2008 OnWatch

NAVAL SEA SYSTEMS COMMAND

NAVSEA

Supporting the Warfighter

NAVSEA
NAVAL SEA SYSTEMS COMMAND

CONTENTS

ON WATCH 2008

The annual magazine of the Naval Sea Systems Command

4
FROM THE COMMANDER
Our growing team of diverse professionals continues to push for streamlined processes — with a commitment to develop lethal, agile and adaptable technology.

6
FROM THE EXECUTIVE DIRECTOR
We need to break down barriers, build partnerships and leverage our resources. This isn't just a theory. It's happening across the command right now.

7
Aligning to the Navy Enterprise
Under the Enterprise Construct, the Navy operates more like a single organization. The Navy Enterprise is about business rules and how we run the Navy … whether it's procuring, maintaining, overhauling or any other function.

8 The Incredible Warfare Centers
The warfare centers maintain unique national assets for the Navy that are not always commercially feasible, such as test and evaluation ranges, and shore facilities and laboratories that replicate "at-sea" systems.

14 Naval Shipyards
NAVSEA's One Shipyard concept provides the Fleet customer with increased maintenance and repair opportunity. Highly skilled shipyard workers demonstrate their innovation and flexibility while they support the warfighter.

18 Building America's Future Fleet
The Navy is an evolutionary force that constantly adapts. The key to producing an effective and affordable future Fleet is a balance between speed, maneuverability, flexibility and modularity.

22 Delivering Today's Fleet
President Teddy Roosevelt launched a young nation onto the world stage in 1907 with the Great White Fleet. In the 100 years since, the Navy's Fleet has become the precision tool of Roosevelt's dreams.

26 Equipping the Warfighter
In the Global War on Terrorism, few warfare communities are closer to the tip of the spear than EOD teams. "Anytime you send a robot to detonate an IED and something bad happens, you've saved a life."

28 SUPSALV: Delving Deeper
While helping shipyards and regional maintenance centers curb Fleet maintenance costs, SUPSALV works hand-in-hand with NAVSEA PEOs and program managers, anticipating maintenance requirements for new vessels.

36 SEA 21: Ships Cradle to Grave
From scheduled maintenance needed for every commissioned ship to essential modernization needed to keep ships ahead of the threat, SEA 21 manages a modernization and disposal strategy that keeps the Fleet running efficiently.

38 Protecting the Fleet
Seaborne threats remain a top concern in maritime domain. Sea mines have damaged or sunk more Navy ships since 1950 than any other threat — and the threat of terrorist attacks against ships remains a grim reality.

42 Today's Carriers
Far from winding down into obsolescence, the *Nimitz* class is thriving as illustrated by two members of the class in different stages of service life: *George H. W. Bush* (CVN 77) and *USS Carl Vinson* (CVN 70).

46 The *Virginia* Class
The *Los Angeles*-class submarines will soon start to go out of service at a rate of three to four per year, and right now we're only building one per year. Can the Navy afford to build two of these per year? The answer is *yes*.

50 Swift, Stealthy, Lethal: The SSGN
USS Georgia's (SSGN 729) delivery was significant for a technologically advanced submarine conversion program: It confirmed how a team with many players works together to reach an aggressive goal by following a game plan.

52 Big Shots!
A high priority has been placed on the naval gunnery team to develop a new long-range, guided projectile. A new "smart" projectile called Extended Range Munition (ERM) will extend the range of the 5-inch gun significantly.

54 Submarine Combat Control
The AN/BYG-1 represents the principal interface between sensors and operators, focusing on a full operational picture supporting tactical employment decisions for the ship and its sophisticated weapons.

56 The New Engine Room
NAVSEA 05D completed a study with a notable conclusion: ship mission and operating requirements should be the primary drivers in the selection of a particular power and propulsion system architecture, not ship displacement.

58 OA: Faster, Cheaper, Better
That's the promise of Open Architecture. During the past year the Navy's Program Executive Office Integrated Warfare Systems (PEO IWS) has made significant strides in important developmental areas of Open Architecture.

60 21st Century Leaders & Diversity
NAVSEA has taken solid steps to expand the capabilities of its workforce and to lay the foundation for the 21st century workforce. NAVSEA's initiatives promise fresh new ways to approach the challenges of this century.

64 A 2007 Photo Album
In a 2007 filled with successes, advances and important work for the Fleet and its warfighters, we also observe and celebrate some of our less visible but equally important milestones, from ship launchings to Bronze Star Medals.

66 Credits
This magazine is produced each year through the awe-inspiring efforts of NAVSEA employees, military, civilian and contractor. They write stories, they take photographs, they design pages and lots more. This is who they are.

INSIDE BACK COVER
NAVSEA 2008 Command Pocket Guide
The Complete Directory to people and offices at the NAVAL SEA SYSTEMS COMMAND

58

14

67

8

42

28

Welcome to the 2008 edition of *On Watch*! I'm excited about all of the things we've accomplished since the 2007 edition, and I encourage you to read through this entire publication. You'll find great information about important NAVSEA programs; you'll also find the pocket guide and fact charts to keep your NAVSEA network and information at your fingertips.

This year I have a couple of thoughts for your review. The first is a challenge, while the second recognizes the achievements of the NAVSEA team.

The challenge: It's no secret that financing the recapitalization of our ship and aircraft Fleet will be extraordinarily difficult as we enter the Program Objectives Memorandum (POM-10) debate.

I fully expect heavy pressure on NAVSEA to produce savings to our customers. This may sound like more of the same recent mantra. Well, as your leader, I need to tell you that:

- We are still the largest consumer in the Navy.
- We still have the largest civilian/contractor payroll in the Navy.
- Much of the great work we do is not well understood by our valued Fleet customers.

As we respond to the pressure of our Enterprise leads to continue with efficiencies, we can't just say, "We gave at the office; we are half the size we were 15 years ago."

Although this is true, the Navy overall has had the same reduction, so we're expected to continue stepping up. I expect every NAVSEA employee to find ways to work smarter and return value to our customers. We do not exist to serve ourselves, rather, we serve warfighters.

Our achievements: We are all about delivering value to our warfighter customers.

The NAVSEA team continues to provide the ships, the systems and the technology that keeps our warfighters safe and gives them an unfair advantage over our enemies. NAVSEA's dedication to keeping them equipped is unmatched. I'm proud to be part of the team that makes it happen. Our focus must remain on doing this as efficiently as possible.

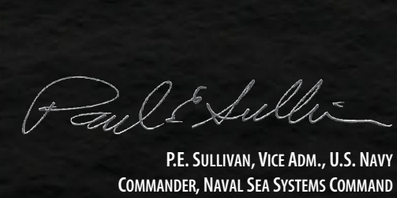
Among the new developments in the last year … we're one year from completing the last of the Nimitz-class carriers, *USS George H. W. Bush* (CVN 77). This ship may be the last in her class, but she is far more advanced than her predecessors. NAVSEA has made that possible. From a propeller design adjustment to the streamlining of the fuel distribution systems, she is designed to be stronger, lighter and more economical than her sister ships.

We're also moving quickly forward with innovative ship design. We achieved milestones in 2007 with operational evaluations of SSGNs and with the *Virginia*-class submarine *USS Hawaii* (SSN 776). These carefully considered designs are great examples of designs for flexibility and sustainability, and we've also improved the production timeline on the *Virginia*-class.

We're already looking forward to CVN 78 as the next-generation aircraft carrier, protecting our Fleet, our Sailors and our nation.

We are protecting our Marines with advanced Naval Surface Fire Support technologies. This is all part of NAVSEA's role in the Maritime Strategy. We equip the Navy with the vessels and technology to maintain maritime security, combat illicit activities and mitigate human suffering around the world.

With our growing team of diverse professionals, a continuing push for streamlined processes, and a commitment to develop lethal, agile and adaptable technology, I'm looking forward to another outstanding year at NAVSEA.



P.E. Sullivan, Vice Adm., U.S. Navy
Commander, Naval Sea Systems Command

Break down barriers, build partnerships, leverage resources

USS George Washington CVN 73) transits from dry dock to a wet slip. The Norfolk-based *Nimitz*-class aircraft carrier is undergoing Planned Incremental Availability and Docking. The availability will prepare *George Washington* to relieve *USS Kitty Hawk* (CV 63) as the Fleet's forward-deployed carrier in 2008.

Welcome to the 2008 edition of *On Watch*. In the year ahead, we've got some fascinating challenges facing us. As NAVSEA focuses on the development of a 313-ship Navy, we have an opportunity to prove just how effective we are at producing superior results.

NAVSEA has always been entrusted with providing our customers high quality ships and weapons systems at a reasonable cost. Today, we're being asked to deliver more products — *faster* — at a reduced cost. To meet this challenge, we must question everything we do and examine how we do it. Here's just one example: We used the Navy's "One Shipyard" to accomplish work on *USS Frank Cable* (AS 40). Instead of sending the ship thousands of miles away to Hawaii for a three-month availability, the right experts traveled from Pearl Harbor Naval Shipyard and several other shipyards to work on the ship in Guam. Instead of reverting to past practices, we improved our process and ultimately saved money by having the work done locally.

NAVSEA is developing new ways to do its job better. The work done on *USS George Washington* (CVN 73) during her Planned Incremental Docking at Norfolk, demonstrates how far NAVSEA has come in learning to streamline. Through process improvement tools such as Lean Six Sigma, Norfolk Naval Shipyard had the ship ready three days ahead of schedule and $14 million under budget.

These are great examples, but we must strive to innovate everyday. We're becoming a competency aligned organization to better leverage our most valuable asset — our people. We are bringing in new perspectives by reaching out to culturally diverse communities. We are getting better at tracking our work with metrics on just how beneficial our services are.

As we did in 2007, NAVSEA will continue to maximize our budgets by honing our practices and leveraging our people and resources. This is tough, but the tremendous success we had in 2007 proves we're up to the task.

As you flip through *On Watch*, you'll see great examples of what NAVSEA is doing for our Navy. I encourage you to read this entire publication and take pride in the great work we are doing to keep our country's Naval forces the strongest and most capable on the planet.

Sharie S. Bourbeau, SES, U.S. Navy
Executive Director, Naval Sea Systems Command

Aligning to the Navy Enterprise

Interview with
Rear Adm. Michael S. Frick,
Vice Commander of NAVSEA

An Air Force B-2 bomber and other aircraft from the Air Force, Navy and Maine Corps fly over *USS Kitty Hawk* (CV 63), *USS Ronald Reagan* (CVN 76) and *USS Abraham Lincoln* (CVN 72) Carrier Strike groups during the photo portion of *Exercise Valiant Shield*.

On Watch: What is the Navy Enterprise and how does NAVSEA fit in?
Frick: First off, the Navy Enterprise is a behaviorial model — a way of organizing, relating and creating opportunities — not a chain of command. It's a new collaborative way of operating that links the Warfare Enterprises and the Providers in order to maximize our resources and improve our return on investment. As a Provider Command, NAVSEA supports all five Navy Warfare Enterprises: Naval Aviation Enterprise (NAE), Surface Warfare Enterprise (SWE), Undersea Enterprise (USE), Naval NETWAR/FORCEnet Enterprise (NFFE) and Naval Expeditionary Combat Enterprise (NECE). Under the Enterprise Construct, the Navy operates more like a single organization. We're more efficient and our funding goes further.

On Watch: What does it mean to say that NAVSEA is part of the Provider Enterprise?
Frick: First, let's talk about what a Provider Command does. A Provider Command is responsible for giving our warfighters what they need to do their job on the front line. It's an organization that does all the support functions so the warfighter at the tip of the spear has the necessary tools to do his or her job. NAVSEA works with the other Provider Commands — the four other system commands, the Navy Personnel Command and the Navy Bureau of Medicine and Surgery — to supply manpower, assets, parts, supplies, research and development, health care and infrastructure to support the warfighter. At NAVSEA, we have a particularly important role, because our expertise really covers the full range of technical, programmatic and financial knowledge when it comes to ships, submarines, warfare systems and everything that goes with them.

On Watch: Why is aligning with the Naval Enterprise a priority for NAVSEA?
Frick: Aligning with the Enterprises is about changing the way we do business. We really have quite a balancing act to do. We must support the Fleet with cutting-edge ships and systems. We need to do it at a reasonable cost. The Naval Enterprise is about creating a balance between efficiency and risk, and it's using innovative strategies to counter the growing financial challenges we face. It's about getting things "leaned out" so our processes are efficient as possible. It's about getting rid of the stuff we don't need and eliminating the processes we don't need to do. By aligning with the Naval Enterprise, we can afford to take care of our people, procure more of the things that the Fleet needs, maintain our equipment and give the warfighters what they need to do the job.

On Watch: NAVSEA's ultimate mission is to support the warfighter. How will "Aligning with the Naval Enterprises" lead to better support of the warfighter?
Frick: Perhaps one of the biggest misconceptions about the Enterprise Construct is that it is a new chain of command. Nothing could be further from the truth. It is not about the chain of command.

On Watch: Can you tell us about how NAVSEA supports the Enterprises?
Frick: Well, you don't have to look hard at all. This year's *On Watch* is full of examples. Rear Adm. Macy's team of experts at the warfare centers, PEO LMW [Program Executive Office Littoral Mine Warfare] and NAVSEA's contracting directorate had a huge success story in 2007 with their counter-Improvised Explosive Device [IED] efforts. They made great strides in giving our people in Iraq the tools they need to counter the IED threat. That effort directly supports the NECE [Naval Expeditionary Combat Enterprise]. NAVSEA and the PEOs — especially Team Ships — are very involved in Surface Warfare Enterprise [SWE].

About 25 percent of NAVSEA's resources and about 20 percent of our military and career civilian employees are devoted to supporting SWE. Our value streams to SWE include providing new ships, modernization, and repair and maintenance of the current Fleet. Rear Adm. Jim McManamon's team in SEA 21 has made great progress as a part of the Sustainment and Modernization Team in the Surface Warfare Enterprise.

So whether it is building new ships and weapons systems, modernizing existing platforms, or keeping ships ready to deploy, NAVSEA and the PEOs are supporting the constantly evolving requirements of the surface force. All of the great cost-savings that are happening in the *Virginia*-class program for Team Submarine directly support USE, and PEO Carriers is doing a great job providing carriers for the Naval Air Enterprise.

I could go on, but it's all here between the covers of *On Watch*.

THE INCREDIBLE WARFARE CENTERS

From computer software to submarine upgrades, to developing the troop rifle of the future, the Navy centers of engineering and scientific expertise bring extraordinary value to the vital role of supporting America's warfighters.

NAVSEA's warfare centers — the Naval Surface Warfare Center (NSWC) and the Naval Undersea Warfare Center (NUWC) — are, first and foremost, technical institutions dedicated to sustaining warfighter readiness today and into the future. The centers ensure the technical integrity of the entire acquisition lifecycle, up to and including demilitarization.

NSWC and NUWC provide a critical concentration of scientists and engineers, more than 3,500 of which hold advanced masters or doctoral degrees. The innovative and technical excellence of this workforce is reflected in the number of patents issued. From 2002 to 2006, NAVSEA's warfare centers rank as first among the Department of Defense's establishments for the number of patents issued.

The warfare centers are unique because they are prepared to do what industry won't, can't or shouldn't do: Won't because it isn't profitable, like obsolescence manufacturing; or can't, like ensuring interoperability with different systems from different sources; or shouldn't, like certification of safety and effectiveness.

The warfare centers maintain unique national assets for the Navy that are not always commercially feasible, such as test and evaluation ranges and shore facilities and laboratories that replicate "at-sea" systems.

The warfare centers are committed to performing the right work and providing the best solutions at the right costs to the warfighter, and they have proven track records of balancing the needs of technical authority and effectiveness with efficiency and Lean Six Sigma business solutions. In the past two years, more than 1,600 Lean events have saved more $350 million. In one outstanding example, ***NSWCs Port Hueneme*** was awarded a Shingo Silver Medallion, deemed the "Nobel Prize for manufacturing" by *BusinessWeek* magazine, for the division's efforts to drastically reduce the costs of future installations of the Rolling Airframe Missile ship defense system on Navy ships.

Supporting today's warfighters

As NAVSEA's technical expert for Electro-Optics (EO) acquisition, in-service engineering and sustainment, ***NSWC Crane*** provided vital support for U.S. Marine Corps. During the past year, more than 4,200 EO systems for the Marine Corps were acquired, delivered or supported for such vital missions as laser targeting for precision-guided weapons, thermal imaging for persistent surveillance and reconnaissance, helmet-mounted display systems for cueing air-to-air missiles, and infrared laser pointers for weapon sighting.

The responsive engineering and production capabilities of ***NSWC Indian Head*** enabled F/A-18 Hornet and T-45 Goshawk aircraft around the world to avoid being grounded when confronted with an unexpected reduction in the service life of their Parachute Deployment Rocket Motors (PDRMs). More than 500 assets were reworked and replaced in fewer than 60 days to provide replacement PDRMs to the Fleet.

Three carrier strike groups were supported by ***NUWC Newport*** during *Exercise Valiant Shield 2007*, which provided a dynamic environment in which surface combatants screened carriers from submarine threats portrayed by several Navy submarines. NUWC teams also supported the evaluation of a non-traditional undersea vehicle in anti-submarine warfare (ASW) exercises; supported the Navy Warfare Develop-

ment Command's examination of Sea Combat Commander and Theater ASW Command & Control; and conducted data collection and assessment of an ASW Decision System that examined contact detection and tracking across multiple ASW platforms.

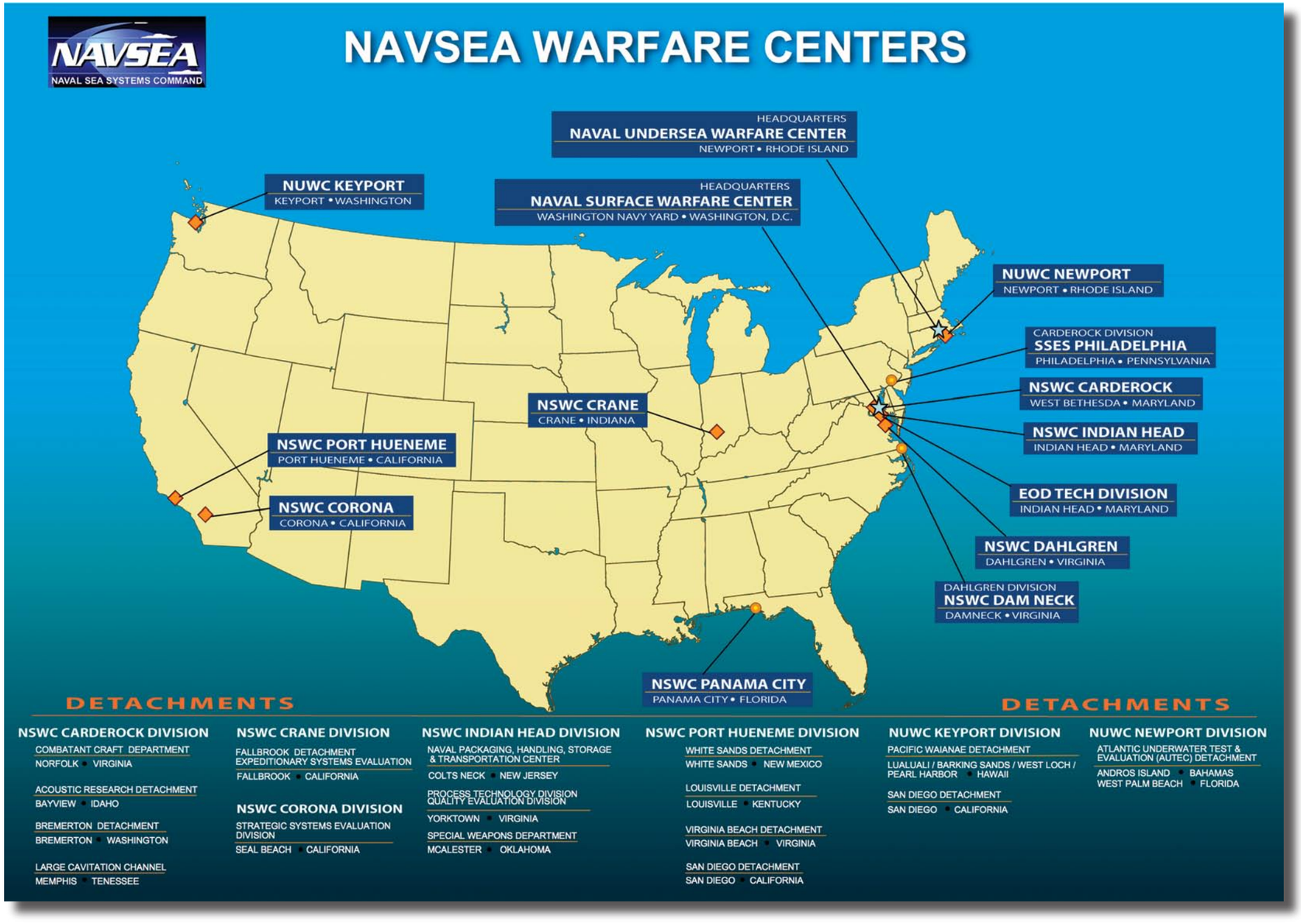
NSWC Carderock helped enable deployment of new T-AKE *Lewis and Clark*-class dry cargo and ammunition ships and LPD 17 *San Antonio*-class ships by demonstrating low magnetic signature capability from these advanced degaussing ships.

Magnetic and acoustic measurements were also conducted on forward-deployed MCM 1 *Avenger*-class mine-countermeasures ships in Bahrain and Sasebo, Japan to calibrate their degaussing systems, reducing their susceptibility to mines.

As the in-service engineering agent for the LCAC service life extension program, ***NSWC Panama City*** provides design, development, and integration for equipment and software which will extend the service life of these important vehicles to the year 2025. ***NSWC Panama City*** delivered a newly modernized Landing Craft Air Cushion (LCAC) and participated in the commissioning ceremonyor *USS Mesa Verde* (LPD 19).

NUWC Keyport supported immediate mission critical obsolescence issues for the *USS Jimmy Carter* (SSN 23) Mission Module Package in a proactive waterfront response. In 60 cases, mostly commercial-off-the-shelf items were analyzed for obsolescence and Keyport accomplished 17 Bridge/Life-of-Type buys resulting in $3.86 million in obsolescence cost avoidance.

The ***Naval Explosive Ordnance Disposal (EOD) Technology Division*** at Indian Head continued to develop and deliver EOD information, tools, equipment and lifecycle support to meet the needs of the Navy warfighter. Major efforts in 2007 included delivery of the 1,000th Man-Transportable Robotic System, testing and fielding a series of Counter Remote Control IED Electronic Warfare systems as part of ongoing counter-improvised explosive device campaigns in Iraq and Afghanistan.



Supporting new systems for the Fleet

The Advanced Sensor Distribution System (ASDS), managed by ***NSWC Dahlgren's Combat Directions System Activity*** in Dam Neck, Va., provides a digital, real-time, efficient and cost-effective method of sensor distribution to all display consoles for surface ship combat systems. This capability is made possible through collaboration with ***NSWC Crane***, ***NSWC Carderock Ship Systems Engineering Station***, and ***NSWC Port Hueneme***.

A joint ***NUWC Newport*** and ***NSWC Panama City*** team is supporting acquisition of an integrated swimmer defense system that will be used by expeditionary forces for harbor security and vessel protection.

NUWC Newport, industry and other government organizations collaborated in the development and fielding of the Common Submarine Radio Room, (CSRR), a common exterior communication system across all submarine platforms, including hardware, software, and logistics. Newport's role included the integration and test of this hardware with the system level control and management software developed by Lockheed Martin.

NSWC Panama City also worked with industry to bring major advances in airborne mine countermeasures to the Fleet when it accepted the first two low-rate initial production units from Northrop Grumman and began performance flights of the Airborne Laser Mine Detection Systems. Panama City also introduced the first modular capability to the surface Navy when it turned over the mine warfare mission package to the first two trained Sailor detachments for the new Littoral Combat Ship.

NSWC Port Hueneme supported near-term Fleet systems introduction by conducting the first firings of the Close In Weapons System and the Evolved Sea Sparrow Missile from the new remotely controlled Self Defense Test Ship, the ex-*Paul F. Foster* (EDD 964).

NSWC Carderock's Ship Systems Engineering Station in Philadelphia continued testing and design work for DDG 1000 *Zumwalt*-class integrated power system propulsion engineering model for the Navy's newest destroyer, and conducted design work and model scale testing for the propeller utilizing its Philadelphia test-bed facility.

NUWC Keyport reduced technology investment, enhanced the safety and security of unmanned undersea vehicle (UUV) field assets, and enabled objective evaluation of emerging UUV technologies when it hosted test events that required the real-time tracking of multiple UUVs without the use of traditional tracking pingers. A portable range detected and processed the UUV message transmissions to non-invasively determine UUV positions, and provided message content for real-time situational visualization, control, and analysis.

NSWC Crane will see the culmination of its efforts to provide an integrated modular family of small arms weaponry for Special Operations Forces with the release and fielding of the Special Operations Combat Assault Rifle in 2008.

Bringing new capabilities to tomorrow's Navy

Since 2005, NUWC has been engaged in a grand challenge initiative, Next-Generation Undersea Warfare, which is full-spectrum warfare emanating from and exploiting the environment from seabed to space, enabled by distributed networked systems. Undersea distributed networked systems will provide

the warfighter with the right information and right amount of information at the right time in the right form for the right operational use.

The technical contributions of the warfare centers were also highlighted by their role supporting ***Aegis Ballistic Missile Defense*** (BMD). The program bridges the gap between near-term introduction to today's Fleet and the truly revolutionary capability it will bring to our future Navy.

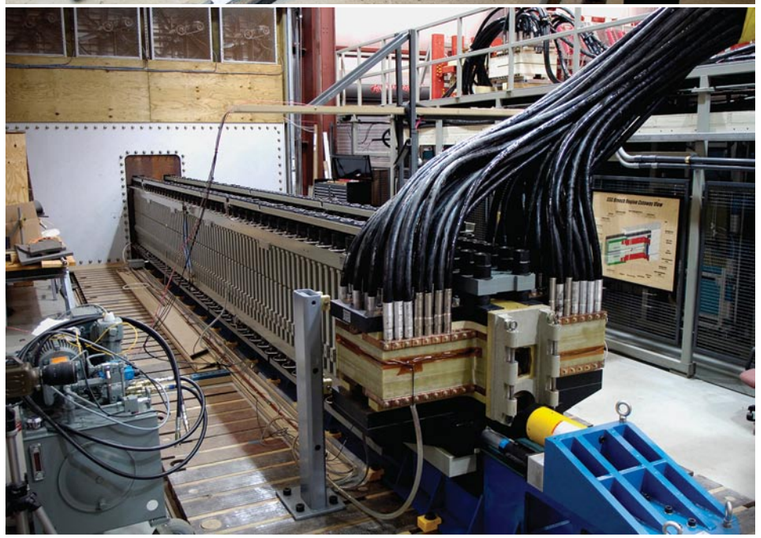
NSWC Dahlgren, ***Port Hueneme, Crane*** and ***Corona*** supported the Aegis BMD program throughout 2007, which in November 2007 culminated in the near-simultaneous intercepts of two ballistic missile targets in the exo-atmosphere. Support for Aegis BMD included enhanced radar detection efforts by Dahlgren; target building, testing and launching by Port Hueneme-White Sands; technology insertion by Crane; data and test analysis assessment by Corona; and installation assistance on both coasts by Dahlgren and Port Hueneme.

A new era in naval capability began in November 2007 when ***NSWC Dahlgren***, in support of the Office of Naval Research, started firing the world's largest electromagnetic (EM) railgun. The EM railgun has the potential to vastly alter Navy and Marine Corps fire support by firing projectiles at ranges in excess of 200 nautical miles at speeds 20 times faster than allowed by current technology.

NUWC Keyport supported Surface Ship Torpedo Defense Future Naval Capability Salvos, capturing critical science and technology data for torpedo detection, classification and localization as well as torpedo countermeasures. Keyport personnel contributed to the development and production of research and development test vehicles to provide threat emulation, development of test fixtures to support launch of the Compact Very Lightweight Torpedo, and modified range operation procedures.

Through its work in human systems integration, ***NSWC Dahlgren*** developed a state-of-the-art Human Performance Laboratory. The Dahlgren facility is connected to other Navy labs to provide an enterprise-wide asset with the capability to perform a variety of experiments and evaluations of the human component of systems.

These many accomplishments are only a few examples of the vital role the warfare centers play supporting the warfighters of today's Navy and the Navy of the future. The warfare centers are committed to sustaining the superiority of U.S. naval forces and their ability to protect the safety and economic security of the nation. As they move forward, warfare centers' leadership is committed to sustaining a specialized workforce that reflects the diversity of our nation, and creating an environment that encourages, empowers and enables each employee to reach their personal professional potential.



Top Andrew Wyman (center), range test engineer at the Naval Surface Warfare Center, Dahlgren Division, explains the impact from the Electromagnetic Railgun (EMRG) to Rear Adm. William E. Landay, Chief of Naval Research (left) and Rear Adm. Victor G. Guillory, Deputy Director of Surface Warfare, following a ribbon-cutting ceremony for the EM Launch Facility. The mission of the EMRG program is to develop the science and technology necessary to design, test, produce and install a revolutionary 64 Megajoule EMRG aboard U.S. Navy ships. **Bottom** The Office of Naval Research 32-megajoule EMRG laboratory launcher is located at NSWC Dahlgren Division.

Warfare centers — worldwide support for the warfighter

NUWC Newport EDSU Mechanical Engineer and certified Navy Diver Vic Marolda performs in-water repairs on *USS Corpus Christi* (SSN 705) in a remote South Pacific location.

NAVSEA'S WARFARE CENTERS are able to draw upon their facilities and the knowledge, skills and ability of their technical workforce to provide real-time support to the warfighter and the Fleet, virtually anywhere in the world.

- ***NUWC Newport*** maintains a select group of engineers, scientists and technicians who are also qualified U.S. Navy Divers in the Engineering and Diving Support Unit (EDSU). EDSU supported towed system repairs on six submarine platforms in 2007. They also provided valuable technical training to Fleet divers that increased their abilities to significantly reduce system malfunctions, failures and problems.

- ***NSWC Crane*** maintains an Electro-Optic (EO) forward repair facility in Bahrain for EO, infrared and laser systems, backed up by logistics support in the U.S. Their expertise enabled critical repairs for a special missions platform that provides persistent surveillance in support of *Operation Iraqi Freedom*. In one example, Crane returned the operational system to the theater within four days.

- ***NSWC Indian Head*** supports a Mishap Investigation Support Team (MIST) for Cartridge-Actuated Device/Propellant Actuated Devices. These devices provide military aircraft with the force and energy required for escape, fire extinguishing, bomb release and countermeasure systems. In 2007, the MIST responded to 15 mishaps and crashes around the world within 24 hours. The teams investigate equipment failure and, if necessary, test and repair the items.

- ***NSWC Corona*** supports warfighter weapon and tactical training by providing range scoring and communications systems, assessing operational performance during exercises, and feeding back lessons learned to the Navy and Marine Corps training communities.

Providing the Fleet World-Class Maintenance and Modernization

Shifting worldwide requirements and evolving Fleet needs spurred the adoption of fresh planning and thinking practices six years ago with the stand up of the One Shipyard concept. Today, this structure continues to evolve among NAVSEA's four public shipyards and private shipyard partners.

Through innovative teaming and planning techniques and a Lean culture of continuous improvement, NAVSEA's One Shipyard concept provides the Fleet customer with increased maintenance and repair opportunity. The Navy's four public shipyards — Portsmouth Naval Shipyard (PNSY) in Maine, Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNS & IMF) in Washington state, Norfolk Naval Shipyard (NNSY) in Virginia and Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility (PHNSY & IMF) in Hawaii — collectively delivered critical assets back to the Fleet ready to fight the Global War on Terrorism.

Success Stories

Approaching challenges with the combined resources of all the shipyards, the "One Shipyard" structure synergizes the capabilities of the shipyard industrial base. Most important, the Navy's highly skilled shipyard workers are able to demonstrate their innovation and flexibility while they support the Fleet warfighter.

USS Frank Cable (AS 40) serves as the Navy's mobile submarine repair and support vessel in the Pacific. Although the ship's crew is able to tackle most maintenance and repair requirements on the ship, a select number of maintenance challenges fell outside of the crew's technical ability. The Navy looked to the expert workers from Pearl Harbor Naval Shipyard, augmented with specialists from Puget Sound and Norfolk Naval Shipyards, to deploy to Guam and complete the full Phased Maintenance Availability on *Frank Cable*, upgrading her electrical equipment, improving fuel tanks, replacing nearly a mile of steam piping and running close to a mile of electrical cable throughout the ship.

More than 8,000 miles away in Kittery, Maine, Portsmouth Naval Shipyard mobilized 110 shipyard employees to partner with Northrop Grumman's Newport News Shipyard in providing assessment, planning and execution of complex emergent repairs to *USS Newport News* (SSN 750). Through the strength of One Shipyard, the submarine is scheduled to be delivered back to the

Opposite, top Kelvin L. Fields, Norfolk Naval Shipyard Heavy Mobile Equipment Mechanic Apprentice, repaints a crane hook on one of the shipyard waterfront's many dock cranes.
Opposite, bottom General Foreman Shipwright and Dockmaster James Pettis discusses a project's status with Assistant Operations Officer Lt. Cmdr. L. Andrew Gish at Portsmouth Naval Shipyard in Maine.
This page One of Portsmouth Naval Shipyard's crane teams coordinate the safe lift of a ship's access brow.

Top During its nearly year-long Planned Incremental Availability plus Docking at Norfolk Naval Shipyard, *USS George Washington* (CVN 73) had a collection of ship alterations performed, including major upgrades to the combat systems suite, known as Capstone. A highlight of the Capstone process was the installation of a new carrier mast strong enough to support the combat system upgrades in January 2007. Thanks to extensive prefabrication work performed pierside, a significant time-saver for the project team was having the new mast installed in a single lift, when previous installations required three separate lifts. **Bottom** A second generation Portsmouth Naval Shipyard employee, Plastic Fabricator Apprentice Steven Bachmann, and his father, Plastic Fabricator Mechanic Kenneth Bachmann, oversee the Teflon coating process applied to ship ball valves.

Fleet on schedule and within budget.

For Puget Sound, completing maintenance on *USS Abraham Lincoln* (CVN 72) was the essential goal. The PSNS & IMF project team joined with the ship's force and maintenance partners in applying Lean practices to the ship's tank maintenance requirements. The team restored 18 tanks in 89 days — crushing the industry standard of six tanks in 101 days.

Back on the East Coast, Lean practices played a key role in the *USS George Washington*'s (CVN 73) early departure from its Planned Incremental and Docking status at Norfolk Naval Shipyard. Again, tank maintenance was a key target, but propeller installation and shafting work also realized significant improvements because of the implementation of Lean practices.

Finally, using a large contractor crane similar to the cranes used to build roller coasters, the team hoisted the carrier's main mast in a single lift instead of the traditional process requiring three separate lifts. This feat saved up to 12 days of work and contributed to NNSY completing *George Washington*'s repair availability three days ahead of schedule and $14 million under budget.

With 2007 being a very busy year for carrier work in Norfolk, these resources and the flexibility derived from Lean practices allowed the completion of overlapping schedules of carrier maintenance and modernization with *USS Harry S. Truman* (CVN 75), *George Washington* and *USS Theodore Roosevelt* (CVN 71).

Future Improvements

Brand-new ship designs come with brand-new maintenance requirements. In 2007, Portsmouth Naval Shipyard was designated as the Ship Availability Planning and Engineering Center (SHAPEC) for the new Virginia-class submarines. SHAPEC's 100 engineers and technicians will plan repairs for all naval shipyards that will work on the new submarine class.

In Portsmouth and in Pearl Harbor, preparations have been underway since 2005 to ready facilities to perform necessary maintenance on these new submarines. Three key areas will receive specific attention: facilities and services with a focus on piers, dry docks and utilities; equipment and tooling to perform maintenance and repair work; employee training and establishment of processes to support the work.

Preparations are also underway in Puget Sound and in Japan for the change-out of the surge carrier *USS Kitty Hawk* (CV 63) by *George Washington*. Because of its CVN designation, PSNS & IMF shipyard workforce will deploy for a few months each year to maintain the carrier's propulsion plant.

Norfolk Naval Shipyard also began two key facility upgrades in 2007: pier replacement and upgrades and modification of the shipyard's carrier drydock to accommodate the larger bow designs of newer carriers.

A Business Plan

The year 2007 also saw the emergence of a Shipyard Business Plan that outlined a strategy to efficiently and effectively implement initiatives, stabilize the shipyard workload, improve efficiencies and serve as a responsible and accountable steward of public funds. NAVSEA's Logistics, Maintenance and Industrial Operations Directorate (SEA04) has sustained this approach for the second year in a row to keep the Navy's "One Shipyard" moving forward. The 2008 Shipyard Business Plan will outline the Navy's plans to invest in infrastructure, information technology and people to continue meeting the needs of the Fleet.

The Navy's "One Shipyard" in Action

From establishing new benchmarks in maintenance and repair efficiency to preparing for tomorrow's challenges by supporting the next generation of ships and submarines, the Navy's shipyards are satisfying the needs of the Fleet warfighter.

Building America's FUTURE FLEET

Future platforms such as the Littoral Combat Ship (LCS), the Zumwalt*-class destroyer (DDG 1000) and the next-generation cruiser CG(X), represent the peak of naval surface warfare technology available to warfighters well into the 21st century.*

The Navy's surface Fleet is an evolutionary force that must constantly adapt to changing threats and conditions. Through careful planning and excellent management, Program Executive Office (PEO) Ships oversees the development of surface vessels necessary to maintain the Navy's global presence in a constantly evolving world. The key to producing an effective and affordable future Fleet is a balance between speed, maneuverability, flexibility and modularity.

LCS

"The Littoral Combat Ship was conceived as a fast, agile, multi-mission ship designed to operate in near-shore environments, yet capable of traditional open-ocean operations," said LCS Program Manager Capt. Jim Murdoch. "The Navy has never had a ship like this. It combines speed and mission packages to deal with virtually any threat it might encounter."

The primary purpose of LCS is to defeat asymmetrical anti-access threats, including mines, quiet diesel submarines and fast surface craft. LCS ships will also perform self-defense, high-speed transit, maritime interdiction operations, intelligence, surveillance and reconnaissance, antiterrorism/force protection missions and support special operations forces and homeland defense.

"We're building two LCS variants, one each by Lockheed Martin and General Dynamics," said Murdoch. "The Lockheed Martin design (LCS 1) is a high-speed, semi-planing steel and aluminum monohull. The General Dynamics design (LCS 2) is an all-aluminum trimaran with a slender, stabilized monohull. We plan on having both delivered in 2008."

Originally contracted to build two of each variant, both Lockheed Martin's and General Dynamics' second ships were cancelled in 2007 due to rising costs. The Navy is now working closely with industry to ensure that future ships are delivered at cost and on time.

To take on a wide array of responsibilities, LCS is designed to utilize mission packages comprised of reconfigurable payloads that can be swapped out quickly to support changing combat technology requirements. The first of these mission packages, the mine warfare package, was delivered to the Navy in the summer of 2007.

DDG 1000

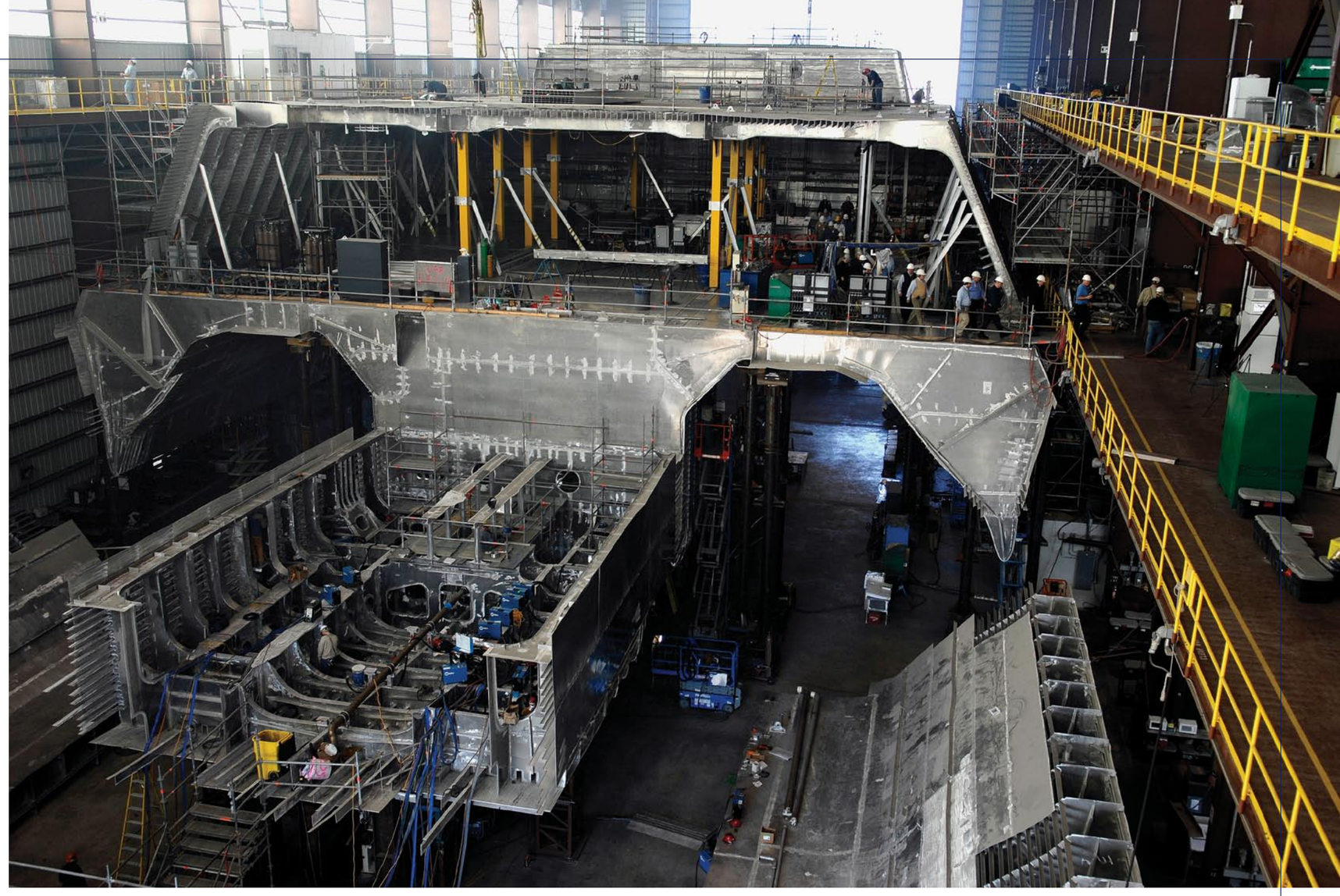
The exciting *Zumwalt*-class warship (DDG 1000) is nearing production. The futuristic destroyer is lead ship of a new class of next-generation, multi-mission surface combatants tailored for land attack and littoral dominance. In addition, it will provide forward presence and deterrence and operate as an integral part of joint and combined expeditionary forces.

"DDG 1000 will provide these capabilities thanks to major advances in ship design," said *Zumwalt* Program Manager Capt. Jim Syring. "The ship will have a 50-fold improvement in stealth capability, rendering the 600-foot vessel to look the size of a fishing boat on a radar cross-section. It will also have a submarine-like acoustic signature level, and a reduced infrared signature. These capabilities will allow the DDG 1000 to stay in the fight longer."

The DDG 1000 sports offensive improvements as well. A new Advanced Gun System (AGS), comprised of two 155 mm guns, will allow the *Zumwalt* class to cover up to 50 times the area of a DDG 51 armed with the current MK45 5-inch gun.

"Couple these capabilities with improved dual-band radar, and increased ship survivability provided by a redesigned hull and safety systems, and DDG 1000 will be an extremely capable Fleet asset," said Syring.

DDG 1000 and 1001 will be concurrently built both by Bath



Above Secretary of the Navy, the Honorable Dr. Donald C. Winter, tours the aluminum hull of the prospective *USS Independence* (LCS 2) during a tour of Austal Shipyards. **Below** The concept *Zumwalt*-class (DDG 1000) destroyer and its high-tech Advanced Gun System, firing the Extended Range Guided Munition.

Bottom The futuristic LHA 6-class will carry more Marines and more aircraft than the *Wasp*-class LHD ships it replaces. **Right** The first Littoral Combat Ship, *USS Freedom* (LCS 1), was launched in September 2006.

Iron Works and Northrop Grumman Ship Systems.

CG(X)

Following the DDG 1000 program, the Navy also plans to develop a next-generation cruiser, currently known as CG(X). CG(X) will provide the future class of Navy cruisers to replace the existing CG 47 class.

CG(X) is expected to provide area anti-air warfare and afloat ballistic missile defense through advanced integrated air and missile defense capabilities. CG(X) will help ensure airspace dominance and protection to joint forces. The next-generation cruiser program has been structured to leverage multiple DDG 1000 critical technologies as well as develop capabilities essential to CG(X) primary mission areas.

The CG(X) Analysis of Alternatives (AoA), completed in the fall of 2007, developed, refined and assessed potential solutions, and provided the analytical basis for the Capabilities Description Document. The AoA will be presented to Navy and OSD leadership and then CG(X) will head to a Milestone A decision in 2008.

Seabasing

In addition to surface combatants, the future Navy will see the development new seabasing concepts and platforms to support the maritime strategy. These ships include the LHA 6 class amphibious assault ship; the Joint High Speed Vessel (JHSV); the Maritime Prepositioning Force Future (MPF(F)); and the Joint Maritime Assault Connector (JMAC).

Awarded for construction in June 2007, LHA 6-class amphibious assault ships augment the capability of seabasing operations. Compared to a Wasp-class LHD, LHA 6-class assault ships can carry an increased number of aircraft, or a similar load-out, with increased operational flexibility.

LHD and LHA class ships will both be able to embark next-generation Marine Corps aircraft, including the F-35 Lightning II Joint Strike Fighter and MV-22 Osprey tiltrotor. LHA 6 will also provide increased fuel and ordnance storage to support higher tempo and sustained operations for a longer period than with current LHDs, and a larger hanger will allow enhanced maintenance of all embarked aircraft.

"Overall, LHA 6 represents a conscious decision to increase the aviation capacity of future 'big decks' in order to maximize investment in future Marine Corps aircraft," said Col. David Lobik, Marine Corps advisor for Team Ships.

Another piece of the seabasing group is the Joint High-Speed Vessel (JHSV). A joint acquisition for the Army, Navy and Marines, the JHSV program merges the Army Theater Support Vessel and the Navy High Speed Connector, taking advantage of the common requirements between these two programs.

The JHSV will provide an intra-theater, roll-on, roll-off, medium-lift platform utilized for movement of personnel, supplies and equipment. The Navy issued a request for proposals in August 2007 and expects to award a construction contract in 2008. The first JHSV is expected to deliver in 2011.

Another key seabasing concept is the MPF(F). MPF(F) is the designation for a squadron of ships comprising three T-AKE-class dry cargo and ammunition ships, three mobile landing platforms, two LHA 6s, 1 LHD, three large, medium-speed, roll-on/roll-off ships and two maritime prepositioning ships.

"MPF(F) will be the actual enabler of the seabasing mission," said Capt. George Sutton, program manager for strategic and theater sealift. "It will provide at-sea assembly, sustainment, support and deployment capabilities for a full combat force."

Also in development is the Joint Maritime Assault Connector (JMAC). It is currently slated to replace LCAC landing craft as a tactical ship-to-shore platform with enhanced capabilities such as the ability to operate in higher sea states, increased range, speed, and payload, increased obstacle clearance and reduced operating and maintenance costs. Although in-service LCACs are currently undergoing a service-life extension program, JMAC is slated to begin replacing older LCACs in 2016.

Delivering the FUTURE FLEET of TODAY

In 1907, President Theodore Roosevelt launched a young nation onto the world stage. For more than two years, the four battleship squadrons of Roosevelt's Great White Fleet sailed the oceans, solidifying America's sovereignty and standing abroad.

In the 100 years since this grand Fleet set sail, the Navy's surface Fleet has become the precision tool of diplomacy of which Roosevelt dreamed. As a fitting tribute to the centennial anniversary of the Fleet's launching, the Navy welcomed several new ships into service during 2007 —from guided-missile destroyers projecting power abroad to new amphibious ships capable of delivering expeditionary forces or desperately needed humanitarian aid.

DDG 51

The *Arleigh Burke*-class guided-missile destroyer is the backbone of the surface Fleet. Since lead ship delivery in 1991, the DDG 51 class has remained the Fleet's most capable and survivable surface combatant, and will continue to be so well into the 21st century.

Of the 62 ships in the class, 10 remain to be delivered. In 2007, the Navy commissioned three new DDGs: *USS Kidd* (DDG 100), *USS Gridley* (DDG 101) and *USS Sampson* (DDG 102).

"DDG 51 was designed around the Aegis combat system," said DDG 51 class Program Manager Capt. Pete Lyle. "Aegis is the world's most advanced defense system. It's the first fully integrated combat system built to defend against air, surface and subsurface threats, and it fully integrates the ship's radar systems with its weapons systems, as well as the combat systems of other nearby Aegis ships."

The heavily armed ships are equipped with a 96-cell Vertical Launching System capable of rapidly firing a mix of Standard, Tomahawk and vertically launched ASROC missiles for air defense and strike missions. Additionally, the ships are outfitted with a MK45 5-inch gun. DDG 51 Flight IIA ships, beginning with DDG 79, can also carry two embarked MH 60 helicopters.

Because the DDG 51s are constructed in flights, or phases, the Navy has been able to make significant technological advances during construction. Flight II, introduced in 1992, incorporated improvements to the AN/SPY-1 radar system and an improved Standard Missile. Flight IIA, the most recent phase, was introduced in 1994 and added two helicopter hangars.

LHD 8

When operating as part of an Expeditionary Strike Group, DDG 51-class ships will complement the newest *Wasp*-class ship, the prospective *USS Makin Island* (LHD 8), now under construction at Northrop Grumman Ship Systems, Pascagoula, Miss. It incorporates design advances well beyond its predecessors. These new features — including a change to gas turbine main propulsion engines, all-electric auxiliaries and an advanced machinery control system — make this ship and class important assets well into the 21st century.

The gas turbine propulsion plant and electrical auxiliaries are the first of their kind for a large-deck amphibious assault ship, and provide significant savings in manpower and maintenance costs associated

The prospective *USS Makin Island* (LHD 8) leads an exciting new class of amphibs with significantly improved capabilities.

with traditional steam-powered amphibious ships.

Wasp-class amphibs were the first specifically designed to accommodate the AV-8B Harrier jump jet and the LCAC and a full range of other Navy and Marine Corps helicopters, other landing craft and amphibious assault vehicles.

Able to support a Marine Expeditionary Unit of 2,000 troops, these amphibs are the "flagships" of the amphibious Fleet. LHDs also contain some of the most sophisticated communications, command and control capabilities at sea, as well as advanced electronic and defensive systems.

"When *Makin Island* was almost halfway complete, Hurricane Katrina severely damaged the Pascagoula, Miss., shipyard where the ship is being constructed," said Amphibious Ships Program Manager Capt. Jeff Riedel. "Damage to the shipyard and the difficulty of replacing many of the skilled laborers displaced by the hurricane has unfortunately slowed construction efforts. However, we are overcoming these challenges and making steady progress in getting construction back up to speed. We expect to deliver Makin Island in November 2008."

LPD 17

Rolling out now are more *San Antonio*-class amphibious transport dock ships, two of which were commissioned in 2007. In March, the Fleet welcomed *USS New Orleans* (LPD 18) during a ceremony in her namesake city. The Navy commissioned *USS Mesa Verde* (LPD 19) in December at Panama City, Fla., after very successful sea trials last fall.

Mesa Verde joined its two in-service sister ships, including class-lead *USS San Antonio* (LPD 17), to bring greatly improved warfighting capabilities, including an advanced command and control suite, increased lift capacity with substantial increases in vehicle and cargo carrying capability and advanced ship survivability features.

The ship is capable of embarking a landing force of up to 800 Marines and supports the Landing Craft Air Cushion (LCAC) vehicle, the Expeditionary Fighting Vehicle, and the MV 22 Osprey tilt-rotor aircraft, making the ship a critical element of today's and tomorrow's expeditionary strike groups.

"The LPD 17 class represents a revolution in amphibious ship design," said LPD 17 Program Director Capt. Bill-Galinis. "The design incorporates state-of-the art radar-signature reduction technologies more commonly designed for surface combatants. The ship's most visible feature, the Advanced Enclosed Mast, was designed for that very purpose, making the ship less visible to radar and allowing it to operate more safely in the littorals."

Perhaps the most important feature of this class is its focus on habitability.

"LPD 17 was designed with the crew in mind," said Galinis. "The Shipboard Wide Area Network provides computer and network access linking every manned space on the ship, including berthing spaces. New sit-up berths have room for a Sailor or Marine to sleep comfortably or to sit up in the bunk for reading or writing. Even the food service spaces were redesigned to ensure better-prepared and more nutritious offerings."

At least six more ships of this class will be joining the Fleet over the next several years. *San Diego* (LPD 22) and *Anchorage* (LPD 23) have already had their keels laid. Perhaps the most well-known of these ships — due to the inclusion of World Trade Center steel in the hull — the future *USS New York* (LPD 21) is scheduled to be christened in March 2008.

LPD 17 class ships will join *Wasp*-class amphibious assault ships to form expeditionary strike groups.

The cargo carrier *USNS Richard E. Byrd* (T-AKE 4) is launched into the San Diego Harbor after a christening ceremony. *Byrd* is the fourth ship of an exciting class of new, highly efficient dry cargo/ammunition ships.

LCAC

The Landing Craft Air Cushion vehicle program, which is carried onboard both LPD 17 class and LHD 1 class ships, has also undergone significant work this year.

The Navy's LCAC Service Life Extension Program (SLEP), which began in 2000, is actively improving and upgrading these versatile platforms.

The program includes upgrading the powertrain to provide additional power as well as decreasing fuel consumption and maintenance needs. SLEP also replaces older technologies, including upgrading command, control, communications, computer and navigation, or C4N, systems.

USS New Orleans (LPD 18)

Of the 91 LCACs originally built, 73 are to receive SLEP enhancements by the time the program concludes in 2016. In 2007, six LCACs began receiving their upgrades, and five more are scheduled to begin in 2008.

"The LCAC is incredibly effective, as it can access more than 80 percent of the world's coastlines," said Amphibious Ships Deputy Program Manager Craig McKay. "The SLEP program ensures that these assets can be effective for years to come."

The LCAC is a high-speed, fully amphibious landing craft capable of carrying a 60-to-75-ton payload. It can carry heavy payloads, such as an M-1 Abrams main battle tank, and travel at speeds of more than 40 knots. It rides on a cushion of air, and no part of the LCAC's hull penetrates the surface of the water — the entire hull rides approximately four feet above the water.

The LCAC's propulsion system has additional safety mechanisms making it less susceptible to mines than other assault craft or vehicles.

T-AKE

In July 2007, the first of the new class of dry cargo and ammunition ships, *USNS Lewis and Clark* (T-AKE 1), departed on her first deployment. Sailing with the *USS Enterprise* (CVN 65) Carrier Strike Group, the ship operated in the Persian Gulf supplying U.S. and allied ships.

"*Lewis and Clark* is the wave of the future of underway replenishment [UNREP] ships," said Jim White, the ship's civilian master. "This ship replaces three classes of UNREP ships and it is going to be a common sight in years to come."

The second ship of the new class, *USNS Sacagawea* (T-AKE 2), departed on her first deployment in December 2007. The ship was delivered to the Navy in February.

"I think the fact that we can deploy these ships so quickly after delivery is a real testament to their usefulness," said T-AKE Deputy Program Manager Frank McCarthey. "These ships provide Fleet underway replenishment capability at the lowest lifecycle cost. They're designed and constructed to commercial specifications and standards, which means that they're much easier to construct than other Navy ships and even easier to deploy."

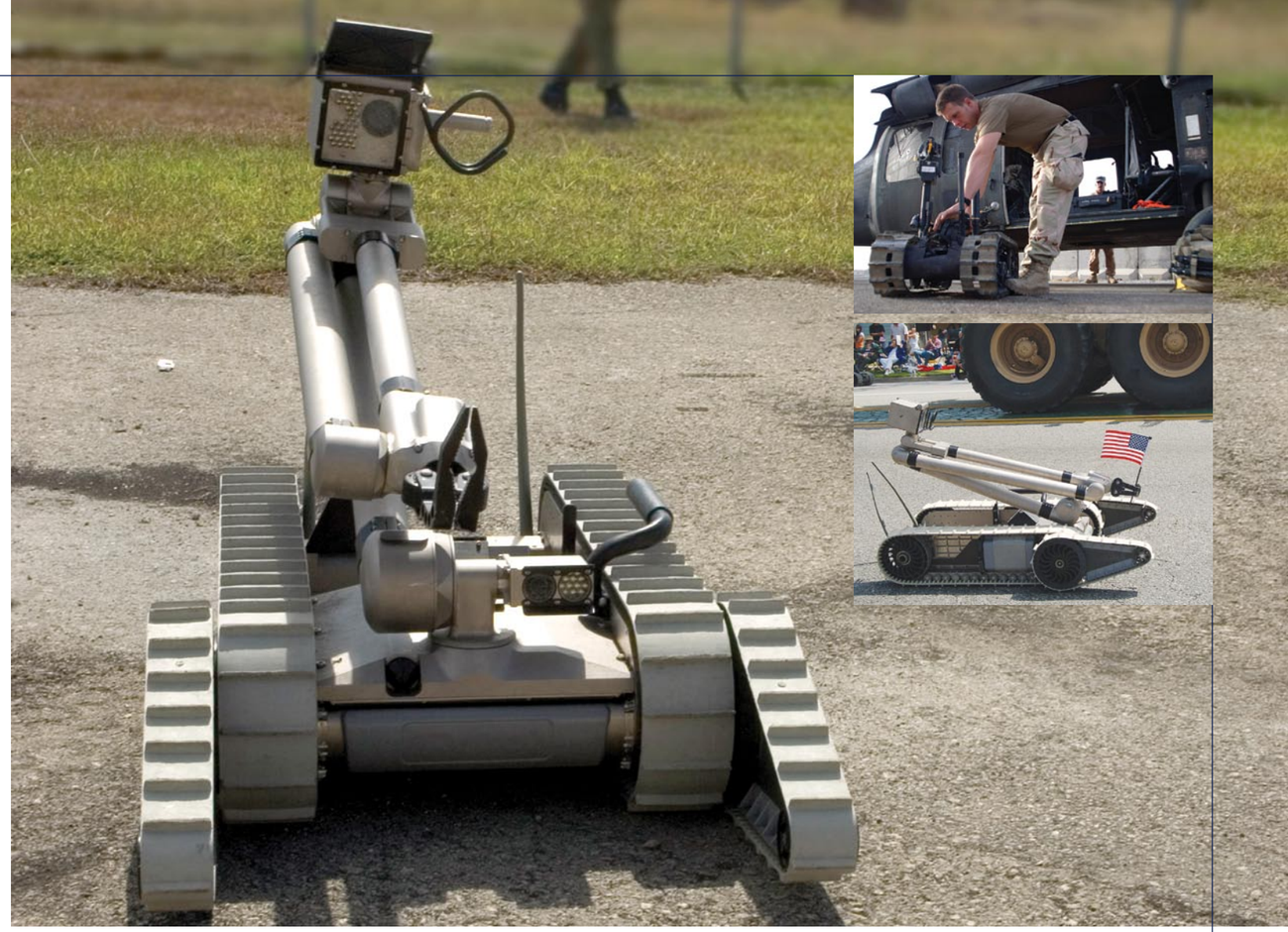
T-AKEs directly contribute to the capability of the Navy maintaining a forward presence.

Providing effective underway Fleet replenishment allows ships to maintain a forward presence without the need for frequent port calls for re-supply, enhancing U.S. and allied operations overseas.

Two other T-AKEs were delivered to the Navy in 2007, *USNS Alan Shepard* (T-AKE 3) and *USNS Richard E. Byrd* (T-AKE 4).

As of 2007, contracts are signed for the first 10.

A Talon Mk.II ordnance disposal robot prepares to unearth a simulated improvised explosive device during an exercise.



Top A Talon EOD robot is deployed from a helicopter. **Main and bottom inset** A Packbot is a small robot that operates on treads. It's smaller and lighter than the Talon, weighing in at about 40 lbs in the basic Scout configuration. Packbot is man-portable and is designed to fit into the U.S. Army's new standard pack, the Modular Lightweight Load Carrying Equipment (MOLLE). Controlled by a Pentium processor that has been designed specially to withstand rough treatment, Packbot's chassis has a GPS system, an electronic compass and temperature sensors built in. Packbot manufacturer iRobot says Packbot can move more than 8 mph, be deployed in minutes and can withstand a 6-foot drop onto concrete — the equivalent of 400 g's of force. Even if a Packbot lands upside down, it can right itself using powerful treaded front flippers, which also help it climb obstacles.

Defeating IEDs and Mines to Minimize the Threat Warfighters

Posted on the walls throughout Program Executive Office Littoral Mine Warfare (PEO LMW) offices is a poster that asks, "What have you done today to keep a name off the wall?" It's a reference to the Explosive Ordnance Disposal (EOD) Memorial at Eglin Air Force Base bearing the names of EOD heroes who made the ultimate sacrifice in defense of their country.

For those involved in the counter Improvised Explosive Device (IED) effort, those words are a way of life, according to the Commander, Naval Surface Warfare Center, Rear Adm. Archer M. Macy. He describes the determined focus of the PEO LMW team, saying, "these people recognize the gravity of the mission. This is something we're doing because people are dying over there," a reference to service members deployed to Iraq and Afghanistan.

In the Global War on Terrorism, few warfare communities are closer to the tip of the spear than EOD teams in war-ravaged regions. According to Capt. James Brakke, Commander, EOD Technical Division (EODTECHDIV), an increased focus on providing improved technology and training in 2007 had a significant impact in reducing casualties from IEDs.

Included in the technology to combat IEDs are an increased number of Man-Transportable Robotic Systems (MTRS), the two-man portable, unmanned tracked vehicles. EOD operators remotely guide the robots into IED threat locations first where they identify, examine and disable IEDs, unexploded ordnance and mines.

"Anytime you send a robot to detonate an IED and something bad happens, you've saved a life," said Brakke.

The number of robots sent to forward-deployed locations topped 1,000 in 2007 and more are on the way.

With insurgents detonating IEDs from a distance using remote control devices ranging from cell phones to garage door openers, electronic jamming solutions remained a priority in 2007. PEO LMW responded with the Joint Controlled Radio Electronic Warfare (JCREW) system that electronically jams adversary attempts to remotely detonate IEDs. They also facilitated the development of the Guardian Backpack system that provides the warfighter on the ground with a portable JCREW capability. Recent reports indicate remote IED detonation decreased dramatically in 2007. Currently 30,000 JCREW systems are deployed in Iraq and Afghanistan.

The ability of the adversary to adapt to these counter measures keeps the Littoral and Mine Warfare program office focused on the future.

"We've attained a great deal of success but we're not resting on our laurels," said Capt. Mark Kavanaugh, EOD/CREW program manager. He noted that the PEO LMW team's efforts are recognized outside the Navy as the Secretary of Defense has assigned the acquisition arm for Joint CREW to the Navy, recognizing expertise in this area.

"We knew that this was a very complex and urgent need," said Jerry Punderson, director of NAVSEA's Undersea Warfare Systems Contracts division. "So the NAVSEA contracting team developed innovative contracting tactics that allowed us to streamline the acquisition process. Thanks to the creative problem solving and creativity of our contracting professionals, we were able to deliver cutting-edge technology to the warfighter in record time."

The speed and agility of the PEO LMW team and the NAVSEA Contracts Directorate to spearhead the R&D and acquisition effort has shortened the time to field effective technology and has incorporated near real time feedback from the field to improve technical solutions.

According to Macy, the PEO LMW/EODTECHDIV team has contributed to decreased casualties inflicted by IEDs as a result of their ability to rapidly identify and field solutions to emerging threats.

"It is one of the most incredible responses to a new weapon that has been seen perhaps in the history of technical warfare," Macy said.

Delving deeper

Supervisor of Diving and Salvage efforts grow efficiencies for divers and Fleet readiness

For Navy diving and salvage experts, the ability to have divers work underwater projects for extended periods of time is limited by the requirements of divers to spend time decompressing to avoid decompression sickness. In 2007, two major developments helped move forward the ability of Supervisor of Salvage and Diving (SUPSALV) professionals to perform salvage and recovery operations more effectively.

The first is the release of revised dive tables — the first since 1957 — that specify the length of required decompression times. The tables are used in conjunction with an oxygen regulating console that feeds pure oxygen to divers as they ascend through the water column and decompress. The new tables and oxygen regulating consoles reduce unacceptable risk levels in the existing tables that were encountered during the TWA Flight 800 recovery operations, and reduce the time divers stay in the water during decompression.

The second is the critical design review stage on major components of a new flyaway saturation diving system. This system doesn't reduce decompression time, but rather changes the decompression environment from the ocean to a pressurized habitat where divers can eat, shower and sleep while not diving.

"This will give us the capability to pack up this system, fly it anywhere in the world, put it on a commercial or Navy vessel and put divers down to 1,000 feet for prolonged periods of time," said SUPSALV Deputy Director Mike Dean.

Unable to identify a suitable commercial off-the-shelf system, SUPSALV moved forward to design and build a portable saturation diving system. The concept is to compress divers in a living chamber to the pressure at which they'll be working. A detachable capsule is then launched from the ship to the salvage site on the ocean floor. Divers can work there for extended work shifts. Once their shift is complete, they ascend to the ship and dock with the pressurized living chamber. After transferring inside, they can eat and rest while a second team descends to the work site in the capsule.

The true value of a system like this is in deep salvage diving. Dean said that back in 1996, when SUPSALV recovered aircraft wreckage from TWA Flight 800 off Long Island, divers were working without the benefit of a saturation system. Had the crash debris field been

Navy divers and special operators from SEAL Delivery Vehicle Team 2 conduct Lock Out Training with the ***Virginia***-class *USS Hawaii* (SSN 776) for material certification near Key West, Fla., Oct. 26, 2007. SUPSALV supports Navy divers by enabling them to work safely and efficiently.

half a mile farther east in deeper water, divers could not have bounced back and forth from the surface for the salvage effort—a saturation unit would have been necessary.

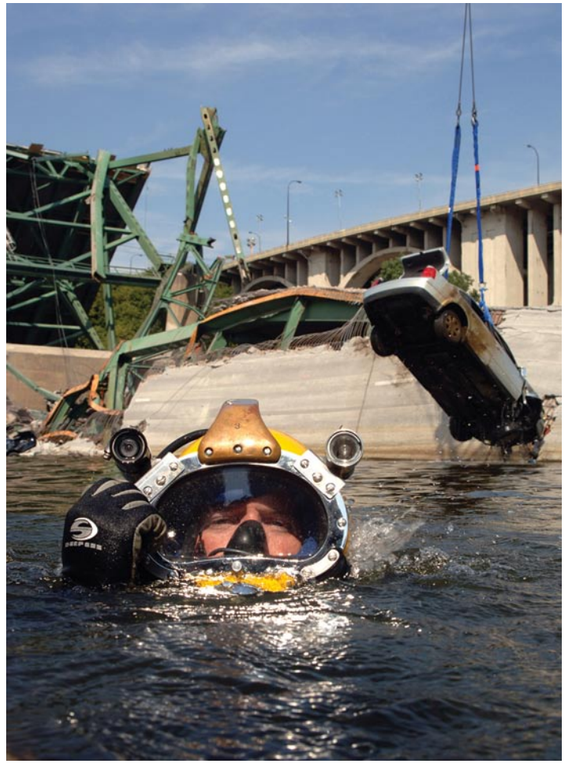
"At the end of the job, they'll still need to decompress," said Dean, "but now they can do it once and in a controlled environment, aboard a ship as it's returning to port."

Even while pushing forward new capabilities, the SUPSALV team had its hands full in 2007, supporting Fleet maintenance staffs in maintaining Fleet readiness through its ship's husbandry program. Throughout 2007, SUPSALV directly supported more than 84 Fleet underwater repair operations on Navy ships and submarines 64 of which resulted in vessels avoiding dry docks.

"It is difficult to get a ship in and out of a dry dock in under a week," said Dean, "so any repair that requires dry-docking means the ship and crew are tied up for a week. The Fleet commander loses that ship for a week, so over the course of the year, 64 ship-weeks is what we're giving back, which is sizable return on the Navy's investment."

In addition to assisting shipyards and regional maintenance centers to curb Fleet maintenance costs, SUPSALV also works hand-in-hand with NAVSEA Program Executive Offices and program managers, anticipating maintenance requirements for new vessels. By designing and building ships that are "diver friendly," the Navy can further reduce dry-docking requirements and drive down life-cycle maintenance costs.

"On the Littoral Combat Ship, replacing a water jet requires dry-docking and each



Navy Diver 1st Class Josuha Harsh, with Mobile Diving and Salvage Unit 2, surfaces after completing a salvage dive in the Mississippi River. The vehicle he and his team rigged for retrieval is lifted from the water. MDSU2 assisted federal, state, and local authorities with disaster and recovery efforts at the site of the catastrophic I-35 bridge collapse in August 2007.

ship has four of them," Dean said. "We have to develop equipment and procedures to allow divers to safely swap them out while keeping these ships out of dry dock. Also, we need the ability to change out the DDG 1000 propeller while afloat. With aluminum hulls that use different anti-fouling paints than the rest of the Fleet, we need to understand how to remove marine fouling from the hulls without damaging the paints. The aluminum hulls also present a challenge to divers who might have to make underwater weld repairs."

Dean noted that the SUPSALV team is assessing the impact of these new requirements with resource sponsors and ship program managers. With a combination of high-tech electronics, traditional cranes, lines and reels, and a constantly shifting schedule of tasks, SUPSALV put its salvage expertise to work around the world in 2007, offering the ability to identify and recover aircraft, flight recorder "black boxes," and even locate and capture on video previously unseen WW II wreckage.

When the Navy lost its first H-60S helicopter off San Diego in January 2007, the Chief of Naval Operations looked to SUPSALV to understand the failure mechanism. The SUPSALV salvage professionals and their team of seasoned contractors quickly pinpointed and retrieved the wreckage 3,700 feet deep in the Pacific Ocean.

Although SUPSALV operates primarily in support of U.S. Navy vessels and craft, international commercial and military agreements extend the reach of their diving and salvage capabilities.

In 2007, for two notable examples that reached outside the U.S. Navy, SUPSALV provided expertise and equipment for the Navy's Mobile Diving and Salvage Unit 2 supporting the Minneapolis I-35W bridge collapse recovery, and located the flight recorder of the downed Indonesian Adam Air Flight 574.

One of the most challenging tasks, however, following a request from the Australian Navy through U.S. Pacific Command, was to support search and recovery effort for an Australian H-60 Black Hawk helicopter lost near Fiji.

Because the Black Hawk lay under about 9,000 feet of water — near the 10,000 foot maximum depth level of the smaller systems — SUPSALV opted to use CURV III, a 12,600-pound Remotely Operated Vehicle (ROV) capable of operating down to 20,000 feet.

"Probably the most challenging aspect of the operation was getting our system half way around the world," said Mike Herb, SUPSALV Director of Salvage Operations. "This was the first airborne deployment of the entire CURV III system. Basically, it would have taken three C-17s or two C-5s for the whole system. And these aircraft are not self-loading, so as soon as you send it, you need a way to get the system off the aircraft as well as meaning we would have had to ship a large USAF K-loader as well."

The answer was a pair of commercial Russian Antonov AN-124, aircraft, the largest transport planes in the world. Hired by the Australian Ministry of Defense, the huge transport planes were able to transfer the CURV III system and the Fly-Away Deep Ocean Salvage System, a ship motion compensation system, directly to trucks and ultimately, to the Motor Vessel Seahorse Standard, under contract to the Australian Navy.

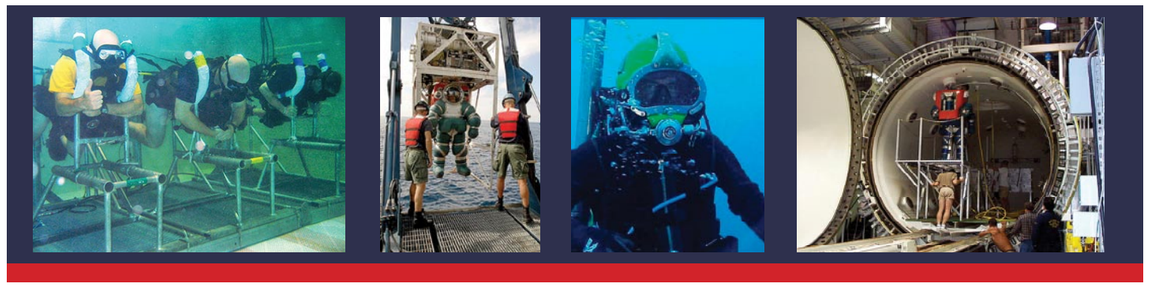
During the successful location and recovery of the Black Hawk, the NAVSEA team received a secondary request to dive on and photograph a recently discovered WWII-era Imperial Japanese M 24 mini submarine near Sydney using the SUPSALV deep ocean search and recovery systems maintained and operated by Phoenix International.

After wrapping that up, Herb said, the team received a final request from the Australian Navy: recover their submarine rescue vehicle Remora in about 460 feet of water off Perth in Western Australia. The CURV III and M/V Seahorse Standard team successfully hoisted the 18.4-ton vehicle to the surface and returned it to the Australian Navy for refurbishment.

When not conducting operations, SUPSALV actively participates in exercise planning and training for operational contingencies worldwide. Foremost among contingency planning is continuous development of SUPSALV's consequence management program, designed to minimize damage to the environment from oil or hazardous material spills.

With 2007 exercises in the Great Lakes and overseas in the 5th Fleet area of responsibility, SUPSALV's team maintains its vigil, standing ready to respond to needs of the homeland.

Navy Diver 2nd Class Ryan Steinkemp, of *USS Safeguard* (ARS 50), steadies himself on a platform during dive operations.



NEDU: PUSHING THE LIMITS

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NAVAL SEA SYSTEMS COMMAND

Navy ship, departing ... Navy Flag officers salute the color guard during the playing of the national anthem at the beginning of the *USS John F. Kennedy* (CV 67) decommissioning ceremony. More than 4,000 people were in attendance to honor *Kennedy*'s 18 deployments and nearly 39 years of distinguished service. The historic warship was placed in an inactive condition.

Navy ship, arriving ... After officially christening the newest Military Sealift Command advanced auxiliary dry cargo/ammunition ship *USNS Alan Shepard* (T-AKE 3), she is launched into the San Diego Bay during a ceremony held at the National Steel and Shipbuilding Company. *Shepard* is named after Rear Adm. Alan Bartlett Shepard, who was the first American astronaut in space and the fifth person to walk on the moon.

Christened

North Carolina (SSN 777)
Truxtun (DDG 103)
Sterett (DDG 104)

Commissioned/Delivered

USS Kidd (DDG 100)
USS Gridley (DDG 101)
USS Sampson (DDG 102)
USS New Orleans (LPD 18)
USS Mesa Verde (LPD 19)
USS Hawaii (SSN 776)
USNS Sacagawea (T-AKE 2)
USNS Alan Shepard (T-AKE 3)
USNS Richard E. Byrd (T-AKE 4)

Delivered First LCS Mission Module (Mine Warfare)
Deployed 30,000 JCREW Systems in Iraq and Afghanistan
Delivered 1000th man-transportable robot

Inactivated

USS Cardinal (MHC 60)
USS Raven (MHC 61)
USS Trenton (LPD 14)
USS Ogden (LPD 5)
USS Hyman G. Rickover (SSN 709)
USS Saipan (LHA 2)
USS Minneapolis-Saint Paul (SSN 708)
USS Shreveport (LPD 12)
USS John F. Kennedy (CV 67)

2007 MILESTONES AND WAYPOINTS

Diversity Awards

The National Society of Black Engineers Golden Torch Awards, John James, Jr. NAVSEA Headquarters
Women's History Month Role Model for Science, Technology, Engineering and Mathematics, Elaine Colston, Norfolk Naval Shipyard
Hispanic Lifetime Achievement Award, Carlos M. Godoy, NUWC Newport
Nathaniel Stinson Award (Large Activity), NUWC Newport
Rhode Island Commission on Women, Woman of the Year Award, Lynn Antonelli, NUWC Newport
Best Workforce Development Program (Human Capital Management For Defense), NSWC Port Hueneme

Engineering Excellence Awards

Top Engineer of the Year, Donald W. Johnson, NUWC Newport
Emerging Investigator Awards
Morris Fields, NAVSEA Cost Engineering and Industrial Analysis; Dr. Ahmed Amin, NUWC Newport
Daniel Brown, Daniel Cook, Dr. John Stroud, Top Engineer Team Award (NSWC Panama City)
Federal Laboratory Consortium Technology Transfer Award (Blue Rose Fiber Optic Perimeter Security System) NUWC Newport
National Defense Industrial Association Bronze Medal (Science or Engineering) NUWC, Newport
NAVSEA Scientist of the Year, Dr. Gregory Ames, NUWC Newport
Puget Sound Naval Shipyard & IMF Laboratory, First to Receive ISO Accreditation
Network World Enterprise All-Star Award (SANS), Surface Combat Systems Center
Captain Robert Dexter Conrad Award, Dr. Rolf Kasper, NUWC Newport

Lean Awards

Shingo Silver Medallion for Manufacturing Excellence, Port Hueneme

Environmental Awards

SECNAV Environmental Award (Pollution Prevention Team), NAVSEA Pollution Prevention Afloat
Best of the Best Stratospheric Ozone Protection Award, Gregory Toms, NAVSEA CFC and Halon Elimination Program
Businesses for the Bay Environmental Excellence Award (Outstanding Achievement for a Government Facility), Norfolk Naval Shipyard
EPA's Best Workplaces for Commuters in Rhode Island, NUWC Newport
SECNAV Energy Conservation Award, NUWC Keyport
SECNAV Energy Conservation Award, NSWC Carderock
State of Maine Clean Marina Award, Portsmouth Naval Shipyard

Professional Distinction Awards

Navy Procurement Excellence Awards, Seaport-e's Management and Governance Teams, NUWC Keyport
RADM Thompson Award for Public Affairs Excellence, NAVSEA Headquarters
RADM Thompson Award for Public Affairs Excellence, NUWC Newport
DOD Value Engineering Achievement Awards
Expeditionary Warfare Systems Division, NSWC Crane
Organization Electro-Optic Technology Division, NSWC Crane
Surface Electronics Warfare Systems Division, NSWC Crane
Special Rolling Airframe Missile Alteration Installation Team, NSWC Port Hueneme
Minehunting Sonar Set Hull Penetrator Cable Improvement Team, PEO Littoral and Mine Warfare
Undersea Weapons Program Office, Special MK54 Lightweight Torpedo, Team Submarine
Computerworld Honors (Open Architecture) PEO Integrated Warfare Systems
David Packard Excellence in Acquisition Award, Gary Vargo, Naval Ordnance Safety and Security Activity
NAVSEA Logistics Team of the Year Award, (VA-Class IPT Team) NUWC Keyport
Office of Naval Research (ONR) Cheapskate Prize for Affordability, NUWC Newport
Rhode Island Federal Employee of the Year, Dr. William Martin
Rhode Island Federal Employee of the Year, Mr. Joseph Muhitch
California Awards for Performance Excellence, silver-level award, Port Hueneme

Safety Awards

System Safety Society Manager of the Year, David C. Schulte, NSWC Indian Head
Chief of Naval Operations (CNO) Safety Shore Safety Award (Large Industrial Category), Norfolk Naval Shipyard
Secretary of the Navy and CNO Safety Ashore Awards, NUWC Newport
OSHA VPP 'Star' Pearl Harbor Naval Shipyard
Department of the Navy Safety Excellence Award in the Field of Acquisition (PMS 394), Team Submarine

From Cradle To Grave

From regularly scheduled maintenance needed for every commissioned ship, to essential modernization upgrades needed to keep these ships ahead of the threat, SEA 21 manages an extensive maintenance, modernization and disposal strategy that keeps the Fleet running efficiently.

The class-lead guided missile cruiser *USS Ticonderoga* (CG 47) is towed out of Naval Station Pascagoula immediately following the ship's decommissioning ceremony in 2004. She is the fifth ship to bear the name *Ticonderoga*.

The average Navy surface ship can be designed to be in-service upwards of 30-40 years," said Rear Adm. Jim McManamon, Deputy Commander Surface Warfare (SEA 21). "Over that length of time, threats and technology can render top-of-the-line ship systems obsolete. Our challenge is to modernize our ships to keep pace with those threats and new technologies to make sure these ships are relevant, capable warfighting assets for the Fleet."

CG/DDG Modernization

Over the next several years, 22 *Ticonderoga*-class guided-missile cruisers and 62 Arleigh Burke-class guided-missile destroyers will undergo a structured modernization to ensure they reach their projected 30-year service life. The ships will be fitted with new software, combat systems, HM&E and machinery upgrades to improve all areas of ship functionality. The first ships to start receiving upgrades are the *Ticonderoga*-class cruisers, three of which were started in 2007.

"The cruisers are our first modernization program," said Evan Littig, SEA 21's senior surface combatant class manager. "New software, systems and equipment will renovate combat capabilities as well as improve crew working and living conditions."

Destroyer modernization will begin in 2010. It will mark the first time a ship program has begun a major modernization program while the remaining ships of the class are still being constructed.

The first *Arleigh Burke* destroyers were built almost 20 years ago, and more advanced technologies are being built into the newer ships that will need to be retrofitted into older hulls.

"We won't officially start modernizing the DDGs until 2010, when *USS Arleigh Burke* (DDG 51) and *USS John Paul Jones* (DDG 53) go into the yards," said Littig. "But all the planning for that has to be done now, and it's been a tremendous effort."

Amphibious and Auxiliary

In addition to the surface combatant modernization, amphibious and auxiliary ships, such as in-service amphibious assault ships, command ships, transport and cargo ships and small craft, need mid-life improvements as well.

"In 2007 alone, we've done lifecycle availabilities on 21 of our amphibious and auxiliary ships," said Sam Samimi, deputy program manager of the amphibious and auxiliary support office. "That includes a mid-life sustainment program on our LSD 41, LSD 49 and LHD 1 classes, as well as upgrade programs for MCM-class mine hunters and PC-class coastal patrol ships."

Similar to the cruisers and destroyers, these ships require similar upgrades and lifecycle extensions to achieve maximum utility, and extend the gap between one generation of vessel and the next. In almost every instance, it is significantly more cost-effective to upgrade a current vessel than it is to construct a new one. These modernization efforts allow the Navy to extend service life on these valuable assets, saving the taxpayers money.

Disposal

Once a ship has reached the end of its useful service life, it is decommissioned and removed from the active ship inventory. Often the ship may still be in good working order and of some value to a friendly foreign navy, either through sale or a grant transfer.

"It's been a busy year for ship transfers," said Deputy Program Manager for Ship Transfers Bob Gronenberg. "Between January and March 2007, the Navy transferred the LPD 4-class amphibious transport dock *USS Trenton* to the Indian navy, the coastal mine hunters *Heron* and *Pelican* to Greece, and the coastal mine hunters *Cardinal* and *Raven* to Egypt."

Decommissioned ships not in a condition to be transferred or sold to friendly foreign navies can be removed from operational status by donation or disposal. In 2007, the Navy announced its intent to transfer the battleship *USS Wisconsin* (BB 64) to the city of Norfolk, Va. With 48 museum ships displayed in 21 states across the country, the Navy's ship donation program commemorates the history of these ships and their crews, educates the public and showcases naval tradition and heritage.

Finally, some environmentally prepared inactive ships can be used as targets in Fleet training exercises or transferred to a state for use as an artificial reef.

Those ships that are not donated to specific organizations for use as a museum, memorial or artificial reef are often dismantled in the U.S. by a private ship dismantling yard. These yards sell the ships' parts and steel and properly dispose of the waste products in accordance with environmental regulations overseen by Navy personnel. In 2007, four ships were being dismantled by private scrapping companies.

Taking the Sailor Out of the Minefield

Sea mines have damaged or sunk more Navy ships since 1950 than any other threat, and the threat of terrorist attacks against ships remains a grim reality.

Today's new land-based Improvised Explosive Device (IED) threat garnered a great deal of attention in 2007, but seaborne threats remained a top concern in maritime domain. Sea mines have damaged or sunk more Navy ships since 1950 than any other threat, and the threat of terrorist attack against U.S. ships remains a grim reality.

In 2007, two major events marked the beginning of major shift in Fleet mine warfare systems, expanding the mine countermeasures (MCM) capabilities of a deployed battle group.

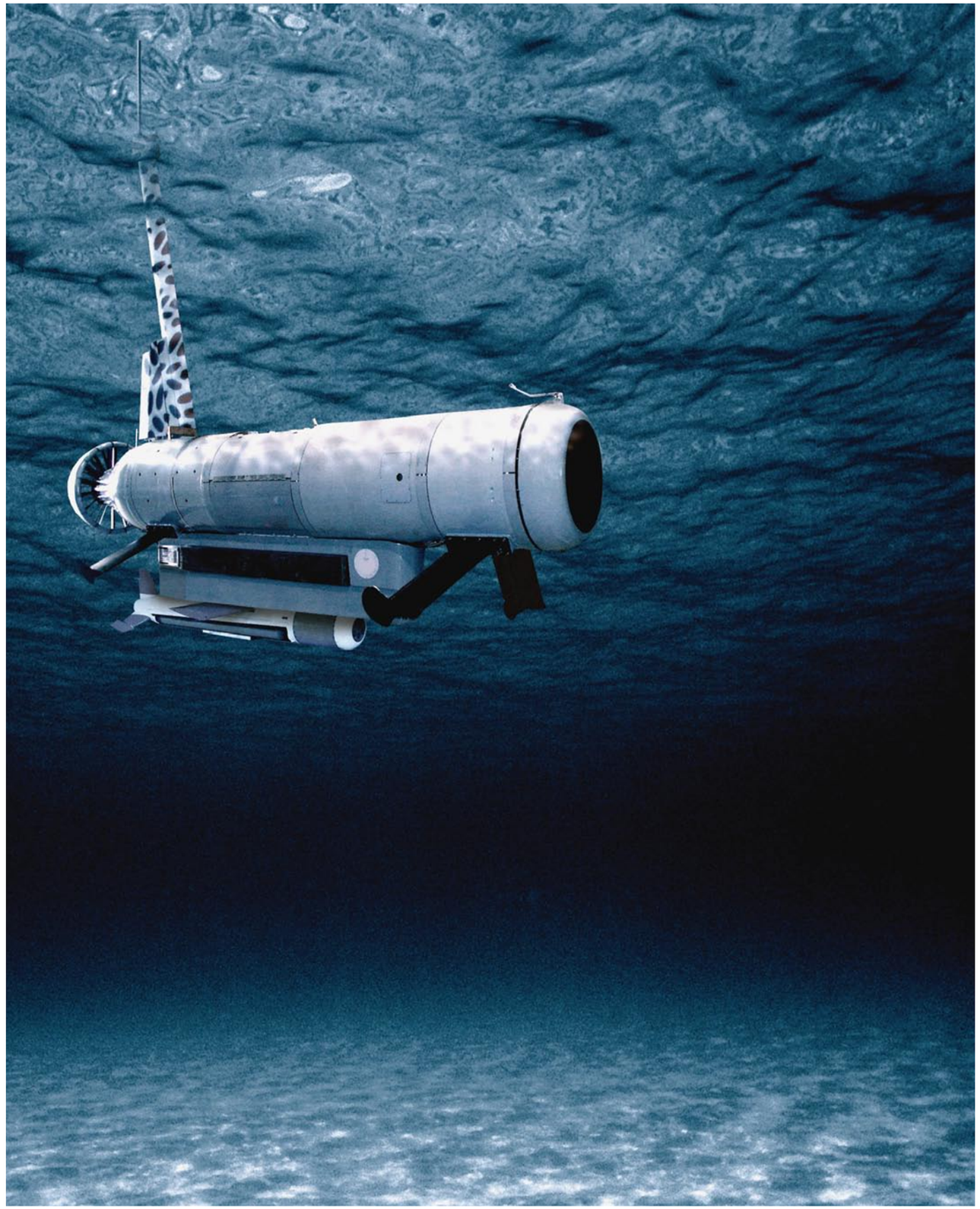
The first was the September deployment of a remote mine-hunting system (RMS) aboard *USS Bainbridge* (DDG-96), the first of its type to deploy aboard an Arleigh Burke-class destroyer. Second, Program Executive Office Littoral and Mine Warfare (PEO LMW), in conjunction with the Naval Surface Warfare Center Panama City, rolled out the first Mine Warfare (MIW) Mission Package that will equip the new LCS class of ships.

"Sailors will now have organic unmanned mine warfare systems deployed with the Fleet that allow them to detect, classify and neutralize mines from a safe distance," said Gary Humes, program manager for the Mine Warfare Program Office in PEO LMW. "RMS on DDG 96 and the LCS MIW Mission Package allows the Navy to keep the Sailor out of the minefield and send a remotely operated vehicle into the danger zone instead."

The RMS uses an unmanned remote vehicle towing a variable-depth sensor that detects, localizes and classifies bottom mines and moored mines. The MIW Package uses a host of organic mine warfare systems, including RMS and other airborne and unmanned systems, to locate, classify and neutralize sea mines.

But mine reconnaissance capabilities are not limited to the surface combatants. In October, a fast attack submarine, the *USS Hartford* (SSN 786), successfully launched and recovered two Unmanned Undersea Vehicles (UUVs) while submerged. Both UUVs used in the testing are part of the AN/BLQ-11 Long-term Mine Reconnaissance System (LMRS), a system designed to enable submarines to con-

Left A Navy HM-53E Sea Dragon helicopter assigned to Helicopter Mine Countermeasure Squadron 15 demonstrates the mine-sweeping capabilities of the Navy's MK-105 Magnetic Influence System, better known as the "sled." **Below** The Remote Minehunting System (RMS) is an organic, off-board mine reconnaissance system that offers carrier strike group ships an effective defense against mines by using an unmanned remote vehicle.



duct clandestine undersea surveys to locate mines. The LMRS, while not going into acquisition yet, is a critical contributor to risk reduction for the next generation of submarine-launched UUV, the Mission Reconfigurable Unmanned Undersea Vehicle System (MRUUVS).

"This is a significant milestone for submarine-deployed UUVs," said Capt. Paul Siegrist, program manager for Unmanned Maritime Vehicles Systems in PEO LMW. "Vehicle recovery while submerged was one of our most complex engineering challenges. Overcoming this hurdle opens a critical path to deliver real UUV capability to the Fleet."

Also in 2007, the Navy took delivery of another type of mine detection system, an above-water system that rides on the MH-60S helicopter called the Airborne Laser Mine Detection System (ALMDS).

Because it has no in-water components, the system's light-imaging detection and ranging laser can quickly detect, identify and classify surface and near-surface mine threats in the water.

And because it's mounted on a helicopter, it can cover a larger amount of sea space in a shorter time.

When these systems are deployed aboard the LCS — current plans call for five airborne countermeasure systems — they will offer carrier and expeditionary strike groups a full spectrum of mine detection and neutralization capabilities that are forward-deployed with the Fleet.

"This highlights an aspect of design and development that has taken a renewed focus on the end-user: The warfighter," said Siegrist. "Using incremental feedback in the development design and testing process, the end product is the result of a process that is warfighter-focused and more effective."

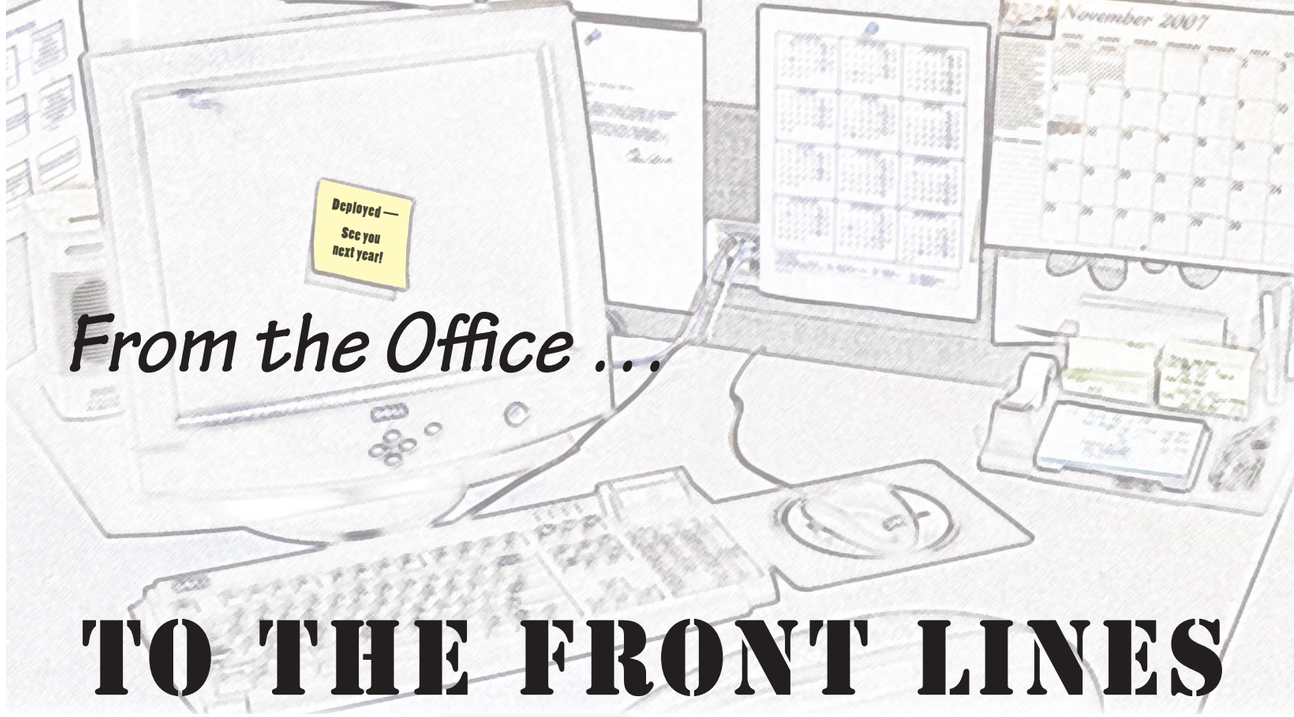
Defending the Navy's Fleet goes beyond hunting down potential mine threats. Significant progress occurred in 2007 with the initial installation of a Shipboard Protection System (SPS).

This system helps provide a ship with situational awareness to protect against what are called "asymmetric threats," or threats from low-tech attacks, similar to the small-boat terrorist attack that killed 17 Sailors and severely damaged *USS Cole* (DDG 67) in 2000.

"The SPS will allow the ship's commander to conduct surveillance, track and evaluate identified threats and respond appropriately, starting with a non-lethal response and progressing to additional defensive measures as necessary," said Capt. John Day, PEO LMW Anti-Terrorism/Force Protection (AT/FP) Afloat Program Manager.

SPS pulls together a number of commercial off-the-shelf technologies into an integrated package of command and control software, sensors, tactical decision aids, warning devices and weapons to provide a full-range defensive capability to naval surface combatants against asymmetric threats.

"The bottom line is that whether it is AT/FP or organic MCM, we are delivering real capability to the Fleet that will save lives," said Jim Thomsen, Program Executive Officer for Littoral and Mine Warfare.



TO THE FRONT LINES

NAVSEA SUPPORTED THE GLOBAL WAR ON TERRORISM (GWOT) IN 2007 WITH A DAILY AVERAGE OF 60 VOLUNTEERS SERVING IN IRAQ, AFGHANISTAN AND THE HORN OF AFRICA.

FROM OFFICER AND ENLISTED INDIVIDUAL AUGMENTEE DEPLOYMENTS TO CIVILIAN ENGINEERS DETAILED TO THE STATE DEPARTMENT, OUR NAVSEA TEAMMATES ARE RESPONDING TO THE NATION'S NEED FOR THEIR UNIQUE SKILLS.

WITH OUR INDIVIDUAL AUGMENTEES ANSWERING THEIR CALL TO SERVICE, NAVSEA IS SUPPORTING THE GWOT WITH SHIPS ON THE SEAS ***AND*** BOOTS ON THE GROUND.

INDIVIDUAL AUGMENTEES

Today's CARRIERS

When *USS George H. W. Bush* (CVN 77) joins the Fleet in 2009, she will be the tenth and final ship in the 32-year-old Nimitz class. Her service life is expected to be 50 years—and her final commanding officer has likely not even been born yet. For such a class of warship, words like "proud," "venerable" and "workhorse" might seem appropriate. But Capt. Tom Moore, program manager for in-service carriers, prefers words such as *adaptable* and *transformational*. Even *revolutionary*.

"The aircraft carrier is the most adaptable platform we have out there," he said. "Why? For an aircraft carrier, the weapons system is the aircraft."

"When *Nimitz* was commissioned in 1975, she was flying A-6 Intruders, A-4 Skyhawks, A-7 Corsair IIs and F-14 Tomcats," Moore said. "As the aircraft and the weapons they use evolved over time, we went from A-6s to the F/A-18 Hornet. Then the F/A-18A/C is replaced by the F/A-18E/F Super Hornet. And it's certainly possible that by the time the *Nimitz* class retires in 2058, we may not have any manned aircraft onboard."

Far from winding down into obsolescence, the *Nimitz* class is thriving as illustrated by two members of the class in different stages of service life: *Bush* and *USS Carl Vinson* (CVN 70).

Vinson, the third ship in the class, was in Norfolk in 2007 getting the Navy's version of an extreme makeover; a Refueling and Complex Overhaul, or RCOH. Much like the service book for an automobile, Navy ships follow a class maintenance plan.

Routine maintenance occurs at specific points in the carrier's service life. Right now, *Vinson* is in the middle of her 23-year checkup. For an outsider, three years and $3.2 billion may indeed seem extreme just to fill up the gas tank. But a RCOH consists of three equally important parts: refueling, maintenance and modernization. According to Moore, refueling, while essential, is not the major focus.

"It is somewhat of a misnomer to call it a refueling complex overhaul, because the refueling portion of it is only about 10 percent of the total cost of the RCOH. The real reason that we have this process, in addition to refueling the two reactors, is to provide a combat-capable ship for another 25 years of service. We do 35 percent of all maintenance over the 50 years during the three-year period," he said.

Far from winding down into obsolescence, the Nimitz class is thriving as illustrated by two members of the class in different stages of service life: George H. W. Bush *(CVN 77) and* USS Carl Vinson *(CVN 70).*

Maintenance, the second aspect of the RCOH, is where *Vinson* gets deep maintenance and repair work done.

"In particular, the distributive systems," Moore said. "We get into all the tanks, into the structure, into the piping systems, chemical holding tanks, chill water, fire main, etc. We overhaul a lot of the pumps and the machinery on board to get the complete overhaul."

For the family car, a 50,000-mile checkup is all about maintenance, what can be done to keep the car road-worthy for another 50,000 miles. For an aircraft carrier, the RCOH almost makes it like a new model warship.

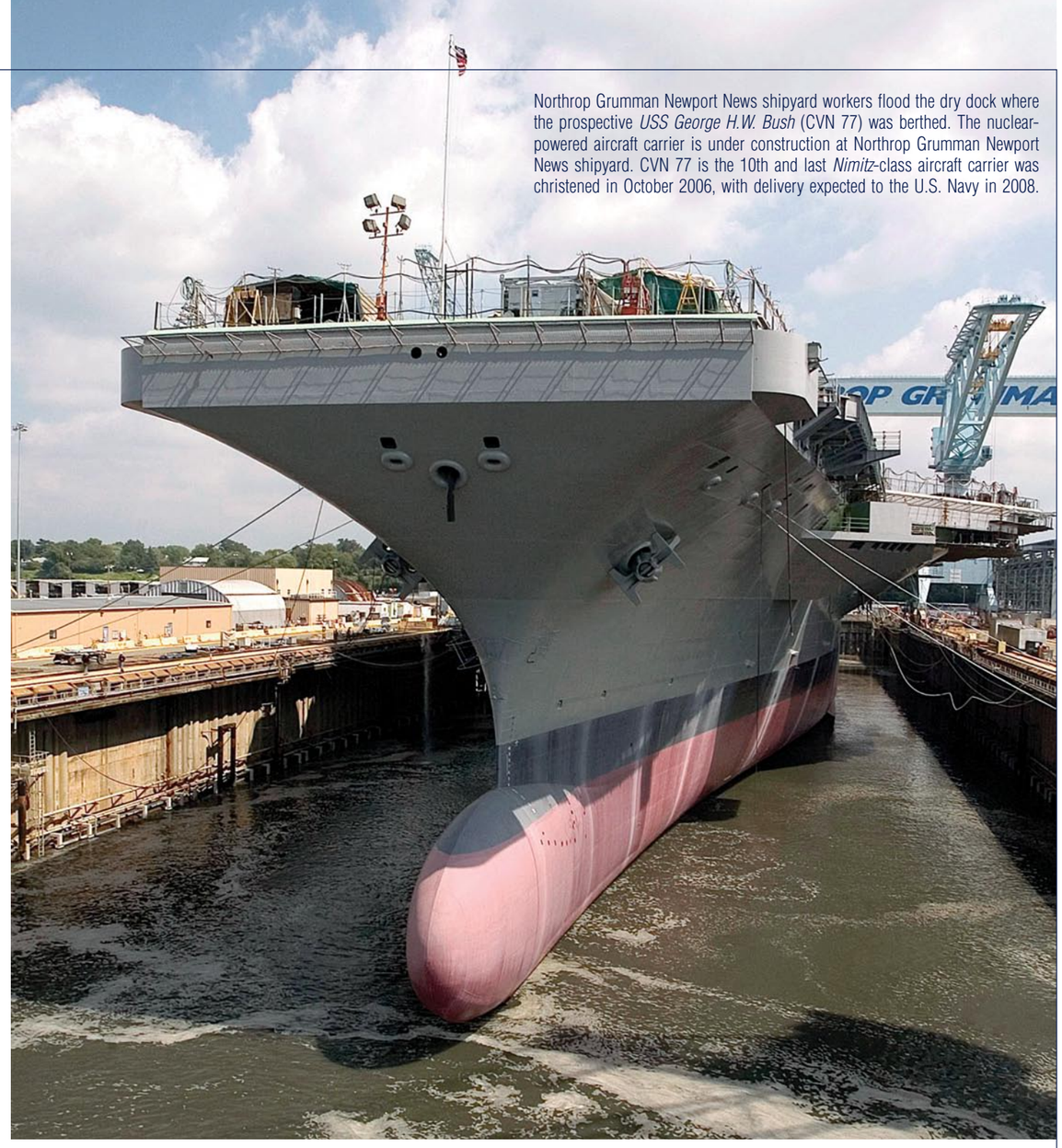
"She may get a new communications system. She'll get the latest IT systems, LANs and backbones," Moore said. "This is also our opportunity to really do significant modernization of the ship, to align its combat capability so that when it comes out of the yard at the end of its RCOH, it's the most capable carrier that we have in the Fleet."

As with a motor vehicle, the *Nimitz* class has evolved over the years. *USS Nimitz* (CVN 68) and *Bush*, respectively the first and last ships of the class, may seem to some more like close cousins than sisters.

"CVN 77 is very similar to CVN 76 in that she's got a bulbous bow for improved sea keeping and improved efficiency of the ship," Moore said. "She has some other things on board that even CVN 76 doesn't have, a couple of interesting technologies we are trying here that will eventually be used on CVN 78."

The changes to CVN 77 may not be exciting stuff to the layperson, but they are important technological advances. For example, she has brand new propellers.

"For years, the *Nimitz*-class carriers have been using propellers that really were sized for an aircraft carrier of around 85,000 tons, but the *Nimitz* class is up around 95,000 tons," Moore said. "It was like having a two-liter engine on a big truck. Every two to four years, we had to swap the propellers out or do costly underwater repairs."



Northrop Grumman Newport News shipyard workers flood the dry dock where the prospective *USS George H.W. Bush* (CVN 77) was berthed. The nuclear-powered aircraft carrier is under construction at Northrop Grumman Newport News shipyard. CVN 77 is the 10th and last *Nimitz*-class aircraft carrier was christened in October 2006, with delivery expected to the U.S. Navy in 2008.

Left The 41st President of the United States, George H. W. Bush, returned to Northrop Grumman Corporation's Newport News shipyard Jan. 25, 2008 to assist shipbuilders and Sailors conduct catapult testing on the *Nimitz*-class aircraft carrier named in his honor. The event marked the fourth shipyard visit by the former president, who previously attended the ship's keel authentication, island landing and christening. Bush said, "In case you're wondering, it's still hard for me to comprehend this fantastic honor, having this ship named for me … One key way this ship will be no different than the one I served on in World War II is the pride and the patriotism and the commitment to duty and honor of the men and women serving aboard it … Heroes don't only live in the past or just in the history books. They are all around us. They're shipbuilders. They're naval personnel." While standing on the carrier's 4.5-acre flight deck, Bush signaled for a "deadload" to be launched into the James River. Catapult testing consists of launching large containers, called deadloads, that are equal in weight to the planes that will ultimately be launched off the flight deck.

The new propellers, made by Rolls-Royce, are the same size, but of a new design made specifically for the *Nimitz* class.

In a cost-saving measure, the old propellers are being melted down and the bronze reused in the new propellers, which eventually will be retrofitted to all *Nimitz*-class carriers.

Another important advancement is the use of a commercial vacuum marine sanitation system that completely eliminates the use of salt water. Waste from the ship is processed through a series of infrared and ultraviolet tanks. The resulting effluent meets EPA limits.

"That is a big deal. It used to be when ships were in port you had these big holding tanks and pumped it to the pier. If you were out just loitering around along the coast you had to get out of certain number of miles from the coast before you were able to pump waste products and foodstuffs overboard," Moore said.

Bush will be the first ship to feature a composite mast. The advantages of using composite material include high strength, low weight and reduced maintenance. "Then you're talking about centers of gravity and things like that. Anything we can do that takes weight down is a good thing," Moore said.

One other major change to CVN 77 is a brand new JP-5 fuel system. On previous Nimitz-class carriers, JP-5 jet fuel is carried throughout the ship through an elaborate piping system.

"That was a very manpower intensive system; a lot of valves, a lot of tanks," Moore said. "In the old days a lot of people on sound-powered phones, opening valves, moving fuel around to the right places. We have simplified the design. It sets up to be completely automated. Eventually, all of those valves will be controlled from a central control station. We will be able to align the system a lot simpler, a lot less maintenance and a lot fewer people."

Ultimately, having fewer people onboard is important, not just for CVN 77's JP-5 system, but for reducing operating costs overall.

"The cost of the *Nimitz* class over 50 years is about $32 billion. That's the cost to build it, operate it and dispose of it. About $14 billion of that $32 billion is people. The largest single cost to that ship is not actually the cost to build it. The largest single cost in the 50-year service life is the cost to manage the carrier. If you want to drive down the total lifecycle cost of aircraft carrier, you've got to get a number of people off," Moore said.

Bush is well on its way to joining the Fleet. She was christened in October 2006 and is now in the water and has steam. Major testing is underway. One of four catapults is completely assembled and undergoing no load testing.

More than 1,000 of the ship's crew have reported for duty and will move aboard starting sometime in the late spring or early summer of 2008.

In 2009, one 25-year-old aircraft carrier will rejoin the Fleet and one brand new one will be commissioned, proving the *Nimitz* class to be both the Navy's most venerable and most transformational platform.

Left *USS Hawaii* (SSN 776) surges past the New London Ledge Light en route to successful Alpha Sea Trials. **Above** The prospective *USS New Hampshire* (SSN 778) is well underway to completion on a pace expected to shave eight months off construction time.

The Virginia Class

Success at Sea and in the Shipyard

In 2007, *USS Hawaii* (SSN 776) successfully completed an Operational Evaluation off the Florida Keys that demonstrated the Virginia class' ability to deploy and recover Special Operation Forces — a giant step for the Navy's newest class of submarine.

"We proved the ship could actually lock out and lock back in a SEAL Team, and this really shows that between the Virginia class and the SSGN, we've increased our work with the special forces," said *Virginia*-class Program Manager Capt. Dave Johnson. "Also, it really drives the relevancy of the *Virginia* class and the SSGN in the Global War on Terrorism."

The *Virginia*-class submarine, the replacement for the veteran Fleet of *Los Angeles*-class attack submarines, is a key focus of the submarine community, according to Rear Adm. William Hilarides, Program Executive Officer for Submarines.

"The 313-ship Navy needs 48 SSNs," said Hilarides. "In order to keep the number of platforms where the warfighter clearly needs, we need to get production to two per year. The *Los Angeles* class will soon start to go out of service at three to four per year, and right now we're only building one per year. Getting to a two-per-year production rate is essential to the future of the submarine force."

So the question is, can the Navy afford to build two of these per year? The answer is *yes*. The *Virginia*-class program is on track to meet the mandate given in 2005 by the former Chief of Naval Operations and current Chairman of the Joint Chiefs of Staff, Adm. Mike Mullen, to bring the cost of each *Virginia*-class submarine to $2 billion, as measured in fiscal year 2005 dollars, by fiscal year 2012.

"The FY 08 boat, 10th in the class, is at $2.4 billion, in [fiscal year] 2005 dollars," said Hilarides. "That means we have to cut $400 million, almost 20 percent, out of a ship that's already in serial production — that's a challenge. Ask any manufacturing activity to take 20 percent out of its cost in four years, and they'll tell you that's a real challenge. Not impossible, but a challenge." The *Virginia*-class program has a solid plan in place to meet this challenge.

"We need the ship builders and suppliers to reduce their hours and material," Hilarides said. "We also need the government to reduce its costs. And we've done that."

In fact, both the government and the shipbuilders have people assigned to work cost reduction, as well as incentivizing the workforce by placing requirements in performance objectives. The phrase "2 for 4 in 12" (two submarines for $4 billion, measured in fiscal year 2005 dollars, in fiscal year 2012) is the oft-repeated mantra supporting the capture of this aggressive organizational goal.

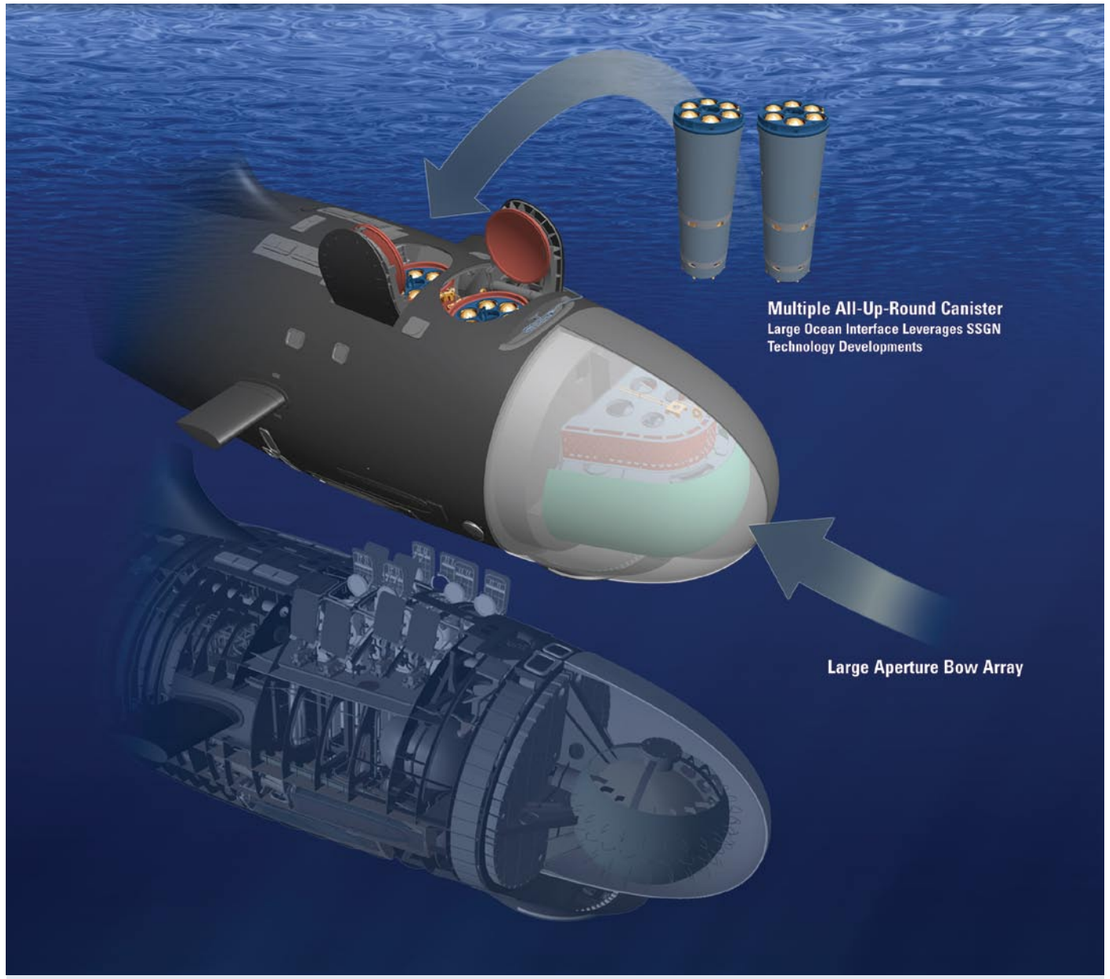
"We've used '2 for 4 in 12' as a rallying cry to mobilize the force and to get everyone to stand up and do their part to reduce the cost," said Hilarides. "I've heard '2 for 4 in 12' everywhere I go, from the deckplates at Electric Boat to the offices of Connecticut Congressman Joe Courtney."

To make "2 for 4 in 12" a reality, the Navy invested $600 million to find ways to drive the cost of Virginia-class construction down in conjunction with the program office's institution of a three-phase cost-reduction strategy.

The first element involves entering into an eight-ship Multi-Year Procurement Contract with Economic Order Quantity in fiscal year 2009. By doing so, the Navy will remove $200 million of cost (in fiscal year 2005 dollars) from each hull, beginning with the fiscal year 2012 ships.

The second phase focuses on improving construction performance from 84 months to 60 months. The Navy submarine builders, General Dynamics Electric Boat and Northrop Grumman Newport News, have been instrumental in reducing the construction span.

"Both yards have done a great job improving their performance and getting boats delivered," Johnson said. "In fact, the fifth ship of the class, *New Hampshire* (SSN 778), is on track to deliver in August 2008, eight months ahead of the contracted for delivery date. *New Mexico*, the sixth ship,



How Virginia's bow was redesigned for improved affordability

Teamwork between the Navy and shipbuilders Electric Boat and Northrop Grumman Newport News is hailed as the key ingredient for the success of the *Virginia*-class Cost Reduction Program.

The team celebrated a decision by the Undersea Enterprise Board of Directors to approve the *Virginia* Cost Reduction Team's proposal for a vertical payload and sonar system redesign that adds $20 million [in fiscal year 2005 dollars] into the cost savings bank.

These changes — combined with 20 projects in this major module — are expected to be nearly $40 million per ship [in FY05 dollars].

This achievement, which helps make the $2 billion [in FY05 dollars] per-submarine goal attainable, is attributed to the cooperation and ingenuity of the team members.

"The *Virginia*-class cost reduction is a premier program that's reversing the trends of cost growth in the shipbuilding industry," said Capt. Dave Johnson, *Virginia*-class Submarine Program Manager (PMS450).

"This program has matured to something beyond my expectations," said John Holmander, Electric Boat vice president and Virginia Program Manager. "There has been lively debate that has resulted in a product that is much better because of it. We all have a common goal that was given by the CNO: The $2 billion ship [in FY05 dollars]. We've got to get there. We are well on our way."

Program Executive Officer for Submarines Rear Adm. William Hilarides commended the *Virginia*-class program office and the two shipbuilders for "knocking down barriers" and sharing lessons learned so that performance continues to improve on each *Virginia*-class submarine.

Below Lt. j.g. Darrin Barber heads out to sea aboard the *Virginia*-class submarine *USS Texas* (SSN 775).

is also tracking toward eight months early," Johnson said.

A key component to reducing construction span is the Capital Expenditure (CAPEX) Program. The Navy set aside a $91 million incentive fee in the Block II *Virginia*-class contract for capital expenditure improvements for both its shipbuilders.

To earn the money, the shipbuilder must submit a business case explaining how it could improve productivity, the cost for the improvements and expected savings. If the Navy accepts the proposal, it would pay for half of the project; when the shipbuilders demonstrate returns, they receive another payment to cover the entire cost of the upgrade.

To date, the Navy has awarded $63 million for 10 projects, four of which are complete, for a savings of $422 million over the life of the program — a remarkable 7-to-1 return on investment. The third element of the cost-reduction strategy involves redesigning portions of the ship to make them more affordable to build. General Dynamics Electric Boat and Northrop Grumman Newport News submitted hundreds of ideas, some of which will be a part of the Block III contract scheduled for award in October 2008.

Some of the ideas represent modest savings, such as modularizing the *Virginia*-class Lock-Out Trunk design for easier assembly, outfitting and testing prior to installation within the hull — something that will save $200,000 in fiscal year 2005 dollars starting with the two *Virginia* subs ordered in fiscal year 2012.

Other ideas, however offer greater savings. Replacing the sonar sphere with a Large Aperture Bow array, the installation of two *Virginia* Payload Tubes, which are identical to the SSGN's Multiple All-Up-Round Canisters, in the place of 12 Vertical Launch Tubes, and 25 associated design changes, for example will save $40 million per ship as measured in fiscal year 2005 dollars starting with the fiscal-year 2012 *Virginia*-class submarines.

"This three-element strategy is working. As of [December 2007], we are $42 million away from realizing '2 for 4 in 12' and we have a plan to get that remaining bogey by March 2008," said Hilarides. "The *Virginia*-class team, the program office, the shipbuilders, Naval Reactors, the Assistant Secretary of the Navy for Research, Development and Acquisition, the Submarine Warfare Division, and the Fleet took the challenge and we are committed to meeting our mutual goal."

"It's important to us, it's important to the Navy, and it's important to the country,' Hilarides said.

Scenes of SSGN
Left The crew of *USS Florida* (SSGN 728) mans the rails during a return-to-service ceremony. (middle left) The diving officer of the watch and crewmen in *Florida*'s control room. **Middle right** The lock-out chamber allows stealthy egress and ingress by special forces onboard *Ohio*-class SSGNs. **Bottom left** *USS Ohio* (SSGN 726) stops for a personnel transfer. **Bottom right** A Navy diver and special operator from SEAL Delivery Team (SDV) 2 perform SDV operations with *Florida* or material certification. Material certification allows operators to perform real-world operations anytime, anywhere.

SWIFT STEALTHY POWERFUL LETHAL:

THE EXTRAORDINARY

SSGN

The SSGN Program Office delivered *USS Georgia* (SSGN 729) back to the Fleet on Dec. 18, 2007. This was two months after *USS Ohio* (SSGN 726), the first submarine to undergo conversion from being a ballistic missile submarine (SSBN), embarked on its first patrol as a nuclear-powered guided missile submarine (SSGN).

Georgia's delivery was significant for this technologically advanced submarine conversion program. It confirmed how a team with many players can work together to accomplish an aggressive and important goal by following the game plan. Program Executive Officer for Submarines Rear Adm. William Hilarides said, "The SSGN program's success grew from a high performing team, lots of teamwork and, frankly, hard work."

According to SSGN Program Manager Capt. Mark Bock, *Georgia* is scheduled for two modernization periods in 2008 to fully upgrade its electronic systems, and the crew will conduct training and certifications. By 2009, it will join the other SSGNs in a routine cycle of maintenance and deployments. On average, this cycle will result in about 2.6 SSGNs being deployed at any time.

From the programmatic side, Bock said the delivery of four boats within one percent of the fiscal year 2002 Milestone C estimated costs and two percent of schedule — 134 months instead of 131 months — is significant.

"The SSGN program accomplished a complex task in a short time that required the cooperation of many organizations involved in design, conversion and testing," Bock said. "This task succeeded because of attention to the technical details of conversion, frequent assessments of cost trends and a dedicated work force that worked hard to make the program a success. There's nothing magical about our success. I think future ship programs can readily incorporate some of the tools, practices and procedures we used to be successful."

Bock added that, although the program has been successful, there have been challenges to overcome — the greatest obstacle being designing, converting, and delivering four platforms in a short time span. The ballistic missle submarines were reaching the mid-point of their service lives when the bold conversion decision was made.

"The decision to convert these submarines to SSGNs instead of retiring them dictated a program that required rapid production of design drawings concurrently with the start of overhauls and conversions," Bock said. "This challenge was only met by the disciplined performance of a superb team consisting of the SSGN program office, Electric Boat, Puget Sound Naval Shipyard, Norfolk Naval Shipyard, the Strategic Systems Program and many Navy program offices and contractors providing equipment and support."

While bringing this transformational asset to the Fleet on budget and on schedule is important, its value is diminished if it doesn't incorporate the right capabilities.

Hilarides and Bock said that the conversion of all four SSGNs gives combatant commanders a new and very powerful tool in their arsenal to prosecute the Global War on Terrorism.

Three distinct benefits of the submarines are the ability to support and launch up to 154 Tomahawk missiles; added capacity for Special Operations Force (SOF) platoons to train and maintain physical conditioning for a sustained deployment; and to serve as a covertly positioned, quick-response land attack and strike platform.

"The unequalled strike and SOF payloads of the SSGNs provide decision makers with enhanced capabilities in a forward-deployed, stealthy platform that can operate covertly for long periods of time," Bock said. "Additionally, SOF need sustained clandestine support from a mobile offshore platform that provides access to targets with an element of stealth and surprise."

"While a typical nuclear-powered attack submarine supports a few SOF personnel, we specifically designed this ship for an entire SOF campaign," Hilarides said. "With lots of mobility, lock-out capability, extra bunks and a robust command and control center, the SSGN really brings a volume effect we've never been able to provide."

"These boats are capable of these missions at a volume level far surpassing our current force," said Hilarides. Additionally, the extended deployment capability of up to 12 continuous months with three crew rotations allows combatant commanders greater flexibility and an extraordinarily versatile at-the-ready asset.

Employing concepts like Open Architecture, SSGNs have been modernized with the most up-to-date combat systems available, representing a revolution in the way submarines are modernized, according to Bock. Noteworthy improvements include the Common Submarine Radio Room (CSRR); enhanced electronic surveillance capability (AN/BLQ-10); the latest combat system (AN/BYG-1, TI04); updated sensors (ARCI); and digital-imaging, non-penetrating periscopes.

"Aside from enhancing combat capability in general, this also gives the SSGNs significant intelligence, surveillance and reconnaissance capability," Bock said. "The transformation of this Cold War ballistic missile submarine to a modern, asymmetric 'Global War on Terrorism' machine is an amazing story all by itself."

Hilarides said the team is now hard at work capturing lessons learned for future programs. "Eventually, a new submarine will be built," he said. "We are looking at the SSGN and *Virginia*-class programs for lessons learned to make sure they're baked in [to new submarine programs]. We need to take those lessons while they're fresh and make sure they're taught to the young people who'll staff that program office in the future.

"This is something we are very aware of, to make sure there is good knowledge and data transfer to the new generation."

Big Shots!

The next round of naval guns will be more accurate, more lethal — and we won't even need to see the bad guys to hit them.

When it comes down to Gun Weapon Systems (GWS) and 21st century requirements for modern naval warfare, the Program Executive Office for Integrated Warfare Systems (PEO IWS) Naval Gunnery Project Office has its hands full. Tasked with the requirement to maintain a technological edge over potential adversaries, the PEO IWS naval gunnery team not only expands the current Fleet capabilities, but also coordinates the development of new systems to arm and defend the next generation of warships.

In 2007, progress in Fleet upgrades and weapons development noted significant milestones. Fielding of MK 34 GWS for new-construction Navy destroyers has been achieved with great success. MK 34 GWS consists of MK 45 5-inch/62 gun mount, MK 160 Gun Computer System and MK 46 Optical Sight System to provide defense against air and surface targets. It also provides naval surface fire support for amphibious assaults from over the horizon. This GWS is fully integrated with the Aegis combat system and SPY radars on the Navy's Aegis cruisers and destroyers.

Last year also saw progress on the MK 110 57mm Medium Caliber GWS. With the completion of initial testing and evaluation, preparations moved forward for production of this system in Louisville, Ky. The medium caliber gun system will defend against surface and air threats. The combination of programmable ammunition and an electro-hydraulic stabilization system makes it extremely accurate, even in high sea-state conditions. Plans for the MK 110 call for it to cross traditional service lines, with installations slated for the Navy Littoral Combat Ships, next-generation *Zumwalt*-class destroyers and the U.S. Coast Guard's Deepwater Maritime Security Cutters.

In addition to its lethal design, the system was also designed with the Sailor in mind.

"As part of the initial testing and evaluation, a group of experienced and entry-level gunner's mates were able to conduct various maintenance procedures on the gun," said naval gunnery Program Manager Capt. Lee Bond. "Our feedback from these Sailors was that it was much easier to access the interior components and complete maintenance on this system than many other in-service systems."

Other major pushes from the IWS team are the result of changes in design to meet the requirements of the 21st century threat environment. Gone are the Cold War combat systems. With today's modern, stealthier adversary, the focus of combat system design has shifted to superior capability in the world's coastal regions. With a requirement to project and protect from a sea base while minimizing collateral damage, the weapons designs now seek greater range in land accuracy and lethality.

A high priority has been placed on the naval gunnery team to develop a new long-range, guided projectile. The current MK 45 5-inch gun can fire its conventional ammunition round to the horizon, but the accuracy at that range is limited. A new "smart" projectile, called Extended Range Munition (ERM), will extend the range of the 5-inch gun significantly through the use of an integrated solid rocket motor.

Additionally, a global positioning guidance system increases round accuracy dramatically through a Circular Error of Probability reduction. This capability was successfully demonstrated at the test range in 2005; however, the challenge with this projectile is to improve its reliability. Significant efforts in 2007 have been focused on design improvement and component obsolescence.

Still in its testing phase, the naval gunnery team will continue to test and refine the ERM design in 2008, anticipating installation onboard the *Arleigh Burke*-class destroyers in the future.

Additionally, PEO IWS has big plans for the *Zumwalt*-class destroyers (DDG 1000) with the development of Advanced Gun System (AGS) and Long-Range Land Attack Projectile (LRLAP).

Designed to engage fleeting enemies in dispersed locations without placing forces ashore, the AGS will have the ability to rapid-fire LRLAP. Using an optimized combination of gun-launch and rocket-assisted energy, the weapon's range will increase even further inland and fire from a new fully-automated weapon handling and storage magazine.

A successful completion of production readiness review for the AGS in 2007 provided a solid foundation for establishing production capability in 2008.

But increasing the range and accuracy is not the only requirement for future shipboard gun systems. Following the attack on *USS Cole* (DDG 67), it became clear to the Navy that existing systems were not sufficient to guard against small craft asymmetrical attacks.

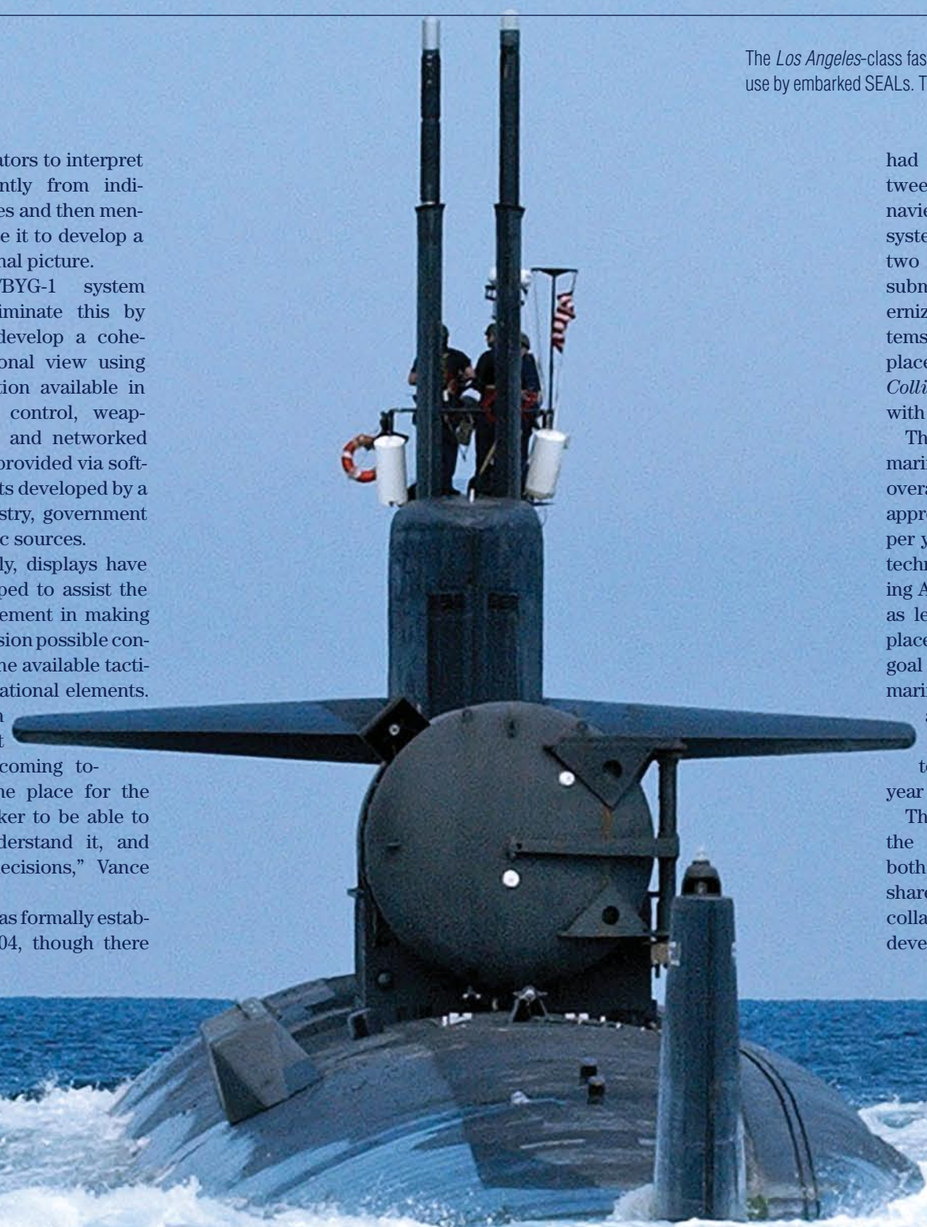
The MK 38 Mod 2 is a 25 mm stabilized chain gun that can fire up to 180 rounds per minute. Its Toplite sensor system, including Forward-Looking Infrared Radar capability, provides ship protection from attack around the clock in all weather conditions. Installations have been undertaken with a planned completion for all LSD and CG ship classes in 2008. Additionally, installations for DDG ship class will also begin in 2008.

Like its weapons that find targets beyond the horizon, PEO IWS anticipates and incorporates threats of the coming years into the design of its systems. Designed around the crew, these future Navy gun systems spell good news for Sailors.

And bad news for adversaries.

Top The remotely operated MK 38 Mod 2 is a high-speed, highly accurate 25 mm stabilized chain gun that can fire up to 180 rounds per minute to protect ships from attack around the clock in all weather conditions. **Above** The futuristic Advanced Gun System (AGS) is designed to engage fast-moving enemies in dispersed locations without placing forces ashore. **Below** The MK 110 Medium Caliber gun offers programmable ammunition and an electrohydraulic stabilization system for extremely accurate shooting, even in high sea-state conditions. **Bottom left** The rapid-fire Long-Range Land Attack Projectile, to be fired by the AGS, uses an optimized combination of gun-launch and rocket-assisted energy and fires from a fully-automated weapon handling and storage magazine.

Submarine Combat Control System



The *Los Angeles*-class fast-attack submarine *USS Dallas* (SSN 700) was the first submarine in its class to have a dry deck shelter (DDS) for use by embarked SEALs. The *Los Angeles*-class boats are among those being fitted with the sophisticated AN/BYG -1 combat control system.

The Submarine Combat Control System points toward a unified 1,000-ship international navy.

"If you think about the CNO's initiative for a 1,000 ship international Navy, the AN/BYG-1 Submarnne Combat Control System certainly drives us down that trail," said Submarine Combat and Weapons Control Systems Program Manager Capt. Brian T. Vance. "With this program we're tied at the hip with our Australian allies. We work together, our systems are consistent and there's coordinated development. It's all there."

The Royal Australian Navy (RAN) and Team Submarine are working together through the AN/BYG-1 Joint Project Office (JPO), to bring this system to both countries' submarines.

In addition to helping to enable the Chief of Naval Operations' vision of an internationally allied 1000-ship Navy, the AN/BYG-1 JPO is delivering the most advanced combat control system to the Fleet. The AN/BYG-1 represents the principal interface between sensors (organic and inorganic) and operators to support the development of the full operational picture, supporting tactical employment decisions for the ship and its weapons.

This next-generation combat system makes use of the most advanced equipment through commercial-off-the-shelf (COTS) technologies by using Rapid COTS Insertion (RCI) as the core business model. The AN/BYG-1 system is currently being retrofitted for the U.S. Navy's *Los Angeles*-class, *Seawolf*-class and the new *Ohio*-class SSGN submarines, while being built into the Navy's newest submarine, the *Virginia*-class, as original equipment.

Before the AN/BYG-1 system, the sensor systems aboard a submarine frequently had unique displays, requiring the operators to interpret data differently from individual sources and then mentally integrate it to develop a full operational picture.

The AN/BYG-1 system helps to eliminate this by striving to develop a cohesive operational view using the information available in the tactical control, weapons control, and networked subsystems provided via software products developed by a host of industry, government and academic sources.

Additionally, displays have been developed to assist the command element in making the best decision possible considering all the available tactical and operational elements. "Information from most systems is coming together in one place for the decision maker to be able to view it, understand it, and make the decisions," Vance said.

The JPO was formally established in 2004, though there had been a relationship between the U.S. and Australian navies for submarine combat systems since 2002. To date, two RAN *Collins*-class diesel submarines have been modernized with AN/BYG-1 systems and there are plans in place for all six ships of the *Collins*-class to be outfitted with AN/BYG-1.

The U.S. has outfitted 34 submarines with the system. The overall modernization pace is approximately 12 submarines per year, which includes both technical refreshes of existing AN/BYG-1 systems as well as legacy combat system replacements, with an overall goal that all U.S. Navy submarines (SSNs and SSGNs) are scheduled to have the AN/BYG-1 combat system by the end of fiscal year 2011.

Through cooperation in the development process, both the RAN and U.S. navies share the initial costs and collaborate on engineering development, programmatic elements and training. The cost to develop, maintain, and upgrade the AN/BYG-1 system has dropped dramatically over legacy systems primarily as a result of the adoption of the RCI and open-system architecture (OA) approach to procurement and sustainment.

"The OA approach allows many potential applications to be evaluated, matured, and transitioned into the system as capabilities," Vance said.

The RAN AN/BYG-1 system is a variant of the core AN/BYG-1 system, and the utilization of common COTS components and software products developed via the OA process results in considerably lower costs than having to develop entirely separate systems for the U.S. and its closest allies.

"It comes down to dollars at the end of the day," said RAN Cmdr. Adam A. Lindsay, deputy project manager for the AN/BYG-1 JPO. "Being able to leverage off of the larger infrastructure available within the U.S. to support the combat systems development and acquisition is a major benefit for Australia."

Vance added that using COTS creates access to some of the latest advances, but using them requires caution.

"I want to be at the front end of technology and allow industry to drive out the risk, then just ride the technology wave. I don't want to be the leading edge," said Vance. "I don't want to push potentially developmental or immature systems or capabilities to the Fleet."

According to Lindsay, system commonality allows both nations to improve their common operating knowledge and decreases the learning curve typically required during joint exercises.

The partnership allows each Navy to focus more on operational cooperation, taking one step closer to the vision of an international allied navy of 1,000 ships.

The New Engine Room

The near-future needs of next-generation warships demand new and more powerful propulsion systems. Here's where they get their kick-starts.

NAVSEA's Naval Systems Engineering Directorate (SEA 05) is at the cutting edge of naval engineering and ship design. SEA 05 provides engineering support to help maintain current Fleet readiness and support new shipbuilding programs. SEA 05 has also been moving forward with new innovations in ship design, analysis of alternative methods of ship propulsion, devising new cost engineering disciplines to provide for an affordable future Fleet, and helping to engineer better interoperability with our allies.

NAVSEA's Surface Ship Design Group (SEA 05D) completed a congressionally mandated Alternative Propulsion Methods Study in 2007 to examine the most cost-effective options for operating future Navy warships. The most notable conclusion of the study was that ship mission and operating requirements should be the primary drivers in the selection of a particular power and propulsion system architecture, not ship displacement.

The study found that nuclear power for medium-sized surface combatants may have reduced lifecycle costs compared to the fossil-fuel alternative if the price of crude oil remains above $70 a barrel. Nuclear propulsion is well-known for operational benefits of shorter transit surge times and enhanced sustainability and flexibility. These important qualities make nuclear propulsion an attractive option to meet the significantly increased power requirements of future medium surface combatants, due to factors such as high-powered radars and directed energy weapons systems.

However, the study also found that nuclear power did not appear to be a competitive option for small surface combatants due to size, weight and cost considerations. For amphibious warfare ships, nuclear power required increased upfront acquisition cost with a lifecycle cost premium of less than 10 percent.

The study's key findings are being used as a basis for planning more fuel-efficient ship designs and are being taken into consideration as the Navy completes its analysis of alternatives for the next-generation CG(X) cruiser.

SEA 05 has led the way in developing the next-generation integrated power system (NGIPS) for Navy ships. In this type of system, the prime movers in an NGIPS generate electricity that is made available through a flexible distribution and switching architecture, as a shared resource for all shipboard needs. Propulsion is implemented with electric drive — electric motor-driven propellers, pump jets, or even external pods. This allows the ship's total power system to be used for both mobility and ship's services, and power can be traded off among functions and mission areas in accordance with changing tactical demands.

Some of the advantages of NGPS include high power density; arrangement flexibility; higher modularity; the ability to allocate power among propulsion, hotel load and weaponry; and lower total ownership costs. Savings and equipment commonality across platforms via a single investment in common technologies and open system architecture is a primary objective of the NGIPS initiative. Major challenges in this area include developing common technologies and architectures that can span the broad range of power/energy needs of submarines, surface combatants, amphibious ships, and aircraft carriers.

SEA 05C introduced probabilistic cost-risk analysis in 2007 as an executive decision tool for the Navy's Planning, Programming, Budgeting and Execution System. SEA 05C's cost-risk curves are used by Navy leadership as a means to understand risk acceptance in the budget determination process. SEA 05C also implemented the sophisticated shipbuilding information management system, a historical cost database providing long-term data analysis of shipbuilding costs.

SEA 05 teamed with the Logistics, Maintenance and Industrial Operations Directorate to focus efforts on reducing costs and duration of depot maintenance availabilities. Technical warrant holders, shipyard representatives and other stakeholders are working together to identify and evaluate high-cost technical and customer requirements to determine if they can be eliminated or performed with reduced frequency without compromising technical standards and quality.

The application of alternative processes or technology is also being aggressively pursued in these areas to reduce costs. The Cumbersome Work Practices Task Force is actively pursuing items for initial implementation on submarines and aircraft carriers, with potential applicability to all ships.

Since 2006, SEA 05 has been looking at ways to reduce the various types of ships, varying subsystems and components that are used in the Fleet. SEA 05 is leading an engineering effort to neck down to potentially fewer platforms and more system and component commonality across platforms in an effort to reduce cost and improve logistical efficiency.

To further improve processes, SEA 05 conducted a dynamic technical authority strategy wargame at the 2007 Engineering Leadership Conference last July at the Naval Surface Warfare Center Carderock Division in Maryland.

The wargame consisted of teams of technical warrant holders and related stakeholders, including participants from the Navy Secretariat and Chief of Naval Operations staff.

The game tested organizational alignment and technical authority decision-making processes in research and systems engineering (RS&E) competency through customer service agreements between Program Executive Offices/program managers, warfare centers and R&SE leadership in a competency aligned organization.

Finally, to improve interoperability with our allies, NAVSEA Force Test Assessment and Readiness Engineering Division (SEA 05W4) facilitated critical U.S. Navy-British Navy technical information exchanges that allowed *HMS Manchester* (D 95) to fully integrate as part of the *USS Harry S. Truman* (CVN 75) Carrier Strike Group on its 6th Fleet deployment to the Mediterranean Sea. The collaboration allowed *Manchester*'s combat systems to be upgraded to a level commensurate with the rest of the U.S. strike group.

"The bottom line is that we are looking at ways to systems-engineer better efficiency, interoperability, and reduce costs as we build the Fleet of today and tomorrow," said Rear Adm. Kevin McCoy, NAVSEA Deputy Commander for Naval Systems Engineering. "Our goal is an effective and affordable Navy Fleet, both today and well into the future. The NAVSEA Technical Community is accountable to reduce costs and help lead the way to achieving 313 ships."

Far left The engine room of Military Sealift Command hospital ship *USNS Comfort* (T-AH 20) is old-school gigantic and complex. Propulsion systems being researched may be smaller and very powerful. **Bottom left** Monitoring the main engine room gas turbine propulsion systems aboard the guided-missile destroyer *USS Russell* (DDG 59). Gas turbines remain powerful and effective powerplants. **Left** Waves crash over the bow of the guided missile destroyer *USS Howard* (DDG 83). Future engine rooms will provide more than enough power to conquer any sea state while providing seamless electricity to the high-tech warships of the future.

Top Machinist's Mate 3rd Class Joshua Davis watches a depth gauge onboard *USS Alexandria* (SSN 757) during Ice Exercise 2007. According to Nick Guertin, Deputy Director of Open Architecture for PEO IWS, all platforms, from amphibs to submarines, operate more effectively using Open Architecture. **Below** *USS Hampton* (SSN 767), *USS Kitty Hawk* (CV 63), *USS Cowpens* (CG 63) and *USS Mustin* (DDG 89) transit in formation following a 15-ship group exercise concluding *Valiant Shield 2007*. **Opposite page** An SM-3 Standard missile is launched from the guided missile cruiser *USS Shiloh* (CG 67) during a joint Missile Defense Agency/U.S. Navy ballistic missile flight test for Aegis Ballistic Missile Defense. The Aegis program's legacy baseline resides in the SHARE repository pilot program. he SHARE repository allows government-owned software to be re-used for other applications.

Faster, Cheaper, Better

The Naval Open Architecture program delivers tools, processes, training materials and guidance

Faster, cheaper and better capabilities to the Fleet customer. That's the promise of Open Architecture. During the past year the Navy's Program Executive Office Integrated Warfare Systems (PEO IWS) has made significant strides in two particular areas of Open Architecture: Software, Hardware Asset Reuse Enterprise (SHARE) repository, and the Contract Guidebook.

The SHARE repository pilot program is a library where system design artifacts for Navy contracts are placed. It is a simple, yet powerful concept. The Navy has already paid for government-purpose or unlimited rights for software. Rather than being simply filed away or used in a single application, these design artifacts can now be made available to a large number of Navy vendors.

"Just as long as you have some business with the Navy we will let you in," said Nick Guertin, Deputy Director of Open Architecture. "You get a username and password and you agree through the SHARE license that anything you take out of SHARE and modify you must put it back, and whatever you do different with it must carry government-purpose rights or better," he said.

SHARE provides a way for companies to access an area in which previously they had been excluded. With SHARE, the Navy is mirroring what's happening in commercial industry, which tries to bring the best products to solve problems. Rather than relying on one vendor, the Navy now has a way to generate a greater number of ideas to improve capabilities.

An example of SHARE in action comes from the Aegis program, whose legacy baseline resides in SHARE.

"A strong competitor, General Dynamics, as it turns out, pulled out that baseline," Guertin said. "They took Aegis stuff out, figured out how it worked and built something that could be used by others in the future. It's our first full cycle of a process that reduces risk and reduces cost. And we got reuse of something that would never have happened otherwise," he said.

SHARE is good for business and it's good for the Navy. "The thing that we asked for early and often is design disclosure," Guertin said. "It requires people to be a little bit more courageous and knowledgeable in terms of what's really going on. This way the program manager has an opportunity to reduce his program risk."

The Naval Open Architecture program itself doesn't deliver specific capabilities; it delivers tools, processes, training materials and guidance. In 2007, the Open Architecture program office published version two of its contract guidebook, which is seeing more use across the Navy Enterprise. The Marine Corps, for example, has evaluated the use of Open Architecture as contract award criteria for certain programs. Over the last year more than 30 programs started to incorporate Open Architecture language in contracts.

"A lot of what we espouse in the contract guidebook is to have a modular design so that you can start changing up pieces that you need to in order to address where you need those capability differences," Guertin said. "In times past we've had large-scale systems that we changed in one large jump. But by having a modular, scalable design, we're able to change only the parts you need in order to maintain that performance differential over our adversaries," he said.

According to Guertin, Open Architecture is about transparency, but it is also about pace. "Why are we even pursuing Open Architecture? Because we want to get more capability to the Fleet faster. By implementing these principles and practices we will evolve to an enterprise that will be more flexible in bringing capability to the warfighter. That's what open architectures all about — improving the pace of change."

NAVSEA: Meeting Challenges of the Future through Diversity

"If you don't work diversity into your business plans ... ... you'll have a 'going-out-of-business' plan."

It is clear from the accomplishments in 2007 that NAVSEA builds and maintains ships and combat systems. But what is NAVSEA? More than 53,000 strong, NAVSEA is a network of people, a diverse mix of DoD civilians, military and contract staff who together are the U.S. Navy's most valuable resource.

In 2007, NAVSEA took solid steps to expand the capabilities of its workforce and lay the foundation for a flexible, capable 21st century workforce. It's not an easy path. Competition for America's professional talent is stiff and resources are limited, but NAVSEA's initiatives promise fresh new ways to approach the challenges of this century.

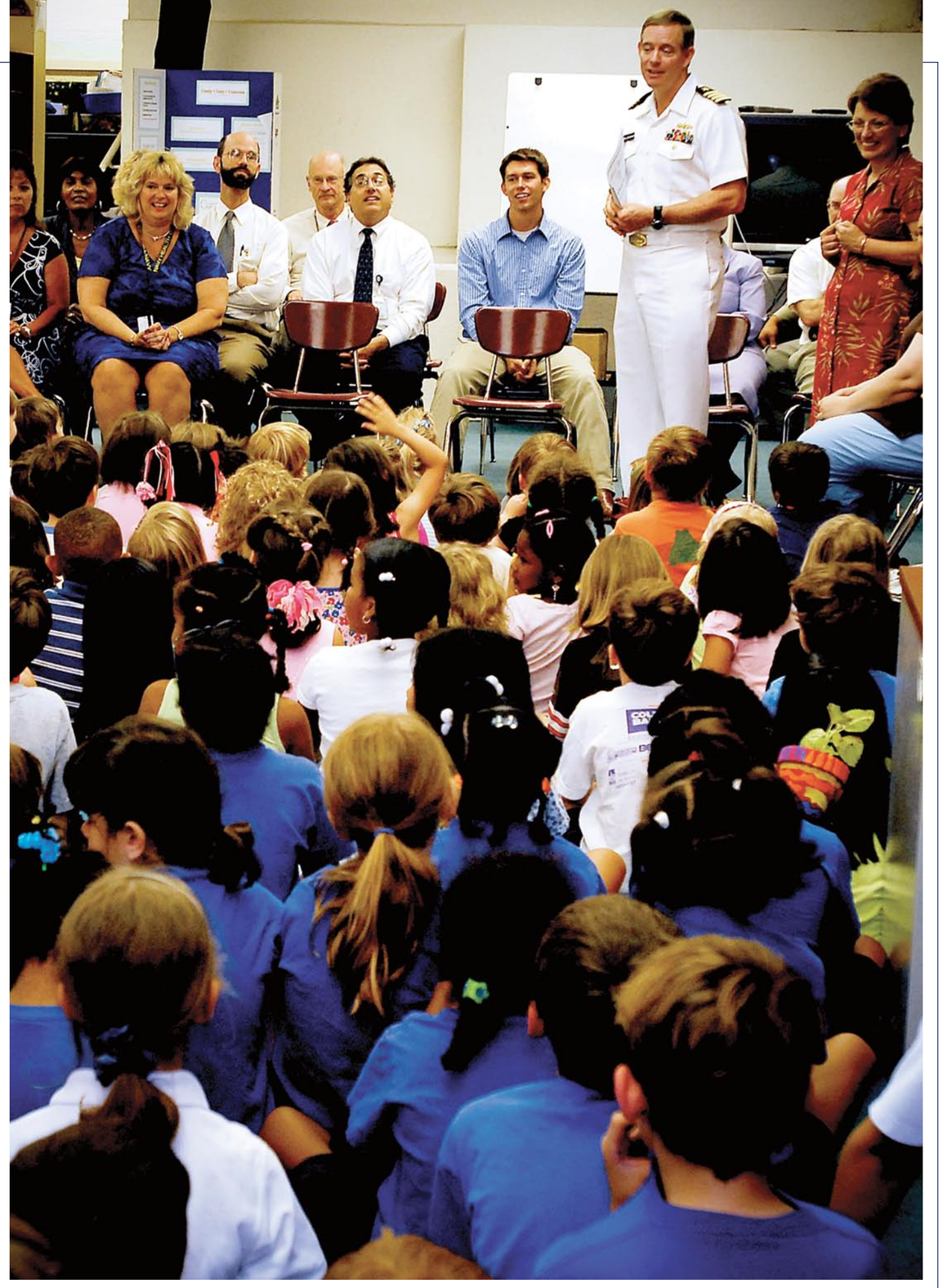
NAVSEA initiatives of Competency Alignment, Enterprise and Metrics all aim to streamline NAVSEA's acquisition processes — not only conceiving, designing and delivering ships and combat systems, but shepherding them throughout their service lives. Further, NAVSEA has developed its own brand of business efficiency tools that has demonstrated some startlingly positive results in 2007. An awareness of process improvement is making its way throughout NAVSEA, and the command is taking concepts such as Lean Six Sigma far beyond its industrial manufacturing roots.

But the most central aspect of workforce development is the NAVSEA diversity program. NAVSEA Commander Vice Adm. Paul Sullivan calls diversity not only the right thing to do, but as civilian industry has discovered as well, a business imperative.

"If you don't work diversity into your business plans, like major corporations have discovered over the last 15 years, you'll have a 'going-out-of-business' plan," said Sullivan, "Because if you can't look like America, then the diverse part of the population won't come and work for you because they don't see anyone that looks like them or has any common cultural background with them."

In 2007, NAVSEA continued to execute the NAVSEA Diversity CONOPS, or concept of operations, which was established in 2006 to outline the NAVSEA workforce development strategy.

"Here we are a year later; we're transforming our workforce and we're also asking ourselves 'What does the CONOPS mean to us now?'" said Scott Lanum, NAVSEA's Chief Diversity Officer. "We're realizing that, in order to succeed with this effort in the long term, we need to expand our goal to much more than just bringing in new smart people. We need to expand our relationships with the institutions that educate and train these people. NAVSEA is interested in more than hiring new employees — we are determined to help develop the workforce of the 21st century."



Left NAVSEA employees attend a discussion group lead by Senior Executive John James during NAVSEA's 2007 Diversity Summit. **Middle** NAVSEA Executive Director Sharie Bourbeau received the Commander's Development Program (CDP) APEX Award during the annual CDP Spring Leadership Forum. Bourbeau is the first CDP member to become NAVSEA's executive director. CDP is part of NAVSEA's overall career development strategy to prepare high-performing personnel to fill key leadership positions. **Right** Winners of the 2007 Women's History Month Role Model Award for Science, Technology, Engineering and Mathematics were honored at a March 21, 2007, ceremony at the Women in Military Service for America Memorial in Arlington, Va. From left to right is Lt. Satonya A. Brown, U.S. Navy Military Winner; Elaine Colston, U.S. Navy Civilian Winner; and Colonel Tracy A. Phillips, U.S. Air Force Military Winner. **Opposite page** Rear Adm. Jim McManamon, NAVSEA Deputy Director for Surface Warfare, talks to students at St. Peter's Elementary School in southeast Washington, D.C., June 5, 2007. NAVSEA headquarters has a partnership with the school to provide volunteers to help pre-K through 2nd graders with math, reading, and writing skills. The program is just one way NAVSEA reaches out to diverse populations to lay the foundation for a flexible, capable 21st century workforce.

Left Trina Faison, NAVSEA Affirmative Employment Program Manager, instructs NAVSEA employees on the organization's Diversity Concept of Operations during a hands-on session at NAVSEA's Diversity Summit in September 2007. **Top** Former Asst. Secretary of the Navy for Research, Acquisition and Development, Dr. Delores Etter, presents David Ruffin with a Letter of Commendation for his team's work effort to rapidly deliver 200 vehicle-mounted electronic jamming anti-IED systems to deployed warfighters. Etter presented an award to each member of PEO LMW's CREW Program Office.

Lanum pointed to a shipyard outreach program in the Puget Sound area that has taken the concept of a training continuum into practice with the local school districts. This, he says, is "Smart Engagement."

The shipyard's outreach efforts have raised awareness of how the shipyards and all of NAVSEA support national defense by standing up a "curriculum review team." It works with local school officials to ensure that students have access to the proper education and training.

Perhaps the most unique aspect of this program is that it is totally comprehensive: recommendations on course work begin at the elementary school level.

In total, NAVSEA headquarters and field activities conducted more than 600 visits to elementary, middle and high schools in 2007 to help develop the reading, math, and science skills that will be necessary for the command to have a viable pool of qualified potential candidates in the future.

But the academic outreach doesn't stop there. NAVSEA is getting involved at the college level as well.

"What we've done with some of the HBCU's [Historically Black Colleges and Universities] is work with school administrators to develop specific degree programs that prepare students for a career within the NAVSEA organization," said Lanum. "It is truly a win-win situation, because the school benefits from NAVSEA's counsel, students benefit from a better education, and NAVSEA benefits because we are increasing the size of our pool of qualified applicants."

Perhaps the most exciting development in the command's diversity outreach to colleges is the recent development of a NAVSEA-PEO scholarship for students attending minority serving institutions. Eleven such scholarships have already been awarded and more will be given through 2010.

Another highlight in 2007 has been NAVSEA's outreach efforts to veterans. The command hired several new employees through the Department of Defense's Operation Warfighter and Operation Hiring Heroes programs in 2007. These programs allowed NAVSEA to harness the military experience of veterans while augmenting the workforce. These former service members have applied their real-world knowledge and experience to the difficult challenges faced by NAVSEA, and that experience has been worth its weight in gold.

On the East Coast, the Portsmouth Naval Shipyard has established an outreach post near the barracks of Camp Lejeune, offering post-service opportunities to former U.S. Marines. Similarly, in the Northwest, Puget Sound outreach efforts are connecting with Department of Veterans Affairs (VA) hospitals and the Ft. Lewis, Wash., veteran community with a similar goal.

In the Washington, D.C., area, NAVSEA headquarters is exploring outreach programs similar to those established in the field. Lanum sees a whole community of veterans who have educational means, in the form of VA educational benefits, but who may be undecided and looking for career guidance and opportunity.

Working in cooperation with the VA, Lanum has a vision to offer that guidance by developing a program that directs talented and interested candidates to degree programs and post-graduate career opportunities at NAVSEA.

With a large and geographically dispersed organization like NAVSEA, the opportunities for outreach across the country are plentiful. The obvious challenge for the command is to align its outreach efforts to best serve NAVSEA's mission of supporting the warfighter.

To align the command's outreach efforts, NAVSEA held its second annual Diversity Summit in Bethesda, Md., in September 2007. More than 200 NAVSEA employees attended the event and speakers included Assistant Secretary of the Navy (Manpower and Reserve Affairs) William Navas, Jr. and former Chief of Naval Operations Adm. Mike Mullen.

"Between this year and last, there have been tremendous successes," said Sullivan during his address at the summit. "I'm proud of the progress we're making, but I know we can improve. We'll continue to review where we're at and adapt where we need to. Diversity is a critical component of keeping us viable."

As NAVSEA looks toward and beyond 2008, the command will continue to develop existing relationships and seek new connections with untapped communities in order to grow its workforce to meet the needs of the warfighter five, 10 and 30 years into the future.

"I am convinced," Sullivan said, "that achieving a workforce that reflects the diversity of our nation will make NAVSEA a better place to work, allow us to achieve higher levels of performance, deliver better products to the Fleet and make us an employer of choice."

Top left Scott Lanum, Command Deputy for Diversity and Equal Employment Opportunity (EEO) Office, discusses NAVSEA's EEO program during the 2007 annual Commander's Conference, Feb. 15, 2007. **Top right** A delegation from Singapore discusses software systems with NAVSEA engineers during a visit to NAVSEA headquarters Aug. 20, 2007.

WASHINGTON (Feb. 8, 2008) Chief Warrant Officer Jeffrey R. Barone (left) is presented with the Bronze Star Medal by Vice Adm. Paul E. Sullivan, commander of Naval Sea Systems Command, for actions in Anbar Province, Iraq. Barone was awarded the medal for his work in countering radio-controlled improvised explosive devices. He also participated in 89 combat patrols and was involved in combat action while seizing enemy munitions and ordnance. The Bronze Star Medal, awarded for bravery, acts of merit or meritorious service, is the fourth highest combat award of the U. S. armed forces.

WASHINGTON, D.C. (May 16, 2007) Trophies are arrayed in order of their presentation for the 24th annual Department of Defense Engineering Awards ceremony, recognizing exceptional value engineering solutions that improved mission capabilities while increasing quality and reducing costs.

WASHINGTON (Feb. 14, 2008) Susan Tomaiko (left), contracting officer for Naval Sea Systems Command, and Brian Cuccias, vice president and DDG 1000 program manager for Northrup Grumman Shipbuilding, sign the $1.4 billion construction contract for the *Zumwalt*-class (DDG 1000) destroyer at a contract signing ceremony at the Pentagon.

Atlantic Ocean (Feb. 14, 2007) Naval Sea Systems Command personnel create a multi-media production, demonstrating the proper procedure on the use of the Casualty De-contamination Station aboard amphibious assault ship *USS Nassau* (LHA 4). *Nassau* Sailors assigned to the damage control/medical team provided the talent for the NAVSEA project support team. The video will be posted in the Surface Warfare Officer School (SWOS) and Damage Control Assistant Senior Enlisted (DCASE) for training on Navy Knowledge Online.

WASHINGTON (April 26, 2007) Commandant of Naval District Washington Rear Adm. Terence McKnight (foreground, left) and Naval Sea Systems Command Executive Director Sharie J. Bourbeau place the first shovels of dirt onto a young pink, flowering crabapple tree. Following their lead, several children on hand for Bring Your Child to Work Day assisted in placing dirt around the tree. NAVSEA planted the sapling in Dahlgren Park on the historic Washington Navy Yard to commemorate the 37th anniversary of Earth Day. Steve Schulze, Assistant Deputy Commander, Maintenance, Modernization, Environment and Safety hosted the event.

BOSTON (July 4, 2007) Vice Adm. Paul Sullivan (far right), commander of Naval Sea Systems Command, speaks to one of America's newest citizensw, Nuro Ahmed Warsame of Somalia, aboard *USS Constitution,* the world's oldest commissioned warship, during her Independence Day turnaround cruise in Boston Harbor. Warsame and nine others were administered the oath of citizenship on the nation's 231st birthday.

Credits:

Cover Design by Cindy Snipes.
P2 (top) (Guided-missile destroyer *USS Mitscher* (DDG 57) pulls into Naval Station Norfolk Sept. 18, 2007, after a six-month deployment in support of Partnership of the Americas. POA is designed to support U.S. Southern Command responsibilities by focusing on enhancing relationships with regional partner nations through a variety of exercises, both at sea and ashore, throughout South America and the Caribbean. U.S. Navy photo by Mass Communication Specialist 3rd Class David Danals.
P4 Guided missile frigate *USS McClusky* (FFG 41) conducts high-speed turns while hosting the Leaders to Sea program off the coast of California Jan 19, 2007. Leaders to Sea is a civilian guest-embarkation program designed to give leaders of the community an opportunity to develop a deeper understanding of the Navy and its mission by boarding a naval vessel and observing daily operations at sea. U.S. Navy photo by Mass Communication Specialist Seaman Apprentice Jonathan Husman.
P6 U.S. Navy photo by Mass Communication Specialist Seaman Jennifer Apsey.
P7 U.S. Navy photo by Chief Photographer's Mate Todd P. Cichonowicz.
P8 A RIM-7P NATO Sea Sparrow missile launches from Mount 4 aboard the *Nimitz*-class aircraft carrier *USS Abraham Lincoln* (CVN 72) Aug. 13, 2007, during a stream raid shoot exercise. Lincoln's self-defense systems fired four Sea Sparrow missiles, engaging and destroying two BQM-74E drone aircraft and a High-Speed Maneuvering Surface Threat remote-controlled Rigid Hulled Inflatable Boat during the event. Lincoln and embarked Carrier Air Wing (CVW) 2 were underway off the coast of Southern California conducting Tailored Ship's Training Availability. U.S. Navy photo by Mass Communication Specialist 2nd Class M. Jeremie Yoder.
P12 U.S. Navy photos (2) by John F. Williams.
P13 U.S. Navy photo.
P16 U.S. Navy photo by Tony Anderson.
P18-19 U.S. Navy photo by Chief Mass Communication Specialist Shawn P. Eklund.
P19 (bottom) Artist's rendering of the DDG 1000 and its Advanced Gun System courtesy Northrop Grumman.
P20 Artist's rendering of the LHA 6 courtesy Northrop Grumman.
P21 Photo courtesy Lockheed Martin.
P22-23 U.S. Navy photo.
P24 U.S. Navy photo by Chief Mass Communication Specialist Shawn P. Eklund.
P25 One of the Navy's newest surface ship, *USS New Orleans* (LPD 18), transits through San Diego Bay May 3, 2007, prior to arriving in her new homeport of San Diego. The San Antonio-class amphibious transport dock, built and commissioned in her namesake city, is the first of the new class of ship to be homeported on the West Coast. U.S. Navy photo by Mass Communication Specialist 1st Class Tiffini M. Jones.
P26 U.S. Navy photo by Mass Communication Specialist 3rd Class Kenneth G. Takada.
P27 (main) U.S. Navy photo Photographer's Mate 2nd Class Edward N. Vasquez; (inset, top) U.S. Navy photo by Mass Communication Specialist 2nd Class Michael Zeltakalns; (inset, bottom) U.S. Navy photo by Mass Communication Specialist 1st Class David McKee.
P28-29 U.S. Navy photo by Senior Chief Mass Communication Specialist Andrew McKaskle.
P30 (top) U.S. Navy photo of saluting officers by Mass Communication Specialist 2nd Class Tommy Gilligan. (bottom) U.S. Navy photo by Mass Communication Specialist 2nd Class Alexis R. Brown.
P34 U.S. Navy photo by Senior Chief Mass Communication Specialist Andrew McKaskle.
P35 U.S. Navy photo by Mass Communication Specialist 2nd Class Adam R. Cole.
P36-37 U.S. Navy Photo by Stacey Byington.
P38 U.S. Navy photo by Mass Communication Specialist 2nd Class Justin K. Thomas.
P39 U.S. Navy photo courtesy Lockheed Martin.
P43 (top) Photo by John Whalen courtesy Northrop Grumman Ship Building; (bottom) Photo by Rickey Thompson courtesy Northrop Grumman.
P46 Photo by Rickey Thompson courtesy Northrop Grumman.
P47 Photo by John Whalen courtesy Northrop Grumman.
P48 Artist's rendering courtesy Electric Boat Corporation.
P49 U.S. Navy photo by Mass Communication Specialist 2nd Class Roadell Hickman.
P50 (top) U.S. Navy photo by Mass Communication Specialist 3rd Class Clarck Desire; (middle, left & right) U.S. Navy photo by Chief Mass Communication Specialist Kevin Elliott; (bottom, left) U.S. Navy photo by Chief Mass Communication Specialist (SW/AW) Dave Fliesen; (bottom, right) U.S. Navy photo by Senior Chief Mass Communication Specialist (DV) Andrew McKaskle.
P52 & P53 (4) Images courtesy Northrop Grumman.
P54-55 U.S. Navy photo by Mr. Paul Farley.
P56 U.S. Navy photo by Mass Communication Specialist 2nd Class Steven King.
P57 U.S. Navy photo by Mass Communication Specialist 3rd Class Mark J. Rebilas.
P58 (top) U.S. Navy photo by Chief Mass Communication Specialist Shawn P. Eklund. (bottom) U.S. Navy photo by Mass Communication Specialist 1st Class Hana'lei Shimana.
P60-63 (all) U.S. Navy photos by Monica McCoy.
P63 (ad) U.S. Navy photo by Bill Black, Norfolk Naval Shipyard.
P64 (top 2) U.S. Navy photos by Monica McCoy; (bottom, left) U.S. Navy photo by Mass Communication Specialist 2nd Class Dustin Gates; (bottom, right) U.S. Navy photo by Mass Communication Specialist 3rd Class Michael N. Minkler.
P65 (top) U.S. Navy photo by Monica McCoy. (bottom) U.S. Navy photo by Chief Mass Communication Specialist Dave Kaylor.

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P6-7 U.S. Navy photo.
P8-9 U.S. Navy photo by Mass Communication Specialist 3rd Class N.C. Kaylor.
P11 U.S. Navy photo by Paul Farley.
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P35 U.S. Navy photo by Monica McCoy.
P37 U.S. Navy photo.
P38-39 U.S. Navy photo by Mass Communication Specialist 2nd Class Joshua J. Wahl.
P42-43 (background) U.S. Navy photo by Chief Mass Communication Specialist Shawn P. Eklund

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