Glider robot a sleek ocean explorer

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The sea was heaving, the skies gray. The captain of the research ship was worried about the weather. About 120 miles off the coast of Spain, three Rutgers University scientists had a narrow window of opportunity to find and retrieve their prize -- an 8-foot, torpedo-shaped yellow robot that they had launched seven months earlier off the coast of New Jersey.

They could grab it and learn from it, or in the rough seas accidentally ram it and sink it.

After an hour of pitching in the 20-foot waves, the shipmates let out a cheer. Having spent 221 days at sea on a voyage of 4,604 miles, the robot dubbed Scarlet Knight was safely aboard.

With that came the completion of a mission that made oceanographic history.

Not only was the robot -- an underwater glider -- the first of its ilk to cross the Atlantic, a mission supporters compared to Sputnik and Charles Lindbergh's solo flight. "She," as the glider is referred to on her Facebook page, also had collected valuable data, finding eddies of current in unexpected places.

The eddies, said Scott Glenn, the Rutgers professor who led the mission, "are the ocean's weather. It's the equivalent of atmospheric storms. And all these add up to give us our climate."

Underwater gliders such as the Scarlet Knight are ushering in a new

frontier of oceanography, researchers say, one that can help solve the riddles of weather and climate change plus provide data to manage fisheries and guide shipping.

Research ships are the traditional way to sample the planet's oceans, but they're expensive and cumbersome, said Dean Roemmich, a researcher with the Scripps Institution of Oceanography in San Diego.

Satellites beam back data, but only from the surface.

Roemmich works with another project, dubbed Argo, which employs 3,000 buoys worldwide, about 180 miles apart, to sample the water column. But they can only drift.

The glider, loaded with data sensors, can be directed.

"We are data poor for understanding how the ocean operates, and this is going to give us the capability to understand this much better," said Richard Spinrad, assistant administrator of the National Oceanic and Atmospheric Administration in Silver Spring, Md.

"If we can go across the Atlantic, we can go just about anywhere with these."

And what a way to go.

For its long, solo flights, the glider needs to be a power miser.

The Scarlet Knight requires the energy of just three Christmas tree lights to run, but stretch that out over a seven-month journey, and the glider had to be crammed with 450 lithium C-cell batteries, making up half its 134 pounds.

Nearly 40 percent of that energy is dedicated to a propulsion system that, instead of using a power-hungry propeller, makes use of changes in its buoyancy.

When its onboard computer instructs the glider to submerge, a piston in the nose draws back, taking in about a cup of water. Even that small amount is enough to make the nose sink.

As the glider descends, its wings translate the downward motion into forward glide.

At the bottom of the programmed descent -- as deep as 600 feet -- the piston pushes the water out, the nose tilts up, and it all happens in reverse.

So it "flies," as they say, in a sawtooth pattern, at just over half a mile an hour.

The researchers program the glider to resurface and "phone home" via satellite at regular intervals, enabling them to check on its vitals and give it new instructions or course adjustments.

Rutgers has deployed more than two dozen gliders similar to Scarlet, developed by Douglas Webb, a Massachusetts oceanographer who was inspired by science fiction. He dubbed his design the Slocum after Joshua Slocum, the first to sail around the world single-handedly, in the 1890s.

By now, Teledyne Webb Research, based in Falmouth, Mass., has made nearly 170, sold worldwide, said Tom Altshuler, general manager.

The quest to send a glider across the Atlantic began three years ago.

At a conference in Lithuania, NOAA's Spinrad took aside three Rutgers professors, Glenn, Oscar Schofield, and Josh Kohut, who, along with a contingent of students, run the Rutgers Coastal Ocean Observation Lab, dubbed RU COOL.

Spinrad knew their work well. They had sent the underwater robots into the teeth of Atlantic gales and through Pacific typhoons. One had survived 30 days in the extremes of Antarctica, collecting in 24 days as much data as ships had gathered in 12 years.

"For the good of your country," Spinrad told them during that late-night, wine-laced discussion, "get one of these things across the Atlantic."

Spinrad said recently that he'd wanted to show U.S. leadership in ocean research. "This was a flagship technology that had to be shown to the world. It had to be done in a way that was dramatic and scientifically meaningful."

But it would be difficult.

The lonely argonaut could be ensnared by nets, enveloped by squid, attacked by sharks, run down by ships. Or it could simply malfunction.

The first attempt fell short in 2008. Nearly 1,000 miles from Portugal, near the Azores, the glider was struck by something about 150 feet deep and began to leak. They now think it was a shark.

The glider surfaced and sent home a distress message. Researchers raced to book a flight and a boat.

But as messages from the "leak detects" came in over the next day or two, they realized it was slowly filling with water. It finally went silent and disappeared.

The mission was counted a success anyway because of all they had learned. And the insurance payment funded much of the $200,000 cost for Scarlet, launched in April about 50 miles offshore from Tuckerton, N.J.

This trip was a nail-biter, too. Just five days out, a fleet of scallopers with heavy cables to tow bottom trawls moved into its path. It also dodged repeated storms, with waves that could have battered the glider.

Glenn and the others kept tabs via their BlackBerries and laptops. On sleepless nights, they'd check Scarlet's position and anxiously awaited her calls, like parents with children out late.

On Aug. 27, in the Azores, Scarlet began to move erratically. It was in trouble.

This time, they got there in time. With a hurricane to the north and a shark nearby, a diver fixed the problem: He scraped off barnacles.

A few tests later, the glider was back on its way.

As if it were needed, this gave yet more proof of the value of gliders. The rescue boat had to make a beeline for shore because of the approaching storm. Scarlet just kept going.

On Nov. 14 Scarlet Knight surfaced in Spanish waters and phoned home. Magnifico!

No way were the researchers going to try to make it dodge traffic in one of the world's busiest shipping lanes. A ship passes every 12 minutes.

But they still needed to get the glider back.

"We want to weigh every single piece of material on it and see if it's corroded or not," Glenn said. "We want to check and see if barnacles have grown in the seams. To look at all the moving parts. Which have worn the most?"

So they kept Scarlet hovering in the current for a month until Glenn and several other researchers could get to Spain, where the research vessel, Investigador, would take them to it.

The mission had gone well beyond an engineering feat. It had identified places where ocean and climate models were wrong.

It also was praised as a model of international collaboration. Researchers from Halifax to Spain, Portugal and beyond had lent expertise and help.

At Rutgers and abroad, teams of undergraduate students had worked on the project. Schoolchildren had followed Scarlet's progress on the COOL lab's Web site and the team's blog.

The researchers had even tucked onboard a memory stick with 100 letters from U.S. schoolchildren, to be delivered to the mayor of the Spanish coastal town of Baiona.

"What I really, really respect them for is that they managed to combine a technological demonstration, scientific experiment, and an educational experience, all rolled into one," Spinrad said.

In Baiona, a celebration was held on Dec. 9, thick with officials from Spain and the United States, and Webb himself, now 80 and still designing.

The researchers are already focused on a new generation of gliders to go farther and deeper on less power.

Indeed, at the fest, Spinrad delivered a new challenge. This time, he said, he wanted them to send a glider around the world.