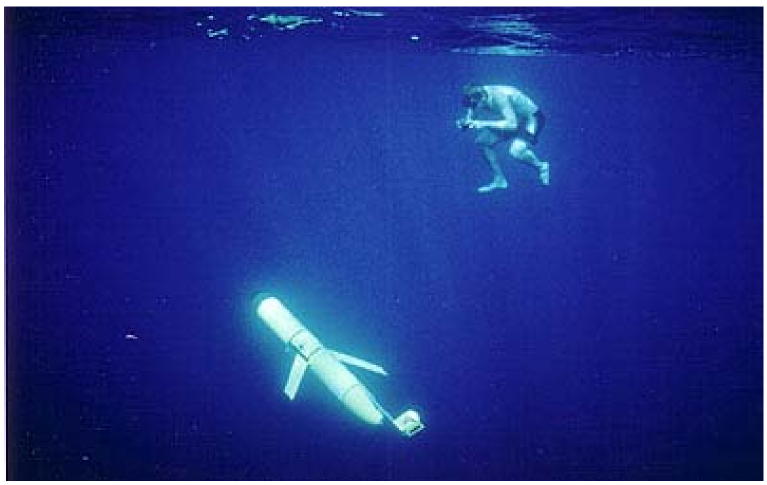
Economist.com SCIENCE & TECHNOLOGY

Sea gliders

Run silent, run green

Feb 28th 2008
From The Economist print edition

John Lund



Where did that come from?

By harvesting its energy directly from the sea, a new underwater robot could cruise the oceans for years

SOMETHING unusual is swimming in the sea near the United States Virgin Islands. It has been there since December, slowly criss-crossing the 65km between St Croix and St Thomas, periodically surfacing and then diving back down again to depths of 4,000 metres. It is likely to keep this up for another three or four months. It is not some strange aquatic creature, but a new robotic underwater vehicle that could revolutionise the way oceans are studied.

Various sorts of remotely controlled machines already explore the sea. Most use electrically driven propellers or thrusters to manoeuvre. Some are tethered to ships, whereas others are cast free to operate like miniature submarines, although these too need the services of a support vessel. Using underwater vehicles can be an expensive business: research ships cost tens of thousands of dollars a day to run, and because the ocean is such a vast place they need to remain at sea for long periods to collect data. The robots also have to keep returning to the ships to have their batteries replaced or recharged.

Some oceanographers have started to use another sort of underwater vehicle that is capable of much greater endurance. These can dive for days or even weeks before having to be recovered. They still rely on batteries for propulsion, but are extremely stingy in their power demands because most of the time they “glide” through the water. These sea gliders do not have an engine and instead manoeuvre vertically by changing their buoyancy while relying on a pair of short, stubby wings to glide forwards.

The gliders use electrical power to operate pumps and valves to transfer oil back and forth between a bladder that is contained inside their torpedo-shaped pressure hull and another bladder that is outside (usually in a flooded part of the hull). To dive, oil is transferred from the external bladder to the internal one. This does not change the craft's mass but decreases its volume, which lowers its buoyancy and makes it slowly sink. To surface, the oil is pumped back outside.

To move forward, the pitch of the craft is changed. This is done by pumping fluid towards the bow, which pitches it down for a dive, or sending it towards the stern to point the nose up when ascending. In some gliders small electric motors also slide the batteries backwards and forwards to adjust the pitch. The angle helps the craft's wings to provide a lifting force and translate some of the vertical motion into forward motion.

Sea gliders move slowly, at around 1kph, tracing a saw-tooth pattern through the water as they constantly ascend and descend. When they reach the surface they communicate by satellite, transmitting any data they have collected, like temperatures and salinity. Before diving again, they take a GPS bearing, which an on-board computer uses to navigate by. The computer steers a rudder, which is usually the only external moving part.

Dive, dive

Sea gliders were conceived in the 1980s by Douglas Webb, a former researcher at the Woods Hole Oceanographic Institution. Only in recent years, though, have they become fully operational and more capable. Some are called “Slocums”, after Joshua Slocum, who in 1898 was the first person to sail single-handedly around the world. A few have managed to stay at sea for several months. In 2004 a sea glider built by the Scripps Institution of Oceanography in San Diego (and called *Spray* after Slocum's self-steering sailing ship) even managed to cross the strong currents in the Gulf Stream on a voyage to Bermuda.

The craft that is steadily plodding between the Virgin Islands is being operated by a team from Woods Hole and the Webb Research Corporation, founded by Mr Webb. It is a Slocum that has been modified to harvest the energy that it needs to operate its buoyancy-propulsion system from the sea itself. In theory, this sea glider could travel for thousands of kilometres on voyages that could last for years.

The craft uses mechanical energy instead of electricity to move oil. It harvests that energy by exploiting the difference in temperature between the warm surface of the sea and its cold depths. The glider contains two wax-filled tubes which operate like pistons. When it rises towards the warmer surface the wax melts and expands, which compresses a tank of air. This compressed air is used as an energy store to push oil between the bladders.

The experimental craft still uses some battery power, albeit tiny amounts, to open and close valves and for its instruments. But even so, Ben Hodges, a member of the Woods Hole team, thinks the glider could operate for a year or so before having to be recovered.

It may well be possible to use the same mechanical forces that produce compressed air to generate electricity to top up the glider's batteries. It could then sail on almost indefinitely, unless a surface vessel damaged it or caught it in its fishing nets. This rarely happens, but there are other more practical limits to endurance, including the need to reset instruments and to remove the inevitable weed, barnacles and other marine life that would encrust a glider during very long voyages.

Green-energy gliders that stayed at sea for many months could undertake long-term studies of the ocean, particularly into the effects of climate change. Indeed, in a science-fiction article written some 20 years ago the late Henry Stommel, an influential Woods Hole oceanographer, imagined fleets of Slocums cruising the sea to collect scientific data. It would not be the first time that science fiction turned into science fact.