

Undersea Warfare Command in the 21st Century

UNDERSEA WARFARE DIVISION



WARFIGHTER PERFORMANCE

A MESSAGE FROM THE NAVAL UNDERSEA WARFARE CENTER



RDML THOMAS WEARS,
USN, COMNUWC



DONALD MCCORMACK,
SES, TECHNICAL DIRECTOR, NUWC

Mastery of the undersea domain and achieving undersea superiority feature prominently in the fundamental objectives discussed in the July 2011 Submarine Force *Design for Undersea Warfare*. VADM Richardson has underscored how "dedicated, technically skilled and engaged warriors" are an enduring attribute vital to the success of our undersea forces. These warriors live and work in a highly complex world, where safety, stealth, mission, threats and the unexpected all demand that unprecedented levels of information and associated risks are assimilated and acted upon. Over the years, Undersea Warfare Community technology providers have delivered to the Fleet platforms, systems or subsystems that contribute to more effective warfighting. We've been proud of the many capabilities we have produced, and continue to seek innovative means to deliver more effective and efficient capabilities in the future. This year NDIA, at NUWC's request, added the new Warfighter Performance Focus Area, which gives us an opportunity to address the human dimension of warfighting. With the drumbeat of budget cuts ever louder in the background it is our responsibility to look at how we can help the Fleet more effectively accomplish its missions within anticipated resource constraints. Warfighter performance is an area that transcends the doctrine, organization, training, materiel, leadership, personnel, and facilities (DOTMLPF) domains. As part of this larger picture, we need to understand how we can influence the outcomes necessary to achieve VADM Richardson's objectives for undersea warriors. Although it is a challenging and complicated issue, we must cultivate capabilities that enhance Fleet warriors' proficiency and ability to execute their missions in both wartime and peacetime.

"...in the July 2011 Submarine Force Design for Undersea Warfare, VADM Richardson has underscored how 'dedicated, technically skilled and engaged warriors' are an enduring attribute vital to the success of our undersea forces."

Before we consider too many of the potential solutions in earnest we should strive for common understanding of the various human and operational elements that have an impact on warfighter performance. This is in itself a challenge, because there is currently no standard definition of what constitutes warfighter performance. Some might argue that it is based primarily in how warfighters interact with systems, while others may feel it comprises everything from being healthy and alert to exercising tactical proficiency in combat. But everybody would probably agree that it involves significantly more complexity than it did just a few decades ago. This complexity is inherent in the way multiple platforms or forces are integrated in joint warfare, for sure, but it is also readily apparent in lower levels—units

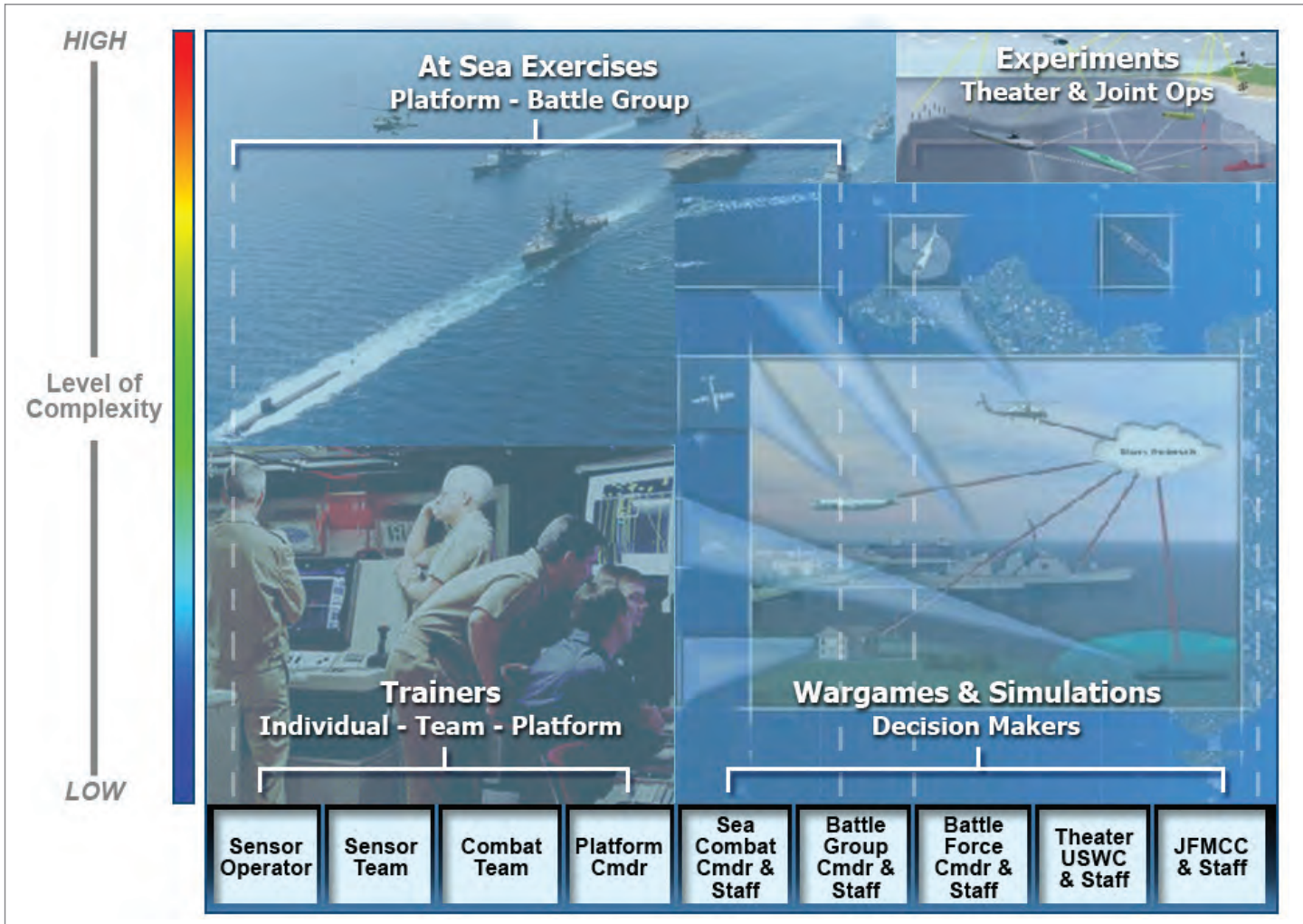
Warfighter Performance continued on page 2

INSIDE THIS ISSUE

<i>Division Chair's Message</i>	4
<i>Spring 2011 NDIA UWD Awards</i>	4
<i>USW Warfighter Performance Focus Group</i>	6
<i>Command, Control, Communications and Combat Systems Committee</i>	7
<i>Vehicles Committee</i>	8
<i>Mine Warfare Committee</i>	9
<i>Aviation Committee</i>	11
<i>Sensor Systems Committee</i>	14
<i>NDIA Top Issues for 2012</i>	15
<i>Fall 2011 UWD Conference</i>	20

WARFIGHTER PERFORMANCE

continued from page 1



(submarines, ships, or aircraft), where operators and maintainers of systems must be coordinated at many levels of command. The figure above illustrates the interrelationships between various command echelons and the increasingly complex levels of peacetime training and experimentation. Just navigating a submarine safely takes a considerable amount of coordination, awareness, and vigilance by the crew. Add a potential threat and vast amounts of sensor data are introduced into the situation, taxing the crew's ability to maintain situational awareness. Throw in a secondary mission and it gets even harder to sustain the unity of effort, awareness, stealth, and safety. Yet we depend on the warfighters' abilities to shift gears from peacetime routines to potential hostilities in a matter of minutes. From the least experienced Sailors on board to the Commanding Officer, we expect that every member of the crew will rise to the level of performance needed. But how and where do we invest to help ensure that happens?

Once we agree on the definition of warfighter performance it may be somewhat easier to calculate potential returns on investment, but even then it would be no simple task. Deter-

mining which metrics should apply at the various levels of the warfighting complexity hierarchy is in itself difficult. We are fairly comfortable with the notion of measuring system performance but we now must take into consideration how the systems being introduced might impact warfighter performance as well as the converse—how to account for the centrality of the human in the system. We must better understand these interrelationships in the context of the desired outcomes across DOTMLFP, bearing in mind that the "M" we tend to focus upon is just one part of the potential solution set. An important facet of this issue is the technical competence of the user; how do we design systems that accommodate the highly trained operator who can handle multiple layers of detailed information along with the less experienced user? How do we measure their degree of competence? As we peel this onion we will find additional layers of questions whose answers will have bearing on investment decisions. For example, how do we field robust systems that can safely streamline the steps needed to execute a given tactical action? Which tasks are best suited for more intuitive interfaces and machine support—and how do we measure how tasks compare on some intuitive scale? Today in the Submarine Force training

WARFIGHTER PERFORMANCE

continued from page 2

occupies almost one-third of a crew's time; what technology or other investments, like adaptive training, would enhance training efficiency and return on investment so that crews benefit more from that time? These and many other questions will need examination across the Undersea Warfare Community DOT-MLPF spectrum before we can make an informed, comprehensive case for investment. Competition for shrinking Navy, other service and DoD resources will be fierce and we must have compelling arguments.

There is good news in that our young Sailors and Officers joining the Fleet are far more receptive to (and are indeed demanding) new information technologies. The generation that has grown up with smart phones, iPads, YouTube, and high-resolution virtual gaming is primed for faster, smarter, and better ways to access the information they require. They already possess some of the knowledge, skills, and abilities that will be necessary to fight their submarine (or ship or aircraft) effectively in an increasingly complex environment. If we can provide technologies, for example, that help automate tactics, techniques, and procedures that warfighters use we could make them even more effective. But we need to approach this in an integrated way so that the technologies we offer will break down existing system stovepipes and not create new ones. We should be looking at graphics interfaces that have a common "look and feel" so that operators can more easily move from one system to another. We need to work on making information dissemination and flow seamless from one level of complexity to the next so that the correct data arrives intact when it is relayed from system operator to the Maritime Component Commander. We should open the aperture to look at all of DOTMLPF and study how such technologies might be beneficial for various support entities ashore, such as staffs, training commands, and logistics organizations. The point is that warfighter performance should be considered as a continuum that requires a holistic approach. We can't attack this need piecemeal by cobbling together disparate, stove-piped systems. Again, in an age of constrained resources, we must make informed investment decisions and coherently deliver the needed capabilities to the Fleet.

Although we have much work ahead of us, we are not starting with a blank canvas. Many worthwhile efforts to address this need have been underway throughout the Undersea Warfare Community. For example, ONR 342 conducted several workshops to address some of the warfighter challenges and participants produced a series of concepts for addressing equipment arrangements, performance-based adaptive training, developing mission and operator performance measures, and mission planning aids. By pulling in scientists, engineers, acquisition experts and current or former warfighters, this process enabled convergence on a number of ideas for potential solutions. PEO IWS 5, through the Advanced Processing Build (APB) program, is aggressively addressing the issues and challenges put forth in the APB-13 Submarine Tactical Requirements Group (STRG)

letter. The issues include system complexity, training burdens, and reliability. APB is actively engaging the commercial sector to leverage their advances in Human System Integration (HSI) technologies and displays. Another effort, the USW Collaboration, Analysis and Fleet Experimentation (CAFE), examines multiple aspects of warfighter performance related to combat systems. One of its most striking features is the collaboration of a group of small businesses in examining new technologies for the BYG-1 Submarine Combat System. NUWC is also working with the National Maritime Intelligence Center, academe, and warfighters to develop "4K" visualization and data fusion capabilities that can help address warfighting capability gaps. Other initiatives underway include assessing operator impact on the Acoustic Rapid COTS Insertion (and vice versa); another study that examines what submarine Approach Officers see, do, and say to help determine how information can be managed to reduce workload; and various efforts to assess and optimize command center and equipment layouts as well as information pathways. At NUWC we have also invested considerable energy into exploring how virtual worlds like Second Life can be used, both for technology development and for providing new tools for warfighters. These are but a few of the many initiatives underway and we expect there will be many more. Many others in the community are making significant progress, and we need to understand and assess their contributions so that we can provide Navy leadership with potential solutions.

The NDIA Fall Joint Undersea Warfare Conference once again offers a superb forum for discussing the many challenges the Undersea Warfare Community encounters. With this year's topic we have an opportunity to exchange ideas on how to help the most valuable asset in the Fleet: its people. We should be asking ourselves many questions about warfighter performance and how it is linked to the desired outcomes at all mission levels, across DOTMLPF domains, so that we can quickly develop systems of systems that provide information and capabilities that matter to the warfighter. Attendees at this year's conference may hear the phrase "cognitive economy", which some of our colleagues in industry describe as the balance that a submarine crew will try to achieve in handling a hierarchy of competing requirements. As we develop new undersea technologies to address this balance, we must be mindful of VADM Richardson's observation in his July 2011 *Undersea Warfighting*, "The need for coordination among undersea systems will be increasingly important." In that same monograph he exhorts undersea warriors to practice aggressive tenacity and tactical innovation. It is our duty to continue our long history of collaboration to provide those warriors with the technological toolset and resultant cognitive economy they need to do just that.

DIVISION CHAIR'S MESSAGE

RICK UDICIOUS, UNDERSEA WARFARE DIVISION CHAIRMAN



Since our Spring 2011 newsletter and conference, COMSUBFOR issued two key documents which reinforce the priority and sense of urgency for our mission. **Design for Undersea Warfare** provides high level guidance to align subordinate commanders as we enter the future – consider it the commander's call for action.

Undersea Warfighting provides a shared professional foundation and

perspective for our undersea warriors and stakeholders. These publications can be found at: <http://www.public.navy.mil/subfor/hq/> and <http://www.public.navy.mil/subfor/hq/>.

As we set to planning for this year's fall conference, feedback from our members and constituents has been used by the committee to frame a relevant and valuable agenda. Those of you

“COMSUBFOR issued two key documents which reinforce the priority and sense of urgency for our mission.”

who attended the spring conference probably noticed some differences from years past – the changes were made in the spirit of responsiveness. Please continue with your timely and quality survey responses. We are reading and taking for action!

On behalf of the division, I welcome and thank all our speakers. This conference has and will continue as a premier venue to gain

insight and share perspectives, evidenced by our sustained attendance by about a thousand members and guests.

Congratulations to our awardees recognized at this conference. You have been selected from a competitive slate of nominees across a wide variety of organizations. A common theme you share is that of an esteemed peer group of technologists and leaders whose achievements have furthered the nation's security in an increasingly uncertain world. And “welcome” to our graduate scholarship recipients. We hope you will begin and sustain your careers toward carrying forward the torch of excellence in the field.

This is the time of year when we post key issues to the NDIA leadership to consider in the context of the overall national industrial base. As in the past, we will share our division inputs on the website and then update you at the spring conference. This is also the year for our biennial report which will address the state of the undersea warfare industrial base to our government and uniformed leaders.

Looking beyond the current year, we are seeking volunteers across our technical committees and to refresh our board as members move on. If you would like to raise your hand, please send me a note, whether for yourself or a nominee who you know is ready to serve.

I hope you find the conference both educational as well as enjoyable. I look forward to talking with many of you and getting your feedback on the conference and the state of the undersea warfare industry during our time at the upcoming Fall Conference in Groton.

SPRING 2011 NDIA UNDERSEA WARFARE AWARDS

BOB KITTREDGE, AWARDS CHAIRMAN



The National Defense Industrial Association (NDIA) Undersea Warfare Division (UWD) was pleased to present four of its most prestigious Awards during the Plenary Session of the 2011 Spring USW Conference in San Diego, CA, on 29 March 2011.



DR. GERARD M. EXLEY, NAVAL UNDERSEA WARFARE CENTER, NEWPORT DIVISION:

The Vice Admiral Charles B. Martell-David Bushnell Award for exceptional contributions in the field of Anti-Submarine Warfare and/or Undersea Warfare technology was presented to **Dr. Gerard M. Exley, Naval Undersea Warfare Center, Newport Division**, for his personal contributions and commitment in the area of Undersea Warfare.

Dr. Exley's Office of Naval Research (ONR) efforts included development of communications protocols for submarine participation in task force networks and development and demonstration of an open architecture radio room design that is now installed on almost all SSNs. Dr. Exley led a team that developed an augmentation to the Automated Digital Network System (ADNS) on submarines thereby spearheading the submarine's transition into internet protocol networking essential for battle force communications connectivity. As a result of his subsequent submarine communication modernization efforts, the ADNS system was augmented with a UHF Asymmetric Communication System that resulted in substantial increases in submarine communications

Spring 2011 NDIA UWD Awards continued on page 5

SPRING 2011 NDIA UNDERSEA WARFARE AWARDS

continued from page 4

data rate. Dr. Exley has chaired a number of submarine platform communications end-to-end assessment teams composed of government and industry experts to identify sea based and shore based shortfalls and provide solutions. The results based on the methodology and processes he developed resulted in complete technical and programmatic assessments that formed the basis for the prioritization of submarine communications program objectives and related Navy budget development. Dr. Exley's contributions to the submarine communications modernization effort have gained him national recognition as a premier authority in this area. His numerous technological breakthroughs have played a pivotal role in guiding the U.S. Submarine Force into the 21st century.



MR. GEORGE W. POLLITT, APPLIED PHYSICS LABORATORY, JOHNS HOPKINS UNIVERSITY:

The **Vice Admiral Charles E. Weakly Award** for meritorious service and/or noteworthy contributions to effective Government/Industry communications in the field of Undersea Warfare was presented to **Mr. George W. Pollitt, Applied Physics Laboratory, Johns**

Hopkins University. Throughout his career Mr. Pollitt has been an advocate and contributor to Mine Warfare. He has managed and participated in numerous Mine Warfare related studies during his career and is a tireless volunteer that the Mine Warfare Community can always depend on for help with critical issues. Mr. Pollitt created his well known Mine Warfare Government/Industry communications distribution network as an outgrowth of a project to analyze the Ship to Objective Maneuver (STOM) paradigm in early 1998. As a result of this project he independently formed an Advisory Group of about 15 individuals from Navy, Marine Corps, Army and various Civilian organizations, such as the Naval Studies Board, to review MIW work and to advise on the potential operability of planned systems. As word of this distribution network grew, more members of the Mine Warfare Community were added, resulting in a distribution network that now includes all Mine Warfare Community members and as such has become "The" forum for the Mine Warfare Community. Its open nature enables all to participate and share opinions and information with the Community and, in doing so, provides a positive basis for the improvement of Mine Warfare. A former COMMINEWARCOM recently commented: "His pro bono work providing situational awareness of Mine Warfare issues to the entire government and industry mine warfare team is truly impressive." He has been a true champion of disseminating Mine Warfare information throughout the Military/Industrial community.



MR. JUERGEN G. KEIL, RITE-SOLUTIONS:

The **Captain George W. Ringenberg Award** is presented to recognize those who, through their service and leadership to the Undersea Warfare Division, have made noteworthy contributions to the organization. This year the Award was presented to **Mr. Juergen G. Keil, Rite-Solutions.** During more than a 40 year

career in undersea warfare in government and industry, Mr. Keil has served the NDIA in multiple roles. In addition to his current membership on the Executive Board of the Undersea Warfare Division he is now in his fifth year of service as Deputy Chairman for the Sensors Technical Committee and serves on the Awards Committee. His diligent service as Deputy Chairman for the Sensors Technical Committee has enabled the Committee to present exceptionally strong technical sessions over the last nine conferences. Eight of these sessions have been split sessions for which he has reviewed all technical paper submissions, helped to structure a solid agenda, and moderated half of the split sessions at each conference. His highly effective networking within the Undersea Warfare research community has also benefited the Awards Committee, reflected in the high standard of achievement for which we recognize our awardees at both our Fall and Spring Conferences.



LT SAMUEL P. MASON, USN:

The **Rear Admiral Jack Jarabak Award** for Technical Excellence in the area of Undersea Warfare by a student at the Naval Postgraduate School was presented, in absentia, to **LT Samuel P. Mason, USN,** for his personal dedication and commitment in the area of Undersea Warfare Technol-

ogy. LT Mason distinguished himself while attending the Naval Postgraduate School from March 2008 to March 2010 in the difficult and highly technical Undersea Warfare curriculum.

His thesis, entitled, "Atmospheric Effects on Radio Frequency (RF) Wave Propagation in a Humid, Near-Surface Environment," provided an innovative method of varying antenna height in taking measurements to support ground wave and near-earth RF propagation. His thesis could represent a significant new means of making riverine RF propagation loss measurements and is expected to serve as the basis for the design and evaluation of systems to detect and neutralize riverine mines and explosive devices.

The NDIA UWD is honored to recognize these significant contributors to the Undersea Warfare community through our awards program. Congratulations to the Awardees.

USW WARFIGHTER PERFORMANCE FOCUS GROUP

JOE NATALE, FOCUS GROUP CHAIRMAN
GARY STREIMER, NUWC DIVISION NEWPORT, NAVY LIAISON



Guidance from the Chief of Naval Operations (CNO) outlined in his ASW Readiness memorandum dated 8 December 2009 suggests a growing emphasis on warfighter performance. Previously, papers on warfighter performance topics were included in the "best fit" Technical Committee. To gain insight into the latest requirements

and developments in USW Warfighter Performance, warfighter performance topics will be consolidated into a new Focus Group Technical Session at the 2011 Clambake. We are also investigating the potential for a future Technical Committee in this area and will be evaluating the opportunity for organizations not normally associated with the USW division such as the Human Performance community to participate in our USW conferences.

A cornerstone of this warfighter performance focus group is that we will look at the warfighter across the full spectrum of USW platforms and communities. Our Navy liaison is NUWC Division Newport. However, to achieve this full spectrum view, we are seeking participation from Fleet, Government, academia and industry organizations.

This technical session will provide a focused venue for topics in Human Systems Integration (HSI), Operator Capability, Training, and Health and Wellness. Within the topics normally covered under existing Technical Committees we are presenting papers on technologies that:

- Improve data visualization techniques and enhance intuitive decision making,
- Improve the reliability of critical information,
- Assist operators in identifying relevant trends and patterns for decision making including, but not limited to, Reconstruction and Analysis, Modeling & Simulation and Concept Generation,

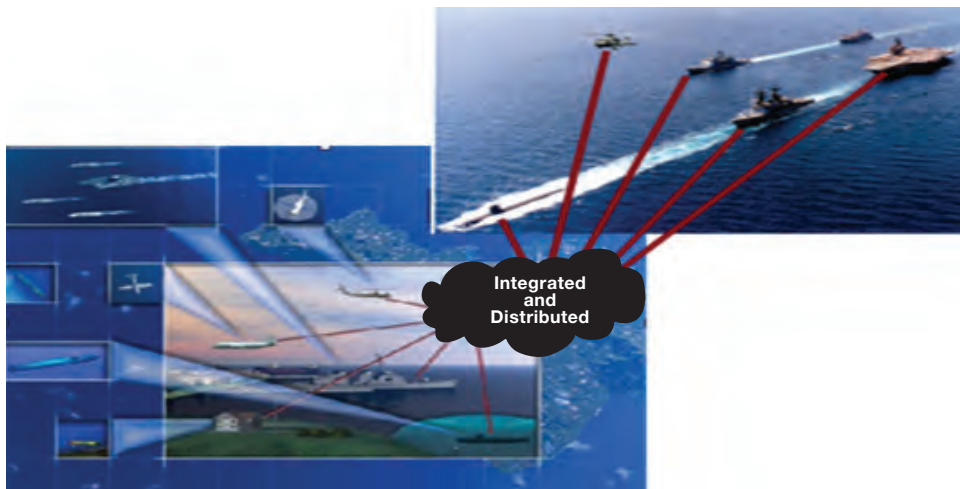
"Guidance from the Chief of Naval Operations (CNO) outlined in his ASW Readiness memorandum dated 8 December 2009 suggests a growing emphasis on Warfighter Performance."

- Improve information and knowledge management for dynamic environments supporting Tactics, Training, and Procedures (TTP),
- Establish linkages between theory, experiments, and training system design, and
- Integrate Modeling & Simulation to increase realism as well as cost efficiency of training.

A new area to the conference is Health and Wellness. In this area we will be presenting papers on technologies that:

- Reduce or counter the negative effects of fatigue, stress, illness, etc., and
- Improve the on-board environment with respect to atmosphere, nutrition, exercise, noise exposure, etc.

Warfighter performance is not a new area of interest for the Navy or the NDIA Undersea Warfare Division (UWD). However, by recognizing it as a focus area, the intent is to facilitate a higher level of industry participation in identifying and providing solutions that contribute to improvements in warfighter performance. We look forward to your participation in this group and to your feedback on its contribution to the USW conference.



UNDERSEA COMMAND, CONTROL, COMMUNICATIONS AND COMBAT SYSTEMS COMMITTEE

PAUL ROSBOLT, CHAIRMAN
DR. BOB ZARNICH, DEPUTY CHAIRMAN
CAPT DEAN NILSEN, USN (PEO IWS 5), NAVY LIAISON



Greetings All! Those of you who were able to make it out to San Diego for the Spring conference know that we had a great session. With strong support from PEO C4I and SPAWAR, we held our first ever C4I breakout session. We had many more good abstract submissions than we could use, and the approach worked so well that the C4I breakout will be a permanent part of our agenda for the Spring conference. Thanks again to RDML Burroughs and to CAPT San Pedro for their help.

In the news—the Submarine Force has published its ***Design for Undersea Warfare***. This should be required reading for us all, as it defines the way ahead for our submarine force, including technology focus areas. In

trying to be responsive to that vision, we have a new breakout session on "Warfighter Performance", which will be headed by CAPT Joe Natale, USN (ret). Joe is uniquely qualified to chair this inaugural session, as he was Commander, Surface Warfare Development Group (SWDG) in his last tour on active duty.

In our CS/C4I session, we have a great lineup, including Captains Nilsen (IWS 5), Hahn (PMS 425) and San Pedro (PMW 770).

I would like to welcome our new Navy Liaison, CAPT Dean Nilsen. CAPT Nilsen is the new IWS 5, having relieved Charles Davis this summer. Welcome, Captain, and thanks for agreeing to serve! Now, a word from our new Navy Liaison.

CAPT DEAN NILSEN, USN

This is my first contribution to the NDIA Newsletter since taking the helm of PEO IWS 5.0, Undersea Systems. As a quick background, I served on four submarines — two Los Angeles Class and two Ohio Class — culminating in command of USS Tennessee Gold prior to shifting to the Acquisition Corps. For the past few years I have been working on Unmanned Maritime Systems within PEO LMW.

As you know, our IWS 5.0 mission is to coordinate the development and fielding of Anti-Submarine Warfare (ASW) combat systems and components for Submarines and Surface Ships. We are also involved in developing an ASW Common Tactical Picture (CTP), necessary to support ASW superiority through a coordinated, networked force. Additionally, I would like to highlight a successful open business model which delivers new ASW capabilities to the Fleet in the form of the Advanced Capability Build (ACB)/Advanced Processing Build (APB) software upgrades.

Borrowing heavily from the Submarine Acquisition Community, the ACB business model for Surface Ships is very similar to the time-tested APB Submarine business model. It is a proven, cost-effective build-test-build ARCI model. Affordability and Cost Growth controls are achievable targets. Industry partners will be happy to note real competition is promoted and multiple contract awards are part of the "best of breed" solution set. Without a doubt, ACB/APB is a good fit for the business we're in and the Fleet stakeholders we serve.

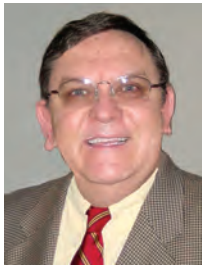
*"... the Submarine Force has published its **Design for Undersea Warfare**. This should be required reading for us all, as it defines the way ahead for our submarine force, including technology focus areas."*

We are in exciting times regarding ASW technology and capabilities. The AN/SQQ-89A(V)15 Sonar Suite benefits from the ACB process delivering greatly expanded sensor performance using open architecture (OA) COTS processing. Updated sensors, advanced signal processing, and sensor performance modeling ensure state-of-the-art ASW prosecution. Our ASW operators are soon to be introduced to Surface ASW Synthetic Trainer (SAST) as a means to improve proficiency. They will be able to experience ship and shore-based training which present authentic training challenges and realistic unit level participation in networked training events. How will ASW suites look and feel to future operators? There are some neat ideas in play from common displays to shared workstations with commercial-style (iPod-like) OMI to potential co-development with APB/ACB/IUSS.

I look forward to a continued strong Navy/Industry partnership in providing ASW capability to the warfighter.

UNDERSEA VEHICLES COMMITTEE

RICH TALIPSKY, CHAIRMAN
 TOM RUZIC, DEPUTY CHAIRMAN
 JIM GRIFFIN, NUWC DIVISION NEWPORT, NAVY LIAISON



CNO NOTES THAT HIGH DENSITY POWER IS A UUV "GAME-CHANGER"

In talking about the value of Unmanned Undersea Vehicles (UUVs), Chief of Naval Operations (CNO) Gary Roughead noted during his remarks at the Association for Unmanned Vehicle Systems International (AUUSI), North America Conference in August 2011: "... you all were

there last year when I cast the net widely to continue the pursuit of high density power. That clearly is something that will be a game-changer for us and I encourage and thank those who have been part of bringing options to the Navy so that we can look at what the best way ahead is. And just in the short time that we have been advocating for increased power, we have seen times rise markedly and we need to continue to do that."

UUV ROADMAP DISCUSSIONS BY N2/N6 FOCUS ON A WIDE RANGE OF MISSIONS THAT WILL FORM THE BASIS OF THE NEXT REVISION OF THE UUV MASTER PLAN

The Navy is developing a new roadmap for UUVs. An update to the original master plan, first issued in 2000 and updated in 2004, is in the works. The CNO Office of Naval Intelligence, Surveillance and Reconnaissance (N2/N6) is working a UUV roadmap that is being discussed in classified circles due to the sensitive nature of mission details. The UUV roadmap is said to cover the entire spectrum of UUV operations including humanitarian and environmental missions as well as military operations.

ONR IS EVALUATING RESPONSES TO BROAD AGENCY ANNOUNCEMENTS FOR CRITICAL UUV ENABLING TECHNOLOGIES

Two UUV-related Broad Agency Announcements (BAAs) from the Office of Naval Research (ONR) are being used to evaluate Large Displacement (LD) UUV technologies. ONR is now reviewing proposals that seek developers that can provide critical technologies to enable UUVs to operate and survive in the littoral environment for over 70 days. The vision is for a pier-launched and recovered UUV with the capability to transit in the open ocean and conduct over-the-horizon missions in littoral waters. The two technology areas to be addressed are Autonomy and Endurance. The two-phased effort will first concentrate on hardware and software for missions of up to 30 days duration in benign environments with some operator assistance. The second phase will develop autonomy and software for mission durations of greater than 70 days without human interaction.

A second BAA focuses on energy section technology for a LDUUV. The goal is to develop and demonstrate power system technologies that will achieve specifications with a threshold of supporting a 46 day mission and an objective of supporting a 70 day mission. The BAA has three phases: (1) an up to 18 month period to meet the threshold metrics, (2) after review of the ability to meet threshold metrics, a 6-month option to finalize the design and initiate full-scale system procurement for the next phase with a plan to attain Technol-

"...you all were there last year when I cast the net widely to continue the pursuit of high density power. That clearly is something that will be a game-changer..."

– ADM Gary Roughead, USN, Chief of Naval Operations (CNO)

ogy Readiness Level (TRL) 6 with a Critical Design Review, and (3) up to 24 month period for developers who meet the threshold metrics to assess the ability to meet objective metrics by attaining TRL 6 in a land-based test that is fully integrated into the specified LDUUV hull.

CNO TASKS PMS 404 TO DEVELOP A MK 54 LIGHTWEIGHT TORPEDO ATT CAPABILITY

The Navy's Undersea Weapons Program Office (PMS 404) has been tasked by the CNO (OPNAV N86) to conduct an at-sea demonstration of the MK 54 Lightweight Torpedo as a candidate weapon system to provide an Anti-Torpedo Torpedo (ATT) capability to Cruisers and Destroyers via software modifications and a minor MK 54 hardware modification. The MK 54 production, operations, and support infrastructure are established. The AN/SQQ-89A(V)15 sonar, fire control, and Surface Vessel Torpedo Tubes may be leveraged to deliver ATT capability at relatively low cost.

This at-sea demonstration leverages the MK 54 ATT feasibility assessment conducted by OPNAV N81. To demonstrate feasibility, MK 54 ATT software modifications were completed and successfully demonstrated using high fidelity hardware-in-the-loop simulations. In preparation for at-sea testing, the Naval Undersea Warfare Center (NUWC) is making additional MK 54 ATT software modifications to improve its functionality. The at-sea demonstration is planned for 2012.

LIGHT WEIGHT TOW SELECTED FOR OSD DEFENSE ACQUISITION CHALLENGE

The Office of the Secretary of Defense Comparative Technology Office selected the Light Weight Tow (LWT) project for the FY11 Defense Acquisition Challenge (DAC). This project will demonstrate rapid technology transition of an innovative modular towed countermeasure that provides torpedo defense capability against threat torpedoes and is optimized for operations in areas not covered by existing systems. The LWT performance has been demonstrated to meet, if not exceed, current Fleet capability in a modular package, making it a viable solution for the Littoral Combat Ship (LCS). The LWT expands the operational envelope of the AN/SLQ-25 "Nixie" system, and enables the installation of a torpedo defense system on any vessel requiring the capability, as its operation requires minimal space, weight, and manning. The primary deliverables within the DAC

Undersea Vehicles Committee continued on page 9

UNDERSEA MINE WARFARE COMMITTEE

ERIC HOLMES, CHAIRMAN
JON WOOD, DEPUTY CHAIRMAN
DONNA CARSON-JELLEY (PMS 495), NAVY LIAISON



Several important changes have recently taken place that impact the Mine Warfare (MIW) community. This is clearly evident with the several organizational changes (such as transition to PEO LCS), a holding of the first ever Commander Fifth Fleet MIW symposium, a renewed emphasis on mining, and the focus on Home Land Defense (HLD) as it applies to harbor security.

MIW COMMUNITY ORGANIZATIONAL CHANGES

The Program Executive Office Littoral Mine Warfare (PEO LMW) was disestablished with the stand-up of Program Executive Office Littoral Combat Ships (PEO LCS) on 11 July 2011. This "zero sum" initiative and timely realignment is essential for improved program execution and delivery of LCS class ships to the Fleet. PEO LCS, under the leadership of RDML Jim Murdoch as the PEO and Ms. Anne Sandel as the Executive Director, brings into line the multiple program offices with MIW responsibilities under a single PEO and includes: LCS Ship Program Office (PMS 501), LCS Mission Module (PMS 420), Remote Mine Hunting Systems (PMS 403), Unmanned Systems (PMS 406), and the Mine Warfare Program Office (PMS 495).

The Naval Mine and Anti-Submarine Warfare Command (NMAWC) also realigned its internal structure by combining the Training (N7) and Assessment (N5) branches under one

N7 Training organization. NMAWC has also increased the scope and responsibility of its Communication Department (N6) for MIW related Command and Control issues. RDML Phillip G. Sawyer, Vice Commander (VCOM), detached from NMAWC and assumed command of Submarine Group SEVEN, with RDML (sel) Kenneth M. Perry reporting soon as the new VCOM.

Finally, Mine Countermeasures Squadron TWO located in San Diego, CA, was renamed Mine Countermeasures Squadron THREE on 1 August to better align with Commander Third Fleet.

MIW SYMPOSIUMS

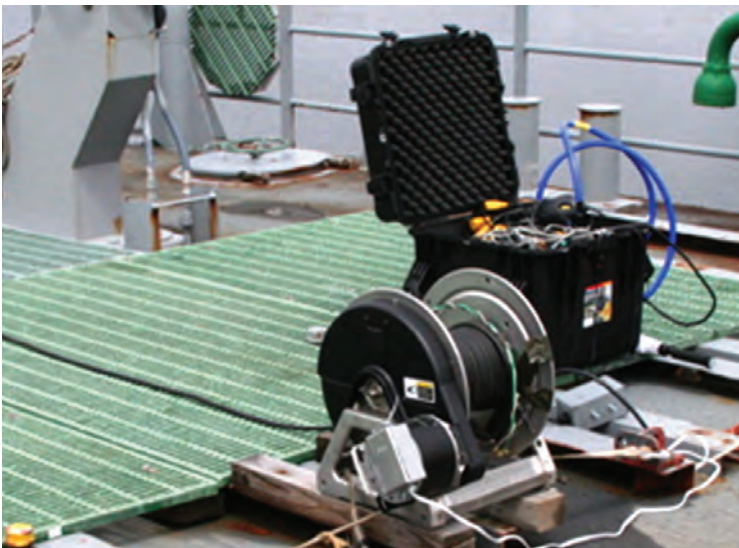
An NMAWC coordinated Commander FIFTH Fleet symposium was held in Bahrain from 18 to 20 September 2011. The purpose of the symposium was to gather senior government and military personnel to review C5F/Navy MIW capabilities and capacity gaps as well as assess potential near term solutions. Themes included: current and future system development; utilization of rapid technologies to solve expeditionary communication gaps; mine sweeping capabilities; unmanned underwater vehicles; and afloat forward staging base concepts.

Undersea Mine Warfare Committee continued on page 10

UNDERSEA VEHICLES COMMITTEE

continued from page 8

proposal will be two complete LWT Torpedo Defense System EDM-1 test assets/systems that have been ruggedized and demonstrated to be effective in the LCS low speed operational envelope through



LIGHT WEIGHT TOW ON TR-841 RANGE CRAFT

at-sea test and evaluation aboard a surrogate platform. Included with these units will be appropriate sparing of Lowest Replaceable Units (LRUs). A prototype system was developed and demonstrated at-sea by NUWC Division Newport using internal investment funding. The LWT is being considered as part of future LCS ASW Mission Packages.

AUV APPLICATIONS CENTER

The Autonomous Underwater Vehicle Applications Center (AUVAC) is an incubator formed by an association of academic, private sector, and government organizations to advance AUV system and subsystem technology and to promote AUV interoperability and availability in support of the international ocean community's needs. From the AUVAC website:

"The role of unmanned systems is evolving to the point where we are now surveying our country's harbors – both our inner harbors and just outside our harbors as well. So I think that when you look at expeditionary warfare and mine warfare, in that regard, that is where unmanned systems can play an extremely significant role."

Drop by the site at www.auvac.org to see what it has to offer. The USW Vehicles Technical Committee is exploring how the use of the AUVAC can help our community collaborate on UUV issues.

UNDERSEA MINE WARFARE COMMITTEE

continued from page 9

MIW FOCUS AREAS

Mining: Improvements in technology and potential tactical applications are changing the way naval mining is viewed. Mining can be employed offensively (in enemy territorial or controlled waters), defensively (in international waters to control sea lines of communication (SLOC)), or protectively (allied controlled waters), all of which allow naval forces to establish and control sea areas. In fact, the future Advanced Undersea Weapons System (AUWS) is envisioned to be used in any of the various operational phases of a campaign (planning, shape, deter, seize, dominate, and stabilize). Future concepts include controllable mobile mines, long range air delivered standoff options, and the use of a long duration large diameter littoral UUV to deliver various payloads.

“As industry is well aware, significant budget cuts are in the near future for the Department of Defense. The MIW community along with all other warfare areas will be pressed to deliver proven, operationally tested innovative technologies that reduce manpower and improve reliability at reasonable cost.”

Homeland Defense: The MIW force efforts in Homeland Defense are currently focused in three areas - policy, readiness and the future force. National policy in the Maritime Operational Threat Response Plan assigns the Department of Homeland Security the mission of preventing mining in the United States and the Department of Defense the mission of mine countermeasures. Given this division of the full spectrum of mine warfare, the Navy is working closely with the U.S. Coast Guard in various ports to ensure cooperation and collaboration on mine warfare issues. Additionally, the U.S. NORTHERN Command is currently conducting a Capabilities Based Assessment on Mine Countermeasures to better support planning by identifying risk, expected performance and mitigations.

To ensure current force readiness, NMAWC leads a field training exercise each year focused on homeland defense mine countermeasures. In recent years these exercises have been in Portsmouth, NH, Norfolk, VA, and Puget Sound, WA. The exercises provide important training for the CONUS MCM forces, particularly in the high clutter, confined waterways of ports and harbors.

As UUVs enter the fleet (MK 18 family of systems currently fielded) the critical role the UUV and improved sonar can play in speeding confined water searches is being realized. Today's challenge is to improve the sonar resolution or techniques to provide full identification and reduce the dependence of divers to confirm and identify minelike objects. Future abilities to detect explosives underwater would allow a reduction in the dependence on 'size and shape' for identification and move the force closer to one pass full detection and identification.

Open Architecture: The modular, open nature of the LCS class ship makes it unique within the Navy Fleet. The LCS mission module concept allows substantial flexibility in the types of activities that the LCS can conduct, as mission modules can be interchanged, with each mission module providing different capabilities. To sustain this approach, the PEO LCS is placing significant emphasis on Open Architecture (OA), including Rapid Technology Insertion (RTI) and an Open Business Model (OBM).

OA is defined as the confluence of business and technical practices yielding modular, interoperable systems that adhere to open standards with published interfaces. PEO LCS OA initiatives focus both on the technical portion of OA and the business portion of OA. The shift to OA lowers total ownership cost while increasing opportunities for innovation, facilitating RTI, and reducing maintenance constraints.

A series of OA Workshops is one of the ways that PEO LCS OA initiatives, often technical in nature, are being pushed forward. Unmanned System Common Control Standards and a Mine Warfare Software Repository are two examples of workshop topics. Within PEO LCS, the Open Architecture Level methodology has been developed to conduct subsystem and component level analysis within the system architecture, in order to look for opportunities for openness within the system, enabling third party development. There are four subcomponents to the OA Level evaluation – documentation, widespread use, ease of making a change, and ownership to support upgrades.

PEO LCS is currently developing a process for RTI, which is tied to an overall OBM. Current methods to get technology to the Fleet take too long to promptly address the dynamic threat that is faced. The RTI process will involve continuous coordination with stakeholders, shaping and leveraging S&T technology investments by ONR, DARPA and other organizations, while providing technical information to industry and S&T organizations to help them transition their products faster. Industry should expect future information and announcements in this area, as PEO LCS looks to provide industry with information about needs and technical details to facilitate speedy and successful transitions. This will likely include a PEO LCS BAA for rapid technology insertion opportunities.

Summary: As industry is well aware, significant budget cuts are in the near future for the Department of Defense. The MIW community along with all other warfare areas will be pressed to deliver proven, operationally tested innovative technologies that reduce manpower and improve reliability at reasonable cost. Decreased total ownership cost is a key driver while maintaining system suitability and effectiveness. The Navy recognizes that the mine threat is real and MIW, though difficult, is critical and not getting easier. This is evident in the recent Commander FIFTH Fleet symposium.

UNDERSEA WARFARE AVIATION COMMITTEE

GLEN SHARPE, CHAIRMAN
CAPT LUIS RAMIREZ, USN (PMA-264), NAVY LIAISON



While Naval Aviation continues to celebrate its Centennial, the airborne USW programs of record are continuing to thrive and move forward towards important milestones. Perhaps the biggest challenge to airborne USW programs will be the upcoming POM-13 budget deliberations to include the ongoing FY12 defense bill churn on Capitol Hill.

However, recent conversations with some of the OPNAV staff indicate that one of the top priorities for the Department continues to be ASW, counter mining and sea based strike. While most airborne USW programs are strongly supported by the Navy the fiscal realities of the pressure on the FY12 defense bills and the apparent "re-do" of POM-13 create a very unstable programming environment that could affect the helo master plan, P-3 sustainment, and P-8 procurement. That said the articles included below illustrate the significant success that a few of the major weapons systems and related support programs in airborne USW are enjoying.

UNDERWATER RANGE REFURBISHMENT COMPLETE

Naval Air Systems Command, Patuxent River, MD — The Navy completed the Barking Sands Underwater Range Expansion (BSURE) refurbishment, located off the coast of Kauai, Hawaii, in November. The Naval Aviation Training Systems Program Office (PMA-205), along with Naval Undersea Warfare Center Division Newport, RI, Lockheed Martin and L3 Maripro, completed the project.

“While Naval Aviation continues to celebrate its Centennial, the airborne USW programs of record are continuing to thrive and move forward towards important milestones.”

“The BSURE refurbishment enhances range capabilities by offering state-of-the-art acoustics and increased frequency bandwidth,” said CAPT John Feeney, PMA-205 program manager. He also said the range provides a safe and realistic environment for the warfighter to train.

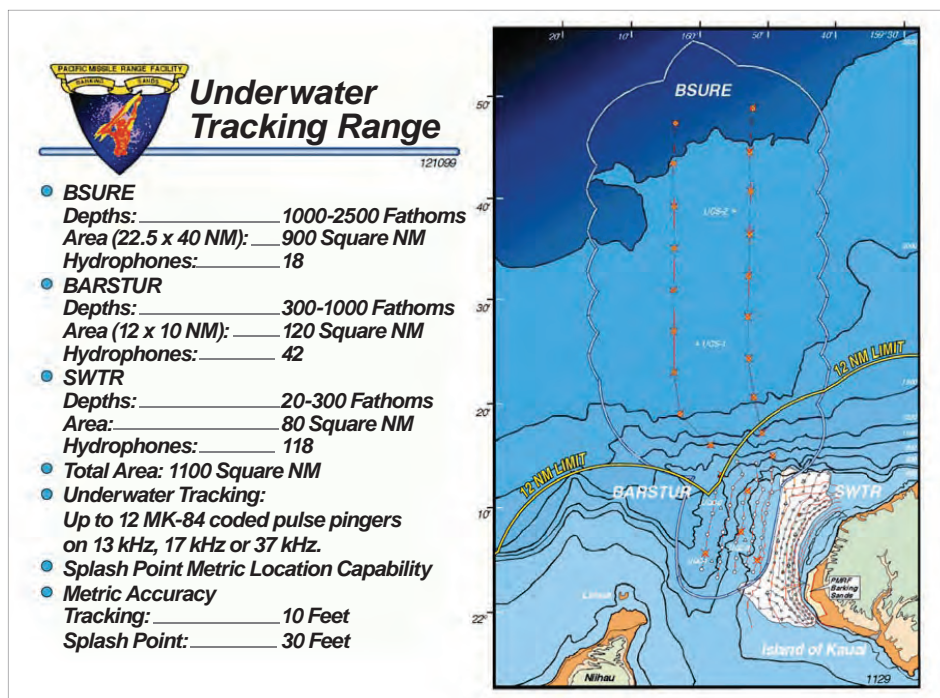
The BSURE facilitates training, tactics development, and test and evaluation for air, surface, and subsurface weapon systems in deep water. As part of the Pacific Missile Range Facility (PMRF), it provides a full spectrum of range support, including radar, underwater instrumentation, telemetry, electronic warfare, remote target command and control, communications, data display and processing, and target/weapon launching and recovery facilities.

Portions of the original system, installed more than 20 years ago, were degraded due to age and environmental effects. The refurbishment included new, advanced hardware and software instrumentation to both the in-water tracking and shore-based electronic systems.

The range is the deep water component of the PMRF. It provides underwater tracking and communications coverage throughout an area approximately 900 square nautical miles at water depths ranging from 6,000 to 15,000 feet. It is the largest portion of PMRF, comprising more than 80 percent of the total underwater tracking area.

The in-water tracking system consists of instrumentation dispersed throughout an area located between nine and 40 nautical miles from shore. When the acoustic sensors detect a sound, or “ping”, they send the information to shore via communication cables which are connected to a data processing facility. The shore-based electronic system translates the raw data (ranging between 15 hertz and 45 kilohertz), identifies the ping source, determines the source location and communicates back to those using the range.

The refurbishment replaced the existing in-water system with new acoustic sensors multiplexed on fiber optic cables. In addition, the team



Undersea Warfare Aviation Committee continued on page 12

UNDERSEA WARFARE AVIATION COMMITTEE

continued from page 11

replaced portions of the shore-based electronic system, integrated the new acoustic sensors with the existing underwater communication at PMRF, and provided new tracking software at the facility.

"The installation was unique in that horizontal directional drilling installation was used, providing a conduit for cables to pass from the in-water system to the data processing facility," said LCDR Charles Kubic, PMA-205 Ocean Systems Integrated Product Team lead. He also said the conduit shields the cables from surf zone damage, protects sea floor and coral reef habitats from harm due to cable trenching or drift, and reduces the need for future cable maintenance.

100 YEARS OF NAVAL AVIATION, 100 ROMEOs

On 8 May 1911, U.S. Naval Aviation was born when CAPT Washington Irving Chambers prepared contract specifications for the Navy's first aircraft. Two months later, that aircraft – the A-1 Triad – made its maiden flight from Keuka Lake in New York. If CAPT Chambers could see a Romeo, he'd be gobsmacked. With its digital cockpit, a multi-mode radar, acoustic sonar suite, long-range infrared camera and other advanced sensors, the MH-60R Romeo is a far cry from the Wright brothers-esque A-1 Triad.

Adding to the legacy of naval aviation at its 100th anniversary, the Navy took delivery of its 100th Romeo on 28 June during a ceremony at MS2's facility in Owego. In all, the Navy is expected to purchase 300 Romeos by 2018. Later that week an aircrew



from Helicopter Maritime Strike Squadron Seven Five (HSM-75) flew the 100th aircraft from the Owego facility to its new home at the Naval Base Coronado in San Diego, CA. The aircraft is the first MH-60R delivered to HSM-75.

During the delivery ceremony, RADM Paul Grosklags, Vice Commander, U.S. Navy Naval Air Systems Command, thanked MS2, partner Sikorsky Aircraft Corporation, and other key suppliers for their contributions to this important program. "In its primary mission roles of anti-submarine warfare and anti-surface warfare,

the Romeo continues to exceed our expectations and frankly no other platform out there is even close," said Grosklags. "And the Sikorsky and Lockheed Martin MH-60R/S partnership gives us the flexibility to use these aircraft to take on new mission roles successfully and affordably."

Earlier in June, during the Paris Air Show, the U.S. Navy formally announced Australia's selection of the Romeo to fulfill the Australian Defence Force's requirement for a fleet of 24 new-generation, multi-role naval combat aircraft. The Commonwealth will acquire the helicopters with associated training and logistical support via the U.S. Government's foreign military sales program. Australia is the first nation outside the United States to purchase the MH-60R. The MS2-Sikorsky team is now exploring opportunities in Denmark and Saudi Arabia.

As mission systems integrator for the Sikorsky-built MH-60R, MS2 provides the equipment and software to allow the aircraft to detect, identify, track and engage surface and subsurface targets. MS2 also integrates a self-defense system to protect the aircraft from missile threats.

The U.S. Navy deployed with 11 MH-60R aircraft for the first time from January to July 2009 with the John C. Stennis (CVN 74) carrier strike group. During exercises in the western Pacific, the MH-60R proved to be an exceptional sub hunter and surface warfare weapons platform, accomplishing a 95 percent sortie completion rate, and showing it can perform utility and search and rescue missions among other secondary missions.

THE PATUXENT SYSTEMS INTEGRATION LABORATORY

Naval Air Systems Command, Patuxent, MD – The Patuxent Systems Integration Laboratory (PaxSIL) has completed final installation and inspections, and is operating at full capacity. The lab is designed to save the Navy money while developing and testing the Maritime Patrol & Reconnaissance Aircraft



Undersea Warfare Aviation Committee continued on page 13

UNDERSEA WARFARE AVIATION COMMITTEE

continued from page 12

Program Office's (PMA-290) P-8A Poseidon. PMA-290 maintains the PaxSIL as a tool to support flight testing and mission system maturity. Specifically, the lab houses flight hardware to test the integration of systems on board the P-8A Poseidon.

"Using actual aircraft components located inside a building for integration testing has allowed the P-8A program to reduce the scope of the flight test effort and save fatigue life on the test aircraft," said Tony Schmidt, assistant program manager for Test and Evaluation.

Inside the lab, P-8A Integrated Test Team members will be able to rehearse test points, test net-ready capability, troubleshoot mission systems, and replay tactical missions. Additionally, the PaxSIL will aid in training future P-8A pilots and tacticians by offering them a way to realistically evaluate unique aircraft characteristics, such as the combined use of autopilot and the integrated systems, without ever leaving the ground. "The PaxSIL will provide considerable support to the current developmental test efforts, Initial Operational Test and Evaluation of the P-8A, and for future test and experimentation efforts," said Neal Rothback, P-8A deputy department head.

In the future, the PaxSIL will house a network of capabilities in support of the Maritime Patrol and Reconnaissance Force Family of Systems and provide the ability to connect to other Department of Defense facilities.

P-8 UPDATE

Final assembly of the second P-8A Poseidon production aircraft for the U.S. Navy, LRIP1-2, began recently in Renton, WA. This is the second of six low-rate initial production aircraft Boeing is building as part of a \$1.6 billion contract awarded in January.

P-8 manufacturing teams have begun installing systems, wires and other small parts to the fuselage. The P-8A's engines and wings will be installed later this fall. The Poseidon team uses a first-in-industry in-line production process and Boeing's existing Next-Generation 737 production system to efficiently design and build P-8 aircraft. The first P-8A production plane completed its maiden flight on 7 July 2011 and is now undergoing mission systems installation. The Boeing team continues to meet program milestones and is on schedule to deliver Initial Operating Capability to the warfighter in 2013. The Navy plans to purchase 117 of the P-8A maritime patrol aircraft to replace its P-3 fleet.

Additionally, the Boeing team recently completed final assembly of the first international version of the P-8, the P-8I maritime patrol aircraft, for India. The aircraft is the first of eight long-range maritime reconnaissance aircraft Boeing is building for India as part of a contract awarded in January 2009.

Once again, the Aviation USW technical session has an excellent mix of platform and sensors program status overviews along with both acoustic and non-acoustic sensor technology presentations. We look forward to your participation



UNDERSEA SENSOR SYSTEMS COMMITTEE

JOSE RIO, CHAIRMAN

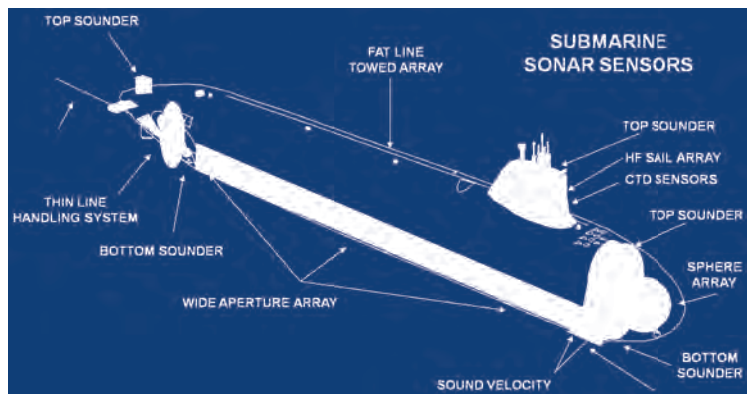
JUERGEN KEIL, DEPUTY CHAIRMAN

CAPT MICHAEL BYMAN, USN (PMS 401), NAVY LIAISON



Our objective is to build an affordable and sustainable fleet capability to effectively empower our forces. Our theme this fall, Undersea Warfare Command in the 21st Century, addresses issues attached to successful warfare command and the ultimate use of our advanced technology to achieve these objectives. Key elements include:

- First, the modernization business model used for submarine acoustic systems allows for the rapid insertion of new technologies and capabilities to address evolving missions and threats, as well as reducing decision making timelines given the number of contacts and the limitations placed on the ship in a littoral ocean environment.
- Second, the increasing need in the 21st century for submarines to operate in the littoral environment requires the development of submarine sensors that can be deployed in a complex operational environment. One of the key elements to support this objective is to show how essential submarine acoustic communication capabilities are being deployed.
- Third, planned updates will allow current and potential industry partners and key stakeholders to better understand the Advanced – Rapid COTS Insertion (A-RCI) business model and modernization process, the current state of submarine sensor development (towed and hull), and how these efforts will achieve Submarine Acoustic Systems Program Office objectives, thus ensuring the Navy's ability to respond to future threats.



Updates will be provided to give the status of the Advanced Processor Build (APB-11) and an overview of planned APB-13 will be supplied. This will be supplemented by Conformal Acoustic Velocity Sonar (CAVES) Large Vertical Array (LVA) at sea results.

On the surface side Anti-Submarine Warfare (ASW) will be adapted to tactically render threat submarines irrelevant against U.S. forces. To contain cost the premise is that the organic structure of the combat system already provides the means to achieve this goal with some restructuring. Modeling, simulation, analysis, and experimentation will be exploited to validate the adaptation needed to achieve these objectives, and to take maximum advantage of the infrastructure in place to guarantee success.

“Our theme this fall, Undersea Warfare Command in the 21st Century, addresses issues attached to successful warfare command and the ultimate use of our advanced technology to achieve these objectives.”

Following is a series of excerpts from our fall agenda to provide a summary of the ongoing work both by representatives of the industry, the Navy laboratories, and academia:

- Undersea dominance is a key objective and this can be reinforced through Maritime Surveillance Systems (MSS). An emphasis is placed on shallow water surveillance, risk reduction, and the leveraging of new technology. Efforts are underway to achieve UUV supported assured communications. Existing Surface ship technology is being extended by exploiting proven processes (i.e. Advanced Processor Build (APB) and Advanced Capability Build (ACB) methodologies) to reduce cost while maintaining functionality. Open system methodology is being applied to distributed underwater networks to achieve commonality and easy cost effective adaptation to unanticipated needs.
- Innovative approaches to our stock search approaches such as Continuous Active Sonar (CAS) offer unanticipated advantages for multi-static use. Clever techniques that glean ever more information through enhanced signal analysis such as using high frequency active returns to deduce the material that the target is made of are used to discriminate between mines and mine like objects.
- There are improvements to our inventory of platforms such as the transition of the SSN sphere to the Large Aperture Bow (LAB) array. Intercept ranging is considered from multiple perspectives including operation in a multi-contact environment in the presence of multi-path and high target dynamic Passive Detect, Classify, Localize, and Track (DCLT) is a promising focus area as is the use of recursive Bayesian inference and tracking distribution to obtain good Matched Field Processing (MFP) performance. There is a high performance periscope detection radar that promises a significant airborne cueing capability. Multiple sensor observation fusion is used to provide the OOD with an operationally cohesive picture for improved operational awareness.
- We also have presentations on portable range measuring systems to increase the agility of our fighting force and provide high fidelity in-situ training and measurement.

These are only some of the topics covered by our agenda. We expect to provide an excellent prospectus of activities in the Undersea Warfare community.

As in the past, I want to thank Juergen Keil for essentially organizing the agenda and providing excellent support. We acknowledge the support of our USW Sensors Liaison CAPT Michael Byman, USN, who supplied a portion of this newsletter. I also want to thank CAPT Bruce Roulstone, USN (ret), and Kim Williams for providing very significant support without which putting on the split sessions as has become the rule for USW Sensors would be impossible.

NDIA TOP ISSUES FOR 2012

Each year the NDIA's Undersea Warfare Division submits inputs to the NDIA Government Policy Advisory Division identifying our top issues impacting industry. The five top issues identified for 2012, discussed below in descending order of priority, have been derived from the following sources:

- Monthly issue papers posted on the NDIA website
- "State of the Undersea Warfare Industrial Base" report submitted to SECNAV
- Inputs from the Undersea Warfare division leadership team

ALIGNMENT OF INDUSTRY WITH DoD REQUIREMENTS, PRIORITIES, AND BUDGETS

We seem to be missing an alignment of industry capacity and investment with DoD program priorities and funds. Budget constraints and operations tempo demand that industry and DoD close the gap between what DoD needs, what industry can produce and when capabilities can be fielded. Gaps in shipbuilding, strategic priorities, undersea warfare and long-range strike are pressing concerns.

The budget has four pillars: taking care of people, rebalancing the force, reforming how the Defense Department does business and supporting our troops in the field. There is a real possibility that the budget won't be enough due to continuing pressure on operations, maintenance and personnel costs, ground forces' equipment recapitalization, and projected increases in military health care expenses. Further pressure will result from the affordability mandates to be implemented over the next five years.

The QDR recognizes the potential requirement to conduct multiple concurrent, large-scale operations in disparate theaters. But it breaks from this in adding the need to conduct a "wider" range of operations to include homeland defense, support to civil authorities, deterrence, current wars and "wars we may someday face." There is some uncertainty and wiggle room in this formulation.

There are significant on-going discussions on the need to re-focus Undersea Warfare. The increasing number of submarines and their increasing operational ranges highlight the threat to guaranteed access to areas of interest. Funding to counter this threat has not been in line with the implied priority. Similarly, there has been significant discussion on the need for unmanned platforms and improved mine warfare capabilities but the funding has not materialized. These confusing signals weaken the ability of industry to invest and lengthen the timeline for fielding capabilities. Denied access enforced through the deployment of submarines and mines is a real and ever increasing threat to the USN and world commerce and deserves the highest levels of DoD attention. The impact of the U.S. budget fiscal imbalance has worsened since last year. Industry response is to not invest in this area as the increased timeline required to field the complex capabilities will defer and dilute the return on investment and capital. Although there is emphasis on special operations capabilities, there is no significant force structure adjustment. One sees aging in Navy and Air Force platforms and the implicit surrender to decreasing force structure in both services.

The outgoing chairman of the Joint Chiefs of Staff described as "unsustainable" the current rate of defense spending.

"Money is not going to keep rolling in...It's just not going to happen. We're in a time of real economic challenge. The military's budget will be affected by these realities. It's unrealistic to expect this will continue." He stressed that one portion of the budget that will not be shortchanged is the "people" programs (personnel, health care, benefits, family support). Sixty to 70 percent of the Pentagon's budget is committed to those programs. This is an issue of concern, obviously, because people and weapons accounts all come out of the same pot, so something has to give. Yet at several major conferences, other four stars have been quoted as saying that people costs are killing them and other administration officials have raised issues and questions which depart substantially from the QDR.

One can draw some conclusions by looking back to the program decisions that came along with the 2011 budget. We saw big program terminations, and the implication that there will be fewer new starts of big programs. As has been stated repeatedly, the fiscal emphasis has shifted to near-term challenges. Consider also pressures on the defense budget from burgeoning health-care costs and the continuing bill for combat operations (logistics primarily) and the capital equipment recapitalization bill that accompanies intense combat operations.

Addressing these issues and challenges will require a different practice and discipline. For example, a two year budget would halve the review and approval time while doubling the program stability period. Congress could and still should review budgets for major programs at the various milestone points and for compliance with the legislation. The DoD budget should be inclusive of operations and therefore not expected to be adjusted by supplemental to balance the checkbook. Earmark reform should be immediate and consistent, the service chiefs and defense secretary should submit a comprehensive budget to meet the requirements established and agreed by the force commanders and national security leadership.

Communication of these requirements to industry as soon as possible would help industry shorten response times and focus investment. In some cases, access to critical classified information is impeded by availability of SIPRNET access. Enhanced dialogue on results of S&T research between government and industry could potentially quicken the transition of capability to fielded systems. Program review and approval at the initial phases should provide a need base and fiscal assessment prior to authorization in the context that future cancellation or termination are not budget and program management tools. Similarly, requirements and fiscal assessments should be equally rigorous prior to any discretionary cancellation or termination. Once a program is authorized

NDIA TOP ISSUES FOR 2012

continued from page 15

there should be sufficient funding committed in the budget for program execution and no ability to increase the requirements or the threshold levels. Additionally, any downward adjustments should be reviewed at the same decision level as was done when they were established. The operational test verification approach should also be established prior to contract award such that the test and acceptance requirements are clearly known by the government program office and contractors. Following delivery, industry exposure to at sea training and operator feedback will be critical to "squeezing" all the capability from our fielded systems. Our ability to conduct operationally significant training exercises at sea is critical to maintaining operational readiness.

SUSTAIN A COMPETITIVE DEFENSE INDUSTRIAL BASE

We have already seen impacts of the stated \$100B cost reduction over the next five years – diluted contractor incentives, potentially shrinking the already tight investment budgets in defense unique technologies, and in some cases reduce the competitive landscape. That contraction has continued to where we now have only one supplier for some major systems and numerous single sources (some overseas) for commodities. As competition is reduced, cost and quality suffer. This is almost axiomatic, but there is a real need, not only to maintain critical capabilities but to do so within the framework of a competitive environment. Maintaining competition when new starts are becoming fewer and further apart is becoming more difficult. But this, too, is fixable. One solution is to dual-source platforms and commodities. The response to this always seems to be that it costs too much. But many studies have documented that competition drives steeper learning curves and increases quality and responsiveness by contractors.

A question often encountered is what to do when systems go out of production. How to keep design teams busy is the number one issue. The challenge is to keep the teams employed between program starts.

One way is to have plans to implement follow-on programs to replace existing capability when it begins to wear out or technology mandates newer, more capable systems. What will the new fighter or submarine look like, and when do we begin the design process? Every system at some point goes away and needs replacement. An orderly planning and development process demands this planning always be ongoing.

Utilizing technology insertion strategies at logical program life cycle intervals is another viable technique to extend the life of major capital platforms. The Navy's open architecture program has shown great examples in this area. By leveraging commercial electronic technologies, costs are reduced and schedules shortened while the design teams are able to sustain a critical mass of domain knowledge throughout the life cycle.

Another technique is to sustain programs in production until follow-on initiatives get under way. This keeps both design and manufacturing engineers in the game as systems are refined, modified, and upgraded throughout their operational lifetime. It

also allows feedback to flow back to the designers for incorporation into current or follow-on designs.

Also of note is that, in the defense sector, if the government doesn't fund a particular system, industry will abandon the effort. Work force and resources will move on to other funded programs. The segment that is not funded will eventually wither and industry will lose that capability. One worrisome example is that for the first time in decades, the U.S. defense industry has no fighter plane design team in operation.

Industry capability has struggled to sustain the necessary resources to support the undersea warfare area; however it has not been investing in breakthrough technology.

Instead of a "step-function" increase in capability to open a wide margin against diesel submarines and modern mines, we have utilized spiral/incremental development programs to insert only that technology which will fit the budget constrained programs with the highest demand signal from the immediate threats. Much of the recent capability enhancement has been via the technology afforded from the telecommunication and computing industry. By using Open Architecture (OA) and Commercial-Off-The-Shelf (COTS) electronics, significant gains in signal and data processing have been achieved with only incremental investment. Although a major leverage at the national industry level, this business model has shifted the recurring production and sustainment of electronics from the defense industry to a generic industrial base which does not invest in national security domain expertise, sensors, or weapons. This has caused a migration of the industry away from some of the key enablers and into a modernization and sustainment role. Additionally, this trend has enabled the government agencies to encroach upon system engineering and integration work previously performed by industry. Spiral development became the antithesis of significant capability development. This incremental, often marginal improvement to legacy systems, does not address the challenges of the future.

The perception that we lack an imminent and credible peer Naval threat has caused resource sponsors and program managers to focus on sustainment and incremental capability insertion. This also impacts the intellectual talent pool available to address technology and application. Without visible priorities and investments, key talent is drawn to the higher profile, better resourced programs. The concept of "pacing the threat" now has us "chasing the threat" and therefore lagging an acquisition cycle behind fielded and observed adversary capabilities. Meanwhile the enemy and competitive international industries have been focused on developing technology at a pace ahead of our counter abilities.

This has been exacerbated by the consolidation of the industrial base and reduction in basic force structure, each dependent upon the other. Without significant government investment, industry's R&D follows the profile of sales and profit which decline with platform volume. In parallel, the government has organizationally shifted to capabilities based

NDIA TOP ISSUES FOR 2012

continued from page 16

resourcing making it more difficult for industry to find decision makers or stakeholders able to commit to the future. As a result of the business environment, industry is losing the capability to provide significant improvements, or in some cases, even to maintain competency on existing programs. Just this year the funding expired on the Navy's undersea distributed sensors program initiatives, leaving promising technologies on the shelf, instead of in the water.

In order to meet its requirements for leading-edge capabilities, the DoD must provide industry better access to requirements and also develop programs which include an adequate mix of work and funding to sustain a capable workforce and physical infrastructure. Industry has the capability to provide leading-edge technologies, system design and integration, and long-term support for systems. Available funding needs to be applied to maximize the delivery of products in a restricted budget environment through cost reductions including increasing the efficiency of the business process. Achieving this change will require a revitalized effort by government and industry.

We have heard pronouncements that the defense industry can surge to meet almost any need on an emergency basis. This ignores the reality of present day access to the special materials mentioned above as well as the complex nature of modern weapons systems and associated manufacturing processes.

Although there have been many studies of industrial matters, none has produced a comprehensive overview of defense manufacturing issues. Also, much of the reporting has been anecdotal, and no study has compiled a list of manufacturing and process vulnerabilities such as single-source suppliers. A cooperative study between government and industry needs to be done. The recently announced Sector-by-Sector, Tier-by-Tier, or "S2T2" project will develop a baseline of data across a wide swath of industry (including aircraft, shipbuilding, space, ground vehicles, missiles, missile defense, services, and information and communications technology). Sustained efforts will maintain and strengthen the data over time, and in the future, the database and methodology will serve as a starting point for the Department's wide variety of industrial assessments. The reservoir of knowledge will contribute to acquisition decisions, help ensure realistic program objectives and reduce program-ming swings that disrupt industrial base investment. It will also contribute to the Department's merger, acquisition, and divestiture reviews and other industrial base policies.

The industrial base requires active management. It can't be left on automatic pilot. And while cost is important, it can't be the overriding determinant in acquisition policy. The nation would be ill served, indeed, in a future crisis by a crippled industrial base that lacked the requisite skills base and capital standing to respond with alacrity to the demands that are placed upon it.

ENSURE THE INTEGRITY OF DEFENSE ACQUISITION

After hundreds of reform studies and thousands of articles, we still haven't put many of those good suggestions into practice. The current performance of major defense acquisition programs

would indicate we haven't hit the proper groove yet. Earlier studies go into detail about requirements discipline, accurate cost estimating, properly resourced and timely test plans, earned value management practices, use of management reserves, systems engineering practices, and on and on. All of these observations and recommendations are on the money, but they only constitute the tool set that provides a good foundation for acquisition excellence. The question is what high-level verities characterize an acquisition organization that uses these tools to best advantage. In a Harvard Business Review article titled, "Delusions of Success," the authors say, "In planning major initiatives, executives routinely exaggerate the benefits and discount the costs, setting themselves up for failure." This problem can be addressed by two factors: Highly experienced professional acquisition personnel and a disciplined approach to requirements.

The system requires trained acquisition professionals to lead military program offices — most importantly, the service acquisition executives. It seems counterintuitive that a key acquisition position would be filled by someone who is not an expert. Yet we all know it happens far more frequently than one cares to admit. On many occasions, waivers are provided to individuals who lack the requisite education or experience to hold a key acquisition position. The problem is that we haven't institutionally treated acquisition as a profession. Managed properly, we would educate and train just as other professions. Examine any successful, large program from the past, and you will find highly experienced acquisition professionals at the helm. Look at current program failures and you will likely find acquisition leaders who don't measure up to the professional proficiency of their predecessors. Acquisition professionals don't come cheap or easy. It takes several years of schooling and training on the job. It has taken us many years to walk away from acquisition excellence, and it will take us some time to get back to it. Hiring twenty to thirty thousand government employees over a short period of time may—staff the bench with players who are not fully ready to tackle the tough job of supplying a force at war from a shrinking investment base.

The acquisition professional needs to articulate the exact impact of the operators' requirements in terms of cost, schedule and performance. The referee for this process needs to be the chief of the service. Additionally, industry should participate in the process with adequate legal and ethics guidelines and processes to prevent any bias in future competitive acquisitions. Some recent interpretations of the administration's revised policies on integrity, ethics, and conflicts of interest have created artificial barriers which impede collaboration between government and industry. The notion of closing the doors to discussion with any and all contractors when a program office first thinks they will have a competition is counter-productive to having a good competition and being good stewards of the taxpayers' dollars. The FAR states that all competitors are to be supplied with the same information, it does not say supply them all with no information, so put everything up on a website and let those who want to access what is available from the

NDIA TOP ISSUES FOR 2012

continued from page 17

beginning. Many bad competitions are the result of closing the doors far too early, providing little or no information on what the government wants other than at Industry Day and in the formal solicitation. There are increasingly more competitions where there is no industry day, no draft RFP, and the technical specification is issued with the RFP giving the contractor only sixty days to design, estimate the cost and schedule, and write a proposal. This could lead to hundreds of unanswered questions upon which the contractor will make bid assumptions, and the government may spend valuable contract funds closing the gap while potentially slipping the schedule in the design phase of the program.

Some of the DoD guidance in the recent challenge to "Do More Without More" suggests that more competition and increased small business participation will lead to more affordable solutions. Developing the requisite data and bid packages for such acquisitions will require that we draw upon the knowledge base and system experience of the existing industrial base. The past few years of experience has seen major acquisitions face delays due to the workload of preparing solicitations which can withstand the test of a post award protest. NDIA can play a key role in establishing the new norms for a revised approach to acquisition and be a trusted partner to sustaining industry capability while maintaining a competitive landscape.

When developing acquisition plans, key issues should be addressed up-front to determine the cost and value of competitive procurements:

- What is the time and expense to prepare the RFP, review by contracts and legal etc?
- What overhead expense will the government indirectly absorb from contractors who develop extensive proposals, and in many cases demonstration assets?
- Has the cost and time for the evaluation of the proposals, the questions, reviews, orals, etc been included in the budget and timeline?
- What is the likelihood and cost of a potential protest?
- Does the risk profile of the program allow sufficient time for an inexperienced company to perform at an unreasonably low bid price?
- What are the potential industrial base outcomes, e.g., will the competitors remain competitive after a major program is awarded?

To survive and succeed, we need a partnering approach to focus requirements, budgeting, research, development, and acquisition. NDIA could play a wider role to facilitate and coordinate industry input to form an enhanced, broadened Government/Industry collaboration toward a common goal. NDIA stands ready to enable partnerships which will sustain competition and fit within the government ethics and conflict of interest policies. Some of the recent legal interpretations of NDIA's role in assessments and studies have challenged our ability to collaborate toward a common objective; these poli-

cies must be quickly and timely reconciled in order to address the overall issue of a healthy and responsive industrial base. The Navy's PEO Integrated Warfare Systems has engaged NDIA to facilitate a conference in December 2011 which will address many and any acquisition issues, a process which will serve to engage a proactive dialogue toward a common mission.

MAINTAIN BALANCE – LARGE, SMALL, PUBLIC, PRIVATE, GOVERNMENT, ACADEMIA

A key concern is the in-house performance of R&D programs by government labs. In this environment, industry is less likely to invest, competition in price and capability trade space is less potent and the ability to "easily" transition capability to fielded systems is more complicated. During the R&D phase of programs, it is important that the labs and other organizations under the working capital fund don't "compete" with industry and also that the oversight agencies review and eliminate redundant efforts across the labs.

It is equally important that in-sourcing not have detrimental effects on the industrial base. The government should ensure that the justifications for in-sourcing are fair and do not unreasonably punish the private sector. One needs to keep in mind that the ultimate goal here is to increase efficiency in federal programs and to make the government a smart buyer. In-sourcing decisions should also include a total cost analysis to ensure that the long term outcome is the best value, just as the out-sourcing decisions and corporate make-buy alternatives are weighed. In-sourcing decisions may have a lasting effect on the competitiveness of future choices.

Also worrisome, is the movement of government depots to bring in-house the workload that currently is performed by industry. The depots argue that under the rule that calls for a 50-50 split of the workload they need more work to keep their percentage up. As the services begin to retire equipment faster than it is being replaced, the result is less depot work. But industry is squeezed as well, since fewer platforms are being procured and industry volume begins to recede at the same time that depot work begins to dry up. Both sides want the work; the challenge is to sustain a balance.

The defense industrial base has only one customer: the government. If the government doesn't buy, the base will vanish. Most companies in the industrial base depend on these sales to survive. Only a few have commercial work, and much of that commercial work is not transferrable to defense products. Any business that wants to survive (if one market segment is declining) will look for other avenues to sell their products. Those products will be of a "dual-use" nature and of a "multiple customer base". Thereby, the government defense customer becomes less relevant in what industry uses as "requirements" to design an innovative system. The industry will then be reluctant to "customize" such a product and expose the result to export regulations unless the government chooses to fund the R&D necessary for transition from commercial to military application. The government must balance the choices of what technologies and investments are critical to national security

NDIA TOP ISSUES FOR 2012

continued from page 18

and which can be expected to sustain under commercial free market situations. The emergence of an asymmetric or major threat is not a commercial market phenomenon.

Growth of the DoD workforce seems to be contradictory with the recent initiatives on cost reduction and productivity announced by DoD. Some growth in personnel seems necessary and prudent. Everyone agrees that shortfalls in the government acquisition work force must be fixed. Of particular concern is having sufficient expertise in key areas such as systems engineering, contracting and program management. Along with all of this have been scattered industry complaints about the government "poaching" industry employees. Although defense officials deny the accusations, it must be acknowledged that the only place where government can recruit qualified acquisition workers is industry.

One concludes that the government does need more expertise in acquisition in order to be a better buyer. But the push to improve capability and skills must be focused and not arbitrary. Also, budget estimates need to be realistic with respect to costs and savings, or else the war fighter ends up bearing the brunt. In-sourcing should not be viewed strictly as savings.

Achieving a balance between the levels of industry, academia and government involvement in the development, production and support of military systems is the key to sustaining defense superiority. The process requires active management to ensure that industry capability does not suffer a critical failure as the in-sourcing process and depot workload reallocation proceed. Clearly something must be done to manage this process. The Defense Department makes it a Policy to rely on market forces to manage the industrial base, yet the department is somewhat managing the industrial base by beginning to pull workload. A way must be found to preserve both competition and industry capability as all this unfolds. A balance is needed, and smart management is required. Leaving it to market forces won't work.

REVISE THE EXPORT REGULATIONS

Current rules do not reflect the dramatic changes in the geopolitical and global economic realms that have occurred during the last 15 to 20 years. There are now less clear-cut distinctions between military and commercial technologies and increased availability of high-tech equipment and services from non-U.S. companies. Suppliers need greater speed and efficiency in meeting global market demands. The export control system is contributing to the erosion of the competitive position of U.S. companies in the global marketplace. Protection of our national security and technological edge in key capabilities must continue to be the principal focus of our export control laws. The war on terrorism has increased concerns about key technologies falling into the wrong hands. We should aim to build higher walls around fewer technologies. The scope and enforcement of export controls should address these legitimate concerns while also contributing to the strength of our defense industrial base by enabling opportunities for U.S. companies to provide solutions for our allies security needs.

In recent years, a number of our closest allies have formally advised the U.S. government that its export control policies and procedures are a major impediment to defense cooperation. European contractors have even indicated their preference to exclude U.S. suppliers from competing for work. In their view, this is due to U.S. companies' difficulty in reliably meeting schedule and availability requirements, which are attributable to a cumbersome, slow-moving export control system. Indeed, in recent competitions, a major criterion has been the ability to demonstrate that export-licensing procedures will not impede a U.S. supplier's capacity to perform if chosen.

We must not lose sight of the security and economic benefits of a more targeted and efficient export control system that allows interoperability with our allies. The actions proposed by the National Export Initiative should enhance the ability of companies to comply with government requirements, improve interoperability with our closest allies while protecting national security, and strengthening U.S. competitiveness in global markets. It also would help to preserve a cutting-edge industrial base, including a highly skilled work force. This initiative is intended to enhance national security by focusing on the enforcement of strict controls around the export of the most critical technologies and products. It also seeks to strengthen the competitiveness of key manufacturing industries in the United States by streamlining the regulation of exports. The president has tasked the Secretary of Defense to lay out these reform proposals as soon as possible. Some of the specifics of this new reform policy include reducing the delay of exports of encryption products, such as cell phone or network storage systems. Currently, makers of products with encryption capabilities need to apply for a Commerce Department technical review of the product before it can be exported. The review can take between 30 to 60 days. There are more than 3,300 such filings each year. This proposed rule is intended to re-place the current review-and-wait process with a more efficient one-time notification-and-ship process, which may eliminate up to 85 percent of all the technical reviews of these products. Another proposed reform would be to eliminate obstacles to exporting to companies employing dual nationals. Currently, U.S. exporters and foreign customers of U.S. goods have to comply with two different, conflicting sets of standards. Under this reform effort, the administration will begin to eliminate about 2,000 munitions licenses a year, which should have a dramatic impact on the compliance programs of both U.S. exporters and foreign customers. It will touch on at least half of the more than 85,000 munitions licenses the United States issues each year.

Many of the recently announced export reforms have been among NDIA's top policy concerns for a number of years. NDIA's International Division is actively engaged in reviewing and commenting on the new proposals and is committed to working with the administration in the successful implementation of the export control reforms.

FALL 2011 UNDERSEA WARFARE DIVISION CONFERENCE

SEPTEMBER 26-29, 2011

PAUL NORMAND, FALL CONFERENCE CHAIRMAN
VICTOR FIEBIG, FALL CONFERENCE CO-CHAIRMAN

UNDERSEA WARFARE COMMAND IN THE 21ST CENTURY

This year's conference focuses on the Undersea Warfare Command in the 21st century. In the Leadership's Design for Undersea Warfare, the emphasis is on the need to be masters of the undersea domain, able to achieve undersea superiority at the time and place of our choosing. The main lines of effort are:

- **Ready Forces:** Provide undersea forces ready for operations and warfighting
- **Effective Employment:** Conduct effective forward operations and warfighting
- **Future Force Capabilities:** Prepare for future operations and warfighting.

Our speakers this year comprise the full spectrum of undersea warfare expertise. They will address research and development, acquisition, and maintenance and modernization. Additionally, speakers will address the capabilities that will help improve decision making at all levels of command.

This year's keynote address will be delivered by *The Honorable Sean J. Stackley, Assistant Secretary of the Navy (Research, Development and Acquisition)*. Our plenary session includes the Director, Naval Reactors; Commander Submarine Forces; Commander Naval Sea Systems Command; Commander, Submarine Force, Pacific; Director, Submarine Warfare; and Deputy Director, Surface Warfare. Also addressing the plenary session are the Chief of Naval Research; Program Executive Officer Air ASW, Assault and Special Missions; Program Executive Officer Submarines; Program Executive Officer C4I; Commander, Naval Undersea Warfare Center/Undersea Enterprise Chief Technology; Technical Director, Naval Undersea Warfare Center; Deputy Commander, Naval Mine and ASW Command; Program Executive Officer Integrated Warfare Systems; Program Executive Officer Littoral Combat Ships; Commander Naval Meteorology and Oceanography Command; and Deputy Director C4ISR N2/N6.

"In the Leadership's Design for Undersea Warfare, the emphasis is on the need to be masters of the undersea domain, able to achieve undersea superiority at the time and place of our choosing."



Attendance provides you the opportunity to gain insights into the challenges our Navy faces across the spectrum of the undersea domain. Take advantage of this opportunity to hear their views on the issues confronting the Navy-industry-academia team as we navigate the waters of an uncertain future that will present new challenges to command of the undersea environment.

NDIA HEADQUARTERS

Assistant Vice President, Operations
CAPT Bruce Roulstone, USN (Ret)
broulstone@ndia.org
Tel: 703.247.2574

Meeting Planners
Kim Williams (kwilliams@ndia.org)
Angie DeKleine (adekleine@ndia.org)
Tel: 703.247.2599

Please notify Kim or Angie of address changes.

Copyright © 2011 NDIA. All rights reserved.
Cleared for public release. Printed in the U.S.A. 4293130

NDIA UWD NEWSLETTER

Published periodically to communicate activities and plans. For inputs or suggestions contact:

CAPT Tom Dion, USN (Ret), Editor
Raytheon Integrated Defense Systems
thomas_c_dion@raytheon.com
Tel: 401.842.5597

Pam Reynolds, Art Director
Raytheon Integrated Defense Systems,
Advanced Media
pam_reynolds@raytheon.com
Tel: 401.842.4426