Our Ship Comes In

Research vessel Neil Armstrong joins WHOI fleet

by Ken Kostel

R/V *Neil Armstrong* arrived in its home port of Woods Hole on April 6, 2016, to a full dock and a joyful welcome that included a multiship escort, a brass band, fireworks, and cannon fire.

Photo by Jayne Doucette, WHOI

I woke up the first night out of Anacortes, Washington, when the ship dropped out from under me and I levitated off my bunk. Then came the sound of shuffleboard in the conference room one deck above. The only trouble was, there's no shuffleboard on the research vessel *Neil Armstrong*.

It was Halloween 2015 in the Northeast Pacific. We were in the first hours of the first voyage of the newest ship in the U.S. academic research fleet, and we were already plowing through 15-foot waves. But the ship's motion made it feel more like we were facing much heavier seas. A hammering gong rang through the hull to announce the trough of each wave, while the shuffleboard game continued through the night. As I lay awake, I kept thinking back to something Kent Sheasley, *Neil Armstrong*'s captain, told me on the bridge just before we cast off: "No one knows how the ship will ride. We haven't taken her out into open water yet."

Then a crowd of well-wishers from town (including one Halloween Frankenstein), who had come to think of the 238-foot-long *Neil Armstrong* and its crew as their neighbors, slipped our lines from the dock and we were away. Come what may, our bow pointed down the Strait of Juan de Fuca to the open ocean.

The first vague idea of what would become the *Neil Armstrong* took shape in the 1990s, when the U.S. Navy began to lay the groundwork to replace some of the largest and oldest Global Class research ships, which by then were well into their third decade of service. In 2002, the Navy announced plans to build a new Ocean Class of vessels. They were intended to cost less to build and operate than the Global Class ships, without compromising their ability to remain at sea for weeks at a time and carry scientists into nearly every corner of the ocean not covered by ice.

In the five decades since astronaut Neil Armstrong landed on the moon, just nine new large research ships have been built and added to the U.S. academic research fleet. Two were retired and replaced by *Neil Armstrong* and its sister ship, *Sally Ride*. That leaves only seven large ships—the equivalent of ocean-going space shuttles—and a dwindling number of small- and medium-sized ships to explore two-thirds of our planet's surface.

There are strong links between outer space and ocean exploration. NASA's space shuttles were all named after famous ships that explored the ocean: *Endeavor* after the ship Captain Cook sailed to discover Australia and New Zealand; *Discovery* after the ship that found the colony in Jamestown, Virginia, and later explored

U.S. Navy photo by John F. Williams/Released

Carol Armstrong, wife of the late astronaut Neil Armstrong and the ship's sponsor, broke a bottle of champagne across the bow of the ship bearing her husband's name during the dedication ceremony on March 29, 2014.

the Northwest Passage; and *Atlantis* after the nation's first ship built expressly for ocean research. Even before the shuttles, the first space missions gave us a new perspective: For the first time, we could look back on Earth from space and see just how the ocean dominates the face of the planet we call home.

In 2012, the U.S. Navy announced that the two newest oceanographic research vessels would be named after pioneers of space exploration. But where the shuttle *Endeavour* alone cost $1.7 billion to build, the *Neil Armstrong* and *Sally Ride* together cost U.S. taxpayers about $200 million.

While Navy officials worked with the science community to hammer out details of the ships' design, four oceanographic institutions competed for the job of operating the new vessels, and in 2010, the Navy awarded the first of the class to Woods Hole Oceanographic Institution (WHOI). What was then known as AGOR-27 would become the latest in a long line of WHOI-operated ships that began in 1930 with the original *Atlantis*. Five more years passed as the ship slowly took shape, first on paper and then in steel on the shipyard of Dakota Creek Industries (DCI).

All that planning and hard work culminated on a rainy autumn day in Anacortes when the last of the lines were cast off. A double crew, almost all of them veterans of the retiring WHOI research vessel *Knorr*, was on board to learn their new ship and bring it south to San Francisco, the Panama Canal, and its home port in Woods Hole, and eventually into the historically fierce conditions of the North Atlantic.

Build it and they will come

Gary McGrath was working as chief engineer on *Knorr* when the plans to replace it with a new ship moved from conference calls and meeting rooms to the shipyard. For much of the three-plus years it took to build the *Armstrong*, McGrath made Anacortes his home away from Cape Cod. His tenure as WHOI's representative at DCI coincided almost exactly with the college careers of two of his children. *Armstrong*'s inaugural voyage marked a third graduation in four months for McGrath.

Neil Armstrong and its sister ship *Sally Ride* were assembled by DCI in large sections known as blocks. Each of the major hull blocks was constructed individually and then fit together like massive Legos. The method is meant to speed the building process, but it also requires a high level of skill and attention to detail.

This was also the first time that DCI built a ship for the U.S. Navy, or anything as complicated as an Ocean Class research vessel. "A commercial vessel is basically just a cargo hold with an engine and a bridge," said McGrath. "There are systems on *Armstrong* you'll never find on a commercial ship. The amount of [electrical and fiber-optic] wire they had to run alone was phenomenal. But they did a great job. Their steel work is excellent. Their welds are perfect. This is one tough little ship."

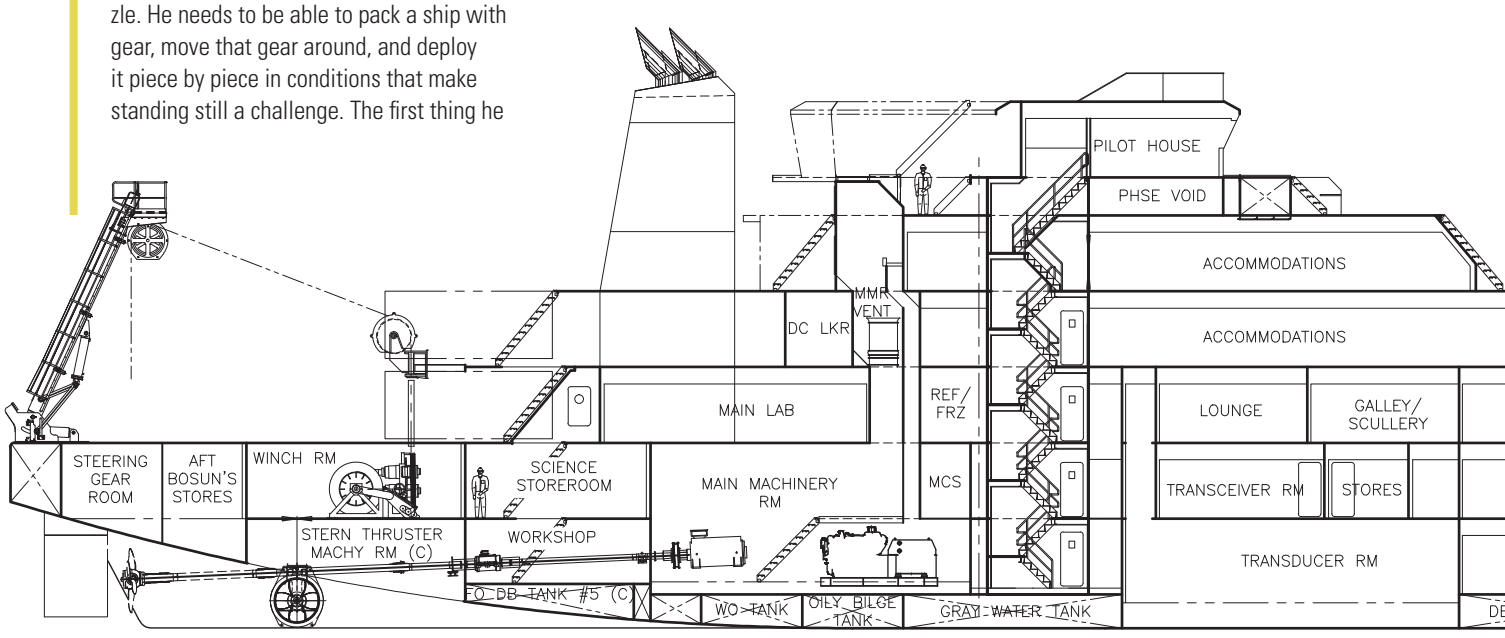
McGrath knows how and where almost every part was installed, how tricky marriages between components were made, and what still needs to be improved. For

Shipshape and Well-Equipped

John Kemp has spent as much time on boats as on land over the past 30 years, putting scientific instruments into the ocean and bringing them back. Kemp is the at-sea operations leader of WHOI's Mooring Operations, Engineering and Field Support Group. To him, a ship is a giant floating puzzle. He needs to be able to pack a ship with gear, move that gear around, and deploy it piece by piece in conditions that make standing still a challenge. The first thing he looks at when he walks on a ship is the size and layout of the deck's work area and the size and position of the ship's crane.

He was aboard the research vessel *Neil Armstrong* for a cruise in February when crew and technicians began testing handling and operations of various instruments and equipment on the ship for the first time. During that trip, he was finally able to answer a question that had been nagging him for quite some time: Is it big enough and flexible enough to handle big loads?

"You look at schematics for two years and wonder how it will do," he said. "But

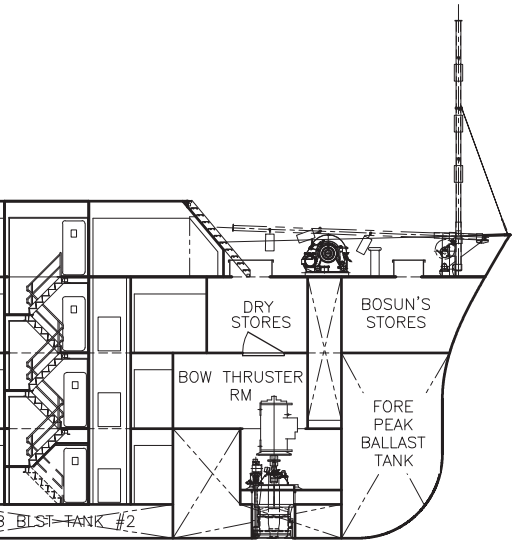


Gary McGrath, WHOI

Neil Armstrong was assembled over the course of three years at the Dakota Creek Industries (DCI) shipyard in Anacortes, Washington, using a technique known as modular block construction. Each of the main hull sections was built separately and then welded together. Here, workers attach the ship's bow section to the nearly finished hull.

when you finally see it, you can tell it's going to be great. I think people are going to be pleased."

More cruises throughout the spring and fall tested everything from the layout of the ship's lab to its collection of acoustic instruments, including two multibeam echo sounders designed to operate at different depths. The EM122 is particularly suited to survey the ocean floor all the way to Challenger Deep, if needed. To this, the ship adds an EM710, which is optimized for shallow water. *Neil Armstrong* and its sister ship *Sally Ride* will be the only ships in the U.S. academic research fleet equipped to conduct high-resolution seafloor surveys almost anywhere the ships can sail.



Scientists are also interested in studying the region between the ship and the seafloor. For this they have three acoustic Doppler current profilers (ADCPs) that can scan the water column at different frequencies to reveal the invisible structure of water at varying depths and resolutions. But the crown jewel of these acoustic instruments is the EK80, a multibeam, multifrequency echosounder that goes way beyond the capacities of its single-beam, single-frequency cousin, the fish-finder. The EK80 can not only detect the presence and abundance of marine life beneath the ship, it also offers the potential to differentiate among species of fish and other marine life hidden beneath the surface. "It's like going from a black-and-white TV to color," said David Fisichella, head of WHOI's Shipboard Scientific Services Group.

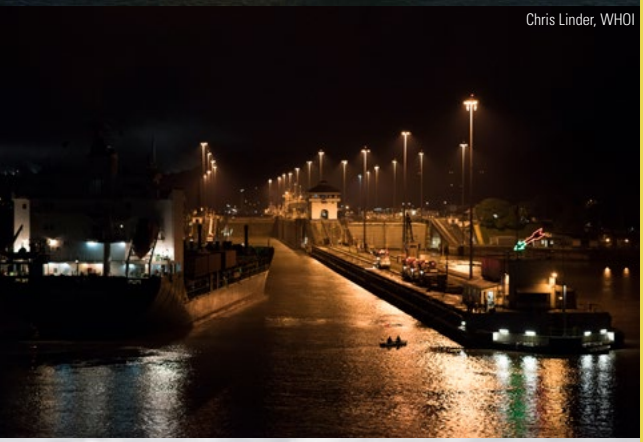
For engineers, *Neil Armstrong* offers plenty to be excited about. In addition to clean-burning diesel-electric generators, it has variable-frequency DC propulsion, which means less wear and tear on critical components and higher efficiency. The new ship's integrated controls provide access on touch screens in the engine room and bridge to virtually every critical system, from propulsion and navigation to electrical load to heating and air-conditioning to ballast. And for those times when a little extra help is needed, the navigation system can be monitored and diagnosed from shore.

But many early and anticipated users of the ship agree, the most important part of the ship's systems are the humans on board to run them. For that, said Kemp, the *Neil Armstrong* excels in ways that no shipyard could design. "Having the *Knorr* crew on board really elevates it."

—Ken Kostel

Gary McGrath, WHOI

Bay Aerial, WHOI



Chris Linder, WHOI

Dave Wellwood WHOI

Daniel Cojanu, WHOI

him, *Neil Armstrong* will always be a work in progress. "When you look at a flat piece of paper, it doesn't really tell you just how everything is going to fit. Now that we're operating, we're always going to find things that need to be changed."

Aboard *Armstrong*'s first voyage in November 2015, the rough weather continued through the next day and much of the following. Our course south toward San Francisco meant that we had to take the southeasterly swells on our stern quarter. The ship, not yet freighted with science equipment, rode high and skittishly. The shuffleboard game turned out to be some loose chairs, which were easily remedied, but as crew members made their rounds, they began taking note of things they would have to adjust.

Countless small things cropped up and were quickly fixed. Bigger things, like the hammering, which turned out to be caused by the way the anchors fit against the bow, would require a design team and the services of a fully equipped shipyard. Thankfully, a shipyard in Charleston, S.C., was the next stop after San Francisco and the Panama Canal. There, the list that McGrath and his engineers began compiling right off the dock met the equally long list for the final phase of the ship's outfitting.

Built-in advances

When David Fisichella looks at *Neil Armstrong*, he sees data—more than any ship in the academic research fleet has ever produced. "It's what she does," said Fisichella, who heads the team of technicians in the WHOI Shipboard Scientific Services Group (SSSG) that operates the scientific instruments on the ship. "Some ships carry cargo or oil. Ours carries data."

After *Armstrong*'s initial transit from the Pacific, it arrived in Charleston in December, where Fisichella and his team helped WHOI's Ship Operations group turn *Neil Armstrong* from an ordinary ship into one of the most advanced research vessels afloat. As part of the construction contract, the Navy provided nearly $10 million to purchase and install scientific instrumentation—from the multibeam sonars on the bottom of the hull to the communications array on top of the wheelhouse. Once calibrated and fine-tuned, all of these will make it possible for the ship to investigate organisms living in the ocean, map the seafloor from shallow coastal waters to the deepest depths, examine interactions between the sea surface and atmosphere, and probe currents beneath its hull. (See "Shipshape and Well-Equipped" on Page 38.)

In many respects, though, it's what can't be seen just by looking at the ship that sets *Neil Armstrong* apart. Though it's still too early to tell for certain, observations during *Armstrong*'s initial cruises indicate that its fuel consumption will be noticeably less than that of other ships. At the same time, its marine diesel engines comply with the Environmental Protection Agency's regulations to reduce exhaust emissions from large ocean-going ships. The separators that remove oil from seawater used as coolant and ballast meet and often exceed international limits for oily water discharged back to the ocean. In some cases, the discharged water will be cleaner than it is when *Armstrong* takes it in.

But one of the biggest advances is in the ship's hull design and overall construction. The keel is designed to keep bubbles away from the acoustic sensors mounted on the bottom of the hull, something that should greatly improve scientists' ability to map the seafloor and

Top to bottom: The trip from Anacortes to Woods Hole began in 2014 when the ship first touched water off a pier at Dakota Creek Industries shipyard. After sea trials and acceptance trials in 2015, *Neil Armstrong* made its inaugural voyage down the West Coast to San Francisco and eventually to the Panama Canal and the Atlantic Ocean. In Charleston, N.C., it received the bulk of its scientific instruments and also met WHOI's other research vessel, *Atlantis*, for the first time before sailing to Woods Hole in April 2016.

> They did a great job. Their steel work is excellent. Their welds are perfect. This is one tough little ship.

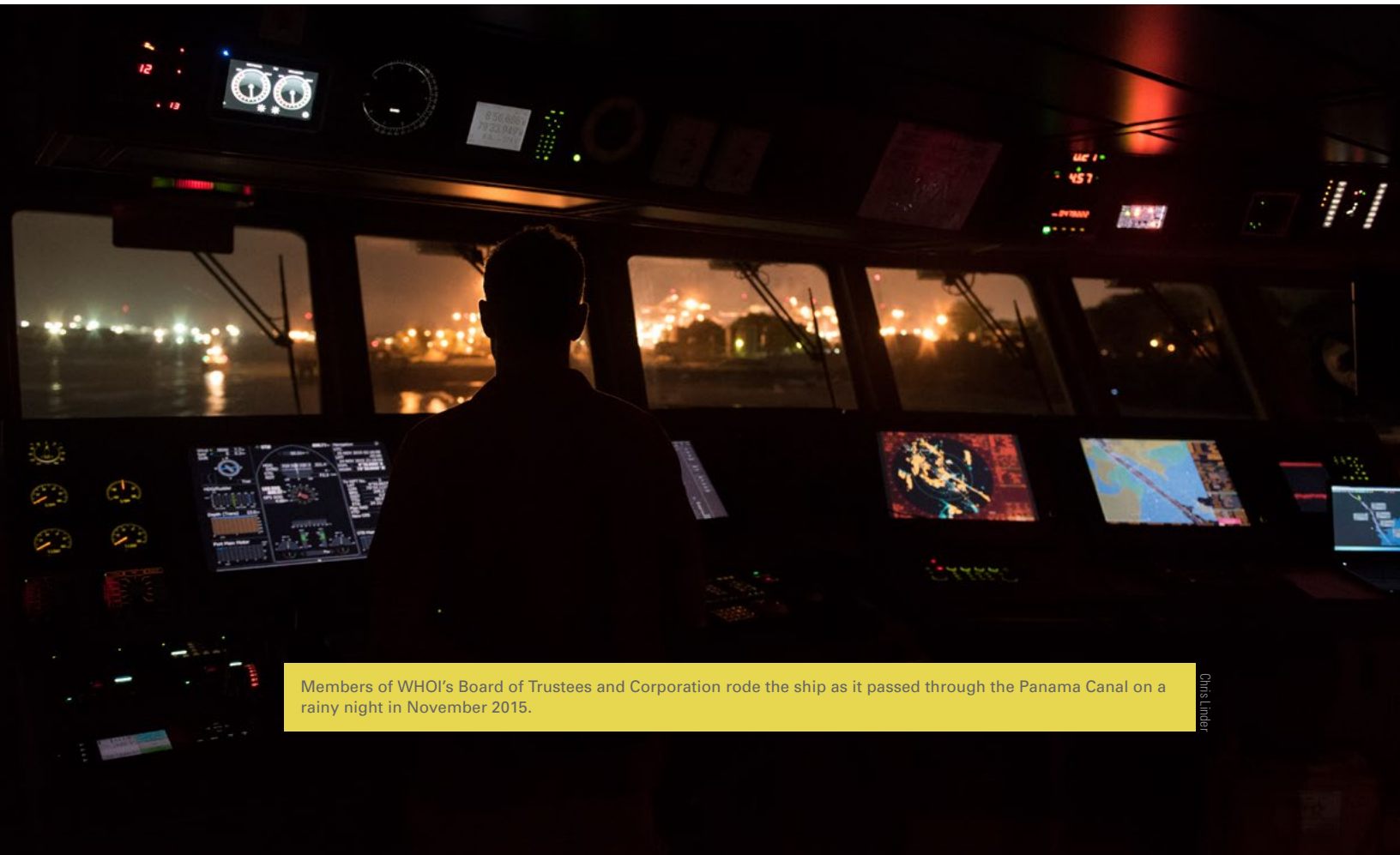
Ken Kostel, WHOI

Chief Engineer Gary McGrath (front), shown here working in the main control station off *Neil Armstrong*'s engine room with second assistant engineer Vasile Tudoron, spent almost the entire period of the ship's construction at the shipyard in Anacortes.

the water from surface to seafloor. In addition, much of the ship's machinery, from engines to air-conditioning units, is mounted on vibration-absorbing shock absorbers to reduce the noise that the ship radiates into the water. The final analysis is yet to be written, but early tests indicate that the ship is much quieter than its design specifications.

"It's a lot of ship in a compact package," said Rob Munier, WHOI vice president of marine operations "And we're going to ask it to do a lot."

Taking a new research vessel out of the shipyard is not like taking a new car out of the lot. It will probably take a few years, he said, before the crew, technicians, and scientists find the ship's "optimal sweet spot," when all systems—ship, instrument, and human—are aligned to maximize performance. The increased complexity of *Neil Armstrong*'s suite of sensors and engineering systems means that technicians and crew have to maintain a high level of performance in conditions that are often nicely referred to as "adverse."



Members of WHOI's Board of Trustees and Corporation rode the ship as it passed through the Panama Canal on a rainy night in November 2015.

Chris Linder

Chris Linder

The ship's system to deploy and recover scientific equipment overboard offers a step up in safety, with fewer people needed to handle lines in rough weather, but it has more moving parts and more delicate electronics that must operate flawlessly time and again while at sea. The same is true of the ship's staggering array of sensors, communications equipment, propulsion, and monitoring systems. These modern advances offer researchers the ability to learn more about how the ocean works and how it affects us on shore—at a time when rapidly occurring changes on our planet demand our greater attention.

"New technology like this always reinvigorates the [ocean science] community," said Jon Alberts, executive secretary of the University-National Oceanographic Laboratory System (UNOLS), the agency in charge of coordinating operations and research on the 21 ships in the U.S. academic fleet. "The community has been waiting a long time for this ship and is watching its progress very closely."

But the increased level of complexity also requires a greater level of knowledge and care, especially in the open ocean far from a shipyard. "When I go on the ship these days, my techs say, 'Welcome aboard, just don't touch anything,' " Fisichella joked.

What's in a name?

The meaning attached to the ship's name isn't lost on Captain Sheasley. He and the crew transferred *en masse* from the retired *Knorr* after earning a reputation in the scientific community for getting the job done no matter what the sea threw at them. Sailing on a ship named after someone who got the job done at Mach 6 or 250,000 miles from home just makes them stand a little taller.

The effect of Armstrong's name on others became clear about twenty miles from San Francisco. We were approaching the sea buoy that marked the entrance to San Francisco Harbor, where we would pick up our harbor pilot for the passage through the Golden Gate. Over the radio, a vessel traffic controller guided us toward the northern buoy. There, we'd start looking for the fast-moving boat carrying our pilot, whose job it is to know the ever-changing seafloor and tricky currents of the harbor.

When it was our turn, the controller gave us rendezvous instructions and then hesitated a moment.

> Everyone wants to see the ship named *Neil Armstrong*.

Captain Kent Sheasley, together with most of the crew who served with him on the research vessel *Knorr*, made the transition to *Neil Armstrong*, a fact that many people point to as a key reason why they have high hopes (and high expectations) for the success of the new ship.

Ken Kostel, WHOI

A portrait of astronaut and Naval aviator Neil Armstrong hangs in the aft stairwell as a reminder of the legacy of exploration that the ship carries.

Would it be all right, he asked a touch sheepishly, if we took on four pilots? We looked around at the towering bulk of an outbound oil tanker, lightly loaded and riding high in the wind and waves. It could easily fit us in one of its holds, but we knew from radio traffic that it was carrying just one pilot. Four? For us? Captain Sheasley just chuckled. "Everyone wants to see the ship named *Neil Armstrong*," he said, before keying the mic and replying that, of course, we would welcome them onboard. One of the mates went to the galley and got more coffee cups.

Whether they were there to see the ship or just because they needed a ride to shore was unclear. But when the senior pilot walked down the gangway after we'd tied up to the dock, he made a beeline for the bow and asked the first person he could find to take a picture with the name Neil Armstrong blazing white-on-blue behind him.

Even for those like third mate Josh Woodrow, who is too young to remember the Space Race or that iconic first step by a human on the moon, Neil Armstrong's name carries great weight. It crystallizes a sense of purpose that continues to pull scientists and crew to sea to learn more about our planet and the ocean that makes life on Earth possible.

"It's really about exploration and discovery," said Woodrow. "A boat named after Neil Armstrong just embodies that sense of exploring, learning new things, and trying to be the first to find out what's out there."

Ken Kostel, WHOI

Neil Armstrong's wife, Carol, donated her husband's congressional gold medal to the ship, where it hangs in a specially designed case on the bridge.