Rigid Inflatable Boat (RIB), a component of the SUW MP Maritime Security Module (MSM), which provides Visit, Boarding, Search and Seizure (VBSS) capability. Within the NAVSEA Warfare Centers and the Department of Defense, NSWC Carderock Division provides full-spectrum engineering services for boats and combatant craft. During USS Freedom's (LCS 1) deployment, Carderock participated in several fly-away teams to conduct maintenance and repairs aboard small boats, enabling NSWC Port Hueneme's MPSF engineers to provide a more capable, organic level of support to USS Fort Worth (LCS 3) as she deploys.

Currently, NSWC Panama City Division supports the development and integration of the vehicles and sensors that comprise the MCM MP. Within the NAVSEA Warfare Centers, NSWC Panama City Division specializes in engineering for littoral warfare and coastal defense. As the NSWC Panama City Division-developed MP systems progress through developmental testing and operational testing in 2015, NSWC Port Hueneme Division MPSF engineers are relying on Panama City's deep knowledge and experience to repair and maintain the highly integrated systems. Panama City will remain an important engineering and logistical partner as the MCM MP deploys to the Fleet in 2016 and beyond.

In the coming years, MPSF will work with NUWC Newport as the ASW MP comes online to become more familiar with the various ASW systems and equipment.

The Surface Warfare, Mine Countermeasures, and Anti-Submarine Warfare MPs all have a software component critical to the performance of the MM and its integration with the LCS ship. Dahlgren and Panama City collaborate to develop and deliver the Mission Package Application Software (MPAS); MPSF will continue to install and support MPAS throughout its lifecycle.

Personnel from Naval Sea Logistics Center (NSLC), a command within NUWC Keyport, are onsite at NSWC PHD's MPSF and play a key role in maintaining the MM configuration in Configuration Data Managers Database – Open Architecture (CDMD-OA). While normally not onsite, the presence of these Configuration Data Managers (CDMs) is needed to keep pace with the rapid changes that occur with MM embarks/debarks and parts replacement, as well as the reliance on updated configuration information for the maintenance system SKED and the Automated Work Notification (AWN) system for issue/failure reporting. Naval Supply Fleet Logistics Center (NAVSUP FLC) also assists with receiving,stowing, and issuing MM replenishment parts and consumables.

"Across the NAVSEA Warfare Centers, we have visibility across multiple portfolios within multiple warfare areas," said Don McCormack, Executive Director of the Naval Surface and Undersea Warfare Centers. "These are great examples of how we are working collaboratively across the NAVSEA Warfare Centers to deliver integrated technical solutions in support of Naval Programs."

One of nine Warfare Center Divisions under the direction of the Naval Sea Systems Command, NSWC Port Hueneme provides the U.S. Navy with weapon system in-service engineering, logistics, and test and evaluation.

Littoral Combat Ship (LCS) quick facts

- A fast, agile, mission-focused platform designed to defeat asymmetric "anti-access" threats such as mines, quiet diesel submarines and fast surface craft.
- Operates in near-shore environments yet is capable of open-ocean operation.
- Outfitted with reconfigurable payloads, called Mission Modules (MMs) that can be changed out quickly.
- MMs are made up of mission systems and support equipment and when combined with crew detachments and aviation assets, they become complete mission packages (MPs).
- The complete MP has the software, equipment and personnel necessary to deploy manned and unmanned vehicles and sensors in support of Mine Countermeasures (MCM), Anti-Submarine Warfare (ASW) or SurMission Package Support Facility (MPSF) face Warfare (SUW) missions.

The future is now:

Navy's autonomous swarmboats can overwhelm adversaries

By David Smalley, Office of Naval Research Public Affairs

An unmanned 27-foot harbor security boat from Naval Surface Warfare Center, Carderock Division operates autonomously during an Office of Naval Research-sponsored demonstration of swarmboat technology on the James River in Newport News,Va., Aug. 12, 2014. During the demonstration, as many as 13 Navy boats, using an Office of Naval Research-sponsored system called CARACaS (Control Architecture for Robotic Agent Command Sensing), operated autonomously or by remote control during escort, intercept and engage scenarios. (U.S. Navy photo by John F.Williams/Released)

A technological breakthrough will allow any unmanned surface vehicle (USV) to not only protect Navy ships, but also, for the first time, autonomously "swarm" offensively on hostile vessels, officials at the Office of Naval Research (ONR) announced on Oct. 5, 2014.

The first-of-its-kind technology, successfully demonstrated over two weeks in August 2014 on the James River in Virginia, allows unmanned Navy vessels to overwhelm an adversary. Its sensors and software enable swarming capability, giving naval warfighters a decisive edge.

"This networking unmanned platforms demonstration was a cost-effective way to integrate many small, cheap and autonomous capabilities that can significantly improve our warfighting advantage," said Adm. Jonathan Greenert, chief of naval operations.

The technology, called CARACaS (Control Architecture for Robotic Agent Command and Sensing), is under development by ONR and can be put into a transportable kit and installed on almost any boat. It allows boats to operate autonomously, without a Sailor physically needing to be at the controls including operating in sync with other unmanned vessels, choosing their own routes, swarming to interdict enemy vessels and escorting/protecting naval assets.

"Our Sailors and Marines can't fight tomorrow's battles using yesterday's technology," said Chief of Naval Research Rear Adm. Matthew Klunder. "This kind of breakthrough is the result of the Navy's long-term support for innovative research in science and technology."

In the demonstrations, as many as 13 Navy boats operated using either autonomous or remote control. First they escorted a high-value Navy ship, and when a simulated enemy vessel was detected, the boats sped into action, swarming around the threat.

In the future, the capability could scale to include even greater numbers of USVs and even to other platforms, including unmanned aerial vehicles (UAVs).

"This multiplies combat power by allowing CARACaS-enabled boats to do some of the dangerous work," said Dr. Robert Brizzolara, program manager at ONR. "It will remove our Sailors and Marines from many dangerous situations – for instance, when they need to approach hostile or suspicious vessels. If an adversary were to fire on the USVs, no humans would be at risk."

The new technology will allow the USVs to detect, deter or destroy attacking adversaries. Any weapons fire from the USVs would need to be initiated by a Sailor supervising the mission.

Naval leadership has emphasized a blended force of manned and unmanned systems in recent years. Not only can USVs take on dangerous missions, thus protecting the warfighter, but even multiple USVs are a fraction of the cost of a single large manned ship.

The swarm demo announcement comes near the somber anniversary of the terrorist attack on USS Cole (DDG 67) off the coast of Yemen. In that October 2000 attack, a small boat laden with explosives was able to get near a guided-missile destroyer and detonate, killing 17 Sailors and injuring 39 others.

Autonomous swarmboat capabilities could play a vital role in protecting people, ports and commerce.

"While the attack on Cole was not the only motivation for developing autonomous swarm capability, it certainly is front and center in our minds and hearts," said Klunder. "If Cole had been supported by autonomous USVs, they could have stopped that attack long before it got close to our brave men and women on board."

To view a video on autonomous swarm, visit: http://youtu.be/ITTvgkO2Xw4.

WAVES is the official online bimonthly publication of Naval Surface Warfare Center, Carderock Division and is approved for public release.

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