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Research-driven Tools for Ocean Mappers

Finding Lost Aircraft with Pingers

Your Guide to Oceanology International 2018!

World's First Fully Autonomous Hydrographic Survey

Hydro INTERNATIONAL

Hydro International is an independent international magazine published 6 times a year by Geomares Publishing. The magazine and related e-newsletter inform worldwide professional, industrial and governmental readers of the latest news and developments in the hydrographic, surveying, marine cartographic and geomatics world. Hydro International encompasses all aspects, activities and equipment related to the acquisition, processing, presentation, control and management of hydrographic and surveying-related activities.

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SURVEYING THE ARCTIC

In 2016, a group of MBARI (Monterey Bay Aquarium Research Institute) scientists and engineers, led by geologist Charlie Paull, returned to the Beaufort Sea on the Canadian Coast Guard Icebreaker *Sir Wilfrid Laurier* in collaboration with researchers from the Geological Survey of Canada and Fisheries and Oceans Canada. Paull and his team conducted mapping surveys with an autonomous underwater vehicle (AUV), followed by dives with a remotely operated vehicle (ROV) to ground-truth the mapping surveys and conduct targeted sampling. This photo was taken during this Canadian Arctic 2016 Expedition. (Photo: Monterey Bay Aquarium Research Institute.)

Trend break

Every two years the oceanographic and hydrographic world eyes London, where Oceanology International takes place. This year the biennial show and conference will take place from March 11 through 13 at ExCeL, London. With around 500 exhibitors, this tradeshow is by far the biggest in the industry and visitor numbers are showing the same: Oceanology International is the place to be. There will be a lot to talk about with each other during OI: the future of the oceans in general and more specifically topics like fossil vs. renewable energy and aquaculture. We haven't been experiencing the best years for hydrography. I am curious to see if this OI can show a trend break in optimism with entrepreneurs and corporate managers alike in their outlook for the business, where low oil prices are still keeping forecasts bleak. It is definitely good to exchange views and opinions, chances and threats and to see demonstrations of innovative products at a friendly competitor's booth. In this issue of *Hydro International* you'll find everything and more about Oceanology and what will be showcased in ExCeL by the large and small companies of our business. The Geomares team will also be producing a show daily for all OI event days: so make sure to grab one of these when in London to be in the know of the latest news. Of course we'll also be present at our booth L20: stop by for a coffee and chat about business, opportunities, challenges and trends – and possibly how to break them in a positive way!

Durk Haarsma,
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The full package

The first *Hydro International* issue of 2018 focusses on Oceanology International, which is why we decided to include a varied series of articles in this edition. I can safely say that this issue pretty much reflects what the hydrographic and marine surveying industry encompasses, as will the next editions. From the search of lost aircrafts on the bottom of the ocean and the exciting developments concerning fully autonomous hydrographic surveying, and shallow-water bathymetry to the massive efforts that will need to be made before we can map the bottom of all the oceans on our planet. We will take you on a pleasant journey in which we will educate, inform and inspire you on the adventurous profession that we are all involved in. And don't forget to visit our website (www.hydro-international) regularly, as this is the quickest way to stay up-to-date with the latest trends and developments in the world called hydrography.

Wim van Wegen, content manager
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HYDRO ALPHABETICAL LIST OF ADVERTISERS

From **Products** to **Data Services**

When looking at the classic work of Hydrographic Offices the most prominent outputs had been navigational charts – either printed or as ENCs – and other products for navigators, like publications. But while these are still the main deliverables of HOs, times are changing. S-102, the first so-called 'Product Specification' within the S-100 series of standards, is intentionally not defining a product navigators or other end-users can buy and consume. It is a data stream for various uses.

Today's world is highly connected. Buzz words like IoT and Big Data Analysis are indications that data is nowadays used in a wider sense than originally envisioned:
Through integration with other data streams, the value of hydrographic data is enriched and reaches user communities which haven't been focussed on before.
This edition of *Hydro International* is on Oceanology. It underlines the trend described above. Oceanology looks at the conditions of the oceans and helps us understand this source of life on Earth better. Hydrography is an essential aspect. Utilising oceanographic and hydrographic data together makes analytical tools possible to provide information that enables new views on topics of importance for Oceanology. It is enabling new strategies for human communities in the future. But in doing so, the hydrographers need to enable access to their data stream without restricting it to a specific use like navigation. Bathymetric data in S-102 is geared up for this and shows that, in its working groups, the IHO has already recognised the transformation from end-user product creation to usage-independent data streams years earlier.
Now it is up to the individual Hydrographic Offices to migrate their organisations in this direction to bring this forward-looking development of IHO to life. And, the industry is already seeing this development. Some HOs are starting to provide the data in this format for various uses. As we see more and more HOs moving in this direction we can increase applications, both in academic research as well as in industry used applications integrating hydrographic data in far reaching 'Big Data Analysis' tools.
But all of that only works if the HOs develop usage agreements supporting this concept. The underlying legal framework with usable and economically viable conditions is essential so that the new data streams can be utilised. This will require a shift in how HOs license their data for commercial use. Again, some HOs have already moved in this direction, but full usage will require larger coverage of available, licensed data – ultimately worldwide. Only then will the community, locally, regionally and globally, be able to really benefit to the largest extent.
Thus, in essence the request to the hydrographic community is
1. Develop and provide data streams in usage independent form, such as, but not limited to, S-102
2. Create data usage agreements to enable and support this.
Research and industry are ready….

▲ *Michael Bergmann.*

Oi18 Expands to Offer Even More Vessel and Dockside Demos for Visitors

▲ *Dockside exhibition area.*

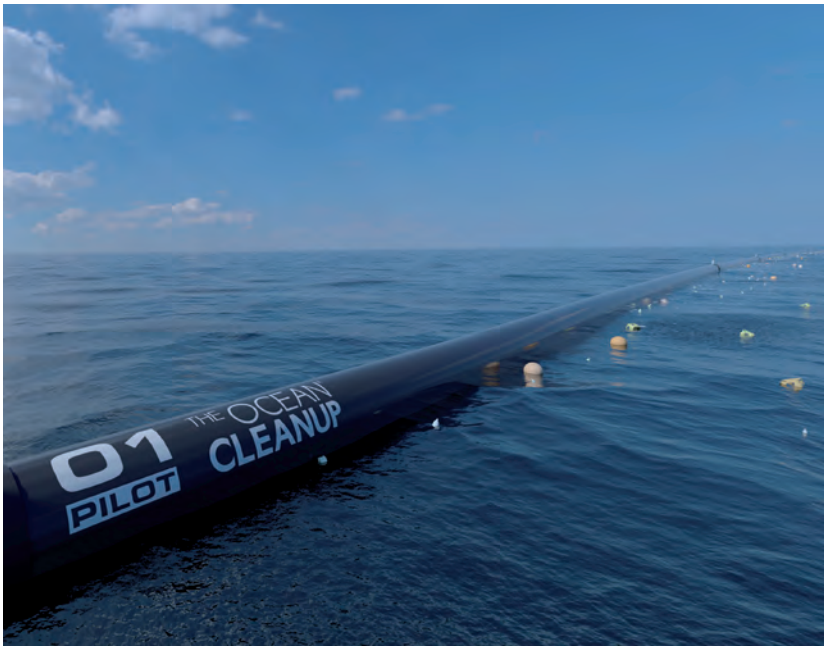
Visitors to Oceanology International 2018 (Oi18) will be able to participate in a series of live product demonstrations from the event's waterside exhibitor area on the Royal Victoria Dock. Oi18 will be held at ExCel, London, UK, from 13-15 March. The programme will offer a great variety of interactive experiences from some of the industry's leading ocean technology manufacturers. As one of the most popular attractions for Oceanology International visitors, this year's dockside and on-water demo programme has been expanded and will now comprise daily demonstrations to offer an even more valuable experience for those attending, whilst allowing exhibitors to share their product effectiveness in a marine environment.

▶ *http://bit.ly/2F3Jrxc*

The Ocean Cleanup Contracts Seatools as Offshore Monitoring System Supplier

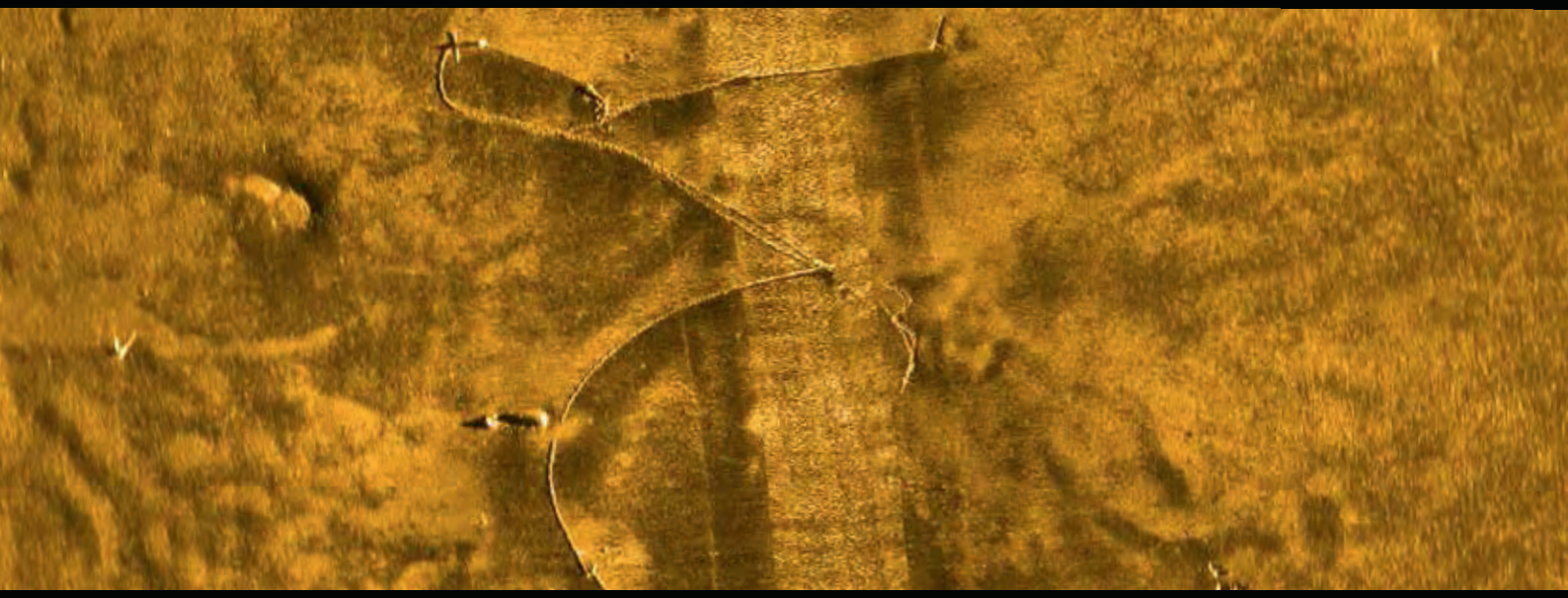
The Ocean Cleanup, the Dutch non-profit organisation developing advanced technologies to rid the world's oceans from floating plastic, has awarded subsea technology company Seatools a contract for the development and delivery of a remote offshore monitoring system. The monitoring system will be used to gain real-time insight into the performance of the first-ever ocean cleanup system, which will be deployed during trials starting later this year on the west coast of the USA.

▶ *http://bit.ly/2F5Rjyp*



▲ *The Ocean cleanup system.*

SAMS: the new generation of side-scan sonar.

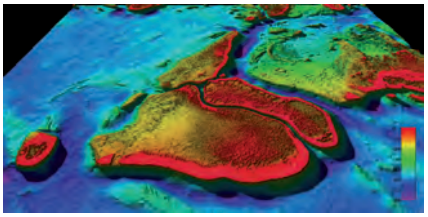


SAMS Series Synthetic Aperture Mapping Sonar
+ Delph Series Software

- High-resolution images on all kinds of carriers
- Real time mapping
- Increased productivity

iXblue

First High-resolution Map of the Great Barrier Reef Released



▲ *High-resolution map of the Great Barrier Reef.*

One and a half million square kilometres of bathymetric seafloor data have been released to the public by Geoscience Australia under partnership with James Cook University and the Australian Hydrographic Service of the Great Barrier Reef. The project carried out high-resolution bathymetric scans, which were combined with existing datasets held by the government to create the most comprehensive, detailed models produced to date.

▶ ***http://bit.ly/2EtKdCy***

UKHO to Conduct Seabed Mapping around British Virgin Islands

▲ *Planned survey priority areas.*

The United Kingdom Hydrographic Office (UKHO) has chartered two boats to survey the waters around the British Virgin Islands as part of the UK's Overseas Territories Seabed Mapping Programme (OTSMP) commitments. Following the interruption of the original UKHO surveys by Hurricanes Irma and Maria in September 2017, the survey team is returning to complete the originally planned activities. In addition, to aid the disaster recovery, several urgent priority areas have been identified locally and added to this survey. Using state of the art multibeam sonar equipment to map key areas of the seabed, the survey will enable the production of accurate and up-to-date navigational charts for ships using waters in Road Bay and North Sound. These charts will improve access for trade and tourism-related industries, and enable a wider range of ships to safely call at the islands.

▶ ***http://bit.ly/2Ev12Th***

N-Sea Awarded £40 Million of International Contracts

UK and Netherlands-based subsea provider N-Sea has announced that it secured major contracts to the value of £40 million, during Q4 of 2017 and in early Q1 2018, providing a sound backlog for the coming season. Known for its innovative work as an independent offshore subsea contractor, N-Sea's expertise in the fields of unexploded ordnance (UXO) survey, ROV and tooling solutions, diving and subsea maintenance and construction will be employed. These projects – which include UK east coast wind farm work, interconnector cable projects and German Baltic scopes – will be delivered with a variety of vessels on behalf of customers in the oil and gas, renewables and utilities sectors.

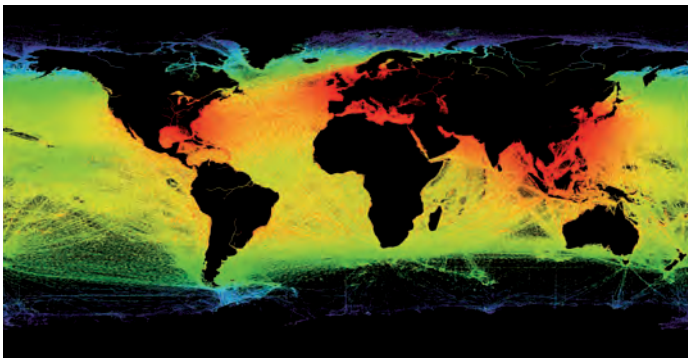
▶ ***http://bit.ly/2HisgZu***

▲ The Siem, *a multi-purpose field and ROV support vessel.*

Satellites Provide Detailed Picture of Maritime Activity

ESA has helped coastal authorities to track up to 70% more ships and pick up nearly three times more ship positions via satellite than was possible before. Large cargo vessels and passenger ships are required to carry Automatic Identification System equipment which transmits the course and speed as well as identification and position information to other vessels and shore stations. Originally developed to prevent collisions, it now also tracks ships to help prevent pollution, aid in the movement of dangerous goods, and promote routine surveillance. The Norwegian Coastal Administration is using the information to manage the national coast and waters for safety, emergency and transport planning.

▶ ***http://bit.ly/2sxIbQo***



◀ *The colour code shows how many times each ship has been observed.*

Subsea 7 Utilises Autonomous Surface Vessel in Mediterranean Pipelay Operation

ASV Global has announced the successful deployment of one of its C-Worker 7 class of autonomous surface vessels for Subsea 7. The 7m autonomous surface vessel was used to support a pipelay operation off the coast of Egypt. Fitted with a survey suite comprising a multibeam echo sounder and side-scan sonar, the C-Worker 7 carried out touchdown monitoring in support of the *Seven Antares* pipelay vessel.

▸ ***http://bit.ly/2EsrB67***

▲ *The autonomous C-Worker 7.*

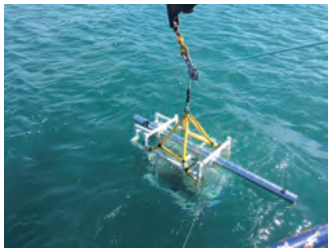
Survey Expedition to Laser Scan the *Titanic* Wreckage

▲ *View of the bow of the* Titanic.

OceanGate, a provider of manned submersible services, and 2G Robotics, a global leader in underwater laser scanners, have formed a strategic alliance to capture laser data of the RMS *Titanic* shipwreck and debris field. 2G Robotics' dynamic underwater laser scanner, the ULS-500 PRO, will be installed on OceanGate's Cyclops 2, the first manned submersible to survey the *Titanic* since 2005. The six-week Titanic Survey Expedition will depart from St. John's, Newfoundland, Canada, in June with scientists, content experts and mission specialists joining the crew in a series of week-long missions. The innovative 2G Robotics equipment will generate real-time 3D models with millimetric resolution. Using the highly accurate laser data, the team will overlay 4K images captured throughout the expedition to create a detailed 3D virtual model of the wreck. This model will serve as an objective baseline to assess the decay of the wreck over time and help to document and preserve its submerged history.

▸ ***http://bit.ly/2Hef6ga***

Teledyne TSS Expands Subsea Product Range



▲ *HydroPACT 660 pipe tracking system.*

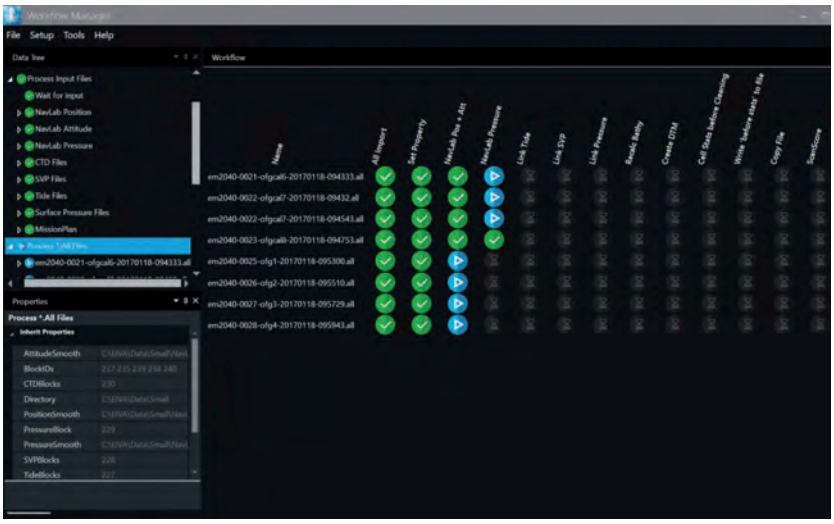
Teledyne TSS, a division of Teledyne Marine, is increasing its range of subsea pipe and cable detection and tracking products with the launch of the new smaller HydroPACT 660 pipe tracking system. The 660 has been designed to help reduce the cost of subsea pipe surveys by allowing the use of smaller classes of underwater remotely operated vehicles (ROVs). In addition, TSS is also expanding the capabilities of its larger HydroPACT 440 pipe tracking system by introducing a new 24VDC upgrade kit.

▸ ***http://bit.ly/2obDqXx***

New Software Tool Automates Subsea Data-processing Workflow

Danish software engineering specialist EIVA has released a new tool, NaviSuite Workflow Manager, for automatic data-processing of large amounts of subsea data, with minimum human involvement. With the Workflow Manager, repetitive tasks are automated and executed in parallel by the software. This means that data is processed faster, and crew members' time is spent more efficiently on errors, interpretations and quality control.

▸ ***http://bit.ly/2EEGshb***



▲ *EIVA Navisuite Workflow Manager.*

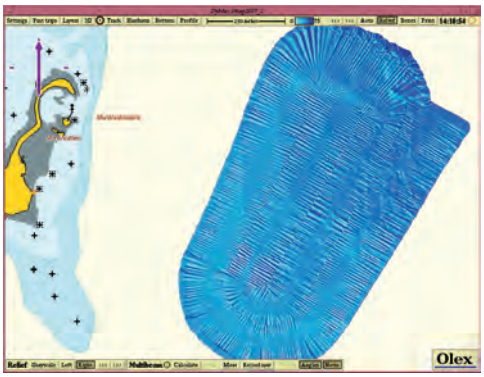
Ocean Infinity to Continue Search for Missing Malaysian Airlines Flight MH370

The proposal by Ocean Infinity, a specialist in collecting high-resolution geophysical seabed data, to continue the search for the missing Malaysian Airlines flight MH370 has been accepted by the Government of Malaysia. The search will focus initially on the zone identified by the Australian Transport Safety Bureau. The *Seabed Constructor* vessel is now close to the search area, which will enable work to commence imminently. The project is expected to last for 90 days. Ocean Infinity will take on the economic risk of the renewed search, only receiving payment if the aircraft wreckage is located.

▸ *http://bit.ly/2o5SbL6*

▲ *The Seabed* Constructor.

Olex Integrates Spatial Inertial Navigation System into Marine Vessels



▲ *Spatial sensor integrated survey allows finer details.*

Nexans Olex has successfully integrated Spatial, an inertial navigation system, into its hydrographic vessel. Spatial is a ruggedised miniature GPS-aided inertial navigation system and AHRS that provides accurate position, velocity, acceleration and orientation. It combines temperature-calibrated accelerometers, gyroscopes, magnetometers and a pressure sensor with an advanced GNSS receiver.

▸ *http://bit.ly/2F32Lus*

United Nations Declares Decade of Ocean Science

▲ *Global Ocean Science Report.*

The United Nations has announced the 'Decade of Ocean Science for Sustainable Development' (2021-2030) to mobilise the scientific community, policymakers, business and civil society around a programme of joint research and technological innovation. The announcement of this decade consolidates efforts by UNESCO's Intergovernmental Oceanographic Commission (IOC) to boost international cooperation in ocean sciences. It will enable better coordination of research programmes, observation systems, capacity development, maritime space planning and the reduction of maritime risks to improve the management of ocean and coastal zone resources.

▸ *http://bit.ly/2Est10r*

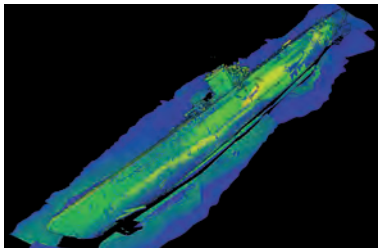
OceanAlpha Delivers Innovative USV Solution to Mining Industry

▲ *Hydrographic survey software interface.*

OceanAlpha's autonomous bathymetric survey boat, the *ME40* for hydrographic survey, has been applied in the mining industry for tailing dam surveys, in addition to its common application in lakes, rivers, reservoirs and oceans. All that is necessary is to set up the survey waypoints; the boat can then acquire online bathymetric data automatically based on GPS navigation.

▶ ***http://bit.ly/2Him1os***

Surveying the Wrecks of the Battle of the Atlantic



▲ *3D model of the German submarine U-576 (Courtesy: 2G Robotics).*

After years of research, the US National Oceanic and Atmospheric Administration (NOAA) discovered two World War II shipwrecks off the coast of North Carolina in the Monitor National Marine Sanctuary in 2014. The wrecks form the remains of the KS-520 convoy attack, as part of the Battle of the Atlantic. It was through EIVA NaviSuite software that 2G Robotics modelled these wrecks, once they had been surveyed from a Triton submersible equipped with a Sonardyne acoustically aided inertial navigation system (AAINS) and scanned by 2G Robotics' laser scanner.

▶ ***http://bit.ly/2Gfxh3Z***

Delivering a Subsea Lidar Virtual Reality Data Platform

3D at Depth, a global provider of advanced subsea Lidar systems and solutions, has partnered with iQ3Connect to deliver a new data visualisation tool to help clients build, maintain, map and monitor subsea assets, environments and resources. The partnership leverages the innovative features of 3D at Depth's subsea Lidar data and the power of iQ3's augmented reality (AR) and virtual reality (VR) platform to transform the value of offshore survey data.

▶ ***http://bit.ly/2EvjaqF***

▲ *3D at Depth subsea Lidar system.*

Zooming in on hydrographic technology

The Technology in Focus articles are frequently featured on the website of *Hydro International*. Aim of this series is to provide marine and hydrographic professionals with in-depth knowledge on a particular technology. This page introduces three of them. You can read the full articles by visiting the website shown.

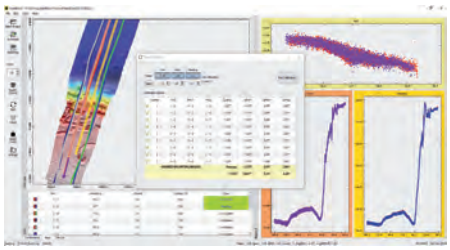
GNSS Receivers

GNSS has now been operational in the surveying industry, and especially in hydrography, for more than 25 years. Whereas the first receivers such as the Sercel NR103 (once the workhorse of the industry) boasted 10 parallel GPS L1 channels, current receiver technology has evolved to multi-GNSS, multi-channel and multi-frequency solutions. In this article, we look at the current state of affairs and try to identify the areas where development can be expected in the years to come.

In hydrography, we can distinguish between 'land use' and 'marine use' of our GNSS receivers. Especially in the dredging, nearshore and inshore domains both land survey as well as maritime receivers are employed. They do not differ in their basic capabilities such as positioning accuracy of number of channels (and GNSS) they can receive. The main differences lie in the form factor of the receiver (portable for land survey, rack mounted for marine survey) and the method of operation. Whereas a land survey receiver is almost always combined with a separate controller running extensive data acquisition software, the marine receiver is more and more of the black box type with at most a minimal display (and sometimes none).

▸ ***http://bit.ly/2GxfAwH***

Hydrographic Processing Software

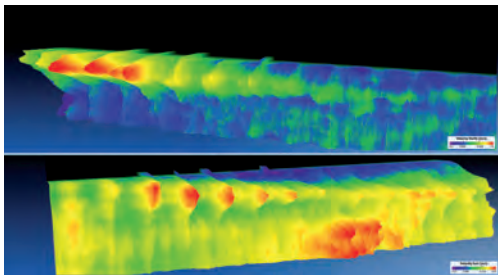


Discussing and comparing software has often been tricky in Hydro International as it is difficult to put the packages together and see clear differences. In this overview of hydrographic processing software, we will highlight trends and movements as indicated by the responses from software suppliers to our questions. In addition, we have added to this our own observations. All in all, this makes for interesting reading as there are movements in the industry that also tell us where the profession is headed.

Firstly, we would like to establish what 'hydrographic processing software' is. Where does 'processing' start and end? Most suppliers start with the acquired data; in most cases the raw data are the starting points for the surveyors working on the set. This even may be live data. Beamworx defines the time that the data is released by the acquisition software as starting point for its specific data patch and data cleaning software. The 'processing' terminates at the time that the georeferenced data is ready to create deliverables like 2/3D models, volume calculations for dredging, contour maps, habitat maps, etc. Most packages can be tailored to fit the workflow of the end-user.

▸ ***http://bit.ly/2fwYhCO***

Acoustic Doppler Current Profilers (ADCP)



Rather than a spinning propeller, the Acoustic Doppler Current Profiler (ADCP) - like dolphins and bats - uses sound to explore its environment. Operating underwater, the method works like hand-held radars used by police to catch speeding motorists. This article explains the technique of this frequently used type of instrument and some of its applications.

A sound burst is emitted by the ADCP along beams angled downward. Echoes are returned due to scattering off particles carried by water currents. A second burst can be used to track movement over the seabed. By analysing these sound echoes, the ADCP makes four different measurements at once.

- Speed and direction of water currents at many levels through the water depth – a 'current profile'
- Spatial distribution of sediments or plankton carried by the water (e.g., a sediment plume)
- ADCP's speed-over-ground and path of travel (revealed by echoes scattered from the bed)
- Range to boundary. This can be water depth (like an echo sounder) or, when the ADCP's beams are directed upward, range to surface. The latter provided a new way to measure surface waves.

This collective of data types used individually and together permits a single ADCP to make a diverse range of measurements.

▸ ***http://bit.ly/2Fnk4H7***

No Line Plan, No Boat Crew, Just Sensors

World's First Fully Autonomous Hydrographic Survey

During September 2017, the world's first autonomous hydrographic survey was performed. 'Autonomous' means not by remote control, but rather that the autonomous surface vehicle (ASV) used guidance from survey software to run pre-planned survey lines or automatically generated lines based on sonar coverage, with human interaction possible but not required. The Channel Coastal Observatory (CCO) commissioned 4D Ocean to undertake a hydrographic survey of the seabed offshore of Hurst Spit, Western Solent, using a SeaRobotics ASV 2.5. The pilot survey was supported by the Maritime & Coastguard Agency (MCA) and UK Hydrographic Office (UKHO).

The seabed offshore of Hurst Spit, Western Solent, was chosen as the survey site as it is subject to a challenging wave climate and strong tidal currents and has not previously been surveyed by multibeam. Furthermore, Hurst Spit is an important natural barrier beach that requires monitoring to manage and reduce erosion and flood risk.

CCO maintain and store the coastal survey data around England. The aim of their surveys is to link the topographic and hydrographic surveys together so that highly accurate coastal engineering decisions can be made from the data and that successive surveys can be assessed to look at temporal variations. Support for the trial was also provided by the Maritime & Coastguard Agency, which funds, manages and delivers the UK Civil Hydrography Programme,

▲ *The SeaRobotics ASV 2.5 is a great size for portability fitting into a box trailer which can be pulled by a normal 4x4.*

a programme that prioritises survey and mapping of UK Home Waters, to provide high-quality hydrographic data that underpin the production of national nautical charts and publications, and to maximise the benefit to maritime safety, the marine environment and efficient maritime transport.

Survey Methodology and Equipment

Preparation for an Autonomous Surface Vessel (ASV) survey is a little different to conventional hydrographic surveys. It is always a good idea, regardless of the type of survey, to get as much prior information as possible as to the tides, currents, shoals, shoreline type and foreshore conditions, potential or actual obstructions, etc. but in the case of an ASV this is critical. Google Earth, though excellent, does not have the resolution required to discern obstructions and there is no information as to the state of the tide when it was surveyed. ASVs have a survey speed of approximately 4 knots and not a great deal of extra thrust when deployed with survey equipment, therefore timing survey operations around tidal currents is essential.

The survey methodology that 4D Ocean employed was two-fold. Survey at low water with an Unmanned Aerial Vehicle (UAV) and then survey at high water with the ASV. This has a number of advantages. The UAV survey collects high-resolution topographic data which though not normally a hydrographic deliverable is highly accurate data that is very useful to coastal engineers. It is also timely so will match with the ASV data. Flying the UAV at low water means that the resulting aerial orthophoto can be analysed for obstructions and used as the shoreline edge of the survey for the ASV to run along.

4D Ocean used the following equipment for the survey:

ASV Survey

- SeaRobotics ASV 2.5
- R2Sonic 2020 multibeam sonar
- Applanix POSMV Wavemaster inertial system
- AML X-Base 2 SVP
- Hypack Hysweep Acquisition Software
- QPS Qimera Processing Software

UAV Survey

- senseFly eBee Plus RTK UAV
- O.D.A 20 M Pixel camera
- senseFly eMotion acquisition software
- Pix4D Processing Software
- QPS Qimera Processing Software

▲ *The senseFly eBee Plus UAV and GNSS base station.*

▲ *3D point cloud of Hurst Castle.*

UAV Survey

The UAV survey was performed over low water springs. As Hurst Spit is a strategically important site at the entrance to the Western Solent, the CCO monitors the barrier beach closely. CCO already have geodetic control points and one of these was chosen as a quality control point for the RTK GNSS observations. Ground Control Points (GCPs) were then established using both man-made and natural features.

The senseFly eBee Plus UAV is fully autonomous. A survey plan is created based on the survey area polygon, the survey resolution required and the wind direction. The UAV also doesn't need GCPs to process the data as RTK GNSS corrections are transmitted to the UAV in real-time via the radio link so each photo is geotagged to approximately 2cm resolution. However, a further quality control was undertaken where the GCPs in the processed data were identified and compared to the GNSS processed GCP positions calculated by the Pix4D processing software. The horizontal

▲ *The launch of the ASV.*

▲ *ASV* Harry *surverying at Hurst Spit.*

positions of the GCPs matched almost exactly, and the vertical accuracy was within 10cm. Post-survey, the data is being GNSS PPK processed to compare a single base station location to the virtual reference position used in real-time. The final difference results will be shown at the conference.

An unknown bonus was that the photogrammetric processing actually created accurate points under the water to a depth of approximately 1m. This was beneficial for comparing the overlap between the UAV and ASV surveys and also for informing future survey planning in less shallow-water areas that need to be surveyed by the ASV, improving efficiency further.

ASV Survey

An ASV has a maximum speed of approximately 6 knots with the sonar deployed so tidal currents need to be carefully planned around to ensure optimal speeds. At Hurst Spit the maximum current over Spring tides is about 6 knots, therefore the planning had to be performed very carefully. It isn't just the speed either, at 90% thrust the battery power is going to be depleted much more quickly so, for efficient survey operations, 60 – 70% power is optimal. It was established that during the 2 hours before low and high water it was possible to survey in the areas where the currents were strongest and for the other times we could survey either along the Spit or round in the Haven. This was also weather dependant, like any survey, as the Spit is exposed to southwesterly, westerly or easterly winds.

The SeaRobotics ASV 2.5 is a great size for portability fitting into a box trailer which can be pulled by a normal 4x4. Small roads and remote places are not an issue. One of the many advantages of an ASV is that you don't need to launch the ASV in a port. Providing you can easily access the water you can launch from anywhere. During the UAV survey a sheltered location was selected at the end of the Spit. The Spit is formed of loose shingle so the main road-worthy trailer couldn't be used. However, the ASV has its launch trailer, which is designed on a jetski trailer, and this was towed to the launch site by the CCO 4x4. The communication computer and WiFi were run on their internal battery during launch and recovery so that the remote control used for the initial and final movements of a mission, could be near the ASV launch and recovery location. Once launched the ASV is put into station keeping mode while the shore station is setup for the survey.

The ASV can either be given a line plan, which it then executes or (and what was used for this survey) the next survey line can be automatically calculated by Hypack, based on the actual sonar coverage in real-time, and including an overlap percentage. Once the line is completed the next line is generated and the guidance information fed by the autopilot driver to the ASV control software. The ASV's line keeping capability was well demonstrated, generally not deviating more than 0.2m from the survey line. As the ASV progressed the next line was then computed and at the end of the survey line a new line was calculated. There were only very occasional issues with gaps in the coverage and this was more based on manually selecting the appropriate degree of thrust during line turns (to either be with or against the current) than the autonomous calculation of the actual line itself. Hypack starts and stops logging automatically at the start and end of each line so no input was required from the onshore surveyor.

The ASV is equipped with a sound velocity probe at the transducer, for beam-forming, and uniquely is also equipped with a winch from which an AML Base X SVP probe can either be launched as part of the mission or manually. The commands to launch the probe tell the ASV to either send the probe down a specific distance or to stop a certain distance from the bottom, where it then uses the sonar depth to set the distance to cast. Once the probe has re-docked on the vessel the data is relayed via WiFi.

The R2Sonic 2020 sonar was run in the new Ultra High Definition mode, which produced 1024 beams in every ping complete with snippets backscatter for each beam. This was coupled to the POSMV Wavemaster which was running the new POS View 5 software which allowed RTK GNSS corrections to be input via online streaming. This negated the need for an extra data radio and the connections and battery usage that would have been necessary.

During the survey the ASV's AIS system was running showing all nearby vessels where it was and why it was on the water. CCO's survey vessel *Zephyr* provided safety cover but just ended up shadowing the ASV.

Where there were infills to do the ASV came into its own. The infill lines were selected, loaded into their own line plan and then the ASV was tasked with running the line plan. It did this efficiently and effortlessly.

Results

The survey area had been split into 3 blocks with Block 1 being adjacent to and south of the Castle, Block 2 was adjacent to and running westward along the Hurst Spit frontage and Block 3 extended between Castle Point and North Point, on the eastern side of the spit, a patch of shallow seabed not surveyed with multibeam. By the end of the 2-day survey window, Block 3 had been completed, and due to weather and tidal current conditions, three-quarters of Block 1 and none of Block 2 had been surveyed. Block 1 was affected on Day 2 by strong winds as well as spring tides which meant that the ASV (and for that matter any small survey boat) could not survey in that block or Block 2.

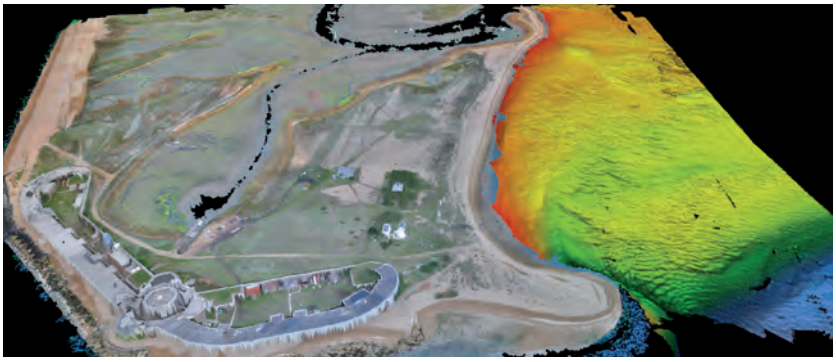
Block 3, though shallow, turned out to be very interesting in that the remains of an ancient forest were possibly found. For navigation purposes the morphology and location of the Spit has changed dramatically since the previous single beam and topographic surveys were conducted so the new extents and depths adjacent to it will be used by UKHO to update the ENC cells and the Admiralty Charts.

The ASV performance was better than anticipated in that the battery life turned out to be approximately 5 hours and that was running at a very high thruster power at times.

The Autoline function in Hypack had a few issues at the start and end of each line in that it tried to write the next line around the edge of the online grid at the end of the line which put a turn in the start of the next line. It was found that occasionally the line had to be manually closed to enable a 'straight' next line to be generated. Future developments should also give the ability to generate the next line with the extents defined by a polygon.

The ASV coped well with strong tidal currents, standing waves, and had good overall system functionality, particularly in terms of line keeping.

The ASV is clearly a cost and time efficient means of undertaking a hydrographic survey. The flexibility and convenience that it brings allows for rapid deployment for a range of survey requirements, from event surveys through to very efficient large coastal surveys.



▲ *3D view of the combined UAV and ASV survey of Hurst Spit.*

▲ *ASV's AIS system outputting its position and status during survey ops.*

Duncan Mallace is the founder and managing director of 4D Ocean. Duncan is a graduate of the University of Newcastle Upon Tyne with a BSc in Surveying Science. After graduating in 1988, he spent two years land surveying before going to sea with Oceanscan in 1990. His offshore time was spent predominantly working with acoustics, either multibeam sonar for mapping and rock dumping or USBL/LBL for offshore construction survey. This led to him setting up the survey company NetSurvey in 2002 as a specialist high-resolution survey company, which became part of MMT in 2011. NetSurvey were also the European reseller for the Fledermaus software suite in Europe, with an IVS3D company formed in the UK in 2007. In 2011, IVS3D was bought by QPS. Duncan was head of Business Development at QPS until April 2017 when he formed 4D Ocean. 4D Ocean are a specialist autonomous survey company conducting high-resolution seabed mapping and topographic surveys using autonomous surface, aerial and underwater vehicles.

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Adaptive Pinger Technology for Undersea Location

Finding Lost Aircraft with Pingers

Although the number of aircraft lost at sea is not very high, in the past years a number of aircraft have literally been lost at sea. With the recently renewed search for Malaysian Airlines flight 370 (MH370), one wonders about the technology in the underwater location of aircraft, and other high value objects. Underwater Locator Beacons ('ULBs' or 'pingers') are used for this, either on the airframe itself or on the black box. Technological advancements to allow better detection are proposed.

Missing Airliners

During the initial search for MH370 nearly 4 years ago, it became apparent that better aircraft location technology was necessary to avoid long searches. This started from the basic limitations of radar tracking, to the realisation that most aircraft do not automatically report location, culminating with the happenstance of limited position information derivable from the satellite data. This resulted in insufficient information to determine where the lost plane may have gone and more specifically in cases such as MH370, where it entered the ocean when it disappeared.

Aircraft at the time that MH370 was lost, and largely today, carry simple, water activated acoustic transmitters to mark the location of the flight data recorder, the so-called 'black box'. The purpose of these 'pingers' was originally to help recovery teams home in on the black box for prompt recovery and analysis. In this case there is an assumption that the crash site is well known. With an entry point known, a 30-day window to find the specific resting place of the data recorders is entirely adequate. As a result, conventional pinger technology is intended for a specific case, assuming that aircraft crashing into the ocean would be monitored from shore, providing a known starting point for undersea search operations. This held true in incidents such as TWA flight 800 (New York 1986) and Egypt Air flight 990 (Massachusetts 1999).

▲ *Aircraft lost at sea.*

From MH370 to Current Technology

During the first weeks after the loss of MH370 significant media airtime was spent analysing the possibilities of 'pings' indicating the location of a sunken airliner. This coverage largely failed to note the original purpose of these pingers with a known point of entry. In cases such as that of MH370, the objective is first to find the airframe or debris field and then home in on key items such as flight data recorders. This is an entirely different requirement from that originally placed upon aviation pingers.

However, there are new technologies (and some old) being applied to better tracking of the aircraft throughout its journey and therefore allowing a better estimate of the location where the aircraft is lost. The new technologies include 'nano' satellite constellations, along with existing satellites (such as Inmarsat), which will receive the new International Civil Aviation Organization (ICAO) required reporting of the aircraft position every 15 minutes. This one change represents a very significant improvement over the status quo. Looking back to MH370, if this had been available it would have greatly improved the probability of detection by knowing where to search early on. But even with such an outcome, the undersea aspects of localising the aircraft, and its black boxes demands more technology.

Current Aviation Pingers

Among other global regulators, The Unites States Federal Aviation Administration (FAA)

issues technical standard orders (TSO) which shape the current technologies used on commercial aircraft. As of 2014, when MH370 was lost, the primary guidance for pingers was TSO-C121 (Underwater Locating Devices (Acoustic) (Self-Powered)).

Pingers (Figure 1) simply transmit a simple signal, a ping, typically starting upon contact with water or loss of power. In black boxes the pingers are water activated. Because a pinger constantly issues a signal it also begins draining its battery immediately. The key parameters of a classic aviation pinger are shown in Table 1. These specifications are usually met with a compact (usually within 12cm long by 3.5cm diameter) and light (under 200g) device, even given the requirement to withstand pressures to 6,000 metres. These dimensions are desirable as airliners aim to minimise size and weight.

Frequency	37.5kHz (+/- 1 kHz)
Acoustic Output re 1μPa@1m	160.5dB
Pulse Length	10ms
Pulse Repetition	1 pulse/sec

▲ *Table 1: Typical 'black box' pinger specifications.*

▲ *Map of the flight path of Malaysia Airlines Flight 370. (Courtesy: Andrew Heneen)*

Pingers in Deep Water

To address challenges existing prior to MH370, regulatory guidance evolved. New black box pingers will slowly be required to provide 90 days of pinging. In addition, there is an upcoming guidance on 'airframe locator' specifications, which will increase the detection range as shown in Table 2. This will require 8.8kHz transmissions and an increase in source level to 180dB increasing the size of the pinger device to roughly 15cm long by 5cm diameter with weight increasing to just over 700 grams.

Recognising that ocean depths can exceed 6km and average ocean depth is over 4km it becomes clear that these improvements are modest. When detection ranges are approximately the same as the local water depth this requires the search system to effectively pass right over the pinger to detect it. In the case of MH370 the estimated search zone was originally estimated at some 60,000 square km, a huge area to cover even with 90 days of pinging. Simple pingers might not be the answer for this type of aircraft loss.

Advanced, Adaptive, Pinger Technologies

There are many advanced technologies that can provide significant improvements for undersea localisation. Unfortunately these concepts exceed the cost or size/weight constraints of the modern aviation industry. Fortunately new concepts for adaptive pingers have been introduced that enable new approaches to energy conservation and acoustic waveform adaptation.

One aspect of the energy conservation methods is delaying the start of the acoustic emissions from the pinger. This simple change allows time to identify the search area, and deploy search vessels on station. If this approach is applied to an airframe locating pinger, presuming conventional pingers remain on black boxes, it provides a significant extension of the search window. An adaptive pinger could be designed to have a 'delayed start' of 30 days, for example, allowing the maximum use of the existing black box pinger battery while also allowing time for searchers to deploy with the proper hydrophone equipment. Alternatively, airframe pingers could start immediately and black box pingers could be delayed. This simple delayed start can easily be applied to existing pingers with minimal impact on cost or size and weight.

In the case of MH370 the estimated search zone was originally estimated at some 60,000 square km

An adaptive pinger also has the ability to change its acoustic waveform for purposes of maximising battery power. Algorithms for this

Frequency	Source Level	Approximate Detection Range
37.5kHz	162dB	1km typical 2-3km depending on sea conditions
8.8kHz	180dB	2km typical 3-4km depending on sea conditions

▲ *Table 2: Approximate aviation pinger detection ranges.*

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- 1000 METRE RANGE
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- INTEGRATED DISPLAY
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- BREAKTHROUGH PRICE
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feature can be predefined and contained within the adaptive pingers circuitry taking input from an integral depth sensor which tells whether it is in shallow or very deep water. The depth of the water will influence the time it takes to be located, so deep water will call for more robust battery conservation than shallow water, thereby extending battery life for the more complex location task and increasing the probability of detection. The depth can also be transmitted as part of the coded pulse to search vessels.

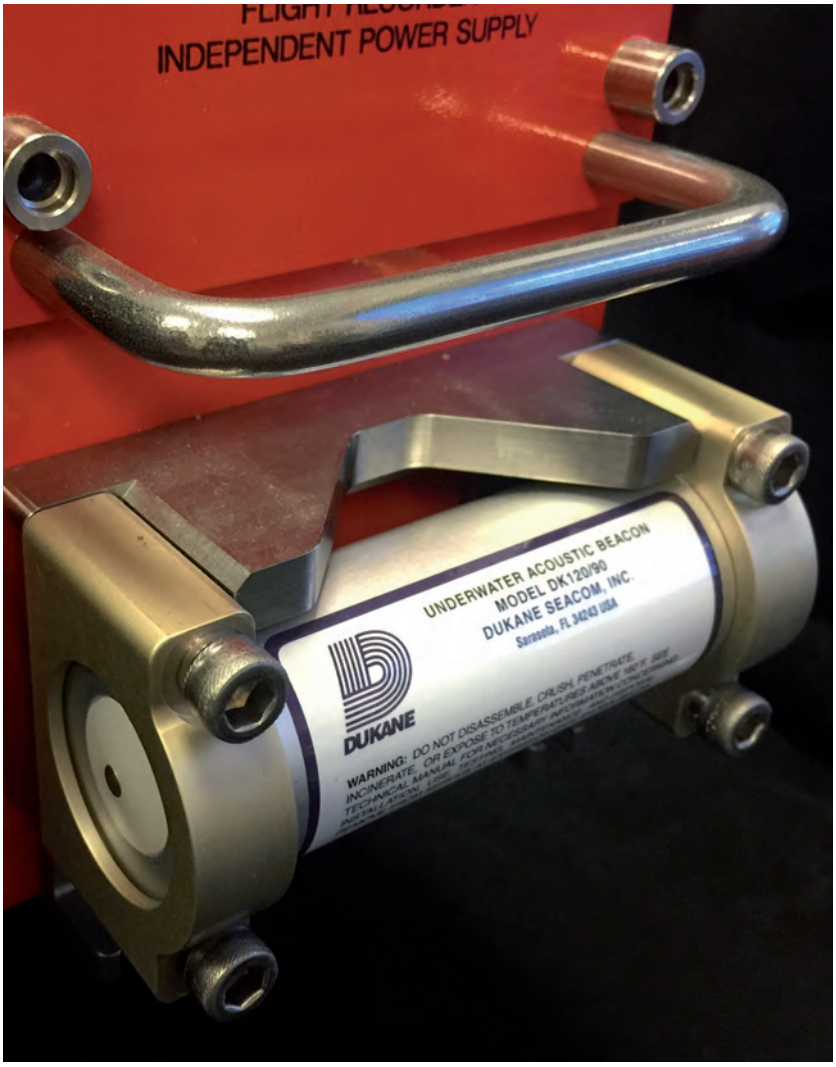
Current pingers emit a high power acoustic pulse, generally every second. This pulse is typically 5-10ms in length and repeats continuously until the battery is depleted. The pulse frequency is 37.5khz for the majority of the pingers in use on black boxes which is most suitable for shallow waters, whereas very deep waters are better served by low frequency pulses of 8-10khz. The lower frequency beacon has become an ICAO requirement for airlines to carry as an airframe locator, and it is likely to become an FAA requirement as well. An adaptive pinger can emit signals on one of two frequencies or on both frequencies and as it can understand, algorithmically, whether it is in deep water, it can then shift its acoustic output frequency to optimise for deep water. Additionally, the adaptive pinger can follow pre-set algorithms to adapt the waveform by reducing the pulse repetition rate, modulate the pulse power, or both, all in relation to the depth sensor inputs.

The depth value is transmitted by either of two methods: one is an acoustic pulse frequency shift (frequency shift key in proportion to the depth), and the other is in a coded pulse sequence similar to the aviation Mode C reporting format for altitude. Once the depth code is received and understood by the search vessel, then by can more quickly narrow the search to areas that match the reported depth.

When the users and end customers of undersea locating systems ask for it, improved technology will be readily available

Conclusion

The techniques described in this article are all available and the adaptive pingers have also been patented. Current technology is not a limiting factor; some of the new adaptive pinger technologies can easily be added to existing products. Others might require additional development. All might require modest new engineering to survive airframe crashes. The primary challenges are the 'social engineering' issues of the business case and regulatory processes. When the users and end customers of undersea locating systems ask for it, improved technology will be readily available. ◀



▲ *Figure 1: A flight data recorder with pinger attached.*

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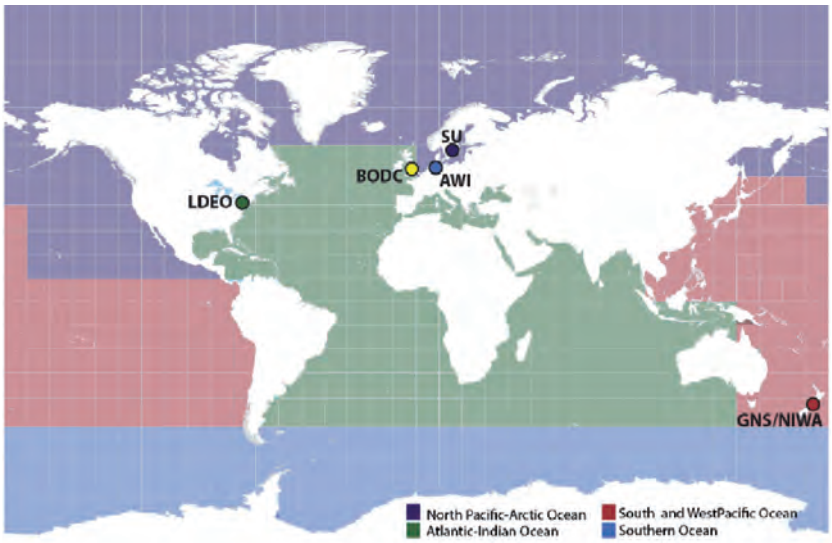
Seabed 2030: A Call to Action

Many people like me start speeches about mapping the ocean with "we know more about the surface of Mars than we do about the bottom of our ocean." And despite years of speeches and countless days at sea surveying, we still have mapped less than 20 percent of the world's oceans. Even in the relatively wealthy United States, only thirty percent of our waters are mapped. It is time to get organised.

In June 2017, the Nippon Foundation announced the launch of a global mapping initiative that is capturing the enthusiasm of Hydrographic Offices and collaborating partners around the world. A joint project with the General Bathymetric Chart of the Oceans (GEBCO) Guiding Committee, Seabed 2030, presents us with a unifying goal -- to produce a complete, high-resolution bathymetric map of the world's seabed from the coasts to the deepest trenches by the year 2030. The whys and hows speak to the compelling need for bathymetric data and the potential for innovative ideas and technological advances to accomplish this goal. From my perspective as the US National Hydrographer and director of NOAA's Office of Coast Survey, Seabed 2030 is an excellent opportunity to reinvigorate and communicate ocean mapping efforts in common cause with other maritime nations.

Seabed 2030 is organised around three project pillars:

- Data discovery - Unearthing existing bathymetric data not already found in national archives such as NOAA's Multibeam Bathymetry Database. Such acoustic data may have been gathered in conjunction with ocean science research cruises, or by industry interests willing to now contribute it for the greater good. Target resolutions vary based on depth, e.g. the grid cell size for 0-1500m depth range is 100x100m; 3000-5750m is 400x400m.
- Data sharing - Creating high-resolution maps of the seafloor to share with the public. The completed maps will be released on Seabed 2030's official website so that anyone can access the latest information, and also through online resources like Google Earth and ESRI's Ocean Basemap.
- Finding and filling data gaps - Identifying and filling in gaps where no data is available. This is perhaps the most captivating part of the project, as we work to explore and survey unknown and unmapped ocean places. Key components include collaborative mapping missions, crowdsourced bathymetry from essential partners such as fishing boats, ocean-going carriers, and recreational vessels, and technological innovations that force-multiply our capacities to collect sonar data efficiently in distant and challenging areas.

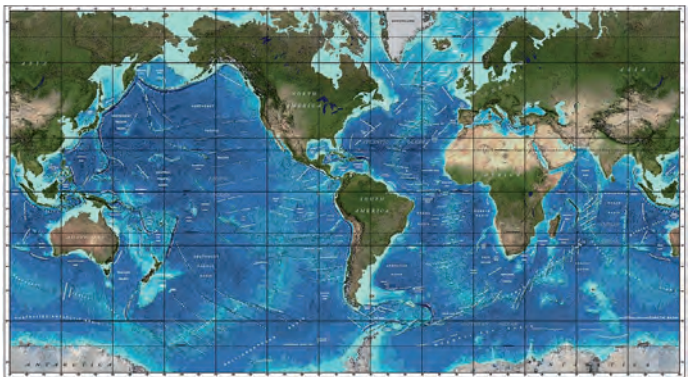


▲ *Figure 1: Seabed 2030 Coordination Centres, GEBCO Nippon Foundation Seabed 2030 Project Business Plan V2.1.6, available from seabed2030.gebco.net.*

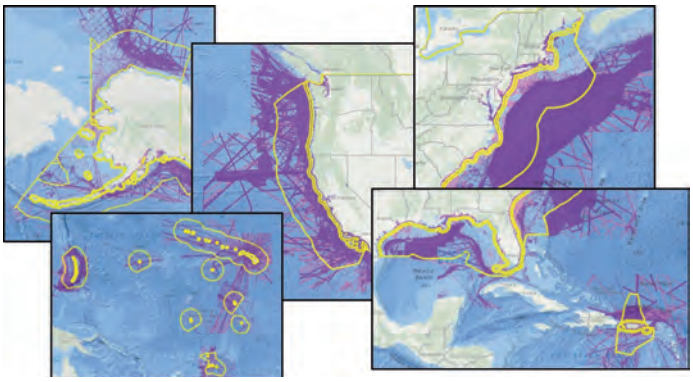
To facilitate the objectives above, the Nippon Foundation and GEBCO have established a Global Data Assembly Coordination Center and four Regional Data Assembly Coordination Centres (Figure 1). These centres are responsible for championing regional mapping activities as well as assembling and compiling the cleaned data into a regional bathymetric grid. They will also ensure that the data meets international standards for metadata and the use requirements for data integration and gap analysis. Most importantly, the centres will work to foster collaboration and avoid duplication so that we use our limited global mapping resources most efficiently.

While Seabed 2030 is a new effort, it builds on longstanding programmes having the same purpose. GEBCO itself was founded over 100 years ago to compile and distribute a map of the global ocean (Figure 2). Since 1988, the International Hydrographic Organisation and NOAA have supported the Data Centre for Digital Bathymetry, to steward the world's collection of digital bathymetry.

This organisational framework positions us well to move forward, but why is it important to survey and map our oceans at all? Why do we need a Seabed 2030 initiative? As hydrographers, we know intrinsically that more comprehensive bathymetric data has inestimable value. We know that seabed mapping is fundamental to the safety, security, heritage and economic prosperity of our nations. We know that bathymetry is a factor in almost every activity that takes place in, on, near, or



▲ *Figure 2: General Bathymetric Chart of the Oceans (GEBCO) World Ocean Bathymetry. Image reproduced from the GEBCO world map 2014, available from www.gebco.net.*



▲ *Figure 3: Preliminary analysis of US EEZ bathymetric data gaps for Seabed 2030, NOAA 2017, available from http://seasket.ch/i0D3ZhDWiQ.*

under the sea. We know that ocean mapping is the blueprint for forecasting weather, tsunami and storm surge events, climate change projections and the outlines of where living marine resources exist. We know that hydrographic surveying is the means to uncover the history of our fallen lost at sea and the framework for seabed mineral discovery. We know that accurate ocean depths are instrumental in connecting the world through safe navigation and transoceanic communication cables, and we know they are critical to emergency response on the high seas. But because people understand the role that bathymetric data plays in their lives to differing degrees around the world -- if at all -- it is incumbent upon us to communicate better the importance of ocean mapping. Seabed 2030 gives us the opportunity to explain to the public and our policy-makers that unmapped and poorly mapped oceans mean that submarines crash into seamounts, like the USS San Francisco did in 2005. It means that discrepancies between estimated and observed tsunami waves exist potentially creating loss of life and property or unnecessary costly evacuations that can total in the tens of millions of dollars. It means that the remains of those lost at sea and the vessels – or aircraft -- containing them may never be found. It means that billions of dollars of offshore wind capacity, fossil fuels and deep-sea mining cannot be exploited, and the ecosystems that may be affected by these activities cannot be protected because they are currently unknown.

At NOAA, we are committed to supporting Seabed 2030 goals with the resources and partnerships available to us. Seafloor mapping is integral to many NOAA products, from nautical charts and accurate assessments of fish and their habitats so vital to our nation's commerce. We use it to model inputs that enable better weather forecasts and climate predictions for agriculture, transportation and insurance industry decisions, for earlier warnings of costly natural disasters, and for a greater understanding of how our oceans drive life as we know it on Earth. Knowing the depth of the seafloor is not only vital to navigation and coastal management, but is also a fundamental parameter for understanding ocean circulation and tides, wave action, sediment transport, subsea dynamic processes, environmental change, underwater hazards, pipeline routing, and for ground-truthing research and commercial satellite observations.

There are countless other reasons to map the seafloor. The oceans cover seventy percent of the Earth's surface, yet more than eighty percent of our oceans are unmapped, unobserved, and unexplored. Only about 10% have been mapped using modern technology. Another approximately 5% were mapped using lead lines and explosives, which provides only a general sense of the area. The global maps of the seafloor that look comprehensive on Google Earth and other projections are actually only capable of resolving features larger than five kilometres, and are frequently hundreds or even thousands of metres in error. That means entire seamounts, channels, and other geologic structures, their corresponding ecosystems, and potential resources go undiscovered for most of the Earth. Our understanding of ocean and seafloor depths and processes is quite limited due to cost, distance and time; we have given little priority to what we cannot see beneath the water's surface. While we have indeed mapped the entire moon to 7-metre resolution and Mars to 20 metres, much of our own planet's seafloor is mapped at best to 5000-metre resolution using satellites that infer depth based on gravity anomalies.

With thanks to the Nippon Foundation and GEBCO for their leadership, Seabed 2030 is a timely call to surveyors and mappers to take action. I am pleased that US federal mapping agencies are on board, as are the Hydrographic Offices of other nations, the International Hydrographic Organisation, the Intergovernmental Oceanographic Commission, numerous academic institutions, and industry partners. NOAA's preliminary data gap assessment shows that there is significant work to be done in the US EEZ (Figure 3).

Seabed 2030 enables us to bring together hydrographic experts with practical at-sea surveying experience, skilled data processors, database managers, software and hardware developers on the leading edge of technology, geologists, geophysicists, other ocean scientists, mariners and marine planners. Everyone on the ocean can play a role in building and benefit from access to a global seabed map, which has the potential to unlock information to revolutionise business practices, scientific inquiry, and general exploration. If we communicate it well, Seabed 2030 will catalyse ocean mapping coordination and collaboration, empowering the world to make informed policy decisions, use the ocean sustainably, and undertake scientific research systematically with detailed bathymetric information of the Earth's seafloor in hand. ◀

Rear Adm. Shepard M. Smith is director of NOAA's Office of Coast Survey and the US national representative to the International Hydrographic Organization (IHO). In 2017, he was elected as the chair of the IHO Council. He is opening the Hydrography, Geophysics & Geotechnics Conference at Oceanology International 2018 on 13 March at London's ExCel, with his paper titled *Seabed 2030: A Plan for high-resolution maps of the ocean by 2030.* Attendance to both the conference and exhibition is free. Register at http://www.oceanologyinternational.com/register

Application of the Kongsberg GeoSwath System

Shallow Inland Water Bathymetry Meeting IHO S-44 Special Order

For many years, the GeoSwath system from Kongsberg GeoAcoustics has been providing an efficient simultaneous swath bathymetry and side-scan seabed mapping solution with accuracies that meet the IHO S-44 Special Order standard for hydrographic surveys. GeoSwath systems have been fitted to a number of small crafts and have been utilised to conduct bathymetric surveys of lakes, ponds, dams and rivers. This article describes two of the vessels that have been employed to undertake this area of work.

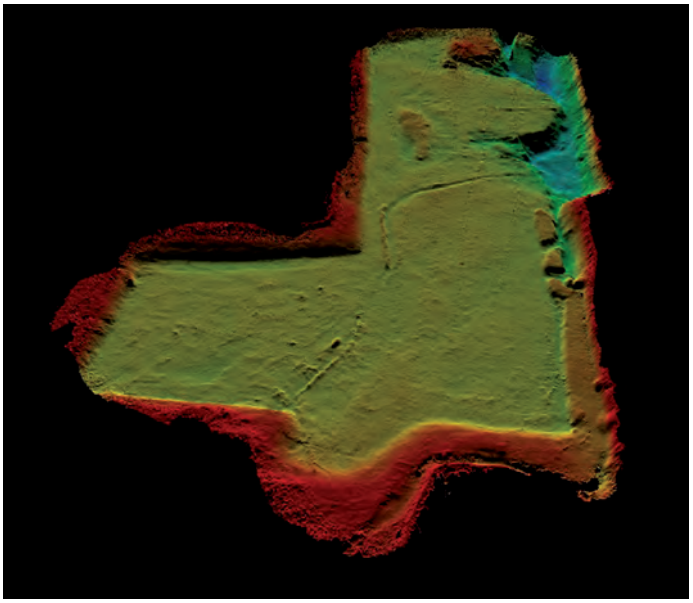
The use of Unmanned Surface Vessel (USVs) allows surveying in locations and situations in which deployment of conventional platforms is not practical or safe such as mine tailings ponds or remote locations where access for traditional vessels is difficult or restricted. Kongsberg have been supplying USVs integrated with a modified GeoSwath system for the last couple of years. The vessels used to date have included the EchoBoat-ASV (Seafloor Systems) and the Z-Boat 1800 (Teledyne Marine). The GeoSwath system installed in the USV is based on the unit designed for use in the Remus 100 Autonomous Underwater Vehicle (AUV) manufactured by Hydroid Inc. The complete GeoSwath USV system comprises a remotely controlled hydrographic survey boat that is fully integrated with a GeoSwath system, GPS position & heading sensor, a motion reference unit (MRU) and a sound velocity sensor. In the case of the Echo-Boat ASV, a Futaba 2.4GHz omni-directional antenna provides remote control of the vessel with a claimed range of up to 2km. Within the USV, the GeoSwath module comprises an industrial PC that runs the GeoSwath data - acquisition software and controls the sonar electronics. The GeoSwath module onboard the USV is connected via a radio LAN modem link (100Mbps) to a shore-based PC that also runs a version of the GeoSwath GS4 software. This modem link allows control commands to be sent from the shore-based version of the GS4 software to the GS4 software running on the GeoSwath USV module to control the data-acquisition settings. This link also allows sonar data as well as data from the GPS compass, MRU and SVS to be transmitted back to the shore-based PC and displayed within the GeoSwath GS4 software. The position and heading information of the USV is displayed in a window within the shore-based GS4 software so that the operator can see where the USV is in relation to a predetermined survey plan. The GeoSwath USV module saves all of the raw data files to a local hard disk drive in a propriety .rff format. These raw data files can be subsequently processed using the GS4 software.

Ability to image a swath up to 12 times the water depth

▲ *Figure 1: The USV in action on the lake near Reading.*

Case Study: Shallow-water Lake

The following is a case study of a survey conducted on a shallow lake using one such system, which was based upon a Seafloor Systems EchoBoat fitted with a SeaPath 134 GPS/MRU. Sound velocity is measured using a



▲ *Figure 2: Bathymetry of the lake near Reading. The majority of the lake has a flat bottom with 2m depth.*

▲ *Figure 3: The Compact Survey Vessel (CSV) shown here fitted with a Seatex SeaPath 134 GPS compass and MRU.*

Valeport MiniSVS that is fitted to the transducer head below the vessel. The EchoBoat is constructed from UV resistant HDPE and measures 1.68m by 0.81m. System power is provided by 2 independent supplies, one for the vessel and one for the GeoSwath system and ancillary equipment. The USV will run for up to 8 hours of operation depending upon speed and environmental conditions, a single battery pack will give up to 2 hrs GeoSwath operation and this can be extended with additional battery capacity.

The USV was used to survey an old gravel pit south of Reading that was being redeveloped into an ornamental lake as part of a new housing development and the developers required a hydrographic survey of the lake. The lake was approximately 150m at its widest point and approximately 300m long. A base station was set up on the side of the lake and used to control the USV as it conducted the survey. The USV was launched by 2 persons from the bank of the lake using a launch trolley, and recovered in a similar manner. The traditional method of surveying such a lake would have been to deploy a small vessel and conduct a survey using a single beam echo sounder to get spot depth measurements and use a depth pole to generate spot data towards the banks of the lake.

The entire survey took less than an hour to complete, which was considerably less time than the alternative method of a boat and pole, and gave more complete coverage than would have been possible. Once the survey had been completed the data was processed using the GS4 software to generate an XYZ plot of the bathymetry for presentation to the client with a 0.5m grid spacing.

Most of the lake is about 2m deep with a deeper 4m channel in the north-east corner. Due to the swath width of 20m (10x water depth) the entire survey was completed in just a few survey lines being run. As well as the bathymetric data recorded, the GeoSwath system also recorded co-registered geo-referenced side-scan data.

Compact Survey Vessel

There are occasions where remote control of a USV is not practical or desirable given the potential size of a survey area, the distance from a base station for communications or the distance from a potential launch site. In order to address these situations, Kongsberg GeoAcoustics have recently launched their Compact Survey Vessel (CSV). The CSV has been specifically designed to survey shallow coastal and inland waterways quickly.

Kongsberg GeoAcoustics have combined a powerful and manoeuvrable two-person catamaran (manufactured by Zego Sport Boat, New Zealand) and have equipped it with the latest GeoSwath 4R system. The GS4R is similar to the system used previously in the USV deployment except that the sonar electronics and control PC are housed in a ruggedised enclosure that is connected in turn to a control PC via an Ethernet link. This control PC runs the GS4 software and is accessed from the helmsman's position.

The CSV is a lightweight two-person catamaran and due to its lightweight is easily transportable on its trailer so that launch and recovery can be made from small slipways or straight from the shoreline. The craft is light enough to be launched by one person, and all the instrument controls, communication systems and survey operating tools are ergonomically designed so that everything can be accessed from the helmsman's position. Fitted to the CSV is a ruggedised laptop, which is used to control the data acquisition through the dedicated GeoSwath 4R software package. An external keypad is provided that has been configured to enable the user to easily start and stop data acquisition without using the laptop's keyboard.

The entire survey took considerably less time than the alternative method of a boat and pole

The vessel is constructed from plastic with all stainless steel fittings. It measures 3m in length, has a width of 1.62m and weighs 182kg, which includes the supplied 30HP outboard engine. Based on the engine manufacturer's fuel consumption data, the CSV will use approximately 4l/h at survey speed. Standard fuel capacity is 24l, which gives the Compact

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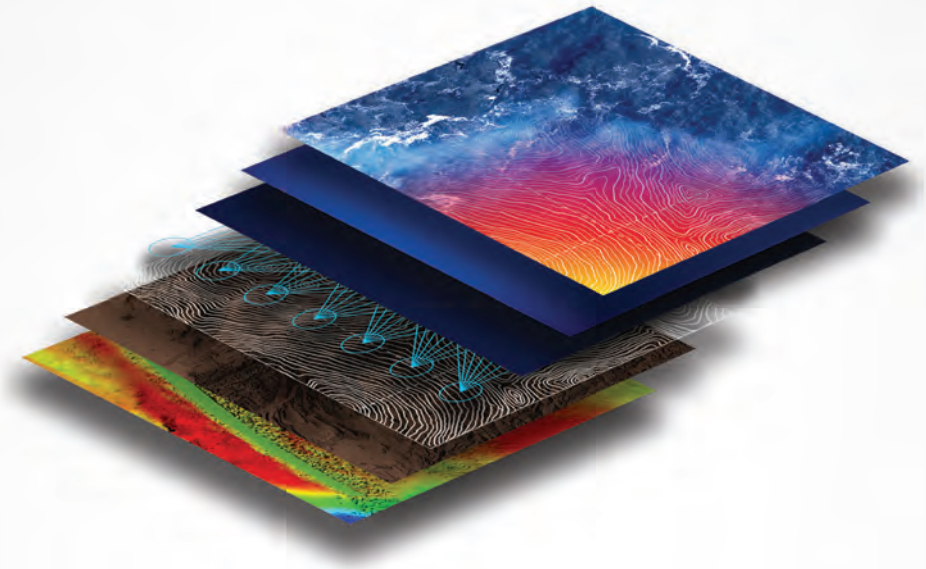

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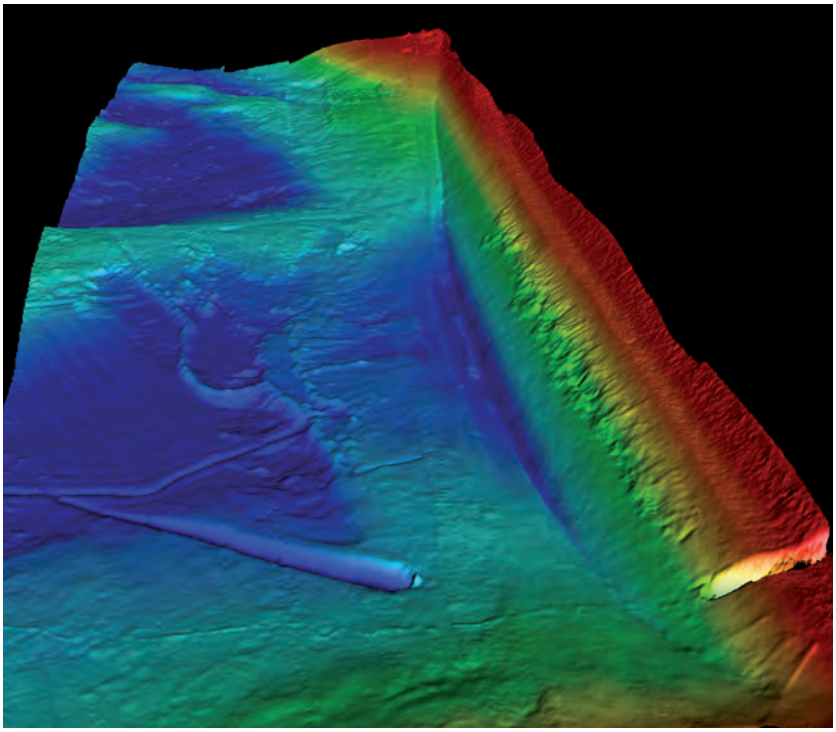

▲ *Figure 4: 3D plot of the bathymetry of part of the west dam wall at Draycote Water. Colour scaling is from the surface down to 17.5m.*

▲ *Figure 5: Co-registered geo-referenced side-scan data for the area adjacent to the dam wall.*

Survey Vessel the ability to operate for approximately 6 hours before the need to refuel. With a top speed of 27 knots it can quickly get from launch site to survey area, although at higher speeds fuel consumption is greatly increased. At 5,500rpm the 30HP engine uses 13L/h.

The vessel has a draft of just 0.35m so it can operate in extreme shallow environments. One of the key advantages of the GeoSwath system is its ability to image a swath up to 12 times the water depth, which in just 35 centimetres of water gives a swath of over 4m wide at survey speed. The actual width of the swath achieved is dependent upon a number of factors such as the bottom material and the material's acoustic absorption characteristics. The GeoSwath transducer is mounted on a retractable pole with a pre-installed motion reference unit (Seatex) and sound velocity sensor (Valeport MiniSVS). The standard vessel is also fitted with a Seapath 134 GPS heading and position system (although other options are available). The GeoSwath system is pre-calibrated in terms of sensor offsets of GPS compass and MRU so that the survey operation can commence immediately on arrival, and no time is wasted running additional survey lines. If the surveyor wishes to run additional calibration lines then these can be done and the data checked to confirm that latency, pith, roll and yaw settings are correct within the GS4 software prior to processing the recorded data.

Deepwater Reservoir Survey

Draycote Water reservoir was completed in 1972 and supplied drinking water to the town of Rugby and the surrounding area. It has a surface area of approximately 2.4km2 and holds 22.7Mm3 of water with a maximum depth of 19m. The site was originally chosen as the land was low lying and was surrounded by 5 small hills and a ridge that were linked together by 6 dams to form the reservoir. The CSV was used to survey an area (700m x 300m) adjacent to the dam wall on the west side of the reservoir in less than an hour. The maximum depth measured in this area was 17.5m and the output provided to the client was in an XYZ format with a 0.5m grid spacing.

By capturing side-scan images at the same time it is possible to extract additional information through subsequent processing such as material classification and texture analysis.

The use of bathymetric measurement systems fitted to small vessels such as the GeoSwath USV and CSV offers the potential of conducting more complete surveys and in locations that would have previously been too difficult or too time consuming to undertake. Each of these vessels have been designed to address a particular need in surveying inland lakes, rivers and dams. The use of USVs addresses some of the health and safety issues raised with having people operating on water bodies that could be potentially hazardous. Improvements in battery capacity combined with autonomous control systems will allow longer duration missions in the future with less input required from the surveyor. A number of jurisdictions and organisations around the world are starting to think about the legal implications of USVs and how much final control from the 'human element' should be included.

The CSV is a vessel which helps bridge the gap of surveying larger bodies of water or longer rivers where it may not be practical to set up a number of shore-based stations or where the site is too restrictive for the use of a conventional survey vessel. ◀

Dr **Richard Dowdeswell** has recently joined Kongsberg GeoAcoustics as general manager. Prior to this he spent 10 years with the UK Government's Centre for Environment Fisheries and Aquaculture Science (Cefas) in a range of management positions. Prior to Cefas he spent 8 years running a university spin-out company.
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Fighting Repetitive, Manual and Error-prone Routines the Smart Way

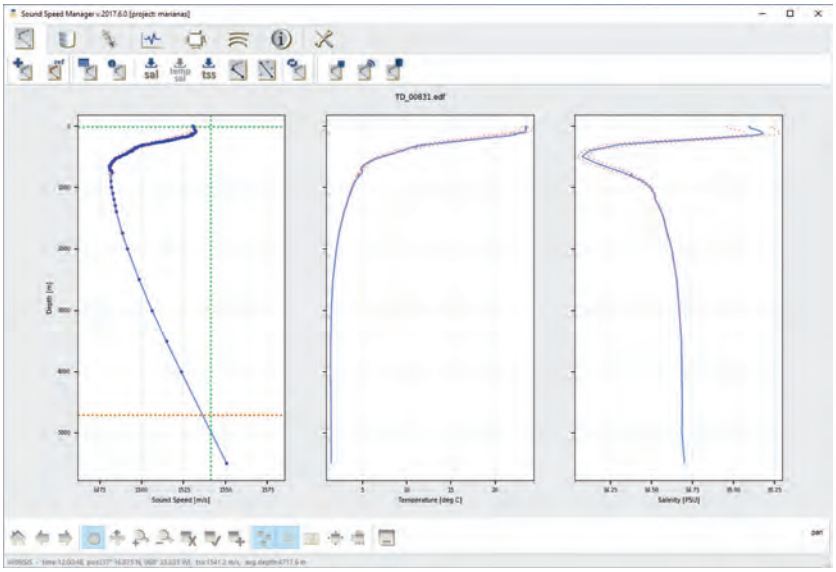
Research-driven Tools for Ocean Mappers

In a world where artificial intelligence plays a key role in our everyday life, it is disappointing when the everyday routines of an ocean mapper or cartographer involve solutions that are crudely manual, repetitive and error prone. Although the root causes of this situation might be debatable (e.g., constraints from abstruse formats, obscure algorithms, obsolete specifications, or a combination) the advantages to the ocean mapping community catching up with current-era technologies and moving towards smarter and more automated solutions are not.

At first sight, many of the current issues are well-known generic problems, often with robust and widely adopted solutions (e.g., cartographic generalisation). However, when the solution is put into the context of ocean mapping, in a large number of cases it cannot be directly applied. Furthermore, it is sometimes the case that, with the addition of specific requirements, an originally strong solution no longer represents the optimal answer. Although the need for more automated tools is clear, it is also important not to be trapped by one-click solutions. Next-generation surveyors will still need to be qualified to understand when the outcomes of a workflow-specific step are not correct, and be able to troubleshoot the causes. This judgement becomes harder (if not impossible) when the processing details are obfuscated by hidden software logic.

Speed up the testing of new ideas and the Research-to-Operations (R2O) transition

To ease the creation of better and well-understood tools for ocean mapping, the Center for Coastal and Ocean Mapping (University of New Hampshire) has conducted a collaborative effort with the NOAA Coast Survey Development Laboratory since 2016 to develop an open research software environment with applications that cover all phases of the ping-to-public process. This effort, called HydrOffice, aims to facilitate data acquisition, to automate and enhance data processing and to improve hydrographic products. These themes are driving the creation of a growing collection of hydro-packages, each dealing with specific aspects of the ocean mapping workflow.



▲ *Figure 1: The Editor tab of Sound Speed Manager provides all the functionalities to enhance and perform quality control of the collected data.*

The HydrOffice environment, by minimising the effort to initiate and test new ideas, facilitates the creation of new tools for researchers, students and those in the field, and, potentially, eases the industrialisation. The overall goal is to speed up the testing of new ideas and the Research-to-Operations (R2O) transition.

Framework

HydrOffice was designed with a modular structure to facilitate its integration into existing infrastructures and workflows. Additionally, appropriate open licences are preferred to encourage community contributions. Given that a key goal is to stimulate the creation of new

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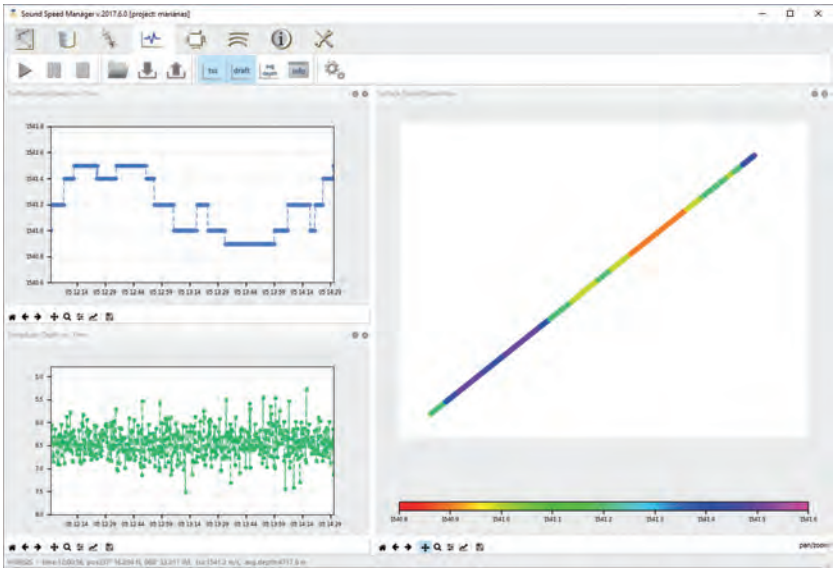


▲ *Figure 2: The Survey Data Monitor embedded in Sound Speed Manager helps the surveyor to evaluate sudden changes of the sound speed at the transducer.*

tools and to explore innovative approaches, several base packages performing commonly required operations have been developed and made available.

To provide access to commonly-used sonar raw data formats, the framework has adopted the Hydrographic Universal Data Description Language (Huddl). This avoids having to create and maintain format-specific libraries, or creating (another) generic format that tends to either provide only a subset or a complex superset of all the information stored in the native formats. Avoiding these limitations, Huddl enables the creation of flexible XML descriptions of existing hydrographic data formats. Once a format is described, both code libraries and human-readable documentation are automatically generated. From an archiving perspective, the Huddl-based description provides a label that can be used anytime in the future to access and interpret the data.

Together with Huddl-based packages, a library to access the environmental data collected by various CTD instruments and sound speed profilers is also available. Moving up the ocean mapping workflow, HydrOffice provides packages to access single- and variable-resolution raster data in the Open Navigation Surface's BAG format as well as vector data in the IHO S-57 format.

Available Tools

In addition to basic building blocks, several applications have been implemented. These applications range from survey management to data distribution and quality control, and illustrate the range of tools enabled by the HydrOffice framework.

The application of customised, automated scans can rapidly identify anomalous data points

Sound Speed Manager

Sound Speed Manager is an application that integrates several best practices and functionalities to process sound speed profiles and other environmental data for use with sonar systems. The application has been designed to easily integrate with existing systems and streamline data-acquisition workflows. In addition to the usual open-source opportunity of learning from (and validating) the algorithms, the liberal licence used preserves the ability to adapt the application for specific organisational needs.

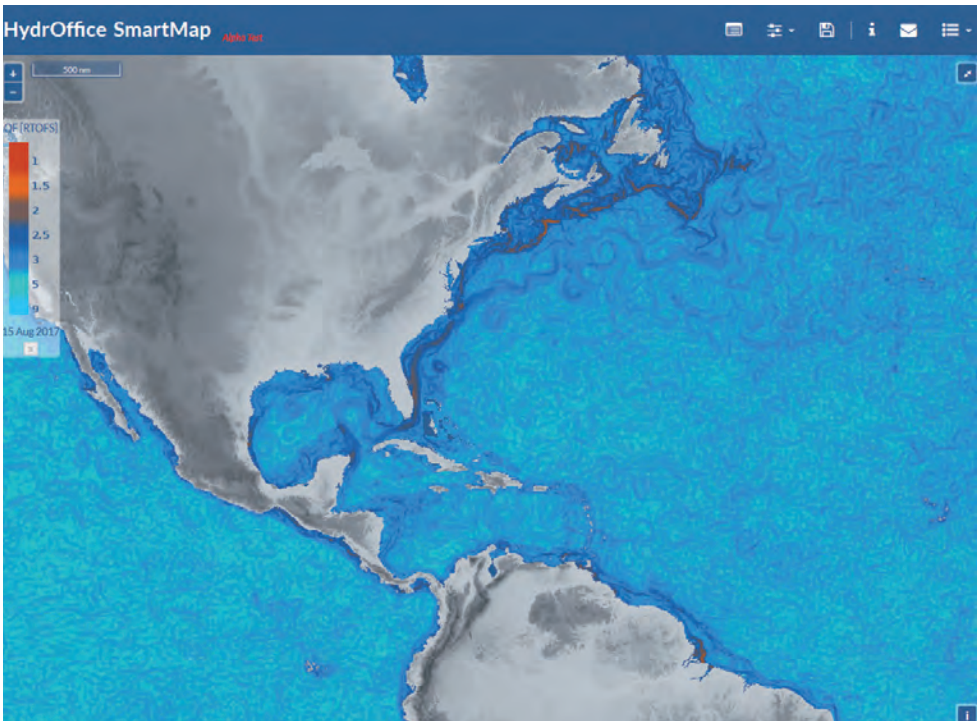
The main functionalities include: wide support of commonly-used sound speed profile formats, integration with common data-acquisition/integration applications, profile enhancement based on real-time and climatological models (Figure 1), and database management of the collected data with built-in functionalities for analysis and visualisation. The most recent developments include the ability to monitor the data-acquisition process and to provide time estimation for the next cast (Figure 2).

With a long-term support and development plan, the app represents a turnkey application that has already been adopted by many professionals and institutions in the hydrographic community. The application is freely available for download from: https://www.hydroffice.org/soundspeed/main.

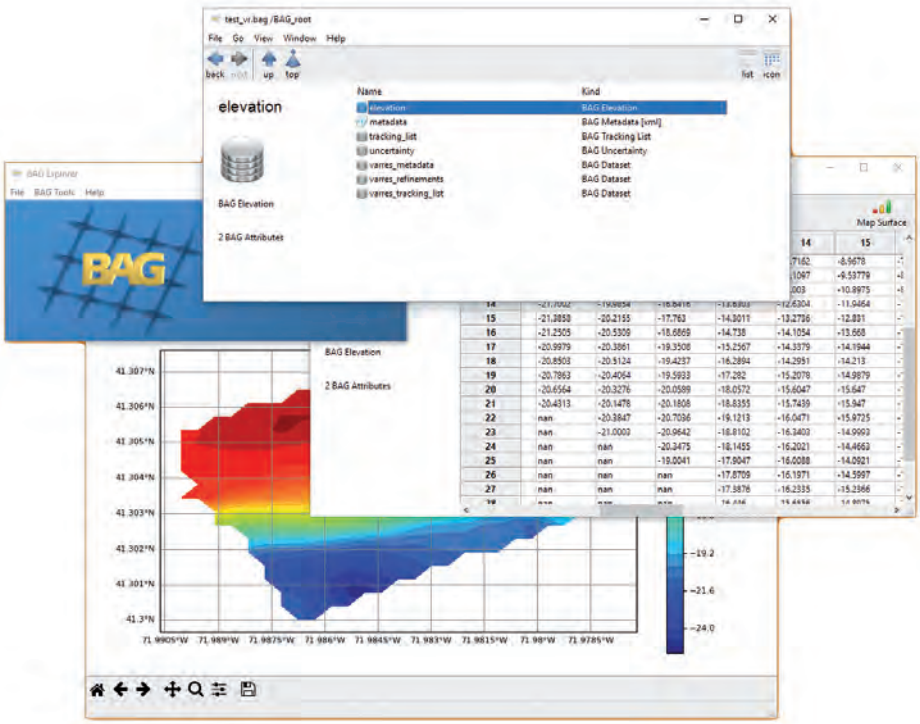
SmartMap

Although existing oceanographic atlases and models provide an enormous amount of four-dimensional information for surveys, such information is delivered in a way that is not easy to translate to the expected survey data quality. The Sea Mapper's Acoustic Ray Tracing Monitor and Planner (SmartMap) project aims to facilitate the evaluation of how oceanographic temporal and spatial variability impacts hydrographic surveys. The task is reached through the calculation of a quality factor that expresses depth uncertainty as a function of local depth. This can help identify problematic spatial and temporal areas to the end-user who is lacking the specialised knowledge.

Currently, the quality factor is calculated on a global scale using oceanographic data derived from the NOAA Global Real-Time Ocean Forecast System. The resulting data is made publicly available through OGC WMS and WCS services as well as a task-specific WebGIS (Figure 3) that can be accessed from: https://www.hydroffice.org/smartmap/.



▲ *Figure 3: The SmartMap WebGIS provides direct access to the Quality Factor values based on RTOFS forecast data for the next seven days.*



▲ *Figure 4: Screenshot of BAG Explorer providing access to the internal structure of a Variable-Resolution BAG file.*

BAG Explorer

BAG Explorer is a lightweight application specifically developed to inspect the content of an Open Navigation Surface BAG data file.

It provides an intuitive mechanism to explore the tree-like multi-layered structure of the file. The application supports visualisation and validation of the XML metadata content, and inspection of the changes applied to the original data and stored in the tracking list. It can also be used to read the optional layers for single- and variable-resolution grids, and to plot the elevation and the uncertainty layers (Figure 4). The application can be downloaded from: https://www.hydroffice.org/bag/main.

QC Tools

QC Tools is a set of software solutions aiming to alleviate the tedious and monotonous tasks, born from applying hydrographic office specifications to vast amounts of data, which continue to persist in hydrographic data processing and review. Many such specifications are objective and quantitative, and are ripe for automation, which allows more time for humans to perform more challenging tasks, at which they excel. These tasks are generally more subjective and unsuitable for automation, such as those requiring the 'judgment of an expert hydrographer'.

By way of example, consider validation of a bathymetric model and S-57 combination. Gridded bathymetry, which quite often represents the final product of a hydrographic survey, routinely consists of tens of millions of nodes - quite unsuitable for human, manual review, although this has been the industry expectation for years. S-57 files often consist of hundreds of features, each with strictly-required attribution, all of which must be consistent with the corresponding bathymetry. Traditionally, this consistency has been evaluated through a manual process which is prone to human error.

QC Tools has numerous functions to rapidly scan through such datasets: gridded bathymetry consisting of millions of data points, bulky feature files, or high-density sounding selections. The application of automated scans, customised to user-specified requirements, can rapidly identify anomalous data points (Figure 5), ensuring product consistency and that all agency-specific

requirements are met. The application of QC Tools to NOAA Office of Coast Survey workflow has resulted in improved data quality and timeliness. Yearly updates and edits to the Hydrographic Survey Specifications and Deliverables are now made with an eye toward facilitating automation and anticipating implementation. QC Tools can be downloaded from its official webpage (https://www.hydroffice.org/qctools/main), which also contains manuals and video tutorials.

Conclusions

Over the years, Hydrographic Offices and other ocean mapping agencies have generally accumulated large, sometimes wordy, specifications that express thousands of experience-based rules. In order to transition this priceless information into automated data acquisition and processing, it is required to convert them to code that can then be executed and scaled using parallel computing.

Although this operation may appear straightforward, it presents complexities related to human interpretation and possible vagueness of specification. Conflicting interpretations of a rule presents a great opportunity to rethink it so as to reach a unique interpretation. This does not mean that all the rules should be algorithmically rewritten, given that some of them may require the 'judgement of an expert hydrographer'. However, such a subset of rules should be carefully identified and labelled as left to human evaluation. The degree of achievable automation is directly linked to the volume of rules that cannot be machine interpreted.

HydrOffice has developed a number of applications that translate to code both existing specifications and long-term best practices, enabled and extended by recent discoveries and research-driven techniques. Increased workflow efficiency reported by many users confirms the benefits of this approach.

Acknowledgements

HydrOffice has received relevant inputs from a number of passionate contributors that would be too long to list. However, we want to explicitly thank Dr. Jonathan Beaudoin (now with QPS), whose original research has been foundational for Sound Speed Manager and SmartMap; Sam Greenaway, Jack Riley, Janice Eisenberg, and John Doroba (NOAA), for the endless efforts in improving the tools; and Paul Johnson (UNH), who greatly helped in their adoption.

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Increased workflow efficiency reported by many users confirms the benefits of this approach

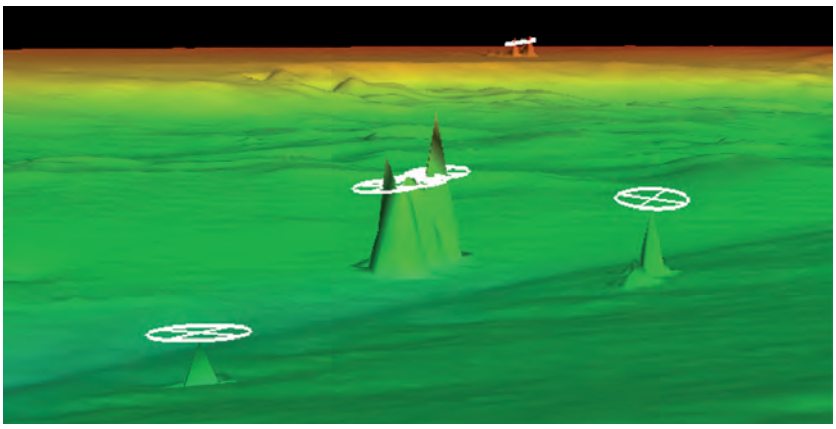

Figure 5: The S-57 output layer of QC Tools Flier Finder highlighting isolated anomalous data fliers.

More Information

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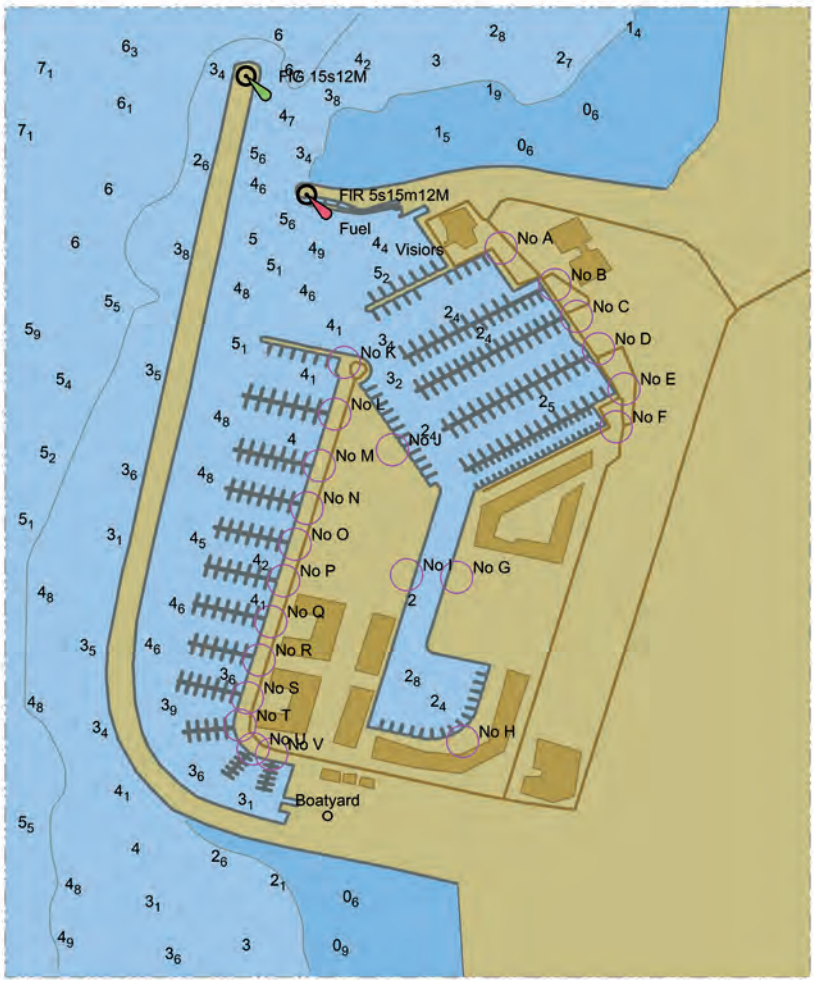
The Transformation to a 21st Century Organisation with New GIS Maritime Workflows

Israeli Navy Transforms to New **GIS Technology**

The Israeli Navy Hydrographic Branch (INHB) is transforming itself into a 21st century organisation. Moving away from traditional methods of generating hydrographic products, INHB have adopted geographic information system (GIS) technology. This forms part of the evolution towards a full modern Marine Spatial Data Infrastructure (MSDI). Speed of production, diversity of the products generated, and a closer working relationship with other departments have been among the key drivers of the transformation.



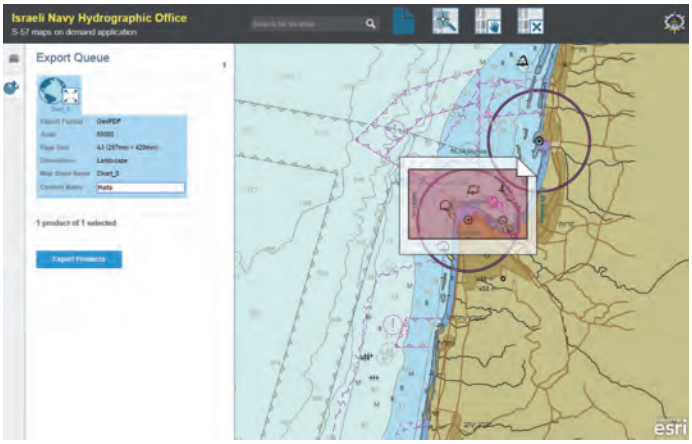
▲ *Figure 1: ENC of Herzliyah.*

Established in 1976, the INHB's mission is to produce all hydrographic and cartographic requirements for the Israeli Navy. That includes surveying, generating paper charts, ENC and nautical publication production. Like many other hydrographic agencies, the INHB has a small staff that satisfies an ever-growing demand for hydrographic products and information services. Efficiency is important given the limited resources.

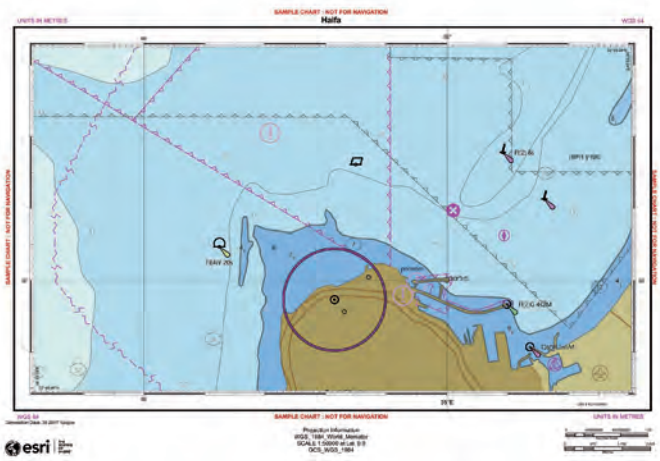
How It Was

INHB is split between multiple sections. In the early days, only 10 staff members were working in the mapping and charting department. The workflows in the old charting system were time - consuming, manual and complicated. At that time ENC production was a faraway dream. And yet, within the department, the mission was to create an automated integrated ENC production line allowing a handful of staff to maintain and update many cells spanning a significant area and various resolutions. Most of the INDB staff did not believe an organisation of this size could accomplish something as complicated as S-57 production.

Internally, it was recognised that the old chart production methods were inefficient. The process required the complete attention of high ranking personnel for every minor process, in minute detail. Developing new processes and



▲ *Figure 2: ENC based Product On Demand System for Chart Automation and Dissemination.*



▲ *Figure 3: Prototype Automated Haifa Chart.*

workflows was time-consuming and difficult to maintain. Many such attempts were left unfinished and undocumented due to changes in staff and software updates, which rendered the changes obsolete. In addition, each department used different software, making it impossible to join the different databases and create an integrated product. A single chart took anywhere from a week to a month to produce.

GIS Adoption

Investigation into an alternative approach also looked at the tools used by the Israeli Defence Force (IDF) and other government departments. Particular note was made of the widespread use of the ArcGIS platform, and further investigation into this GIS technology showed it was both flexible and open. This meant the platform was highly scalable and provided ease of automation, offering the possibility of getting more done without needing to add resources. Overall, it was recognised within INHB that there was a need to move from what had been narrow inefficient methods, towards building an MSDI. That is a spatial data infrastructure which could be used to summarise activities, processes, relationships and physical entities. An infrastructure which could provide interoperability with land data and information (Figure 1).

It is possible to produce a 50-map portfolio in a few hours instead of days

The conclusion of the investigation was that GIS could help to modernise the processes and workflows. With the help of Esri, the global leader in the technology, the migration to GIS started in 2006. Data was a key first area of focus, i.e. generating a digital library of all assets and related data. In GIS vernacular that meant first building what is called a system of record. All data needed to be in a digital format, and stored together in one central geodatabase. That required converting the Navy Nautical Database to a Nautical Information System (NIS) and building quick and easy workflows for creating maps and charts.

Staff are now able to work on different projects, using standard workflows

During the early development stage the INHB worked closely with the Esri Maritime Team. The Esri Maritime Team helped with a number of challenges, and provided important training. INHB staff began using desktop GIS products for data collection, production, georeferencing, mapping, charting, and creating display maps and database management. Through web-based GIS it is allowed to share information with different departments and organisations. Also the FIS capabilities are extended to the field. Mobile GIS apps are used to work at sea and assimilate the data seamlessly into the database without additional processing.

Impact and Benefits of GIS Adoption

By implementing a GIS solution, the workflows are streamlined and automated. It is easier to delegate simpler tasks to less experienced personnel, freeing the more experienced team members to work on development and quality control. Training has also become simpler and faster, since the focus is on a single product suite. Staff are now able to work on different projects, using standard workflows.

Currently there are three departments using ArcGIS solutions. The Mapping and Charting Department produces S-57 electronic charting, additional charts and display maps. The Coastal Research Department uses ArcGIS to manage their database, produce display maps, and publish additional charts. The GIS Department manages the GIS platform for Naval intelligence along with its database, and develops GIS web applications and custom solutions using geoprocessing tools. In addition, assistance is also provided to other development groups within the Navy (Figure 2).

Key benefits achieved through the adoption of GIS technology have included:

- A team of five people are able to create and maintain 60 cells, a task which in the past would have been impossible for such a small group.
- The project life cycle from data collection to ENC production and delivery was shortened

from an annual quarter to approximately a week.

- The new NIS system has allowed for the merging of all data into a single versioned database, which has enabled to do parallel updating and streamline quality control.
- Working with one database (NIS) for the production of maps, charts, and display aids. For a small organisation the use of a single database has made it possible to maintain all information products without the need for additional resources.

Many of the workflows are automated. Nowadays it is possible to produce a 50-map portfolio in a few hours instead of days (Figure 3).

The use of an enterprise GIS has helped INHB move from being a somewhat isolated department, to more closely interacting with other departments. Using a standard platform has simplified the integration of databases from the IDF and other government offices. This has greatly helped with data sharing. Working with a single software suite creates a common ground between the different departments, enabling lower training costs and higher diversity within the organisation. Standardising on a single platform means staff now no longer need to learn multiple processes.

Standardising on a single platform means staff now no longer need to learn multiple processes

Looking to the Future

Looking ahead INHB continues to evolve, and partnering with Esri has proven important in this process. The new S-100 standard will be operational in 2018, replacing S-57. Esri is helping to prepare for these changes, and together INHB and Esri are building a long-term partnership which will help to continue to take advantage of the many benefits offered by GIS.

The adoption of enterprise GIS technology has helped to improve how the small team works from day to day. The 'ENC first' approach means more efficient production of navigation products. Creation, storage and visualisation of hydrographic information are all now available through a single convenient workflow. The speed of production has increased dramatically, as has the variety of products. Thanks to standardising on the same GIS platform as other government departments, INHB is more closely connected to the wider organisation. Overall, INHB is well positioned to meet the Navy's hydrographic needs for both today and tomorrow. ◀

Commander **Avi Dror** is hydrographer at the Israeli Navy, where he serves as head of the Hydrographic Branch. Prior to this position, Dror was head of the Mapping and Charting section at the Hydrographic Branch, the Israeli Navy's body responsible for meeting the hydrographic and cartographic requirements of the Israeli Navy. Dror has a PhD and Master of arts (MA) in GIS & Coastal Geomorphology.

Derinsu Underwater Engineering

Offshore Survey Business in Turkey

Turkey is surrounded by three major seas, the Black Sea, the Marmara/Aegean Seas and the Mediterranean Sea, and is strategically very important for Offshore Survey companies due to its geographical location. Derinsu was founded in Turkey in 1998. The company will be celebrating its 20th anniversary in 2018. The headquarters are located in Ankara, the capital city of Turkey, and we have a branch office with a marine base located in Istanbul, Turkey.

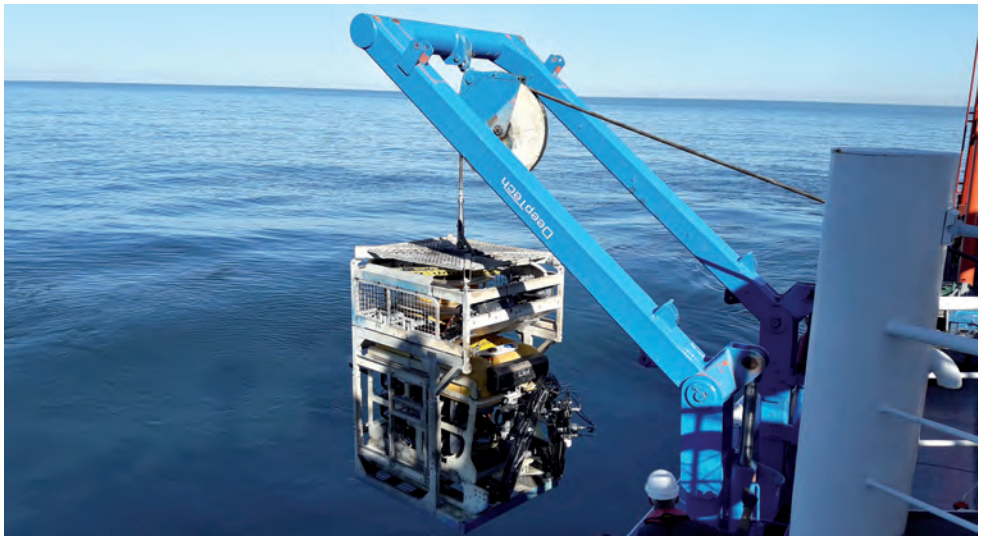
Growing Turkish Market

The company was established by a 100% private investment in the offshore business. The founder of company has an engineering background in Ocean Engineering, Science and Technology. During the late 1990s, the Turkish offshore survey market was only represented by the marine science divisions of a few universities and the interests of some foreign companies. Even though a great many offshore services were requested by the Turkish Authorities, it was difficult to deal with all the requests in terms of time, cost and quality. With this in mind, Derinsu has focussed on the offshore business and has become the leading Turkish company

▲ *The Derinsu Management Team.*

in the field of Offshore Survey and Subsea Engineering Solutions in Turkey.

The provision of high-quality marine survey data is the first step in the development of any offshore project. A good understanding of the geophysical, geotechnical, hydrographical and oceanographic conditions of the marine site, provides a good basis for the engineering designs. Particularly during the last decade, Turkish Offshore Oil & Gas projects have had a project cycle of exploration, field development, production and decommissioning. Exploration is the first step and provision of high-quality marine survey data is crucial in the development of any offshore oil & gas project. Derinsu provides data-acquisition, processing and interpretation services required for the exploration cycle. We are able to acquire high-quality seabed data with our survey vessels and provide the highest density, quality data required for detailed modelling and interpretation. Deepwater seabed surveys with water column data-acquisition and 2DUHR seismic surveys can be done with offshore survey vessel *RV DERINSU* under the Turkish Flag.
All marine environmental surveys, oceanographic surveys, hydrography for offshore and nearshore, port and harbour development projects are carried out by our own survey vessels *RV BELUGA* and *RV DERINSU*, located in Turkey.
Major projects in the Turkish offshore business are generated by the energy sector. The most popular investors are TPAO and BOTAS, which belong to the Turkish Wealth Fund Management in Turkey. Offshore oil and gas exploration projects are the best opportunities for developing offshore survey companies working in Turkey. Besides the energy sector, the subsea defence, port and harbour development projects, mega tunnels and bridge projects are the most common services that require plenty of marine survey and engineering tasks.
RV *BELUGA* has been carrying out marine monitoring for the Akkuyu Nuclear Power Plant Project since 2012. It is a very important project that monitors the environmental aspects on nuclear investment in Turkey. *RV BELUGA* has an extended contractual commitment until the end of the 2020.



▲ *Pipeline surveyed by* RV DERINSU.

▲ RV DERINSU *Offshore Survey Vessel .*

Pipeline Inspections

An important project recently being covered by *RV DERINSU* is in the Marmara Sea, namely the BOTAS Pipeline Inspection. The almost 120km natural gas pipeline has been surveyed by ROV and other new sonar technologies. BOTAS has offshore natural gas pipelines and has requested that the existing pipelines be inspected periodically. There are some other natural gas pipelines around Turkey such as TANAP, Blue Stream, Turk Stream Projects. Derinsu is fully interested in and has the capability to supply survey inspection services for these projects.

The offshore survey market in Turkey has developed rapidly. Derinsu has continuos investment plans for new technology survey equipment and offshore survey vessels for its customers. The latest requirements for deep-sea oil and gas field surveys encourage us to develop the Derinsu survey vessels' capabilities accordingly. Especially for deepwater gas hydrate with water column data investigations and seabed sampling, *RV DERINSU* has proven experience from working with TPAO Turkish Petroleum Association. Up to 3000m water depth, water column data analysis, seabed sampling with coring, and water sampling on selected ranges of depths are very important to develop potential sites. Data processing and interpretations with high-resolution seismic records are clients' major requirements from Derinsu.

Bright Future

The offshore survey market in Turkey has been divided depending on water depths. The figures provided for the last 20 years show that between 0-100m water depths we have almost 10% of market share while, for projects between 100m-2000m water depths we have 90% in terms of budgets. Even though the number of projects in deepwater ranges are fewer in number than those in shallow water, Derinsu focussed on the deepwater projects. Our target for economic growth in the offshore business market in Turkey is 20% per year for the next 5 years. We are proud to announce that for the last 3 years this trend has been achieved. We are celebrating our 20th anniversary in the Turkish offshore market and we would like to thank our clients for showing their respect and trust in our services. In the meantime, while developing our company sources, we are ready to cooperate with all market leaders willing to work and invest in Turkish offshore projects. ◀

Geo·matching

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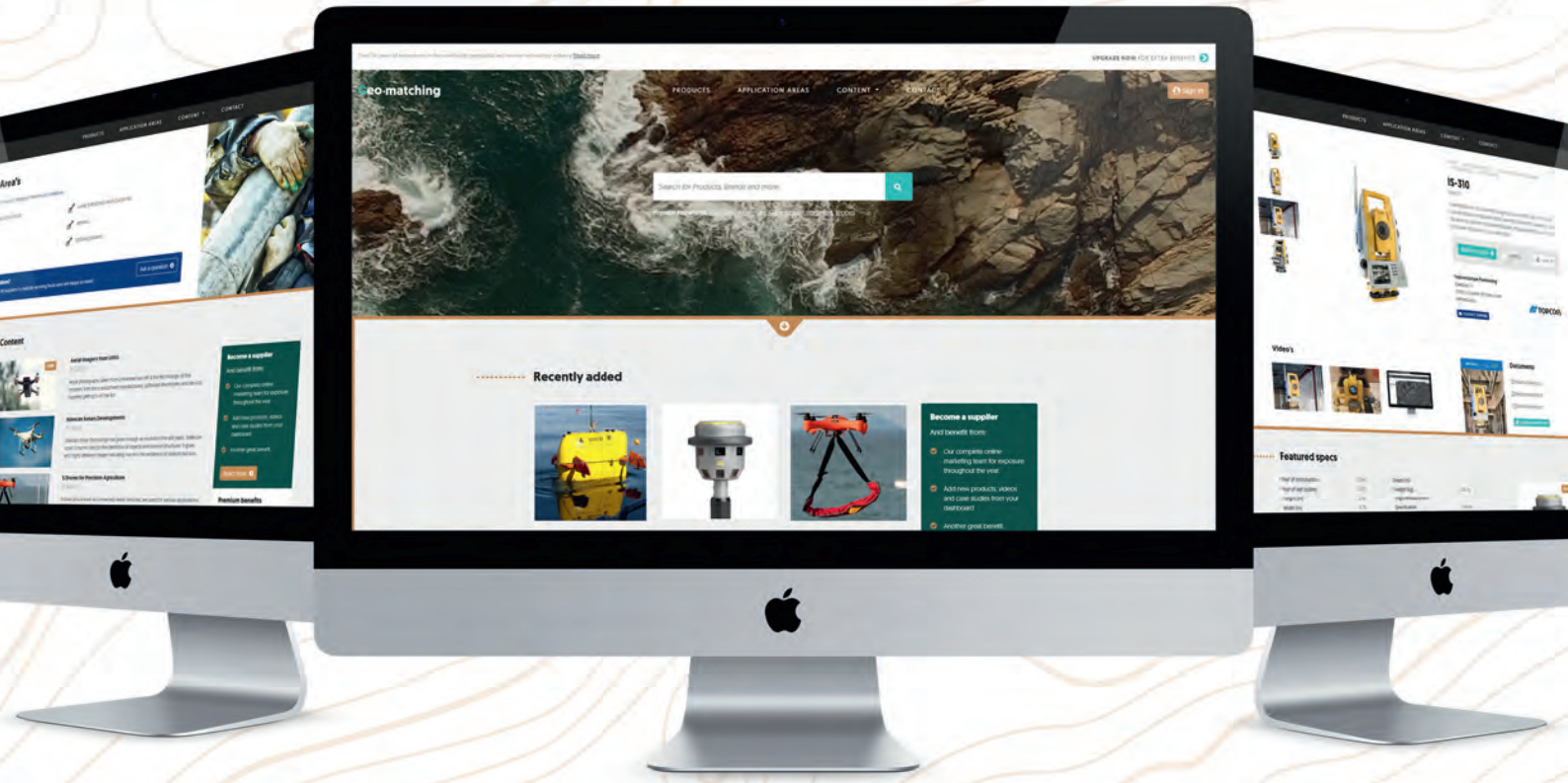

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FEATURE | **FRÉDÉRIC MOSCA** AND **DIDIER CHARLOT**, IXBLUE, FRANCE

Side-scan Sonar or Synthetic Aperture Sonar

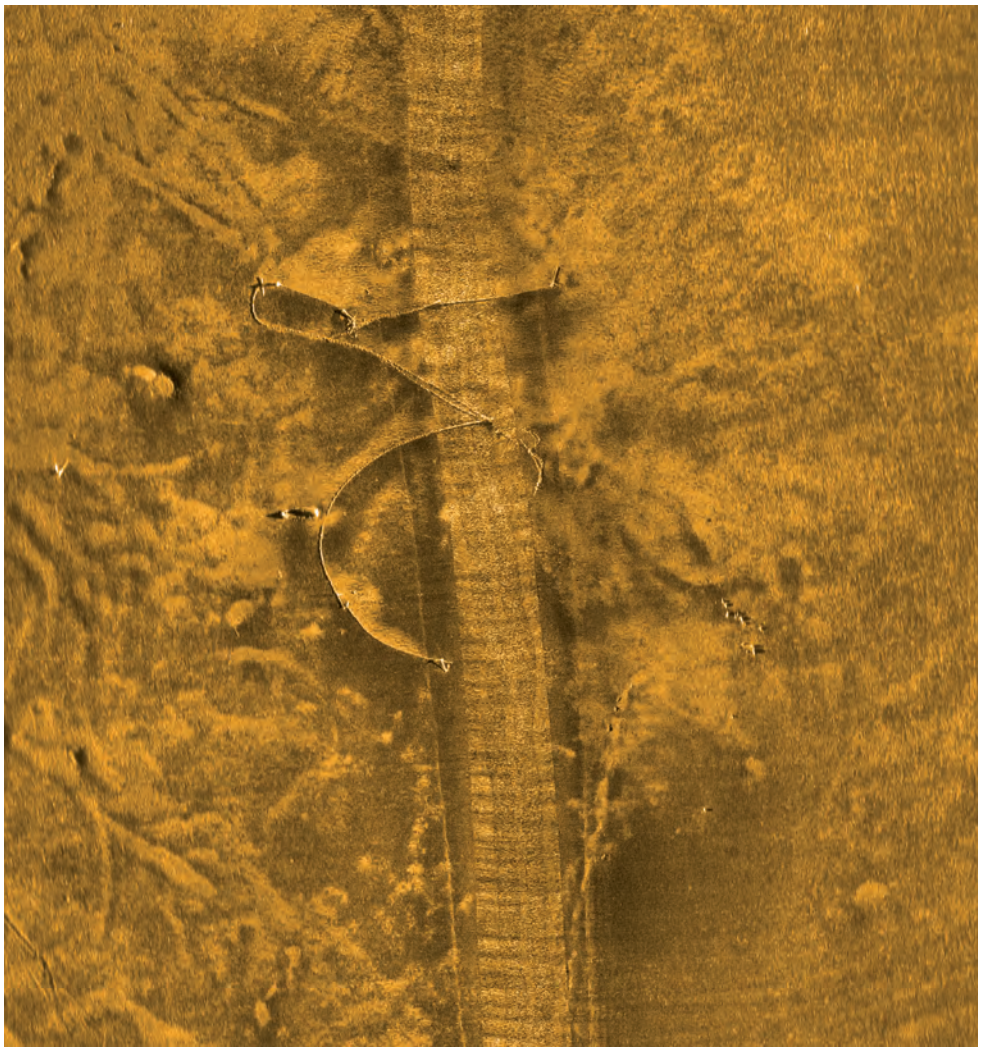
Towards a New **Sonar Imaging Concept** for Survey

Since the 70s and the emergence of the first analog systems, the side-scan sonar (SSS) has experienced several major revolutions. Signal digitisation in the 1990s has significantly improved signal quality and robustness. Dual frequency and interferometric systems have allowed better analysis of the seabed. In the mid-2000s, a significant development was the appearance of multibeam SSS with dynamic focussing. These systems, as well as the integration of the first gapfillers, have allowed considerable productivity gains and improved imaging quality. [Key, 2000]

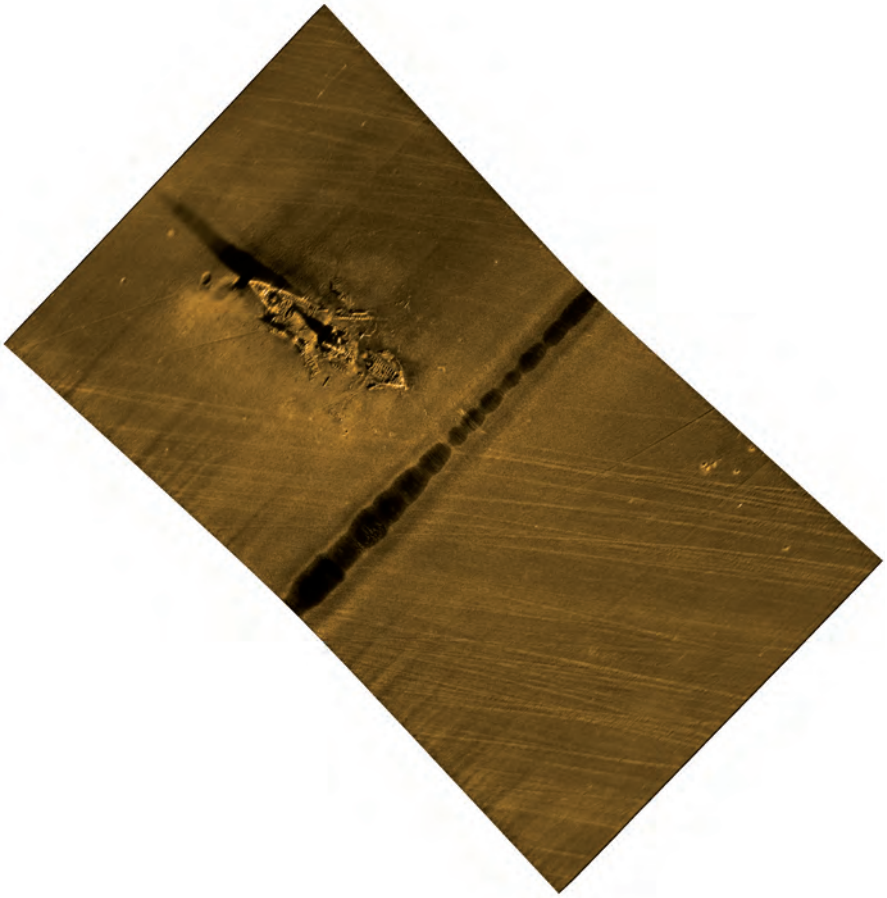
SSS Limitations

But SSS has not evolved much over the past decade. Although the progress made by multibeam echo sounders (MBES) for shallow-water backscatter imaging should not be overlooked, SSS remains the tool of choice for seabed imagery despite several limitations:

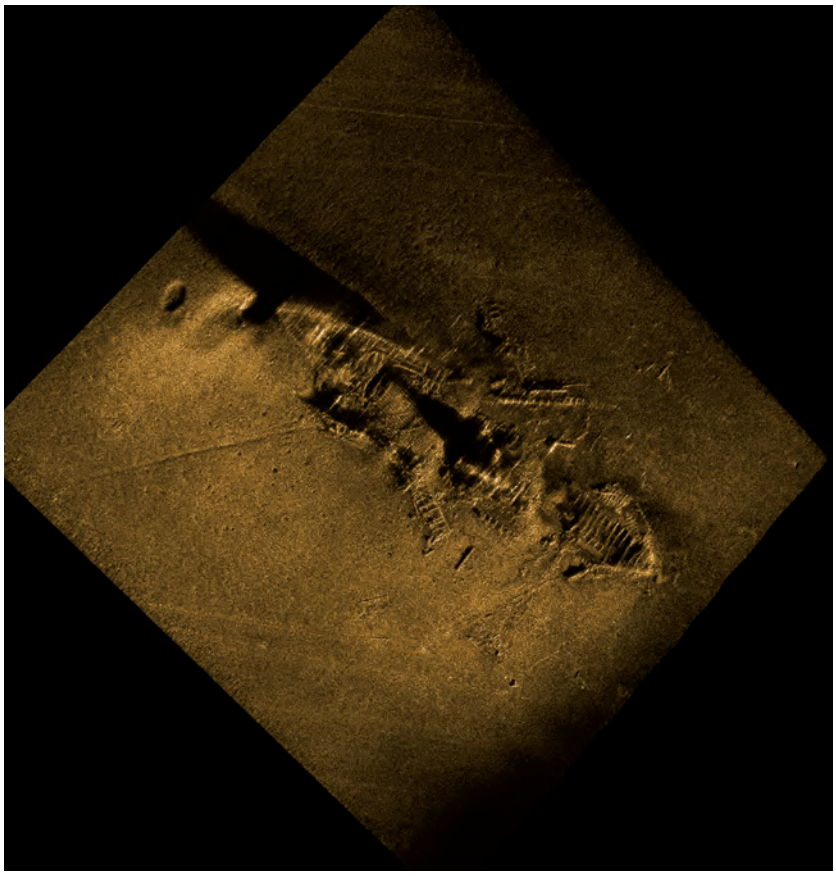
- **Variation of the along-track resolution with range:** related to the diffraction of the beams and to the limit of platforms payload capacity in term of antenna length. This range / resolution tradeoff imposes, according to the needs, to work at high frequency (a few hundred kHz) to optimise the resolution, or to work at low frequency (a few tens of kHz) to optimise the coverage.
- **Sensitivity to platform motion:** working with a SSS means using beams of very small aperture to get good along-track resolution. This leads to severe navigational constraints in terms of platform stability which, if they are not respected, generate distortions in the image and thus affect object detection capabilities. [Blondel, 2010]
- **Pixel positioning inaccuracy:** although some SSS are equipped with positioning systems (acoustic and/or Inertial Navigation Systems), the standard methodology of image construction in the platform's reference frame (waterfall) and the projection onto a map (mosaic) does not allow precise georeferencing and platform motion compensation. Consequently, the produced mosaic may show shifts and distortions leading to a lengthy contact repositioning and interlines management process for surveyors.



▲ *SAMS mosaic at 10cm grid resolution: full coverage SAS + gap filler.*



▲ *SSS and SAS mosaic produced by DELPH software at 10cm grid Resolution.*



▲ *Coherent SAS high-resolution mosaic at 3cm grid resolution.*

A New Type of Sonar to Solve Traditional SSS Issues

If standard Synthetic Aperture Sonar (SAS), based on micronavigation [Belletini, 2002], seems the most appropriate system to solve the first limitation, it only partially addresses the other two. Indeed, SAS on Autonomous Underwater Vehicle (AUV) is gaining ground in areas where resolution is critical: Maritime Mine Counter Measures. However, executing this system is complex and it remains extremely sensitive to the platform motion, hence its use on more stable platforms such as AUVs or actively stabilised towed fish. Furthermore, an important overlap between two successive acquisitions is needed with micronavigation, which limits survey speed. Finally, the large amount of data generated does not always make real-time processing possible as well as raw data storage.

iXblue has thus developed a new type of sonar system, a Synthetic Aperture Mapping Sonar (SAMS), to solve those issues. SAMS is based on the following 3 features:

- **Fine coupling between acoustic data, inertial navigation and acoustic positioning:** it allows focussing on each pixel in the mosaic, avoiding distortion of the projection of the waterfall on the mosaic. The pixels relative positioning precision is almost perfect thanks to the coupling with the INS while the absolute precision equals to that of the acoustic positioning system.
- **Wide aperture in transmission coupled to multi-channel reception and multi-ping integration:** this architecture ensures full coverage even on passive platform in bad conditions of navigation. Multi-channel reception allows dynamic focussing as for a multibeam SSS. Accurate measurement of the relative displacement combined with the wide transmission aperture makes it possible to perform integration over several recurrences. This multi-ping integration capability makes it possible to perform the two following synthetic aperture processing simultaneously and in real-time:
- **Non-coherent integration (summation of signal amplitudes)** [Allais, 1998]: allowing for significant improvement of image quality thanks to signal-to-noise ratio gain and coherent noise reduction.
- **Coherent integration (summation of signal amplitudes and phases):** allowing for significant improvement of the resolution. iXblue warrants a SAS gain of a factor of 6 on passive tow fish. For instance, SAMS MT3000 has the range of a 100kHz SSS with the resolution of a 600kHz SSS.

- **A truly integrated survey platform:** SAMS exploits the synchronous acquisition and positioning capabilities of multi-sensor data to offer a fully integrated survey platform. In addition to positioning systems and SSS, SAMS platforms can embed an interferometric system, a MBES serving as a gapfiller, a Sub-bottom Profiler, a pinger locator and a magnetometer. All of the synchronised sensors and navigation data are processed and displayed in real-time in a 3D environment using iXblue's Delph Software. This allows the implementation of data fusion method to improve the survey area analysis.

A Full Product Range for All Applications

The SAMS Series, that can be integrated on various platforms such as towed fish, ROVs or AUVs, thus addresses all the increasingly demanding needs of surveyors:

- **SAMS ST1000,** is a plug-and-play SAS interfacing with all types of positioning systems (INS & acoustic). No optical link is required and its implementation is as easy as a conventional SSS. Along-track resolution is better than a decimetre with a 500m swath and is ideal for use in shallow-water or continental shelf applications.
- **SAMS MT3000,** is a hydrographic survey platform submersible down to a depth of 3000m. It offers a full swath of 800m for a constant resolution of 15cm. This sonar is best suited for cable route or site survey and has unique capabilities in strong current conditions (Marine Renewable Energy site survey).
- **SAMS DT6000** is a deep towed platform (6000m depth rating) with positive buoyancy incorporating a dead weight and an emergency recovery system. It allows a full swath of 1800m for a constant resolution of 40cm. SAMS DT6000 is the state of the art tool for deep geophysical or search and rescue surveys.

Several marine institutes and hydrographic services are now equipped with SAMS systems and operate it to fulfill their advanced missions, exceeding the traditional limits of SSS while avoiding excessive constraints of use of commercially SAS.

The SAMS series thus expands the capabilities of conventional imaging SSS by integrating positioning and navigation capabilities and performing real-time coherent and non-coherent SAS integration, making SAS technology available to all hydrographic surveyors. The combination of all these technologies gives SAMS systems optimal imaging performance with respect to environmental conditions in terms of swath, resolution, image quality, coverage rate and absolute pixel positioning accuracy. ◀

Further reading

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Bellettini, A., & Pinto, M. A. (2002). Theoretical accuracy of synthetic aperture sonar micronavigation using a displaced phase-center antenna. IEEE journal of oceanic engineering, 27(4), 780-789.

P. Alais, P. Cervenka, P. Challande, V. Lesec, Non coherent synthetic aperture imaging, Acoustical Imaging 24, 1-8, Plenum Press, 1998.

Enjoy Your Visit to **Oi18!**

oceanology international 2018 13-15 MARCH 2018, LONDON, EXCEL

The biennial Oceanology International event will be held at the ExCeL International Exhibition Centre in London from 13-15 March 2018. Thanks to the conference programme, Oi18 will bring together the latest technologies and thought leaders worldwide, and it will serve as a meeting place for buyers and suppliers as well the place to be for education and inspiration.

From a commercial point of view, the exhibition floor is the prime destination, as it will be filled with a unique audience of global buyers, specifiers and users of marine and ocean technologies from a variety of different end-user sectors. *Hydro International* highlights the key exhibitors with their own company profiles. Read on to find out what these leading companies have to offer, and why you should definitely stop by their booths.

Geomares, the media company behind *Hydro International*, will be present at Oi18 with a team that predominantly represents this publication, but also Geo-matching, the world's largest product database for surveying, navigation and machine guidance. Moreover, *Hydro International* will be publishing the Oi18 show dailies in cooperation with Reed Exhibitions, the company that organises Oceanology International. We hope you enjoy reading this issue, and that the show dailies will be a relevant source of information on the events taking place during the three days in which the whole marine and hydrographic sector gathers in London.

Applanix

Applanix, a wholly owned subsidiary of Trimble, designs, builds, delivers and supports products and solutions designed specifically for the hydrographic survey industry. Our products and solutions provide robust, reliable, and repeatable positioning and motion compensation solutions from vessels.

▸ ***Booth N100 I www.applanix.com***

▲ *Applanix POS MV.*

ASV Global

▲ *The newly developed C-Cat 3.*

ASV Global will be showcasing its latest developments in autonomous vessel technology including the newly developed C-Cat 3. The C-Cat 3 has been developed to complement the existing ocean-going ASV Global vessels for survey and support tasks where a smaller vehicle is better suited to missions such as areas of shallow water.

Since its launch in November 2017, the C-Cat 3 has already proved its ability to conduct high-accuracy surveys utilising a multibeam echo sounder and a Lidar laser scanner. The vessel has been used for river and coastal survey work in Rotterdam, Aberdeen, Portsmouth and London.

ASV Global is a world leader in autonomous vessel technology. The company designs, builds and operates ASVs on a worldwide basis and has developed its own, industry leading, autonomous control system, ASView. ASV Global has produced over 90 autonomous vehicle systems and developed more than 30 different payload packages for inland, coastal and offshore operations.

▸ ***Booth G401 I www.asvglobal.com***

Atlas Professionals

As of the beginning of this year the Atlas Competence Programme (ACP) is fully integrated into the Atlas Quality Management System (QMS) and is audited and certified in accordance with the ISO 9001:2008. The ACP, currently covering the ROV and Survey industries, meets all requirements as described in the IMCA freelance framework guidelines.

Atlas Professionals is committed to provide a safe, reliable and competent workforce, while working to meet clients' needs globally. Through the Atlas Competence Programme we further assure that all professionals meet the requirements of the job and in this way add value to our clients.

Our Competence Manager, Dingena Peddie-Theunisse, will explain how this programme is set up, the involvement of the IMCA frameworks and how professionals can join during brief masterclass sessions at our booth.

Booth D351 I www.atlasprofessionals.com

A safe, reliable and competent workforce.

CHC Navigation

CHC APACHE 5 USV.

CHC Navigation designs, manufactures and markets a wide range of competitive and reliable GNSS receivers and provides complete positioning solutions for surveying, construction, GIS and marine applications in more than 100 countries. 'Make Your Work More Efficient' is CHC's slogan. CHC knows exactly why customers choose us. In order to help customers save more time, human resources and material resources, CHC always concentrates on their needs and provides them with products that facilitate their managements of time, budget and workloads.

ISO 9001 certification applies to all aspects of CHC's every development process and workflow, covering all steps from the initial design to the final delivery. CHC products are widely used in Americas, Europe, Middle-East, Africa and Asia-Pacific. CHC's international partner networks bring dedicated and professional support to end-users everywhere. CHC was invited and will display its latest marine products at A109. Welcome to a strong presence.

Booth A109 I www.chcnav.com

Blueprint Subsea

Oculus M Series multibeam sonar.

Blueprint Subsea are innovative designers and manufacturers of world-class underwater sonar, navigation and positioning systems. We provide robust solutions to international subsea, offshore and defence markets. We offer: The StarFish side-scan sonar, a single person deployable towed sonar system for shallow-water survey applications. The Oculus M Series multibeam sonar, designed for use across a wide variety of underwater applications. Compact in size it is ideally suited to small sized ROV platforms, while rugged in construction it is an excellent choice for larger work-class vehicles and subsea infrastructure. The SeaTrac Mirco-USBL system, comprising of multi-purpose acoustic transponder beacons, is capable of simultaneous asset position tracking and bi-directional data exchange. The ArtemisPRO diver handheld sonar and navigation system, a submersible console combined with a multibeam sonar, DVL and GPS navigation system, is designed for use by naval mine clearance divers, commercial divers, police and SAR divers.

Booth F650 I www.blueprintsubsea.com

Deep Trekker

Deep Trekker DTX2 ROV.

Deep Trekker was incorporated in 2010 in the heart of the Great Lakes - Ontario, Canada. We are innovators, creators, skilled engineers, technologists and dreamers of the underwater world. Deep Trekker's mission is simple: we want to give anyone on earth an opportunity to explore the depths of our vast open waters, inspect and maintain subsurface assets, and bring innovation to how we monitor underwater activity, during research or maintenance - with our portable, affordable and easy to use remotely operated vehicles.

Deep Trekker will showcase its latest in innovation with the DTG2 and DTX2 ROVs for advanced inspections in the harshest ocean environments, providing continuous real-time discoveries to physical, biological and geological ocean realms.

Join Deep Trekker at Booth E600 to participate in product demonstrations live on 13 March - 2:30-3:15pm, 14 March - 2:30-3:15pm and 15 March - 2:30-3:15pm.

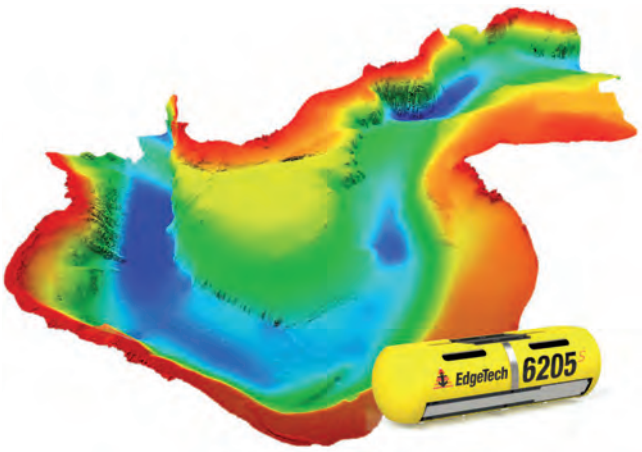
Booth E600 I www.deeptrekker.com

EdgeTech

EdgeTech, a leader in high-resolution sonar imaging systems and underwater technology, is excited to introduce four new products at OI 2018. The company, located at booth H201 during the show, will be unveiling: their next generation Sub-Bottom Profiling System, a new tri-frequency motion tolerant side-scan sonar system, the newest shallow-water bathymetry system and a rugged shallow-water acoustic release.

EdgeTech is known worldwide for its high-quality products which include: side-scan sonars, sub-bottom profilers, bathymetry systems, AUV, USV and ROV-based sonar systems, combined and customised solutions. In addition to the full line of underwater survey products, EdgeTech provides reliable USBL systems, transponder beacons, deep-sea acoustic releases, shallow-water and long life acoustic releases, and customised underwater acoustic command and control systems.

Booth H201 / www.edgetech.com



EdgeTech 6205.

EvoLogics

EvoLogics S2C spread-spectrum communication technology stems from bionic concepts and spans over a whole ecosystem of products. This includes several series of underwater acoustic modems, modular underwater positioning systems (USBL, LBL, SBL), a framework for developers in both networking and hardware design, as well as a modular ASV for bathymetry and monitoring.

Keyword is 'modular', as most EvoLogics products are designed to provide the highest degree of customisation. EvoLogics strives to offer highly configurable solutions instead of 'bespoke tailoring' for a particular operation (still possible, as every scenario is unique). Pre-configured modules make it possible to build a device that caters to the client's application while maintaining effective price points and delivery lead times.

Facing the increasingly demanding challenges of offshore and maritime industries, one of the main vectors of EvoLogics development strategy is underwater 'internet of things' that enables intelligent cooperation between vehicles and sensors.

Booth C251 / www.evologics.de

EvoLogics product range.

iXblue

▲ *iXblue DriX USV.*

From sensors to vessels iXblue is a global leader in the design and manufacturing of innovative solutions devoted to navigation, positioning and underwater imaging, as well as shipbuilding. Come discover our new products & solutions (navigation, positioning, imagery and shipyard) during OI London and assist with an exclusive demo of our new USV on the Thames on board iXblue's own hydrographic vessel.

▶ ***Booth E100 I www.ixblue.com***

Innomar

▲ *SES-2000 smart.*

Innomar has been providing parametric sub-bottom profilers (SBP) and associated software for more than 20 years. The 'Innomar SES-2000' parametric SBPs are used to get high-resolution datasets in water depths between less than one metre to full ocean depth. Applications include visualising sediment structures for dredging and geological surveys as well as mapping buried pipelines/cables or prospective offshore building sites. A full user-friendly software package for data acquisition and post-processing is available. Transducers can be hull- and pole-mounted.

New developments include a multi-transducer SBP to acquire high-data density suitable for 3D visualisation and highly portable systems for unmanned or autonomous vehicles, such as AUVs and USVs. At OI 2018 Innomar will show the latest shallow-water model SES-2000 smart, mainly intended for inshore applications using small survey platforms. Furthermore, a major upgrade of the Innomar post-processing software ISE will be introduced.

▶ ***Booth N350 I www.innomar.com***

Kongsberg Maritime

Norwegian marine technology specialist Kongsberg Maritime, a veteran Oceanology International exhibitor, will focus on its established and industry leading technology and solutions that enable the contemporary 'Digital Ocean' at Oi18. With emphasis on streamlining and simplifying the journey of data from below the surface to vessel, and forward to shore, Digital Ocean is built on Kongbergs's well-known expertise in subsea technology, communication systems, data platforms and post-processing solutions. As a world-leading manufacturer of marine electronics and underwater instrumentation, Kongsberg Maritime will be showcasing its latest products for deployment in subsea environments, including seabed mapping, cameras, AUVs and underwater acoustic positioning, and will carry out live demonstrations, including beaming footage and data of live operations back from the Norwegian coast using the groundbreaking Marine Broadband Radio (MBR) solution. The company is also planning to show the latest developments within its EM echo sounder portfolio.

▶ ***Booth D600 I www.km.kongsberg.com***

▲ *Digital Ocean.*

Leica Geosystems

The Leica Chiroptera II is a combined bathymetric and topographic Lidar sensor for coastal survey. The cost-effective and innovative system simultaneously captures full waveform in both the 35kHz bathymetric channel and the 500kHz topographic channel, making it the ultimate tool for seamless coastal survey from water to land. With survey depths of 25m, the system targets the growing need of high-accuracy data for environmental monitoring, seabed classification, nearshore charting, survey of shallow-water regions, and seamless shoreline capture. The system includes the Leica RCD30 80 MP camera for point cloud colourisation.

▲ *Leica Chiroptera II.*

Leica Lidar Survey Studio provides a fast and automated workflow which processes waveform and position data, calibrations, refraction correction and incorporates four-band camera data. The software allows for the management of projects, analysis of data and creation of point clouds with maximum efficiency, using one intuitive interface.

▶ ***Booth A406 I www.leica-geosystems.com***

MMT

▲ *MMT's record-breaking Surveyor ROV 2.*

MMT, a Swedish marine survey company, is exhibiting at Oceanology International for the 7th time and will demonstrate the new version of the fast going survey ROV Surveyor Interceptor, now upgraded with Pipe Tracker capacity at speed, another first in the industry. The gradiometer system is being upgraded for DOB (Depth of burial) / UXO (UneXploded Ordnance) which will be in the market this summer. MMT is known for unsurpassed resolution and performance with substantial cost efficiency. MMT launched the first version of the Surveyor ROV at Oceanology International in 2014. Since then it has been working on some of Europe's largest pipeline and cable route projects and has been developed in close cooperation with partners and clients. Join MMT for daily presentations at stand F601 at 2 pm and grab something good to drink and meet their sales team. MMT will also have a presentation about the upgraded Surveyor Interceptor 2 in the Trade & Innovation theatre at Oceanology International on Thursday 15 March 2018, from 12:55 pm to 1:15 pm.

▶ ***Booth F601 I www.mmt.se***

NovAtel

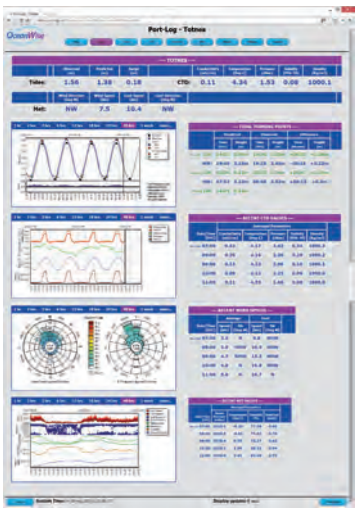
▲ *NovAtel VEXXIS GNSS-800.*

Marine integrators have been relying on NovAtel's world-leading Global Navigation Satellite System (GNSS) OEM positioning technology for over two decades to ensure their equipment performs when needed most. NovAtel's ATEX qualified marine GNSS antennas are designed with INMARSAT interference rejection for optimal performance in challenging conditions, and our Oceanix GNSS correction services deliver exceptional sub-decimetre positioning for marine applications such as dredging, hydrographic survey and mapping. Select SPAN receivers offer NovAtel's real-time motion compensation algorithm to eliminate the effects of wave and swell movements from measurement data, and Inertial Explorer software post-processes data ensuring the most accurate positioning. With these leading technologies, our greatest asset may be the trust our customers place in us for reliability, on-time delivery, and responsiveness to business level solutions. To learn more, visit www.novatel.com/OI2018.

▶ ***Booth D400 / www.novatel.com***

OceanWise

OceanWise will be showcasing its latest development in Environmental Data Monitoring and Publishing 'Port-Log' services, which are provided to ports, harbours and coastal authorities worldwide. Tide and weather data comprising observed, predicted and forecast water levels, wave heights and periods, wind speed and direction, and visibility are available online in real-time to support maritime operations and situational awareness and historically to support planning, engineering and environmental studies.



▲ *Port-Log Connect.*

Port-Log Connect, developed in cooperation with Associated British Ports (ABP), Peel Ports, VTS, PPU, weather forecast, dredging and even tunnelling software providers; integrates data from multiple sources and makes it readily available in critical and non-critical applications. As there is a wide range of data formats that need handling, work is underway to develop a common data standard that can be employed consistently irrespective of how the data is transmitted, whether via VHF (AIS), mobile networks or other means.

▶ ***Booth P161 / www.oceanwise.eu***

Planet Ocean

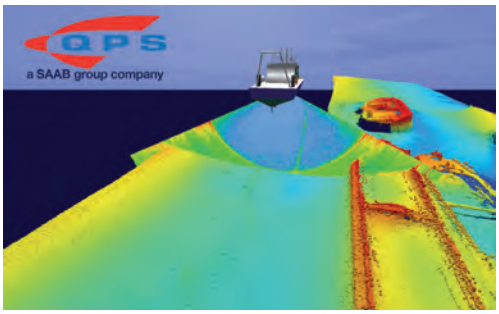
Planet Ocean will be showing the latest technology from their partners around the world on their new booth located at K100. On display will be the latest smart hydrophones and accessories from Ocean Sonics, the ALART E.Coli system from Fluidion, the new LISST-200X and AUV variant from Sequoia, the latest Calypso USV from dotOcean, new GPS and Inertial wave sensors from XEOS and Planet Ocean and for the first time anywhere the SeaScan ARC Mk-II side-scan sonar from ATLAS – MST, and of course the two ecoSUB AUVs from ecoSUB Robotics. This year they are sharing with their sister company ecoSUB Robotics, as well as Canadian ROV manufacturer Deep Trekker, that will have their 200 gallon tank on the booth where you can try your hand at piloting the ROV.

▶ ***Booth K100 / www.planet-ocean.co.uk***

▲ *Calypso USV.*

QPS

QPS BV (Quality Positioning Services) makes industry leading software for collection, post-processing and visualisation of maritime geomatic data. Our products QINSy, Qimera, Fledermaus and Qarto seamlessly partner ArcGIS for Maritime, to solve problems and gain efficiencies for maritime-related business. QINSy is a software suite used for many types of maritime geomatic surveys, ranging from simple single beam surveys to the very complex offshore construction works. Qimera is an evolution in hydrographic data processing, and it combines the core technologies of QINSy and Fledermaus. Fledermaus is a powerful tool used by commercial, academic and government clients worldwide to interact in 4D with geographical datasets. Qarto uses the hydrographic data to produce rapid ENCs for navigation with a one day turnaround time. Our product Qastor is Electronic Chart Software (ECS) that enables navigation, piloting and precise docking, as well as several other application such as Oil & Gas FPSO/SPM mooring, patrol vessel and tugboat operations. QPS (part of SAAB) is an independent software company headquartered in the Netherlands and with offices in USA, Canada and the UK.



▲ *QPS QINSy.*

▶ ***Booth H100 / www.qps.nl***

Rowe Technologies

▲ *Rowe Edge ADCP.*

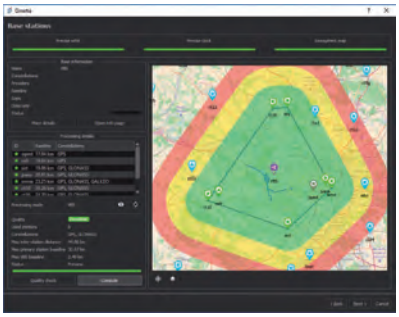
Rowe Technologies employs a highly innovative staff with over 250 years of experience in the development and manufacturing of leading-edge Acoustic Doppler Current Profiler (ADCP) and Doppler Velocity Log (DVL) sonar systems. These sonars are deployed on moving vessels or fixed moorings simultaneously measuring vertical profiles of 3-axis currents, echo intensity, and plankton/sediment size distribution, plus bottom velocity and altitude.

We are proud to release our 3rd generation (ADCP 3) which expands ADCP capability by:

- Employing cutting-edge phased and piston array transducer technology to produce dual-frequency 4 or 5 beam sets from a single transducer array, achieving both high-resolution and long-range profiling from a single ADCP.
- Dual up/down transducers to extend the profile measurements in subsurface applications.
- Advanced low power electronics for adaptable acoustic and processing operation and long battery life.
- Mooring depth range of 200-6000m.

▶ ***Booth H450 I www.rowetechinc.com***

SBG Systems



▲ *Qinertia.*

Attend a free demo of Qinertia, SBG Systems' new INS/GNSS post-processing software, during Oceanology International. Demos will be organised every day at our booth D250. Register at: www.sbg-systems.com. This full-featured software enhances SBG inertial navigation systems' performance by post-processing inertial data with raw GNSS observables. Qinertia is a tightly coupled solution for unmatched accuracy and reliability that can reach a centimetric position using offline RTK corrections or Precise Point Positioning. Qinertia also enables a seamless integration of dual antenna GNSS receiver. Supporting multi-constellations (GPS, GLONASS, GALILEO, BEIDOU), Qinertia is open to all industry standards.

New Micro IMU!
SBG Systems is also glad to introduce its new Ellipse 2 Micro Series during Oceanology International, which brings industrial-grade IMU, AHRS and INS to high volume projects. Cost-effective and weighing only 10 grams, it provides orientation (0.1)°, a 5cm accurate heave, and connect to external GNSS receiver for continuous navigation.

▶ ***Booth D250 I www.sbg-systems.com***

RTsys

▲ *EA-SDA14 Underwater Noise Recorder.*

RTsys is specialised in passive and active underwater acoustics and drones. We have more than 30 years of expertise and extensive business experience in the development of high-tech products. Our innovations are used not only in the civil sector, but also for defence, and are equipped with SDA (Synchronous Data Acquisition) technology, developed by our R&D team. Within a context of increased monitoring of the marine environment, in connection with reducing noise pollution, we are the front-runners in acoustic monitoring, following huge investment in research and development, and in cooperation with the scientific community. Our recognised expertise in the defence sector and close collaboration with the French Navy enable us to develop innovative underwater detection tools and drones for use in anti-submarine warfare. We invite you to come by our booth to meet our team that will answer your questions. See you there!

▶ ***Booth J551 I www.rtsys.eu***

Seabed

Seabed will release their new GNSS Receiver, the SGR7, at Oceanology International 2018. The SGR7 is a robust, high-precision receiver designed to be an ultra-flexible and user-friendly device, and will thereby meet all user's requirements. The SGR7 will have features such as an integrated touch display, integrated modem, user-friendly and easily accessible web interface, rugged IP67 housing, 2 port 1gb switch, 16GB onboard memory for data logging and the unit is compatible with all IMUs. Visit our booth F700 to see the receiver and Seabed's full range of survey equipment. Starting in March 2018 Seabed will have an official calibration lab to support all AML customers with the calibration of their sensors in Europe. Visit our booth F700 to learn more about our service.

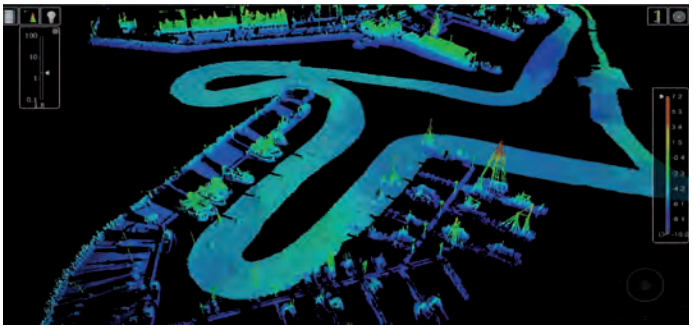
▶ ***Booth F700 I www.seabed.nl***

▲ *SRG7 GNSS receiver.*

Teledyne CARIS

For over 35 years, Teledyne CARIS has been the leading developer of marine mapping software. Teledyne CARIS offers a highly effective solution for near real-time processing and robust quality control of sonar data and the creation and distribution of maps, charts and digital datasets. The Ping-to-Chart software is designed to deliver an integrated and seamless solution for the entire workflow of hydrographic information. CARIS software offers a comprehensive level of support with training sessions, consulting, and a series of courses as well as technical support via online services, multilingual telephone support and email.

▸ ***Booth H500 I www.teledynecaris.com***



▲ *Ping-to-Chart Software.*

Valeport

▲ *Valeport SWiFTplus.*

A regular exhibitor at the Oceanology series worldwide, UK equipment manufacturer Valeport will be showing their current range of instruments for the Hydrographic and Oceanographic markets. New to the show will be the shallow-water profiler SWiFTplus which combines Turbidity observations with sound speed, temperature and pressure sensor technology coupled with the convenience of Bluetooth connectivity and rechargeable batteries. Data can be quickly downloaded and reviewed wirelessly, via Bluetooth, using an App and instantly shared, in industry standard formats through email and cloud services. In addition to the directly measured observations, Conductivity, Salinity and, therefore, Density are calculated using Valeport's proprietary DASH algorithm. Valeport's new turbidity sensor is essentially 2 sensors in one. The first is a 'classic' turbidity sensor (nephelometry using a 90° beam angle) for low turbidity levels (0-2000 NTU) and the second uses an OBS optical backscatter arrangement (~120° beam angle for optical backscatter) at high turbidity levels (>20,000 NTU). Intelligent sampling eliminates the need to gain switch at higher turbidity levels.

▸ ***Booth H301 I www.valeport.co.uk***

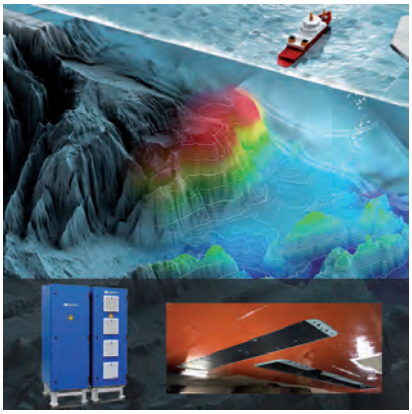
Teledyne Marine

▲ *Teledyne Marine product range.*

Teledyne Marine's One Team will once again be out in full force at OI London. With 23 brands and a full team of professionals on hand to support you, OI attendees will want to make booths F100 and G100 their first stops. Through acquisitions and collaboration, Teledyne Marine has evolved into an industry powerhouse, bringing Imaging, Instruments, Interconnect, Seismic, and Vehicle technology together to provide our customers with solutions ranging from tiny hydrophones and connectors all the way up to one-of-a-kind turn-key systems. At OI 2018, Teledyne Marine will be unveiling several new products, conducting dockside and on-water demos, and presenting on several conference topics. Stop in to see just how easy and enjoyable one-stop shopping can be!

▸ ***Booth F100 / G100 I www.teledynemarine.com***

Wärtsilä ELAC Nautik



▲ *Wärtsilä multibeam solutions.*

Wärtsilä ELAC Nautik develops and manufactures state of the art multibeam systems for precise charting of water bottom topography for customers in the field of hydrography, for surveys of harbours, rivers and lakes as well as for oceanography, marine geology and marine biology. Our systems cover all depth ranges with more than 50 years of multibeam know-how. Wärtsilä ELAC SeaBeam 3012 and ELAC SeaBeam 3020 are high-performance deepwater multibeam systems, providing excellent real-time bathymetric data, bottom amplitudes, side-scan data and beam data for water column imaging (WCI). The ice resistant versions of the transducer arrays withstand all forces occurring under ice conditions. Due to their unrivalled Swept BeamTM transmission technology, excellent depth performance, wide coverage and multi-ping operation, Wärtsilä ELAC SeaBeam 3012 and ELAC SeaBeam 3020 are the ideal hydrographic sensors for full ocean depth surveys.

▸ ***Booth F500 I www.wartsila.com/elac***


AUTONOMOUS VESSELS
FOR HYDROGRAPHIC
SURVEY
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AVAILABLE FOR PURCHASE OR
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ASV unmanned marine systems

S2C TECHNOLOGY: COMMUNICATION AND TRACKING COMBINED

- time, space and cost-saving solutions
- low power consumption for autonomous operations
- advanced data delivery algorithms, addressing and networking, remotely configurable settings
- extendable platform with multiple configuration options: power-saving Wake Up module, acoustic releaser, additional sensors, custom solutions, OEM versions available

USBL POSITIONING SYSTEMS

simultaneous positioning and communication - no need to switch between positioning mode and modem mode

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: up to 0.04 degrees

LBL POSITIONING SYSTEMS

highly accurate, precise and stable performance, simultaneous positioning and data transmissions

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: better than 0.01 m

UNDERWATER ACOUSTIC MODEMS

reliable data transmissions even in adverse conditions, customizable R-series modems, light and compact M-series "mini" modems, **new S2CM-HS high-speed modem**, special editions for developers, S2C communication and positioning emulator - remote access or standalone device

- range: up to 8000 m
- depth: up to 6000 m
- data rate: up to 62.5 kbps

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