REVISION 1

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 074-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	18 March 2004	Symposium Paper 17-18 March 2004

4. TITLE AND SUBTITLE
Operational Impacts of the Aegis Cruiser Smartship System

5. FUNDING NUMBERS
N/A

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
USS ANTIETAM
CG 54
F.P.O., AP 96660-1174

8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
N/A

11. SUPPLEMENTARY NOTES
Prepared for the Engineering the Total Ship (ETS) 2004 Symposium held in Gaithersburg, Md. at the National Institute of Standards & Technology and sponsored by the Naval Sea Systems Command & the American Society of Naval Engineers

12a. DISTRIBUTION / AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE
Approved for public release; distribution unlimited	A

13. ABSTRACT *(Maximum 200 Words)* The Chief of Naval Operations guidance over the past few years has challenged the fleet with finding ways to increase efficiencies while maintaining overall readiness as a highly effective force. In addition, today's ships must be continuously ready and surge capable in accordance with the Fleet Response Plan. One way to meet these goals is to leverage technologies that will optimize ship manning and streamline shipboard training.
The Smartship installation in *USS Antietam* (CG 54), when used in synergy with a flexible manning concept (Core Flex), the conversion of steam systems to all-electric, and the development of web-based administrative tools enables the ship to meet and exceed these challenges. *Antietam* uses the enabling tools of virtual training devices and simulators, in conjunction with IT-21 installation and Core Flex to reduce underway watchstanding requirements and increase ship readiness, personnel qualifications, and training depth throughout the ship. These combined efforts reduce required unit level training time, increase situational awareness and dramatically decrease the administrative burden on personnel.

14. SUBJECT TERMS
Smartship, Cruiser, Situational Awareness, Reduced manning, USS Antietam, Integrated Bridge System, Integrated Condition Assessment System, On-Board Trainer, HYDRA, Machinery Control, Fuel Control, Enabling Technology

15. NUMBER OF PAGES
11

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	UNCLASSIFIED	UNCLASSIFIED	UL

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Operational Impacts Of The Aegis Cruiser Smartship System

"IT ISN'T JUST THE TECHNOLOGY-IT'S HOW YOU USE IT THAT MAKES THE DIFFERENCE"
Captain Jeff Fullerton, Commanding Officer (CG 54)

ABSTRACT

The Chief of Naval Operations guidance over the past few years has challenged the fleet with finding ways to increase efficiencies while maintaining overall readiness as a highly effective force. In addition, today's ships must be continuously ready and surge capable in accordance with the Fleet Response Plan. One way to meet these goals is to leverage technologies that will optimize ship manning and streamline shipboard training.

The Smartship installation in *USS Antietam* (CG 54), when used in synergy with a flexible manning concept (Core Flex), the conversion of steam systems to all-electric, and the development of web-based administrative tools enables the ship to meet and exceed these challenges. *Antietam* uses the enabling tools of virtual training devices and simulators, in conjunction with IT-21 installation and Core Flex to reduce underway watchstanding requirements and increase ship readiness, personnel qualifications, and training depth throughout the ship. These combined efforts reduce required unit level training time, increase situational awareness and dramatically decrease the administrative burden on personnel.

Innovative ideas for leveraging technology to increase control and monitoring capability, and adapting our training organizations around new functionality allows for increased readiness and war fighting power. Employment of this technology is key. Unit level training time and required manning are decreased through automation. Situational awareness is increased through web enablement and a better common operating picture. This leads to a higher level of unit effectiveness and readiness, while directly supporting Strike Group needs, Fleet Commander ideology, and clearly sets foundations for future innovations.

BACKGROUND

During a yard period from April to August 02, *Antietam* jointly received two large alteration packages. The Smartship upgrade (CG 47 586K) was composed of the following eight systems:

- Integrated Bridge System
- Machinery Control System
- Integrated Condition Assessment System
- Fuel Control System
- Damage Control Quarters
- Local Area Network
- Wireless Communications Network
- Onboard Trainer

Antietam also received the all-electric alteration (CG 47 588K), eliminating the waste heat boilers and replacing the Vapor Compression distilling plant and steam heat exchangers with Reverse Osmosis (RO) distilling plants and electric heat exchangers. In addition, *Antietam* utilized the capabilities inherent in the IT-21 ISNS network installation to create web-based versions of virtually all Engineering administrative programs. The shift to web-based interfaces has dramatically reduced the use of paper, streamlined information flow, improved the common operating picture of administrative management programs, and greatly increased the accessibility of information throughout the ship.

All upgrades are used in concert to achieve watchstation reductions, improved ship-wide situational awareness, and reduced administrative burden while maintaining an increased level of personnel qualifications and depth of training, thereby increasing the overall capability of the crew. It is the synergy of these installations and their employment that has powered a dramatic leap in capability; examples will follow in specific areas.

CG-47 Class Smartship installations have been ongoing since prototype installation on *USS Yorktown* (CG-48) through production installations on *USS Ticonderoga* (CG-47), *USS Monterey* (CG-66), *USS Valley Forge* (CG-50), *USS Mobile Bay* (CG-53), *USS Antietam* (CG-54), *USS Hue City* (CG-66) and *USS Cape St. George* (CG-71). Ongoing system improvements are incorporated into each successive installation. The most recent improvements include integration with Aegis large screen displays in CIC, integration with AN/SPS-73 radar, sharing displays with NAVSSI, automated heat stress analysis integration, digital fuel control, survivability lessons learned from *USS Cole* (DDG 67), and additional shock hardening for the equipment, including consoles, which are now MilSpec 901D Grade A compliant. The improvements also include new engineering Onboard Training Software (OBT), ECDIS-N (Electronic Chart Display and Information Systems – Navy) compliant electronic navigation software in the form of the Navy standard Voyage Management System for the Integrated Bridge System (VMS-IBS).

INTRODUCTION

"THE TRUE INNOVATION OF SMARTSHIP IS IN THE APPLICATION"
(Captain Ric Rushton, Commanding Officer CG 48 and CG 54)

The Smartship installation allows ship operators to "think out of the box" in how ship operations are manned and executed. This breaks Naval traditions and routines set for years. The Smartship and All-Electric upgrades were designed to allow for a reduction in manning while simultaneously increasing survivability, enabling embedded training, and increasing situational awareness throughout the ship. Smartship systems have greatly enhanced the control, monitoring and training capabilities of the engineering plant on SMARTSHIP CGs. The infusion of COTS technology enables the Smartship installation to improve engineering control system capability and enhance engineering readiness and reliability. This paper will give examples of benefits to ship operations in the areas of training, situational awareness, readiness, manning reduction, and maintenance based on the experience of *Antietam*.

The Smartship installation utilizes operator stations and data acquisition units built on Versa Module Eurocard-based (VME) architecture running a Microsoft Windows NT operating system. These common building blocks are used to monitor and control equipment and provide an operator interface for the integrated systems. Inter-unit communications occur over a redundant, highly survivable Fiber Optic Based ATM LAN.

In brief, the Smartship Integrated Ship Control (ISC) is a combination of core systems described below:

Integrated Bridge System (IBS): Provides navigation assurance via automated piloting, ship's course and track analysis with radar, and digital nautical chart overlay including collision avoidance. The Navy Standard Voyage Management System (VMS) software, soon to be certified, will reduce or eliminate reliance on paper charts, making all electronic navigation a reality. IBS integrates these features into a form that increases the situational awareness of the bridge watch team, and at the same time reduces the manning requirements and increases navigational safety.

The principal feature of the IBS is its ability to present information to watch standers in a way that allows them to evaluate it quickly and correctly. The IBS brings together the ship's navigation data, piloting functionality and radar functionality in one place by utilizing the

Voyage Management System to plot the ship's information on a digital nautical chart as well as the tracks of other vessels hooked by the navigation radars. This allows the watch stander to be aware of everything that is happening during the watch.

Watch standers can choose to view the actual radar data of any of the ship's three navigation radars on the Automated Radar Plotting Aid (ARPA) or they can view any hooked tracks on the VMS chart display. Using VMS to view the tracks gives watch standers a consolidated picture of their own ship as well as any vessels being tracked by the radar, against the background of the electronic chart display.

The IBS also includes the ability to track steer. This allows the navigation team to input a desired track in the form of a voyage plan. Upon approval of the voyage plan, the ship's watch team can engage the IBS for that voyage plan. The IBS will take control of the ship's helm and steer the ship along the track. This eliminates the continuous requirement of a helmsman. The ship may also be steered using an auto-pilot function to steer a designated course when track steering is not desired.

Machinery Control System (MCS):
Increases monitoring and control capabilities throughout the ship. The legacy Engineering Command and Control System, replaced by Smartship equipment, previously used stand-alone, single function Propulsion Auxiliary, Electric Plant, Fuel Control and Damage Control consoles locally and in CCS to monitor and control the engineering plant. Smartship provides approximately 30 reconfigurable operating stations, each of which can assume total engineering plant control for any one or all of the Smartship systems if required. The distribution of workstations throughout the ship removes the requirement to control the Engineering Plant from CCS and increases situational awareness. The decrease in the number of different assembly types of the legacy system reduces equipment support costs, including manning requirements.

The fault tolerant system architecture provides high survivability and availability. Enhanced control and monitoring functions built into the object-oriented control software and the human machine interface (HMI) software provide improved operator visibility into plant operation and intuitive safety-related control features.

The Smartship system has growth potential for additional monitoring and control capability, offboard monitoring/control, and integrations such as surveillance video, voice alerts, and battlegroup interfaces. These will move toward the goal of reduced manning.

Fuel Control System (FCS):
Allows for distributed control and monitoring of fuel movement and storage throughout the ship utilizing common hardware with the MCS. This replaces the legacy stand-alone, single function Fuel Control consoles and JP-5 Control station. The new software improvements provide improved operator visibility into fuel system status, including total fuel volume, percentage and distribution.

Damage Control Quarters (DCQ): Provides real-time information throughout the ship via an automated damage control management system. The DCQ application can be found on all of the MCS consoles (the approximately 30 stations mentioned above includes the repair lockers, helo hangar, and Combat Systems Maintenance Central (CSMC) as well as the engineering spaces), and two of the IBS consoles (Combat Information Center (CIC) and the CO's Cabin).

The basic premise behind DCQ is putting the ship's Damage Control Plates onto the computer and including decision aids and management tools with them that take advantage of the computer environment. Such extras include an instant messenger, which replaces the need for sound-powered phone talkers as long as the network remains active; a breathing apparatus manager (*Antietam* currently has the Self-Contained Breathing Apparatus installation), which keeps track of the amount of time that a breathing apparatus has been active; a Machinery Space Fire Doctrine checklist, which allows all concerned to keep track of the progress of response to a machinery space fire; an alarm monitor, which allows the DC organization to keep an eye on all DC related sensors; and a Chemical, Biological, Radiological Defense (CBRD) window which has a number of administrative and management tools associated with CBR defense.

There are also other tools such as a GQ window which allows all users the ability to track the progress of going to GQ, including manned and ready and Zebra reports; a training mode which includes the ability to record and replay any prior events for debriefing or lessons learned; and the ability to print any portion of the display.

Overall DCQ provides a marked improvement in the tools and capabilities over the previous existing damage control facilities and tools.

Integrated Condition Assessment System (ICAS): Allow for implementation of machinery monitoring and condition based maintenance (CBM). ICAS leverages existing ships' infrastructure by interfacing to machinery control systems to receive all pertinent information without duplicating sensor or processing hardware. For additional (non-automated) data points, ship's force utilizes a portable data collector to upload data, via a serial interface to the workstations. This data is automatically trended, evaluated, and fused at the deck plate to allow for automated diagnostics.

ICAS also links to digital logistic products such as the Engineering Operational Sequencing System (EOSS), Planned Maintenance System (PMS), and Interactive Electronic Technical Manuals (IETMs). These links not only allow for browsing, but also for maintenance recommendations to be linked directly to the appropriate section or card.

Recent efforts include the movement of data shoreside to provide for remote continuous assessments of monitored systems. This information can also be used to effect maintenance periodicities, design changes, and operational practices.

Local Area Network (LAN): Hosts the above technologies on a system utilizing Versa Module Eurocard (VME) bus based Data Acquisition Units (DAU's) and workstations. The DAU's are on a chassis that have interface cards and Field Transition Modules (FTM) that are capable of accepting various different signal types including voltage, current, frequency, etc. The network consists of 4 switches connected by a full-mesh OC-12c ATM backbone. The Data Acquisition Equipment (consisting of two or more DAU's) and workstations have 10-megabit per second Ethernet connections over multimode fiber to two separate network switches. The DAU's and workstations are distributed throughout the ship and control all major Hull, Mechanical and Electrical (HM&E) systems including main propulsion, electric plant generation and distribution, switchboard and shore power interface, and damage control, including fire and flooding detection, and fire pump control.

Wireless Communications (Hierarchical Yet Dynamically Reprogrammable Architecture (HYDRA)): Provides hand-held secure communications for key ship's personnel in or near the ship, tied into Integrated Voice Communication System (IVCS). This wireless communication system has become the primary means of communication in the damage control, engineering, operations, and training arenas. It is also very reliable for coordinating amongst all the Flex teams and enhancing topside communications. The ability to turn to any programmed circuit with a single radio while staying mobile has moved shipboard communications to a new level. Additionally, being able to dial a radio from an IVCS phone keeps anyone in touch with key personnel. The system is more reliable than previous wireless communications systems and much more effective than sound-powered phones.

Onboard Trainer (OBT): Gives the ability to conduct realistic engineering drills without affecting the engineering plant operations through engineering software including an Instructor Graphical User Interface and a physics based machinery plant simulation loaded on each workstation. The Integrated Bridge navigation training software loaded on the IBS equipment and the Damage Control Quarters training software provide similar realistic training capability.

CORE-FLEX ORGANIZATION

The innovative approach in organizing the ship's watch structure with a Core Flex organization, as opposed to the traditional manning structure, has enabled broader depth of training and experience in the crew, reduced some manning requirements and enabled more rapid response to casualties. The ship normally fights from a Condition III manning environment vice going to Condition I. *Antietam* handles casualties without stripping tactical watch stations. No loss of tactical situational awareness occurs in transitioning the ship to a higher state of readiness or handling battle damage casualties.

The Core watch is the minimum personnel to operate a cruiser at sea 24/7. Flex Teams augment the Core only when needed. Some Flex Teams are short term, while others are sustainable over extended periods of time. The results are reduced watchstanding requirements and an increased number of sections. On the whole, the crew experiences an increased depth of qualifications (cross-trained personnel) with more opportunities for personnel to gain qualifications, and more efficient use of training and maintenance man-hours. Overall, this results in higher **SUSTAINED READINESS.** Additional detail is presented as it applies to the bridge, engineering, damage control and training.

BRIDGE OPERATIONS

Increased situational awareness and electronic navigation capabilities have given the confidence to reduce the bridge watchteam to an Officer of the Deck (OOD), Junior Officer of the Deck (JOOD)/Conning Officer, Boatswain's Mate of the Watch (BMOW), Quartermaster of the Watch (QMOW) and aft lookout. Five Bridge watchstanders were eliminated. In addition, the separate CIC Navigation team is no longer required in restricted maneuvering situations.

The VMS electronic navigation system greatly enhances situational awareness and navigation accuracy, while reducing the number of personnel required and the administrative burden of paper chart maintenance. The reduction in watch team manning enables those personnel to be used on other watches, maintenance or training.

Ship Control is almost exclusively maintained in automatic pilot using VMS during open ocean operations, eliminating the need for a full time helmsman. During long transits, use of autopilot or track steering modes improves the steadiness of the course steered over a long distance, increasing efficiency. If a course change is required, the Conn simply enters the new course and the ship responds. In case of emergency, any of the bridge watchstanders can take manual control of steering and/or throttles with a touch of a button.

A Maneuvering Flex Team is called away when a dedicated helmsman is needed. The Maneuvering Flex Team (Helmsman, Lee-Helm, additional lookouts) is used for restricted maneuvering situations, where precise and timely control is necessary. Such situations include harbor transits/mooring, underway replenishment, plane guard, man-overboard, Visit, Board, Search, and Seizure (VBSS), small boat operations and reduced visibility transits.

This configuration is also used during Restricted Maneuvering conditions, when the Navigation Flex Team needs to be set. Additionally, one radar operator provides radar fix information to the Navigation team on the bridge and the primary plot always remains on the bridge. *Antietam* is well on the way to becoming the first U.S. Navy ship with certified ECDIS-N navigation using VMS as the primary method of navigation in 2004. This major accomplishment is the first step to total elimination of paper charts in the U.S. Navy.

ENGINEERING OPERATIONS

Antietam has reduced the number of underway engineering watchstanders from twelve to six per watch section. Realistic watch reduction has been realized without compromising plant control by installing multi-function workstations and converting all the steam systems to All-Electric. In addition, CG54 maintains five qualified underway-engineering watch sections through the consistent and extensive use of the Engineering OBT software combined with occasional live plant drills.

On *Antietam*, the EOOW and PACC CCS watch stations have been combined into one watch. In addition, the ERO and ERM watches were combined and the ARO/ARM/SOUNDING & SECURITY watches were combined. The EPCC watch was combined with the DC Console watch. The combination of Smartship technology with aggressive crew training allows the ship to raise the proficiency of the watchstanders to the point that watchstations can be combined without sacrificing capability. Watchstanders are now able to multi-task across previously separate watchstations. EOSS has been rewritten to support the CCS watchstation reduction. *Antietam* utilizes an Engineering Casualty Response Team (a core watch team) to improve response effectiveness and plant restoration. The Casualty Response Team is available to respond 24/7 on no notice, and team members serve no additional watch functions.

The All-Electric alteration has eliminated the waste-heat boilers and steam heat systems, dramatically reducing both the watch and maintenance workloads related to the auxiliaries plant. The RO distilling plants are much more reliable and more cost effective. The preservation and cleanliness of the spaces is also improved with the all-electric plant. The combination of Smartship and all-electric installations is vital to achieving manpower reductions, cost savings and overall better material readiness.

The reduction in watch manning requirements has enabled the ship to train more personnel more efficiently, free up additional man-hours for maintenance, improve material readiness, and sustain a four to five section rotation despite normal personnel turnover.

DAMAGE CONTROL

The implementation the DCQ program on nearly every workstation on the ship allows for the distribution of the Damage Control Plot and eliminates the dedicated DC Console (DCC) watch. The days of grease pencil plotting boards and dedicated phone talkers are gone. The ability to plot on the DCQ isometric graphic screens, enabling DC actions to be seen by all, without phone-talker interpretation, has significantly improved command, control and communication.

The Incident Commander (usually the DCA) is in direct communication with the Team Leader/Scene Leader via the HYDRA wireless radios, which are clear and have no dead spots. DC actions are entered directly to the DCQ LAN and seen by all command and control stations. The improved communications have given the ship's personnel the confidence to move away from the traditional General Quarters response to casualties. The DC Organization consists of a seven man Rapid Response Team and an eight man Isolation Team that are available 24/7. The Rapid Response and Isolation Team members do not serve any additional watch function onboard the ship.

The Rapid Response and Isolation Teams have been implemented to assess casualties and take immediate actions in emergency situations. The teams set fire and smoke boundaries around the affected space to prevent rapid spread of damage and allow a flexible response of additional Attack Teams of trained DC personnel without manning GQ stations in the traditional manner. The Rapid Response Team enters the space on SCBA air in protective clothing immediately, while boundaries are being set. This is much faster and effective than setting GQ and ZEBRA while the fire continues to burn. ZEBRA is not set shipwide, only within defined boundaries, which enables the crew to move more efficiently throughout the ship with equipment. Material condition ZEBRA is set pre-emptively only in the case of a CBR situation as MOPP Levels are increased, to enable Circle "W" and use of counter measure washdown systems.

The DC organization further consists of three Attack Teams: A, B and C. Attack Team A is the heavy hitting firefighters. Attack Team B is specifically focused on structural damage, shoring, flooding, etc. Attack Team C is primarily trained as Aviation/flight deck firefighters. All Attack Teams are trained in all areas of DC, but function specifically as described. Many members of each team hold higher-level qualifications.

All personnel onboard are qualified through DC INVESTIGATOR (PQS 312) after completing a 21-day INDOC training period as newly reported personnel. Past fleet norms for qualification to this level averaged approximately six months and did not include all hands. The DCA is the Incident Commander, and several other personnel are also qualified in case the DCA is on watch elsewhere at the time of the casualty. Every ESWS qualified sailor is also qualified as a Scene Leader (DC 313), which is a pre-requisite for ESWS qualification aboard *Antietam*. This significant depth of qualification in DC functions across the command enables efficient use of every person aboard in the DC arena, if and when required. All other personnel not actually on watch or assigned to other activated Flex Teams (i.e., Air Defense, USW, SUW, maneuvering, etc.) are designated as DCQ personnel and man up forward and aft (DCQ stations), with a Senior Chief Petty Officer or Officer in charge. The operational philosophy is that damage control is an all hands function and every person aboard has to be trained and competent to fulfill damage control functions in the case of a hit from a modern missile, mine or CBR attack. The lessons learned from the Falklands War, *USS Stark*, *USS Samuel B. Roberts*, *USS Princeton*, and *USS Cole* bear this out.

When the ship sets DCQ, no tactical watchstanders are relieved, they continue to maintain situational awareness and fight the ship. The depth of shipboard qualifications enables those not actually on other Flex Teams to meet all DC functions. The Incident Commander dispatches teams to any scene as needed, and coordinates reliefs, SCBA re-charge, equipment movement, and casualty response. At all times, the DCA has a ready trained manpower pool at his fingertips, in a safe clean-air environment to be dispatched as required. Meanwhile, the activated tactically-related Flex Teams fight the ship and maintain combat systems and engineering readiness.

COMBAT INFORMATION CENTER

CIC and the CSOOW have the ability to monitor main propulsion, electrical and auxiliary plant machinery, Damage Control actions, and steering and navigation of the ship. Smartship also provides the ability to steer and navigate from CIC, if desired. For example, the Conn, with rudder control, can be shifted to the ASW Evaluator station. This has greatly increased the overall situational awareness of CIC and the CSOOW organization. The CSOOW and Combat Systems Casualty Response Team can more easily coordinate their actions with the EOOW and DCA, to ensure rapid restoration of combat systems equipment. This capability better enables personnel to maintain tactical capability, fight the ship, and maintain overall mission effectiveness, even in a damaged condition.

TRAINING

The embedded software installed on each workstation allows realistic training for both navigation and engineering whether inport or underway. The OBT allows Ships Force to invest in the future and maintain proficiency of every sailor, not just a select few.

The Integrated Bridge System training mode allows for simulated underway operations. Bridge watchstanders can watch the screens and study the transit with a bird's eye view using the electronic charts while pier side. The playback feature, which stores thirty days of ship's movements, allows for accurate review of navigational details and other underway operations. This enables de-briefs of evolutions and team performance.

This function is not the same as MSI or similar versions of ship-handling simulators. Future initiatives to install ship handling simulation systems, such as Conning Officer Virtual Environment (COVE), aboard Navy ships will provide an additional degree of realism that marries the navigation functions to a visually realistic computer based shiphandling trainer. Adding this dimension to the existing Smartship capability will be extremely beneficial in training bridge personnel, particularly in preparing for transits through unfamiliar harbors.

OBT software for engineering has been used extensively and completely changes how engineering drills are conducted. The need for dedicated time for the entire ship to support engineering drills no longer exists. Prior to the Smartship install, the ship was virtually incapable of conducting either combat systems drills or sustaining strike group responsibilities while conducting engineering drills. This is because engineering drills frequently disrupt Combat Systems Support Services such as electric power, chilled water, compressed air, navigation, mobility, etc.

Engineering OBT has greatly improved the ability of the ship to train people as individuals and as teams. Engineering drills are now conducted using OBT with absolutely no impact on the ship's operations or other missions. OBT drills do not actually affect power or propulsion capability and have been accomplished during helo ops, gunnery exercises, and many other events. The ship is now free to conduct Combat Systems operations and other training evaluations irrespective of the status of engineering training, and thus has increased the frequency and effectiveness of such training in all departments.

Conducting live-plant power and propulsion limiting drills requires shifting many of the ship's mission duties to another ship, such as duties of Air Defense Commander, CAP or USW aircraft control, LINK, Strike missions, etc. Conducting live-plant drills in normal Battle Group operations also impacts transit speeds, costs fuel to re-gain PIM and causes wear and tear of the plant equipment. Over the course of an eight-month Western Pacific deployment, *Antietam* averaged four to five drill sets per week using OBT. Had live-plant drills been conducted, the ship would only have been able to accomplish perhaps one per week on average. The ship suffered NO CASREPS on GTGs and only one GTM CASREP during deployment. This is at least partially a result of limiting the wear and tear on the plant by avoiding the repeated equipment starts and stops previously required during engineering evolutions and ECC drills. Training with the OBT not only reduces the degradation to machinery and allows for more maintenance time. Live plant drills are still necessary from time to time, and are conducted in an ITT environment to train the rest of the ship to deal with power loss and propulsion limiting casualties. These drills include actual isolation of an engine room in a main space fire scenario, and actual loss of power and restoration of combat systems equipment in a simulated tactical scenario.

OBT provides realistic simulation of casualties and system responses to the operator's actions. It can be used as a training tool for an individual to study systems/parameters, practice EOP evolutions or EOCC actions just as easily as for the entire watch team.

OBT has decreased the time required to qualify new watchstanders while increasing the proficiency of current watchstanders. The engineering OBT has given the ship the ability to effectively train inport, underway or in the course of other exercises. With the OBT, *Antietam* was able to EOOW qualify a newly reported Ensign, (a SWOS Division Officer, Engineering specific graduate) in approximately eight weeks. It has greatly enhanced qualifications throughout the department, enabling a five-section watchbill throughout an eight month deployment, despite routine personnel turnover.

Ship's Force is divided up into departmental training teams, each with an Executive Agent (EA) to manage administration, coordination and integration of each team. All administrative documentation is maintained on the IT-21 LAN and is accessible to all-hands. The Combat Systems Officer (CSO), assisted by the ship's Training Officer, heads up the Training Organization. The experience and maturity of the CSO enhances the overall ship's focus on sustained, effective training ship-wide.

Through the use of web-based IT-21 applications, the management, scheduling, performance, and de-briefing of drills is much less burdensome. With the use of several customized applications, *Antietam* is able to plan out every watch replacement on the ship and the training of ship's personnel up to one year in advance. This Watch Team Replacement Plan is tied to Personnel Qualifications Standards (PQS), proficiency matrices, Fleet training & readiness databases (TRMMS/SORTS), personnel rotation information and training requirements/objectives to make the administrative management tools easier to use. Web-based scenario plans, drill cards, briefs, and de-briefs ease the administrative requirements attendant with training. They virtually eliminate paperwork and tie many management tools together to make the overall process more efficient. Just as important, they greatly improve accessibility of information to all hands instead of only the few program managers. All hands know their status, requirements, and goals, as well as the ship's overall plans for training, and how their piece fits into the overall mission accomplishment goals. Web-based applications have sped the time at which information can be distributed throughout the command. Plans can be quickly adjusted, updated, and distributed. All personnel are able to spend more time training, and less time doing the paperwork to support the administration of training.

The Engineering and Damage Control Training Teams have improved their coordination effectiveness with the use of the HYDRA wireless radios. The ability to program radios to different channels has eased the coordination, implementation and control of complex drill scenarios, as well as the coordination of routine ship wide evolutions. This is a side benefit to training from a system primarily designed for a reliable damage control communications network. This common operating approach to wireless communications is an integral part of the Smartship network where the various consoles share and display vital plant and DC information ship wide, real-time.

Integration and visibility of all the various administrative tools allow personnel to meet the administrative requirements of Naval training programs while maintaining the focus on the depth and content of training itself. Core Flex requires smooth, simple management, effective use of available man-hours for training, and visibility of each sailor's qualifications, goals and progress in order to achieve the desired results of depth, flexibility, broad-based professional growth, cross-training and reduced manning. A true commitment and focus on training from the top down, everyday, means training is the priority, not administration. The results of the synergistic use of Smartship, IT-21 and Core Flex are higher overall sustained readiness, a better trained crew, a lower administrative burden, and improved professional growth for every Officer and Sailor.

MAINTENANCE

The PC-based, solid-state architecture of the Smartship system has greatly reduced hardware failure occurrences. Redundancies built into the Smartship system allow for uninterrupted operations when failures occur. The Smartship system performs Built In Tests on all hardware components enabling constant on-line monitoring of system function and communication. BIT provides the operator with indications of failures, which are also logged. The Interactive Electronic Technical Manual (IETM) on each operator station conveniently provides troubleshooting and maintenance information, such as signal flow diagrams, enclosure/LAN interconnection diagrams, disassembly/assembly instructions, illustrated parts breakdowns, test procedures and OEM manuals.

The Smartship systems require additional training of GSE, IT, and ET ratings in software and network skills. The current schoolhouse courses have not caught up with the need to train personnel before they arrive on their first Smartship. This applies to operators and technicians alike. The consequence of reduced manning is that those personnel who remain must be highly trained and cross-trained to maintain, repair, and operate these new complex systems.

RETURN ON INVESTMENT

The Center of Naval Analyses has recently published a study commissioned by the Navy to obtain cost/benefit metrics and perform a return-on-investment analysis of the Smartship installation.

The conclusions included a total quantifiable benefit of about $6.3 million per ship per year. After subtracting the initial installation costs, the study concluded with an expectation to develop a net positive benefit to the Navy in less than three years, and over the lifetime of the cruisers in the CG-47 class, a greater than six fold return on investment.

In addition, the study points out several benefits the CNA was unable to quantify, including increased situational awareness, improved training, and improved ship support for the Battle Force. Additionally, it points out there may be other unquantifiable benefits in terms of fire, collision, and grounding avoidance.

RECENT OPERATIONS

The installation of Smartship and the associated technologies, along with a forward thinking organizational approach by the crew, has allowed *Antietam* to effectively complete training evolutions in considerably shorter time. The ship conducted CART II one week after a five and a half month yard period where Smartship and All-Electric were installed. Five weeks after CART II, FEP was completed, normally a 10-16 week process. The Underway Demonstration (UD) was completed just 10 days after CART II. Ships Force credits the daily focus on training, the Core Flex organization, and synergistic use of SMARTSHIP and IT-21 capabilities with enabling that success. The ability to simultaneously conduct engineering drills with combat systems and seamanship training and evolutions in lieu of the sequential methods of the past enabled a shortened training period. It should be noted that *Antietam's* dramatically shortened basic phase workup was necessitated by a Fleet surge deployment requirement. This was disruptive, expensive, and did not allow time to thoroughly train every crewmember to the depth desired. The ship's training focus and efforts following basic phase ultimately enabled more depth of qualifications and greater proficiency.

CONCLUSION

Smartship technologies being installed on the CG-47 Class have allowed for some realistic manpower reductions and reduced training cycles, while improving qualifications, professional development and depth in the crew. The combined Smartship and IT-21 technology implementations enable labor savings, efficiencies in training, and greater maintenance time. They also aid in improving information flow, knowledge and team depth. As a result, traditional shipboard operations must be reviewed and modified to take advantage of new possibilities. *Antietam* found that developing and implementing Core Flex was the multiplier necessary to realize the full capabilities of the technology enhancements. Simply installing new technologies, which are not integrated with each other or existing capabilities to the fullest extent possible, is not the answer. The true power and benefit comes from a willingness to innovate, implement more efficient organizational practices, and try new approaches to gain synergy. Every member of the crew has to be trained and committed to trying new ideas, while maintaining a focus on the ship's mission and training readiness standards. Gains can be achieved in efficiency, effectiveness and cost reduction if there is a willingness to try new ideas and innovations. The training of a ship's crew does not come cheap or easy; it takes time and it must be a top priority in the command and across the waterfront.