SEABED GAZETTE

2023

Ice Ice Baby, traveling to wonderful Iceland

MIWB Survey Weeks

Seabed is expanding!

SEABED

Getting to the bottom of things

www.seabed.nl

Seabed Crane system

Seabed's Crane system is the solution to all your excavation and dredging jobs, the crane system is deployed as an all in one unit in a multipurpose portable ruggedized case. This highly advanced guidance system is efficient, and can be installed through a user friendly WebGUI.

The system is equipped with a computer and software, so all the data acquisition is done in a professional manner.

SEABED

Getting to the bottom of things

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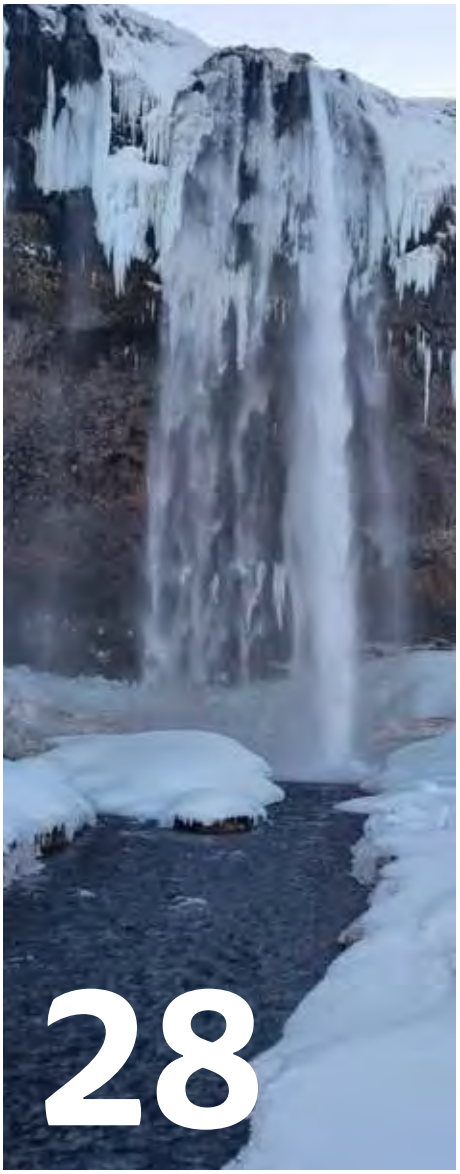


SOMAG

GYRO STABILIZATION MOUNTS
FOR MARITIME APPLICATIONS

- Automatic pitch and roll compensation
- Precise sensor stabilization in harsh environments
- Pin-sharp images and high-quality data capturing
- Import of external IMU data or NMEA frames possible
- Quality made in Germany

www.somag-ag.de

SEABED END OF SUMMER DEMO DAYS 2023

After the succesful Demo Days last year, Seabed will again open it's doors on Wednesday 13th and Thursday 14th of September 2023. We will demonstrate the newest products of our partners and ourselves while serving up delicious food and drinks. Our beautiful location is the same as last year: Restaurant het Bosch at the Nieuwe Meer in the south of Amsterdam.




Looking Forward to see you!
Please sign in via rsvp@seabed.nl

www.seabed.nl

Seabed
Orinoco Solo V3

**Based on the successful Orinoco line of tide gauges, the OrinocoSolo V3 is the latest offspring. The basic unit is a high capacity data logger with up to eight analogue inputs and up to four RS232 inputs (optional)
and one serial data output which supports multiple formats.**

SEABED

Getting to the bottom of things

Client tale

The Port of Antwerp-Bruges is one of the biggest ports in Europe. The survey team for the Antwerp port area is responsible for surveying this area at least 2 times a year.

We have 3 main areas, the left bank site of the river Scheldt is around 512 ha behind the locks.

The right bank site of the river is approximately 1391 ha behind the locks and last we are responsible for the commercial docking places on the river ± 463 ha.

On top of that recurrent task we do quay wall inspections, dredge monitoring and sunken object detection.

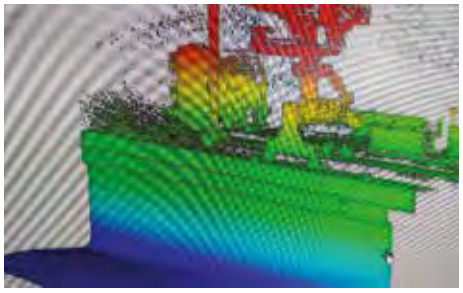
To complete this entire package we have 2 vessels we can use.

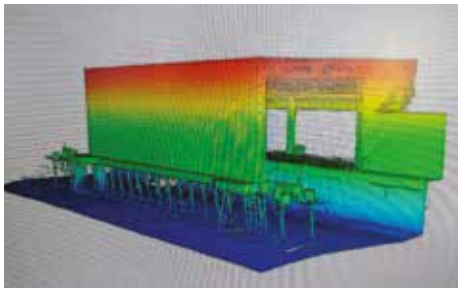
Our main vessel is the Echo and its little sister the Echodrone.

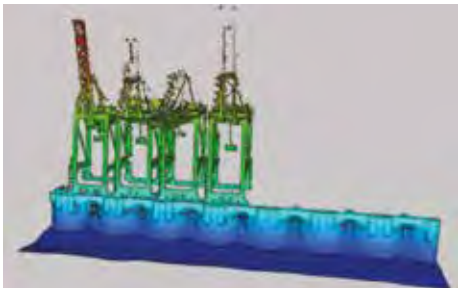
The Echodrone is equipped with a Norbit WBMS sonar, this vessel is used for shallow area's and difficult to reach places.

Than the Echo has a range of possibilities, we have a single beam, a sub bottom, an echoscope and since march 2023 we exchanged our multibeam for Norbit Winghead i77h with an additional iLidar for above water quay wall inspection.

We are very pleased with these new devices and the professional installation provided by Seabed.







Port of Antwerp Bruges

Hydrographic Surveying with USV and SV for Dredging

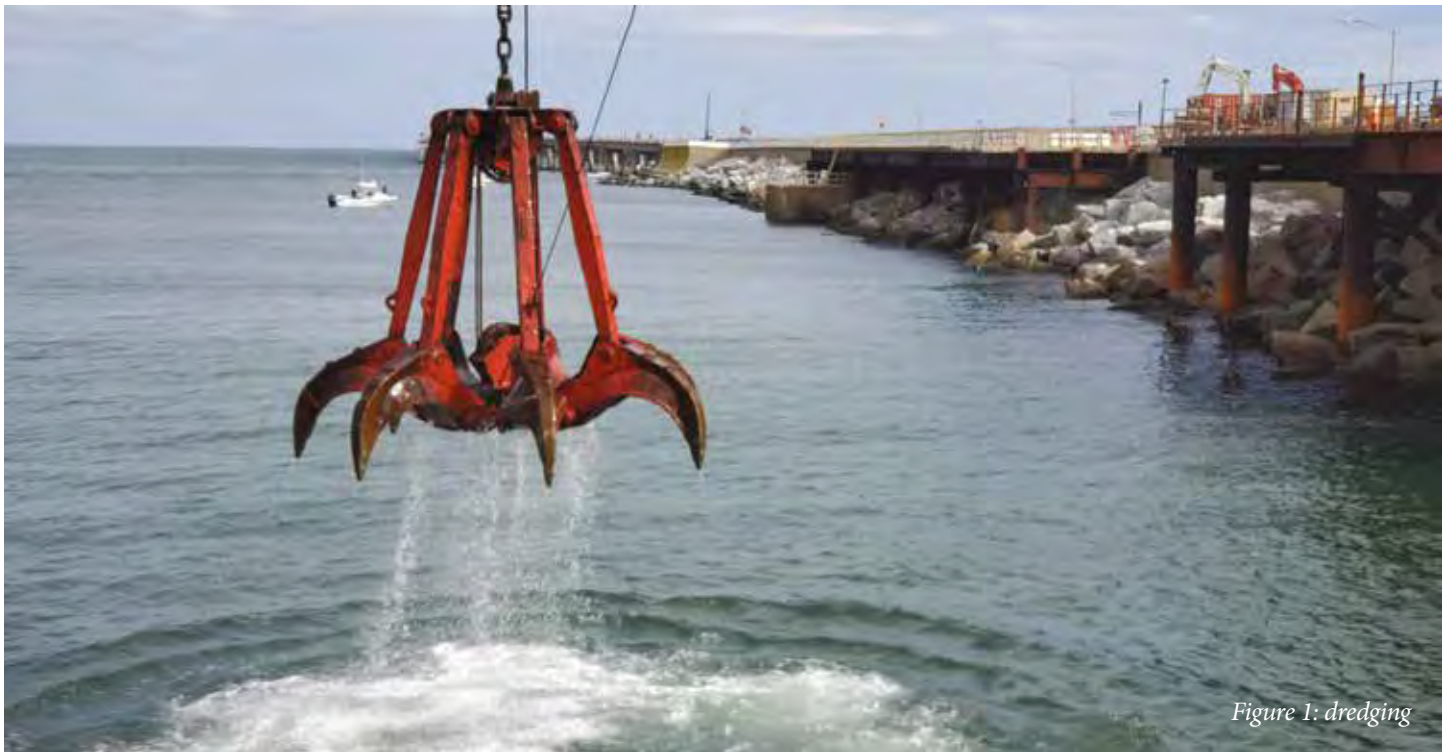


Figure 1: dredging

In the resent years the construction industry has seen a shortage of resources available to conduct hydrographic surveys for dredging operations, in an effort to improve the mobilization time and reduce the overall "footprint" the industry is investing in smaller and more environmentally friendly vessels – such as USVs (Unmanned Surface Vehicles) and small SVs (Surface vehicles).

In a typical dredging scenario, to run a bathymetric survey, a surface vessel, skipper, hydrographic equipment, and a hydrographic surveyor must be present at the job site from mobilization to demobilization. As the dredging industry requires more and more hydrographic surveys it has become essential to find a way for survey companies to use the hydrographic surveyors more efficiently, grow their participation in areas where they are vital, and limit their involvement in areas that can be performed by other personnel

NORBIT is introducing a new and resource-saving application providing the technology to divide the hydrographic survey into two parts: Design and Execution.
The survey design is done by a hydrographer or surveyor who can operate remotely, setting up and planning the essential part of the survey.
The actual survey is then performed by a skipper or USV operator at the job site.
A dedicated software connects the hydrographer and surveyor, and the two functions are consolidated in one solution.

A solution to streamline the USV bathymetry survey is to use the NORBIT WINGHEAD multibeam integrated with high-end GNSS/INS Navigation, which can be mounted on any USV. The dredging solution includes NORBIT's integrated acquisition software NORdredge, which performs real-time processing and is essential for survey efficiency and ease of use.

The main difference between this solution and other dredging survey software is that NORdredge allows a concurrent operation of a remotely located hydrographer and an on-site operator who is conducting the survey. The architecture of NORdredge has been designed to facilitate remote access and perform advanced tasks by the hydrographer while, at the same time the operator uses a hand-held device to conduct the survey.

There are two critical elements to the solution.
One is the repeatable operations done by the operator at the site related to the safety of the survey, data collection, sound velocity casts, and launching and recovery of the vessel.
The second is the mission-critical skills performed by surveyors, such as preparing and loading the design templates, preparation of the survey lines, setting up the sonar system, ensuring the data is collected with good quality, and finally, analyzing and approving the data.

Figure 2: NORdredge one consolidated solution

NORdredge has been designed to facilitate all the above efficiently and conveniently.

The hydrographer accesses the system on the USV remotely via a web browser and then sets up the mission. He prepares the design template satisfying the required clearance, ensures that the proper reference system, geodesy, and other required items are chosen correctly, and then prepares the local station offset file and loads it in the system; this way, the operator can easily see where to drive the boat. Finally, the survey lines for the vessel to run, are drawn, and will, automatically populate on the operator display.

Figure 3: WINGHEAD multibeam sonar mounted on vessel of opportunity

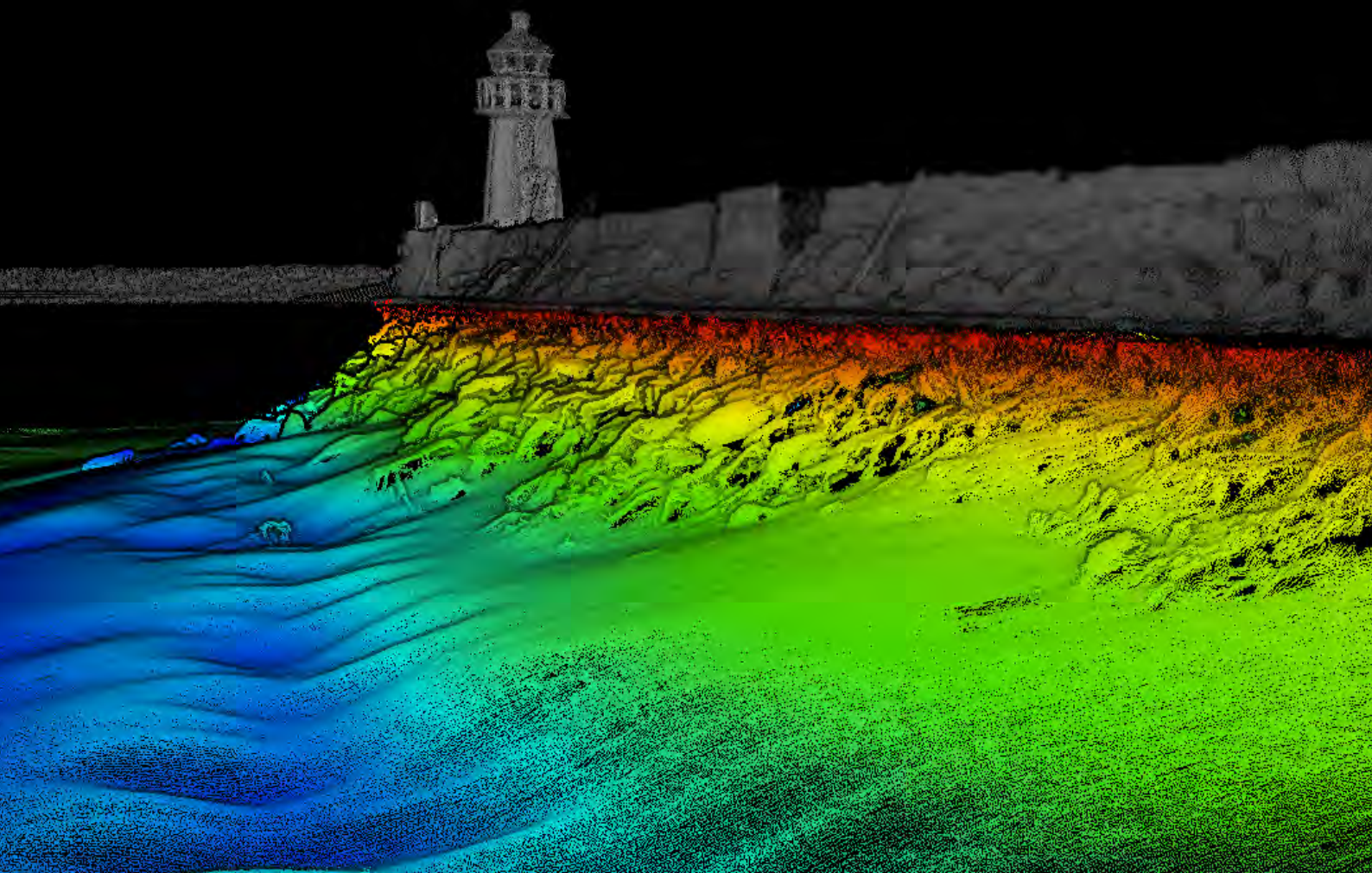
The surveyor will also identify the potentially dangerous places by bringing in other information if needed. The background image is overlayed on the map and loaded to all connected displays.
While the hydrographer sets up the system, the operator will use a hand-held device and can observe the effect of that work.

When the survey preparation is finalized, the operator starts the survey and collects the data. Concurrently, the hydrographer can independently access the data on his displays; he can check the coverage and plot and checks the profiles without disturbing the operator.
The hydrographer can verify the data's quality by examining the collected data's standard deviation and seamlessly transfer the data to GIS software via build in WMS and WFS interface for further tasks such as report generation, volume computation, and other processing tasks. When the survey is over, the collected raw data can be reprocessed for the final delivery. The hydrographer can access several other surveys in a similar manner. Remotely accessing each concurrent survey via the NORdredge interface allows him to improve his efficiency and lower the cost for the customer. His work has been optimized, and the impact of his skills maximized while, at the same time, the boat operators conduct the quality survey and perform multiple other tasks.

Dredging companies can lower operation costs by using hydrographers for the critical part of the survey and then utilizing skippers and operators to drive the vessels. At the same time, the NORdredge solution permits the skipper or the operator to manage the execution part of the survey with a simple hand-held device. This new approach allows full utilization of the surveyor's experience to prepare and manage the survey admitting the use of the needed skills more efficiently to run concurrent remote surveys. At the same time, this technology allows the surveyors to manage more jobs from a remote location and optimize the cost of their service.

NORBIT

NORBIT
WINGHEAD®



Ultra High-Resolution Multibeam Sonar

www.norbit.com

Meet... Remy Pronk

Engineer

Date of birth?
April 15th 1997.

Single, in a relationship or married?
In a relationship.

Any hobbies?
Airsoft, gaming, watersports, touring with my motorcycle.

Fast food, bistro or Michelin starred restaurant?
Bistro.

Netflix or the cinema? And what is your favourite TV-series or movie?
Netflix. The series Shooter.

What kind of job did you want growing up?
Fighter jet pilot.

What is it you like most about your current job?
The things I still learn and the different jobs we do, working inside and outside the office.

What do you learn from your colleagues?
More product knowledge and how to work with this.

If you would win the lottery, what would your life look like?
Most likely normal, but with less work and more traveling around the world.

DEMCON UNMANNED SYSTEMS

Demcon unmanned systems (DUS), a part of the DEMCON group, develops and produces high-tech electric unmanned autonomous vessels (USVs) for inspection, monitoring, and maintenance applications in inland waters, coastal, and offshore environments.

In 2017, DUS collaborated with the maritime contractor Van Oord to develop a reliable and autonomous alternative to traditional manned vessels powered by fossil fuels. The result was the DUS v2500, a compact and robust 2.5-meter inspection platform that has since been successfully deployed in multiple locations.

In addition to the DUS v2500, the company has also developed a smaller type, the DUS v1375, for very shallow inland waters and a larger type, the DUS v5750, for challenging offshore conditions and longer operations at sea. The DUS v5750, for example, can be used for survey activities in dredging operations and the construction and maintenance of offsho-

re wind farms. By keeping all developments in-house, fully customized solutions are possible based on specific technical and functional customer requirements.

These autonomous vessels have proven to be highly effective for surveying activities that need to be performed remotely, efficiently, and cost-effectively. By minimizing the use of traditional manned vessels and the associated costs and environmental impact, DUS vessels are an excellent alternative for coastal and offshore inspections and monitoring.

The USVs use the company's own developed patented positioning system. A fixed rim-driven thruster configuration enables full motion control in all directions without moving steering components such as rudders or rotating thruster pods, requiring less maintenance. The vessels can remain stationary at GPS coordinates for measurements or move sideways for water traffic safety. This innovative system won the Maritime Innovation Award in 2021.

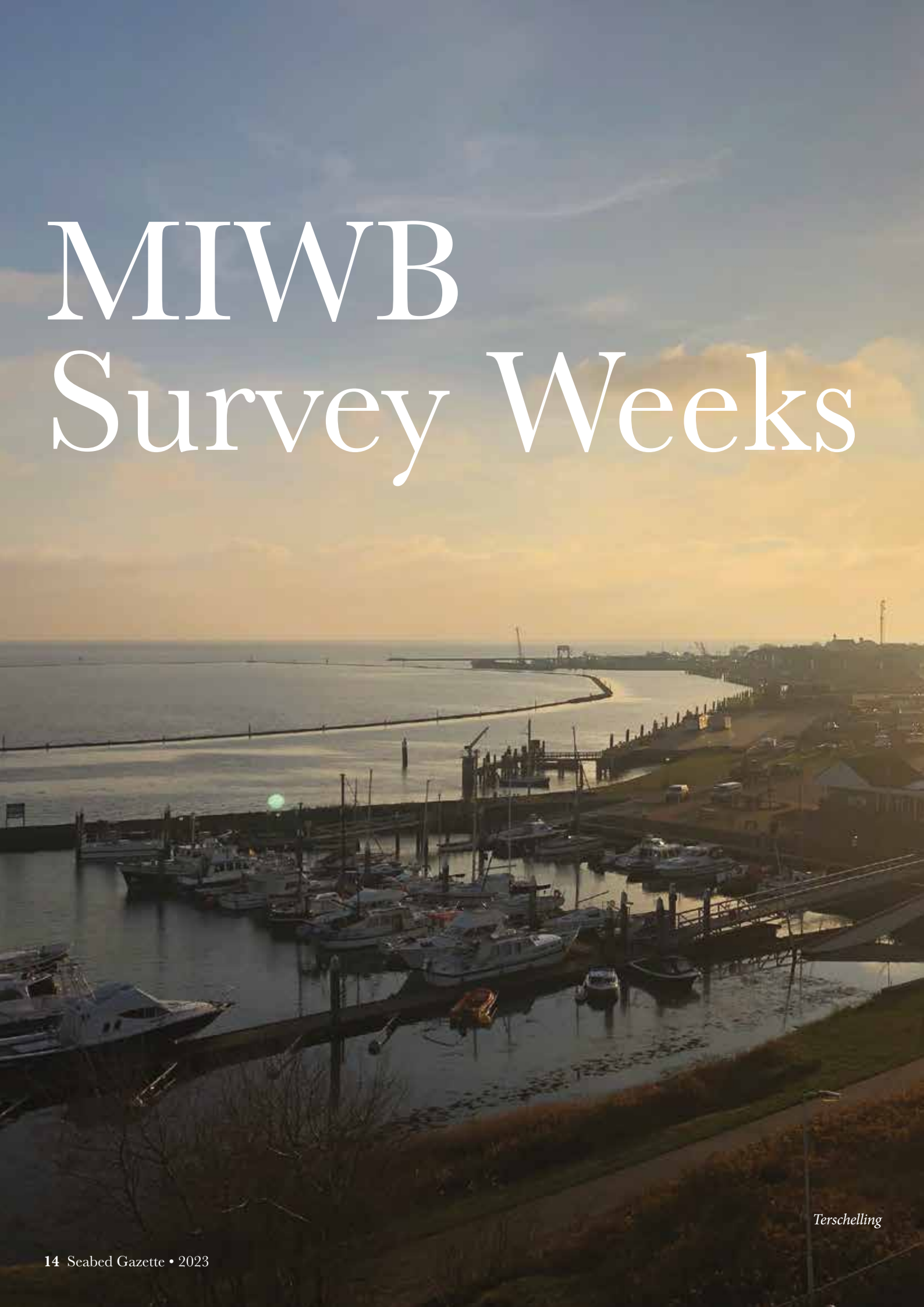
The innovative and modular autonomous navigation system of these vessels allows for obstacle detection and avoidance, ensuring safe and reliable operations. Full electric propulsion makes the USVs quiet, they emit no emissions, and have no fluids on board. In combination with shallow draft and with their lightweight and compact design, DUS vessels can collect high-quality data without disturbing the local marine environment.

In addition to providing efficient and sustainable solutions, DUS vessels are also modular and customizable, making them ideal for various applications. With the ability to adapt to specific requirements and changing environments, DUS vessels have become a go-to solution for marine inspection and monitoring activities.

More information about DUS autonomous unmanned vessels can be found on the website: **www.demcon.com/unmanned**

DEMCON | UNMANNED SYSTEMS

MIWB Survey Weeks

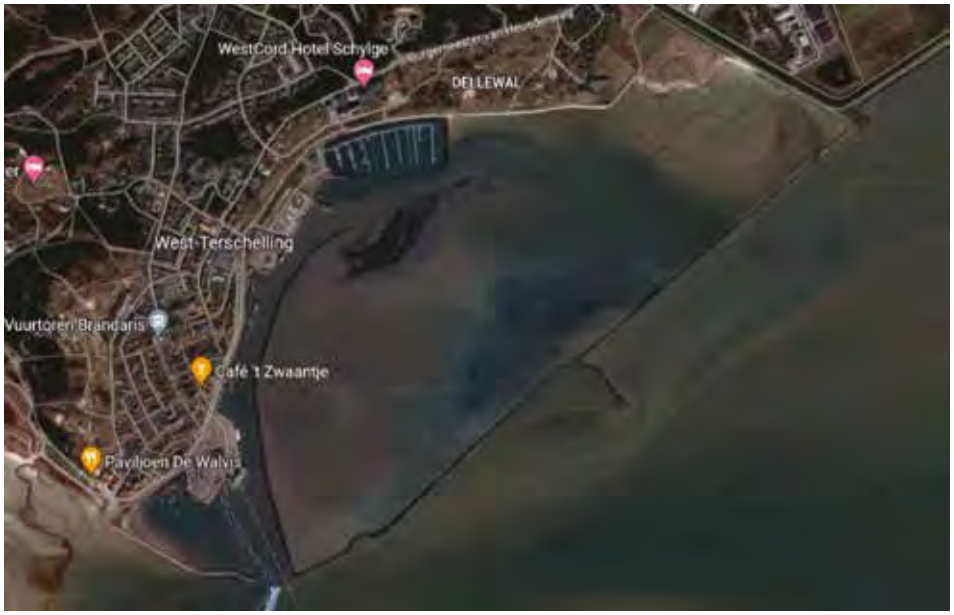


Terschelling

In one of the latest Gazettes, a small article was written about the study Ocean Technology, based at the Maritime Institute Willem Barentsz at Terschelling-West. This 4 year program is the only bachelor course in the Netherlands where the students can get their Cat-A certificate, next to their Bachelor degree. During these 4 years, the students will conduct multiple surveys and practical tasks around the harbor of Terschelling-West.

Just before the end of each school year, 2 weeks before the summer break, a survey of 2 weeks is conducted by the first and second year students of Ocean Technology. During these two weeks, they will bring what they have learned during the theoretical lessons into practice. The main goal of these two weeks is that the harbor of West-Terschelling is mapped (Figure 1).

A couple of weeks before the survey, groups are created with a mix of first and second year students. Each group will choose a 'party-chief' and a 'second-best', the ones who will communicate with the 'client' (teachers). After this, a schedule will be made by the students, who will work when and with which systems. Next to mapping the harbor, it is also important that the students can work together and learn how to communicate with other groups, because they need to lend equipment from other groups.



Survey area (source Google maps)

The 'Razende Bol'

Each group will 'get' one main system they need to mobilize and calibrate:
- The 'Razende Bol' (figure 2);
- The 'Otter' (lend from Seabed BV) (figure 3);
- The Drone;

After the mobilization, they can start with survey, but need to rotate the systems because not all the systems can be used on each part of the area that needs to be surveyed. Some parts of the survey area are shallow, so that it is not possible to use the 'Razende Bol' and that they need to use the 'Otter'. Other parts are of the area are dry during neap tides, so that it is also possible to use the drone. During these two weeks, the students will learn how to work with different systems, how to work with an acquisition package, why it is important to keep a working log and how to process the data.

Each group is responsible for their own 'area', but they also need to work together with the others groups. Like mentioned before, the goal of these two weeks is that one map is created that contains all the data (drone, Otter and Razende Bol). The 'party-chiefs' will discuss regularly how they can help each other and when which system is available.

But the most important task is (next to learning) that they have a wonderful project. That they learn new things, and that they can work with the latest technology.

Razende Bol and Otter

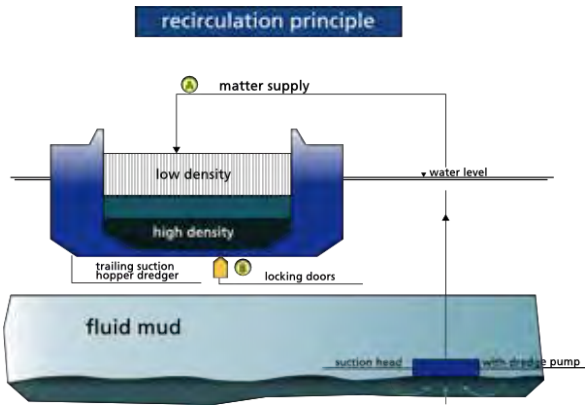
The Otter

DENSITY matters...

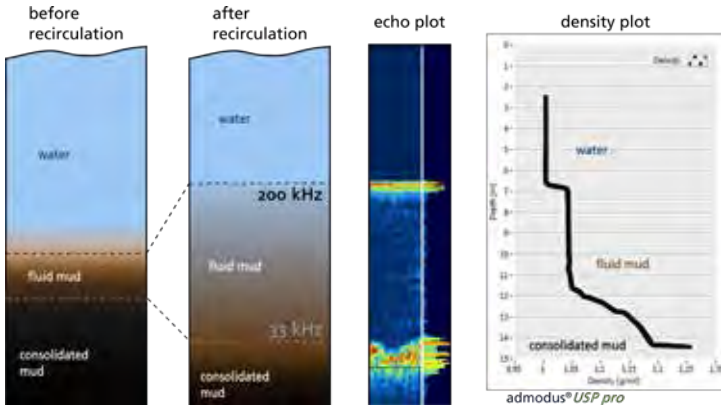
Port of Emden, Germany reducing dredging costs by 90%

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
Phone: +49 6821 40172-0 - Fax: +49 6821 40172-11 - E-mail: info@admodus.de

NEW GIMBALS FOR MARITIME APPLICATIONS LAUNCHED

SOMAG AG Jena announces the launch of two new Gyro Stabilization Mounts. With the launch of the OSM 5000 and the launch of the RSM 50, SOMAG introduces two gimbals of the new series 5 for industry-leading stabilization in offshore settings.

Both gyro stabilizers are equipped with high-precision built-in sensors to detect in real-time angular movements of boats, ships, Unmanned Surface Vessels (USVs), autonomous platforms and buoys caused by sea swell. The Gyro Stabilization Mounts automatically compensate the movements to keep the sensor payload in a leveled position even when the ground is moving to provide razor-sharp imagery and comprehensive situational awareness. The IP class 67 weatherproof design allows the gimbals to do their job perfectly in humid and salty environments.

RSM 50 facts

The electromechanical gimbal addresses the stabilization needs of customers who want to significantly improve their data captured offshore. The Mount stabilizes in real-time movements up to ≤± 20.0° in the roll and pitch axis. Advanced control algorithms assure a stabilization accuracy that has been improved to ≤0.3° rms for best sensor performance and detailed image capture.

"It is impressive what a giant step forward we have made with the RSM 50. The Mount offers a higher performance level, better dynamic and 3 times more torque than its predecessor. It can compensate for larger movements with higher angular velocity at the same time as higher lateral accelerations are imposed to the gimbal. This enables customers to succeed in their mission to capture crisp data even with increased G-forces caused by heavy wave slamming or by a sensor installation up high on a mast. Higher angular velocities result in the Mount being optimally prepared for a deployment on fast vehicles or speedboats", says Sebastian Schreiber, CTO at SOMAG.

Stronger motors ensure precise leveling of payloads up to 40 kg. Despite greater performance and increased payload, the gyro stabilizer does not consume more power. On the contrary, due to a modified mechanical design, the power consumption is even lower than that of the predecessor device. In addition, the RSM 50 comes with an energy-saving mode. This stand-by mode is advantageous for long-term applications, such as on buoys, where power supply is critical.

Additional features include extended diagnosis possibilities and a failsafe braking system to securely lock the payload during power outage. The new Ethernet communication interface allows for an integration into existing networks as well as a control and monitoring of multiple mounts within a network.

The multi-functional all-rounder for outdoor use is designed for a broad range of vehicular applications requiring stabilization of motion-sensitive equipment, such as antenna arrays, gravimeters, PTZ cameras, CCTV systems or other camera-based surveillance gear. The ruggedized Mount ensures that the sensor always points exactly in the desired direction. With the modified mechanical design of the RSM 50, customers' requests for an upside-down hanging installation are now fulfilled.

Figure 1: 360° camera installed on RSM

OSM 5000 facts

The OSM 5000 is the most powerful gyro-based stabilization platform ever developed by SOMAG. The hydraulic gimbal system was designed to ensure precise leveling of heavy single- or multi-sensor payloads up to 300 kg (660 lbs) at only 55 kg own weight.

Schreiber says: "When you consider the dimensions, it is quite amazing what we have created. With the OSM, we offer our customers a unit that can theoretically balance 4 grown men with an accuracy of ≤0.3°. The Gyro Mount is extremely powerful, but not monstrous. We clearly stand out from other devices on the market in terms of form factor, which has been kept as small as possible in relation to the performance of the Mount, being able to generate a peak dynamic torque of 550 Nm."

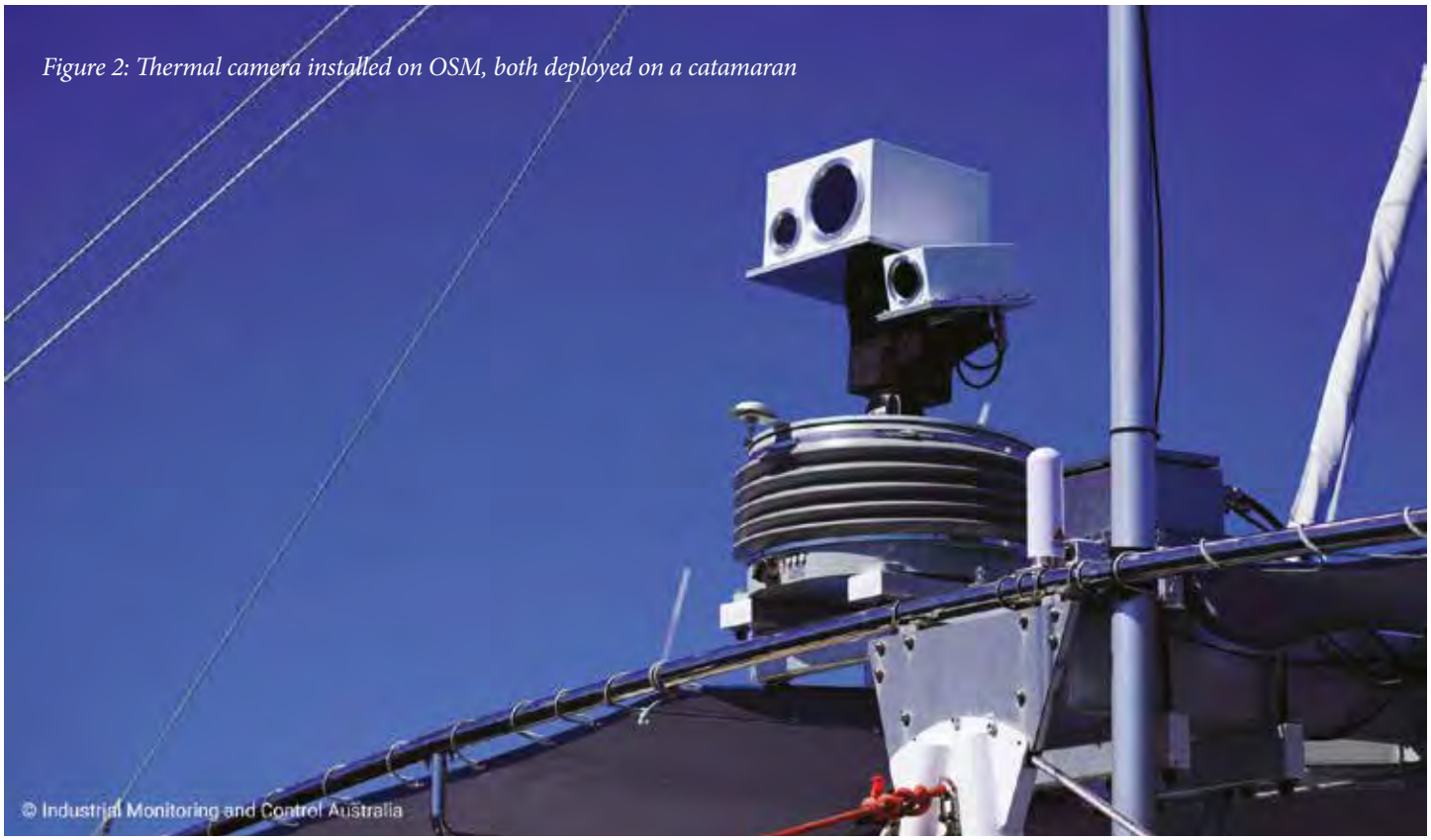


Figure 2: Thermal camera installed on OSM, both deployed on a catamaran

SOMAG offers the OSM 5000 in two different configurations, depending on the customer's application, in order to do justice to the variety of possible use cases of the gimbal and the resulting requirements.

With its symmetrical stabilization range, the Gyro Stabilization Mount compensates movements in roll and pitch up to ≤± 14.1°. This configuration is particularly interesting for customers who want to install their sensor on a land vehicle or floating support, since the general motion stimulation is rather symmetrical. However, if the OSM is to be installed on ships, the asymmetric configuration with ≤± 12.2° pitch and ≤±17.4° roll axis stabilization is recommended. As shown by studies on ship motions, motions in the roll axis pose greater challenges than in the pitch axis.
Because ships are longer than they are wide, motions in the pitch axis are quite limited. In contrast, movements in the roll axis in sea state 6 can reach between 13° to 19°, depending on the width of the vessel [1].

The OSM 5000 features advanced control algorithms, enhanced diagnosis possibilities and an Ethernet communication interface that allows integration into existing networks as well as control and monitoring of multiple Gyro Mounts within the network.

Possible maritime applications include:

- Maritime Patrol and Coastal Surveillance
- Search and Rescue Missions
- Anti-Collision Systems on USVs
- Offshore Data Transmission
- Offshore Survey
- Renewable Marine Energies

[1] Data is based on US Navy ship motion studies

For further product information and sales inquiries please contact:
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Sales Manager
Phone: +49 3641 633 68 18
E-Mail: s.lieske@somag-ag.de

About SOMAG AG Jena

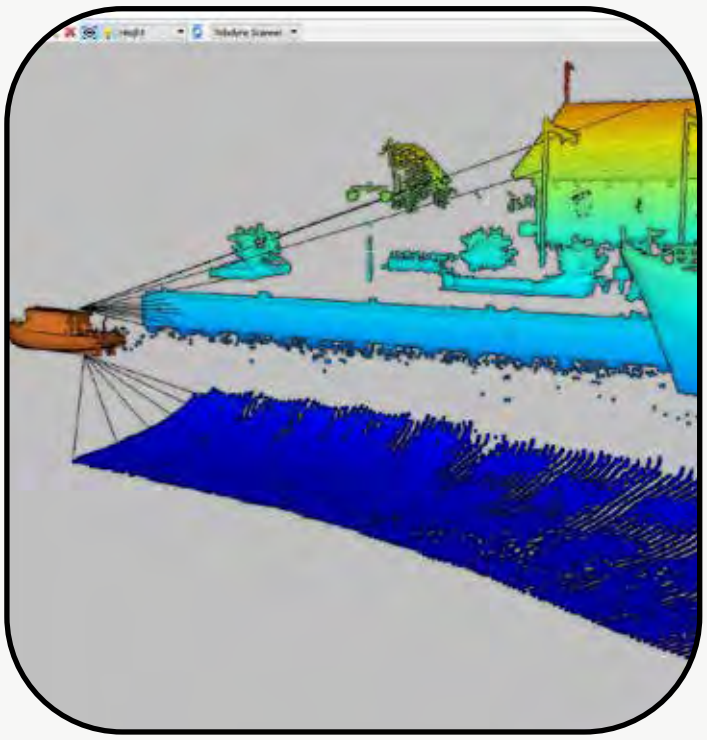
SOMAG AG Jena is a worldwide leading specialist for high-precision gimbal systems. The company, consisting of hand-picked experts in the fields of electronics and mechanics, has focused since 2004 on the development of Gyro Stabilization Mounts for data acquisition and surveillance applications. All products are assembled and tested with highest precision at the headquarters 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.

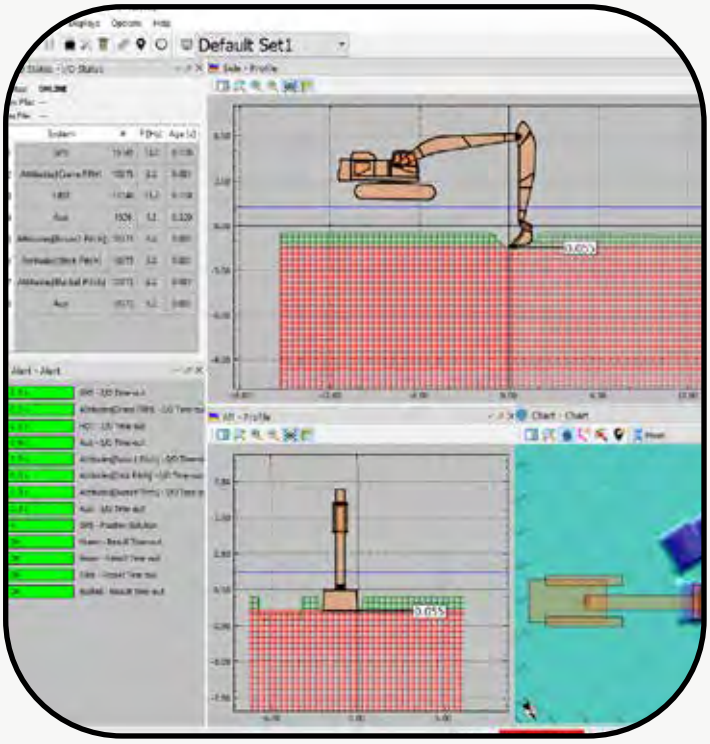
For further information and technical specifications, please visit:
www.somag-ag.de

SOMAG

BeamworX

Hydrographic Software Suite





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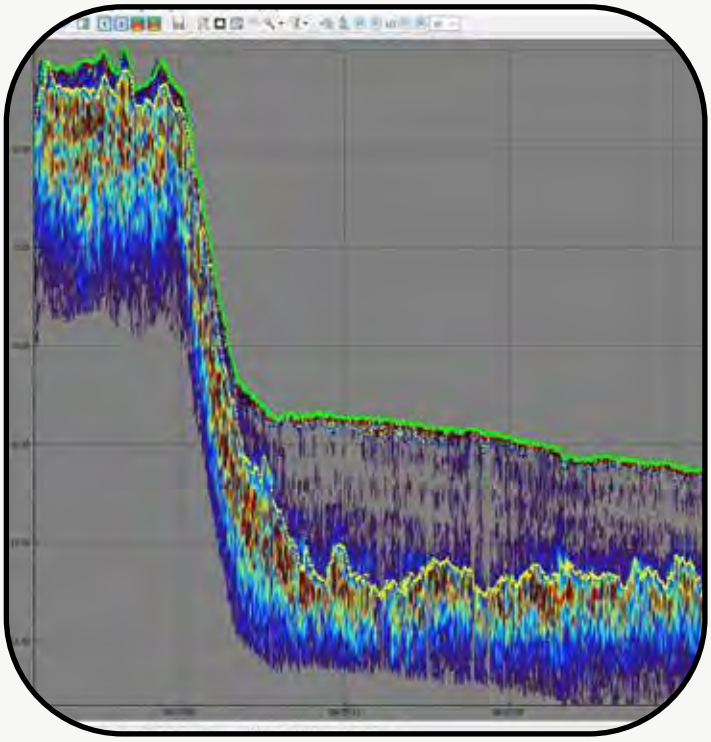


NavAQ·AutoClean·AutoPatch·TrajectEdit·SBEdit·BwxGeo

www.beamworx.com

Meet...

Robert Hooiveld
Administration

Date of birth?
My birthday is on the 9th of October and what i like to do the most on my birthday is eating with my friends and family and and drink the whole night.

Single, in a relationship or married?
I'm single.

Any hobbies?
My hobby is playing football.

Fast food, bistro or Michelin starred restaurant?
I like fast food very much but I also like eating out and even in a star restaurant.

Netflix or the cinema? And what is your favourite TV-series or movie?
Netflix and my favorite series is the Walking dead.

What kind of job did you want growing up?
I always wanted to be a professional football player.

What is it you like most about your current job?
I like dealing with money and i'm from finance and sales so that's good.

What do you learn from your colleagues?
I mainly sit behind the computer all day, so if I go sailing with one of the engineers to test something, I always learn something new, I don't know much about that anyway.

If you would win the lottery, what would your life look like?
I would buy a house for my parents in Spain and for my self a few as an investment. I would travel around the world and see every nice place.

Here's the future

Seabed offers students of different types of study programs a chance to do an internship at the company. During the internship, students are offered the opportunity to develop their selves in their field of discipline and to undergo their personal development. So that after their study they have an idea of what the labor market looks like and what is expected of them when they start working. During the internship, students are trained in different fields of work such as sales, administration and engineering.

Introducing the Seabed interns:

What is your name?
Jaimy Grevelt.

What are you studying?
Electronic Engineering.

Why this study?
I knew I wanted to do something technical however wasn't sure what exactly I wanted to do. Creating my own circuit boards sounded interesting to me, so I applied for this study.

Why Seabed for your internship?
I originally had another internship at another company. After they messaged me pretty late that they wouldn't be able to grant me any internships, I asked my teacher if he knew of any other companies that would fit me. He recommended Seabed.

What do you expect of Seabed during your internship?
That Seabed can learn me things I didn't yet know. Also, I hope Seabed will help me pass my final year.

What are your plans after you graduate?
I have several plans for what I would like to do after I graduate. The problem is only that these aren't very realistic. For now, the only plans that I have that are remotely realistic are to find a job somewhere, find a place to live and get a car.

What is your name?
My name is Kylian Bloem.

What are you studying?
I am currently a third year electrical engineering student at the Amsterdam University of Applied Sciences, in my study I focus on intelligent devices and sensors.

Why this study?
For me this study is able to challenge me constantly with difficult math, circuits or physics but it also feels like a big reward when I finally understand something. When I study a subject it really feels like I am expanding my knowledge.

Why Seabed for your internship?
Around the time when I was looking for an internship I had a personal GPS/RTK project going on and during a conversation about said project with a classmate he mentioned Seabed since Seabed is also involved in GPS and RTK. He knew I was looking for an internship and said he heard great things about Seabed. When I looked Seabed up on google I liked everything that I saw, the main occupation, the small team, the location, the website and the innovative technology. These reasons made it the perfect internship for me and are the reason I sent an e-mail.

What do you expect of Seabed during your internship?
I expect to learn how the day of an engineer looks at a good engineering company. I also hope I'm able to learn about all the things my study doesn't teach me, things that are different in the field.

What are your plans after you graduate?
I haven't decided yet, I am leaning towards looking for a job and starting my career. But at the same time I would really like to continue studying and get a masters degree. Perhaps a part time job in engineering so I can work and study for a masters degree simultaneously.

FALMOUTH SCIENTIFIC INC
MARINE SENSORS – SYSTEMS - TRANSDUCERS

SENSORS: CURRENT - WAVE - TIDE

- LOW POWER – LONG LIFE FOR MOORED SYSTEMS
- 2D & 3D SINGLE POINT CURRENT MEASUREMENTS
- WAVE HEIGHT & STATISTICS
- TIDE w/ SOLAR POWER - RADIO
- COASTAL FIXED MOUNT & BUOY SYSTEMS w/ TELEMETRY
- SUPPORTS ADDITIONAL SENSORS (TURBIDTY / O2 / ETC)

SYSTEMS: SEISMIC – BOTTOM PROFILERS – COMBINED & DEEP TOW

- BUBBLE GUN SEISMIC SYSTEMS
- CHIRP SUBBOTTOM PROFILERS
- COMPACT COASTAL SYSTEMS
- COMBINED SIDESCAN & SUBBOTTOM
- DEEP TOW SYSTEMS

TRANSDUCER MANUFACTURING: SUBBOTTOM -PINGERS- TRANSPONDERS - CUSTOM

- MULTIPLE BANDWIDTHS AVAILABLE
- 1-10KHz / 8 – 25KHz / 50KHz PROFILING
- 100KHz / 400KHz SIDESCAN
- ACOUSTIC MODEMS / TRANSPONDERS / PINGERS
- WIDE BAND & CUSTOM PROJECTORS

Falmouth Scientific

Pocasset, MA USA 02559 • Tel:+1-508-564-7640 •Fax: +1-508-564-7643
sales@falmouth.com • www.falmouth.com

Falmouth Scientific Inc. Company Overview:

Acoustic Sensors / Seismic Profiling Systems / Transducers

Falmouth Scientific, Inc. (FSI) has completed the full build out of their new facility. This new facility allows FSI to continue to provide innovative and reliable sensor and survey solutions for a variety of global applications in salt and fresh water environments. FSI's product sectors are Marine Sensors, Systems and Transducers that include advanced seismic, sub-bottom, and combined sub-bottom & side scan sonar imaging systems; current, wave, and tide meters; electro-acoustic transducers; and acoustic relocation systems.

Services include custom system design, development, integration, and production sensors, systems, transducers for the marine environment. FSI's nearly 10,000 sq. ft. 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 are innovative system and design engineering, on-site assembly and production operations, and electrical, acoustic, environmental, and system testing facilities.

FSI was founded in 1989 based on WHOI technology licenses, and is located in the heart of the New England marine technology cluster on Cape Cod in Pocasset, Massachusetts. This move left behind a 40 year legacy of innovations in the Marine Industry housing companies like Datasonics, Benthos and Falmouth Scientific Inc. with history going back to 1980. Founded in 1989 FSI has focused its attention on sensors, systems, transducers and other acoustic technologies over a variety of product segments. As part of the focus on acoustic systems, in 2000 FSI occupied the facility previously housed by leading marine industry technology companies now including Falmouth Scientific Inc. In 2010, FSI acquired Hegg Marine Solutions to establish a geophysical line of acoustic products to add to their system solutions.

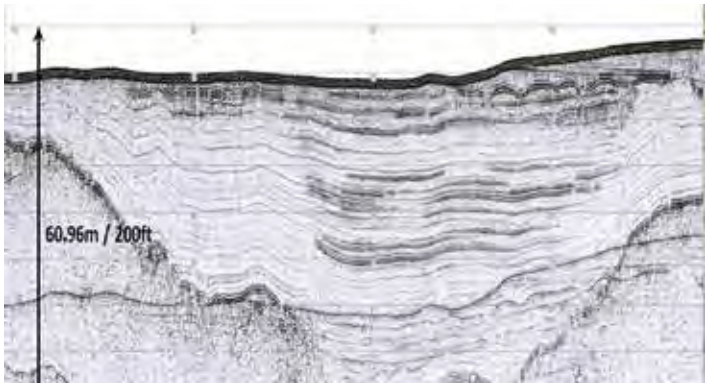
Hegg Marine Solutions is a brand of FSI products for sub-bottom, seismic, combined side scan sonar system technologies as well as field support services. The main products are the HMS-620 Bubble Gun family of seismic systems, The HMS-622 CHIRPceiver Sub-bottom and the HMS-6x5 Combined Sidescan & Sub-bottom systems. The HMS-6x5 is available 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 energy, low 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 "Bubble Gun" electro-mechanical acoustic transducer has three standard installed configurations mounted on a tow vehicle to provide deep sub-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 (Single, Dual and LF), and the Falmouth Scientific HMS-620 Hydrophone Streamer. The Bubble GunT™ 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 Sub-bottom Profiling System** is a high power, portable, sub-bottom 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 transducers can be configured to transmit and receive and the hydrophone arrays can be configured to perform the receive functions based on of the system.

The HMS-622 CHIRPceiver uses a flexible Graphical User Interface connected via Eternet that allows the user to set CHIRP or CW mohdes 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 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 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. 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.

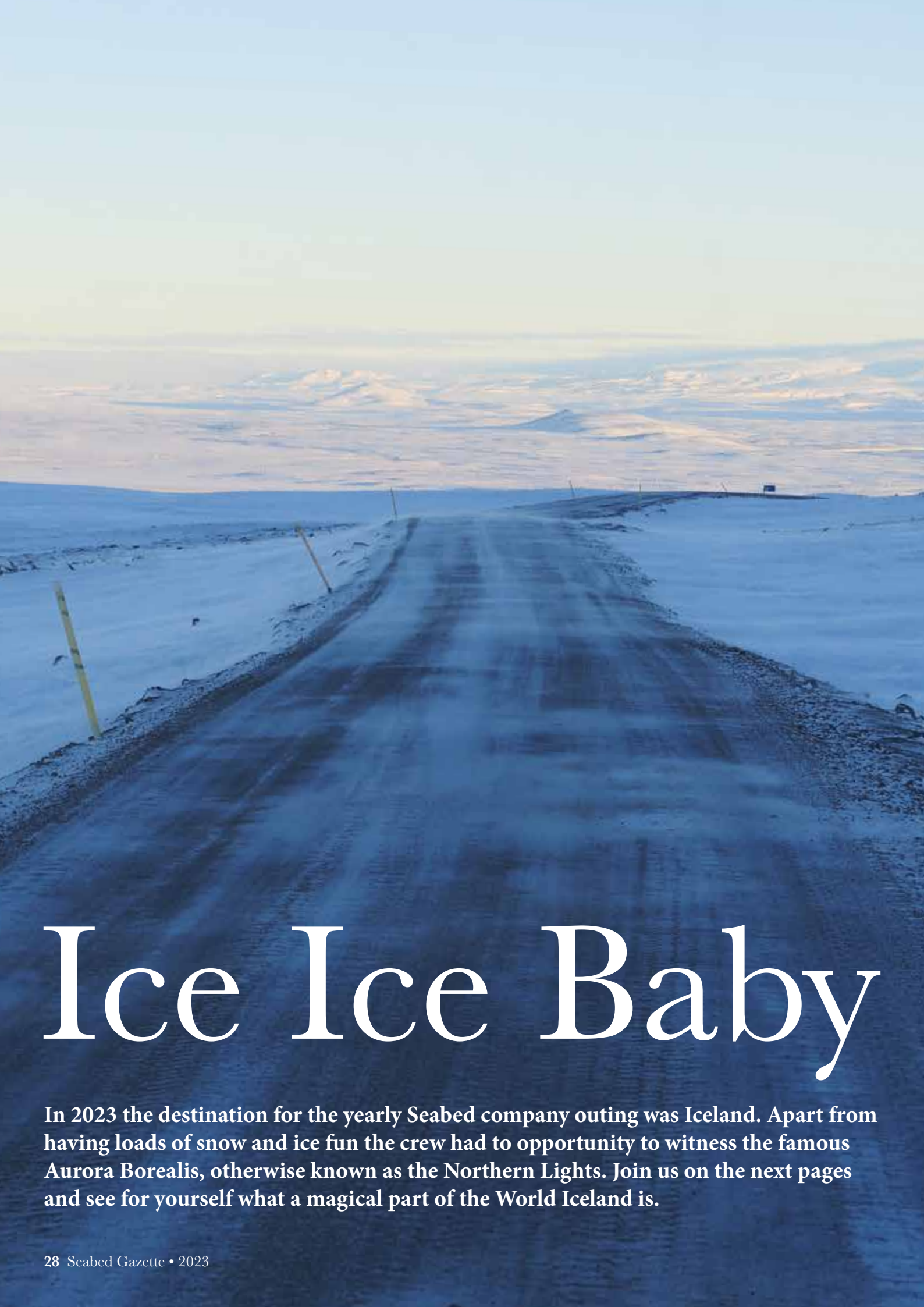
HMS-ATTR-15K-9-120 is a high power 7 element tonpilz line array designed to operate in the 8kHz to 23kHz range.
TVR: 155 dB re 1uPa/Vrms
RVS: -165 dB re 1Vrms/uPA
Power Rating: 1000 Watts 15% duty cycle
Beam Width: 120degrees fwd/aft, 9 degrees athwart
Operating depth up to 3000m.
Main application is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

HMS-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-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.

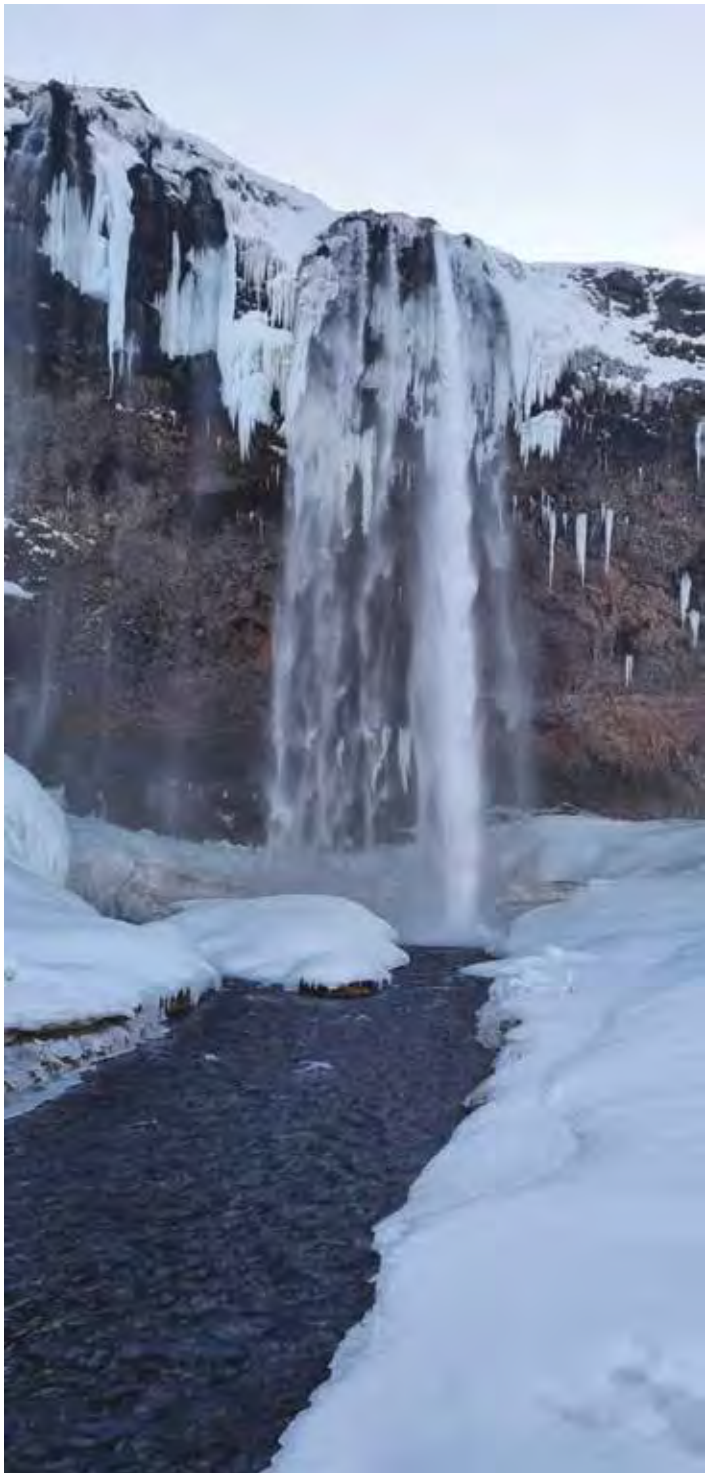
Falmouth Scientific

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



Ice Ice Baby

In 2023 the destination for the yearly Seabed company outing was Iceland. Apart from having loads of snow and ice fun the crew had to opportunity to witness the famous Aurora Borealis, otherwise known as the Northern Lights. Join us on the next pages and see for yourself what a magical part of the World Iceland is.



Mapping and imaging the seafloor: Subsea Tow Camera System provides an alternative to sonar

In 2023 the most effective way to map the seafloor in detail is through the use of subsea cameras. In the past, active sonar was used to map the seafloor, and while these maps and images were essential for ocean exploration, they are unable to provide details of what the seafloor actually looks like. Through the implementation of subsea imaging and camera systems, researchers and industry experts can now view and capture high-definition video and images of the seafloor in real time. This development has changed the way we map the ocean floor, helping us better understand, and harness the potential of our oceans.

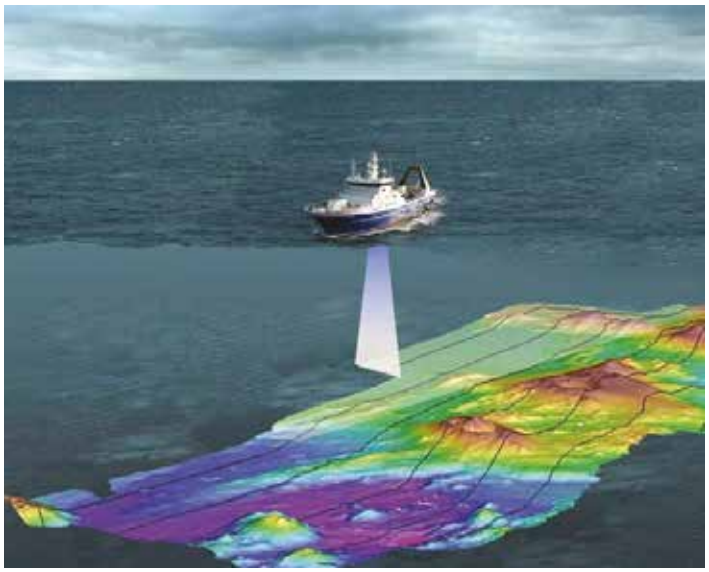
Since the early days of ocean exploration, ocean technology has had an extraordinary evolution, peeling back the curtain and revealing many of the mysteries held by the deep. Advancements in subsea equipment have allowed researchers to study even the deepest parts of our oceans, discover new species, and better understand ocean ecosystems. While ocean exploration has been made much easier by technological advancements, one area that long remained a mystery was the seafloor itself.

Modern technologies such as sonar, can provide depth readings and identify important features such as canyons or mountains underwater. By using transducers to produce acoustic pulses, sonar technologies can produce accurate images and maps that, while accurate, are not a true representation of what the seafloor looks like. As an alternative to sonar systems, it is becoming increasingly common to employ subsea imaging and camera systems for mapping and seafloor imaging purposes.

SubC Imaging's Tow Camera System: The product

Why Map the Seafloor?

Ocean exploration has existed for centuries, and seafloor mapping has existed just as long. In its early days, seafloor mapping was largely used to identify hazards on the seafloor that could impact vessels. These crude but effective maps allowed ships to avoid breaching on rocks, avoid shallow areas near ports, and prevent damage to vessels. While damage prevention and breach avoidance are still important, modern demands on our oceans have created the need for increased and more advanced mapping.



Sonar Example (Image Credit: Schmidt Ocean Institute)

Seafloor mapping helps us better understand our oceans. It is a key practice in determining the best possible routes for shipping and transport, as well as ocean exploration and research. Mapping provides 'eyes' on the seafloor, in areas that are not easily accessed by humans. Subsea mapping has solved many mysteries of the past, allowing researchers and ocean archeologists to uncover shipwrecks and vessels, thought to be lost forever. Seafloor mapping is also helping to solve modern mysteries, by assisting in the search for lost aircraft, and uncovering vehicles and tools lost at sea.

Ocean imaging and seafloor mapping are essential for deep-sea mining and mineral extraction, as well as oil and gas exploration. Mapping must be carried out before any installation of infrastructure, including for offshore wind, ocean research and observation, and fiber optic communication cables. Seafloor mapping ensures that not only will infrastructure be placed in the correct areas, but that these installations will have the least impact possible on the surrounding environment.

Crew member streaming video data in a field office

As we demand more and more from our oceans, it is imperative that ocean infrastructure is effective and sustainable, while also making little to no impact on the environment. This means that the tools and technology used to map and explore the seafloor must evolve along with this demand.

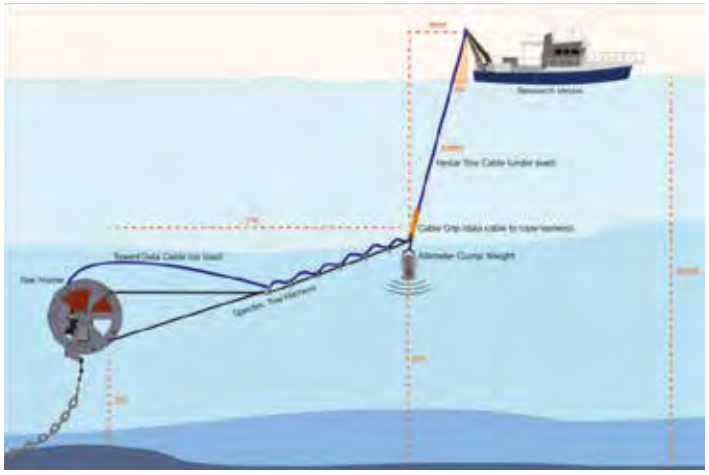
Mapping Methods: Soundings to Sonar to Subsea Cameras

From soundings to sonar, seafloor mapping has seen tremendous advancements since its early days. Weighted lines, called soundings, were used to map the seafloor. Early maps were created by measuring the tension in the line and identifying when it became slack. This was repeated several times until a pattern was formed.

SubC Imaging's Tow Camera System: In the test tank

This practice could only identify large features and could only be carried out close to shore, severely limiting the scope of what could be mapped.

In the early 20th century sonar systems began mapping the seafloor. By creating an acoustic pulse and measuring the strength of the return signal, sonar systems can create accurate images and maps of the sea floor. Over the last century, sonar systems have advanced to become reliable and effective mapping and imaging tools. However, sonar systems are expensive and require extensive training and expertise, as well as a large amount of space for deployment and use. Active sonar systems are also known to be disruptive to aquatic life, and they cannot produce detailed images that are true to the seafloor. These are some of the reasons why researchers and industry leaders are turning to subsea camera systems for marine observation and mapping needs.



SubC Imaging's Tow Camera System: How it works

Static and mobile camera deployments offer a unique alternative to mapping through sonar. Where sonar provides information for users to interpret, subsea cameras are a real-time window into what's happening below the surface. There is no need to interpret or guess at camera data, as it is like seeing with your own eyes. Subsea camera and imaging systems have advanced to where images and videos taken underwater have the same detail, clarity, and quality of images taken on land. These systems tend to be more compact than other mapping systems and they can be deployed to great depths and provide intricately detailed images and video. While previously depth and lack of light were limiting factors, modern camera systems are equipped with LED lights and lasers and can withstand the enormous pressure at even the deepest points of the ocean. These all-in-one systems are becoming the gold standard in detailed seafloor mapping, as they provide high-definition images and video, true to the seafloor.

Benefits of Subsea Imaging and Camera Systems for Seafloor Mapping

Subsea imaging and camera systems, such as those designed and built by SubC Imaging, can deliver video and images in real-time, and they can be adjusted and adapted during active deployment.

While static deployments can provide excellent data, the most effective use of underwater camera and imaging systems for mapping is through a Tow Camera System. This camera system combines a Rayfin Coastal camera with LED lights and lasers, all inside a sturdy frame. Once connected via a kevlar tow cable, this durable plug-and-play mapping system is ready to deploy. The Tow Camera System requires far less space and is easier to use than traditional sonar systems, resulting in significant cost reductions as there is no longer a need to hire a large vessel or a team of sonar experts.

SubC Imaging's Tow Camera System has been tested in some of the harshest aquatic environments, including the North Atlantic. This system is non-invasive, user-friendly, and cost-effective, while also providing high-quality data that can be viewed in real-time. The Tow Camera System is ideal for marine observation, seafloor mapping, fisheries research, conservation, and search and rescue missions, as these systems can cover large areas in short periods without sacrificing data quality.

Traditional video mapping techniques use sleds that are towed along the seafloor. The Tow Camera System designed by SubC Imaging effectively performs ocean mapping and imaging activities without making contact with the seafloor. This is made possible through the mechanical design of the system. Designed using the principles of hydrodynamics and buoyancy, the Tow Camera System uses a small drag chain and a clump weight with an embedded altimeter to passively control the distance to the seafloor from the camera system. This ensures that photos and videos have a consistent subject distance. The intelligent design of the Tow Camera System minimizes contact made with the seafloor, resulting in little to no interference or destruction of the natural environment.

Each component of the Tow Camera System has been designed and built to be exceptional on its own, however, once combined, they create a complete system capable of mapping and imaging even the most difficult areas under harsh conditions. The integrated sensors provide real-time data on the altitude and depth of the system, as well as roll and tilt. The Tow Camera System is capable of NMEA data logging, compatible with all modern GPS systems. This system can therefore be used for any kind of ocean survey that requires consistent transect imaging of the seafloor.

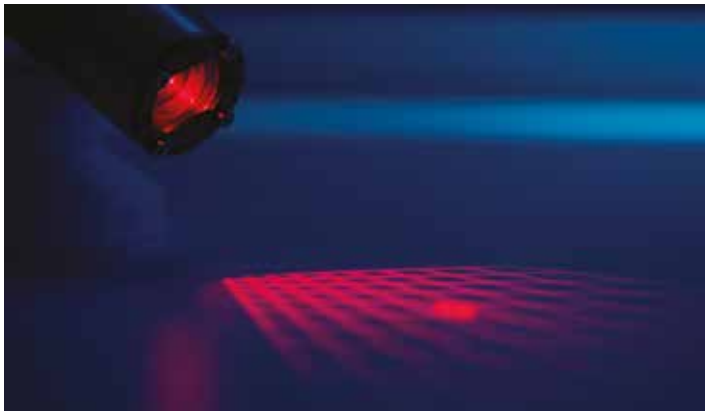
Seafloor Mapping and the Ocean Decade

The United Nations Ocean Decade has listed ten challenges, one of which is "the development of a comprehensive digital representation of the ocean." In response to this challenge, the Seabed 2030 project was launched. Seabed 2030 aims to map the entirety of the seafloor by 2030 and, to date, approximately 25% of the seafloor has been mapped. The majority of this mapping has been done through modern multibeam sonar systems. Subsea camera systems can make significant contributions to the mapping efforts of Seabed 2030 while removing some of the barriers that traditional sonar systems present. As the Ocean Decade progresses, employing the use of new technologies such as subsea camera systems for marine observation and tow camera systems for seafloor mapping and ocean imaging can help the world achieve ocean sustainability goals.

Conclusion

The importance of seafloor mapping has been known for centuries.

SubC Imaging's Tow Camera System comes equiped with a Rayfin Coastal camera



Lasers are included with SubC Imaging's Tow Camera System

From the earliest maps created using soundings to prevent breaching and shipwrecks to the sophisticated sonar images produced today, seafloor mapping and subsea equipment have undergone a significant transformation. As our demands and needs from our oceans continue to grow, so must our understanding of the aquatic environment. By employing the use of new technology, such as subsea cameras and imaging systems, huge tasks, such as mapping the entirety of the seafloor by 2030, become less of a pipedream and more of a feasible goal.

As we progress through the Ocean Decade, the need for seafloor mapping will only increase. Camera systems are a viable way to map the seafloor, acquiring essential and high-quality data, in a way that is both environmentally and cost-conscious, as well as accessible and convenient.

To learn more about SubC Imaging's Tow Camera System visit **subcimaging.com**

SubC Imaging

Meet the Se


I am
Robert Hooiveld,
Sales Administrator
Hello, I'm
Mustafa Kursad Ulosoy,
Software Engineer
My name is
Elice Collewijn,
General Manager
I am
Suzanne Cranfield,
Process manager
I'm
Remy Pronk,
Engineer
Do you want to
join our team?
Send an e-mail to
sales@seabed.nl

eabed Team


My name is Anya Siemons, Financial Administrator
Hoi, I am Hans Tuinman, Director
My name is Bart Admiraal, Engineer
And I am Evert Bootsman, Senior Engineer

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SEABED AT THE EXPO'S

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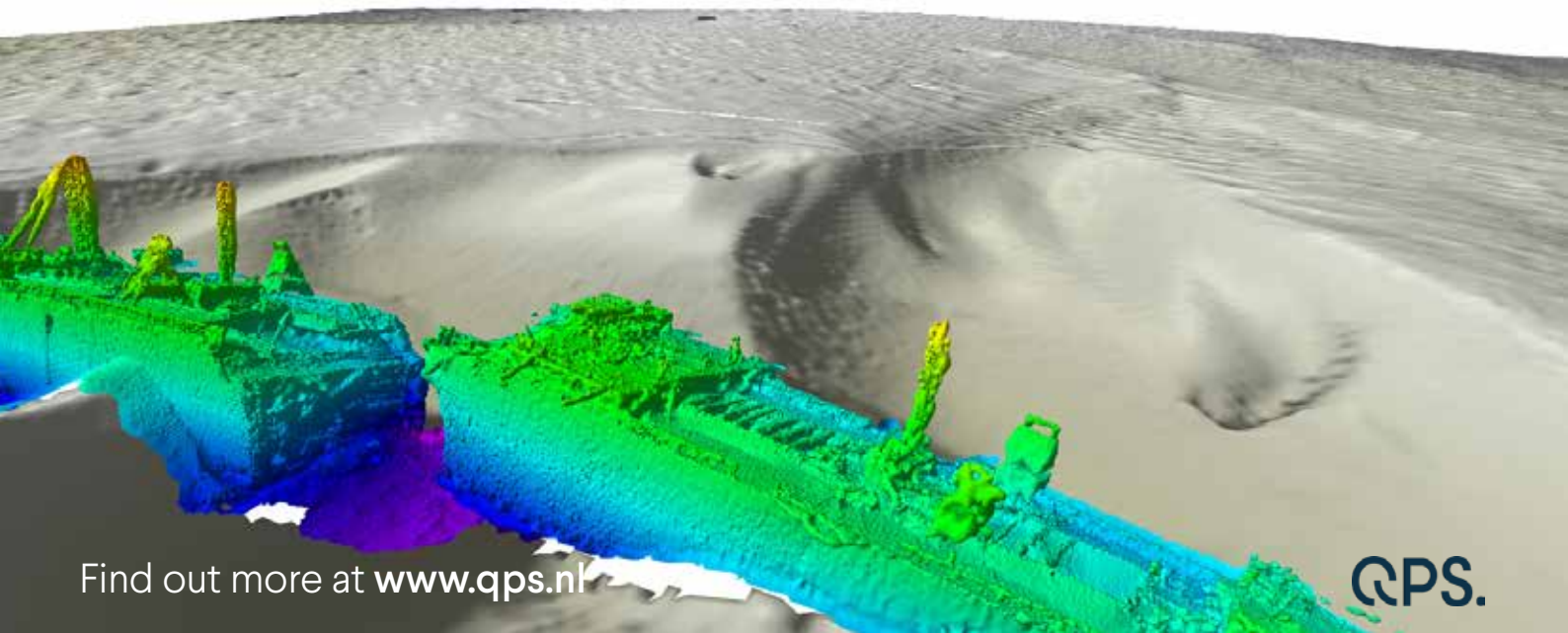

Find out more at **www.qps.nl**

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www.seabed.nl

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

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USV

Underwater Sensoring

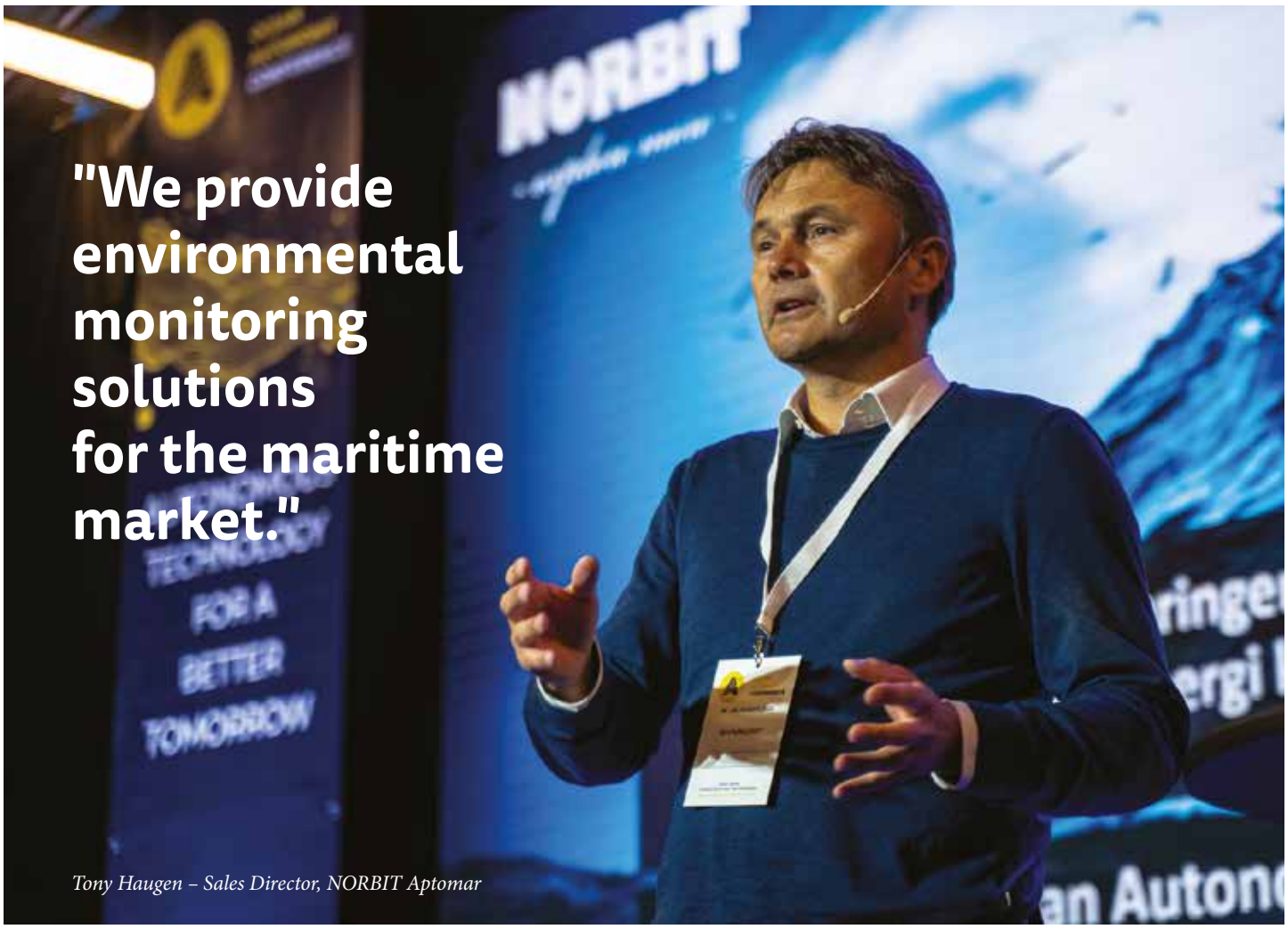
Positioning

Bottom Sampling

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

SEABED

Getting to the bottom of things



Tony Haugen – Sales Director, NORBIT Aptomar

NORBIT Aptomar, a part of NORBIT Oceans, provides environmental monitoring solutions for the maritime market. This is done by integrating sensors data from the air, the sea surface and subsea into an advanced GIS-based framework.

Tony Haugen, Sales Director, NORBIT Aptomar says:

"We acknowledge that we need maritime transport, ports, terminals and offshore energy for many years to come. We need the energy, we need to transport goods, and the oceans will continue to be extremely important for this. Even if we meet the Paris goals set for 2030, fossil energy will still be a major part of the energy mix for many years towards 2050. "Business as usual then" people say, but no. It will not be business as usual for the maritime segment in my view. We experience an industry in full transformation. The drivers are many, the following being among the most important ones in my view:

1. Cost as usual, and new threats force us to re-think our strategies as we suddenly see new types of risks.
2. Digitalisation, IoT, AI, ML, increased connectivity to mention a few, enables new business models and ways to handle our operations more efficiently. Early movers that are able to adapt to this successfully, will gain terrain quickly.
3. Climate changes and a global consensus of the environmental challenges require changes in the mindset of everyone, including the maritime industry. Our operation's "footprint" has an increasing financial cost in addition to the obvious cost to our environment.
4. Our ESG rating will have a major impact on our business if we are to be attractive for investors, customers and young talents.

With this in mind, we in the maritime segment must do everything we can to make sure that our maritime operations are safe, secure, and sustainable. We need to document our clean operations as well as enable full transparency and show that we have nothing to hide. The public "license to operate" will be more and more important if we are to continue to expose our environment to our operations.

The NORBIT Aptomar solutions are designed to aid maritime businesses to conduct their operations in a responsible and sustainable way." This is the way we will contribute to keep our industry attractive also in the future.

The NORBIT Aptomar solutions

Managing diverse maritime operations in terms of asset protection, acute chemical pollution, plastic waste pollution, fishery inspections, vessel traffic monitoring and emergency response, require customized solutions based on analyses, hardware, software and human expertise.

SeaCOP Workstation

The requirements for special sensors, dataprocessing and visualization, force the operators to rely on parallel, standalone systems. This is, however, an expensive approach with low operational efficiency. By choosing NORBIT Aptomar SeaCOP as the framework and backbone of the monitoring, detection and emergency response system, the operator need only one screen solution, and can select the relevant functionality from a large number of specialized modules. Each module adds a set of tools that are tailored to meet the needs for the operations in question. Typical application areas for SeaCOP are within general environmental monitoring, offshore energy, maritime law enforcement, ports and harbours, coastal surveillance, waterside security and search and rescue (SAR) operations to mention a few.

Sensors and data processing products

What ultimately decides the functionality and range of the SeaCOP, are the sensors and data sources as well as the data processing units integrated into the system. A large number of sensors, sensor platforms and data processing units are supported:

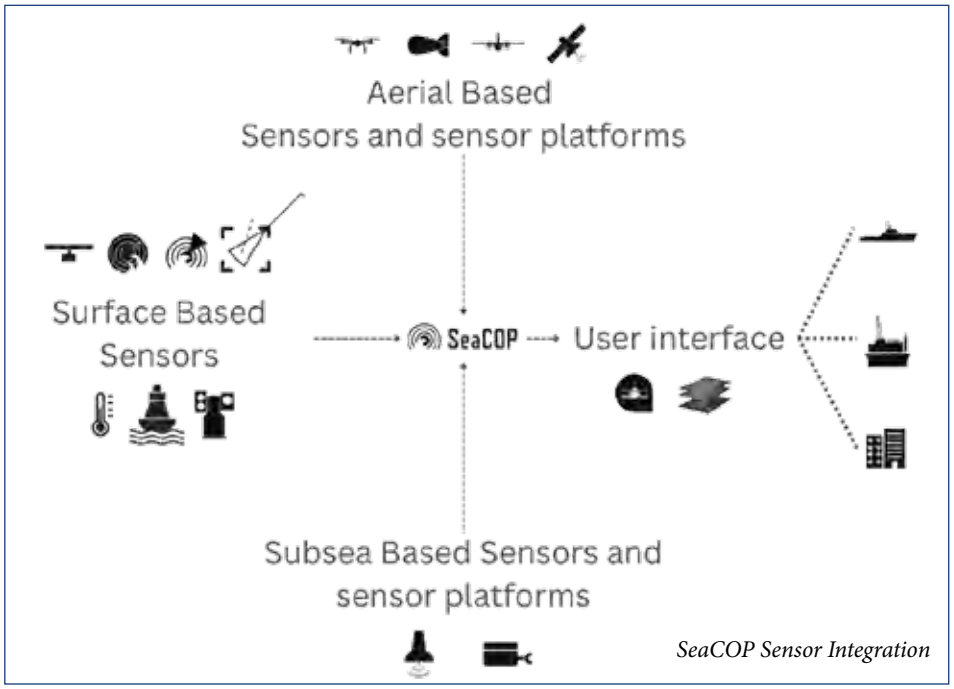
Sensors:
- Radar
- Automatic Identification Systems (AIS)
- Stabilized infrared (IR) and daylight camera systems
- Environmental sensors (air particles, Sx/Nx , radioactive radiation etc.)
- SAT imagery (oil spills, chlorophyll, vessels etc.)
- Sonars
- Vessel navigation sensors

Sensor platforms:
- Underwater Autonomous Vehicles (UASs)
- Remotely Operated Vehicles (AUVs)
- Unmanned Surface Vehicles (USV)
- Unmanned Aerial Vehicles (UAVs)
- MetOcean buoys

Data processing and real time analyses:
- Vessel Tracking
- Small Target Detection
- Oil Spill Detection
- Ice detection

To meet the new operational requirements and activities in an industry that is getting fit for a sustainable future, new sensors and systems are added continuously. This makes SeaCOP both future-proof and scalable.

By merging, co-analysing and displaying geo-referenced data in an electronic chart interface, developing new filters and detection algorithms, using geo-fencing and alarm-management, and deploying automation and artificial intelligence, NORBIT Aptomar work to make SeaCOP become the best possible decision support tool for the operations at hand.



SeaCOP Sensor Integration


Shore Based Control Room

Multiple users on multiple locations

The SeaCOP is not confined to a oneperson, one system solution. Depending on what kind of operation and what kind of resources that are required, SeaCOP can be everything from a single vessel installation to a complex setup with one centralised operator managing multiple operations on multiple locations. During any normal daily monitoring operation or unwanted incident, SeaCOP provides all the involved resources with a full situational overview and common operating picture. It supports the users with dataflow, task management and documentation on the chain of events before, during and after an incident, information that is of high value for planning, early warning and effective counter measures in the future.

The NORBIT Aptomar SeaCOP system is one of the first single-solution monitoring and detection systems that combines the functionality needed to safeguard both personnel, the environment and assets for most maritime operations, giving full overview both above and below water.

Customer groups

NORBIT Aptomar delivers environmental safety solutions to the industry leaders within the Offshore Energy Sector:

Vår Energi - Goliat

Goliat is an oil field located in the Barents Sea offshore Norway. The field is operated by Vår Energi Norge, a subsidiary of the Italian energy company Eni. The FPSO Goliat and the Shuttle Tankers bunkering at the field uses NORBIT Aptomar's oil spill detection system for oil spill preparedness and response, monitoring the operation from multiple perspectives.

Vår Energi chose to use NORBIT Aptomar's SECurus system as part of their overall oil spill preparedness strategy. In 2016 at the start of production, Goliat was the northernmost operated offshore oil field in the world. The company recognized the importance of having advanced technology for detecting and responding to oil spills in the harsh environment and remoteness of the Barents Sea. They chose NORBIT Aptomar's Securus system because of its proven track record in providing reliable and effective oil spill detection and response capabilities also in total darkness. It is a testament to the importance of proactive and comprehensive oil spill preparedness strategies within the offshore oil and gas segment, especially in environmentally sensitive areas like the Barents Sea.

The Norwegian Coastal Administration (NCA), Norwegian Coast Guard (NCG) and the Norwegian Cleans Seas Association for Operating Companies (NOFO)

The NORBIT Aptomar technology is a central part of the Norwegian oil spill preparedness. NOFO is the organization tasked with securing the oil spill contingency on the Norwegian continental shelf on behalf of the member companies within offshore oil and gas. Along with the Norwegian Coast Guard and the


Hilda Knutsen and Goliat – Photo Credit to Vår Energi and Knutsen

Norwegian Coastal Administration, both working on the behalf of the government, they all make sure Norway has suitable, robust and modern technology for combating oil spills. They are using the Aptomar systems for:

- Detecting, locating, and estimating the total area of combatable oil.
- Predicting drift of an oil spill.
- Support for finding the most efficient combating method.
- Showing the effect of the action taken and documenting it.

The system enables coordination of bigger operations and sharing of sensitive live information between sea, air, and land resources. Sharing a Common Operation Picture between parties involved, it enables the decision makers to take better decisions, faster. To this day, spills from offshore oil and gas operations have never reached Norwegian shores.

Norway is the only country in the world that permits planned and controlled spills of mineral oil in the sea for exercise- and research purposes, making sure the equipment and procedures are working as intended. This has created a global interest for the equipment and technology used in the Norwegian oil spill preparedness, setting the standard of best practices.

Aerial IR-input by drone

Enbridge

The recently completed Enbridge Straits Maritime Operations Center (ESMOC) utilizes NORBIT Aptomar's SeaCOP situational awareness platform to monitor its subsea assets in the Straits of Mackinac, Michigan, USA. A significant risk from each of the many passing vessel comes from potential anchor strikes, so to secure the safety of the gas-transporting pipelines, the SeaCOP system was set up to automatically detect, identify, and document each vessel transiting the Straits. As such, camera sensors monitor each vessels anchoring system, confirming proper stowage while transiting.

EO & Radar sensors, photo credit: Enbridge

Enbridge and NORBIT partnered up and installed a system for monitoring, detecting, and documenting safe operation. The SeaCOP system's intuitive user interface provides the operators with a 24-hour notice in advance of planned vessel traffic, allowing for investigation of vessel details such as ownership, cargo and any incident history. The SeaCOP solution integrates seven sites on both sides of the Strait fitted with radar and electro-optical sensors, including NORBIT Aptomar's SECurus and SeaView cameras, bringing critical decision support tools to the operators of the 24/7-operated ESMOC.

In partnership with NORBIT Aptomar, Enbridge is going the extra mile to ensure a sustainable, safe, and transparent operation in the Straits of Mackinac. The company has reduced its risks for incidents, the local government has insight into a clean operation, and the public opinion has changed- giving a win-win scenario for all parties involved, as well as providing the company with a public license to operate. With the integration of the SeaCOP solution, Enbridge solved a safety risk of their operation, enabling them to have a proactive approach to alleviating risk to the environment.

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AML
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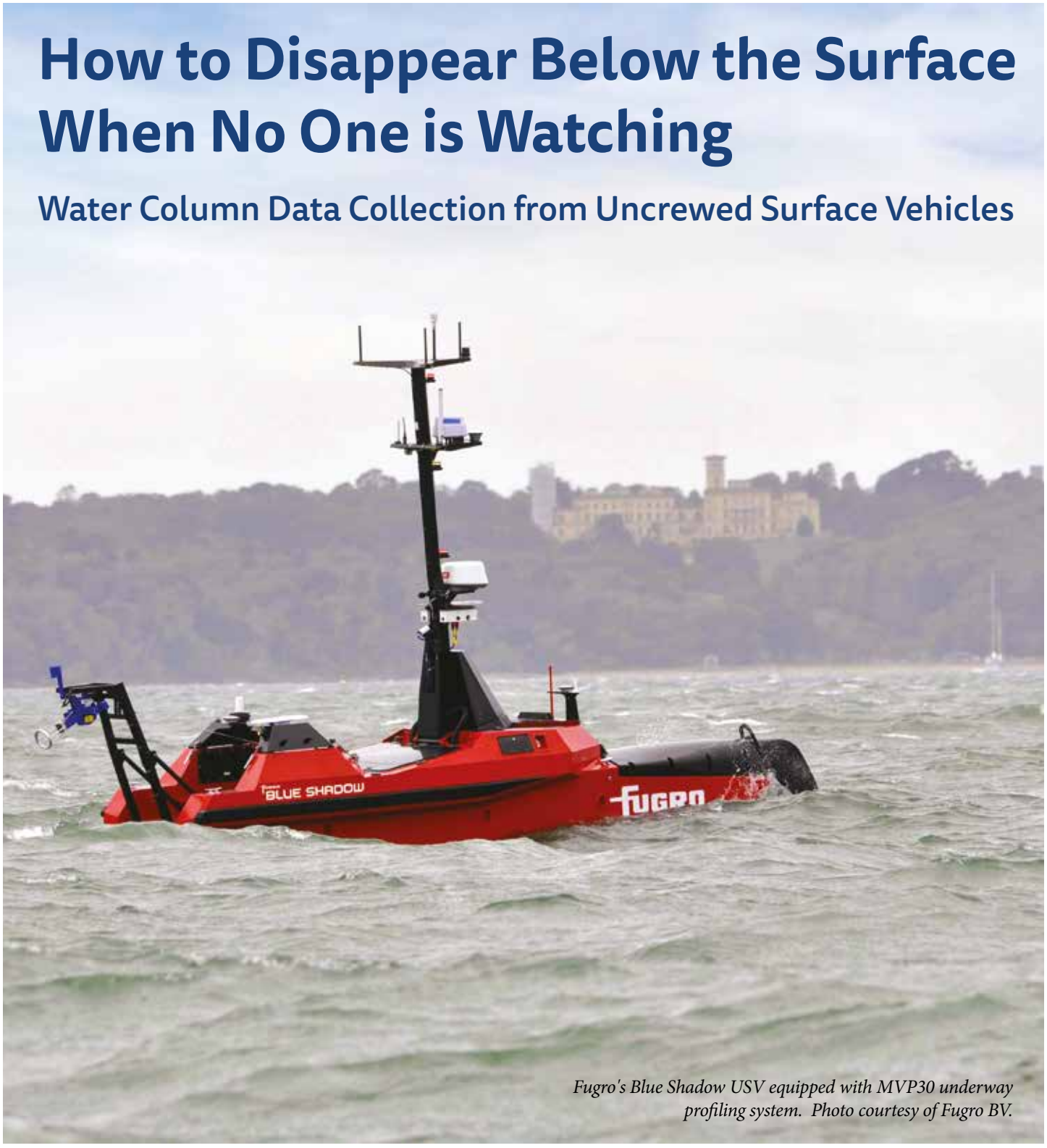
How to Disappear Below the Surface When No One is Watching

Water Column Data Collection from Uncrewed Surface Vehicles



Fugro's Blue Shadow USV equipped with MVP30 underway profiling system. Photo courtesy of Fugro BV.

The use of Uncrewed Surface Vehicle (USV) capabilities has exploded in recent years with larger platforms, greater autonomy, and capabilities that rival traditional crewed survey vehicles. These remotely controlled and autonomous platforms are already in wide use around the world helping to complete survey, inspection, and research projects. As technology advances, USVs will increasingly support and may ultimately replace the majority of crewed survey vessels.

Moving surveyors, technicians, and crew off of vehicles and onto shore has many advantages. Surveyors can work remotely and aren't required to spend days away from home during surveys. Technicians can work on equipment in the workshop rather than onboard a vessel. Even if the total number of people required to run the survey and support the equipment may not be reduced,

the flexibility of remote operations should make it easier to recruit personnel. Uncrewed vessels that work around the clock can make use of remote operators in different time zones so that each individual can work a standard daytime shift. Safety at sea issues can also be minimized when crew are working from shore.

Although there are many benefits of keeping personnel off of vessels, there are significant challenges. Besides the technical challenges of remote controlled or autonomous operations, there are practical operations easily handled by crew that present enormous challenges when crew are not on board. From basic troubleshooting to equipment and line handling, it is currently much more complicated without human operators. Even the most trivial task such as dropping a CTD or sound velocity profiler over the side to collect water column profile data to input into multibeam processing software becomes a technical nightmare for USVs to complete.

Even at the best of times, no one likes to think about stopping to take SV profiles during a survey. Crewed vessels go out of their way to minimize the number of times they stop, and often invest in automated or semi-automated systems to help minimize the pain of pausing the survey to measure the water column. The most advanced survey vessels use Moving Vessel Profiler (MVP) to eliminate the need to stop for water column profile data collection, but in normal operations there is still a person available to monitor the system from the lab on board, and crew required to deploy and recover the MVP tow body.

USV operators have been juggling the requirement to collect water column profile data in a number of ways to date, including "cheating" - using a crewed vessel alongside the uncrewed vessel and applying the SV or CTD profile collected from the crewed vessel to cover the entire survey area. In this mode, the USVs are considered a force multiplier, extending the reach of the crewed vessel. This is a valid and practical approach, but it only works when a crewed vessel is available in the area being surveyed. When crewed vessels are not available, USV operators typically install standard survey profilers with automated or remotely controlled winches. This solution is practical and effective, but it

Saildrone Surveyor equipped with AML-6 WCR CTD SV Profiler in Dutch Harbour, Alaska. Photo courtesy of Saildrone Inc.

stretches the capabilities of both the winches and instruments that are not specifically designed for uncrewed operation.

AML is working on several fronts to bridge the gap between existing winch technology and an ideal solution for USV.

There are two categories of winches available: instrumented and non-instrumented. Instrumented winches use electromechanical cables capable of supplying power to and receiving data from CTDs or SV profilers while they are winched down and up through the water column. AML's MVP is an example of an instrumented winch solution with power and data over the tow cable. A few of AML's customers have adapted the MVP to USV use by adding additional remote control systems, and in 2019 AML worked with ASV Global (now part of L3 Harris) and Fugro to develop a customized USV MVP solution. AML continues to advance the USV-friendly features of MVP with an integrated PLC-based control system that exposes the winch API to the vessel control system directly via Ethernet. The newest MVP, MVP40, has a control enclosure designed to be USV ready with an all in one package without the requirement for a PC in the lab. AML will continue to develop the MVP platform towards full autonomy including uncrewed tow body launch and recovery in step with customers who are also pushing towards this capability.

While MVP and instrumented winches in general are a great solution to the CTD and SV profile data collection problem, their electromechanical cables are thicker than mechanical rope which tends towards larger winches that require more power to operate to reach a desired profile depth. Smaller USVs may not be able to carry MVP so non-instrumented winches are the logical choice. In 2016 AML released the Base-X2, the first oceanographic instrument with integrated wireless data transfer capable of collecting SV and CTD profiles to a water depth of 500 m. In 2020, AML followed up with the AML-3 LGR, a more capable 3 sensor instrument with integrated WiFi communications. Although the Base-X2 and AML-3 LGR weren't designed specifically for the USV market, several USV manufacturers selected them for use due to their compact size and robust WiFi-based data transfer capability. When paired with a suitable winch, their only limitation was battery life.

AML addressed the battery life concern with another global first - wireless charging for sound velocity profilers. In 2021, AML released a wireless charging profiler for SV, CTD, and multiparameter applications by adapting the AML-6 LGR 6 sensor profiler platform. Saildrone included this solution into their Voyager and Surveyor bathymetry platforms, proving the potential of long endurance USV-based hydrographic survey. In 2023 AML announced that wireless charging will be released for the AML-3, AML's most popular SV and CTD profiler. The latest iteration of wireless charging comes with several key improvements, including a mechanically simple docking station that provides reliable charging in any rotational orientation. The newly designed WiFi system makes use of network mode so that the instrument joins the USVs wireless network rather than forcing the USV PC to join the instrument. Subtle improvements like this help to ensure optimal reliability.

As USVs increasingly perform surveys that would normally be covered by crewed vessels, CTD and SV profile data collection is one of the last big hurdles to overcome. The challenge of lowering an instrument hundreds of meters below the surface and recovering it safely, tens or hundreds of times during an uncrewed survey, is being met by pioneering companies pushing the boundaries of current technology. AML is working in tandem with its customers to develop both MVP-style winch systems and wireless charging instruments destined to be the default technical solution in the near future.

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In 2022 Seabed celebrated it's 10 year collaboration with AML Oceanography and Norbit Subsea.
It has been a great journey with both companies and we are sure it will be for many more years to come.

AML OCEANOGRAPHIC

SEABED

NORBIT

SEABED END OF SUMMER DEMO DAYS

last years' End of Summer Demo Days was as sunny and succesful as the year before. At Restaurant het Bosch at the Nieuwe Meer our partners and clients enjoyed two days of loads of demo's. Be sure to be a part of it this year!

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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®

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 [illegible] g/cm³."
„Determining the Nautical Bottom", Markus Jahren

admodus®*USP pro*

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

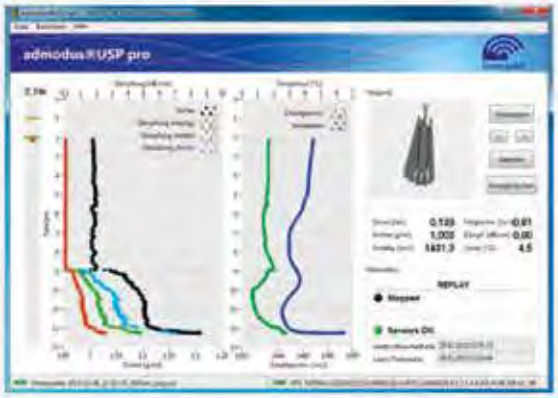
The admodus®*USP pro* is linked via high-speed Ethernet to a PC which displays all measurement data clearly laid out and in real time, stores them, and exports them as a PDF report as required. The user software features an automatic recording mode which permits serial measurements without interaction.

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



admodus®*SONAR*

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.

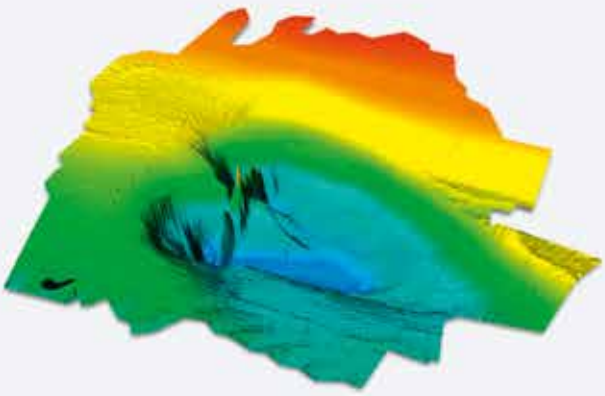
The single beam system with dual frequencies enables effective surveying of seafloor conditions, and of the different layer formations of suspended matter and sediments, ranging from fluid mud to well consolidated silt.

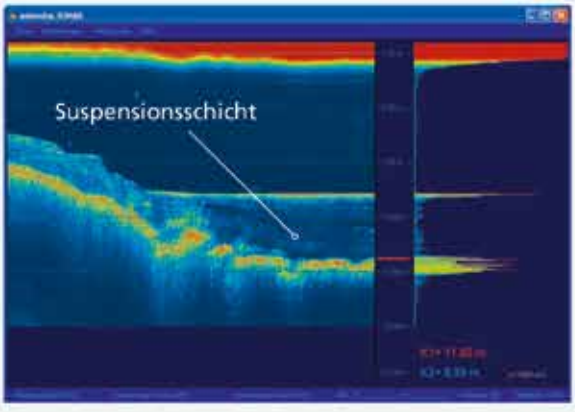
All data are transferred in real time to a computer via Ethernet, then visualised and stored. In addition, the admodus®*SONAR* user software provides an interface with widely available surveying software programs such as QINSy, WinProfile and Profile 2000, so that the horizons identified can also be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

- 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

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.





SEABED IS EXPANDING!

Seabed's Portfolio is growing, Seabed's staff is increasing and therefore Seabed is bursting at the seams. We had to increase our footprint by adding another location to be able to do our work in a clean and tidy environment and maintain the quality level. Should we move entirely? Fortunately this was not necessary. We are just expanding by adding another office unit, to the 2 units we already have, and just right across the street!

Skilltrade Hydrographic **Survey Online Training**

Since 2001 Skilltrade has been sharing hydrographic knowledge and experience. We started with a two-day Introduction to Hydrography course and evolved into specific courses like Multibeam echosounder, DGPS, RTK, Side Scan Sonar, Sub-bottom Profiler and Tides. Hundreds of people have been trained on these short courses to date.

Since 2008 we also offer a **full Hydrographic Survey Category B curriculum** as defined by the FIG/IHO/ICA International Advisory Board on Standards of Competence for Hydrographic Surveyors (IBSC). All theoretical lessons are delivered in a practical combination of online instructor-led training and guided self-study on our e-learning platform. The exams are given online with the use of a platform for online proctoring. After successful completion of the exams, the students are welcomed in the Netherlands for 6 weeks workshops and completion of their Comprehensive Final Field Project, all in line with IBSC regulations. Subjects from our Cat B course can also be followed independently, like our short courses, to demonstrate an ongoing commitment to Continuing Professional Development (CPD), necessary to obtain or retain hydrographic certification.

Skilltrade offers various **short courses**, including our two day Introduction to Hydrography that we run several times a year. On request for a quotation these courses can be adjusted to specific training requirements and be given at any desired location (in-class or online).

E-learning modules: Underwater Acoustics, Bathymetric Systems, Land Surveying, Coordinate Reference Systems (Geodesy), GNSS operations and Positioning.

Handbook of **Offshore Surveying**

The series **Handbook of Offshore Surveying Volume I, II and III** is an encompassing series that is unmissable for the modern day hydrographer. This complete set of books should be on the desks of every hydrographic survey company and the professionals working for them, while it can be used as reference book for daily practice in offshore surveying in the fields of projects, preparation & processing, positioning & tides and acquisition sensors.

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(excluding shipping).

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or contact us at **office@skilltrade.nl**

SKILLTRADE

Skilltrade e-learning

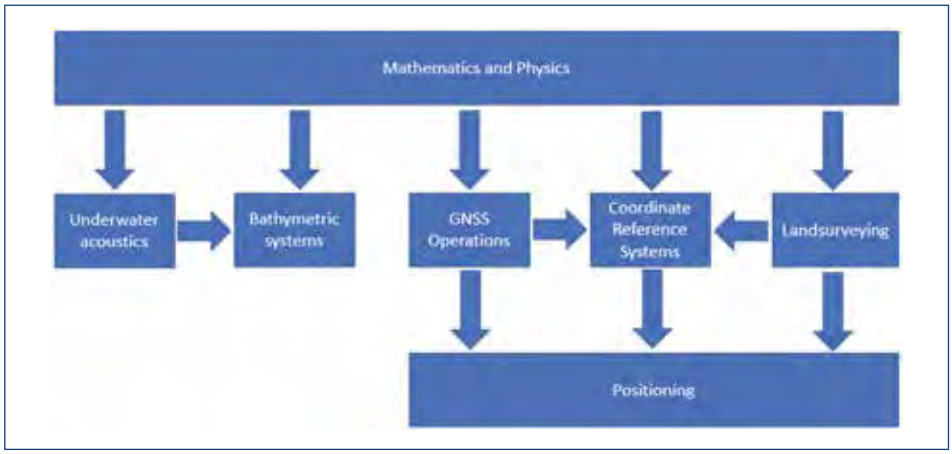
Skilltrade wanted to offer easier access to Hydrography Training and therefore developed several interactive on-line structured e-learning courses. These modules can be followed separately but are also part of the Hydrographic Survey Category B Course.

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

- Underwater Acoustics
- Bathymetric systems
- Land Surveying
- Coordinate Reference Systems (Geodesy)
- GNSS Operations
- Positioning
- Mathematics self-test as a precursor to the Cat-B mathematics
- Physics self-test as precursor to the Cat-B physics

You can access the modules online through most browsers where the course adapts to the available type of device and screen layout where possible, but also offline through the Moodle Mobile app on your mobile device. Each module is accompanied by background material; which are from the Handbook of Offshore surveying.

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 6 modules are presented as a Power Point video with an overlay of spoken instructions. The study load is approximately 40-50 hours per module.



Level

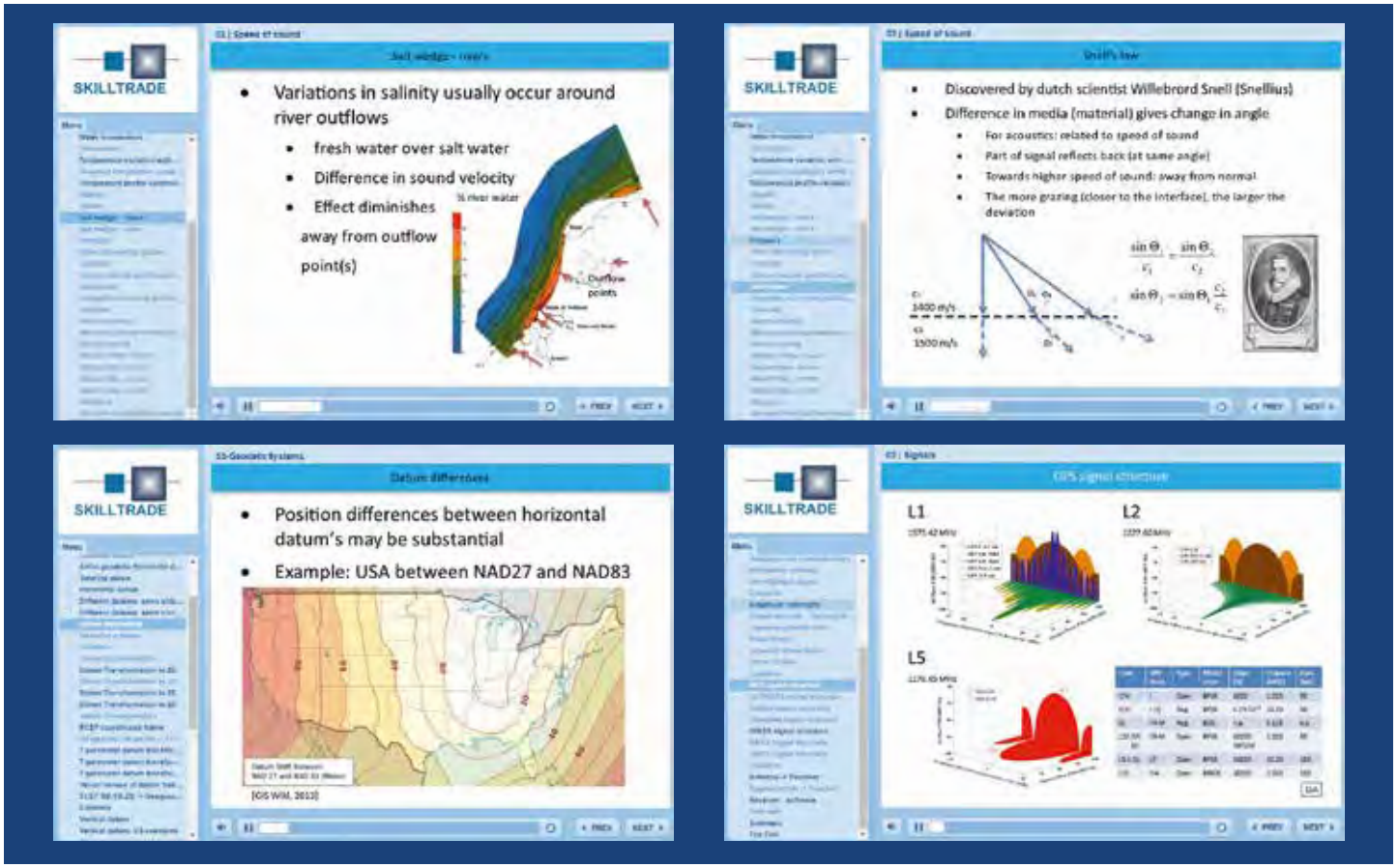
Mr Huibert-Jan Lekkerkerk, sr. lecturer and developer of the Skilltrade e-learning modules: "The theory that is presented in these e-learning modules is actually a little bit above Cat B level. As we include slightly more complicated computations that could have been part of a Cat A level course. We have done this to allow these modules also to be used for continuous professional development or to gain the required theoretical knowledge for a professional assessment scheme. The theory covers the subjects according to selected competencies from 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 of 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 with the exception of the assessment modules which required an internet connection to pass the results to the learning management system.

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.



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. 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.

Cat-B as blended learning

The Skilltrade Hydrographic Survey Category B Course was first recognized by the FIG/IHO/ICA International Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers (IBSC) in 2008. Since then Skilltrade has trained over 270 individuals from various countries around the world. In 2020 the pandemic forced Skilltrade to review how the course was delivered. With approval from the IBSC Skilltrade included online instruction. After two years of positive experience with online teaching, Skilltrade has chosen to continue working according to this blended learning curriculum. All lessons that can be given on-line will be taught using digital formats and for a large part through the e-learning described before. The student not only studies through e-learning but also joins online instructor-led training. With the lectures rotating from a two week online to a two week e-learning schedule, the student is relatively free to study at his or her own pace. If a student was unable to attend a lecture, they can review the lecture afterwards. Any formal course requires exams. For the Category B Course, the exams will be given online with the use of a platform for online proctoring. Online proctoring allows students to sit their exams anywhere and without risk of fraud.

Hydrography is an applied discipline and supervised training should follow the theoretical portion of the Category B programme. Workshops, practical instruction and assignments are held in The Netherlands for a period of 6 weeks. A part of this practical period is the Comprehensive Final Field Project (CFFP). The student will perform the required tasks from the start to the end of a hydrographic survey project in a tightly controlled environment while being supervised and assessed. Students who pass the CFFP are awarded the FIG/IHO/ICA Certificate of Programme Completion.

SKILLTRADE

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Seabed Winch

The Seabed Winch is a fully automated Winch, useable for a wide number of applications. With its stainless-steel AISI 316 frame, the Winch can be placed on the rear of the vessel, on a buoy, or on a quayside, or any other location the Winch can be used to monitor the environment. And to make the Winch even more versatile deployable, the setup can be powered by a solar panel.

SEABED

Getting to the bottom of things

Exploring Mediterranean Sea waters with a state-of-the-art combined current profiler and echosounder

A test deployment in the Mediterranean shows how the Signature100 current profiler – with dedicated echosounder functionality – provides high-resolution oceanographic measurements from a surface vessel throughout the full water column.

Nortek sampled the warm, salty waters over the continental shelf and slope in the Western Mediterranean Basin off the coast of Toulon, France (Figure 1) in depths ranging from 150 to 450 m. Water temperature at the sea surface in the region ranged from approximately 20.0 to 21.5 °C, and sea surface salinity was approximately 28 (Alvarez-Berastegui et al., 2020).

Three dedicated echosounder channels operating on a fifth vertical beam can be configured by users to allow for testing and optimization of settings to suit the local environmental conditions.

Current profiling in a changeable ocean environment

Upwelling events in the Gulf of Lions are forced by the north and northwesterly mistral and tramontane winds (Millot, 1979). On the morning of 24 August, wind conditions were Beaufort 2, with estimated wind waves and swell at less than ~0.3 m. By the end of the day, Beaufort 5 seaward winds prevailed, with significant wave heights of ~0.5 m. On 25 August, wind conditions were Beaufort 2 with wind waves less than ~0.2 m and swell less than ~0.1 m. Such variable environmental conditions are the norm for this region – presenting unique operational challenges for those working offshore.

Deploying multiple ADCPs for current profiling and echosounding measurements

A barge vessel (Figure 2) was used to deploy Nortek's Signature acoustic Doppler current profilers (ADCPs). A Signature100 and

Figure 1: Location map (left) of test region with site map (right) showing approximate track locations (dashed lines). ©Google Maps

Figure 2: Barge in dock (left) and at sea with crane extended (right).

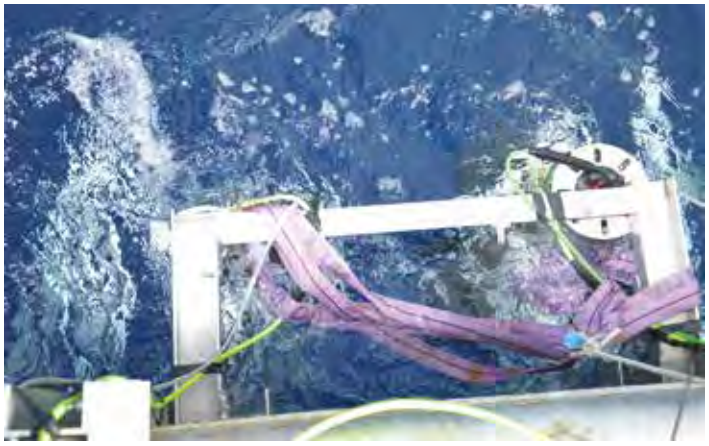


Figure 3: Signature100 and Signature55 in aluminum frame in standing position to prevent losses due to drag (left) and in deployed position as viewed from above (right).

a Signature55 ADCP were mounted to an aluminum frame on the bow (Figure 3) and lifted by a crane to eliminate drag during transport.

Current profiling and echosounding measurements were made as the barge vessel transited across the region with a maintained sail speed of 1.6 to 2.0 m/s (3.1 to 3.9 knots). At low current speeds, the barge experienced up to seven degrees of change in pitch and roll, but the Signatures were still functional under these conditions.

The impact of changing the echosounder transmit length is seen in Figure 4 and Figure 5. The features in the Echo 2 echogram are in sharper relief compared to Echo 1.

Optimizing the echogram of the combined current profiler and echosounder

The Signature100 ADCP with echosounder was enabled with two frequencies (70 and 120 kHz) and a short (0.5 ms), moderate (1.0 ms), and long (3.0 ms) transmit pulse. Transmit pulse length is a trade-off between the amount of energy put into the water (long values) and the degree of acoustic resolution provided (short values). Longer pulse lengths yield a stronger return signal, while shorter pulse lengths acoustically resolve features that are closer together. Uniform cell size (0.5 m), blanking distance (10 m) and non-pulse compression were used.

Identifying physical ocean processes from echograms

The test resulted in high-resolution echograms over the continental shelf and slope that depict stratification and water column features. Echograms of relative volume backscatter (Sv) are displayed in Figure 4 through Figure 7. Seabed delineations were extracted using maxima filtering, outlier removal, interpolated gap filling and smoothing.

The selected tracks display horizontal structures indicative of stratification – these are intensified in the upper 50–75 m where solar radiation creates strong temperature gradients. This upper layer is underlain by a lower-intensity layer extending to depths between 100 m and 150 m.

Discrete and less distinct features appear along the continental slope and shelf. In Track 1, sampled in the early afternoon of 24 August, this feature has an apparent upward velocity and bends around the slope summit into a horizontal layer at about 120 m depth. Strong northerly winds are associated with upwelling, and while surface temperatures do not indicate an event strong enough for cool waters to reach the surface, it is possible that upwelling was initiated at depth.

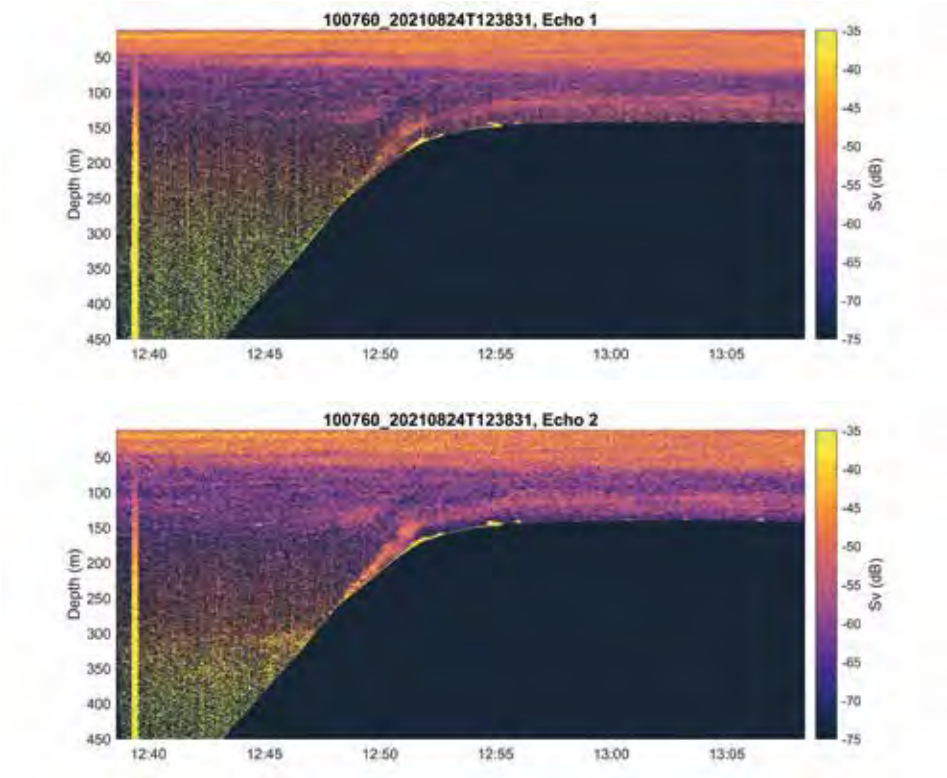


Figure 4: Track 1 (120 kHz), Echo 1 with transmit length of 0.5 ms (top) and Echo 2 with transmit length of 3.0 ms (bottom).

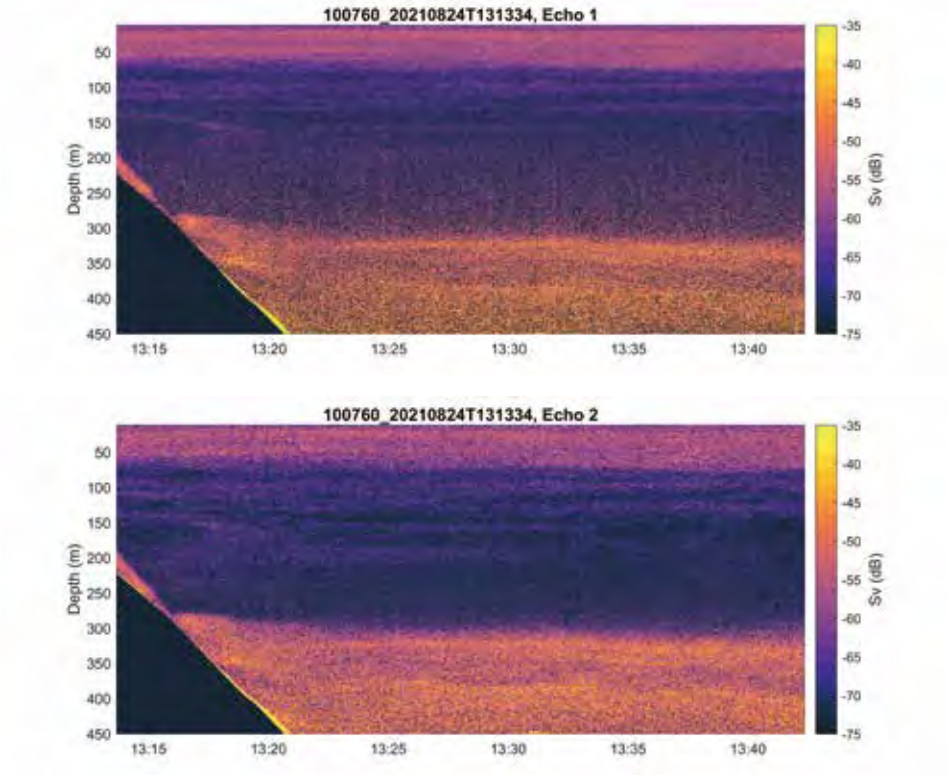


Figure 5: Track 2 (70 kHz), Echo 1 with transmit length of 0.5 ms (top) and Echo 2 with transmit length of 3.0 ms (bottom).

Combining sensor technology to provide improved environmental insights with clear visualizations

This deployment demonstrates vessel-mounted Signature100 echosounder performance in depths of up to 450 m in low-nutrient, high-temperature, high-salinity waters. Using two echosounder channels from an ADCP with fast sampling capability and dual functionality enables measurements to be temporally and spatially identical yet provides an opportunity to resolve different features and processes that coexist. Post-processing with Echoview software enables these features and processes to be visualized clearly and effectively, which improves our understanding of our marine environment (see Figure 8).

References:

Alvarez-Berastegui, D., Frontera, B., Rotllan-García, P., Heslop, E., Fernandez, J.G., Tugores, M.P., Juza, M., Tintoré, J., 2020. The Mediterranean Sea Surface Exploration Tool.

Millot, C., 1979. Wind induced upwellings in the Gulf of Lions. OCEANOLOGICA ACTA 2, 14.

Figure 6: Track 3 (70 kH
(transmit length of 3 ms

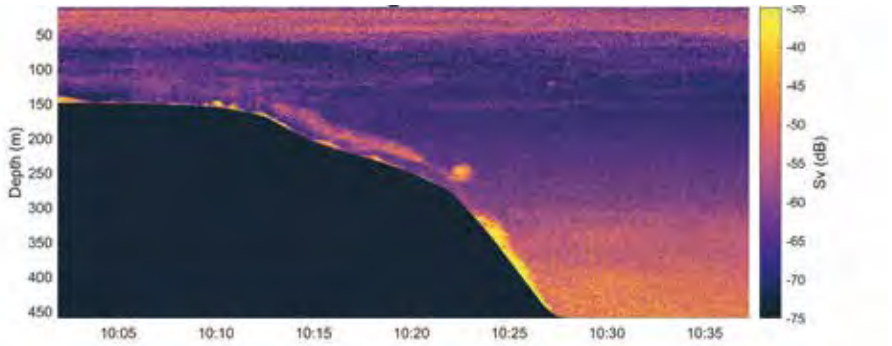
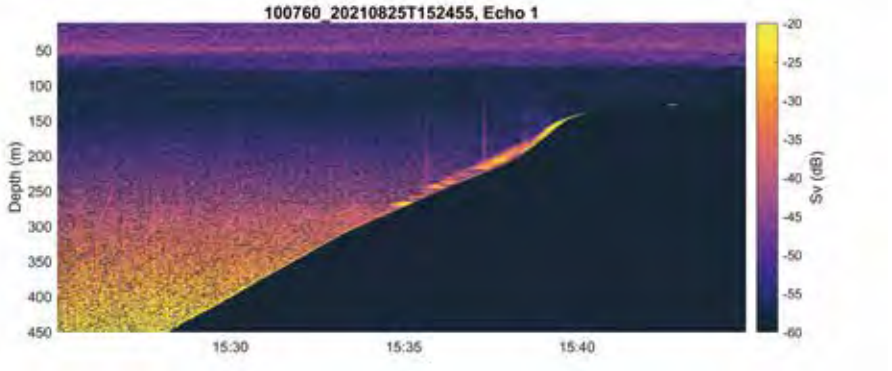


Figure 7: Track 4 (120 k
(transmit length of 1 ms



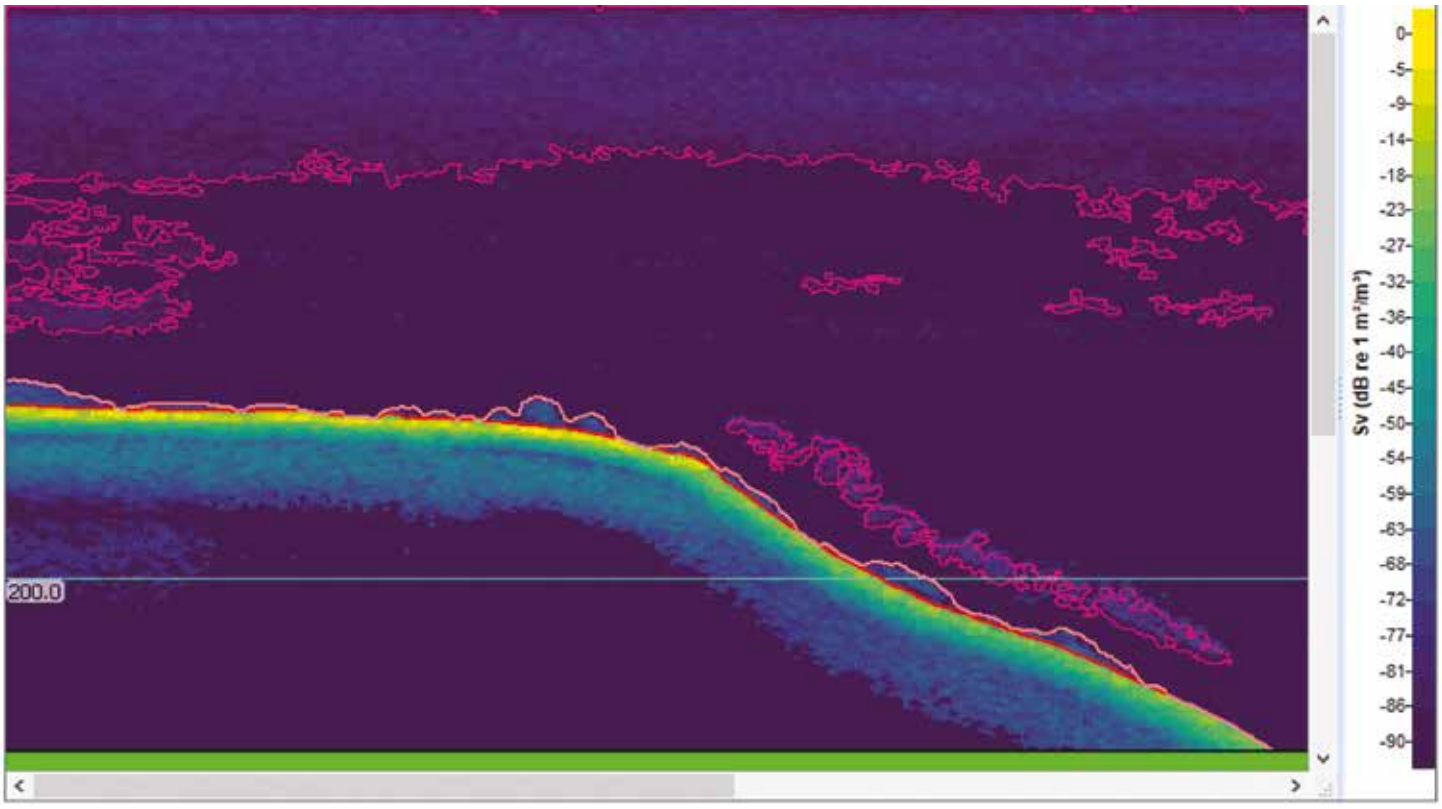
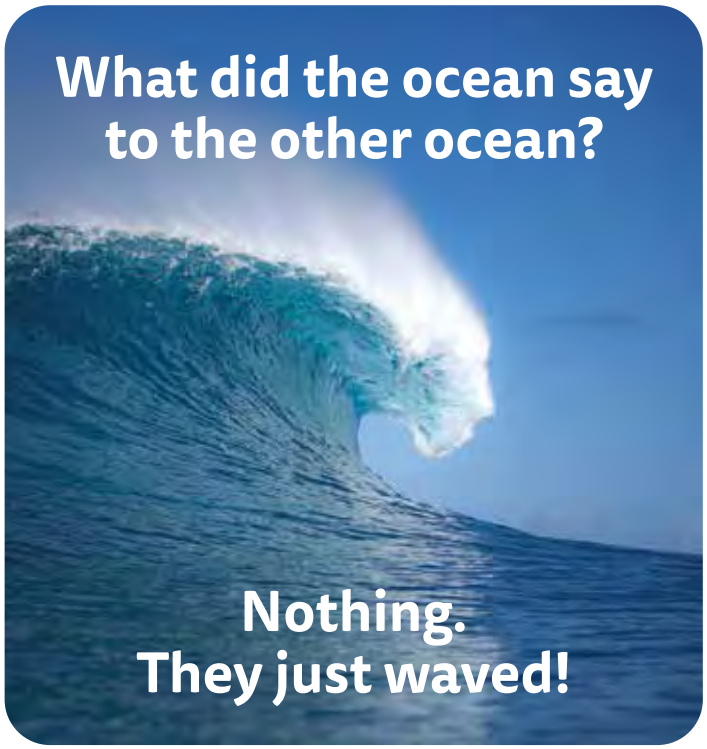
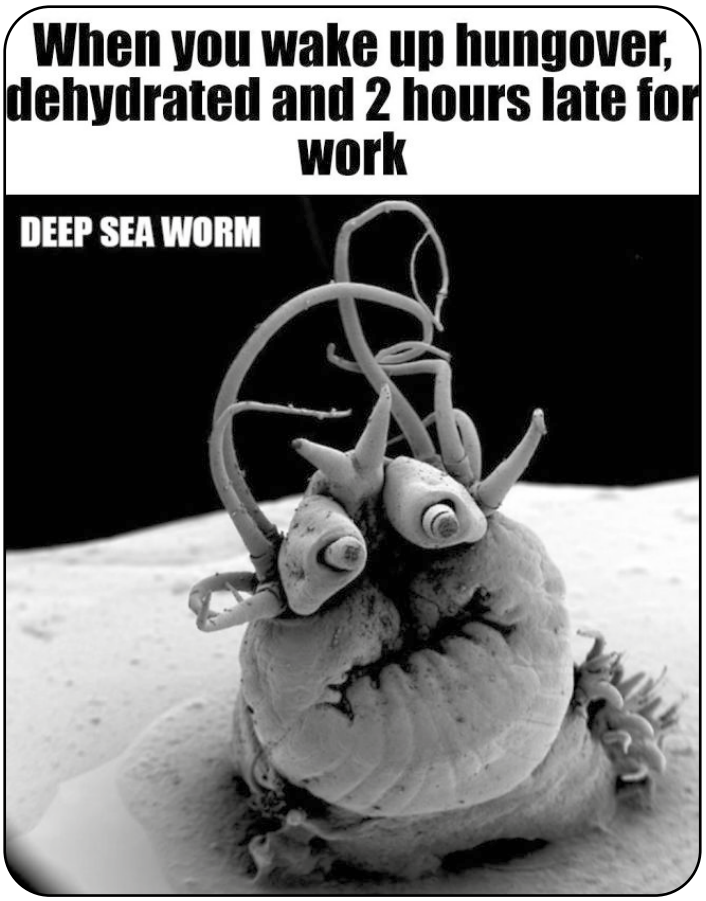
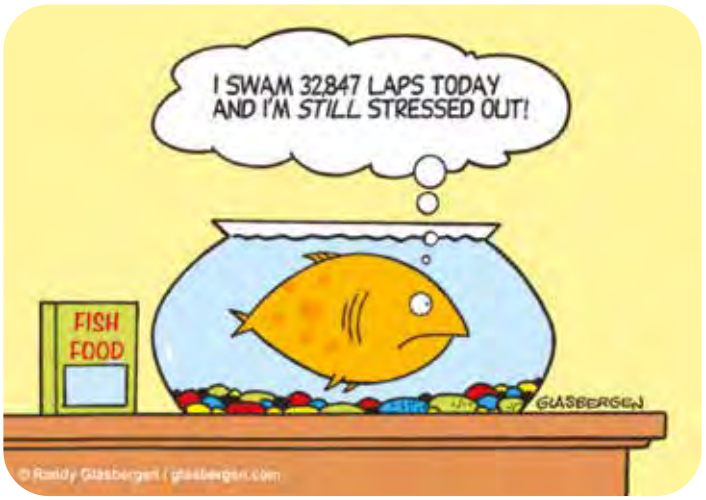


Figure 8. Track 3 (70 kHz), Echo 1 (transmit length of 3 ms) with Echoview post-processing.

Make them laugh

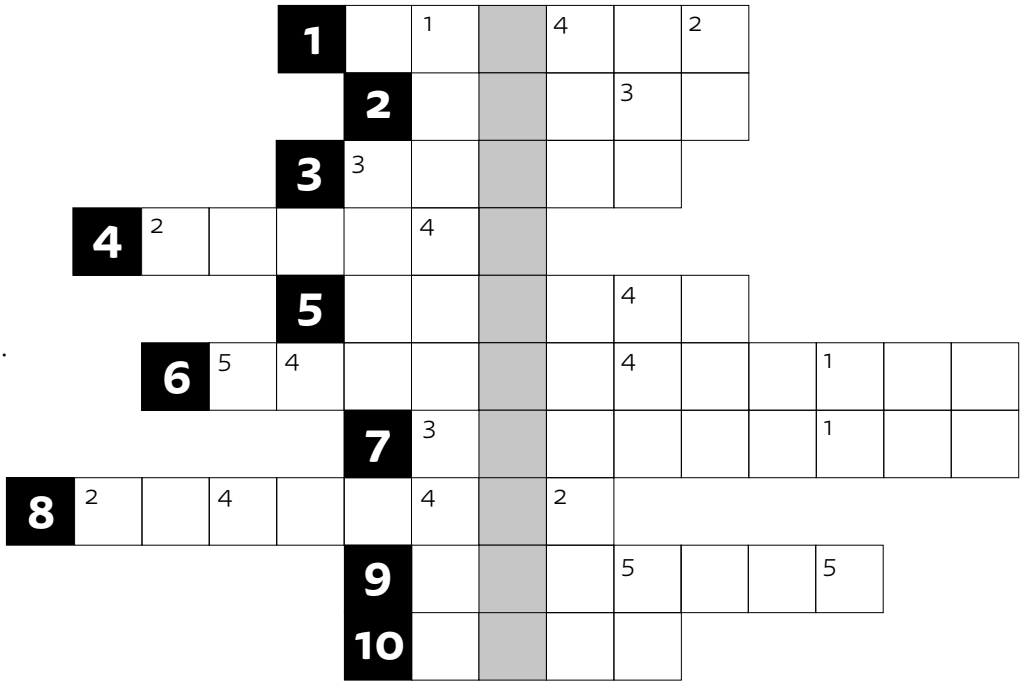






Puzzle

The object of the puzzle is to find words using the hints below. The letters in the grey column will form the name of one of Seabeds' bottom sampling instruments.

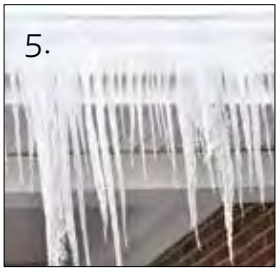


1. The Donau, Mississippi and Thames are...

2. 

3. Poisonous snake living in Africa and Asia.

4. Seabed end of ..... Demo Days.

5. 

6. Home of the Maritime Institute Willem Barentsz.

7. Seabeds' General Managers' last name.

8. 

9. Instrument used for celestial navigation.

10. Sono-...
Kilo-...
Holo-...

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Photography: Elice Collewijn, Stock

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