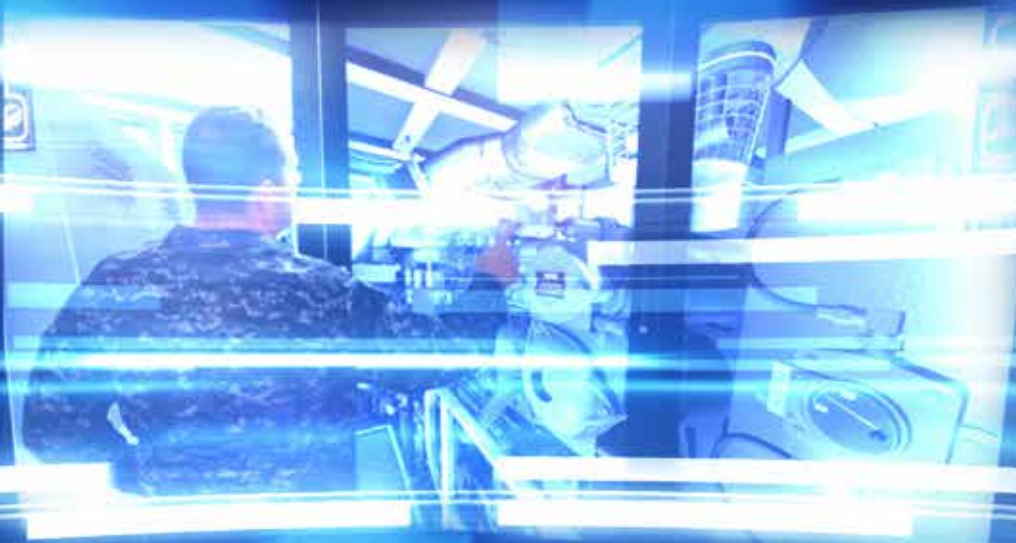


Multipurpose Reconfigurable Training System 3D™

Award Winner: NAWCTSD Team



In a breakthrough application of the latest three-dimensional (3D) physics-based gaming technologies, a team from the Naval Air Warfare Center Training Systems Division (NAWCTSD) has developed a standardized architecture and framework for producing a family of training simulators that replicates the functionality of the U.S. Navy's aviation, submarine, and surface ship tactical systems. This standardized framework can be used to produce photorealistic weapons systems in a simulated 3D environment for the military departments and our allies. The new Multipurpose Reconfigurable Training System (MRTS) 3D™ VIRGINIA Torpedo Room trainer and the MRTS 3D VIRGINIA Emergency Diesel Generator (EDG) trainer, both developed by NAWCTSD's Surface and Undersea Programs, represent a significant step forward in low-cost, high-fidelity simulation of tactical shipboard equipment and set the standard for future trainers. The MRTS 3D project has been focused on reducing total ownership cost since its inception. Compared to producing traditional single-purpose trainers using tactical equipment, NAWCTSD was able to significantly reduce costs by approximately \$15 million (80 percent reduction) leveraging open-source, industry-standard software development tools and the free Unity game engine. Employing commercial off-the-shelf (COTS) computer hardware running a commercial, open-source, physics-based gaming engine, the team created one of the most realistic 3D trainers available anywhere in the world.

Background

A traditional approach to weapons system trainers has been to modify tactical equipment for training use. Tactical training equipment (TTE) costs about as much as actual equipment fielded on naval platforms, requires specialized maintenance technicians, and competes with the fleet for spares and materials. TTE also tends to be single purpose in nature and takes a relatively large footprint in the Navy's training facilities.

There are dozens of computer-based training simulators in use by the Department of Defense. However, the vast majority of these multimillion-dollar trainers are limited in use to a specific airframe, ship, or vehicle.

Problem/Opportunity

Submarine training sites already had Legacy MRTS Weapons Launch Console Team Trainers (WLCTTs), which were two-dimensional representations of the Weapons Launch Console subsystem of the whole weapons system. These trainers used a single set of hardware to simulate three different classes of submarine weapon systems, and five different system configurations within those classes.

There were three problems:

- A full VIRGINIA Torpedo Room training simulation needed to be added to the WLCTT to three training sites. This simulation had to simulate the entire room's hydraulic and electronic systems and a full load-out of torpedoes and Tomahawk cruise missiles. The trainer had to enable the crew's entire weapons handling party to perform all actions associated with handling weapons and conducting torpedo and missile launch operations in a realistic 3D environment. The approximate cost to procure TTE was over \$12 million per site plus facilities modifications.
- A VIRGINIA Emergency Diesel Generator trainer needed to be added to two training sites. An actual diesel generator would cost \$3.5 million per training site, plus facilities modifications.
- The Groton, CT, training site had a diesel front panel simulator using much older non-MRTS technology and tactical components, but it failed and the Navy was having technical difficulty in repairing the trainer.

Approach

The MRTS 3D team has been focused on reducing project total ownership cost since its inception. The team was able to significantly reduce costs by leveraging open-source, industry-standard software development tools and the free Unity game engine. The team also developed government-owned editing tools to speed the creation of Navy-unique environments such as the VIRGINIA Torpedo Room. The MRTS 3D VIRGINIA Torpedo Room project totaled just \$1 million in software development costs and \$250,000 in hardware procurement. Because the software code is owned by the government, future installations will incur only the cost of new COTS hardware. The training simulation enabled the program office to offer weapons reload party team training without the cost of adding \$12 million torpedo tube banks at each of the seven training sites.

In regards to the Groton failed diesel front panel simulator, the MRTS 3D VIRGINIA Emergency Diesel Generator provided a very low-cost solution. Groton already had the MRTS 3D VIRGINIA Torpedo Room trainer, and the MRTS 3D VIRGINIA EDG software had already been produced for other training sites. For less than \$3,000 in labor and travel, NAWCTSD sent one engineer up to Groton and installed the MRTS 3D VIRGINIA EDG software application onto the MRTS 3D trainer and provided training to the diesel instructors. When compared to the approximately \$40,000 in materials that would be required to repair the diesel front panel simulator, the MRTS 3D VIRGINIA EDG trainer yielded 93 percent savings and actually provided improved training fidelity and capability compared to the older front panel simulator.

The MRTS 3D trainers use 55-inch flat panels with display technologies that allow for pressure sensitivity on the display with unlimited inputs. The display features near-zero parallax and ul-

tra-low latency so that the touch interface moves objects precisely, and with no hesitation. The physics engine used to develop the simulation is an industry standard that enables rigid body and soft body creation and object collision detection. The physics engine implements logical constraints between the objects, giving maximum flexibility during content creation.

The simulator allows an operator, by touching a display panel, to open and close the torpedo breech door, align the pivot tray with the torpedo tube, and use the hydraulic rammer to tubeload a torpedo or cruise missile in a realistic 3D environment. What makes the NAWCTSD trainer stand out, in addition to 3D imaging, is the successful replication of the real-world physical characteristics of each task. For instance, valves do more than simply turn “on and off.” Each valve is programmed to emulate common, real-world characteristics such as “stuck,” “easy to turn,” “hard to turn,” and “sticky.” As a result, NAWCTSD was able to achieve a training environment that is so realistic that, according to one submariner, “it’s almost like the actual component is there—and just sitting behind a sheet of glass.”

With the development of a standardized hardware specification and software architecture, additional MRTS 3D training applications can be developed for a single hardware device. By avoiding the use of proprietary software packages and ensuring that the government retained all software data rights, the team ensured that future device installations and code maintenance would come at minimal cost.

Outcome

The MRTS 3D VIRGINIA Torpedo Room and MRTS 3D VIRGINIA EDG are currently fielded on a shared hardware trainer to two training sites, with a third site scheduled to receive them soon. The Legacy MRTS WLCTT training applications also run on these hardware devices, saving approximately \$250,000 in hardware costs per training site, or \$750,000 total.

With the standardization of the COTS hardware specs for all MRTS 3D software applications, multiple training simulations can be loaded onto a single type of hardware, greatly reducing the cost and square footage required to train on a variety of training systems. The MRTS 3D VIRGINIA EDG software was loaded onto the same fielded hardware trainer as the VIRGINIA Torpedo Room, saving \$250,000 in computer hardware. Adding multiple software applications to a single hardware trainer also saves approximately 400 square feet in footprint requirements and tens of thousands of dollars in facilities preparation and installation work.

The MRTS 3D VIRGINIA Torpedo Room and MRTS 3D VIRGINIA EDG trainers yielded over \$45 million in cost avoidances compared to procuring tactical training equipment. MRTS 3D life-cycle costs are approximately 75 percent less compared to operating and maintaining tactical trainers.

Due to the success of the MRTS 3D program for the Naval submarine force, the Naval aviation and surface communities have funded additional MRTS 3D products, including trainers for the *FORD* class aircraft carrier's Electromagnetic Aircraft Launch System (EMALS) and Advanced Arresting Gear (AAG), the Mobile Electric Power Plant (MEPP) for aviation support equipment, and a radio room simulation for the *NIMITZ* class aircraft carriers.

Current Status

Fielded MRTS 3D trainers support sailors in initial pipeline courses, pre-deployment team training, and submarine crew operational performance. The aviation support equipment trainer, MRTS 3D MEPP, will be fielded in 2016 to support Navy and Marine Corps technician pipeline courses. The MRTS 3D EMALS and MRTS 3D AAG trainers are in the early stages of development and will be fielded in FY18–20. All of these trainers can operate on a single-hardware platform, allowing a single set of hardware to provide training to an almost unlimited variety of mechanical and electronic technicians.

Challenges

Some technicians and training leadership personnel were hesitant to shift from tactical hardware to computerized simulations of their equipment. After personnel have seen and used the MRTS 3D products, the popularity of NAWCTSD's approach has exploded, which has resulted in the aviation and surface communities funding additional MRTS 3D projects. NAWCTSD has been able to achieve a training environment that is very realistic.

About the Award Winner

The NAWCTSD team consisted of David Thomas, Darrell Conley, Bill Zeller, Khoa Vu, and Christopher Freet. Mr. Thomas was the lead project manager for all MRTS projects. Mr. Conley was the project manager for the MRTS 3D VIRGINIA Torpedo Room and MRTS 3D VIRGINIA EDG. Mr. Zeller was the lead systems engineer for the MRTS 3D VIRGINIA Torpedo Room, Mr. Vu was the lead systems engineer for the MRTS 3D VIRGINIA EDG, and Mr. Freet was the lead software engineer for both projects.