 BY FFJOURNAL STAFF

Anchors aweigh

Plunging deep beneath the sea, aptly fabricated submersibles dive thousands of feet into the Atlantic

On any given day, the team at Woods Hole Oceanographic Institution in Woods Hole, Massachusetts, fabricate manned submersibles, tethered vehicles and autonomous, free-swimming craft that operate under Antarctic ice, in temperate Atlantic waters, or in the black waters of Challenger Deep, the deepest known point in the Earth's hydrosphere.

Bob McCabe, supervising engineer of Woods Hole Oceanographic's mechanical group, works with skilled operators, fabricators, welders and instrumentation specialists to develop, assemble and maintain oceanographic equipment.

Funding for oceanographic research comes from many sources: the United States Navy, the National Science Foundation, the Office of Naval Research, and even NASA, McCabe says. "In our shop, mostly what we are building are underwater, cabled systems, including deep-diving submersibles vehicles. We also make a lot of surface buoys. Those are our two largest products."

Generally, vehicle types break down into several classes. First, there are manned submersibles—human occupied vehicles [HOVs] that are launched from a ship and that can travel independently. The best known of these is ALVIN, a deep-diving vehicle that Woods Hole operates for the U.S. Navy. ALVIN made 12 manned dives to the Titanic wreck, more than 12,000 ft. deep in the Atlantic.

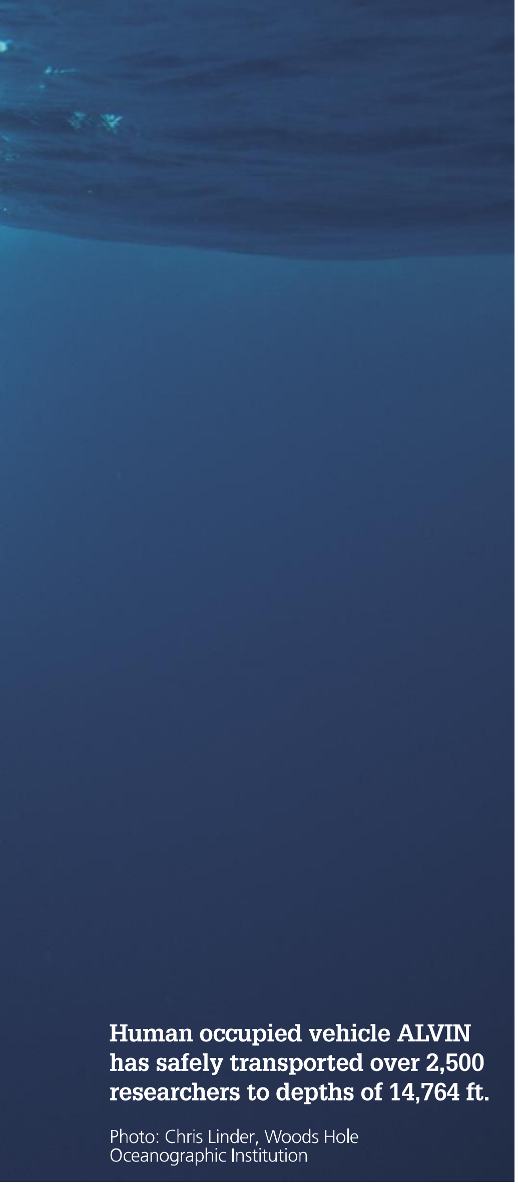
Beginning in 2012, McCabe and his team participated in a years-long redesign and expansion of ALVIN that would, among other things, increase its maximum diving depth from 14,000 ft. to over 20,000 ft.

The second type of vessel is the remotely operated vehicles (ROVs), which remain tethered to ships and are controlled by the crew aboard ship. The largest of these are the two-vehicle Jason-Medea duo, which can reach 6,500 ft. and enable scientists to explore seabed terrain for up to four days at a time. Medea remains tethered to the host ship, and acts as a shock absorber and mother ship to Jason, which moves about on a lighter, more flexible cable to conduct detailed exploration.

Lastly, McCabe's team builds autonomous vehicles (AUVs). These are free-swimming robotic vehicles that explore and collect data for download and review after retrieval.

Versatile necessity

At Woods Hole, every component, such as a buoy, circuit, or vehicle is custom-produced from a diverse mix of materials: Everything from marine plywood (often



Human occupied vehicle ALVIN has safely transported over 2,500 researchers to depths of 14,764 ft.

Photo: Chris Linder, Woods Hole Oceanographic Institution

Fabrication of CSM buoy components made from aluminum using waterjet cutter.

Photo: Tom Kleindinst, Woods Hole Oceanographic Institution

Installing top-forward section of syntactic foam onto ALVIN.

Photo: Tom Kleindinst, Woods Hole Oceanographic Institution

used to make forms) to syntactic foam, plastics and fiberglass, rubber, aluminum, glass, grade 316 stainless steel, and titanium. The first step in the fabrication process typically involves cutting.

"Almost everything we build starts on the waterjet," says McCabe, describing it as the one piece of equipment the shop cannot do without. Sixty to 70 cutting jobs may flow through the facility's 1,600-sq.-ft. cutting area on a given day. The Omax 55100, a large, cantilever style CNC waterjet, runs 10 hours a day, six days a week.

"We cut a huge variety of materials—everything from soft rubber gaskets to very brittle syntactic foam, to very aggressive 2-in.-thick titanium used in structural parts for undersea vehicles," he says. "We might run all of those materials in a single day."

Comparing costs

While some fabricators would turn to a CNC mill for production of finished-dimension parts, Woods Hole can often turn them out faster using waterjet cutting. Milling consumes a greater amount of time for part-to-part tooling changes, and a mill could never handle the volume of different materials, claims McCabe.

In particular, "We cut a lot of parts that go directly into weldments." The design flow fosters the creation of many parts with a lot of tab-and-slot features that make many of our large weldments self-fixturing, McCabe says. The waterjet gives his team the ability to do that. "So a lot of parts are cut to finished dimensions and sent to welding."

The rest, of course, are cut to rougher dimensions and then receive secondary machining to reach finished size.

"With the waterjet, you've got a single machine that can go from material to material by changing just a few settings," McCabe says. "Even if you recognize that waterjet cutting is not the perfect way to do the job, we don't necessarily have the floor space, or the money, to accommodate all of the ideal specialized equipment. And not many shops do all the things that we do."

Even the Woods Hole carpentry shop uses the waterjet: "We cut a lot of plywood just to make fixtures and templates for other operations. It saves hours of time for fabricators if they can just take a sketch—with all the holes in all of the right places, lay that down on top of a piece of material, then cut it and drill it out," McCabe says.

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>
> **Bob McCabe**, Woods Hole Oceanographic Institution

Essential to the operation of the waterjet is the use of Adirondack 80 HPX, a high-performance garnet abrasive from Barton International, a material supplier that McCabe and Woods Hole have relied upon for 15 years.

HPX abrasive is entrained in a high-pressure stream of water in the waterjet machine's cutting head. The suspended garnet crystals exit through a mixing tube with extreme velocity and can cut virtually any material with precision.

According to Barton International, 80 HPX garnet is the most versatile grade of abrasive garnet produced, with abrasive sizes that blend and balance the cutting performance and speed of coarser grades (such as 50 or 65 HPX) with the edge quality produced by finer abrasive sizes (120, 150 HPX and up).

Because it meets cutting requirements for the Woods Hole shop, there's never any concern about shutting the waterjet down to change abrasives.

"Barton has been flexible in response to our needs, enabling us to place a large order but then shipping it incrementally, on demand," McCabe says. "We've tried other products in the past, but have always gone back to Barton because of their quality and consistency."

To meet expected future demand for components, McCabe says that plans are under way at Woods Hole to build a new and larger waterjet cutting area. **FFJ**

Barton International, Glens Falls, New York, 800/741-7756, www.barton.com.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, 508/548-1400, www.whoi.edu.