

Hydro

INTERNATIONAL

Business Guide 2022

MARKET ANALYSIS | COMPANY PROFILES | INDUSTRY INSIGHTS | PRODUCT HIGHLIGHTS



Report: Hydrographic Industry Survey 2022

Q&A Round-table: Experts Share Their Thoughts

The Challenging Search for Hydrography Professionals

Greener, Faster, Safer.

Able to conduct both remote-controlled and supervised autonomous operations the DrIX USV offers outstanding seakeeping and speed capabilities. It is a versatile and efficient USV that can host a wide range of payloads and that offers optimum conditions for high quality data acquisition in both shallow and deep waters.





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



Geomares
 P.O. Box 112, 8530 AC Lemmer, The Netherlands
 Phone: +31 (0) 514 56 18 54
 E-mail: info@geomares.nl
 Website: www.geomares-marketing.com

No material may be reproduced in whole or in part without written permission from Geomares. Copyright © 2021, Geomares, The Netherlands. All rights reserved. ISSN 1385-4569

Director Strategy & Business Development: Durk Haarsma
Financial Director: Meine van der Bijl
Editorial Board: Huibert-Jan Lekkerkerk, Mark Pronk, BSc, Marek Smit, Auke van der Werf
Content Manager: Wim van Wegen
Copy Editors: Serena Lyon and Claire Koers
Business Development Manager: Jurjen Visser
Account Manager: Myrthe van der Schuit
Circulation Manager: Adrian Holland
Design: ZeeDesign, Witmarsum, www.zeedesign.nl

Advertisements
 Information about advertising and deadlines are available in the Media Planner. For more information please contact our account manager: myrthe.van.der.schuit@geomares.nl or go to www.geomares-marketing.com.

Subscription
 Hydro International is available on a subscription basis. You can subscribe at any time via <https://www.hydro-international.com/subscribe>. Subscriptions will be automatically renewed upon expiry, unless Geomares receives written notification of cancellation at least 60 days before the expiry date.

Editorial Contributions
 All material submitted to the publisher (Geomares) and relating to Hydro International will be treated as unconditionally assigned for publication under copyright subject to the Editor's unrestricted right to edit and offer editorial comment. Geomares assumes no responsibility for unsolicited material or for the accuracy of information thus received. In addition, Geomares assumes no obligation for return postage of material if not explicitly requested. Contributions must be sent to the content manager wim.van.wegen@geomares.nl.

P. 10 Hydrography: Growth Prospects on the Horizon

Every year, *Hydro International* conducts a survey to gather the latest insights into the status of the hydrographic industry. Based on the contributions of 500 respondents, this article represents an attempt to identify the most interesting trends, developments and views on the sector for the years ahead.



P. 15 More Training, Please!

Looking at the current hydrographic market, an interesting aspect is the continuous search for hydrographic personnel. However, while quite a few of the current hydrographic surveyors obtained their training in the field, this is becoming increasingly difficult; not only due to the increasing complexity of surveying systems, but also because clients require hydrographic surveyors to be certified.



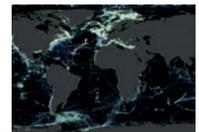
P. 18 Empowering Women in Hydrography

Workplaces that foster equity, diversity and inclusion are not simply 'doing the right thing': they also benefit from the ensuing diversity of perspectives, and increase their talent pool and economic productivity. Achieving meaningful transformation, however, requires employers and policy makers to address barriers and to commit to making the cultural and structural changes necessary at all levels to build more inclusive workplaces.



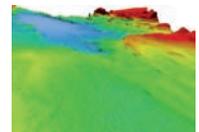
P. 21 The Evolution of Capturing the Seabed

Over the last few centuries, mapping the ocean seabed has formed a major challenge for marine geoscientists. Ocean bathymetric charts and submarine geomorphology have significantly impacted our understanding of our planet, from plate tectonics to deep-sea ecosystems.



P. 29 Surveying Lake Superior the Uncrewed Way

Two Uncrewed Surface Vessels (USVs), remotely controlled via satellite, conducted pioneering survey work on Lake Superior for the Canadian Hydrographic Service (CHS) in partnership with IIC Technologies. The project marks the first time that USV technology has been used to gather bathymetry data in inland waters in Canada.



P. 45 Hydrographic Experts Share Their Thoughts

Hydro International invited various leading experts with different professional backgrounds to share their thoughts on the present and future of the hydrographic industry. This series of Q&As captures the state of the sector from a variety of perspectives, such as which technological and societal developments will have the most impact on the hydrographers of today and tomorrow.



P. 5 Editorial

P. 7 Product Highlights

P. 32 Munitions and Wrecks in the North Sea

P. 36 Company Profiles

Cover Story

The energy transition will require a lot more survey activities, in particular for offshore wind farms. Pictured here is the *Patriot*, one of the advanced survey vessels of Braveheart Marine – an international survey company based in Urk, The Netherlands, with geophysical survey work in the offshore wind industry as one of their specialities. (Courtesy: Braveheart Marine)



THE FUTURE OF FIBER OPTIC GYROSCOPES

BOREAS - GNSS / INS

-  0.005 ° Roll & Pitch
-  0.006 ° GNSS Heading
-  0.01 ° Gyrocompass Heading
-  0.001 ° /hr Gyroscope



BOREAS

THE WORLD'S 1st FULLY DIGITAL FOG

Boreas takes FOG technology to the next level with new patent pending digital FOG (DFOG) technology. The revolutionary DFOG technology combines a specially designed closed-loop optical coil with advanced digital signal techniques that have been developed over the last 25 years. This ground-breaking gyroscope combined with our AI-based algorithm provides unparalleled performance and reliability, with the lowest SWaP-C (Size, Weight, Power and Cost) on the market.



**ADVANCED
NAVIGATION**

Increase the attractiveness of hydrography

Beyond the pandemic that is economically ravaging small- and medium-sized companies and households and personally impacting the lives of many people – young and old – all over the world, there’s another disaster on the horizon: global warming. In many areas of the world, global warming is already having an impact – droughts and heatwaves, tornados and floods and failed harvests – impoverishing many. The energy transition, meant to limit or even reverse the effects of global warming, are having their effects as well: surging energy prices that impact the price we pay for heating our homes or driving our cars, but also visual effects such as changes to the landscape through large solar farms and wind parks. Onshore wind parks in particular are often met with a lot of resistance. I don’t want to go into the NIMBY syndrome here, but it often seems quite hard for people to see the good for the long term instead of the bad for the short term. Nevertheless, developing wind parks offshore always seems a good idea, and the same goes for new tidal and wave energy farms.

In this Business Guide, we summarize the outcomes of our yearly Readers Survey for you (see page 10). Editor Wim van Wegen dived deep into the answers returned by more than 500 (!) readers of *Hydro International*. It was a pleasant surprise to see that this year’s outcome is that 82% of the respondents expect growth for 2022 (compared to 63% in 2021). 80% also see better prospects for 2022 (of which 28% much better prospects). So, despite the two disasters currently facing mankind, optimism is still very much part of the hydrographic business. Of course, part of this optimism is due to all the projects underway, including the offshore wind parks I mentioned earlier to limit global warming. The energy transition will require a lot more survey activities in the years to come.

Respondents to the *Hydro International* survey acknowledged that the boom in renewable energy – wind, tidal and wave – is indeed the driver behind the growing need for hydrographic surveyors. There’s one ongoing concern we have to touch upon here as well: the lack of skilled personnel. That lack, which has been worrying respondents to our surveys for a few years now, is still a main point that needs addressing. The difficulty however is who to address: education is fragmented and the shortage is not felt the same everywhere. Still, let me make a heartfelt call to all decision-makers and policymakers in education, the private sector, governments and beyond: put your heads together and come up with a strategy to increase the attractiveness of aspiring to a career in hydrography. If not, the optimism about growth could turn into pessimism because the sector is simply not able to deliver!

Let me end by wishing you lots of pleasure reading up on everything that we have brought together in this last issue of this year: the Business Guide. We’ll see you in the New Year!



▲ Durk Haarsma.

*Durk Haarsma,
director strategy & business
development*

✉ durk.haarsma@geomares.nl

ADVERTISERS (AND COMPANY PROFILE)

Advanced Navigation	4 (35)	Hypack	22 (38)	RIEGL	20 (40)
Airmar	17 (35)	Innomar	24 (38)	Saab Seaeey	25
AML Oceanographic	35	iXblue	2 (38)	SBG Systems	28 (41)
Applanix	24 (36)	Klein Marine	42 (38)	Seabed	28 (41)
Aquatic Drones	36	Kongsberg Marine	51 (39)	Seafloor System	20 (41)
Baywei	36	Leica Geosystems/Hexagon	14 (39)	Sensor Technology	(43) 46
Blueprint Subsea	33 (36)	MacArtney	8 (39)	Subsea Europe Services	43
CHC	22 (37)	Norbit	26, 27 (40)	Teledyne CARIS	6 (43)
EdgeTech	37	PyroScience	40	Valeport	14 (43)
EvoLogics	52 (37)	RBR	40		

Geo-matching

Your Product Platform for
Surveying, Positioning and
Machine Guidance

✓ Search and compare
✓ Get insights
✓ Connect

www.geo-matching.com

Teledyne Geospatial
Imaging Solutions for Land and Water



LEGEND HAS IT THAT WHEN THE SUN SETS
AT SEA CLOSE TO THE EQUATOR, IT CREATES
A POWERFUL GREEN FLASH.



CZMIL SUPERNOVA

CZMIL SuperNova comes equipped with the most powerful green laser on the market. When in use, it's powerful green flash is legendary.

CZMIL SuperNova has the best penetration in turbid waters with exceptional performance in coral reefs, inland waterways, beaches and deep water marine. A complete geospatial solution, SuperNova is powered by CARIS processing and sensor fusion software.



FOR MORE INFORMATION:

www.teledyneoptech.com/czmil-supernova



© 2021 Teledyne Optech and Teledyne CARIS, are both Teledyne Technologies companies. All rights reserved. Specifications are subject to change.

The Smart Choice for Hydrographic Surveys

AIRMAR®



Airmar's ultrasonic EchoRange 200kHz Smart Sensors deliver depth and water temperature data to any NMEA device for instant display. Real-time NMEA 0183 data is transferred to a computer via the RS-422 standard. With embedded transceivers and sophisticated digital signal

processing, EchoRange sensors are ideal for applications such as mobile or fixed hydrographic surveys and bridge inspection from 0.4m to 200m.

Our next-level EchoRange+ Dual-frequency Smart Sensor with Echo Envelope Option is a 900-point time series of the echo amplitude that enables user-defined depth range and echo waveform for bottom detection. By analysing the shape of the echo envelope, information indicative of the seafloor type is revealed.

EdgeTech Introduces New Nadir Gap-fill Sonar for the 2205 AUV, ROV and USV-based Sonar Solutions



EdgeTech, the leader in high-resolution sonar imaging systems and underwater technology, has recently introduced

an innovative and new method to provide nadir gap coverage on the EdgeTech 2205 sonar platforms. Complementing this new technology is SonarWiz from Chesapeake Technology, providing a software solution to support processing and mosaicking the new gap-fill solution.

The 2205 system with gap-fill technology is designed specifically for hosted platforms operating in shallow water or within close proximity to the bottom. The sonar is ideal for Unmanned Surface Vehicles (USV) and Unmanned Underwater Vehicles (UUV/ AUV). The new 2205 system is available in a number of dual and tri-frequency configurations and the gap-fill technology is available in a number of frequency options. The most popular frequency set, the 850kHz and 1,600kHz dual frequency combination, is ideal for high-resolution sidescan sonar surveys where the nadir gap can now be filled with data while the vehicle performs single pass survey operations.

For more information, please visit: www.edgetech.com (and www.chesapeakeotech.com)

Klein 4K-SVY



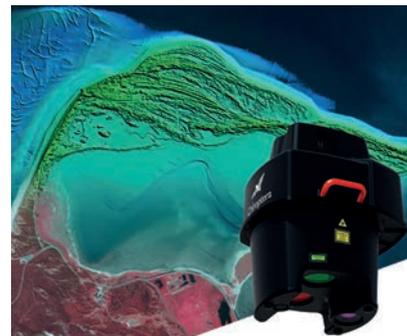
The KLEIN 4K-SVY is the first in a new series of professional survey sidescan sonars that is designed specifically to meet new industry standards for offshore renewable energy and oil & gas survey operations.

The survey and high-definition simultaneous modes of operation provide optimized range and resolution-dependent configurations, while Tru-Bottom tracking reduces data processing overheads with a dedicated altimeter for optimized bottom tracking.

Klein's innovative blue technology transducers and advanced processing algorithms produce unmatched image quality and range performance.

KleinSales@MIND-Technology.com

Highly Efficient Coastal and River Surveys



The Leica Chiroptera 4X bathymetric and topographic Lidar sensor provides seamless data from seabed to land and addresses the growing need to accurately map shallow water regions. The system's unrivalled water depth penetration down to 25m even in turbid water detects objects in detail and

offers a productivity gain of >50%. The cost-effective and innovative sensor provides intelligent data and seabed classification for coastal and river surveys, charting and environmental monitoring.

NEXUS 8: the future, now



MacArtny adds the NEXUS 8 to the tried and trusted NEXUS multiplexer family. This new, future-proof model with a 6,000m depth rating is smaller and lighter than its predecessor and

specifically designed for environments where space and agility are premium. The NEXUS 8 is a multiplexer capable of multibeam sonar, gigabit ethernet, HD video and additional sensors carried over one single-mode optical fibre via CWDM (Coarse Wavelength Division Multiplexing). Also included are programmable eFuses for dynamic performance.

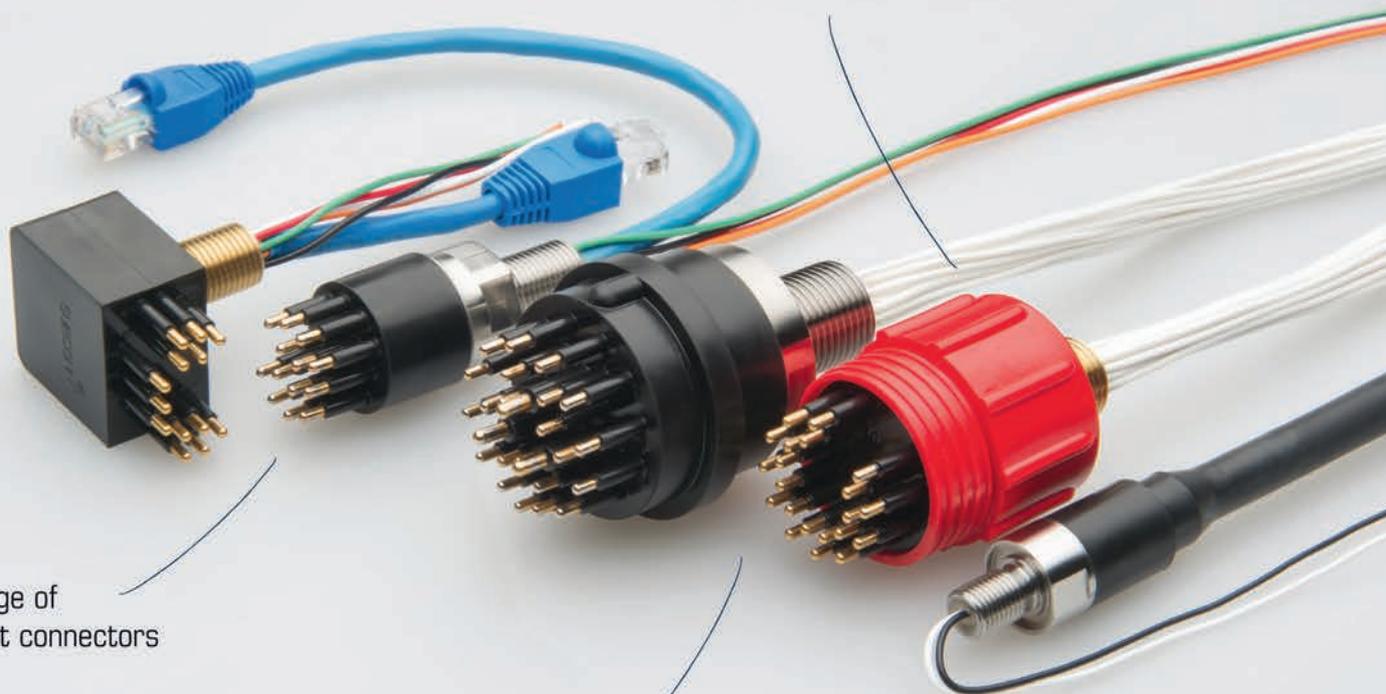
NEXUS 8 meets the market's demands for technology and data acquisition now and in the future. Advanced, compact and versatile.

Website: www.macartney.com



Wet-mate connectors

Recognised throughout
the industry



Full range of
Ethernet connectors

More than 40 years
proven track record

Available worldwide

Denmark | Norway | Sweden | Finland | United Kingdom
Netherlands | Germany | Poland | France | Spain | Portugal
Italy | UAE | Israel | Turkey | South Africa | USA | Canada | Mexico
Colombia | Chile | Brazil | Singapore | China | India | Pakistan
Russia | Belarus | South Korea | Japan | Taiwan | Australia



RIEGL Airborne Lidar for Transition Zone Surveying

With advancing global warming, the ongoing monitoring of terrain changes in transition zones along coasts and rivers is a must. RIEGL's fully integrated airborne laser scanning systems VQ-880-G II and VQ-880-GH are ideally suited to providing high-resolution topographic and bathymetric data for acquiring base data to protect natural habitats, settlements and infrastructure. The systems carry out laser range measurements of underwater topography providing water penetration of 1.5 Secchi depths. Topography above and below the water is captured at up to 279,000 meas./sec., and high-accuracy ranging is based on echo digitization and online waveform processing with multiple-target capability.



Integrated Solutions to Drive Autonomous Surveys

Developed by Hamburg-based hydroacoustic technology specialists Subsea Europe Services, the integrated Hydrographic Survey System (iHSS) is an easy to configure, deploy and operate system for high-quality multibeam data acquisition. The system is one of the building blocks of new total survey solutions that harmonize sensors, systems, platforms and expert support into a single turnkey delivery. Possible through close collaboration with technology, USV and AUV partners, Subsea Europe Services' innovative approach to combining technology and unmanned vessels is driving the industry towards more autonomous, cost-effective and environmentally friendly marine surveying.



A Robust USV for Challenging Environments

The HydroCat-180 is Seafloor's largest USV to date, and is capable of transiting from inshore to nearshore environments while carrying high-resolution payloads. The vessel has a 5.5m (18ft) footprint with individually articulating hulls, a self-stabilizing deck and dual-actuated electric motors to ensure precise navigation in rough waters. The vessel also boasts a retractable multibeam sonar mount, SVP winch and aerial drone landing pad. Similar to our other models, the onboard AutoNav allows operators to programme predetermined survey routes for heightened accuracy when collecting data. The HydroCat-180 is the most versatile unmanned survey vessel to come out of Seafloor's production facility. Confidently gather precision data and boldly go where few USVs have gone before with this big cat.



Next-generation Profiler Combines Measured CTD with Turbidity

Designed with the intention of a seamless workflow, the new SWiFT CTDplus Turbidity is the latest addition to Valeport's range of SWiFT profilers and delivers enhanced accuracy and versatility for those requiring precise CTD data combined with turbidity observations.

This is the first time that measured CTD and turbidity data has been available with all the benefits of the SWiFT profiler; ease of use, Bluetooth wireless technology, a rechargeable battery and an integral GPS to geo-locate each profile. The new SWiFT CTDplus Turbidity uses survey-grade sensor technology to deliver the highest quality CTD profiles in a compact, robust and portable package.



An analysis of the key findings of the annual industry survey

Hydrography: Growth Prospects on the Horizon

Every year, *Hydro International* conducts a survey to gather the latest insights into the status of the hydrographic industry. Based on the contributions of 500 respondents, this article represents an attempt to identify the most interesting trends, developments and views on the sector for the years ahead. To summarize the outcome in a single sentence: the shift towards an economy based on renewable energy and growing efforts to enhance nautical charting are two driving forces behind a business that will increasingly turn to autonomous, uncrewed surveying methods – with the lack of skilled personnel as the main constraint.

COVID-19 LEAVES ITS MARK

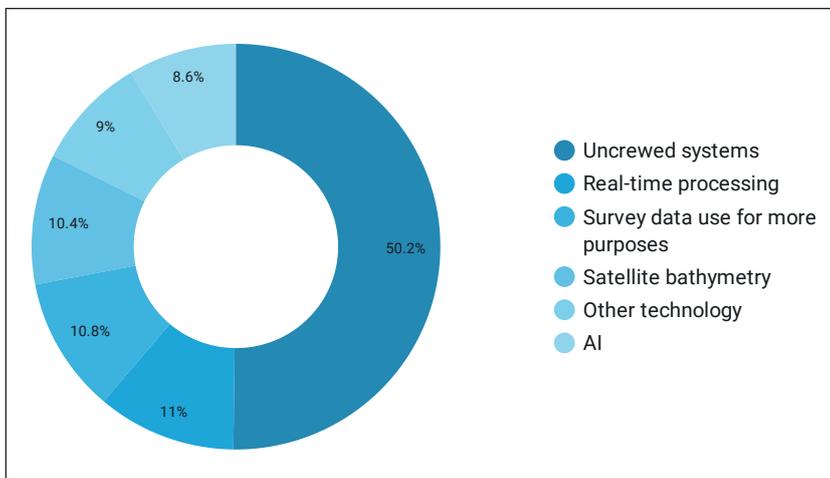
We had hoped not to have to mention the COVID-19 pandemic again when writing our report on the outcome of our annual hydrographic industry survey. However, unless we bury our head in the sand, there is no escaping having to take a closer look at how the coronavirus crisis is affecting our businesses. To get a good picture of how the ongoing pandemic is impacting our profession, we had no choice but to repeat last year’s question on the effects that the pandemic is having. The trend shows a stable pattern as this question was answered in almost exactly the same way as a year ago:

14.7% of the survey participants rated the impact as very negative, 41.3% as somewhat negative, 30.4% experienced no impact, and about 13.5% even experienced a positive impact.

In answer to the question: “Which effects of the COVID-19 pandemic have had the biggest impact on your business?”, travel restrictions posed a serious hindrance and frustrated many plans, with a score of 57.6%. The main obstacle was national lockdowns for 18.2% of respondents, and cancellation of trade shows and other events for 7.1%. The pain of travel

restrictions was clearly felt, especially when it came to performing work and being unable to visit trade fairs and other events.

Some interesting findings on how COVID-19 is impacting our industry include: shifting of scheduled activities over time, contract cancellations and postponement of work, closing of schools and fewer students in a class, personnel quarantine requirements that are not covered by contract holders and, last but not least, the semiconductor shortage. As the pandemic had a serious impact on the semiconductor industry – with major disruptions to global supply chains – this has not been without consequences for manufacturers of high-end survey instruments and solutions, and therefore has also affected companies such as hydrographic service providers.



▲ Looking at hydrography as a whole, which technological development do you expect to be the main driver in the coming years?

WORLD ECONOMIC OUTLOOK

It is impossible to consider the status of the global economy separately from the coronavirus as, in most parts of the world, countries are combatting the pandemic not only for the sake of public health but also to keep the economy running. Lockdown measures – sometimes very strict – have led to an economic downturn or even standstill. Government interventions such as large-scale financial aid programmes have proved vital for many companies, and have also played a role in keeping many hydrographic businesses on track.

In October 2021, the International Monetary Fund (IMF) reported that the global economy is projected to grow by 4.9% in 2022: “The global economic recovery is continuing, even as the pandemic resurges. The fault lines opened up by COVID-19 are looking more persistent – near-term divergences are expected to leave lasting imprints on medium-term performance. Vaccine access and early policy support are the principal drivers of the gaps.”

Another phenomenon that should be taken into account is the prospect of inflation. According to the IMF, however: “Despite recent increases in headline inflation in both advanced and emerging market economies, long-term inflation expectations remain anchored.” Although headline inflation plummeted during the last couple of months of 2021, as predicted, it is projected to return to pre-pandemic levels by mid-2022 for most economies, reports the IMF.

THE MOOD IN THE HYDROGRAPHY SECTOR

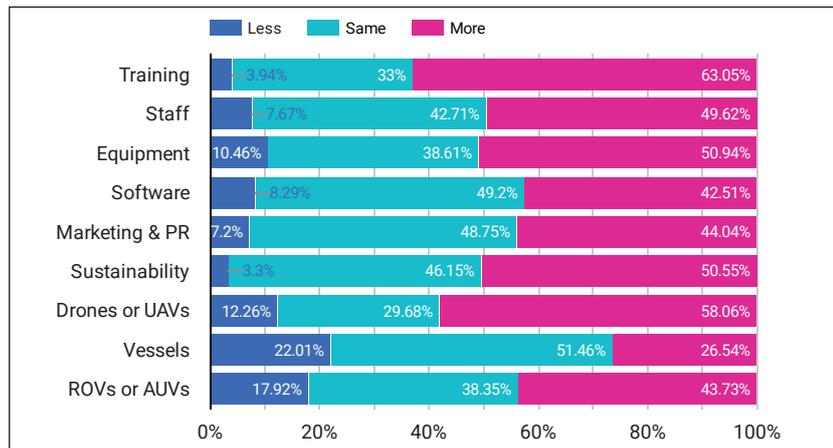
It is interesting to see how investment readiness relates to the global economic situation, but this cannot be analysed without considering the predictions of industry professionals for the growth of their companies in 2022 and the next couple of years. The findings give reason for optimism: no fewer than 20.9% of the respondents foresee more than 10% growth from 2022 onwards, while another 16.9% expect a 5–10% increase in their business, and 18.4% think growth between 2% and 5% is within reach. With 11.8% expecting neither growth nor decline, and 2.4% predicting a decline in growth, it is safe to say that optimism is high in the hydrography branch.

The following figures summarize the mood properly: although 63% of respondents expected growth for 2021, a whopping 82% expects growth for 2022. Furthermore, while 10% expected no growth but a decline for 2021, only 3% expect a decline for 2022. More respondents therefore expect growth compared with last year, and more of these respondents also expect higher growth than last year.

So, how will this wave of optimism translate into an appetite to invest? When asked how they plan to prioritize technology investments over the next three years, the top three answers were: (1) renew equipment inventory, (2) expand equipment inventory, and (3) software and data management. Taking a closer look at the organizational investments planned for the



▲ The energy transition will require a lot more survey activities, in particular for offshore wind farms. Pictured here is the Patriot, one of the advanced survey vessels of Braveheart Marine – an international survey company based in Urk, The Netherlands, with geophysical survey work in the offshore wind industry as one of their specialities. (Courtesy: Braveheart Marine)



▲ Intended investments for 2022 sorted by average priority with a breakdown into smaller, equal or larger investment expectations compared to last year. It is worth noticing that organizations that indicated that they already use Drones are much more likely to plan to invest in Drones.

next three years, we see a strikingly high score for training and competency development, while the wish to increase staff numbers is also frequently mentioned. Investments in research & development follow at a slight distance, but are still worth a mention.

One of the survey questions asked how participants view the prospects in the hydrographic surveying industry in 2022, compared with the past couple of years. The answer was quite clear: 51.2% see better prospects, 28% see much better prospects, and 17.3% do not expect much change.

HYDROGRAPHIC OPTIMISM EXPLAINED IN A NUTSHELL

Positive signs are therefore emerging from the industry, but what is behind this optimism? If we

analyse the answers provided by the survey respondents, some unmissable trends and developments come to the surface. Yes, people expect the coronavirus pandemic to die down, and a resumption of hydrographic activities after the stagnation period imposed by the pandemic restrictions and therefore better prospects, but there is more to it than that.

To come straight to the point: the energy transition will require a lot more survey activities, in particular for offshore wind farms. Many respondents acknowledge the boom in renewable energy as the driving force behind a growing need for hydrographic surveyors. Also mentioned is the increased interest by governments to survey their waters regularly, and increased funding for oceanographic research efforts. Requirements associated with

the mitigation of climate change and opportunities related to the UN Ocean Decade are also answers that are given repeatedly. Global warming is just around the corner when talking about opportunities for hydrographers: bittersweet prospects, perhaps. As one respondent puts it: "The emerging technologies and the effects of global warming will create a butterfly effect in the sector in a positive way."

RENEWABLE ENERGY VERSUS OIL AND GAS

The transition towards a low-emission economy is widely considered as an important growth area for the hydrographic industry. For our survey, we made a distinction between 'traditional' renewables – wind farms – and upcoming renewables, such as tidal and wave energy. 15.7% of the respondents indicated that they regard wind farms as their number one growth area, whereas 10.8% consider tidal and wave energy to be a key opportunity. One survey participant said that the uptake of renewable energy sources offshore should improve prospects for major offshore projects. Many respondents also mentioned how governments across the globe are putting a strong emphasis on investments in the blue economy. One of the respondents noted a downturn in oil and gas exploration, but that this is being replaced by a strong increase in wind farm and cable route surveys.

With renewables so prominent in the spotlights, we could be tempted to lose sight of the importance of the oil and gas industry to the hydrographic surveying profession. However, they always have had and still have a harmonious relationship, as reflected by the

outcome of the question concerning in which domains of hydrography our respondents work. 34.3% indicated that they work in the oil and gas industry. Although the share of fossil energy in the hydrographic sector may decline over the decades to come, it will still be a vital element for the years ahead. One of the comments can be summarized as follows: the survey demand for oil and gas will also increase due to sustainable prices above US\$60 per barrel. Another respondent expects an increase in the demand for oil and gas as a result of the post-COVID economic recovery.

NAUTICAL CHARTING

Another important growth area is nautical charting, especially due to the many major charting programmes that have been established or are projected for the coming years. Many survey respondents mentioned this as an opportunity with high expectations. An example is the Australian Hydrographic Office's HydroScheme Industry Partnership Program (HIPP), which focuses on national charting priorities between government and industry. Heading a bit further north, we see the archipelago country of Indonesia exploring and continuing to update its ocean data at a large scale, including bathymetry and data for ENCs.

There is of course nothing new about the fact that, without hydrographic surveyors, nautical charts would not exist, as the hydrospatial data they capture is used to update nautical charts – resulting in information that is crucial to navigate the ocean and other waterways. What is new, however, is the staggering demand for hydrographic data of a higher quality. The hydrographic profession is being challenged to

find new methods to gather the information necessary to produce more and more accurate nautical charts. As one of the respondents points out, ECDIS (and navigation) can only be made more effective if much more accurate hydrographic surveys are carried out.

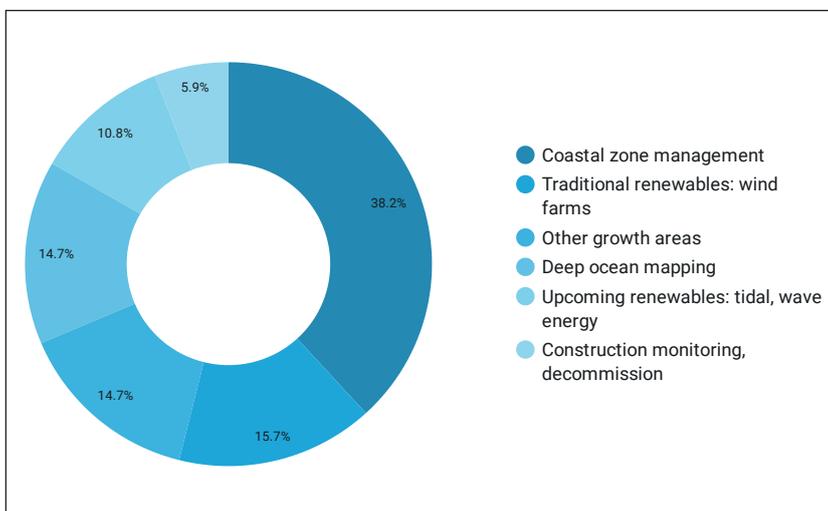
UNCREWED

As readers of *Hydro International* are undoubtedly aware hydrographic surveys can be conducted employing various methods, depending on the application and required data. Autonomous, uncrewed surveying is definitely the main takeaway from this industry survey. No fewer than 50.2% of the respondents indicated that they regard uncrewed systems as the technological development that will be the main driver for hydrography as a whole in the coming years.

There are several reasons why investment in autonomous technology is attractive. For example, it lowers the cost of hydrography while enabling the coverage of wider areas. Survey area requirements are getting larger and moving farther offshore. Having autonomous systems means larger coverage with the same manpower. There is another reason why autonomous survey vessels are receiving attention: they are more attractive for surveyors from a social aspect, namely the reduction in CO₂ emissions. And, of course, the lower survey costs are also a key factor. One hydrography expert was crystal clear: the future is autonomous. The decreasing costs and the risks involved in having a crew on board are now the main focus.

To paraphrase one of the survey respondents: as electronics and storage become cheaper, and methods of storing an abundance of data mature, the verification of algorithms to support autonomous decision making is a logical result – with the rise in autonomous systems becoming reality. But will it really be as straightforward as simply pushing a button to launch an autonomous vessel and start surveying right away? This would be too simplistic.

Developers of AUVs and USVs can benefit greatly from the rising demand for uncrewed surveying, which in turn is catapulted by the tremendous technical developments that we have seen over the past years. Does this mean there is no future for companies specialized in building traditional hydrographic survey vessels? Certainly not. What resonates from this year's industry survey is that a combination of crewed and uncrewed is what



▲ What do you consider to be the most important growth area for the hydrographic industry?

many hydrographers have in mind. One of the respondents argued that one vessel deploying numerous unmanned USVs and AUVs to achieve a greater rate of effort would be a solution that fits the need to map our seas.

AI

The findings of this survey related to artificial intelligence (AI) are a little ambiguous. Many respondents see AI as one of the developments that will influence the hydrography profession strongly in the coming years. Comments include: AI is expected to drive autonomous data acquisition and data analytics at a level we did not dare to predict in the recent past; the use of AI in data editing makes handling large volumes of data more practical and financially viable; AI not only enables the development of accurate surveying equipment and algorithms, but may also help carry out more systematic surveys where errors could be easily identified and accurate corrections applied, and; with the advancements in AI and autonomous uncrewed technology, there will be many more hydrospatial opportunities.

Indeed, expectations among some of the respondents are high, but we need to bear in mind that only 8.6% of respondents said that they expect AI as a technological development to be the main driver in the coming years. The briefest summary may well be that the emergence of AI in hydrography is still full of challenges. Readers can expect more articles on this evocative phenomenon. Expect stories focusing on how analysing hydrographic data fits so well with AI, and why it works best when it has large datasets to work with, with image processing as the prominent application.

LACK OF SKILLED PERSONNEL

Although the results of this survey are largely optimistic, there are some clouds appearing on the horizon. The lack of skilled personnel is clearly the main concern among many hydrographers. One of the respondents called it the shrinking pool of skilled offshore survey personnel. Another respondent said it is difficult to obtain personnel with knowledge of data acquisition and processing. Ensuring that the industry can retain and develop a sufficient number of qualified and experienced personnel to cover the increased activity safely could be one of the key outcomes of this year's industry survey.

Of course, we are talking about skilled personnel here. It cannot come as a surprise to many of us that training and education are also mentioned



▲ With the rapid advances taking place in newly developed autonomous platforms, the hydrographic profession is in a technology transition. (Courtesy: Unmanned Survey Solutions)

frequently. Not only fresh graduates, but also the concept of lifelong learning – the latter especially due to the fast rate of technological developments. As one respondent strikingly described: if you don't have the manpower and expertise to support the industry, the growth of the industry will be hampered.

Another respondent stated that IHO standards for surveyors are lagging behind the industry, and argued that tomorrow's surveyors will need to be much more data-centric and IT savvy. Data management and coding skills will be required to support the growing AI/ML efforts within hydrography. Indeed, this is a comment that echoes one of the major outcomes of this year's edition of our annual industry survey.

CONCLUSIONS

To summarize, there is optimism when it comes to growth and project/work opportunities in the hydrographic sector, with possibly significant business growth expected for the coming years. Although the COVID-19 pandemic has caused a downward trend over the past two years, the outlook is seen as positive as soon as the coronavirus is better under control.

The growth will be caused by developments in autonomous surveying and in the energy market. It should also be noted that, although coastal zone management has not been mentioned in this article, the industry survey shows that it is an important growth market. Autonomous is also partly reflected in investments, which are in drones and ROVs/AUVs and less in survey vessels. The willingness to invest is undisputable.

Furthermore, what stands out are planned investments in the replacement of existing equipment and substantial investment in personnel training and development. Growth is foreseen mainly in wind energy and the further expansion of nautical mapping.

The hydrography sector sees opportunities through improved technology – AI resulting in more information processing, but especially through remote and autonomous surveying solutions. The expectations of and interest in autonomous and uncrewed survey methods stand head and shoulders above the rest. Risks are budgets that remain the same or even decrease, but also a lack of insight into the environment in relation to surveying and conservative behaviour. Another big risk is the challenge of finding capable personnel, which poses a major constraint.

So, optimism dominates, and many companies and organizations plan to open their wallets, but the positive mood is tempered slightly by the struggle to find skilled personnel. ◀



Wim van Wegen is head of content of *Hydro International*. In his role, he is responsible for the print and online publications of one of the world's leading hydrography trade media brands. He is also a contributor of columns and feature articles, and often interviews experts in the sector.

✉ wim.van.wegen@geomares.nl

High-performance Airborne Bathymetry

The Leica Chiroptera 4X and HawkEye 4X bathymetric LiDAR systems provide unprecedented water depth penetration and seabed object detection even in turbid waters. The system is scalable, collects seamless data from water to land and leverages the Leica LSS 3.0 end-to-end processing workflow for LiDAR calibration, refraction correction, point cloud classification, data enhancement and visualisation.

leica-geosystems.com/chiroptera-4x



Leica Geosystems AG

leica-geosystems.com



© 2021 Hexagon AB and/or its subsidiaries and affiliates. Leica Geosystems is part of Hexagon. All rights reserved.

— when it has to be **right**

Leica
Geosystems

V ALEPORT SWIFT CTD



Measured CTD, with all the benefits of the SWiFT

CTD & Environmental • Current • Echosounders & Bathymetry • Sound Velocity • Tide

AUV • ROV & ASV • HYDROGRAPHY • HYDROMETRY • METROLOGY & POSITIONING
OCEANOGRAPHY • PORTS, HARBOURS & DREDGING • RENEWABLE ENERGY

Visit valeport.co.uk to find out more

+44 (0)1803 869292 \ sales@valeport.co.uk

More Training, Please!

Looking at the current hydrographic market, an interesting aspect is the continuous search for hydrographic personnel. However, while quite a few of the current hydrographic surveyors obtained their training in the field, this is becoming increasingly difficult; not only due to the increasing complexity of surveying systems, but also because clients require hydrographic surveyors to be certified. At the same time, we are witnessing an ever-increasing outflow of experienced hydrographic surveyors, as the average age of the workforce increases and people retire. What, therefore, can be done to remedy this?

BUSINESS CYCLE

Both the dredging and the offshore market seem to depend on economic factors. A personal observation is that fluctuations in the economy seem to translate within a very short time span into similar fluctuations in investments in infrastructure and energy production.

Another personal observation (obtained through years of involvement in education) is that investment in personnel seems to directly follow the general business cycle. When a few years ago the market was down and investments were low, many surveyors were laid off. Investment in training also dropped for the remaining personnel. Then, when the market rose again, there was an outcry for more personnel and of course no more time to train those who had stayed.

An interesting question is how to break this cycle. On paper, it should not be that hard. General economics dictate that the best time to invest is when the market is down, supply is ample and demand low. That is when investments are at their 'cheapest' and the choice at its largest. However, this economic law does not seem to work all that well in the hydrographic world, probably because, as a service provider (and because of low margins?), we get hit hard and direct with market changes. Or, is it because we fear we might be hit hard and therefore hedge our investments for a better day? I will leave it up to each individual reader or company to decide which is true.

As long as we do not break this cycle, we will always find that we do not have enough qualified personnel when the market improves. One thing that may sway the decision is that

people who lose their job during a downturn are usually 'lost' to the market. They move on to another career and in general only a few of them return. We therefore lose all the investments that were made.

To make a rough calculation of the investment lost, let's assume the following. A Cat B education (increasingly required as the minimum standard, see below) takes at least half a year according to the IHO competency standard S5-B. The training cost, based on internet prices for a commercial Cat B course, is between €10,000 and €15,000. This excludes salaries, which easily amount to another €25,000 over the same period. In other words, training a certified surveyor costs between €35,000 and €40,000. At the same time, the work cannot be done by the employee who is in

training, easily increasing the costs by another €25,000.

By training when the market is low, we spend less money (no need for a replacement?) or at least do not lose any money. Now, I know not many companies actually pay the amount of money given above, as they rely on new blood being trained at school. However, the costs simply come from a different pocket. Bear in mind also that the above sum excludes the costs of 'breaking in' a new employee, which may take anywhere from a few weeks to a few months, easily adding another €10,000 to the costs, even if training can be avoided and the new employee is immediately available when the market is ready. However, considering the number of emails looking for fresh blood in my inbox, I would say that this is not the case.



FORMAL EDUCATION

This brings us to formal education. As I said, a hydrographic career did not in the past have to start with a hydrographic education. However, more and more clients require one or more certified hydrographic surveyors on a project. My personal prediction is that this number will only increase in the years to come.

When looking at formal education, we need to consider IHO recognized training. The IHO-FIG-ICA standards of competence (S5 and S8) define two levels of hydrographic courses. One is the Category B ('Cat B'), aimed at practical surveyors (S5-B) and practical cartographers (S8-B). The other level is Category A ('Cat A'), aimed more at the research and management level. A Cat B course should take at least half a year; a Cat A course at least a full year.

The S5 and S8 standards further detail what a hydrographic surveyor or cartographer should know and at what level. The standards are

revised when required and try to follow developments in the hydrographic field. However, no standard can predict the future and it is up to institutes to follow market trends and augment their training. The IHO S5 / S8 standards describe the minimum rather than the maximum that should be covered.

We see a strong division in the available courses between those 'in and for the Navy' and those for commercial hydrography (offshore, construction, dredging). While the primary background of the IHO is the safety of navigation, we see that about half the institutes do not primarily train for safety of navigation but for hydrography for research and economic development. This uses the same tools, but in a different process, and these processes are sometimes hard to reconcile, especially when discussing what is truly relevant. Where the offshore industry may emphasize underwater acoustic positioning, the Hydrographic Offices of the Navy may emphasize harmonic analysis and the construction of nautical charts.



It is not easy to run a hydrographic institute: student numbers are low, and certification requirements are high. Another issue is resources. Survey equipment and software (and a vessel) are major investments that often need to be sponsored in some way. Otherwise, an institute would need to compete with the market to pay for the resources; something which, from

		Applicant Qualification and Experience			
		Category A	Category B	Surveying Degree	Certificates/Diplomas
Affiliate		Certificate or proof of study.	Certificate or proof of study.	Certificate or proof of study.	Certificate or proof of study.
Level 2		1 years relevant experience.	2 years relevant experience.	Additional formal courses. 3 years relevant experience.	Additional formal courses. 4 years relevant experience.
Level 1		2 years relevant experience including supervisory time.	Additional formal courses. 3 years relevant experience including supervisory time.	Additional formal courses. 5 years relevant experience including supervisory time.	Additional formal courses. 7 years relevant experience including supervisory time.
Level Ø		10 years relevant experience including supervisory time.	15 years relevant experience including supervisory time.	16 years relevant experience including supervisory time.	N/A

an academic point of view, should not be done. From personal experience, I know that the industry is usually heavily involved in this sponsorship, for which institutes should be and usually are very thankful.

COMPETENCY ASSESSMENT SCHEMES

Finally, there are people working in the industry without formal training at a Cat A or Cat B recognized institute, but increasingly required to prove their proficiency. Or, some people may have a related certificate that is not recognized in the hydrographic world (i.e. not Cat B or Cat A).

For this group of people, but also for those with Cat B or Cat A training who want to demonstrate their practical proficiency, we see more and more professional accreditation schemes. Some of these are national, while others are recognized by the IHO. One such scheme is that of the International Federation of Hydrographic Societies (IFHS), who recently submitted their Hydrographic Professional Accreditation Scheme. Other recognized

schemes are already in place in Canada and Australia.

All schemes follow a similar path; those who apply are required to provide proof of academic qualifications (as mapped against the S5 standards). However, even though they need to provide evidence of having acquired all the S5 competencies, they need not have followed a Cat A or Cat B recognized course. They can also prove these competencies through later training or affiliated courses. Often, they need to follow additional courses on specific subjects to fully obtain all the competencies.

Furthermore, depending on the level of recognition sought, they need to supply proof of practical proficiency through logbooks, CVs or survey reports. The sum of academic qualifications and practical proficiency then affords them a recognized level in a certain scheme. Most schemes recognize a level '2', which can be obtained after attending a recognized Cat B course or equivalent set of academic competencies and a certain number of years in the field. There is also a level '1',

which requires Cat A or equivalent and more years of experience. HPAS also recognizes a level '0' for those individuals with an outstanding track record in hydrography.

CONCLUSION

To conclude, as a market we need to think about how we obtain, and more importantly hold onto, our hydrographic professionals. However, there are more ways to achieve qualification: either through a recognized Cat A or Cat B course or through a professional accreditation scheme. Whatever we do, it is important to continue to invest in qualified personnel. ◀



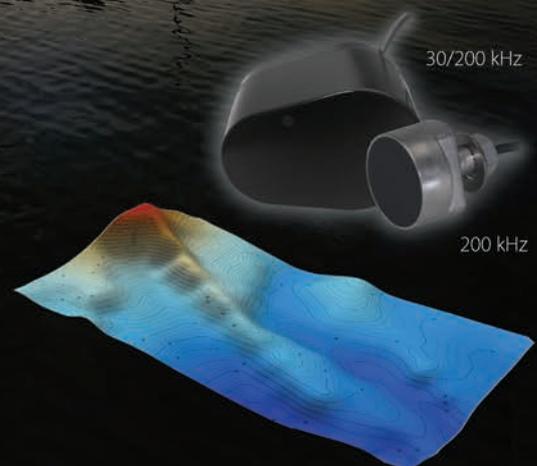
Huibert-Jan Lekkerkerk is a contributing editor, freelance hydrographic consultant and author of publications on GNSS and hydrography and principal lecturer in hydrography at Skilltrade (Cat B) and the MIWB (Cat A) in the Netherlands. He is also a member of the IFHS initial HPAS panel.

✉ info@hydrografie.info

The Smart™ Choice for Hydrographic Survey

EchoRange™ Smart™ Sensors deliver depth and water temperature data to any NMEA device. EchoRange+ with Echo Envelope Option enables user-defined performance and echo waveform for bottom detection to 200 m. Compact and cost effective, with multiple mounting options, EchoRange+ is the most versatile line of field survey transducers available for autonomous hydrographic survey and fixed applications.

Photo and 3D Bathyscape courtesy of SimpleUnmanned, LLC



Talk with us about how EchoRange+ can integrate into your next survey project.

AIRMAR.COM/ECHORANGE



Empowering Women in Hydrography: Achieving Meaningful Change

Workplaces that foster equity, diversity and inclusion are not simply 'doing the right thing': they also benefit from the ensuing diversity of perspectives, and increase their talent pool and economic productivity. Achieving meaningful transformation, however, requires employers and policymakers to address barriers and commit to making the cultural and structural changes necessary at all levels to build more inclusive workplaces.

Like other science, technology, engineering and mathematics (STEM) fields, hydrography has traditionally seen low rates of female participation. Though recently more women have entered the field, the COVID-19 pandemic

may have adversely impacted some of these gains, since women scientists disproportionately bore the economic and socioeconomic costs of the lockdowns and school closures when compared to their male counterparts.

At the same time, the pandemic has also demonstrated that many jobs in hydrography can be performed effectively, at least in part, from home. These shifts in work style coupled with an awakening in the public consciousness



▲ The first all-female CHS crew aboard the *Louis St. Laurent* for an Arctic survey. Sara Raymond, Shauna Neary and Claire Haysom, August 2020.

in many parts of the world on issues of diversity and inclusion present an unprecedented opportunity for hydrographic organizations to lock in these cultural shifts and attract more women and other underrepresented groups to the profession.

Governments who develop policies to support diversity and inclusion in STEM fields will in turn foster greater participation in the sector and increase their GDP. For example, a 2015 analysis from the European Institute for Gender Equality found that closing the gender gap in STEM by 2050 would lead to a 2–3% per capita increase in EU GDP, equivalent to €610–€820 billion.

Flexible work arrangements that flourished during the pandemic are one tool that hydrographic organizations could adopt in the long term to support women in the workplace. On average, women still shoulder a relatively greater burden of domestic responsibilities. These arrangements afford all employees a better work-life balance and, when coupled with reliable childcare, allow parents to better balance domestic and workplace responsibilities.

I saw these benefits first hand as a young mother and scientist working for the Canadian Hydrographic Service (CHS). Being privileged to live in a part of the world that saw minimal lockdowns and day-care closures, working from home greatly improved my quality of life. With childcare in close proximity, I could see more of my children and still breastfeed my youngest during the day, something I could not do with my older child when I returned to work in 2018 and did not have the option to work from home.

Across STEM fields, the underrepresentation of women begins in educational institutions and becomes even more pronounced in leadership roles. In my home country of Canada, more women than men obtain a university degree, but only half as many women opt for a degree in STEM (Statscan, 2016). In the field of hydrography, specifically, most leadership positions are still occupied by men. Of the International Hydrographic Organization (IHO) bodies, for example, only 13% are chaired by women.

I am pleased that as part of the United Nations' Decade for Ocean Science for Sustainable Development (2021-2030), Canada has worked closely with partners on projects to promote

gender equity. For example, Canada provided financial support for a research programme led by the World Maritime University to improve gender equality in ocean research and science-dependent governance systems. Canada also sponsored the IHO project Empowering Women in Hydrography (EWH), which aims to raise awareness of the different

Men still outnumber women at the director level, but we are starting to see gender equality at the managerial and supervisory levels

jobs available to women in hydrography and support them in reaching leadership positions and participating in governance.

The EWH project was endorsed by IHO members in November 2020. With the project funding in place, the IHO is now asking members to propose initiatives, but scoping the scale of the gender gap remains a challenge. As the chair of the IHO Capacity Building Sub-Committee, Evert Flier, put it: "The biggest challenge is men thinking there is not a problem. We could start raising awareness by having IHO Member States report on the gender distribution of their workforce in different parts of their organization and at different management levels."

I am proud that my employer has begun to address issues of diversity and inclusion at home as well. For example, CHS has been partnering with Canadian universities to help attract candidates from more diverse backgrounds. We also formed the CHS Women in Hydrography Network, led by Annie Biron, to identify and recommend ways to overcome barriers to female participation in our workplace. Many difficult conversations were had in offices across the country. The network looked at issues ranging from health, hygiene and safety, to work-life balance and harassment prevention. Members of the network also identified historical inequities, including gender barriers that limited women's access to field work.

While our work is ongoing, we are seeing signs of progress. When I first started with CHS in 2018, there were very few women in leadership roles, but this has changed dramatically in the past three years. Men still outnumber women at

the director level, but we are starting to see gender equality at the managerial and supervisory levels.

Although women have participated in surveys at CHS for decades, they were typically in the minority on ship. In a big milestone, the CHS had its first all-female survey crew in the Arctic

last year. This is exciting because it shows we are breaking down barriers. As a next step, CHS is now beginning to look beyond gender, to see the best way to support diversity and inclusion more broadly.

Seeing individuals who historically may not have had a chance to go on survey experience the joys of hydrography is very rewarding. As Sara Graham, one of our hydrographers from Nova Scotia, described: "I love that I get to be involved in offshore mapping projects. Often times the area you're sounding has never been 'seen' by human eyes and you get the feeling like you're an explorer – are you going to find really interesting undersea features like canyons or ravines with steep slopes? Every day is different." ◀

Acknowledgements

Special thanks to Dr Geneviève Béchar, Luigi Sinapi, Leonel Manteigas, Sarah Jones Couture, Annie Biron, Andrea White, Liisa Parameki, Evert Flier, Sara Graham and Sara Raymond for their input and review.



Sonja Bhatia is a senior advisor to the Director General of the Canadian Hydrographic Service (CHS). In her substantive role, she is supervisor of the Tides, Currents and Water Levels group, also with the CHS, in Dartmouth, Nova Scotia. Sonja holds a PhD in Earth Sciences from Dalhousie University and has held teaching faculty positions at several universities in the Halifax area.



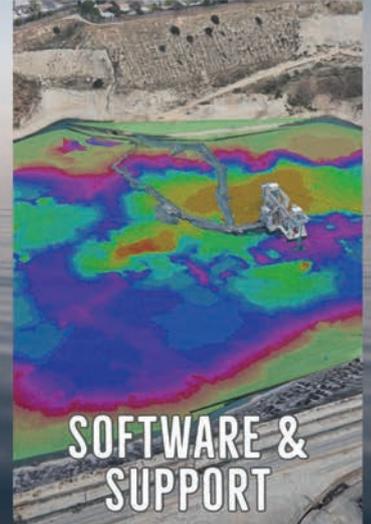
COMPLETE HYDROGRAPHIC SURVEY SOLUTIONS.



HYDROGRAPHIC INSTRUMENTS



UNMANNED SURVEY VESSELS



SOFTWARE & SUPPORT

WWW.SEAFLORSYSTEMS.COM

+1(530) 677-1019

INFO@SEAFLORSYSTEMS.COM

RIEGL VQ-840-G

TOPO-BATHYMETRIC UAV LASER SCANNER



- ideally suited for integration on UAVs and helicopters
- green laser providing more than 2 Secchi depths water penetration
- measurement rate 50 kHz - 200 kHz
- integrated inertial navigation system and digital camera

EFFICIENT HIGH RESOLUTION UAV COASTLINE OR SHALLOW WATER SURVEYING



Scan this QR code to watch the RIEGL VQ-840-G video on our YouTube Channel.

Explore the full portfolio of proven RIEGL LIDAR sensors and systems www.riegl.com

[f](#) [t](#) [in](#) [w](#) [y](#) [v](#) [e](#) [n](#) [e](#) [n](#) [e](#) [w](#) [s](#) [t](#) [r](#) [o](#) [o](#) [m](#) [.riegl.international](#)

www.riegl.com



Austria | USA | Japan | China | RIEGL WORLDWIDE | Australia | Canada | United Kingdom

The Evolution of Capturing the Seabed

Ocean Mapping: A History of Exploration in Meaningful Words

Over the last few centuries, mapping the ocean seabed has formed a major challenge for marine geoscientists. Ocean bathymetric charts and submarine geomorphology have significantly impacted our understanding of our planet, from plate tectonics to deep-sea ecosystems. The history of ocean mapping can be viewed through scientific trends based on words used in the scientific literature. To this end, data mining was carried out on 454 papers dated between the 1930s and 2019 using the keyword ‘seabed mapping’.

The first bathymetric maps were based on ‘lead line’ (plumb) measurements. In 1855, a first bathymetric profile of the Atlantic Ocean was shown in a textbook published by Matthew Fontaine Maury. From 1873 to 1876, the HMS *Challenger* expedition collected more than 500 plumb measurements, revealing the depth of the Mariana Trench and a more comprehensive map of the Atlantic Ocean, with the Dolphin, Connecting and Challenge Ridges, known today as the Mid-Atlantic Ridge. Bathymetric charts became an important asset worldwide, and in 1903, Prince Albert I of Monaco launched the first General Bathymetric Charts of the Ocean (GEBCO).

The beginning of the 20th century was marked by a change in the seabed mapping approach. The development of acoustic technology introduced the use of echosounders, allowing the collection of much more data in much less time. After World War II, with its extensive use of echosounders, Maurice Ewing, Bruce Heezen and Marie Tharp produced a series of bathymetric maps revealing the physiographic features of the ocean floor, published in a seminal Special Paper of the Geological Society of America (1959). The ocean floor morphology provided key information to fill in the plate tectonics puzzle, and also supported Wegener’s hypothesis of continental drift. In 1977, the global seabed map produced by Heezen and Tharp and painted by the artist Tanguy de Rémur, *The Floor of the Oceans*, became a milestone in seafloor mapping and physiography.

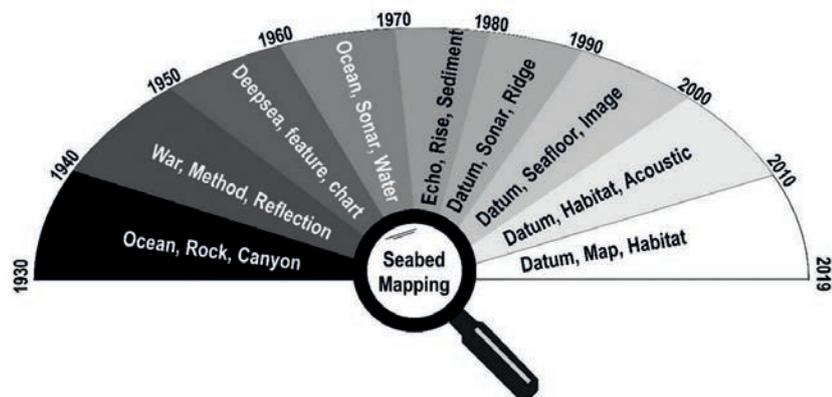
The continuous development of acoustic technology brought a novelty to seabed mapping: the revolutionary multibeam bathymetry system. The first non-military multibeam system was used in 1977 during the Jean Charcot Expedition (Seabeam and Hydrochart). In the past decades, we have witnessed the striking technological development of acoustic and non-acoustic seabed mapping techniques and systems.

TEMPORAL EVOLUTION

The lexical analysis of scientific literature pinpoints the state-of-the-art evolution in seabed mapping over almost a century. Not only was a growth in scientific production observed, but also a clear trend in the use of scientific, technological and methodological terms. In general, the literature began with exploratory

investigations (‘ocean’, ‘interpretation’, ‘investigation’), shifted to the importance of technology in scientific results (echo, side scan, multibeam), and recently turned toward applications of ocean mapping, as terms such as habitat mapping, seabed classification and backscatter became more common. The widespread use of the word ‘datum’ over the last decades is also consistent with an increase in data availability and quality.

Over the entire timeframe, it is clear that scientific publications related to seabed mapping have followed investment trends in research, science and technology, but also reflect national and multinational concerns. In the past two decades, the demand for the definition of exclusive economic zones, support for marine spatial planning programmes, use of



▲ Illustrative scheme summarizing the most frequent words by decade. (Image source: Menandro & Bastos, 2020)

Your View Below The Surface

Survey around the world with confidence!

HYPACK®

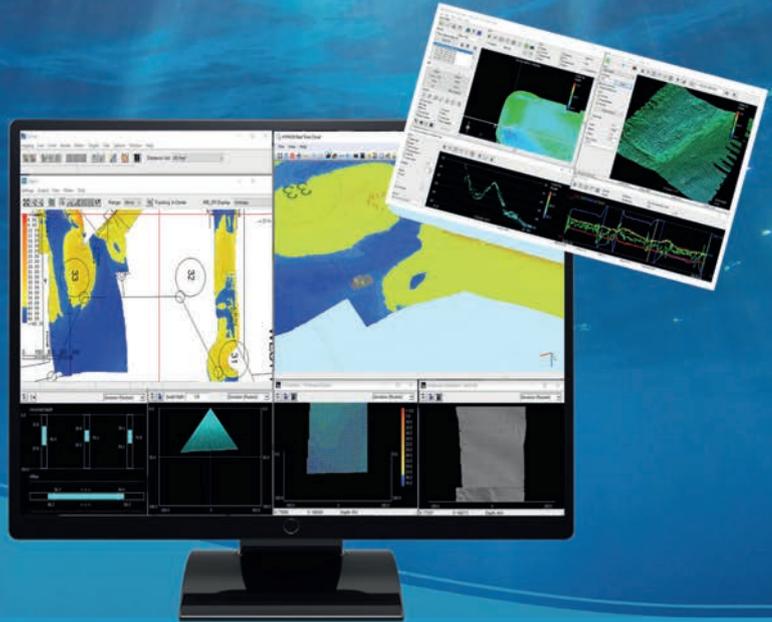
Acquisition and processing software for Single Beam, Side Scan, ADCP, Sub-bottom and Magnetometer systems.

HYSWEEP®

Acquisition and processing software for Multibeam, Backscatter, and Topographic Laser Systems.

DREDGEPAK®

Software for dredging control on Cutter Suction, Hopper, Excavator and Bucket Dredges.



sales@hypack.com • www.HYPACK.com

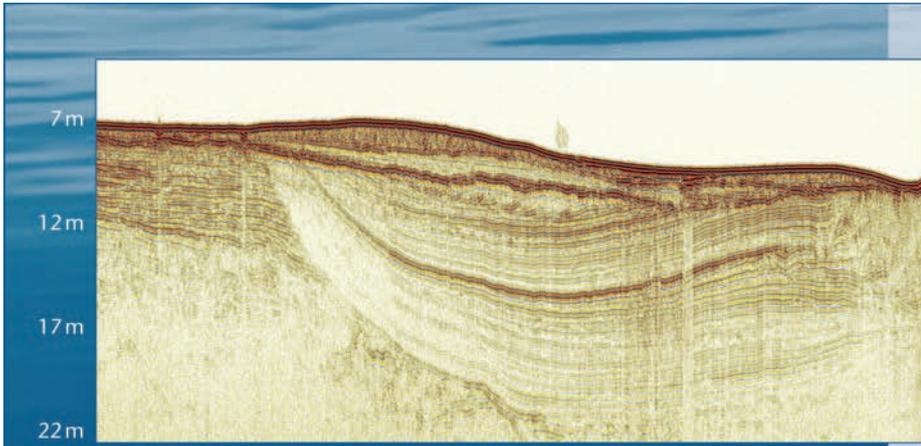
CHCNAV

SOLUTIONS FOR AUTONOMOUS ADCP AND BATHYMETRIC SURVEYS

APACHE 4 | HYDROGRAPHIC SURVEY USV



www.chcnv.com



Data example Innomar medium-100 SBP, 6kHz

Innomar Parametric Sub-Bottom Profilers

- ▶ Discover sub-seafloor structures and buried objects
- ▶ Acquire unmatched high-resolution sub-seabed data with excellent penetration
- ▶ Cover all depth ranges from less than one meter to full ocean depth
- ▶ Highly portable equipment for fast and easy mobilisation
- ▶ User-friendly data acquisition and post-processing
- ▶ Used worldwide for various applications by industry, authorities and science

Innomar Technologie GmbH • Germany
 Schutower Ringstr. 4 • D-18069 Rostock • Phone +49 (0)381-44079-0



Shallow-Water Solutions



High-Power Solutions



Remotely-Operated Solutions



Multi-Transducer Solutions



www.innomar.com



Solutions for Hydrographic Survey and Marine Applications marine@applanix.com





▲ *Detail of the North Atlantic Ocean floor map by Bruce Heezen and Marie Tharp, painted by the Austrian painter and cartographer Heinrich C. Berann (Courtesy: US Library of Congress, Geography and Map Division).*

environmental impact studies and climate change models. All of the social targets of the UN Decade of Ocean Sciences also require seabed mapping.

Following the trends observed in the lexical analysis, the evolution of seabed mapping will

seabed is mapped, we will learn more about our ocean morphology. The Five Deeps Expedition and the Northern Depths and Ice Age Geology of the Great Barrier Reef Expeditions are good examples of new ocean floor data revealing unknown features or mapping the real depth for the first time.

Exploration during the next decade will therefore have a profound impact on our knowledge of the oceans

probably consist of increasingly integrated investigations using new technology for data acquisition (AUVs, multibeam, multispectral multibeams, Lidar, underwater drones), sophisticated classification tools (unsupervised approaches, machine and deep learning, convolution neural network), and possibly new features and geographical analysis. As the

Exploration during the next decade will therefore have a profound impact on our knowledge of the oceans. This will enable us to discover new marine landscapes, predict seabed habitats (mainly deep-sea habitats) for better resource management, improve circulation and climate models, and hopefully make the data available for everyone. The effort to achieve the sustainable

development of the oceans demands ocean mapping, and the scientific publications on seabed mapping will register the new findings and developments achieved during this decade. By 2030, our knowledge of the ocean seafloor will have developed significantly, as happened with the seminal work *The Floor of the Oceans* by Bruce Heezen and Marie Tharp. This will impact not only the marine geosciences but the entire marine sciences. ◀

Further reading

Menandro, P.S.; Bastos, A.C. Seabed Mapping: A Brief History from Meaningful Words. *Geosciences* 2020, 10, 273. <https://doi.org/10.3390/geosciences10070273>



Pedro Menandro: PhD candidate (MBES multispectral backscatter data for seabed classification) in Oceanography at Universidade Federal do Espírito Santo (Brazil). Currently

works on habitat mapping using different datasets, exploring different approaches and classification tools at Marine Geosciences Lab (Labogeo/UFES), and as a Visiting Graduate Research Student at Dalhousie University (SEAM Lab).



Alex Bastos: Professor in Marine Geology at Universidade Federal do Espírito Santo, Brazil since 2004. Received his PhD from the University of Southampton/National Oceanography

Centre, UK, in 2003. His background is in marine sedimentology, ocean mapping and stratigraphy and he combines these scientific realms to investigate the sedimentary and geomorphological record of sea-level and climate changes and submarine geomorphology such as seabed habitat and paleolandscapes.



SAAB SEA EYE



SAAB

Case study: NORBIT's WINGHEAD Wideband Multibeam Sonar Applied for Subsea Leakage Detection

Multibeam Sonar for Ship Wreckage Leakage Detection

An oil slick was seen on the surface of Nootka Sound and staining on rocks of nearby Bligh Island, west of Vancouver Island, Canada, in late 2020. This set in motion an emergency operation to identify the source of the pollution and plan measures to protect the local ecosystem. Canadian authorities contracted the Resolve Marine Group, which requested Trondheim-based NORBIT to perform a technical assessment. NORBIT's U.S. partner Seahorse Geomatics executed the contract.

The key objective was to make a rapid and accurate determination of the source of the diesel and oil that had appeared on the ocean's surface. The company carried out hydrographic survey work using a NORBIT WINGHEAD i77h multibeam echosounder (MBES) system. The team deployed the device both from the surface, mounted onto a small rescue-type craft, and underwater, from a Helix remotely operated vessel (ROV) model XLX 66.

ROV EQUIPMENT INSTALLATION

On the ROV, the WINGHEAD i77h was installed alongside a NORBIT compact high-resolution forward-looking sonar (the

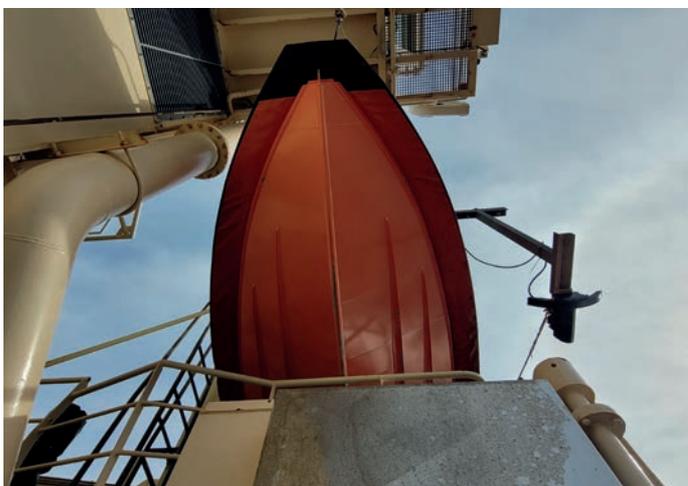
WBMS-FLS) and various sensors for ROV navigation and positioning purposes: a VERIPOS LD5 integrated sensor positioning system, an iXblue Phins Subsea inertial navigation system (INS) (for ROV position, true heading, attitude, speed, depth and heave) and a Kongsberg HiPAP 501 acoustic positioning system.

MULTIBEAM SONAR TO DETECT SUBSEA LEAKAGE

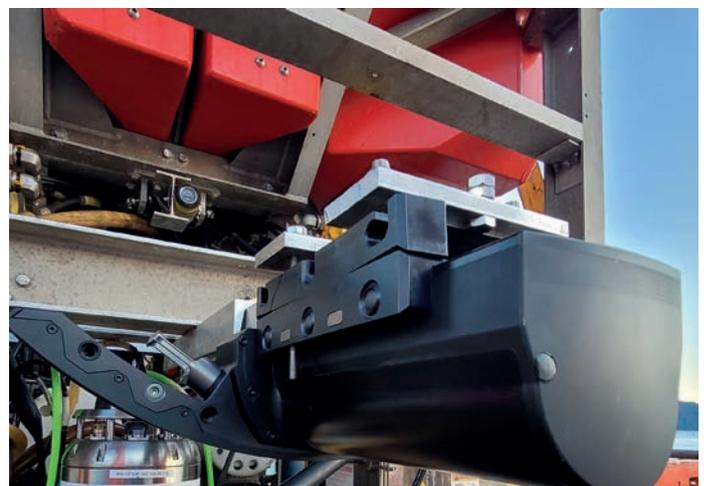
MBES technology has wide applicability in subsea leakage detection. The technology uses acoustics (sound signals) to build up maps of underwater space. This leaves the underwater environment undisturbed, which is particularly important in

situations of hydrocarbon leakage. The NORBIT WINGHEAD, launched in mid-2020, is a unique curved-array ultra-high-resolution bathymetry sonar system utilizing the latest in analogue and digital signal processing.

The WINGHEAD is versatile, easy to use and optimized for rapid mobilization on any platform. It offers a 0.5° x 0.9° beam width at 400kHz and a HD beamformer providing 1,024 beams per ping. The system's low power consumption means that it can be battery operated. It provides a simple ethernet interface and signal processing capabilities, including roll stabilization, water column and



▲ The NORBIT WINGHEAD i77h MBES mounted onto a small rescue-type craft in preparation for surface hydrographic survey work in Nootka Sound, west of Vancouver Island, Canada.



▲ The NORBIT WINGHEAD i77h MBES mounted onto the Helix XLX 66 in preparation for the underwater surveys.



▲ The Atlantic Condor cargo ship served as the base for the offshore operations.

backscatter output. The NORBIT WINGHEAD system offers maximum signal-to-noise ratio and ultra-high resolution via an 80kHz FM signal – the widest available in the industry – and long pulse lengths, providing maximum energy.

The ability to capture water column and backscatter data in addition to bathymetry is an advantage of multibeam sonar when detecting and classifying oil spills. The intensity of the sound echo reflected back to the sonar transducer provides information about features in the water column. These can be as detailed as fish, plumes, gas bubbles or pockets of viscosity.

MAPPING A HISTORIC SHIPWRECK

In this case, multibeam surveys confirmed the source of the diesel and oil as leakage from the MV Schiedyk, a 147m cargo ship that sank in these waters more than 50 years ago, in 1968. The shipwreck remained some 106–122m below the



▲ The ROV was tethered to the cargo ship and lowered into the water for the subsea survey work, which was performed at 10m above the seafloor.

surface, too deep for divers. An estimated 60 tonnes of diesel and heavy fuel oil were still in the hull.

The bathymetric surveys showed the ship resting bottom-up on the seafloor. The multibeam images also revealed plumes of oil travelling through the water column. With these, responders were able to pinpoint specific areas of leakage from the hull that could not be captured by video surveys. Importantly, the images showed that the vessel was leaking from more than one area.

VERSATILITY, EASE OF MOBILIZATION AND INSTALLATION

Equipment versatility, ease of mobilization and ready installation are important considerations in operations such as this one. This is where the WINGHEAD really showed its added value. The team mounted it first onto a small rescue-type craft to conduct bathymetric surveys from the surface of the water. They then mounted it onto the ROV for the subsea operation.

DATA ACQUISITION AND PROCESSING

For data acquisition during the survey work carried out from the surface, the team relied mainly on NORBIT's graphical user interface (GUI) and DCT data acquisition software. The DCT software displays the general bathymetry grid in a web browser. This allows the operator to readily assess coverage and data quality in real time while running the survey. DCT offers four displays: depth, standard deviation, sounding density and backscatter. Operators can operate or toggle between these views using a touch screen on a navigation plotter, tablet, smartphone or PC.

For the surveys using the ROV, the data acquired from the equipment was streamed topside via ethernet to a PC that was additionally running the QPS Navigation and Positioning Software (QINSy).

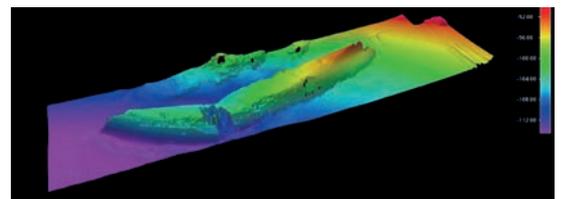
SHOWCASE OF THE STRENGTHS OF THE NORBIT WINGHEAD SYSTEM

This use case, in Nootka Sound, was a showcase of the strengths of the NORBIT WINGHEAD system. The technical

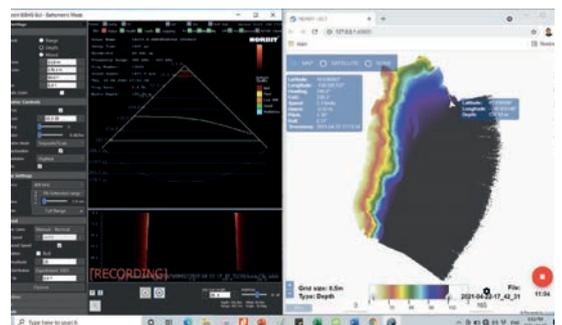
assessment team needed an echosounder system that was ultra-high resolution, to accurately reveal the places where the ship wreckage was leaking so that temporary seals could be applied to reduce the release of oil where possible. The system also had to be reliable, robust and quick to mobilize, as weather conditions could not be known in advance. Finally, a versatile system was needed, as in addition to the bathymetric surveys from the surface vessel, closer-range ROV survey work had to be done to gain a fuller picture of the MV Schiedyk's condition and risks to the environment. Particularly, the existence of oil in the various tanks had to be confirmed, their locations mapped and any obstacles to oil removal identified. ◀



▲ The MV Schiedyk, a 147m cargo ship owned by the Holland America Line that sank in the waters of Nootka Sound, west of Vancouver Island, Canada, in 1968. Oil and heavy fuel leakage from the wreck was sighted in late 2020, prompting an immediate remedial operation.



▲ Bathymetry data results from the ROV survey (400kHz).



▲ BI's WBMS ROV and data acquisition software (DCT). Colours on the image to the right show the slope of the seafloor. The displays are intuitive and can be operated from any web browser.

We would like to shine a light on some of our rental products



Sonar



USV



Underwater Sensing



Positioning



Bottom Sampling

Seabed has a complete range of rental products available. Go to www.seabed.nl/rental or contact us at sales@seabed.nl for rates and availability.



Getting to the bottom of things

Making Hydrographers' Tasks Easier



Courtesy of Cadden

Navsight Marine Solution

State-of-the-art Motion & Navigation Solution



Qinertia

The Next Generation INS/GNSS Post-processing Software

Performing High-quality Data Collection in a Safe and Environmentally Friendly Way

Surveying Lake Superior the Uncrewed Way

Two Uncrewed Surface Vessels (USVs), remotely controlled via satellite, conducted pioneering survey work on Lake Superior for the Canadian Hydrographic Service (CHS) in partnership with IIC Technologies. The project marks the first time that USV technology has been used to gather bathymetry data in inland waters in Canada.

The Canadian Hydrographic Service (CHS) project was funded through the Government of Canada's Oceans Protection Plan (OPP) initiative. It was carried out by IIC Technologies and XOCEAN in the world's largest freshwater National Marine Conservation Area. CHS's main objective was to evaluate the operational readiness of commercial off-the-shelf USV technology in a real working environment. This included the ability for uncrewed platforms to acquire high-quality data that meets the International Hydrographic Organization (IHO)

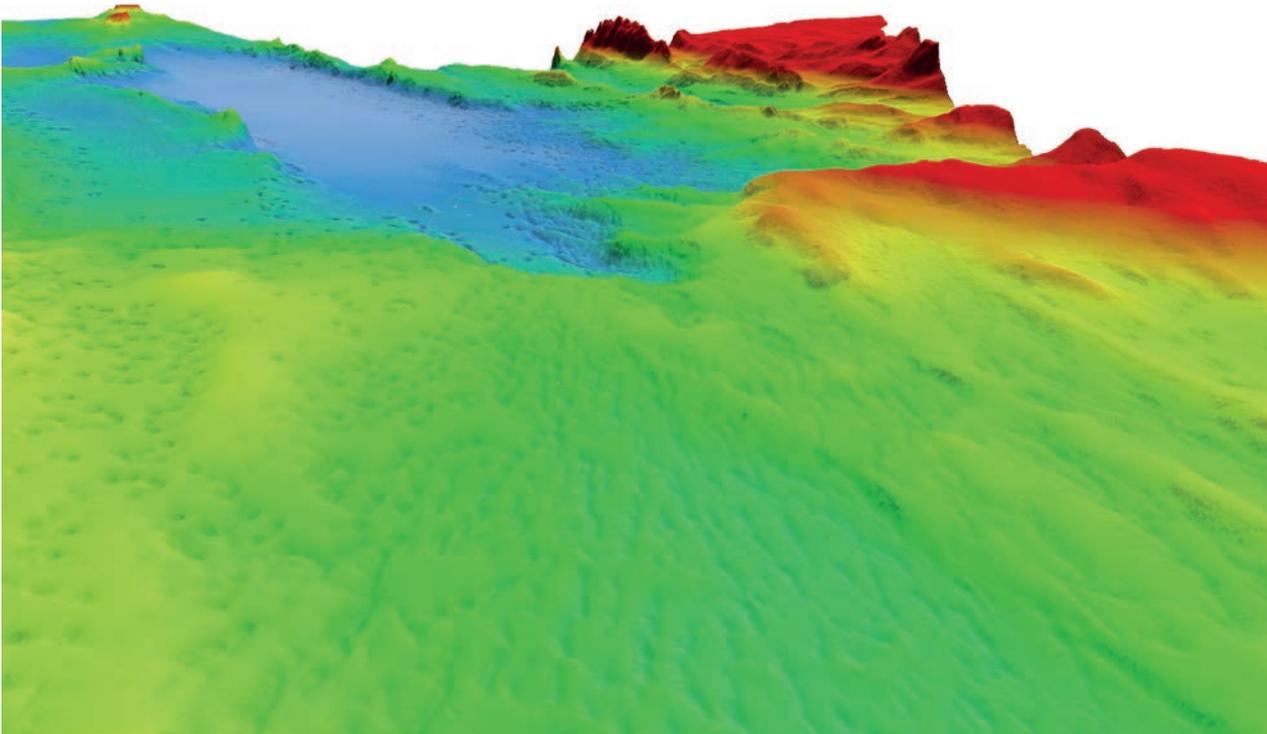
Standards for Hydrographic Surveys (S-44). The hydrospatial data would later be used to update navigational publications to facilitate safe and efficient navigation and contribute to the blue economy in general.

By testing the technology in this project, the CHS could assess the suitability of USVs as a force multiplier (with a larger survey vessel and/or multiple USVs) to expedite seabed mapping in the Canadian Arctic. The ability to reduce the operational time is important in the Arctic, given

the relatively short window of opportunity to survey each year (~July to October).

CHALLENGING ENVIRONMENT

The project area was in the northern part of Lake Superior and the survey was conducted in October and November 2020. The area and timeframe were selected to simulate an Arctic working environment, as the Great Lakes are known for their intense storms and strong winds. An average sea state of 3 on the Beaufort scale, with a maximum sea state of 6, and



▲ Sample bathymetry data captured during the Lake Superior seabed survey.

average wind speed of 25 knots were observed during the survey and transits.

The high winds and low temperatures resulted in freezing spray. It is common for vessels in the region to have ice build-up from these conditions, which can form on just one side and increase the risk of capsizing due to uneven weight distribution. This risk required careful assessment, but the stability of the USVs was not compromised. The low-water USV design and lake water temperature meant that most of the hull was ice free. The convex solar deck, which forms part of the USV's low carbon hybrid power system, also helped to melt any ice that did form. The freezing spray did result in ice forming on the USV gantry. However, the small surface area prevented large ice formations and did not dramatically change the weight distribution or impact the manoeuvrability of the USVs.

WORKFLOW PROCESS

XOCEAN provided and remotely operated the XO-450 USVs from its control centres in the UK and Ireland, while IIC provided the survey party chief, shore-based data processing and logistical support. The USVs are around the size (4.5 metres) and half the weight (750kg) of an average car, and are designed to be remotely monitored and controlled 24/7 via a satellite connection by a team that can be located anywhere in the world. Throughout the mission, the IIC Technologies hydrographers and data processors and XOCEAN USV pilots and surveyors remotely monitored the USVs to ensure safe operation of the vessels and the quality of data acquisition.

The USV automatically followed survey lines during the survey, with the remote pilots monitoring operations. A 50% overlap between adjacent lines was specified by CHS as part of

the survey specification and this was entered into the acquisition software (QINSy) AutoSwath settings. The survey lines were not straight but followed the outer edge of the previous swath, maximizing efficiency. The data density, quality and efficiency were all easily controlled. The USV worked for approximately one week before being recovered for data download, refuelling and servicing. After download, the data was backed up and the USV re-launched. While the USV was surveying, IIC processed the data and reported any issues or data gaps to the XOCEAN operators. IIC then performed the final processing and quality control of the data. This workflow proved to be very productive, and by conducting operations 24 hours per day, the crew could take full advantage of weather windows and field personnel could complete the majority of the processing.

LEARNING OPPORTUNITIES

An important aspect of the project was to record any lessons learned that could be applied to future true Arctic operations. This project presented great learning opportunities for conducting uncrewed hydrographic surveys in northern environments.

The USVs can be conveniently launched using available slipways and boat ramps in the area of operations using a cradle or transport trailer for the USV. It was however noted that, if working in rural and coastal areas, preparations should be made to ensure the launch and recovery equipment can adequately handle poor road conditions (larger/robust trailer tyres, etc.).

The freezing spray posed an issue for one of the USVs and resulted in ice blocking the air intake when the gantry froze over. Sections of the USVs closer to the water line proved less prone to freezing, so the air intake was modified by the IIC team on site to place it closer to the water line and prevent future freezing. The air intake, and other considerations for ice, freezing spray and cold should be closely examined for potential weak points, and these factors have already resulted in an improved design of the XOCEAN USV air intake systems for future operations.

GATHERING BATHYMETRY DATA IN INLAND WATERS

The success of the project demonstrated the highly flexible and collaborative nature of the technology, enabling industry experts to have direct access to real-time data, from any location. The Great Lakes have never been



▲ XØ AN USVs departing for site.



▲ Lake Superior MDI S satellite imagery showing ice coverage. (Courtesy:  A)

mapped in detail in this area and it is likely that the USVs, which produce negligible amounts of carbon, will continue to be used to collect high-quality, high-density data to support initiatives such as Lakebed 2030, while lowering the environmental impact of marine mapping.

The USV platform has demonstrated itself to be a safe, reliable and carbon-neutral solution for the collection of data for this project in inland waters. The same technology and operational efficiencies can be applied to gather bathymetry data in the Arctic and in Canada's ocean environment in general. As industry, government departments and academia continue to collaborate to evolve regulations for Maritime Autonomous Surface Ships (MASS) in Canada and other countries, the applications of USV technology will continue to grow for mapping inland waters and the world's oceans.

A MULTITUDE OF APPLICATIONS

XOCEAN recently celebrated the milestone of delivering over 100 projects in 14 different countries and passing 30,000 operational hours of USV ocean data collection. There are a wide range of applications for the USV platforms, which can be fitted with a large variety of commercial grade payloads. This includes sensors to collect bathymetry and other ocean data types.

Many stakeholders in the marine environment (government agencies, energy companies, research institutes and others) are interested in improving safety by reducing the need for personnel to be offshore, and in reducing carbon emissions during survey operations. Remotely operated USVs provide this and have been used in projects to inspect assets for offshore wind farms and other renewable energy projects (turbine foundations, export and inter-array cables), oil & gas assets (pipelines and platforms), geophysical surveys for new site developments, data harvesting to download data from subsea systems, fisheries surveys for the evaluation of fish stocks, and metocean data.

HOW TO INTERVENE IF SOMETHING GOES WRONG

Pilots and online surveyors interact with the USVs through CyberDeck, which is a highly secure cloud-based environment, and XOCEAN's information security management system is ISO 27001 certified. The control and monitoring of the USV, and online data collection through CyberDeck, is facilitated using several communication channels. These



▲ The XØ AN XØ 450 uncrewed surface vessel in action.

include the primary satellite connection for full uncrewed 'Over-The-Horizon' operation, but also 4G cellular and Wi-Fi connections when working closer to shore. As part of safe operations, a back-up mode of communication is needed in the event of a primary communications failure. In addition to the main satellite receiver, the USV is fitted with a back-up transponder for real-time, two-way messaging to ensure communications redundancy.

The trained and certified pilots continuously monitor the USVs using multiple information feeds for situational awareness to make safe and efficient decisions during operations, and to avoid other marine traffic. The information is provided to the pilots through CyberDeck using the satellite (or other) communication link. This includes details of Automatic Identification System (AIS) equipped vessels, four visible light cameras (facing forwards, to port, to starboard and aft), each with a 90° field of view, a thermal camera for use during periods of poor visibility, artificial intelligence (AI) software to analyse the camera feeds and aid in the identification of possible hazards, and Lidar sensors to notify the pilots of any detected objects.

XOCEAN's operational procedures also employ best industry practices to safely avoid vessel traffic. This includes issuing Notices to Mariners (NtMs) to provide notification to others of the uncrewed operations, and USV pilot standing

instructions to maintain safe distances from other vessels and traffic.

CONCLUSION

XOCEAN has been working with customers in Canada in the second half of 2021 to deliver ocean data for different applications. The projects include an inspection survey for pipeline decommissioning in Nova Scotia, a return to Lake Superior with IIC to collect more high-resolution data for CHS and the mapping of inland waters, and using an XOCEAN USV for the first time in the Arctic for CHS as a force multiplier to perform seabed mapping with IIC and a main survey vessel.

These projects highlight the suitability of uncrewed operations to perform high-quality data collection in a safe and environmentally friendly way in any part of the world, including regions as remote as the Canadian Arctic. ◀



Wim van Wegen is head of content of Hydro International. In his role, he is responsible for the print and online publications of one of the world's leading hydrography trade media brands. He is also a contributor of columns and feature articles, and often interviews experts in the sector.
✉ wim.van.wegen@geomares.nl

Munitions and Wrecks in the North Sea

Dangerous War Remnants

Countless ships and aircraft were lost at sea in the two world wars. Many of these went down with a large amount of fuel and munitions onboard, not to forget the countless sailors and airmen who lost their lives and are entombed in the wrecks. After the wars, redundant ammunition was dumped in the sea, sometimes together with the ships that carried it to the dumpsite. As a result, there are many thousands of wrecks and many tons of conventional munitions and chemical warfare agents in the sea. The question is how these affect our everyday lives.

POTENTIAL DANGERS OF WRECKS

For a long time, the hazard mainly considered was the danger that the wrecks presented to shipping. Over the years, hydrographic offices logged the positions and minimum depths of the wrecks, to decide whether they pose a risk to shipping. Those considered to pose a considerable danger were removed, and the rest were marked on the nautical chart and with buoys where required.

However, two other hazards have come to light over the years. One is the potential explosion of unexploded conventional munition remnants (UXO). Of course, this is nothing new and regular UXO surveys are performed. However, these usually focus on areas of the bottom that are perceived as free from wrecks. As we are running out of space, however, the wrecks with munitions are gaining more attention. The other hazard is less clear and possibly more dangerous. As said, most ships went down with

fuel and munitions onboard and, depending on their operations, they may have even had an almost full complement of both. Over the years, these wrecks have deteriorated. Steel which might have been brand new when the vessel sank is now over 100 years old for wrecks from WWI. However, not only the steel of the vessel deteriorates, but also the materials containing the explosives and the fuel tanks. Consequently, the chemicals contained are being released into the environment, but how much and to what effect?

NORTH SEA WRECKS

To answer these questions, a European Interreg North Sea Region research project was started in 2018 called North Sea Wrecks with the aim of investigating this problem. The project is a cooperation between organizations in Belgium, the Netherlands, Germany, Denmark and Norway. As part of the research, each country is investigating several wrecks which may still

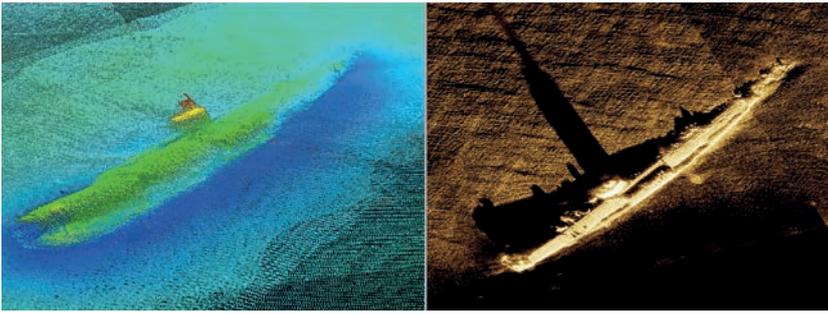
contain dangerous materials in their respective areas of the North Sea. Research is being done by VLIZ in Belgium, the Maritime Institute Willem Barentsz (MIWB) in the Netherlands, the Alfred Wegener Institute in Germany, Aarhus University in Denmark, and the Defence Research Establishment (FFI) in Norway. The focus of the research is mainly on munitions, as least is known about the risks involved with these. The wrecks were selected using historical research with a focus on the war history and the possible presence of munitions on board at the time of sinking.

Using historical records such as those in the German Shipping Museum (DSM) and the German Naval Archives, but also from local records and diving clubs, a survey and sampling campaign was built for each of the wrecks. In each area, several wrecks were surveyed using multibeam echosounder (MBES) and sidescan sonar (SSS) to verify the condition of the wrecks and assess the possibility of finding any remaining munitions. In the Netherlands, MIWB students selected four wrecks as possible contenders. After an initial survey in 2018/2019, two of these wrecks were found to be in such a bad shape that the chance of finding any munitions was small. The two other wrecks, a former Vorpostenboot (a patrol vessel) – the *Max Gundelach* from WWII – and the submarine UB-61 from WWI, were selected for further research.

Using detailed records from the German Naval Archives, the war history of both wrecks was researched. The *Max Gundelach* was found to have been torpedoed by aircraft. During a short but intensive fight, part of the ammunition was used, but the depth charges and much of the smaller munitions were not used in the fight and



▲ Wrecks around the island of Terschelling in Dutch waters. Highlighted is the UB-61.



▲ UB-61 SAS and MBES data from the 2021 survey.

should still be lying on or around the wreck. MBES surveys in 2020 and 2021 showed the wreck in recognizable shape, allowing a directed sampling campaign. The submarine UB-61 hit a mine early on its patrol and sank with all hands after the mine exploded at least two of the torpedoes in the bow. However, the stern was found to be fully intact during the 2020 and 2021 surveys and should still contain two torpedoes, according to the war records. A further synthetic aperture sonar (SAS) survey by the Royal Netherlands Navy vessel *Geosea* confirmed the state of both wrecks.

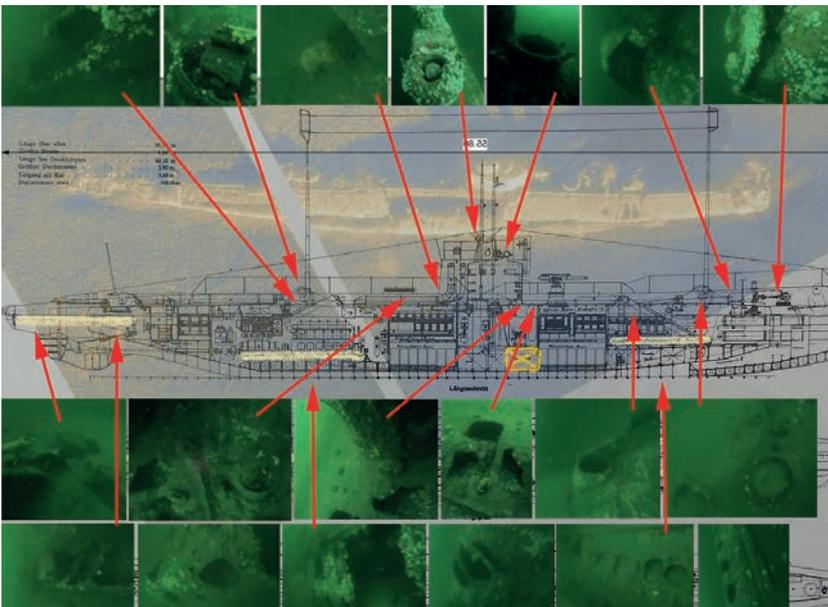
The next step was to perform extensive biochemical sampling. For all wrecks, this was mainly done using divers who not only took samples during their dive but also investigated the condition of the wrecks using video where possible. For the *Max Gundelach* and UB-61, the MIWB students developed a sampling campaign which was executed by the Royal Netherlands Navy in the summer of 2021 using

the HNLMS *Geosea* and *Schiedam* and their dive teams.

Both bottom and water samples were taken at various distances around the wrecks or visible munitions in all countries. In addition, passive samplers and mussels were left on the wreck where possible. Both the mussels and the passive samplers (basically artificial mussels) function as water filtering membranes. During their time on the wreck, they filter the water and any chemical substances are absorbed into their membranes. After a few months on the wrecks, they are retrieved by divers and sent to the Institute of Toxicology at Kiel University. By analysing the membranes, the presence and total amount of chemical substances such as TNT and its derivatives can be assessed.

DANGEROUS OR NOT?

The big question is not whether any chemical substances are leaking from the munitions, which can almost be guaranteed after 100 years



▲ Stills from the dive video overlaid on the drawing and SAS data from UB-61.



www.blueprintsubsea.com
sound by design

oculus

Multibeam Imaging Sonars
Single and Dual Frequency Operation
500m, 1000m and 4000m Depth Rated



seatrac

Micro-USBL Tracking Beacons
Bidirectional Acoustic Data Modems



starfish

Portable Sidescan Sonars
Towed, OEM, Hull and Pole Mounted



find out more

www.blueprintsubsea.com





▲ The legal complications involved in each wreck.

in salt water, but how badly. This concerns not so much the amount that is leaking, but the danger that this presents to the environment in general and humans in particular. These substances are absorbed into the food chain where they can cause cancers and mutations, but the animals who absorb these substances are also eventually eaten by fish, which in turn are eaten by humans.

This danger is not simple to deduce, as the substances are discharged into the water surrounding the munitions and from there disperse. The stronger the currents, the faster the substances disperse and the lower the concentrations found. The research is focusing on determining the amounts that find their way into the food chain and therefore into human foodstuffs. The Institute of Toxicology at Kiel University is investigating the possible toxicological effects on humans.

Most of the samples have now been taken and some of them have been fully analysed. The results confirm the leakage of chemical substances such as TNT derivatives from the munitions. However, the important questions are those concerning their toxicity to animals in general and humans in particular. So far, nothing conclusive can be said on the effects in the real world. In 2021, an additional grant was awarded to the North Sea Wrecks consortium to

assess food safety more closely in relation to wrecks and munitions.

LEGAL COMPLICATIONS

There are so many wrecks that it is hard to decide which ones to deal with first. However, another issue is that little is known about many of the wrecks at sea. In the past, often only positions and depths were logged for the nautical chart. Sometimes we have a name, but rarely information on the cargo carried. One aspect of the project is to determine which information is available and should be collected in a database to assess the risk of the wrecks in terms of munitions and other dangerous substances. Periphus in the Netherlands and North.io in Germany are focusing on this part of the research and are developing a decision support system that will allow policymakers to determine which wrecks should take priority based on objective criteria.

In addition, while there are many national laws and international conventions concerning wrecks, it is unclear which law should take precedence in a certain situation. For example, a war wreck can be a war grave, a cultural historical object, a danger to navigation or a danger to the environment. Often, it is not a choice of one of these but a combination of factors. This legal complication is being further exposed as part of the work done by the MIWB within the project. Ideally, this should result in a

clear decision framework on what to do with a certain wreck in a certain situation (based on the outcome of research and the decision support system). The issue is being discussed within the OSPAR EIHA committee and will hopefully result in the sharing of best practices and possibly a shared approach to the risk assessment of wrecks containing munitions.

CONCLUSIONS

The issue of hazardous wrecks is a complicated one. Currently, we do not know how big the problem is or even if we have a problem at all where the environment or food safety are concerned. More research is required, and a sound policy framework needs to be developed. A good start could be to start compiling a database, accessible for national authorities, of wrecks that are known to contain munitions so that more effective decisions can be made. ◀



Huibert-Jan Lekkerkerk is a contributing editor, freelance hydrographic consultant and author of publications on GNSS and hydrography and a principal lecturer in hydrography at Skilltrade (Cat B) and the MIWB (Cat A) in the Netherlands. He is also a member of the IFHS initial HPAS panel.

✉ info@hydrografie.info

Advanced Navigation



Advanced Navigation is a worldwide leader in AI-based navigation solutions and robotics. We develop solutions from the ground up with a long-standing history of building bespoke hardware and software for our customers. Our expert engineers specialize in developing low SWaP-C (Size, Weight and Power, Cost) solutions in inertial

navigation, GNSS, underwater acoustic navigation and robotics using artificial intelligence. We're trusted by the world's most innovative companies, including NASA, Airbus, Boeing, Tesla, Google, Apple and General Motors. Our latest navigation solution, Boreas, offers a 40% reduction in size, weight, power and cost relative to competing

systems. Boreas is a high-accuracy GPS-aided INS, based on Advanced Navigation's new DFOG (Digital Fibre Optic Gyroscope) technology, which is the culmination of 25 years of development involving two research institutions. Advanced Navigation is an ISO 9001 certified company. All our solutions are designed and manufactured in Australia.

Advanced Navigation, www.advancednavigation.com, +61 2 9099 3800, info@advancednavigation.com

AIRMAR



AIRMAR Technology pushes the boundaries of ultrasonic technology to develop advanced products that withstand the harshest ocean environments while reliably facilitating data gathering from surface to full ocean depth. Our comprehensive suites of oceanographic and survey transducers, plus our IPX7-rated WeatherStation instruments, deliver performance that meets the most challenging mission requirements.

SENSING THROUGH WATER

AIRMAR offers a comprehensive line of transducers for hydrographic survey and underwater scientific applications, including

models suitable for shallow and deepwater survey, sub-bottom profiling, navigation, fisheries research and aquatic habitat assessment. Customization of transducers for specific marine applications is also available.

SENSING WEATHER

We also offer ultrasonic WeatherStation Instruments for ASVs, buoys, offshore monitoring platforms, and more. Developed with an IPX7 rating, along with other features that meet the operational challenges faced at sea, our rugged instruments are trusted to deliver proven performance under the toughest conditions.

ECHORANGE SMART SENSORS

AIRMAR's ultrasonic EchoRange Smart Sensors deliver depth and water temperature data to any NMEA device. With embedded transceivers and sophisticated digital signal processing, they are ideal for applications such as hydrographic survey, ASVs, UUVs and inspection.

Our next-level EchoRange+ with Echo Envelope Option enables user-defined depth range and echo waveform for bottom detection to 200m. Compact and cost effective, with multiple mounting options, EchoRange+ is the most versatile line of field survey transducer available for autonomous hydrographic survey and fixed applications.

AIRMAR Technology Corporation, www.airmar.com, +1 603 673 9570, sales@airmar.com

AML Oceanographic



AML Oceanographic has been a manufacturer of high-performance hydrographic and oceanographic equipment in Canada since 1974. Available through a global network of distributors, AML ensures quality support regardless of buyer location or language.

In 2020, AML debuted the X2•Series Instrumentation and X2change sensors. These highly configurable

multiparameter sondes are designed to suit a wide range of applications. As well as minimizing downtime, the field-swappable sensors also help companies reduce logistic costs. AML's award-winning UV biofouling solution is available with the X2•Series.

AML's Moving Vessel Profiler is the market leader in underway profiling systems and is backed by over

20 years of experience and thousands of successful surveys. By reducing technical and financial unpredictability, the MVP helps survey companies achieve a higher ROI.

Providing a premium service for all is at the heart of AML's mission. Reach out today and experience better with AML Oceanographic.

AML Oceanographic, www.amloceanographic.com, +1 250 656 0771, sales@amloceanographic.com

Applanix



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

With over 20 years of established leadership in the marine sector, POS MV has become the industry standard in positioning for hydrographic vessels. Georeferencing data generated from multibeam

sonar technology using the GNSS-aided inertial positioning system POS MV produces the most advanced and accurate solution for mapping the seafloor. Applanix POS MV products are optimized for marine applications, incorporating technology such as TrueHeave. POS MV can be installed on dedicated survey vessels or deployed on vessels of opportunity for ad hoc survey tasks, covering a variety of applications including seafloor mapping, harbour mapping and coastline mapping above and below the waterline. POSpac MMS for marine is powerful post-mission software for processing sensor

data from your POS MV for highly accurate and robust direct georeferencing. Optimized for the marine environment and compatible with a wide variety of hydrographic processing packages, this software solution achieves both maximum accuracy and maximum efficiency for direct georeferencing survey data. Applanix marine positioning solutions offer a complete hardware and software integrated solution, with industry-leading global support, lowered costs of deployment, faster times to completion and improved quality of data. In a dynamic world, trust Applanix.

Applanix Corporation, www.applanix.com, +1 905 709 4600, marine@applanix.com

Aquatic Drones



Aquatic Drones delivers data processing and predictive maintenance models that fit our clients' workflows and software. More data, fewer costs, a lower carbon footprint and more effective interventions.

Today's challenges in the field of water, river, port, nearshore and sea monitoring for maintenance are complex and require a multidisciplinary approach. We develop sustainable solutions in

collaboration with other technical innovators, our customers, research institutes, our suppliers and leading experts. We also consider the broader environmental and ethical context of where our technology is used. In this way, we aim to balance economic and environmental goals. We are committed to realizing the best for human progress: smart, safe, cost-effective and sustainable.

Authorities and companies that manage and maintain marine assets require data to plan this maintenance. Effective AUV surveys combined with our predictive maintenance models can help them plan dredging operations, repairs and water quality improvements more effectively. The models predict the rate and location of the deterioration of the assets, reducing the costs and the environmental footprint of maintenance operations.

Aquatic Drones, www.aquaticdrones.eu, +31 88 988 8888, info@aquaticdrones.eu

Baywei



Baywei offers high-quality sonar technology at an affordable price, because we believe in making

underwater exploration simpler and more accessible. Baywei delivers the ideal product for the

price-conscious hydrographic professional.

Baywei, www.bayweisonar.com, +36-707-717-680, sales@bayweisonar.com

Blueprint Subsea



Driven by innovation, Blueprint Subsea's leading range of compact, robust, intuitive and affordable underwater acoustic products have been meeting the rigorous demands of the global subsea, offshore and defence

markets since 2006. We specialize in two-dimensional imaging sonars, acoustic positioning beacons and diver navigation systems. Designed, manufactured and tested in-house in the UK's Lake District, we deliver high-quality,

low-cost innovative solutions. All products come with extensive technical support and comprehensive customer service.

Blueprint Subsea, www.blueprintsubsea.com, +44 1539 531536, enquiries@blueprintsubsea.com

CHC Navigation



CHC NAVIGATION AT A GLANCE

CHC Navigation (CHCNAV) is a publicly listed company creating innovative GNSS navigation and positioning solutions. With a global presence across the world and distributors in over 100 countries, and more than 1,300 employees, CHCNAV is today recognized as one of the fastest-growing companies in geomatics technologies.

FROM GNSS SURVEY TO MARINE CONSTRUCTION

CHCNAV develops advanced geospatial technologies and provides a wide range of state-of-the-art

solutions for land surveying, construction, GIS, hydrography and bathymetric survey, deformation monitoring, precision farming and 3D mobile mapping for mass data acquisition.

OUR MARINE SURVEY SOLUTIONS

The Apache series consists of several integrated marine drone solutions for conducting bathymetric surveys, high-resolution hydrographic projects, current profiling and water sampling in a fully autonomous manner. The Apache 3 is an unmanned portable vessel that provides a cost-effective solution for conducting single-beam

bathymetric surveys. The Apache 4 is specifically designed for marine current profiling and is compatible with all major ADCP brands. The Apache 6 is a USV design for high-resolution hydrographic surveys with integrated Norbit™ multibeam echo sounders.

MAKE YOUR WORK MORE EFFICIENT

The CHCNAV slogan perfectly summarizes the way our GNSS positioning and integrated navigation solutions are designed to dramatically improve productivity and provide an outstanding return on investment for our customers and business partners.

CHC Navigation, www.chcnav.com, +86 21 5426 0273, marketing@chcnav.com

EdgeTech



EdgeTech designs, manufactures, sells and supports industry-leading underwater technology solutions. The company has been serving the marine industry for over 50 years with commercial off-the-shelf and customized underwater systems. EdgeTech sonar systems include sidescan sonars,

sub-bottom profilers, bathymetry systems and combined and modular systems. The solutions are available in a range of configurations for towed, deep towed, AUV, USV, ROV, ROTV and custom platforms. The company's underwater actuated and transponding solutions include highly

advanced and reliable USBL systems, transponder beacons, deep-sea acoustic releases, shallow-water and long-life acoustic releases, ropeless fishing systems and underwater acoustic command and control systems.

EdgeTech, www.edgetech.com, +1 508 291 0057, info@edgetech.com

EvoLogics



EvoLogics was founded in 2000 in Berlin, Germany. The company develops innovative bionic technologies for maritime and offshore industries through interdisciplinary cooperation between engineering and life sciences.

EvoLogics solutions for underwater acoustic communication, positioning and novel robotics implement bionic concepts that combine state-of-the-art engineering with the best ideas found in nature.

EvoLogics S2C spread-spectrum communication technology became the basis for the company's commercial line of underwater acoustic modems. Over the years, it grew into an ecosystem of products that includes positioning systems and several series of underwater acoustic modems.

The Sonobot 5 is EvoLogics' uncrewed surface vehicle for hydrography, monitoring and search & rescue. Capable of both autonomous and remotely controlled operation, the robust, fast

and manoeuvrable vehicle is a cost-effective solution for surveys in harbours, inland and coastal waters, as well as hard to reach and dangerous locations.

EvoLogics advanced robotics include several unmanned underwater vehicles based on cutting-edge bionic research. The concepts of Manta Ray, Pogy and PingGuin AUVs draw from wildlife locomotion studies to innovate the modern approach to UUV design.

EvoLogics, www.evologics.de, +49 30 4679 8620, sales@evologics.de

HYPACK



HYPACK, a Xylem brand, has been developing HYPACK, HYSWEEP and DREDGEPACK software solutions since 1984. With over 30 years of experience, and over 10,000 users, HYPACK is a leading provider of hydrographic and dredging software worldwide, supporting over 400 different sensors and devices. HYPACK provides simple-to-use tools to design your survey, acquire and process your data, and create the required final products. HYPACK provides all you need for single beam, sidescan, magnetometer and sub-bottom surveys. Powerful 64-bit editing tools enable you to quickly review and clean your data in preparation for your final output. Modules to create

electronic navigational charts, calculate volumes and generate DXF contours and sidescan mosaics are all part of the package.

HYSWEEP is the add-on module for calibration, data collection and processing for your multibeam sonar and Lidar systems. Supporting nearly all multibeam sonars on the market, you can acquire backscatter, intensity and water column simultaneously with bathymetry. Online real-time CLOUD displays show the system in operation. In the 64-bit HYSWEEP EDITOR, process large datasets efficiently, analysing your data with CUBE, Wobble Analysis and Beam Angle Test. Grid your data and calculate your output for your project requirements: average, mode,

median, standard deviation and more. Export to ASCII XYZ, LAS, matrix files and other custom formats.

DREDGEPACK enables you to monitor and track digging operations for all dredge types. DREDGEPACK monitors the position and depth of the cutting tool in real time and re-maps the bottom based on the depth and location of the digging tool. The colour-coded depth information is displayed in plan and profile views to show the 'As Surveyed' and 'As Dredged' depths for millions of cells. This enables you to maximize digging efficiency and precision to reduce the risk of dredging errors and provide a record of digging operations.

HYPACK - A Xylem Brand, www.hypack.com, + 1-860-635-1500, sales@hypack.com

INNOMAR



INNOMAR provides parametric sub-bottom profilers and associated software that are perfectly suited for high-resolution sub-seabed visualization in water

depths from less than one metre to full ocean depth. Applications include, but are not limited to, dredging, geological surveys, mapping of buried

pipelines, cables and UXO or reconnaissance and route surveys at prospective offshore building sites, such as wind farms.

Innomar Technologie, www.innomar.com, +49 381 44079 0, info@innomar.com

iXblue



iXblue is a global high-tech company specializing in the design and manufacture of advanced marine, photonics and autonomy technologies. The in-house expertise group includes innovative systems and

solutions devoted to inertial navigation, subsea positioning and underwater imaging, as well as shipbuilding and test & simulation. iXblue technologies support civil and defence customers in

carrying out their sea, land and space operations with maximum safety, efficiency and reliability. Employing a workforce of 750 people worldwide, iXblue conducts its business in over 60 countries.

iXblue, www.ixblue.com, +33 1 30 08 88 88, contact@ixblue.com

Klein



Klein, a MIND Technology business, is a leading supplier of sidescan sonar systems. Klein enjoys a worldwide reputation of excellence founded

on high-quality products and customer service. Klein sidescan sonar systems are respected as the standard of excellence in the industry

and are deployed by governments, navies, port authorities, surveyors and universities worldwide.

KLEIN – A MIND Technology Business, www.mind-technology.com, +1 603-893-6131, KleinSales@MIND-Technology.com

Kongsberg Maritime



Kongsberg Maritime is the largest marine technology organization in the world. Its matchless portfolio of integrated, next-generation products and services, supported by a network of expert staff in 117 international locations, enables the company to provide a 'full picture' single supplier solution to meet every customer requirement across the merchant, offshore, subsea and naval sectors, from upgrades to newbuilds. Kongsberg Maritime's comprehensive array of cutting-edge automation, power, propulsion, navigation and dynamic positioning systems, bolstered with an abundance of specialist engineering skills and experienced technical insights, covers all aspects of vessel

design, construction and operation from concept and commissioning onwards, encompassing a vessel's complete working life. Committed to environmental responsibility, Kongsberg Maritime is driving the digital transformation of the maritime industry, enabling the practical application of sustainable ocean policies which meet IMO emission reduction targets. Kongsberg's innovative electric and hybrid power solutions, its offshore training simulators, its development of advanced remote operation and autonomous systems plus its cultivation of IoT platforms capable of integrating and leveraging big data are all designed to enhance energy efficiency,

operational safety, reliability and value. Kongsberg Maritime's portfolio accommodates other clean energy initiatives such as hydroacoustic solutions to facilitate offshore wind turbine installation, operation and maintenance. Beneath the surface, its products range from marine robotics, subsea monitoring and subsea mapping & positioning systems through to integrated drilling units, aquaculture solutions and underwater cameras. Kongsberg's vessel-to-cloud data infrastructure system, Vessel Insight, allows operators to easily access and interpret fleet-wide vessel data, conduct trend analysis and supervise communications, all from a single web interface.

Kongsberg Maritime, www.kongsberg.com, +47 32 28 5000, km.sales@kongsberg.com

Leica Geosystems



AIRBORNE BATHYMETRY SOLUTIONS

Leica Geosystems' airborne bathymetric sensors, Leica Chiroptera 4X and Leica HawkEye 4X, offer unprecedented water depth penetration and seabed object detection even in turbid waters. Together with the Leica Lidar Survey Studio (LSS) processing workflow, the innovative 4X technology increases the point density by a factor of four, significantly reduces operational costs and provides more detail from every flight.

SCALABILITY AND SEAMLESS DATA FROM WATER TO LAND

With integrated bathymetric and topographic sensors, the Chiroptera 4X collects seamless data from water to land. The system is designed to address the growing need to collect high-accuracy data for environmental monitoring and surveying of shallow water regions with a survey depth down to 25 metres. When fitted with the HawkEye 4X deep bathymetric module, the water penetration depths increase to 50 metres.

NEW HIGH-PERFORMANCE PROCESSING WORKFLOW

The LSS workflow provides end-to-end data processing from automatic Lidar calibration, refraction correction and point cloud classification to data enhancement and 3D visualization. The workflow has brought unprecedented improvements for depth penetration, hydrographic object detection and data accuracy.

Leica Geosystems - Part of Hexagon, www.leica-geosystems.com/chiroptera-4x, +46 361 966 80, info.gsd@leica-geosystems.com

MacArtney Underwater Technology



The MacArtney Group is a global supplier of underwater technology solutions specializing in the design, manufacture, sale and service of a wide range of solutions to offshore industry operators, ROV, diving and subsea surveyors, the renewable energy sector, ocean science institutes, maritime civil engineering industries and navies across the world.

MacArtney offers a wide variety of advanced and reliable products and system solutions, from subsea cables and connectors to state-of-the-art integrated packages, including fibre optic telemetry, underwater cameras and lights, oceanographic instruments,

marine winch systems and remotely operated, towed vehicles.

All products supplied are designed and tested to provide high quality, efficiency and reliable performance in the challenging underwater environment.

The highly skilled and experienced staff form the best basis for the supplied services and products. MacArtney aims to be accessible around the world and around the clock. 'Global access to local support' is a mantra recurring throughout the organization at all locations.

MacArtney is a privately owned corporation established in 1978 with group headquarters in Esbjerg (DK). The MacArtney Group also reside in Aberdeen (UK), Stavanger (NO), Mölnlycke (SE), Aix-en-Provence (FR), Bologna (IT), Rotterdam (NL), Kiel (DE), Bremen (DE), Houston, Boston and San Diego (US), Victoria (CA), Dartmouth (CA), Santiago de Chile (CL), Rio de Janeiro (BR), Mumbai (IN/ UAE), Perth (AU), Ningbo (CN) and Singapore (SG).

Moreover, MacArtney operates an extensive network of 23 representatives and distributors spread across every continent. This way, MacArtney products are available locally – with global 24/7 support.

MacArtney A/S, www.macartney.com, +45 7613 2000, +45 7613 2000, info@macartney.com

NORBIT Subsea



NORBIT Subsea designs and develops wideband multibeam sonars for hydrographic applications, forward-looking applications and advanced subsea leakage detection. Our solutions are based on the latest in analogue and digital signal processing and

our products provide wide coverage monitoring combined with high sensitivity and accuracy. NORBIT Subsea is part of the NORBIT Group, an industrial corporation with companies in SubSea, Intelligent Traffic Systems and Original Design

Manufacturing of industrial electronics. Our engineers have pioneered groundbreaking innovations within monitoring, instrumentation, telemetry and communication solutions for harsh environments.

NORBIT Subsea, www.norbit.com/subsea/, +47 73 98 25 50, subsea@norbit.com

PyroScience



PyroScience is one of the world's leading manufacturers of state-of-the-art optical pH, oxygen and temperature sensor technology for industrial and scientific applications, in particular in the growth markets of environment, life science, biotechnology and medical technology. The application areas range from deep-sea research to space exploration.

PyroScience offers innovative sensor concepts with expert customer support to the worldwide research and industrial community, NGOs and governmental organizations. These include several optical meters for diverse analytes (e.g. oxygen, pH, temperature) and a broad range of optical sensor heads based on proprietary REDFLASH technology. All instruments

and sensor heads are developed, designed and produced in-house. PyroScience has transformed its expertise in innovative lab sensor solutions towards a flexible underwater sensor platform and recently launched a unique all-in-one optical sensor technology for advanced underwater applications.

PyroScience, www.pyroscience.com, +49 241 5183 2210, info@pyroscience.com

RBR



Established in 1973, RBR designs and manufactures oceanographic instruments that measure water parameters in some of the harshest

environments on the planet. Our sensor technology is mounted on underwater drones, dropped out of planes, and sent to the bottom of the ocean –

sometimes for years at a time – all in an effort to get precise and accurate data to support world-changing climate research!

RBR, www.rbr-global.com, +1 613 599 8900, info@rbr-global.com

RIEGL – Topo-bathymetric Airborne Laser Scanners and Systems



RIEGL is an international leading provider of cutting-edge Waveform-Lidar technology in airborne, mobile, terrestrial and UAV-based laser scanning solutions in surveying.

For combined topographic and bathymetric surveying, RIEGL offers the **fully integrated airborne laser scanning systems VQ-880-G II and VQ-880-GH**, ideally suited for coastline and shallow water mapping, river bed profiling, measurement

of aggradation zones, hydro-archaeological surveying, and so on. These turnkey surveying systems include a high-end IMU/GNSS unit, up to two high-resolution cameras, and an integrated infrared laser scanner to support the detection of the water surface. The compact and robust housing is compliant with typical aircraft hatches and stabilized platforms. Additionally, the VQ-880-GH's form factor with reduced height is

specifically optimized for helicopter integration. The compact **RIEGL VQ-840-G Topo-Bathymetric Airborne Laser Scanner** offers more than two Secchi depths water penetration. The scanner provides high spatial resolution due to a measurement rate of up to 200kHz and a selectable laser beam divergence. Its low weight of just 12kg allows integration in various aircraft platforms, including UAVs.

RIEGL, www.riegl.com, +43 2982 4211, office@riegl.com

SBG Systems



SBG Systems is a leading supplier of compact, high-performance & cost-effective inertial motion sensing solutions. Our motion sensors and inertial navigation systems are ideal for hydrographic applications, ship motion monitoring, Lidar and buoy orientation and positioning, ROV & AUV control, camera stabilization and antenna tracking.

NEW: FAST AND INTUITIVE POST-PROCESSING IDEAL FOR ALL MARINE SURVEYORS' PROJECTS

SBG Systems' post-processing software, Qinertia, gives access to offline RTK corrections from more

than 8,000 base stations located in 164 countries. Trajectory and orientation are then greatly improved by processing inertial data and raw GNSS observables in forward and backward directions. Qinertia supports third-party IMUs and all GNSS receivers, and covers all surveyors' projects with its new GNSS licence to post-process both static and kinematic GNSS data.

It now includes a brand new Virtual Base Stations (VBS) feature. The VBS computes a virtual network around your project in which position accuracy is maximized, homogeneous and robust, as for PPK short baseline. Surveyors can collect data far from

base stations or over large areas, making it ideal for corridor mapping.

ALL-IN-ONE SOLUTION DEDICATED TO HYDROGRAPHIC SURVEYS IN ALL CONDITIONS

Highly versatile, the Navsight Marine Solution comes as a Motion Reference Unit (MRU), providing roll, pitch and heave, or as a full Navigation Solution with an embedded tri-frequency GNSS receiver or using an external GNSS receiver. Navsight INS offers a continuous position in all conditions, such as surveying under a bridge or during GNSS outages due to coastal infrastructures (buildings, harbour cranes, etc.).

SBG Systems, www.sbg-systems.com, +33 1 80 88 45 00, sales@sbg-systems.com

Seabed



Seabed (founded in 2004 and based in Amsterdam, the Netherlands) is specialized in high-quality equipment for surveying and dredging. Our team of highly qualified engineers, surveyors and sales persons develop, produce and sell products for the offshore and onshore industry.

With our complete team of developers, support engineers, hydrographic surveyors and sales operatives, we aim for the right balance in sales, support and engineering, and are specialized in out-of-the-box solutions. This, together with dealerships of well-known global brands offering

equipment of a very high standard, makes Seabed a reliable partner for all your needs. Our strength lies in finding the most suitable solution for every requirement by using existing equipment and by system integration to fulfil the client's needs. Our team can provide support for every step of the process, including installation and training.

We offer the following products: positioning solutions, sonar/bathymetry, unmanned surface vessels, autonomous underwater vehicles, mobile mapping, underwater sensors, moving vessel profilers, hydrophones, density probes, subsea cameras, DVL,

bottom sampling, crane systems, software solutions, telemetric solutions and cables, and connectors and housing.

All these products are also available for rental. We are expanding our rental pool continuously to keep up with changes in technology.

Interested? Seabed organizes demo days yearly in September, where all the latest equipment is demonstrated. If you wish to attend, please email us at rsvp@seabed.nl. For more information, check out our Seabed Gazette.

Seabed, www.seabed.nl, +31 20 6368443, sales@seabed.nl

Seafloor Systems



Seafloor Systems Inc. is a leading provider of integrated solutions for hydrographic survey applications. Our team of engineers and technicians realize the need for efficiency out in the field, and that's what drives us to keep innovating. From hydroacoustic sonar equipment to our renowned fleet of Unmanned Survey Vessels (USVs), Seafloor offers a breadth of products and services to ensure the success of your hydrographic endeavour – large or small. With proven technological platforms and unparalleled customer service, Seafloor is your go-to supplier for dependable, rugged hydrographic survey solutions.

HYDROGRAPHIC INSTRUMENTS

Seafloor specializes in applications of single beam and multibeam sonar. As system integrators, we offer trusted solutions and components from our portfolio of third-party partners. Our suites of hydrographic and land survey equipment can be scaled to fit any project's desired performance and budget.

UNMANNED VESSELS

Seafloor has been building USVs for over a decade. We lead the market with dynamic platforms that

extend the capabilities of traditional equipment and enable surveyors to remotely navigate otherwise challenging environments. Seafloor's turnkey USV platforms integrate professional-grade technology to efficiently conduct missions on water.

SOFTWARE & SUPPORT

Seafloor's team of engineers and field techs wants to ensure your project goes smoothly. Whether it involves system integration, instrument / software setup or renting equipment before taking the leap to ownership, your success is our priority.

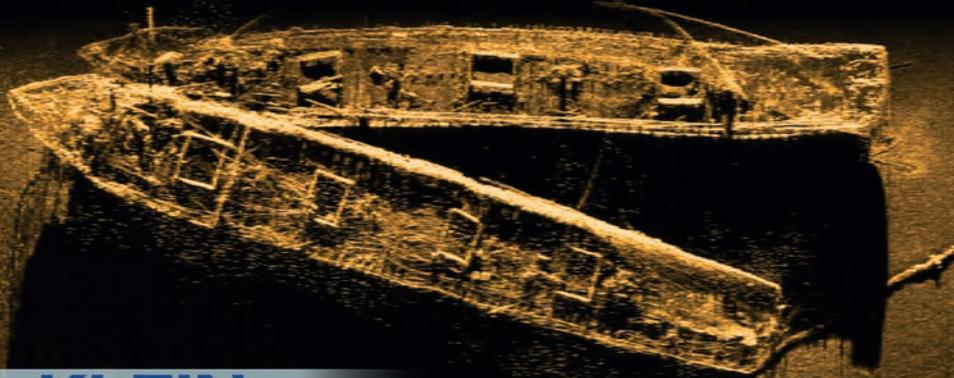
Seafloor Systems, www.seaflorsystems.com, +1 530 677-1019, info@seaflorsystems.com

KLEIN 4K-SVY

Professional Survey Sidescan Sonar
With Tru-Bottom™ Tracking



Dual Modes of Operation:
Survey / High Definition (300 kHz / 600 kHz)



KLEIN
A MIND Technology Business

mind-technology.com



Editorial Overview for 2022

Hydro International Magazines and Theme Weeks



Magazines & Online Theme Weeks

Leading trade journal for hydrography professionals

ISSUE 1

Geophysical Data Acquisition Systems

The availability of multibeam echosounders, sidescan sonar and sub-bottom profilers opens up many possibilities for using different survey configurations.

Orders before: 9 February Artwork before: 16 February Publication date: 2 March

ISSUE 3

Prestigious Projects

This special edition is aimed at highlighting awe-inspiring examples of how technical innovations have made it possible to capture hydrographic data.

Orders before: 20 July Artwork before: 27 July Publication date: 10 August

ISSUE 4

Platforms

Dedicated to vehicles in a multitude of forms, but all with a common feature: the ability to mount sensors on them to do a decent survey job.

Orders before: 28 September Artwork before: 5 October Publication date: 19 October

16
MAR

ONLINE

Offshore Surveying & Marine Renewables Weeks

Focused on the survey requirements for installing windfarms, commissioning and decommissioning platforms, and laying pipelines and cables.

Orders before: 28 January Artwork before: 4 February 14 February - 18 March

11
MAY

ISSUE 2

Positioning & Navigation Systems

Highlighting recent developments in positioning and navigation systems, and investigating how new solutions are set to bridge the gap between RTK & PPP.

Orders before: 20 April Artwork before: 27 April Publication date: 11 May

10
AUG

ONLINE

Bathymetry & Hydrographic Data Weeks

Focusing on bathymetric surveying, the captured data and the use of echosounders, sidescan sonar and advanced positioning systems.

Orders before: 26 August Artwork before: 4 September 12 September - 16 October

19
OCT

14
DEC

ISSUE 5

Business Guide

Once a year we publish the *Hydro International* Business Guide, which serves as a reference work for geo professionals around the world.

Orders before: 23 November Artwork before: 30 November Publication date: 14 December



Sensor Technology



Sensor Technology Ltd. is a client-driven manufacturer of piezoelectric ceramic solutions, custom acoustic transducers and custom hydrophones. Throughout our 38-year history, we have specialized in providing our clients with innovative, customized solutions with repeatable results, which has propelled us into becoming global leaders in piezoelectric-based acoustic tools and systems.

Sensor Technology Ltd. is a Canadian company with an international customer base. We are pleased to

serve clients across the world, with 70% of our products being delivered to international customers. We are well versed in Canadian export regulations and requirements, and we specialize in the defence, aquaculture, energy, oceanography and hydrography industry sectors.

Sensor Technology's success is credited to the long-term foundation of our three core values: Innovation – With a strong research and design foundation, Sensor Technology focuses on providing

effective product solutions to our clients.

Knowledge – With our 35 years of experience in the marketplace, clients can capitalize on Sensor Technology's expertise to create efficient solutions. Customization – Our hallmark is customized solutions. Our strength is in providing innovative, custom solutions to meet each of our client's unique needs. By being nimble, we can provide effective products that reflect the ever-evolving demands of the industry.

Sensor Technology, www.sensortechcanada.com, +1 705 444 1440, techsupport@sensortechcanada.com

Subsea Europe Services



With an extensive portfolio of technology, services and expertise designed to help every organization collect and evaluate marine data on their own terms, Subsea Europe Services GmbH makes it easy to access and use precision sensors and equipment, complete survey systems, cutting-edge unmanned and autonomous platforms and innovative, unifying solutions.

The company's unique 'sensors, systems, solutions' capability, enabled through partnerships with leading technology innovators including R2Sonic, MARTAC, Sonardyne, AML Oceanographics, BeamworX and Seatronics, is as fast as it is flexible, ensuring availability of the best tools for on-demand and planned marine surveys anywhere in Europe on a

rental, sales or – uniquely – subscription basis. While serving a diverse customer base, from offshore wind farm owners and contractors to hydrographic survey companies, government organizations and research institutes, Subsea Europe Services continues to create new developments that simplify and automate the collection of marine data.

Subsea Europe Services, www.subsea-europe.com, +49 40 30700784, surveyready@subsea-europe.com

Teledyne Geospatial



Teledyne Optech and Teledyne CARIS have united to form the new Teledyne Geospatial, offering holistic solutions to seamlessly map land and sea through the integration of industry-leading Lidar sensors and

world-renowned software workflows. This collaboration empowers customers with a competitive edge in mapping and delivering data products inside one complete workflow. Ease of

collection and processing through to final products is enhanced with efficiency-driving AI noise classifying algorithms and real-time quality control.

Teledyne Geospatial, www.teledynegeospatial.com, VAU_inquiries@teledyneoptech.com

Valeport



Valeport provides leading-edge marine sensing and monitoring solutions. We are a British manufacturer of hydrographic, oceanographic and hydrometric instrumentation, which includes bathymetry, CTD & environmental, current, sound velocity and tide gauges.

Valeport has supplied the subsea sector for more than 50 years, supporting hydrographic survey with a comprehensive portfolio of products that deliver highly innovative solutions.

Our recent innovation, the SWIFT CTD, is the next

generation of our most popular range of SWIFT profilers. The SWIFT CTD uses Valeport's world-leading high accuracy sensor technology to combine sensors for multiple profiles in a single drop and provide seamless data transfer for instant use.

Featuring a new fast response thermistor temperature sensor and operating to a depth of 500m as standard, the SWIFT CTD provides enhanced accuracy and versatility for those requiring direct CTD measurements.

The SWIFT CTDplus Turbidity is also available and

incorporates turbidity observations alongside conductivity, pressure and temperature. All with the convenience of Bluetooth connectivity, a rechargeable battery and an integral GPS module to geo-locate each profile.

Find out why Valeport technology is selected by leading subsea, hydrographic, hydrometric, metrological & positioning, oceanographic, ports, harbours & dredging, renewable energy and scientific research organisations worldwide by visiting www.valeport.co.uk.

Valeport, www.valeport.co.uk, +44 1803 869292, sales@valeport.co.uk

A round-table Q&A session with a variety of perspectives

Hydrographic Experts Share Their Thoughts

Hydro International invited various leading experts with different professional backgrounds to share their thoughts on the present and future of the hydrographic industry. This series of Q&As captures the state of the sector from a variety of perspectives, such as which technological and societal developments will have the most impact on the hydrographers of today and tomorrow. Market trends, technological drivers, the main challenges and the impact of the climate crisis were discussed, and the impact of the COVID-19 pandemic reviewed.

5 Questions to....

Commodore Stewart Dunne, Australian Hydrographic Office

What has been the impact of COVID-19 on your business?

The Australian Hydrographic Office (AHO) was affected by COVID-19 lockdowns, restrictions on workplace attendance and travel. As a government agency, we maintained full compliance with the directions mandated by the NSW Government to keep our people and the wider community safe.

The extended lockdown and restrictions significantly affected our people's ability to attend and access the purpose-built facilities and systems at the AHO. Operationally, we did not stop receiving data and assessing its impact on maritime safety. In fact, the amount of information we received continued to grow during lockdown. Our very successful HydroScheme Industry Partnership Program (HIPP) continued to operate and conduct surveys around the country; a testament to the commitment of our industry partners to work and deliver within these trying conditions.

We were able to pivot quickly to enable remote working arrangements and, ultimately, there was no disruption to fulfilling our maritime safety critical obligations.

Additionally, we provided direct support and assistance to the Australian Government's response to the COVID-19 pandemic, with almost 40% of our workforce seconded to Services Australia.

Travel restrictions have meant that in-person attendance at forums, meetings and other key events has essentially ceased. However, modern day technology has allowed a high level of virtual attendance to maintain a tempo of engagement with our domestic and international stakeholders, as well as our near neighbours.

The challenges presented by COVID-19 have also offered an opportunity to develop ICT advancements in our systems, and I am rightly proud of the commitment of our people and what the AHO has been able to deliver in this very challenging time.



What do you consider the key market trend in the coming years?

With the development of advanced positioning and maritime sensors, growing vessel numbers, larger vessels requiring more precise under keel clearance data, and the availability of increasingly sophisticated electronic navigation systems, there has been a steady decline in the use of traditional paper nautical charts and publications.

Our customers are also demanding more of the AHO, wanting data, products and services to be delivered in different and more accessible ways. Since 2018, the International Maritime Organization has mandated that international shipping use Electronic Chart Display and Information Systems (ECDIS), and official electronic navigational charts (ENC) for primary navigation.

The International Hydrographic Organization's (IHO) new hydrographic standards, under the

banner of the S-100 Universal Hydrographic Data Model, have been the impetus behind our digital transformation strategy and implementation plan.

New ENC specifications from the IHO, such as S-101, S-102, S-104 and S-111, will offer more opportunities for the distribution and consumption of high-quality navigation data and efficient route planning; far beyond the current ENC standard of S-57.

From 2025, the AHO will roll out electronic charts compiled to the new S-101 ENC format. This early S-101 production will support training for navigators and pilots, product improvements and the maritime industry in Australia, ensuring we are ready for the arrival of advanced S-100 ECDIS capable ships.

Another notable change for Australian mariners will be to traditional paper charts, which will be replaced by a modern web service. This web service will allow customers or resellers to generate and print 'on-demand paper charts' from the most current electronic navigational chart data available. These 'on-demand charts' will replicate the traditional paper chart experience as far as practicable.

Which technological driver do you consider most important in the coming years?

The big shift in this space is transitioning from a product-centric technological foundation to one that is data-centric, network-enabled and based on the principles of FAIR* data. Agility and interoperability will also be important drivers for our approach to technology in the coming years. As remote sensing and autonomous underwater vehicle technology enhance traditional hydrographic survey data collection, we are managing an unprecedented volume of hydrospatial data at a fidelity and spatiotemporal coverage never before seen; collecting data from remote and autonomous sensors in space, the ocean column, on and below the seafloor.

So, as a modern hydrographic office, we need to be agile and adopt technology that supports realizing the value of our data assets, through analysis, insight and data-driven decision-making. As technology and data-driven innovation continue to develop and mature, our products and services will also evolve through digital transformation projects and marine data infrastructures that support the principles of FAIR* data.

*Findable, Accessible, Interoperable, Reusable [FAIR Principles - GO FAIR (go-fair.org)]

What do you see as the main challenge in the coming years?

We are at a pivotal point for the AHO and the way hydrographic data is collected, processed and delivered. The main challenges for the business are twofold; HIPP and transitioning organizational processes and structures to realize the S-100 Universal Hydrographic Data Model.

A focused data strategy is the key driver in this space, positioning the business into a place of innovation and proactive engagement to realize the S-100 Universal Hydrographic Data Model. The HIPP is a partnership with industry to meet our National Survey Function obligations. Over the medium to long term, HIPP will help drive fundamental change in the delivery of hydrographic and oceanographic services, and the development and innovation of environmental data collection capabilities. The exponential increase in data presents challenges to the current AHO infrastructure in terms of storage, timely processing and distribution. The opportunity to develop and contribute to new products and services as a result of S-100 and advances to modern shipping is inspiring, challenging and exciting.

The climate crisis urges companies to contribute to a safer and more sustainable world. What is your vision on this?

Climate risk offers challenges to those who use our seas and oceans for work or recreation, or who live on the coastal margins.

As a government agency, we are part of the contribution that Australia is making to the global efforts to manage climate risk using practical approaches. One interesting initiative which is specific to the maritime sector is the Clydebank declaration for green shipping corridors. That agreement, which was recently signed at COP26, is an example of a practical way in which the maritime sector will contribute to a more sustainable world.

As Australia's national hydrographic office, it is our role to support not just safety at sea, but also the sustainable use of the global ocean commons, and we will work to that end with our partners at home and overseas. The AHO looks to focus on our Pacific region and to work with our neighbours, recognizing that hydrography has a role in tracking the effects and better understanding the risks associated with climate and disaster risk impacts.

Stewart Dunne

Commodore Stewart Dunne was commissioned into the Royal Australian Navy in August 1990.

During his 31-year career, he has specialized as a hydrographic surveyor and gained experience at sea and ashore in the areas of command, training, operations and capability. As a long-term surveyor, he has a passion for innovation and innovative uses of technology and the Pacific region.

He assumed the role of Hydrographer of Australia on promotion to Commodore in December 2020. Stewart is recognized as a Charge Surveyor and has achieved the internationally accepted H1 specialist qualification and been awarded a Graduate Diploma of Hydrographic Surveying from Plymouth University.



5 Questions to....

Paul Seaton, Fugro

What has been the impact of COVID-19 on your business?

The early impact of COVID-19 was complex for the communities and global markets in which we live and operate. Our priority was to ensure the health and well-being of our colleagues and clients. The pandemic and subsequent closed borders required us to stop all non-essential travel and embrace remote working. There was widespread impact on projects across the world as clients reviewed their plans and the impact that it would have on their own operations. This meant we had to review how we were structured and operated. Despite these challenges, our teams responded well and we were able to continue many of our operations.

Many of the investment and innovation programmes that we had worked on prior to the pandemic became even more important in this new challenging environment. We had been reducing our footprint in the field and working on delivering projects remotely for some time. Our first autonomous vessels were being introduced and new airborne-based systems such as the rapid airborne multibeam mapping system (RAMMS) and the enhanced laser airborne depth sounder (LADS) HD+ were being introduced, with reduced teams in the field. Remote systems and technologies had been developed prior to the pandemic and allowed us to acquire and transfer data from vessels and aircraft straight to the cloud for data processing. We had also been working on cloud-based artificial intelligence and machine learning applications to complement our processing and increase the consistency, quality and speed of data delivery. Through dedicated online platforms, clients were able to access project data in near real time, which enabled quick decision-making. Remote solutions allowed our teams to work from almost anywhere around the world and continue to work on projects and deliver high-quality geodata to our clients when needed.

What do you consider the key market trend in the coming years?

The markets that we are engaged in are changing with an ever-increasing need for accurate geo and hydrosatial data. We will continue to see an

acceleration in the energy transition, the need for sustainable infrastructure and climate change adaptation. Hydrography has a key role in all these trends. Offshore renewable energy will be essential to meet the world's increasing energy needs and reduce carbon emissions. These offshore energy developments require accurate information on the seafloor and a broad range of other marine site characterization analysis.

As the world's population is rapidly growing and becoming increasingly urbanized, we are seeing an increased need for all communities, particularly those in coastal environments, to invest in sustainable infrastructure and the need for more geodata across the land-sea interface. The traditional importance of hydrography to support the safety of navigation for trade, transport, tourism and industries such as fishing is also on the increase. This includes a growing demand for subsea telecommunication cables that are now the backbone of the global economy.

Which technological driver do you consider most important in the coming years?

With an increasing need for geodata, we will see major changes in how it is acquired and analysed and how insights are shared. Fugro is pioneering the introduction of remote and autonomous vessels to enable hydrographic and geophysical surveys and remote inspection services to take place with a reduced project footprint. These will also be faster than conventional methods and safer, as operational teams are now working onshore from remote operations centres (ROCs). With secure satellite or point-to-point communications, we are able to obtain and process data in near real time using a combination of machine learning and artificial intelligence. This transformation in the maritime industry is allowing for a more diverse workforce, which is bringing new insights into the world of hydrography and benefits our stakeholders.

What do you see as the main challenge in the coming years?

The global demand for geodata is increasing. From the hydrographic industry's perspective, we will be required to collect and analyse



ever-increasing quantities of data to be able to provide the advice needed by a broad range of stakeholders to contribute to a safe and liveable world. We will need to continue to invest in innovations such as autonomous vessels, remote sensors such as airborne lidar bathymetry (ALB) and RAMMS systems. We will need to increase the use of cloud-based machine learning and artificial intelligence to keep up with the exponential increase in datasets collected per project.

We need to be open to the broader use of hydrosatial data. No longer will the focus only be on the safety of navigation but also on the wider need for information to manage marine and coastal environments.

The biggest challenge that we will all face in the coming years will be ensuring that there are sufficiently trained and qualified people to meet the challenge. We will need a new generation of well trained and committed professionals to embrace the new remote way of working and collaborating, to deliver the insights our clients

Paul Seaton

Paul Seaton is regional director for Strategic Sales and Marketing (Asia Pacific) for Fugro, a leading geodata company primarily serving the energy and infrastructure industries. With a strong focus on sustainable development, Paul focuses on commercializing remote sensing innovation and harnessing geodata expertise to contribute to a safe and liveable world. Paul has extensive experience with government-funded projects and has represented government at a diplomatic level and as a trade and investment facilitator and a lobbyist. He promotes all of Fugro's carbon-reducing innovations, particularly in hydrography and coastal resilience projects. He leads Fugro's contribution to the GEBCO Seabed 2030 initiative in the Asia Pacific region.

need. This will also have to include our stakeholders, so that they are able to interpret and use the information that is provided. Public and private partnerships and the engagement of communities will be key to us meeting this challenge.

The climate crisis urges companies to contribute to a safer and more sustainable world. What is your vision on this?

Fugro's vision is that we contribute daily towards a safe and liveable world. The climate crisis,

which comes at a time when we are seeing increasing population growth, urbanization and demand for energy and natural resources, makes the task of finding sustainable solutions more important than ever. The commitment of the Fugro team to contribute towards this vision and to help meet the sustainable development challenge is very encouraging.

Throughout our business, we are seeing our colleagues work together to integrate social, economic and environmental considerations into all aspects of the decision-making process. We have set net zero targets for our operations

by 2035 and are on track to meet or exceed these. Embracing low-carbon emission solutions for data collection and increasing the ability to analyse and deliver advice is making a real difference. We are increasingly collaborating with communities and the public sector to deliver these solutions to broader stakeholders. Our workforce is becoming more diversified and increasingly innovative. This is also attracting new and increasingly engaged talent to our teams who want to play a role in meeting the climate challenge, and that is inspiring.

5 Questions to....

Patrick Reyntjes, GEOxyz

What has been the impact of COVID-19 on your business?

COVID-19 has had a huge impact on our company, and required adaptation and rapid change. Certainly, for our logistics department and the offshore teams, it is still a big challenge. But in general, we were able to adapt to the 'new normal' and maintain operations throughout our fleet. We even introduced our new Geo Ocean V during the pandemic and were able to fill her order book completely. We didn't witness a decrease in market demand for our services. There were of course a lot of practical consequences, such as a strict testing policy for the marine and survey crew and ever-changing travel restrictions. Most of our office teams were able to work remotely. Combined with the consequences of the Brexit, COVID-19 has required a lot of extra effort from most of our employees, for which I would like to express my gratitude.

What do you consider the key market trend in the coming years?

The growing renewables market and especially the construction and O&M phase of OWF development will continue to push market demand for the next five years in our main focus regions. Our clients are publishing more and more multidisciplinary tenders that require a combination of techniques and cover the offshore nearshore and intertidal areas. At GEOxyz, we want to support the complete lifecycle of a wind farm.

In the longer term, I think that decommissioning oil rigs or converting them into carbon dioxide

storage facilities will lead to an additional need for hydrographic surveys.

Which technological driver do you consider most important in the coming years?

I believe that the development of USVs will change the way survey campaigns are undertaken. GEOxyz group is investing in the development of USVs that are capable of carrying multiple sensors. Smaller units can be used for port and intertidal surveys and the bigger ones will be used offshore, first as a force multiplier and later as a standalone solution.

I also hope that data processing can be further automated by deploying artificial intelligence. Another challenge is data transfer: being able to transfer the enormous amount of survey data from the survey vessel to shore for high-speed processing at a reasonable cost would further drive our industry.

What do you see as the main challenge in the coming years?

We expect an increasing demand for hydrographic services due to the large investments in the renewable energy market. The current global fleet of survey vessels is too limited to support the market demand. We'll need more manned survey vessels, USVs and remotely operated underwater vehicles. However, most important will be finding the right people to develop and operate these vessels, process the data and turn it into valuable



information. The main challenge will be the 'war on talent'.

GEOxyz has multiple open vacancies for hydrographic surveyors, data processors, project managers, tender engineers and marine crew. I invite all your readers to check out our job-site: <https://jobs.geoxyz.be/en>. Be the captain of your career and come and sail with us.

The climate crisis urges companies to contribute to a safer and more sustainable world. What is your vision on this?

As a company, GEOxyz has a passion for the sea and a strong bond with water and nature. We are always looking for ways to reduce our ecological footprint and increase our sustainability. This is why we are very proud to participate in the ISHY project. The objective of the ISHY project is the development, testing and validation of technical tools and socioeconomic models (business cases) for the implementation of hybrid and hydrogen fuel cell technologies in vessels and ports. Demonstrating the feasibility of these technologies by retrofitting different types of existing vessels is one of the goals. We are also participating in an Interreg Seaweed and Wind project. This project aims to greatly improve the quality and yield of seaweed cultivation at sea. This should make profitable

and sustainable seaweed cultivation possible within wind farms in the Belgian-Dutch border region and throughout the North Sea. The project contributes to the multiple use of space for the wind farms. We are supporting an industrial transition towards a resource-efficient economy, promoting green growth, eco-innovation and environmental performance management.

Patrick Reyntjens

Patrick Reyntjens (1975) is the son of a topographic surveyor and founded GEOxyz in 1999 after obtaining his degree as a construction engineer. GEOxyz started as an onshore survey company but Pat's passion for the sea pushed their activities to nearshore survey and then towards offshore activities. GEOxyz has established itself as a European leading service provider, focusing on marine surveys and offshore renewable support activities with a fleet of over 20 vessels. GEOxyz is currently active in European waters but looking into further expanding its activities.

5 Questions to....

Harald Sternberg, HafenCity University Hamburg

What has been the impact of COVID-19 on your business?

The biggest impact was problems in offline teaching, such as students lacking the technical equipment for home study (webcam, microphone, powerful computer for processing hydrographic data), and for the international students especially there were difficulties with travelling and less contact with the other students. Unfortunately, less practical teaching was able to take place due to additional organizational obstacles such as the implementation of hygiene procedures and restricted group sizes.

However, after the initial problems at the beginning of the pandemic, the technical infrastructure improved drastically, with virtual platforms set up to provide organizational and didactic content. A well-developed digital infrastructure is another important improvement in the overall academic environment, but the lack of contact between teachers and students is still a barrier that cannot be replaced by video conferencing.

There were also disadvantages in terms of research projects and cooperation, as there was less exchange with academic partners, especially in the beginning. Since there were fewer conferences, it was difficult to make new contacts and to network and establish future research projects. Research cruises, including deep-sea monitoring, also had to be cancelled at the beginning of the pandemic but are now taking place although with time-consuming organizational restrictions (quarantine, tests).

What do you consider the key market trend in the coming years?

I don't think there will be just one trend, but a series of further developments, and one of the trends will certainly be the incorporation of BIM in the hydrography sector. Platforms will become more and more modular and adapted to the different survey areas, such as inland water surveying from very shallow waters (creeks, small rivers) to medium-deep waters (coastal waters, large rivers, estuaries) with strong currents.

There will also be a trend towards unmanned vehicles, especially in harbours and other hard-to-reach areas. There, small remotely operated USVs are frequently deployed to cover risky survey areas that cannot be reached by ships. The transition from land to water will be better covered, so there will be a comprehensive underwater and land survey (for quay walls, landing sites, areas with varying water levels) by combining terrestrial scanners and MBES. Lastly, I see increasing opportunities to hire hydrographic survey systems instead of buying them, due to modular systems and changing requirements.

Which technological driver do you consider most important in the coming years?

The most important drivers lie in the automation processes that simplify and accelerate all aspects of marine surveying. Examples are data acquisition with autonomous underwater and surface vehicles and research fields such as autonomous navigation and positioning (above and below the water surface) or even automatic target tracking. Another example is automatic data processing,



which starts with the weighting of individual sensors in Kalman filtering and includes automatic object detection and classification (from both acoustic and optical data) and advanced artificial intelligence for the stable representation of the environment and the automation of processes and methods to produce nautical charts according to S-57 standards.

Finally, sensors will continue to be combined (positioning devices, acoustic, optical, oceanographic, chemical and other sensors), leading to new platforms for observing the marine environment, increasing accuracy and precision and creating multifunctional marine measurement systems.

Harald Sternberg

Harald Sternberg was Professor of Engineering Geodesy from 2001 to 2017 and took over the professorship of Hydrography and Geodesy at HafenCity University in 2017. His research areas include mobile mapping systems on different carriers (cars, ships and indoor cars), the use of low-cost sensors for positioning, indoor positioning, including with 5G, monitoring of structures and analysis of mass data using artificial intelligence. In the field of hydrography, he works on autonomous underwater vehicles, the automatic analysis of underwater images and the interpretation of backscatter data. Prof. Sternberg has also been vice president for teaching since 2009.

What do you see as the main challenge in the coming years?

The biggest challenge is dealing with the immense amount of data that is constantly accumulating in the various fields. It is also necessary to optimize the digital infrastructure, especially in the current pandemic, but the further exploration of undiscovered areas such as the deep sea and a better understanding of the ocean ecosystem are also on the agenda. Here, a current topic is the exploration of the deep sea for resources. This is a major challenge as it involves the sustainable use of the oceans, the establishment of marine protected areas, but also the exploration of renewable resources.

Increasing economic trade leads to the need for a stable marine infrastructure in coastal areas, ports and rivers. This is why there will be further large-scale projects such as the deepening of the river Elbe. It is the task of hydro companies and institutes to monitor and protect such projects with their expertise (also with regard to the environment).

The climate crisis urges companies to contribute to a safer and more sustainable world. What is your vision on this?

We are all urged to do our part, and this starts with adapting internal company policies to ensure a carbon-neutral company/institute. We need to balance the net benefits of each survey against the carbon emissions it generates and, with regards to

marine mammals communicating through sonar signals, we need to try to avoid noise emissions and operate in a responsible manner. We also need to improve our methods for maintaining risk- and hazard-free routes through appropriate surveying in coastal and inland waters. For example, it is of major importance to ensure safe shipping passage, as accidents on the water can cause irreversible damage to the natural environment. Research projects and extended exchanges between young and motivated researchers contribute to a better understanding of natural processes, which is the key to a safe and sustainable world. The hydrographic institutes can play an important role in this.

5 Questions to....

Duncan Mallace, XOCEAN

What has been the impact of COVID-19 on your business?

2020 saw some projects delayed until 2021, but we still managed to triple our growth in 2020 and are on course to do the same in 2021. Logistically, it was difficult in 2020 to get the USVs to project locations and we had to be creative with where we fitted out and tested the survey equipment. We have also had to work hard on procedures and guidelines as we have been shipping the USVs worldwide and relying on third party companies to maintain and launch the USVs. Once in the water, the USVs are controlled by our USV pilots remotely. All the companies we have worked for and with have been absolutely brilliant and very accommodating.

What do you consider the key market trend in the coming years?

There are three main trends. The key growth market is offshore wind. This is on a global scale now and will only increase. Judging by our clients' comments and requests, the operational trend is definitely towards uncrewed solutions both above and below water. Carbon neutral and safety continue to be key ESG goals. There is also a trend to collect ever higher resolution data as it de-risks the installation and long-term life of the offshore wind farms. USVs collect great data as they are so acoustically quiet and we use the latest, highest resolution technology.

Which technological driver do you consider most important in the coming years?

Low Earth orbit satellites providing high bandwidth, low latency and low cost will have a significant impact. This will enhance many aspects of our business and produce new ways of working. Having fibre-like speeds will allow us to upload the survey data as soon as it is acquired, which will then feed into our cloud-based data processing network.

What do you see as the main challenge in the coming years?

We plan to recruit a further 100 people across the business over the next six months. As our personnel operate our USVs remotely and our data processing is in the cloud, all employees can work remotely. This offers a different work-life balance for our team without the need to go offshore. We are also trying to 'follow the sun' by having employees across the globe, so



that unsociable shift patterns can be a thing of the past.

The climate crisis urges companies to contribute to a safer and more sustainable world. What is your vision on this?

From the beginning of the company, safety and sustainability have been at the core of everything we do. Our emissions are 0.1% of those of a normal survey vessel and no people are required to go offshore. This approach aligns closely with that of our customers and partners – where the remote collection of high-quality data is key. ◀

Duncan Mallace

Duncan Mallace is chief strategy officer of XOCEAN. He has over 29 years of experience in the collection, processing and analysis of ocean data. A highly skilled hydrographic surveyor, he was a pioneer and early adopter of high-resolution multibeam technology in the early 1990s and helped push the boundaries of multibeam technology from its infancy to the de facto tool for seabed mapping that it is today.



KONGSBERG

TECHNOLOGIES FOR

SUSTAINABLE OCEANS



RRS Sir David Attenborough is one of the world's most advanced polar research ships, helping scientists to address the environmental challenges of the future.

KONGSBERG's integrated Full Picture solutions provided will maximise the vessel's performance. Scan the QR-code to read the full story.



kongsberg.com/maritime



EvoLogics®

SMART SUBSEA SOLUTIONS

Delivering data in most adverse conditions: underwater acoustic modems with advanced communication technology and networking

Accurate USBL and LBL positioning of underwater assets

Modem emulator and other cost-saving developer tools

Autonomous surface vehicle for bathymetry, monitoring, search & rescue, and AUV support

**NEW
USBL BUOY**

**AVAILABLE
NOW**

The easiest way to deploy a USBL transceiver:

the USBL buoy is a fully integrated solution based on EvoLogics S2C USBL devices

