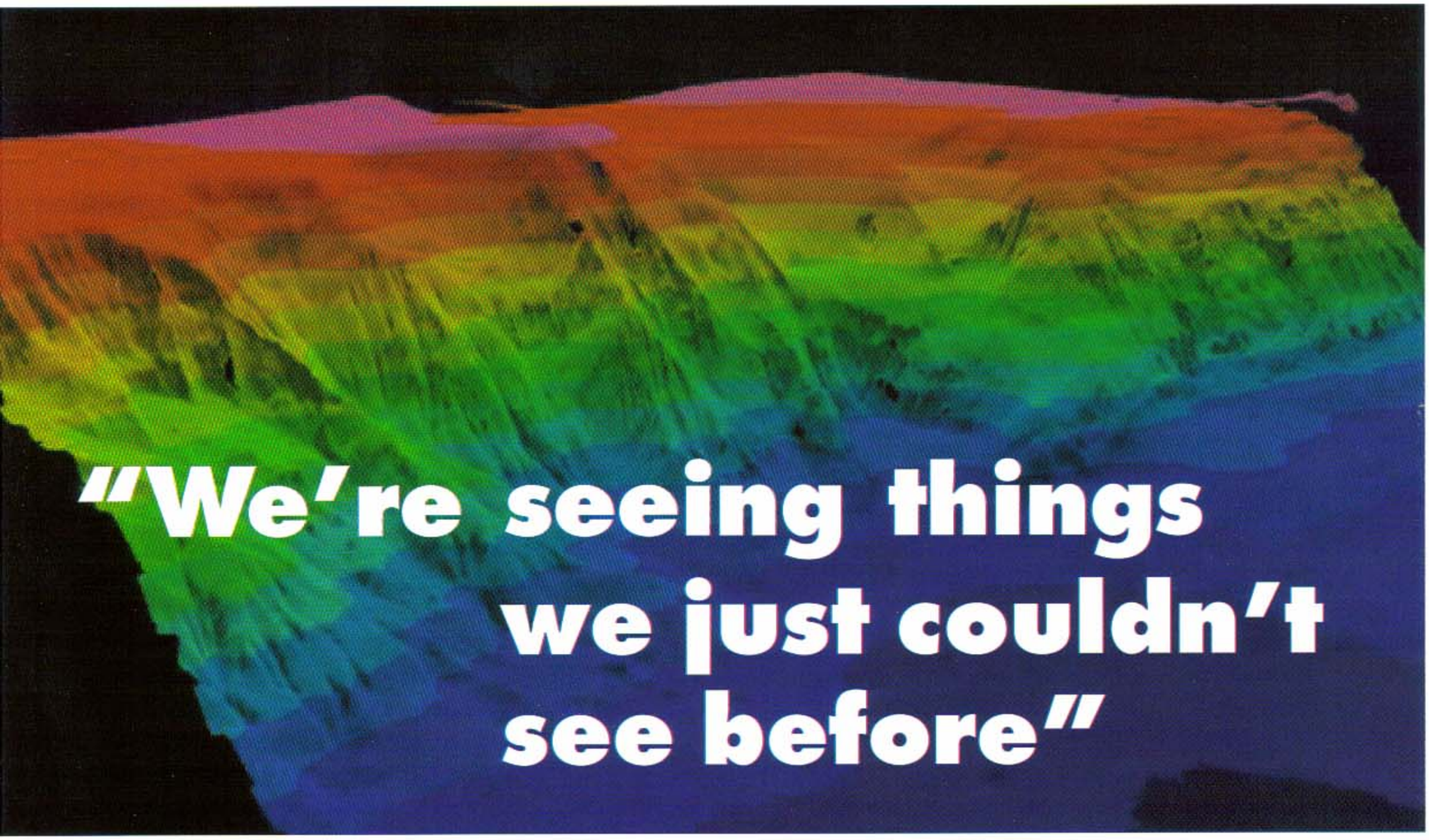


"We're seeing things we just couldn't see before"

Autonomous underwater vehicles (AUVs) are now delivering meaningful deepwater data on commercial surveys for the offshore oil industry. Some of this data was presented for the first time at the excellent Underwater Vehicle Master Class organised by the Society for Underwater Technology at the Southampton Oceanography Centre last year.

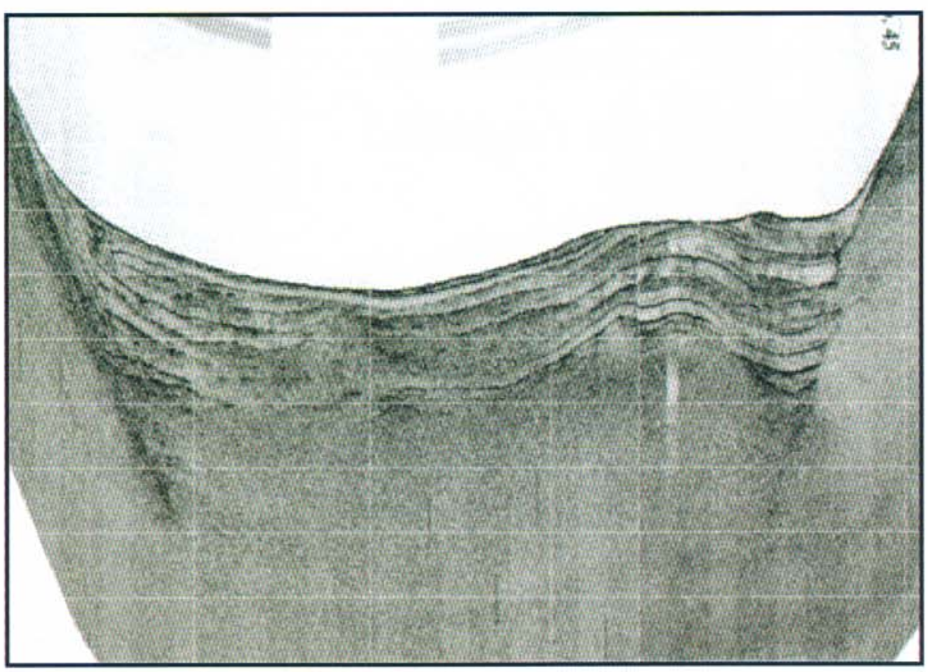
The data was shown in a talk by Roger Lott, Head of Survey, Upstream Technology Group, BP Exploration. His talk went beyond the presentation of data to look at the next steps in AUV development from an oil company viewpoint.

Report by Bob Barton

First AUV data from deepwater Gulf of Mexico

Surveying the Sigsbee Escarpment

These two illustrations are swath bathymetry and sub-bottom profiling data from part of the Sigsbee Escarpment in the Gulf of Mexico. They were obtained by the *Hugin* AUV, owned by C & C Technologies, Lafayette, USA, and operating for BP on its Holstein and Mad Dog developments last year (2001). The Sigsbee Escarpment is a fea-



ture so big it could be seen from the moon if the water wasn't in the way. *Hugin* worked in areas where water depth varied from 1250m to 2300m along slopes of up to 45 degrees and obtained sidescan, multibeam and sub-bottom profiling data. The amazing multibeam record shown here is an isometric view of seabed topography along the side of the escarpment; the profiling data is from an area at the foot of the escarpment with 5x vertical exaggeration.

Overall, said Roger Lott, data from AUV surveys will reveal slope instabilities, mud volcanoes and evidence of benthic communities living on and around hydrate seepages. None of this, he says, could be mapped to such quality or resolution - if at all - by conventional deeptow survey systems: "We're seeing things we just couldn't see before," he said.

"Collecting this information will allow us to make an improved assessment of seabed and shallow geological conditions, leading to better design parameters in facilities design."

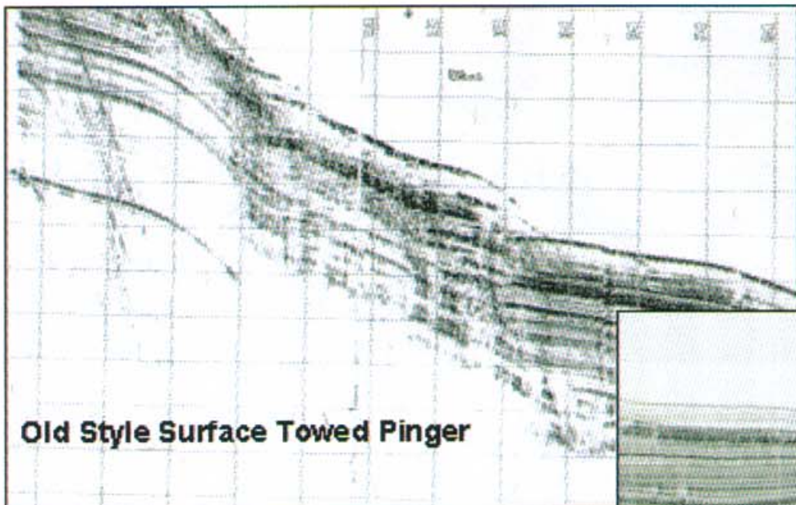
Then there was the question of time taken to obtain data by AUV compared with deeptow - of which more below.

Sub-bottom data improvement

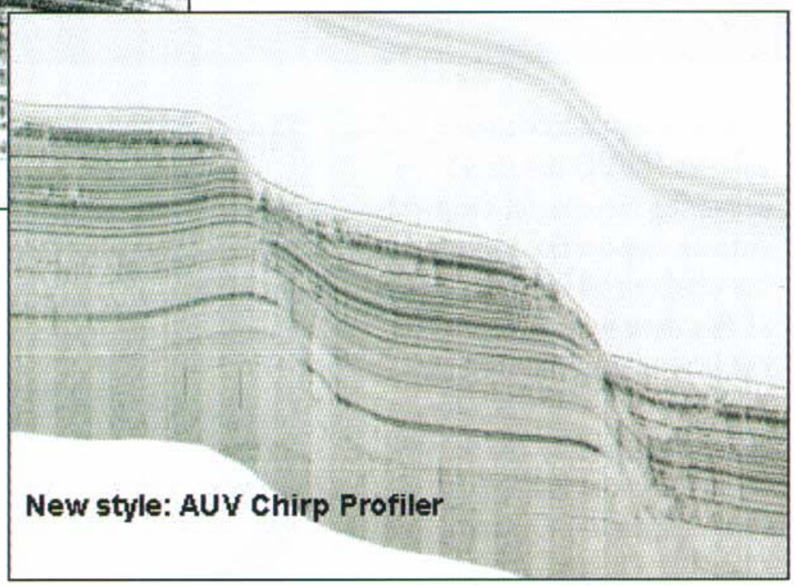
A dramatic demonstration of the data quality improvement to be had by putting the sensor close to the seabed. It's a comparison between a surface-towed pinger and the *Hugin*-mounted EdgeTech chirp profiler over an area at the foot of the Sigsbee Escarpment.

Improvements in data quality are matched by those in operational (and hence economic) efficiency: on a "lawnmower" survey of 17 lines at 150m spacing the AUV took 8.6 hours; this would have been at least 45 hours using a conventional deeptow shipborne method. With up to four hours unproductive survey time being taken up by ship turns on conventional deeptow surveys, some two-thirds of a site survey is unproductive. At a time when 3D seismic exploration costs are reducing exponentially and drilling costs per metre are also coming down, business management questions why site survey costs are increasing. Only the use of AUVs will drive costs down.

On the Holstein and Mad Dog surveys for BP, *Hugin's* longest dive was 42 hours; average was 38. Maximum working depth was 2225m.



Old Style Surface Towed Pinger



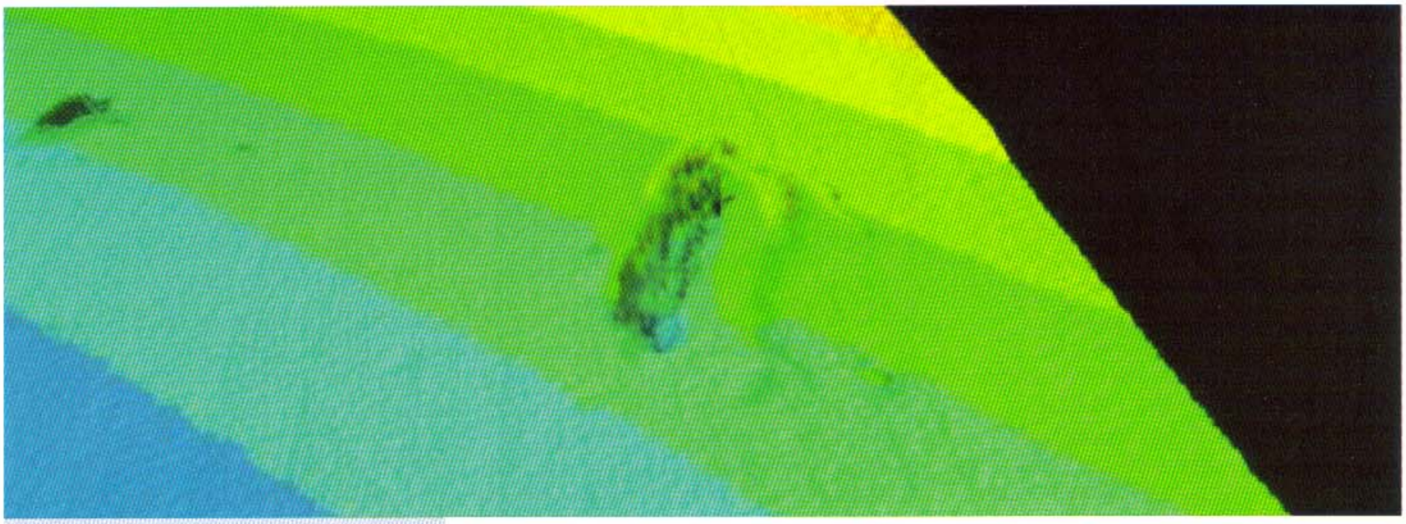
New style: AUV Chirp Profiler

Slope instabilities, mud volcanoes, benthic communities - all will be revealed

Reprinted from

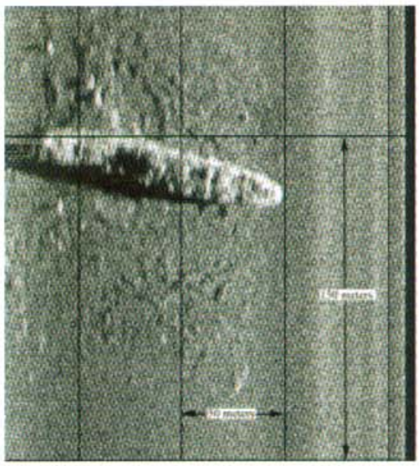
International Ocean Systems

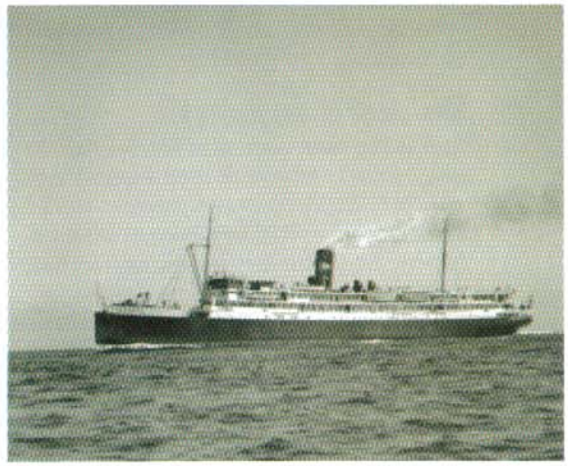
January/February 2002

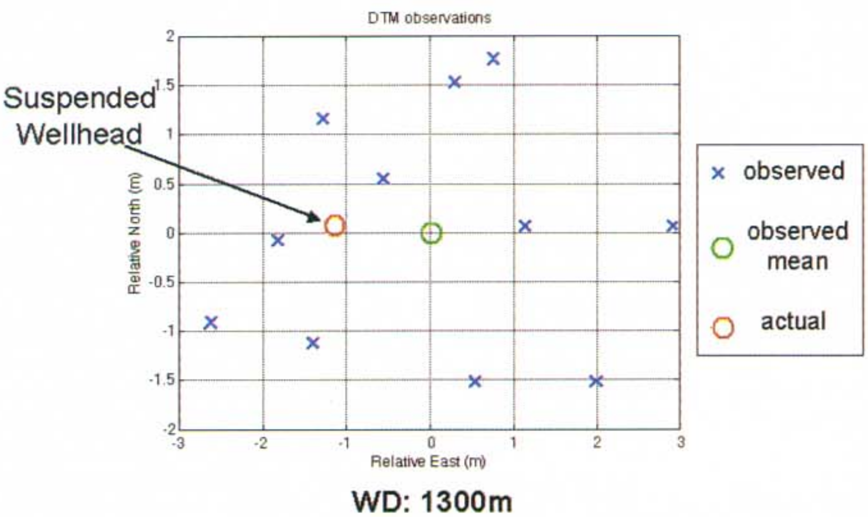


Serendipity

A pipeline route survey took *Hugin* through an historic wreck area. Using a line spacing of 20 metres, results were obtained "that could not possibly have been obtained with a deeptow system," said Roger Lott. Two examples: a German U-boat captured by swath bathymetry at 1525m water depth at 0.5m cell size; and the S.S. Robert E. Lee on a 120kHz sidescan - together with a picture of the vessel, courtesy of the Mariners' Museum, Newport News, Virginia.







We need LBL acoustic navigation for pipeline route and other linear surveys

Navigation - and beyond

Here are some navigation accuracy test results from *Hugin's* work for BP in the Gulf of Mexico at a water depth of 1300m. The navigation system, payload systems and internal control system all performed well, Roger Lott reported. There was a big concern before the present surveys that the navigation system would not be adequate for the task - but it proved itself. However, for the future, and under more demanding conditions, there will need to be improvements, he said. For example, it would be desirable to have long baseline (LBL) acoustic navigation - not necessarily an array but the occasional single beacon on linear (pipeline route *etc*) surveys to gain a significant improvement in accuracy.

And at present the AUV cannot track features: it will follow a set of pre-programmed coordinates but onto the wish-list goes the facility to follow cables and pipelines - buried or unburied - even if their exact location is not known: "we need a feedback loop from the detection sensors to the navigation," said Roger Lott.

Then there will be the requirement to see the AUV operating in rather more complex environments: "We'd like to see a survey-class vehicle that can get near a structure to look at - for instance - the catenary of risers and other close-in features. This will be a challenge for the sensors - visual and lighting - and with a consequent power demand," he said.

There are conflicts at present in integrating the standard survey sensors - sidescan, multibeam and sub-bottom profiling - in order to get optimum deployment within a single vehicle. Is the time coming, asked Roger Lott, when it will be possible to throw overboard three cheap and cheerful AUVs with dedicated sensors - one for sidescan, one for multibeam, one for profiling, and so on?

No more support?

And is the time coming when we can do away entirely with dedicated support vessels for AUVs for site survey work? Should not the AUV be deployed from the (strictly linear survey) seismic exploration vessel to go off to make its "analogue" pre-drill and site hazard surveys?

Looking further beyond (but perhaps only a year or so) there will be the need for hybrid AUV/ROVs for intervention work in field development and then IRM. "The vehicle will need to swim from its garage - wherever that may be - to wherever it needs to work on an oilfield development or production facility," said Roger Lott. "Because of the power requirements it will need to go into a built-in docking facility in order to perform its IRM tasks before departing to its 'garage'".

Obviously this would be too expensive to retrofit, but even existing field developments - such as BP's deepwater Gulf of Mexico Crazy Horse, due to come on stream in 2004/5 - might still be amenable to design changes to incorporate intervention AUVs, Roger Lott pondered, in conclusion to his presentation.

Now *that* gave the vehicle developers in the audience something to consider.

How about three cheap vehicles, each with a dedicated sensor, operating simultaneously?

SAILARS

Hybrid AUV/ROVs figured large in the rest of the SUT/SOC meeting. James Ferguson of International Submarine Engineering, Canada (ISE) brought delegates up to date on progress with SAILARS (Semi-Autonomous Intervention, Launch and Recovery System). This is a semi-submersible, dynamically positioned, 19m long hybrid AUV/ROV. It is based on the successful Dolphin semi-submersible minehunting design developed by ISE, the Canadian Defence Research Establishment and DCN of France.

SAILARS is being developed jointly by ISE and Mentor Subsea Technology Services, a subsidiary of J. Ray McDermott. The semi-submersible AUV operates and provides power for standard, unmodified, 50-150hp work class ROVs. It will operate in Sea State 6 to ranges of 28km from an existing offshore platform

The thinking behind the semi-submersible concept as opposed to fully submersible hybrid ROVs is that the latter have low speed and endurance, a low communications bandwidth, limited mobility at the seabed and a reliance on a subsea infrastructure. SAILARS, on the other hand, can provide much higher levels of endurance and power to the ROV. It can transmit continuous high bandwidth ROV data to the controlling platform and has high accuracy GPS-based positioning. It can be based on existing offshore platforms without the need for special facilities to be built into them.

The 19m long vehicle has twin 360kW diesels to give it a speed of nine knots (two knots with the ROV deployed) and an endurance of 96 hours, plus the ability to handle a 110kW ROV on 3000m cable length.

The time is coming when AUVs will be deployed from seismic exploration vessels to undertake engineering surveys

Thales & Fugro

Other highlights at the meeting were presentations about two vehicles which should be in the water by the time this is published. The first of the Thales GeoSolutions vehicles building by Bluefin Robotics is 3.45m long, 0.5m diameter, has a speed of 3-4 knots and will gather about 100 line-km of survey data on a 24-hour autonomous cycle at depths to 3000m. Each vehicle weighs just 430kg in air.

The Thales vehicles come with EdgeTech sidescan sonar and sub-bottom profiler, along with a Reson multibeam (100 or 200kHz) echo sounder. There is a sophisticated navigation package based on a Litton LN250 inertial system coupled to DigiQuartz compass and 300kHz RD Instruments Doppler velocity log. Hull design is such that the vehicle operates with very low ambient noise to give "clean" sonar records.

Due to go on sea trials in mid-November was the AUV joint venture between Boeing, Oceaneering and Fugro. It's a big machine: 5.63m long, weighing in at 5,300kg. It features an active ballast system to enable it to maintain constant height in conditions of changing salinity and has an interchangeable payload module so that sensors can be changed at sea to meet different survey mission requirements.

There is an impressive navigation system, the design of which draws on Boeing's US Navy experience. It includes a Kearfott 5035 inertial unit, RDI Doppler velocity log, altimeters, depth sounders, long baseline (LBL) interrogator and ultra short baseline (USBL) transponder. It is capable of tracking four seabed-mounted transponders simultaneously.

Standard payload on the Boeing/Oceaneering/Fugro (BOF) vehicle includes 120/410kHz EdgeTech sidescan sonar, 1 and 6kHz EdgeTech sub-bottom profiler and Kongsberg Simrad 200kHz multibeam sounder.

An altogether fascinating meeting for which the SUT and its organising committee are to be congratulated. ■