## Strike Group Defender: The Missile Matrix

Video game enhances ship-defense training of U.S. Navy personnel.

From extending the reach of the military, to defending against ballistic missiles, to countering piracy, to responding to natural disasters, the U.S. Navy surface fleet performs critical missions to protect national interests at home and abroad. The emerging capabilities and proliferation of modern anti-ship cruise missiles (ASCM) present a considerable threat to Navy surface ships and their missions. The Navy has developed an array of hard-kill (missile interceptors) and soft-kill (electronic warfare, e.g., decoys, chaff, jammers) counter-ASCM systems to defend against this threat.

For optimal effectiveness, each system must be employed quickly, correctly, and judiciously relative to the particular threat scenario. For example, a single decoy may be very effective at countering simultaneous threats coming from one direction but not so effective at countering threats coming from multiple directions. In the latter case, several decoys or a combination of hard- and soft-kill options must be used. Sailors therefore must understand the correct employment and likely effectiveness of not only individual systems but also combined systems. Layering individual counter-ASCM systems into a single defensive strategy increases the complexity of the combined systems' capabilities and limitations. This complexity makes it difficult for sailors to decide which layered response will prevent the ship from getting hit—a decision that must occur in a matter of seconds.
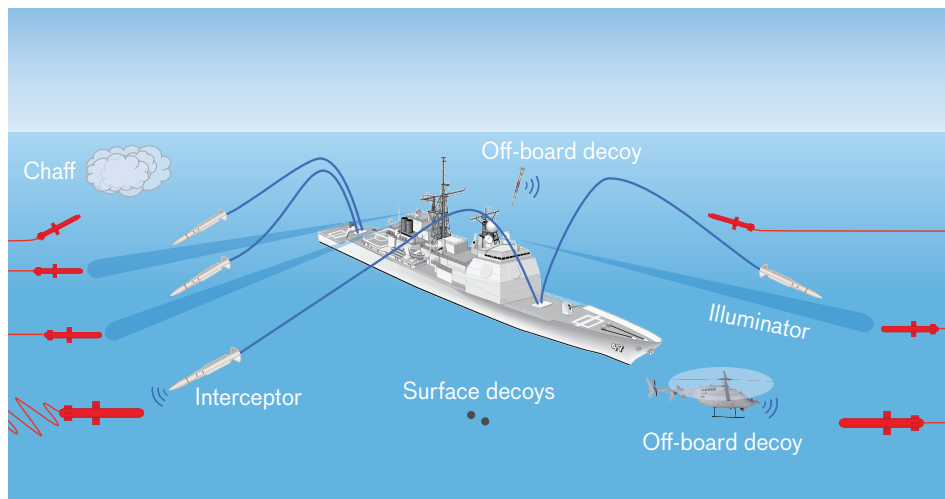
U.S. Navy personnel can deploy various hard- and soft-kill systems to defend their surface ships against anti-ship cruise missile threats (red).

A Training Game for a Modern Challenge

Under the direction of the Office of Naval Research, Lincoln Laboratory has partnered with industry video game developer Pipeworks to create an interactive surface warfare game that trains sailors to tactically plan for and respond to threats posed by modern ASCMs. Featuring compelling gameplay and commercial-quality graphics, *Strike Group Defender: The Missile Matrix* immerses users in realistic threat scenarios and challenges them to select appropriate countermeasures to cruise missiles heading toward their ships.

Gameplay is based on a performance matrix representing all pairings of threat missiles and countermeasure systems. Each matrix entry contains a percentage indicating the likelihood of the countermeasure defeating the threat. At the most basic level of instruction, users improve their performance by learning which individual defensive systems to use against particular threats, and when. As players advance their skills, they learn how best to combine multiple defenses to counter incoming threats.

Game Modes

Scenarios are played in real time and typically last a few minutes. Each of *Strike Group Defender's* modes provides different instruction to the user:

- Tutorial. Straightforward scenarios with a single type of incoming threat coupled with a virtual instructor teach players where and when to deploy the correct countermeasures.
- Single-player defense. Controlling a single ship or group of ships, users defend against a computer-controlled ASCM attack in a variety of scenarios across a range of difficulty levels based on the number of incoming threats and the availability of countermeasure resources.

- Multiplayer defense. Through in-game text messaging or over a voice network, multiple players collaborate in real time to defend surface ships against a computer-controlled ASCM attack.
- Multiplayer offense versus defense. One player controls the adversary ASCMs (i.e., offense) while all other players collaborate as the defense. This setup enables players to gain insight into potential adversary strategies and the tactics to counter them.

Benefits
Because the software was built using the Unity Technologies cross-platform engine and runs on any web browser, the game is easily deployable to and accessible by a wide user base. The game is deployed in a similar way to many commercial online games, with software updates being pushed out to all players' local computers; at startup, the game connects to a primary cloud server so that players are always presented with the most up-to-date software version. Other benefits are found in the following areas:

Education
Unlike traditional lecture-based teaching methods, *Strike Group Defender* is based on an adaptive-learning approach. Data collected during every game are fed into machine-learning algorithms that extract features useful for assessing how players are learning (e.g., the tutorials they are selecting, the frequency at which they pause the scenario). Instruction can then be tailored to the learning needs of individual players. A virtual tutor could, for example, suggest that a sailor who has been replaying a simple scenario try a more challenging one.

Evaluation
During the game, players' behaviors, down to the individual mouse-click level, are recorded. By analyzing this behavioral data, instructors can determine the areas in which students are excelling and those in which they are having difficulty. With this knowledge, instructors can mitigate mistakes commonly made by players. The behavioral analysis may also reveal inno-

The primary display uses a third-person perspective, with the ships under the player's command in blue and the inbound threats in red. A top-down view of the entire scene is shown in the lower-left corner. To respond to threats, players select from among the available countermeasures (blue boxes on right). Alerts of new threats and incoming messages from other players are sent via the dialog box (lower right).

vative defense strategies that can then be taught to other naval personnel. Game logs that provide feedback on the actions operators take during the simulations can fuel improvements to the training scenarios by providing insights into the operators' decision-making processes.

Exploration
The intuitive nature of video games and the immersive environment of *Strike Group Defender* encourage users to experiment with tactics. For example, playing the same scenario multiple times, users can test different strategies, thereby gaining a deeper understanding of which ones do and do not work and why. Players can also construct their own scenarios through the game's built-in scenario editor. The real-time simulations help sailors develop the rapid-reaction decision-making skills that are required to respond to complex, real-world missions.

Collaboration
The game's interactive features support peer-to-peer instruction. Through built-in message boards similar to those on social media networks, players can discuss strategies and share scenarios they have built. A scenario-playback feature lets players watch how others approached a situation. Because players receive scores based on their performance, the scenario leaderboard, which tracks top performers, promotes competition and motivates players to improve their skills.

Evaluation and Enhancement
A panel of international judges at the 2014 Interservice/Industry Training, Simulation, and Education Conference selected *Strike Group Defender* as the best serious game entered by a government organization into the Serious Games Showcase and Challenge. Lincoln Laboratory engineers and Pipeworks developers, along with personnel from the Naval Postgraduate School, the Naval War College, and the Navy's Third Fleet, continue to evaluate *Strike Group Defender*. Their recommendations will help determine modifications to the software.

Recently, the game was updated to include more realistic effects, such as limited and even erroneous situational awareness. Future versions of the game may add more analytical tools to help commanders evaluate users' understanding of defense strategies. As new threats in ship defense emerge, game weapons and scenarios will be adapted. ∎

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