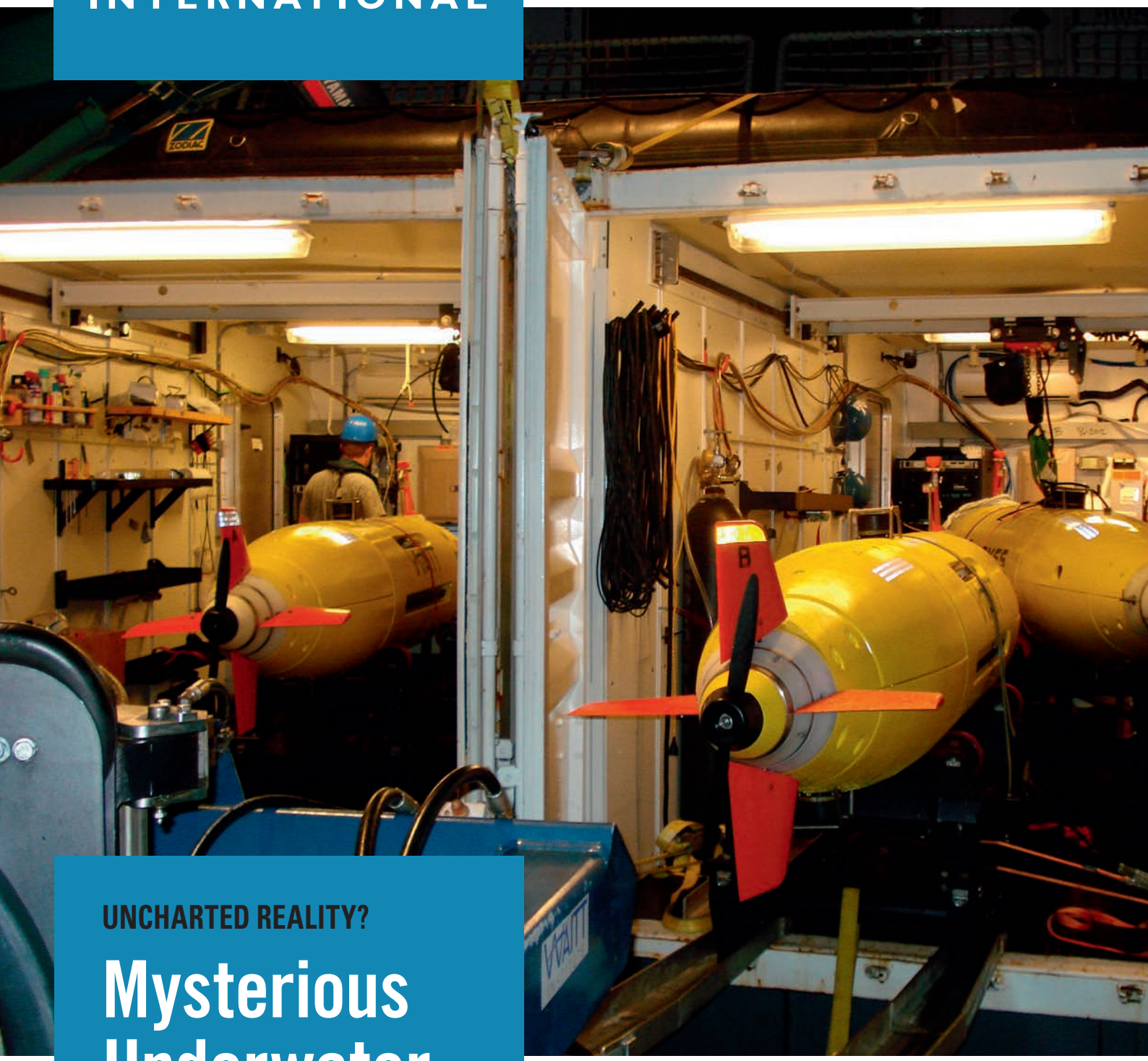
Hydro INTERNATIONAL

THE GLOBAL MAGAZINE FOR HYDROGRAPHY

WWW.HYDRO-INTERNATIONAL.COM

geomares PUBLISHING

JANUARY / FEBRUARY 2015 | VOLUME 19 NUMBER 1



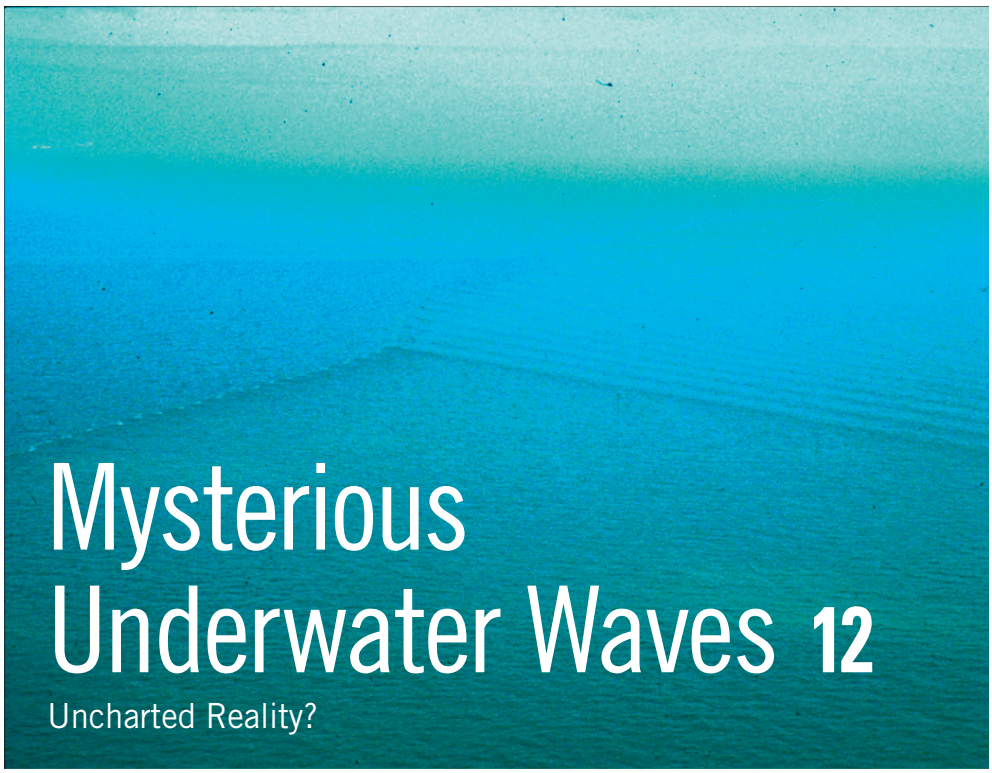
UNCHARTED REALITY?

Mysterious Underwater Waves

Hovercraft-based Munitions Detection System

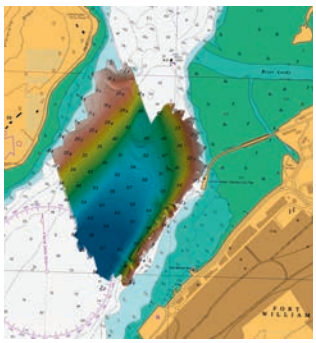
AF447 Search Lessons Learned

Hydro International Interviews Mike Purcell



Mysterious Underwater Waves 12

Uncharted Reality?



January/February 2015
Volume 19 #1

AUVs in a van, in use at WHOI. In this issue: an interview with WHOI's Mike Purcell. He shares his experience with deep-sea aircraft searches. Image courtesy: Mike Purcell.

HYDRO ALPHABETICAL LIST OF ADVERTISERS

Hydro International is an independent international magazine published 8 times a year by Geomares Publishing. The magazine and related e-newsletter inform worldwide professional, industrial and governmental readers of the latest news and developments in the hydrographic, surveying, marine cartographic and geomatics world. Hydro international encompasses all aspects, activities and equipment related to the acquisition, processing, presentation, control and management of hydrographic and surveying-related activities.

Publishing Company:
Geomares Publishing
P.O. Box 112, 8530 AC Lemmer, The Netherlands
Phone: +31 (0) 514 56 18 54, Fax: +31 (0) 514 56 38 98
info@geomares.nl
www.geomares.nl

 ISSN 1385-4569

Advertisements
Information about advertising is available in the media planner on our website or by contacting our account manager (herma.lenten@geomares.nl).

Buyers Guide
Hydrography is booming — survey companies, data specialists, hydrographers, cartographers, oceanographers. . . they are all working hard to get the job done. And they need to invest for an improved handling of their clients requests. Time is scarce. . . that's why Hydro international is preparing a Buyer's Guide to facilitate communication between you and your clients.
The Buyer's Guide features Company Profiles, Contact Details and an online directory with a categorised overview of suppliers. The Buyer's Guide is distributed among subscribers of *Hydro International*, visitors to international trade shows throughout the year and is available from www.hydro-international.com/buyersguide — thus it is a valuable information source to consult regularly throughout the year. For further information, please contact herma.lenten@geomares.nl

Paid Subscription
Hydro International is available bi-monthly on a subscription basis. The annual subscription rate for Hydro international is €100 within the European Union, and €145 for non-European countries. Subscription can commence at any time, by arrangement via our website or by contacting Abonnementenland, a Dutch subscription administration company. Subscriptions are automatically renewed upon expiry, unless Abonnementenland receives written notification of cancellation at least 60 days before expiry date. Prices and conditions may be subject to change. For multi-year subscription rates or information on current paid subscriptions, contact Abonnementenland, Postbus 20, 1910 AA Uitgeest, Netherlands, +31 (0)251-257926, (09.00-17.00 hrs, UTC +1) paidsubscription@geomares.nl

Editorial Contributions
All material submitted to the publisher (Geomares Publishing) 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 Publishing assumes no responsibility for unsolicited material or for the accuracy of information thus received. Geomares Publishing assumes, in addition, no obligation for return postage of material if not explicitly requested. Contributions must be sent to the editorial manager joost.boers@geomares.nl.

Reprints
Printed copies of all articles (including those published in earlier issues) can be ordered. For more information, please contact trea.fledderus@geomares.nl

PHOTOGRAPHY: ARIE BRUINSMA (WWW.ARIEBRUINSMA.NL)

Old and **New**

It's with great pleasure that I write this first editorial of the new year 2015, although we are still in the last days of the old year. 2015 will again be a year in which *Hydro International* will bring you monthly updates on news and developments in the world of hydrography – and of course you can find all the news, every day, on the website www.hydro-international.com. The word 'world' is not only taken literally - while we try to report from different corners from our globe, we also physically and digitally send our magazine to all those corners as well.

A new year ahead in which we will try to shed light on all aspects of hydrography, old and new, brought to you by our editors – also old and new. I wouldn't dare to make the comparison myself, but because Andreasen brought it up, I think I can: like the two grumpy old men of the Muppet show, Statler and Waldorf, RADM Angrisano and RADM Andreasen give their views on hydrography from the balcony. Both former presidents of the International Hydrographic Bureau, they give an update from Monaco. Chris Andreasen reports in his Insiders' View column on page 6 on what he sees as the most important decision taken during the 5th Extraordinary Hydrographic Conference held last October in Monaco: the adoption of 'Crowdsourced Bathymetry'. Giuseppe Angrisano already gave a broad overview in the Visited for You column of *Hydro International*'s last issue of 2014. On a side note, I know that the comparison only holds for the part of looking down from the balcony of the hall of hydrography, giving valuable comments for the younger generations. Both men are far from grumpy and not at all old! I am grateful that they chose *Hydro International* to share their views!

Our editor Marck Smit went down to Woods Hole, Massachusetts, United States, to interview Mike Purcell, principal engineer at the Oceanographic Systems Laboratory of the Woods Hole Oceanographic Institute (see page 9). Purcell is the man whose team finally found the wreckage of flight AF447, which went down in the Atlantic Ocean off Brazil in 2011. A story that is still very current, taking into account the disappearance of flight MH370, which has still not been found in the vast sea areas of the Indian Ocean west of Australia, and as I write this, a new drama is unfolding as AirAsia flight QZ8501 went missing in the Java Sea off the coast of Indonesia. Hydrography sees itself placed at the forefront of the dramatic task of looking for the wrecks of these planes and giving answers to the many questions on the causes of the incidents. A dramatic task that becomes gratifying when successful – and the bereaved finally receive information on the last resting places of their family, the victims of the disaster.

I am sure this year's first issue of *Hydro International* will make for an interesting read; not just the above-mentioned pieces , but also the other articles and news items. I would like to end this first editorial of 2015 by wishing you a safe, successful, healthy and optimistic new year!

Durk Haarsma durk.haarsma@geomares.nl

Important Step Forward by the IHO

RADM Angrisano and I, as former Presidents, were invited Observers at the 5th Extraordinary Hydrographic Conference held in Monaco. As we were seated high in the hall, one Delegation commented that we were like Statler and Waldorf, the two grumpy old men in the balcony of Muppet shows. It is a pleasure to express views from the 'balcony' for 'Insider's View'.

The most important decision taken was adoption of 'Crowdsourced Bathymetry'; acquisition of bathymetric data from vessels of opportunity equipped with a data logger. For us old timers, this is not a new thought in that for years the US Defense Mapping Agency sought to equip such vessels with its 'black box' concept, an effort before its time.

There are significant uncharted ocean areas and areas to be monitored for change. As many civil vessels such as cruise ships, fishermen and private sailors venture into such areas, they present an opportunity for collection of data albeit not to IHO standards since the data will not likely have tidal control, sound velocity calibration, etc., yet such soundings are of great interest to others who follow into these uncharted areas. In addition, remote sensing from aircraft and satellites provides another non-standard source of great interest.

The Conference decided to assign the task of developing a 'cook book' to guide the acquisition and handling of such data to the GEBCO (General Bathymetric Chart of the Oceans) committee, a joint IHO/IOC (Intergovernmental Oceanographic Commission) committee. GEBCO has been developing the bathymetric representation of the world's oceans for decades using non-standard and standard data along with expert scientific interpretation of seafloor topography. In 1990, the IHO Data Center for Digital Bathymetry was established to support the GEBCO effort, and this will store the crowdsourced data. GEBCO bathymetry was originally compiled at 1:10 million scale, however, as time has progressed, a regional series has been evolving at a scale of 1:1 million. GEBCO and the Google Ocean compilations are clearly bumping up against the work of national charting authorities. Adoption of 'Crowdsourced Bathymetry' by IHO provides a way forward that can avoid potential conflicts while benefitting the mariner.

The handling of such data within the IHO community, particularly the GEBCO Committee, presents radically different challenges. Vice Admiral, Dr. Shin TANI of Japan, Chair of the GEBCO Guiding Committee, raised the possibility of moving the Committee from the IRCC (Inter-Regional Coordination Committee) to HSSC (Hydrographic Services and Standards Committee), but this was not accepted. From the 'balcony' position, I think it is correct to maintain the non-standard data in IRCC, but there will certainly be major impacts for HSSC display of the data.

RADM Angrisano (left) and RADM Chris Andreasen (right) observing during the E-IHC in October 2014.

A major challenge will be how to represent the non-standard data to the mariner in conjunction with standard chart data. The current approach of CATZOC assignment of Zones of Confidence is gaining traction, but much standard data has yet to be categorised. As an old timer, I always liked the concept of 1% of depth plus a fixed value for the uncertainty near shore. A presentation on satellite bathymetry at the EIHC cited 15% of water depth plus 0.5 metre. Remote sensing techniques will certainly provide data that are accurate within 5%, 10% and 25% of depth with the added complication of differing resolutions.

IHO Member States will learn that satellite bathymetry with look angles, glint, geodetic controls, tides coordination and water clarity are quite complex with significant risk of poor data if not handled expertly. Industry and the hydrographic offices need to partner to address such challenges.

The Professional Yachting Association, which participated in a demonstration with the IHB, strongly supported the adoption of crowdsourcing. Their members want such data to be compiled and made widely available.

The most important aspect is to develop a means for display of these data in a way that causes the mariner to have lesser confidence in the data and to exercise greater caution when navigating such areas due to the greater uncertainties.

As this evolves, Rear Admiral Angrisano and I will be watching from the balcony commenting somewhat like our Muppet compatriots!

The new Geomares Publishing offices are situated on the quayside.

New Offices for Geomares Publishing

Geomares Publishing has moved to new premises. The company moved to Vuurtorenweg 18b in Lemmer, the Netherlands on 5 December 2014. After more than 20 years at the centre of Lemmer, the publisher of *Hydro International*, *GIM International* and *Geo-matching.com* has relocated to a quayside location.

▸ ***http://bit.ly/151QAKB***

Third Fugro Vessel and AUV Joins Search for Missing MH370

An additional Fugro vessel has been commissioned to carry out underwater search activities for missing Malaysia Airlines flight MH370. *Fugro Supporter*, a multi-purpose offshore survey vessel, is currently on its way to the Southern Indian Ocean search area, having conducted trials in Bali. The vessel is equipped with a Kongsberg HUGIN 4500 autonomous underwater vehicle (AUV) which will be used to scan those portions of the search area that cannot be searched effectively by the equipment on other vessels.

▸ ***http://bit.ly/151QSRJ***

Fugro Supporter.

Top 5 Geo-Matching.com

Geo-matching.com The right choice

Multibeam Echo Sounders	
Kongsberg Maritime EM 2040	http://ow.ly/HCFV6
Teledyne Reson Seabat 7125	http://ow.ly/HCG1w
R2Sonic Sonic 2024	http://ow.ly/HCG7z
Kongsberg Maritime EM 2040 Compact Single	http://ow.ly/HCGdX
Edgetech 4600	http://ow.ly/HCGiI

Most Shared

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

Seafloor Exploration in Malta - http://bit.ly/1yEUV4n
Teledyne Gavia AUV to Aid in Search for AirAsia QZ8501 - http://bit.ly/1yERPgC
Deadly Combination of Changing Ocean Conditions Poses Threat for Coral Reefs - http://bit.ly/1yEVCKM
OpenSeaMap - the Free Nautical Chart - http://bit.ly/1yEVLOD
Deepwater Black Box Retrieval - http://bit.ly/OePanF

MACHC Welcomes New Members

The Meso American & Caribbean Sea Hydrographic Commission (MACHC) held its 15th meeting in Manzanillo, Mexico, from 10-13 December 2014, during which it welcomed Saint Vincent and the Grenadines and Costa Rica as members. The meeting was preceded by the Second Mexican Hydrographic Conference and a Hydrographic Awareness Seminar. The Government of Mexico, through the Mexican General Office of Oceanography, Hydrography and Meteorology, also organised some Industry Day activities for the delegates.

▸ ***http://bit.ly/1yESK0s***

Subsonus USBL Released

Advanced Navigation has released their Subsonus USBL underwater acoustic positioning system. According to the manufacturer, this is a next-generation USBL underwater acoustic positioning system that provides high-accuracy position, velocity and heading at depths of up to 1,000 metres. The system features a hydrophone array combined with an internal tightly coupled INS, all packed into a miniature titanium enclosure small enough to fit in the palm of a hand.

▸ ***http://bit.ly/151ReaX***

Subsonus USBL

Quick-deploy 'PulSAR' Side-scan Sonar

Kongsberg Maritime, Norway, has introduced a tow fish side-scan sonar for use in search and recovery (SAR) missions as well as underwater inspection, engineering and scientific surveys. Developed by Kongsberg Geoacoustics, PulSAR is designed for intuitive operation and easy deployment by non-specialised personnel, enabling effective short-notice surveys using vessels of opportunity.

▸ ***http://bit.ly/151S8nL***

Kongsberg PulSAR Side-scan Sonar

Hydro International Interviews Mike Purcell

Lessons Learned From the AF447 Search

It was a rainy day at Woods Hole, Massachusetts, USA. The scenery reminds me of the Twin Peaks atmosphere. I am about to interview Mike Purcell, the man whose search team finally found the wreckage of flight AF447 in the deep ocean in 2011. Only five years after this tragedy a second airliner, the MH370, vanished into the deep ocean. Major search operations have been going on since then. *Hydro International* found this to be a good reason to look back with Mike and see what lessons have been learned in this deep ocean search operation.

When did WHOI get involved in the AF447 search?

We were asked to participate in the search that started about ten months after the crash by the BEA, the French Bureau of Aeronautical Safety. We worked from the M/V *Sea Worker* with three identical AUVs. It was a large mission with a lot of people on board. As I said, the terrain was so rough that we really had to learn about it. On the first three missions we ran into vertical cliffs. In the first week we operated just one AUV. Good multibeam data were available of the entire search area, collected by Ifremer research vessels. After a steep learning curve we were successful in operating the three vehicles.

The search in 2010 was unsuccessful. So a new operation was started in 2011.

It took almost a year before a new search operation started in phase IV. Especially Air France and Airbus really wanted to know what had happened with that plane. The search operation in phase IV changed entirely - we went on a much smaller vessel, with a smaller team entirely focused on the AUV search operation. Operating AUVs does not require a very sophisticated vessel, which allowed us to keep the costs lower. You don't need DP, you don't need an ROV in the search phase. We were able to use the AUV cameras to identify side-scan sonar targets. We did not have to bring anything back, we only had to locate it. And if we were to find it they would organise a follow-on operation, for which they already had bids available. Deploying our own Launch and Recovery System (LARS) ensured smooth and effective operations

Can you describe the moment that you found it?

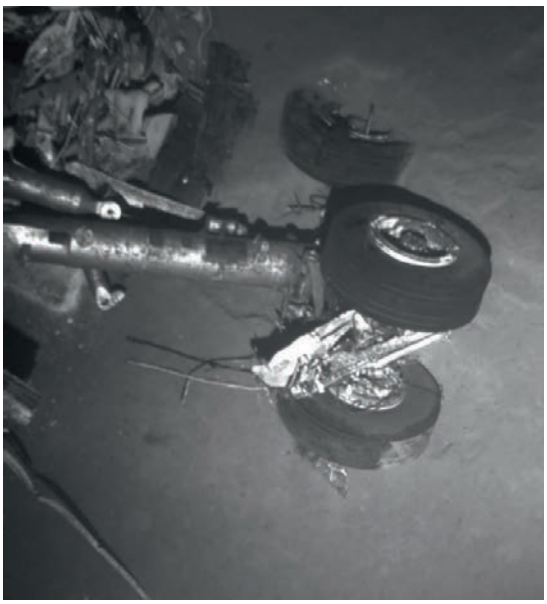
We found it on the 9th day! Mission 109. We got those side-scan images and we were quite sure that this was going to be it. An exciting moment! We sent out Mission 113 to take pictures. When the vehicle came up to the surface we had the worst weather. It was the worst storm during the 70 days that we were out there. We had to wait 2 hours to get the AUV on board. Weather conditions could change rapidly in this region. Once we got it on board, it took several hours to download all the pictures. However, we could start looking at the pictures we had downloaded and there

▲ *Mike Purcell. Image courtesy: Marck Smit.*

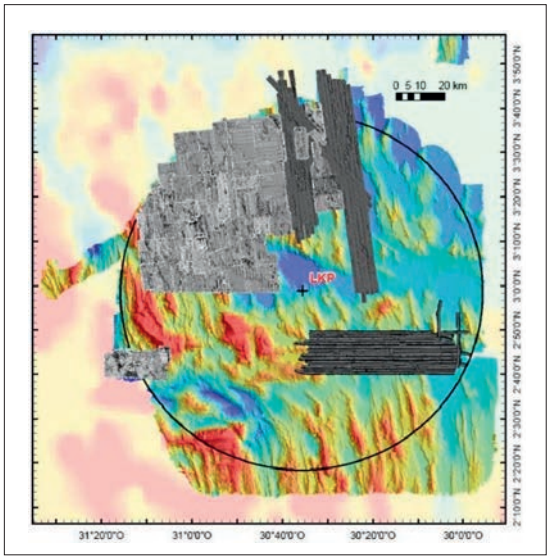
was no doubt! We had found it! In all we took 85,000 pictures.

I can imagine that finding the plane resulted in mixed emotions?

From a professional point of view it felt like a great achievement. We had made a big commitment to the search for two years and we were happy that it turned out to be successful. It was also good to see that a technology that we had been working on for a long time made a significant contribution. On the other hand, at the moment of finding the wreckage we suddenly realised what a catastrophe it was. It definitely affects you emotionally. It was not easy to look at the pictures, but I know from talking to relatives of victims that it meant a lot to them that the plane had been found. And in the recovery operation a lot of the remains were recovered. I know this provided closure for some of the relatives and friends of the victims. This is one of the reasons for making a similar effort with the MH370 flight.



▲ *Figure 2: Landing gear of AF447. Image courtesy: BEA/WHOI.*



▲ *Figure 3: AF447 search area. Image courtesy: Stéphanie Dupré/Ifremer/BEA*

What do you consider as critical success factors?

Using the right equipment! The AUV was definitely the right piece of equipment for the AF447 search. In phase III, when the towed system was there, we went back into areas that they had already surveyed but that required another look because of the terrain. Having multiple vehicles definitively allowed us to cover a lot of ground faster. And running the three AUVs at one time resulted in a very effective operation. We managed to cover up to 240km²/day in the more benign areas. I think even operating 4 vehicles at the same time would be possible. You might need a second launcher and a few extra people. If you have 4 vehicles you cover the ground so fast that you might not able to move the LBL transponders fast enough with one ship. There is certainly an advantage when operating identical AUVs compared to operating different AUVs that might have different navigation systems. Because we developed the AUVs here and experienced just about everything that could go wrong, I think we took a more aggressive approach in using them. But in the end, in my opinion, the most important factor in this tough environment is perseverance. You will not find it until you look in the right place. The more places you look, the more chance you have of finding it. So just start mowing the lawn and keep on doing that as fast as you can.

Just start mowing the lawn and keep on doing that as fast as you can

What lessons did you learn from this operation?

What we discovered is that you are dealing with a lot of uncertain information in such a search operation. You cannot count on the pingers: after a crash it is always unclear if they are going to work. They towed the pinger locators right over the wreck shortly after the crash, and they didn't hear anything. When the black boxes were found, only one pinger was still attached. The other one was never found. So you cannot fully rely on these tools. And you can't rely 100% on the oceanographic modelling. The modelling by the oceanographers should lead to an estimated point of impact. But there just wasn't enough information to develop a good model. There are no extensive measurements of that area. At the time, these data did not provide the answers we needed.

How would you compare towed versus AUV search operations?

It has a lot to do with what the terrain is going to be. If you are working in rough terrain the AUVs perform better. Since the towed systems can put power down the line, they can look at longer ranges. In cases where the search area is very large then you can tow for long distances without having to turn around. Turning a towed system takes a lot of time, while an AUV can turn around in 10 seconds. If you have multiple AUVs you can compete with a towed systems coverage rate. You can be a lot more flexible in your search strategy using AUVs. It is easy to go back to an area that you have missed. Or checking a target by taking pictures can be done easily, without having to pull a towed vehicle out of the water. And your side-scan data will have a higher resolution. On the other hand, many survey companies are more familiar and experienced with using towed systems, making it a more robust choice.

What are the major differences compared with the MH370 search?

We are currently not directly involved. It would be a tough project for us. To take a lead in such a large project. You have to look at 60,000km² in 300 days, that's a huge contract. We were contacted by many parties. There is hardly any knowledge on the position and the search area in much larger - more than 4 times the size of the

AF447 area. Even this search area has many uncertainties. A key factor is that no floating debris has been found so far. They are further from shore, which makes the logistics more difficult. The weather there

In all we took 85,000 pictures

is potentially much worse and could be a real factor. It also affects AUV operations. Fugro won the the Australian Government's contract. At this moment [December 2014, ed.], they are primarily doing towed sonar operations using two vessels in the southern part of the search area. The more south, the rougher and deeper it gets. And Phoenix is out there with a third vessel on a Malaysian contract in the northern part of the search area.

Could the black box pingers be improved?

Black box pingers ping at a very high rate, every second. They don't need to ping that often. So they are just using old technology developed for something else. This could change. A lower frequency would extend the range. Using a transponder instead of a pinger would also be an option.

I'm not an aviation guy but there is obviously the possibility of reporting location information once every minute or every second, rather than once every 10 minutes. That would lessen some of the issues. Why the MH370 stopped transmitting the information is a mystery.

Two airliners disappeared into the deep ocean in a period of five years. The search for a black box pinger calls for a really rapid response. Is the world community ready for such a rapid response?

The towed pinger locator operations in the MH370 search did not start until almost a month after the disappearance. Approximately 62% of the battery life of the black box pingers had by then already been consumed. As a result of the AF447 crash, the required battery life will be increased to 90 days as of March 2015 and a low frequency pinger 8.8kHz will be mandatory, increasing the range from 1km to 4km. The US Navy has a contract with Phoenix to be almost on standby for search and recovery operations. They can respond really quickly. But it is costly to have the equipment on standby. A relatively small joint investment by the airlines industry could ensure that they have the right personnel and equipment on standby. ◀

Michael Purcell

Michael (Mike) Purcell (56), the man whose team finally found the wreckage of flight AF447, works at Woods Hole Oceanographic Institute (WHOI) as principal engineer in the Oceanographic Systems Laboratory. He started at WHOI in 1991 as engineer in the Oceanographic Systems Laboratory working with towed systems and Sea Floor Observatory Systems. He has been working on AUVs since 1994. During the AF447 search operation he was Chief of Sea Operations on the research vessel *Alucia* operating 3 Remus 6,000 AUVs.

✉ mpurcell@whoi.edu

Uncharted Reality?

Mysterious **Underwater Waves**

In addition to surface waves generated by wind, tidal forces or, in case of tsunamis, seismic events, there exists a less well-known class of bigger waves under water. These underwater waves (internal waves) are generated by the same forces, but owe their existence to the ocean's non-uniform density distribution. This paper introduces various underwater waves that appear on interfaces or in continuous density stratification. In uniformly-stratified seas, these waves differ from surface waves in nearly every conceivable aspect, creating underwater 'storms' at certain hotspots, which may possibly impact natural and man-made structures, and which may transport heat and material vertically.

The ocean's salt and heat content, which determines its density, vary with depth. This stable stratification supports underwater waves. Due to slight differences in density, these waves easily displace fluid parcels vertically over hundreds of metres.

The presence of localised regions of intense internal wave activity may be keeping the oceans healthy

Depending on the local rate with which density increases with depth, they propagate either horizontally or obliquely into the abyss. The former, interfacial waves, are partly visible at the surface, but the latter, abyssal waves, remain elusive. Theory and laboratory idealisations provide understanding, but observing their unusual properties at sea remains challenging owing to lack of proper instruments.

Internal Waves

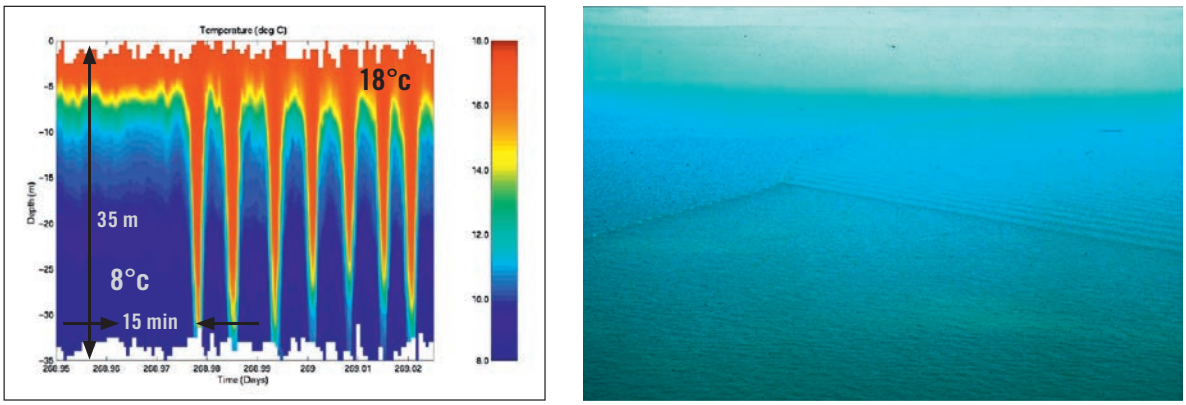
Regular arrays of clouds in the sky are manifestations of waves in the atmosphere, visualised by condensation of water vapour in wave crests. They classify as internal waves as their maximum vertical displacements occur in the atmosphere's interior, away from its boundary. While ocean and atmosphere are dynamically quite similar, we never see such waves in the ocean though, because the ocean is opaque. Light penetrates a mere hundred metres, leaving the remainder of the ocean literally and figuratively in the dark.

But oceanographic instruments 'visualise the invisible'. These show temperature and salinity, and hence density, to vary with increasing depth. Below the wind-mixed surface layer this change occurs abruptly, at the so-called thermocline, which supports horizontally propagating interfacial waves. Below the thermocline, density increases gradually, and an entirely different type of wave penetrates obliquely into the deep sea.

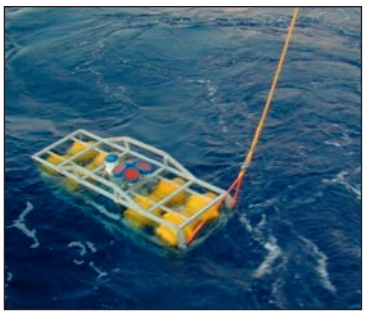
Interfacial Waves

Interfacial waves, propagating along a thermocline, are similar to surface waves. But, since the density contrast between underwater layers is much less than that between water and air, the acceleration of gravity that a displaced fluid parcel senses is reduced by approximately a factor thousand, the ratio of the cross-thermocline density difference to mean density. Therefore, interfacial waves attain larger amplitudes (up to hundreds of metres), have longer periods (longer than 10 minutes, say) and have wavelengths (up to kilometres) that are short compared to those of surface waves of identical period. Interfacial waves of tidal period (internal tides), for instance, are much shorter than the thousands of kilometres long surface tides.

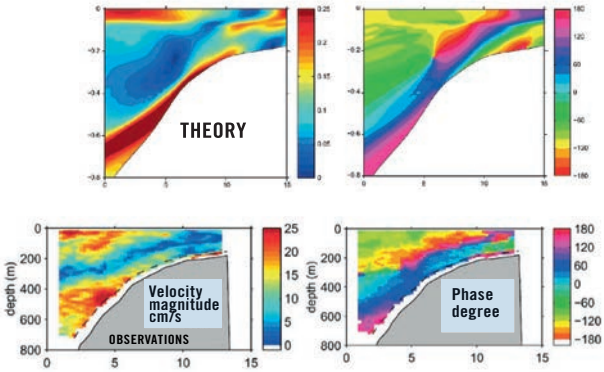
Underwater interfacial tides steepen and form trains of solitary waves (see Figure 1a, showing temperature as a function of time-depth). Strong accelerations in these solitons have likely caused reported submarine crashes. Because of the proximity of the interface to the surface, converging and diverging currents associated with solitary waves strain short surface wind waves, leaving an imprint at the surface that can be spotted from satellite or, as in Figure 1b, airplane. Here, a front marks the transition between salty North Sea water on the left and fresh river Rhine water on the right that flows out on top of it. At the interface between the two, internal solitary waves are present. These are imaged at the surface while propagating towards the reader and are quite distinct from the short familiar wind waves. Compare also to the tanker in the upper right of this photo.



▲ *Figure 1: a. Soliton train. (Image courtesy: Stanton and Ostrovsky, 1998). b. Aerial photograph of front with surface expression of underwater solitons. (Image courtesy: Rijkswaterstaat).*



◀ *Figure 2: a. Towed ADCP. (Image courtesy: Hans van Haren). b. Modelled and observed internal tide. (Image courtesy: Lam et al, 2014).*



Deep-sea Underwater Waves

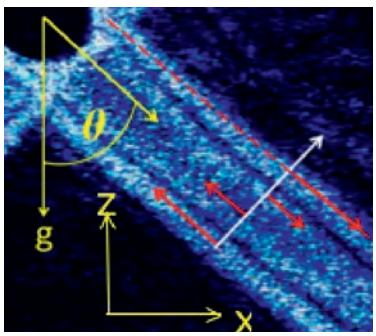
Internal gravity waves propagating in the continuously-stratified deep sea may however go unnoticed. At present, there is no instrument that can give us a good spatio-temporal view of the internal wave field. We have to do with a collection of contact instruments, like thermistors, current meters, or with remotely-sensing instruments, such as the Acoustic Doppler Current Profiler (ADCP) shown in Figure 2a, instruments that are either deployed or employed on a moving ship (Figure 2b). The intensity and Doppler-shifted frequency of the ADCP's back-reflected, previously transmitted sound can be used to determine density surfaces and to measure currents along the line of view. Figure 2b shows numerically computed (top) and observed (bottom) cross-topography velocity amplitude (cm/s, left) and phase (degrees, right) of the internal tide generated near the shelf edge in the Bay of Biscay as a function of cross-topography distance (km) and depth (m). Needless to say, neither moored nor ship data yield a complete view of the (four-dimensional!) internal wave field. The sparse data leave voids, voids often filled with model results. For this reason internal waves are studied in conceptual theoretical, laboratory and more realistic numerical models, leaving the discovery of their spatio-temporal patterns in nature for future work.

Laboratory Experiments

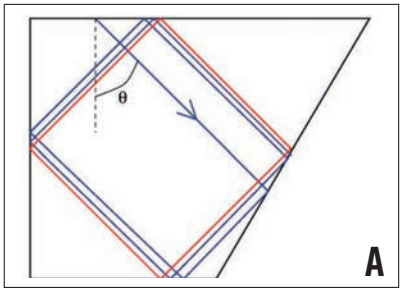
A laboratory model of a uniformly-stratified ocean can be created by adding successively more salt to a fluid when filling a tank from the bottom upwards. Perturbations of this quiescent, undisturbed state are produced by oscillating a cylinder vertically (Figure 3). Using the fact that light refraction depends on fluid density, underwater waves change brightness and reveal their oblique propagation. The beam inclination θ relative to the direction of gravity, g, turns out to be uniquely determined by the ratio of the oscillation frequency to a frequency characterising the stratification rate. It produces four internal wave beams (one shown here) along which energy propagates obliquely up and downward and left and rightwards. Phase (crests and troughs) propagate perpendicular to these beams (white arrow) and sheared currents (red arrows) are parallel to the beams.

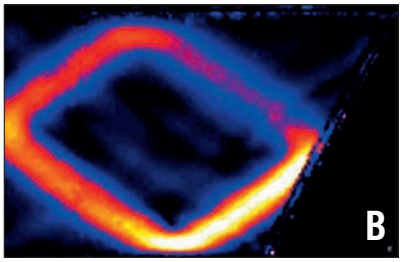
Since reflection of an underwater wave does not change its rate of incidence, neither will its inclination θ. Therefore, when this beam undergoes multiple side wall reflections (blue lines Figure 4a) it focuses onto a periodic orbit, called an internal wave attractor (red line). Since the wave beam's energy flux is preserved when the underwater waves reflect from sloping walls intense beams result. As in the laboratory experiment in Figure 4b, in semi-enclosed seas this may lead to 'hotspots' where underwater wave energy piles up.

Oceanographic instruments 'visualise the invisible'

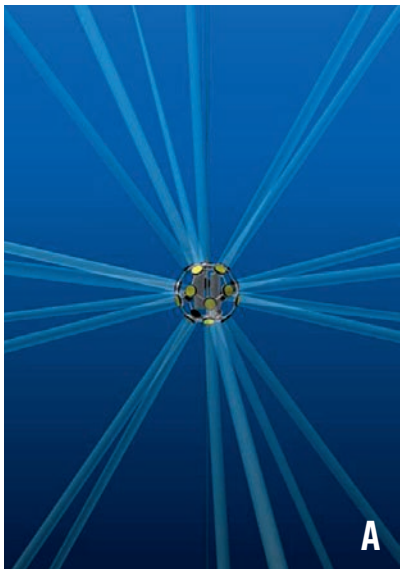


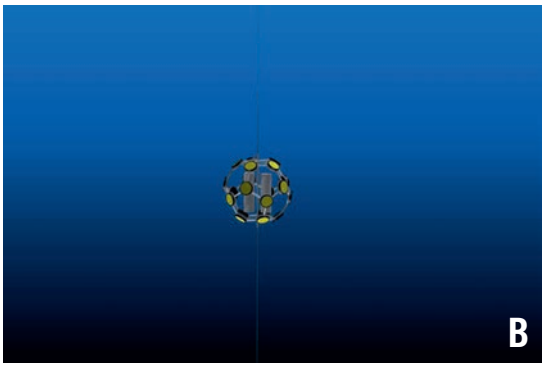
▲ *Figure 3: Experimental excitation of underwater wave beam.*





▲ *Figure 4: Side view of trapezoidal basin containing a uniformly-stratified fluid, displaying a wave attractor.*





▲ *Figure 5a, b: Artist impressions of 'futuristic' Dodecahedron-shaped ADCP.*

Conclusion

Because the ocean is three-dimensional, of complex shape, non-uniformly stratified, and 'large', it is currently impossible to predict whether and where ocean attractors exist. Internal waves might follow paths that are perhaps too long to overcome viscous and frictional damping. On the other hand, this decay might be counterbalanced by re-amplification due to intermediate reflections from sloping bottoms. Thus, generally speaking, we expect the appearance of localised regions where internal wave activity is large. These hotspots may be perceived as locations subject to underwater storms, which may prove hazardous to e.g. risers, submarines or exploitation platforms. The presence of localised regions of intense internal wave activity may also be keeping the oceans healthy as it may offer a fast track along which oxygen, plankton and nutrients may be transported from surface to bottom or vice versa. A widely-spaced array of conventional, seafloor-tethered ADCPs will still not provide the horizontal spatial resolution required to capture these hotspots. But, perhaps a new type of ADCP that 'watches' in all kind of directions will allow us to measure three-dimensional velocities within a spherical domain, enabling us to 'see' underwater waves (Figure 5). ◀

Further Reading

Lam, F.P.A, Maas, L.R.M. and T. Gerkema, 2004, Spatial structure of tidal and residual currents as observed over the shelf break in the Bay of Deep-Sea Research I 51 (2004) 1075–1096.

Stanton, T.P. and Ostrovsky, Observations of highly nonlinear internal solitons over the continental shelf, 1998, Geophysical Research Letters 25, 2695–2698.

Maas, L.R.M, Wave attractors: linear yet nonlinear, 2005, International Journal of Bifurcation and Chaos, Vol. 15, No. 9 (2005) 2757–2782.

Hazewinkel, J., S.B. Dalziel and L.R.M. Maas, Attractive internal wave patterns. https://www.youtube.com/watch?feature=player_detailpage&v=w444rzkJv8I

Leo Maas

Prof **Leo Maas** is an oceanographer, interested in waves in stratified and rotating fluids. He has published over 60 papers in international journals and teaches a class on internal waves at Utrecht University.
✉ maas@nioz.nl

MEC/UXO Detection in Previously Unreachable Locations

Hovercraft-based Munitions Detection System

Survey efforts in shallow water present a challenge; when coupled with protected species and critical habitat such as coral reefs, they can prove impossible. Tetra Tech, in conjunction with Neoteric Hovercraft, Inc., has developed an environmentally sensitive survey platform, which now allows for data collection in such areas. The TEMA-Lite (Towed ElectroMagnetic Array) is a hovercraft-based munitions detection system capable of collecting data in areas where previously only more expensive, less sensitive aircraft-based systems were able to perform.

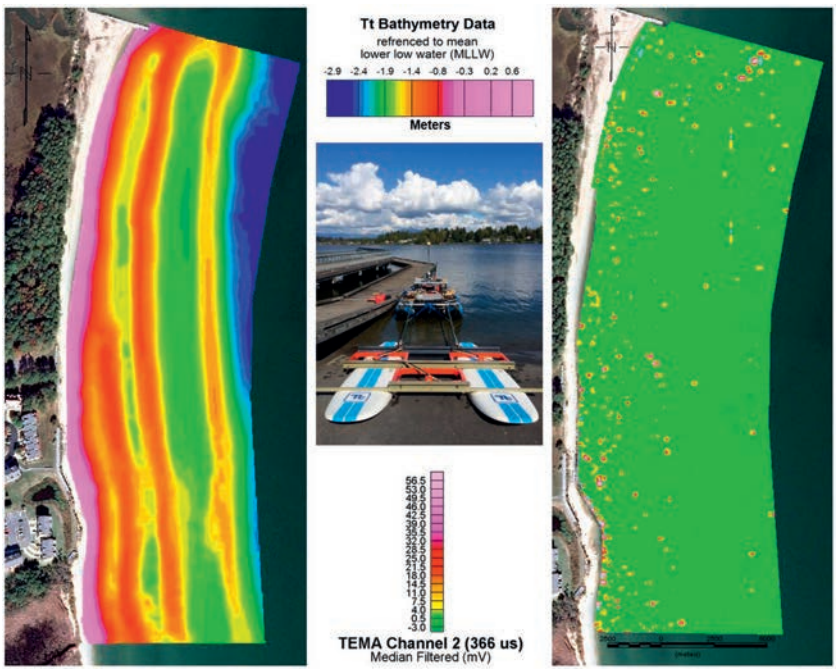
The TEMA (Towed ElectroMagnetic Array) system has multiple form factors and two deployment types, each with a three-metre swath width. The deep-tow TEMA MK3 operates in 3 to 100 metres of water; the TEMA-Lite operates in extremely shallow water to approximately 40 metres depth.

The system can be configured as a surface-floated array or bottom-towed sled. It can be pushed, surface towed, or dragged as a sled behind a small boat, or pushed while rigidly attached to a boat or to a customised hovercraft. When deployed via hovercraft, it increases shallow-water capability. The detector system can be hand-carried and assembled in remote locations.

Underwater Detection Capability

Tetra Tech's detection systems were developed based on several decades of Munitions & Explosives of Concern/Unexploded Ordnance (MEC/UXO) detection and remediation for the US Navy, US Army Corps of Engineers and commercial clients. Differentiators include:

- Unlike a magnetometer, the TEMA is an active sensor that can detect all metals, ferrous (magnetic) and non-ferrous (e.g. aluminium), requiring only one system and one pass for full detection capability.
- The system's detectors are focused and thus are insensitive to nearby metal structures such as piers, bulkheads and bridges, allowing surveys in areas where magnetometers cannot operate.
- Equipped with 1080p HD video/still cameras and underwater lighting, the system provides real-time visual data informing operators on detects (e.g. an anchor vs. a bomb).
- Data from all devices - multiple EM sensors, altimeters, attitude sensors and video/photos - are multiplexed and streamed real-time to the surface via a single fibre optic cable.



▲ *Figure 1: Example of multibeam bathymetry data (left) and electromagnetic data (right) from a shallow-water MEC/UXO site.*

The Hovercraft

Tetra Tech has researched the use of hovercraft for MEC/UXO survey for many years, particularly for use in difficult areas for data collection, such as surf zones and shorelines. A hovercraft allows ingress to areas inaccessible by foot or by conventional watercraft.

Tetra Tech selected Neoteric Hovercraft, Inc. to produce the hovercraft for their system for several reasons. Neoteric is the world's original light hovercraft manufacturer, with

▲ *Figure 2: Example 1 of coral reef areas that are now accessible due to the use of a hovercraft to deploy the sensor platform.*

▲ *Figure 3: Example 2 of coral reef areas that are now accessible due to the use of a hovercraft to deploy the sensor platform.*

commercial, rescue, military and recreational customers in more than 50 countries.

Additionally, the Neoteric HoverTrek was found to outmanoeuvre other hovercraft, and Tetra Tech's projects require that increased control. The hovercraft features a patented fly-by-wire reverse thrust system, making it the only model on the market with effective brakes. Neoteric's reverse thrust system surpasses jet aircraft in efficiency: while most aircraft deliver an average of 18 percent thrust in reverse, the HoverTrek delivers 60 percent. This innovative system enables the hovercraft to fly backward, spin and hover over ice and on swift water. Since it weighs less than 600lbs. (273kg), the hovercraft can be piloted directly to sites or it can be airlifted.

System that can travel where no other watercraft is able to travel

Finally, Neoteric has long expertise in custom manufacturing hovercraft to customer specifications, and the company mandated repeated, extensive testing throughout the customisation of the hovercraft for the survey work.

Customisations

The customisations incorporated during the manufacture of the hovercraft that was used for the survey include:

- Mounting points for the sensor array
- Mounts for the sensor's electronic modules
- Mounts for the pilot's display and for data collectors' displays (2)
- Table for data collectors
- Detector battery mounts (3)
- GPS antenna mounts (2)
- Bimini top

Previous Survey Work

The TEMA system has been deployed on multiple MEC/UXO surveys as part of the suite of tools used, including multibeam bathymetry, side-scan sonar, sub-bottom profiling and underwater video. The system has been deployed as surface-towed as well as pushed. An example of data from the surface-deployed detection system is shown in Figure 1. Both the underwater and surface deployments are generally lower vibration than equivalent land-based carts. This yields data with less vibration induced noise.

The First TEMA/Hovercraft Project

Tetra Tech will use the hovercraft-based system in the spring of 2015 to conduct Phase 2 of an ongoing MEC/UXO remedial investigation and feasibility study at a Defence Environmental Restoration Programme (DERP) for Formerly Used Defence Sites (FUDS) location in the Caribbean. The site served as an impact range for aerial bombs and rockets, missiles, mortars and naval projectiles from 1903 until 1975. Phase 1 work involved performing an environmental baseline study (EBS) of the site. The purpose of the EBS was to provide information to help characterise the nature and extent of sensitive marine habitats such as coral reefs and seagrass beds and endangered or threatened species within the boundaries of the site. The objective of the EBS field activities was to identify areas and boundaries of sensitive habitat and to determine where towed operations and sampling can be safely conducted without damaging these resources during the follow-on phases of the field investigation. This will include the Phase 2 activities using towed geophysical sensors and the Phase 3 intrusive activities. Underwater investigation activities conducted as part of the EBS consisted of visual observations, boat operations and remote sensing surveys including multibeam bathymetry, side-scan sonar and underwater video.

The entire site comprises 1,030 acres; the area to be surveyed using the hovercraft-based system is more than 200 acres consisting of shallow coral reefs with listed and protected corals. This area was originally excluded from the survey due to the potential for damaging the coral.

Positioning Equipment

For the Caribbean project, Real-Time Kinematic Global Positioning System (RTK GPS) along with the following systems:

- iXBlue Global Acoustic Positioning System Ultra Short BaseLine acoustic positioning system (iXBlue GAPS USBL)
- Applanix Position and Orientation System

▲ *Figure 4: In an early prototype developmental model Neoteric Hovercraft, the TEMA-Lite concept is tested and evaluated in the determination of the optimal pivoting and pushing system.*

Marine Vessel (Applanix POS MV)
- iXBlue PHINS 6000 subsea inertial navigation system (INS).

Conclusion

In conjunction with Neoteric Hovercraft, Inc., Tetra Tech has created a munitions detection system that will travel where no other watercraft is able to travel and where sensitive habitat is only inches below the water's surface. By using this system, which hovers nine inches (0.22m) above the surface of water, a MEC/UXO survey can now be conducted in the Caribbean with confidence that the coral reefs will not be harmed.

▲ *Figure 5: Onboard instrumentation and work stations in the customised hovercraft.*

The hovercraft-based system is also significantly more cost-effective than a helicopter-based system, which is the only other viable alternative. This new system also allows more effective detection of UXO, since a hovercraft travels closer to the items than would a helicopter.

In the future, Tetra Tech plans to use the Neoteric HoverTrek with many other sensor systems, including bathymetric and laser line scanners. ◀

Richard Funk

Richard Funk, PG, Senior Geophysicist with Tetra Tech's Marine Mapping Group, USA, is lead designer for development and testing of Tetra Tech's custom towed underwater sensor platforms. His 16 years of experience include design and management of high-resolution integrated geophysical programmes for marine investigations, including dredge design and monitoring, geotechnical, geologic, hydrogeologic, cultural resource features and OE/MEC/UXO.
✉ Richard.Funk@tetratech.com

Christopher Fitzgerald

Christopher Fitzgerald, Mechanical and Aeronautical Engineer, is founder/president of Neoteric Hovercraft, Inc., and Hovercraft Training Centers, LLC., as well as founder and past president and treasurer of the HoverClub of America, Inc. For decades he has organised major hovercraft events throughout the world, and is co-author of *Hovercraft Technology, Economics and Applications and Light Hovercraft Design.*
✉ Chris@neoterichovercraft.com

Sharolyn Herring

Sharolyn Herring, Writer/Consultant to Neoteric Hovercraft, Inc. and Hovercraft Training Centers, LLC, also serves as Writer/SEO/SM director for numerous hovercraft websites and events.
✉ Sharolyn@neoterichovercraft.com

Mapping the **Floor of Upper Loch Linnhe** Using AUVs

Due to their particularly shallow and turbulent thermocline, conducting seafloor mapping in lochs, fjords and other estuaries always presents a unique challenge to the hydrographic surveyor. Surface vessels often struggle to obtain accurate measurements due to the highly variable impedance of an estuary's mixing layer, which causes frequent and significant changes in the salinity (and, by extension, density and temperature) of the brackish water. These rapid changes in the sound velocity of the mixing layer introduce a refraction error as sonar travels through the medium, and this error is extremely difficult to account for. This effect is especially prominent in lochs and fjords, where the mixing of fresh and salt water is so vigorous and close to the surface that, in many cases, traditional survey techniques utilising hull-mounted sonar simply cannot be used.

Upper Loch Linnhe is a shallow-silled loch in northern Scotland. One of the larger lochs on the country's west coast, the loch is approximately 15 kilometres long and ranges in depth from 0 to 150 metres. The mouth of the loch leads out to Loch Linnhe at the Corran Narrows, a bottleneck less than 200 metres wide, where a sill 11 metres deep separates the upper loch from the much larger lower one (Figure 1). This narrow passage contributes to the sea-loch's relatively strong cross-sill tidal currents, which encourage the mixing of sea and fresh water and make surface ship-based hydrographic surveying difficult.

Mapping Upper Loch Linnhe

The Fort William Underwater Centre is a training facility for commercial divers and remotely operated underwater vehicle (ROV) pilots, which is located at the landward end of Upper Loch Linnhe. In addition to a replicated offshore environment housing oil platforms and welding stations, the Centre makes use of 11 wrecked craft (seven ships and four tracked vehicles) that have been scuppered in Upper Loch Linnhe over the years for its training programmes. Divers and pilots in training use these resources to hone their skills before putting them to use in the field.

Collecting high-resolution images of these seafloor resources for use by the Centre's students has proved particularly difficult, as data collected using surface vessels was often distorted by variability in the loch's mixing layer. This was especially true in the areas immediately surrounding the Centre, as it is located approximately half a kilometre from the mouth of the River Lochy, the primary freshwater source of Upper Loch Linnhe. In addition to the natural challenges presented by the loch's currents, the process of surface vessel surveying – acquiring a ship, arranging contractors and deploying – was a logistical and resource challenge for the Centre.

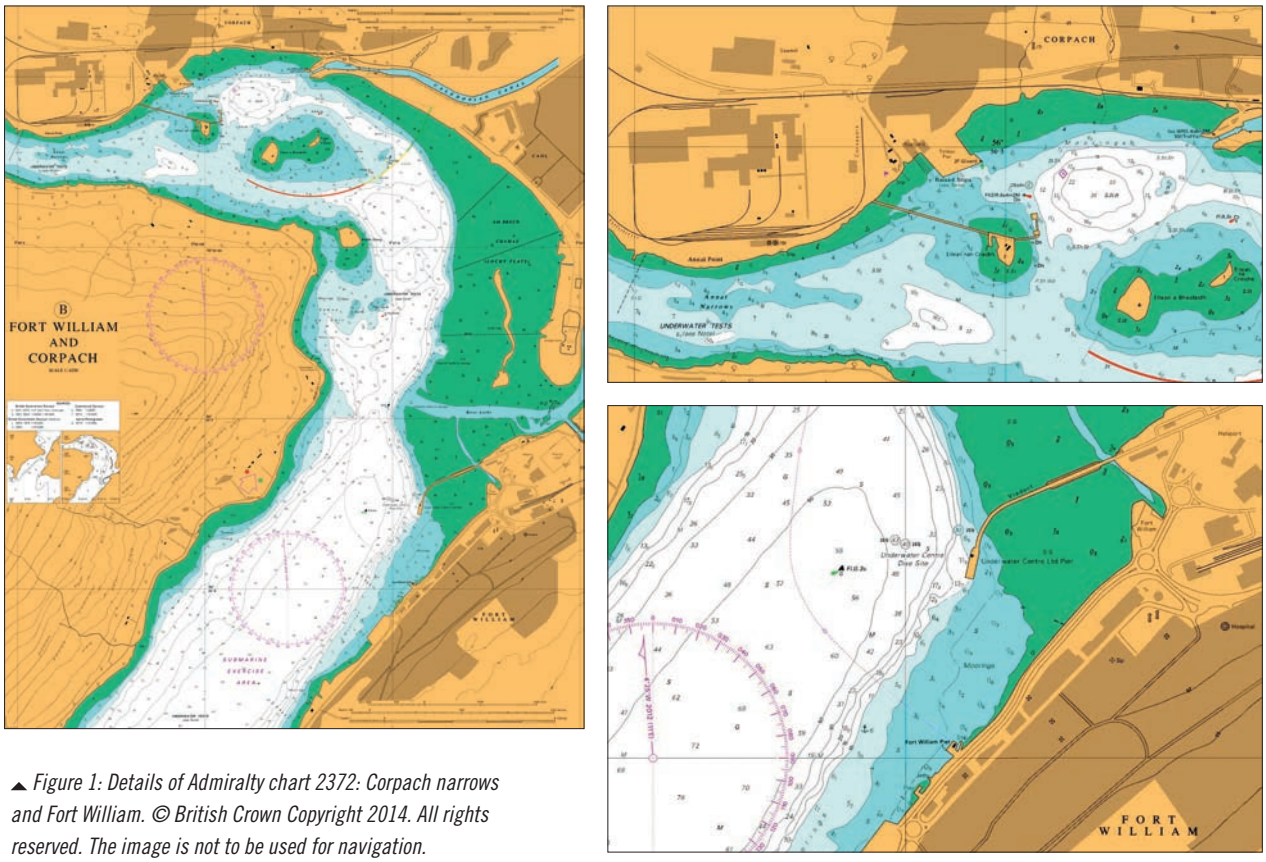
The multibeam echo sounder and side-scan sonar were used in tandem

Introducing AUVs

In June of 2014, the Centre decided to map the seabed of Upper Loch Linnhe using a low logistic autonomous underwater vehicle (AUV) provided by Kongsberg Maritime Aberdeen. Though AUVs are frequently used for surveying in open water, the vehicles have rarely been deployed to survey inland waterways. This was partly due to logistics, but also because shallow waters reduced the navigation capabilities of the vehicles. With the availability of military grade inertial measurement units, when coupled to Doppler velocity loggers and depth sensors, we have the ability to implement close coupled fully integrated inertial navigation solutions while previous subsea ventures would rely heavily on acoustic positioning only. This in turns gives the high levels of accuracy required to provide high-resolution imagery in shallow water surveying.

Recently, however, advances in positioning technology have created systems with high enough accuracy to provide reliable data for shallow-water surveying.

Using an AUV to map the loch seabed offered two important advantages over traditional hydrographic surface vessel operations. Firstly, because the AUV operates below the thermocline in the deep water protected by the sill of the loch, it is not subject to



▲ *Figure 1: Details of Admiralty chart 2372: Corpach narrows and Fort William. © British Crown Copyright 2014. All rights reserved. The image is not to be used for navigation.*

interference from the surface-level mixing of sea and fresh water. Most AUVs are capable of safely operating within several metres of the seafloor, which enables them to collect high-resolution acoustic data regardless of conditions in the water closer to the surface.

Secondly, AUVs that operate in inland waters require significantly less logistical support than surface ships. While AUVs that operate at depths below half a kilometre require significant infrastructure, such as a large support vessel with a dedicated launch and recovery system (LARS), vehicles that deploy in the relatively shallow water found in fjords are typically man-portable and can be launched from any pier or vessel of convenience. Together, these capabilities drove the decision to use a portable AUV to map the bottom of Upper Loch Linnhe.

Equipment Used

A variety of equipment was used in the surveying effort. The AUV used was a Kongsberg Hydroid REMUS 100 equipped with a suite of sensors, including a Kongsberg Geoacoustics Geoswath Multibeam Echo sounder, Edgetech side-scan sonar and conductivity-temperature-depth (CTD) sensor. The multibeam echo sounder and side-scan sonar were used in tandem, which meant that a single AUV mission could generate both two- and three-dimensional sonar images simultaneously. Essentially we have a true side-scan mosaic representation of the seafloor but, in addition, the Geoswath allows us to give true xyz datapoints referenced to any particular datum allowing quantifiable measurements to be taken on the seafloor rather than relying on the shadow lengths as conventionally done when using solely side-scan sonar systems. The temperature and salinity information, along with all other sensor data, were available post-mission for analysis, allowing both temporal and spatial control of the collection.

Missions and Results

Two missions were conducted in the area around the Centre's private pier, in waters ranging from 8 to 68 metres in depth (Figure 2) referenced to lowest astronomical tide (LAT). The AUV was in operation for a total of approximately three and a half hours, with each mission lasting between one and a half and two hours.
Both missions were launched directly from a nearby tethered barge by a two-person team of AUV operators. The vehicle flew below the loch's mixing layer and thermocline, which varies in depth due to the fast changing bottom depth but lies at approximately 8 to 16 metres. Therefore, its onboard sonar instruments were subject to significantly less noise and were able to gather data using much shorter pulse lengths than would have been possible from a surface ship. This enabled the AUV to generate extremely high-resolution sonar images of the wrecked craft on the seabed around the Centre (Figure 3). These two wrecked craft are located just off the Centre's main pier, in water approximately 45 metres deep. They can also be seen in Figure 2, slightly to the West of the pier's end.

The Centre can now use the data collected by the AUV to generate geo-referenced maps of Upper Loch Linnhe, which included the true locations of all wrecks of interest on the seabed. These maps, used in conjunction with an ultra-short baseline (USBL) positioning system, make it much easier for the Centre's ROV pilots and divers in training to locate the wrecks and begin their work.

Conclusion

Lochs, fjords and other estuaries present a unique surveying challenge because they are subject to so many variables. Rapid changes in the refractive index in the water, caused by variations in salinity, temperature and density, have typically forced surface ship surveyors to live with data artefacts, essentially resulting in a low-resolution dataset. Lochs and fjords,

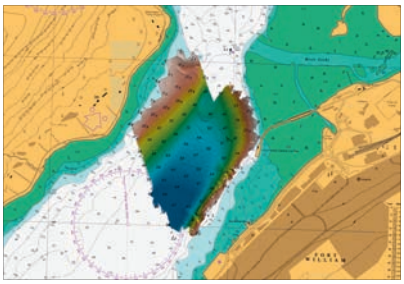
Richard 'Bungy' Williams RN

Richard 'Bungy' Williams RN joined Hydroid Inc., a Kongsberg company, as Regional manager, Europe in September 2013 with responsibility for sales and support of REMUS AUV vehicles across Europe, Middle East and South Africa.
rwilliams@hydroid.com

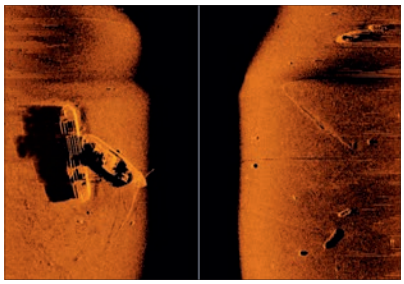
Craig Wallace

Craig Wallace has spent the last 9 years specialising in technology related to the underwater mapping community within Kongsberg Maritime, initially working with surface survey solutions. Now aiding with the development of the most recent AUV units he hopes to help advance the industry and continues to seek new challenges.
craig.wallace@km.kongsberg.com

This article was originally written for and published in the AUV Special of *Hydro International*, September 2014.



▲ *Figure 2: Data collected by the Geoacoustics Geoswath Multibeam Echo sounder on the REMUS 100, superimposed over an overhead view of Upper Loch Linnhe (Image courtesy: Kongsberg Maritime Ltd, Aberdeen, UK).*



▲ *Figure 3: An Edgetech side-scan sonar image of one of the discovered vessels in Loch Linnhe, taken by the REMUS 100 provided by Kongsberg Maritime Aberdeen (Image courtesy: Kongsberg Maritime Ltd, Aberdeen, UK).*

in particular, are difficult for surface-based surveying, as the majority of their sea and freshwater mixing (and, by extension, their variations in impedance) occurs close to the water's surface.

As the Centre's experience mapping Upper Loch Linnhe shows, using an AUV can help surveyors overcome the challenges that estuaries present. Mounting instruments on an AUV allowed vehicle operators at the Centre to fly below the mixing layer and collect data of significantly higher resolution than would have been possible using surface ship instruments. Additionally, the low logistical requirements of the man-portable AUV enabled Fort William Underwater Centre staff, working in conjunction with Kongsberg Aberdeen, to map the majority of their area of interest in an afternoon, eliminating the logistical requirements of a surface ship. ◀

World War II **Charting**: The **Pacific** War

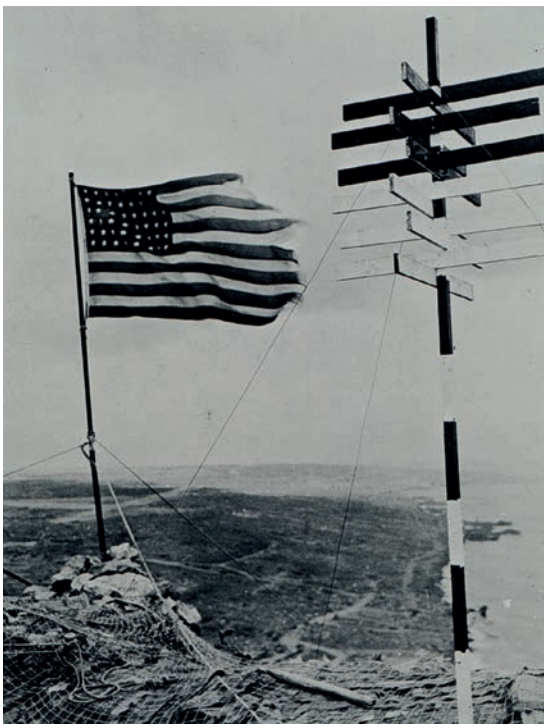
In late November of 1941, the USS *Sumner* AG-32 proceeded to Pearl Harbor and joined the United States Pacific Fleet. This ship had begun its career as the USS *Bushnell*, a submarine tender, but had been ordered to hydrographic duty and renamed in 1937. It was moored at the Submarine Base at Pearl Harbor on the morning of 7 December 1941.

At approximately 0755 local time, bombs began raining down on Hawaiian airfields and the battleships moored in the harbour. The *Sumner* went to general quarters at 0759 and four minutes later shot down an attacking plane. Lieutenant Commander I. W. Truitt, commanding officer of the *Sumner*, in his after action report stated: "0803 Torpedo plane passed close aboard, within about 100 yards of *Sumner*'s stern, on W course, altitude about 75 feet, leveled off for launching torpedo at BB's. Plane continued on its course until it was about 300 yards distant from *Sumner*'s stern, when it was struck by a direct hit from *Sumner*'s No. 3 A.A. gun. Plane's gasoline tank believed ignited, as plane immediately disintegrated in flames and sank in fragments. Torpedo believed sunk without exploding; Gun Captain, Campbell, H.L., BM2c, and Pinter, Pastor, J.M., MM2c, are believed worthy of special commendation for their coolness and promptness in bringing their gun into action and in scoring a hit on the plane." Thus, hydrographers of the US Navy were among the first to engage the enemy in the opening minutes of US involvement in World War II.

Some islands and reefs had not been surveyed since the days of James Cook and Charles Wilkes

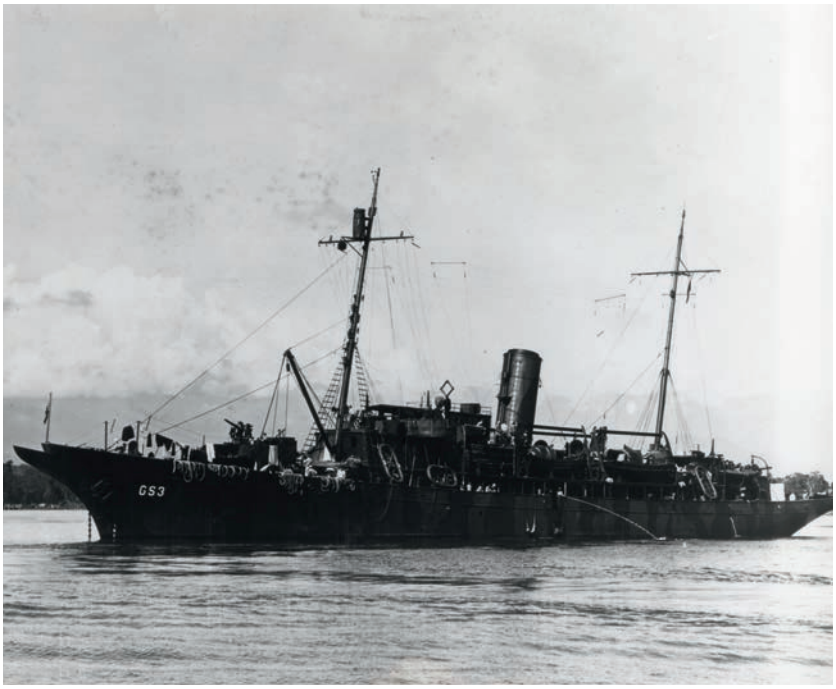
The *Sumner* (re-designated AGS-5) was the primary hydrographic survey vessel in the Pacific Fleet for much of the next year and, beginning in January 1942, commenced surveys in the southwest Pacific at potential fleet bases including Tongatabu, Nandi Island and Samoa. In May, the ship transported marines to Wallis Island and then commenced survey operations at New Caledonia, in the New Hebrides, and finished the year surveying at Tulagi, Solomon Islands. However, the Pacific theatre of operations extended from the Aleutian Islands to the Solomon Islands and from the Panama Canal to Australia, nearly 1/6 the surface of the Earth. It was dotted by numerous islands and reefs, some of which had not been surveyed since the days of James Cook and Charles Wilkes. Accordingly, more survey ships were needed. To fill this need, the *Pathfinder* AGS-1, *Oceanographer* AGS-3, and *Hydrographer* AGS-2 were transferred from the Coast and Geodetic Survey (C&GS) to the Navy in 1942 and 1943 with their officer complements and much of their crews; the navy hydrographic ship USS *Bowditch* AGS-4 was transferred from the Atlantic to the Pacific in 1943 and assigned a contingent of C&GS officers; and a number of new survey ships that were either built or converted from minesweepers and other small ships joined the hydrographic forces in 1944 and 1945. Collectively, these vessels compiled a remarkable record and conducted literally hundreds of surveys and reconnaissances for the US Pacific Fleet. A few of the larger ships had there own printing facilities; thus, the hydrographic units were surveyors, compilers and printers of charts. Although not assigned to survey vessels, an additional source of United States hydrographic capability were the Coast and Geodetic Survey officers assigned to Army Engineer Boat and Shore Regiments. These will be discussed in a future article.

There was a wide range of duties for the hydrographic ships, including classical wide-area hydrographic surveys designed to increase naval tactical operating areas and improve harbours and anchorages. There were also amphibious assault surveys, which were classified into pre-invasion surveys, assault surveys and post-assault surveys. Pre-invasion surveys were conducted off hostile shores and were often conducted by detached parties at night from rubber boats with hydrographers using lead-lines, luminous compasses and pressure gauges for tidal observations. The nature of this work required that most data acquired be committed



▲ *Figure 1: Hydrographic survey signal on Mt. Suribachi, Iwo Jima. This signal was erected within a short time of the famous American flag raising.*

to memory as there was little opportunity to properly record depth and position information. The second class of survey work was the assault survey that required, in general, such activities as: 1) the location and marking of obstructions and hazards in the approaches to the landing beaches; 2) close development of the zone between debarkation of landing craft and high tide line on beach; 3) development of anchorage areas including layout of berths by number and establishment of lane markers; 4) small craft emergency refuge anchorages and beaching area; 5) anti-torpedo net locations; 6) blasting, surveying and marking small craft channels; 7) tanker moorings for fuel off-loading lines; 8) establishment and location of approach and night station-keeping lights; and 9) wire-dragging seaplane anchorages, runways and constricted traffic lanes. The post-invasion surveys that followed the initial assaults and major combat operations were more akin to standard peacetime surveys of various islands and harbours although even these surveys were often subjected to air attack.



▲ *Figure 2: Coast and Geodetic Survey Ship* Oceanographer. *World War II service 1942-1944. Known as 'The Green Goblin'. Served in the Solomon Islands. Hydrographers on this vessel named the waters Ironbottom Sound.*

The dangers of the pre-invasion and assault surveys were quite real. The *Pathfinder* was subjected to over 50 bombing raids while in the Guadalcanal area, it shot down two enemy aircraft in Tulagi Harbor, and then, later in the war, was crashed by a kamikaze aircraft at Okinawa with the loss of one member of the crew. The small survey ship *Dutton* was also crashed by a kamikaze at Okinawa on 27 May 1945. The resulting explosion carried away part of the bridge, killed one crewman, and holed the ship, fortunately above the waterline. Artillery was also a hazard. During survey operations at Iwo Jima the *Sumner* was hit by shore-based shellfire resulting in the death of one crew member and wounding of three more. Fortunately, the shell failed to explode and there were no further casualties. Shore parties and small boat operations were not immune from attack. Coast surveyor Ernie Stohsner described an attack at Guadalcanal:

"The ship was out doing hydrography between Florida and Guadalcanal Islands at the time. I had the wire drag out and was on the 30-foot guide launch about two miles east of the ship. Our first knowledge of the actual attack was a geyser of water next to the *Pathfinder* caused by the near-miss of a dive bomber. A number of planes pealed out of the sun at the same time attacking aircraft in the vicinity of the *Pathfinder*. One of these escaped fire from the ships and came directly towards us and commenced strafing. All personnel topside dove over the side. The recorder, dragmaster and myself were at the plotting table below and did not have time to get out. Six machine gun slugs hit the launch up forward within a few feet of us...."

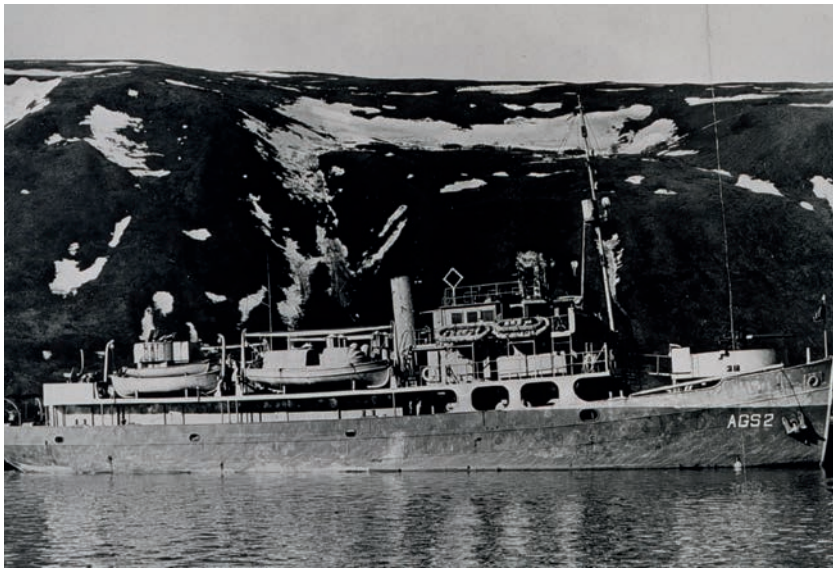
▲ *Figure 3: USS* Bowditch, *a Navy hydrographic vessel. During WWII, C&GS officers made up the first survey contingent on the* Bowditch. *Captain George L. Anderson, C&GS, was executive officer.*

Former crew member, A. F. Funk, wrote a letter to Captain William Scaife, the wartime commanding officer of the *Hydrographer*, in 1952 recalling an incident during operations on Guam: "I also remember you bringing a jeep and getting us out of a tight spot on Guam when we were under sniper fire. It was on the high cliff to the right of the channel going into the harbour. Groves and I were at that station as well as an officer and a radioman with a walkie talkie. There was another party over on the jetty and the *Hydro* was running lines in the channel. When the rifle fire put us to cover, we called you by radio and you came by jeep and picked us up. One

of the Marine patrols shot a Jap Lieutenant sniper just a little while after we left. I can remember that because one of the two officers that came aboard the day before was with us and he almost went over that cliff when one of the bullets whistled past his ear."

Although there were many individual and collective feats of valor within the hydrographic survey crews of the United States fleet in World War II, it was not until after the battle of Tarawa that a unified hydrographic survey command emerged. A lack of understanding of both tides and hydrography led to many casualties and near disaster for this first large amphibious operation of the central Pacific. Within a few weeks of the Tarawa operation, Lieutenant Ira Sanders was detached from the *Bowditch* and assigned to the staff of the commander amphibious forces, United States Pacific Fleet. His first job was to plan and execute surveys at Kwajalein and Roi-Namur during Turner's second major assault. For this job he also brought Ernie Stohsner and John Tribble from the *Bowditch* on a temporary duty basis. They were assigned to mobile hydrographic units, which accompanied the initial landings at 'H' hour. Stohsner was on an LCC that was used as a sounding boat while Tribble was attached to small vessels, which were used for wire drag. Sanders acted as operations officer coordinating the activities of the hydrographic parties. By D+2, channels and anchorages had been sounded and a chart was distributed to battleships and cruisers as they entered the lagoon to anchor.

The dangers of the surveys were quite real



▲ *Figure 4: USS Hydrographer in the Aleutians. Vessel served from Aleutians to Gilbert Islands. One of first vessels into Massacre Bay, Attu, during attack to recapture.*

Commander Sanders commanded mobile hydrographic units at Saipan and Tinian and was awarded the Bronze Star Medal for directing hydrographic units charting enemy held waters in the face of active and determined opposition. Because of surveys conducted under his direction, heavier vessels were able to take safer and more advantageous positions, which allowed them to take a more active part in defeating the enemy. During the Iwo Jima and Okinawa campaigns, Sanders was responsible for all hydrographic surveys needed for the plans and operations of the US Pacific Fleet. His staff responsibility included control of the survey ships *Bowditch*, *Sumner*, *Hydrographer*, and *Pathfinder* as well as the Hydrographic Survey Group, which was made up of eight smaller vessels such as the USS *Littlehales*. This small ship conducted clandestine surveys of Iwo Jima prior to the amphibious landings. Commander Sanders was awarded a Gold Star in lieu of a second Bronze Star Medal for personally supervising the surveys off Iwo Jima and Okinawa "in the face of intense hostile fire and heavy aerial attacks by the enemy." The citation continues that Commander Sanders "contributed materially to the success of these two major operations."

▲ *Figure 5: The Coast and Geodetic Survey Ship* Pathfinder *enroute to Okinawa where it sustained a kamikaze hit but survived to enter Tokyo Bay at the end of hostilities.*

As a footnote to the Iwo Jima campaign, it is noted that a shore party from the USS *Sumner* placed a hydrographic signal on the top of Mount Suribachi shortly after the iconic flag raising by the United States Marines on its summit. The placing of this signal on Suribachi is a testimony to the quiet courage of all those hydrographers who fought the Second World War with sextant, lead-line and fathometer. Their work, often under fire, was crucial to the movement of men and materiel throughout the Pacific on the road to Tokyo. They did their job and did it well. ◀

Research Vessel Technicians Share Innovations

INMARTECH 2014

The INMARTECH 2014 conference for Research Vessel Technicians was hosted by Oregon State University in Corvallis, USA. More than 200 attendees from all over the world exchanged innovations, tips & tricks and experiences in the field of technology for sea and ocean research.

▲ *Figure 1: IMARTECH participants.*

Chair of the organising committee David O'Gorman can look back on a very successful and well organised event. O'Gorman: "As marine technicians we always do the same job, but we never do it together. That is the nature of the job. This event enables us to interact and to share knowledge. My highlights during this conference were: the large number of lessons-learned presentations, the interactive multibeam training sessions, the icebreaker session and the mini vendor show."

A wide variety of subjects were presented, including: sampling equipment, coring, ships, ROVs, AUVs, buoys, moorings, wires and winches. A few of these presentations are highlighted below.

Running a Research Cruise from Shore

Normally a research vessel and a group of scientists go to sea to explore the environment. The availability of a high-bandwidth shore connection generates really new possibilities. Dwight Coleman of the Inner Space Centre of the University of Rhode Island gave an exciting presentation about a 'NASA-like science survey'. The use of Telepresence Technology in the NOAA funded programme resulted in bringing others to a research cruise, especially for a short period, comparable with the doctor-on-call idea. Via a live video connection scientist Eric Cordes added from his university lab: "During exploration of the sea you do not know what you are going to find. Now you can involve specialists that you would not expect." Other advantages proved to be: operational and technical problem solving, and public outreach by interactive involvement of the public.

The Use of Surface Buoys for Ocean Observations

Ed Dever of Oregon State University presented the state of the art Ocean Obeservatory Initiave (OOI) buoy array that will soon be deployed off the coast of Oregon. The array is designed to be operational for 25 years and will have a two way communication to shore.

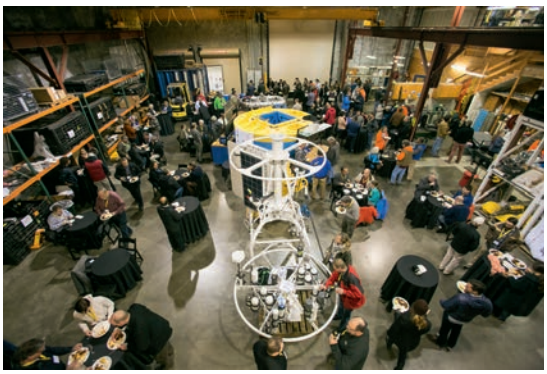
Yvo Witte of NIOZ presented another array of tethered surface buoys recently deployed in the Mid-Atlantic measuring the transport of Saharan dust. This dust has many relations with the global climate as studied in the project DUST-TRAFFIC by NIOZ scientist Jan-Berend Stuut.

Maintenance Free Flow-through-sea-water-system

Richard Finley of the University of Miami developed a fully automated flow-through-sea-water-system and had it installed on two major Caribbean cruise vessels. The project aimed for the installation of an Automated Meteorological and Oceanographic System (AMOS). The latest version of the AMOS design was based on the use of 'off-the-shelf' components, open architecture, low maintenance, high reliability, resistance to bio-fouling, remote operation and trouble shooting, and fully fail-safe shutdown. The first field results were very promising.

At the end of the conference, research institute IMR from Bergen, Norway announced that it will host INMARTECH 2016. ◀

▲ *Figure 2: During the reception, the RV technicians were able to demonstrate their hands-on-skills in the 'Niskin bottle cocker award contest'.*



▲ *Figure 3: Reception in Oregon State University Oceanography workshop.*

Our Oceans Challenge Initiative

Expertise and Creativity Meet for Cleaner Oceans

A Dutch initiative brings together entrepreneurial minds with experts from offshore and marine businesses to create viable and scalable business solutions to clean our oceans and keep them healthy.

We are all aware of the mainly negative impact that human activities have on our planet's oceans. Our oceans are seriously polluted; coral reefs are damaged or dying; many species of sea animals are threatened with extinction and huge islands made up of plastic waste float on the oceans' surface. More than ever we are in need of practical initiatives to clean up our oceans and create solutions for sustainable lifestyles. Many ideas have been put forward, but not everyone with an idea has the expertise or resources to implement it. Two Dutch companies, Heerema Marine Contractors (HMC) and Outside Inc., wanted to solve this problem by bringing those with good ideas into contact with companies that have the resources to turn their ideas into viable and sustainable business solutions — thus creating a real impact. It is this very ambition that led them to found Our Oceans Challenge (OOC) Foundation.

Partnering Up

One of the first initiatives of the OOC Foundation was to find like-minded partners willing to commit to setting up an online platform where ideas could be generated, discussed and refined in an interactive way.

▲ *Figure 1: OOC Challenge Event on 25 September 2014, RDM Campus Rotterdam.*

The OOC Foundation soon managed to enlist support from ECN, TNO, KPMG, World Ocean Council, Jules Dock, NIBC, VU University Amsterdam, Interface Floors, NIOZ and Willteco. By joining forces, these partners can share their expertise in engineering, research and business to turn the proposed solutions into new, sustainable businesses.

The Challenge

During June and July 2014, the Our Oceans Challenge online platform was opened to innovators, entrepreneurs, students, scientists, hobbyists, etc. – basically anyone with a creative idea and willing to enter into discussions with like-minded people. HMC's Seriena Bal, the OOC project leader, says: "We wanted to find a way to connect offshore and marine companies with smaller companies, start-ups or even individuals with smart solutions for clean and healthy oceans. We believe that together they can convert these ideas into sustainable and scalable businesses. That is why we set up this online platform. Our partners, with all their expertise and experience, can really boost the plans of these small companies, who don't normally have direct access to all this information."

By 1 August, 88 business ideas had been posted on the platform and many of these had been discussed in depth by the 400-plus registered participants. These business proposals ranged from removing and recycling plastic from the oceans, generating energy from wave motion, farming seaweed, etc. to constructing whole communities that live on and from the sea in a sustainable way.

A jury consisting of representatives from our founding companies and partners then went through all of the 88 business ideas and selected the 16 most promising ones. The minds behind them were then invited to the Challenge Event on 25 September.

We must continue with our initiative and generate more solutions

The Event was attended by almost 100 offshore and marine professionals and was kicked off by inspirational keynote speaker Reinier Mommaal, founder and former CEO of DyeCoo. He spoke about achieving global success with a proposal of developing a machine that substitutes water with carbon dioxide in the fabric dyeing process, with such companies as Nike, Adidas and IKEA all adapting the technology.
Those behind the ideas then presented their proposals at an interactive marketplace before discussing them in more detail in workshops grouped around the following themes: data collection and up-cycling of ocean waste, ocean farming and energy from the ocean, sustainable offshore industry and sustainable shipping and ports.

Demo Day and Follow-up

Following the Challenge Event, each business idea was actively supported by a coalition of

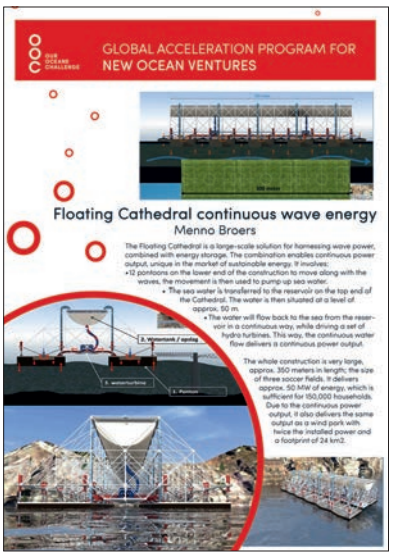
different partners who helped in developing the initial ideas into proper business proposals and solved some of the more specific challenges.

Outside Inc.'s Marieke den Nijs, the OOC community manager, says: "The final event was held in January 2015. On that day, named Demo Day, the participants presented finished business plans, an excellent opportunity for the start-ups to attract investment from interested parties and further any partnerships that may already have been formed. With that we conclude the first cycle of Our Oceans Challenge."

▲ *Figure 2: OOC general poster.*

However, this will not be the end of the OOC Foundation. These 16 ideas will not change the world overnight. An ongoing effort is needed to generate more solutions. Seriena Bal: "It is too early to measure the success of our initiative – we can only do that once these ideas have had the chance to turn into real businesses, which might take years. We cannot sit back now and congratulate ourselves on a job well done - we must continue with our initiative and generate more solutions. We are now looking at how we can guarantee the continuation of this initiative into 2015 and beyond." ◀

✉ seriena@ouroceanschallenge.org



▲ *Figure 3: Example of one of the OOC concepts named Floating Cathedral.*

More information
www.ouroceanchallenge.org

2014 In Review

The IHO

Last year's theme for World Hydrography Day – 'Hydrography - more than just nautical charts' is exemplified in a review of the highlights and achievements of the IHO in 2014. As well as moving forward with several revisions to its existing standards and guidelines, the IHO made significant advances in its wider activities, including its capacity building programme, contributions to several important IMO initiatives including the e-Navigation concept and the Polar Code, encouraging and assisting its Member States to contribute to Maritime Spatial Data Infrastructures (MSDI), and considering the use of crowdsourced bathymetry programmes and satellite derived bathymetry.

Capacity Building

The IHO capacity building programme reached a new level of achievement with double the funds available in 2014 compared to 2013. This was a result of the ongoing financial support provided by the Nippon Foundation of Japan and the Republic of Korea, supplemented by a contribution from the IHO budget and in-kind support from Member States and from industry. A total of 11 technical visits and 31 different training activities were planned.

A number of joint IMO-IALA-IHO seminars and workshops were delivered in 2014 to help overcome the fact that many coastal States still have limited or no national maritime or hydrographic authorities. Ways and means to improve regional hydrographic capabilities was on the agenda of most of the 12 out of 15 Regional Hydrographic Commissions that met during the year.

MSDI

2014 saw a growing awareness among IHO Member States of MSDI and the role that Hydrographic Offices should play in the emerging and unstoppable transition of many national mapping organisations, from being the country's producer of official maps and charts to being the national data manager and provider of official geospatial data.

The IHO raised awareness of the important role of hydrographic geo-information at the Geneva Ministerial Summit of the Group on Earth Observations and at the 4th session of the UN Committee of Experts on Global Geospatial Information Management (UN-GGIM). The growing importance of MSDI was further consolidated by the establishment of an IHO-European Commission Network Working Group, which will support the hydrographic aspects of the implementation of the European Union INSPIRE Directive and the Marine Strategy Framework.

e-Navigation

In 2014, the IHO continued to play an important role in the development of the IMO's e-Navigation concept which is aimed at integrating existing and new navigational tools, in particular electronic tools, in an all-embracing system that will contribute to enhanced navigational safety, and at the same time reduce the workload on ships' navigators. Of particular importance to the IHO, was the further development and implementation of the IHO S-100 standard, not only for the next generation of electronic navigational charts (ENC), but also because it will be the underpinning data exchange standard for e-Navigation itself. Because of the increasing focus on digital data, the IHO adjusted the organisation of its technical working groups from the end of the year to better support the various different maritime service portfolios that are envisaged under the e-Navigation concept.

Charts and Charting Standards

There are now about 12,500 ENC cells covering the world - all published in accordance with the IHO standards. The task of maintaining and upgrading those IHO

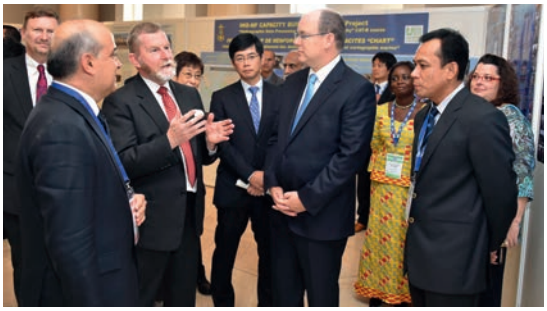
▲ *Figure 1: FIG-IHO-IBSC Stakeholders Seminar in Monaco.*

▲ *Figure 2: Nautical cartography in Haiti.*

▲ *Figure 3: Presentation of the Montenegro flag.*

▲ *Figure 4: SAS Albert II and Gilles Bessero listening to Robert Ward's speech during World Hydrography Day.*

▲ *Figure 5: Training session on ENC Production in Vietnam.*



▲ *Figure 6: Prince Albert II being informed about capacity building during the EIHC in October 2014.*

▲ *Figure 7: The IHB and the Hydrographic Bureau of Italy made a movie on hydrography to attract young people to the profession.*

standards and introducing new standards is a cornerstone of the IHO programme of work. There are now 52 standards and guidelines published.

A number of charting standards were upgraded in 2014, both for ENCs and paper charts. Good progress was also made on extending the S-100 geospatial data framework model and on the next-generation product specification for ENCs (S-101) and other product specifications for associated maritime information services, including Navigational Warnings (S-124), Sea Ice Information (S-411), and MetOcean Forecasts (S-412). This was made possible through the enthusiastic and active involvement of experts from several IHO Member States and from the invaluable support and experience of industry stakeholders and partner organisations.

Other Standards and Publications

A revised edition of the Joint IMO/IHO/WMO Manual on Maritime Safety Information was completed and presented to the IMO for its consideration and approval.

In addition, the IHO, in association with the International Association of Geodesy, published edition 5.0.0 of the *Manual on Technical Aspects of the United Nations Convention on the Law of the Sea* (IHO Publication C-51). New editions of IHO publications *S-5 - Standards of Competence for Hydrographic Surveyors* (Ed. 11.1.0) and *S-8 - Standards of Competence for Nautical Cartographers* (Ed. 3.1.0) were also published by the IHO after approval by its joint sponsors - the IHO, FIG and ICA.

Polar Regions

The long-held concern of IHO Member States over the limitations of surveying and charting in both polar regions was recognised in 2014. This has now been reflected in the IMO's mandatory code for ships operating in polar waters, ensuring that mariners' attention is drawn to the limitations and the attendant dangers of navigation in polar waters. Meanwhile, the 37th Antarctic Treaty Consultative Meeting adopted a new Resolution covering hydrography and nautical charting. The new Resolution acknowledges the currently less than acceptable situation regarding hydrography and nautical charting in Antarctica and nominates the IHO Hydrographic Commission on Antarctica (HCA) as the coordinating body for hydrography and nautical charting in the region. For the northern polar region, the Protection of Marine Environment Working Group (PAME) established by the Arctic Council, recognised the Arctic Regional Hydrographic Commission (ARHC) as its expert group for hydrographic-related science and analysis. The ARHC provided the PAME with a clear picture of the state of hydrographic surveying and nautical charting in the Arctic Region when the PAME met in Whitehorse (Yukon, Canada) in September.

5th EIHC

In October, 66 of the 82 Member States of the IHO met in Monaco for the 5th Extraordinary Hydrographic Conference - the equivalent of an Assembly in other intergovernmental organisations such as the UN. The Conference took a number of significant decisions including work on establishing guidelines for collecting bathymetry by crowdsourcing. The Conference also saw the launch of two video clips that provide simple explanations of hydrography and the role it plays in everything that happens in, on or under the sea. ◀

More information
www.iho.int

Australasian Hydrographic Society

AHS Annual General Meeting (AGM)

The AHS AGM was held in Sydney in November with a small gathering meeting at the NSW State Library followed by an informal dinner. The meeting saw a change in the executive board with the president Alec Millett not seeking re-election. Alec held this position for four years and his efforts are much appreciated. The new office bearers for the AHS are:

- President: Commander David Crossman, RNZN
- Secretary: Nick Goodwin
- Treasurer: Steve Duffield

The executive board also agreed to the AHS transitioning its website to a cloud-based solution. The transition has already commenced with membership capabilities implemented. For membership renewals, the website is http://ahs.wildapricot.org. The rest of the website will be migrated over early in 2015.

The existing website http://www.ahs.asn.au will be maintained for content until the new site is fully developed and populated.

During dinner, Mr. Wayne Dunn (Australian Hydrographic Service) was presented with his AHS Award of Merit – Career Achievement in Hydrography. This award recognises Wayne's outstanding contribution to hydrographic surveying and mine warfare operations in support to the Royal Australian Navy (RAN) over a period spanning 45 years.

Australasian Hydrographic Symposium 2015

The AHS will be hosting the Australasian Hydrographic Symposium 2015 in warm, sunny Cairns in November 2015. Cairns is the gateway to the Great Barrier Reef and is a beautiful, tropical city in northern Queensland – a great place to be, particularly for anyone in wintery northern climates….. We look forward to seeing you next year.

For more information
visit the AHS website at:
http://www.ahs.asn.au/conferences.html

Australasian Hydrographic Society Award for Ron Furness

Mr. Ron Furness, IIC's Manager for Pacific Region, was presented with two awards at the Australasian Hydrographic Society Annual Dinner in Sydney Australia on 14 November 2014. The president of the Society at that time, Alec Millett, acknowledged, by presenting the award, Ron's service over many years as Treasurer of the Society.
In addition, the Society's prestigious Order of Merit was awarded by the membership, acknowledging Ron's long-standing, meticulous and uninterrupted support over many years upholding the values and aspirations for which the Society stands. IIC has seen first-hand Ron's commitment to the hydrographic industry at large over the years, and is thankful to have him as a valued member of the IIC family. ◂

◂ *Alec Millett presenting Wayne Dunn with his award.*

▲ *Figure 1: The participants of the ceremony near the memorial plaque, third from the left: D. Schennikov.*

Hydrographic Society Russia

In Memory of the First Russian Seafarer

On 19 September 2014, D.L. Schennikov, member of the Hydrographic Society, and representing the delegation of public organisations of Russia, took part in the celebrations dedicated to the opening of the square in Tallinn, Estonia, named after the great Russian explorer, admiral of the Russian Imperial Navy and native of Estonia, Ivan Krusenstern (Adam Johann von Krusenstern).
Worldwide, I.F. Krusenstern is known as the leader of the global scientific expedition, which marked the beginning of systematic studies of the ocean. One of the travel books, released in England, called *From Magellan to Krusenstern* says that he made a major contribution to world science. A total of 13 geographical objects in different parts of the world have been named after I.F. Krusenstern: two atolls, an island, two straits, three mountains, three capes, a reef, etc.

Russia took the initiative in naming the square in Tallinn after I.F. Krusenstern and was supported by the World Club of St. Petersburg, the Russian Geographical Society, the Russian military-historical society, the Hydrographic Society, other public organisations, as well as the crew of the sailboat *Krusenstern*.
Krusenstern Square is on the grounds of the Baltic Shipyard, near the old town, between the area of Kalamaja, port Noblessner, and Petri Street and Staapli Street.
Present at the opening of the ceremony were Deputy Mayor of Tallinn Echo Vyrg, honoured guests from Russia and Estonian citizens. Among the guests were the Captain-mentor of sailboat *Krusenstern* M.N. Novikov and descendant of the explorer and businessman from St. Petersburg, A.V. Krusenstern. Representing Estonia at the ceremony were the famous explorer of the sea Vello Myass, Elder district O.A. Lasnamae, businessmen, leaders of BLRT Grupp and others.
On 20 September 2014, the delegation of public organisations from Russia laid flowers at the grave of the great compatriot in the Duomo and visited Kiltsi Cathedral, where I.F. Krusenstern was buried in 1846. The cathedral also serves as a museum about I.F. Krusenstern and a school for the younger generation of Estonians.

Visit to NAVY-DALS

A delegation of the Russian Hydrographic Society (RHS), headed by Doctor N. Nesterov, visited the scientific and technical company

NAVY-DALS on 14 November. Other members of RHS included: Doctor V. Smirnov, the executive secretary, Mr. A. Kharlamov, member of the Board and Mr. D. Milyakov (Figure 2).

Olga Glushkova, the general manager, showed the facilities and then presented aspects of the work. Captain (retired) Andrey Bogdanov, the development director (the former Head of Hydrographic service of the Nord Fleet) gave a detailed excursion.

Nowadays, NAVY-DALS develops and offers mass production and services:

1. Receiver-indicator Kvitok for positioning and determination of motion parameters of sea objects using signals of radionavigation systems LORAN-C, CHAYKA, MARS-75, BRAS, RS-10.
2. Navigational echo sounder NEL-1000 and NEL-1000M, which can measure ocean depths up to 2000-6000m.
3. Magnetic compass KF-1, used as additional, reserve or emergency device for heading indication.
4. The systems of managing and monitoring of aids to navigation TP-SUPR.

The products of NAVY-DALS are purchased not only by the Russian Navy but also by shipping companies in Russia and abroad.

The atmosphere during the visit was warm and friendly and laid the foundation for future collaborations.

▲ *Figure 2: Sitting (from left to right): V. Smirnov, O. Glushkova, N. Nesterov; Standing at the back: A. Kharlamov, A. Bogdanov.*

90th Birthday of Doctor Alexander Sorokin

The joint meeting of the Mathematical Geography and Cartography Committee of the Russian Geographic Society (RGS) and the Russian Hydrographic Society (RHS) was held on 28 October in the building of the RGS. This meeting was devoted to the 90th birthday of Doctor Alexander Sorokin, professor and honorary member of RGS and RHS, rear–admiral (retired), and corresponding member of the Russian Academy of Science (RAS).

Professor N. Neronov, the president of RHS gave a talk. He told the audience about Alexander Sorokin's biography starting from his time as a student to being an advisor for RAS. Several early published works by the guest of honour were presented. Mr. Neronov also noted that in addition to numerous scientific papers, monographs, and inventions used even nowadays, Doctor A. Sorokin also wrote poetry and fiction.

Mr. Mozhenok, chairman of the Mathematical Geography and Cartography Committee, showed photographs, illustrating the life of A. Sorokin. The participants recognised themselves on these pictures. Captain (retired) S. Mikavtadze spoke about the celebrations at the Military Hydrography Sub-faculty of the Naval Academy, where he was the head from 1974 to 1989. Here Alexander Sorokin received a personal award by the Commander in Chief.

▲ *Figure 3: Rear–admiral (retired) Alexander Sorokin.*

The participants of the meeting were presented with Sorokin's books. During the dinner the guests toasted Alexander Sorokin, his wife, and the future prosperity of Hydrography. Mr. Mozhenok presented Mr. Sorokin with a gift – a steering wheel barometer symbolising his longtime management of the Mathematical Geography and Cartography Committee. ◀

FEBRUARY

Euromaritime 2015
Paris, France
→ 03-05 February
For more information:
E: sabrina.jonas@euromaritime.fr
www.euromaritime-expos.com

The Unmanned Systems Expo (TUSExpo)
The Hague, The Netherlands
→ 04-06 February
For more information:
http://tusexpo.com

UI2015 - Underwater Intervention
New Orleans, LA, USA
→ 10-12 February
For more information:
www.underwaterintervention.com

Subsea Expo
Aberdeen, UK
→ 11-13 February
For more information:
www.subseaexpo.com

HSB/DHyG Workshop 'Dynamics of the Wadden Sea'
Terschelling, The Netherlands
18-19 February
For more information:
www.hydrographicsocietybenelux.eu

INC 2015 - International Navigation Conference
Manchester, UK
→ 24-26 February
For more information:
E: conference@rin.org.uk
www.international navigationconference.org.uk/

MARCH

IEEE/OES Eleventh
Current, Waves and Turbulence Measurement Workshop (CWTM)
St. Petersburg, FL, USA
→ 02-06 March
For more information:
http://cwtmc2015.org/index.cfm

US Hydro 2015
National Harbor, USA
→ 16-19 March
For more information:
www.thsoa.org

Arctic Technology Conference (ATC)
Copenhagen, Denmark
→ 23-25 March
For more information:
www.arctictechnologyconference.org

APRIL

Ocean Business
Southampton, UK
→ 14-16 April
For more information:
www.oceanbusiness.com

MAY

RIEGL Lidar 2015
Guangzhou and Hong Kong, China
→ 05-08 May
For more information:
E: riegllidar2015@riegl.com
www.riegllidar.com

OCEANS'15 MTS/IEEE Genova
Genoa, Italy
→ 18-21 May
For more information:
oceans15mtsieeegenova.org

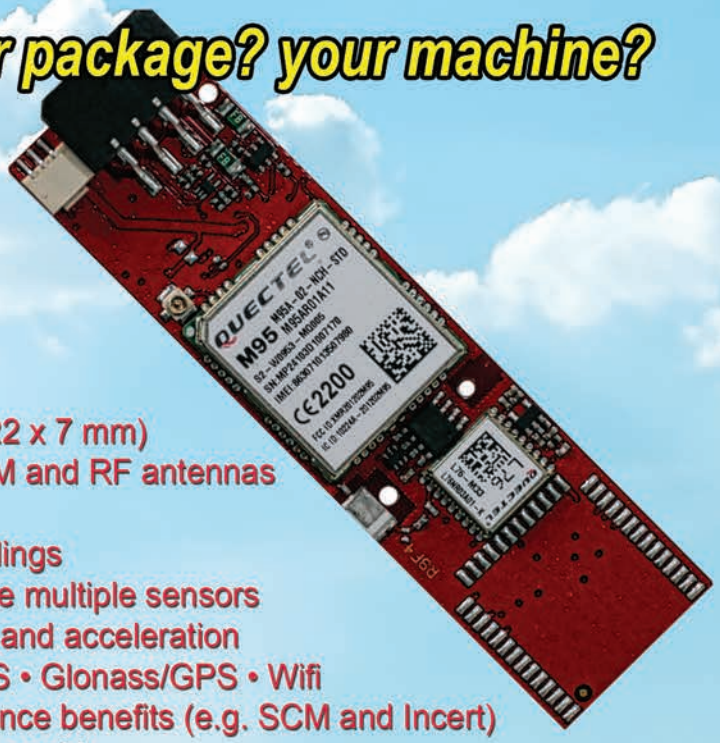
JUNE

OTE 2015 - Offshore Oil & Gas Technology, Equipment Exhibition
Nantong, China
→ 12-15 June
For more information:
E: jennifer@uaec-expo.com
www.ote-china.com

Calendar Notices

Please send notices at least 3 months before the event date to:
Trea Fledderus, marketing assistant
E: trea.fledderus@geomares.nl
For extended information on the shows mentioned on this page, see our website: www.hydro-international.com

Where is your vehicle? your package? your machine?
Find it with TraceME!

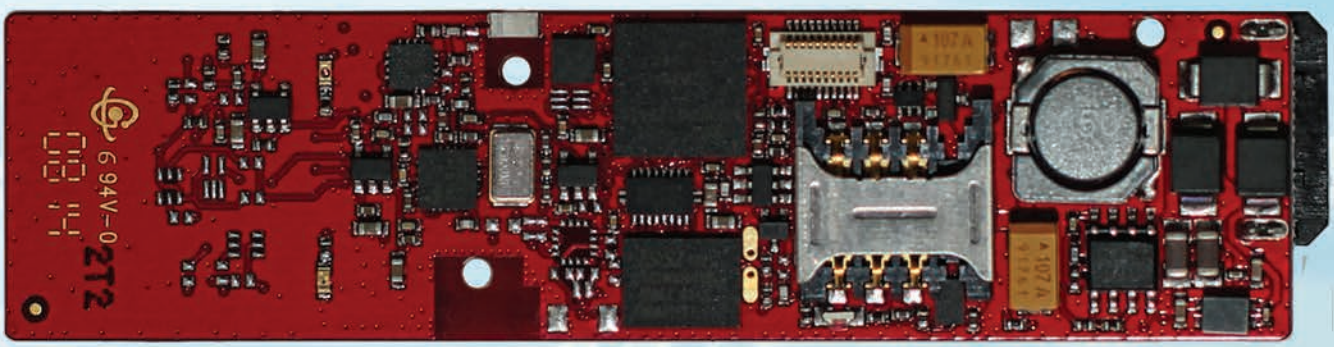


Introducing the new TM-203

The TM-203 is the newest addition
to our family of TraceME products.

Unique features:

- Very small fully-featured GPS Tracker (87 x 22 x 7 mm)
- Weighs only 15.5 grams, including GPS, GSM and RF antennas
- Advanced power saving, down to 3uA
- Location-based positioning (LBS) inside buildings
- Portable or externally connectable to integrate multiple sensors
- On-board sensors for compass, temperature and acceleration
- Worldwide coverage: Quad-band GSM/GPRS • Glonass/GPS • Wifi
- Complies with additional standards for insurance benefits (e.g. SCM and Incert)
- Complies with automotive safety standard (E-mark)



We would like to invite you to have a look around our website and get inspired by the possibilities of what KCS TraceME products can bring to your project. Whether you need a solution for personal tracking, trace and control vehicles, object protection or more advanced M2M solutions, KCS TraceME can deliver it.

GPS/GPRS enabled GPS Tracker with advanced I/O. This will allow you to remotely track & trace and/or control a huge diversity of objects, machines and/or vehicles. KCS TraceME is absolutely the most versatile and adaptive Track-n-Trace solution in the market today. Our clients use the TraceME hardware for the most diverse tasks. It is truly an all-round performer and exceeds anything in the market currently available.

- KCS TraceME is available in different form factors (Key fob, OEM., Aluminum & custom made casing);
- GPRS, UMTS, SMS, GSM, Wi-FI, RFID, E-mail;
- Fully configurable administration tool;
- Event driven, can run custom code, remotely configurable;
- Connect M2M to any device;
- G-shock detection, temperatures, tilt, motion, iButtons, mobile phones, camera's;
- See the rest of the site for the full options!

Please contact us if you want to discuss your ideas!

OEM & Distributor requests are welcome!

www.Trace.ME

No. 3594

S2C TECHNOLOGY: COMMUNICATION AND TRACKING COMBINED

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

USBL POSITIONING SYSTEMS

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

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

LBL POSITIONING SYSTEMS

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

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

UNDERWATER ACOUSTIC MODEMS

reliable data transmissions even in adverse conditions, customizable standard modems or **new M-series "mini" modems** in a light and compact design, special editions for developers, S2C communication and positioning emulator for free with every purchase

- range: up to 8000 m
- depth: up to 6000 m
- data rate: up to 31.2 kbps

Meet us at
OCEAN BUSINESS
2015!
14-16 April 2015
Southampton, UK
Stand W22

EvoLogics GmbH
Ackerstrasse 76,
13355 Berlin, Germany

tel.: +49 30 4679 862-0
fax: +49 30 4679 862-01

sales@evologics.de
evologics.de

No. 3592