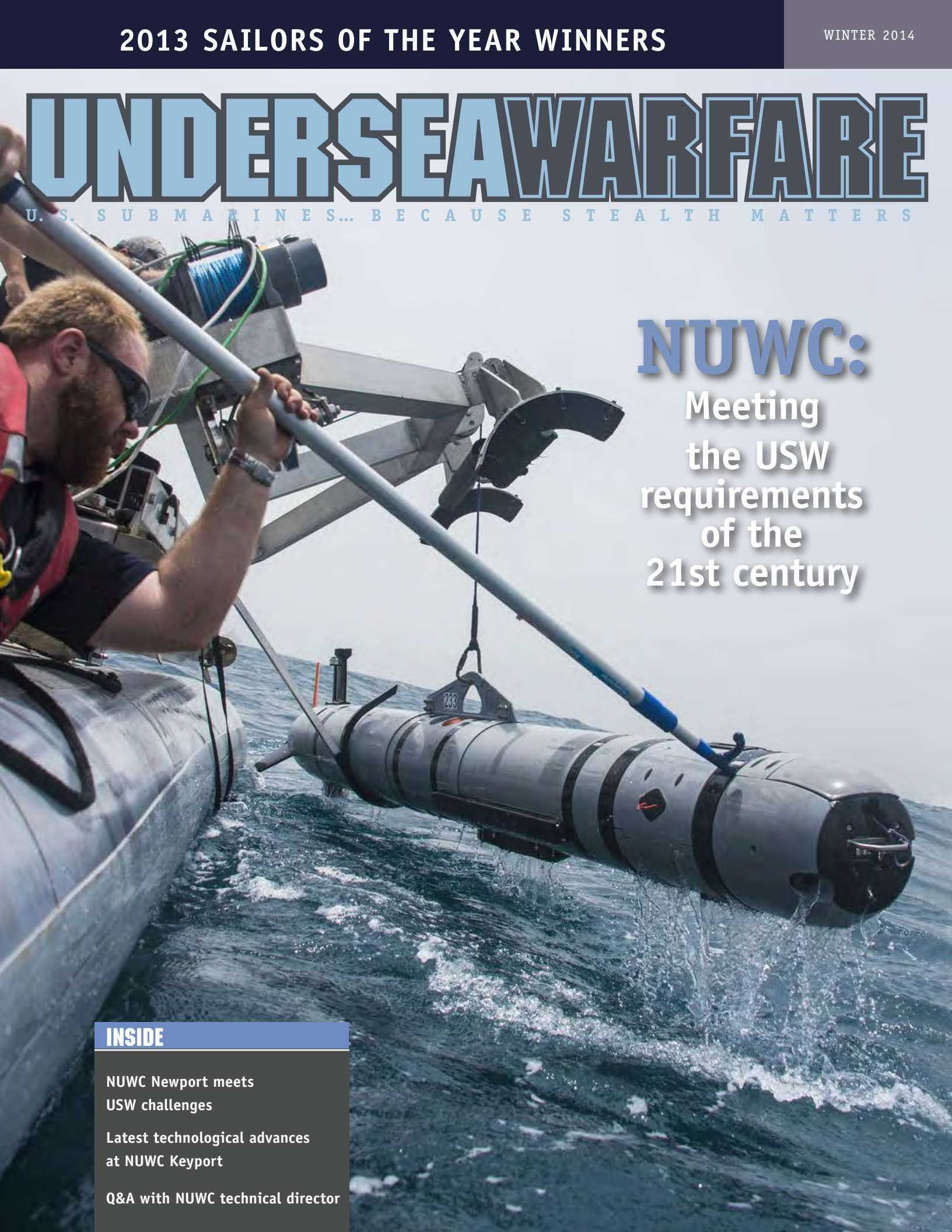
UNDERSEA WARFARE

U.S. SUBMARINES... BECAUSE STEALTH MATTERS



NUWC:

Meeting the USW requirements of the 21st century

INSIDE

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Issue No. 53

UNDERSEAWARFARE
THE OFFICIAL MAGAZINE OF THE U.S. SUBMARINE FORCE

NUWC:
Meeting the USW requirements of the 21st century

On the Cover

An unmanned underwater vehicle (UUV) operator recovers a UUV after a successful run during International Mine Countermeasures Exercise (IMCMEX) 13.
Photo by MCS 1C Daniel Gay

Departments

UNDERSEAWARFARE is online at:www.public.navy.mil/subfor/underseawarfaremagazine

FORCE COMMANDER'S CORNER

Vice Adm. Michael J. Connor, USN
Commander, Submarine Forces

Submariners,

We welcome the new year reflecting back on the remarkable year we had in 2013, and knowing that we have the talent to perform even better in 2014. Your reputation as a warfighting community is solid, globally dominating the undersea with outstanding crews and world-class boats. You conduct valuable missions in harsh environments. Our success through 2025 will build on our core submarine foundation and add innovative use of autonomous, unmanned vehicles that add reach, capacity, and presence.

The demand for the strategic capability of our SSBN force and tactical capability of our SSN/SSGN force remain high. The submarine and its crew will continue to be the foundation of our fighting force, but the age of undersea autonomy is coming fast. As with manned submarines, these unmanned undersea devices will only be valuable if we provide them with stealth, persistence, and capability. Combined with the world-wide access our submarine crews deliver every day, autonomous vehicles can be thoughtfully designed to exponentially increase our undersea influence.

"The submarine and its crew will continue to be the foundation of our fighting force, but the age of undersea autonomy is coming fast."

It is worth noting that, while technology changes, our highly qualified Sailors remain the most vital component to our success. Thank you for executing the mission today and considering the exciting possibilities that lay ahead.

I am proud of you all.

M. J. Connor

DIVISION DIRECTOR'S CORNER

Rear Adm. Joseph E. Tofalo, USN
Director, Undersea Warfare Division

In January, I relieved Rear Adm. Breckenridge as the Director of Undersea Warfare, and I'm thrilled to be here and be part of the OPNAV N97 team!

During this very dynamic time in the undersea warfare arena, I am privileged to be serving as our community's resource sponsor. I am pleased to report that, even as we face uncertain financial challenges, things are going very well for the Submarine Force as we work within the Pentagon to ensure we remain a valuable asset in America's warfighting arsenal for years to come.

As the new director, my orders to the helm remain the same: maintain an uninterrupted, survivable nuclear deterrent, continue to build *Virginia*-class SSNs at a rate of two per year, and deliver payload capacity and payloads to address our future global security challenges.

- Ohio Replacement SSBN(X) – As the most survivable leg of our nation's nuclear triad, recapitalizing the SSBN force as the *Ohio* class begins to retire is a solemn duty we must take on. Submarines from this new class of SSBNs will be on patrol into the 2080s. There will be a lot of debate in the near future on how we can afford this investment as our defense budget continues to shrink, but rest assured, as the Navy's #1 priority we will build this important national asset to maintain a credible, modern, and survivable sea-based deterrent as the *Ohio* class has done for the last three and a half decades.

- Two per year *Virginia* class – This program continues to deliver whole warfighting capabilities well ahead of contractual delivery dates and within budget. Building two per year ensures we maintain the SSN force structure that sustains the undersea capabilities needed to operate effectively in anti-access and area denial environments as a high number of 688s retire in the next 10 years.

- Deliver payloads – Continue the R&D needed to build the Virginia Payload Module (VPM). VPM will add three times the Tomahawk capacity at only 15% increase in cost to the current *Virginia* design. VPM is critical in mitigating the loss of undersea strike capacity as our powerful SSGNs begin to retire in 2026. Additionally we will explore new designs and improve current payloads to enhance the undersea influence of the submarine.

Let's take a fix to see how we are moving down track.

- R&D for the Ohio Replacement remains fully funded and the program is on track to begin construction by 2021 for delivery in 2031. The Trident D5 Life-Extension (D5LE) is fully funded. Both of these will be necessary to ensure there is no gap in coverage as the aging *Ohio* class begins to retire.

- The *Virginia*-class shipbuilding program continues to be a model of excellence. PCU *North Dakota* (SSN 784) is scheduled to be delivered in May. This will be the first Block III and the seventh consecutive *Virginia* to deliver ahead of the contractual delivery date, a feat even more impressive considering the 20% design change incorporated into the Block III design.

- The Joint Requirements Oversight Committee approved the VPM Capabilities Development Document, and R&D is funded through FY18.

- This year we will restart MK 48 ADCAP production. This will be the first year since 1996 that a new heavyweight torpedo is produced.

I am humbled by the tremendous opportunity to serve the Submarine Force, and I look forward to another exciting and productive year. Thank you to everyone who is a part of this community. Nothing succeeds like success, and it is your hard work and dedication that has put the Submarine Force in a position to weather the current and future financial storms.

J. E. Tofalo

UNDERSEA WARFARE
The Official Magazine of the U.S. Submarine Force

Charter

UNDERSEA WARFARE is the professional magazine of the undersea warfare community. Its purpose is to educate its readers on undersea warfare missions and programs, with a particular focus on U.S. submarines. This journal will also draw upon the Submarine Force's rich historical legacy to instill a sense of pride and professionalism among community members and to enhance reader awareness of the increasing relevance of undersea warfare for our nation's defense.

The opinions and assertions herein are the personal views of the authors and do not necessarily reflect the official views of the U.S. Government, the Department of Defense, or the Department of the Navy.

Contributions and Feedback Welcome

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CHINFO Merit Award Winner

Silver Inkwell Award Winner

LETTERS TO THE EDITOR

In keeping with *UNDERSEA WARFARE* Magazine's charter as the Official Magazine of the U.S. Submarine Force, we welcome letters to the editor, questions relating to articles that have appeared in previous issues, and insights and "lessons learned" from the fleet.

UNDERSEA WARFARE Magazine reserves the right to edit submissions for length, clarity, and accuracy. All submissions become the property of *UNDERSEA WARFARE* Magazine and may be published in all media.

Please include pertinent contact information with submissions.

Send submissions to:
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Washington, DC 20350-2000
or **underseawarfare@navy.mil**

FROM THE EDITOR

Stay connected, stay informed, and keep learning.

If you don't already follow us on Facebook and Twitter, now is the time to start!

Follow us to receive submarine related news and updates throughout the day, learn about submarine history through our daily entries, and interact with other readers.

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at http://www.facebook.com/USWMagazine

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SAILORS FIRST

Machinist's Mate Seaman Bradley Hale of the *Los Angeles*-class fast attack submarine USS *Tucson* (SSN 770) hugs his girlfriend Jessica Hill at the submarine piers following the return of the submarine to Joint Base Pearl Harbor-Hickam, March 7, following a deployment to the Western Pacific region.

Photo by MCS 1st Class Steven Khor

by Rear Adm. David M. Duryea, Commander, Naval Undersea Warfare Center

Naval Undersea Warfare Center

For over 140 years, the Naval Undersea Warfare Center (NUWC) and its predecessor organizations have been charged with meeting the undersea warfare (USW) requirements of the U.S. Navy. Over these many years, we have established a reputation for technical excellence and for our commitment to our fundamental role of serving the fleet.

NUWC is an Echelon III shore command and part of the Naval Sea Systems Command. Headquartered at Newport, R.I., NUWC has divisions at Newport, R.I. and Keyport, Wash. and an Echelon V command, the Naval Sea Systems Logistics Center, at Mechanicsburg, Pa. Our detachments and remote sites are geographically spread across North America and the Pacific Basin with locations including Andros Island, Bahamas; Lualualei, Hawaii; Hawthorne, Nev.; Kings Bay, Ga.; Bangor, Wash.; Pearl Harbor, Hawaii; San Diego, Calif.; and Nanoose, British Columbia. The command employs approximately 4,600 personnel worldwide, with more than 50 percent of civilians being scientists and engineers, and draws on the support of about 2,000 on-site contractor partners.

Rear Adm. David M. Duryea

As the Navy's principal research, development, test and evaluation assessment activity for submarine and undersea systems and subsystems, NUWC's most important responsibility is to steward the Navy's technical capabilities in our USW mission area. Our work spans the entire lifecycle of a system that may remain in service for 40 to 50 years. As the Navy's trusted technical agents, we exercise technical authority through various roles including In-Service Engineering Agents and Technical Design Agents for Navy acquisition programs; Technical Warrant Holders in technical leadership areas; and USW technology scientists, analysts, consultants, and advisers to our warfighters and other organizations.

We work with numerous customers including the Naval Sea Systems Command and Space and Naval Warfare Systems Command-affiliated Program Executive Offices, the fleet, and the Office of Naval

Research to help ensure that Navy and other programs are successful. In addition, we provide the fleet with unbiased technical advice to meet national security challenges of today and tomorrow. NUWC partners with other government agencies, industry, and academia to develop traditional and novel non-traditional scientific and technical solutions that create new value for the current Navy, the next Navy, and the Navy after next.

We also deliver an array of responsive options and services for fleet needs and are ready at a moment's notice, 24/7/365, to help get the right people and the right technical services to the fleet. NUWC provides innovative rapid-response solutions to the deployed and operational fleet, helping to maintain readiness so that our warfighters can wholly focus on their mission. The fleet is our number one priority, and we pride ourselves on our ability to diagnose technical problems and get fleet systems back up and operating quickly.

It is the fleet that is driving requirements, and NUWC helps meet those requirements by working in the laboratory environment to explore and develop ideas for the future Navy. We also help by brokering technical solutions that are under development elsewhere and help translate them into innovative approaches for Navy applications. It isn't always about new capabilities. We are equally invested in finding ways to make ships and systems more affordable for the Navy while providing in-service engineering, acquisition lifecycle support, fleet support, maintenance, and always working with our sponsors to find ways to reduce total ownership costs and the cost to deliver our technical support more inexpensively.

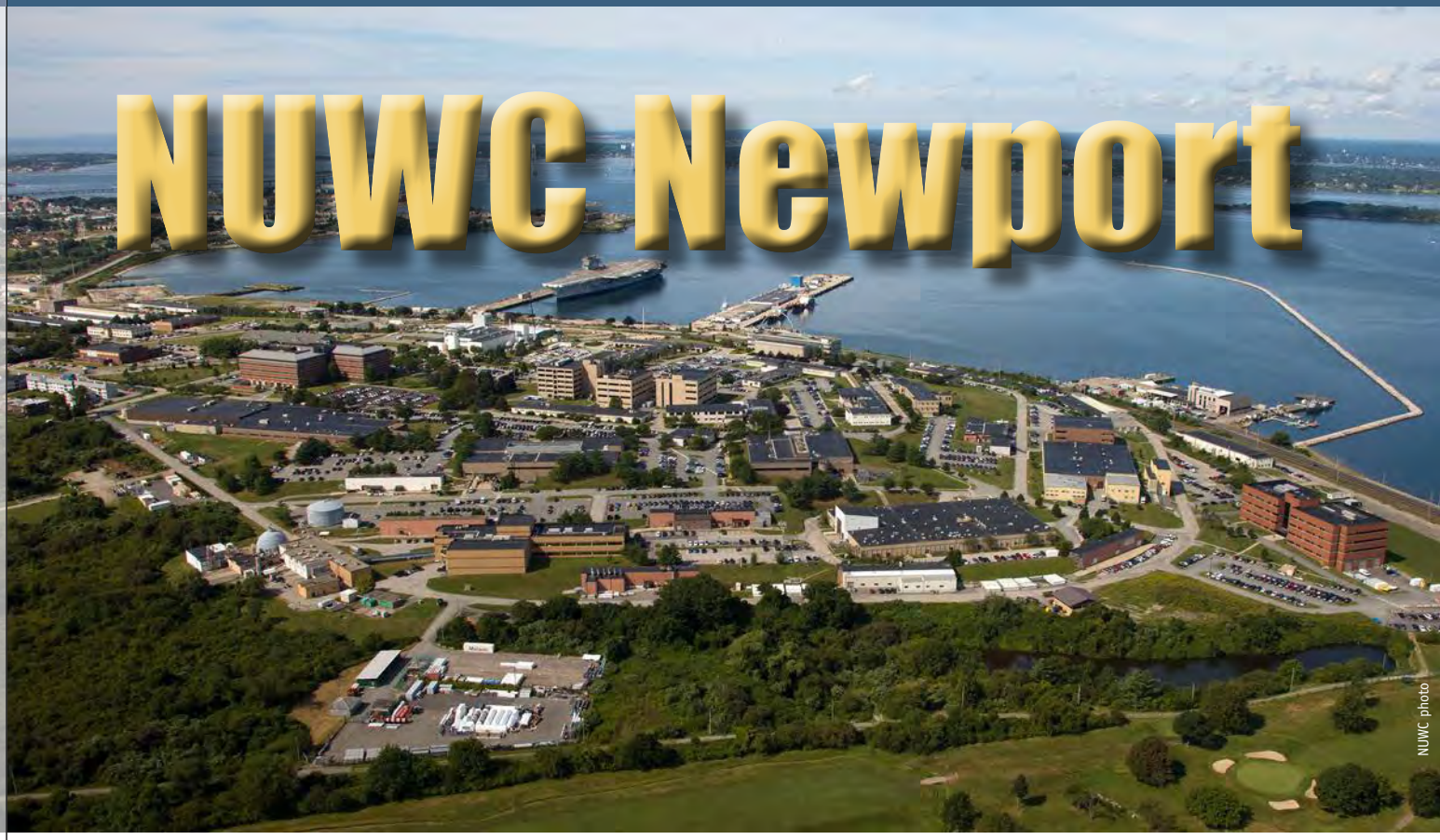
Mission: To operate the Navy's full-spectrum research, development, test and evaluation; engineering; and fleet support center for submarines, autonomous underwater systems, and offensive and defensive weapon systems associated with USW and related areas of homeland security and national defense. NUWC also provides the Navy's core technical capability for the integration of weapons, combat, and ship systems into submarines and undersea vehicles.

While the majority of the Navy is "mission-funded," with congressionally appropriated budgets executed over the course of a fiscal year, NUWC operates as a Navy Working Capital activity. Under the unique principles of the Navy Working Capital Fund, we are held accountable for the efficient delivery of products and services. Our work is contractual in nature; funds must be received before the work is performed (by law), tasking is screened through a work acceptance process, and cost estimates are based on stabilized rates structured for full cost recovery. Successful operation under these guidelines demands that NUWC be innovative and effective in all of its operations.

As NUWC moves forward, we will continue to strive to bring together fleet needs with emerging technology and engineering expertise and offer sound technical solutions to today's and tomorrow's Navy in support of our nation's continued USW dominance.

by Don Aker, Deputy Technical Director, NUWC Newport

NUWC Newport



NUWC photo

Providing Undersea Superiority for the Navy

The Naval Undersea Warfare Center (NUWC) Division Newport provides research, development, test and evaluation (RDT&E), engineering, analysis and assessment, as well as fleet support capabilities for submarines, autonomous underwater systems, and offensive and defensive undersea weapon systems and stewards existing and emerging technologies in support of undersea warfare (USW).

NUWC Newport traces its roots back to 1869 when the Secretary of the Navy authorized the establishment of an experimental torpedo station on Goat Island in Newport harbor. The station was responsible for developing torpedoes and conducting experimental work on other forms of naval ordnance.

When the Torpedo Station was permanently disestablished in 1951, the manufacture of torpedoes was awarded to private industry. In place of the Torpedo Station, a new research and development facility, the Naval Underwater Ordnance Station, was established. In February 1966, the Ordnance Station and the Naval Underwater Weapons Systems Engineering Center were combined to better coordinate all underwater programs conducted at the Naval Base in Newport. Several years later, the center was merged with the Underwater Sound Lab in New London, Conn. to become the Naval Underwater Systems Center. A merger in 1992 with additional naval facilities created what is now the Naval Undersea Warfare Center (NUWC) Newport.

Personnel are testing and proofing torpedoes at the Naval Torpedo Station in Newport, R.I., during World War II.
(Naval War College Museum photo)

The Bridge

Today, NUWC Newport's 2,750 engineers, scientists, technicians, and administrative support personnel provide full-spectrum USW products, systems, solutions, and support. The command depicts its various mission areas using a metaphor of a bridge that spans a broad cross-section of the undersea warfare domain, from basic science and technology (S&T) to development and acquisition, and finally to direct fleet support.

At the S&T end of the continuum, scientists, mathematicians, and engineers conduct basic research and analysis in materials, systems, computer code, and other elemental aspects of the USW environment. This work contributes to new USW technologies and improvements to existing systems and materials. Whenever possible, NUWC Newport leverages common hardware and software solutions to provide the best value to its customers.

Under the center "development" portion of the bridge, NUWC Newport personnel seek new solutions to existing or future USW challenges while also working to improve existing concepts, sensors, weapons, delivery systems, and other products. This includes development of prototypes, system improvements, and the application of existing technologies to other USW requirements. Complex engineering and detailed analysis of USW activities, exercises, and experiments—all conducted with an eye toward maximizing commonality across platforms—contribute to the developmental process as well.

While NUWC Newport does not write acquisition requirements, it does inform and support the acquisition process. The work done in Newport helps program sponsors to define operational, material, and performance requirements for new or improved USW systems. In addition, NUWC Division Newport's unique laboratory facilities can be harnessed to test and evaluate new USW equipment before it is installed onboard surface ships, submarines, or aircraft, saving program sponsors both money and time within the acquisition process.

Finally, NUWC Newport directly supports USW equipment and operations throughout its entire lifecycle within the fleet. With its many labs that replicate nearly all shipboard USW systems, personnel can work remotely with fleet units to help diagnose technical problems and propose solutions to those problems. In cases where technical experts cannot provide such solutions remotely, they can provide on-site expertise in solving equipment, software, and procedural problems. In addition, NUWC Newport's Navy diver program supplies fully qualified divers for underwater support who are also systems-qualified engineers and scientists.

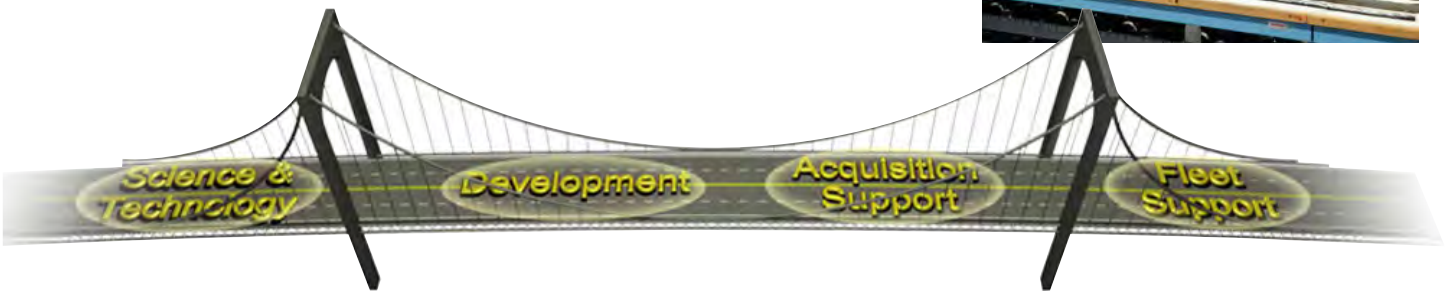
Unique Facilities

NUWC Newport is home to many unique facilities that comprise a networked "virtual submarine," providing a capability that will be important to developing undersea technologies to support the Navy's evolving vision for undersea dominance. Many of these one-of-a-kind laboratories provide state-of-the-art simulations and networking capabilities while reducing cost, risk, and development time. Each is highly specialized for USW and is applicable across the full lifecycle of Navy USW systems. They provide precisely controlled, instrumented environments that enable the most cost-effective method of bringing systems from conceptualization to in-service. By effectively using its unique facilities, the command

Within the Maritime Undersea Sensors and Sonar Systems Complex the Surface Ship Undersea Warfare Lab (shown above) supports surface anti-submarine warfare combat system development, testing, training, performance evaluations, integration with external systems, and in-service support activities for a variety of currently deployed and planned future systems. (NUWC photo)

In the Division's Torpedo Test Facility NUWC engineers execute a comprehensive systems test of a MK 54 Lightweight Torpedo on the MK 695 Torpedo System Test Set. (NUWC photo)

At right, Two technicians are working on an array module in the Towed Systems Complex. (NUWC photo)



1907
Naval Torpedo Factory was built to manufacture torpedoes for the Navy

1909
The MK 7, the first steam-powered torpedo, was developed.

1911
The MK 8 was developed to fill a need for surface-launched, longer-range, faster running weapons with larger warheads. They remained in use up to the first part of WW II

1915
Sonar demonstrated successfully for the first time

embraces fiscal judiciousness while offering its customers unparalleled technical products and solutions.

NUWC Newport operates instrumented ranges for performance evaluation of sensors, weapons, and ships' companies that complement other test ranges within the Warfare Centers. These include the Atlantic Undersea Technical Evaluation Center at Andros Island in the Bahamas and both deep and shallow water ranges in Rhode Island. The command also operates a portable instrumented range that can be delivered to the fleet almost anywhere in the world.

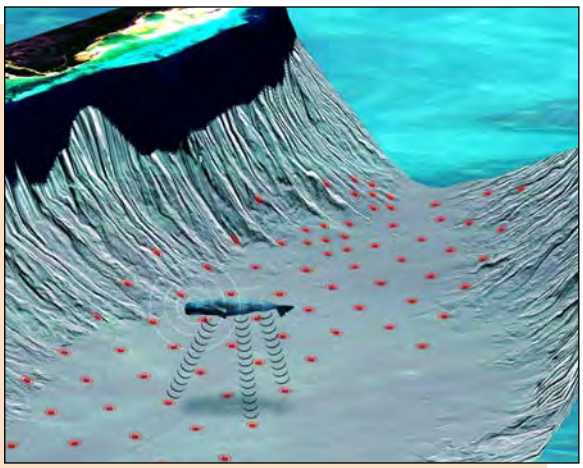
In addition, seven technical departments operate a series of complex, single-focus simulators and laboratories that enhance the Navy's USW capabilities, including the following:

- Maritime Undersea Sensors and Sonar Systems Complex – provides over 154,000 square feet of laboratory capabilities supporting a full spectrum of sensor and sonar capabilities including developing critical acoustic sensors, sonar self-noise reduction and control, signal processing technologies, and operational support to fleet systems and testing of prototypes in specialized facilities.
- Towed Systems Complex – provides facilities and equipment that span the entire systems engineering lifecycle, from research and development to in-service engineering and depot-level support. Virtually all towed sonar arrays operating in the fleet today were fabricated, developed, and tested here.
- Electromagnetic Sensor facility – a 54,000

Atlantic Undersea Test and Evaluation Center (AUTEC): providing unparalleled range capabilities for nearly half a century

One of the Navy's premier east coast in-water test facilities is the Atlantic Undersea Test and Evaluation Center (AUTEC), a detachment of NUWC Newport. AUTEC's mission is to support the full spectrum of undersea warfare by providing accurate three-dimensional tracking, performance measurement, and data collection resources to satisfy research, development, test and evaluation requirements, as well as for assessing fleet training, tactical and material readiness.

AUTEC consists of two facilities. One in West Palm Beach, Fla., supports test planning, logistics, and administrative requirements. The second includes the test facility and range complex and is located at Andros Island and the Tongue of the Ocean (TOTO) in the Bahamas.



A Navy asset since 1966, the AUTEC test facility on Andros Island covers approximately one square mile. The test range sea surface covers over 2,670 nautical miles. Chosen because of its ideal natural characteristics and its climate that permits year-round operations, the TOTO is a U-shaped, relatively flat-bottomed trench approximately 20 miles wide by 150 miles long with a depth that varies gradually from 3,600 feet to 6,600 feet. Its only exposure to the open ocean is at the northern end and, except for this ocean opening, the TOTO is surrounded by numerous islands, reefs, and shoals, which make a peripheral shelter isolating it from ocean disturbances, particularly high ambient noise, which degrades undersea tests and evaluations.

The range systems provide accurate underwater and in-air tracking for both firing platforms and targets using a variety of acoustic beacons and sensors. For the purpose of tracking underwater vehicles, a series of bottom-mounted hydrophones are spatially distributed across the sea floor covering an area of nearly 350 square nautical miles. By taking advantage of the growing maturity of underwater acoustic telemetry, AUTEC can also provide two-way digital data communications with submarines operating at speed and depth.

AUTEC recently established a shallow-water test range and minefield to meet the need for operations and evaluation in the challenging littoral environment.

1917-18

NTS manufactured more than 1,000 torpedoes, hundreds of primers, fuses, bombs, and other explosive devices. Also provided R&D for defensive weapons such as sea mines and ASW harbor nets.

1928

NTS began production of the MK 11 torpedo, the first to be developed completely by the Navy

square foot facility that includes six laboratories and a five-story periscope tower designed to repair and certify periscopes, submarine communications systems, electronic warfare equipment, and imaging/optical systems and provide spaces for both personnel and equipment for prototyping, acquisition and production support, as well as in-service engineering and test functions.

- Virginia Payload Tube (VPT) Life Cycle Support Facility – houses a VPT as well as the ship's systems that support the VPT in an actual ship's configuration, thereby allowing NUWC Newport and contract personnel to replicate ship functionality while augmenting the capability to integrate future large payloads.
- USW Unmanned Payload Development and Integration Facility – serves as the home of USW unmanned payload development, command and control development, and mission module integration.
- Propulsion Test Facility – provides safe and environmentally compliant land-based propulsion system, sub-system, and component testing. Supported systems and technologies include: electric (batteries and fuel cells), open and closed-cycle thermal, and stored chemical energy.
- Common Submarine Radio Room – offers a land-based test facility to provide timely, secure, reliable, and covert communications testing and training for the *Virginia*, *Seawolf*, *Ohio*, and *Los Angeles* classes of submarines.
- Submarine Bridge Trainer/Integrated Submarine Piloting and Navigation Trainer (SBT/ISPAN) – provides a high-fidelity, state-of-the-art training system for surfaced submarine operations to instruct Submariners on handling various scenarios with a particular focus on operational safety, shiphandling, and mariner skills.
- Underwater Sound Reference Division – serves as the U.S. standardizing activity in the area of underwater acoustic calibration. It is the Navy's primary activity for underwater acoustic calibration, test, and evaluation measurements and transducer standards.
- Underwater Transducer Materials Resource – established in support of the design and advancement of transducer materials and devices, it encompasses a broad program dedicated to materials research and transducer design. By providing the Navy, academia, and private industry with unbiased and independent underwater transducer materials evaluation and a materials database, it promotes cooperative research and the rapid transition of new materials into the fleet.

The command also maintains three different anechoic chambers for precise measurement of source-generated noise: both acoustic and electromagnetic frequency anechoic chambers and an anechoic wind tunnel to evaluate flow turbulence noise. NUWC Newport counts a water tunnel, an over-water antenna arch, a reconfigurable combat control, weapons analysis facility, launcher lab, and unmanned underwater vehicle lab among its unique facilities.

A key element of NUWC Newport's mission is to analyze the undersea domain and anticipate its evolution in order to provide the Navy with effective USW systems and solutions for tomorrow.

Support to the Fleet

NUWC Newport provides direct cradle-to-grave fleet support for its products and systems but often gets called to respond to short-notice, emergent, or short-fused casualty reporting or operational requirements. For example, when USS *Hartford* (SSN 768) required emergency mast repairs following a collision at sea with USS *New Orleans* (LPD 18) in the Strait of Hormuz in March 2009, a NUWC Newport team was dispatched and worked around the clock to restore the imaging, navigation, and communication capabilities that enabled the boat to safely travel back to the U.S.

One of the unique facilities at NUWC Newport specifically designed to provide direct fleet support is the Submarine Combat Support Center $(SC)^2$, a purpose-built, continuously manned fleet support facility that enables NUWC Newport to support submarine operations real-time and keep deployed units in the highest combat systems readiness state possible. When activated, the facility provides live chat, a "war room," and real-time fleet problem tracking. The $(SC)^2$ publishes the "Total Combat System Information Newsletter (TOCSIN)," which provides maintenance and technical articles on all deployed combat systems and maintains a $(SC)^2$ website that provides access to TOCSIN, ready reference manuals, and interactive electronic technical manuals for ships, regional maintenance centers, and type commanders.

During Operation Odyssey Dawn (OOD) in March 2011, when American and British ships and submarines launched missiles on Libyan air defenses, NUWC Newport personnel supported the OOD Strike Force and the Tomahawk Weapon System (TWS) Program throughout the entire event. NUWC Newport engineers and scientists provided 24/7 live technical support to the submarine force and operational commands across the TWS, a contribution that was an essential part of the mission's ultimate success.

NUWC Newport has also recently serviced periscope and electronic warfare systems in Pearl Harbor and Guam; conducted first use of the torpedo maintenance Advanced Process Control System at the Pearl Harbor Heavyweight Torpedo Intermediate Maintenance Activity; performed readiness-based sparing modeling and analysis of the ballistic missile defense system of systems to shift spares support from individual system approaches to a single, integrated, optimized approach; and supported the Fifth Fleet's Urgent Operational Need to provide block upgrade software for the MK 54 torpedo.

The command's interaction with fleet commands, customers, and partners is strengthened through a global network of approximately 75 field team members. These

1945

The Columbia and Harvard sound labs were combined and the Navy Underwater Sound Lab (NUSL) was established in New London, Conn., which became the center for surface ship and submarine sonar development until 1970.

1959

The MK 37, Mod 1, the first operational wire-guided ASW homing torpedo, was issued to the fleet.

NUWC Division Newport worked closely with the Naval Research Laboratory and Oceaneering International Inc. to develop the eXperimental Fuel Cell (XFC) unmanned aerial system (UAS). In August 2013 the XFC UAS was deployed from the submerged submarine USS *Providence* (SSN 719) and vertically launched from a Sea Robin launch. (Photo) by NAVSEA-AUTEC)

individuals are NUWC Newport's forward presence who play an important role in the early identification and rapid response to critical fleet needs.

NUWC Newport and the Future of Undersea Domain Influence

A key element of NUWC Newport's mission is to analyze the undersea domain and anticipate its evolution in order to provide the Navy with effective USW systems and solutions for tomorrow. This demand to meet the needs of the next generation of naval forces and those of the "Navy after next" drives a significant RTD&E effort throughout the NUWC Newport campus. A variety of innovative systems has offered new USW capabilities and enabled bold operational warfighting concepts. NUWC Newport is a driving force behind the convergence of USW systems that offer opportunities for the Navy to maintain its undersea dominance while identifying and neutralizing potential threats. Recoginizing the need to be good stewards of limited resources, the engineers and scientists at NUWC Newport have adopted a comprehensive, system-wide perspective with a goal of delivering the most technologically advanced solutions within available resources.

Unmanned Vehicles

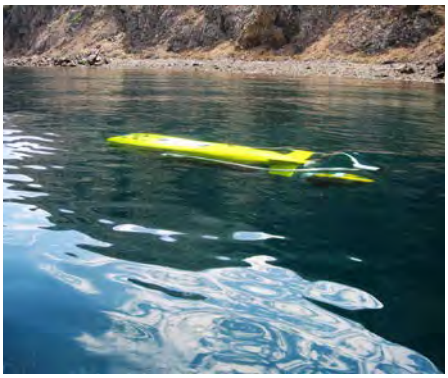
The exploding potential for naval applications of unmanned systems is being investigated for underwater, surface, and air applications pertinent to USW. NUWC Newport is driving the transition of advanced unmanned undersea vehicle (UUV) technologies, including advanced autonomy, advanced underwater non-traditional navigation, collision avoidance and environmental awareness, mission situational awareness, advanced sensors, and others.

UUVs are being developed to expand naval capabilities across a wide range of missions. One major focus is in air-independent propulsion (AIP) systems that will extend mission times over those presently realized using batteries. NUWC Newport is actively investigating fuel cells under the sponsorship of the Office of Naval Research (ONR) and the Department of Energy. Early results indicate that fuel cells are a promising technology for enhancing UUV mission capability.

Several NUWC Newport departments are collaborating and focusing on electronic miniaturization with the goal of bringing new capabilities to different UUV platforms to meet present and future mission objectives. Engineers and scientists are working on UUV technology development and transition, including advanced simulations, command and control capabilities, new in-water test beds, future payload development, autonomy, modular and efficient vehicle hardware, software design, and operational simulations.

NUWC's propulsion and advanced energy laboratory and test facilities provide a national resource for the development and fielding of new vehicle (weapon, target, and UUV) technologies. These include the fuel cell test facility (which is dedicated to testing oxygen-breathing fuel cells along with hydrogen), propulsion noise test facility, the high energy chamber for testing high energy density systems, the deep depth test facility, and modern acoustic, materials, and chemistry laboratories.

UUVs have additional demanding requirements for sensing and navigation. The respective primary objectives of the coupled forward-looking sonar (FLS) and non-traditional navigation development projects are to provide a multi-purpose FLS for terrain mapping and avoidance, obstacle detection and avoidance, and high-resolution imaging for undersea survey missions and to develop and implement novel approaches to minimize positional uncertainty for UUVs operating in areas where global positioning system (GPS) fix-



A team of engineers, including NUWC Division Newport, SPAWAR Systems Center Pacific (SSC PAC), Boeing, Progeny Systems, and SAIC, was formed to execute a project called Persistent Autonomous Maritime Surveillance (PAMS) to demonstrate the feasibility of using a LDUUV to transport and deploy a sensor payload. (NUWC photo)

ing is unavailable or undesireable. Scientists and engineers initiated a complete re-design of the bathymetric map matching processing to better support input from arbitrary sonar systems and reference maps with differing resolution. As its name implies, bathymetric map matching identifies the translation that brings a snippet of bathymetry collected by a UUV into alignment with a previously collected geo-referenced bathymetric map, thus allowing a UUV to precisely determine its position on the world without using GPS fixing.

The weaponization of unmanned systems in support of USW is also underway. An example of NUWC Newport's efforts in this area was an unmanned surface vehicle (USV)/Precision Engagement Module live-fire test wherein, for the first time, long-range surface-to-surface missiles were successfully launched from a moving USV. The test proved the concept while providing extensive data for integrating weapons systems with unmanned vehicles.

NUWC Newport is actively pursuing research designed to harness the enormous potential of unmanned aerial systems for USW. NUWC Newport engineers have worked closely with researchers, scientists, and engineers from the Naval Research Laboratory (NRL) on a unique unmanned aerial system (UAS). The results of their effort were demonstrated in August 2013 at AUTEC when they successfully launched an eXperimental Fuel Cell (XFC) UAS from USS *Providence* (SSN 719). This marked the first time a UAS has been successfully launched from the torpedo tube of a submarine—a significant milestone for both the submarine force and the UAS community. The XFC UAS is an expendable, fully autonomous, man-portable, fuel-cell-powered, long-endurance, small unmanned system with an endurance time of more than six hours that can be tube launched from land or sea. During flight, the submarine received real-time data from the XFC UAS and instantaneously relayed those data to other remote sites.

One of 10 projects approved as new Fiscal Year (FY) 2013 Joint Capability Technology Demonstration (JCTD) starts, the Advanced Weapons Enhanced by Submarine Unmanned Aerial System against Mobile targets (AWESUM) was identified as the Navy, U.S. Pacific Command (USPACOM), and Office of Secretary of Defense for Acquisition Technology and Logistics (OSD-ATL) top priority for the rapid capability in an Anti-Access Area Denial (A2AD) environment. A continuation of submarine UAS efforts that have included at-sea demonstrations from submarines starting in 2009, the AWESUM JCTD will deliver an undersea-launched UAS, optimized for deployment through existing submarine three-inch countermeasure launchers, to perform targeting, intelligence surveillance and reconnaissance, and the potential for limited attack capabilities. The two-year effort will transition capabilities to existing programs of record at PEO Submarines PMS 425; PEO C4I, the Submarine Integration Program Office (PMW 770).

At the direction of the CNO's Information Dominance Office (OPNAV N2/N6 F24), a project was developed to demonstrate the feasibility of using a large-displacement unmanned undersea vehicle (LDUUV) to transport and deploy a sensor payload. The project, known as Persistent Autonomous Maritime Surveillance (PAMS), was a partnership between the Unmanned Maritime Systems (PMS 406) and Maritime Surveillance Systems (PMS 485) program offices. A multi-disciplinary government-industry team of engineers from NUWC Newport, SPAWAR Systems Center Pacific (SSC PAC), and several defense contractors were brought together to execute this two-year demonstration project.

The final at-sea demonstration in 2012 affirmed that the LDUUV and payload performed as models predicted. The PAMS demonstration project has provided valuable insight into the complexities that will need to be accounted for and has paved the way to enable procurement of units for the Navy to perform autonomous deployment of sensors in waters anywhere in the world.

One operational challenge of underwater vehicles is that the ability to attain substantial underwater speeds is severely constrained by the power required to overcome the large drag forces on an underwater body. NUWC Newport is actively engaged in possible applications of supercavitation, which has been used by foreign nations to produce a high-speed threat to naval and civilian platforms. The goal of the Underwater Express/Supercavitation project was to facilitate new operational opportunities in the underwater battle space. During a final experimental test run, the vehicle successfully ran in a cavitation bubble faster than any propeller-driven U.S. electric or thermal underwater vehicle in history. Follow-on proposals seek to use this newly demonstrated technology for long-duration torpedo propulsion concepts.

One operational challenge of underwater vehicles is that the ability to attain substantial underwater speeds is severely constrained by the power required to overcome the large drag forces on an underwater body.

USW Electronic Systems

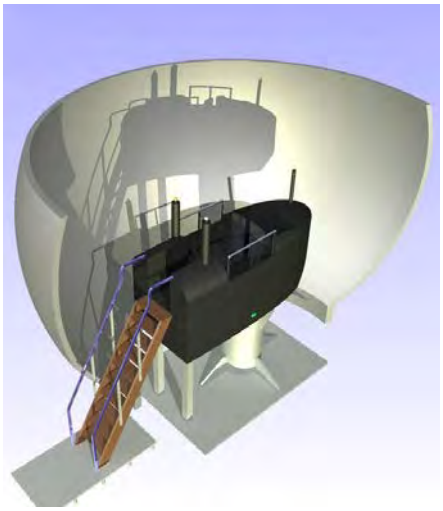
NUWC Newport will open a new Electromagnetic Sensor facility in the spring of 2014 that will provide significant capabilities to keep submarines at the forefront of emerging electromagnetic sensor technologies well into the future. This unique facility serves as the foundation for electromagnetic systems design, prototyping, acquisition and production support, in-service engineering and test functions, and other emerging requirements. The laboratory is the Northeast regional maintenance facility for periscopes and the national repair facility for the Submarine High Data Rate (SubHDR) antenna system. To accomplish its mission, the facility will include periscope and photonics areas, the Integrated Submarine Imaging Systems (ISIS) clean and prep areas, imaging mast disassembly and

1992

The Naval Undersea Warfare Engineering Station (Keyport), NUSC, and the TCCSMA were combined to create the Naval Undersea Warfare Center (NUWC) with headquarters at Newport.

1995

The Orlando sound research lab became part of NUWC. The Naval Combat Systems Engineering Station, established in 1963 as the Electrical Maintenance Center at the Norfolk Naval Shipyard, became part of NUWC.



The SBT portion of the trainer resides in a two-story space that resembles a small Image Maximum (IMAX) theatre—except that imagery is 360 degrees around the observer. (NUWC)

assembly areas, a five-story tower to test and calibrate imaging masts and periscopes in a vertical orientation, a secure/electromagnetic shielded Extremely High Frequency (EHF) radio room, optics labs, fleet training rooms, and a six-axis motion table to replicate the movement of an antenna at sea on a submarine. Antenna work associated with periscope masts includes special ops systems, EHF communications systems, an advanced communications mast for USS *Jimmy Carter* (SSN 23), and SubHDR systems.

NUWC Newport has also worked closely with PMW 770 on the development of an Undersea Connectivity Roadmap, designed to better understand and coordinate current and future technology development aimed at improving undersea connectivity. NUWC Newport has a unique understanding of issues related to communications at or near the air-water interface based on its long history with submarine communications. In the past, the command has supported PMW 770 in the development of technologies and systems to support submarine communications at depth and has worked with PMW 770, SSC Pacific, and others in the areas of design and integration of submarine optical communications systems. Many of these same technologies can be adapted to meet future undersea needs, such as high data rate data exfiltration and robust, secure connectivity with undersea nodes.

A leader in the Navy's development of acoustic communications systems for submarines, surface ships, and UUVs, NUWC Newport has also worked in other areas, including communications networking, UUV communications, and command and control for unmanned vehicles.

NUWC Newport is advancing in submarine mast design and functionality. During FY13, evaluators completed antenna pattern testing of the redesigned Very High Frequency/Radar Absorbing Structure (VHF/RAS) unit at NUWC's Overwater Antenna Arch Test Facility and then tested it at sea on an SSN with follow-on testing at a contractor facility. Once completed, testing results will be used to produce an engineering change proposal later this year.

Recently, representatives from NUWC Newport, PMS 435, NRL, and ONR participated in a design review for the Affordable Modular Panoramic Photonics Mast. NUWC Newport and the Naval Submarine Medical Research Laboratory further defined changes to be made to the video and graphical user interface simulation used in panoramic photonics display testing to support the more complicated search routines and tactical display updates. Based on the results of tests and incorporating the displays developed by the Advanced Processor Build (APB) process for 360° stitching, follow-on tests will focus on the use of panoramic displays to improve continuous search performance.

USW Combat Systems

One of the unique prototypes developed recently at NUWC Newport is the Submarine Bridge Trainer/Integrated Submarine Piloting and Navigation Trainer (SBT/ISPAN). This trainer provides a high-fidelity, state-of-the-art training system for surfaced submarine operations to instruct Submariners on handling various scenarios with a particular focus on navigation, ship handling, and mariner skills. A major contribution for this trainer is what it can simulate: nighttime operations, unassisted landings, and emergency situations with a full bridge party that works toward ship-handling proficiency. The crew members being trained are those who man the sail and the control room during surfaced events. The trainer itself is a near-life-size mock-up of the front end of a generic submarine sail surrounded by a 360-degree horizontal and a 70-degree vertical dynamic visual simulation that includes 18 channels of visual imagery and 16 channels of 3D sound with ownship dynamics provided by Navy-certified hydrodynamic models. Realistic control rooms for the *Los Angeles* and *Virginia* classes have been constructed and provide the ship systems (including commercial and military radar simulations) and dual periscopes needed for surfaced events.

For the squadron staff or tactical readiness evaluation team, the SBT/ISPAN provides a platform for conducting assessments of the full navigation and piloting

In the Virtual Schoolhouse, students are represented as avatars in a shared virtual space, each viewing the exact trainer displays he or she would see in a real-world setting. Students have full interactivity in the remote session with two-way control of the distant trainer asset. (NUWC graphic)

NUWC Newport developed a Submarine Bridge Trainer and Integrated Submarine Piloting and Navigation (SBT/ISPAN) trainer, the first of its kind in the Navy.

team in surfaced submarine operations. Prospective Commanding Officers (PCOs) and Executive Officers can use the SBT/ISPAN to familiarize themselves with the particular operating and maneuvering characteristics of a submarine class. For command qualification, the SBT/ISPAN can be used to conduct practice landing/mooring operations and getting underway under the supervision of another Commanding Officer.

The SBT/ISPAN prototype was sponsored by the USW Training Committee, which includes SUBLANT and SUBPAC N7 representatives, Office of the Chief of Naval Operations (OPNAV - N871B), Naval Sea Systems Command (NAVSEA - 07TR), and the Submarine Learning Center (SLC) in Groton, Conn. Once flag leadership evaluated its potential as a future mariner skills trainer, the SBT/ISPAN became a program of record with Division Newport as the project's lead. Two operational SBT/ISPAN systems have since been installed at the Navy Submarine School, Groton, Conn., and the Naval Submarine Training Center, Pacific, Pearl Harbor.

A development team has been examining virtual worlds technologies for their potential to enhance training while reducing potential costs, increasing analysis power and capabilities, increasing collaboration across organizations, supporting planning, simplifying design and acquisition decision making, and a wide variety of other applications.

A NUWC Newport-led virtual worlds project was initially conceived as a focused technology development project, sponsored by the Assistant Secretary of the Navy Research, Development & Acquisition (ASN(RDA)) and advocated by the Navy Modeling and Simulation Office (NMSO). The objective was to develop a Virtual Worlds Standard Interface to provide two-way interoperability between a distributed simulation environment and a virtual world environment. This interface is anticipated to enable a host of potential applications where a number of participants could make use of a virtual world client from any networked location to allow them to observe, immerse, collaborate, and interact with entities controlled by the federated simulations. This capability will open the door to a host of cases pertinent throughout the acquisition lifecycle and enhance collaboration.

The Virginia Payload Tube (VPT), nearly 30 feet long, seven feet in diameter, and weighing 95,000 pounds, was installed into the new VPT Life Cycle Support Facility at Division Newport's Launcher Lab in November 2013. This facility will provide fleet support for the *Virginia* class by enabling the Division's engineers and technicians to troubleshoot and determine solutions without requiring a ship to be dockside. (NUWC photos)

In early 2012, the SLC in Groton asked NUWC Newport's virtual worlds team to collaborate on applying virtual worlds technologies to training Submariners more effectively and at less cost. In particular, SLC had identified two specific courses—the Sonar Technician (Submarines) Prospective Leading Chief Petty Officer and the Fire Control Technician (Submarines) Prospective Leading Chief Petty Officer courses—as the most challenging because sailors had to be sent from their home duty stations to the Naval Submarine School (NSS) in Groton for seven or eight weeks.

In the Virtual Schoolhouse, students who are physically located in different locations around the world are represented as avatars in a shared virtual space, each viewing the exact high-fidelity trainer displays he or she would access in a real-world setting. Students have full interactivity in the remote session with two-way control of the distant trainer asset. Each student avatar can observe his or her full surroundings, including other displays, students, and tactical information.

NUWC Newport is also working with its partners to develop and deploy next-generation ASW Command and Control systems, most notably the USW Decision Support System (USW-DSS). Developmental and operational testing of USW-DSS was conducted for two years to test system capabilities during major joint military exercises. The tests included at-sea system utilization in a variety of ASW events, an information assurance evaluation and penetration testing component, ASW mission planning events on several ships, and a maintenance demonstration that consisted of fault isolation and repairs. As a result of this testing, Commander Operational Test and Evaluation Force (COMOPTEVFOR) deemed USW-DSS operationally effective and suitable. Additionally, Commander Destroyer Squadron 15 released a naval message that highlighted many of the capabilities of USW-DSS and recognized gains in situational awareness during fleet ASW operations that the system provides.

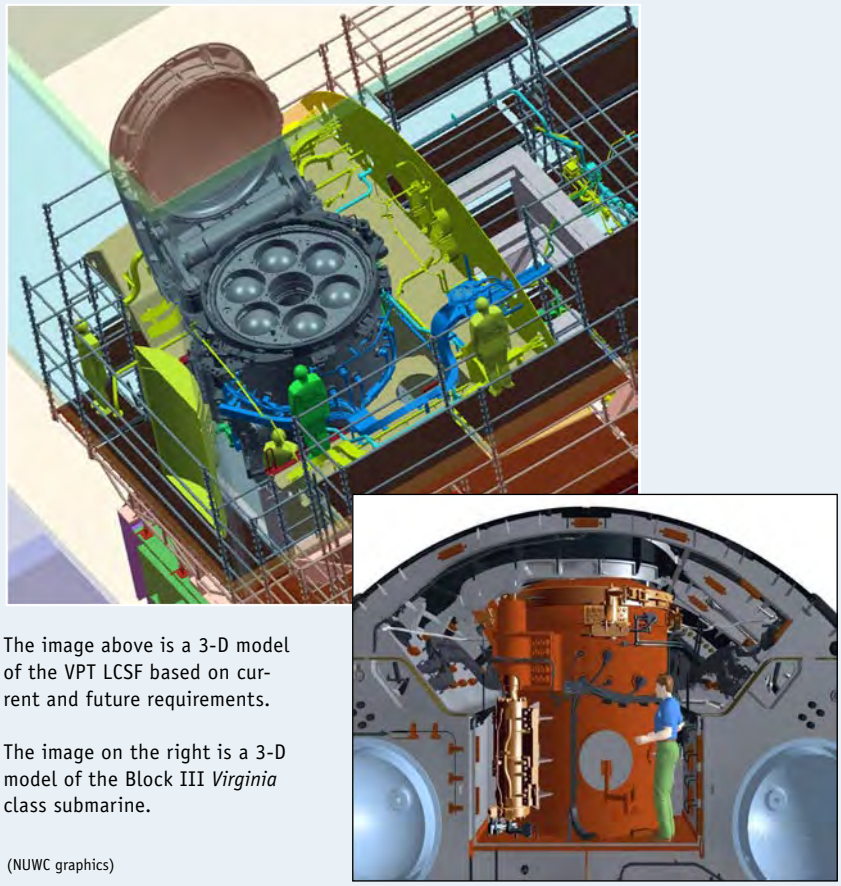
NUWC Newport's Submarine Local Area Network (SubLAN) team is developing a Consolidated Afloat Networks and Enterprise Services (CANES) baseline for submarines. CANES is the PEO for the

Command, Control, Communications, Computers and Intelligence (C4I) program of record network for both surface ships and submarines and is the follow-on network to SubLAN. As full partners in the CANES program with SSC Atlantic and Pacific, the team has evaluated CANES requirements, completed initial system architecture, and began the process of hardware selection. Delivery of a ready-to-install package is expected by FY16. The CANES program is also executing two additional configurations to accelerate CANES introduction into the fleet.

USW Sensors

NUWC Newport is the home of USW sensor development across the submarine and surface Navy enterprise. This includes basic research and development of sensor element technologies, sensor software development and improvements, and the full manufacturing and maintenance responsibilities for systems such as towed arrays.

For example, the NUWC Signal Processing Working Group team recently developed a towed array ranging algorithm using wave-front curvature. In the course of about three months, NUWC Newport was able to produce a working prototype of the ranging algorithm meeting the required thresholds defined by a ranging focus group. The algorithm was accepted into the Acquisition Program Baseline (APB) 13 and is currently in the final phase of the APB step process.



The image above is a 3-D model of the VPT LCSF based on current and future requirements.

The image on the right is a 3-D model of the Block III *Virginia* class submarine.

(NUWC graphics)

Analysts at NUWC's USW Analysis Lab support decision makers in managing risk across an environment of significant complexity and uncertainty. (NUWC photo)

NUWC Newport coordinated an at-sea submarine demonstration of a towed array built with a next-generation telemetry system that potentially provides reduced cost and increased reliability over present arrays. The fleet has requested that the array be installed on additional ships for continued longevity testing. Similar advancements in the quality and reliability of towed array handling equipment are also developed and evaluated within NUWC Newport's towed array labs.

Launchers

The *Virginia*-class Block III configuration has undergone design changes from previous *Virginia*-class hulls. It replaces the traditional 12-missile tube configuration with two modified SSGN tubes designated now as the Virginia Payload Tube (VPT). NUWC Newport, as the In-Service Engineering Agent for the *Virginia*-class submarine program, has developed and installed a land-based test facility to support fleet readiness and operational availability.

This facility, designated as the VPT Life Cycle Support Facility (LCSF), houses not only the VPT but all of the ship's systems that support the VPT in an actual ship's configuration, thereby allowing the facility to replicate ship functionality. This capability will provide engineers and technicians the ability to mimic, troubleshoot, and discover the proper repairs required to resolve fleet issues without the requirement of having the ship dockside.

In addition, future technical advances and alterations can be developed and proofed within the facility before going to the ship, which will save time and money in addition to minimizing impact on the ship's operational availability.

This state-of-the-art facility augments the capability to integrate future large payloads. For example, large-diameter payloads may be

integrated into the tube, with mission capabilities limited only by one's imagination. The VPT LCSF will be tied into NUWC Newport's Virtual Submarine Network, providing end-to-end connectivity with NUWC's Combat Control System lab to enhance the virtual capability between all the systems co-located on the Newport campus, including sonar and sensors. The Virtual Submarine Network is a unique capability and a national asset in submarine warfare, payload integration, and technology for NUWC Newport.

Combining both future payload integration and lifecycle support capability into a single ship-like facility, the VPT LCSF reinforces NUWC Newport's position as the world's leader in payload integration and submarine warfare, delivering the latest technology to the fleet in a timely, cost-effective manner.

Torpedo Defense

Under the sponsorship of Undersea Defensive Warfare Systems Program Office (PMS 415), a Surface Ship Torpedo Defense team, including NUWC Newport personnel, successfully completed the installation of the first Torpedo Warning System and Countermeasure Anti-Torpedo (CAT) systems on the USS *George W. Bush* (CVN 77). This 25-ton installation included the enlargement of port and starboard sponsons to accommodate CAT launch systems, installation of a new winch that necessitated bulkhead cuts, and interfaces to the combat direction center and bridge for new displays requiring over two miles of cabling.

For over a year, the installation team often worked double shifts and weekends in the shipyard and pierside to ensure the carrier would have the new systems installed on schedule. The installation was tested successfully during the ship's first at-sea integration test and recently completed a quick reaction assessment sea test by the Commander, Operational Test and Evaluation Force. This installation delivers the very latest torpedo defense systems to an aircraft carrier.

USW Analysis

NUWC Newport is also the home of a robust and talented team of USW analysts tasked with an extensive portfolio of studies designed to advance new concepts, improve warfighting, enhance operational efficiencies, and improve technology applications.

NUWC Newport's USW Analysis Department recently coordinated a multi-departmental analysis effort in response to an operational need generated by the Commander, Pacific Fleet. Just one of several sites tasked, NUWC Newport's response included both technical proposals and warfare analysis. The warfare analysis component included threat torpedo performance modeling, characterization of the operating environment, systems assessments, and engagement analysis using Simulation-II.

NUWC Newport's analysts have also been instrumental in the early operational assessment of the *Ohio*-class replacement. Through modeling and simulation, Newport supported the effort funded by the Ohio Replacement Program Office (PMS 397) for COMOPTEVFOR by quantifying *Ohio* replacement's improved survivability relative to the *Ohio* class while on patrol.

Analysts also helped develop the LDUUV concept of operations and employment for the LDUUV acquisition program. Sponsored by the Unmanned Maritime Systems Program Office (PMS 406) and resourced by OPNAV N2/N6F, concept of operations analysis efforts included framing and scoping interoperability and integration assessment efforts; defining the tasking, collection, processing, exploitation, and dissemination challenges; defining the operational employment and sustainability space for LDUUV concepts; and exploring operational risks, opportunity costs, employment objectives and sequences, conducting expeditionary basing, and operations scheduling.

The MK 48 Torpedo

A workhorse of the submarine fleet since its introduction in 1972, production of All-Up-Round MK 48 torpedoes ceased in 1996. As a result, much of the specialty tooling, test equipment, and support infrastructure required to produce the MK 48 has been mothballed or discarded. In addition, the technology used in many of the electronic subassemblies is outdated and difficult to procure.

Loss of inventory, evolving mission requirements, and requests from foreign military customers created a need to re-start torpedo production and increase the Navy's active torpedo inventory. Funded through a combination of U.S. and foreign military sales, a program to restart production of the heavyweight torpedo was initiated in 2009.

Despite the layoff in production, NUWC Newport had maintained the knowledge base for torpedo design, production, and testing. Under the sponsorship of the Undersea Weapons Program Office (PMS 404), the command began working closely with selected industry partners to conduct a technology refresh of torpedo subassemblies, update the technical data package, and build and test preproduction units.

Leveraging these activities, NAVSEA is now beginning the process of issuing a competitive solicitation for industry to build new torpedoes in accordance with the updated design documentation. It is anticipated that the production contracts will be awarded in FY16.

The Mission

NUWC Newport's mission is to provide RDT&E, engineering, analysis and assessment, fleet support capabilities for submarines, autonomous underwater systems, and offensive and defensive undersea weapon systems and steward existing and emerging technologies in support of undersea warfare to fully integrate with COMSUBFOR's Design for Undersea Warfare (DUSW). Each element of the NUWC organization aligns with one or more of the three DUSW lines of effort: to provide undersea forces ready for operations and warfighting, to maximize employment effectiveness during forward operations and warfighting, and to develop future force capabilities by preparing for future operations and warfighting.

The scientists, engineers, and support staff at NUWC Newport are committed to providing high-quality, innovative, and affordable products while fulfilling the center's vision of "Fleet Undersea Superiority: Today and Tomorrow."

by Alan D. Kent, Acting Technical Director, NUWC Keyport

Providing Technologies that Sustain the Navy's USW Systems

The mission of Naval Undersea Warfare Center (NUWC) Division Keyport has changed dramatically since the creation of the command nearly a century ago. One thing hasn't changed: the commitment to our nation's warfighters.

The Pacific Coast Torpedo Station was founded in November 1914 to meet the Navy's need for a West Coast torpedo depot. As the Navy's needs expanded, so did the product and service offerings of the command to the point where torpedoes now comprise only one-third of NUWC Keyport's business. The command is known not only for its torpedo expertise but for its unique test and evaluation capabilities, exceptional engineering and fleet support, cutting-edge autonomous underwater systems, and creative custom engineered and obsolescence management solutions, which are in high demand.

Undated photo of a Mk 14 anti-ship torpedo on the deck of a battleship

Torpedo Depot and Intermediate Maintenance Activity

NUWC Keyport is always adapting to the changing world situation with improved technology and weaponry. A prime example of this adaptability is the Torpedo Depot, which provides fleet material support, modernization and industrial technology engineering, and full industrial depot repair capability for undersea warfare (USW) weapons and systems. The Depot was created in response to the need for a facility to perform major repairs and maintenance to heavyweight and lightweight torpedo components and systems. In this role, the Depot has supported every variation of torpedo that has served the U.S. Navy as well as those of several foreign navies.

The Depot provides complete end-to-end repair services including component disassembly, failure analysis, mechanical and electronic systems reverse engineering, new component or systems design and engineering, mechanical and electronic component repair or manufacturing, reassembly, testing, and reissue as "A-Condition" or "as new" hardware.

NUWC Keyport's industrial complex contains the testing capabilities and infrastructure to perform depot maintenance on MK 46, MK 54, MK 48, and MK 48 Advanced Capability (ADCAP) torpedoes, which includes automated test capability for most electronic components and subassemblies. In addition to the Depot repair capability, NUWC Keyport operates two of the Navy's three Heavyweight Intermediate Maintenance Activities (IMA): one in Keyport, Wash. and the other at the Pacific Detachment in Pearl Harbor, as well as the Navy's only Lightweight IMA at Keyport.

The synergy created by having depot, IMA, and engineering capabilities at one Navy facility improves the efficiency for delivery of USW weapons and vehicles to the fleet.

MK 30 Target Depot and Operating Sites

Going hand in hand with torpedo support is the command's support of mobile targets.

The Navy's only MK 30 Mobile Target Depot is operated by NUWC Keyport. The Depot is responsible for performing the basic depot operations of hardware repair, hardware maintenance, and required support functions in support of MK 30 target runs worldwide.

> **"The peninsula lies in the shape of a flask with a narrow neck and is almost entirely surrounded by tidewater, which at no point is less than a quarter mile wide. In an entirety, it affords an ideal location for secrecy."**
>
> — C.F. Riddell, Navy attorney, in a letter to Ira Bennett of the *Washington Post*, July 21, 1913.

The MK 30 targets provide the capability to simulate dynamic, acoustic, and magnetic attributes of a live submarine used to train crews in submarine detection, localization and classification, and exercise weapon firings.

The operational sites prepare, maintain, schedule, and provide MK 30 targets in support of fleet anti-submarine warfare (ASW) training operations. NUWC Keyport operates four MK 30 op sites: Keyport, Wash.; Kauai, Hawaii; San Diego, Calif.; and a recently established site in Guam. Each MK 30 op site supports the following training ranges, respectively: Dabob Bay in Washington and Nanoose in British Columbia, Canada; Pacific Missile Range Facility; Southern California Offshore Range; and open ocean operations for the Pacific Fleet in the Western Pacific.

Application of Advanced Technologies, Repair Techniques, and Processes to Sustain Fielded Systems

Partnering is a key to success when dealing with emerging technologies.

Working closely with industry, academia, and other DoD industrial organizations, NUWC Keyport develops and promotes application of new industrial technologies for improved repair, fabrication, and production in support of fielded weapon systems. The command's work has led to its designation as both a DoD Manufacturing Technology Center of Excellence and a DoD Center of Industrial and Technology Excellence.

Some of the new industrial technologies being used include the following.

Custom Engineered Solutions (CES). Unique maintenance engineering and industrial capabilities enable obsolescence

Sandra Perry-Campbell of NUWC Keyport's Torpedo and Mine Maintenance Division works on a lightweight torpedo in the Intermediate Maintenance Activity in Keyport, Wash. (NUWC photo)

management of DoD materials and components by applying reverse engineering expertise, technology development, and component fabrication and repair capabilities. Components include circuit cards, cables, power supplies, and gyros that have been abandoned by industry. CES capability ensures a ready supply of weapon system components to meet current and future military requirements.

Aluminum Laser Cladding. Aluminum laser cladding is used in a variety of applications for undersea vehicle systems as well as aviation components.

Three Dimensional (3D) Laser Scanning. An automated laser scanning system has been implemented to enhance reverse engineering and part inspection capabilities enabling quick development of computerized part models for undocumented hardware and enhancing in-process parts inspection.

Advanced Composites. Equipment and processes are used for standard and high-performance composites using fiberglass, carbon, and Kevlar materials. An autoclave system controls temperature, pressure, and vacuum for bonding and curing composite structures.

3D Printing. 3D printing and rapid prototyping processes have been commonly used at NUWC Keyport for more than a decade with more than 25,000 components produced on the selective laser sintering system for tooling, test and production fixtures, and end-use tactical parts.

In addition, the AMCAST rapid prototyping system at NUWC Keyport is the only system in DoD capable of printing sophisticated sand molds directly from three-dimensional computer part models. The normal process of producing sand molds and cores is costly and time-consuming but, with AMCAST, NUWC Keyport has reduced mold making time dramatically. In one case, the time to make the mold dropped from nine months to three days. AMCAST castings are currently in service on various submarines, proving their reliability in demanding settings daily.

NUWC Keyport's focus on maintenance and fabrication technology enables sustainment and stability of existing equipment, allowing scarce resources to be applied for weapons technology advances versus redesigning systems based simply on obsolescence.

Direct Support to the Fleet

Part of the fleet's strategic priority to *Operate Forward* is being achieved with NUWC Keyport's direct support to the fleet.

NUWC's divisions in Newport and Keyport teamed with the fleet to identify the level of in-service engineering (ISE) support required for various systems and jointly determined that support should be delivered to key submarine force concentration areas. The delivery mechanisms included on-site presence, fly-away teams, and a distance support system.

By adding a NUWC presence in Pearl Harbor and Guam, the fleet substantially reduced challenges it had previously experienced with communicating across multiple time zones and dealing with delays when on-site response was required from a NUWC engineer or technician traveling from the mainland.

Critical non-propulsion electronics systems like fire control, imaging, electronic warfare, vertical launch, and towed systems are now supported with on-site NUWC expertise that not only delivers NUWC's ISE role but has the added benefit of delivering engineering and technical support to the TYCOM and squadron staffs.

As submarine support requirements have grown in Guam, NUWC's waterfront support has grown along with it. NUWC Keyport's Guam on-site office mitigates the time zone challenge of having fewer than 20 common workweek hours with the rest of the United States. NUWC responded to the fleet's need for forward-positioned ISE representatives and recently developed a forward-deployed torpedo exercise support capability.

Naval Sea Logistics Center: Managing Maintenance for the Fleet

Naval Sea Logistics Center (NSLC) is a shore activity that administratively reports to NUWC Keyport. The professional workforce of over 300 civilian logisticians, engineers, technicians, and analysts located at six primary sites serve as NAVSEA's technical agent for developing, maintaining, and assessing lifecycle logistics support policies, procedures, products, and data systems.

A primary function of NSLC is to centrally manage the Ships Planned Maintenance System (PMS). This includes producing PMS Force Revisions, answering and brokering Fleet Technical Feedback Reports, and leading Fleet Maintenance Effectiveness Reviews (FLEETMERs). FLEETMERs are one method used to improve class maintenance plans. FLEETMERs are conducted periodically to validate that existing maintenance requirements meet the principles of the MIL-STD-3034, Reliability-Centered Maintenance (RCM) process.

Systems are selected using the Maintenance Planning – Engineering Analysis (MP-EA) process, which supports the identification, prioritization, and scheduling of maintenance requirements for RCM engineering reviews. Other inputs that can trigger system selection include fleet input and identification of troubled systems by maintenance figure of merit, top management attention/top management issues, and troubled systems program. FLEETMERs are intended to bring together all stakeholders from the maintenance, technical, and fleet communities to review and improve Navy maintenance. The reviews cover all levels of maintenance performed on the system.

The reviews are typically held in fleet homeports to promote and encourage participation of fleet Sailors, whose knowledge and experience is especially valuable. The reviews provide an opportunity for Sailors to get a first-hand look at the way maintenance is reviewed in accordance with principles of RCM and gives them an opportunity to provide feedback on maintenance requirements, best practices, procedures, tools, and materials based on their experience.

The proud men and women of NSLC work to provide the best quality logistics products to the men and women on our ships and submarines.

1956

In partnership with the University of Washington Applied Physics Laboratory, the 3D Tracking Range on Dabob Bay was developed and became operational.

1958

USS *Sargo* (SSN-583) was the first submarine to use the Dabob Bay Range's underwater course for tracking newly developed acoustic torpedoes.

1965

U.S. and Canadian governments established the Joint Torpedo Test Range in the Strait of Georgia, British Columbia.

Photo by Dylan Solomon, NUWC Division, Keyport

NUWC Division, Keyport's Heavyweight Test Vehicle Launcher (HTVL) is readied for launch by Keyport engineers aboard the R/V NAWC-38. HTVL was used to successfully launch MK 48 based threat surrogate test vehicles against the USS *George H.W. Bush* (CVN 77).

Fielding New Capabilities

Save lives and equipment.

That was the ultimate goal when a challenge was met 85 miles off the coast of Virginia in November 2013. The Surface Ship Torpedo Defense (SSTD) System had been successfully tested once before; however, the Chief of Naval Operations (CNO) issued a challenge: could the partners involved in the program install SSTD on USS *George H.W. Bush* (CVN 77) during a brief, 18-month window prior to deployment?

The answer was "yes."

A successful three-day quick reaction assessment (QRA) was conducted by Commander, Operational Test and Evaluation Force and was one of the final steps in the CNO's "Push to Bush" challenge. It was only the second aircraft carrier at-sea test of the system. NUWC Keyport's inventory of heavyweight test vehicles, design and production of the heavyweight test vehicle launcher (HTVL), and use of the portable tracking range, all aided in the success of the QRA.

NUWC Keyport is a partner in the SSTD program, managed by the Undersea Defensive Warfare Systems Program Office (PMS 415). SSTD consists of a torpedo warning system (TWS) and countermeasure, anti-torpedo (CAT) and is considered a "system of systems" to be installed on aircraft carriers and combat logistics force ships by 2035.

NUWC Keyport's inventory of heavyweight test vehicles supporting CAT and TWS development provides the command's experts the surrogates for threat torpedoes to provide stimulation for the TWS towed array or for the CAT. The modular design of the test vehicles also allows them to serve as a test bed for efficiently developing and proofing out various CAT systems.

NUWC Keyport developed the HTVL to facilitate testing on USS *George H.W. Bush*. This portable slide launcher can launch up to four heavyweight test vehicles from a surface craft and can be deployed from a craft of opportunity anywhere in the world.

Also developed for the SSTD QRA was a modified variant of the shallow-water integrated flexible tracking range to provide 3D underwater track reconstruction of SSTD test events. This system can be deployed anywhere in the world and can provide the same quality of underwater 3D track data that the fixed ranges can provide.

These tools now enable NUWC Keyport to transport a load of eight heavyweight test vehicles to any maritime environment in the world.

1978
NTS Keyport renamed to Naval Undersea Warfare Engineering Station (NUWES) to reflect the expanded mission.

1981
NUWES began developing robots for industrial work, such as painting.

1992
The Arctic Submarine Lab was re-organized as a detachment under NUWC Keyport.

Photo by MCS 3rd Class Bryan Blair

Aerographer's Mate 2nd Class Jason Fisher, right, briefs Japan Maritime Self-Defense Force officers on the capabilities of a remote environmental monitoring unit (REMUS 100) aboard the amphibious transport dock ship USS *Denver* (LPD 9) during Keen Sword 2011. The REMUS 100 is an unmanned undersea vehicle used for mine detection. Keen Sword is the 10th joint training exercise since 1986 involving Japan Maritime Self-Defense Force and the U.S. military.

Unmanned Undersea Vehicles – Tomorrow's Undersea Weapon

The Navy's ongoing commitment to unmanned undersea vehicles (UUVs) has been evident in NUWC Keyport's work in technology experimentation and demonstrations for test vehicles/trucks, payloads, propulsion systems, energy capabilities, and launch and recovery.

The military operation waters in the Pacific Northwest provide a wide variety of comparable threat environments for tactics, techniques and procedures development, as well as operator training. Varying depths, currents, salinity, bottom types, and bathometry with influences such as commercial and recreational vessel traffic, fishing fleets as well as sub, surface, and air fleet military assets afford the environments and tools to emulate future missions.

Additionally, these waters have environmental approval to support UUV and payload operations along with fixed and portable tracking capabilities for real-time precision location of the UUVs, as well as underwater acoustic measurement capability to ascertain the vehicle's radiated noise signature.

The Pacific Northwest Ranges have proven to be so well suited for these applications that it has served as host to major activities, such as the Autonomous Unmanned Vehicle Festival that featured more than 50 vehicles; the collaborative networked autonomous vehicles that deploy 44 REMUS 100 vehicles to form an underwater network; the persistent littoral undersea surveillance network that supported five large research vessels in addition to 25 systems, and 125 UUVs used for research and development demonstration of payloads and launch and recovery.

Unique Underwater Test Ranges

The protected waters situated between the Kitsap Peninsula and the towering Olympic Mountains have played an important role in our nation's defense for decades: they house a unique underwater testing range.

The six square nautical miles of the highly instrumented Dabob Bay Range Complex boasts a variety of depths, currents, and other factors that are ideal for testing undersea warfare equipment and systems. In addition to the Dabob Bay Range, NUWC Keyport partners with the Royal Canadian Navy to operate the Canadian Forces Maritime Experimental and Test Ranges in Nanoose, Vancouver Island, Canada. With 52 square nautical miles and depths up to 1,300 feet, the Nanoose Firing Range is able to host large fleet exercises. Both ranges use acoustic tracking capability for real-time exercise control, reconstruction and analysis, support radiated noise measurement of undersea vehicles and platforms, and use underwater targets for weapon/vehicle stimulation. The ranges are supported by a fleet of marine vessels, including two yard torpedo test (YTT) vessels capable of launching both torpedoes.

New capabilities will need to address tracking multiple underwater objects, preventing interference with systems under test (SUT), and tracking extremely quiet SUTs. Ideally, future underwater acoustic tracking systems will be capable of tracking at any selected frequency to avoid interference with systems under test. A major step in this direction was accomplished with the dual-frequency tracking arrays installed in Nanoose. The technology not only allows the use of two tracking frequencies but provides the ability to track in the presence of countermeasures and increases the number of items tracked.

In conjunction with acoustic tracking systems, the future shows potential for optical tracking. Although limitations currently exist, laser technologies offer interesting opportunities to track and communicate with new weapon systems. NUWC Keyport is actively working to develop test beds for using and employing these emerging technologies.

Similar to in-air challenges, the underwater frequency spectrum is becoming more congested as new weapon systems take advantage of frequencies available. This resulted in the development of the common acoustic acquisition system (CAAS), a new test and evaluation system deployed on the Nanoose and Dabob Bay ranges in 2012 that allows for radiated noise acquisition at higher frequencies. Because of its modern open architecture system, CAAS can be updated easily and is common with many other range systems, including underwater tracking systems.

Perhaps the most dynamic of all underwater range instrumentation are target systems. As weapon systems become more complex, fooling them with simple targets

is no longer achievable. Targets must now be furnished with enhanced realism capabilities. NUWC Keyport is a leader in undersea warfare target development for research and development.

Fleet Synthetic Training — Changing the Way the Warfighter Learns

Merging the real world with the virtual world is something gamers deal with every day. But it's not just about games. The Navy is finding beneficial, cost-effective ways to blend those worlds as well.

The Office of Naval Research (ONR) has demonstrated that merging those worlds is the key to future training in the Navy and has done so by creating the Fleet Integrated Synthetic Training/Testing Facility (FIST2FAC).

FIST2FAC is located on Ford Island at Joint Base Pearl Harbor at NUWC Keyport's Pacific Detachment. FIST2FAC enables a scientific approach to the study of information, computation, and application to advance synthetic training effectiveness and efficiency in the Navy.

The practical evaluation of concept technologies involves artificial intelligence, computer graphics, human-computer interaction, and computational complexity theory. FIST2FAC allows Sailors to interact with artificially intelligent forces in countless settings and train for multiple missions simultaneously. The system can replicate simple and complex situations involving aircraft carriers, helicopters, lethal and nonlethal weapons, and more.

In August 2013, an experiment was conducted to explore improved integrated training solutions for the Warfighter to defeat the fast attack craft – fast inshore attack craft (FAC/FIAC) threat. Fleet operators staffed multiple shipboard and helicopter stations and successfully demonstrated integrated training across multiple visual monitors at various stations and platforms.

Because the system combines a hassle-free setup with software and gaming technology, those involved with the program believe this will help development of strategies for a variety of missions and operations. Ultimately, this could result in improved mission success and enable quicker transitions to new programs.

FIST2FAC allows Sailors to "train like they fight" by presenting realistic forces in a visual, tactical and operational environment. In addition to the fast attack craft threat, FIST2FAC has been used to simulate ASW and strike group operations with aircraft carriers, destroyers, and helicopters. Soon, the system will address electronic, mine, and anti-air warfare scenarios. The goal is to make this capability available on ships at sea.

The next century promises to build on those successes with innovative technical products that demonstrate that NUWC Keyport's first priority is the Navy's undersea superiority.

The associated cost benefits with FIST2FAC could be substantial. Although the system has an initial investment, in contrast to real-life training missions, simulations can be re-used to train multiple warfare areas across multiple platforms without recurring costs. Users can explore endless possibilities without the expense and logistical challenges of putting hundreds of ships at sea and aircraft in the sky.

Photo by John F. Williams

Lt. j.g. Bret Andrews, assigned to the guided-missile destroyer USS *Paul Hamilton* (DDG 60), stands officer of the deck watch in the Office of Naval Research (ONR) Fleet Integrated Synthetic Training and Testing Facility (FIST2FAC) operated by the Naval Undersea Warfare Center Division Keyport, located on Ford Island, Hawaii. FIST2FAC allows Sailors to interact with artificially intelligent synthetic forces in various settings.

A Century of Service

The transition from a fledgling command with 16 enlisted men and eight civilians on a remote peninsula to one with nearly 2,000 civilians and military personnel throughout the world was one that no one could have envisioned when the command was founded a century ago.

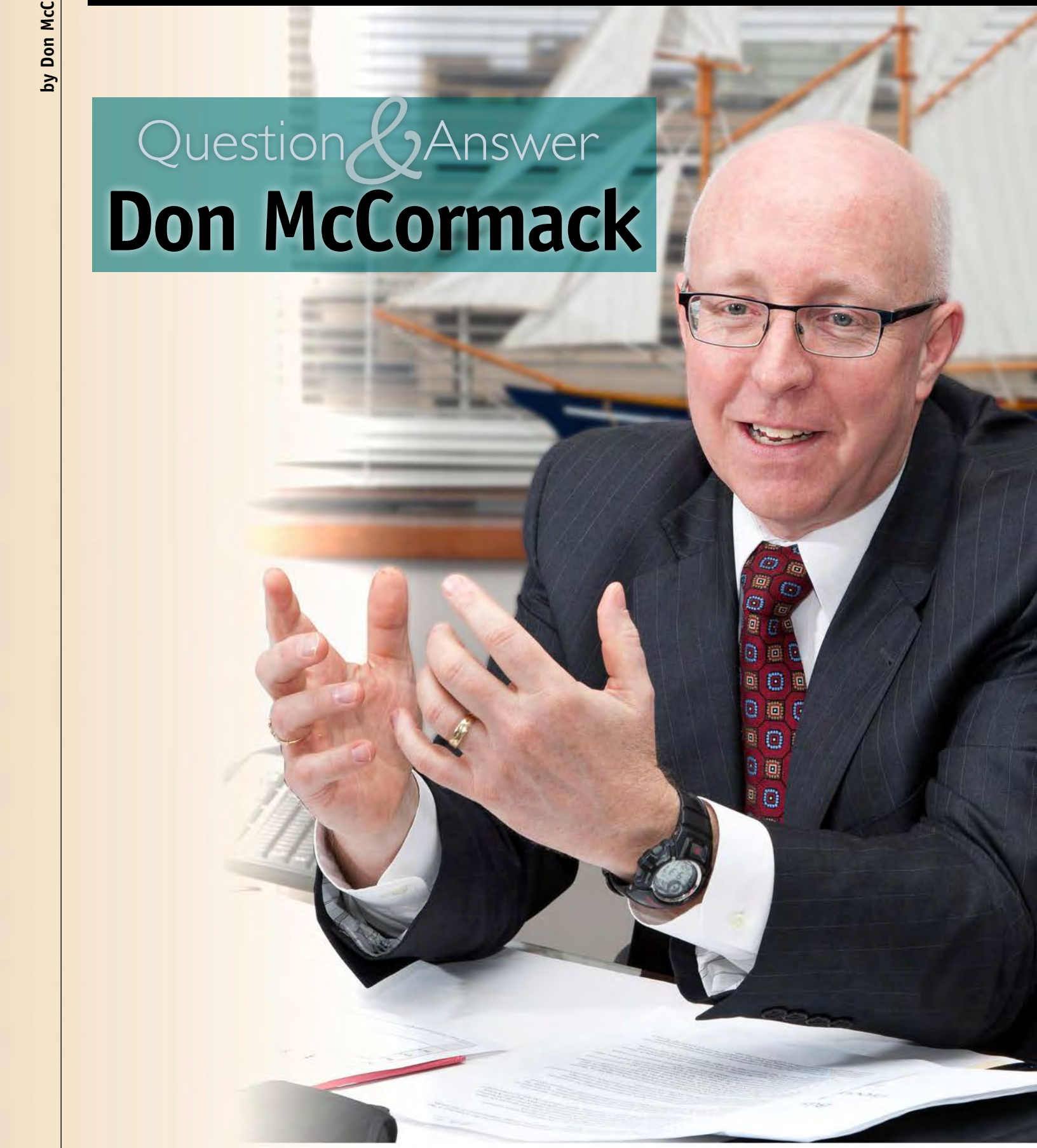
The remarkable innovations, technology, and support to the fleet and our nation were the hallmarks of NUWC Keyport's first 100 years. The next century promises to build on those successes with innovative technical products that demonstrate that NUWC Keyport's first priority is the Navy's undersea superiority.

by Don McCormack

NUWC'S ROLE IN THE UNDERSEA

Question & Answer

Don McCormack



DOMAIN OPERATING CONCEPT:

Donald McCormack, Technical Director of the Naval Undersea Warfare Center (NUWC) and Acting Technical Director of the Naval Surface Warfare Center (NSWC), sat down to discuss some of the challenges and opportunities in the undersea domain.

From your perspective as a Warfare Center Technical Director, how would you briefly explain the Undersea Domain Operating Concept (UDOC)?

CNO and maritime strategists have long advocated that the nation push more combat power under the sea to further exploit the concealment offered by the ocean depths as the threats on the surface and above become more challenging. As a technical community, we agree and always believed the undersea domain "promise" has been underutilized and under exploited. The UDOC, as an operational concept, provides a list of mission areas that should be emphasized further by forces that work in and into the undersea domain. It explores how undersea forces (submarines as well as surface and air platforms and unmanned systems and vehicles) could work synergistically across domains to achieve national security needs. The UDOC seeks to maintain the U.S. asymmetric advantage of operating in the undersea domain. It includes an action plan that assigns responsibilities that will move the concept toward reality.

What is the Warfare Center's role in supporting the UDOC?

NUWC was identified as a supporting organization in eight of the 11 actions in the UDOC action plan. Consistent with the role of the Warfare Centers, we are excited to contribute in the RDT&E, analysis, conceptual development, and experimentation efforts that will result in the future capabilities outlined in the UDOC, and we also can assist in identifying and planning these efforts. Together with a strong connection to the fleet and in conjunction with our industry, academia, and other Warfare Center partners, we will pursue more creative and timely solutions that ensure we are maintaining our undersea edge.

What specific technologies will NUWC work on?

NUWC and its partners have been engaged for years in the development of new technologies and new ways of using existing technologies to better support the concepts contained in the UDOC. We acknowledge that technology alone does not provide an operational capability. As a Warfare Center we must look at the wholeness of a technical capability and work to ensure the technologies are employable and sustainable by operational forces. These operational factors must be considered in the trade space of technology options. One of the things the UDOC stresses is the need to think beyond individual platforms, vehicles, and sensors to the collective operation of these devices across the domain. I expect the Warfare Centers will pursue more creative solutions to ensure undersea dominance, look for new technical ways to exploit the attributes of the domain (covertness, dwell, proximity), and keep pace with our friends, allies, and potential competitors. That said, we continue to pursue technologies from a broader context in a number of areas:

- Command and control/communications
- Mission planning tools
- Unmanned Undersea Systems (UUS): UUVs, Distributed Networked Systems (DNS), submarine-launched UAVs
- Undersea Sensing

Keeping up with the world in undersea technology

While the U.S. Navy develops the Undersea Dominance Campaign Plan, a similar competition for the use of the undersea domain is occurring. Both China and Russia, for example, are heavily investing in undersea technology which is diminishing the asymmetric advantage the U.S. has enjoyed for several decades. If the U.S. loses this advantage, a potential adversary will be able to:

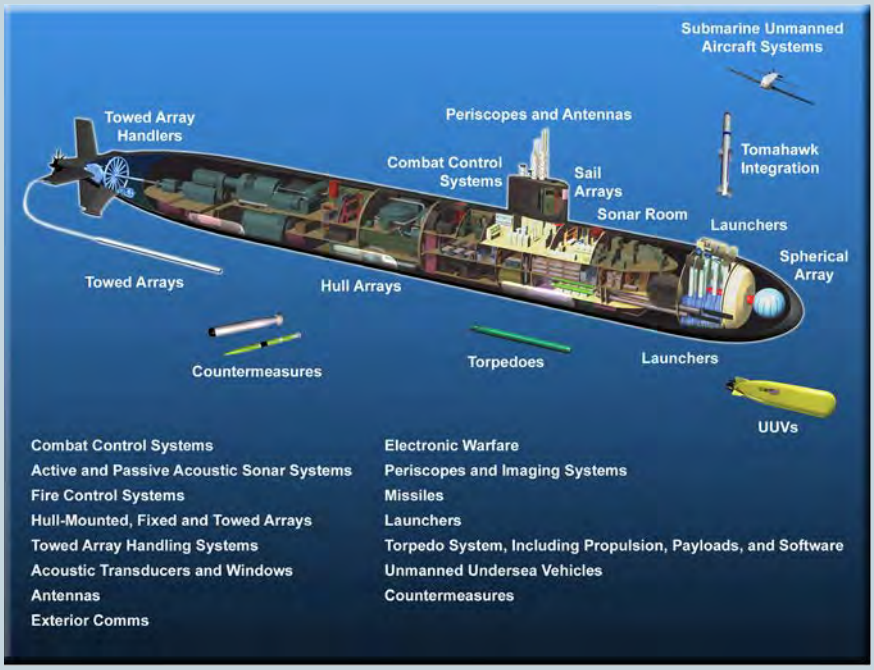
- Deter the flow of U.S. assets to a theater of interest by surfacing an out-of-area submarine off a U.S. forward base, an allied coast, or continental U.S.[1]
- Deter U.S. force involvement by an out-of-area submarine launch of a pre-emptive strike on a U.S. forward base.
- Weaken U.S. forces and protract the conflict by disruption of U.S. sustainment and dilution of anti-submarine warfare (ASW) resources by an undersea attack on U.S. logistic ships via an undersea rear flank.
- Prevent U.S. armed force escalation through the use of non-lethal weapons from under the sea.
- Dissuade U.S. ally cooperation by out-of-area submarine missile launch over or into allied sovereign territory.
- Weaken U.S. or its allies by undersea-initiated disruption of international commerce.
- Weaken U.S. or coalition allies by undersea-initiated attack on critical undersea international information infrastructure.
- Weaken U.S. or coalition will by undersea-initiated attack on critical energy ports or terminals.

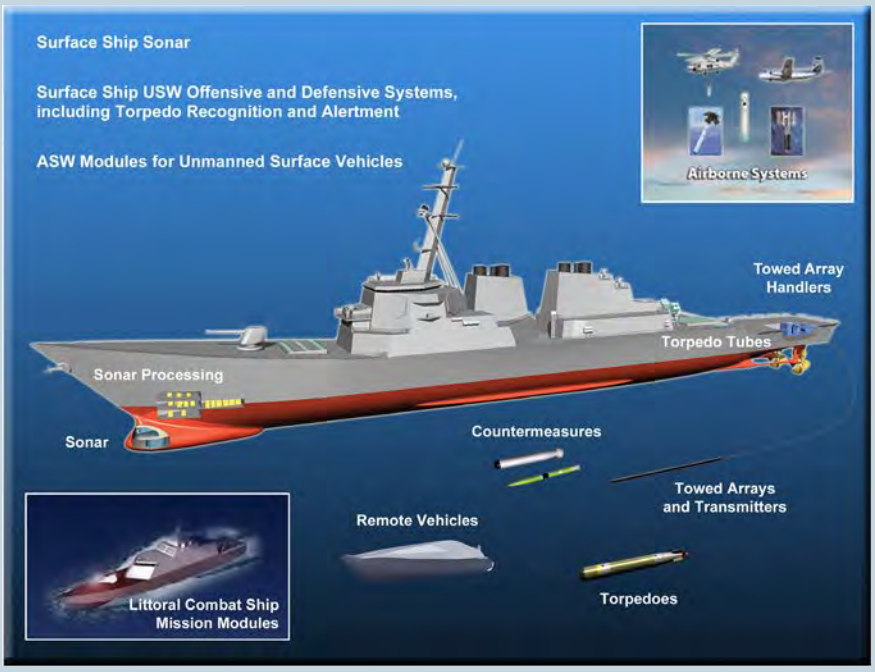
1 In 2004 a PLA Navy *HAN*-class nuclear attack submarine entered the waters off Guam before intruding into Japan's territorial water (Shirley A. Kan, *Guam: U.S. Defense Deployments*, CRS RS22570, Mar. 29, 2012). PLAN submarines have also been seen close to Japanese and South Korean waters. (*The Chinese Threat Below*, Strategy Page http://www.strategypage.com/htmw/htsub/20100205.aspx accessed June 12, 2012)

• Advancement in undersea weapons
• Improved modeling and simulation

What do you see as the biggest undersea domain technological challenges?

Operating within a domain and in the cross-domain context of the Joint Operational Access Concept is different than operating a single platform, vehicle, or sensor. While there are certainly technological challenges for these individual assets, scaling to the cross-domain level brings even more operational, and thus technological, complexity. As an example, communications with a submarine at depth is a platform issue that needs a solution. From the broader domain perspective, reliable and redundant communications must exist between the assets under the sea, the cross-domain surface, air, and space assets, and Command and Control authorities. Future undersea domain concepts also rely heavily on the use of unmanned fixed and mobile devices. Finding technology that provides the right tradeoff of energy density and power control to meet conceptual mission profiles is a major technology hurdle, not to mention timely data exfiltration. Additionally, the physical challenges of the undersea domain necessitate various levels of autonomy that are more complex and technologically challenging than those associated with surface and air assets. In addition, there is the challenge to develop technologies that will allow these new assets to be affordable in numbers. One, two, or even tens of devices will not be sufficient to operate across the domain. Capability and capacity are required to achieve an operational capability. Lastly we must consider the second-order effects that cross-domain implies and consider how our surface, air, and space domain "partners" can be leveraged to technically achieve our end goals and help us get our job done.





NUWC is developing several advanced technologies to assist the U.S. Navy in sustaining its advantage in the Undersea Domain. Many of these new technologies foster a cross-domain approach that extend beyond the individual sub-surface, surface, air, and space platforms.

From a Warfare Center perspective, what are the UDOC's implications for the fleet?

The UDOC highlights the untapped potential of further exploiting the undersea domain and its relationship to Joint Force operations. The UDOC concept goes beyond the notion of the Silent Service and includes the synergistic effect of assets that work in, from, and into the undersea. As a concept, it provides an awareness of how exploitation of an underutilized domain can increase Joint Force success with reduced risk. The fleet needs to conduct experiments based on these concepts and validate the gains to be had.

What are the next big steps for NUWC in turning the UDOC concept into reality?

As the CNO-designated leader of the Undersea Warfare community, Vice Adm. Connor is responsible for overseeing the execution of the UDOC actions. He has developed an Undersea Dominance Campaign Plan that outlines actions and activities toward maintaining undersea dominance. From a technical perspective, this entails a mix of Programs of Record, S&T/R&D efforts, and Rapid Fielded Initiatives. NUWC is aligned with and supporting the admiral's plans for moving forward.

Change of Command

COMSUBDEVRON5
Capt. Douglas Perrry relieved
Capt. Jeffrey T. Jablon

COMSUBRON 11 and
COMSUBPAC REP WC
Capt. Eugene J. Doyle relieved
Capt. Thomas E. Ishee

COMSUBRON 17
Capt. Mark Behning relieved
Capt. John Tolliver

USS *Alaska* (SSBN 732) (G)
Cmdr. Craig Gummer relieved
Cmdr. Bob Wirth

USS *Albany* (SSN 753)
Cmdr. Wade Landis relieved
Capt. Dave Soldow

USS *Frank Cable* (AS 40)
Capt. Mark Benjamin relieved
Capt. Pete Hildreth

USS *Georgia* (SSGN 729) (B)
Capt. William Breitfelder relieved
Capt. Dan Christofferson

USS *Henry M. Jackson* (SSBN 730) (G)
Cmdr. Edward Robledo relieved
Cmdr. Jeffrey Farah

USS *Henry M. Jackson* (SSBN 730) (B)
Cmdr. Richard N. Massie relieved
Cmdr. Jon H. Moretty

USS *Louisiana* (SSBN 743) (B)
Capt. Kevin M. Byrne relieved
Cmdr. Paul Varnadore

USS *Minnesota* (SSN 783)
Cmdr. Brian Tanaka relieved
Capt. John Fancher

USS *Ohio* (SSGN 726) (G)
Capt. Michael D. Lewis relieved
Capt. Rodney A. Mills

USS *San Francisco* (SSN 711)
Cmdr. Jeff Juergens relieved
Cmdr. Eric L. Severseike

USS *Seawolf* (SSN 21)
Cmdr. Jeffery M. Bierely has relieved
Capt. Broderick V. Berkhout

USS *Topeka* (SSN 754)
Cmdr. David Lammers relieved
Cmdr. James Belz

Navy photo by Mass Communication Specialist 3rd Class Jon Erickson

Command Master Chief James Schneider, left, discusses the ship's navigation systems with Kamar de los Reyes, center, and James Burns, both voice actors from the video game 'Call of Duty – Black Ops II.

Call of Duty Visits *Frank Cable*

James Burns, the voice of Sgt. Frank Woods, and Kamar de los Reyes, the voice of Raul Menendez, portrayed in the video game 'Call of Duty - Black Ops II', toured the USS *Frank Cable* (AS 40) and met with Sailors to thank them for their service overseas.

Burns and Reyes received a demonstration of the ship's Firearms Training Simulation (FATS) system in the ship's weapons department. The system simulates various live-fire exercises used to assist Sailors in maintaining firearm qualifications.

The tour continued to various work centers onboard the ship, where Burns and Reyes were able to personally express their appreciation for the Sailors on *Frank Cable* as well as offer autographs and photo opportunities for their fans.

"I'm honored and humbled by the men and women who work here in support of our country," said Reyes. "This was an opportunity for us to come aboard and show our appreciation and our support."

Burns and Reyes both agreed that they were in awe of the efforts the Sailors aboard *Frank Cable* put into ensuring their mission is successful.

"This is by far the most prime example of what it takes to make the military run," said Burns. "People don't realize that the bulk of jobs in the military are the ones behind the scenes like the ones here. The workers here are the ones that make our Navy run smooth."

"It was incredible, I'm still having a hard time wrapping my brain around it all," said Reyes after touring all the work spaces. "The cohesiveness of this unit is really, really impressive. Watching all the Sailors work together, it seems like they're at the top of their game and it's been impressive to watch."

Qualified for Command

Lt. Allen M. Agor
COMSUBRON 11

Lt. Cmdr. John Babick
USS *Louisiana* (SSBN 743) (G)

Lt. Johnathan Baugh
USS *Pennsylvania* (SSBN 735) (G)

Lt. Cmdr. Christopher Blais
USS *New Mexico* (SSN 779)

Lt. Cmdr. Joshua Dishmon
USS *Tennessee* (SSBN 734) (G)

Lt. Thomas Dixon
COMSUBRON 15

Lt. Cmdr. Michael Kessler
COMSUBRON 19

Lt. Cmdr. Michael Lilleberg
COMSUBGRU 7

Lt. Alex Rafal
COMSUBRON 1

Lt. Cmdr. Nicholas Saflund
COMSUBRON 1

Lt. Anthony Stranges
USS *Toledo* (SSN 769)

Lt. Terry Turner
USS *Rhode Island* (SSBN 740) (B)

Lt. Joseph Turner
COMSUBRON 1

Lt. Cmdr. Adam Zaker
USS *Toledo* (SSN 769)

Qualified In Submarines

Lt. j.g. Andrew Adelsen
USS *Helena* (SSN 725)

Lt. j.g. Justin Bergman
USS *Boise* (SSN 764))

Lt. j.g. Jaub Bialek
USS *Tucson* (SSN 770)

Lt. Nicholas Bona
USS *Houston* (SSN 713)

Lt. j.g. Brett Bonds
USS *Annapolis* (SSN 760)

Lt. j.g. Andrew Brooks
USS *Buffalo* (SSN 715)

Lt. j.g. Jeremy Browning
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Zachary Castaneda
USS *Annapolis* (SSN 760)

Lt. j.g. Juanzen Deloney
USS *Rhode Island* (SSBN 740) (B)

Lt. j.g. Christopher Derego
USS *Greeneville* (SSN 772)

Lt. j.g. Jesse Duhn
USS *Georgia* (SSGN 729) (B)

Lt. j.g. Matthew Frantz
USS *Santa Fe* (SSN 763)

Lt. j.g. Timothy Geil
USS *Greeneville* (SSGN 772)

Lt. j.g. Andrew Hardy
USS *Helena* (SSN 725)

Lt. j.g. Matthew Hettiger
USS *Alabama* (SSBN 731) (G)

Lt. j.g. Maxx Irelan
USS *Rhode Island* (SSBN 740) (G)

Lt. j.g. Marcus Johnson
USS *Georgia* (SSGN 729) (B)

Lt. j.g. Scott Jones
USS *Norfolk* (SSN 714)

Lt. j.g. Benjamin Kalkwarf
USS *Tennessee* (SSBN 734) (B)

Lt. j.g. William Kincaid
USS *Norfolk* (SSN 714)

Lt. j.g. Michael Lewis
USS *Olympia* (SSN 717)

Lt. j.g. Miguel Lewis
USS *Greeneville* (SSGN 729)

Lt. j.g. James Ley
USS *Greeneville* (SSGN 729)

Lt. j.g. Matthew Libby
USS *Bremerton* (SSN 698)

Lt. j.g. Khoury Mains
USS *Tennessee* (SSBN 734) (B)

Lt. j.g. Casey Murphy
USS *Tennessee* (SSBN 734) (G)

Lt.j.g. James Nevins
USS *Helena* (SSN 725)

Lt. j.g. Kevin Plumer
USS *Columbia* (SSN 771)

Lt. j.g. Joshua Pound
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Thomas Prinsen
USS *Rhode Island* (SSBN 740) (G)

Lt. j.g. Christopher Reilly
USS *Charlotte* (SSN 766)

Lt. j.g. Jonathan Rizor
USS *Alabama* (SSBN 731) (B)

Lt. j.g. Frank Roney
USS *Bremerton* (SSN 698)

Lt. j.g. Karl Schrutka
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Glenn Shober
USS *Bremerton* (SSN 698)

Lt. j.g. Hudson Spears
USS *Oklahoma City* (SSN 723)

Lt. j.g. Adam Vieux
USS *Key West* (SSN 722)

Lt. j.g. Brian Yaptinchay
USS *Santa Fe* (SSN 763)

Lt. j.g. Jacob Webb
USS *Pittsburgh* (SSN 720)

Lt. j.g. Justin Wetzel
USS *Rhode Island* (SSBN 740) (G)

Lt. j.g. Timothy F. Whitney III
USS *Pittsburgh* (SSN 720)

Lt. j.g. Eric Wittig
USS *Pennsylvania* (SSBN 735) (B)

Lt. j.g. William Yzaguirre
USS *Nevada* (SSBN 733) (B)

2013 Battle "E" award winners

The Battle "E" is an award of merit presented to the most proficient submarine crew in each squadron and recognizes sustained superior technical performance and continual combat readiness throughout the year. The awards are presented by the commodore of each squadron to the submarine under their command that has demonstrated the highest level of battle readiness during the evaluation year.

COMSUBLANT Battle "E" winners:

USS *Missouri* (SSN 780), SUBRON 4 (Groton, Conn.)

USS *Norfolk* (SSN 714), SUBRON 6 (Norfolk, Va.)

USS *Dallas* (SSN 700), SUBDEVRON 12 (Groton, Conn.)

USS *Georgia* (SSGN 729) (B and G), SUBRON 16 (Kings Bay, Ga.)

USS *Wyoming* (SSBN 742) (B and G), SUBRON 20 (Kings Bay, Ga.)

COMSUBPAC Battle "E" winners:

USS *Greeneville* (SSN 772), (SUBRON) 1 (Pearl Harbor, Hawaii)

USS *Jimmy Carter* (SSN 23), SUBDEVRON 5 (Bangor, Wash.)

USS *Cheyenne* (SSN 762), SUBRON 7 (Pearl Harbor, Hawaii)

USS *Albuquerque* (SSN 706), SUBRON 11 (San Diego, Calif.)

USS *Chicago* (SSN 721), SUBRON 15 (Guam)

USS *Nebraska* (SSBN 739) (B and G), SUBRON 17 (Bangor, Maine)

USS *Ohio* (SSGN 726) (B), SUBRON 19 (Bangor, Maine)

Submarine Tender USS *Emory S. Land* (AS 39) (Diego Garcia)

Special Category was awarded to Floating Dry Dock Arco (ADRM-5) and the Undersea Rescue Command (URC), both in San Diego.

Supply Officer Qualified in Submarines

Lt. j.g. Jason Bentley
USS *Albany* (SSN 753)

Lt. j.g. Timothy Geil
USS *Greeneville* (SSN 772)

Lt. j.g. Gary Rayfield
USS *Pennsylvania* (SSBN 735) (B)

Lt. j.g. Leanne Riley
USS *Lousisana* (SSBN 743) (G)

Lt. j.g. Ashly Wisniewski
USS *Maine* (SSBN 741) (G)

Qualified Nuclear Engineering Officer

Lt. j.g. Andrew Allison
USS *Alabama* (SSBN 731) (B)

Lt. j.g. Joshua Anderson
USS *Santa Fe* (SSN 763)

Lt. j.g. Patrick Arrigo
USS *Texas* (SSN 775)

Lt. j.g. Eric Beall
USS *Charlotte* (SSN 766)

Lt. j.g. Joshua Bergeron
USS *New Mexico* (SSN 779)

Lt. j.g. Brian Bink
USS *Maryland* (SSBN 738) (G)

Lt. j.g. Matthew Bouwense
USS *Nebraska* (SSBN 739) (G)

Lt. j.g. Tyler Bristol
USS *Jefferson City* (SSN 759)

Lt. j.g. Jeremy Browning
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Karen Bru
USS *Wyoming* (SSBN 742) (G)

Lt. j.g. Brett Campbell
USS *Boise* (SSN 764)

Lt. j.g. Andrew Castrodale
USS *Springfield* (SSN 761)

Lt. Andrew Christian
USS *Wyoming* (SSBN 742) (G)

Lt. j.g. William Clark
USS *Providence* (SSN 719)

Lt. j.g. Matthew Clement
USS *Topeka* (SSN 754)

Lt. j.g. Joshua Collins
USS *Olympia* (SSN 717)

Lt. j.g. Steven Connell
USS *New Mexico* (SSN 779)

Submarine Junior Officers for 2013

The Junior Officers of the Year program recognizes Submariners who demonstrate superior seamanship, management, leadership and tactical and technical knowledge. The following are those selected for 2013.

Lt. j.g. Andrew L. Hutchison
USS *North Carolina* (SSN 777)

Lt. Alexandar D. Knowles
USS *Jimmy Carter* (SSN 23)

Lt. Jeffrey E. Vandenengel
USS *Cheyenne* (SSN 773)

Lt. James P. Mahan
USS *Albuquerque* (SSN 706)

Lt. j.g. Merritt L. Pearson
USS *Oklahoma City* (SSN 723)

Lt. Garold Munson
USS *Nevada* (SSBN 733) (G)

Lt. Vanessa E. Esch
USS *Ohio* (SSGN 726) (B)

Lt. Stephen G. Boatwright
USS *Frank Cable* (AS 40)

Lt. Taylor T. Johnson
USS *Georgia* (SSGN 729) (B)

Lt. Matthew B. Macnac
USS *Alaska* (SSBN 732) (G)

Lt. David E. Guthmann
USS *Newport News* (SSN 750)

Lt. j.g. Joseph D. Sheffield
USS *Springfield* (SSN 761)

Lt. Robert G. Schultz
USS *Scranton* (SSN 756)

Lt. Jonathan W. Blair
USS *Dallas* (SSN 700)

Lt. Marten Coulter
USS *Alexandria* (SSN 757)

Lt. j.g. James Davis
USS *Alabama* (SSBN 731) (G)

Lt. j.g. Brian Decker
USS *Hawaii* (SSN 776)

Lt. j.g. Christopher Derego
USS *Greeneville* (SSN 772)

Lt. j.g. John Dimotakis
USS *Albuquerque* (SSN 706)

Lt. j.g. Alexander Duncan
USS *North Carolina* (SSN 777)

Lt. j.g. Stephen Erickson
USS *Ohio* (SSGN 726) (B)

Lt. j.g. Matthew Evans
USS *Chicago* (SSN 721)

Lt. j.g. Donald Fannon
USS *Pasadena* (SSN 752)

Lt. j.g. Brian Fischer
USS *Alabama* (SSBN 731) (G)

Lt. j.g. Landon Fuhriman
USS *Nebraska* (SSBN 739) (B)

Lt. j.g. Seth Gay
USS *Charlotte* (SSN 766)

Lt. j.g. John Gorman
USS *Toledo* (SSN 769)

Lt. j.g. Richard Griffith
USS *Buffalo* (SSN 715)

Lt. j.g. Daniel Hagen
USS *Louisville* (SSN 724)

Lt. j.g. Jacob Hartsfield
USS *Jimmy Carter* (SSN 23)

Lt. j.g. Daniel Hearding
USS *Pittsburgh* (SSN 720)

Lt. j.g. Tyler Hochschwender
USS *Helena* (SSN 725)

Lt. j.g. Matthew Horner
USS *Alabama* (SSBN 731) (G)

Lt. j.g. Brian Huff
USS *Maine* (SSBN 741) (G)

Lt. j.g. Matthew Kelly
USS *Alexandria* (SSN 757)

Lt. j.g. Russell Kropp
USS *New Hampshire* (SSN 778)

Lt. j.g. Adam Kulczycky
USS *Maine* (SSBN 741) (G)

Lt. Paul Jarrett
USS *Boise* (SSN 764)

Lt. William Jenkins
USS *Providence* (SSN 719)

Photo by Lt. j.g. Phillip Chitty

"Iron Chef" visits Groton

Celebrity Chef Robert Irvine and his wife, professional wrestler Gail Kim, stand alongside current and future Navy culinary specialists at Cross Hall Galley during his second visit to Naval Submarine Base New London, Jan. 24. Irvine, a former British Royal Navy culinary specialist, toured the facility's full-scale, fully functional replica of a *Virginia*-class submarine galley and spoke with future culinary specialists of the Submarine Force. "The training that you have in your career will put you in great standing in civilian life. I hire former military members because you have the discipline, you show up and you want to work," said Irvine. Irvine gave the culinary specialists compliments and a few chef secrets before touring *Virginia*-class attack submarine USS *Missouri* (SSN 780).

Lt. Scott Larsen
USS *Helena* (SSN 725)

Lt. j.g. Eric Larson
USS *Nebraska* (SSBN 739) (G)

Lt. j.g. Rachel Lessard
USS *Ohio* (SSGN 726) (B)

Lt. Matthew Linsley
USS *Oklahoma City* (SSN 723)

Lt. j.g. Evan Long
USS *Toledo* (SSN 769)

Lt. James Mahan
USS *Albuquerque* (SSN 706)

Lt. j.g. Khoury Mains
USS *West Virginia* (SSBN 736) (G)

Lt. j.g. Andrew Mamroth
USS *Dallas* (SSN 700)

Lt. j.g. Laura Martindale
USS *Maine* (SSBN 741) (G)

Lt. j.g. Joshua Matter
USS *Ohio* (SSGN 726) (G)

Lt. j.g. John Mendenhall
USS *Norfolk* (SSN 714)

Lt. j.g. Vincent Mejia
USS *Asheville* (SSN 758)

Lt. j.g. Karl Meyer
USS *Columbus* (SSN 762)

Lt. j.g. Donald Mills
USS *Florida* (SSGN 728) (B)

Lt. j.g. Gregory Mosley
USS *New Hampshire* (SSN 778)

Lt. j.g. Jacob Newell
USS *La Jolla* (SSN 701)

Lt. j.g. Mitchel Normand
USS *Alaska* (SSBN 732) (B)

Lt. Thomas Nowrey
USS *Charlotte* (SSN 766)

Lt. j.g. Angel Nunez
USS *Jacksonville* (SSN 699)

Lt. j.g. Joshua Paine
USS *Chicago* (SSN 721)

Lt. j.g. Kevin Pate
USS *Kentucky* (SSBN 737) (B)

Lt. j.g. Victor Perez
USS *Cheyenne* (SSN 773)

Lt. j.g. Daniel Perry
USS *San Juan* (SSN 751)

Lt. Ryan Pifer
USS *Maryland* (SSBN 738) (G)

Lt. j.g. Leroy Pimental
USS *Henry M. Jackson* (SSBN 730) (B)

Lt. Craig Potthast
USS *Missouri* (SSN 780)

Lt. j.g. Ryan Rager
USS *Montpelier* (SSN 765)

Lt. John Reeves
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Matthew Rickert
USS *Hartford* (SSN 768)

Lt. j.g. Mathieu Roa
USS *Michigan* (SSGN 727) (G)

Lt. j.g. Craig Schaefer
USS *Henry M. Jackson* (SSBN 730) (B)

Lt. j.g. Brenton Schiffer
USS *Hampton* (SSN 767)

Lt. j.g. Glenn Shober
USS *Bremerton* (SSN 698)

Lt. j.g. Matthew Smith
USS *Olympia* (SSN 717)

Lt. j.g. Stephen Smith
USS *Miami* (SSN 755)

Lt. j.g. Hudson Spears
USS *Oklahoma City* (SSN 723)

Lt. j.g. Megan Stachitas
USS *Ohio* (SSGN 726) (G)

Lt. j.g. Steven Szalay
USS *Hawaii* (SSN 776)

Lt. j.g. George Thompson
USS *Tennessee* (SSBN 734) (B)

Lt. j.g. Justin Tworek
USS *Annapolis* (SSN 760)

Lt. j.g. Jason Ulbrich
USS *Columbia* (SSN 721)

Lt. Jeffrey Vandenengel
USS *Cheyenne* (SSN 773)

Lt. j.g. Jonathan Ventura
USS *Ohio* (SSGN 726) (B)

Lt. Aaron Webster
USS *Louisiana* (SSBN 743) (G)

Lt. j.g. Matthew Willmann
USS *Newport News* (SSN 750)

Lt. j.g. Timothy F. Whitney III
USS *Pittsburgh* (SSN 720)

Lt. j.g. Jessica Wilcox
USS *Wyoming* (SSBN 742) (G)

Lt. j.g. Steven Wright
USS *Mississippi* (SSN 782)

Lt. j.g. Brandon Zoss
USS *Florida* (SSGN 728) (B)

Engineering Department Master Chief

ETC Damian Colin Chenot
COMSUBRON 17

ETC Anthony Thomas Mazza
USS *Florida* (SSGN 728) (B)

MMC Robbie Lee Davis
NNSY Rep

MMC John Travis King
USS *Jefferson City* (SSN 759)

MMCS Chad Warren Lewis
NNSY Nuclear Rrc

EMC Shane Thomas Cary
USS *San Francisco* (SSN 711)

EMC Brandon Christopher Haschke
COMSUBGRU 8

MMC Steven Eugene Johnson
USS *Albuquerque* (SSN 706)

Qualified Surface Warfare Officer

Ens. Michael Kratzer
USS *Frank Cable* (AS 40)

CW03 Raymond Miller
USS *Frank Cable* (AS 40)

Lt. Albea Quentin
USS *Frank Cable* (AS 40)

CW02 Jason Senecal
USS *Frank Cable* (AS 40)

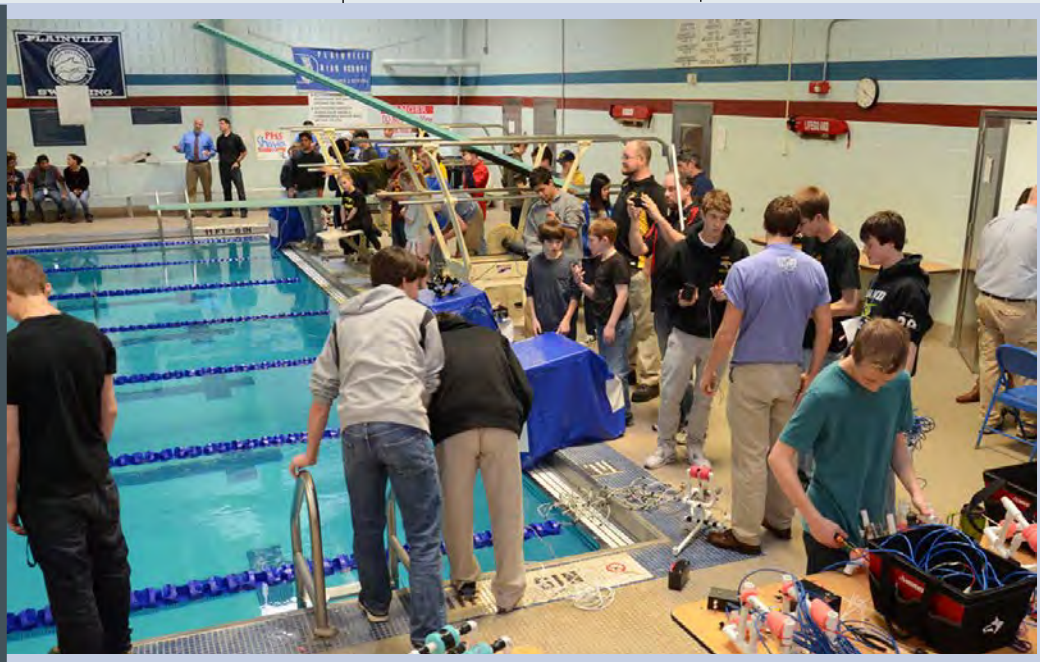


Photo by MCS 1st Class (SW/EXW) Jason J. Perry

Sailors Judge Underwater Robotics Competition

Groton-based divers and enlisted Submariners helped judge a statewide underwater robotics competition in Plainville, Conn., Feb. 27.

Half a dozen Naval Submarine Support Facility divers and nine enlisted Sailors stationed aboard USS *Minnesota* (SSN 783) travelled to Plainville High School. A total of 53 three-person teams from 15 schools across Connecticut competed.

"These young students are really inventive, I am impressed," said Machinist's Mate (Nuclear) 1st Class (SS) Jonathan Bentley, a Sailor assigned to USS *Minnesota*. "You might not think it's possible to build a submersible robot with a 20-dollar kit and some PVC pipe, but they did and it's awesome to watch."

The Navy divers evaluated the obstacle course and a deep water transfer challenge. *Minnesota* Sailors helped grade those events as well as the speed trial event.

Greg Kane, adjunct professor at Central Connecticut State University and coordinator for SeaPerch Connecticut, worked with the Navy to organize the event.

"I really love seeing the interaction between the Sailors and students," said Kane. "They get to see that this is more than just a neat toy to play with in the pool but that it's a tool that the Sailors can use every day."

The SeaPerch program provides students with the opportunity to learn about robotics, as well as science, technology, engineering and math (STEM) while building an underwater remote operated vehicle (ROV). Throughout the project students learn engineering concepts, problem solving, teamwork, and technical applications.

2013 Submarine Sailors of the Year

Photo by MCS 2nd Class Kyle Carlstrom

COMSUBLANT Senior and Junior Sailor of the Year finalists with Vice Admiral Connor.

SUBLANT Senior Sailors, Electrician's Mate First Class (SS) James R. Gagnon (near) and Machinist's Mate First Class (SS) Joseph A. Stockton (far) receiving awards from the Hampton Roads Submarine Vets association.

Commander Submarine Force Atlantic (COMSUBLANT) and Commander Submarine Force Pacific (COMSUBPAC) have announced their 2013 Senior and Junior Submarine Sailors of the Year.

The SUBLANT Senior Sailors of the Year are Electrician's Mate First Class (SS) James R. Gagnon assigned to the USS *Montpelier* (SSN 765) and Machinist's Mate First Class (SS) Joseph A. Stockton assigned to the Nuclear Regional Maintenance Department, Kings Bay, Ga.

As the Senior Sea and Shore Sailors of the Year, Gagnon and Stockton will represent SUBLANT in the Atlantic Fleet Sailor of the Year competition conducted by Commander, U.S. Fleet Forces Command. The other Atlantic Fleet type command winners will compete in the fleet competition. The Atlantic Fleet Sea Sailor of the Year winner from that competition will be meritoriously advanced to chief petty officer, while the Atlantic Fleet Shore Sailor of the Year winner will enter the Chief of Naval Operations competition in Washington, D.C.

The 2013 SUBPAC Senior Sailors of the Year are Electrician's Mate First Class (SS) Scott P. Koenig from USS *Jimmy Carter* (SSN 23) and Machinist's Mate First Class (SS) James A. Nelson assigned to the Commander, Submarine Squadron 15 Performance Monitoring Team. Both SUBPAC Senior Sailors of the Year go on to represent the Pacific submarine force in the Commander, Pacific Fleet Sailor of the Year competition.

Photo by MCS 2nd Class Kyle Carlstrom

Capt. Tom Ishee (far left) and Force Master Chief Michael Caldwell (far right) stand with the finalists for Commander, Submarine Force U.S. Pacific Fleet Sea Sailor of the Year for 2013.

Photo by MCS 2nd Class Kyle Carlstrom

Machinists Mate 1st Class (SS) James Nelson (center) stationed at Commander, Submarine Group 15, Guam, is awarded Commander Submarine Force U.S. Pacific Fleet Shore Sailor of the Year for 2013 by Capt. Tom Ishee (left) and Force Master Chief Michael Caldwell (right).

USS *Silversides* (SS 236)

Muskegon, Mich.

The USS *Silversides* Museum opened in 1987 when the WWII *Gato*-class submarine arrived at its new home in Muskegon, Mich. She was built by Mare Island Navy Yard, Vallejo, Calif., launched on August 26, 1941, and commissioned on December 15, 1941.

USS *Silversides* received 4 Presidential Unit Citations and 12 battle stars for outstanding service in the war. Completing 14 war patrols, she sank 23 ships totaling more than 90,000 tons of merchant shipping, the third-highest tonnage sunk by a U.S. submarine during the war.

In May 1942, while maneuvering through a fishing fleet toward several enemy cargo ships, the submarine's periscope became entangled in a fishnet marked by Japanese flags held aloft on bamboo poles. *Silversides* bored in on the enemy ships, fishnet and all. Her attack tore open one ship's stern and hit a second ship. *Silversides* is probably the only American submarine to make an attack while flying the Japanese flag.

On Christmas Eve 1942, *Silversides*' pharmacist's mate performed an emergency appendectomy on one of the crew. With the operation over, she surfaced only to be forced down by a Japanese destroyer and depth charged. When *Silversides* surfaced later, the destroyer was still there along with a Japanese airplane, which dropped three bombs on her, causing her bow planes to lock on full dive. *Silversides* leveled off just short of crush depth and evaded the enemy ship before surfacing to recharge batteries and make emergency repairs.

While patrolling off Kyushu, Japan, she aided in the rescue of USS *Salmon* (SS 182), which had been badly damaged in a depth charging and was forced to surface and try to escape while fighting enemy escorts in a gun battle. She deliberately drew the attention of some of the escorts and then dove to escape the gunfire. Soon submarines USS *Trigger* (SS 237) and USS *Sterlet* (SS 392) joined in helping to guard *Salmon* and escorted the stricken submarine back to Saipan.

After the war, *Silversides* served as a U.S. Navy Reserve training boat near Chicago. Decommissioned in 1969, she was saved from scrapping by the Great Lakes Navy Association in 1972.

Silversides is on display in Pere Marquette Park and is virtually unmodified since her last refit in 1945. The museum includes exhibits focusing on USS *Silversides*, WWII, the Pearl Harbor attack, submarines, the Cold War, marine technology, and Great Lakes shipping. The museum's theater currently features a documentary about U.S. involvement in WWII and the role of the U.S. Navy Submarine Service.

www.silversidesmuseum.org