SEABED GAZETTE

2021

Will Amsterdam become the new Atlantis

A Day On The lake

Slippery when wet

SEABED

Getting to the bottom of things

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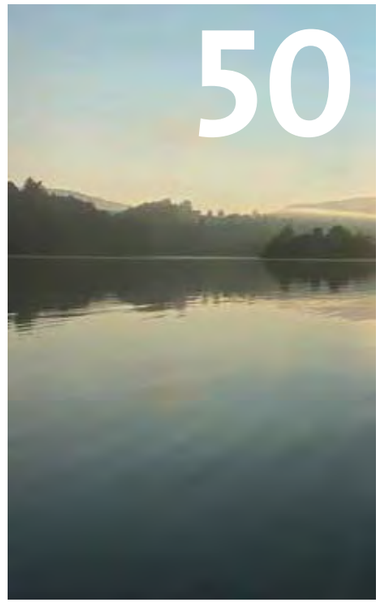


Enchanted by the cover?

Then let us introduce you to the artist:

Rudolf Broersma is a real creator. What started as a hobby grew over the years into a full-time artistry. He has crystallized the various disciplines in which he works within photography for himself down to the smallest details. The still lifes he creates in his studio have a lively and colorful atmosphere, which harks back directly to the masters of the golden age. His collages that take months of photography and image editing tell the story of an artist who has a deep respect for every particle that makes up his art.

His favorite quote from Elliot Erwitt tells in a nutshell Broersma's philosophy:
“Photography is an art of observation. It has little to do with the things you see and everything to do with the way you see them ”

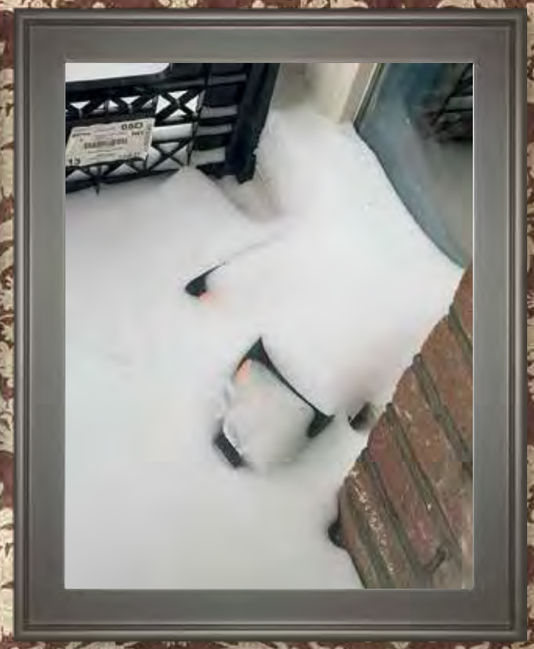
Are you interested in purchasing one of his works or just to see his other beautiful creations, check out his website: www.plaatjesmaker.webnode.nl or on Instagram under the name Roedaki.

Slippery when wet

During Seabed’s last demo days all the visitors received a goodie bag. In this goodie bag there were Seabed Slippers among other things. We have asked the visitors to send in a picture while wearing the slippers. The most original picture would receive a Hotel voucher of 100 euro.

Due to privacy regulations the name will not be printed here but the winner will recognize him or herself in the picture and will receive the voucher in the mail. Congratulations!

See more entries on the following pages!



Slippery when wet

Hydrography – growing in importance

Safety for maritime traffic and harbours

International trade is booming, and shipping along with it. Given the ever growing quantity of shipments and the expansion of harbour locations, there is a corresponding increase in requirements for the secure maintenance of waterways and harbour basins.

In many of the world's largest harbours, appropriate hydrographic monitoring of suspensions accumulating as fluid mud, as well as sediments in the form of more or less consolidated silt, is a necessary requirement in order to keep dredging costs for maintaining a satisfactory nautical bottom[1] within commercially sensible limits.

Every year in Germany alone action taken to secure the prescribed water depth produces an accumulation of around 45 million cubic metres of dredged material, the disposal of which entails high financial and environmental costs. Accurately determining the nautical bottom allows for a considerable reduction in operating costs, since dredging work can be carried out more systematically and efficiently.

[1] The nautical bottom is defined as „the level where physical characteristics of the bottom reach a critical limit beyond which contact with a ship's keel causes either damage or unacceptable effects on controllability and manoeuvrability".
(Joint PIANC-IAPH Report on Approach Channels: A Guide for Design, Vol. 2, 1997)

admodus® solutions for cost-effective waterway management

Echo-sounding is an internationally recognised technique for establishing the depth of a body of water. Dual frequency echo sounders such as the admodus®*SONAR* work with signals of differing frequency. Where there is a firm subsurface, both signals deliver identical readings for the depth of water, and in this case the readings correspond to the nautical bottom. However, if the results show greater variance this indicates the presence of sediment suspension: while the high frequency signal is dispersed at layers of low density, the low frequency signal penetrates through the suspended matter almost entirely, and is only reflected from deeper, more solid layers. Even though this technique succeeds in identifying accretions of low-viscosity suspended matter and fluid mud, it is not possible to determine the exact location of the nautical bottom. For this, an additional in situ analysis is required.

A method of analysis still frequently used, albeit one which is very time- and cost-intensive, is that of sampling combined with subsequent offline analysis in the laboratory.
An innovative and significantly more cost-effective option is the highly accurate online characterisation of suspensions and sediments achieved using the admodus®*USP pro* depth-profiling probe. The probe is lowered from the vessel, and can thus carry out real-time measurement of the density profile of the layers through which it penetrates, as well as record other parameters of rheological value. With the help of this profile, the nautical bottom can be established on the spot and with great accuracy[2].

[2] The nautical bottom can be defined area-dependently by a limiting density of approximately ρ=1.20 g/cm3.
„Determining the Nautical Bottom", Markus Jänen

Determining nautical depth in real time

The admodus®*USP pro* is an innovative in situ measuring probe for online monitoring of the nautical bottom in harbours and waterways. The system provides a depth-dependent density profile quickly and reliably, as well as a variety of other indicators for characterising suspended matter and sediments.

The probe is a robust and easy-to-use device made of seawater-resistant stainless steel. With its high inherent weight it can be used even in extreme flow conditions

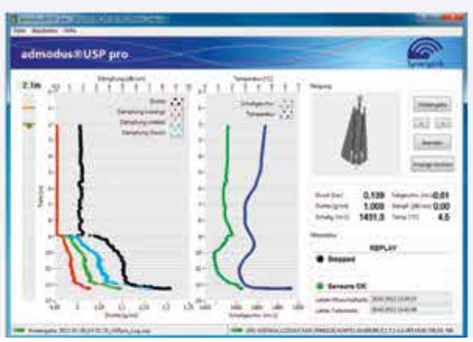
The admodus®*USP pro* is linked via high-speed Ethernet to a PC which displays all measurement data clearly laid out and in real time, stores them, and exports them as a PDF report as required. The user software features an automatic recording mode which permits serial measurements without interaction.

As the probe descends it continuously records its depth and inclination, as well as the density, frequency-dependent acoustic loss, speed of sound and temperature of the medium.

The measurement data ascertained can be stored together with the GPS data of an external receiver, so that the precise location of measuring points and a correlation with echo sounder bearings are both easily achieved.

The highly accurate point-by-point measurements achieved with the admodus®*USP pro*, combined with the area data capturing of the dual-frequency admodus®*SONAR* echo sounder, are one of the most accurate methods for hydrographic surveying currently available.

- Monitoring the navigability of harbours and waterways
- Supporting intelligent dredging management by technically efficient measurement
- Silt and sediment characterisation
- Analysis of fluid mud layers (e.g. in estuaries)
- Monitoring in sedimentation basins
- Investigation of sediment transport
- Online analysis in place of costly sampling



Registering and recording sediment layers

The admodus®*SONAR* dual-frequency echo sounder is especially suited for hydrographic surveying of harbours, waterways and coastal water areas.

The admodus®*SONAR* can be operated as a self-contained echo sounder with a variety of different transducers. Furthermore, it can be used as a passive digital supplement to existing analogue echo sounders.

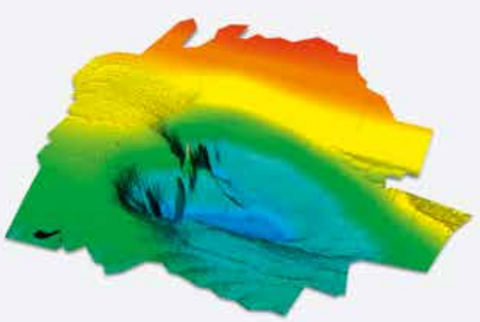
The single beam system with dual frequencies enables effective surveying of seafloor conditions, and of the different layer formations of suspended matter and sediments, ranging from fluid mud to well consolidated silt.

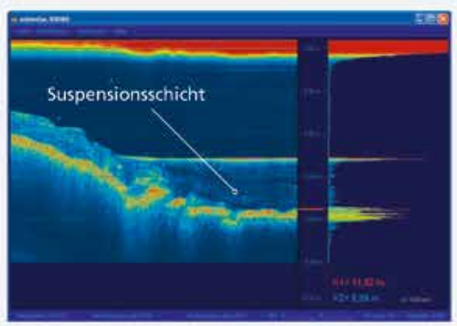
All data are transferred in real time to a computer via Ethernet, then visualised and stored. In addition, the admodus®*SONAR* user software provides an interface with widely available surveying software programs such as QINSy, WinProfile and Profile 2000, so that the horizons identified can also be externally recorded and further processed.

With its compact dimensions and the splash-proof design of its housing, the system is also highly suitable for mobile field work.

The area data capturing of the dual-frequency admodus®*SONAR* echo sounder, combined with the highly accurate point-by-point measurements achieved with the admodus®*USP pro*, is one of the most accurate methods currently available for hydrographic surveying.

- Hydrographic surveying of harbours, waterways and coastal water areas
- Area monitoring of fluid mud and silt layers
- Supporting intelligent dredging management by technically efficient measurement
- Creation of digital terrain models
- Digitalisation of existing analogue echo-sounder systems



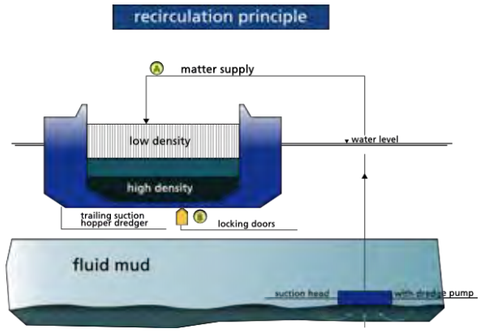


DENSITY matters...

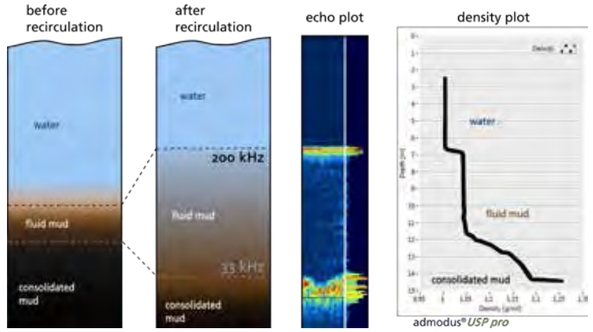
Port of Emden, Germany reducing dredging costs by 90%

In many of the world's largest harbours, appropriate hydrographic survey is a necessary requirement in order to keep dredging costs low. The port of Emden succeeded in reducing the dredging costs by 90% with the help of a new dredging management and hydrographic survey using the density probe **admodus®** *USP pro*.

In 1994, after many years of research, the port authority managed to maintain the fluidity of suspended sediments, which were carried into the harbour basin by the river Ems. This so called "sediment conditioning" is mainly based on the prevention of the fluid mud's reconsolidation process by a regular treatment (recirculation). As a result, these sediments no longer have to be **removed** from the harbour basin and a lot of disposal costs can be saved.



Recirculation principle



Fluid mud layer before and after recirculation.

The challenge:

How to monitor the density of this 'fluid mud' or measure the nautical depth in the harbour basin in a fast and reliable way, in order to guarantee navigability?

After 10 years of experience and development, **admodus® MARITIME DEVICES** released the new **admodus®** *USPpro* in 2013, with improved precision, ruggedness, better software and easier handling like the one-man-automatic-mode. The port of Emden was the first customer who purchased and still uses this device with great success.

Conclusion

A lot of maintenance costs can be saved by an intelligent dregding management. Investigations in recent years have shown, that ships can navigate safely through fluid mud layers up to a density of 1.15kg/dm³ at the port of Emden. This 1.15kg/dm³ horizon is often much deeper than the 200kHz horizon of an echo sounder. Thus, there is 'more water' under the keel with less dredging.

admodus®MARITIME DEVICES is a brand of Synergetik GmbH - Am Nusskopf 20 – 66578 Schiffweiler, Germany
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Client tales #1

Last year Braveheart Survey B.V. got the change to hire the Otter to do a survey in Harderwijk, both on a lake and in an area surrounding a building site for future housing. Our initial plan was to use a larger 2 man vessel that could fit on a trailer, but some bridges were placed which were too low to sail under.

As surveyors we're used to No Limit type vessels or larger (like our 25 m long MV Patriot or Guardian) for surveying, so it felt like a real opportunity to explore this new service.

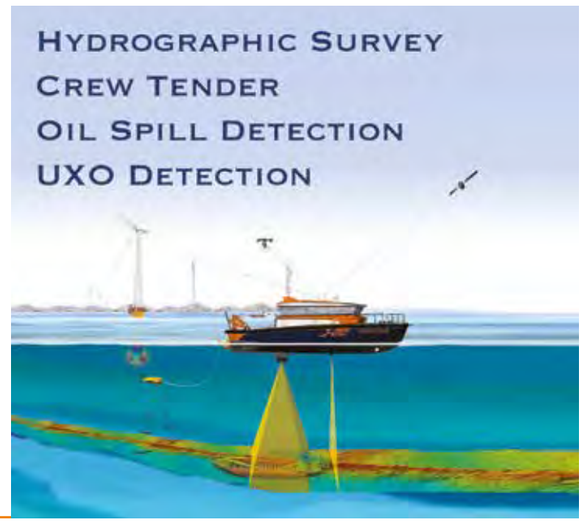
Seabed B.V. supplied the vessel and engineering support, including a NORBIT MBES system, also a first for us. After a brief meeting to discuss the operations for that day, and setting up the field office, we (and with 'we' I mean the engineers from Seabed) put the Otter into the water; a good exercise to start the day with.

Soon after this the survey began, some yachts managed not to spot the brightly orange painted Otter. Fortunately we were able to dodge them manually and the data collection went quite well.

After we finished our survey on the lake, we continued in an area were housing was being developed. The plans involved a canal surrounding these, and we were asked to survey these as well. Due to the sharp corners it was decided to manually steer the vessel through the canal, which not only gave great photos, but also some sunburn due to the amazing weather.

At the end of the day we looked back on two successful surveys, a happy client and a great cooperation with Seabed B.V.

BRAVEHEART MARINE BV



NORBIT NORdredge Dredging Monitoring Made Easy. IR-210014

1. Summary

The dredging development, since its beginning in 15th century throughout further industrialization of the dredging market, has been directly allied to development of the monitoring capabilities of the water depths during the dredging operations. When concerning water transportation and safety of voyages, the maintenance and monitoring of waterways has always been a major issue. Providing a safe passage have had a direct relation to the size of the vessels and ultimately the development of the maritime transport industry. Over the years the dredging industry extended from simply controlling the waterways to other activities such as extraction of shellfish, underwater mining, civil engineering works, recreational activities, preserving flora and fauna and all sorts of other marine eco-system maintenance and control. Further expanded into protection of underwater structures and underwater construction support with rock dumping operations. All of these require real time monitoring, not just visual, but accurate measurement system to allow the dredging operations to efficiently function and develop for the current and future applications.

The monitoring of the dredging operation is indeed an elementary part of the dredging process. As early application, underwater acoustic play essential role as remote sensing method, replacing mechanical measurements. Recently, multibeams gave a real boost to the underwater dredging monitoring due to wide coverage and high efficiency. The intrinsic problem with multibeam dredging monitoring has been the complexity of system setup and sonar operation, which often required extensive experience in hydrographic surveying. It became a problem for smaller dredging setups where the operation is carried by single operator or a small number of personnel. They rely on sub-contracting of the hydrographic surveys to third party companies which reduces their revenue margins and sometimes makes impossible to achieve financially sound operation.

In 2018 NORBIT introduced a 3D sonar system, called STX360, for dredging applications allowing to observe the 3D bathymetry and imagery in real time during the dredging operation facilitated by the electronic scanning capabilities build into the transmitting antenna of the system. The STX360 scanning sonar has been used in bathymetry surveys and in dredging surveys but also in several adjacent applications like rock dumping and cable laying set-ups. In all cases the system offers excellent performance and efficient monitoring of the operation in real time.

With the tightly integrated GNSS/INS system and the 360 deg titanium rotation system the iSTX360 system has become a dredge survey ready suite for any installations. In 2020 NORBIT has developed a software utility to facilitate the data collection and visualization for iSTX360 used for dredging monitoring and was given a name NORdredge. NORdredge is based on the NORBIT Open Hydrography Platform and continues the software solution simplifying the data acquisition initiated by the bathymetry data acquisition software - DCT.
NORdredge is a web-oriented utility which directly interfaces to NORBIT iSTX360 multibeam sonar system and is designed to monitor the dredging operation in real time with simple user interface and minimal installation efforts. It has been designed to facilitate three kinds of use case serving different users, needs and installations. These are:

a) Standalone operation supporting smaller installations and end users,
b) Used as a middleware as integrated part of in third-party (OEM) solution,
c) As monitoring tool adding an extra redundancy to large productions. That is to increase safety and efficiency of the operation.

This article details out the use first cases of NORdredge as a standalone utility and briefly discusses other use cases.

2. NORdredge and iSTX360 in a standalone operation

The first and main use of NORdredge is a standalone operation for dredging or rock dumping. The users connect to the data acquisition PC (via Wi-Fi, LAN or 4G network) using nothing else but the web browser. It is completely web based and any device with the web browser can be used to access and operate NORdredge.

The dredger is equipped with the iSTX360 which is the integrated 3D sonar with INS system and robust titanium rotating mechanism. All in one consolidated lightweight device attaches to the pole or frame of the dredger or barge. The single pair of cables connect to the top side which connects the GNSS antennas for navigation as well as provides the power to the rest of the system. The industrial computer hosts the NORBIT software including NORdredge server and is responsible for all data acquisition.

The clients can connect in various ways to the NORdredge computer either directly, via mouse and keyboard, but more importantly with the

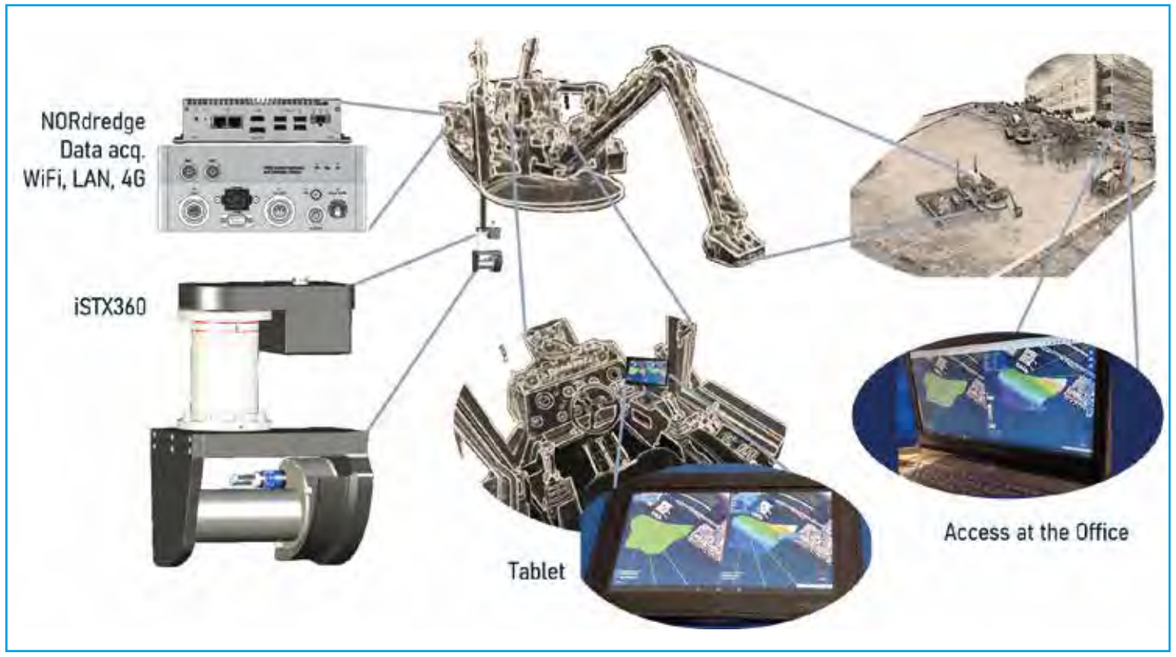


Fig. 1 NORdredge operated via web browser on rugged tablet or PC

remote clients utilizing the ruggedized tablets connected wirelessly. The wireless connection helps tremendously in limiting the network of cables and avoids expensive failures due to puncturing or destroying the cables. The wireless communication is facilitated by standard Wi-Fi or even mobile communication standards such as 3G/4G/5G and internet networking. The latter being useful when client is in remote location where standard Wi-Fi does not reach. The office personnel can take great advantage of that feature where the particular dredging station can be access from any location in the world.

All the users' terminals, that is the operator and all remote users, share the same underlying data in the real time. Each user can take advantage of several displays offered by NORdredge such as real time bathymetry, differential grid, backscatter imagery and couple of QC tools such as standard deviation of the bathymetry soundings and their density.

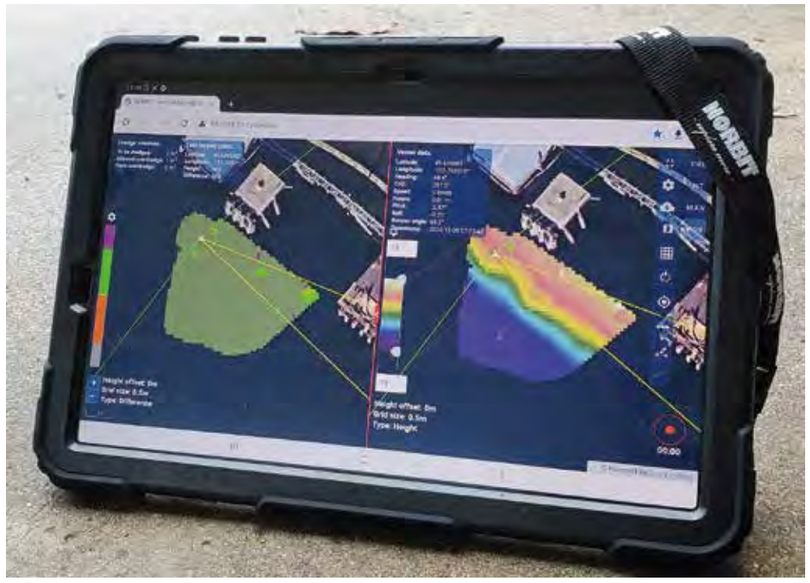


Fig. 2 NORdredge split screen display with real time and differential depth

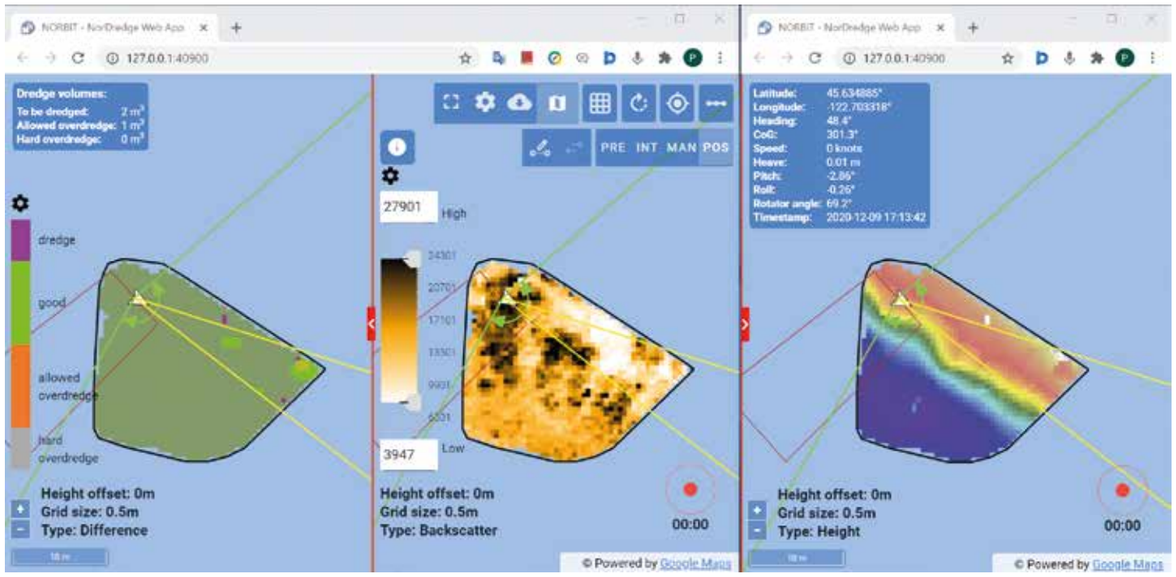


Fig. 3 NORdredge differential, backscatter and depth displays

The users operate on the same underlying data and can use NORdredge to effectively manage the dredging monitoring by adjusting the coverage, setting up the run lines or planning the next step during the mission. NORdredge natively supports split screen display with the real time depth display and differential depth display. The real time depth display shows the current measured depth while the operation progresses. The cursor informatics displays the current height with RTK aided navigation. All necessary navigation data are conveniently displayed on the screen and can be hidden with a mouse click.

The differential grid on the left-hand side provides immediate information on the area to be dredged by comparing the reference grid to the real time depth and showing in simple colors what and where to dredge. The reference grid can be prepared as a design template by importing the XYZ ASCII file outlining the desired channel or by using one of the previously collected bathymetry data. In that case the data could be any data collected with NORdredge or even imported from previous surveys performed with DCT as both are compatible.

With a single button click the user instructs the system to collect the data. The data is securely stored on the survey computer in NORBIT WBM format as well as in a popular s7k file. The WBM file is useful if user wants to replay the data or export it to another format using NORBIT GUI. The concurrently generated s7k files contain all bathymetry data and navigation data and can be used for future postprocessing if needed. At the same time the system collects the raw GNSS/INS observables which can be used to postprocess the navigation with PPK etc. which can be used for the final delivery of the bathymetric maps for PRE and POS surveys. That offers a possibility to avoid expensive pre- and post- surveys and use the data collected during the dredging as a final deliverable.

At any time during the operation the operator have access to QC displays. The real time display shows the mentioned real time depth and also standard deviation, sounding density and backscatter, all of which are updated at the same time and available for all connected clients. All displays run concurrently on one or several clients, e.g. operator can view depth display and surveyor or QA remote assistant can view standard deviation and sounding density display. The backscatter display allows to differential between hard and soft bottom and avoid expensive mistakes when dropping the bucket on the boulder or submerged structures. The background maps (Google maps, satellite view or GeoTiff) can be selected according to user preferences differently on different clients. Zooming, panning and boat location/tracking options are available also on all displays.

The operator can take a decision in the real time on when to plan the next drop just simply by looking at the differential display. The immediate result from the scanning confirms the desired depth in the area of interest. When the entire area is confirmed and the operator is satisfied with the result the dredger moves to the next location and repeats the operation.

3. NORdredge in action

Some smaller operations tend to be very dynamic and the dredger moves from one area to another quickly. There is no time for extensive logistics or extra survey vessel to conduct the pre/post survey and the readings of the bathymetry needs to be done on spot to allow the operator to take an immediate decision to move the dredger to next location. NORBIT iSTX360 and NORdredge is designed for this kind of operations. The instantaneous measurement of the bathymetry and clear displays on a single screen is sufficient for operator to conclude the survey.

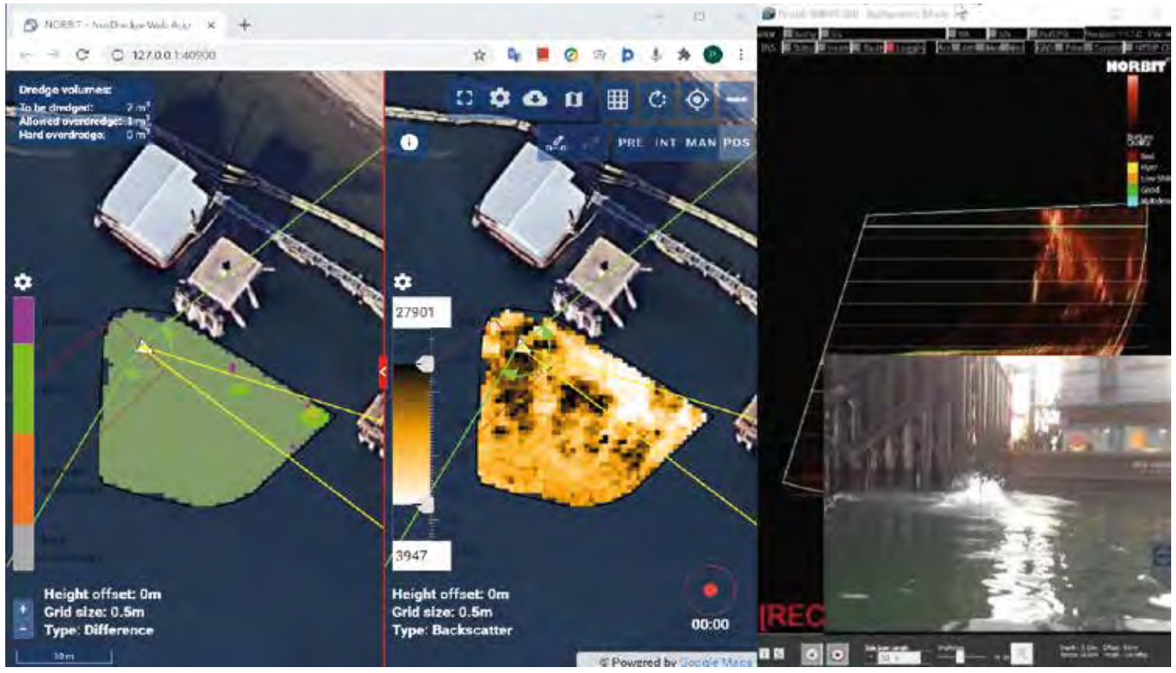


Fig. 4 NORdredge in real time dredging monitoring

As an example of such dynamic survey a short dredging operation was conducted in December 2020 where couple of buckets drop were needed to be performed in certain areas and move very quickly to another area along the shore of Columbia River in Portland, Oregon.

With this type of operation NORdredge offers great advantage to the operator with the capability of quick measurement the bathymetry of dredged area and swiftly conclude the mission without any wait time for survey vessel to perform additional surveys. The raw data is securely stored on the industrial PC and can be further postprocessed for the final delivery without the need to perform the additional post survey.

4. Other uses of NORdredge

We will just mention two additional use cases in limited details due to the size of this article but more information is available on NORBIT web site and will be published in the future.

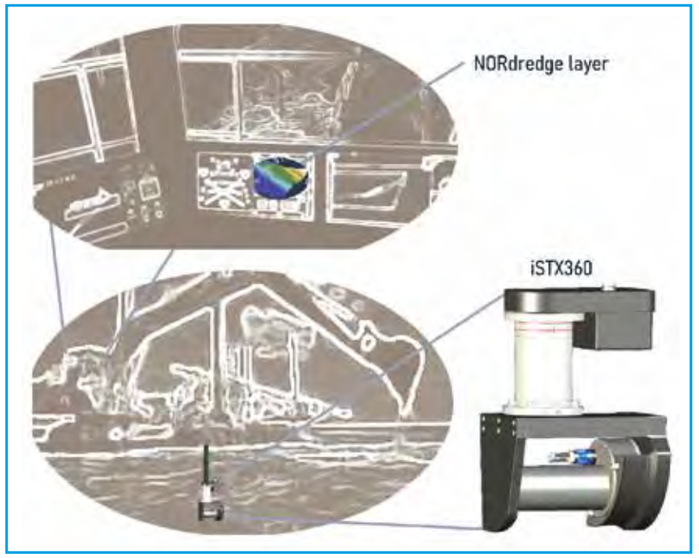


Fig. 5 NORdredge used as middleware in 3rd party solution

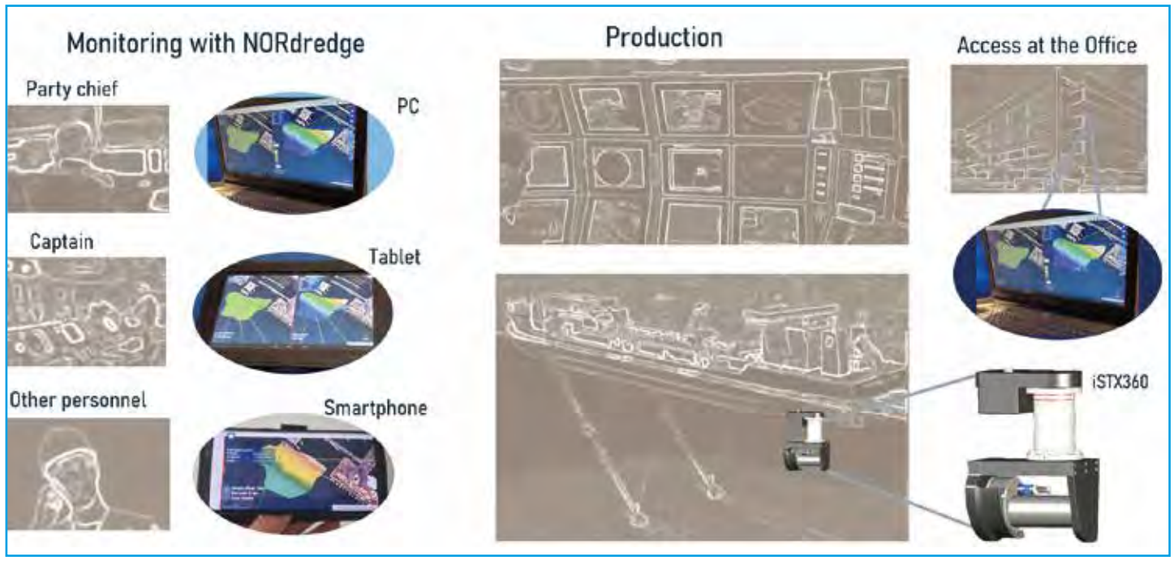


Fig. 6 NORdredge in real time dredging monitoring

4.1. NorDREDGE use as middleware

The second use case for NORdredge is unique opportunity for OEM partnership for companies who provide their own offerings in the dredging industry. It allows the third-party solution provider to seamlessly integrate the bathymetry layer offered by NORBIT into their product without undertaking on the whole development of data acquisition and bathymetry maps generation. All that is already managed by the Open Hydrography Platform (OHP) architecture on which NORdredge is based on. That includes the well-known GIS platforms GeoServer, Postgres database and PostGIS which are used by NORBIT OHP and provides seamless access to the data as well as tiles of generated maps.

4.2. NorDREDGE use as monitoring and planning tool

Large dredging production involve multiple sensors for their operation. There are specialized software (such as EIVA, Qinsy or Hypack and others) which consolidates all different sensors into one platform serving many users with many displays and features. This type of operation and logistics is beyond NORdredge intended use. However, the challenging production like this is surrounded with supporting functions which also requires access to the dredging data for progress monitoring and planning reasons. These supporting functions could be for example a party chief to watch the progress of the mission or a captain planning for the next vessel position. It also could be a next shift of the personnel who is curious what situation is awaiting his/her shift. In all of these cases the situation awareness can be provided by NORdredge, which can operate concurrently with large production dredging software. That adds the needed redundancy to the current main framework as the map generation is completely detached from the mainframe map generation and does not infringe any risk of disturbing the production logistics.

In this case the NORdredge function is simply monitoring function where redundant terminals are separated from the main production and can be freely used by all interested parties. That includes the vessel personnel but also the personnel in the office, which can access the same operational picture via internet. This immediate situation awareness improves the logistics and planning as well as efficiency as all interested parties have access to the same information without disturbing the main production team.

5. Conclusions

NORBIT iSTX360 solution along with NORdredge utility is simple and useful tool for various dredging operations. The web browser interface allows to conduct and monitor the dredging mission in efficient way. It is suitable for small dredgers and single person operations as well as the larger operations working as middleware or as monitoring tool supporting the main production. The iSTX360 and NORdredge through web-based displays allows to access the survey result and monitor the progress from any terminal in the network either local or remote.

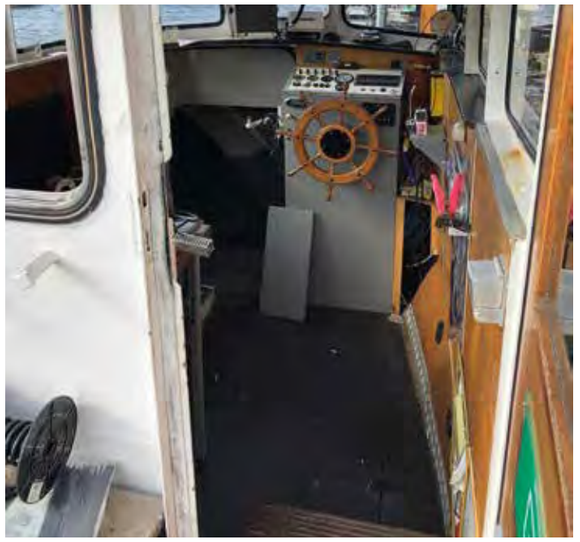
6. References

1. Pawel Pocwiardowski, "NORBIT STX 360deg 4D Sonar for Dredging Applications", WEDA, Pacific Chapter, 2019 Annual Meeting, October 29 to 31, 2019
2. Pawel Pocwiardowski, "NORBIT DCT Hydrographic Survey Made Easy", MARINE TECHNOLOGY, June 2019 via internet.

NORBIT

Seabed's Survey vessel Hennie

Seabed was already in possession of a survey vessel called Naatje which was used to test the equipment, and occasionally rent out as a survey vessel. To ensure that Seabed always has a vessel available, we invested in a second vessel. We called it Hennie.



Hennie is built in 1960 and was a former policeboat from Germany. Now Seabed uses Hennie for testing, Hennie can be rented, or we just sail with our team to enjoy the Amsterdam canal and unwind. Unlike Naatje, Hennie has a cabin so we can go out on the rainy days with the comfort of a roof over our head.

After purchasing the boat, there was work to be done. The electronics were outdated and not suitable for testing the equipment like we do with Naatje. For example, the batteries didn't charge when the boat was connected to power from the shore. There was also a power supply needed for 12 and 24V.

When the work was done, and the floor was back in place, Hennie was ready for action.

Ceremonial ship launching

This boat is named after the mother of Hans (owner of Seabed). The name was revealed during the Seabed End Of Summer Demo Days in September 2020, where Hennie herself performed the baptism ceremony. We look forward to many safe (s)miles and a lot of fun with our new boat.

SOMAG AG Jena launches Nautical Gyro Stabilization Mount NSM 400

SOMAG AG Jena has expanded its maritime portfolio's capabilities with the launch of the NSM 400. The Stabilization Mount is a medium-sized gimbal classified between the smaller RSM 400 and the larger OSM 4000 and complements the product portfolio of Gyro Stabilization Platforms, which are designed for offshore use.

Fig. 1 NSM 400 product picture

Reliable Gyro Stabilization for Multiple Optical Sensors

The NSM 400 is primarily designed for the stabilization of optical sensors on medium (starting from 1.0 kt onwards) to large maritime vessels. Un-stabilized systems follow the movement of the water caused by the swell which adversely affects the detection capabilities of the sensor. Using a Gyro Stabilization Mount ensures a stabilized field of view and high-resolution images by compensating the movements of the vessel. This allows imaging systems to scan their environ-ment without interference even in extreme sea conditions. The NSM 400 is the perfect gimbal for multi-sensor systems, laser scanners, antennas, radars and monitoring sensors and can be installed on boats, ships, USVs and floating platforms.

Highest stabilization range for the best gimbal performance on the market

Like all SOMAG marine Mounts, the NSM 400 is IP 67 compliant and made to perform in very rough sea conditions, up to sea state 6 and beyond. To achieve this performance, the NSM 400 features a hydraulic gimbal system and stabilizes payloads up to 62.5 kg*. Users who choose an NSM 400 not only opt for an extremely powerful Mount, but also for one with a uniquely large stabilization range. The NSM 400 compensates for movements in roll and pitch up to ≤±20°. Placing the stabilization mount in an elevated position on a mast high above the ship's pivot, such as on 30-meter high masts, does not affect its performance. For this kind of applications SOMAG provides power cables with a length of up to 30 meters. The NSM 400 is the first SOMAG Mount to offer an Ethernet interface which makes the device network compatible and offers an easy remote access via the SOMAG Mount Control App.

Fig. 2 NSM 400 with sensor

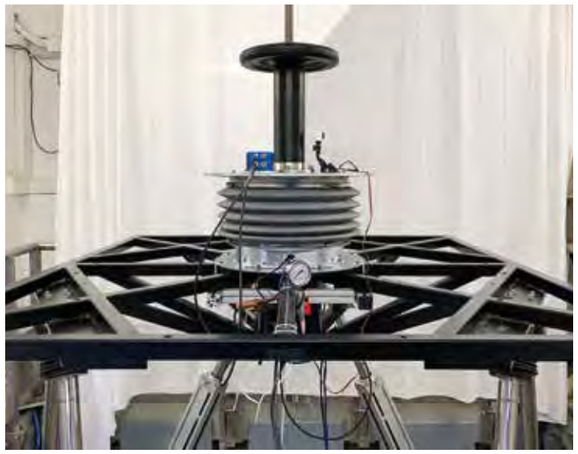


Fig. 3 Hexapod Stabilization Performance Test - A video of the test can be found on the SOMAG AG Jena website

Tested Stabilization Performance

Designed to work 24/7 the NSM 400 offers an unmatched stabilization accuracy. The stabilization performance of the Mount was tested at the Institute of Ship Technology and Transport Systems of the University of Duisburg-Essen. A total of 13 different hexapod tests were performed simu-lating movements up to 20° in roll and pitch and lateral accelerations up to 0.5 g. The NSM 400 successfully completed all 13 tests and achieved a stabilization accuracy of ≤0.17° rms without external IMU data, exceeding its own stabilization accuracy specification. The integration of ex-ternal ship data (NMEA frames) or IMU data to improve the long-term stabilization performance of the Mount is also possible.

For further product information and sales inquiries please contact:
Sören Lieske
Sales Manager SOMAG AG Jena
phone: +49 3641 633 68 18
mail: s.lieske@somag-ag.de

In order to give you the best possible assistance, please include the following information in your request:

- Where should the Mount be installed (floating platform, ship etc.) on?
- Dimensions (length/width/height/weight) of the floating platform or vessel
- Installation height above the waterline of the Mount and the payload
- Center of gravity and weight of the payload

The more information we get about the planned application, the better we can support you with choosing the right Stabilization Mount.

About SOMAG AG Jena

SOMAG AG Jena is a worldwide leading specialist for high-precision gimbal systems. The compa-ny, consisting of handpicked experts in the fields of electronics and mechanics, has focused since 2004 on the development of Gyro Stabilization Mounts for data acquisition and surveil-lance applications. All products are assembled and tested with highest precision at the head-quarters in Jena, Germany and at independent test facilities. The company is certified according to DIN EN ISO 9001:2015. SOMAG AG Jena clients include military, governmental and commercial organizations as well as research institutions.

In addition to their maritime mounting systems, SOMAG AG Jena offers Gyro Stabilization Mounts for airborne applications, which are the perfect add-ons for bathymetric airborne laser scanners.

For further information and technical specifications, please visit:
www.somag-ag.de

somag® AG JENA

* The possible payload to be stabilized is related to the center of gravity of it as well as the lat-eral accelerations the Gyro Mount and payload have to withstand.

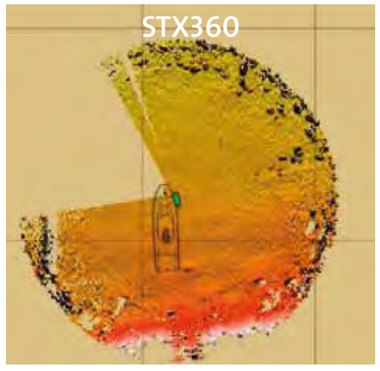
Norbit Rotator STX360

Compact and high-resolution curved array FM bathymetric mapping systems for stationary 360 Survey.

As we all know Norbit has a beautiful product range of mulitbeams. One of the multi-beams known as the STX is a steerable projector system that allows the transmit beam to be directed ±10° in a scanning pattern. This functionality aids inspection surveys by giving a more complete picture of the survey area or target. Additionally, it can be used to capture extra detail on complex structures, such as shipwrecks, during a single pass.

Even when using the STX it could happen that you have blanks in your data. With the use of a Pan system, called the Norbit Rotator, it is possible to fill in that blank or to detect objects without moving the survey- or operating platform.

The Pan unit is designed for subsea use in typical areas of application for remote handling of WBMS sonars. The system is tightly integrated to a titanium rotating system ensuring a full 360 deg stationary high-end survey capability.



Seabed was requested by DEME to place the Rotator in combination with the WBMS STX (STX360) on the Livingstone. The STX/Rotator was installed on a large pole. The rotator turns the multibeam so you can see 360 images and follow objects during operations without moving the vessel. The purpose of this is to be able to accurately follow touch down of a cable during the cable laying process on the seabed.

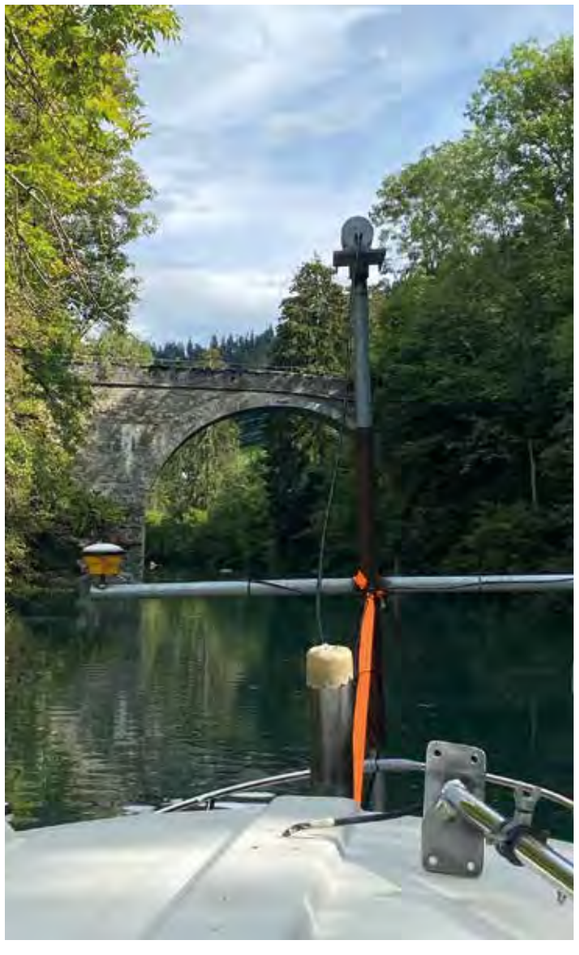
Client tales #2

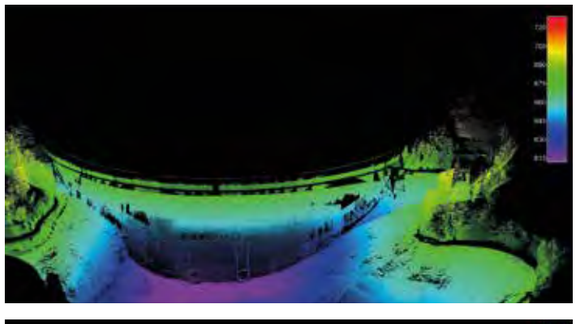
Group E is an electric company that serves 400,000 inhabitants mainly in the cantons of Fribourg and Neuchâtel by providing a wide range of energy products and services to its customers.

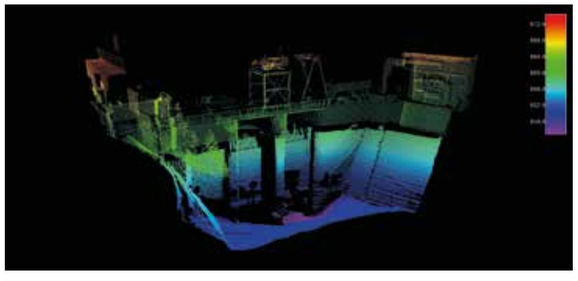
Group E's production fleet consists of eight hydroelectric plants and one thermal power plant. Participations in companies operating different types of power plants (biomass, solar photovoltaic, heat-force couplings, waste incineration) complete the company's own production. These facilities allow the production of 1. 4 TWh/year.

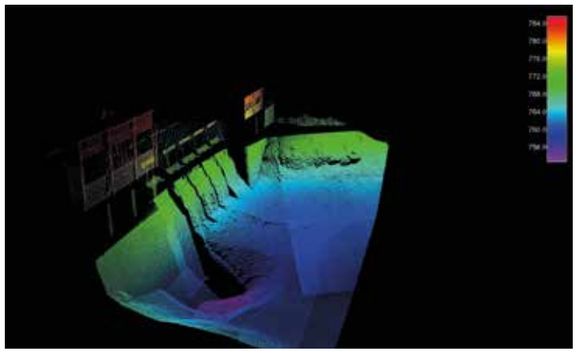
In order to monitor the evolution of sedimentation in the lakes and to know as precisely as possible the volumes of water available at different altitudes, Group E has called on the company Seabed to perform several bathymetrys in different lakes since 2017:

These measurements were carried out with professionalism and to our complete satisfaction by the Seabed company of the Netherlands by means of a multibeam sonar supplemented by a Lidar laser scanner for the surface parts. The surveys provided a 3D graphic representation of the bottom of each lake and a 3D representation of the sediment distribution, especially at the level of the safe and operationally impacted locations.









Groupe E est une entreprise électrique qui dessert 400'000 habitants principalement dans les cantons de Fribourg et Neuchâtel en fournissant une large palette de produits et services énergétiques à ses clients.

Le parc de production de Groupe E est composé de huit centrales hydroélectriques et d'une centrale thermique. Des participations à des sociétés exploitant différents types de centrales (biomasse, solaire photovoltaïque, couplages chaleur-force, incinération des déchets) complètent la production propre de l'entreprise. Ces installations permettent la production de 1.4 TWh / année.

Afin de suivre l'évolution de la sédimentation dans les lacs et connaître le plus précisément possible les volumes d'eau disponibles à différentes altitudes, Groupe E a fait appel à la société Seabed pour réaliser plusieurs bathymétries dans différents lacs depuis l'année 2017:

Ces mesures ont été réalisées avec professionnalisme et à notre entière satisfaction par l'entreprise Seabed des Pays-Bas au moyen d'un sonar multifaisceaux complété par un Lidar laser scanner pour les parties émergées. Les relevés ont permis d'avoir une représentation graphique en 3D du fond de chaque lac et de se rendre compte de la répartition des sédiments, surtout au niveau des endroits sensibles impactant la sécurité et l'exploitation.

groupe e

SEABED
END OF SUMMER DEMO DAYS

Greetings from the 2020 Seabed End of Summer Demo Days, the only hydrographic event of the year 2020!

Falmouth Scientific Inc. Company Overview:

Acoustic Sensors / Seismic Profiling Systems / Transducers

Falmouth Scientific, Inc. (FSI) provides innovative and reliable sensor and survey solutions for applications in salt and fresh water environments. FSI's sensor based standard product areas include advanced seismic, sub-bottom, and side scan sonar imaging systems; current, wave, and tide meters; electro-acoustic transducers; and acoustic relocation systems. Services include custom design, development, integration, and production of marine technology. FSI's modern manufacturing facility houses an acoustic test tank, pressure chamber and calibration lab for qualification tests as well as value-added services such as prototyping, product assembly and subsea cable. At our core is innovative system and design engineering, on-site assembly and production operations, and electrical, acoustic, environmental, and system testing facilities.

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Services include custom design, development, integration, and production of marine technology. FSI's modern manufacturing facility houses an acoustic test tank, pressure chamber and calibration lab for qualification tests as well as value-added services such as prototyping, product assembly and subsea cable.

At our core is innovative system and design engineering, on-site assembly and production operations, and electrical, acoustic, environmental, and system testing facilities.

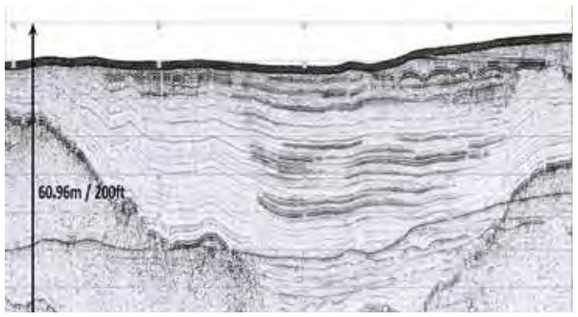
Hegg Marine Solutions is a brand under the FSI umbrella for sub-bottom and side scan sonar system technologies as well as field support services. The main products are the HMS-620 Bubble Gun family of seismic systems, The HMS-622 CHIRPceiver Subottom and the HMS-624 Sidescan. There is also a combined sidescan and subbottom available the HMS-6x5 in 2000m-6000m configurations.

Seismic Profiling Systems: HMS-620 Bubble Gun™

Dual Bubble Gun Deployment

Easy to deploy portable system

The Falmouth Scientific **HMS-620 Bubble Gun™ Seismic Profiling System** is a high power, portable, low frequency acoustic profiling system that provides deep bottom penetration through sediments that are very difficult to penetrate with the higher frequency profilers. The patented "Bubble Gun" electromagnetic acoustic transducer installed on a single tow vehicle provide bottom penetration through coarse sand and gravel, all the way to bedrock. The profiling system consists of three main components: the Falmouth Scientific HMS-620 Bubble Gun Transceiver, the Falmouth Scientific HMS-620 Bubble Gun Tow Vehicle, and the Falmouth Scientific HMS-620 Hydrophone Streamer. The Bubble GunTM has produced great results for port expansion projects, wind farm sight surveys and sand reclamation projects.



Data from Sand Reclamation Survey Courtesy of the University of Rhode island Graduate School of Oceanography

HMS-622 CHIRPceiver™

The Falmouth Scientific **HMS-622 Subbottom Profiling System** is a high power, portable, subbottom profiling system for towed, hull mounted and over the side configurations utilizing linear swept FM or "Chirp" technology that provides deep bottom penetration through a variety of sediments. Sub-bottom profiling applications in diverse sediments require multiple frequency bands to support diverse survey requirements. The HMS-622 CHIRPceiver™ and transducer arrays and vehicles fill this wide range of survey needs. The frequency band supported by the HMS-622 include standard LF (1KHz-10KHz), and optional ULF (200Hz-2KHz) and HF (8KHz-23KHz). It can be easily configured for up to 50Khz with a standard 2 channel transceiver. CW frequencies can also be programmed within the respective band. The transducer and hydrophone arrays are configured to perform both the transmit and the receive functions of the system.

The HMS-622 CHIRPceiver uses a flexible Graphical User Interface connected via Ethernet that allows the user to set CHIRP or CW modes of operation, Start and Stop frequencies, and Pulse Lengths and Power Level for the output pulses. The receiver controls allow for Gain and Attenuation as well as Diagnostic modes. The user selectable direct 24 bit A/D input allows the user to input data for the HMS-620 Bubble Gun or other analog seismic system. The HMS-622 CHIRPceiver will also support multi-ping modes for higher along track resolution when operating in water depths deeper than a given ping rate. All sonar data is logged in SEGY format using industry standard acquisition software.

The CHIRPceiver is also available in a low cost single channel version (CHIRPLitt) for coastal surveys less than 500m water depth.

Acoustic Sensors:

The Falmouth Scientific 3-Dimensional **Acoustic Current Meter (ACM-PLUS)** collects, outputs and stores instantaneous current velocity data in three dimensions along with 3-axis compass data, 2-axis tilt data, temperature data, and data from optional sensors, including an integrated CTD. The current velocity and tilt data can also be output and stored as vector averages over specified averaging intervals. The ACM-PLUS is configured and operated using ACMProPlus, a Microsoft Windows based software program included with the instrument. With ACMProPlus you can configure and deploy the instrument, acquire data in real time and download the data from the instrument's memory. And the real-time data can be viewed on a real-time monitor or a dashboard.

The ACM-PLUS Instrument:

The **ACM-PLUS** measures current velocity in the two horizontal dimensions and the vertical dimension using four acoustic transducers. Included inside the instrument's housing is a 3-axis solid state compass for measuring the Earth's magnetic field and a 2-axis solid state accelerometer for measuring tilt. A temperature sensor for measuring water temperature is located on the top end cap. Along with the optional CTD, the ACM-PLUS can optionally include two auxiliary analog input channels which interface with most DC output sensors, including dissolved oxygen, pH, chlorophyll, light transmission, and others. The ACM-PLUS can be powered from an external DC power supply or from an internal alkaline battery pack. Data can be acquired in real time in ASCII format through an RS-232 or RS-485 serial interface at baud rates up to 115200 bits/sec, or the instrument can be deployed and the data stored in its memory for later retrieval. A single bulkhead connector on the top end cap provides the RS-232 or RS-485 connection and inputs external power. The ACM-Plus is small in size and low in weight and has a depth rating of 200 meters. In addition, a 1.5-ton working strength 316 stainless steel frame is included with pad eyes on the top and bottom for securing to a mooring line, and zinc anodes are attached to the frame to provide cathodic protection. Optionally available is a 5-ton 316 stainless steel frame. In addition, a 7000-meter rated ACM-PLUS is optionally available.

Acoustic Transducers and arrays:

Falmouth Scientific also, designs and manufactures a variety of piezo electric transducers and arrays. Our transducer products range from low cost pinger, transponder and flow meter transducers to high power line arrays and deep water tonpilz projectors for our side scan sonar and sub-bottom profiling systems. Custom transducers can also be supplied to meet specific project requirements.

Standard Acoustic Transducer products

HMS-ATTR-4.5K is a high power tonpilz designed to operate in the 1kHz to 10kHz range.
TVR: 152 dB re 1uPa/Vrms
RVS: -165 dB re 1Vrms/uPA
Power Rating: 600 Watts 30% duty cycle
Beam Width: 80 degrees conical
Operating depth up to 3000m.
Main application is sub-bottom profiling.

HMS-ATTR-15K is a high power 7 element tonpilz conical array designed to operate in the 8kHz to 23kHz range.
TVR: 155 dB re 1uPa/Vrms
RVS: -165 dB re 1Vrms/uPA
Power Rating: 1000 Watts 15% duty cycle
Beam
Width: 20 degrees conical
Operating depth up to 6000m.
Main application is sub-bottom profiling.

HMS-ATTR-15K-9-120 is a high power 7 element tonpilz line array designed to operate in the 8kHz to 23kHz range.
TVR: 155 dB re 1uPa/Vrms
RVS: -165 dB re 1Vrms/uPA
Power Rating: 1000 Watts 15% duty cycle
Beam Width: 120degrees fwd/aft, 9 degrees athwart
Operating depth up to 3000m.
Main application is sub-bottom profiling pipeline detection.

HMS-AT-650 ULF is a high power flextensional transducer designed to operate in the 200Hz to 2kHz range.
TVR: 138 dB re 1uPa/Vrms
RVS: -190 dB re 1Vrms/uPA
Power Rating: 1500 Watts 15% duty cycle Beam
Width: Omni
Operating depth up to 300m.
Main application is sub-bottom profiling.

Falmouth Scientific

More detailed information on any Falmouth Scientific products can be found at www.falmouth.com

Otter controlled from the shore

An Otter Job

In the centre of Harderwijk by the water of the Veluwemeer, a new neighbourhood is being build. Many canals and harbours will be located in this neighbourhood, to refer to the rich history of Harderwijk with water and fishing. When the canals are dredged, these need to be checked. Not every survey vessel is able to sail in these waters, but the Otter can.

Harderwijk

Harderwijk is an old town that lies on what used to be the Zuiderzee shore. In the time of the Zuiderzee (till 1932 when the Zuiderzee was cut off from the North Sea) The economy of Harderwijk relied on fishing and seafaring[1]. After 1932 the economy of Harderwijk changed and between the shore and the centre came more and more industrial companies. Harderwijk lost its touch with the water and the traffic became more and more an issue.

This is the reason why Harderwijk builds the Waterfront. The Waterfront is a new neighbourhood for living and working with respect for nature[2].

The Waterfront

1. https://en.wikipedia.org/wiki/Harderwijk, 2. http://www.waterfrontharderwijk.nl

The Otter

All this new water in the waterfront needs to be dredged. After the dredging, the depth needs to be checked. The narrow canals, low bridges and high walls make it very hard to launch a survey vessel in the water and carry out the survey.

But not for the Otter. The Otter is very flexible in manoeuvring and can be put in the water by two people. The Otter is a small remote-controlled vessel manufactured by Maritime Robotics. It is possible to control the Otter with a tablet via a WIFI or 4G connection. Its manoeuvrability makes it easy to fill in all the corners that will otherwise be left in the unknown. Also, it is possible to let the Otter follow a line plan you can make from your desk up-front. So then it is just a matter of clicking play and you can just sit back and relax as it will carry out the survey for you.

A multibeam can be mounted to the Otter to record the data for the survey. The Otter is equipped with a camera for a real time feed for when the Otter is out of sight. Ideal for this situation under various bridges.

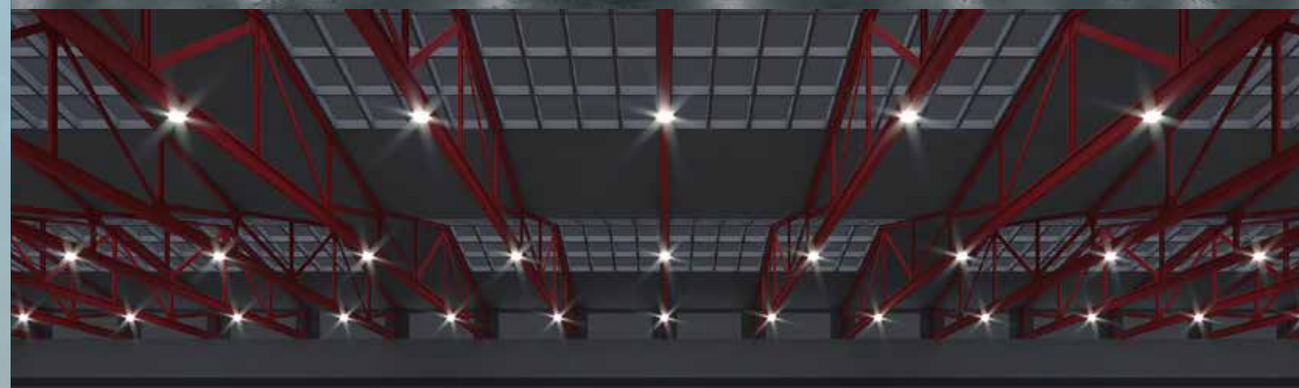
Braveheart preformed the survey while Seabed supplied the equipment like the Norbit multibeam, survey laptop with Qincy and the Otter itself of course.After a successful day of surveying Seabed sent the recorded survey data to Braveheart for processing.

With the otter it is possible to sail under small bridges and cover every small corner

The Otter „a small remote-controlled vessel"

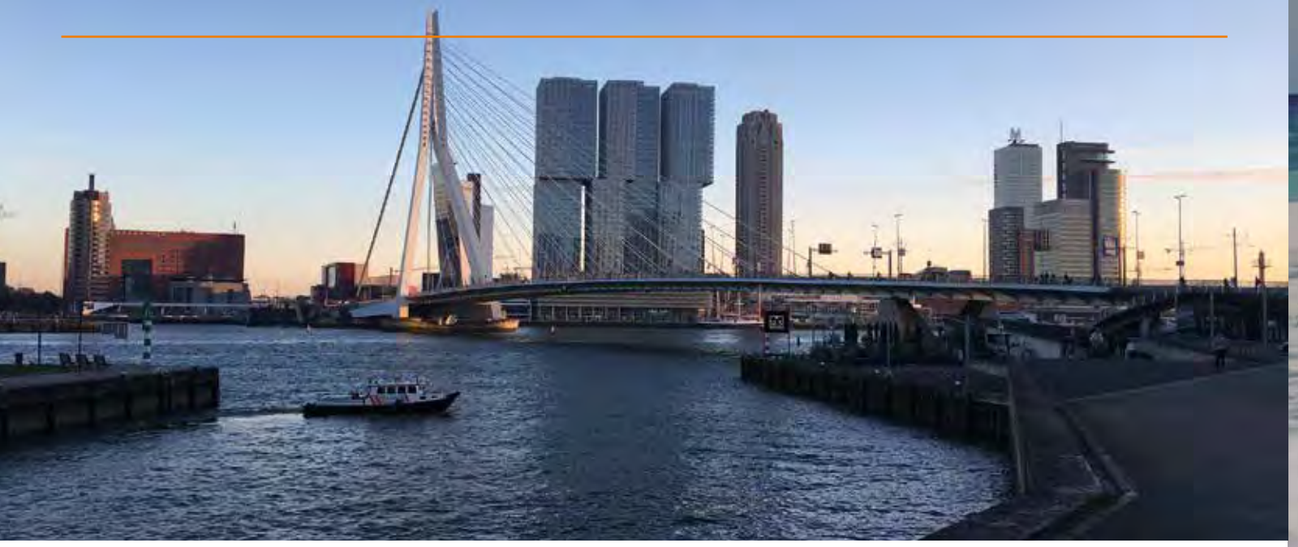
Result of the project

2020 wasn't a great year for Expo's

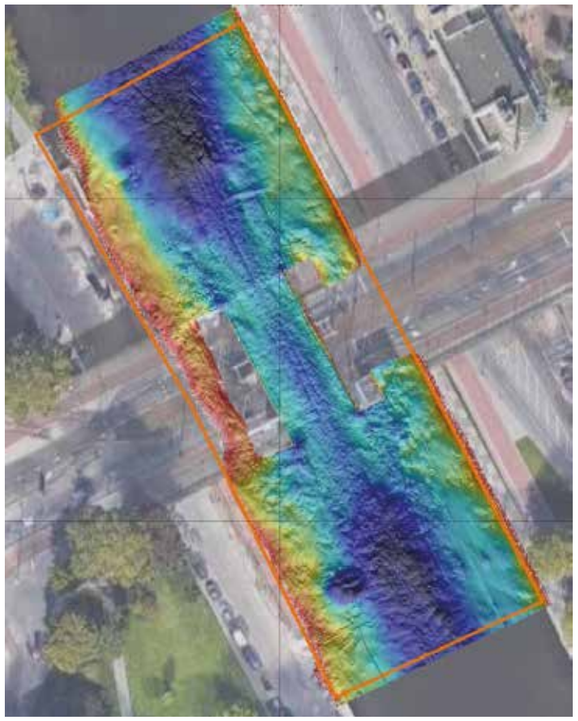


We hope to see you again soon, and show you what Seabed has to offer in person. Wherever that will be in the World!

Client tales #3



360survey is a young Belgian company, specializing in geophysical, geotechnical and UXO surveys. We regularly operate in the Netherlands and are happy to find a reliable and flexible partner in Seabed.



One of our latest projects has been a bathymetrical survey in the Rotterdam area. We deployed a Norbit iWBMS system in order to map areas around over 60 communal bridges and water locks. The aim of the survey was to monitor scour and erosion processes; allowing our client to plan maintenance works wherever they have become necessary. On a side note, our surveyors happily enjoyed the view on some of the city's most stunning landmarks from their floating office!

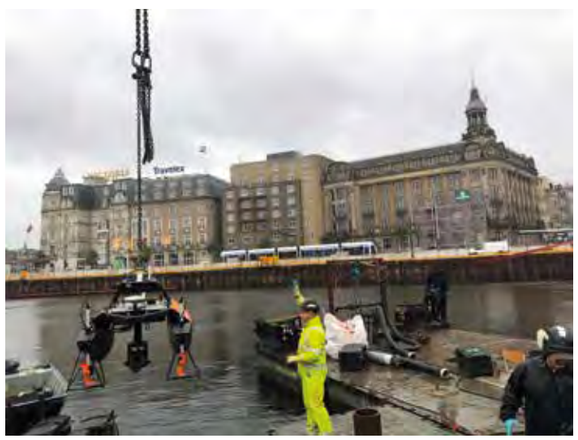
In Rotterdam and beyond, Seabed's team and equipment support us in offering the best solution for each and every project. We're looking forward to seeing them soon!

360 survey UXO | GEOPHYSICS | GEOTECHNICS

Will Amsterdam become the new Atlantis?

Amsterdam is inextricably linked to water, we can say that the canals, the Amstel and the IJ are her lifelines. The many bridges and quay walls connect the districts and neighborhoods with each other, and give the city her well known character. But the question if Amsterdam becomes the new Atlantis has more meaning to it than it appears, now that more research has been conducted the condition of the embankments, quays and bridges in the characteristic Amsterdam canals are being reviled. The results of the conducted research is utterly shocking, several bridges and embankments are beyond the breaking point of collapsing.

In recent years, quay walls collapsed or subsided several times. The municipality is responsible for the safety and maintenance of a total of 600 kilometers of quays and banks and has allocated millions for the restoration at the beginning of last year.



Amsterdam's councilor of traffic Sharon Dijksma said: "Especially bridges on wooden posts require short-term measures to guarantee that they won't collapse. Everything on wood is very, very bad. We already knew there was serious neglect, but the latest research results are disappointing".

For years, too little has been invested in the maintenance of bridges and quays. Since the 1980s, cuts have been made consistently. Previously each district was responsible for its own maintenance, but not all districts considered it to be a priority. Civil servants who expressed concerns about this were told that administrators would rather spend money on live ability or social affairs. Recently the maintenance of the bridges falls directly under the responsibility of the Municipal Executives.

In effect of the latest results the city has started mapping 829 bridges and dozens of embankment kilometers, as of now astonishingly only 21 have been fully investigated and ten of those were in such a bad shape that immediate measures were required, especially the historical part of Amsterdam is in a very poor condition.

The renewal operation will have enormous financial consequences and will take at least 20 years. The exact amount is not yet been determined considering the research has just begun. In the coming years, 300 million has been set aside for investments, but the coalition already took into account the astronomical amount of 2 billion euros last year, in the long term. The renewal operation is not only extremely expensive, but will also paralyze the city.

Several dredging companies and contractors have been contracted to perform these surveys and renovations, Seabed has been contacted by some of them to perform some tests and provided detailed information of the canal bed and conditions underneath several bridges. Seabed provided the Otter and their VLET 'Naatje' embedded with the integrated 0.9deg wide beam STX Multibeam system.

www.seabed.nl

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

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

SEABED

Getting to the bottom of things

Sound Velocity Profiling: Where, when & how often?

By Chris Malzone & David Wilson, AML Oceanographic

Sampling strategies for determining the sound velocity structure in the water column are vast and varied. Increases in the demand for accurate hydrographic data is providing career opportunities for freshman surveyors. The background for these junior hydrographers range from weekend boaters to Category A and/or B surveyors. Regardless of education and training, many surveyors approach their survey design with some level of uncertainty as to the impact that sound velocity may have on their data collection efforts.

Following the completion of a well done installation, sound velocity has the most drastic impact to the quality of your data. Since multibeam utilizes the transmission and reception of acoustic pulses, knowing the exact path each wave front takes on its round trip journey to the seafloor and back is crucial. There are three primary influences that impact this pathway: conductivity, temperature and pressure (depth). To give you an idea:

1 ° C change in Temperature = 4.0 m/sec change in velocity

1 ppt change in Salinity = 1.4 m/sec change in velocity
100 m change in Depth (10 atm's pressure) = 1.7 m/sec change in velocity

As these 3 factors vary as does the sound velocity. These changes bend the "acoustic beam" causing it to change direction and when not measured correctly, frequently enough or in the wrong location, you get what is called Refraction Errors. Refraction errors tend to get worse the further off-nadir (from the center sonar beam) you are due to the decrease in incident angle. When the measured velocity is higher than it should be, a flat surface will bow upwards (eg 'smile') and when it's too low, a flat surface will bow downwards (eg 'frown'). For example, in 10m of water, the error at 10m off-nadir on the seafloor is 4.6cm. This may not seem like much scale that up to 100m and out to the full swathe coverage of your multibeam.

Since the ocean is highly dynamic, listing all the factors that may impact the temperature and salinity are too numerous to list but Figure 1 summarizes some of the processes that must be accounted for in your survey plan.

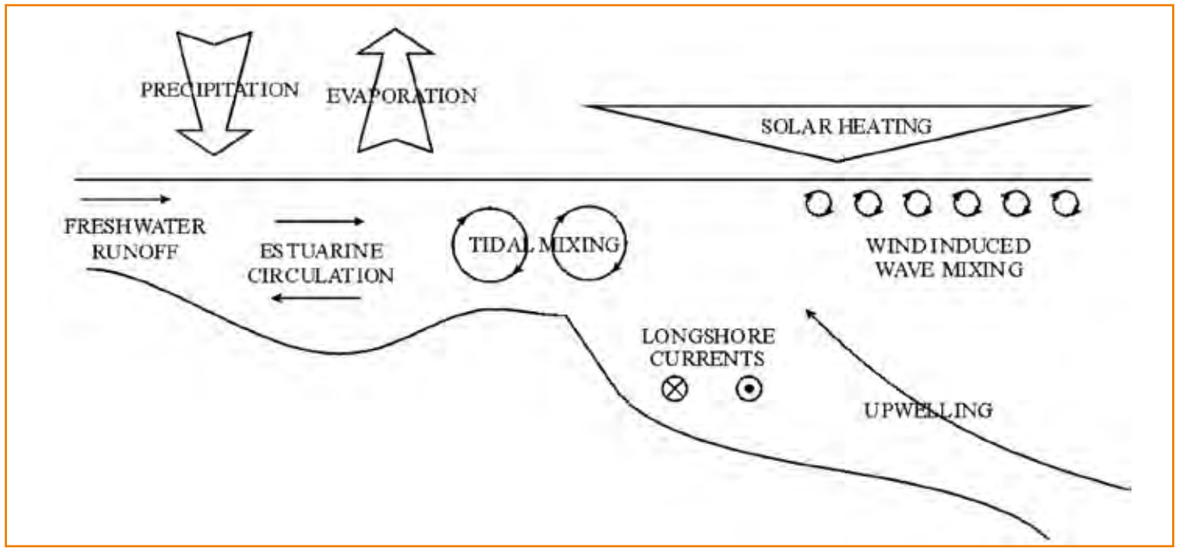


Fig 1. Illustration from Hughes Clarke (1999) showing the complexity of oceanography of coastal water masses.

With a large number of unknowns, it is safe to conclude that there is not one comprehensive model that you can apply universally to all survey operations to dictate your sound velocity sampling strategy. Sampling is situation and location dependent as the following examples illustrate:

Estuarine Surveys

Estuaries are regions in which exchange between inland freshwater systems and marine environments take place. In many estuaries the dominant components that impact hydrographic surveying are:

- Decreases in density/salinity by the freshwater discharge and ebbing tides
- Increases in density/salinity by flooding tides

These processes lead to salinity distributions that may take the form of a tidal prism (commonly known as a salt wedge) (De Nijs, 2010). Partially mixed or stratified systems are often characterized by frontal zones, separating the less dense and fresher river waters from the more dense seawater. The salt wedge is not a static feature; it can vary in both size and extent as the tide ebbs and floods (see image below).

Another issue with estuaries is that they are regions of high sediment transport, which for the purpose of hydrographic surveying means that the depth in any one location is varying constantly as is the sound velocity. Knowing the sound velocity in these regions is critical due to the varying bathymetry. To further complicate matters, rainfall, runoff, tidal cycles, storm surge, and other events all impact the physical oceanography – and hence the sound velocity – of an estuary. The Port of Rotterdam, one of the busiest ports in the world, is situated in an estuary. For this reason, authorities such as the Royal Netherlands Navy sample sound velocity continuously during survey operations in order to remove any uncertainty in the quality of their data.

The fact remains, most of our largest ports including; London, Hamburg, Vancouver, New York City and many more, are located in estuaries. Similar issues will be present regardless of location, and knowing exactly what is happening and when remains unseen without consistent sampling.

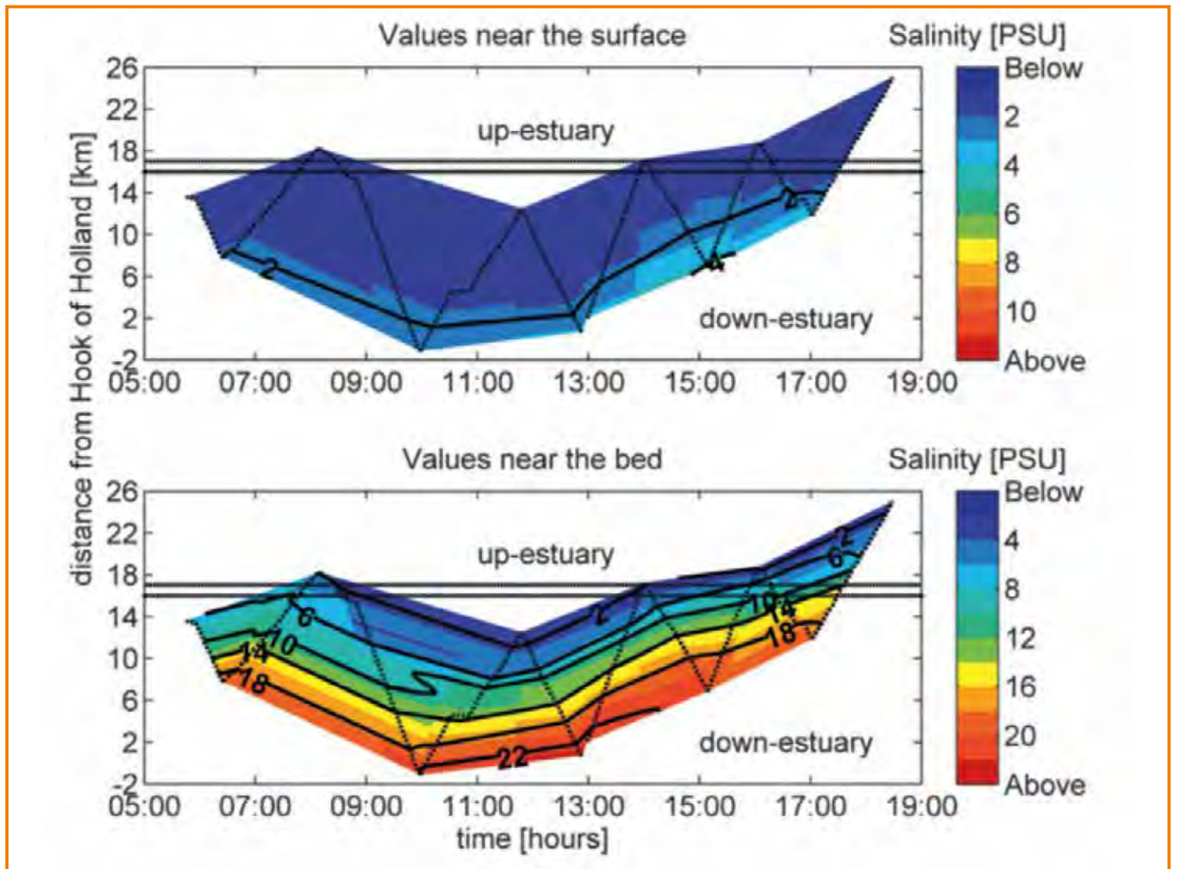


Fig 2. The estuarine environment that encapsulates the Port of Rotterdam estuarine location makes for dynamic conditions (De Nijs, 2010)

Offshore Surveys

Many people make the assumption that as they move offshore, layering is displaced by mixing and the spatial scales for sound velocity becomes more forgiving. In 2017 John Hughes Clarke published a study on sound velocity focusing on coherent refraction of "noise" in multibeam data due to oceanographic turbulence (Clarke, 2017). In that study, Dr Clarke cites two external inputs which create density differences in the ocean that impact hydrography; solar heating and freshwater inflow. In addition to those inputs, shear zones are also outlined as contributing factors to sound velocity refraction errors. Shear zones are layers of turbulence that form due to the imbalance between mixing at the surface currents (which are caused by wind) and bottom currents along the seabed (caused by friction).

Two oceanographic features that form in the water column which can impact your multibeam data either separately or together are; Kelvin Helmholtz (KH) waves (aka instability) or internal waves. Both form due to mixing at the pycnocline.

- KH waves form in the presence of shear (eg two bodies of water moving at different directions) which can take place at a variety of scales. Due to the fact that they can form regardless of bottom morphology (eg pretty much anywhere), it's next to impossible to predict when KH waves will form and dissipate. However, what is consistent is their impact on the bathymetry which shows up as an overall increased roughness of your data.
- Internal waves appear when mixing at the pycnocline is disturbed by the underlying morphology. They can have wavelengths of 100's of meters and amplitudes of 10's of meters. Internal waves will show up as "undulations" along the seams of adjacent swaths.

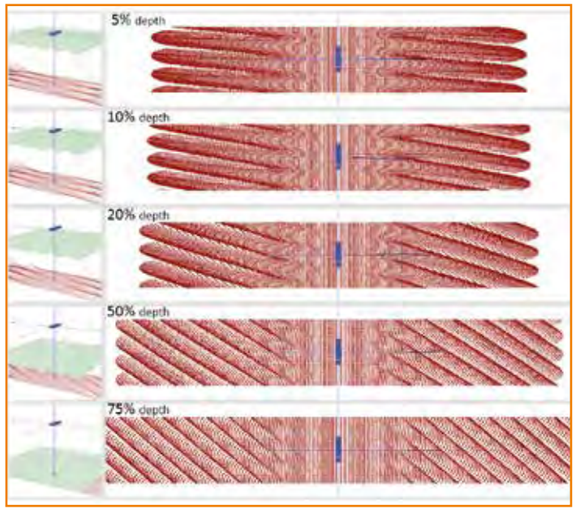


Fig 3 Internal waves create an acoustic anomaly that appear as asymmetric undulations on the seafloor. The degree of these asymmetric anomalies are directly relative to the "step" change in unmeasured sound speed (Clarke, 2017).

Regardless of whether it's KH or Internal waves or both, density driven features in the water column are not entirely resolved even utilizing an MVP however more frequent sampling will improve your overall data quality.

High Latitudes

Regardless of the presence of KH or internal waves, other factors may exist when surveying at higher latitudes and/or in the presence of significant bathymetric features such as a shoal. For example, in springtime a feature is present in satellite imagery over Georges Bank that indicates significant upwelling is present. This particular section of Georges Bank is not only known for higher springtime stratification due to increased solar radiation but as you migrate into summer, a strong thermocline is established that constantly migrates back & forth in response to tidal variations. The migration sets up a region of shear along the pynocline which further increases during spring tidal cycles. The perturbation of the pycnocline over the bank then results in large internal waves which then slowly propagates along the thermocline which then forms a front at the shelf-slope break. This front of tidal mixing tends to migrate back and forth over a spatial extent of roughly 8 km during the tidal cycle (Clarke, et al 2000).

Quantifying SVP Sampling Strategies

Back in the late '90's, in conjunction with the Canadian Hydrographic Service, John Hughes Clarke conducted a multibeam survey over a section on the Northeast corner of Georges Bank off the Coast of Maine (Clarke, et al 2000). During the survey, the MVP was deployed with profiles obtained every 2.3 minutes along 45 km transects in 100m water depth.

The approach that John Hughes Clarke took during the data analysis is ingenious in its simplicity. Rather than taking less profiles, he simply down sampled the profiles to illustrate how "little" one could get away with in terms of the impact that sound velocity data density has on multibeam data quality.

Moving from top to bottom in Figure 5, we first see the entire sound velocity profile data set with values ranging from 1515m/s in pink to 1480m/s in blue. At 2.3 minute intervals, strong stratification is present as well as evidence of tidal mixing and entry of cold water at a depth of roughly 60m near the end of the survey. The data is down sampled by reducing the number of profiles from 2.3-minute intervals to 17, 34 and then 70 and finally 140 minute intervals. It's worth noting that an interval between profiles of 2 hours and 20 minutes is by no means extreme, and for many organizations may be considered too frequent. Regardless, it is evident that the 140-minute data is not representative of the regional oceanography.

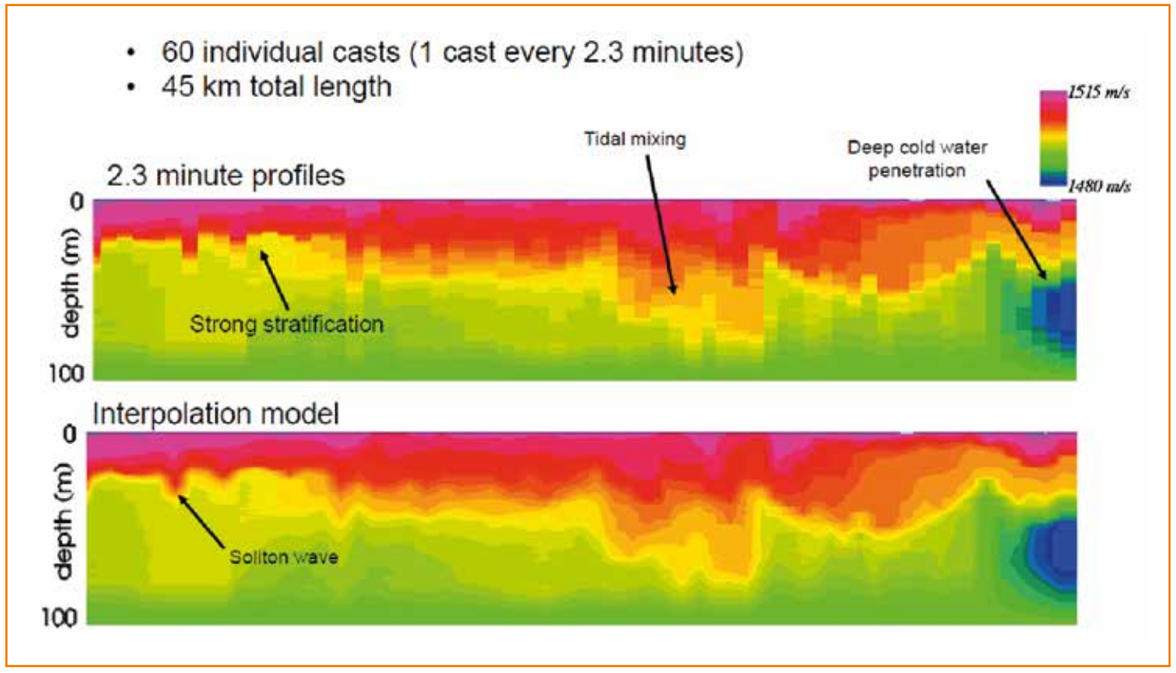


Fig 4. 2.3 minute sound velocity profiles showing the structure over Georges Bank off the coast of Maine (Clarke, et al 2000).

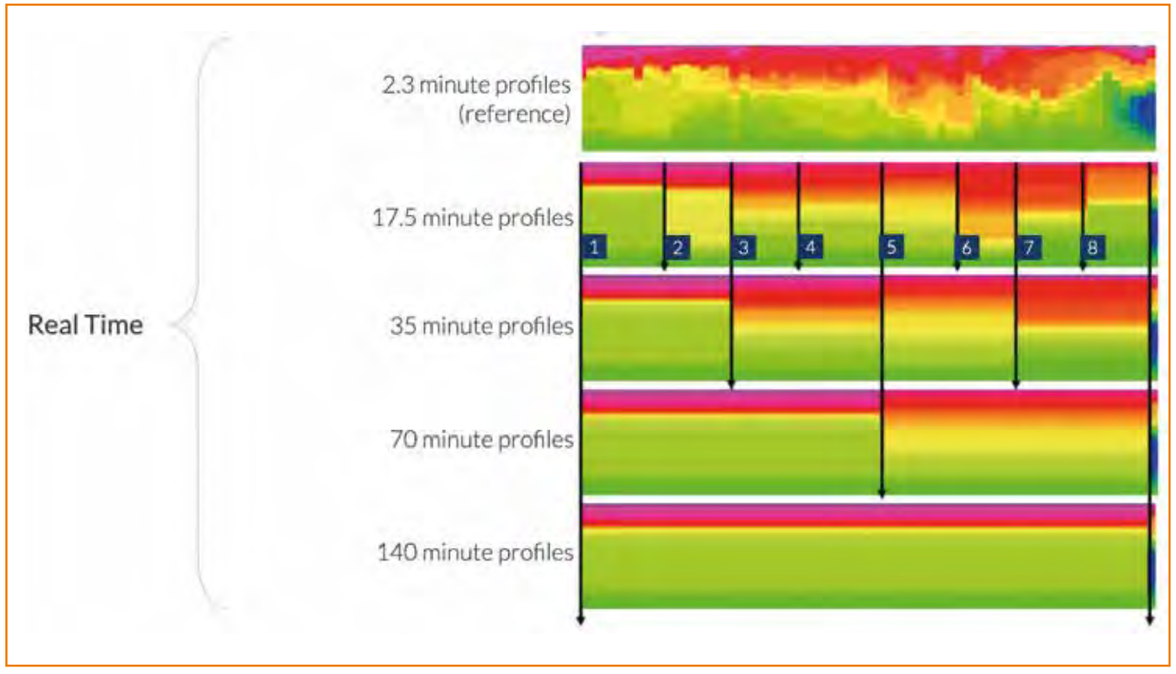


Fig 5. Sound velocity profile data downsampled from 2.3 minutes to 140 minutes illustrating the loss of structure with less sampling (Clarke, et al 2000)

Following the down sampling, the data was interpolated between SV profiles by merging the data between two profiles, with a bias depending which profile is geographically closest at any particular point. Even at 17.5-minute intervals we can see differences in the data, and with 140 minute sampling the results are not nearly representative of the oceanography: the internal waves and tidal mixing are non-existent, while the cold water is influencing 50% of the area whereas in reality it is closer to 10-15%. One quick conclusion that resulted from this part of the study was that interpolation is only useful and productive if the SV profile frequency is greater than the rate of change in oceanographic conditions. Following this conclusion, the analysis focused on how this translates down to the multibeam data.

The sound velocity data for the interpolated and real-time were separately applied to multibeam data for all time intervals (Fig 7). Differences grids were created looking between the 2.5-minute data versus the 17.5 min and the 2.5 min versus the 140 minute data. The root-mean square (RMS) errors were then calculated from which errors exceeding 5% were observed. These errors were greater during times when the sound velocity structure was complex. From this study it was then concluded that under typical survey conditions:

- There is no indication as to how complex the oceanography may be
- Attempts to improve results using interpolation are only useful if the sampling period is shorter than the time or distance scale of which the oceanography changes.

Conclusion

The nature of hydrographic survey locations are dynamic and difficult to predict. Oceanography features, both small, such as those found in estuaries to large, such as those in the open ocean, may lead to large errors if not properly accounted for. All of the studies cited, provide no clear indicators that there is a uniform sound velocity sampling strategy outside of sampling more frequently. While this conclusion may seem like a convenient coming from the manufacturer of the Moving Vessel Profiler, the fact remains that the more profiles obtained along a survey route, the higher the confidence in your data quality.

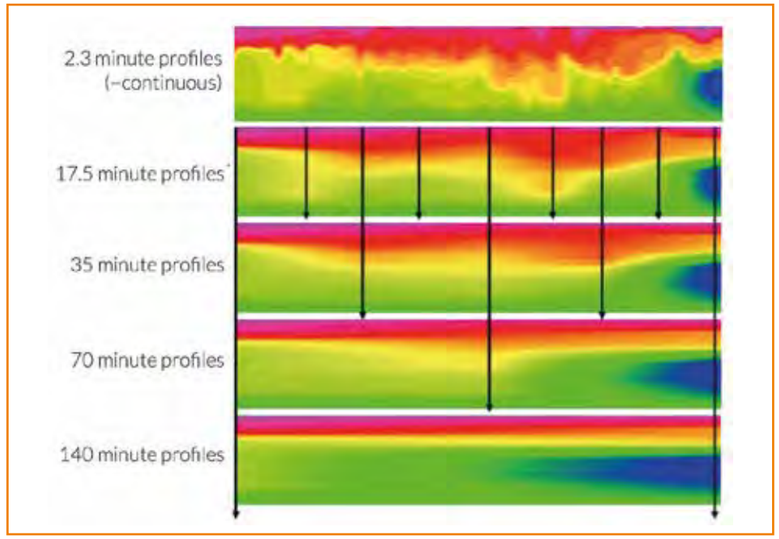


Fig 6. Interpolated Sound Velocity Profile data from Georges Bank (Clarke, et al 2000)

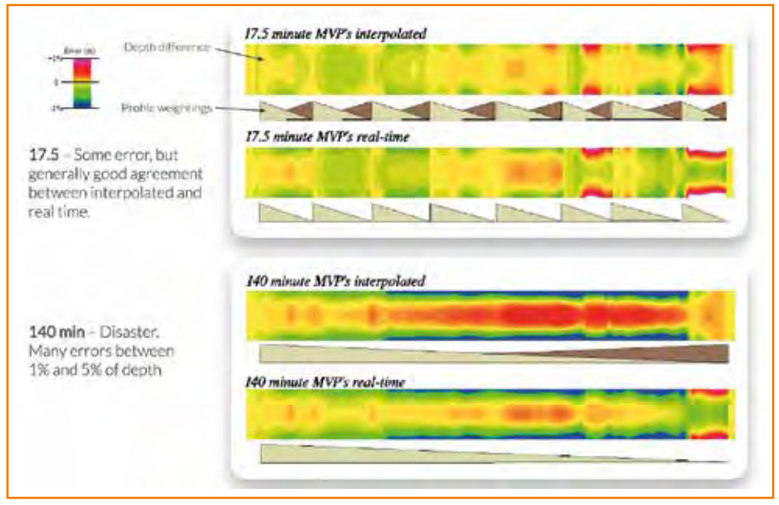


Fig 7. RMS Error plots of sound velocity profiles obtained at 17.5 minute intervals (actual and interpolated) and 140 minute intervals (actual and interpolated) (Clarke, et al 2000)

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A Day on the lake

Seabed was asked to assist with a survey on three lakes in Switzerland in the summer of 2020 by Groupe – E. Due to COVID-19 the survey was rescheduled several times but in September it was finally possible. Groupe – E is a Swiss electricity supply company and owns and maintains the dams at these three lakes. The main objective of the surveys was to monitor the increasement of sediment in the lakes since this is an important thing to know in these reservoirs where the volume is critical.

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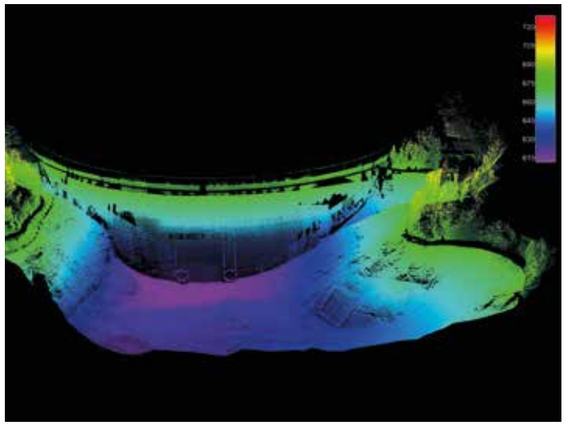
The three lakes have a combined surface of 10,12 km² of which 9,6 km² contributes to the surface of lake Gruyere. With a length of 13,5 km this is the longest artificial lake in Switzerland. Part of Lake of Gruyere is the Rossens Dam of which construction was completed in 1948. The arch dam has a height of 83 meters and a crest length of 320 meters. The last time Lake of Gruyere was surveyed was in 1996 and was done using singlebeam echosounder. Being surrounded by mountains and beautiful weather makes it a great experience and an amazing work environment.

While doing the survey we faced a couple of challenges. In Lake of Gruyere there were a lot of cut down trees in the water near shore which made it hard to survey the full area. Therefore the beam direction function of the Norbit iWBMS was used, which made it possible to survey a greater area than otherwise would be possible. Due to clear water it was easy to safely navigate, even in shallow waters, this was different in Lake of Lessoc and Lake of Vernex. Due to heavy rain and snowfall the reservoirs were being filled up which made the water cloudy as a result of sediment brought in to the lakes. Also with Lake of Vernex and Lake of Lessoc being not as deep as Lake of Gruyere it made it hard to estimate how close to shore it is possible to survey.
During the survey the water level of the lakes was not at its maximum, therefore the Norbit iLidar was used to measure up to the maximum water level.

Figure 1: Point cloud of Dam Rossens

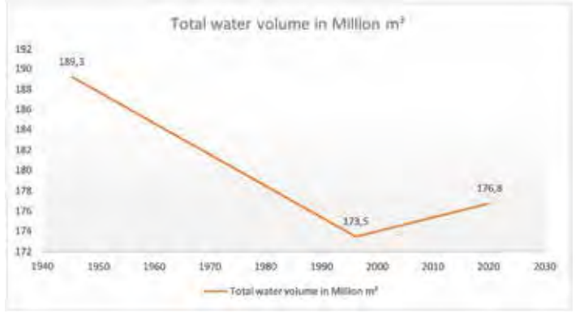


Survey Equipment.

The multibeam used for this survey was the Norbit iWBMS with a custom-made mounting system for the boat, which was provided by Groupe – E. In addition, the Norbit iLidar was mounted to collect data above the waterline.

Results.

First Lake of Gruyere was surveyed then Lake of Vernex was surveyed and as last Lake of Lessoc. Looking at the results of the water volume we can see that since the last measurements the volume of Lessoc and Vernex are decreased, in contrast to Gruyere, which increased in volume by 3,3 million m³ since 1996. An explanation for this difference can be the use of the latest high-end equipment, instead of the results of the survey done in 1996 using only a singlebeam echosounder.



Hemisphere GNSS

The latest product from Hemisphere GNSS, the R632 GNSS receiver can be used as a compass, base station, rover, or reference station. A full-solution product in an exceptionally compact and powerful package, the R632 easily upgrades to an astounding 0.01° accurate heading. Built on the foundation of Hemisphere's new Lyra, Cygnus, and Aquila core technologies, the R632 features incredible new interference rejection and multipath mitigation. The result is an exceptional combination of performance, communications, and connectivity.

The R632's standard configuration offers multiple methods of connectivity and an impressive array of wireless communications. Through Hemisphere's Atlas correction network, the R632 offers worldwide stand-alone positioning to 4 cm.

Hemisphere GNSS' R632 can access more than 1,100 channels for position and heading. The R632 tracks and uses all available GNSS signals and constellations including GPS, GLONASS, BeiDou (including phase 3), Galileo, and QZSS. The R632 is the perfect solution for almost any application requiring a professional-level position and heading performance.

The R632 has a built-in WebUI you can access from a smartphone for simple configuration. To configure your R632, you do not need any additional software, simply connect your smartphone to the R632's WiFi, open a web browser, and access the WebUI. The built-in dual band (400MHz and 900MHz) radio and GSM modem provide multiple RTK options. Use the WebUI to configure UHF and NTRIP, complete firmware upgrades, start raw data logs, and download data files.

Cygnus – Interference Mitigation Technology

Interference is a growing concern in GNSS, particularly as modern technologies increasingly become part of everyday life. As more devices, such as phones, tablets, PCs, headsets, and smartwatches connect and charge wirelessly, GNSS antennas are trying to track these very faint signals from satellites 20-30,000 km away with enough precision to deliver cm-level results. With an evermore crowded RF spectrum, Cygnus™ interference mitigation technology cuts through the noise to deliver on performance.

New on Phantom and Vega receivers, Cygnus interference mitigation technology incorporates the latest digital filtering technology. It uses an integrated Fast Fourier Transform (FFT) analyzer for real-time spectrum analysis and interference detection. Paired with high-resolution Analog to Digital Converters (ADC), Cygnus is well-prepared for superior anti-jamming performance.

Cygnus continually scans all GNSS signals watching for interference, ready to automatically engage sophisticated mitigation techniques to keep the signals pure. No special commands are needed, nor a degree in signal processing to know what to do if interference is detected. The Cygnus architecture instinctively deploys precisely targeted technology with in-band filtering measures and minimal impact or disruption to available GNSS constellation signals.

The results? Superior satellite availability when interference is present, and solutions where other receivers have none. Or simply put, Cygnus delivers confidence and peace of mind.

Atlas® Scalable, Global GNSS Correction Service for All High-Precision Applications

Atlas is an innovative, industry-leading GNSS-based global L-band correction service, providing robust performance at market-leading prices. Atlas is a flexible and scalable service, delivering its correction signals via L-band satellites at accuracies ranging from sub-meter to sub-decimeter levels. Leveraging more than 200 reference stations worldwide and with L-band satellites distributing Atlas corrections, the entire globe is virtually covered. The Atlas GNSS global correction service provides correction data for GPS, GLONASS, BeiDou, and Galileo constellations.

Positioning accuracy is a key decision for any operation. Atlas has scalable solutions to fit user's needs. Atlas Basic offers 50 cm 95% (30 cm RMS), useful in regions without SBAS or IALA coverage. The Atlas H30 service provides 30 cm 95% (15 cm RMS) for improved accuracy. For top performance, Atlas H10 is available with 8 cm 95% (4 cm RMS). Atlas is available on land and within 20 km of the shoreline. Atlas Offshore service is also available for those venturing further out to sea.

Hemisphere®

Meet...

Mike Mulder
Engineer

Date of birth? And what is it you like to do on your birthday?
I'm born on the 10th of February in 1998. What I like to do on my birthday is to have a nice meal with the family, that is all I really need.

Single, in a relationship or married?
Currently single, looking forward to what the future has to offer.

Any hobbies?
I like to listen to a lot of music, walking in the woods or at the beach. Watch a movie or fixing things. Always something to do.

Fast food, bistro or Michelin starred restaurant?
I prefer bistro because of the informal eating. (Don't expect me to eat spareribs with a fork and knife : P). But I have never been in a Michelin starred restaurant before, so maybe I will try that some time.

Netflix or the cinema? And what is your favourite TV-series or movie?
I don't really have a preference. It depends on the show or movie I want to watch. Sometimes going to the cinema with friends is also fun, closing off with a few beers to complete the evening.

What kind of job did you want growing up?
At first I wanted to be a garbage truck driver because of the huge trucks (I was a small boy at the time, so they were BIG). As I grew older, I wanted to do be an inventor to invent things that help people. Then I found Mechanical Engineering and completed the Bachelor study.

What is it you like most about your current job?
I graduated with a project at Seabed as a Mechanical Engineer. I never thought I would end up in the industry that I am in now. What I like is that no day is the same at Seabed. The work activities are very versatile. Sometimes behind the computer, but also in the workshop or on a boat. The team at Seabed is very young, making it a really nice work environment.

What do you learn from your colleagues?
As a mechanical engineer, I learn a lot about the electrical side of engineering. Also, I am getting to know a lot more about the offshore industry.

If you would win the lottery, what would your life look like?
If I win the lottery, I will probably drive a nice car, have a nice house with a wife, kids and some dogs, go on a nice sunny vacation, In the garage there will be an old-timer for the cruises. But I will live a normal life, it will all depend on the amount I win.

YUCO, the micro-AUV

Nowadays, the use of operational AUVs is limited in the community. Their heavy weights, their low manoeuvrability, their complex deployment, and high prices can discourage the operational use of AUVs and their possible application to short-term measurements in coastal areas.

Many questions come to mind when thinking about micro AUVs use and coastal deployment:

- How reliable is it?
- Will it find its way underwater?
- Will I be able to deploy it easily?
- What can it do?

YUCO is a range of several micro-AUVs carefully designed toward customers' key expectations: high reliability, precise navigation, lean deployment and cost effectiveness.

Each YUCO micro-AUV is a single-person deployable AUV, weighting less than 10kg and measuring around 1m with a functional bio-inspired design. YUCO is 300m depth-rated, runs up to 10 hours on rechargeable batteries, can reach speed up to 6 knots. All YUCO micro-AUVs come with a complete software suite and accessories to make it ready to use, from deployment to recovery. Each YUCO model embeds a payload dedicated to one key application.

How reliable is the YUCO?

AUVs robustness is an important point and the first risk for an AUV is water leaks, for instance in the mast area and the fins. To ensure perfect sealing, YUCO is compartmented in 2 sections. The dry section located in the middle and rear area is never to be opened by the user. This section hosts everything dedicated to navigation, including batteries, actuators, localisation sensors and embedded electronics. The wet section located in the front (nose) hosts the payloads (measurement devices) which are accessible to users. The wet section also embeds all necessary connector, for quick plug-and-play integration of new sensors. To ensure everyday use in rough conditions, critical parts like mast and fins have been optimized over the years leading to a robust bio-inspired design.

The second biggest risk in AUV use is to fail to recover it at sea. YUCO has special features that allow it to avoid such inconvenience. On the surface, you can easily spot it day and night thanks to its neon pink color and powerful flashing LEDs. YUCO micro-AUV mast is equipped with 3 types of wireless communication antennas: satellite, GSM and radio to ease recovery. At the end of its mission, a handheld remote-control and surface communication tool called RELOC regularly displays GPS positions of the YUCO when it is at surface. RELOC also provides an operational help to recover the micro-AUV with a "come-back-to-my-position" function.

Will it find its way underwater?

The objective in terms of navigation is to fit the size of the micro-AUVs and to be cost effective while offering a level of navigational accuracy sufficient to meet the expectations of offshore operations.

Off-the-shelf INS (Inertial Navigation System) in coherent price range are mainly designed for surface or aerial applications and rely on frequent GPS position updates. The lack of absolute positioning makes these INS unsuitable underwater. Furthermore, there is limited possibilities of sensor fusion with other underwater-specific positioning systems such as depth sensor, Doppler Velocity Logger (DVL) or Long Baseline (LBL).

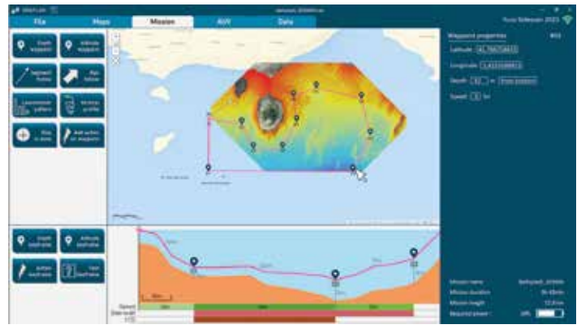
No navigation system already on the market was answering SEABER expectations. This is why SEABER team developed their own accurate navigation system for YUCO micro-AUVs, the INX©. Based on in-house advanced underwater navigation algorithms and being full owned development, INX© provides full mastering of the navigation performances. This gives SEABER the capability to evaluate and tune the thinnest parameter, to optimize and continuously improve the navigation experience. DVL and depth sensors are fully integrated and more positioning systems could easily be added in the future.

Will I be able to deploy YUCO easily?

YUCO micro-AUV comes with an intuitive software called SEAPLAN. It enables to program and upload a mission in less than 10 minutes. YUCO micro-AUV is programmed with SEAPLAN software via Wi-Fi so that it can be recharged while user interface is used.

SEAPLAN software is made to be as user-friendly as possible. In a single view, you can see and edit the elements of the mission (path, speed, payload, deployment and recovery points). Even untrained users can easily prepare a mission, thanks to its modern graphical interface and high-level navigation patterns. Advanced users can also access low-level navigation functions, payload activation and parameters with the same ease-of-use. Multiple online maps are available in SEAPLAN, but you can also create custom offline maps as most standard format can be imported.

SEAPLAN is also the AUV dashboard. At a glance you have access to YUCO status, sensor state and mission feasibility. Smart mission analysis audits autonomy, speed and accuracy considering YUCO's capabilities and field parameters. Moreover, a robust protocol and log analysis tools guarantee seamless security. It makes SEAPLAN a safe platform and gives users a great confidence in the success of every mission. YUCO calibration, firmware updates and mission upload are all made simple and done wirelessly via SEAPLAN. Once the mission uploaded, the AUV will simply start when submerged.



Once the AUV is recovered, SEAPLAN connects to YUCO and provides a clear mission debrief. The user can access the main mission indicators, quickly see if any problem occurred and import the raw mission data in open formats.

What can it do?

YUCO range offers numerous possibilities regarding the applications and is able to answer many needs.

YUCO-CARRIER is the YUCO without integrated payload. The wet section of the micro-AUV accepts a variety of wet payloads, either self-powered or YUCO-powered, as required.

YUCO-CTD is the ideal YUCO for oceanographic, biochemical and water quality monitoring in the water column.

YUCO-SOUND is the most suitable YUCO for monitoring marine mammals, capable of traveling up to 50 km. It has two recording modes: continuous or on command, with possible AUV engine shutoff.

YUCO-SCAN equipped with ~500kHz side-scan sonar and a 1MHz DVL, for more accurate navigation, the YUCO-SCAN that has the ability to follow a route and keep a distance from the sea floor. Thanks to its ease of use and fast recovery times, it leads the way to perform swift bathymetric surveys, allowing to reduce costs and optimize operational time at sea.

In a nutshell, via YUCO, SEABER is leading the way to switch common practices on using AUV platforms. Its operability in coastal areas, its ease of use and its affordability make it deployable for uses that would usually hardly be considered. The idea is that you can deploy a YUCO micro-AUV as if you would deploy any oceanographic instrument.

SEABER

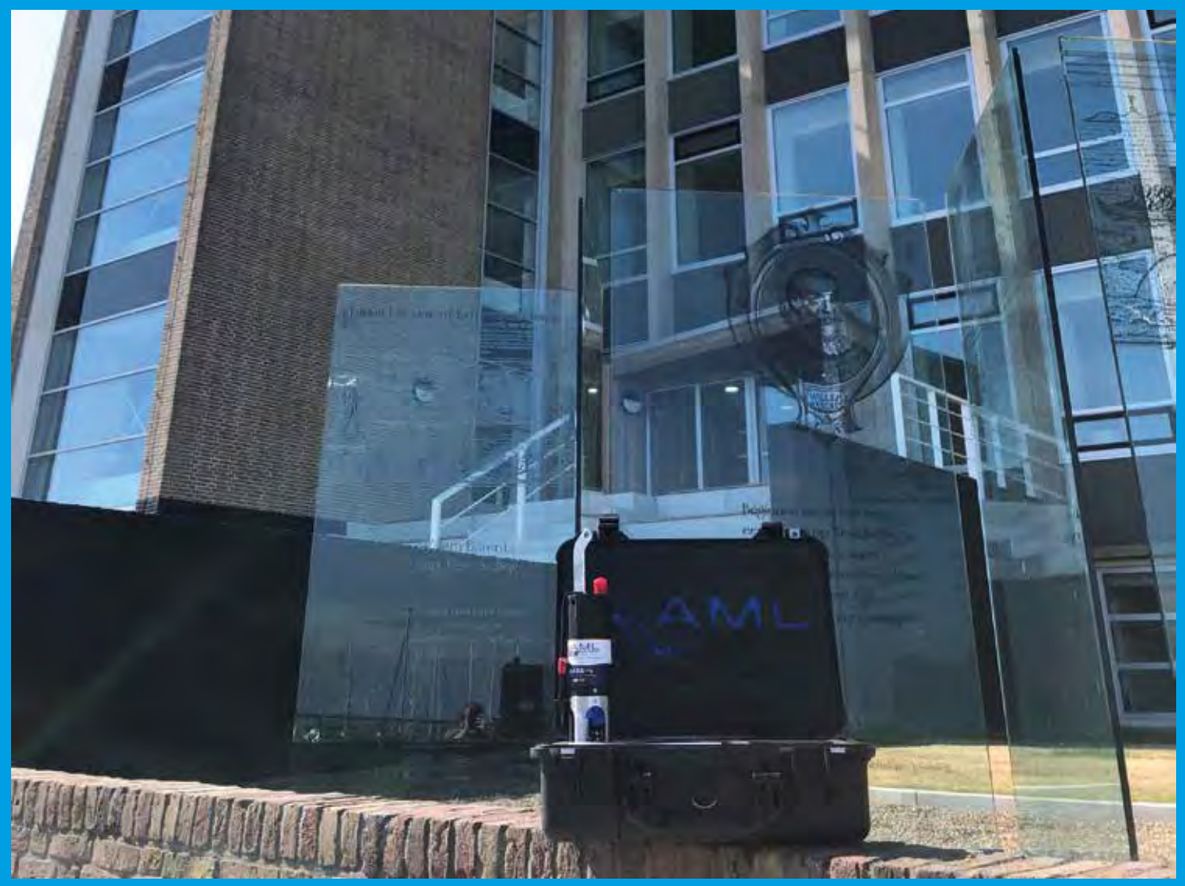
AML sponsors Maritiem Instituut Willem Barentz with a Base X2

Thank you note from MIWB:

The OT team at Maritiem instituut Willem Barentz would like to thank AML and Seabed for sponsoring an AML BASE X Sound Velocity Profiler to the Maritime Instituut Wilem Barentsz at Terschelling!

Theory lessons are very important in every school but what if you can never test your theoretic knowledge in practice. Of course the MIWB does not have the funds to purchase all this equipment. Therefore Seabed asked their supplier AML Oceanographic if they are willing to sponsor the MIWB with a sound velocity profiler, and AML was more than willing.

The system will be used for practical lessons at the Study Ocean Technology to prepare and teach the students. We at the MIWB are very happy with our relationship with Seabed and AML!



Meet...

Suzanne Cranfield

Process Manager

Date of birth? And what is it you like to do on your birthday?
28-10-65. My girlfriend also has the same birthday so I love getting our 2 families together to celebrate with good food and lots of wine!

Single, in a relationship or married?
As good as married to Jeffrey who does everything to make me smile. 😊 I now have 3 children, my son James and my 2 "bonus" kids; Rosalie and Jonah.

Any hobbies?
Socializing with friends and family, sailing in and around Amsterdam, having friends to stay from the UK to enjoy my adopted hometown and our wonderful home with it's own water paradise (canal)! But the hobby that is closest to my heart is giving creative ideas to Jeffrey for him to build and…. of course giving orders! hahaha

Fast food, bistro or Michelin starred restaurant?
Any cafe or restaurant that has a friendly atmosphere and of course good food and wine to be consumed with family or friends. My kids answer to this question would be Sushi!!!

Netflix or the cinema? And what is your favourite TV-series or movie?
I like going to the cinema with the kids but Netflix is also good enough for a family film night – just a battle to find a film that everyone wants to watch! One of my personal favorites is Shawshank Redemption or just about any film with Jason Statham in it, doesn't matter what! LOL

What kind of job did you want growing up?
A Racing driver! From an early age I always had a passion for fast cars, I got that from my mother. She taught me to drive in a Lancia Beta Coupe! Before I permanently moved to Amsterdam I had a Audi TT roadster that I still miss very much. I don't have what I would call a "fast" car any more so have to be more creative in "living in the fast lane".

What is it you like most about your current job?
Working with a small team to build something big! The ability to use my previous experiences and knowledge to implement a new system from scratch, tailoring to meet the business and operational needs, and still being able to increase my own personal development as I go! Who can ask for more?? I have an amazing opportunity to join a vibrant team, working together to stimulate new ideas, ways of working and ultimately add value to the organization. Is it work or fun… ?

What do you learn from your colleagues?
That they are open to change. Sharing ideas, getting those creative juices flowing is a great motivator and results in a productive team building quality products and processes that add value to both the end user(s) and the organization.

If you would win the lottery, what would your life look like?
Hmm that is a tricky one. I think the first thing I would do is buy apartments for our kids to get them on the property ladder, an apartment for my brother in Amsterdam and a restaurant/ business for a friend that is the best chef that I know! Oh and of course a house in Spain… Would I carry on working? I will let you know when I win, first need to buy a ticket. 😊

The creation of the renewed S44 Standard

In the last three years that I worked at the NL Hydrography Service I was involved in renewing the S44 standard for hydrographic surveying. Seabed gave me the opportunity to share experiences with you in this always pleasant to read Seabed Glossy. In this paper I will tell you how the new standard came about; why it was necessary; what has changed (in very broad terms) and what I have noticed in the cooperation with international partners.

John Loog
Hydrographer from the NL Hydrography Service, retired

Before I deterred everyone with S44, my own first reaction was "it's necessary but possibly boring". However, working on the S44 was a lot of fun and has given me a lot of new insights that I like to share. The new version S44 edition 6 has now become official and is quite different from its predecessors.

Every hydrographer somehow encounters the S44 standard. The most well-known part is Table 1, which lists all kinds of standards that survey work must meet. S44 is used by clients to record requirements, by equipment manufacturers to show that their equipment meets the appropriate requirements and by hydrographers who must be able to demonstrate that their work has the desired quality. The S44 standard is propagated by the International Hydrographic Organization (IHO) and the primary objective has always been "safe navigation".

IHO STANDARDS FOR HYDROGRAPHIC SURVEYS (S-44)
6th Edition March 2020

7.6 MATRIX

Matrix for Hydrographic Surveys. To be read in conjunction with the full text set out in this document, m = metres, all uncertainties at 95% confidence level.

	Criteria	1	2	3	4	5	6	7	8	9	10	11	12	13	14
B	BATHYMETRY														
a	Depth THU [m]	500	200	100	50	20	15	10	5	2	1	0.5	0.35	0.1	0.05
b	Depth THU [% of depth]	20	10	5	2	1	0.5	0.25	0.1						
c	Depth TVU "a" [m]	100	50	25	10	5	2	1	0.5	0.3	0.25	0.2	0.15	0.1	0.05
d	Depth TVU "b" Note 1	0.20	0.10	0.05	0.023	0.02	0.013	0.01	0.0075	0.004	0.002				
e	Feature Detection [m]	50	20	10	5	2	1	0.75	0.7	0.5	0.3	0.25	0.2	0.1	0.05
f	Feature Detection [% of Depth]	25	20	10	5	3	2	1	0.5	0.25					
g	Feature Search [%]	1	3	5	10	20	30	50	75	100	120	150	200	300	
h	Bathymetric Coverage [%]	1	3	5	10	20	30	50	75	100	120	150	200	300	

So, let's get to work, with an international company from all continents. To keep progress and not deviate too much from the original objective, the work was framed:

- The standard had to be "technique agnostic" as far as possible. In principle, specific surveying techniques are not mentioned anywhere in the new standard.
- Use of terminology in definitions and explanations in accordance with official scientific terms.
- Usable for wealthy IHO members, but also for the less fortunate countries that are limited in resources.
- Suitable for "Safe Navigation" but also for engineering, for example.

Was it necessary for the S44 to be renewed as standard? Within the IHO, the general idea was that the standard needed a refresher and hydrographic services, and industry were asked to cooperate in a project team. The first question within the project team was: "Is an update necessary?" "And then: " What is needed?". For this purpose, a questionnaire was sent out internationally. Based on the answers, it should be rather easy to propose changes.

The questionnaire soon showed that S44 was really in need of change.

- Locally, higher accuracy requirements were already used (as in the Netherlands). Higher accuracies were needed, for example, due to smaller under keel clearance margins.
- New recording techniques give more possibilities and no longer fit in edition 5.
- Current techniques collect much more data than before.
- Data itself is subject to ever higher demands and not only accuracy but also on the meta data in which everything from the dataset itself is described.

When all that was established, the work could start quickly. It suddenly became interesting when it turned out that apparently everyone "does it differently". From hydrographic services you would expect them all to make the same sea map and that the surveying work and chart production largely is done the same way. Nothing could be less true. I had already noticed this earlier in consultations between countries around the North Sea. Around the North Sea all maps fit together nicely, but the recording and production process differs per country. On a global scale, the differences are much greater. This has everything to do with the underwater environment that varies greatly from place to place and requires a different approach.

With your own standardized working method, you do not immediately consider the problems that other hydrographers face, due to differences in the underwater environment. The North Sea, for example, has large sediment movements and is constantly on the move. As a result, the time factor and the degree of change is something that needs to be considered. Explain that to a country with a rock bottom.

The project team's biggest challenge was how to apply ideas for innovation and set them in a consistent standard. First the team had to agree on the broad outlines, that sounds easy but, as soon as the broad outlines are discussed, the details of why something cannot be done quickly come up.

The illustrious Table 1 should be greatly expanded to contain all the new requirements. This was a bridge too far. One of the first decisions was that Table 1 would remain virtually unchanged and so stay recognized by the hydrographic community. With an additional table the standard could be expanded with all wishes. This extra table soon became "the matrix". The matrix now contains many more standard values that could be met.
The matrix makes it possible to name more measured values in a much larger range of accuracies. In the original Table 1, accuracy decreases from left to right reading. With the matrix it is the other way around, the accuracy reading from left to the right increases. This allows the matrix to be replenished in the future without changing old values.

Table 1 is still suitable for navigation safety and was yet added with an additional category: Exclusive Order, a compromise. However, the matrix gives much more possibilities to characterize requirements for measurements. All values in Table 1 are also included in the array, making it possible to delete table 1 in a subsequent version of S44.

Another fundamental change is that depth no longer has a separate chapter. In the old version, there was still a difference between position and depth. With current techniques and databases, this no longer makes much sense. The new version of a three-D position has been used. A feature can be indicated by an XYX position, accuracy, and properties.

I could write this magazine completely full of all topics that have been heavily discussed for the new version. It should be clear that version 6 is one great compromise to identify all the wishes and situations in global hydrography. It is therefore a miracle that the result was achieved in three years. What helped a lot was that it was only hydrographers and surveyors who argued with each other. With good people, it is good business. Also special to mention was that the project team was the only team within the IHO that engaged in pure hydrography.

It is now important that the new S44 version is embraced and used by the hydrographic community. Within the Hydrographic Society Benelux (HSB) attention will be paid this year to the new version and how it can be used. I am very curious whether the new version will be workable in practice. From my own background, I know how important it is to know exactly what requirement the data meets, in order to be useable for multiple purposes. Surveying work is expensive and single use of data is a waste of the time and effort that has been put in.

The new S44 version can be downloaded and read at the following web address:
https://iho.int/uploads/user/pubs/Drafts/S-44_Edition_6.0.0-Final.pdf

IHO STANDARDS FOR HYDROGRAPHIC SURVEYS (S-44)
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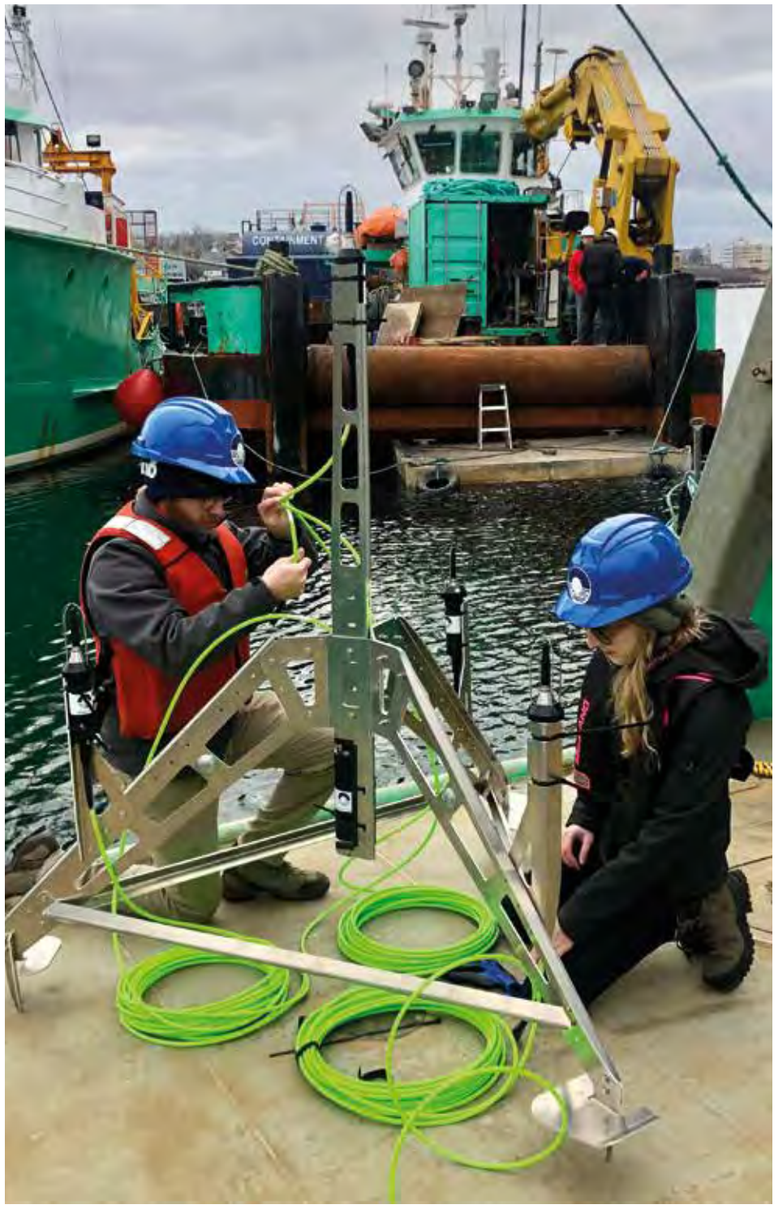
7.3 TABLE 1 - Minimum Bathymetry Standards for Safety of Navigation Hydrographic Surveys

To be read in conjunction with the full text set out in this document, m = metres, all uncertainties at 95% confidence level, * = Matrix Reference.

Reference	Criteria	Order 2	Order 1b	Order 1a	Special Order	Exclusive Order
Chapter 1	**Area description** (Generally)	Areas where a general description of the sea floor is considered adequate.	Areas where underkeel clearance is not considered to be an issue for the type of surface shipping expected to transit the area.	Areas where underkeel clearance is considered not to be critical but features of concern to surface shipping may exist.	Areas where underkeel clearance is critical	Areas where there is strict minimum underkeel clearance and manoeuvrability criteria
Section 2.6	**Depth** THU [m] + [% of Depth]	20 m + 10% of depth *Ba5, Bb2	5 m + 5% of depth *Ba8, Bb3	5 m + 5% of depth *Ba8, Bb3	2 m *Ba9	1 m *Ba10
Section 2.6 Section 3.2 Section 3.2.3	**Depth** TVU (a) [m] and (b)	a = 1.0 m b = 0.023 *Bc7, Bd4	a = 0.5 m b = 0.013 *Bc8, Bd6	a = 0.5 m b = 0.013 *Bc8, Bd6	a = 0.25 m b = 0.0075 *Bc10, Bd8	a = 0.15 m b = 0.0075 *Bc12, Bd8
Section 3.3	Feature Detection [m] or [% of Depth]	Not Specified	Not Specified	Cubic features > 2 m, in depths down to 40 m; 10% of depth beyond 40 m *Be5, Bf3 beyond 40m	Cubic features > 1 m *Be6	Cubic features > 0.5 m *Be8
Section 3.4	Feature Search [%]	Recommended but Not Required	Recommended but Not Required	100% *Bg9	100% *Bg9	200% *Bg12
Section 3.5	Bathymetric Coverage [%]	5% *Bh3	5% *Bh3	≤ 100% *≥ Bh9	100% *Bh9	200% *Bh12

Multi-Hydrophone Deployments: An Array of Possibilities

At Ocean Sonics we are often asked, "Why use two or more hydrophones? Can one be just as effective?". The answer is, it depends.



Tetrahedral Array with four hydrophones

A single hydrophone deployment can be incredibly effective for certain projects such as creating ocean soundscapes, measuring SEL/SPL for impulsive sounds, as well as monitoring earthquake and geological activity. A single hydrophone deployment is best used when the sound data being collected does NOT need to be directional. This means that the direction of the sound source and the location of the sound source are not important to the project. If direction or localization is important, a multi-hydrophone deployment is the most effective way to collect your data. This type of deployment is known as a hydrophone array. An array can be two, three, ten or even hundreds of hydrophones, working together to collect ocean sound data.

There are ways to quickly and easily turn single hydrophones into arrays without complicated design or deployment. If you are using more than one hydrophone and you would like to sync them together but they are located too far apart you can use GPS time to sync them. This can be done by using a GPS time sync, buoy, or an Ocean Sonics wifi capable deck box, known as Launch Box.

With changing regulations surrounding environmental monitoring for marine construction, many regulatory bodies are introducing multiple hydrophone monitoring requirements. By placing one hydrophone connected to a Launch Box 10m from the sound source, and a second system 50m from the sound source, the internal GPS sync of these tools allow the user to use these two independent deployments as a synchronized 2 hydrophone array.

A basic static array of two hydrophones can be used to provide direction and localize a sound source. This is done by determining time of arrival or TOA.

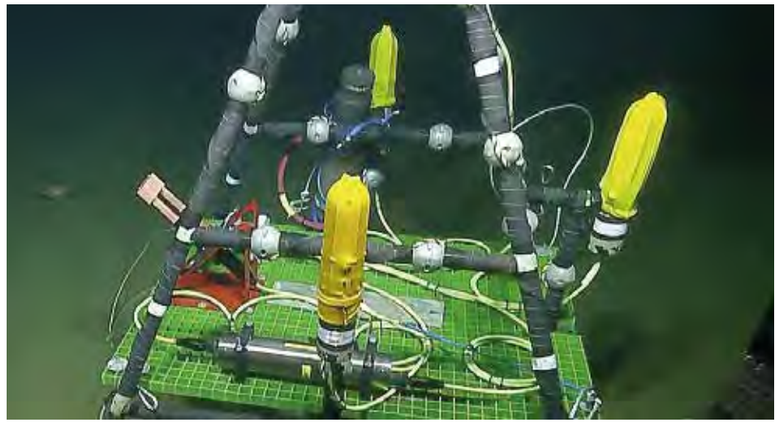
Advertorial

Buoy up close

When looking at the data from the hydrophones, the TOA of a sound will differ and based on the separation distance of the sensors, someone can determine the direction that the sound came from and how fast it's traveling. By adding a third hydrophone in a triangle formation, it's possible to reduce left-right ambiguity and potentially localize a sound source. These types of deployments are a good solution for monitoring vessel traffic and speed and tracking and localizing marine mammals. A great example of a static, multi-hydrophone array is a tetrahedral array. Using a tripod, like the one Ocean Sonics has created, allows the user to mount multiple hydrophones on a sturdy mooring with uniform separation between all the sensors. The use of a tripod for deploying a tetrahedral array ensures even separation of the hydrophones of 1m. This benefits the user by allowing for simple math during post process to quickly glean important information. By deploying an array for 4 hydrophones and using the TOA, it is easy to detect and tack on the X and Y axis. A number of these tetrahedral arrays are currently in use on the west coast of Canada. They are part of a large-scale marine mammal tracking network, tracking the movements and behaviours of the endangered Southern Resident Killer Whales in real-time. There are also a number of tetrahedral arrays deployed as part of Ocean Networks Canadas ocean observing program. These deployments collect and stream continuous acoustic data from depths greater than 2000m.

A vertical array is comprised of multiple hydrophones assembled into a vertical format. This is a specific type of array that allows the user to monitor sounds at varying depths throughout the water channel. Static vertical arrays are typically

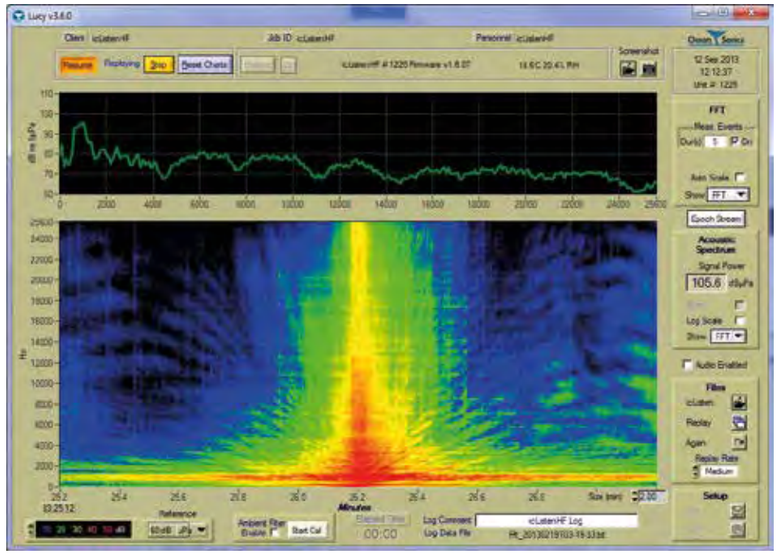
ONC Hydrophone Array deployment



used for beam steering. By introducing multiple hydrophones in a stationary vertical formation, it is possible to get accurate measurements of a sound throughout the entire process of a specific sounds travel throughout the water column.

Attaching multiple hydrophones to a drifting buoy is a simple way to create a drifting vertical array. This is an omnidirectional mobile array. A drifting array using an Ocean Sonics wifi buoy allows the user to collect and view processed data from multiple hydrophones in real-time. This deployment has been used as a non-invasive way to monitor marine mammal behaviour at varying depths in the water channel. Because the buoy is silent and the data is sent via wifi, users are able to collect this acoustic data without altering the animals behaviour with the presence of a vessel or diver. It is also possible to equip these buoys with radio capabilities, allowing users to collect, stream, and view data over greater distances. These long range drifting deployments are excellent options for monitoring large or remote areas such as offshore energy installations or marine protected areas.

Finally, a towed array is a multi-hydrophone deployment consisting of multiple neutrally buoyant hydrophones towed a vessel or vehicle. In order to effectively collect sound data in this scenario, the use of a depressor is encouraged. This allows the hydrophones to be towed at a consistent depth behind a vessel so there are no discrepancies in the data due to changes in hydrophone depth.



Passing boat in Vancouver

While there are many different types of arrays and different uses for all of them, one thing that all arrays have in common is the amount of knowledge than can be gained. By using multiple hydrophones in a deployment instead of a single sensor, the user can get a much clearer picture of what is happening in an environment. More hydrophones means more data, which ultimately will provide better results.

Ocean Sonics, trusted world leaders in underwater listening, designs and builds the icListen family of Smart Hydrophones. The icListen is the only digital hydrophone to provide high quality, ready to use acoustic data in real-time, delivered directly to your computer, tablet or smart phone. Use icListen as a real-time listening device or as an acoustic recorder. The icListen provides users unique features such as:

- *Real-time data visualization*
- *Built-in event triggers*
- *SEL/SPL measurement*

and many more…

icListen streamlines the collection, processing, and use of ocean sound data and has been adopted as the hydrophone of choice by users around the world. As of 2021, there are icListen Smart Hydrophones in use in every continent, including Antarctica. Environmental monitoring is simplified by the icListen's real-time data delivery and built in processing features. Ocean Sonics brings innovative marine sound management solutions to help you achieve operational excellence and sustainability

Listen Now. The Ocean Sonics Way.
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OCEAN SONICS

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Mark Gerhards, Teamleader Operations

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Jeroen Vos, Intern

Mike Mulder, Engineer

Suzanne Cranfield, Process Manager

?

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Why accurate subsea navigation was vital for an ROV assisting with deep ocean research

Pelagic Research Services was looking to improve the accuracy of the subsea navigation systems on its ROV. Find out how an accurate and high-performing DVL paired with an inertial navigation system enabled smooth operation in tricky conditions by hydrothermal vents in the deep ocean.

Pelagic Research Services, based in Cape Cod, has been carving out a niche in the remotely operated vehicle (ROV) market with its versatile Odysseus vehicle, which can carry out a wide variety of duties despite its small footprint.

The ROV is capable of providing real-time HD imagery, lifting loads of up to 4000 lb (1814 kg – in-air weight) and using seven-function manipulators to carry out precise work in water depths down to 6000 m.

The ROV has proved to be a flexible tool for University of Victoria's Ocean Networks Canada (ONC), which installs infrastructure in the waters around Canada's coasts to deliver data in real time for scientific research to help government and industry decision-making on future projects.

As part of ONC's "Wiring the Abyss" program, Odysseus has carried out several assignments. Operating in one of the most hostile underwater environments on the planet, the ROV has enabled ONS to monitor and install infrastructure in an area of hydrothermal vents some 200–300 km offshore Vancouver Island at depths of greater than 2200 m.

Pelagic Research Services' Odysseus ROV, ready for deployment off Canada's Pacific coast, equipped with the Nortek DVL1000 for improved navigational accuracy. (Photo ©: Ocean Networks Canada and Pelagic Research Services.)

Accurate navigation is vital in a complex subsea environment

The vents provide a unique habitat, so they have long been the target of serious investigation. But this is not an environment that is easy to work in or get around.

"It can take one or one-and-a-half hours to get to the sea floor at 2200 m, and you might be limited by a weather window, so once you get down there, you need to be able to work quickly and effectively. To do that, accurate navigation is vital," says Ed Cassano, Pelagic's Chief Executive.

A high-accuracy DVL and inertial navigation system to pinpoint subsea location

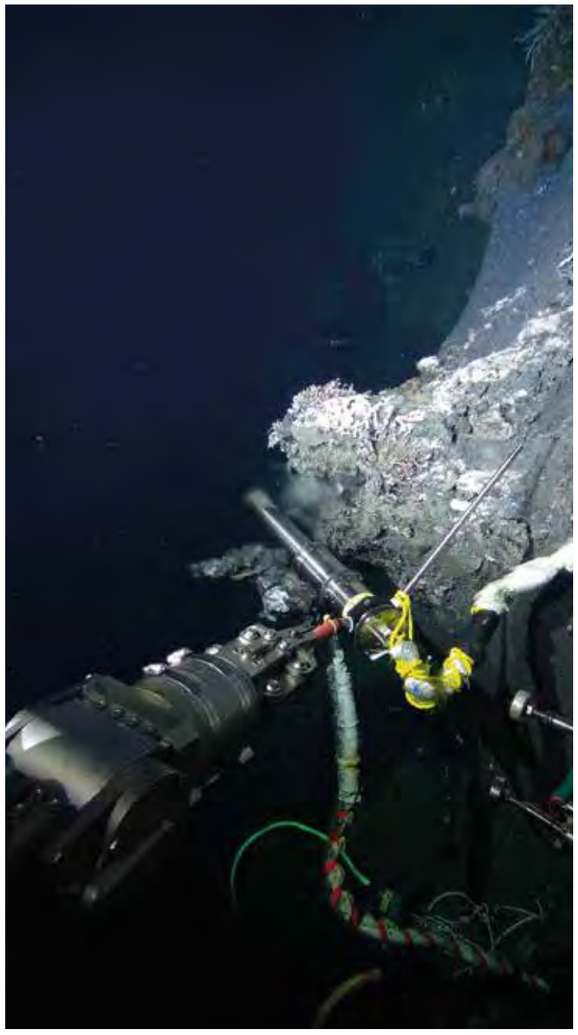
An inertial navigation system (INS) on board means the Odysseus can navigate with considerable precision across the tricky contours around the hydrothermal vents. But an INS only functions correctly if it knows its exact starting location, and that is not straightforward in this environment.

An ROV's INS routinely uses ultra-short baseline (USBL) acoustic positioning, which sends pings from the ROV to a transceiver on the surface vessel that can then be interpreted to provide positional data. But that becomes less accurate the deeper the ROV goes and the greater the number of water layers of differing density the sound must pass through, as changing density alters the acoustic properties of water.

Even the highly accurate USBL system Pelagic was using routinely resulted in positioning errors of around 25 m down on the seabed. That might be fine for navigation in some deployment scenarios, but not for the precision work required around the hydrothermal vents.

So, Pelagic needed input independent of surface-based technology to accurately establish the ROV's position. This is where Nortek's Doppler Velocity Log came in.

A DVL fires acoustic pulses from its transducers on board the ROV into the water at various distances from the vehicle and then records the time it takes for each of those pulses to be reflected back to the transducer from particles in the water. By applying equations based on the Doppler effect to this data, as well as using proprietary algorithms, this DVL can calculate the ROV's speed very accurately.



Aided by a Nortek DVL, an Odysseus ROV at work among the hydrothermal vents.
(Photo ©: Ocean Networks Canada and Pelagic Research Services.)

Because it requires no direct input from the surface to do this, a DVL makes an ideal aid for inertial navigation systems. Once the position of the ROV's INS has been fixed at a point where surface-based positioning technology can function correctly, accurate velocity readings from the DVL on board the ROV will then help maintain the accuracy of the INS, even when Odysseus is moving around areas where USBL positioning is not viable.

Pelagic integrated the Nortek DVL1000, a Doppler Velocity Log combining accuracy with a small footprint, to their ROV. The 1 MHz DVL, which has a maximum operating depth of 4000 m, is widely used by subsea operators, not just because of its light weight and compact form, but also due to its high accuracy, state-of-the-art technology, and ability to operate close to the seabed.

The control room for Odysseus on board the surface vessel. (Photo ©: Pelagic Research Services.)

"The DVL1000 integrated seamlessly with the INS system right off the bat. After the first time we took it into the field, the client basically said: 'You've solved navigation for us,'" Cassano recalls.

Improved efficiency in subsea navigation means cost savings

"We were able to move around the subsea spires and vents with confidence and with great efficiency. It really allowed the world to come into focus for us down there. And that meant we had more time to do the work and get the job done faster, which can save thousands of dollars for the client just by speeding it up," says Cassano.

Given some of the equipment being deployed around the vents can cost hundreds of thousands of dollars, mislaying it is not really an option with which anyone involved wants to be presented. The accuracy and reliability of the Nortek DVL1000 has helped ease stress levels among the crew too.

Nortek's DVL1000 installed on the underside of the Odysseus ROV. Pelagic Research Services chose the instrument as part of its navigational equipment, due to its high accuracy, advanced technology and ability to function close to the seabed, as well as its compact form. (Photo ©: Pelagic Research Services.)

Skilltrade e-learning

Skilltrade wanted to offer easier access to Hydrography Training and therefore developed 3 interactive on-line structured e-learning courses and 2 interactive tests that can be followed by anybody interested in the subject at hand. These modules are also a part of the Hydrographic Survey Category B Course.

Skilltrade offers the following, hydrography and geodesy related E-learning:

- Mathematics
- Physics
- Bathymetry
- Geodesy
- Global Navigation Satellite Systems

The Mathematics and Physics modules are designed to test the students' knowledge of these subjects as required at the entry level for the Skilltrade Hydrographic Survey Category B Course. On the theory slides the student can also find links to specific modules from the worldwide renowned Khan Academy to enhance their knowledge. The other 3 modules. Bathymetry, Geodesy and GNSS are presented as a Power Point video with an overlay of spoken instructions. The study load is approximately 40-50 hours per module.

Level

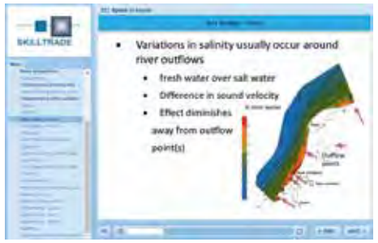
Mr Huibert-Jan Lekkerkerk, lecturer and developer of the Skilltrade e-learning modules: "The theory that is presented in these e-learning modules is actually a little bit above Cat B level. As we include slightly more complicated computations that could have been part of a Cat A level course. We have done this to allow these modules also to be used for continuous professional development. The theory in these slides is the complete theory for these subject according to the Standards Of Competence For Hydrographic Surveyors S5(B). Here and there it is extended to include certain additional topics we found useful from a practical perspective. Each of these theoretical modules is accompanied by a self-assessment the student can do in his or her own time."

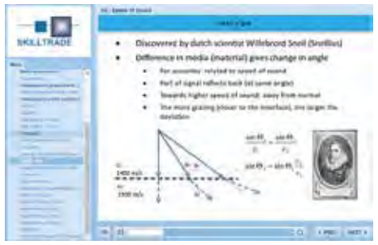
Advantages e-learning

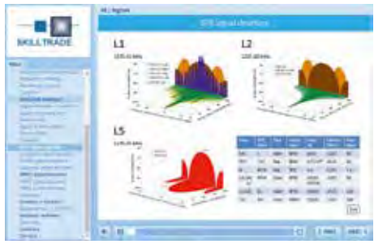
E-learning has boomed over recent years to become a very popular method of learning. This makes sense: E-learning is convenient and flexible. As long as the student owns a computer and has at least once an internet connection, it doesn't matter in which part of the world he or she is and what time it is or with our modules even whether the student has online access when they wish to study. The Skilltrade modules are also followed offline available through an app on a mobile device once downloaded initially. This way learning can be done on the train, on a plane or during downtimes at work. Whilst a student used to be confined to the classroom, the whole world, including any offshore survey vessel or remote dredging project, can now be their classroom. A student will be able to immediately apply the new knowledge on the job, he will be able to make connections and learn more effectively.

Another advantage is that the training is tailored to the student: If a student feels he or she already knows a particular area well and doesn't need to spend an hour on it again, then they can skim over it and concentrate that time on something they feel they need to work more at. This way everyone is able to learn at their own pace.

Furthermore e-learning is cost effective; no more travel and accommodation expenses for employees. The IHO requires







that a Cat B course last at least 26 weeks. With the addition of the 13 weeks e-learning programme we have minimalized this this down to only 13 weeks in class room including a week of offshore recognized safety training. In 2008 the Skilltrade Cat B programme first received recognition by the FIG-IHO-ICA International Board on Standards of Competence for Hydrographic Surveyors. Skilltrade received continued recognition for 6 years for their updated curriculum, which includes the 13 weeks e-learning programme, in April 2016.

Interaction

A potential limitation of online learning is that it may feel like a solo act. The e-learning platform is not a one way road, Skilltrade has added interaction and made it more personal. The student can connect with the experts through e-mail. Huibert-Jan Lekkerkerk: "Not every student likes to do self-study alone. Sometimes they have questions which they cannot solve for themselves. To prevent that a student gets stuck in a module, we offer e-mail support. On a daily basis our teachers check the e-mail box and they try to answer the question a student has". The student can also connect with his or her fellow students from all over the world.

Furthermore we offer the possibility to subscribe for tele-conferencing sessions based on a fixed schedule. Both the student and the trainer can monitor progress through the E-learning system. As each E-learning lecture is accompanied by an interactive assessment, after answering the questions the results is immediately available from the E-learning system.

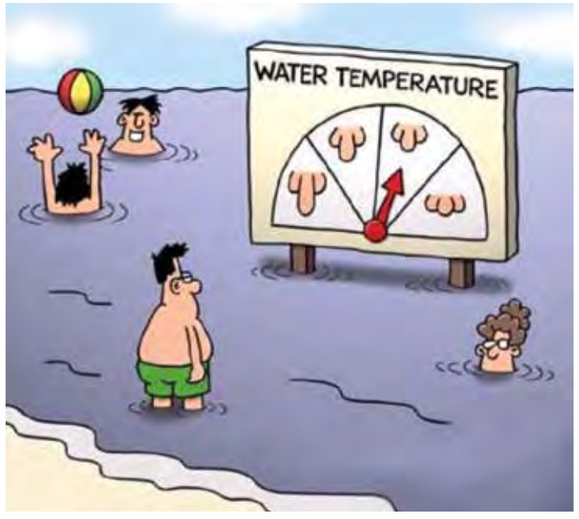
Hydrographic Survey Category B Course

The students of the Skilltrade Hydrographic Survey Category B Course have to complete their e-learning before continuing their study in The Netherlands.
The Cat B students are positive about the e-learning: it gives them more time to digest the subject matters and relieves the pressure during the theoretical, on-site part of the Cat-B course in IJmuiden.

SKILLTRADE

www.skilltrade.nl

Make them laugh

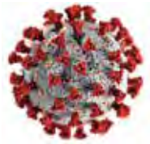


Puzzle

 - B |  E = I |  A = E

( - P) + ( 2nd T = H)

 M = S |  - EIGHT

 + ( W = N) + ( - AGERS)

 - E |  !

The object of the puzzle is to find words using the hints above. Together the words form a sentence.

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www.seabed.nl

Seabed Electric Vibrocoror (SVC) series

The SVC-series have a long track record and are successfully being used by our clients world wide on various types of soil including soils containing gravel.
The Seabed vibrocorer has been designed to obtain cylindricalcores in soft, cohesive soils at a maximum water depth of 200 meters.

SEABED

Getting to the bottom of things