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Supporting the Naval Enterprises

NAVAL SURFACE WARFARE CENTER

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FROM THE TOP:

EVOLVING WITH THE NAVY TO SUPPORT THE ENTERPRISES EFFICIENTLY AND EFFECTIVELY

By Captain Mark Thomas, C. Randy Reeves, and Captain Mary Logsdon

In 2005, the U.S. Navy began implementing an enterprise framework to help manage change and to ensure an affordable future, while deploying today's combat-ready Navy. The former Chief of Naval Operations, Admiral Michael Mullen has called the Navy Enterprise framework "one of the most important things we did to enhance alignment." The Navy Enterprise structure consists of five enterprises: Naval Aviation (NAE), Surface Warfare (SWE), Undersea (USE), Naval NETWAR FORCEnet (NNFE), and Naval Expeditionary Combat (NECE).

To support a more agile, disciplined, and cost-effective response to workload demands by the Naval Enterprises, NAVSEA began transforming to a competency aligned organization in 2006. Through competency alignment, NAVSEA can achieve a balance between workload demands and employee talent. Additionally, such an alignment provides clearly defined career paths to develop employees with the knowledge, skills, and abilities to meet the Naval Enterprise requirements.

These movements have taken root within the Warfare Centers, resulting in the Warfare Center Next Evolution, which stood up on May 1, 2007. "We are confident that this new evolution of our management structure will better support the Navy's Enterprise framework, as well as NAVSEA's transformation to a competency aligned organization and will help us to become more efficient and effective," said Warfare Center Commander Rear Admiral Archer M. Macy Jr. In implementing this realignment, Warfare Center leadership seeks four main benefits:

- Ensuring long-term stewardship of technical capabilities, facilities, and people within the Warfare Centers through restoring an SES executive position as Technical Director. C. Randy Reeves was appointed Technical Director of Carderock Division.
- Aligning leadership architecture with the Naval Enterprises. This leadership consists of SES National Enterprise Executives to liaison with each of the Navy's five Warfare Enterprises and the PEOs. This will ensure that the Warfare Centers continue to stay technically relevant to and effectively supportive of today's and tomorrow's Warfighters' needs. These executives are as follows: J. Jerry LaCamera (NAE, Acting), Marc Magdinec (SWE), Dennis McLaughlin (NNFE), Paul Dunn (USE), and Ann Tate (NECE).
- Streamlining the national level work management effort. The Product Area Director (PAD) structure, which was discontinued, was very effective in bringing discipline and transparency to the work accepted within the Warfare Centers. These PAD functions were redefined between the National Enterprise Executives, the COs and TDs of the sites, and the overall coordination and monitoring by a SES full-time Business Executive, Mary Wohlgemuth.
- Ensuring an efficient and effective interface for promulgating common processes and 5 Vector Models throughout all Warfare Center sites as NAVSEA moves to a competency aligned organization.

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The SEAFRAME staff reserves the right to edit or rewrite all submissions.

On the cover: The five Navy Enterprises–With this issue, SEAFRAME magazine is altering its focus. Once a product of the Ships and Ship Systems Product Area, SEAFRAME now highlights Carderock Division's integrated efforts in support of the Naval Enterprises.
Cover design by Gloria Patterson.

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The transformation of NAVSEA into a competency aligned organization is large in scope and requires behavioral and organizational shifts. The three basic facets of this construct are to manage the workforce, manage our processes, and manage the workload. NAVSEA has identified nine competency domains: business financial management/comptroller; contracting; corporate operations; explosives/ordnance safety and disposal; industrial operations; legal; logistics; program management; and research and systems engineering. Of the more than 3,100 people employed by Carderock Division, approximately 88% fall under the research and systems engineering competency.

The changes made at the top levels of Navy, through NAVSEA and the Warfare Center, have trickled down to some slight changes in SEAFRAME. Since its inaugural issue in Summer 2005, SEAFRAME has highlighted the Navy's integrated efforts in supporting the fleet's ships and ship systems, with a focus on the work performed under the auspices of the Ships and Ship Systems Product Area. While still highlighting the integrated efforts that support the fleet's ships and ship systems, SEAFRAME is now a NSWC Carderock Division publication, showcasing how the Division supports the Naval Enterprise structure.

As the Carderock Division leadership, we strongly endorse the Navy's direction and the realignments necessary to get us there. The Carderock Division has been well aligned with our customers, and we anticipate this transition to have minimal impact on the organization. It will, in fact, strengthen our identity and help us to sustain our technical capabilities and facilities into the future.

MARITIME TECHNOLOGY INFORMATION CENTER DEDICATED

By William Palmer

A dedication and ribbon-cutting ceremony was held to officially open the Maritime Technology Information Center at Naval Surface Warfare Center, Carderock Division's (NSWCCD) West Bethesda headquarters. The MTIC facilities foster open dialog between ship design proponents in government, the maritime industry, and academic naval engineering interests and will enable close ties between Navy ship design experts and their industry and academic counterparts to create integrated engineering solutions for the fleet.

Dr. Michael F. McGrath, Deputy Assistant Secretary of the Navy for Research, Development, Test and Evaluation, the event's keynote speaker, said it is entirely fitting that NSWCCD is the home of a center focused on promoting collaboration in ship design and naval engineering. McGrath, newly appointed as the Pentagon champion for the Naval Warfare Centers, said "Carderock has a long history of technical leadership in making our ships and ship systems more effective, sustainable, and affordable. We are counting on that knowledge as we move forward not only with our current shipbuilding plan but also with the development of a new maritime strategy for the nation."

Rear Admiral Archer M. Macy Jr., Commander, Naval Surface Warfare Center, observed that the Navy, Marine Corps and maritime communities have come to depend on the expertise and innovative spirit of NSWCCD in addressing evolving Navy missions. He said, "The advent of MTIC as a collaborative environment for ship design and new concepts in naval engineering will further strengthen the ability of the Navy to accelerate its efforts to design ships and systems that are more modular, affordable, and adaptive to all the different missions and types of warfare we will face in the future."

Left: A host of high-tech features augment the center's capabilities and enhance its attractiveness.
Photo by Martin Sheehan, NSWC Carderock Division.

Left: Ceremony keynote speaker Dr. Michael McGrath (standing), Deputy Assistant Secretary of the Navy, spoke of the long history of shipbuilding excellence. The event formally opened the Maritime Technology Information Center.
Photo by Martin Sheehan, NSWC Carderock Division.

Above, the well-attended ceremony convened in the center's auditorium, which seats 400, and boasts a 19-by-10-foot high-definition video rear projection screen, at right.
Photo by Martin Sheehan, NSWC Carderock Division.

Above: The ribbon-cutting which officially opened MTIC. From left to right: Steven D. Roush, Head, Survivability, Structures and Materials Department NSWCCD; Charles (Randy) Reeves, NSWCCD Technical Director; Cdr. Raymond Mardini, NAVFAC North Potomac Public Works Officer; Lt. Cdr. William Middleton, the ceremony's chaplain; Dominick Murray, Assistant Secretary for Regional Development for the Baltimore Region, Maryland Department of Business and Economic Development; Dr. Michael McGrath, Deputy Assistant Secretary of the Navy for Research, Development, Test and Evaluation; Rear Admiral Archer M. Macy Jr., Commander, Naval Surface Warfare Center; Captain Mark W. Thomas, Commander, NSWCCD; Kenneth Reichard, Senator Benjamin Cardin staff member; Usha Vishnuvajjala, Representative Christopher Van Hollen staff member; Sue Tabach, Senator Barbara Mikulski staff member; Richard E. Metrey, former NSWCCD Technical Director; Randy Holt, Project Executive of Skanska USA Building Inc.; Dennis Clark, retired Director of NSWCCD Strategic Planning; and William J. Santer, Samaha Associates – Architect.
Photo by Martin Sheehan, NSWC Carderock Division.

Dominick E. Murray, Assistant Secretary in the Maryland Department of Business and Economic Development, represented Maryland Governor Martin O'Malley at the event and said Maryland's heritage is steeped in all aspects of the maritime industry. "Today, Maryland is recognized as one of the premier states in the nation for maritime activity. MTIC will enhance that reputation and surely become a key asset to the Navy, Maryland, and the country."

William J. Santer, a principal with Samaha Associates, the architectural firm which designed MTIC, praised the Carderock Division design committee, which oversaw integration of MTIC into Division operation. "They were very instrumental," he said, "in what they wanted in the facility–the type of spaces, the ambience, the character, and the nature. From the very beginning, everything was to be first class, top shelf. They were really inspirational. All in all, we're just happy to be a small part of this big picture."

Conference rooms and facilities in MTIC pay tribute to the founders of the Carderock Division, Admirals David W. Taylor and George W. Melville, and the ship classes which these men played a significant role in developing. Other distinguished guests of the event included representatives from the offices of Senator Barbara Mikulski, Senator Benjamin Cardin, and Representative Christopher Van Hollen, as well as David Taylor, grandson

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of the fourth cousin of Admiral Taylor, and Ellen Thorson, great granddaughter of Admiral Melville.

MTIC features include a 400-person auditorium with advanced technology to support VTC and multi-media presentations. Also featured is a 19-by-10-foot rear-projection screen, which gives superior high-definition video capabilities. The center's impressive audiovisual systems were designed, acquired, and installed by personnel from Space and Naval Warfare Systems Command. Nine conference rooms with advanced VTC and conference equipment are also available, with rooms containing an integrated audio teleconferencing system, a stand-alone PC for multi-media presentations, either a projector or plasma screen, a DVD/VCR deck, and video graphics array inputs for laptops. A guest services room has a lounge equipped with copier, printer, fax, phone, and TTY capability, as well as computer desks with access to the NMCI network. The cafeteria has a 200-person dining area and an executive dining room, with conference catering available.

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INVESTING IN THE FUTURE

BUSINESS

International Sub Races Host Largest Field of Entries

By William Palmer

The International Submarine Races (ISR) were held in late June at the Naval Surface Warfare Center, Carderock Division's (NSWCCD's) towing tank facilities. Twenty-four teams fielded 26 human-powered submarines–the largest since the races began in 1989. Countries represented were the United States, Canada, Mexico, and the United Kingdom. While technological improvements in design occur every time the races are held, the more important benefit is realized by the Navy as they inspire naval architecture and marine engineering students to pursue ship design careers with NSWCCD.

Indeed, race officials have indicated that more than 2,500 students have participated in the biennial event. Dan Dozier, head of NSWCCD's Innovation Center and the ISR's host, says, "Over the years, we easily have 30 employees who now work [at NSWCCD] as a result of coming through the submarine races and being exposed to what we do. The system engineering problems require life support, conversion of human power into thrust in the water, structures, materials, flotation, etc. It requires all the fundamentals of naval architecture and marine engineering, which is what we do when we're not hosting this race every two years."

During this race, a Canadian team set a new world record in speed, as the *Omer 5*, a submarine crewed by two students from the Ecole de Technologie Superieure at the University of Quebec in Montreal, was clocked at 8.035 knots, or about 9 miles per hour. Race enthusiasts had previously claimed it would be impossible for a human-powered submarine to achieve a speed greater than 8 knots. The previous record was set by the same school in 2001 at a speed of 7.192 knots. Cash and trophies, provided by the Foundation for Underwater Research and Education, were awarded to teams based on innovation, best use of composites, best spirit, and speed. The ISR has the support of sponsors such as General Dynamics and the Institute of Electrical and Electronic Engineers.

Wayne Neu, an instructor in aerospace and ocean engineering at Virginia Tech (VT) in Blacksburg, VA, was on hand to assist students in fielding their entry, *Phantom 5*. Neu has been supporting the ISR since 1995. "Every time you do one of these things," he says, "it's a great learning experience for these students. They get a chance to design and build things, play with ideas, and

apply some of the things we're teaching." Neu said the *Omer 6* team, a non-propellered sub from Canada, had broken VT's non-propeller record in this ISR.

Matt Young, a junior majoring in ocean engineering at Florida Atlantic University, reflected Neu's comment about learning experiences, some of which involve fixing things that break. Young says FAU's entry has a 15 year-old hull, which requires chasing down what he calls "old lady" problems, like fiberglass delamination from being in the water every day, latching problems which cause them to lose their main hatch, and misaligned rudders. "We get in maybe three or four runs a day, and we're just trying to get in as many runs as we can. The current speed record for this hull is 6.1 knots, set by a guy on our team two years ago–a retired Navy diver who had started attending our school. We're hoping to get up to 5.5 knots this trip." They made it to 4.795 knots.

Bill Elliot, who teaches a senior-level elective course called Ship Design at the University of Maryland College Park (UMCP), said the course will have students design the craft, then the succeeding class will build the craft. Elliot said one UMCP entry was discarded for months then rebuilt to race this year, and the team also fielded a second newer design. "It was built for the 2005 race," he said, "but they didn't get it done in time. This new one is a theoretical hull and was a student's senior design project."

Previous races in 2005 and 2003 hosted 19 teams at each race and have grown since then. Race officials had high praise for the support given by NSWCCD personnel, as well as the Navy salvage divers who played several roles in and out of the water. Said one official, "I don't think we've had any problems whatsoever. It's been a pleasure."

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The International Submarine Race event brings together men and women from around the world who create technological solutions to solve the unique challenge of propelling a submersible vehicle through the water using only human strength and energy.
Photo by Martin Sheehan, NSWC Carderock Division.

BUSINESS

Continuous Process Improvement

Acoustic Research Detachment Seeks to Improve Lake Test Planning

By Leslie Spaulding

Planning is vital to any test program. The Carderock Division's Acoustic Research Detachment (ARD) recently used Lean Six Sigma to improve its approach to planning tests conducted at its facility. The detachment is built on the shores of Lake Pend Oreille, which provides a deep (1,150-foot), quiet body of water where a free-field ocean-like environment is available without the associated problems and costs of open ocean operations. Unique experimental hardware and floating platforms support a wide variety of R&D programs, ranging from measuring flow-fluctuations on sonar domes to calibrating full-scale surface ship sonar transducers.

This spring, an ARD team conducted a value stream analysis (VSA) to review the processes used to identify and plan test requirements to configure test models, execute testing, and produce data and data reports. This VSA was another step in the process improvement which began a decade ago and included a major review in 2005 under the command's Lean initiative. The team included detachment employees, who are involved in the testing process, as well as contractors and a sponsor representative from the Naval Sea Systems Command. Although the team initially looked at all test planning, it narrowed the focus to medium-range tests for which the proposed process would have the most impact.

The Acoustic Research Detachment, built on the shores of Lake Pend Oreille, provides a deep, quiet body of water for testing, where an ocean-like environment is available without associated problems.
Official Navy Photo.

"A common lament in the testing process is that 'if someone else would have planned better, then my job would be easier,'" said then-ARD Director Henry Netzer. "So we invited all parties to help put together the best process to improve the situation."

During the three-day analysis, the team examined the process using the customary tools. With inputs from everyone involved in the planning process, they identified three or four "current states" or current planning processes.

"That was a revelation," said Netzer. "The different approaches resulted from the team members' experiences with customers who had different needs. There was no 'standard' operating procedure when it came to test planning."

"We were trying to improve the planning process, so less time and money is spent on that phase for these tests and to improve the execution of the testing down the road," explained Marvin Miller, the Carderock Division Black Belt who facilitated the analysis.

The team worked through the various processes and developed a single, standard "future state." The details of this process are being worked out through rapid improvement events. All ARD employees involved in test planning will adhere to the procedure when it is complete. The implementation of this new process is expected to result in nearly 5% annual savings in the cost of executing trials.

"The future state of the process spends more time on the planning phase, but we expect that to pay off in the execution phase, with fewer surprises, less need to repeat tests, and less chance of interruption," said Miller.

Added Netzer, "We are committed to transforming the detachment to better serve the Navy's research interests. While we may find that it will cost us more to plan using this procedure, that is okay with us and our sponsor. We expect the additional planning to pay for itself. An often cited planning rule indicates an hour spent in planning saves three hours in execution."

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Customer Advocacy

Warfare Center International Program

Fostering a Spirit of Cooperation in Support of the 1,000-Ship Navy

"... Ship transfers are an important aspect of interoperability with the navies of our allies. These transfers also contribute to the 1,000-Ship Navy vision by building partner nation capacity, while reducing the taxpayer costs of maintaining or disposing of decommissioned ships."

- Admiral Michael G. Mullen,
former Chief of Naval Operations
Before the March 28, 2007, Senate Committee
on Appropriations Subcommittee on Defense

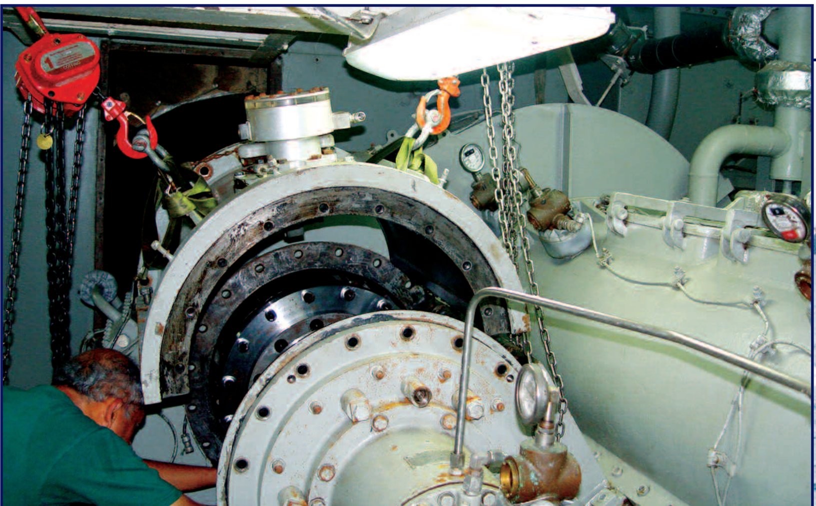
By Leslie Spaulding

At a 2006 Surface Navy Association Symposium, former CNO Admiral Michael G. Mullen described the 1,000-Ship Navy as "a world fleet of like-minded navies and coast guards teaming up in a sort of global neighborhood watch." He also stated, "People realize our fates are lashed together now more so than at any other time in history."

In a concerted effort, the Naval Sea Systems Command (NAVSEA) Warfare Center International Program Team (NWCIPT) helps connect the Navy's international customers with the best available Warfare Center expertise to satisfy their requirements. The team also helps build teaming initiatives across division and warfare center lines where there is shared experience and capability to meet customer needs. The NWCIPT fosters a spirit of cooperation based on communication, collaboration, and shared vision that leverages the Warfare Center's capabilities to the maximum extent possible, keeping in sharp focus the U.S. Navy's goals laid out by the former Chief of Naval Operation's 1,000-Ship Navy vision.

1,000-SHIP NAVY (Continued on page 8)

Below: NSWCCD-SSES engineer Mohan Ranade visually inspects the SSS clutches for the Ex-*USS Kidd* Class.
Photo by Ezio Treglia, NSWC Carderock Division.



Below: A starboard view of the guided missile frigate *USS Samuel Eliot Morison,* (FFG-13) underway off the coast of Puerto Rico during Exercise Ocean Venture '88. The *Morison* is part of the Naval Reserve Force Atlantic Fleet.
Official Navy Photo.

1000-SHIP NAVY (Continued from page 7)

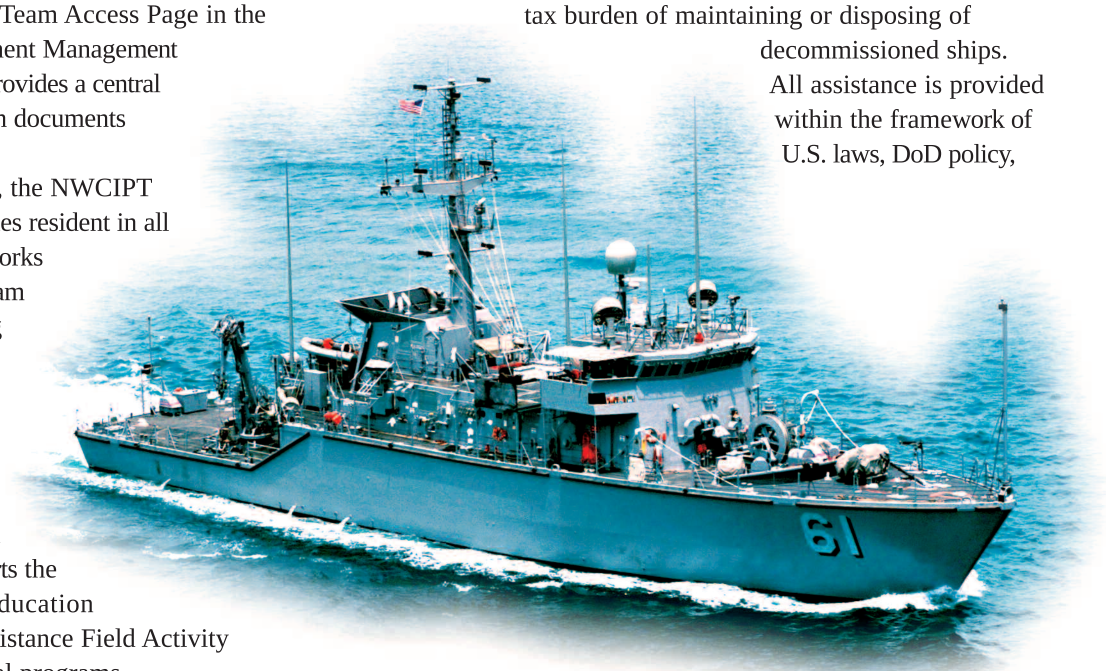
Serving as customer advocates for their divisions, the NWCIPT members unite to represent the entire Warfare Center (WFC) Enterprise. To facilitate/enable the cross-teaming effort, the team is developing a NWCIPT Product and Service Listing, which allows each team member to easily identify which division within the Warfare Center can assist the international customer. They also established the International Programs Team Access Page in the NAVSEA Corporate Document Management System–"Livelink," which provides a central location for maintaining team documents accessible via the web.

Chartered in 2002, the NWCIPT represents support capabilities resident in all WFC divisions. The team works with the International Program Office (PMS 326), providing in-service support for ships already transferred to allied entities; as well as the Ship Transfer Program Office (PMS 336), supporting acquisition efforts. The team also supports the PEO SUB and the Naval Education and Training Security Assistance Field Activity (NETSAFA) in international programs.

Currently, the Naval Surface Warfare Center actively supports approximately 40 countries worldwide, involving more than 400 ships, both United States and foreign built. This effort involves on-site technical assistance to more than 11 foreign maintenance facilities on major systems such as command and control, anti-air warfare, radars, electronic warfare, anti-submarine warfare, surface warfare, surface ship missiles, and hull, mechanical, and electrical. As the Navy's principal RDT&E analysis and assessment activity for ship and submarine platform and machinery technology, the WFCs are the forefront of information for the Ship Transfer Managers.

Examples of the support provided by Carderock Division include technical services for installing and operating Forward Area Combined Degaussing and Acoustic Range (FACDAR) systems for the Egyptian Navy. Additionally, the Division provides technical support on installation of air-cooled 400 Hz static frequency converters on the ex-*Kidd* Class ship in support of the Taiwan Navy's reactivation effort. This support consists of developing drawings, supervising and supporting installation, and performing reassembly, light-off, and groom. Acquisition Engineering Agent support services are also provided to IPO/PMS 325F's many boats and craft FMS programs.

These efforts and the multitude of other support provided under the International Program helps the Navy build partnerships with allied nations, while reducing the tax burden of maintaining or disposing of decommissioned ships. All assistance is provided within the framework of U.S. laws, DoD policy, and congressional guidance. Emphasis is placed on protecting key technologies while facilitating release authority for transferable technologies and providing training and education.



This year former CNO Admiral Mullen sought legislative authority to transfer coastal mine hunting ships, such as the above *USS Raven* (MHC 61), to Lithuania and Turkey in 2008. Limited in speed and endurance, the MHCs were designed as non-deploying assets which offer limited and costly capabilities in a Homeland Defense role.
Official Navy Photo.

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Ship Integration & Design

Avanced Ship and Submarine Evaluation Tool

Celebrating 25 Years of Successful Contributions to Navy Ship Design

By William Palmer

For the past 25 years, ship designers have consistently turned to the Advanced Ship and Submarine Evaluation Tool (ASSET) to help them make the big decisions about ships in the process of development. ASSET directly supports ship design managers to address challenges brought to light by all the Navy Enterprises, but most notably the Surface Warfare Enterprise and the Undersea Enterprise.

ASSET is a computer program which began life limited by the computational, memory, and graphics capabilities of then-modern computer systems. Having grown in sophistication far beyond the wildest goals of its creators, ASSET has been at the root of the design process of almost every Navy ship since the early 1990s. Bruce Wintersteen, who will mark his 20th year as development manager of ASSET in 2008, said ASSET was originally developed to perform technology assessment, that focus coming from Dr. Alan Powell, then Technical Director of Carderock Division. "The early formation of ASSET," said Wintersteen, "was done by Technical Director Technology Application Teams, which were very similar to today's Innovation Cells. ASSET helped us identify what technologies were beneficial in the total ship sense."

In the beginning stages, ASSET used some rudimentary ship design algorithms, which, over time, were merged together to form a single uniform ship design tool. At the time, design calculations were done by hand, and those calculations were subjected to several iterative processes, also done by hand, such that it took a very long time to do what a ship designer can do today in a few hours. Beside technology assessments, ASSET began to grapple with identifying and quantifying the interrelationships among ship structures, systems, and ancillary components. To do this, ASSET uses a series of modules, each of which deals with a primary ship design function, such as resistance, machinery, and weight. Also, it is important to maintain "sight" of the common thread of interrelated functions, and ASSET performs

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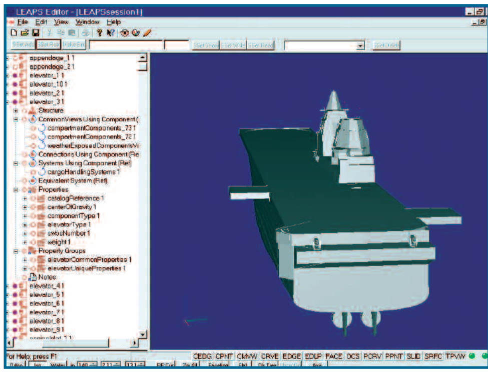
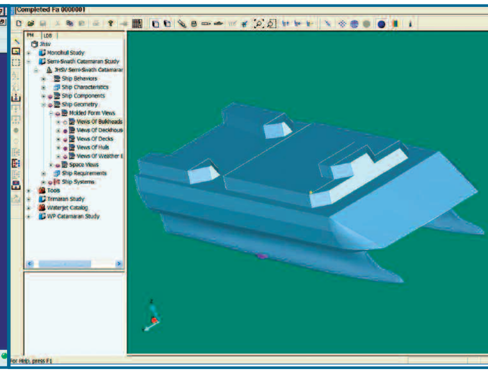
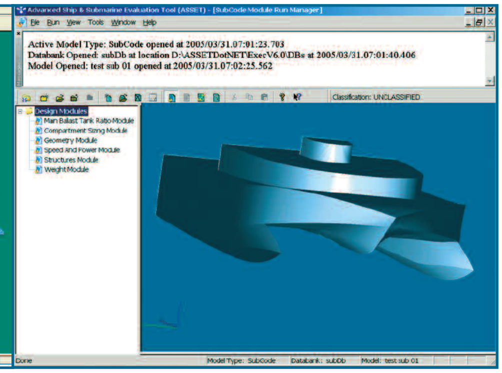
ADVANCED SHIP (Continued from page 9)



View of LHA(R) design generated by ASSET.
Image by Bruce Wintersteen, NSWC Carderock Division.



Multi-Hull design generated by ASSET.
Image by Bruce Wintersteen, NSWC Carderock Division.



ASSET user interface showing machinery layout.
Image by Bruce Wintersteen, NSWC Carderock Division.

this function for designers, optimizing efficiency in the design process.

At a recent gathering of ASSET users, programmers, managers, and sponsors, participants celebrated the 25-year mark of the use of ASSET for ship design efforts. One of the principle proponents of the early development of ASSET, Dennis Clark, a Carderock Division retiree, attended the reception. "All things created involve two aspects," he said. "courage and risk. ASSET was a huge risk, not only on the employees' part, but also on management's part. The technical director, who at the time was Dr. Alan Powell, had no desire to get into computer programs, but Dr. Powell allowed us to take the risk and the result was a significant benefit to the Navy ship design capability." Capt. Norbert Doerry, Technical Director of NAVSEA 05D, said ASSET is critical to the way NAVSEA conducts its ship-building business. "It gives us the ability to do concept studies to impact decision-making as rapidly as possible. We can have, in three weeks, what used to take us 12 weeks to accomplish. It's indispensable to us right now." And Chris Cable, a NAVSEA oversight manager of ASSET functions, is very proud of the software. He said, "A decent product has been there for users to produce designs that give our leaders insight into billion-dollar decisions on a regular basis."

The newest feature of ASSET is that its programmers have transformed the "executive" software infrastructure to a completely new environment which gathers all pertinent design data and populates it to an integrated design environment called Leading Edge Architecture for Prototyping Systems (LEAPS). With this data transfer, more rigorous design analyses such as vulnerability or signatures assessment, which alone require significant modeling, can be accomplished. "We developed LEAPS," said Wintersteen, "to have a product model infrastructure that another computer application could interrogate to acquire ship design information. Prior to LEAPS, this process was done manually." Using that infrastructure, LEAPS enables designers to find the bounds of a compartment, for example, and input that and other design information into various analysis programs, then transfer the analysis data back to ASSET for prediction of overall design characteristics and performance. The process enables designers and analysts to see a significant reduction of man-hours required to build the application specific models.

In a move to extend the range of applicability, ASSET programmers are expanding the program's capabilities in the areas of submarine and multi-hull design. The submarine design development is a collaborative effort with NAVSEA and General Dynamics Electric Boat.

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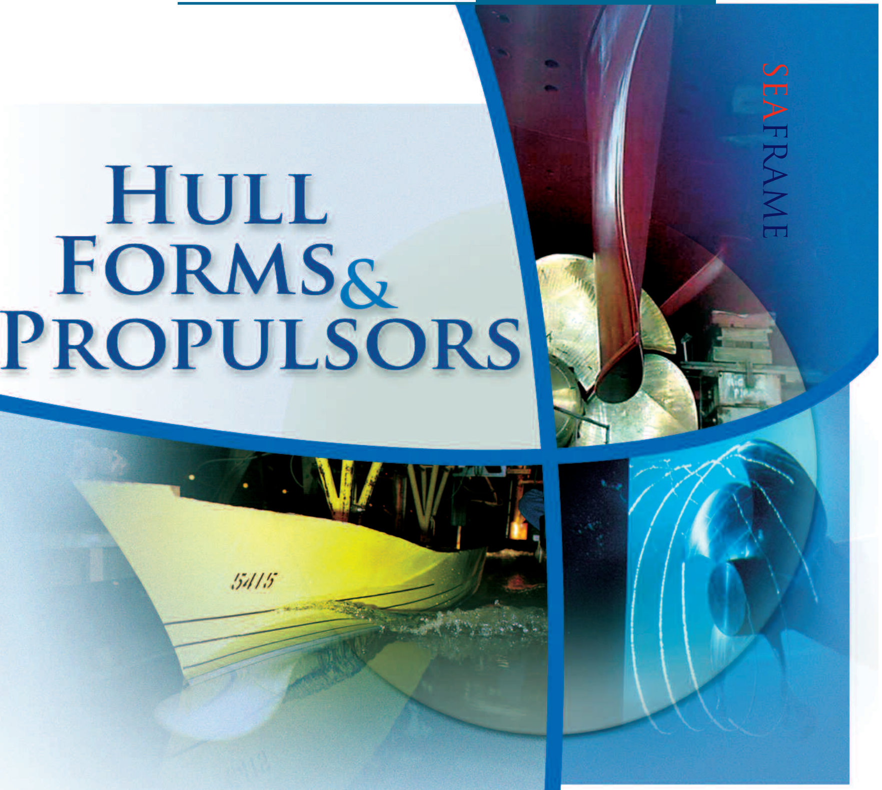


DDG 1000 Open Water Model Testing

One-of-a-Kind Model Testing Helps Establish Full-Scale Seakeeping Characteristics

By William Palmer

In the waters of the Chesapeake Bay, off the coastline of southern Maryland, test personnel from the Naval Surface Warfare Center, Carderock Division, are performing open-water performance testing of a 20th-scale model of the DDG 1000, the Navy's 21st century destroyer. Division engineers conducted rough water runs at various combinations of speeds and headings with respect to the waves. The runs were conducted within a 4-nautical-mile square test area near the western shore by Patuxent River Naval Air Station. Inside a breakwater, where the water surface was less susceptible to weather-related influences, calm water maneuvers were performed. While the test site afforded research personnel a nearby location, with an established support infrastructure and the correct wave environment, it also presented many unique challenges.

First, because of the variability of elements resulting from testing on open water, test schedules had to be flexible. The model, ballasted to the inertial and mass properties of the real ship, had to be tested in waves and wind which were realistically scaled to the environmental conditions of interest. Consequently, only the spring and fall seasons presented the best opportunity for local winds to build to a certain level, creating waves of

DDG 1000 (Continued on page 12)

The DDG 1000 model is transferred from a custom trailer to the water via an overhead crane. The model was pulled from the water each day after testing, hosed down, and returned to a high-bay garage for overnight storage. Hard drives containing as much as a terabyte of video data and gigabytes of test data were off-loaded and blank disks put in place for the next day's tests.
Photo by Martin Sheehan, NSWC Carderock Division.

Above: The 20th-scale model of the Navy's new destroyer class, the DDG 1000, conducts maneuvers in a test area on the Chesapeake Bay in Maryland. The model measures 30 feet in length and weighs about 2 tons.
Photo by Martin Sheehan, NSWC Carderock Division.

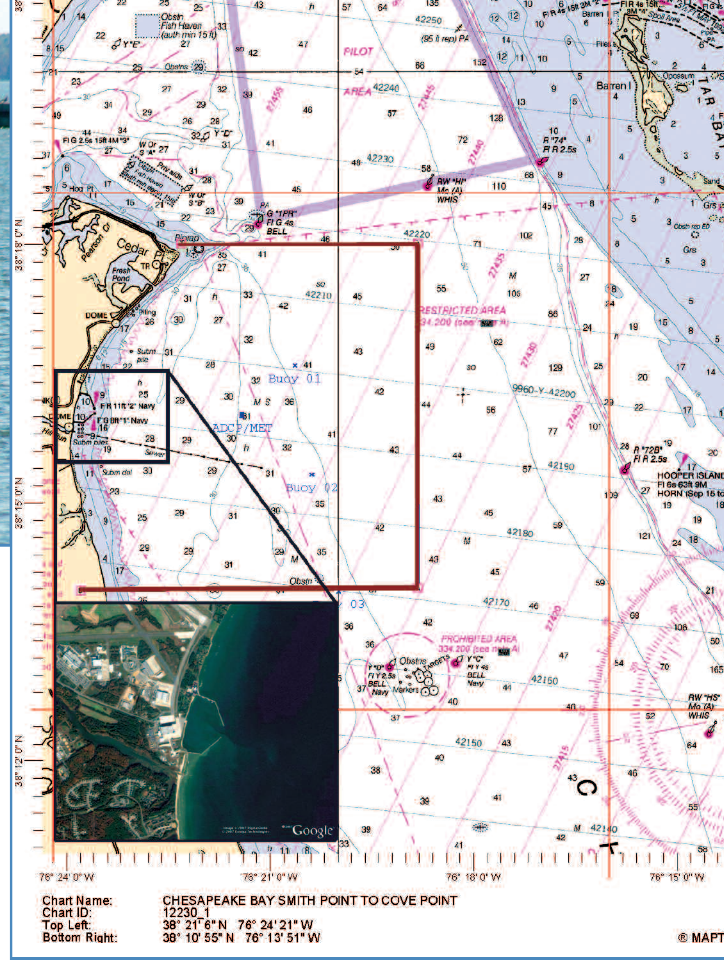
DDG 1000 (Continued from page 11)

a certain height, which were of the proper size to match the scale of the model.

Also, the model was autonomously controlled by an autopilot system, designed to replicate the response to a full-scale DDG 1000 to control inputs. To quantify wind and wave elements of the test area, three wave buoys, deployed in the center of the test area, and oriented in a north-to-south line, provided telemetry data in real time to characterize sea state, wave height, and wave period. In case test runs took the model far away from the buoys, other sources of wave characteristics and weather data were available. These include an over-the-bow Doppler wave radar on a 100-foot command chase boat to measure wave height, an acoustic Doppler current profiler, which measured the direction and speed of any water currents, wind measurements taken on the chase boat, and stationary weather instruments on the shore. The intention was to gather as much environmental data as possible so that researchers could reconstruct everything happening at a given moment.

The salinity of the Chesapeake Bay water was a crucial data point for test personnel to collect. Salinity, which changes with the seasons, affects the density of water, which in turn would affect the buoyancy characteristics of the DDG 1000 model. In replicating how the model would float in the salt waters of the open ocean, researchers had to measure the Bay's salinity daily, and then adjust ballasting in the model to have its waterline closely match.

Also, the bottom contour of the test area was fairly uniform, ranging from 25 to 45 feet deep. This means waves generated in this area will be equally uniform in their characteristics, as opposed to a shipping lane further to the east, which is dredged out for commercial shipping and has a depth about 100 feet.



Above: The Patuxent River test site, depicted by bold red lines. Inset shows breakwater area, where maneuvering tests were conducted under calm conditions.
Graphic by Todd Carrico, NSWC Carderock Division

Construction of the model was done at the Division's West Bethesda site, where the model design and subsequent machining, milling, and fabrication were done completely in a digital environment. Testing of this type, particularly in a high (scaled) sea state environment, required the model to be designed to be extremely robust, portable, watertight, radio-controlled, and environmentally-friendly. Todd Carrico, a Division naval architect who designed the model and oversaw its construction and general readiness, explained "The project actually began about two years ago. I was the lead naval architect on the project. A big challenge for us was that we have equipment and infrastructure here [at West Bethesda]. For this testing project, we had to go offsite, and had to take everything with us. We had to be completely self-sufficient."

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Machinery Systems

Optimizing Logistics

SWE Moves Forward to Develop a PBL Process for Legacy Equipment

By Alan Karpovitch and Dennis Russom

The Surface Warfare Enterprise (SWE) is developing a process to optimize legacy programs in the areas of cost and performance. The process centers on the use of performance based logistics (PBL) and is being developed in conjunction with a pilot program involving the gas turbine generators (GTGs) that provide ship service electrical power onboard all DDG 51 and CG 47 Class ships.

In February 2007, the SWE Sustainment and Modernization PBL Team, headed by Scott Dilisio (NAVSEA 04L), set out to develop a comprehensive process for accessing the performance of legacy programs and, if supported by a business case analysis, move them into a PBL environment. The goal was to develop a model that will take this effort from theory to realization. Dilisio's team includes subject matter experts from the Naval Sea Systems Command, Fleet Forces Command, Naval Inventory Control Point, Defense Logistics Agency, Carderock Division's Ship Systems Engineering Station, and various private industry concerns, including The Thomas Group. Early tasks involved performing an initial program assessment, capturing the SWE's requirements, and developing a product support strategy. The team then performed a business case analysis (BCA) "light" with the goal of identifying areas of potential savings. BCA light findings were the core of a move-ahead plan that centers on a comprehensive BCA and the development of performance based contracts (PBCs) as required.

Left: Carderock Division engineers Jeremy Nichols (standing) and Brian Connery troubleshoot the No. 2 Gas Turbine Generator (GTG) Full Authority Digital Control (FADC) Load Control Panel (LOCOP) aboard *USS Vella Gulf* (CG 72).
Photo by Chris Corso, NSWC Carderock Division.

Above: Carderock Division engineer Chris Corso conducts the Generator Control Unit (GCU) checkout procedure aboard *USS Princeton* (CG 59).
Photo by Jeremy Nichols, NSWC Carderock Division.

Above: Chris Corso works on the No. 3 GTG FADC LOCOP aboard *USS Vella Gulf*.
Photo by Jeremy Nichols, NSWC Carderock Division.

OPTIMIZING LOGISTICS (Continued on page 16)

The 2007 International Submarine Races teams and their entries. Participants traveled from as far away as England and Mexico to compete in the ISR. Photo was taken by Dan Dozier, NSWCCD host for the event. *See article on page 4.*


RESERVED
K15
RESERVED
K14

OPTIMIZING LOGISTICS (Continued from page 13)

At the time of this writing, the GTG pilot program has progressed to the point where BCA light findings and recommendations have been endorsed by the SWE Board of Directors. Future plans include developing a comprehensive statement of objectives that will be structured with the government retaining product support integrator (PSI) responsibilities and each major program element undergoing a BCA to weigh current costs against potential savings. The timeline for the GTG pilot program targets PBC award in early 2009.

"This PBL is part of the Navy's effort to transform to doing business differently," said Marine Gas Turbine Program Manager Alan Karpovitch. "The end goal is to achieve savings that facilitate ship recapitalization, with zero degradation of fleet readiness."

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MACHINERY SYSTEMS

Remote Monitoring of Shipboard Machinery

Increasing Ship/System Readiness While Reducing Total Ownership Cost

By Brian Finley

Increased ship operation tempos, longer deployments, surge capable requirements, reduced crew sizes, budgetary constraints, and the need to reduce operating and support costs have presented significant challenges in how the Navy plans, schedules, and executes maintenance of shipboard machinery. To meet the Navy's goal of increasing ship and system readiness while reducing total ownership costs, the Surface Warfare Enterprise (SWE) has identified the importance of further leveraging distance support (DS) technologies. Specifically, the increased implementation and utilization of condition based maintenance (CBM) and the remote monitoring (RM) of shipboard machinery, while ships are pier side or deployed.

The Naval Surface Warfare Center, Carderock Division, Ship Systems Engineering Station (NSWCCD-SSES) plays a key role in developing and implementing the CBM and RM technologies. Furthermore, as members of the SWE RM Barrier Removal Team (BRT), NSWCCD-SSES is assisting in enhancing these technologies and the processes that use these technologies, both on the deckplate and within shoreside activities.

The Navy's current program to enable online automated shipboard CBM is the Integrated Condition Assessment System (ICAS). NSWCCD-SSES started implementing ICAS within the fleet more than a decade ago. Today, ICAS is installed on approximately 100 Navy ships and land-based sites. The system leverages existing ships' infrastructure by interfacing to machinery control systems to receive pertinent information without duplicating sensor or processing hardware. Additional data points are acquired via hand-held portable data collectors. These data are automatically trended, evaluated, and fused at the deckplate to allow for automated diagnostics. If a condition is identified that requires action, the recommended maintenance action is provided to the onboard operator in real-time.

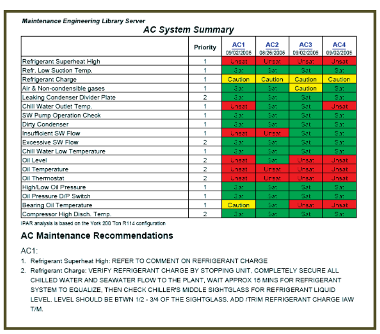
To meet the challenges posed by increased ship operation tempos, shorter in-port periods, and the need for shoreside maintenance planners to have shipboard machinery condition information at hand, NSWCCD-

SSES along with COMNAVSURFOR (CNSF) and the Regional Maintenance Centers (RMS), developed and began implementing RM technologies and processes in 2002. Through the SWE RM BRT, these have been further defined and enhanced.

Now, as often as daily, ICAS data is electronically sent from the ship to the shoreside Maintenance Engineering Library Server (MELS), which is maintained by NSWCCD-SSES. Currently, 31 surface combatant ships have the electronic transmission capabilities; the remaining ICAS ships must submit data monthly on CD-ROM.

Once shoreside, data entered into MELS is run through advanced algorithms that evaluate known equipment failure modes, compare information against fleet averages, and categorize equipment failure mode status as green (SAT), yellow (CAUTION), or red (UNSAT). This information is then processed into an Integrated Performance Assessment Report (IPAR). For each system, the responsible RMC subject matter expert (SME) reviews the IPAR and adds specific maintenance recommendations for all red and yellow conditions. Once the SME review is completed for all applicable machinery, the individual system IPARs are combined and emailed to the ship and shore technical communities. Currently there are IPARs available for 12 systems, including gas turbine and diesel engines, air conditioning plants, and air compressors.

Recently, under SWE RM BRT direction, process changes were implemented to improve IPAR cycle times and provide ships' force with quicker feedback on the condition of their systems. For the electronic submission capable ships, the RMC SME reviews have been removed, and ships receive weekly IPARs without SME recommended maintenance actions. Ships' force resolves red and yellow conditions shown on the reports. If a condition can not be resolved, they submit a request for assistance through the technical assist process. This process is also being revamped via the SWE Tech Assist BRT.



Maintenance Engineering Library Server

AC System Summary

	Priority	AC1 09/02/2005	AC2 08/26/2005	AC3 09/02/2005	AC4 09/02/2005
Refrigerant Superheat High	1	Unsat	Unsat	Unsat	Unsat
Refr. Low Suction Temp.	1	Sat	Sat	Sat	Sat
Refrigerant Charge	1	Caution	Caution	Caution	Caution
Air & Non-condensible gases	1	Sat	Sat	Caution	Sat
Leaking Condenser Divider Plate	2	Sat	Sat	Sat	Sat
Chill Water Outlet Temp.	1	Unsat	Sat	Sat	Unsat
SW Pump Operation Check	1	Sat	Sat	Sat	Sat
Dirty Condenser	1	Sat	Sat	Sat	Sat
Insufficient SW Flow	1	Unsat	Unsat	Sat	Sat
Excessive SW Flow	2	Sat	Sat	Sat	Sat
Chill Water Low Temperature	1	Sat	Sat	Sat	Sat
Oil Level	2	Unsat	Sat	Unsat	Unsat
Oil Temperature	2	Unsat	Unsat	Unsat	Unsat
Oil Thermostat	2	Unsat	Unsat	Unsat	Unsat
High/Low Oil Pressure	1	Sat	Sat	Sat	Sat
Oil Pressure D/P Switch	1	Sat	Sat	Sat	Sat
Bearing Oil Temperature	1	Caution	Sat	Unsat	Unsat
Compressor High Disch. Temp.	2	Sat	Sat	Sat	Sat

IPAR analysis is based on the York 200 Ton R114 configuration

AC Maintenance Recommendations

AC1:

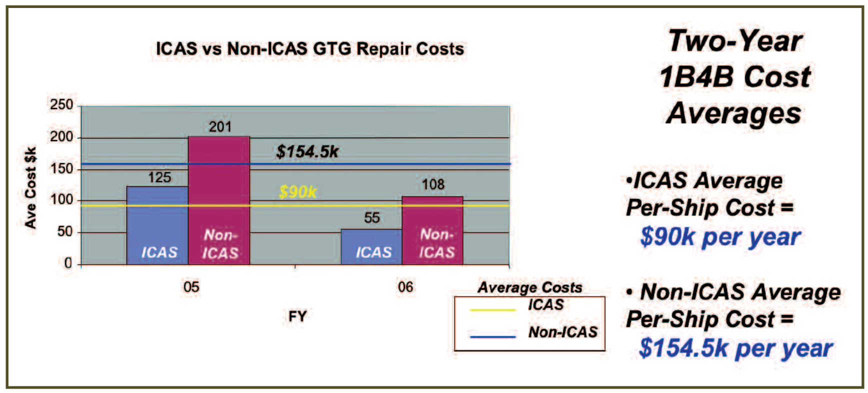
1. Refrigerant Superheat High: REFER TO COMMENT ON REFRIGERANT CHARGE
2. Refrigerant Charge: VERIFY REFRIGERANT CHARGE BY STOPPING UNIT, COMPLETELY SECURE ALL CHILLED WATER AND SEAWATER FLOW TO THE PLANT, WAIT APPROX 15 MINS FOR REFRIGERANT SYSTEM TO EQUALIZE, THEN CHECK CHILLER'S MIDDLE SIGHTGLASS FOR REFRIGERANT LIQUID LEVEL. LEVEL SHOULD BE BTWN 1/2 - 3/4 OF THE SIGHTGLASS. ADD /TRIM REFRIGERANT CHARGE IAW T/M.

Integrated Performance Analysis Report (IPAR)
Graphic provided by Brian Finley, NSWC Carderock Division.

A higher level of analysis is also provided in MELS. IPAR failure mode information is processed into Enterprise Performance Analysis Reports (ePAR). The difference between the two reports is that an IPAR is for a specific system on a specific ship, an ePAR is for a specific system across all ships where installed. This report shows the percentage of time a failure mode has been active for a selected timeframe, across each ship in which the specific system is installed. The intent of the report is to provide an enterprise view of system level assets which can be used in identifying classwide equipment issues.

MELS is accessible to anyone within the Navy's technical community via the internet, https://mels.navsses.navy.mil. The site is pki certificate controlled, and accounts can be requested on the site.

Studies, by both NSWCCD-SSES and COMNAVSURFOR, have shown that continuous and remote monitoring has resulted in cost savings to the fleet. CNSF conducted a study on maintenance costs for the Allison 501-K34 gas turbine engines. The study, results shown in the Cost Synopis figure, compared ICAS-monitored engines vs. non-ICAS-monitored engines and showed an average savings of $65K per ship per year for this specific engine. This result correlates to previous NSWCCD-SSES studies, in that GTGs are one of 12 systems monitored per ship by ICAS. The total cost savings average $350K per ship per year for all ICAS monitored systems. Additionally, these studies show reductions in both ships' force workload and fuel usage.



CNSF Allison 501-K34 ICAS vs. Non-ICAS Repair Costs Study.
Graphic provided by Brian Finley, NSWC Carderock Division.

Through this type of monitoring, conditions are identified early and preventive maintenance can be accomplished prior to catastrophic failures. Furthermore, the maintenance can be properly scheduled when the ship is either in-port or during maintenance availabilities. Early problem identification, prevention of catastrophic failure, and ability to properly schedule required maintenance all lead to improved operational availability for monitored systems, resulting in an increased ship and ship system readiness.

REMOTE MONITORING (Continued on page 18)

REMOTE MONITORING (Continued from page 17)

Future improvements are planned to provide additional capabilities and increase fleet savings. Current improvements underway are further implementation of the automated electronic data submission capability, automated 2-Kilo generation for identified maintenance actions, and the integration to mission readiness systems. Planned improvements include shipboard IPAR generation and development of prognostic capabilities. These improvements will be implemented within the fleet over the next few years.

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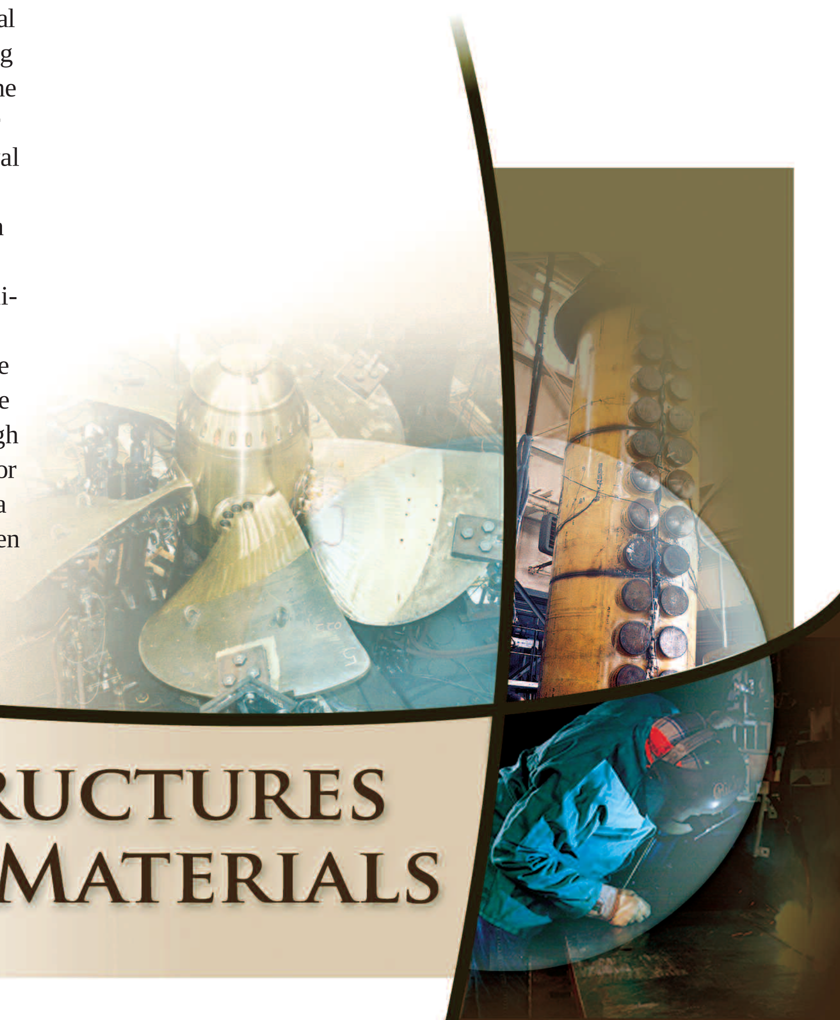
Aluminum Development for Fast Ships

How Aluminum Plays a Crucial Role in Structures of Current and Next Navy Ships

By Dr. Catherine R. Wong, Gerard P. Mercier, and Johnnie J. Deloach

Aluminum has long been used by the Navy–in fact, the Navy helped to pioneer the use of aluminum as a structural alloy. Advances in aluminum processing developed during the late 1800s made the material more accessible to the broader market and allowed its use in early naval patrol and torpedo craft. Since the turn of the 20th century, aluminum has been widely used in Navy patrol craft, small ship hulls, deckhouses, hydrofoils, and many other applications. More recently, the Navy began to develop new classes of smaller and faster ships that are re-configurable and capable of operating in the littoral environment. These ships include the Littoral Combat Ship (LCS), Joint High Speed Vessel (JHSV), and Joint Maritime Assault Connector (JMAC), all of which make use of aluminum alloys as a primary structural material. The use of aluminum is driven by its high strength to weight ratio, weldability, and good corrosion resistance in naval environments.



STRUCTURES & MATERIALS

Above: Stress corrosion cracking in a non-structural bulkhead of a Ticonderoga Class cruiser.
Photo provided by Catherine Wong, NSWC Carderock Division.

Above: Research scientist Norris Lindsey performs susceptibility testing on aluminum in a high-temperature, high-acidity environment. Temperature in the test was set at about 170 degrees Fahrenheit, with a pH of between 1.0 and 2.0.
Photo by James Contreras, NSWC Carderock Division.

While the Navy's experience with aluminum is extensive, past uses were based on minor adaptations of steel structural design technologies. Significant differences in stiffness, strength, fabrication techniques, and formability make steel design techniques inappropriate for many aluminum alloy applications. Unlike steel, welding aluminum reduces the strength of the material, and designing aluminum structures with steel rules led to fatigue cracking problems in ship designs from the 1970s and 1980s. Furthermore aluminum has a much lower melting point than steel, limiting its ability to withstand fires over long periods of time. Lastly, while marine aluminum alloys are highly corrosion resistant there are issues. One such issue is that seawater exposure reduces the fatigue strength of unpainted aluminum plates and welds. Also, joining aluminum to steel creates a galvanic mismatch that can cause massive corrosion of the aluminum in a seawater environment. Another issue involves the fact that high temperature in-service exposure of aluminum over extended periods of time can sensitize the material. Finally, sensitization reduces corrosion resistance and can lead to stress corrosion cracking and exfoliation. In the mid 1980s a combination of these issues caused the Naval Sea Systems Command (NAVSEA) to set the fatigue limit of marine aluminum alloys to such a low value that Navy ship designers largely abandoned aluminum superstructures in new designs. As a result, there has been little technical work done on marine aluminum alloys within the Navy since that time.

Currently, there are many programs aimed at understanding and coping with the four key aluminum material issues: (l) as-welded strength that is lower than the strength of the plate; (2) fatigue resistance that is lower in unpainted aluminum in seawater environments; (3) in-service sensitization; and (4) strength retention during fires. The Office of Naval Research (ONR) recently began the Structural Reliability Program which will collect and provide valuable material property data to ship designers and modelers. Collected data will then be used to accurately predict ship life and survivability based on aluminum structural designs. The Structural Reliability Program aims to predict seaworthiness and ship integrity over the full range of a ship's life from keel laying to the scrap yard. Structural models are being evaluated to optimize designs, and fabrication techniques and vulnerability assessments are being made to understand how an aluminum ship will behave under combat loads.

The Carderock Division is supporting Congressional special interest programs focused on the development of new aluminum alloys with improved properties. The alloying addition of scandium to aluminum has been known to enhance strength at normal service and elevated temperatures. Other techniques such as powder metallurgy and nanocrystalline material technologies are used to increase strength for armor applications for the U.S. Navy, Marine Corps, and Army. The Carderock Division also employs advanced metallurgical and thermodynamic modeling and simulation techniques in an effort to predict and optimize the properties of aluminum components based on the processing methods used in production.

The Division supports ship construction and design efforts. Researchers are evaluating novel welding techniques such as friction stir welding (FSW) for use in aluminum structural components for LCS, amphibious assault ship (LHA 6), and the LCAC hovercraft. FSW is a high productivity, high quality process which can reduce distortion in welded components. The Carderock Division is also involved in other aluminum welding technology research: (1) developing weld parameters for gas metal arc welding to minimize the formation of high residual stresses in weld metal and adjacent base metal, and (2) studying the effects of cleaning preparation on the mechanical properties of welded joints. Another manufac-

ALUMINUM DEVELOPMENT (Continued on page 20)

ALUMINUM DEVELOPMENT (Continued from page 19)

turing technology being evaluated is the use of extrusions with integral stiffeners that make use of the superior formability of aluminum to reduce fabrication costs.

The Carderock Division has been researching sensitization of aluminum alloys in service for several years. Material specifications have been updated to include testing which would preclude the use of sensitized materials in initial construction. Research efforts are seeking ways to identify sensitized materials in-situ to reduce repair costs. Testing is being performed to determine the effect of sensitization on strength and fracture toughness of marine aluminum alloys. The time and temperature required to sensitize different alloys and tempers are being measured as is the actual thermal profile of ships superstructures. The ultimate goal of the sensitization research is to develop test methods to evaluate the rate of sensitization in service and ensure that the Navy uses aluminum alloys that will last the life of the ship.

There is progress in the effort to understand aluminum and apply science to the Navy's structural use of aluminum alloys. There are many new research projects aimed at aluminum and support for them is increasing at ONR and NAVSEA. The dramatic increase in Navy platforms using aluminum alloys requires that research be done to overcome challenges presented by their use in structural design for both the Navy of today and the Navy of tomorrow.

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Environmental Quality Systems

Hazardous Material Control and Management Distance Support

Moving Hazardous Material Workload from Ship to Shore Reduces HAZMAT and Improves Ship Safety

By
By Leslie Spaulding
(Portions Reprinted from Winter 2007 Edition of Currents—the Navy's Environmental Magazine)

Hazardous material (HM) experts from the Naval Surface Warfare Center, Carderock Division (NSWCCD) and the U.S. Fleet and Industrial Supply Center (FISC) in Yokosuka, Japan, developed a pilot program to demonstrate the benefits of moving hazardous material control and management (HMC&M) responsibilities from the shipboard afloat community to the ashore community. Working with the

The crew of the guided-missile cruiser *USS Cowpens* (CG 63) worked with hazardous material experts from Carderock Division and the U.S. Fleet and Industrial Supply Center in Yokosuka, Japan, on a pilot project to maximize distance support and minimize hazardous material handling for ships' crews.
U.S. Navy Photo.

crew of *USS Cowpens* (CG 63), the team demonstrated that moving these responsibilities from the ship to FISC Yokosuka provided workload reduction, reduced HM onboard ship, reduced HM offload quantities, and reduced quantities of HM in waste streams.

"The pilot project [was] critical to the future deployment of Littoral Combat Ships (LCS), which will have smaller crews," said Jehdia Bottinelli, regional hazardous material director at FISC Yokosuka. "And it is an important part of distance support. ... As the Navy reduces the number of Sailors onboard ships, distance support is going to happen. Pollution prevention, reducing waste, and getting behind distance support initiatives are hugely important. It just makes sense."

In addition to working with FISC Yokosuka and ship's force, the Division also teamed with Naval Air Systems Command (NAVAIR). "Our primary role in this pilot was to define the engineering requirements for HAZMAT, itself," said Robert Klimas, who heads the NSWCCD Hazardous Materials/Waste Afloat Group. This involved defining the ship's HM needs by developing an inventory for daily operations, researching the ship class' HM history to account for potential equipment casualties requiring hazardous material, and working with the NAVAIR to develop the HM requirements for the embarked 2H60 helicopters aboard ship.

Not only will these efforts reduce the workload on ship's force, but they will also decrease the amount of hazardous materials aboard ship, which will lessen the amount of HM to be offloaded when a ship makes port. These efforts will also help to minimize the amount of HM found in the ship's waste streams. Inspections by both the Navy Board of Inspection and Survey and the Navy Inspector General (IG) identified issues with the fleet's current methods of HM storage and use and with excess inventory, which increased the amount of HM to be offloaded and disposed. The Naval Sea Systems Command (NAVSEA) IG estimated these practices cost the Navy between $50 and $100 million annually, most of it spent on disposal of unused HM.

Currently, the ships carry much of the responsibility for managing HM–inventory management, submission of feedback reports for unauthorized material, labeling, shelf-life management, ensuring proper storage, and consolidating used HM–to name a few. This is done through a shipboard hazardous material minimization center (HAZMINCEN), manned by side-duty personnel from other departments. "HAZMAT from the HAZMINCEN is critical and can either make or break the ability for a ship

HAZARDOUS MATERIAL CONTROL (Continued on page 22)

Below: Storekeeper 3rd Class Christopher Santos, distance support expert Storekeeper 1st Class Mark Ross, and logistics support representative Storekeeper 1st Class Ernest Cutler, all from FISC Yokosuka, inventory supplies about to be loaded onboard *USS Cowpens* (CG 63).
Photo by Yohsuke Onda, FISC Yokosuka.

Above: Distance support logistics experts and other Sailors of FISC Yokosuka, form a human chain to safely load and off-load supplies from *USS Cowpens.*
Photo by Yohsuke Onda, FISC Yokosuka.

Above: Carderock Division representative Mark Lynch shows SK1(SW/AW) Sean Mahoney of *USS Cowpens* how to identify and minimize hazardous materials.
U.S. Navy photo by Phil Molter, CFAY Public Affairs.

Above: Jehdia Bottinelli, FISC Yokosuka's regional hazardous materials director (center, right side of table) leads the discussion onboard *USS Cowpens* at the beginning of a partnership and pilot program for hazardous material minimization. Personnel from FISC Yokosuka and Carderock Division worked to transfer responsibility for hazardous materials from ship to shore.
U.S. Navy photo by Phil Molter, CFAY Public Affairs.

HAZARDOUS MATERIAL CONTROL (Continued from page 21)

to accomplish a mission or to remain mission capable," stated Amy Balog, who managed the NSWCCD portion of the Cowpens pilot. "If a certain type of HAZMAT is not available the ship will not be able to accomplish its assigned mission. As a result, these Sailors have quite a large amount of responsibility to ensure that these materials are onboard and in the quantities needed."

Through this pilot program, the team of experts validated HM requirements, conducted a wall-to-wall shipboard HM inventory, and improved HMC&M operations and facilities onboard *USS Cowpens*. The team also established a ship-to-shore HM management process for afloat/shore standard operating procedures. The Hazardous Inventory Control System Windows were restored with validated data, and dual stations were set-up both shipboard and ashore. The ship was outfitted with the authorized HM inventory, and all onloads and offloads of HM were tracked. The effort resulted in more than $23K in material cost avoidance, and reduced the number of HM line items loaded. Additionally, the team conducted underway one-on-one HM management training.

The success of this pilot program was built upon earlier success with the carrier fleet. Working with *USS Harry S. Truman* (CVN 75) and *USS Theodore Roosevelt* (CVN 71), Carderock Division personnel developed HAZMAT management standard operating procedures for the CVN 68 Class. "By providing standard operating procedures, the Navy can ensure that each ship in the class is efficiently managing HAZMAT, is safely controlling used HM generated by shipboard processes, and improving safety and health, as well as controlling costs and adhering to defined environmental engineering requirements," explained Klimas. "However, the standard operating procedures for the carriers left much control with the ship. The surface combatants and smaller ships do not need to retain that much control."

FISC Yokosuka is continuing to work closely with *USS Cowpens* to maintain its hazardous materials inventory, with Carderock Division supporting as needed. Additionally, work is underway to automate as much of the process as possible to allow FISC to anticipate ship requirements and ensure the crew's needs are met. Carlos Cruz, who headed the Afloat Hazardous Materials Group at the time of the pilot, said "This is all being driven by our need to find a better way to do business. We need to make sure the ship has all the material it needs and that it will get to its destination safely."

In anticipation of future needs, NSWCCD personnel are working with the LCS Pre-Commissioning Unit regarding the ship's HM requirements. COMFISC in San Diego, CA, has established a logistics support team to review all lessons learned from the carrier project and the *Cowpens* pilot in order to develop standard operating procedures for LCS distance support. This summer, personnel from both Carderock Division and FISC began working with the DDG 1000 design group in anticipation of that class' HM needs, as well.

"Automation, communication, and cooperation are key tools to the success of HM distance support," explained Klimas. Work is underway on developing an automation tool to assist in gathering and delivering data to help in trend analysis and planning for standard and casualty HM requirements while a ship is underway. Additionally, communication of needs between the ship and shore needs to be improved. With better communication tools, the FISC can have hazardous materials delivered to a ship's next port of call in anticipation of needs. Finally, ship's force must take ownership of any process in order for it to work, and that ownership is driven from the top.

According to Lieutenant Commander Ramon Marin, who was the *USS Cowpens* Supply Officer during the pilot, this initiative was welcomed by the fleet. He said, "The fleet appreciates the overall benefits of this process. Ultimately, it will mean less hazardous material for us to carry and manage."

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Vulnerability & Survivability Systems

DDG 1000 Damage Tolerance Design

How Ship Designers Are Building Survivability into the Navy's Newest Destroyer

By William Palmer

The DDG 1000 ship design program has been in existence for a number of years, and each year designers have been increasing the detail with which they scrutinize damage tolerance, or ways to keep the vessel functioning after suffering damage inflicted by a weapon hit or an onboard casualty. The Naval Surface Warfare Center, Carderock Division team, numbering about 30 people, is looking at issues surrounding vulnerability and recoverability. This in turn will provide an accurate damage tolerance assessment of the ship's design. The team is comprised of individuals representing a broad swath of talent across the Division's West Bethesda and Philadelphia sites. The execution of this design also marks the first time a metric for vulnerability and recoverability has been an integral part of a Navy ship design.

A critical factor of damage tolerance is to determine how vulnerable a ship design is to damage events. When ship systems are compromised or eliminated because of a weapon hit, fire, or collision, sometimes the only feature of the ship design which keeps it operating is a survivable architecture. Researchers are therefore looking at two distinct assessments, one involving assessing the ship's condition immediately after a weapon hit, and a second involving recoverability, or determining

DDG 1000 DAMAGE TOLERANCE (Continued on page 24)

Left: Artistic rendering of the DDG 1000 in action, along with the program's logo. Above, a DDG 1000 model undergoing structural integrity testing.
Media provide by Robert Wunderlick, NSWC Carderock Division.

DDG 1000 DAMAGE TOLERANCE (Continued from page 23)

what systems are available for recovery. Bob Wunderlick, the DDG 1000 Damage Tolerance System Engineering Manager at Carderock Division, says an important distinction in this program is to understand the functionality of not just major warfare systems, such as radars or combat systems, but also the power plant and its auxiliary support systems. "We have to sense what the damage is," says Wunderlick, "determine the proper plan of action, and recover the ship to the greatest of its ability given the systems that still remain." Wunderlick has been working in the program since 1998.

Since the current study involves an intense look at the ship's design, several groups whose expertise lies in such areas as materials, underwater explosions, control system logic, and distributed systems, are focusing their attention on how the DDG 1000 will fare in a casualty. Some features of the ship design involve automated response to a damage event, and use a damage control automated response to establish situational awareness and, where a fire is concerned, setting initial fire boundaries with a primary damage area cooling system. One such system was successfully demonstrated in a weapon hit on the ex-*USS Peterson* (DD 969), where automated firefighting systems rapidly extinguished onboard fires resulting from the hit.

The program is currently in the detailed design phase of ship design, which began in 2005, and the focus is on getting ready for the design's Production Readiness Review, expected to take place in late 2008. If the review indicates that the design process is ready to move to physical construction of the ship, then shipyards will begin "cutting steel" to bring the design off paper and into reality.

Based on lessons learned, the designers of DDG 1000 defined a requirement for vulnerability and recoverability, and this will have a significant influence on future ship designs and design requirements. A ship design "feedback loop" was established, where vulnerability experts are shoulder to shoulder with the ship designers in optimizing DDG 1000's architecture, so that both groups are in on the day-to-day decision-making. If ship designers discover an issue with the architecture, such as awkwardly placed cabling or piping system, the issue is documented and reviewed during weekly cross product team meetings. Issues are analyzed on a number of levels, from early-stage design to total ship architecture.

Pulling together a team from a vast array of Surface Warfare Enterprise assets, the designers of the Navy's newest class of destroyer are using this team to the fullest advantage, ensuring full understanding of DDG 1000's architecture from a vulnerability and recoverability perspective, and providing the Navy's fleet with a ship ready to absorb battle damage and continue to function as a viable naval asset.

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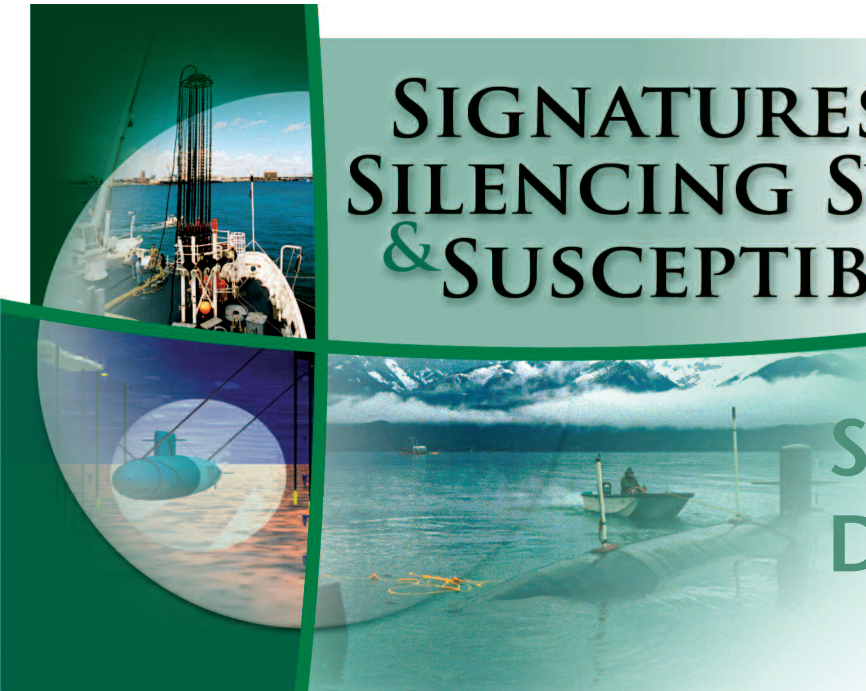
Signatures, Silencing Systems, & Susceptibility



Sonar Tactical Decision Aid

Assisting the Fleet in Detectability and Vulnerability Decision-Making

By David Sracic

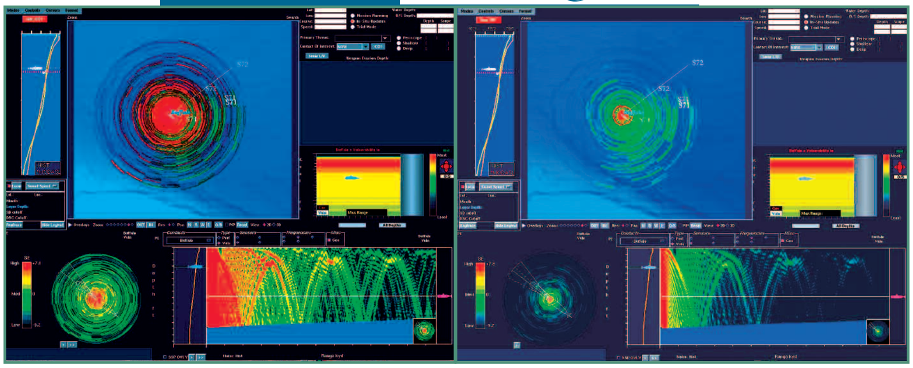
Sonar operators and their commanding officers continually strive to maintain minimum vulnerability to a threat while maximizing their ability to detect and hold that threat. They make continual tactical decisions to this effect, and these decisions are based upon several key factors, including their own acoustic vulnerabilities, their adversary's sonar system performance characteristics, and the environment separating them from their adversary. Today's Sailors use the Sonar Tactical Decision Aid (STDA) system to gauge their vulnerability. In addition, due to reciprocity, STDA is able to predict the vulnerability of adversaries to ownship sensors. STDA's ability to predict detectability of a threat and own-ship vulnerability to that threat helps Sailors make the best possible tactical decisions.

STDA is a set of software components largely developed by NSWC Carderock Division, and delivered to the fleet as part of various integrated sonar systems. STDA is used for both mission planning and in-situ analysis, with the latter allowing STDA to receive real data from the sonar system in which it is installed, and providing the operator with a constantly updated picture of the boat's vulnerability characteristics and sonar system performance, as well as recommendations on how to make the best use of the current operating environment to minimize vulnerability and maximize detection. STDA allows the operator to analyze the possible vulnerability and coverage impacts of a potential tactical decision before acting, in order to maintain tactical advantage.

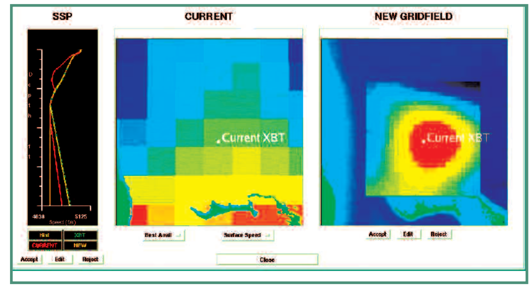
The STDA software components were designed to be reusable and applicable to multiple Navy sponsors and communities. This allows STDA technology to be delivered to multiple Navy communities at minimal cost, with reduced risk and rapid development and delivery cycles. In addition, a portion of these software components are directly leveraged into the Submarine Multi-Mission Team Trainer (SMMTT) and other NSWC Carderock Division training products. This, in turn, allows the fleet to have a consistent, standardized set of tools through which to perform environmental and signature assessment, whether planning a mission before prosecution, analyzing their current situation while underway, or during a training or reconstruction exercise while in port.

Using the sensor parameters provided by the sensor developers, platform acoustic information gathered by the NSWC Carderock Trials teams, and threat information provided by the Office of Naval Intelligence, STDA uses acoustic models to generate performance predictions that reflect the potential range to detection in a given environment. In addition, STDA automatically generates cumulative assessments of multiple performance predictions across multiple near environments, allowing an operator to see at a glance whether they could improve their current situation by, for instance, changing their depth, heading or speed, without any negative vulnerability implications.

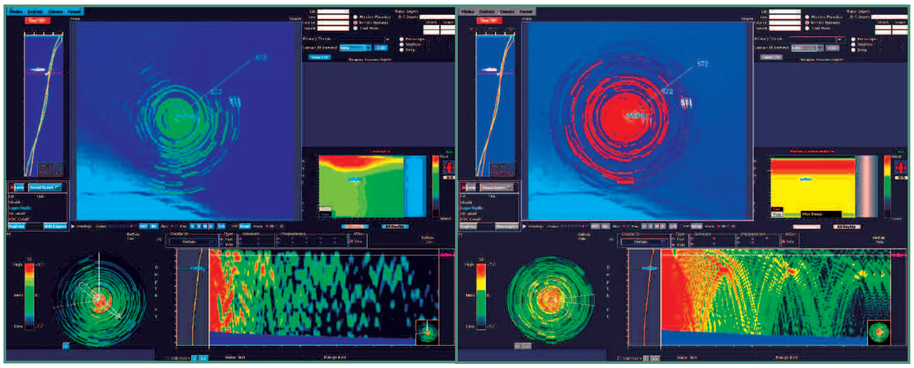
SONAR TACTICAL DECISION AID (Continued on page 26)



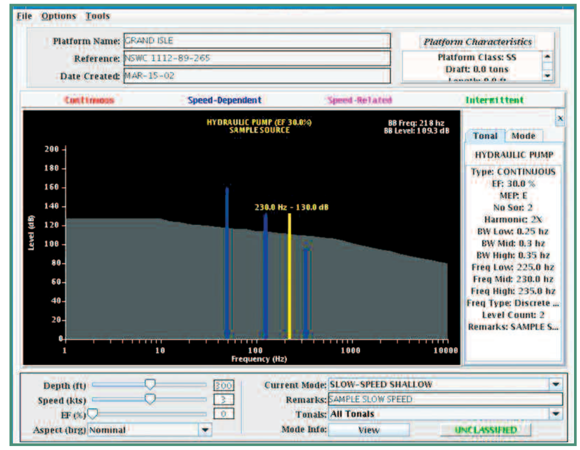
Above: The STDA, at left, shows predicted vulnerability. The STDA, at right, shows a significant tactical advantage based on predicted sonar coverage (green) having a much larger range than predicted vulnerability (red) along all bearings.
Screenshot courtesy of the NSWC STDA Team.



Above: This STDA shows the difference between the historical sound speed in a given location and the current sound speed profile as measured by a recent submarine-launched expendable bathythermograph, or SSXBT.
Screenshot courtesy of the NSWC STDA Team.



Above: The STDA, at left, shows predicted sonar coverage. The STDA, at right, shows a significant tactical disadvantage based on predicted vulnerability (red) having a much larger range than predicted sonar coverage (green) along a majority of bearings.
Screenshot courtesy of the NSWC STDA Team.



Above: This STDA allows the operator to select sources upon which to base a vulnerability assessment.
Screenshot courtesy of the NSWC STDA Team.

SONAR TACTICAL DECISION AID (Continued from page 25)

STDA calculations use the best signature data available at the time, whether NSWC Carderock trials data, Total Ship Monitoring System (TSMS) radiated noise measurements, or operator-provided information. Future plans may include delivery of NSWC Carderock Detection and Detectability reports and trial reports to the boat concurrently with an STDA-readable summary of that data, so that at the conclusion of an acoustic trial, a given boat will be able to use STDA to see the immediate tactical impact of any noise issues discovered, in terms of range of vulnerability to a potential threat.

STDA tactical deliveries leverage the Scalable Tactical Acoustic Propagation Loss Engine (STAPLE). STAPLE is a set of NSWC Carderock software components allowing acoustic performance predictions to be done independent of display resources, using as many or as few processors as required to accomplish a calculation in a tactically acceptable amount of time.

STDA is currently delivered as a part of the submarine AN/BQQ-10 sonar system, the surface community's Sonar Performance Prediction Functional Segment (SPPFS) in the SQQ-89 A(V)15 sonar system, and the Integrated Undersea Surveillance System (IUSS) Integrated Common Processor (ICP) sonar system. It contains various STDA and STAPLE components delivered as a part of the Undersea Warfare Decision Support System (USW-DSS), Littoral Combat System (LCS), SMMTT, Acoustic Analysis Trainer (AAT), Sonar Employment Trainer (SET), and Common Operator Analysis and Employment Trainer (COAET).

The utilization and contribution of STDA development efforts under the multiple Naval Enterprises assures an overall cost savings to the Navy, commonality of high fidelity modeling, and commonality of signatures guidance tools and decision aids across the fleet.

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TECHNOLOGY & INNOVATION

INDEPENDENT APPLIED RESEARCH

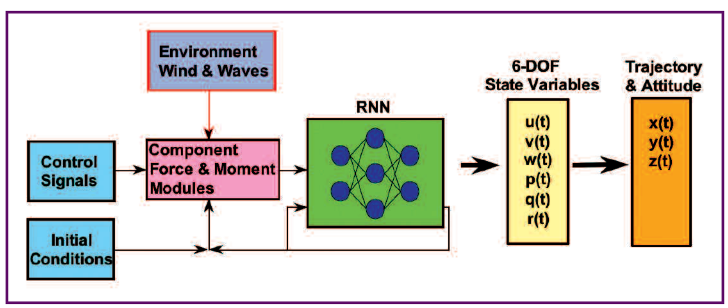
Ship Maneuvering Simulation Using Recursive Neural Networks

By Dr. David E. Hess

A three-year project to develop a faster-than-real-time ship maneuvering simulation tool has been funded by the Independent Applied Research (IAR) program at Naval Surface Warfare Center, Carderock Division (NSWCCD). The IAR program receives funding from the Office of Naval Research and distributes it each year through competitive awards to recipients across the Division. The program is managed by the Director of Research, Dr. John Barkyoumb.

The project's purpose is to develop nonlinear time-domain ship simulation software for use as both ship simulation models as well as in advanced control systems for marine vehicles. The need for such systems is pressing. The U.S. Navy is developing ships for high-speed transport of men and equipment. These vehicles will be required to safely operate in high sea states. Of concern on such vehicles is the shock transmitted to the crew in rough seas, as well as the stresses endured by the vehicle, raising fatigue concerns. Also, the use of unmanned surface vehicles (USV) has proliferated around the world. Operation of these vehicles in high sea states limits their persistence and effectiveness, and seakeeping issues must be addressed. In particular, the stability of the USV, serving as a sensor or weapons platform, is of concern as is the ability to launch and recover. Another area of interest is the two-body (or multi-body) problem in which two or more vessels are required to maintain a constant separation distance. Commonly, this problem occurs during the transfer of cargo at sea. Increasing the range of conditions under which such transfers can be safely conducted is a high priority.

To address these concerns, the Navy is looking at recursive neural network (RNN) simulation. This is a computational technique for developing time-dependent nonlinear equation systems that relate input ship control variables to output ship state variables. A recursive network is one that employs feedback–namely, the information stream issuing from the outputs is redirected to form additional inputs to the network. An RNN can be trained to provide a faster-than-real-time nonlinear time-domain simulation of a surface vessel responding to control-effector and environmental forcing. The availability of such a model then permits predictive and model reference control approaches to be explored.



The above diagram shows RNN ship simulation.
Graphic provided by Dr. David Hess.

The formulation of the ship simulation problem is depicted below in the figure. Forces and moments acting on the vehicle at time (t) are input into the RNN. The network is then trained to predict vehicle motion at time using experimental or computational training data. The input forces and moments are developed using control inputs as well as output state predictions from the

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previous time step (or initial conditions for the first time step). To use the trained network, one must only provide control time histories and initial conditions. Note that the force modules represent a series of equations designed to pose the problem well for the network by trying to capture the key forces and moments that are driving the motion. The equations need not be exceedingly precise; instead, one exploits the power of the network to find a solution between the inputs (forces and moments) and the outputs (vehicle motion) for a well-posed problem.

Over the course of the project, now in its third year, the technique has been successfully used to develop simulations for full-scale ships (AOE 6 and LSD 50) in calm seas with wind and for a pre-contract *Arleigh Burke* Class destroyer model (5514) operating in the Manuevering and Seakeeping Basin (MASK) at NSWCCD's West Bethesda site in extreme regular waves simulating Sea State 7. As the IAR program comes to an end, the real-time nonlinear simulation approach is transitioning into several ONR and acquisition programs. Among the funded efforts are simulations of the full-scale catamaran *Sea Fighter*, operating in Sea States 4 and 5; the model-scale DDG 1000 *Zumwalt* Class destroyer in regular waves; the model-scale Landing Craft Air Cushion (LCAC) operating in waves, the Newport News non-axisymmetric underwater test vehicle, *Nnemo*; and for initial work to develop a roll damping model for a surface ship.

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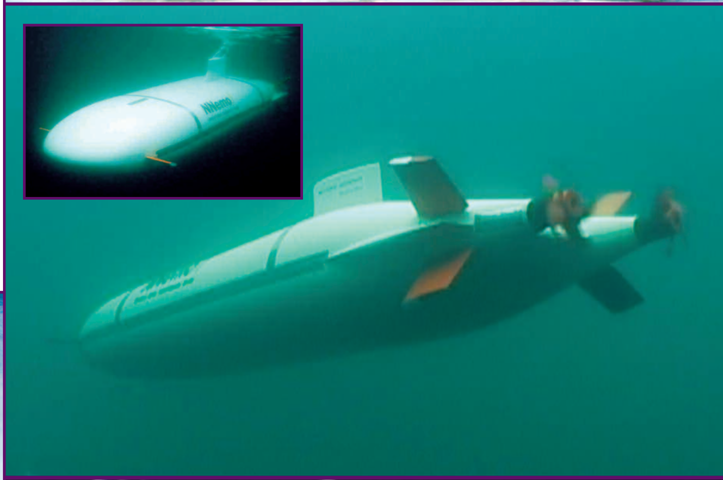
A three-year project to develop a faster-than-real-time ship maneuvering simulation tool will help in the Navy's development of ships for high-speed transport of men and equipment, such as the Landing Craft Air Cushion (LCAC) *(bottom, left)*, the *Sea Fighter* (FSF 1) *(below)*. Below middle, a neural network maneuvering simulation has been created to develop a controller for the Northrup Grumman Newport News non-axisymmetri submarine *Nnemo.* Bottom, the 5514 (DDG 51) Model Scale Prototype was run in Carderock Division's Maneuvering and Seakeeping Basin (MASK) to evaluate maneuvering in high sea states.
Official Navy Photos and NGNN Nnemo Photo.



Ship Integration & Design

This core equity applies specialized expertise for surface and undersea vehicle design including early concept development, assessment and selection of emerging technologies, integration of selected technologies into optimized total vehicle designs, and evaluation of those technologies and designs for cost, producibility, supportability, and military effectiveness.

Machinery Systems

This core equity provides full-spectrum technical capabilities (facilities and expertise) for research, development, design, shipboard and land-based test and evaluation, acquisition support, in-service engineering, fleet engineering, integrated logistic support and concepts, and overall life-cycle engineering.

Hull Forms & Propulsors

This core equity provides the Navy with full-spectrum hydrodynamic capabilities (facilities and expertise) for research, development, design, analysis, testing, evaluation, acquisition support, and in-service engineering in the area of hull forms and propulsors for the U.S. Navy.

Vulnerability & Survivability Systems

This core equity provides full-spectrum capabilities (facilities and expertise) for research, development, design, testing, acquisition support, and in-service engineering to reduce vulnerability and improve survivability of naval platforms and personnel.

Environmental Quality Systems

This core equity provides facilities and expertise for research, development, design, human systems integration, acquisition support, in-service engineering, fleet support, integrated logistic concepts, and life-cycle management resulting in mission compatible, efficient and cost-effective environmental materials, processes, and systems for fleet and shore activities.

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This core equity specializes in research, development, design, testing, acquisition support, fleet guidance and training, and in-service engineering for signatures on ships and ship systems for all current and future Navy ships and seaborne vehicles and their component systems and assigned personnel.

Structures & Materials

This core equity provides the Navy with specialized facilities and expertise for the full spectrum of research, development, design, testing, acquisition support, and in-service engineering in the area of materials and structures.

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