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An Examination of Options to Reduce Underway Training Days Through the Use of Simulation

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Cover Photo: Gas Turbine Systems Technician (Electrical) 3rd Class Chris Withers monitors the ship's online generators while standing watch at the electrical plant control console in damage control central aboard Arleigh Burke-class guided-missile destroyer USS Shoup. U.S. Navy photo by Mass Communication Specialist 3rd Class James R. Evans.

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Summary

The U.S. Navy trains its surface combatant ship crews through a combination of shore-based, onboard pier-side, and underway training. Much of this training has traditionally involved significant periods of underway time, which allows units to achieve required certifications and readiness levels. Underway training is expensive, however, because fuel and consumables are expended while a ship is underway; wear and tear on operating equipment also drive up maintenance costs. One day's worth of fuel for one surface combatant costs approximately $40,000.[1] Tight budgets and increasing recapitalization costs have forced the Navy to examine various methods to reduce the annual operating costs of the fleet.

Technological improvements have increased the fidelity and realism of simulators, and simulation is being used more widely for training within the U.S. Navy, in other navies, and in commercial shipping companies. Although the Navy's surface combatant community currently uses simulators in its training regimen, an increased use of simulation could improve training efficiency, sustain training readiness, and potentially reduce underway days.

[1] This figure is based on the cost of fuel in fiscal year 2007, when oil cost approximately $70 per barrel. Fuel costs have since spiked, suggesting that any savings derived from substituting simulation for underway training would be even greater.

Purpose and Methodology

The Navy's Assessment Division asked RAND to examine the training requirements of surface forces, determine where credit is granted for the use of simulation, estimate what training gets done underway, examine simulation technology, and identify areas where simulation could be substituted for underway training without any decrease in readiness.

We focused our research on the DDG-51 Arleigh Burke–class surface combatants, and did so for two reasons. First, the DDG-51 class has the greatest number of ships in the surface combatant fleet (there are 50), and more are under construction. This provided a large data set for our analysis of training exercises performed. Second, if efficiencies could be realized through a greater use of simulation, those efficiencies would apply to the largest ship class in the Navy, thereby offering large economies of scale as well as applicability to new ships.[2]

This research identified underway training requirements for surface combatants for unit-level training (ULT), the number of underway days required to accomplish that training, and where credit for meeting training requirements through the use of simulation is currently granted. In addition, we identified which training requirements can only be completed underway, which can be completed in port without simulation, and which can be completed in port via simulation. We then surveyed available simulation technologies to determine if they could be substituted for training that is currently being performed underway.

Findings

What Training Is Done Where

The crews of surface combatants perform exercises in 15 mission areas that range from mobility exercises of seamanship, navigation, and engi-

[2] New Arleigh Burke destroyers (i.e., DDG-97s and above) are being built with an embedded engineering training capability.

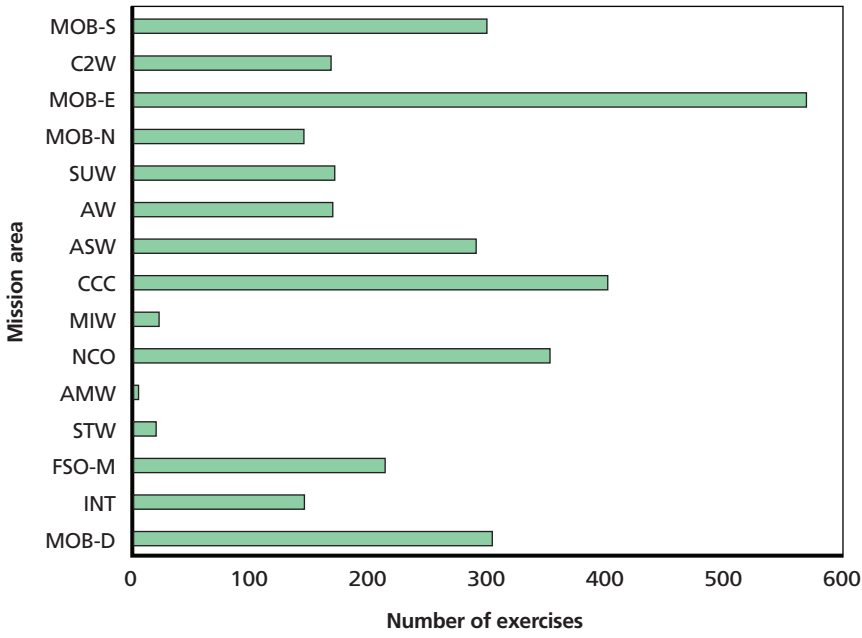
neering to tactical exercises such as air warfare, antisubmarine warfare, and surface and strike warfare. The 15 mission areas for surface combatants are

- mobility-seamanship (MOB-S)
- mobility-engineering (MOB-E)
- command and control warfare (C2W)
- mobility-navigation (MOB-N)
- surface warfare (SUW)
- air warfare (AW)
- antisubmarine warfare (ASW)
- command, control, and communications (CCC)
- mine warfare (MIW)
- noncombat operations (NCO)
- antimine warfare (AMW)
- strike warfare (STW)
- fleet support operations–medical (FSO-M)
- intelligence (INT)
- mobility–damage control (MOB-D).

The Navy's *Surface Force Training Manual* (SURFTRAMAN) specifies the training exercises that surface combatants must complete to sustain readiness.

To determine which training exercises are currently accomplished while a ship is underway, we created a database that lists completed training exercises as reported by DDG-51s. We then overlaid this information with the ship employment schedules, which we used to determine whether a ship was underway or in port when it reported each exercise complete. Figure S.1 shows the number of exercises completed by underway DDG-51–class ships that commenced and completed ULT in calendar year (CY) 2004. The data indicate that more than 70 percent (3,500) of CY 2004 ULT exercises were completed while ships were underway. They also show that engineering (i.e., MOB-E) exercises were the ones completed most often during ULT underway periods.

Figure S.1
Number of Exercises Completed by Underway DDG-51–Class Ships in ULT, by Mission Area, CY 2004



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Simulation Could Potentially Reduce Underway Training

The Navy's Surface Warfare Officer School (SWOS) in Newport, Rhode Island, has an extensive simulation capability to train prospective engineering department heads and engineering officers of the watch. As noted above, engineering training is a major driver of underway time in ULT.

An increased use of simulation for training engineering watchstanders could reduce the need for underway training. Increased repetitions through simulation might also make underway training more effective because watchstanders will have had more practice performing engineering drills and evolutions.[3] It can be challenging to establish the

[3] Training literature indicates that team training works when the training is driven by theory, focused on required competencies, and designed to provide trainees with realistic

correct level of complexity for a watch section manned by both newly qualified and experienced personnel at sea. Newly qualified personnel need to master the basics, whereas experienced personnel require challenging drills to reach peak effectiveness. An engineering simulator can be used to provide increased opportunities for junior (and senior) personnel to practice and receive feedback. The Navy already uses simulators to train personnel in engineering tasks, and these simulators are widely seen as providing credible training.

The Afloat Training Group (ATG), Atlantic, recognizes the value of the SWOS's full-mission engineering simulators to train prospective engineers. At the end of the training curriculum, ATG assessors are flown from Norfolk, Virginia, to Newport, Rhode Island, to assess prospective engineers' performance of engineering drills and evolutions on the full-mission simulator.

Performing engineering casualty control (ECC) drills underway is not identical to doing them in a simulator. Differences include physiological sensations (e.g., sound, smell, sight, and movement of the ship) as well as differences in activities and communications. Shipboard activities and communications include interactions (e.g., reports, logs, and evolutions) among central control station (CCS) watchstanders (who man the propulsion and electric-plant control consoles), engine room and auxiliary space watchstanders, and the bridge. The quality and fidelity of a simulator also accounts for differences. A high-quality, high-fidelity simulator that accurately represents the characteristics of onboard equipment minimizes the differences between onboard ECC drills and those conducted in a simulator.

Other Options to Reduce the Need for Underway Training

Our analysis also indicates that many other exercises performed underway could be done in port. We examined where exercises *could* be completed (i.e., underway or in port) and where they *actually* were com-

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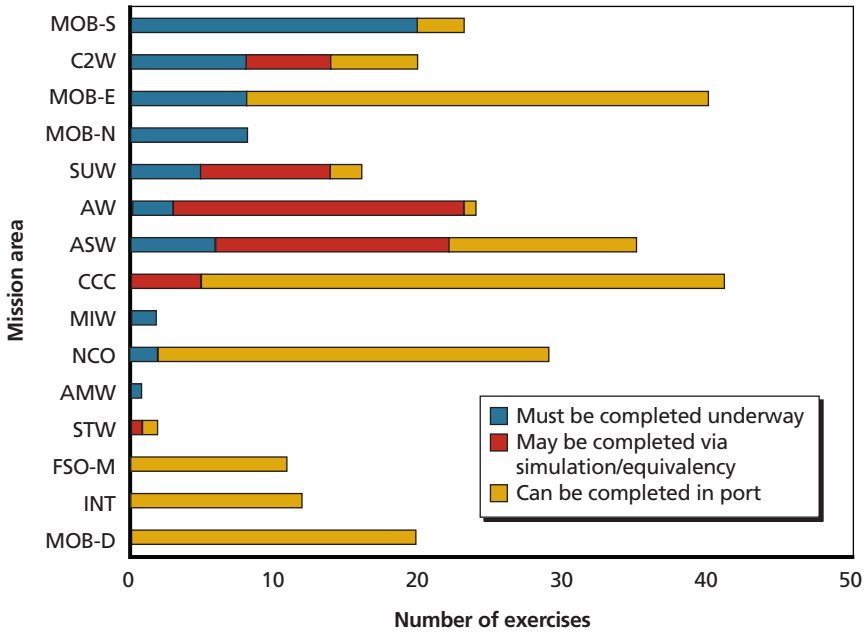
opportunities to practice and receive feedback. See Eduardo Salas and Janis A. Cannon Bowers, "The Science of Training: A Decade of Progress," *Annual Review of Psychology*, Vol. 52, 2001, pp. 471–499. Evolutions are actions such as aligning, starting, and stopping ship's engineering equipment and systems such as fuel oil, lube oil, chilled water, sea-water service, and firemain.

pleted. Figure S.2 shows, by mission area, the total number of exercises that DDG-51–class ships must complete. It also shows how many exercises can only be completed underway (shaded in blue), how many may be completed in port using simulation (shaded in maroon), and how many can be completed in port without simulation (shaded in yellow).

Seamanship and navigation mission areas contain the highest percentage of exercises that must be done underway. Seamanship exercises include activities such as replenishment at sea and getting underway from a pier or mooring. Navigation exercises include harbor transit, piloting by gyrocompass, and low-visibility piloting. These exercises require total ship integration and coordination—of the bridge, combat information center, engineering watch teams, and special evolution teams—and although ship-handling simulators exist and are used by

Figure S.2
Number of Exercises Required for DDG-51–Class Ships, by Mission Area and Location



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ship crews, no equivalencies are granted for their use.[4] Therefore, these exercises are done underway.

Our review of the data indicates that although most exercises are done underway, many could be done in port. We do not know if ships complete exercises underway because the ships already are underway, or if the ships get underway to complete the exercises. The fact that most of the training for ULT is done underway may be due to culture, policy, or practice. In-port time for engineers can be dominated, among other demands, by maintenance needs and equipment upgrades that cannot be accomplished at sea. In addition, underway training offers the ship's commander a unique opportunity to exercise most of the ship systems when the entire crew is present and focused on training. However, this does not mean that other training approaches cannot train crews to an acceptable level of proficiency.

We explored opportunities where using simulation might reduce underway training for DDG-51–class surface combatants. We focused on engineering training, a major driver of unit-level underway training, and explored options to sustain in-port readiness through the use of simulation. Our findings offer a potential solution to supplement and sustain the readiness of DDG-51 engineering CCS personnel through the use of an engineering simulator. The Navy's surface combatant community might be able to use an engineering simulator (similar to the one used at SWOS) for DDG-51–class ships. These simulators could be placed at the fleet training centers in major homeports to better prepare crews for underway engineering training and to make the use of underway time more efficient.

We also found that the DDG-51s currently being fielded have embedded training simulators that enable crews to train via simulation while using actual operational equipment. These simulator suites (provided through the Total Ship Training System upgrade) are being retrofitted on ships that are currently in service, but this is occurring at the relatively slow rate of two or three two ships per year.

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[4] The equivalency certification means that an exercise conducted on the simulator counts toward readiness reporting.

Recommendations

In light of our findings, we recommend that the Navy take the following three actions.

1. Invest in shore-based DDG-51 engineering simulators and place them at fleet concentration areas (FCAs). Wider use of engineering simulators at FCAs might reduce costs and increase watchstander proficiency in the performance of ECC exercises through increased repetitions and practice. Investing in such simulators appears to be cost effective. An engineering simulator similar to the one used at SWOS would cost approximately $1.6 million (not including sustainment costs). Given that fuel alone costs $40,000 per steaming day per DDG-51, it only takes a reduction of 40 steaming days to offset the simulator acquisition costs. As fuel costs increase, the number of underway days needed to offset the simulator acquisition decreases.

2. Take other actions to reduce underway days for ULT by completing more exercises in port. Our analysis indicates that many or most MOB-E, CCC, NCO, MOB-D, and FSO-M exercises could be done in port. To reduce underway training days, the Navy should direct those exercises that *can* be done in port indeed *must* be done in port.

3. Consider accelerating the installation of upgrades that provide DDG-51–class ships with an embedded engineering training capability that allows training to be performed onboard on the ship's equipment. The Navy is retrofitting DDG-51–class ships with an embedded engineering training capability through Total Ship Training System upgrades. Naval Sea Systems Command officials indicate that these installations are proceeding at a pace of one to two DDG-51s per year. Accelerating the rate of the installations would provide more ships with an embedded training capability and allow more training to be done in port on the ship's own equipment. These measures could produce cost savings. The costs, benefits, and feasibility of this approach must be evaluated.