The Promise of Shipboard Virtual-Reality and Handheld Training

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The Navy is shifting its training approach from an industrial model of sending sailors to schoolhouses toward one that includes bringing training directly to the fleet through gaming consoles. Today's consoles pack the power of full-fledged simulations into the ease and convenience of compact, shipboard-friendly sizes. Mobile virtual reality (VR) provides embodied immersion that builds muscle memory, while handheld gaming personal computers (PCs) increase the frequency of practice sessions without disrupting daily routines. Small enough to fit in a drawer and be played in a berthing or on the mess decks, portable commercial-off-the-shelf devices are tailored to a generation of sailors reared on video games.

Naval Air Warfare Center Training Systems Division (NAWCTSD) demonstrated the success of this approach in the fleet when it collaborated with a commercial vendor to convert a legacy touchscreen classroom program into a self-paced simulation run on affordable handheld gaming PCs and untethered VR headsets. The VR program received perfect scores from sailors, all of whom preferred it over the touchscreen version. This innovative technology is poised to directly support sailors ashore, afloat, and submerged.

The Opportunity

Classroom training is costly and inefficient. Congestion and delays in the training pipelines cost $400 million annually.[1] The moment sailors exit a classroom, they start forgetting what they just learned. The “forgetting curve” suggests that the half-life of newly acquired knowledge is often measured in mere hours.[2]

The Navy’s Ready Relevant Learning (now the Career Training Continuum) strategy aims to address these inefficiencies with instruction delivered directly to sailors in the flow of their work.[3] Instead of scheduled classes, sailors need repeated practice in digital environments that match the equipment and spaces they use and work in every day. Onboard training combats skill decay through spaced repetition.

To answer this challenge, the vendor adapted a module of the Multipurpose Reconfigurable Training System (MRTS) 3D® program that features a detailed 3D environment on 55-inch touchscreens in classroom settings. MRTS 3D allows sailors to engage in various simulated scenarios to practice real-time troubleshooting and maintenance procedures. The NAWCTSD team recognized the potential of a VR version to provide immersive training.

The VR Demonstration Program

With a VR simulation that completely engulfs users, sailors step into a virtually rendered submarine machinery room of convincing fidelity. Turning valves and tightening bolts, they feel tactile vibration in their hands and hear the diesel engine roar to life when started. It can be experienced in stand-alone VR headsets that are easily deployable on board. Users do not need cords or a PC, can be seated or standing, and can proceed in self-paced or multiplayer environments.

The unique value of VR is in the sense of “presence” (feeling of being there) and “agency” (having control over your actions) students experience as they rehearse tasks over and over.[4] Anyone who has not experienced the startling sensation of being transported to a virtual environment and performing hands-on tasks under stress—tasks such as troubleshooting a flooded diesel engine in a submarine machinery room—probably would not appreciate how far VR technology has come already. The feeling of presence is so convincing that students forget they are not actually there. Users pick up a wrench with their hands, fit it onto a bolt, and turn it, just as they would in the real world. The hyper-realistic 3D models, directional sound, and haptic-feedback hand controllers hack their senses of sight, touch, and hearing. Fully absorbed, sailors lose track of time as they learn and practice skills in a safe environment.

An instructor screen follows sailors through every step as they navigate the virtual *Los Angeles*–class submarine diesel engine, providing videos and text instructions to guide them through starting it. Students grab the instruction screen and position it in midair at the location most suitable for the task they are performing. Just like in real life, they use their hands to turn valves, push buttons, check gauges, tighten bolts, and pull levers. If they make a mistake, the scenario can easily be reset. Arrows at their virtual feet show users where to walk to their next task. If their real-world space is large enough, they have the option to physically walk around the simulated submarine or use controller thumbsticks to navigate the virtual space while seated or standing.

As sailors progress from the step-by-step instructions of the "learning level" to the "practice level," they gain realistic work experience. During the practice level, learners depend on real-world checklists and the competencies they built in the learning level. Contextual support tools, such as "help me" buttons, assist them when they get stuck, fostering a gradual, scaffolded buildup of proficiency.

Handheld Gaming PC Version

When a lack of comfort, space, or cybersecurity on board ships makes VR use challenging, sailors can engage with simulations on handheld gaming PCs, such as the Nintendo Switch and the Valve

Steam Deck. These devices have skyrocketed in popularity and are ideal for training on board a moving ship with limited physical space. The recent arrival of handheld Windows 11 gaming devices can bring learning simulations on board. Like the VR version, the PC program is self-paced, with tutorials, corrective feedback loops, and scaffolding. Navigating a virtual submarine with game controllers provides a user experience that matches the handheld gaming systems sailors have been using most of their lives. The same program developed for the handheld also can run on standard PCs with game controllers and Xbox consoles. These handheld companions give sailors countless rounds of practice and repetitions, perfectly complementing the deep immersion and hands-on practice of VR.

The program transcends traditional dimensions of fidelity, encompassing not only visual fidelity (looks real) and functional fidelity (acts real), but also achieving cognitive/psychological fidelity (feels real).[5] The focus is on replicating the essential cognitive skills of situational awareness and decision-making under stress. By immersing trainees in scenarios that mimic real-world challenges, the program ensures sailors develop the mental agility and emotional resilience necessary for effective performance in high-stakes environments.

Future Steps and Research

Future versions of the program could include a generative AI tutor. Imagine a virtual companion that would engage with sailors in open-ended conversations, providing personalized guidance and feedback. This approach could address psychologist Benjamin Bloom's "two-sigma problem," which identifies the challenge of delivering the benefits of one-on-one tutoring on a large scale.[6] By offering real-time assistance on a pocket-sized device, the AI tutor could go beyond learning to performance support.

Adding 3D spatial scenario recording for detailed after-action reviews is another capability that has proven essential for effective learning.[7] Learners and instructors can "walk around" in the 3D environment during the playback, rewinding key moments and debriefing with a live or AI-powered expert about how to turn insights into future mastery.

Future iterations of the program could incorporate gamification elements such as time pressure and scoring systems to foster a state in which learners become deeply engrossed in their activities, lose track of time, and fully engage with the material. By making the learning process more interactive and enjoyable, these elements would motivate trainees and reinforce their skills.[8]

The VR program's perfect user ratings and overwhelming sailor preference give compelling proof of concept, with enthusiastic support from Navy leaders further underscoring its potential. Yet, more research is needed to evaluate the efficacy of these new learning approaches. This includes analyzing cost savings, such as reducing training pipeline delays and evaluating performance improvements, which can reduce error rates and elevate productivity. In addition, the practicality of shipboard training must be further assessed, focusing on the durability and reliability of storing, maintaining, and using VR headsets and handheld gaming PCs in a shipboard environment. Another concern is the potential for them to cause seasickness on a moving ship. Finally, a comprehensive cybersecurity analysis is crucial to ensure the secure operation of these devices and systems.

Accelerating Navy readiness requires a full commitment to adopting these technologies. As Chief of Naval Operations Admiral Daryl Caudle has directed, Navy live-virtual-constructive efforts must expand beyond current practice "to span from unit-level training . . . to tailored wargaming."[9] This transition is not just about updating training tools, but also about fundamentally reimagining how to train sailors at sea. The new generation of portable simulations promises to accelerate learning at scale for the Navy, flattening the learning curve and boosting fleet readiness, whether in port or underway.

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