

Space to Sea: Low Earth Orbit to Ocean Dominance

After years commanding satellites,
an engineer dives deep

BY ELAINE BRABANT, BOEING WRITER

Off the California coast, divers drop into the ocean. They stay mostly hidden, like the underwater vehicles they design and now test.

What these engineers do is so progressive, so impactful to U.S. security that much of their work is secret. Yet these teammates are openly developing and producing the U.S. Navy's Extra Large Uncrewed Underwater Vehicle (XLUUV), known to the U.S. Navy as Orca. The development program will produce the world's largest autonomous submarine. Boeing self-funded a proof-of-concept vehicle, the 51-foot-long (16-meter-long) Echo Voyager.

SURFACING AUTONOMY

Boeing's prototype, Echo Voyager, undergoes testing off the coast of Southern California.

PHOTO: BOEING



DEEP CONVERSATION

Ann Stevens (red vest) discusses logistics before ocean testing in Long Beach, California, with fellow Boeing engineers (from left) Dutch Williams, Brian Phelps and Meghan Guerrero.

PHOTO: PAUL PINNER/BOEING

A Force of Nature

The vessel must independently navigate the ocean for months at a time, withstanding forces more extreme than air or space. It's a responsibility that self-described "space geek" Ann Stevens couldn't resist.

"I've always liked to solve really hard problems," said Stevens, who spent the first of her two decades at Boeing working on satellites.

Now she leads Boeing's Maritime & Intelligence Systems business.

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A Product Without Wings

Shock often registers on people's faces when Stevens or her teammates explain they're building a submarine. Even though Boeing has developed underwater vehicles for 60 years, most of the company's products fly. The relatively small Maritime Undersea team specializes in solving a unique set of challenges.

Underwater vehicles must endure highly pressurized, corrosive ocean water. Plus, unlike airplanes or spacecraft, undersea vehicles don't have a communications link.

"You can't talk to something underwater," said Stevens, who once monitored satellites and recalls the need to "talk" to them, giving commands 24/7. "Our maritime vehicles need to do their missions perfectly without any human intervention. That's the headset of this team. That's the way we think of autonomy."

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ALONE AND UNAFRAID

This is the second and latest XLUV developed and built by Boeing. Known as Orca, it uses advanced autonomy to operate for months at a time without human intervention.

PHOTO: BOEING



XLUV Deep Dive

Boeing's XLUVV delivers unprecedented endurance, capacity, mission flexibility, reliability and autonomy. This game-changing combination expands strategic and tactical options for previously unattainable missions, allowing operators to reexamine their approach to undersea and seabed warfare.

Key Features

- **Advanced autonomy:** Operates for months at a time in open, congested and contested waters on its own.
- **Obstacle avoidance:** Enabled by sonar and proven autonomous algorithms.
- **Resilient and redundant:** Provides unmatched mission assurance.
- **Payload:** Offers unprecedented internal and external volume.
- **Independent of host ship:** Swims from the pier to simplify labor and logistics.
- **Reduced cost:** Enabled by in-water maintenance through a blend of endurance, host-ship independence and novel design features.



IMAGE: BOEING



DIVE-READY

The main mast houses communications and snorkel capability during littoral-/surface-level operations. (Left) Capt. Jason Weed, U.S. Navy Commodore of the Unmanned Undersea Vehicles Squadron ONE, stands with retired Boeing engineer Dan Tubbs, who played a crucial role in the development of Boeing's XLUVV.

PHOTO: BOEING

In some ways, the team operates like a startup. Customers bring them problems. Then, engineers and technical experts in Huntington Beach, California, and Herndon, Virginia, propose, debate and provide solutions. Their products can go from concept to design, development, assembly and deployment in just a few years.

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XLUUV in the Numbers

- 1 Advanced, trusted autonomy
- 2 Multi-spectrum communications
- 3 Redundant sensor/snorkel masts
- 4 Independent field-replaceable pressure vessels
- 5 Redundant battery and diesel generator
- 6 Modular multi-mission payload bay
- 7 Multi-sensor situational awareness capability
- 8 Multi-source integrated navigation
- 9 Integrated mooring system
- 10 Precision forward/downward sonar

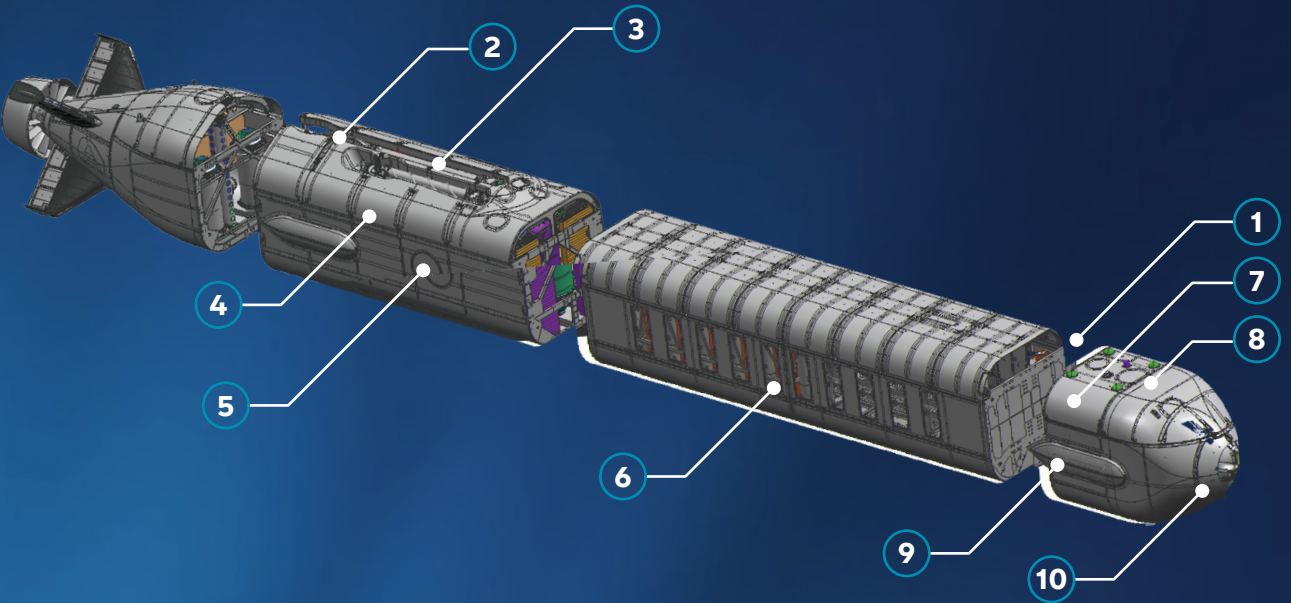


IMAGE: BOEING

Tough Talk Yields Transparency

Though sea challenges differ from those Stevens encountered putting satellites into space, she notices a common thread. Tough problems require tough conversations. Stevens doesn't back down from either.

Teammates say they never have to guess what she's thinking. That thing no one wants to talk about? She'll go there. But she has learned to do so thoughtfully.

"If people are talking around a problem, I could be blunt and say exactly what's on my mind, but that may not be well received," said Stevens, who studied human and group behavior, earning a master's degree in organizational management.

"As I've matured as a leader, I haven't grown less transparent, but I have learned how to read a situation and be mindful of how I deliver that transparency," she said.

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WATER ONCE-OVER

Engineers enter the ocean to inspect the vehicle and adjust equipment.

PHOTO: BOEING

That philosophy also applies to how she develops people.

“My job is to make my team the best they can be,” Stevens said. “I tell them when I think they’re right or wrong, and I give them the help they need to grow.”

She and her leadership team talk weekly about talent. They spotlight individuals’ achievements and career goals, as well as identify ways to expand skills through on-the-job experiences and mentorships.

“There are so many opportunities at Boeing,” Stevens said, pointing to her own journey from space to sea. “I’m proof that you can have more than one career here. It’s an incredible place to be if you are an ambitious engineer, and you want to do really meaningful things.” **IQ**

DRIVE-BY

A Boeing team member evaluates Echo Voyager during sea trials.

PHOTO: BOEING



IN SILENT SERVICE

Orca will soon roam the seas, keeping a quiet watch from below.

PHOTO: BOEING



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