Penn State Project with NSWC Dahlgren Division Explores Safer, Smarter Ordnance Handling

ATLANTIC OCEAN – U.S. Navy Gunner’’s Mate Seaman Desmond Summers removes a Mark 45 5-inch round from an ammunition bin aboard the guided missile destroyer USS Arleigh Burke (DDG 51) Feb. 26, 2014, in the Atlantic Ocean. Onboard today’s naval warships, some of the most critical weapons tasks still depend on human muscle. Automating projectile handling could make the task safer and more efficient. (U.S. Navy photo by Mass Communication Specialist 2nd Class Carlos M. Vazquez II/Released)

By Kristin Davis, NSWCDD Corporate Communications, Jan. 21, 2026

DAHLGREN, Va. – While modern naval warships field advanced

weapons systems, many essential ordnance-handling tasks still depend on human muscle. Sailors manually move heavy projectiles and propellant charges through cramped, hot and constantly moving spaces.

The work is labor-intensive – and inherently dangerous.

Engineers at Naval Surface Warfare Center Dahlgren Division are exploring how commercial robotics systems can be adapted to automate projectile handling, making the process both safer and more efficient. While some technology already exists, the end-of-arm tool – a component that directly interfaces with the ordnance – must be customized for each weapon system, said Matt Lehr, Mechanical Design and Integration lead for the Gun Weapon Systems Mechanical Design Branch of the Integrated Engagement Systems Department at NSWCDD.

This past fall, NSWCDD partnered with Penn State, sponsoring a capstone project in which engineering students took on the task of developing such a tool. They had one semester to research existing robotic grippers and effectors, design a custom end-of-arm tool, build and test prototypes and refine their product.

The project brought a fresh perspective to NSCWDD engineers working to make ammunition handling safer, faster and more sustainable for today's fleet – while giving students the chance to tackle a real-world defense challenge.

There were surprises along the way – and ultimately, success.

But before any of that work could begin, the project started the same way many real-world engineering challenges do: with a team of strangers.

Hands-on innovation

None of the students knew each other at first.

"Starting a big project with random people you don't know was

definitely a new experience," said Jackoy Gayle, an electrical engineering senior at Penn State.

But they quickly organized into team roles and divided up tasks based on their experience and areas of expertise. Victoria Walker, a mechanical engineering student who has analyzed acoustic data from unmanned underwater vehicles and built a robotic dog, would serve as project manager.

Walker was immediately drawn to the project. She plans to study robotics in graduate school and has already worked on unmanned underwater vehicles for Naval Surface Warfare Center Carderock Division. Still, the end-of-arm tool was different from anything she'd worked on before.

"At Carderock, it was a lot of code processing and data. This was very hands-on," she said.

It was also the first time Walker and the other students had relatively free rein to engineer a solution to a problem.

"In school, we receive really structured projects," she said. "Dahlgren gave us parameters and told us to come up with what we thought would work best. We started by coming up with a ton of different solutions for the end-of-arm tool."

Among them: an electromagnetic gripper to retrieve projectiles from their inventory and place them into a loading system. They nixed the idea; such a gripper would only be compatible with certain materials.

"We talked to others at the university and settled on a vacuum gripper," Walker said.

It was an out-of-the-box solution that surprised Lehr.

"I was initially skeptical of the vacuum approach," Lehr said. "But it allowed the team to keep the design compact, which is needed for the system to be able to deposit the projectile into the narrow receptacle of the handling system."

The engineering challenges weren’t theoretical – they showed up immediately in the lab. Gayle, the electrical engineering student, discovered that the electronic prototyping platform he utilized was rated for 5 volts but the equipment he needed to run was more than twice that. He solved the problem by using a relay. When air began to leak through the vacuum system once it reached a certain level, he resized the tubing. And with no real-life projectile to work with, Gayle earned a metal shop certification so he could resize their dummy ammunition.

From concept to proof of capability

Over the course of the semester, students had regular meetings with NSWCDD engineers as they designed and 3D-printed a custom vacuum manifold fitted with suction cups, paired with a simple vacuum system and pressure reservoir. Early prototypes successfully lifted a 40-pound model projectile. Later versions successfully handled a 70-pound model – the equivalent of a Mark 45 5-inch gun round.

To take it a step further, the team integrated the tool with a robotic arm, demonstrating that it could lift and place a projectile into a loading bay – a key step toward automating future magazine-to-gun workflows.
From Lehr’s perspective, the students more than met the intent of the project.

“They did a wonderful job and accomplished a lot within the time and budget they were given,” he said. “They developed a prototype end-of-arm tool, integrated it with a robot, demonstrated projectile manipulation and proved the design could pick up a round in both vertical and horizontal orientations.”

In a fitting finale to the project that bridged academic innovation with real-world Navy impact, the team attended the Capstone Project Showcase at Penn State College of

Engineering’s Learning Factory, where their end-of-arm tool took second place.

“We’re really proud of it,” Walker said. “It worked, we were able to demonstrate it worked, and we were able to show that on a specific robot. We’re proud of how far we came, and I think another team in the future could make it even better.”

Looking ahead

If the project is funded for further refinement, the prototype could be improved to ensure it would be capable of operating in harsh environments, Lehr said. “We would also add redundancy features to ensure there is no possibility of a mishap in the event of a fault.”

While many other portions of automation must be developed before fielding a complete system, this project represents an important first step toward reducing risk and physical strain for Sailors.

“This type of technology could be used in the deep magazine to withdraw projectiles and feed them into the ammunition hoist,” Lehr said. “This would allow the system to keep up a high rate of fire over long durations without fatiguing the crew.”

Similar robotic tooling could one day be applied to propelling charges and other ordnance, forming the backbone of semi-automated or fully-automated weapons handling systems across the fleet.

If matured and fielded, the impact on Sailors and the Navy could be significant.

“The goal is to provide Sailors with tools that reduce their workload,” Lehr said. “From a Navy standpoint, automation can reduce the demands for crew size, allowing more assets to be fielded for a given force and enabling that force to be prioritized for other tasking.”

For the Penn State engineering students, the experience offered a rare opportunity to work on technology that could one day be used by Navy warfighters.

“I’m grateful for the team, the support we had from NSWCDD and the chance to work on something that really matters,” Gayle said.