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NOVEMBER-DECEMBER 2015 | VOLUME 19 NUMBER 8

INTERVIEW: SHEP SMITH

Excited by Automation Driven by MAS

INTRODUCING GIS TO SUPPORT MARINE ACCESSIBILITY

Designing a New Way to Deliver Marine Weather Data

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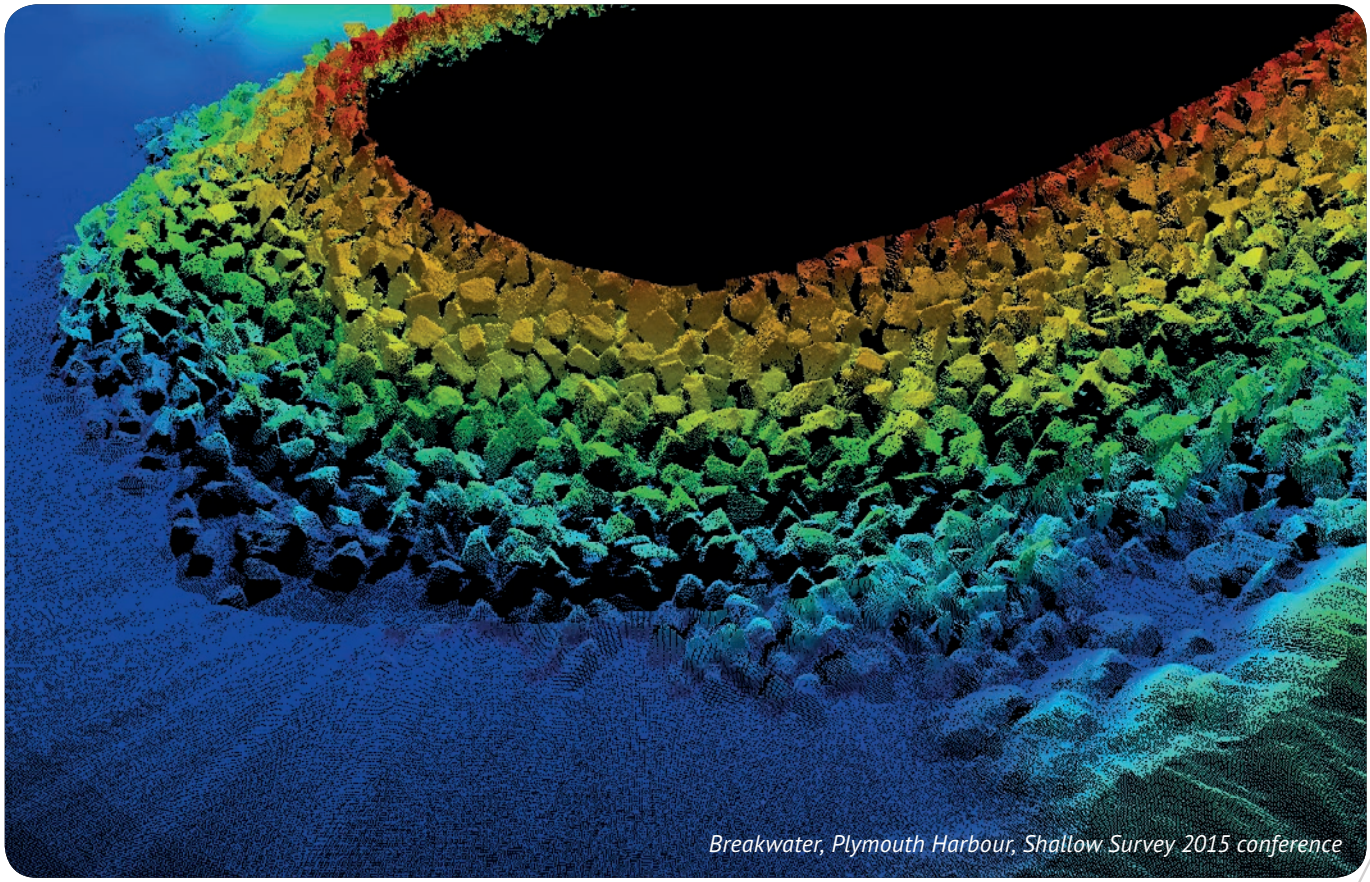

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Training vessel Bryn *returns in the port of Plymouth, UK. This is one of the training vessels of the Fugro Academy Training Centre that opened in Plymouth on 3 November 2015.*

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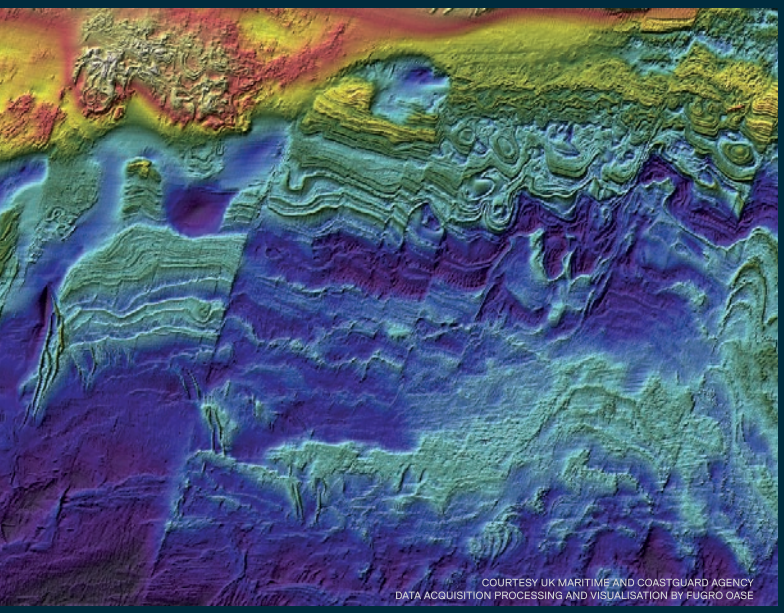
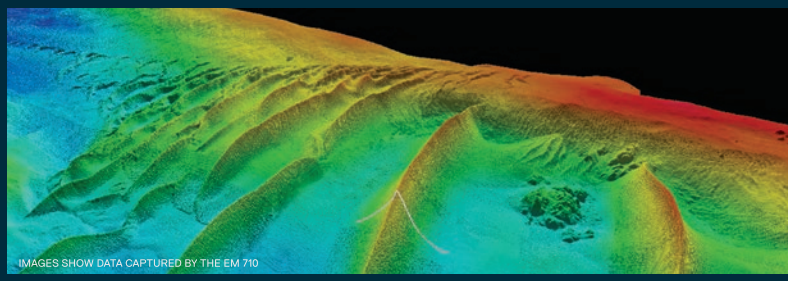
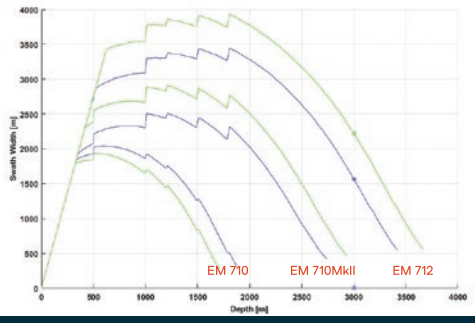

COURTESY UK MARITIME AND COASTGUARD AGENCY
DATA ACQUISITION PROCESSING AND VISUALISATION BY FUGRO OASE


IMAGES SHOW DATA CAPTURED BY THE EM 710

SWATH COVERAGE

Comparison between:

- EM® 710
- EM® 710MkII
- EM® 712



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No. 3722

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Dream

For many of us it wasn't the year we expected. The world is in turmoil. Economies still shaky and the oil prices at the lowest level for years. Many companies have cut back – not just the big ones active in offshore oil & gas, but also the smaller ones that have survey ships lying in harbours instead of being out there at sea – and have been forced to lay off loyal employees. It's difficult to see this period that may have struck as lighting for a lot of professionals in hydrography coming to an end anytime soon. It is such a shame that a technological, forward-looking industry is suffering – especially for those who have lost their jobs or saw their companies shrink or even disappear, while they should be thriving with new ideas and opportunities. But… let's not be too pessimistic, we're on the brink of a new year, which might bring us new chances, new technologies, and even new companies…

2016 could be the year that Lidar and satellite bathymetry and crowdsourcing come to maturity and that autonomous surface vehicles are fully deployed all over hydrography. We are in good company, as Captain Shep Smith from the National Oceanic and Atmospheric Administration (NOAA) expects the same. We interviewed Cpt Smith in this issue of *Hydro International* (see page 12). He works as hydrographer and Commanding Officer of the NOAA ship *Thomas Jefferson*. His story is one from the heart of one of the world's largest chartmakers and thus, user of massive amounts of hydrographic data. Smith does indeed see enough room for new technologies, but refers to the fact that discrepancies from the different sources is quite high and return survey is therefore often needed. NOAA also has another optimistic forecast. In his Insiders View column on page 6 Rear Admiral Gerd Glang, director of NOAA, US Hydrographer and respected member of our Editorial Advisory Board sees chances for the hydrographic industry to develop products for precision navigation while vessels are becoming increasingly larger and navigation in narrow ports & harbours increasingly more difficult.

There's way more in this last issue of *Hydro International* of 2015, but I would like to highlight both Glang and Smith because they share our optimistic view on hydrography. This can provide some support to those that are little more pessimistic because of developments over the past year, to look past the turn of the year and dream with the two Americans of a 2016 with lots of enthusiasm and energy!

Durk Haarsma durk.haarsma@geomares.nl

Will Hydrographic Offices Rise to the **Challenge Of Precision Navigation**?

As the size and capacity of vessels entering our ports continue to increase, mariners are challenged with navigating in increasingly constrained spaces. Mariners are demanding more accurate and higher resolution data as ports push the limits of their sea room to compete for megacarriers. This demand creates an opportunity for Hydrographic Offices to provide new products for precision navigation. The demand calls out for the standardisation of data formats to enable interoperability.

▲ *Rear Admiral Gerd Glang.*

For NOAA's Office of Coast Survey, building a product that provides decision-making tools necessary for precision navigation means going beyond our traditional foundational information. We must provide port-scale ENCs that are interoperable with a suite of high-resolution data including bathymetry, forecast and observed water levels, currents, winds, waves, salinity, and geophysical models to underpin sub-decimetre positioning. Data must also be readily available in internationally recognised data formats and disseminated by robust means for use at the point of decision.

This level of precision, allowing the mariner to know their vessel's current and future position in three dimensions within a decimetre of uncertainty, requires increased standardisation. The International Hydrographic Organization's S-100 universal hydrographic data model provides the framework to develop new products that will be interoperable on the bridge of a ship and conform to the International Organization for Standardization (ISO) standards. Drafts of the first of many needed S-100 product specifications — such as S-111 surface currents and S-102 high-resolution bathymetry — are currently under development. However, we still need more involvement of Hydrographic Offices in furthering the development of standards.

Coast Survey is currently testing several precision navigation products in the ports of Los Angeles and Long Beach, allowing us to examine them under at-sea conditions. Ultra large crude carriers (ULCC) entering the Long Beach channel must contend with potential winter storm swells where a single degree of pitch may increase a 1000-foot ULCC's draft by as much as ten feet. An under keel clearance system is being developed at the Port of Long Beach to determine the probability of grounding for all ULCCs entering the channel. Once validated, this system will guide pilots to make risk-based decisions before beginning a transit into port. This tool is enabled by a new nearshore wave model and wave observation buoys. Also available are large-scale S-57 ENC overlays based on new high-resolution bathymetry. These decision support tools and high-resolution navigation products will improve port efficiency and increase vessel safety.

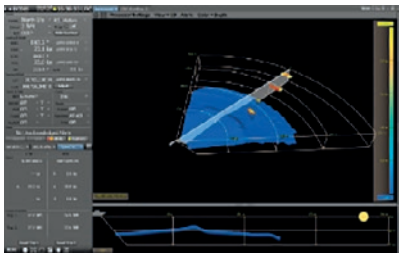
The success of precision navigation services ultimately depends on commercial vendors' willingness and ability in achieving an integrated platform. Our precision navigation product development gives industry the data needed for emerging technologies, and we are encouraged by the enthusiasm generated during discussions about the possibilities of high-resolution data fusion.

An integrated data stream for precision navigation brings a heightened opportunity — and challenge — for Hydrographic Offices to supply their valuable data for new uses, where it is needed.

3D Sonar Integrated into Wärtsilä SAM Electronics' NACOS Platinum Series

FarSounder, USA, has entered into an integration partnership with Wärtsilä SAM Electronics. 3D sonar data from FarSounder's navigation systems can now be visualised and controlled directly from all NACOS MULTIPILOT workstations. The forward-looking capabilities of FarSounder's navigation products add a new dimension of situational awareness to the NACOS Platinum Series.

▸ ***http://bit.ly/1PxDNoL***

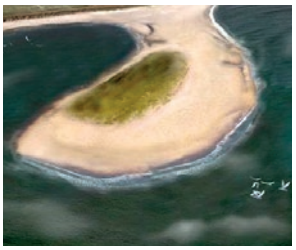


Screen print of the FarSounder 3D Sonar.

Sand-engine to Protect against UK Coastal Erosion

The UK's first investigation into the use of beach-widening to reduce coastal flooding and erosion is being led by the National Oceanography Centre (NOC) in partnership with the University of Liverpool. According to the leader of the project, Dr Jenny Brown from the NOC, rising sea levels and the expansion of built-up areas around the coast are causing beaches to become 'squeezed' into thinner strips.

▸ ***http://bit.ly/1PxDBpv***



The Sand-engine as it was built in the Netherlands.

Most Shared

Most shared during the last month from www.hydro-international.com

Sand-engine to Protect Against UK Coastal Erosion - bit.ly/1PxDBpv
Very Shallow Water Survey - a New Approach - bit.ly/1PxDFph
Underwater Electromagnetic Propagation - bit.ly/1PxDKt2
Reconnaissance Surveying Using Satellite Derived Bathymetry - bit.ly/1PxDOch
Farsounder 3D Sonar Integrated into Wärtsilä SAM Electronics Nacos Platinum Series - bit.ly/1PxDNoL

Deep Trekker ROV for High Arctic Research

In March 2015, Dr. Alex Nimmo Smith and Mr Peter Ganderton from the Plymouth University Marine Physics Research Group included a Deep Trekker DTG2 'Worker' supplied by Planet Ocean Ltd in the equipment that they took on a research trip to the Norwegian Arctic. The Deep Trekker ROV was successfully operated through ice holes in water of -2°C, with tasks including the inspection of other instruments and providing a visual survey of the underside of the ice.

▸ ***http://bit.ly/1PxDWZg***

Operating the Deep Trekker ROV before it dives under the ice.

Unique Group Acquires GSE Rentals

GSE Rentals (Geophysical Survey Equipment), established in Aberdeen, UK, has been acquired by Unique Group. The company is now wholly owned by Unique Group and the company's workforce will be retained. Former owner, Stan Moroney, will continue as business advisor and consultant to Unique Group. GSE Rentals will continue to operate from its facility in Aberdeen, a short distance from Unique Group's UK headquarters in Dyce.

▸ ***http://bit.ly/1PxEsGH***

From left to right: Andy Doggett, director of Unique Group's survey equipment division; Stan Moroney, former owner of GSE Rentals; and Ray Hughes, managing director of Unique System UK Limited.

Official Release of CARIS Onboard 1.0

CARIS is releasing its near real-time data processing and mapping application, CARIS Onboard. The development of this new technology will revolutionise the way in which bathymetry and imagery data is processed. CARIS Onboard automatically converts data as it becomes available and applies a range of pre-determined corrections. The data can then be used to generate a terrain model or mosaic. This allows for early visualisation of seafloor characteristics, putting a greater emphasis on quality control and supporting an environment of improved decision making and greater efficiency.

▸ ***http://bit.ly/1PxEqhU***

Annual Survey of the River Hamble

ABP Marine Environmental Research (ABPmer), UK, has been contracted by the River Hamble Harbour Authority to undertake its 2015 annual bathymetric survey. The survey is carried out to help the River Hamble Harbour Authority to maintain its knowledge of the water depths within the river and to capture any morphological changes that might occur over time.

▸ ***http://bit.ly/1PxFane***

River Hamble Estuary.

Valeport Hyperion Fluorometer.

Valeport Launches Hyperion Fluorometer

UK-based Valeport has released a range of optical sensors, which debuts with the launch of a fluorometer for measurement of chlorophyll, rhodamine and fluoresceine. The Valeport Hyperion Fluorometer delivers a high-performance measurement of chlorophyll A, rhodamine and fluorosceine in a compact and robust package for ROV and AUV use.

▸ ***http://bit.ly/1PxF6E2***

Plymouth's Fugro Academy Training Centre Opens

Plymouth's Lord Mayor, Cllr Dr John Mahony, opens Fugro Academy Training Centre.

The official opening of the Fugro Academy Training Centre by Plymouth's Lord Mayor, Cllr Dr John Mahony, took place on 3 November 2015 at Turnchapel Wharf, Plymouth, UK, part of the former home of 539 Royal Marines Assault Squadron. The Fugro Academy Training Centre comprises offices, training suites, engineering workshops, a café and recreation space, with access to Fugro's two training vessels moored in Cattewater, where the mouth of the River Plym merges with Plymouth Sound, immediately outside the training centre building.

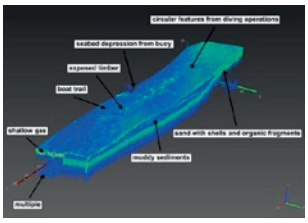
▸ ***http://bit.ly/1PxEgqW***

The LinkQuest EchoSweep 300 multibeam echo sounder.

LinkQuest Enters Multibeam Echo Sounder Market

LinkQuest, USA, recently added a multibeam echo sounder product to its product family of acoustic instruments. The EchoSweep 300 multibeam echo sounder is a high-resolution, highly robust and cost-effective swath bathymetric system for the mapping of sea floor, inland waterways and reservoirs. The EchoSweep 300 system is capable of reaching up to 280 metres in range with 140 beams. It operates at 260kHz and has a swath coverage of 140 degrees.

▸ ***http://bit.ly/1PxEC0w***



Innomar SES-2000 quattro parametric sub-bottom profiler data.

VLIZ Invests in Three Instruments for Marine Research

A measuring system for wind-driven sand transport, a set-up for acidification experiments with algae and a multi-transducer parametrical echo sounder are the three new research instruments that will be purchased by the Flanders Marine Institute (VLIZ, Belgium) for marine research in Flanders and its surroundings. These instruments were selected by the Scientific Committee through a call for proposals to invest in the marine research infrastructure of VLIZ in 2015.

▸ ***http://bit.ly/1PxEYo2***

HYPACK Joins Xylem

Xylem Inc. (USA) has acquired substantially all of the assets of HYPACK, Inc., effective 22 October 2015. HYPACK's expertise in hydrographic survey data acquisition, processing and visualisation software will complement Xylem's capabilities in Ocean and Coastal analytics and applications. Harold Orlinsky will continue as the general manager of HYPACK. Pat Sanders will continue to play a prominent role in the business, serving as a technical and marketing consultant and Lourdes Evans will continue as sales manager.

▸ ***http://bit.ly/1PxEXAp***

Meeting the Challenge of High Latitude Navigation

Recently, the Norwegian Polar Institute offered iXBlue live artic testing of their products while conducting a routine mission to recover scientific instruments. At North latitude, a greater problem than stability is determining the correct heading without bias. Thanks to its precision, iXBlue Phins consistently delivered performance similar to that at lower latitudes. Furthermore, iXBlue gyroscopes, compensated for thermal behaviour, maintained performance even mounted on the exterior of the vessel.

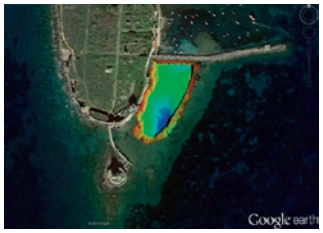
▸ ***http://bit.ly/1OPXJTH***

The Lance *vessel equipped with iXBlue's inertial navigation systems.*

Underwater Antiquities Uncovered in Greece

A team of marine geophysicists from the Laboratory of Marine Geology and Physical Oceanography at the University of Patras has completed a marine geophysical and hydrographic survey off Methoni, Greece. The survey was conducted under the auspices of the Greek Ephorate of Underwater Antiquities (Ministry of Culture and Sports), with support from Kongsberg Maritime.

▸ ***http://bit.ly/1PxE4aY***



The castle of Methoni (Greece) and colour coded the bathymetry of the town's ancient harbour and submerged breakwater.

Ocean Aero's Submaran Presented to the Market

Ocean Aero is taking orders for the Submaran S10 wind and solar-powered surface and sub-surface vessel. This vessel is specifically designed for extended autonomous ocean observation and data collection and it has the ability to dive ten metres, remain under water to avoid poor weather conditions, traffic or detection and then re-emerge, thus combining the capabilities of an AUV and a USV. The Submaran S10 will have the power and payload capacity for a wide range of sensor systems, dependent on the user's needs and desires.

▸ ***http://bit.ly/1PxFjqF***

Ocean Aero Submaran AUV-USV.

Top 5 Geo-Matching.com

Geo-matching.com
The right choice

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CARIS HIPS and SIPS	http://bit.ly/1OPY6NY
Eye4Software Hydromagic	http://bit.ly/1OPY74C
ECA Group Triton Perspective-MBE	http://bit.ly/1OPYbkS
QPS Qimera	http://bit.ly/1OPYc8v
EIVA NaviSuite Post-Processing	http://bit.ly/1OPYfBa

Sea Ice Plays a Pivotal Role in the Arctic Methane Cycle

The ice-covered Arctic Ocean is a more important factor concerning the concentration of the greenhouse gas methane in the atmosphere than previously assumed. Experts from the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) report on the newly discovered interactions between the atmosphere, sea ice and the ocean in a recent online study in the journal Nature's Scientific Reports.

▸ ***http://bit.ly/1PxEApu***

Phoenix International Assists in Locating *El Faro*

Phoenix International (USA), under the operational direction of the US Navy's Office of the Supervisor of Salvage and Diving (SUPSALV), successfully located the US flagged cargo vessel *El Faro* using the US Navy's deepwater side scan sonar search system, Orion. The ship was found in approximately 5,000 metres of seawater (msw) in the vicinity of Crooked Island in the Bahamas.

▸ ***http://bit.ly/1PxERce***

Hydro International Interviews Capt. Shep Smith

Excited by Automation Driven by **Autonomous Vehicles**

NOAA is one of the bigger organisations in the world that has surveying and charting in its portfolio. It's an immense task as the USA has about 95,000 miles of coastline, important ports and a wide range of users – from recreational boaters to the biggest container vessels and tankers. The country also has to deal with environmental disasters like hurricanes and oil spills. NOAA is undergoing changes as the chart portfolio is 'going digital' and new initiatives such as using Maritime Autonomous Systems (MAS) for surveys. *Hydro International* interviews Capt Shep Smith, who generously gave an insight behind the scenes.

Your most recent accomplishments focus on improving charts and charting workflow. Where is there more room for improvement?
We need to make the whole chart system simpler and support faster updates. In the era of Google Maps, we have come to expect our maps to be seamless and continually updated. In online mapping, there is no such thing as individual maps or editions.

New generation navigation systems — chart plotters, tablets and mobile devices — and web mapping applications increasingly use tile services like Google Maps. Currently, these systems use tile sets created from our raster navigational charts. This is time consuming and awkward, since multiple charts may cover the same area at the same scale and one chart must be chosen to populate each tile. As a result, the companies that do this to support their deployed systems only update their tiles once or twice per year.

▲ *Figure 1: Capt. Shephard Smith.*

Over the coming year, NOAA will roll out a set of chart tile services compatible with these systems. NOAA will update these tile sets weekly with the latest Notice to Mariners and any other changes to the charts that are made that week. These tile packages can then be updated with weekly 'delta' packages, containing only the tiles that have changed since the last full package. This will dramatically reduce the bandwidth requirements necessary to keep a vessel's chart suite up to date.

We have a huge opportunity now to dramatically reduce the time it takes to update charts. When we were printing editions of charts every few years, we would save changes to the charts on a working version of the chart and only release it to the public at the time of a new edition, which added several years of latency from the time an observation was made until it was available for use. We needed to publish changes to more dynamic features, such as aids to navigation or channel depths, in the Notice to Mariners in order to make them available to the public.

We now use a print-on-demand system for paper charts, so, with the end of paper inventory, there is no reason to hold back changes to the charts. NOAA has quietly been updating its digital charts weekly for the past 18 months. These changes are no longer limited to Notice to Mariners corrections; they might include full hydrographic surveys or shoreline updates as well. We apply these updates to all versions of the chart, including the print-on-demand charts. We can now support digital publication of changes to the chart that happen on time scales of months. An ocean inlet that is reconfigured by winter storms could be charted accurately in time for the summer small boating season.

We also have a lot of work ahead to optimise our ENCs for electronic navigation using ECDIS and electronic charting systems. We have heard from users concerning too many alarms, discontinuous depth areas, chart clutter, and unclear symbology. NOAA ENC Online, serving our whole ENC suite as a web mapping service, was intended to serve as a base map for various ocean-related mapping projects and services, such as the United States Coast Guard Search and Rescue service. However, it would have been worth deploying the system if only for internal use. It was the first time that everyone in the Coast Survey had ready access to view our ENCs as

Figure 2: Reviewing sample printed charts from printing on demand partners.

a seamless suite, and we could readily see the inconsistencies and discontinuities.

As we near completion of the population of our vector charting database, we are planning a suite-wide update of our ENCs, examining all the features that cause alarms, with an eye to reducing the incidence of unnecessary alarms. We will look at the depth areas we digitised originally from paper charts, and augment the depth areas where we need to distinguish safe water from shoal water. We will review all isolated hazards, such as wrecks and obstructions, to ensure they have the attribution necessary to reduce false alarms and chart clutter.

During your time at the Marine Chart Division, you oversaw the end of government printed paper charts. Will there still be a future for paper charts?

I think most responsible ships and boats will continue to carry some paper charts to sea for some time to come, for the purposes of backup. However, the regulatory requirements will continue to become more relaxed. In the context of type-approved electronic navigation, backup chart suites may include only a subset of paper charts, and may not be hand corrected.

The transition to digital navigation with paper backup happened in the US recreational boating industry about twenty years ago. Most larger recreational boats use electronic navigation in the form of chart plotters and computer-based navigation systems as their primary minute-by-minute aid for navigation.

Many boats also carry a conveniently-bound regional book of charts that can be used on a small chart table or in the cockpit.

NOAA sees these commercial products as a critical part of its distribution system, in support of its mission to get up-to-date charts onto every vessel. Commercial involvement in distribution, including approved print-on-demand agents, allows us to focus our efforts on updating the charts with new information quickly, and to seek out the best available information to resolve charted discrepancies.

In the two years you were commanding officer on the NOAA Ship* Thomas Jefferson*, you cut the cost of mapping output by 50%. Where were these savings found? How did you implement them (so rapidly)?

We did not find any savings.

We compute the cost of hydrography by taking the annual cost of the ship, people and equipment and divide this by the annual output of the ship. The cost of simply having the ship, equipment and crew is about 80 percent of the total cost, while the cost to operate the ship is about 20 percent. In optimal conditions, *Thomas Jefferson* can survey about 200 linear nautical miles (LNM) per day with the ship, and about 50 LNM per day with each of two launches, for a maximum of 300 LNM/day. With a single crew, the ship can operate about 240 days at sea.

However, the ship is seldom scheduled for such a big year, and most projects do not use the ship and launches simultaneously for the whole project. The year 2010 was exceptional, when the ship had 220 days at sea, and most projects used the ship and launches simultaneously. As a result, we logged record productivity for the year, and since the cost does not rise in proportion to our operational tempo, the cost per mile was low.

Cost per lineal mile is only one performance measure, of course. Another is the high value of surveying an encroaching shoal, determining the least depth on an isolated obstruction, or disproving a position approximate submerged pile in the centre of a natural channel — measures that arguably improve navigation safety more than resurveying an area that turns out to be already adequately charted.

Looking back to the Deepwater Horizon disaster when you were on command of NOAA Ship* Thomas Jefferson*, what in your view was the biggest take-away for surveyors?

Interesting question. We really transformed ourselves from a hydrographic ship into a more general oceanographic ship in order to try to characterise the subsurface oil. We left our launches in the davits, and traded out some of our permanent crew for additional scientists with needed expertise. We formed a team of water sampling experts and bio-acousticians, and built a processing workflow for on board analysis of water column backscatter. We had to think differently, work differently, and use new tools, all to observe a phenomenon never before seen. The main take-away I had, from a technical point of view, was that there is an enormous amount of potential in water column backscatter to gain insight into both physical and biological phenomena. It reminds me a bit of early multibeam, when we started seeing evidence of lots of benthic phenomena, sand ripples, iceberg scours, etc. We saw interesting anomalies in the backscatter, such as internal waves, that could be the focus of studies for other disciplines.

Figure 3: Capt. Shep Smith uses a sextant challenging junior officers in visual bearing and celestial navigation should automated systems not be available.

What do you see as the biggest developments in recent hydrography for charting?

I am excited by the move toward automation driven by the autonomous vehicle market. On my ship, we are following a path toward greater automation that includes both our manned and unmanned platforms. As a first baby-step, we now have autopilots driving survey lines on the ship and its two launches. As we develop better adaptive mission planning and system health monitoring tools for our autonomous surface vessels, we plan to apply these to our manned systems as well. We are already benefitting from higher quality data and a reduced holiday rate from the autopilots, and we are looking forward to additional efficiencies and quality improvements from additional automation.

We could also turn that question around. Multibeam surveys have been good enough for charting purposes for some time, but charting has not kept pace with multibeam surveys.

We have often used the value of each additional foot (or decimetre) of a ship's draft in a dramatic fashion to make the case for more accurate surveys of ports and approaches. However, our customary products, paper charts and ENCs, do not preserve enough seafloor detail to truly make use of the full detail of a multibeam survey to support navigation decisions to optimise the management of risk/return in ship movements from the sea buoy to the berth.

Last year, NOAA launched a pilot project in the Port of Long Beach, where we are helping pilots with 'precision navigation'. We pulled together a high-resolution depth surface in S-102 format with real-time water levels, salinity, currents, wave conditions and winds. By using its new underkeel clearance decision support system fed by these navigation data streams, the Port of Long Beach will save an estimated USD10 million per year by eliminating the need to offload cargo from vessels offshore before they enter the port. That project showed the need for next-generation navigation systems capable of streaming interoperable charting and observation data into optimised planning and real-time decision making. NOAA is developing its NextGenNav concept now. The system's precision navigation tool will address several navigation challenges, including a major advance from static chart depths relative to chart datum, to dynamic water depths representing the depth of water at the actual time of transit.

Recently, autonomous surface vehicles (ASVs) have been taken into service for very shallow water surveys. What are the first results?

I know of a number of projects to do this, I will focus on the experience on my own ship.

We have two small ASVs that draw about 0.2m with endurance of about 15NM at 4kt survey speed. We have used them to investigate shoals that are unsafe for our ten-metre long manned launches and to calibrate and validate satellite-derived bathymetry. Later this year, we will be using them to junction with bathymetric Lidar.

We commissioned the single-beam survey systems aboard our new ASVs as we would any other, with dynamic draft trials, timing checks, and a reference surface comparison with a trusted multibeam system. We have full confidence in the survey system and results.

Complying with US navigation rules, ASVs operate under the immediate supervision of an operator, who can assess the risk of collision and take appropriate action. This implies a requirement to maintain reliable and continuous communications with the ASV, even if it is surveying autonomously. This has proven to be a limiting factor, as our radio communications are reliable only to about 1 kilometre. Where it is available, we are looking at using shore side 4G infrastructure. We are also looking at longer-range marine radio telemetry systems.

The autonomy system we are using is still pretty rudimentary, basically able to follow a pre-programmed route. We envision additional behaviours to make the autonomy system better adapt to survey findings. For example, the ASV might be instructed to survey to the 1m curve, then break the line and proceed to the next. For a multibeam-equipped boat, it could create its next line to optimise coverage with the previous line. This example is under development at NOAA's Joint Hydrographic Center at the University of New Hampshire.

Lastly, we have worked out first-generation deployment and retrieval systems for the ASVs from the ship and launches. These limit the operating window to benign conditions, even more than the survey operations limit, and way below survivability.

More broadly, NOAA is evaluating a broad range of autonomous vehicles to assess their capabilities, from light, calm-water ASVs to large blue water vehicles. We are also investigating new ship designs that will enable the deployment, recovery and support of these vehicles as we think about recapitalising our existing fleet.

What do you think of Lidar or Satellite-derived bathymetry data for nautical charting related to data from ASVs?

I see them as complementary. Where we can get high-resolution bathy Lidar or satellite-derived bathymetry, we should do so. However, in most cases, these are incomplete, due to areas of deeper water or higher turbidity. In some recent bathy Lidar surveys of Atlantic inlets, we got coverage only to 1-2m deep. We need to be able to chart both the safe water and the unsafe water, which means we need sonar to finish the survey. If that sonar work is in shallow water, we need a vessel appropriate to those waters, which might be a skiff or an ASV.

It is also important to recognise that survey standards require more than depth accuracy. They include requirements to systematically cover an area, determine the least depth on

any significant features detected, and to disprove or otherwise address charted features in the survey area. While the resolution of bathymetric Lidar has improved in recent years, I would not yet say that we could use them to disprove rocks, wrecks and obstructions, such as submerged piles. High-resolution side-scan or multibeam sonar is necessary to confidently disprove and get least depths on submerged features.

How do you judge the added value of ASVs for hydrographic surveyors?

ASVs are an alternative to other types of manned vessels, and can be equipped with any sort of sensor package. The old saw for AUVs is that they are best applied to areas that are 'Dirty, Dangerous, Dull, Denied, or Deep.' ASVs have no particular advantage in deep water, and are readily visible, so are less attractive for denied areas, but the other three ('Dirty, Dangerous, or Dull') apply equally well to surface vessels.

As with any new technology, ASVs may allow us to do things we could not do before. In the case of NOAA Ship *Thomas Jefferson*'s operation, we are now able to survey safely in much shallower water than we could reach with our launches. (Dangerous). The boats we are using were adapted from systems designed for surveying in mine tailing ponds (Dirty).

We also envision ASVs to be used as an alternative to manned boats in order to gain extra productivity without additional staff. We might use them in a convoy formation to the mother vessel, effectively getting multiple swaths in a single pass, or we might give them their own work in an area deemed safe for them to operate. We are also investigating the possibility of having our boats optionally manned, so the same hull and sensors could be used for manned work when necessary, such as nearshore and in high traffic areas, and in an unmanned mode in safer water (Dull).

What do you consider as the minimum depth for 'navigable waters' to be surveyed?

For the last 25 years in the US, we have primarily focused our hydrographic efforts on areas critical to deep draft traffic. This was the right priority, as full multibeam and digital side-scan sonar have permitted us to find and measure least depths on thousands of rocks, wrecks and obstructions of potential danger to large ships. However, these systems, and the platforms on which they are deployed, have a practical safe inshore limit. NOAA has set this inshore limit at 4m, though often full coverage multibeam stops seaward of this curve. This limit is appropriate to the requirements of deep draft traffic, and to the tools we use to fulfil that requirement.

However, there are other hydrographic requirements for other user groups. While we focused on deep draft traffic, chart adequacy in near coastal waterways has degraded significantly. There are over 2000 reports of shoaling on NOAA charts, mostly in less than 4m of water. These reports come from vessels, often as the result of groundings or near-groundings, and are concentrated near harbours, inland waterways, and ocean inlets that are critical to our coastal towns, and the vibrant tourism, recreational boating and fishing industries. For most of these applications, the 'too shallow to worry about' limit is 1-2m. There are hundreds of smaller ports and small waterways for every large port, and hundreds of small boats for every large ship. The aggregate economic impact of recreational boating and small commercial boats is huge.

The US has 95,000 miles of coastline, and we cannot afford to resurvey all of these areas to the same level of care as we use in critical underkeel clearance areas for deep draft traffic. So I would propose a different approach: instead of surveying large areas systematically in order to find and resolve hazards, we should respond to chart discrepancies, resolving each through systematic surveys. These discrepancies might be reported to us directly, as were the 2000 cited above, through programmes like the one we have with US Power Squadron, where we compare the data to the chart, and chart shoal depths and contours as 'reported' if they are deemed credible and potentially dangerous to navigation.

Or they might be reported indirectly, such as through online cruising guides, or teased out of crowdsourced bathymetry databases, or from comparison of satellite bathymetry to the chart, or by examining AIS traffic patterns. The potential number of discrepancies from all of these sources is very high and represents a large amount of high return survey work.

Are there any new standards that we need to look at internationally? Vertical datums, projections, symbology, layers, inputs from radar, GPS, tide gauges and even cameras?

A year ago, NOAA hosted an 'industry day' at the Annapolis Boat show, where we invited all the navigation system manufacturers to hear short presentations and to meet with NOAA experts on various forms of environmental intelligence. We explained the availability of charts, high-resolution hydrographic data, tides and current station observations and predictions, full 3D hydrodynamic models of our coasts, weather, wave prediction models, high-frequency radar observations of coastal currents, and satellite-measured sea surface temperature. There was enormous interest in better integrating these datasets into the intermittently-internet-connected navigation systems that are in common use in the recreational and light commercial industry.

Eventually, there may be standards for some of these types of data, specifying formats, resolutions, etc. However, for now I think it wisest to let the open market start to settle on some priorities, use cases, and to develop some prototypes from which we can build standards later.

Instead of surveying large areas systematically in order to find and resolve hazards, we should respond to chart discrepancies, resolving each through systematic surveys

Shepard Smith

Captain **Shepard "Shep" Smith** is a career hydrographer with the National Oceanic and Atmospheric Administration. He has served as the US Deputy Hydrographer and as the head of the Marine Chart Division, leading chart production and distribution. He is currently at sea for an encore tour as the Commanding Officer of the NOAA Ship *Thomas Jefferson*.

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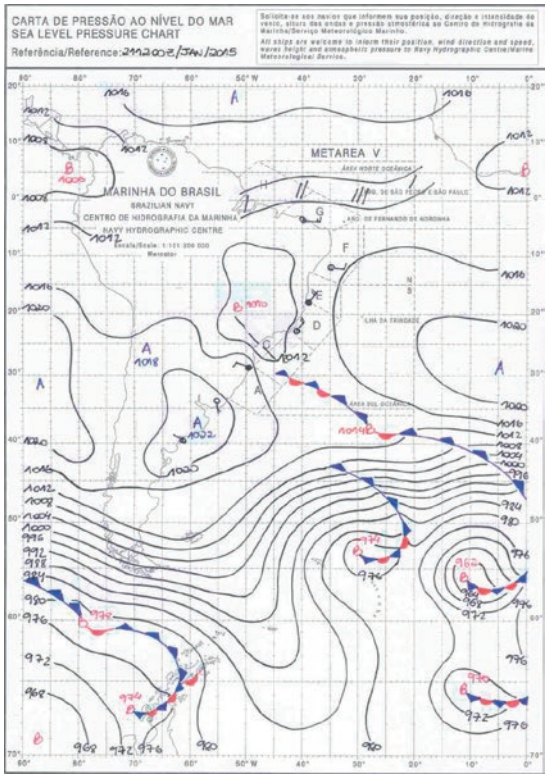
S-100 Universal Hydrographic Data Model for Informational Overlays

Designing a New Way to **Deliver Marine Weather Data**

Mariners rely on many sources of information during daily operations to ensure their safety at sea; nautical charts and weather information are critical and can sometimes lead to life-changing decisions. The ways in which navigation and weather data are created, disseminated and displayed by mariners are drastically different, having made integration of this information difficult in the past. NOAA and the Brazilian Navy Hydrographic Center are working together to develop a new methodology and international standard that will allow weather forecasts and analyses to be displayed like navigational charts: as an overlay on Electronic Chart Display and Information Systems (ECDIS).

As the maritime industry becomes more high tech, bridge electronics will tend to become increasingly integrated. Bridge electronics integration reduces ship operational costs and increases situational awareness, promoting safety at sea. Since the mid-1990s, the International Maritime Organization (IMO) has led an e-Navigation programme to integrate useful information into a single display for mariners. ECDIS is the only equipment on the bridge that provides an overall view of all navigational sensors simultaneously with nautical charts. Displaying multiple information feeds on one screen enhances the navigating officer's situational awareness. ECDIS modules currently available to the maritime community are limited in the data sources they can display, but visualising weather information directly on the ECDIS display will be possible in the future using the S-100 Universal Hydrographic Data Model.



▲ *Figure 1: Brazil's manual forecasts will upgrade to S-412 digital. Image courtesy: Brazil's Navy Hydrographic Center, Marine Meteorological Services.*

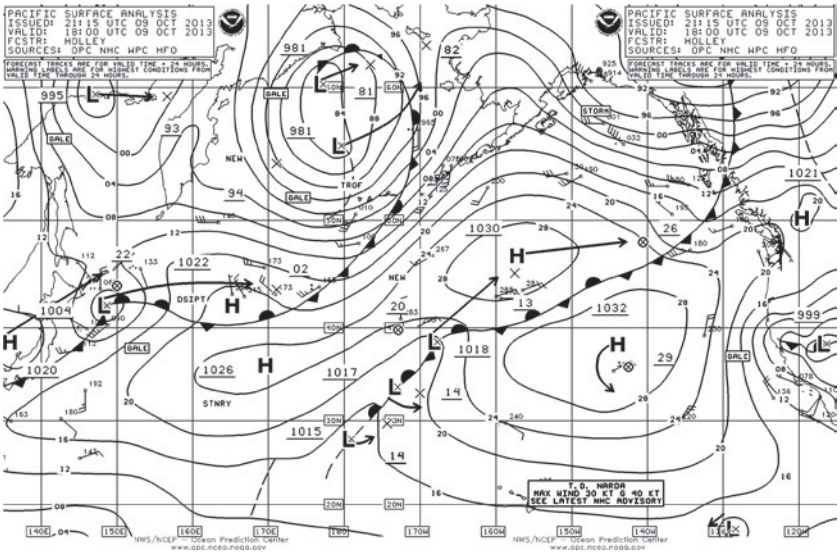
International Collaboration

Marine weather forecasting has evolved significantly over the last 20 years due to advances in computing power and space-borne remote sensing. Despite the change in forecasting technology, the way the information is disseminated to mariners remains unchanged. Ships at sea rely on radio voice broadcasts, VHF text broadcasts and radiofax transmissions for accessing weather forecasts. Now that roughly half of the large commercial vessels at sea have internet access, it is time to start developing the next generation of weather forecast products that can leverage satellite internet communications.

The Joint WMO-IOC (World Meteorological Organization – Intergovernmental Oceanographic Commission) Technical Commission for Oceanography and Marine Meteorology (JCOMM) made ECDIS weather overlay products a priority in 2012 and designated the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) as the project lead. The Brazilian Hydrographic Office recognised the importance of delivering life-saving weather information via ECDIS and joined the project in 2014. This started a partnership to develop the S-412 Weather Overlay, a marine weather forecast product format compliant with the future S-100 hydrographic model.

To launch the international collaboration, Brazil sent a visiting scientist to work at the NWS Ocean Prediction Center (OPC) in College Park, Maryland. LCDR Cesar Reinert B. de Morais, an oceanographer from the Brazilian Navy Hydrographic Center, spent four months working side-by-side with OPC personnel to advance the S-412 Weather Overlay specifications development as part of the Brazilian Navy's 'Science Without Borders' programme.

Cooperation and collaboration on S-412 doesn't end with Brazil and the United States. Creating a set of standards and technical specifications to display weather information in electronics primarily designed for displaying navigational charts requires teamwork and support from both the marine weather and hydrographic communities. Experts on both sides of the table are necessary to define the



▲ *Figure 2: Electronic weather charts provide more information than paper radiofax.*

meteorological needs of mariners and how the information can be portrayed by the same means as features on Electronic Navigational Charts (ENCs). Input is also needed from private companies that create ECDIS units to assist with final feature portrayal and data transmission.

Creating an international marine standard that complies with the S-100 charting framework is an immense task. This standard must meet the needs of the international maritime community not only now, but for several decades into the future. Developing the S-412 Weather Overlay standard reaches far beyond compiling and defining features and their numerous attributes. In some ways, the technical aspects of its development might be the simple part of the project. One of the first challenges encountered concerned determining what information to incorporate into the S-412 Weather Overlay.

Each country provides slightly different products and services. In order to meet the demands of the mariner, the international community must reach a consensus on the form and contents of the final product. This includes using a standard set of nomenclature and symbolisation, despite the slight differences found between most countries' products. All features and their attributes passed several review and comment periods by members of the JCOMM Expert Team on Maritime Safety Systems (ETMSS). Edits and revisions of the features and specifications will continue throughout the development of the standard. In addition to the semantic challenges, the development of the Weather Overlay must also factor in technological challenges. For many countries, developing a system that outputs digital geographically referenced weather features will require a significant effort.

Weather Information for Mariners

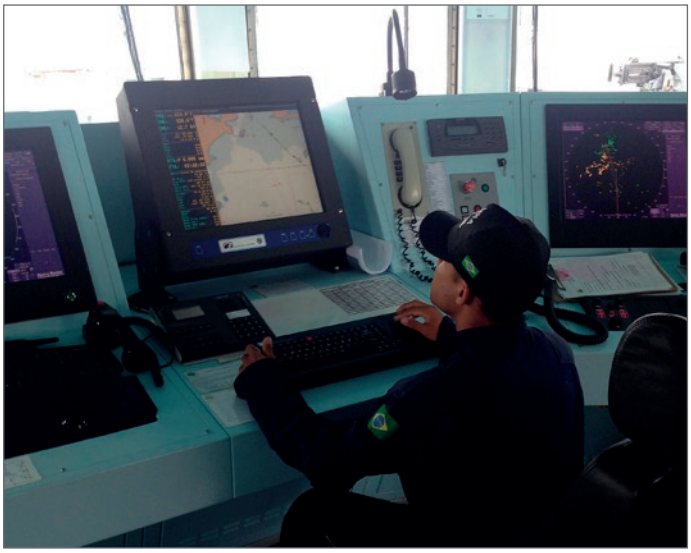
Adding informational overlays into ECDIS was not possible until the development of S-100, the Universal Hydrographic Data Model. S-100's predecessors were hard-coded, static models, but the new model is dynamic, allowing new specifications written in machine readable code to be added to the ECDIS. The flexibility inherent to S-100 will allow S-412 and other informational overlays to provide valuable information to mariners, oceanographers, meteorologists, researchers and students.

The features portrayed in the S-412 Weather Overlay are designed to replicate and enhance the radiofax charts used today by mariners. A series of point, curve and area features will mimic the internationally accepted symbols commonly found on surface analyses and marine weather forecast charts. Some of these features include high and low pressure centres, locations of hurricanes and typhoons, isobars (atmospheric pressure) and frontal features. Weather symbols will be familiar to mariners, but having them displayed in ECDIS will allow much more information to be presented as opposed to the legacy radiofax paper print outs. The features captured in the S-412 Weather Overlay portray both atmospheric and oceanographic information: wave heights and other critical sea state information will be available to mariners in this new product.

S-412 Technical Development

To date, 40 objects and 80 attributes comprise the draft feature catalogue and have been

▲ *Figure 3: ECDIS units are key situational awareness software suites. Image courtesy: LT Adrienne Hopper, NOAA Corps.*



▲ *Figure 4: ECDIS are integral to a ship's navigational electronics suite. Image courtesy: LT Jonathan Kepler Bulhões de Morais, Brazilian Navy Ship* Apa.

▲ *Figure 5: ECDIS units aid safe navigation on NOAA research vessels. Image courtesy: LT Adrienne Hopper, NOAA Corps.*

peer-reviewed through JCOMM's Expert Team on Marine Safety Systems, an international working group that supports international marine safety, Search and Rescue, and pollution emergency response. The group facilitates international cooperation and the review of technical implementation of services for international maritime emergency response. The portrayal rules are now being developed for the features that will comprise the S-412 Weather Overlay. Development is currently focusing on 13 features most commonly used on international marine forecast charts. The remaining features will be developed after these original 13, which will allow data testing to begin before the entire portrayal catalogue is completed.

Scalar Vector Graphics (SVG) and eXtensible Markup Language (XML) files are being used to define how the points, curves, and surfaces will be represented on an ECDIS. Like navigational charts, the features are being designed to have different day, dusk, and night colour palettes so weather information can be accessed by mariners on the ship's dark bridge at night. Official marine forecast and analysis products created using the S-412 specifications will be produced by the countries responsible for the international METAREAS, the different areas of responsibility for marine weather warnings maintained by the WMO. The ISO/EIC 8211 format will be used to transmit these forecasts, keeping file sizes low and data accessible to vessels at sea with limited bandwidth.

Future Developments

Over the coming years efforts will concentrate on completing the portrayal catalogue and creating test data. NOAA expects to generate test datasets using the Advanced Weather Interactive Processing System – II (AWIPS-II), the software package the National Weather Service uses to generate forecast products. As data is tested, more technical details will be added to S-412's product specifications, including parameters such as how large coverage areas may be and the limits to S-412 file sizes.

The team is focused on having a set of specifications and products ready for display on ECDIS by 2018. To meet this goal, further international, inter-agency, and intra-agency cooperation is essential. This project is a prime example of a diverse community coming together despite distance, boundary and resource challenges to complete a common goal and advance the use of digital data in maritime forecasting.

Visualising weather information directly on the ECDIS display will be possible in the future

Acknowledgements

Many thanks are due to NOAA's Julia Powell, Colby Harmon, and Joseph Sienkiewicz for their support and subject matter expertise during the S-412 development to date. ◀

More Information

IHO Universal Hydrographic Data Model (January 2010) available for free download at http://www.iho.int/iho_pubs/standard/S-100/S-100_Version_1.0.0.zip

Information technology - Specification for a data descriptive file for information interchange (ISO/IEC 8211:1994) available for download at http://webstore.ansi.org/RecordDetail.aspx?Sku=ISO/IEC%20 8211:1994&PageType=1

LCDR **Cesar Reinert B Morais** graduated from the Brazilian Naval Academy in 1997, became a Hydrographer in 2001 and earned an MSc in Meteorology and Physical Oceanography from the Rosenstiel School of Marine and Atmospheric Science-University of Miami in 2010. He is currently working at the Brazilian Navy Hydrographic Center.
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Hydrographic Surveying in the Port of Rotterdam

Introducing GIS to **Support Maritime Accessibility**

The Port of Rotterdam is Europe's largest port and is one of the world's key logistic hubs. Hydrographic data is critical to the Harbour master's department for the operation of the Port of Rotterdam, to support the nautical accessibility of the deep-sea vessels by electronic nautical chart. The introduction of PortMaps enables the Port of Rotterdam to produce a wide variety of information products, including ENCs, from the Port's survey data, in less than 48 hours.

With over 500 line connections to and from more than 1000 ports around the globe (Figure 1), the Port of Rotterdam is the cornerstone of international freight transport:

- Port area: 12,500ha (land and water, of which approx. 6,000ha are business sites).
- Length of port area: over 40km.
- Employment: 180,000 jobs.
- Throughput: approximately 450 million tonnes of cargo per year.
- Shipping: approximately 30,000 sea-going vessels and 110,000 inland vessels per year.
- Added value: (direct and indirect) over EUR21 billion; 3.5% of GNP

▲ *Figure 1: Connections of the Port of Rotterdam.*

Thanks to its strategic geographic location directly on the North Sea coast at the mouth of the Rhine River, the unparalleled depth, the absence of locks and minimal tides, the Port of Rotterdam is accessible 24/7, even for the biggest deep-sea vessels. An extensive intermodal network of waterways, railways, roads, pipelines and short-sea connections ensures an optimal connection to the European hinterland. This makes Rotterdam the perfect base for import and export and a gateway to the European market and its more than 500 million consumers. The deep-water terminals are quickly and safely accessible from the open sea. As a result, ships can be unloaded and reloaded in no time and quickly sent on their way to their next destination.

Dredging

This favourable location has one downside, namely siltation. The silt in the Port of Rotterdam originates from both the sea and the river. Siltation from the sea is transported by tide and the siltation from the river is transported by the current flow of fresh water. The annual siltation in the port area varies between 5-6 million m^3.
Dredging operations are an ongoing business to keep the port accessible for all vessels and especially deep-sea vessels with a draught of more than 23 metres.

Surveying

Hydrographic data is critical to the Port of Rotterdam's operations.It must be extremely accurate and supplied in time.
Understanding the depths throughout the port is a critical piece of information for the Port of Rotterdam's day to day work. As the Dutch Hydrographic Office only produces ENCs for harbour usage, the Port of Rotterdam investigated the possibility of producing 'berthing' ENCs containing high-density depth data to support decision making within the port.
Hydrographic surveys are conducted on a daily basis in the Port of Rotterdam using a survey programme based on siltation rates, dredging operations, port operations and client requests. This is mostly scheduled, but it needs to be flexible to monitor the dredging operations.

The port operates two survey vessels on a daily basis. The survey vessels *Surveyor 1* and *Surveyor 2* conduct at least three surveys per day. Furthermore, the rib *Calypso* was added to the fleet to operate in shallow survey areas. *Surveyor 1* and *Surveyor 2* are equipped with

▲ *Figure 2: Survey vessel* Surveyor 1 *multibeam echo sounder configuration.*

the latest Teledyne Reson multibeam echo sounders, Applanix Inertial navigation systems, Riegl laser scan systems, Valeport SVPs and operated by QINSy and five hydrographic surveyors.

Multibeam surveys contain overlapping tracks for quality assurance and checks for sound velocity changes. The noise is removed by depth area cleaning filters. The survey data is processed on board on the day it is collected. Noise is removed from the survey and checked by Beamworx's Autoclean. All surveys have to meet the Port of Rotterdam Survey Standards for multibeam surveys.

A mean 1x1m grid is generated after cleaning the data to reduce the amount of data. On slope areas of bottom protection rock dump areas, a mean 0.5 x 0.5 grid is created to retain bottom integrity. Once the survey has been fully processed, it is sent as a clean 1x1m digital terrain model (DTM). The survey vessels are connected with the Port of Rotterdam network by UMTS cellular connections. The survey data can be copied to the network drive that is monitored.

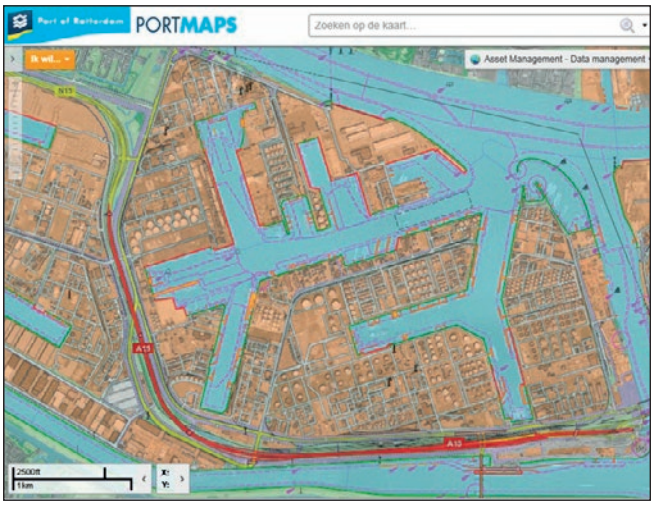
The New GIS: PortMaps

In 2013, the Port of Rotterdam decided to partner with Esri to replace the old GIS with the implementation of the PortMaps system. Portmaps, built using the ArcGIS platform, is an integrated information system for all Port assets. The platform had to be user friendly, so all users could find information at the port within three mouse clicks. The Port of Rotterdam also required an adaptive system to handle facilities management, accommodate mobile devices, and integrate with its other corporate information systems: SAP, Microsoft (Sharepoint) and DMS (Document Management System).

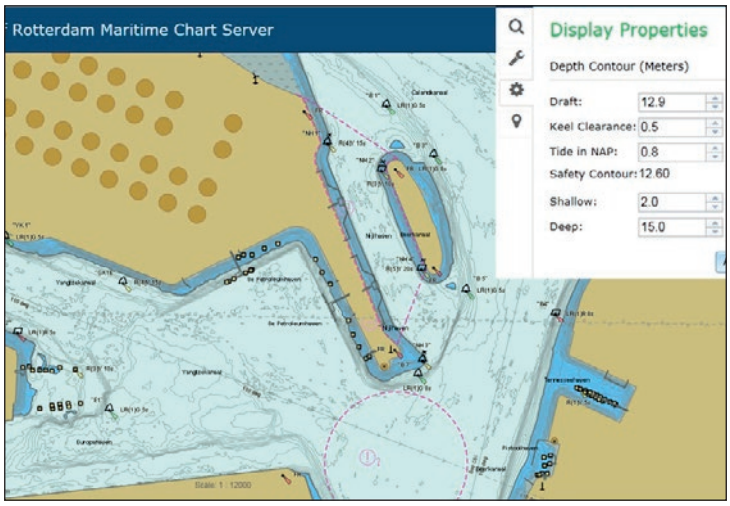
PortMaps is an asset management system and provides the framework for the hydrographic production at the port.
The hydrographic system consists of three primary components: the Bathymetry Information System (BIS), the Nautical Information System (NIS) and the Maritime Chart Server (MCS).

The BIS is the bathymetry database for the port and replaced the Oracle database Dolomiet developed in-house. When Esri and the port implemented the BIS, the port identified several metadata attributes that they wish to track and maintain for each survey. Over 3,500 surveys were extracted from the former bathymetry database, Dolomiet, transformed into dual-band GeoTIFFs, and registered along with their associated metadata with the BIS.

The NIS is the base geodatabase for the Esri Nautical Chart production system. Using the ArcGIS for Maritime, Charting solution and extract-transform-load (ETL) processes, information from various sources was combined to populate the NIS. ENC cells from the Dutch Hydrographic Office are then augmented with information from the Port of Rotterdam's existing port ENC cells and



▲ *Figure 3: Example of a PortMaps screen.*



▲ *Figure 4: Maritime Chart Server.*

information from the Port Object Information database (POI).

With the implementation of the PortMaps project, harbour masters, asset managers and pilots have access to Esri's Maritime Chart Server (MCS). MCS serves the most current ENCs available for the port, including some created by the port with depth information surveyed that day. MCS gives the organisation of the port as a whole access to dynamic querying on the rich data contained within ENCs in order to assist with planning and domain awareness.
A dredging-atlas is created by PortMaps to support the dredging activities. This atlas features a difference layer between the maintenance depth levels and the survey data in the BIS. The layer thickness is displayed as an information product, but also on 'paper charts'.

ENC Production

With the bathymetric base of the port's ENC stored with the BIS, the next production step is to manage and update the other ENC features. All of the non-bathymetry ENC features are stored in the NIS database. An ETL extracts data and transforms it into the S-57 data model.

When an ENC update is required, the ENCs can be exported easily from the NIS. The tools use an ENC cell coverage layer to select and batch export ENC cells that need to be updated.

In the next stage of production, the exported ENCs do not include any bathymetric information. To complete the S-57 ENC, the Data Management office uses QINSy by QPS. In order to reduce the depth data in the ENC, a process is run overnight on the complete bathymetric surface model maintained by the BIS. The process takes the 1x1m model and generates a 5x5m grid. The process selects the shallowest grid depth within the 5x5m grid and writes the depth and the original horizontal coordinates to the 5x5m grid. This results in a 5x5m irregular DTM of shallowest depths.

Figure 5: Map showing individual soundings.

An average hydrographic survey in Rotterdam covers three ENC cells of four square kilometres each. Processing this survey from vessel to ENC takes only a few hours of direct user involvement. The combined workflow of the hydrographic survey collection, processing and ENC production is generally finished within two days.

Once the ENCs have been updated, they are made available to a wide variety of different uses in the Port of Rotterdam. The two principal ENC consumers are the Port Authority and the Pilots. Both these groups use the information in different formats to assist in the safe navigation of ships with marginal UKC.
Any ship that is limited to the fairway by draft has to call in to the Port Authority at least 48 hours ahead. When the ship calls in, the Harbour Masters' office (HCC) checks the fairway and berth depths using MCS. The HCC officer can enter the ship's draft, UKC and the tide level into the MCS user interface. The safety contour will be derived and shown automatically in MCS.

Survey programme based on siltation rates, dredging and port operations, and client requests

Conclusion

Hydrographic surveying is one of the important parts of port operations as vessels are using less keel clearance for maximum loads. Safe navigation needs regular surveys, delivered on time and to specified accuracies. Data errors are significantly reduced and data is synchronised by joining the GIS activities of all asset management departments of the port in PortMaps to update the S-57 objects. This directly impacts decision making in vessel traffic management.

The level of data synchronisation at the Port of Rotterdam directly impacts how the port manages traffic and vessel safety. Because the hydrographic production system is so closely linked and integrated with the port's enterprise GIS, the hydrographic data is easily utilised by all areas of the port. This innovative approach to hydrography truly allows the data to be used for more than charts and creates potential for hydrographic data outside of traditional uses.

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Jeroen van Reenen graduated with a BSc in Hydrography from the Nautical college in Amsterdam in 1991 and joined the Port of Rotterdam in 1999 as a hydrographer. He later became project manager for the survey & dredging department and now works as team manager for the Data Management department. Before joining the port, Jeroen worked for Royal Boskalis Dredging for seven years on various international dredging projects.

Cutting the Red Tape without Cutting Corners

Robust Data in Sensitive Environments

There are settings where an unmanned survey represents more than a safe, cost-effective alternative; it may be the only option. Capitol Lake in Olympia, WA, USA, is such a location. In this article, we report on a recent survey that highlights the advantages offered by an unmanned platform operating in a highly public, environmentally sensitive setting.

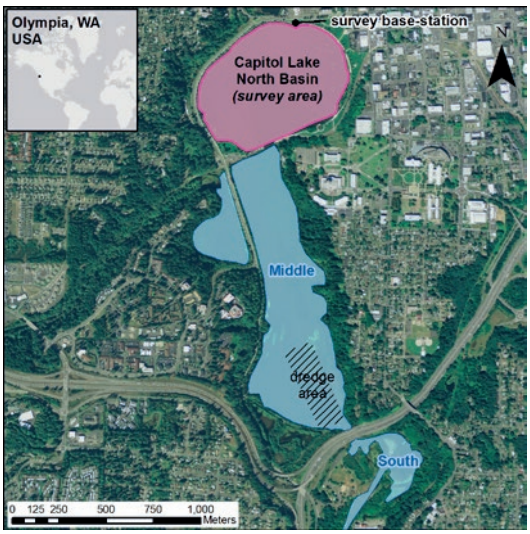
From their Sediment Management and Marine Sciences office in Seattle, WA, NewFields has been investing in USV research and development to expand services and client relationships for their local consulting and engineering offices throughout the USA. In 2014, the Seattle office acquired the Teledyne Oceanscience Z-Boat 1800 equipped with a dual frequency, single-beam echo sounder. When the challenges presented by the Capitol Lake setting required specialised sonar, they turned to the expertise of a locally-based and well-recognised manufacturer of aquatic habitat and fisheries echo sounders, BioSonics, Inc. In a collaborative effort, the NewFields USV was reconfigured with a sonar payload optimised to detect and differentiate submerged vegetation from the true bottom.

▲ *Figure 1: The Z-Boat 1800MX operating in the restricted waters of Capitol Lake.*

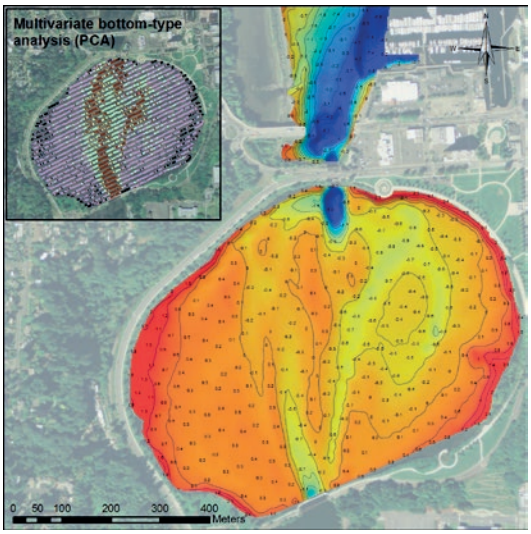
Unique Setting

Capitol Lake is a man-made body of water and prominent feature of downtown Olympia, Washington. Located on the State Capitol campus, it is fitting that the lake is also the focal point of a divisive environmental policy issue that has dragged on for decades. The lake was created in 1951 when the State administration implemented a campus improvement plan which included the damming of the Deschutes River and tidal estuary to form a reflecting pool for the Capitol Building. Poor water quality has plagued the lake since its creation, and management of the 35,000 cubic yards of sediment delivered by the Deschutes River every year has become increasingly expensive, leading to a vigorous debate of whether or not to remove the dam and restore the estuary.

Most of the sediment delivered by the Deschutes is captured along the middle stretch of the lake, which has previously been dredged to trap sediment. The sediment has recently been determined unsuitable for release to the natural environment, adding complexity and cost to dredging. With the sediment trap at capacity, more material is expected to reach the ~100 acre North Basin (Figure 2). Regular bathymetric survey data is needed to understand the volume and spatial extent of sediment deposition in the basin;

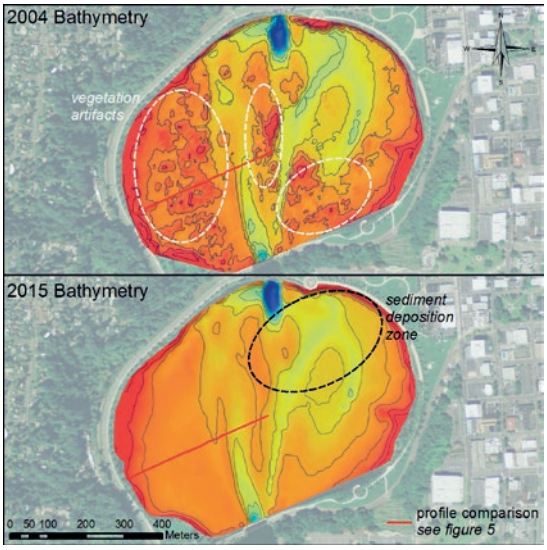


▲ *Figure 2: Capitol Lake survey area and vicinity.*



▲ *Figure 3: Shaded-relief digital elevation model of Capitol Lake and receiving waters, with soundings and 0.5m elevation contours (NAVD88). Inset contains location of actual survey data points symbolised with Visual Habitat bottom-type classification.*

▲ *Figure 4: Comparison of 2004 & 2015 digital elevation models (DEMs) highlighting areas where vegetation interfered with accurate soundings. Differencing the DEMs shows a general shoaling trend outside vegetated areas, with the circled (black) region exceeding 20cm of deposition.*



however, the recent infestation of a high-risk invasive species has introduced a new challenge for researchers.

In 2009, the New Zealand Mud Snail (NZMS) was found throughout the Capitol Lake basin. The tiny snail is extremely difficult to eradicate and is easily transported between lakes and streams on the boots and boats of fishermen and scientists alike. To contain the infestation, access to Capitol Lake and the shore has been prohibited. This has consequently limited research intended to address the multitude of problems plaguing the lake, including sediment management and water quality.

Survey Equipment

The Z-Boat operated by NewFields is a 1.8m vessel with dual 24V electric thrusters, dual antenna GNSS, and a 40kg payload capacity which can accommodate several different sonar systems. Originally designed for high speed operation in flooding rivers, the 10kt survey boat offers a stable platform for surveying inshore environments such as ponds, lakes and reservoirs. With a hand-held remote control unit and laptop, the operator is able to navigate and view data acquisition in real-time through a high-bandwith 5GHz wireless Ethernet connection capable of transmitting over 1km. Navigation along pre-determined survey lines can also be automated by adding an optional control module.

The engineers at BioSonics reconfigured the NewFields Z-Boat to match the specs of the turn-key Z-Boat 1800MX using HYPACK for survey line navigation. The MX echo sounder with 204.8kHz, 8.5° single-beam transducer is optimised for plant detection and substrate classification in addition to bathymetric data collection with an accuracy of +/- 2cm. Visual Acquisition software installed on the shore laptop is used to control the MX and data logging.

Survey Design

An important objective of the survey was to compare with an existing US Geological Survey (USGS) dataset. In 2004, the same area had been surveyed using a personal watercraft outfitted with a 200kHz single-beam echo sounder. At that time, patches of submerged aquatic vegetation (SAV) could be seen beneath the surface of the lake, and made it impossible to determine the true bottom for several areas.

The original USGS survey lines were used for mission planning. Each planned line was split so that transects would cover about ½ the distance across the lake. Using this method allowed for an efficient, controlled transition between survey lines in open-water. Geodetic control was established by relating the lake water level to a physical monument measured on the seawall. Elevation of the physical monument was surveyed using the iGage X90 OPUS antenna, utilising the precise National Geodetic Survey OPUS post-processing service.

A survey work plan was emailed to the State, which included deployment and recovery of the Z-Boat 1800MX from an elevated seawall. Avoiding the muddy shoreline significantly cut the decontamination steps required to conduct the work, and played a large part in having the low-impact work plan approved by multiple agencies in less than 2 weeks.

Acquisition & Post-Processing

Under calm, clear skies on 17 April 2015 the 6hr survey covered more than 20km with minimal cross-track error. Thrusters and rudder trim were adjusted to maintain a consistent ~5kph survey speed and true course throughout the day. Ground control GPS data were recorded for 5hrs during the survey to generate an OPUS solution with vertical position accuracy of +/-1cm.

The MX data files were processed with BioSonics Visual Habitat software, which provides information about the location and quantity of submerged vegetation, substrate types and bathymetry. Visual Habitat utilises a proprietary algorithm to generate a bottom track based on user defined signal level threshold and echo characteristics. A separate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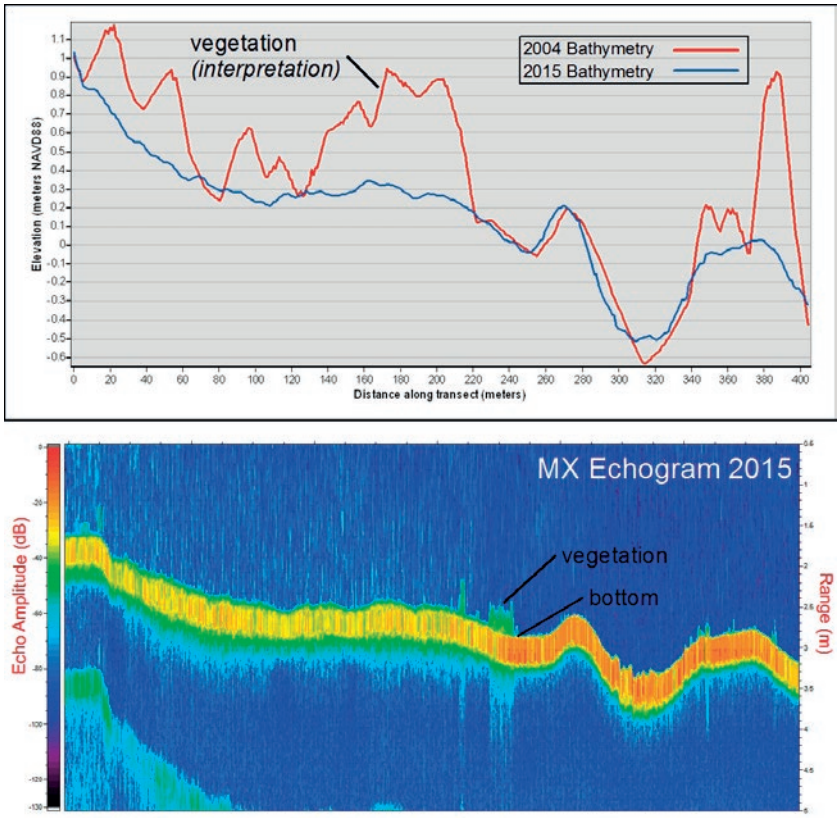
algorithm – matched to the vegetation type - is used to generate the plant canopy line. Substrate classification is based on a principal components analysis resulting in delineation of distinct substrate area based on the relative hardness or smoothness of lake bed.

The Visual Habitat results were exported in a format suitable for viewing in Google Earth to generate preliminary maps for quick assessment. Data were then exported in table format and loaded into QGIS, an open-source geographic information system (GIS). Corrections were then applied to each record based on timestamp to translate depth to NAVD88 while accounting for variation in the lake level. A triangulated irregular network (TIN model) was generated from the bathymetry data and converted to a raster grid. The result was a 2 metre resolution digital elevation model (DEM) which could be used to create a shaded bathymetric map and facilitate volumetric computations (Figure 3).



▲ *Figure 5: Comparison of 2004 & 2015 bathymetry along the transect drawn in Figure 4. Sharp relief in 2004 is interpreted to be an artifact of dense vegetation coverage at the time of survey. In contrast, the MX data file displayed in the bottom panel was used to identify vegetation and substrate type for the 2015 survey using BioSonics Visual Habitat software.*

Uncompromised Results

Results of the Capitol Lake survey were directly compared to the 2004 survey. Areas where submerged vegetation obscured the bottom were obvious when comparing the transect data and the DEMs from the two surveys (Figures 4 and 5). The echo sounder used in the 2004 study was limited to a serial data feed of digitised soundings only. Those soundings were post-processed (filtered) to remove plant artifacts, leaving high uncertainty in areas of dense vegetation. The raw acoustic data captured by the MX echo sounder was essential for determining an accurate depth in this setting, and distinguishing between plant canopy and the true bottom. It follows that comparing the plant data from the 2015 survey shows a similar pattern as the irregular contours from the 2004 survey. Results of the bottom-type analysis are presented along with bathymetry in Figure 3, and reveal a pattern that correlates with the general morphology of the former river channel and current lake basin. Sediment cores collected from the area in 2005 suggest that the patterns are likely driven by distinct spatial patterns in grain size.

Lessons Learned

Settings such as Capitol Lake demonstrate some of the advantages of utilising USVs for inland or nearshore applications. With the Z-Boat 1800MX as an example, a stable and reliable platform is key to transitioning from the test-tank to the real world. Commercial users of unmanned technology, such as NewFields, can easily add unmanned surveys as a versatile complement to existing client services. And with the growing market, more manufacturers are designing instruments with compact electronics and housings that are compatible with the power and size limitations of USVs, ROVs and AUVs. Building on the success of the Z-Boat 1800MX platform, BioSonics is currently working to integrate their split beam DT-X echo sounder into the Z-Boat for fish stock assessments in remote areas, and offer the MX system in a more compact geometry for ROV/AUV applications.

Acknowledgment

We would like to thank the USGS for assistance with planning and data requests, and the Washington Department of Enterprise Services for help in expediting survey approval. ◀

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Gold, Glory, and — HYDRO!

This month marks the 555th anniversary of the death of Prince Henry of Portugal, known as the Navigator, on 13 November 1460. Henry had set in motion a series of events that led to a new understanding of the earth, the discovery of the Americas, and on a darker note, the African slave trade. One month short of thirty-two years after his death, Christopher Columbus landed on a small island of the Bahamas.

Henry was driven 'To discover what lay beyond the Canaries and Cape Bojador; ...to fulfil the predictions of his horoscope, which bound him to engage in great and noble conquests and attempt the discovery of things that were hidden from other men; to find Guinea'. Underlying all of this was the zeal of a crusader motivated to find a sea route to the mythical east African kingdom of Prester John in order to regain the Holy Land for Christendom. If he profited from these endeavours, so much the better. To do this, Henry sent a series of exploratory cruises down the west coast of Africa and into the Atlantic. In doing so, he launched the First Great Age of Exploration as he urged his captains down the coast of Africa further and further into the unknown until Gil Eannes in 1434 rounded the geographic barrier of the mind known as Cape Bojador, the Legendary Gates of Hell. With the passing of Cape Bojador, the shackles of superstition that had held medieval man close to home were burst asunder and the European exploration of the world began in earnest.

Figure 1: Battista Agnese's 1543 map showing the first known sounding on a map (verbal, 11 brazas at the head of the Gulf of California at high tide) and an early indication of the Gulf Stream off NE North America.

Before Henry's death in 1460, Portuguese exploration extended down the coast of Africa and past Cape Verde. Portuguese navigators discovered many eastern Atlantic islands including the Azores, Madeira, and the Cape Verde Islands. The Canary Islands were known by the Greeks, Phoenicians, and Romans and had an indigenous population that Spain conquered in the 15th century. The Portuguese, besides extending their reach further down Africa, sent expeditions to the west as far as the eastern edge of the Sargasso Sea. In the course of these Atlantic expeditions, they made a great meteorological discovery, the "volta do mar" — the North Atlantic Gyre with winds circling the central northern basin of the Atlantic in a clockwise direction. It was these explorations that attracted the attention of other nations and helped Christopher Columbus convince King Philip of Spain that he could sail across the Atlantic to the East Indies on the southeast trade winds and return via the northern westerly winds to Europe.

Columbus as Hydrographer

The name Columbus is inextricably associated with the discovery of the Americas. The early hydrographic history of the Americas, and indeed all continents, is sketchy at best with a sounding recorded here, a sounding there; bottom characteristics noted occasionally; sailing directions and prominent features used in piloting chanced upon in journals and histories.

Fortunately, Columbus left a journal in which many hydrographic firsts in the New World were recorded. He was a skilful hydrographer, complementing his success as a pilot, navigator, and to some degree cartographer. To Columbus go many hydrographic accolades in the New World. His diaries contain a plethora of references to harbour descriptions, sailing directions, soundings, bottom characteristics, tidal observations and current observations. He also made geographic, meteorological, ethnographic and biological observations. Overall, he was a keen observer of the world around him, and, given the nature of his training and the tools available to him, his accomplishments were remarkable.

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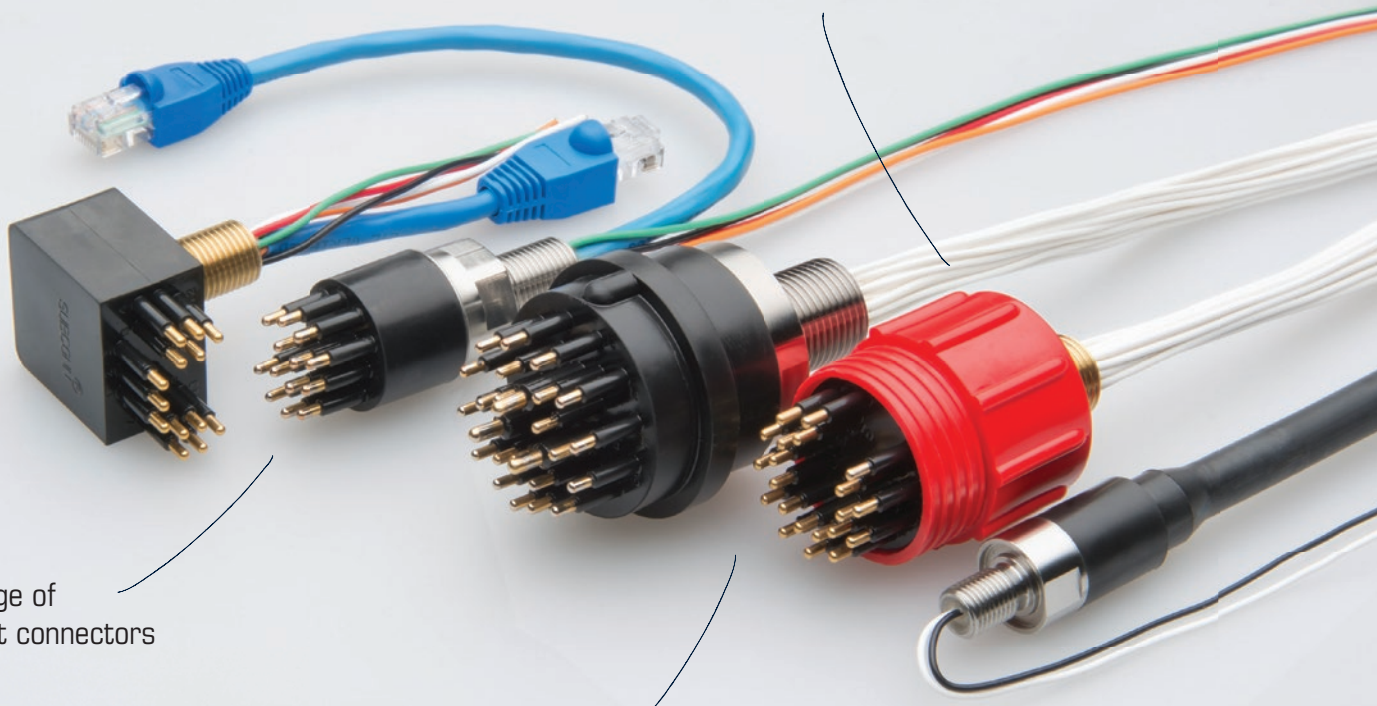

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▲ *Figure 2: Prince Henry of Portugal a.k.a. Henry the Navigator.*

▲ *Figure 3: Christopher Columbus*

▲ *Figure 4: Hernando Cortes.*

13 September 1492, a week's sail from the Canary Islands, Columbus noted that at sunset the 'needles of our compasses declined to the NW and in the morning they declined to the NE'. This was perhaps the first observation of the geographical variation of the magnetic compass. Four days later he entered the Sargasso Sea and noted (incorrectly) that the sea was less salty by half than it is in the Canary Islands. Like many mariners of the time, he believed that many types of birds indicated proximity to land. Accordingly, even in mid-Atlantic he often claimed proximity to land based on bird sightings.

On 19 September 1492, in Mid-Atlantic, he tied two deep-sea sounding lines together and sounded 200 fathoms into the weed choked Sargasso Sea. This was perhaps the first attempt to sound an oceanic basin. He didn't find bottom, but during this same sounding operation, Columbus noted that the current was setting to the southwest, placing him on the southeast edge of the North Atlantic Gyre. It is conjectured that he observed the angle of his sounding line as it was streaming out from the ship to deduce the current direction.

On 12 October, Columbus made landfall and named this island San Salvador. Some of the natives that he encountered had small gold nose rings causing Columbus to inquire as to its source. Always, even on other islands, it was always said to be further on. By 14 October, he was commenting on how easy it would be to enslave these native Americans. Also on the fourteenth he had observed that minimal tide existed in the lagoon inside the reef line as 'the sea in it moves no more than the water in a well'. The following day he observed a tidal current hindering his transit to the next island declaring 'the tide detained me' and then on the 16th he provided a bathymetric description of these steep-sided, narrow shelved islands: '...a couple of Lombard shots offshore [approximately 600 yards] there is so much depth that you cannot find bottom.' On the 17th, he conducted the equivalent of the first hydrographic survey in the New World after anchoring outside of a potential harbour: "It seemed reasonable to me to look it over well and take soundings, so I anchored outside and went in with the small boats. It was fortunate that I did, for there was no depth at all." Columbus was no desk hydrographer. He would clamber in the boats and direct the sounding operations.

He was a skilful hydrographer, complementing his success as a pilot, navigator, and to some degree cartographer.

Sunday, 28 October 1492, marks a milestone in the hydrography of the Americas. Columbus entered the present day Bahia Bariay, Cuba, and took the first recorded numerical sounding in the New World. His log reads "The mouth of the river I entered is 12 fathoms deep and quite wide enough to beat about in." He followed this event 2 days later with the first recorded latitude: "I took a reading with the quadrant and Rio de Mares (Bahia de Gibara) is 42 degrees north of the equator." The correct latitude was 21 degrees North. This error was perpetuated on various maps for at least the next 40 years. On 18 November at Puerto de Principe (Bahia Tanamo) he observed that, "The sea here rises and falls much more than in any harbour I have visited in this land..." He added to this observation that, "The tide is the reverse of ours [meaning at Palos, Spain]: when the moon is SW by south, it is low tide here..." Here he makes a landmark observation by inter-comparing states of tide on opposite sides of an ocean, an early precursor to the study and theory of tides in oceanic basins.

Columbus also made the first recorded sounding on the South American coast off modern day Venezuela of 2 fathoms on 10 August 1498; first recorded soundings on the North American continent off the coast of Honduras in August 1502; first observation of a probable Caribbean tsunami in the Gulf of

▲ *Figure 5: Painting by Pieter Breugel showing three 16th century ships on a stormy sea.*

▲ *Figure 6: The* Santa Maria*, flagship of Columbus, departing Palos, Spain, on 3 August 1492.*

Paria on 4 August 1498; and first theory of oceanic circulation suggesting that all waters follow the heavens from east to west. Quite a list of accomplishments for one man. Perhaps some of his theories were a little odd and did not stand the test of time but he showed himself to be a worthy First Hydrographer of the Americas. His perseverance, remarkable navigation, common sense in going ahead with the sounding boats to new harbours and anchorages, his skill with the lead, all show him to be a hydrographer of the first rank. (Fuson, Morison 1963, 1971, 1974, and 1983 were relied upon for information on Columbus. See Theberge, 1992, for Morison references.)

The Conquistadors

Although the Portuguese and Spanish maritime explorers all had to have knowledge of hydrography, some of the more interesting examples of hydrographic skills were shown by the overland explorers and conquistadors. Of those, the most talented was Hernando Cortes. Cortes combined the skills of warrior and diplomat with those of engineer, cartographer, and, on occasion, hydrographer. His 1524 map of the Gulf of Mexico is the first relatively accurate depiction of that body of water. In 1525, while on an expedition to coastal Mexico, he was confronted with an estuary that was gauged at 500 paces across. To turn back would have meant death while going ahead seemed impossible. "In a canoe with two Spanish sailors, Cortes sounded the whole bay and estuary, and everywhere they found four fathoms of water. They strung pikes together and sampled the bottom, which was covered with two more fathoms of mud and slime, making the total depth six fathoms…" Not to be daunted, Cortes directed the cutting of native timber and built a bridge across this expanse of water in six days.

Perhaps the most interesting sounding operation conducted by the conquistadors occurred in the Mississippi River near present day Ferriday, Louisiana, in early June, 1542. "Carrying with them a Biscayan called Ioanes de Abadia, who was a seaman and great engineer, they went out one afternoon to take some soundings. With all possible dissimulation, lest the Indians perceive what they were doing, they acted as if they were fishing and enjoying themselves in the water. Thus they found that the stream was 19 fathoms deep in the centre of its channel, and a quarter of a league wide; and with this discovery, they determined to bury the Governor within its depths" (Vega). Thus, the first soundings in the Mississippi were meant to determine the suitability of the river as a final resting place for its overland discoverer, Hernando de Soto.

By the time of de Soto's death, a new understanding of the world had been attained. The outline of the continents was progressing, new trade routes established, and the vast expanses of the newly discovered Pacific Ocean crossed and the earth circumnavigated. Using primitive navigational and hydrographic tools, the great explorers of the day had crossed unknown oceans, used the lead to feel their way down newly discovered coasts, and sketched the outlines of their discoveries. The year after de Soto died, the Venetian cartographer Battista Agnese placed a note indicating the depth of water at the mouth of the Colorado River in the Gulf of California. The note read: "Vermilion Sea in which there are eleven brazas in the channel at high water and more than eight at low water." This was the first mention of depth found on any chart or map, a first whisper leading to the modern nautical chart. ◀

More information

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Helzel Messtechnik

A **Wavelength Ahead** for 20 Years

Helzel Messtechnik GmbH celebrated its 20th anniversary on 16 October 2015 together with customers, friends and family at its headquarters in Kaltenkirchen, Germany. Helzel markets the WERA system, an oceanographic land-based over-the-horizon radar that provides real-time measurement of ocean surface currents, waves and wind over large distances. While buoys and ADCPs only provide point measurements, WERA information is available over the entire coverage area up to 300km offshore.

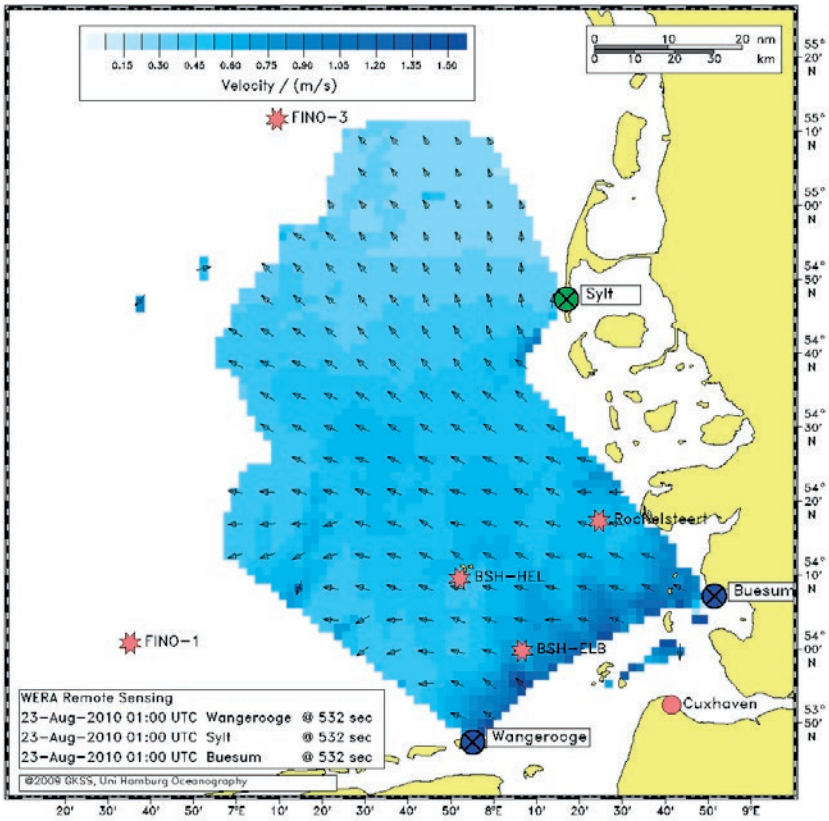
Founded in 1995 by Thomas Helzel and Matthias Kniephoff, the company began with the development and production of intelligent industrial electronics, manufactured signal generators, synthesizers and high-frequency amplifiers before entering the oceanographic and environmental measurement market in 1999.

In the year 2000, the first commercial WERA system – originally developed at the Institute of Oceanography at the University of Hamburg – was delivered to the University of Hawaii. The WERA systems are currently available with compact antenna versions for simple applications or as high precision systems with 8 to 16 antennas arranged as linear array. "These high end systems are the main business area of Helzel Messtechnik" Thomas Helzel explains. "With this technique it is possible to provide quality flags for each data point, and there are thousands of data cells within the monitored area. These qualified data are perfect for professional applications such as harbour management, search and rescue operations or disaster warning. Furthermore, these data can be used for data assimilation into hydrodynamic models to improve the reliability of met-ocean forecasting."

▲ *Figure 1: The Helzel team.*

Global References

Due to the high quality of the measured data, WERA enjoys an excellent international reputation. As a result, it has been installed in more than 30 countries worldwide. The interesting fields of application of WERA vary from the monitoring of currents and waves in shipping channels, environmental monitoring (e. g. oil spill drift prediction), to the improvement of search and rescue operations, planning support for offshore industries, ship-detection, and as a component for Tsunami Early Warning systems. For this last mentioned application, the Sultanate of Oman has chosen ten WERA systems for the main part of their National Multi-Hazard Early Warning Center (NMHEWC). The monitoring of MetOcean data in shipping channels is the focus for Rijkswaterstaat (RWS) in the Netherlands and the Helmholtz Center for Material and Coastal Research (HZG) in Germany. RWS operates two systems in the Maasmond area at the Port of Rotterdam. HZG operates three WERA systems on the islands of Sylt, Wangerooge and in Büsum. The oceanographic data for the German Bight has been implemented in the COSYNA network and finds its way to the different users.



▲ *Figure 2: Current map created using the WERA System.*

More information
www.helzel.com

Development, production and international sales of these products are centred in Kaltenkirchen. The company is a member of the Maritime Cluster North Germany, which supports the innovative development group of Helzel and, in particular, international marketing.

Company founder, Thomas Helzel says "we appreciate the high commitment of our team, which made it possible to manage the very complex projects and installations over the past 20 years. We now actually need to strengthen our team and will recruit another motivated software engineer who is capable of supporting customers, and in addition loves to work on hardware-oriented tasks and will support our team on their installations abroad." Young, committed engineers can grow within Helzel Messtechnik, as shown by the career of Leif Petersen who joined the board of directors at the end of 2014, after having been employed for 10 years.

Approaching Tsunami in Deep Water

Dr. Anna Dzvonkovskaya from the Technical University of Hamburg and an expert in Tsunami and Ship Detection/Tracking joined the Helzel team, along with Marek Swirgon, oceanographer from the University of Szczecin in 2014. The ongoing research in the field of Tsunami detection actually concentrates on a test system installed on the west coast of Canada by Ocean Network Canada 'ONC'. This research project has its focus on the timely detection of near-field Tsunamis as such events are most critical with regard to pre-warning time. The latest results with optimised WERA signal processing has shown that such an ocean radar can already detect an approaching Tsunami in deep water (>1,000m). This is a big step forward in improving Tsunami Early Warning and, in particular, in reducing the false alarm rate. The company has built a worldwide international partner and support network over the past 20 years, which is continuously growing. Starting in 2016, the Latin American market will be supported by INESI, a company founded by Roberto Gomez, a former team member and WERA software expert from Mexico. This is an important step in accessing the growing Latin American market.
The 20th anniversary party was the icing on the cake of this year's WERA Operators Seminar. The Seminar is held every year in Kaltenkirchen to train international sales partners and customers. This year, it was again a colourful mix of visitors from Germany and overseas, which will contribute to the company's continued success.

▲ *Figure 3: Aerial image of the Helzel office.*

Data Sharing Essential for EMODnet Development

The EMODnet Open Conference took place in Ostend, Belgium on 20 October 2015 and aimed to connect the 350 users, data providers, politicians, industry members and other stakeholders from Europe. The delegates received an update of the project from various angles and were able to see what has been achieved over the past years. The speakers emphasised the importance of sharing data and insights to increase the quality of the EMODnet offerings, thus contributing to the blue economy.

In his opening address, Belgian Secretary of State for the Sea, Bart Tommelein, emphasised the importance of the blue economy as he expected growth. He mentioned that 90% of all raw materials and end products are at some stage carried over sea. He anticipates opportunities if local governments make local data accessible and available to citizens to add to them. Open marine data can the industry money, and so release funds for research and to create jobs, he added.

Data Open for Public Domain

João Ferreira, Member of European Parliament, gave an insight into the discussions in Brussels, where the aim is also to increase the potential of the blue economy through availability of data and research. Data should be open for the public domain as a general rule, he emphasised. He saw the lack of skilled workers at all levels as a challenge and a hurdle for the blue economy in achieving its goal.

Matthew King of DG Mare saw the blue economy as a hidden gem. It is possible to have an interesting career at sea, and research is the cornerstone of the blue economy and a key to marine resources. Open data like those in EMODnet are important. He mentioned that there are also big projects in China and the USA to develop coastal areas and their economy. He was keen to find out how EMODnet's visibility could grow and how it could improve itself for the users.

Integration in Global Data Programmes

IOC Secretary General Vladimir Ryabinin took a global perspective of the data and demonstrated the uses of global data aggregators for science and research. It was obvious that EMODnet fits in and he stressed the importance of these sources working together to make all the data accessible.

Updates on various EMODnet projects followed these keynote speakers, demonstrating integration of bathymetry data into GEBCO - various sources of data that can be integrated for habitat data mapping and how the data quality could be checked and monitored – to name but a few applications. In addition, the human interpretation and derivatives of the data is a relatively new activity that has already been able to show interesting products.

Building on the Foundation

Discussions on how EMODnet could be further improved took place in the afternoon. The sessions were interactive and aimed to generate useful and practical solutions to build on in the near future.

This one-day conference was a part of a week-long event dedicated to discussions and meetings for special interest groups. The message was clear: the funding of EMODnet should ensure the continuation and extension of the basis that has been laid – and all organisations and businesses collecting data are encouraged to contribute to the dataset.

Figure 1: The plenary session. Image courtesy: Dirk Leemans, VLIZ.

Figure 2: Lively interaction during the workshops in the afternoon. Image courtesy: Dirk Leemans, VLIZ.

Cooperation with Regional Agent during International Trade Show

Oceanology International **China** 2015

A very fruitful exhibition, but above all an interesting experience. That's how Radac BV's marketing manager Katja Roose would typify Oceanology International, which was held in China for the third time in a row. Radac – established in the Netherlands –had already been represented through their agent Laurel Technologies in earlier editions but had now also sent company representatives.

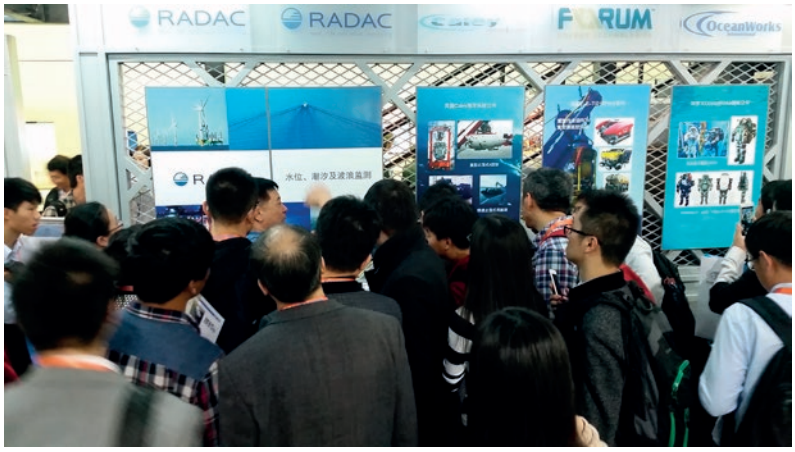


Figure 1: Crowds gathered in the booths during presentations to obtain information.

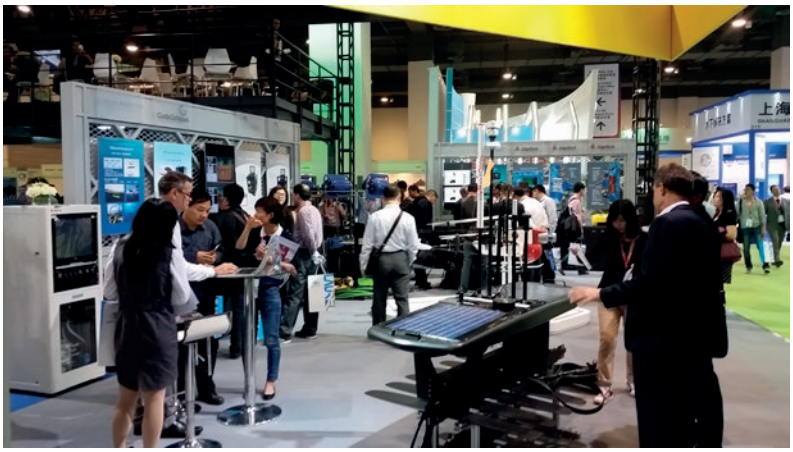


Figure 2: Overview of the show floor: international companies were well represented.

The Chinese marine industry is big, like most markets in China actually. China's gross marine production increased by 7,6% in 2013 over the previous year, according to the 2013 Statistic Bulletin of China's Marine Economy by State Oceanic Administration People's Republic of China. As for Radac, an important part of their turnover is achieved in China, and shows great potential for growth. But the differences in culture and way of working are great. And then we are not even talking about the language… so having a representative in China is key.

With their two-floor booth (proudly announced to be the biggest at the exhibition) they are an important player in the Chinese marine market. For Radac, having just attended Offshore Energy in Amsterdam, the differences with this exhibition were striking. In China, they were empowering Laurel in their work. As most of the show visitors are from China and do not (dare to) speak English, the company representation was of little direct use on the show floor. However, face-to-face contact is of great importance for building your relationship, with both distributor and end-customers. And just being there means people will respect and trust your brand, which are the basics of doing business in China.

Presentations and demonstrations attracted much attention. It was easy to gather a group of more than 20 people at the booth by presenting products in detail, showing graphs and explaining measurement principles. Research results are of great interest to the mainly well-informed visitors, who are very eager to learn and love to gather brochures – of course in Chinese.

The opening day was by far the busiest. Especially in the morning, visitors were queuing up to enter CECIS, the new exhibition centre in Shanghai where OI2015 took place. Over 200 suppliers from 20 countries and regions were represented and over 5,000 visitors were expected. Final visitor figures were not yet available at the time of printing. The background of the visitors was diverse, ranging from marine science to oil & gas, and from defence & security to aquaculture. The second day was also well visited. The attendance rate on the closing day was lower, likely to be related to Chinese traditions during diner. Many exhibitors invited their customers and relations for a Chinese diner on the last evening, an important part of their culture. Emptying your glass after one of the many toasts shows respect. But it has its effect on the next day…

Hydrographic Society Benelux

GNSS PPP-RTK Workshop

Hosted by the Offshore and Energy Exhibition at the Amsterdam RAI Conference Centre, the Hydrographic Society Benelux presented the GNSS PPP-RTK workshop in the parallel programme on 14 October 2015. Global Precise Point Positioning (PPP) at decimetre level has been possible for the last 10 years. In the last year real-time kinematic (RTK) techniques using fixing of ambiguities have become possible. This allows centimetre level accuracy on a global scale. During the workshop main service suppliers in the market and uses of PPP-RTK in offshore applications were highlighted as were general techniques. The event was attended by over 100 delegates who were also able to visit the show floor. Four presentations were made. Pieter Toor (GNSS Technology manager at Veripos) presented Enabling RTK-like positioning offshore using the global VERIPOS GNSS network. He was followed by Matthew Goode (geodesist, Fugro-Intersite) on G2+ worldwide positioning services. After a coffee break, Marco Kwanten (project surveyor at Allseas) explained aspects of Positioning the *Solitaire* – the largest pipelaying vessel of the company and gave an insight into the challenges this brings. The last speaker of the afternoon was Wim Kanneworff (chief surveyor Project Gemini, Van Oord Offshore Wind Projects bv). He gave a presentation on Gemini – Wind farm positioning beyond the horizon.

Gravity Expedition at Sea Symposium

The Hydrographic Society Benelux cooperated with the Gravity Expedition at Sea symposium that took place on 11 November 2015 in the Science Centre of the Technical University in Delft. This concluded a project by Delft University of Technology that focused on that subject. The symposium highlighted aspects of geodetic and geophysical science, particularly on Prof Vening Meinesz and the cooperation with the Netherlands Royal Navy. He went on a voyage with a submarine, the *K XVIII*, to conduct subsea gravity measurements in order to map anomalies on the seafloor.

Several speakers gave a presentation on the Beagle cruise that followed the itinerary the voyage Vening Meinesz undertook but in the opposite direction; this included details on the submarine, how to make technical science accessible for a wide audience, historical mechanical clocks, the heritage of Vening Meinesz' work, the cooperation between the Royal Navy and science, and the search for the lost submarine *O13*.

After the presentations in the beautiful Mekel room, there was an opportunity to see a range of vintage measuring devices including the gravity machine Vening Meinesz used, chronographs and a model of the submarine *K XVIII*.

Figure 1: Presentations highlighted aspects of gravity and time measurement. Rogier Broekman talks about the cooperation between the Navy and science.

Figure 2: Impressive vintage measurement devices were exhibited.

Figure 3: A model of the K XVIII *Submarine.*

JANUARY 2016

HYPACK 2016
Tampa, USA
→ 4-7 January
www.hypack.com

Least Squares Adjustment for Offshore Survey
Newcastle, UK
→ 18-20 January
www.ncl.ac.uk/cegs.cpd/cpd/lsadjust.php

EERA DeepWind 2016
Trondheim, Norway
→ 20-22 January
www.sintef.no/projectweb/deepwind_2016/

FEBRUARY

TUSExpo 2016
The Hague, The Netherlands
→ 2-4 February
tusexpo.com

Underwater Intervention
New Orleans, USA
→ 23-25 February
www.underwaterintervention.com

International Conference on Ocean Energy (ICOE)
Edinburgh, UK
→ 23-26 February
http://bit.ly/ICOE2016

MARCH

57th Marine Measurement Forum
Wallingford, UK
→ 3 March
www.mmf-uk.org

International Geomatics Congress
Havana, Cuba
→ 14-18 March
www.informaticahabana.cu/es/eventos/show/91

Oceanology International
London, UK
→ 15-17 March
www.oceanologyinternational.com

APRIL

MARID V
North Wales, UK
→ 4-6 April
maridv.bangor.ac.uk

Oceans '16 MTS/IEEE Shanghai
Shanghai, China
→ 10-13 April
oceans16mtsieeeshanghai.org

MAY

All-Energy
Glasgow, UK
→ 4-5 May
www.all-energy.co.uk

International Conference on Coastal Zone Management
Osaka, Japan
→ 16-18 May
coastalzonemanagement.conferenceseries.com

Canadian Hydrographic Conference (CHC)
Halifax, Canada
→ 16-19 May
www.chc2016.ca

OCTOBER

Offshore Energy
Amsterdam, The Netherlands
→ 25-26 October
www.offshore-energy.biz

FEBRUARY 2017

Oceanology North America 2017
San Diego, USA
→ 14-16 February
www.oceanologyinternational-northamerica.com/

APRIL

Ocean Business
Southampton, UK
→ 4-6 April
www.oceanbusiness.com

XIXth International Hydrographic Conference
Monaco
→ 24-28 April
www.iho.int

Calendar Notices
For more events and additional information on the shows mentioned on this page, see www.hydro-international.com. Please send notices at least 3 months before the event date to: Trea Fledderus, marketing assistant, email: trea.fledderus@geomares.nl.

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