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UNDERWATER
TECHNOLOGY

ISSUE 3 2021



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2 John Street,
London WC1N 2ES

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Editor: John Howes
John@ut-2.com
+44 7859905550

Editorial Assistant:
Holly Smoke

Production:
Sue Denham

Advertising:
Zinat Hassan
UT3subsea@gmail.com

Tel: +44 (0) 845 6522 483
Mobile: +44 (0) 781 1200 483

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UTTM
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TECHNOLOGY

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PIPELINES
TRENCHERS
RENEWABLES

Edgetech 2050-DSS Side
Scan and Sub Bottom
System towed sonar
Image: Edgetech

NSRI SUBSEA UK

After 14 years of success in matching industry demand with academic research to accelerate the commercialisation of underwater technology, NSRI is to become part of Subsea UK.

The stand-alone organisation, originally set up as a focal point for subsea research and development, has been working closely with Subsea UK for the last six years on supporting cross-sector innovation across the underwater industry.

NSRI will now be fully incorporated into Subsea UK as part of an on-going transition towards the establishment of a Global Underwater Hub.

Bringing the organisations together under the Subsea UK banner will harness the knowledge, contacts and programmes around technology and innovation to inform and shape a clear, industry-led commercialisation strategy that will be a major pillar of the Global Underwater Hub.

With industry at its heart and funding from both the UK and Scottish Governments, the Hub will have the necessary resources to transform the subsea industry, making sure it is well-placed to capitalise on the opportunities in the energy transition and the blue economy.

It will do this through a focus on increasing exports, collaborating to deliver cross-sector technology and innovation, accelerating start-ups and scale-ups and developing capability and skills.

ONESUBSEA TO SIEMENS



Siemens Energy will provide subsea pressure and temperature sensors for the Bacalhau field Image: Siemens

OneSubsea has awarded a contract to Siemens Energy to turnkey package for the ultra-deepwater Bacalhau field located in Santos Basin, Brazil.

Under the contract, Siemens will provide pressure and temperature sensors for the subsea production system for the Equinor-operated field.

By provide monitoring data for the seabed production system, the sensors help operators to make informed decisions and ensure safe and efficient production.

The contract also includes electrical distribution equipment comprising flying leads, umbilical terminations, connectors for subsea modules, and multi-leg harness assemblies.

Additionally, Siemens Energy will deliver variable frequency drive (VFD) for the floating, production, storage, and offloading (FPSO) vessel at the field. Siemens Energy industrial applications solutions senior vice-president Jennifer Hooper said: "Providing electrical distribution equipment and instrumentation as part of the complete turnkey package will reduce the number of required suppliers for the subsea production system.

"This will significantly lower interface risks and overall project complexity for OneSubsea."

The company plans to undertake manufacturing work at its Siemens Energy Boemlo factory in Norway and the subsea connector factory in Ulverston, UK.

Ultra-low density high performance syntactic foams

Meeting the need for enhanced manoeuvrability on ROV/AUV/HOV/XLUUVs Balmoral offers a range of ultra-low density syntactic foams

The materials operate at depths of 2000-7000msw boasting excellent water ingress resistance, negligible long-term buoyancy loss and impressive mechanical properties.

For ROV/AUV purposes the materials are supplied either in slab or customised form using aerospace grade bonding materials.

Contact our experts or visit our website for further information.

surety@balmoral.co.uk
balmoraloffshore.com/syntactic



BLUE ABYSS

Blue Abyss has announced plans to develop the world's biggest and deepest pool for testing the latest underwater technology and advancing subsea robotics.

Costing £150 million, the Blue Abyss facility will be an extreme environment research, test, and training centre serving the offshore energy, marine, defence, and space sectors.

The centrepiece of the facility will be the aquatic centre featuring a 50m by 40m stepped pool with a 50m deep shaft, which will hold over 42 000 m³ of water making it the largest and deepest indoor pool in the world.

The pool's temperature, lighting and salinity can all be controlled to simulate different conditions, including different currents at varying depths. It is expected to help in the further development of remotely operated subsea robots and mini submersibles.

BRAE BRAVO REMOVAL

Heerema and AF Offshore Decom have commenced one of the largest topside removal projects of its kind in the North Sea on behalf of client Abu Dhabi National Energy Company PJSC (TAQA), one of the largest listed integrated utility companies in the Europe, Middle East and Africa.

The Brae Bravo removal campaign is the first major asset removal project for TAQA, and as a late-life asset operator in the UK, safety and environmental impact principles are at the centre of the project for TAQA and its partners. The Brae Bravo platform, first commissioned in 1988, is being removed over three separate phases in 2021 and 2022, using *Thialf* and *Sleipnir*, two of the world's largest Semi-Submersible Crane Vessels (SSCVs); each greater than 200m in length.

After removal the topside and jacket will be transported to the AF Environmental Base in Vats, Norway for further decommissioning, recycling and reuse; aiming for a 95% recycling or reuse target.



JOHAN SVERDRUP

Aker Solutions has delivered a steel jacket for the largest industry project ever in Norway, the Johan Sverdrup field.

The contractor previously delivered three platform jackets for phase 1. Now, this jacket for phase 2 of the project, means that four out of a total of five jackets have been built and delivered from the yard in Verdal, Norway.





Leonardo da Vinci

LEONARDO DA VINCI

Prysmian’s new cable laying vessel (CLV) Leonardo da Vinci is shortly to commence sea trials after completing the final outfitting phases. This will include testing the vessel trial speed, main propulsion systems, steering gear, manoeuvre, power management, and other equipment.

The final tests and measurements are carried out on winches, bollard pull, 100 tons offshore crane, A-frame and towing/lifting winch, which will support burial tools used for operations.

The 170m long vessel will feature installation capabilities for water depths of more than 3000m, maximum speed of above 14 kts, two carousels of 7,000 tonnes and 10,000 tonnes, two independent laying lines, DP3 positioning and seakeeping systems, and a specifically designed engine and propulsion set up.

The cable laying vessel, with its dual engine rooms and hybrid power, can operate safely in winds up to 130 kph, according to RINA, Italian classification society that has been carrying out statutory and class certification of Prysmian’s new cable laying vessel.

RWE Renewables has contracted Prysmian Group to provide the turn-key high voltage submarine and land export cable connection for the Sofia offshore wind farm.

The 1.4-GW Sofia offshore wind farm will be located on Dogger Bank in the central North Sea, 195 km (121 mi) off the UK’s northeast coast.

The contract is valued at more than €200 million (\$235 million). The companies signed the preferred bidder agreement in November 2020.

Prysmian Group will be responsible for the design, supply, installation, and commissioning of an HVDC symmetrical monopole cable system that will connect Sofia’s offshore converter station with the onshore converter station in Teesside. The project involves more than 440 km (273 mi) of ±320 kV submarine export cables with XLPE insulation, and 15 km (9.3 mi) of ±320 kV land cables with P-Laser insulation. Commissioning of the project is scheduled by the end of 2026.

OCEAN INFINITY ACQUIRES AMBREY.

Ocean Infinity has acquired maritime services company, Ambrey. Ambrey provides a range of bespoke offshore services including, security, crisis and risk management, intelligence, insurance, fleet operation and vessel design and build.

The acquisition combines Ocean Infinity’s robotic vessels, data, cyber, artificial intelligence, and low emission operations with a leading brand in the maritime security sector.

Ocean Infinity’s data and software capabilities is planned to revolutionise Ambrey’s intelligence and insurance services, whilst its robotic surface and sub-surface vessels have huge potential for Ambrey’s shipping and offshore client base.

Ambrey’s vessel manufacturing and fleet management capabilities will bring meaningful operational advantages as Ocean Infinity moves closer to mobilising its ‘Armada’ fleet of robotic vessels, set to be the largest fleet of its kind in the world.

Ambrey’s and Ocean Infinity’s highly complementary competencies will enable the enlarged group to expedite its strategy of becoming the world’s leading marine robotics company, with technology and sustainability at its core.

EMPOWERING

world leader in electric underwater robotics

SAAB SEA EYE



MIXED FORTUNA

The Fortuna Image: REUTERS/Oliver Denzer



According to Reuters, the Russian vessel *Fortuna* has started laying pipes for the Nord Stream 2 gas pipeline in German waters.

Nord Stream 2, designed to double the capacity of the existing Nord Stream gas pipeline, will take gas to Europe via Germany, bypassing Ukraine, which will deprive the Kiev government of lucrative transit fees.

The project is also opposed by the United States and eastern European countries which have claimed the pipeline increases Europe’s dependence on Russian gas. The US

has imposed sanctions on some entities involved in the project. Vessels involved in the project have been added to a US sanctions list.

Last month the Green party in Germany made an election commitment to abolish the \$11 billion project Nord Stream 2 pipeline that transports Russian gas to Europe. This may become a problem in any alliance with Chancellor Angela Merkel’s Christian Democrats (CDU) conservatives.

The conservatives, who have backed the Gazprom-led Nord Stream 2

pipeline, are leading in polls ahead of September elections. They are likely, however, to seek a coalition with the Green party that is forecast to come second.

The Green party says it has climate and energy implications but also gives the wrong response to Russia’s annexation of Crimea and its arming of separatists in east Ukraine

A poll by the Forsa research institute recently put the Greens on 21%, behind the conservatives whose share has fallen to 29%.

JOINING FORCES

The two heavy lift vessels of Scaldis, Gulliver and Rambiz, arrived at the horizon near Scheveningen beginning of June.

Upon arrival an extensive training and real scale testing and measuring program started for an upcoming unique civil-marine project in shallow but challenging waters and as a result of many engineering hours and a 3D computer simulation.

The most spectacular part of this trial was the a Double Duo Lift, a simultaneous and synchronised 5000t lift with Rambiz and Gulliver.

For this lift we created a copy of the actual lifts to be performed, by placing a test load pontoon on the transport barge, combined with a unique and safe rigging design.



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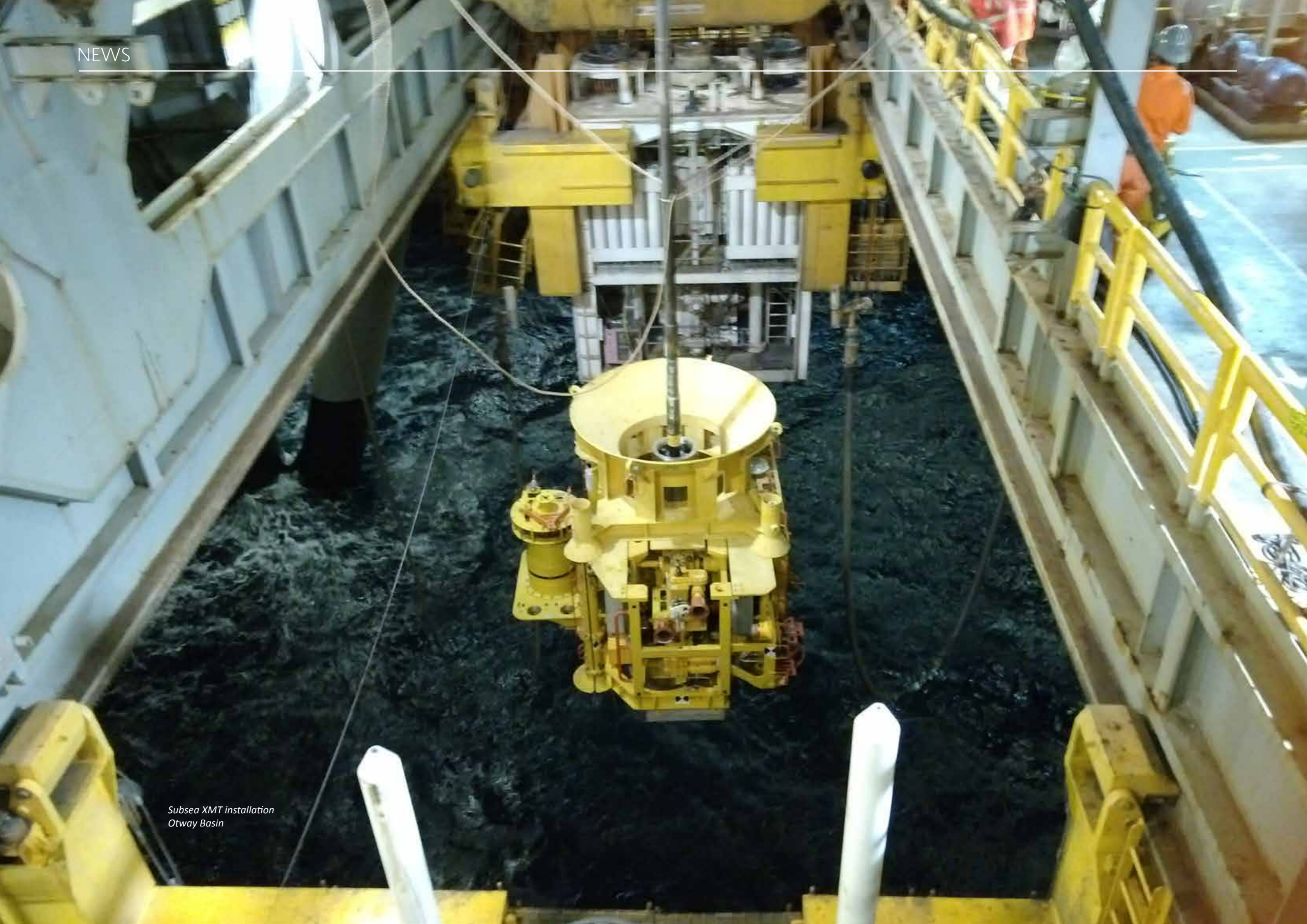
Seven Vega working out in the Gulf of Mexico, sailing into the sunset after completing a successful project.
Image: David Houston.



BP AND ENI

bp and Eni have entered into a non-binding memorandum of understanding (MoU) to combine their upstream portfolios in Angola, including all their oil, gas and LNG interests in the country.

A business plan for the company would allow it to capture future opportunities in exploration, development and possibly portfolio growth, both in Angola and regionally.



*Subsea XMT installation
Otway Basin*



PISTON CORER BREAKS DEEP-OCEAN SAMPLING RECORDS

Ocean Scientific International Ltd's (OSIL's) Giant Piston Corer systems has broken two records in scientific ocean drilling and coring on the International Ocean Discovery Program (IODP) Expedition 386.

The expedition has been staged by the European Consortium for Ocean Research Drilling (ECORD) to gain an insight into the seismic history of the study region off the Japanese coast, and is supported by the Japan Agency for Marine-Earth Science and Technology (Jamstec).

The team on board the *RV Kaimei* recorded an historic sampling water depth of 8023m, and recovered a 37.74m core in a 40m barrel string, a 94.3% recovery rate and record deepest sub-sea level sample (from 8060.74m below sea level).

The Giant Piston Corer operates in a very similar manner to traditional gravity coring systems, with the exception of the piston itself, which plugs the core barrel once the corer has been fully deployed into the sediment and, in combination with the core catcher, holds the sample more securely inside the core liner than in a regular gravity corer system and prevents sediment slump.

The piston also reduces internal friction within the core liner and prevents clumping of the sample.

This ensures that the Piston Corer systems deliver a more well-defined sediment sample to the operator.

NEW miniIPS2 & uvSVX

The next generation of interchangeable pressure sensors



Valeport has launched the new miniIPS2 and new uvSVX which both offer operationally specific interchangeable pressure transducers that deliver enhanced accuracy for specific depth ranges.

These field-swappable sensor heads make it easy for users to select the correct pressure range for their work and offer increased accuracy at any depth.

Visit valeport.co.uk to find out more

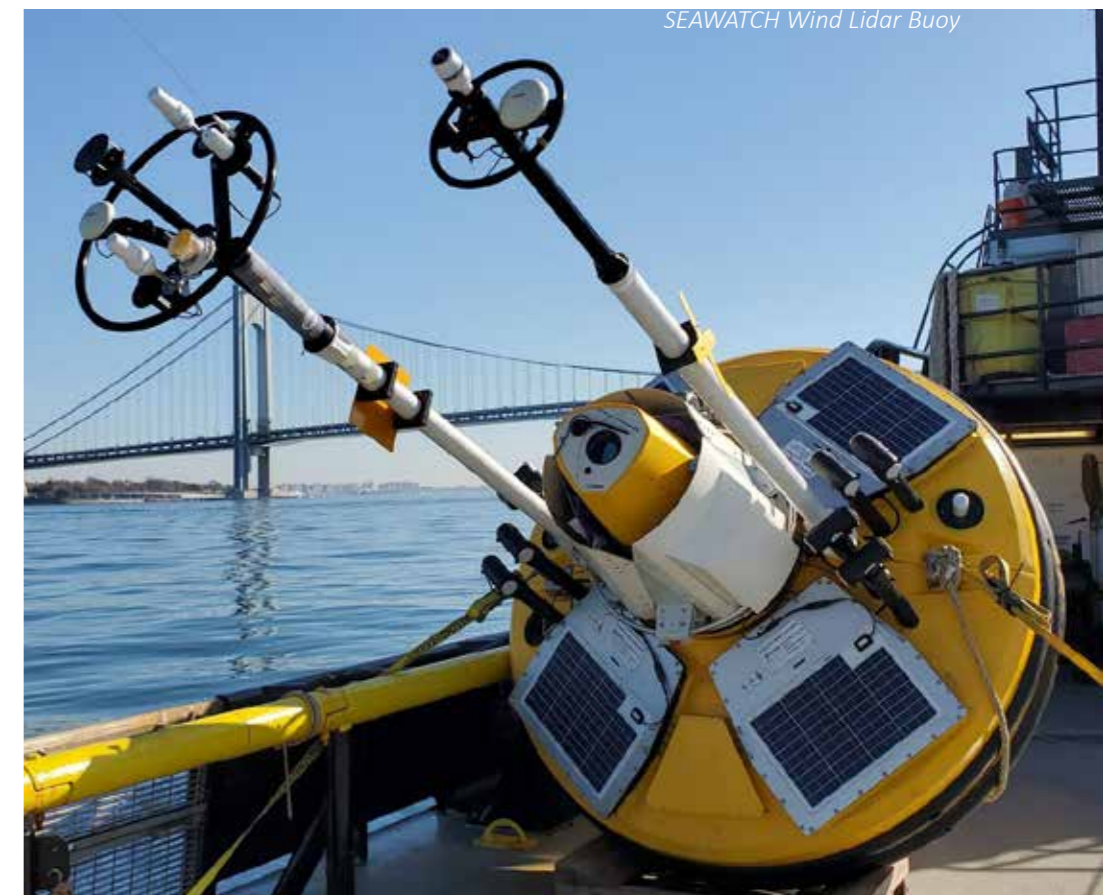
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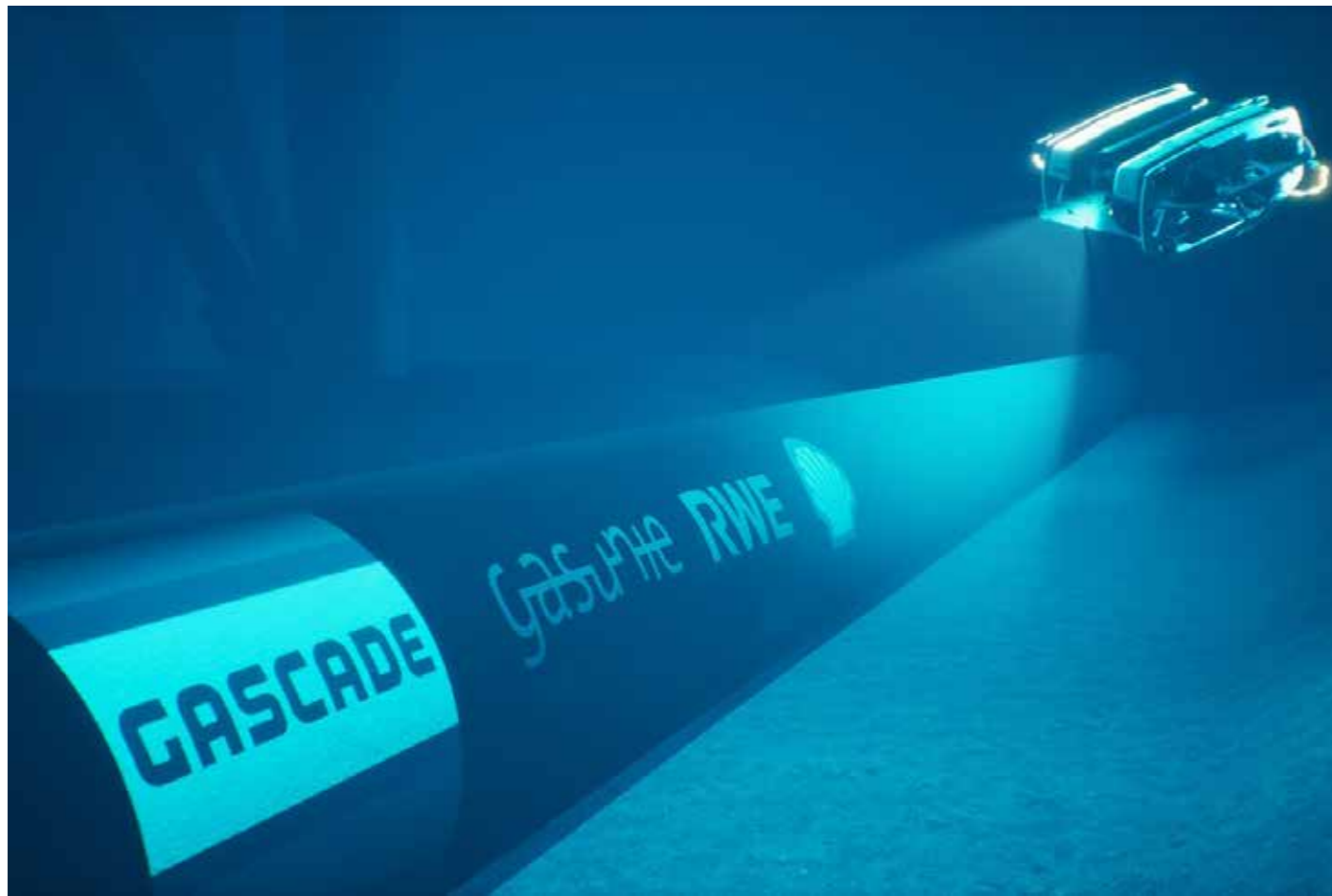
ATLANTIC SHORES CONTRACT RENEWALS

Fugro has received a contract renewal from Atlantic Shores Offshore Wind (Atlantic Shores) for the provision of real-time wind and metocean measurements off the coast of New Jersey in the US over the next 2 years.

The award is the latest in a set of three contract renewals between Fugro and Atlantic Shores based on a successful 2020 work season. Along with metocean services, Fugro's geophysical and geotechnical contracts have also previously been renewed, all three to support the safe design, permitting and construction of future wind farm facilities within the 740 km² lease area.



AquaDuctus



Project partners GASCASCADE, Gasunie, RWE and Shell signed a declaration of intent to further intensify their collaboration on the AquaDuctus project.

The AquaDuctus pipeline will transport green hydrogen from the North Sea directly to the continent. It is part of the AquaVentus initiative, which plans to install 10 gigawatts of electrolysis capacity for green hydrogen production from offshore wind power between Heligoland and the Dogger sand bank.

In the dovetailed sub-projects, demand, generation and transport of hydrogen are to be synchronised

in order to enable a swift market ramp-up.

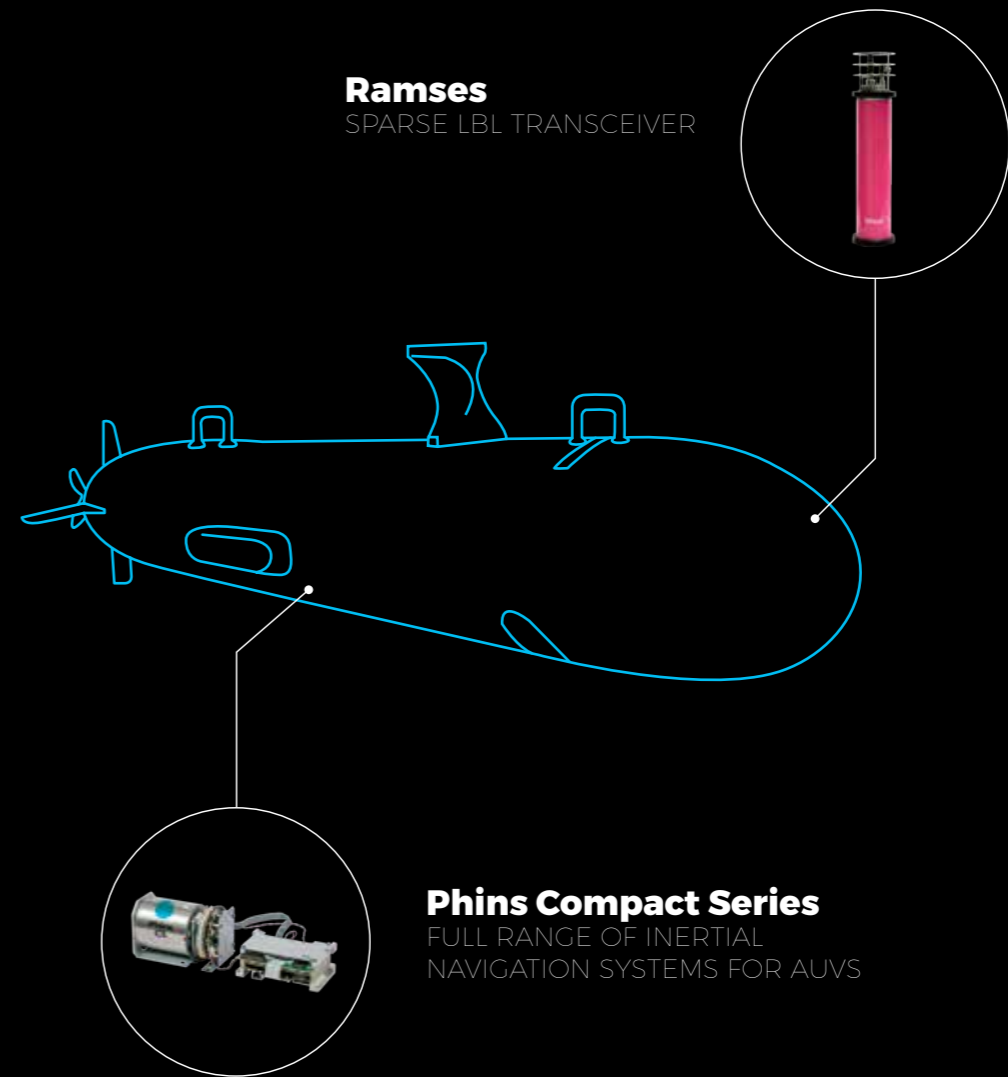
The AquaDuctus pipeline is the vision for the first German offshore hydrogen pipeline. Once the construction of the generation plants is fully completed, AquaDuctus would transport up to one million tonnes of green hydrogen annually from 2035 onwards, thus making a substantial contribution towards the decarbonisation of energy supply in Germany and Europe.

AquaDuctus is therefore a key milestone in the implementation of the German and European hydrogen strategies.

Compared to the transport of electricity generated offshore, the pipeline offers clear economic advantages. The pipeline will replace five High Voltage Direct Current (HVDC) transmission systems, which would otherwise have to be built. It is by far the most cost-effective option for transporting large volumes of energy over distances of more than 400 kilometres.

The first step in the AquaDuctus project is to carry out a detailed feasibility study. AquaDuctus has also participated in the IPCEI (Important Project of Common European Interest) process of the German Federal Ministry for Economic Affairs and Energy.

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C-Kore deployment

CRANIUM ENGINEERING DEPLOYS C-KORE UNITS

C-Kore Systems recently completed another successful campaign with VAYCO Oil tools and their Nigerian partner Cranium Engineering for a major oil operator offshore Nigeria. The C-Kore tools were used to test the electrical integrity of the subsea assets.

With their quick results, the C-Kore tools insured minimum interruptions to the field, reducing the vessel time on the operation while not requiring any additional personnel offshore.

C-Kore's subsea testing units are used on both asset integrity and installation operations to verify the health of subsea electrical systems. The Cable Monitor unit tests the insulation resistance and continuity of the electrical line while the Subsea TDR unit localises faults with an accuracy of around 20cm.

KYSTDESIGN SUPPLY OCEIN

KYSTDESIGN has signed a contract with Ocein for the supply of 15 Stealth Cleaner net cleaners.

The Stealth Cleaner is a remotely-controlled subsea vehicle for gentle cleaning of fish farms and moorings and has become an important tool for lice control and to safeguard the welfare of farmed fish.

The development of the Stealth Cleaner's is based on KYSTDESIGN's extensive experience in ROV and subsea robotics in addition to Ocein's broad expertise within sea-based fish farming.

Ocein is experiencing a high demand for these products both in the Norwegian- and international market and is now well established both in Norway and Chile.



Stealth Cleaner

BLUEPRINT LAB PICKS FALCON FOR MANIPULATOR TESTING

Electric robotic manipulator creator, Blueprint Lab, has chosen the Saab Seaeye Falcon as their lead in-house development platform for being a reliable, proven, and easily deployable vehicle.

Blueprint Lab's design concept means their all-electric manipulators can be easily integrated onto different manufacturer's robotic vehicles, with the Falcon seen as a valuable resource for further manipulator testing in real-world scenarios.

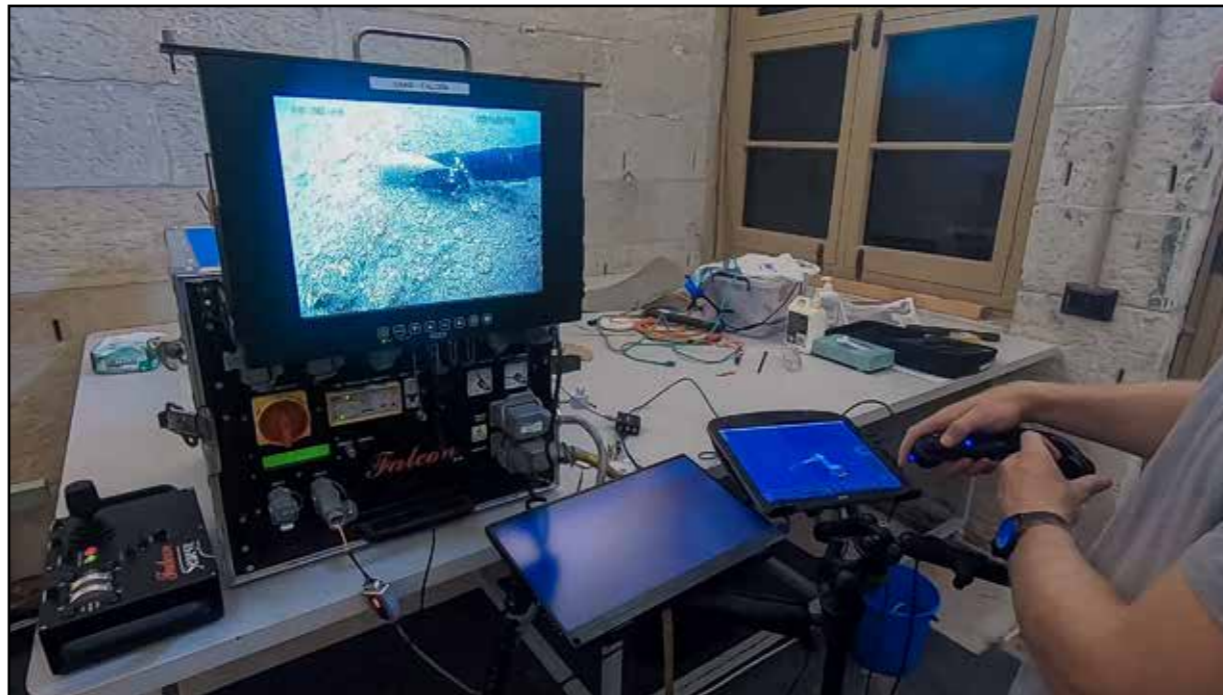
Global interest comes as operators discover the dexterity of electric manipulator performance with its smooth, precise and controllable operation.

The modular technology design in Blueprint Lab's manipulators, with a lift capacity exceeding 10kg, and over 1200N of grip force, allows multiple end-effector options to be fitted for a wide variety of applications.

The advancement of their integrated tooling technologies will be helped by utilising the Falcon's iCON intelligent control system.

Blueprint Lab also say the Falcon's compact size makes for easy deployment at test sites when trialling manipulator solutions to real-world problems.

"We're excited to push the



Remotely operating the manipulator



Manipulator grasping sea flora



Monitoring the manipulator

boundaries of what Falcon customers can do with their vehicle when fitted with our electric manipulators," says Blueprint Lab's Business Development Manager, Anders Ridley-Smith.

"Fitted with our Bravo manipulators and the Falcon Integration Kit, operators will have access to a new capability for use in visual and NDT inspection, construction and recovery operations, and other complex tasks," he adds.

One key reason for choosing the Falcon is the match between the market sectors in which it is deployed and Blueprint Lab's own

markets, including defence, offshore energy and marine science.

With a reliability record covering over a million hours of undersea operations, the Falcon's 20-year success comes from being a powerful, highly manoeuvrable, multi-tasking, easy to use, metre-sized vehicle, depth rated to 300 and 1000m and enhanced with Saab Seaeye's revolutionary iCON future-flexible intelligent control system.

Blueprint Lab is supported in their development work by the Australian Government.

FALCON EYES BRAZILIAN PIPELINES

Brazilian offshore IRM operator, SISTAC, has added another Falcon to their fleet of Saab Seaeeye underwater robotic vehicles.

On-line fibre optic video surveillance of the 'Pull in – Pull out' pipeline connection process by the Falcon's HD camera is the vehicle's initial contracted task.

Operators on board will monitor the process throughout the operation.

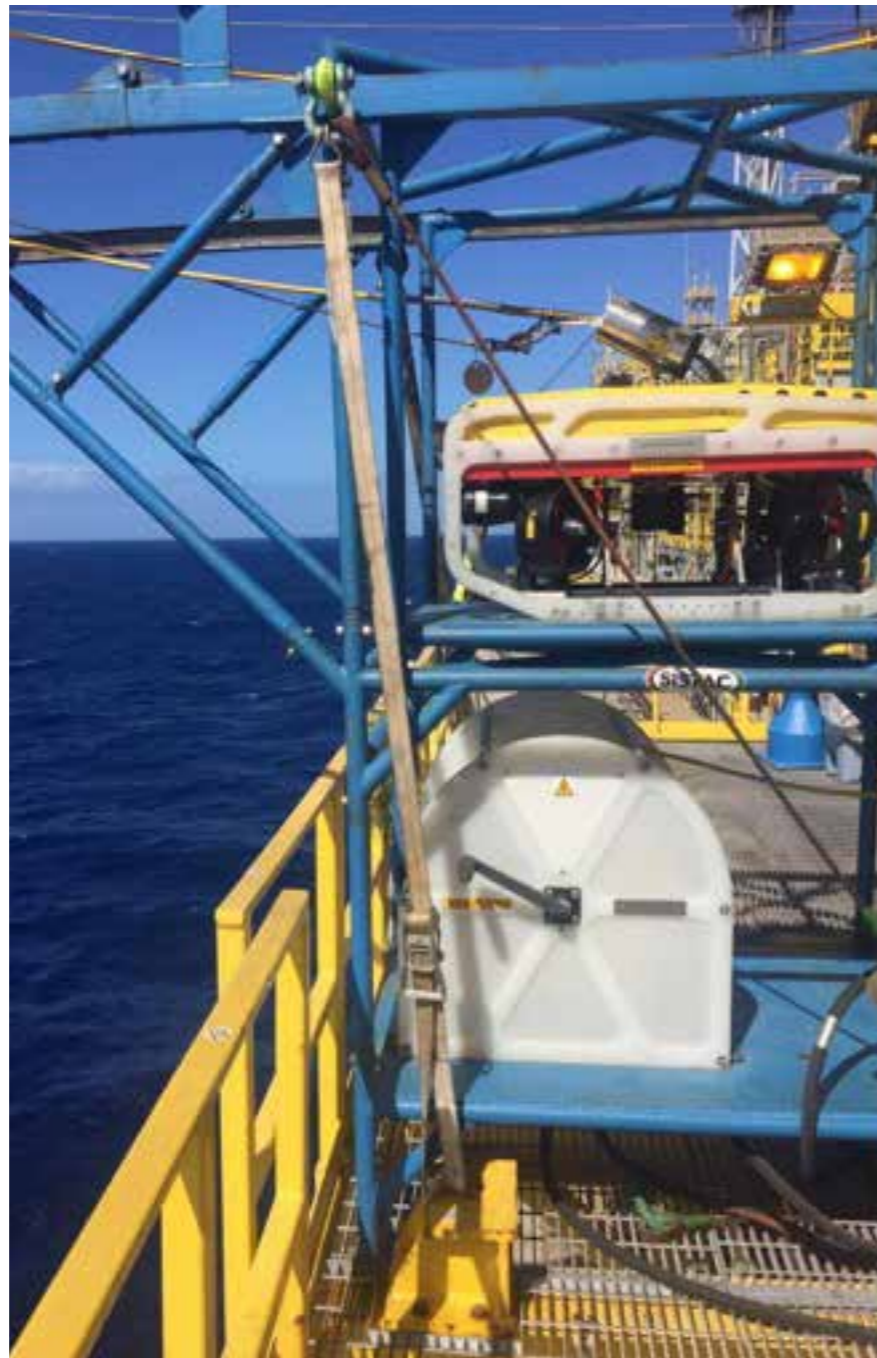
SISTAC Sistemas de Acesso already has Seaeeye Tigers and Falcons in their fleet, and long experience working with Seaeeye over many years means they like to keep their fleet standardised.

They say their choice of Saab Seaeeye comes because the company has more than 20 years' experience of robotic vehicle manufacturing and SISTAC find their vehicles "very reliable in terms of operational perspective".

They also like that Seaeeye has a strong support team with a high degree of technical knowledge of the equipment and new technologies in the underwater robotics market.

An upgrade is also being made to another of the Falcons already in their fleet with the same fibre-optics system as the new vehicle.

A handy metre-sized, multi-tasking, easy to use vehicle, the Falcon is depth rated to 300m, with five powerful thrusters and intelligent control.



Saab Seaeeye's revolutionary iCON future-flexible intelligent control system, has created a highly

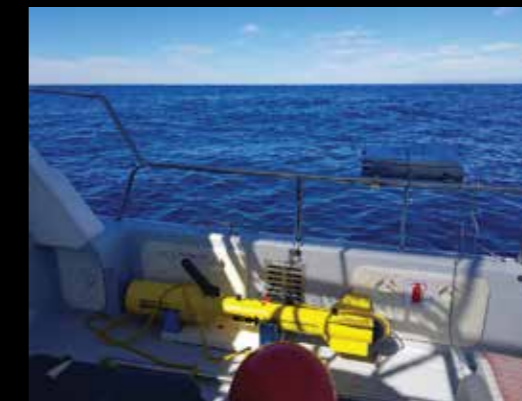
manoeuvrable vehicle that can handle strong currents whilst fully loaded with a wide range of cameras and tools.

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VALEPORT WATER

Oceanographic and hydrographic instrument manufacturer, Valeport, has continued to expand by launching a new company dedicated to providing highly accurate and innovative instruments to the Water industry. The new company, Valeport Water, will leverage the expertise and manufacturing capabilities of its sister company, Valeport.

Although this expansion of the Valeport brand was born out of the pandemic, the marine tech firm which has

served the subsea market for decades, also has a long history serving the hydrometry and hydrology markets. Indeed the first Valeport product was a Braystoke Impeller Flow Metre used for the Thames Barrier project in 1969.

"No doubt 2020 was one of the strangest years ever, but it has also been one of our busiest. Expanding the Valeport brand to serve the water market, is something that we had planned before the pandemic", Matt Quartley, Valeport Group managing director commented.

"Although for many years Valeport has worked in the Water industry, it has been pretty much under the radar. We do have a long-standing relationship with an international water cycle management company, developing for them insertion flow technology for water distribution networks and acoustic Doppler technology for sewer flow.

The launch of Valeport Water, which will sit alongside the original Valeport marine instrument business and a third company, Valeport Service, is part of the firm's ambitious growth strategy as it targets market leadership in the environmental sensors sector.



Valeport Water

OPERATION RAVENEL

THE SEARCH FOR THE WRECK HAS BEGUN IN SAINT-PIERRE-ET-MIQUELON

A research campaign aiming to find the wreck of the *Ravenel* fishing trawler, which disappeared back in January 1962 off the coast of Saint-Pierre-et-Miquelon, began last May.

Despite several attempts over the past decades, the wreck remains unfound. Thanks to the use of DriX Unmanned Surface Vessel (USV), designed, developed and operated by iXblue, however, this new research campaign relies on unprecedented technological means to solve this mystery, that remains one of the most important shipwrecks in the history of French fishing.

The 15 sailors aboard the *Ravenel* left for sea in January 1962 and dramatically disappeared after 8 days of sailing. The wreck of the vessel has never been found since then.

In April 2021, Annick GIRARDIN, France Minister for the Sea, announced the launch of a major research campaign, which aroused great interest from the local population.

A search area of 439 km² has been defined thanks to information and documentation collected by the two associations of descendants of the missing, *Ravenel* and *Ravenel Research*, as well as by

teams of Meteo France (French national meteorological service) and the Department of Underwater Archaeological Research (DRASSM).

Since May, iXblue's DriX autonomous surface vessel has been mapping the seabed of this newly defined area, looking for clues about the location of the wreck of the *Ravenel* or components of its structure.

Developed by iXblue, this drone is equipped with powerful means of localisation and detection of obstacles, allowing it to perform these missions autonomously. It is in constant contact with the ground and an accompanying vessel.

The DriX operates 24 hours a day and is supervised by three iXblue surveyors. To accompany the DriX, four government vessels take turns on the surface: the French Navy Fulmar patrol boat, the *P'tit Saint-Pierre* from the "Armement des Phares et Balises", the *Charente*, a vessel from the "Service des affaires maritimes et portuaires (SAMP)" of the Préfecture de Saint-Pierre et Miquelon, and the SAO vessel from France Gendarmerie Nationale.

The Canadian authorities issued their authorisation for the prospecting in their international waters and offered their assistance in this research, that will last a total of one month.



OFFSHORE WIND CABLE STABILITY SYSTEM PREVENTS DAMAGE

With recent publicity surrounding offshore wind cable failures, Aberdeen-based Balmoral Comtec says its integrated cable protection stability system offers up to 75% reduction in subsea cable movement helping prevent irreversible damage.

The stability solution, which complements Balmoral FibreFlex, the company's patented cable protection system, offers enhanced tensile and creep performance by using weighted modules to improve cable curvature response while maintaining system geometry over life.

The proprietary system has been proved to offer up to a 75% movement reduction in subsea environments with a corresponding trebling of cable life subject to seabed topology and metocean data.

Even in the most extreme environments a 50% reduction in subsea movement is achieved that more than doubles cable lifetime performance.

Balmoral's offshore wind cable stability system is designed to prevent long term damage



Balmoral FibreFlex, the company's patented cable protection system

EDGETECH RENTAL

Ashtead Technology has invested over £1million in a range of EdgeTech sonar imaging and underwater technology systems to enhance its extensive equipment fleet.

The systems, which will be available for rent throughout the company's international technology and service hubs, include the 4205-Tri-Frequency Side Scan Sonar System, the 4200-Side Scan Sonar System, the 2205-ROV Side Scan and Sub Bottom System, and the 2050-DSS Side Scan and Sub Bottom System.

The EdgeTech 2050-DSS is the latest product to combine EdgeTech's highly successful line of side scan sonars and sub-bottom profilers into one fully integrated system. The 2050-DSS comes complete with a combined towfish, digital telemetry that runs over a single coaxial cable, a 19-inch rack mount topside interface, and EdgeTech's DISCOVER acquisition software.

The 2050-DSS can be integrated with several auxiliary sensors such as magnetometers and USBL responders. Additionally, an interface is fitted to the electronics so that the electronics and sensors can be mounted onto an ROV.

The 2050-DSS is ideal for applications such as cable and pipeline surveys, marine construction surveys and pre and post dredging surveys.





SUB BOTTOM IMAGER ON FORMOSA 2

PanGeo Subsea has delivered its Sub- Bottom Imager (SBI) to Taiwan, supporting Jan de Nul on the Formosa 2 Offshore Wind Farm Project.

Initially, PanGeo plans to have one SBI unit resident in Taiwan with a plan to ship additional SBI units as operations dictate. The company will be supporting the growing renewable markets in the region by providing acoustic imaging services for cable depth of burial specifically for Formosa 2 with plans to provide technology solutions to other developers in the region as more offshore wind projects are announced.

The move comes as PanGeo was awarded a series of cable depth of burial survey along the export cables of one of the region's largest offshore wind farms.

The surveys will see the SBI image the cables to a depth greater than 1.5m burial depth while the SBI is mobilized onto an ROV for the duration of operations.

Formosa 2 offshore wind project is located between four and ten nautical miles off Miaoli County, with 376 MW installed capacity. There will be 47 Siemens 8 MW turbines on jacket foundations installed in up to 55m water depth.

TREASURE HUNTERS

Every day, treasure hunters search sunken shipwrecks or sites of interest to retrieve artefacts that can be sold on the open market or donated to museums for preservation.

Hollywood has made movies about the thrills of treasure hunting for decades, and JW Fishers' search equipment has been a part of numerous high-profile films. Paul Walker and Jessica Alba used the Pulse 8X in multiple scenes of "Into the Blue" in search of gold in the Caribbean Sea. Matthew McConaughey and Kate Hudson both used the detectors looking for a sunken Spanish galleon called the *Aurelia* in "Fool's Gold." JW Fishers has also been featured on "Rob Riggle Global Investigators" and on "The Curse of Oak Islands" Series multiple times.

An estimate of the value of sunken treasure in the world begins with a guess at the number of sunken ships. In 2012 James Delgado, then director of the Maritime Heritage Program at the National Oceanic and Atmospheric Administration (NOAA), estimated that there are a million shipwrecks underwater. "Given everything that's charted and all the rest, I would say that the majority of them remain undiscovered," Delgado says. After all, 70% of the planet's surface is water, and humans have only begun to reach the depths. Considering this, 95% of the ocean still remains unknown to us. "It's the last frontier," Delgado stated. "We know more about the surface of the moon than what's at the bottom of the sea."

Fishers' equipment is in use by police, military, fire rescue, and search teams across the globe, and it is this same equipment that treasure hunters often choose as their detector of choice: the Pulse 8X underwater metal detector. This award-winning underwater metal detector has been in use by for over 25 years by professionals all across the globe.

Nelson Jacas has been an avid user of the Pulse 8X underwater metal detector for many years. His journeys have taken him across the globe and have definitely paid dividends in locating old antiquities. He has found artefacts ranging from a Viking ring, multiple 1700 era coins, and a one-of-a-kind gold cross recently discovered in England!



UNDERWATER OPERATIONS

WAMS ADDS DRIX

The newly-created Brazilian rental and services company, WAMS, has added iXblue's DriX Unmanned Surface Vehicle (USV) to its existing pool of equipment.

This new investment marks an important turn in the company's offering. Available for WAMS customers in Brazil, the DriX USV will increase operational performance for shallow water hydrographic and geophysical surveys as well as LBL array box-in operations, and ROV/AUV tracking for deep water projects.

With over 10 000hrs in operations around the world, iXblue DriX USV, along with its efficient launch and recovery system, is a seasoned asset in the environment of supervised autonomy.

A force-multiplier, DriX is able to conduct both remote-controlled and supervised autonomous operations (within visual range or Over The Horizon), and offers outstanding seakeeping and speed capabilities. Versatile and efficient, the unmanned platform performs extremely well in severe weather conditions and keeps downtime to a minimum compared to traditional survey vessels.

Capable of hosting a wide range of payloads, DriX offers optimum conditions for high quality data acquisition and subsea positioning in both shallow and deep waters.



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- ▶ Oil and Gas (*Roto Climber®*)
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- ▶ Pipelines (*Roto Crawler*)
- ▶ Jacket Cleaning (*Roto Cleaner*)



Roto Climber® Mk 1 on a pile. It is equipped with 2 each barracuda nozzles and a Cygnus WT Probe and video cameras.



Control Van with screens and controls.



Roto Climber® Mk 2 on a pile with Traction unit on top and Cleaning, Close Visual Inspection and PAUT Module below.

If you are interested in using the technology or becoming an agent or investor, then please contact the following:
Enquiries@rototech.sg Website: <http://rototech.sg/>

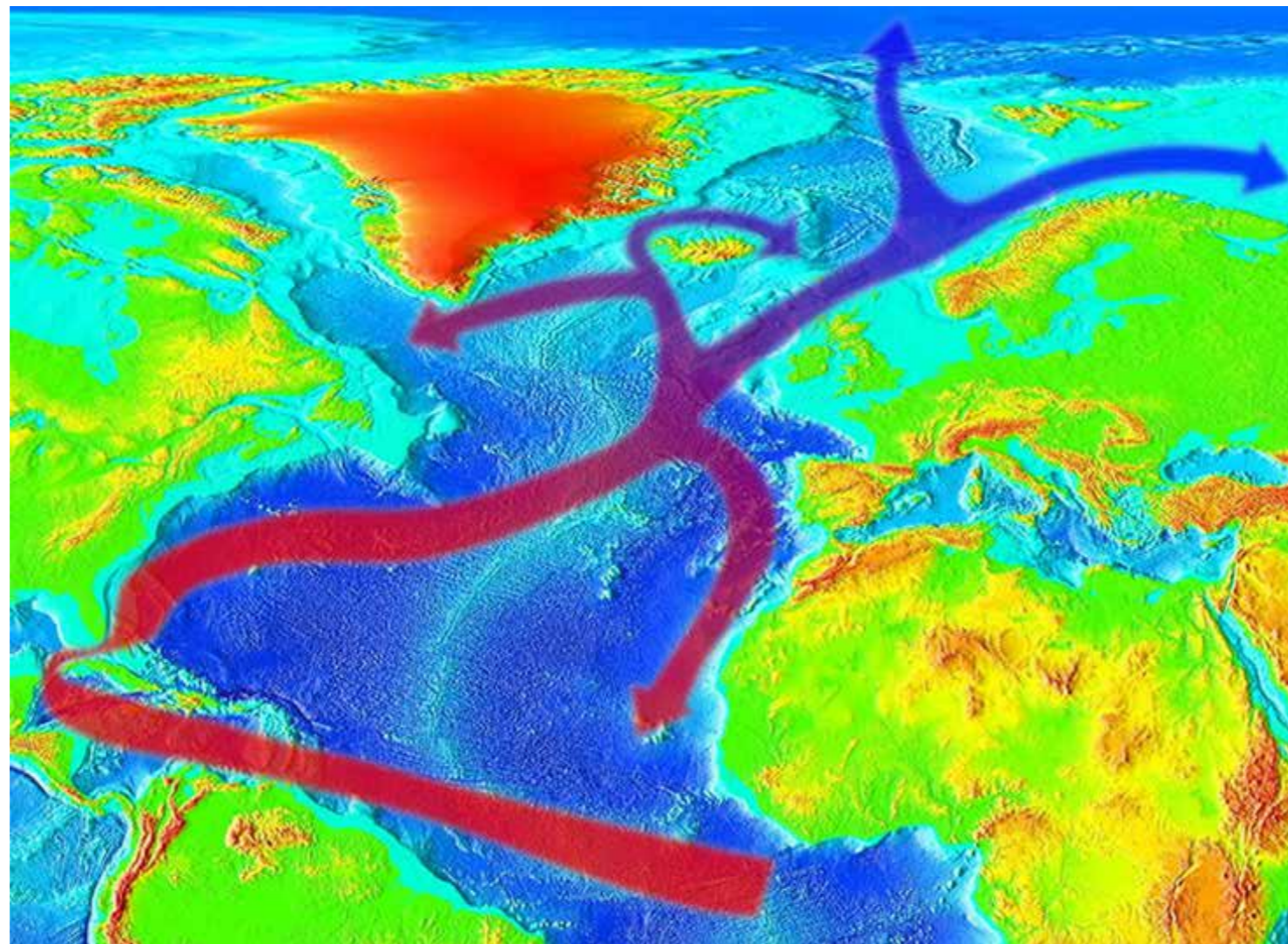


SAILDRONE GULF STREAM MISSION

The Gulf Stream, the fast-flowing, warm ocean current in the western North Atlantic Ocean, is hugely influential on weather and climate in Europe and around the globe and plays a key role in regulating the global carbon budget.

Scientists have known for decades that increased Gulf Stream observations might have an outsized impact on weather forecasting and improving understanding of ocean carbon exchange, but the Gulf Stream is chronically undersampled due to strong currents and violent storms that make for ship-based data collection challenging and dangerous for scientists and crew.

Saildrone is set to launch a first-of-its-kind mission sending a fleet of uncrewed surface vehicles (USVs) into the turbulent waters of the Gulf Stream for one year to study air-sea heat and carbon exchange, in partnership with some of the world's leading weather and climate



scientists. Funded in part by a more than €1m grant from Google.org, the mission is expected to provide extraordinary insights into the impact of the Gulf Stream on weather forecasting and global carbon models.

“Since our first science mission, in the Arctic in 2015, Saildrone has worked tirelessly to measure climate quality data from Earth’s most remote oceans and deliver that data to scientists all over the world,” said Saildrone founder and CEO Richard Jenkins.

“We are delighted to be collaborating with Google on this amazing project that will dramatically improve understanding of critical climate processes. We believe this data will enable more accurate predictions of our future, which will in turn help guide global climate policy and decision making.”

An illustration showing the path of the Gulf Stream and how it impacts weather on both sides of the Atlantic, with data from NOAA National Center for Environmental Information. Photo: RedAndr/Wikimedia.

Historically, fewer than a handful of ship-based studies in the Gulf Stream have provided only week-long snapshots of air-sea exchange due to the treacherous conditions, especially in winter. Free floating platforms that might gather data tend to get quickly ejected from the Gulf Stream. Attempts to use moored instruments to collect measurements have also been made, but strong currents and winds have led to only short duration successes.

The Saildrone fleet has logged more than 10,000 days at sea in some of the most extreme weather conditions on the planet. The impressive capabilities of Saildrone’s autonomous vehicles have been proven in numerous operational missions for science, ocean mapping, and maritime security, covering over 500,000 nautical miles from the Arctic to the Southern Ocean.

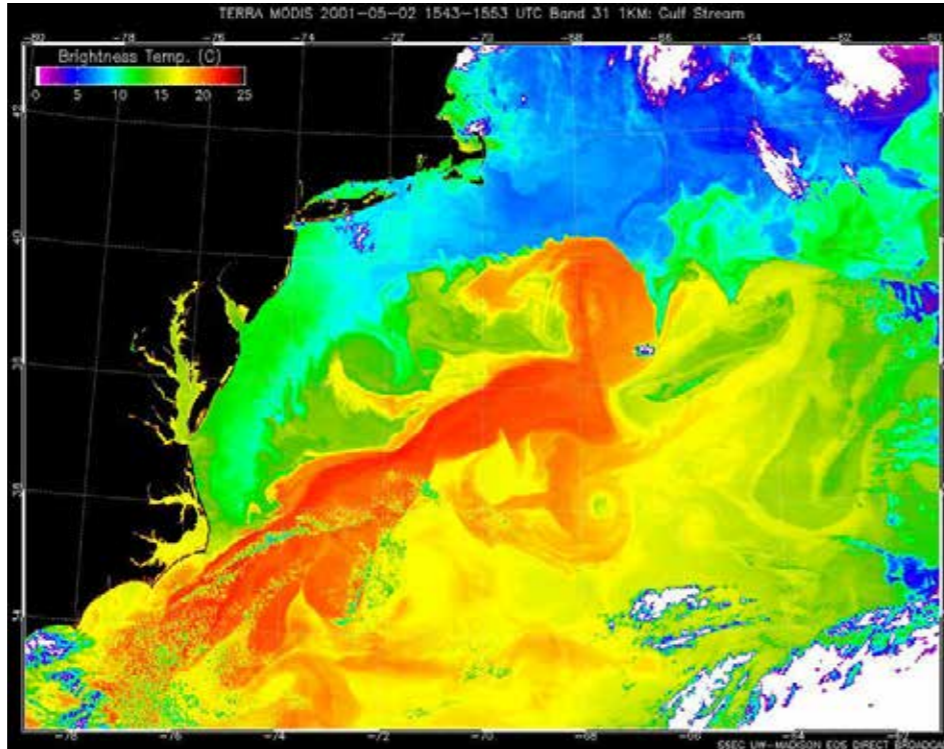
A fleet of Saildrone USVs can collect detailed scientific data along the length of Gulf Stream for an entire annual cycle, at a fraction of the cost of using traditional equipment, while replacing diesel with wind and solar power. Such observing power is transformative, both in capturing the surface fluxes along the current and in showing a path forward to using autonomous surface vehicles to monitor oceans globally.

The Gulf Stream mission will collect data at a resolution that has not previously been possible, supporting two concurrent science investigations

The European Centre for Medium-Range Weather Forecasts (ECMWF) will lead weather forecasting research. ECMWF is arguably the world's premier weather forecasting agency, and it is both a research institute and a 24/7 operational service, producing numerical weather predictions every six hours on a global scale.

"The location of the Gulf Stream and the sharp temperature differences on either side can have a big impact on weather forecasts and climate predictions," said Philip Browne, a research scientist at ECMWF. "We are excited to be able to target saildrones to collect data from this physically and scientifically challenging region and begin exploiting the information they will provide to help improve our earth system approach to forecasting."

Dr. Jaime Palter, associate professor of oceanography at the University of Rhode Island's Graduate School of



A heat map showing the Gulf Stream current in red, which carries warm water up the eastern coast of the United States and collides with cold North Atlantic waters. Photo: NASA Earth Observatory.

Oceanography, leverages the use of leading-edge technology in the field of climate research.

She has been studying the Gulf Stream for more than 20 years and will lead the carbon measurement component, using Saildrone data collected with the world's most accurate and proven pCO2 sensor, developed by the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory (NOAA PMEL) and integrated onto the Saildrone vehicle under a joint cooperative R&D agreement. NOAA PMEL will support quality control and post-processing of the carbon sensor data.

"70% of the world is covered by oceans, and they control crucial

aspects of both weather and climate. The storms that feed off of Gulf Stream heat also pump CO₂ into the ocean at some of the highest rates globally," said Palter.

"As the Gulf Stream responds simultaneously to warming, shifting winds, and the impact of melting sea ice and ice sheets, there is an urgent need to quantify its role in carbon uptake, to predict its stability or vulnerability in the future."

For carbon dioxide fluxes, this data will be the first in history to quantify variability of fluxes over an annual cycle in the Gulf Stream. Their existence alone will be a primary indicator of success, which enables scientific progress in understanding the carbon cycle budget for forecasting global climate change.



THE ULTRA HIGH RESOLUTION SONAR COMPANY

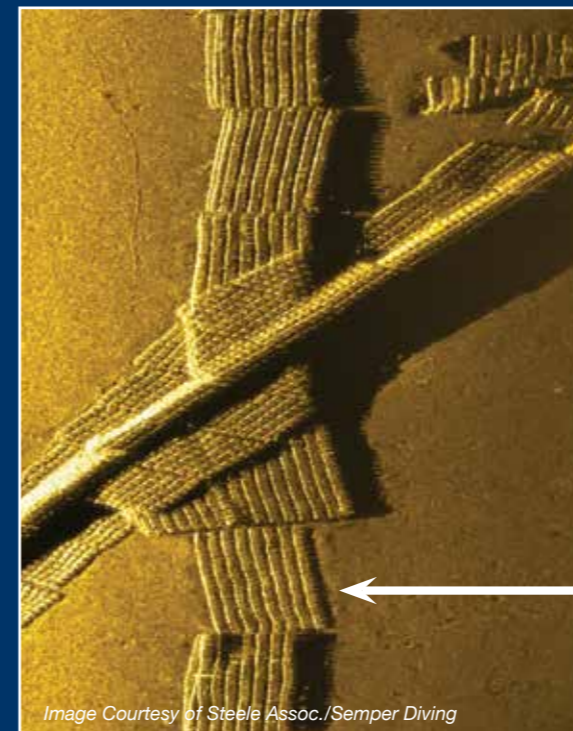


Image Courtesy of Steele Assoc./Semper Diving



Concrete Mat Installation

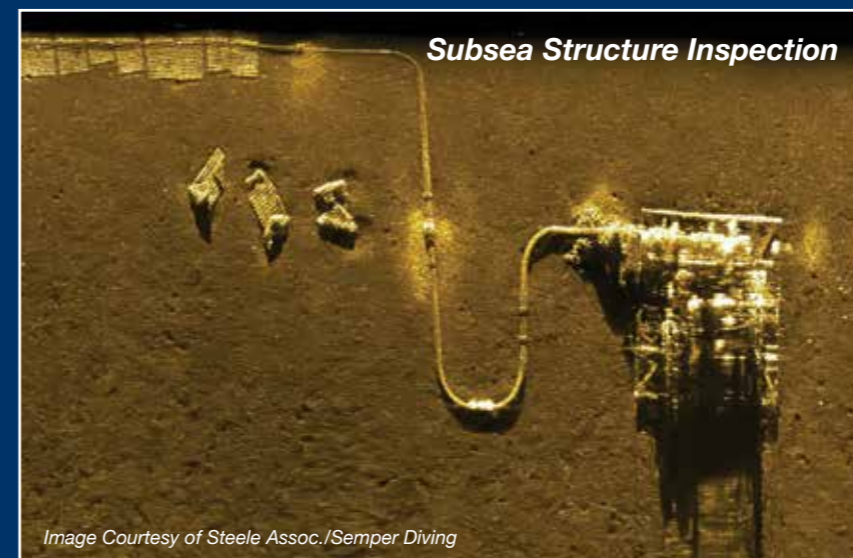


Image Courtesy of Steele Assoc./Semper Diving

- Tri-frequency options give long-range capability and high resolution classification
- Systems for AUVs, ROVs, USVs as well as Towed
- EdgeTech is the first manufacturer of commercial Side Scan Sonar Systems and the technology leader since 1967
- 24-Hour support from the world's most experienced Customer Service Team

UNCREWED SURFACE VEHICLES



72FT SAILDRONE

Earlier this year, Saildrone launched the 72ft Saildrone Surveyor uncrewed surface vehicle. It was developed in part through a public-private partnership with the University of New Hampshire (UNH) and the Monterey Bay Aquarium Research Institute (MBARI) to integrate and test sensors for mapping the seafloor and revealing life in the water column.

While conducting ocean mapping missions, the Surveyor will collect samples of environmental DNA (eDNA) from the water column—DNA originating from the sloughed-off skin, mucus, and excrement of a wide variety of marine animals—which will reveal the genetic composition of organisms inhabiting the water.

This PPP was supported by a three-year grant from the National Oceanic and Atmospheric Administration (NOAA) Office of

Ocean Exploration and Research (OER) through the National Oceanographic Partnership Program (NOPP).

Enhanced seabed mapping is vital for the security, safety, and economic health of every country bordering the ocean and critical to the growth of the 'Blue Economy', which, according to the Organisation for Economic Cooperation and Development (OECD), is valued at \$1.5 trillion a year and creates the equivalent of 31 million full-time jobs.

The launch coincides with the start of the United Nations Decade of Ocean Science for Sustainable Development and presents a paradigm shift in enhanced seabed mapping.

Ocean mapping is currently done with very large and expensive crewed ships. The Saildrone Surveyor

is a scaled-up version of the Saildrone Explorer, the 23ft wind and solar-powered saildrone, which has been proven in numerous operational missions for science, ocean mapping, and maritime security, covering more than 500 000 nautical miles from the Arctic to the Antarctic.

The Surveyor carries a sophisticated array of acoustic instruments for both shallow and deep-water ocean mapping; the Kongsberg EM 304 multibeam echo sounder is capable of mapping the seafloor down to 7000m below the surface.

The Surveyor also carries two state-of-the-art Acoustic Doppler Profilers (ADCPs), the Teledyne Pinnacle 45 kHz ADCP and the Simrad EC150-3C ADCP, to measure ocean currents and understand what is in the water column. The Surveyor is also equipped with the Simrad EK80 echo sounder for fish stock assessments.

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SONAR

REAL APERTURE SONAR

vs Synthetic Aperture Sonar

by Garry Kozak GK Consulting

*The Yankee 406ft steam powered cruiser
shipwreck in Buzzards Bay, MA*

SONAR

Since its first development in the 1950s, all Side Scan Sonars have been Real Aperture Sonar (RAS) Systems. These RAS systems still makeup the majority of commercial systems manufactured and in use today.

The newer Synthetic Aperture Sonars (SAS) are often presented as being a technique that offers improved resolution over conventional RAS. Their technical advantage is often quoted as having an improved along-track resolution compared to RAS systems. In this way, SAS is promoted as being 'Revolutionary'.

But is it really?

SAS IMAGE RESOLUTION

The resolution of a sonar image is comprised of three components:

1. Across-track resolution
2. Along-track resolution
3. Acoustic Shadow clarity

Across-track resolution is dependent on the pulse length or bandwidth of the transmitted acoustic pulse. Both SAS and RAS sonars transmit very similar acoustic pulses, resulting in both system types having 1-3 cm of Across-track resolution.

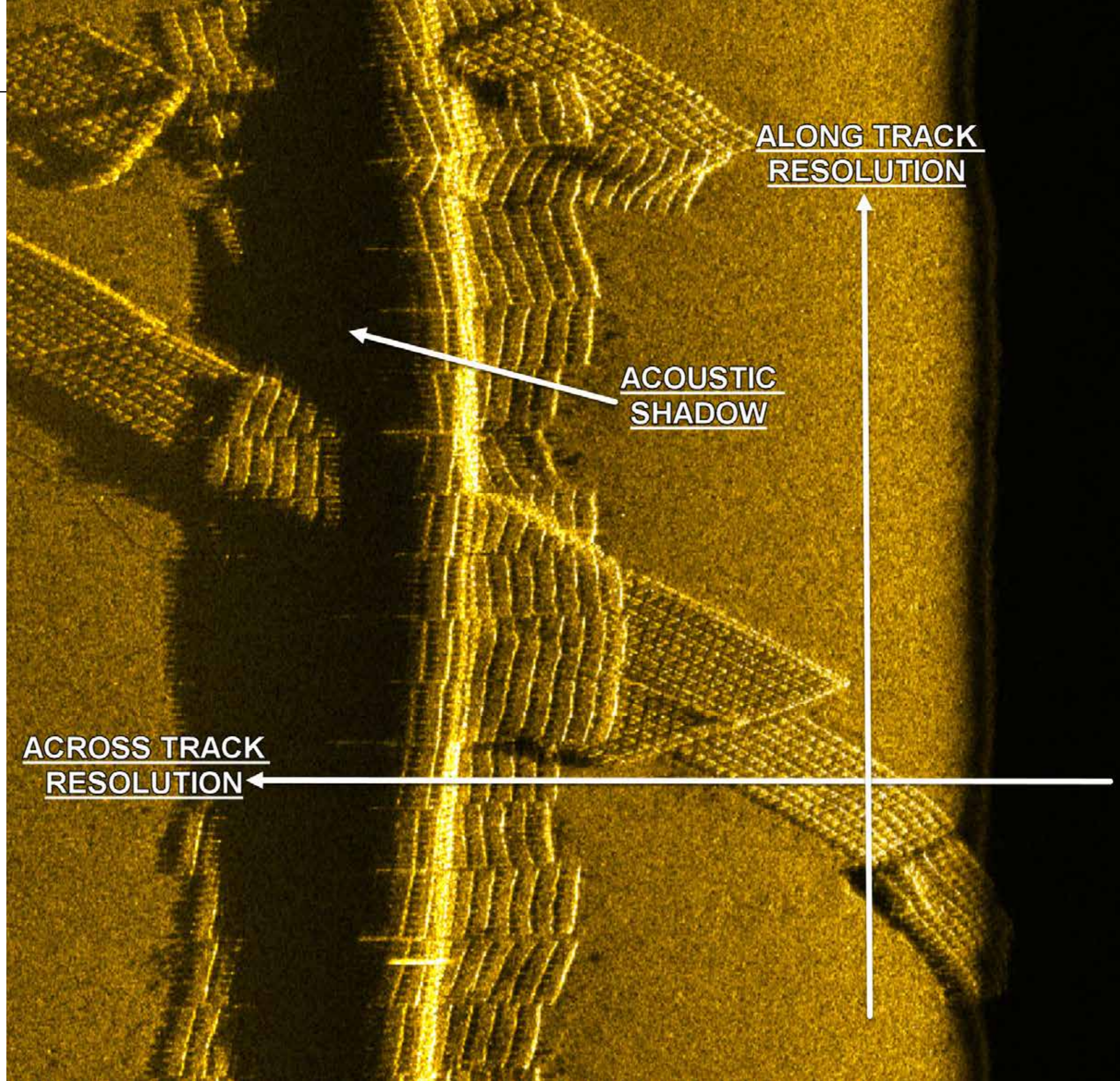
Along-track resolution is a function of array length whether real or synthetic. The along-track resolution of RAS systems is on the order of 10-20 cm whereas the SAS systems claim a theoretical 2-3 cm.

Acoustic shadows are generally sharper with RAS sonar images compared to SAS sonar images. This is due to SAS bleed around of the acoustic transmit energy from the wide horizontal transmit beam width that is required for SAS systems to work.

Thus, a sonar image is more than just 'Along-Track Resolution'. All three resolution components must be considered when determining how good a feature on the seafloor will look when imaged by the sonar.

SAS, THEORY VS EXPERIMENT

In theory, synthetic aperture processing should increase along-track resolution. In practice, they do produce high resolution images, but it is impossible



SONAR

to measure the real resolution with any sort of accuracy.

What is lacking is a 'ground truth' test, where a resolution target is placed on the seafloor and then a SAS system is used to collect data at the maximum operational range.

The target needs small spherical reflectors spaced in a pattern at various relative angles where the spacing pattern is varied from 2cm to 20 cm. The processed data needs to show that the theoretical resolution can be verified by the experimental data and that reflectors spaced 2 or 4cm apart can be resolved.

In the past, Sonar resolution targets have been used for 'proof' of capability.

To date, most, if not all SAS systems have not performed a resolution verified experiment to demonstrate real world resolution improvements.

In fact, a resolution experiment should also include the collection of a RAS sonar data set of the same test target for comparative purpose and conclusions. It would be beneficial if SAS provided the along-track resolution improvement that is supported by the theoretical calculations.

RAS TO SAS COMPARATIVE IMAGES
Since SAS manufacturers do not provide experimental test data sets to illustrate the claimed resolution improvements, the best that can be done is to compare similar sonar imagery of RAS vs SAS.

One such RAS sonar image was taken of the of the "Yankee" shipwreck in Buzzards Bay MA. The Yankee, a 406ft steam powered cruiser, was used as a US Navy training ship. In 1908, while on a training manoeuvre the *Yankee* ran aground 5 miles south of Bedford MA. It has since become a dive site as well as a target used for sonar testing.

It is possible to compare the news archive images taken by SAS image as a comparison with the RAS sonar image. The resolution differences between SAS and RAS are subjective but there is no clear Along-Track resolution difference.

Navies around the world have important requirements for sonar systems to locate mines and mine-like objects. The dimensions of the objects are typically in the 1-3m in size range. High resolution is desired to aid in filtering out objects of interest from surrounding bottom clutter as well as aiding in their classification.

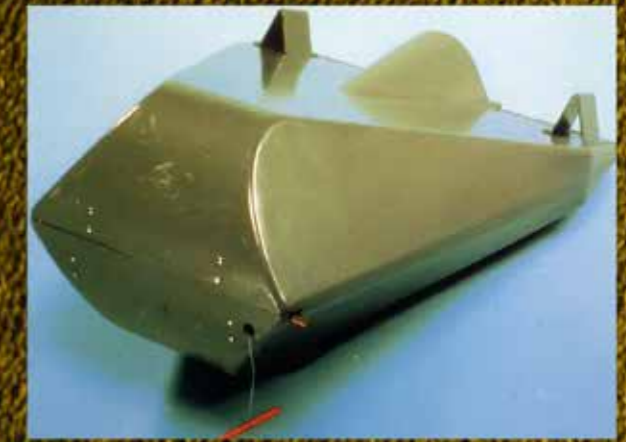
RAS side scan sonar systems have been used for decades for this going all the way back to the 1950s when the first Navy system, the C-Mk1 Shadowgraph was developed. SAS claims an advantage over RAS systems for mine-like objects, but this is not always supported out by reality.

RAS of Mine Shapes

Manta



Rockan

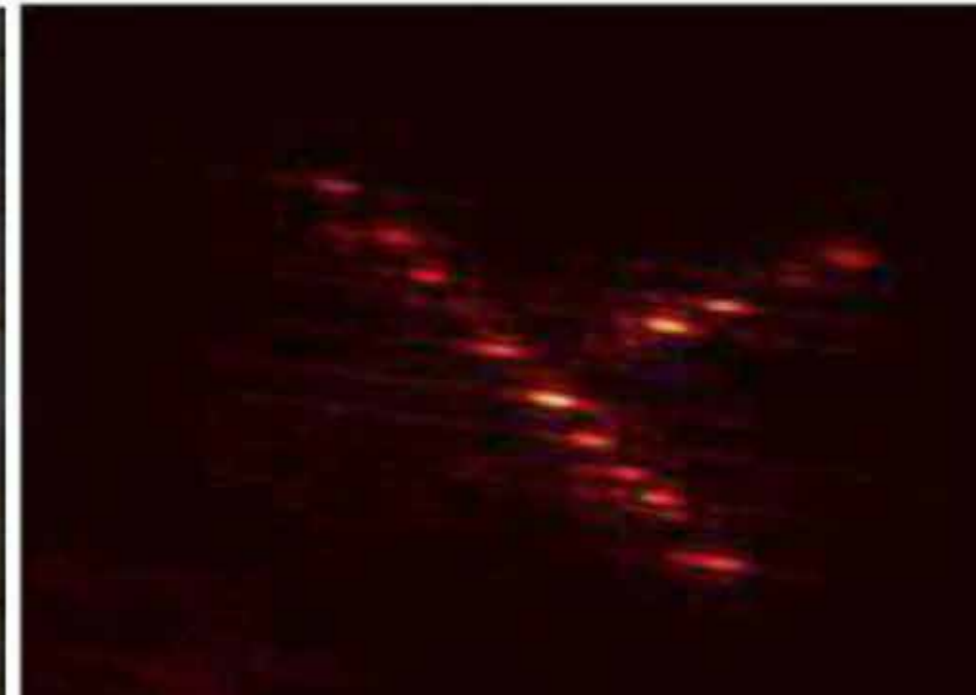
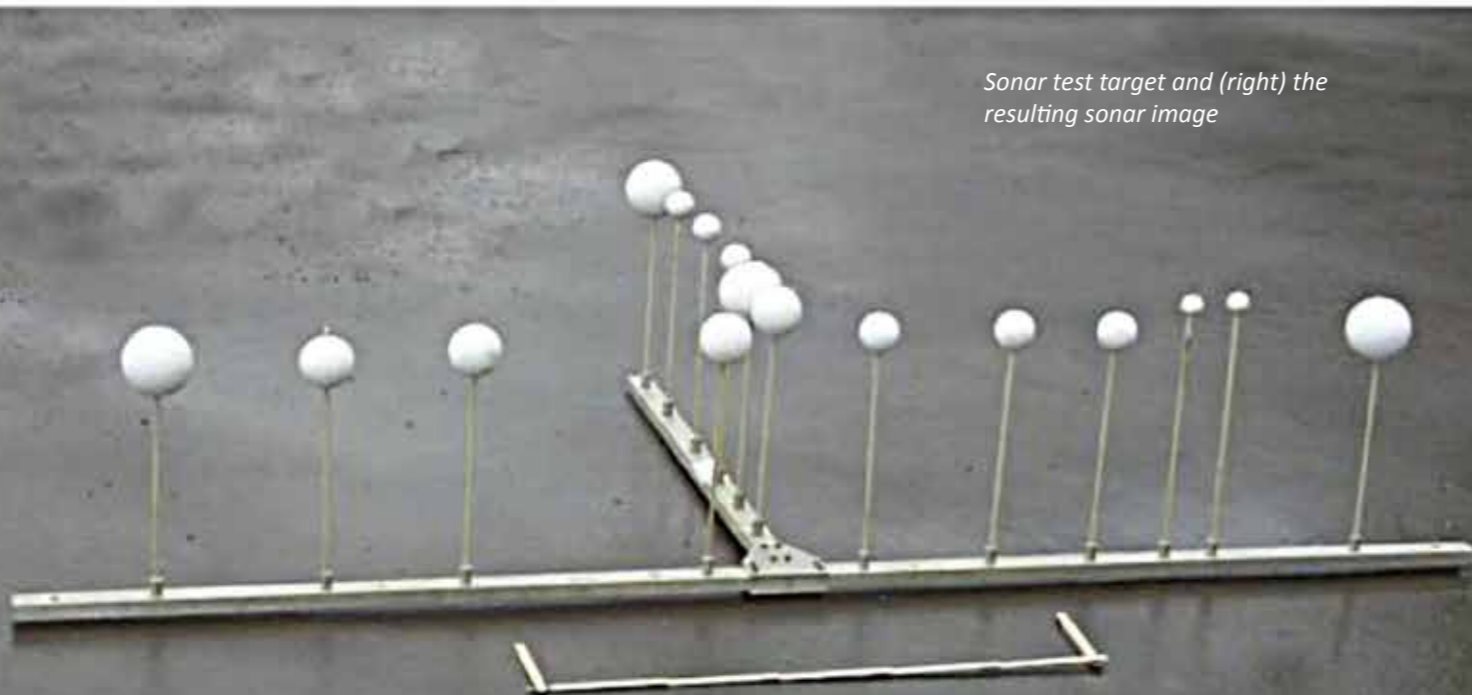


A similar common SAS image of chains illustrates again that when a comparison is made, any perceived resolution improvements of SAS is subjective with both displaying very high resolution.

The major advances in side scan sonar began in the 1980s and

again in the 1990s when digital designs replaced the earlier analogue systems. Improvements in computers and software development lead to the next big jump with integrated positioning from GPS and the ability to process the raw sonar data for maximum sonar image fidelity and resolution.

Sonar test target and (right) the resulting sonar image



The latest development of tri-frequency RAS systems offer surveyors a very flexible system that can handle diverse survey requirements from large area seafloor mapping or search needs to ultra-high resolution target and feature classification. These new systems are the standard for both towed as well as autonomous surface and underwater systems.

SAS is an interesting technique but many ask if the high cost and complexity of SAS provide a proportional improvement in the sonar product output. A recent

conversation with a USA government official and very experienced RAS side scan sonar user provides perspective. Participating in a SAS technology demonstration, he came away with some interesting observations and comments.

"The technology undoubtedly made nice high resolution images, but they did not appear much different than traditional RAS images," he said.

"The product output is in the form

of geo-referenced Tile images which are not a form that is ideal for the mosaic production. The image Tiles vary in intensity and gamma as well as positional misalignment when a mosaic is created.

"The volumes of data created in acquisition were significantly large, particularly compared to RAS systems.

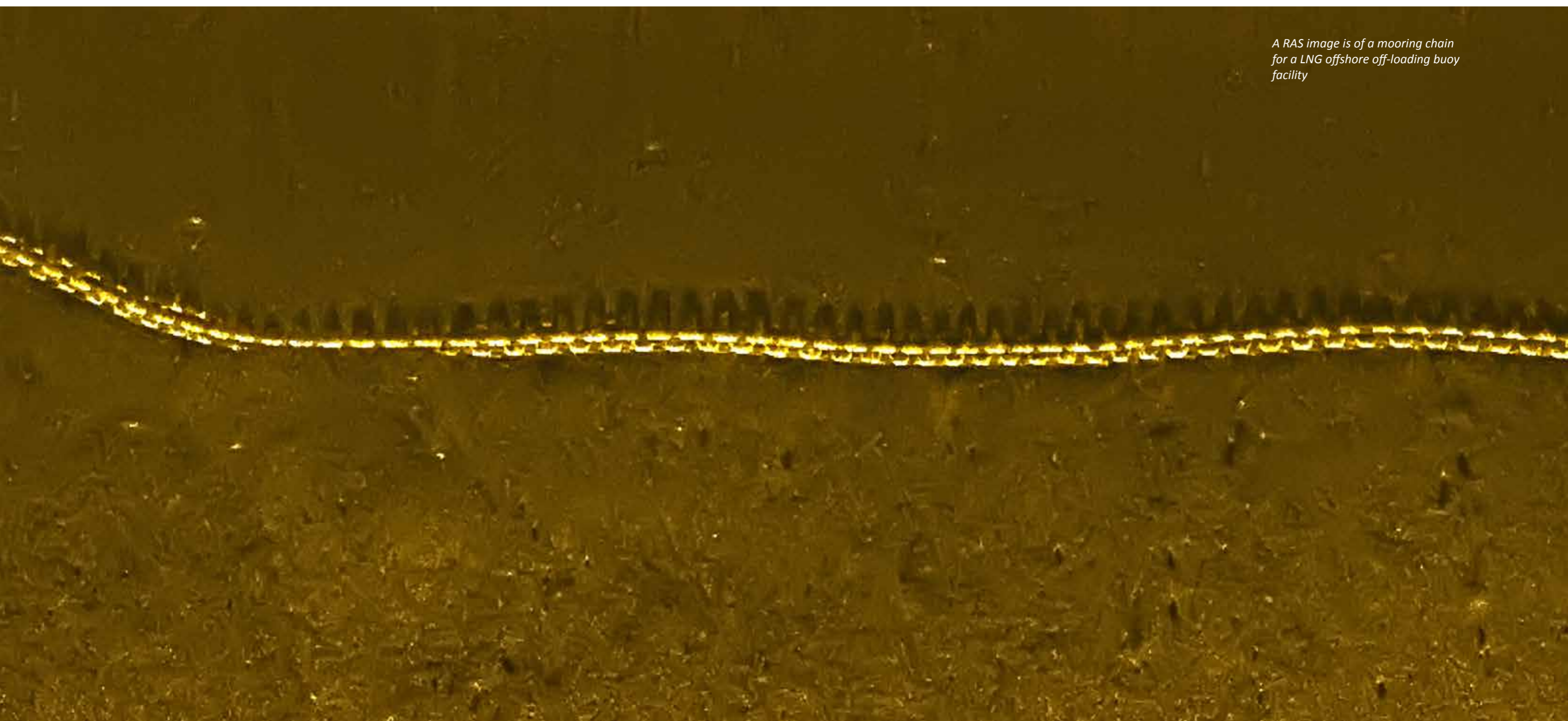
"The processing overhead was high because of the large data volume size and though it is claimed that the data

is 'near real time', it is in fact not real time because of the SAS processing time.

"With SAS systems costing 5 to 10+ times the cost of field proven RAS systems. *I don't really need a new*

tool in search of a job".

RAS systems will remain the main stream workhorse for the foreseeable future with SAS being for those willing to invest in an exotic expensive solution.



A RAS image is of a mooring chain for a LNG offshore off-loading buoy facility

SUBSEA CLAMP AND HOT TAPPING

STATS Group was recently contracted by a global engineering and construction company operating in the Bass Strait, Australia, to provide a subsea mechanical clamp and hot tapping services. The 18in clamp incorporated a 12in offtake to provide a tie-in point which would allow a new gas field to be brought online and fed into the existing 18in gas pipeline.

The 18in clamp was designed to class 900 with a 1500 class 12in branch. Following manufacture, STATS conducted a full client witnessed Factory Acceptance Test (FAT) programme on both the mechanical clamp and hot tap machine at their headquarters in Kintore, Aberdeenshire.

"The FAT was conducted using STATS live remote monitoring system, which offers a unique opportunity for clients to witness an FAT without the need to attend their facilities in person," said Gareth Campbell, Regional Manager for Asia Pacific at STATS Group. "The remote monitoring system is a collection of live feeds from cameras and other devices, all brought together in a centralised and secure web console.

"The FAT was carried out and captured using high-definition video, real-time voice communication and file sharing to allow two-way communications and interaction between client personnel and STATS on-site team throughout testing.

"This arrangement was particularly beneficial to the client who was based in Australia, due to the ongoing COVID 19 pandemic travel restrictions.





"Post pandemic, the remote monitoring system will provide significant savings for clients in travel and accommodation costs and time out of the office.

"In addition, this approach allows clients to reduce their carbon footprint, aligning with sustainability policies and therefore helping to protect the environment."

Upon successful completion of all FAT operations and procedures, the equipment was mobilised to Victoria in Australia, where diver familiarisation training was carried out prior to mobilisation.

With the vessel and equipment at location in the Bass Strait, divers began preparation works at the tie-in point to dredge the pipeline and remove marine growth. A hot tap skid was then overboarded and positioned in the trench next to the pipeline.

The hot tap assembly including STATS SureTap hot tap machine, 12in valve and mechanical clamp, which was pre-assembled and rigged onto the frame, was overboarded and lowered onto guideposts on the hot tap skid.

Once positioned next to the pipeline, the hot tap machine was angled by 2deg and rigged onto the pipeline. The clamp was then hydraulically activated, closing the two halves of the clamp around the pipeline and bolted together.

STATS mechanical clamp design incorporates dual seals and locks, the locks are mounted outside the pressure boundary which positions them away from the pipeline contents

and provides optimal loading to the pipeline.

Clamp seal compression flanges were then actuated to set the seals which are energised against the pipewall without setting the clamp locks. This allows a pressure test of the seal annulus cavity to be carried out, confirming that the seals are leak-tight and the pressure boundary sound.

Once the seal test is confirmed the locks are then set, each lock segment is independently activated to ensure each lock fully engages onto the pipewall. A feature that is particularly beneficial on pipelines that are oval, ensuring full lock engagement. A final seal test ensured the clamp integrity prior to hot tapping into the pipeline.

A leak-test of the clamp against the closed valve was successfully conducted, this allowed the pressure to be equalised from the hot tap machine and the valve was opened.

The hot tap cutter was manually fed by diver up to the pipewall before the divers returned to the dive bell. The hot tapping operation was then conducted while the 18in pipeline remained at 72.5 barg, the cut pipe coupon was retracted with the hot tap cutter and the 12in valve was closed.

With hot tapping completed the hot machine was unbolted from the valve and removed from the water with the deployment frame.

A short pipe spool was lowered and positioned onto the subsea skid before being rigged and bolted onto the 12in valve providing the new tie-in point for the 6km flowline.

POSEIDON

DEEPWATER PIPELINE INSPECTION

Deepwater oil and gas pipelines have been traditionally inspected using intelligent pigging. In this, an intrusive inspection device equipped with various sensors able to record the pipe wall geometry and/or remaining wall thickness as it travels. This pig is inserted into one end of the pipeline and, driven through the pipe by a fluid pumped under pressure, it is recovered at the pipeline's opposite end.

Intelligent pigging is certainly the most complete pipeline inspection option as it allows for scanning the entire length of a pipeline with high accuracy. Indeed, pig sensors are nearly in contact with the pipe inner surface, promoting excellent conditions for pipe wall thickness measurement and anomaly detection. There are, however, several drawbacks and limitations:

Production (and so Revenue) Deferrals:

Pigging requires shutting down the pipeline for several days, impacting the platform's production and associated revenues.

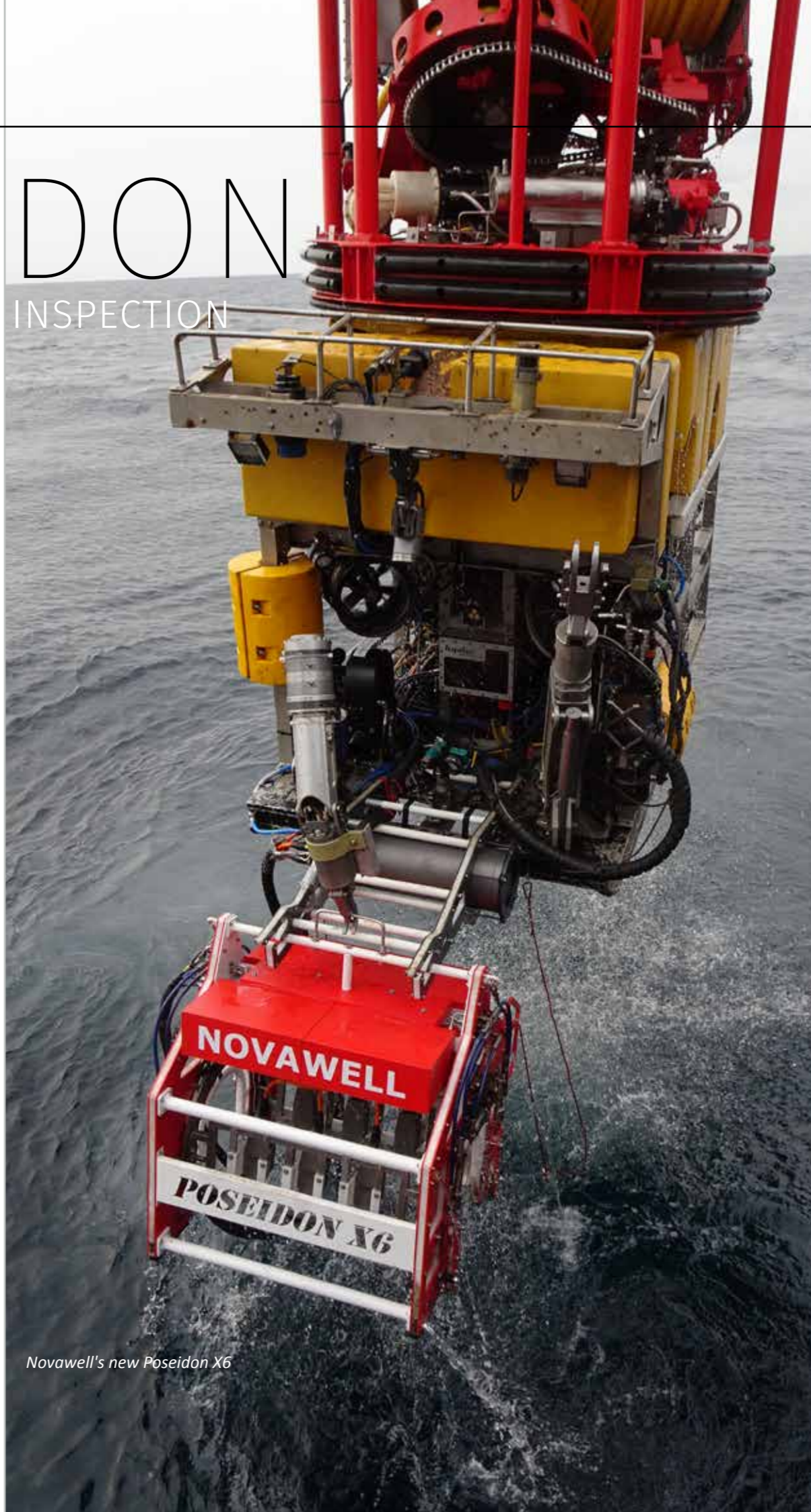
Pipeline Piggability:

Pipelines and subsea facilities need to be designed for pigging at project stage, avoiding varying diameters of pipelines, incompatible bends, branches, connectors, valves, dead legs, the absence of topside or subsea pig launcher/receivers that may make many pipelines or sections of pipeline unpiggable.

Risks of Pig Blockage:

Pigging remains a risky operation from a production perspective. Pig blockages are not rare and may have severe production and financial consequences.

Risks are generally higher on mature fields, as older pipelines may have suffered from undetected damage over time, which may promote pig blockages. The paradox is, that it is the older pipelines that are those needing the most of intelligent pigging due to their higher probability of integrity issues. Because of the higher risk, some companies do not bother.



Novawell's new Poseidon X6

Intelligent Pigging Costs:

Intelligent pigs are advanced and expensive pieces of equipment. Their deployment requires significant preparation, personnel and equipment, all of which make the costs of intelligent pigging campaigns very significant.

These costs, risks and technical challenges can limit the use of intelligent pigging for pipeline inspection, particularly in the environment of cost reduction which has prevailed in the oil and gas industry since the oil price drop late in 2014.

Consequently, oil companies have been on the lookout for complementary or alternative solutions which still allow them to deliver on their pipeline integrity management programmes. Novawell's new Poseidon X6 has been designed to fill the technological gap left by intelligent pigging in a fast and competitive manner.

POSEIDON X6

The Poseidon is a non-intrusive pipeline inspection tool deployed by ROV and rated for 2500m water depth. Equipped with multiple probes, the Poseidon can assess the remaining wall thickness of 1m length of 6in to 16in pipeline at 360deg through very thick coating (up to 100mm, possibly more in some conditions).

The tool can be easily moved by ROV from one position to another and so cover several meters of pipelines per hour.

The Poseidon is the result of significant R&D investments from NOVAWELL over the last 5 years to improve the reliability and accuracy of advanced electromagnetic techniques applied to deepwater pipeline inspection.

This involved the parallel development of advanced subsea power and signal processing technologies which enable the tool to deliver 2D and 3D corrosion maps of the inspected sections of pipeline nearly in real-time.

"The Poseidon not only satisfies the limitations of intelligent pigging, but also from other non-intrusive technologies," said Novawell director, Vincent Gervy.

"Ultrasonic testing (UT), for example, can be highly accurate but is typically limited to non- or lightly-insulated pipelines. UT and most non-intrusive techniques remain conditional on the preliminary removal of pipeline coating.

"Pipeline coating removal in deepwater environment is a complex matter which generally makes a non-intrusive inspection campaign turn into a costly project.

"The capacity of the Poseidon to inspect insulated pipelines quickly and without any impact on production makes it an ideal corrosion-erosion screening tool. Pipeline screening campaigns consist in deploying the Poseidon at various locations along a single pipeline or along several ones, potentially covering the pipeline network of an entire field.

"The 'jigsaw' of corrosion maps collected at various locations provides an overall corrosion status, evidencing pipelines and local areas which are the most affected by wall thickness losses and worrying corrosion patterns.

"Beyond delivering an overall corrosion status in a fast and competitive manner, the Poseidon also allows for applying intelligent pigging and costly non-intrusive techniques only to critically corroded pipelines and areas pre-identified and pre-scanned with the Poseidon.

"Costly techniques can then be more efficiently used over a limited period of time, thereby reducing significantly the overall costs of oil companies' pipeline integrity management programmes."

S W O R D F I S H

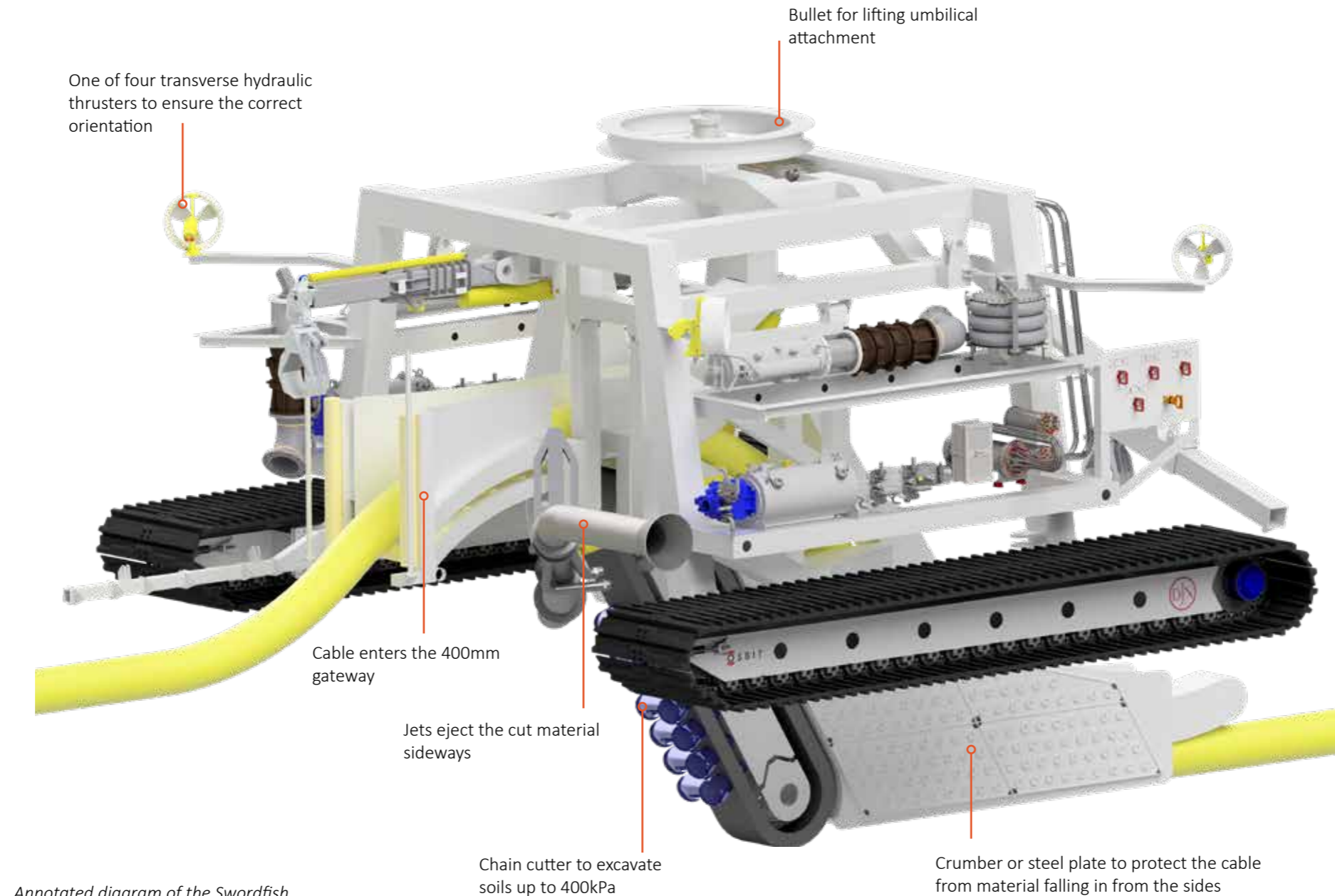
JAN DE NUL GROUP HAS SIGNED AN AGREEMENT WITH OSBIT FOR THE DESIGN AND CONSTRUCTION OF A NEW SUBSEA TRENCHING VEHICLE. DELIVERY IS SCHEDULED FOR THE FIRST QUARTER OF 2022

When Luxembourg marine contractor Jan De Nul Group looked to invest in a versatile cable trencher to carry out future operations, they recognised that in order to achieve efficient burial across expected project sites, they required two different trenching tools.

One requirement was for a lightweight Jetting system able to operate on low-strength soils. The second was for a robust chain cutting machine that could effectively operate in harder grounds, trenching up to 400 kpa soils.

Jan De Nul had already designed and built two intertidal trenching vehicles, the Sunfish and the Moonfish for the Racebank Offshore Windfarm Export Cable campaign in the UK. Both trenching vehicles received several industry awards for their innovative design and these have subsequently been modified and used in support of several cable installation and protection projects in Europe.

Correspondingly, when Jan de Nul invited companies to tender for a new trencher design, they had a strong view of what they wanted and what they didn't. This was highly compatible with Osbit's collaborative working methodology and ultimately led to the Northumberland-based equipment supplier being awarded the contract for Swordfish.



Annotated diagram of the Swordfish

The design that Osbit developed in response to the Jan De Nul brief was a single reconfigurable machine that not only satisfied these very different requirements, but did so with efficient use of materials, power and deck space.

"The design we developed could be safely and quickly reconfigured from one functional layout to another on a very compact deck footprint," said Robbie Blakeman, Joint Managing Director at Osbit. "The common main vehicle consists of a caterpillar tracked frame about 8m wide with interchangeable modules providing optimised Jetting or Chain Cutting functionality, the latter able to load and safely manage subsea cables"

HEAVY DUTY CHAIN CUTTER

The main functional component of a chain cutter is the cutter boom that excavates the trench, its array of tool picks cutting the stiff seabed materials and transporting them away as the vehicle moves forward.

The chain cutter design uses multiple mechanisms to efficiently excavate materials including a high powered eductor, ensuring that as the excavated material reaches the surface, it is ejected sideways.

The cutter can excavate a 2m deep trench and safely manage the pre-laid cable over the cutter and down

to depth using a plated in crumber and depressor.

"In theoretical homogeneous stiff clay a vertical sided trench would be stable and the product could fall into such a slot behind the cutter without the need for a plated in product path. Most seabeds, however, are actually heterogeneous or made up of differing strengths of cohesive materials.

They may be faulted and often incorporate inclusions, sand pockets and significant areas of sand overlay. In these conditions the trench is at significant risk of collapse or partial infill preventing the cable from reaching target burial depth," said Blakeman.

"Existing machines often use an aft tool to fluidise this infill, or suck it out using an eductor. The risk with this approach is an assumption that any passive infill material is fluidisable or eductable.

"The solution we used to be certain of attaining target cable lowering, was a fully boxed-in side plate arrangement extending the cutter crumber. This consists of steel plates that essentially protect the cable from the sides of the trench caving in until the product is at the bottom of the trench. It means that it is possible to always ensure burial to the correct depth even through pockets of soft clays or sands.

JETTING

The same large mass that represents a clear advantage when the vehicle is employed cutting, becomes a disadvantage when moving in less

dense materials like loose sands and soft muds.

"Designing one vehicle to carry out two quite diverse tasks is enjoyably challenging from an engineering perspective," said Blakeman. "For chain cutting, it is important to have as much mass as possible to maximise cutter forces engaged with the hard seabed.

"For a vehicle employed in jetting more friable soils, however, it is advantageous to impose only the lightest pressure through the tracks onto the seabed.

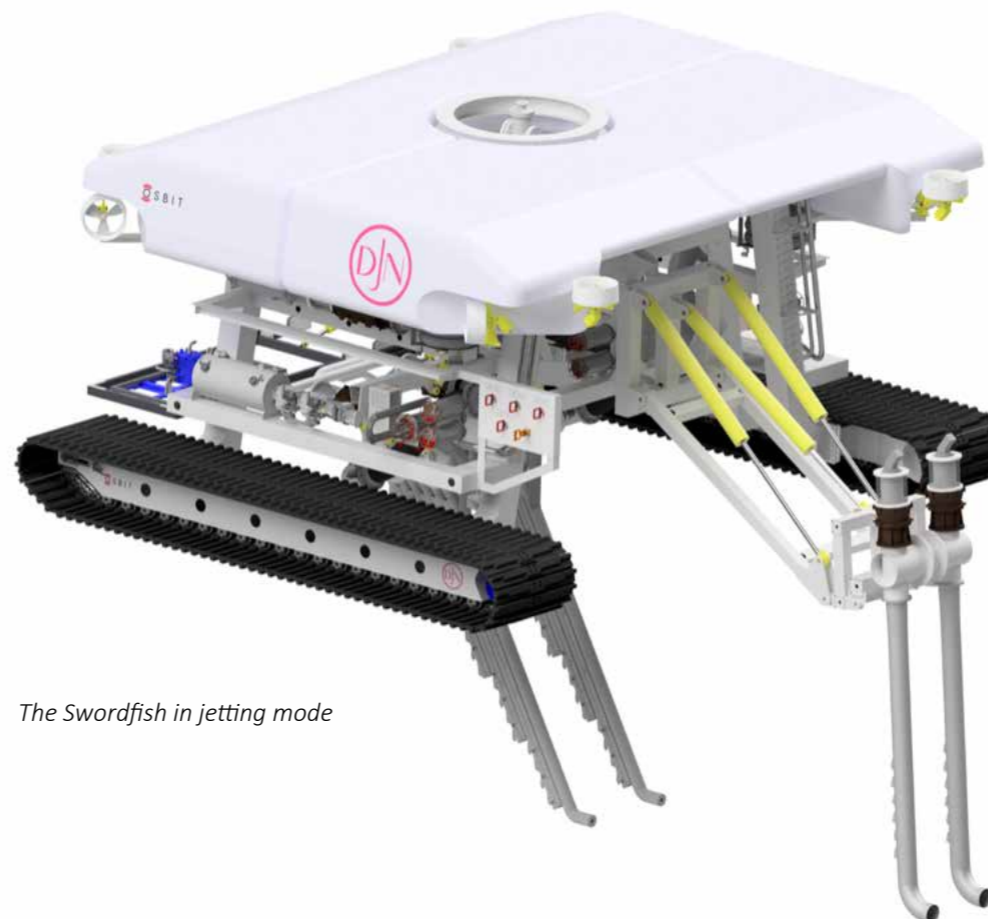
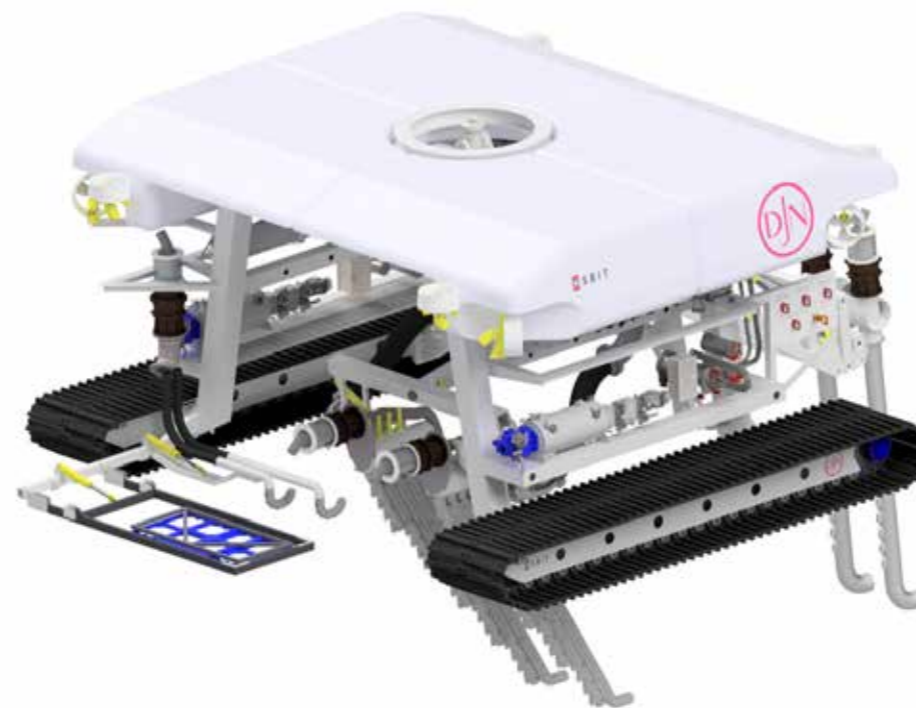
Swapping out the heavy chain cutter cassette for the mass optimised jetting cassette allows a step change in vehicle structural weight.

"To make the Swordfish much lighter in water, we have incorporated a large syntactic buoyant foam assembly which effectively reduced the weight pushing down on the seabed 20t to less than 1t. This results in a ground pressure not exceeding 5 kPa which allows trenching vehicle operation in very soft soil conditions."

"Jan De Nul were very clear in what they wanted the vehicle to achieve and specified a pre jetting system," said Blakeman.

"When jetting, the cable will sink through the fluidised soil in a catenary shape, so matching jetting to this shape provides efficient burial. To assist this, the client engineers reasoned that pre-fluidising the seabed before the swords engaged would result in a more successful trenching operation. We therefore designed two articulated arms incorporating these forward jets.

"In front of these, we can swing a cable tracker downwards.



The Swordfish in jetting mode

The main jetting is carried out by a pair of swords, one either side of the cable.

"The swords are quite conventional in design," said Blakeman, "but Jan De Nul raised the issue that should the light vehicle suddenly encounter a boulder or something similar on the seabed, the vehicle could be forced to adopt a roll angle.

This roll would not be so large to cause stability problems *per se*, but it could affect the angle of the swords. This, in turn, could potentially impart lateral loading onto the cable."

Osbit responded by designing a novel self-levelling arrangement where the main jet swords have the articulations of the current state of the art systems, including separation adjustment, accommodate different sizes of product, pitch rotation and vertical travel.

There is also a linkage that gives them an additional freedom. They can orientate independently of the trencher, maintaining a vertical cut despite roll movement from the vehicle.

The main jetting tool incorporates a backwash system supplied with separate water feeds to ensure optimised pressure and flow. The main swords also feature a graduated shut off system to focus water power into lower sword sections when operating at shallower depths.

Finally the jetting system also includes an additional rear backwash tool to maintain fluidisation for stiffer products.

POWER

For one vehicle to carry out two very different functions, it is necessary to have a very versatile power and control system able to satisfy the most demanding of applications yet be shared across various consumers.

The Swordfish has 1200kW of power available to it. This is divided into a pair of 300kW flexible hydraulic power units and a pair of 300kW electric high pressure jet pumps.

"When we change modes, we have a custom quick connect manifold arrangement that redistributes the hydraulic power according to which module is fitted. The control system manages the available power and smart distribution.

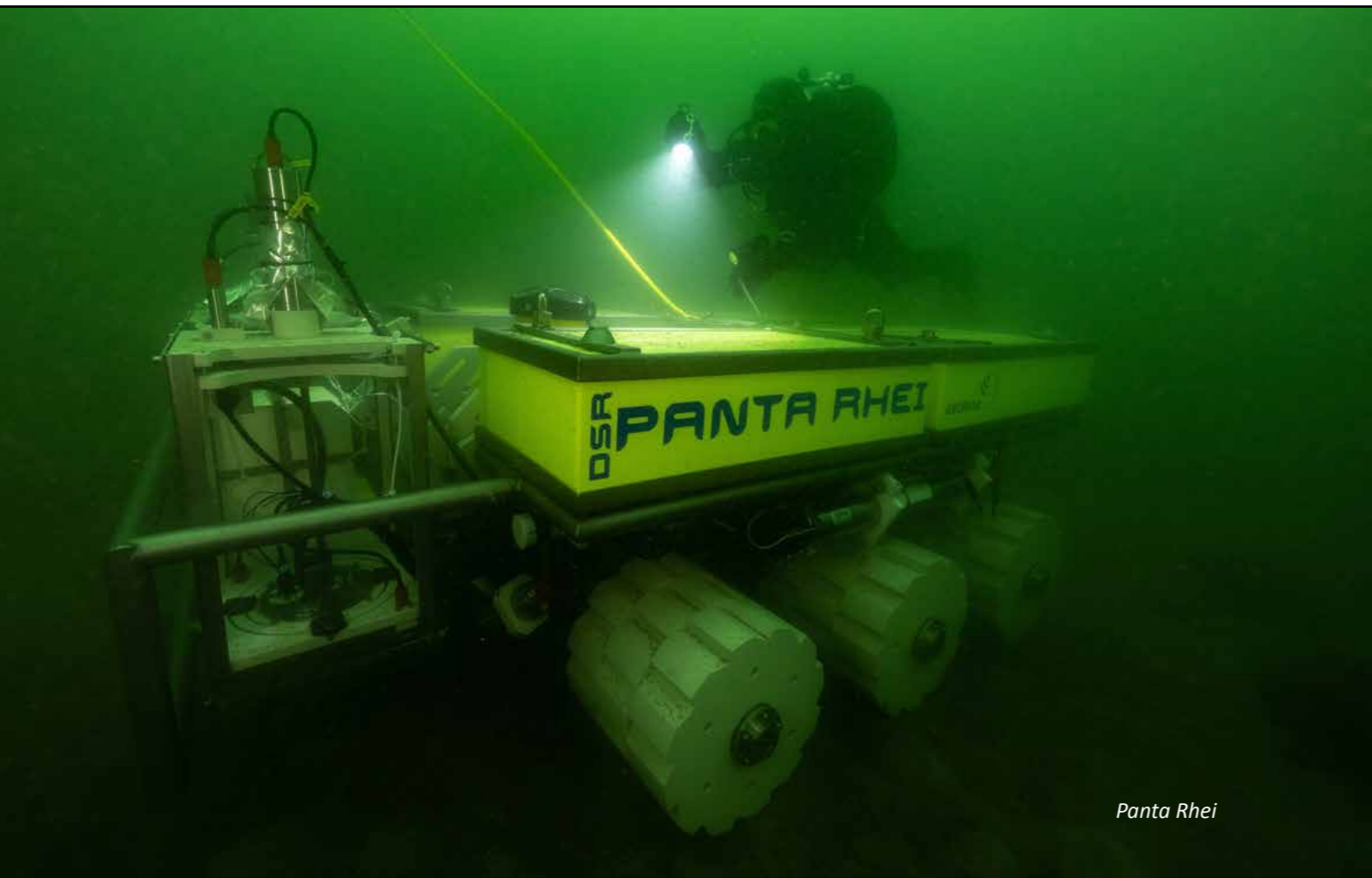
"In jetting configuration, we can tackle soil strengths up to 125kPa, thanks to its 1120kW of pump power. In mechanical or hybrid mode, it will be able to cope with soil strengths up to 400 kPa, using its 400 kW chain cutter tool and more than 700kW of water power used for eduction and jetting.

The vehicle is fitted with an extensive surveillance suite and accurately controlled using Osbit's proven modular subsea control equipment. The control cabin is designed for comfortable use over long time periods, allowing for the vehicles high levels of reliability and resilience.

The vehicle is launched and recovered on the power umbilical, and it can be used in 500m water depths in both operational configurations, concluded Blakeman.

PANTA RHEI

NEW DEEP-SEA ROVER TO EXPLORE THE VARIABILITY OF SEAFLOOR MATERIAL



Panta Rhei

Last April, the PANTA RHEI completed its first sea trials in the Eckernförde and Strander Bays. The latest instrument carrier developed at the GEOMAR Helmholtz Centre for Ocean Research Kiel's Technology and Logistics Centre, it is designed for research in water depths of up to 6000m.

The name PANTA RHEI originates from the Greek and means "everything is in constant flux",

an name redolent of conditions in nature that are permanently changing.

The PANTA RHEI has, therefore, been designed to take measurements both at different places on the seabed and at different times in the same place, "to spatially and temporally resolve flux changes at the seabed," explained GEOMAR biochemist and vehicle co-designer Dr Stefan Sommer.

The initial impetus for the development came from the REEBUS research project, which deals with ocean eddies in the tropical Northeast Atlantic.

They are up to 120km in diameter and transport nutrient-rich water from the coast of Mauritania westwards into the open ocean. During this journey, the trapped nutrients lead to an increased production of plankton. This organic

material rains down from the eddy and provides the otherwise nutrient-poor deep sea with vital organic carbon.

But where the material settles on the seabed depends on various factors, including its topography, and is difficult to predict. In order to study the effect of organic carbon provided during the passage of a productive eddy on the deep-sea benthic ecosystem, a mobile measuring platform that can stay on the seabed for several months would be ideal.

PANTA RHEI is designed for missions that can last for up to one year. On the seabed, the rover moves slowly and repeatedly records the oxygen consumption of the sediment in special incubation chambers. From this, the rate of organic carbon degradation can be derived.

As measurements are repeatedly taken over a long time period at different locations in two measuring chambers, both the spatial and temporal variability of the carbon cycle in the seabed is recorded. Among other things, this allows to track the coupling of seabed ecosystems with processes at the sea surface.

"In order to meet the high demands of long-term missions, simplicity, reliability and robustness were the main priorities for the rover design," explains Gabriel Nolte from the GEOMAR TLZ and his colleague Matthias Türk adds: "The rover weighs 1.2 tonnes and has the dimensions of a small car. This means it offers enough space for the incubation chambers, sensors for recording oxygen, conductivity, flow and physical parameters, as well as cameras, lighting, control units and the power

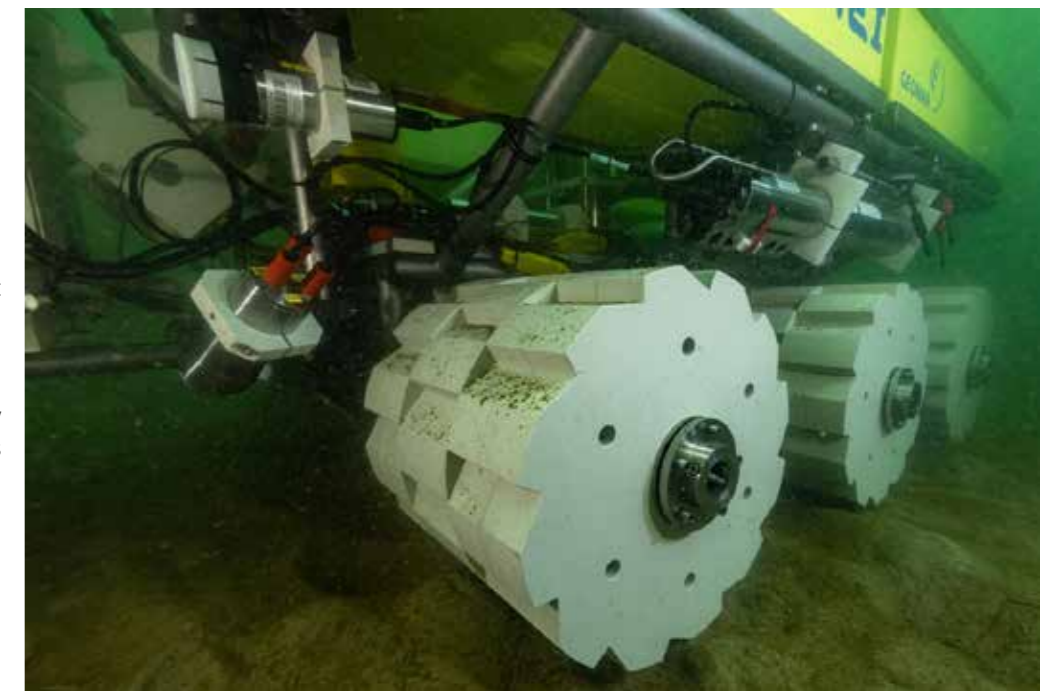


Panta Rhei

supply." For short-term missions, an underwater modem enables positioning and data exchange with the research vessel.

The development was funded by the REEBUS project as well

as the Helmholtz environmental observation program MOSES (Modular Observation Solutions for Earth Systems), and the Helmholtz future project ARCHES, which aims to develop an autonomous network of robotic systems.



Six solid plastic wheels on three axes, above them a rectangular platform to which Plexiglas tubes, cables and various sensors are attached

ASSOTRENCHER IV MK12

Asso Subsea's AssoTrencher IV is currently undergoing its twelfth upgrade. The vehicle is designed to carry out post lay burial of products in hard seabed

It incorporates a 650mm wide chain system that can cut down to 2.3m in soils with shear strength of up to 3MPa.

For harder soils of around 50MPa, it has a 450mm wide cutting wheel located in the centre of the trench, that can trench to depths of 1.25m.

It can work in water depth up to 800m and its tracks can transport it at gradients of around 10deg. It offers a wide variety of tracks to ensure best traction/ground pressure ratio.

Backfill material in the bottom of the trench can be removed by a pair of eductors, one in the rear and one mid-length.

It has 16 low-light cameras and 16 LED dimmable lights. Seven of these camera/light systems are on pan and tilt units.

The AssoTrencher IV Mk2 has a variety of electronic sensors to assist in the excavation. These included three imaging or profiling sonars and three Blueview 2D Multi-beam sonars. It has a Valeport miniIPS sensor, and a CSL TOGS/NAV FOG Octans or Lodestar system. It may also use a TSS 350/440 Cable Tracker.

The vehicle has, in total, 6 x 260 kW = 1560 kW output, out of which multiple configurations can be selected depending upon project requirements.



NODULE COLLECTOR

CONVENTIONAL TRENCHERS EXCAVATE DEEP, NARROW CHANNELS. THE NEW QC2000 DIGS VERY SHALLOW CHANNELS BUT 10M WIDE

JOHN HOWES DISCOVERS WHY

Newcastle-based SMD is a pioneer of seabed excavation, spending the last 30-40 years successfully designing underwater machinery. They understand what works and what doesn't work. The company has recently turned its attention to designing Seabed Nodule Collectors.

"Large areas of the Pacific seafloor consists of polymetallic nodules lying on the surface of the seafloor," said Sales and Business Development Manager, Subsea Equipment Power and Mining Systems, Graeme Walker. "Many of the soils have a shear strength of 1-10kPa, roughly the consistency of very soft like yoghurt or soup. They lie 5000m below the surface. Our engineering challenge has been to extract these nodules but disturb as little of the surrounding area as possible.

"In order to exploit this resource, some companies have designed heavy excavation machines that have to be lowered down onto the seabed by wire, possibly incorporated within an umbilical.

"These sink deep into the seabed, churning up the sediments indiscriminately as they essentially plough deep, wide furrows. They are retrieved by pulling up on the cable from the surface. Considerable forces go through these umbilical termination points. These become a weak link and subject to mechanical failure."

SMD has been monitoring such designs while working on its own solution. Patents of key components are now in place. They have followed a low-impact philosophy, to make the vehicle as light as possible.

"We have considerable trenching experience; probably more than any other single company in the world," said Walker. "This design employs the same fundamental technologies as many of our trenchers but instead of excavating a relatively narrow channel up to 3-4m deep, we have designed it to cut a 10 metre wide swath.

NODULES
The size of the nodules varies between 15-150mm diameter. They



The QC 2000

sit on the surface or lie slightly submerged. The seabed is generally flat but does have local slopes up to 10 deg slopes that the trencher must negotiate. Their plan is to

just remove the upper 10-30mms of the seabed and generally provide minimal disturbance.

The QC2000 can remove nodules up to 200mm if required. At the design speed, and the width of the collection head, it can gather between 430 and 720 tonnes per hour depending on abundance.

This has culminated in the development of a free-flying lightweight vehicle called the QC2000.

"It incorporates caterpillar tracks but these are mainly for stability than locomotion," said Walker. "They don't provide the traction but they do control the speed as going faster than the tracks would result in a ploughing action. The tracks are wide enough that they don't sink.

The vehicle propulsion power comes from a hydraulic system based on 16 thrusters. The vehicle weighs 85t in air but only 4.5t in water while the thrusters have in excess of 6 tonnes of thrust. This means that the trencher be effectively lifted off the seabed as required. The information on the vehicle height and the seabed is provided by downward-pointing sonars.

The horizontal thrusters can propel the vehicle at a speed of around 0.8 0m/sec or 3km/hr. At the design speed and the width of the collection head, it can gather between 430 and 720 tonnes per hour and can remove nodules up to 200mm diameter.

At the front of the QC2000 is the nodule collector. A plate at its base assures that only the top 10-30mm of the seabed is disturbed while providing a stable skid base for a seabed datum. The height relative to the sea bed can be measured using multibeam sonars and this in turn, regulates the collection depth.

As the excavator moves forward at around 0.8m/sec, the collector plate at its leading edge skims the surface of the seabed, sweeping nodules into the collector.

"One feature we have often incorporated into our specialist subsea ploughs, are small ground-engaging tines or prongs that protrude from the plate. While the plough body sits on the seabed, these tines dig

down into soft muds and lift larger boulders to the surface, reducing the stiction. We have incorporated this feature into the QC2000. The tines penetrate the seabed a further 50mm and larger, and selectively lift the nodules up, over the plate, and into the mouth of the collector while leaving the surrounding seabed mud matrix in place.

"Another tool we commonly use in excavator design, are eductors. In a traditional trenching system, 2-3 metres of soil is effectively removed from underneath the pre-laid pipe."

As the trencher moves forward, it may take 20-30m behind the vehicle, for the suddenly suspended stiff pipe to eventually make contact with the trench floor. In the meantime, friable backfill may gravitate down the slope and into the floor of the newly dug channel. One solution to keeping the channel clear is to use eductors to remove this sediment.

Eductors work by driving a primary fluid (seawater) through a tube which creates a vacuum enough to suck a secondary fluid (slurry).

The advantage of these systems is that they are lightweight and have no moving parts. The downside is that they are power inefficient although quite suitable simply for lifting the nodule-rich slurry from the nodule collector skating the seabed, up into the main vehicle.

"In total, there are 20 eductor tubes that span the 10m wide collector head," said Walker. "Inside each eductor tube, the slurry is sucked in at a rate of around 90 lit/sec," said Walker. "The nodules account for 3-5% by volume."

The nodule flow is directed into a collection tank where the nodules are separated from the majority of the water flow and pumped to the riser with only 20% of the water.

COBALT BLUES

Each vessel is designed to produce 12,000 tonnes of cobalt year. If global cobalt production is 140,000 t/year, one vessel represents 9% of this output.

"At the moment, the world is looking at electric vehicles to reduce the amount of Carbon," said Walker. "These electric vehicles will require about 50% of all cobalt production. Some estimates put each Tesla model 3 as containing 5kg/vehicle of cobalt."

The automobile manufacturing industry is currently making 3,000,000 cars a year but replacing the internal combustion engines will require around 70 million cars a year. There is currently no realistic Cobalt resource able to supply this other than seabed collecting.

By the time that the remaining 80%, the watery slurry along with smaller nodules is ejected out of the rear, the velocity has fallen to around 0.5m/sec.

Because of this, the ejected sediment does not spread far from the path of the excavator and instead, a slow waterfall of silt gradually settles back on the seabed within a short distance of the collector with

energy too small to create a plume. This minimises the disruption footprint.

"This means that if we are cutting between 10 and 30 millimetres of the sea bed, only 2-6mm of this is removed to the surface and the rest quickly returned to the seabed," said Walker.

Meanwhile, the nodules and sediment matrix, is routed up to the surface by virtue of a large cast steel centrifugal dredge pumps weighing 2.2 tonnes, perhaps the largest single item on the vehicle.

The nodules and slurry are accelerated through the vertical riser tube and into the surface vessel at a collection rate of between 432t and 720t/hr.

"At the surface, the nodules and silts are removed from the slurry and the flow is sent back down to the seabed again," said Walker. "We have designed this for two main reasons."

"The first is ecological. Taking water from 5000m below the water surface and discharging it into the top of the water column potentially releases microbial life which may cause biological contamination repercussions that we can't even envisage. This is certainly a great concern to marine ecologists and an issue we have taken on board.

"The second reason for returning the separated water is that the silts are retained in the vessel so they do not create a plume at the seabed."



Eductor tubes

UMBILICAL

The QC2000 is powered by four 375kW motors that provide power for the tracks, eductors, dredge pump and thrusters.

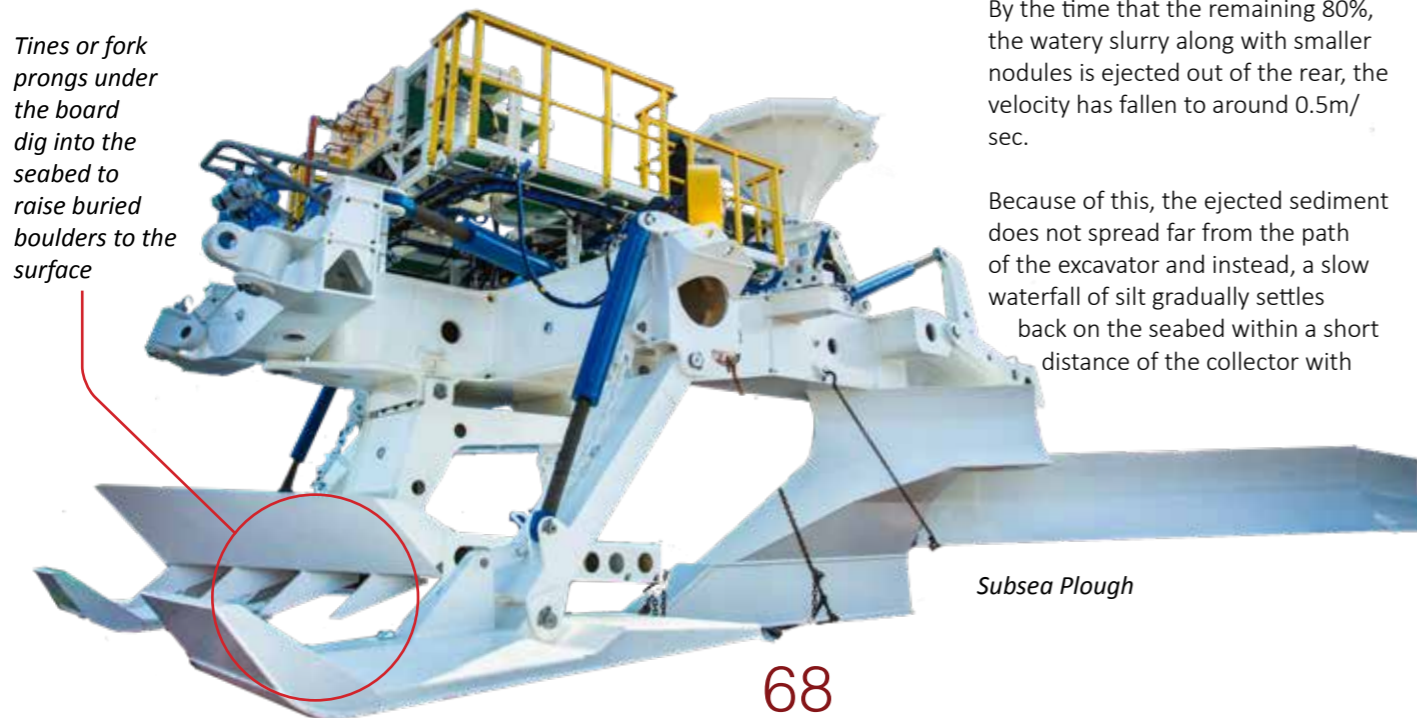
"One perennial issue of deep water vehicles is getting power down to them and this influences the conducting properties of the umbilical design," said Walker. "The more power required, the larger and heavier the conducting elements and the higher the weight. Some umbilicals are also designed to lift the entire structure."

"All things being equal, it is advantageous to make the umbilical as small as possible and we have had

to really push our supply chain to deliver the design we have specified. Designing high voltage umbilicals for decades, however, has given us an insight into both what works and what will work with a high degree of certainty.

"We plan to use a 6.6 KV design which is similar to systems we have previously supplied for large seabed excavation vehicles, such as Nautilus.

"We have often employed steel armouring on our umbilical but this deepwater collector lends itself more to a synthetically armoured line. By deciding on a free-flying vehicle design, this means the



Tines or fork prongs under the board dig into the seabed to raise buried boulders to the surface

Subsea Plough

SEABED VEHICLES

umbilical only has to lift its own weight in water as opposed to the entire mass of a heavy seabed crawler.

While it must be able to recover the entire vehicle to the surface in an emergency, this still minimises loading requirements significantly maximising the power we can transmit through the umbilical.

"The umbilical we are proposing contains four 375 kW three-phase conductors surrounded by synthetic fibres to support the weight of the copper. It is 75mm diameter and it weighs approximately 2.7t/km which, as umbilicals go, is very light in water

"Multiplying the 2.7 by 6km gives a 16,200t umbilical weight in water weight. Add 4.5t for the vehicle and the total weight is less than 21t. This resides comfortably within the 30t safe working load. Not being called upon for regular vehicle retrieval improves its design life.

"In the field, the nodules lie anywhere between 4000m and 6000m. In the design we have been focussing on the 5000m water depth. If we look to work at 6000m, the vehicle weight only goes from 85 tonnes in 95t.

It works 24/7 365 days a year with an uptime greater than 85% and can work in very high sea states over 4.5hs.



The QC 2000



THE WORLD'S MOST POWERFUL TIDAL TURBINE

Orbital Marine Power has successfully launched Orbital O2, its new 2MW floating tidal stream generator. The design follows the SR2000 full-scale prototype which was successfully tested at the European Marine Energy Centre (EMEC) in 2016-2018.

While still retaining the 2MW output of its predecessor, the new O2 differs in two main areas. The first is that the mooring chains are no longer joined to the hull at a central turret. A more important feature, however, is that the arms (alternatively called legs or wings) that incorporate the turbines at their tips, are attached to the hull amidships by a hinged arrangement.

HULL

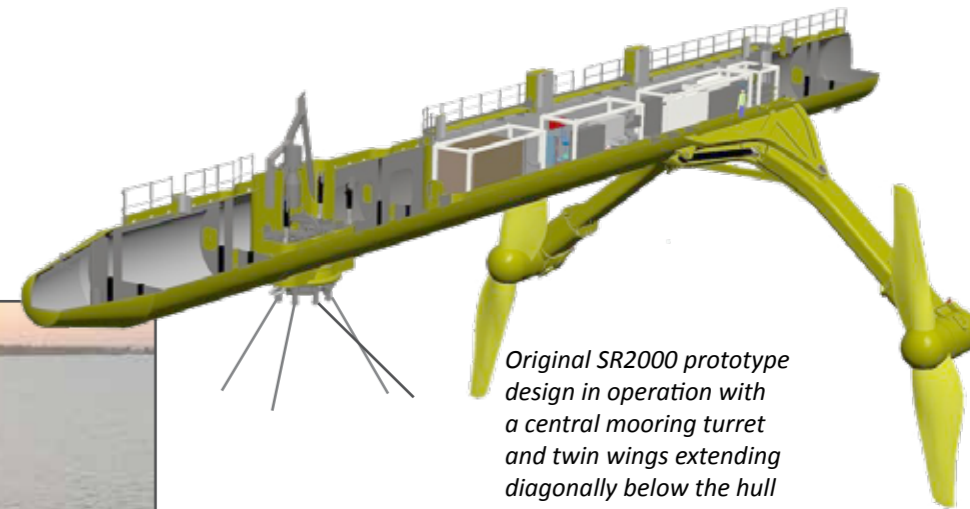
The O2 is based on a 74m long cylindrical floating steel hull superstructure which contains the power conversion and auxiliary systems.

One keynote of the SR2000 prototype, was that the pair of arms were permanently extended diagonally in a fixed position so that the turbine rotors could be positioned into the main flow.

In the O2 design, however, the design has changed with the resting position of the arms being horizontal and only rotated into a diagonal position when in operational mode. It can be returned to the horizontal on demand.

Keeping the turbine body partially out of water helps with the transportation of the structure. More importantly, provides easier access to all major components of the 1MW power train for through-life servicing.

To achieve this repositioning, each arm is physically attached to the hull superstructure by an hinged arrangement at the side of the tubular hull body. Welded onto



Original SR2000 prototype design in operation with a central mooring turret and twin wings extending diagonally below the hull

In late April, the O2 arrived in Orkney Waters after being towed from Dundee by Leask Marine's new multicat vessel, the C-Force. It was temporarily moored at Deer Sound for final commissioning and then towed to the European Marine Energy Centre (EMEC) Fall of Warness tidal test site.

Following connection to the national grid, EMEC will undertake an independent power performance assessment for Orbital.

The O2 is Orbital Marine Power's first commercial demonstrator and represents the culmination of more than 15 years of product development and testing in Orkney. It is envisaged that the O2 will become the basis for first commercial sales of the technology.

the arm, very close to the hinge, is a vertical steel A-shaped frame.

The apex of each A-frame is connected by a bar to an articulated mechanism such that when hydraulically-actuating rams are engaged, they effectively push A-frame sections outwards.

This linkage forces the articulated arms downwards from the horizontal, pushing the nacelles and contra-rotating rotors into the optimal flow area of the tidal stream.

MOORING

The original SR2000 prototype was kept in position by means of a single turret mooring point. Station keeping of the O2 superstructure, however, is enabled by a

lower cost forward and aft mooring connectors hold the platform in line for flood and ebb tides.

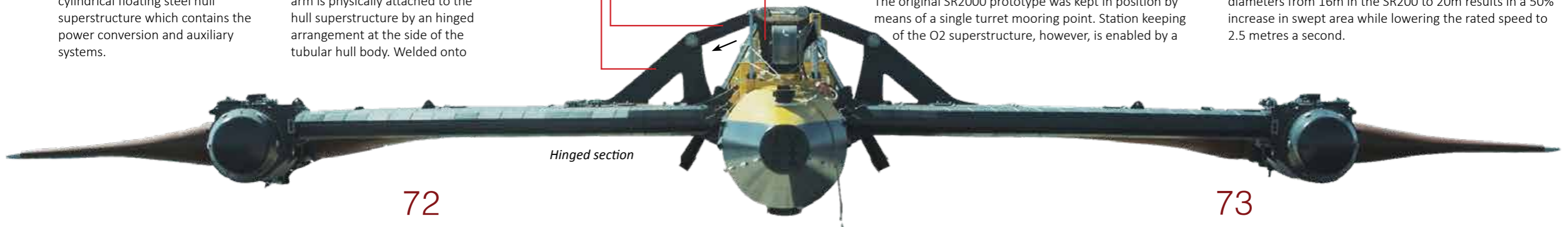
Power is exported from the turbine via a dynamic cable from the superstructure to the seabed where it connects to seabed static cabling infrastructure that exports power ashore to the EMEC substation.

The 10m blades give the O2 more than 600m² of swept area to capture flowing tidal energy. Increasing rotor diameters from 16m in the SR200 to 20m results in a 50% increase in swept area while lowering the rated speed to 2.5 metres a second.

1 Fixed A-frame

2 Rigid connector bar linkage

3 Movement of rams pushes the rigid bar against the A frame and forces the hinged arm downwards



Hinged section



BOMBORA

TECHNIPFMC RECENTLY FORMED A STRATEGIC PARTNERSHIP WITH WAVE ENERGY TECHNOLOGY COMPANY BOMBORA, TO DEVELOP A COMBINED FLOATING WAVE AND WIND POWER PROJECT.

THIS IS JUST THE LATEST POTENTIAL APPLICATION OF M-WAVE TECHNOLOGY.

Bombora is an indigenous Australian term for an area of large sea waves passing over a shallow area such as a reef, or sand bank that is located some distance from the shoreline.

It is also the name of an innovative company that patented multi-megawatt mWave technology that converts wave energy into electricity.

At peak capacity, the latest system being assembled in Pembroke docks will generate 1.5MW which will make it the biggest wave energy machine in the world.

At an elementary level, mWave is based on air-filled modules. Each consists of a cavernous concave steel cell. The cell modules are large, each 15m in length and

weighing 75t. Over the upper surface of each cell is stretched a flexible membrane composed from industrial grade rubber.

The longstanding use of similar materials in a range of marine applications has demonstrated the material's reliability and longevity.

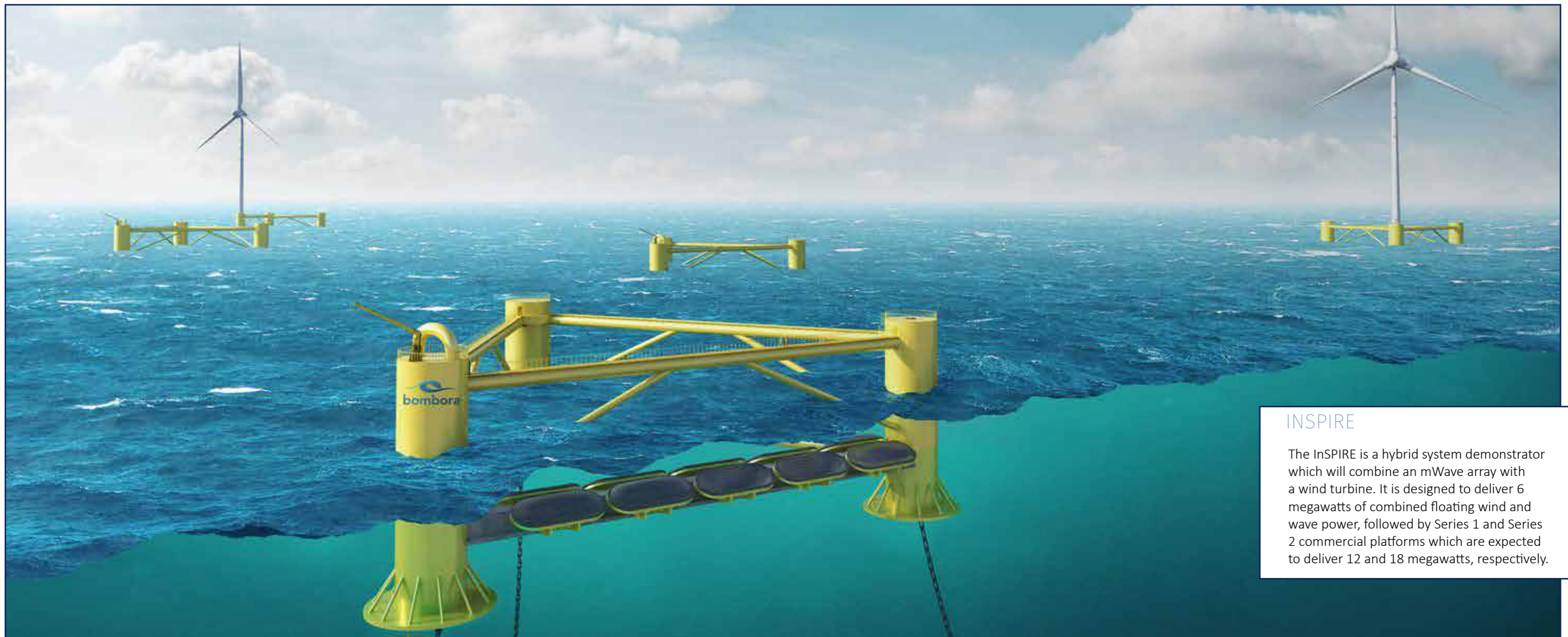
Several individual cells are assembled

into a steel structure around 75m long and 20m wide and weighs a total of 850t. They are laid on the seabed or mounted on a concrete structure in around 15m of water.

As the waves roll over the device, the underwater pressure naturally increases. mWave's rubber membrane expands and contracts accordingly.

As waves pass, air is sequentially pushed out of each cell through a series of valves into the central one-way air-ducting that runs through the body

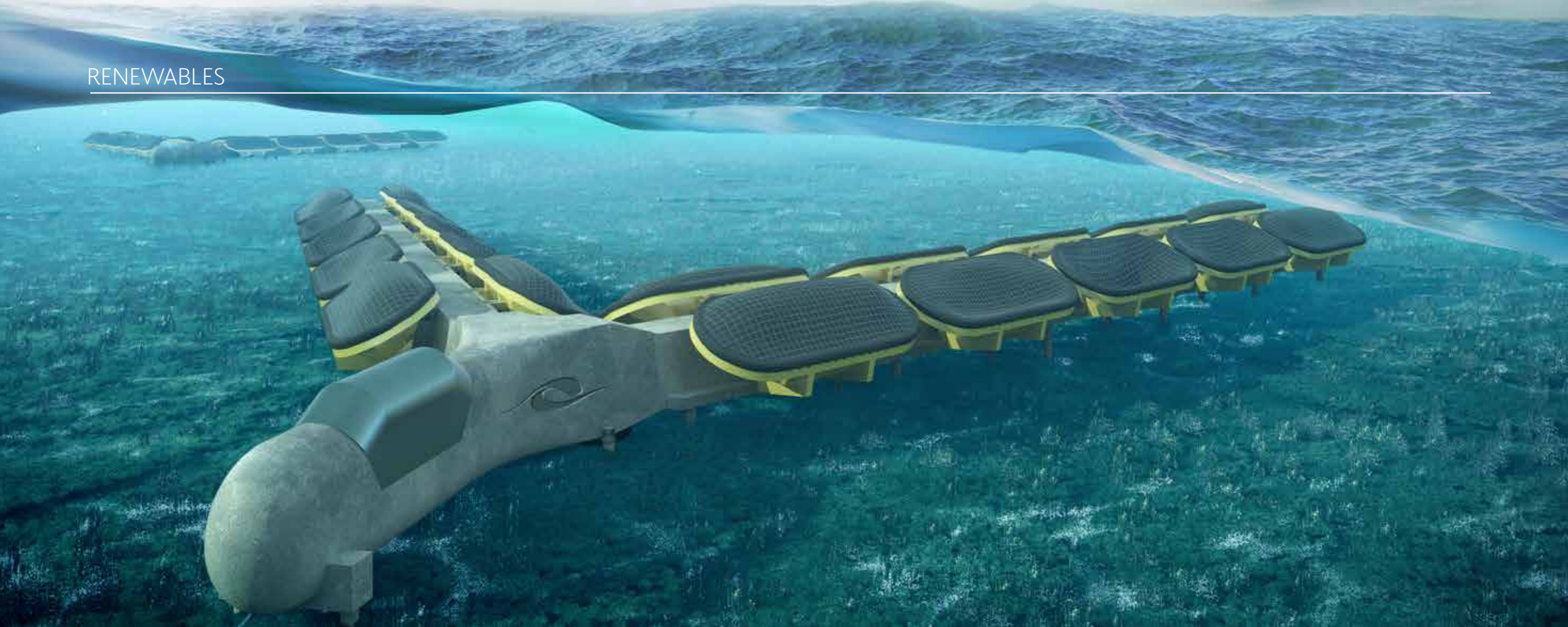
The air flow enters an 86t power take-off unit and into an unidirectional flow turbine. It is this that captures the pneumatic energy from the cell modules. The turbine



INSPIRE

The InSPIRE is a hybrid system demonstrator which will combine an mWave array with a wind turbine. It is designed to deliver 6 megawatts of combined floating wind and wave power, followed by Series 1 and Series 2 commercial platforms which are expected to deliver 12 and 18 megawatts, respectively.





is connected to a variable-speed generator which creates the electrical power. Electricity from the generator is transferred to the shore via a sub-sea cable. Following a process of power conditioning, the electricity is delivered into the local grid.

The turbine and generator are essentially off-the shelf products, adapted for the mWave operating envelope.

After the air has passed through the turbine, it is delivered back to the cells reinflate each membrane.

OPERATION

"The mWave has no external parts, other than the flexible rubber membranes," said a source. "The main advantage of the system is that the rubber cell membrane extracts power simply without complex

mechanisms and as such, greatly reduces maintenance requirements.

"Indeed, because of the replaceable modular arrangement, it is easy to retrieve individual parts to the surface and this makes it simple to maintain. It is possible to both operate and maintain the system using existing service vessels.

"The design makes the mWave uncommon among wave energy converters as it simultaneously addresses the 'cost of energy' and 'ocean wave survivability' challenges."

For optimum power generation, the mWave structure can be positioned at an angle to the incoming waves. It can be deployed on different platforms to suit a nearshore or offshore ocean environment.

One interesting feature of mWave's cell modules are their unique ability to shut down in extreme storm events, thus limiting the loads reduces capital costs and improves the all important cost of electricity.

DEVELOPMENT

Bombara dates back more than a decade. On the way, the company has won numerous awards, particularly in Australasia where the technology was invented, as well as grants to encourage the development.

In 2015, the company embarked on mid-scale prototype trials to allow the developers the ability to optimise system configurations and control systems. For the first time, this also saw the testing in salt waters. In 2015, the device was also used for the first time on a commercial scale wave farm.

By 2017, the original developers had stepped down and the company launched a multi-million investment round. It also began to look for a European headquarters.

The Welsh government saw renewable power as the sort of development that they wanted to be associated with and aided with a £10.3 million EU development fund grant successfully lured the Bombara to Pembroke Dock.

Local companies were quick to work with Bombara and before long, Mainstay Marine Solutions won the Fabrication and Assembly contract for the first full-scale mWave.

In 2019, Bombara was selected to provide a grid-connected wave farm on Lanzarote, the first phase seeing up to 4mw of generating capacity the our the deployment of a subsea array of 1.5mW m-Waves. Pembrokeshire fabricator Altrad were awarded the contract for the fabrication

of the mWave cell modules for the energy demonstration project.

This saw the mWave resting on the sea floor 10 meters beneath the ocean's surface like a fully submerged reef making it invisible from the shoreline while extracting maximum energy. The success of the project saw an a commitment to seven-figure sum financing from the bank of Wales.

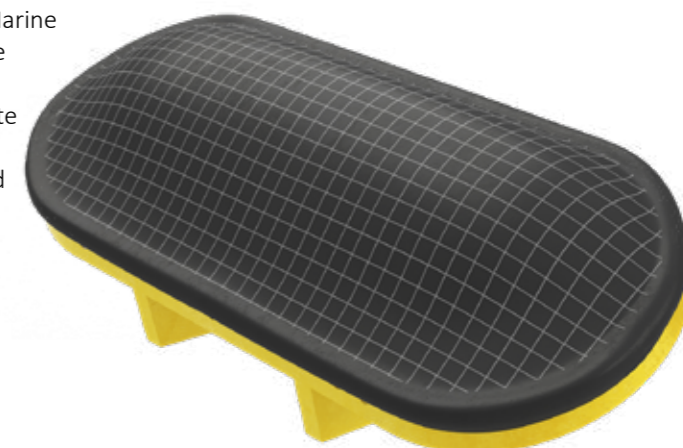
Last year, Bombara has joined forces with the Offshore Renewable Energy (ORE) Catapult's Marine Energy Engineering Centre of Excellence (MEECE) in Wales to further investigate the feasibility of co-location with floating wind structures.

Meanwhile, the company

looked to combine the mWave with floating platform technology. Engineering company Apollo were appointed to look into taking Bombara's utility scale wave energy converter into deeper waters.

The Apollo project formed part of a comprehensive strategic study to verify the case that mWave can play a vital role in adding value to large scale offshore energy projects.

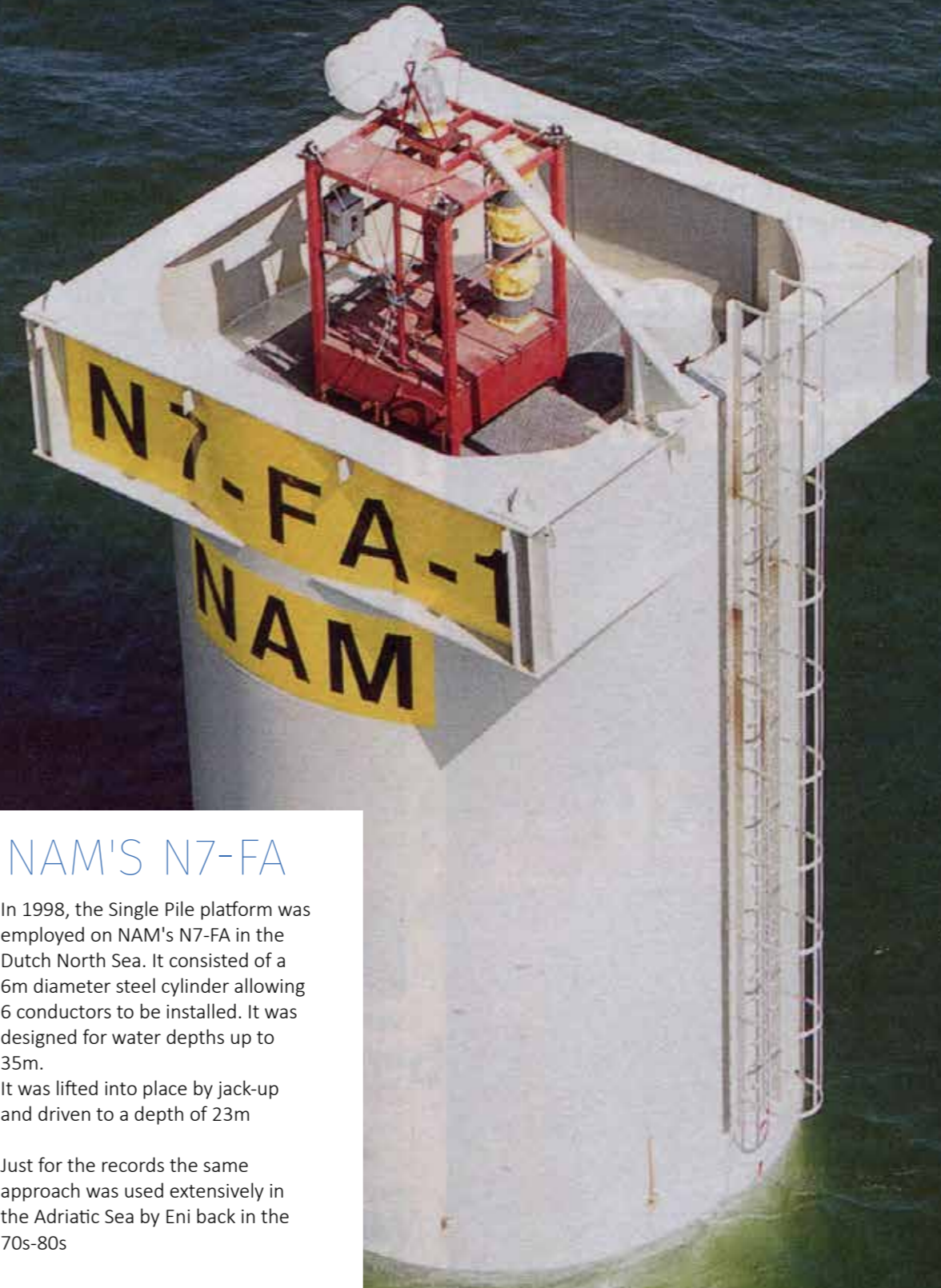
mWave



OFFSHORE PHOTOS

CHECK OUT THE
UT2SUBSEA
PAGE ON
LINKEDIN EVERY
FRIDAY

SPP



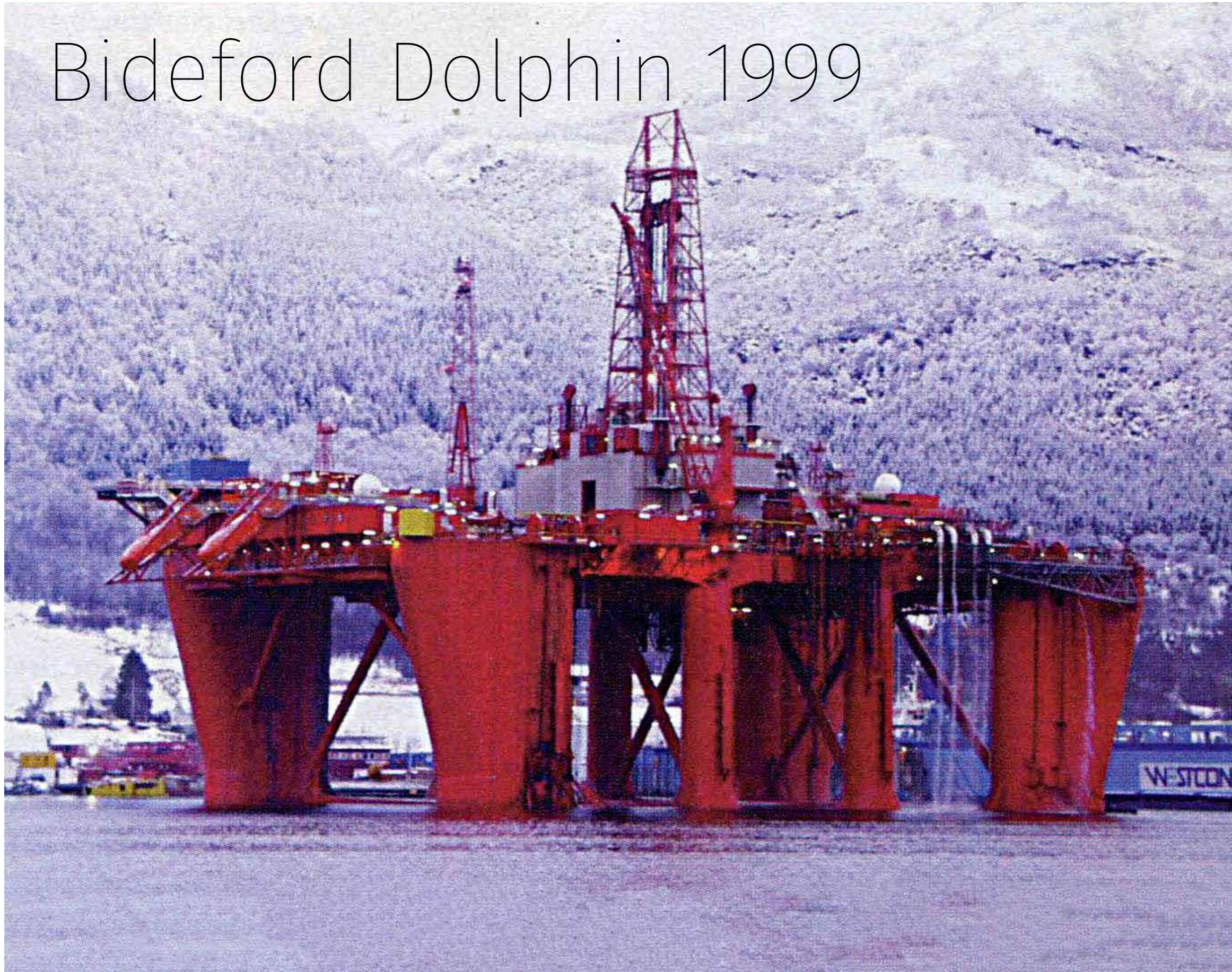
NAM'S N7-FA

In 1998, the Single Pile platform was employed on NAM's N7-FA in the Dutch North Sea. It consisted of a 6m diameter steel cylinder allowing 6 conductors to be installed. It was designed for water depths up to 35m.

It was lifted into place by jack-up and driven to a depth of 23m

Just for the records the same approach was used extensively in the Adriatic Sea by Eni back in the 70s-80s

Bideford Dolphin 1999



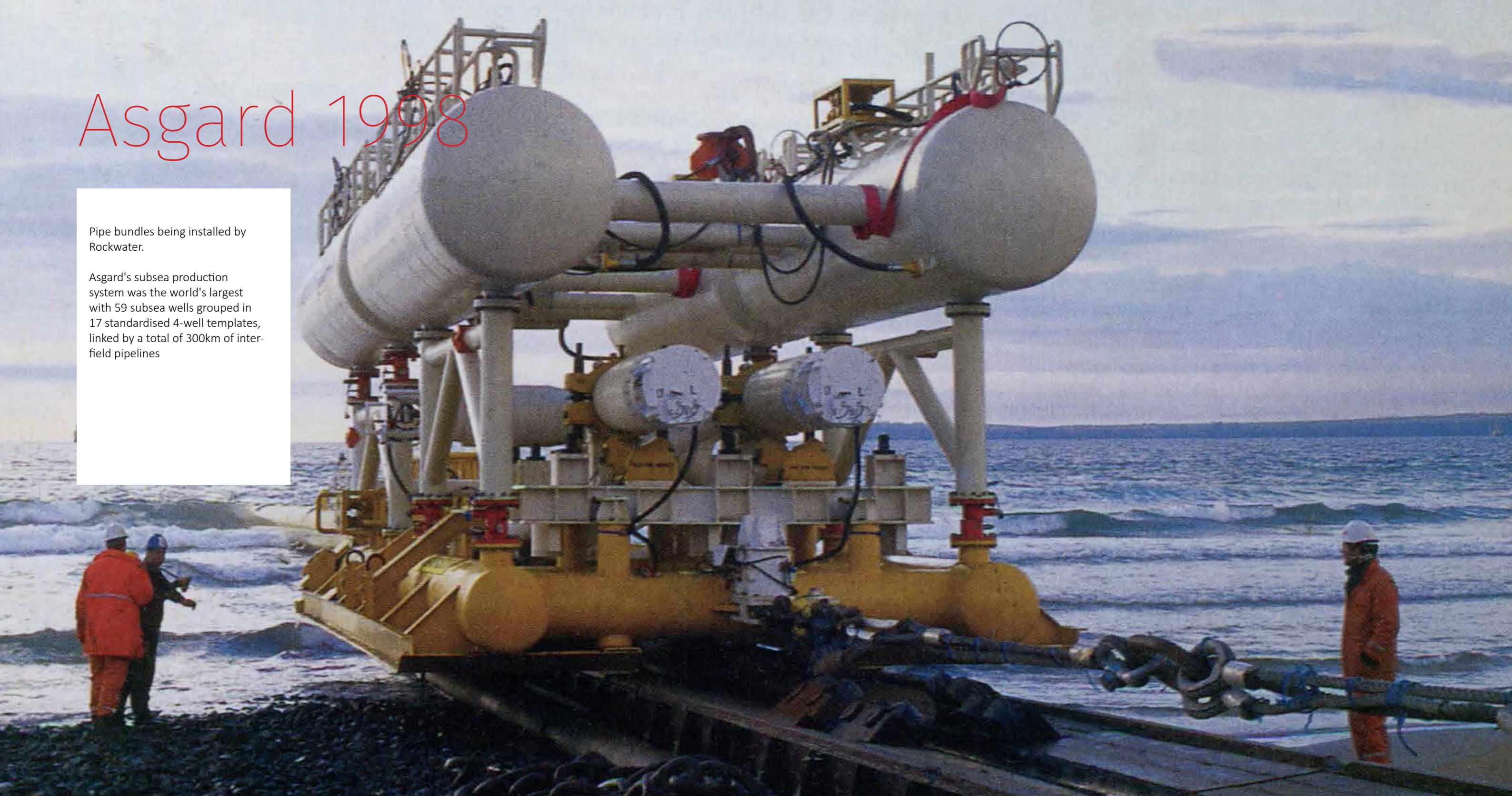
Drilling on Visund for Saga. The BD was selected for the first use of Maritime Hydraulics' Ram Rig system. This represented a new stage in automated drilling.

I worked in a repair yard in Holland on the Blackford Dolphin many years ago that had been left floating at sea apparently! Massive holes in it's main deck!

Asgard 1998

Pipe bundles being installed by Rockwater.

Asgard's subsea production system was the world's largest with 59 subsea wells grouped in 17 standardised 4-well templates, linked by a total of 300km of inter-field pipelines



RS We were onboard the Adams Challenge with roV Mrv5 for this and the Heidrun bundles. We flew along the bundle and cut off ballast chains in strategic places to level out the bundle ready for tow. Then infield operating the flooding valves.

6 man cabins and open top wooden

lift boats, I don't miss that ship at all!

I remember this job well. As a matter of fact I still have the pre-commissioning procedures on a 4.5" floppy disc! A bit of a rush-on to get those buoyancy tanks nitrogen filled, I recall! Robert Davidson

I was Statoil Site Rep on the tow.

Packed a little extra in my bag with half an idea I might de-mob diverting through Paris. The Scotland v Brazil game took place after I was transferred to the Rockwater Semi 1: Bundle final placement ongoing. Got home in time for the Scotland v Norway game.



West Vanguard 1985

One person died when the West Vanguard drilled off the Haltenbank for Statoil. It hit a shallow gas pocket and a faulty diverter resulted in a blowout. The rig was a Smedvig Drilling's Bingo 3000 type semi

Learn from mistakes
Don't gamble with maintenance on well,
control equipment

During the search for anchors after it was towed Freifjorden near Kristiansund, the ROV operator found a crashed World War II Heinkel He 115 on the seabed, which had been based at Trondheim, Norway during the Second World War. The plane had been cut in to two by the movement of one of the Vanguard's anchors

I wouldn't ever like to be in that situation and having to divert... Especially if your equipment wasn't in the best condition. You would like to think maintenance schedules are a lot more stringent these days!

Remember it well, the guy died in the shakerhouse, if my memory serves me well. One of my drillers was on that rig at the time doing an extra hitch to help out, wrong place wrong time.

We mention this incident every week, as an intro to shallow gas, in our IWCF Well Control Equipment section.



Heather

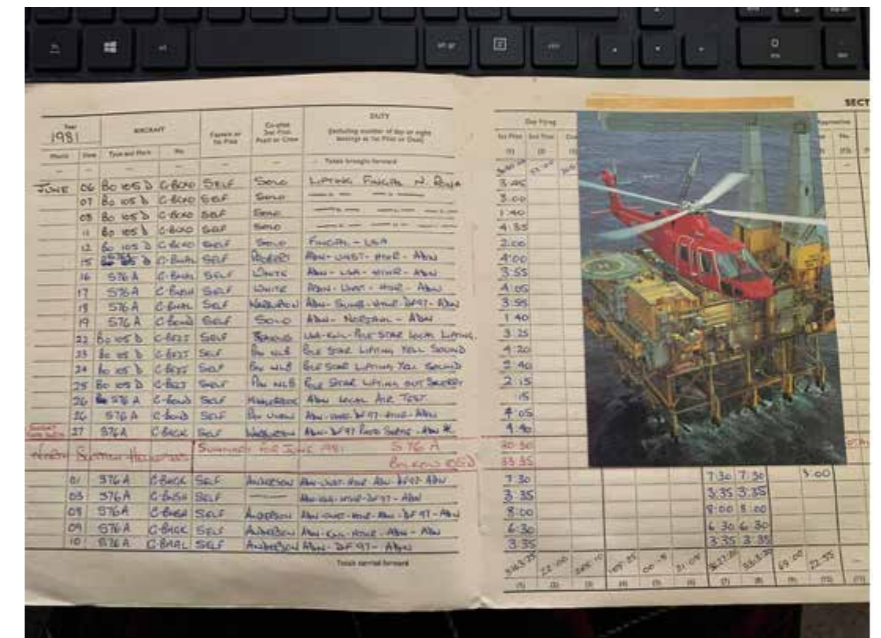
This photo was proof copy for an advert and probably mocked up rather than a direct photo, but there again, maybe not. Huge amounts of skills required either way. Dates from around 1981.

This was definitely not mocked up. I was the pilot of the aircraft on that day. Two S76's flew out from Aberdeen to the Heather Alpha to get that shot. Another similar photo was taken with a Drill Rig possibly the Nortroll as the backdrop. Dave Kinnell was the pilot of the aircraft from which the photos were taken Those were the days!!!

Spent two weeks on their in 2017 for project work. Possibly the filthiest cabin I have ever had to sleep in, the in cabin shower room was just as bad. Asked for a room change, as usual non available. Externally the place was in a right state, little or no maintenance being carried out, rotten gratings covered with scaff boards due to severe corrosion? Glad I did not have to go back.

I also had two weeks on Thistle for the same project, smallest 2-man cabin I have ever had to sleep in, and it was also filthy. Also having to walk along the corridor to get to the toilets & shower rooms as non en-suite and this was only a few years ago. No investment at all from Enquest to update and improve the living facilities. Absolute joke.

For all its faults, I really liked the Heather. The drill crew were a great bunch of guys and the craic was amazing.



DA Just checked my logbook and it was 27th June 1981. Aircraft registration was G-BHGK and the Drill Rig that a similar photo was taken was the DF 97.

JA This photo is 100% genuine, my father Dave Allen is the pilot you can see in the cockpit. According to him Sikorsky paid the photographer £25,000.



The AH001 at HiFab

Yes, we have had pics of the Amerada Hess AH001 before, but that was on Tyneside. To the left are Marathon Brae B modules

I remember my first visit to AH001 just after the Piper Disaster and when we had a fire alarm we mustered at the lifeboat station, not the accommodation !!

I remember the Tharos at Piper

Fantastic place HiFab. Worked on both Amerada Hess and Marathon projects at Nigg. Great memories.

Iain Fraser as Conoco staff engineer on the Hutton TLP I grew increasingly less confident in the concept. It is equivalent to standing under a 60,000 te load. The MPSS SYSTEM of a square ring semi, steel cat risers, dry dry trees and buoyant moorings evolved in 1980, during the design in Colliers Wood. This system is now standard for deepsea production.

Thanks Craig. I read earlier this week that the decommissioned hull was towed into Invergordon for dismantling. Almost full circle and we haven't aged a bit!! Remember that we'll... Sedco Phillips SS then, sister design to the Tharos. She was in Nigg drydock, must've been around 88/89? Load tested the 350te Clyde crane on her before the Crane was dismantled and removed and sold to a far east buyer

I was Client representative during infield flowlines onboard the Apache and also during pipeline installation and later during ROV pipeline umbilical and well head inspection

surveys happy days

Spent 2+ years on the Phillips SS with Oceaneering Norway A/S in the greater Ekofisk field. 24 day rotations. ONAS eventually lost the contract to 2W. Cutbacks saw the 365 day inspections reduce to 3 months before the Phillips SS was sold off for conversion and converted into AH001. Happy days

She looks quite different these days as PPF-1, the pontoons & topside facilities are much larger

That is the understatement of the year, Kredimir! The last modification cost almost \$1 billion and Petrofac were not pleased. I understand they will never use a semi submersible ever again?

Was on the conversion to PPF-1 in the yard in Gdansk. Won't get many jobs better than that one 🙄

PPF1 (ex AH001) a great project to work on with a great team both offshore and onshore at Petrofac



Brent

In 1995, the Brent Bravo topsides was refurbished at a cost of £500 million. It had already been onstream for 19 years and this gave it around another 15 years of life.

The Good Old Brents. Worked on them all. Remember OPM and P & W offshore. The 61's and the Bells. Must be the worst place in the world for fog. Had many hard lies in the Bravo snooker room.

Quickest trip ever. 25 minutes. Hi I am the new welder. (we only have 5 welding plants on here, we have 10 welders.) I don't need a welder. Bye. Back on the same chopper. Can't remember the date.

Worked in the galley for 4 weeks with USI on the Delta at Easter,1977 whilst still a student at Dundee University. Remember a lot of gas alarms and mustering.

Some great craic out there. Really enjoyed mytime on the Charlie last year on the abandonments. It's a shame that they are going (well, gone, gone, going and gone) but they were a milestone in oil and gas.

I got my start on the Charlie NDES project at Burntisland- must have been around the same time? 95/96? Moonlighting whilst a full-time student in Dundee!

Was on the Charlie and Bravo during that time living on the Polyconfidence

Welding superintendent for the uplift, I remember all the computer geeks on board due to the amount of info to be downloaded and for some of us the start of using or being dragged into the modern world!?

Worked on the Brents in the early 80s shuttling to the Treasure Finder, Shell Staff had some funny rules on Brent Alpha, like the time's we got fogged onboard and although their were empty cabins and beds onboard these couldn't be occupied by common contractors so we'd to sleep on the floor in the cinema....yip some funny rules ☹



Stena Drilling's Kolskaya

The 3-leg jack up was designed by Gusto and was able to drill wells up to 6500m in water depths of 100m

Would that be the same Kolskaya that was owned by Noble and sadly sunk whilst on tow?

Ian Morris it was chartered and managed by Noble. We must have met because I joined late 2000. The Denmark time was not good indeed. Later in the Netherlands was she was performing great.

Morecambe Bay 1984

The Safe Lancia and Morecambe Flame servicing the slant drilling platform, able to drill holes 28-30deg into the shallow reservoir

I spent one trip on Morecambe Flame as Assistant Driller in 1985 and working a slant rig was challenging to say the least. Glad to have the experience but happy to get back to a semi-sub and get a Driller's Job not long after. A lot of walking if you needed to do Hot Work over the Platform by the time you had been to the various offices.

I worked a lot onboard the Safe Lancia back around 2000-2004 in the Bay of Campeche Mexico.

Worked on the Flame back in the 80ies, it was built in John Browns Clydebank, I later found out my

uncle worked on its construction.. Slanted driller and pipe loading V doors, automatic roughneck machine helped a lot.

My first ever trip offshore in 1984.. as a 20 year old tiffy! DP3 I Believe the satellite!?

I too was on that job, never did get to stay in Blackpool always on the accommodation platform. The joke at the time was singing to the Paul hardcastle song, "The average age of a tiffy on morcambe bay was n- n- n-nineteen".

I came on board the Hook-up from the Tyra Field in Denmark in 1984 and was day shift foreman for the electrical squad who were staying in Pontins Holiday camp, I was offshore on the accommodation, can you imagine what came off the helicopters around 6.30 / 7.00am in the morning. I lasted



The Flame now part of the Douglas Complex in Liverpool Bay, my home for many years



1 trip and went to Brae B.

Remember this well, my Office was just behind the Helideck on the

Safe Lancia, the start of meeting many people who are now esteemed colleagues and friends and some mentors who taught me what I

know today, I spent 2 1/2 years on DP3, CPP, AP, DP1, DP4 and went back again for a year of Brownfield Modifications. Happy Days.

Flexjet II



Robert "Skip" Voss

Sonsub's Cable and pipeline trenching system. Able to work in up to 500m and trench up to 3m.

One of the many machines I and the engineers and all the Perry team built. It was a first of its kind. We built the first one for Coflexip. The one you see in the picture was the second unit built for Sonsub. This was a long time ago, back in the mid 90ies.

Gerry O'KaneThe oscillating swords were a novel idea and we did battle with them for years BUT eventually they were operational. impracticable due to the downtime needed to keep them going- one of the best ideas was the buoyancy tanks that were conveniently effective sometimes. One of its far reaching

ideas was its high seabed clearance and VERY robust frame structure- eliminated a lot of seabed operation problems!

Am I showing my age. I remember this as a Coflexip tool

Someone said they made the umbilical longer in order to go deeper. That would not work. The flex jet frame is a pipe structure, the pipes are pressure vessels and provide added floatation. However, due to weight limitations during the design process, the pipe frame was designed very close to the 500 meter depth limit. If you go deeper the pipe frame will collapse. I could tell you exactly where this failure will occur, but it is not important. What is important is the fact that you cannot

go deeper without risking catastrophic frame failure.

Gentlemen.....I am interested to jump in to this interesting discussion, of which apologize for this unsolicited of mine.

I was wondering if this Flexjet II is accompanied with structural intact integrity analysis toward water depth? It will bring a lot help for us as an ordinary users interesting to learn the system more.

I have my own Seaeeye Panther XT Semi W/C with water depth capability over 3K mtrs. And start wondering if there is also impact to its structural integrity shall its go deeper than it should, provided umbilical is long enough to go.

A great machine, spent many great years on the EARLIER beast and loved it!

Can't be much of the original one left it's been rebuilt and modified that much.

Got some of my best offshore stories from working on this thing!

Flexjet was one of those innovations that probably led to all of us who are 50+ learning how to develop new subsea business segments and advance the industry as a whole. I'm sure that we all have a good collection of war stories about how we got the job done, but ultimately it all led to methodical advancements in engineering and design.

Ho ho ho, rebuilt this beauty more times than I wish to remember. Last saw it in Ravena it was to be rebuilt again , poor Mike Boden was going to look at the servos and the controls , he found it all in bits in a box lol.

remember the days with Mike and Cyril , Rick Steel Shagger Shenton Scotty Beef. Mungo, Graeme Yourston Snips Rafferty. Mike Cassey. wow memories.....

Ah yes Flopjock- a new generation of trenching machine with Triton WROV at the core back in the day. Sonsub modified a number of things inc the nozzle design, the HP pumps and the tracks. Rock water were first to realise its potential so off to Fort Bill for trials. First job was on the Regalia at Draugen to support NOS who had a wee issue. Could have been a good machine for today's site clearance work scopes. Happy days trying to get this to work as was designed/built.

Ahh the rotating swords... not many people recall the issues we had with clay... but you remember my friend... in fact if memory serves me well the ROV sup

I remember. It was a large day rate

plus personnel.

Still operating? Last heard in Iran I believe, Aleron Ltd got the contract to get it going.

I remember joining the umbilical together (twice) so they could go deeper.

I was out on a job in 2001 with sonsub's, and we'd started to run out of parts. CSO were 'good' enough to sell us a parts package they had in stores. What they didn't tell us was said package must have been wet at some point- I opened the crate to find a huge single block of rust where there should have been some track motors, pumps and thrusters!

Only did one trip on 2 with sonsub most of the time I was on 1 with Coflexip Stena

BALDER 1999

The FPSO sailing out of Bouygues subsidiary UIE's Inchgreen facilities in Scotland after modifications.



I was on it modifications are an understatement. Complete shambles but that's what you get when you build on the cheap in Singapore. Brilliant happy Memories

I thought Balder was a barge.....



Call for Papers

Smart Operations: Driving a Lower Carbon Future

The Society for Underwater Technology, The Hydrographic Society in Scotland and The International Marine Contractors Association are jointly holding our annual online seminar in November 2021.

Our businesses continue to operate in mature regions – stable, predictable environments that can generate significant revenue. How we maximise profitability today is a significant contributor to funding lower carbon initiatives.

Mature regions expect a reduction of large greenfield projects – with operator focus shifting toward smart operations: efficient exploration methods, short cycle projects and lower OPEX. This promotes lower development costs, standardised infrastructure and increased utilisation driving production costs down.

Our challenge is to deliver developments in the most efficient & sustainable way possible, maximising value **today, tomorrow** and for the **future**.

Abstracts of 150 words are invited considering the below topics of interest to members of all three societies, with the aim of providing a **20-minute presentation**.

Today's challenges are to promote 'Infrastructure Led Exploration and Development' by considering:

- Data led decision-making
- Conversion of legacy data to digital
- Brown-field remote sensing & detection
- Reservoir monitoring techniques
- Enhanced Oil Recovery
- Re-purposing facilities

Tomorrow's challenges focus on delivering continued value more efficiently from existing facilities by considering:

- Standard tie-back approaches
- Basin data lakes
- Life extension / condition monitoring / inspection
- Economics / effective investment, how and where are the decisions made?
- Carbon footprint of operating, maintaining, and servicing new & existing infrastructure

Future challenges could unlock further value, through reducing cost and risk by considering:

- Un-crewed facilities and vessels
- Decarbonising vessel operations
- Subsea from shore – remote operations and interventions
- Infrastructure sharing agreements
- Simplifying commercial arrangements
- Subsea power generation & storage
- Robotics & Level of Autonomy

Abstracts should be submitted to callforpapers@sut.org by 30 July 2021

All submissions will be acknowledged, and speakers advised by 31st August 2021 if their abstract has been accepted.

Note: Sponsorship opportunities also exist with the option to deliver an elevator pitch.

For more information contact callforpapers@sut.org

Molikpaq 1989

Need to drill and produce in ice environments? Enter the Molikpaq ice resistant structure. Originally built to explore for oil in the Canadian Beaufort Sea, it was mothballed in 1990, later installed in the Astokh area of the Piltun-Astokhskoye field, 16km offshore, on in 1998. The Molikpaq has production capacity of 90,000 barrels per day of oil and 1.7 million cubic meters of associated gas.

Well this was initiator which led to fuel development of Sakhalin 2 . I knew Mr K Taylor who spoke about first hand experiences during installation of the Ice protection Bund , Compaction of inner core and drilling activities ? The ice....Met the designers at Sandwell Engineering Vancouver . Interesting solution which ended up as 2no Mega Platforms seated on GBS's.

Cracking shot of a marvellous piece of ice engineering, and even better example, one of the finest in the industry, of the reuse of an asset from Canada to Russia and still going strong

Amazing unit- attended the upgrade / conversion in Kojé and subsequent installation offshore Sakhalin. Glad she is still going and looking at continued use.

Got lost on there a few times and not by choice

I was on the first well it ever drilled. Very modern for those days. TCP charges and primer cord kept in a bunker out on the ice. Darn polar bears...

I had 6 very good years on the MPQ , the work could be a challenge there sometimes with the low temps and travelling but a fantastic platform and a fantastic team. The MPQ has went through many changes through the years and I believe there is an upgrade on the drilling package ongoing.

I think this was an Earl & Wright design out of the San Francisco head office? I may be mistaken, but my near namesake Earl Permattei was immensely proud of the (ground) ice-breaking structure. Ahead of its time, that's for sure- hence it's later life

I remember when the big four were in the Beaufort and all of different hull design.

The CIDS, now the Orlan
The Molykpaq
The Kulluq (sp?)now scrapped
The SSDC, ???

Did a site-inspection of Molikpaq in the 90s while in Drydock (barge) in Korea before shipping to Sakhalin. Enormous beast. While i was on quayside the alarms went off and we ran to the shelters. Several thousand square metres of scaffolding covering the entire structure detached from the rig and crashed around us. Marathon company man casually turned and said..." and that, my friends, is why it is so cheap to do this work in Korea..."

I remember when I first arrived onboard it in Sakhalin Joe, there was still a lot of construction work ongoing, you really had to keep your wits about you with walkways open to the sea at points! In the end we spent 2 months on it that trip, with daily transfers from a boat on a billy pugh to the helideck, terrifying stuff!

Frozen standpipes, loss annular control of DST strings. Brrrrrrr. Real challenges with winterisation. Plenty pre mob planning for Production tests. Iceberg watch 24/7.

Very Cool, last time I saw her she was surrounded by broken ice in Russia and we were trying to do survival boat training.

Rowan Gorilla VI

Not sure about this. Being towed, you would have thought that the legs would be out of the water so it is likely that the legs have not been installed yet and that it is being towed from Vicksburg to Rowan's Sabine Pass yard in Texas for completion.



GG Here is the VI leaving Dundee January 2021.

SR Spent 5 years on that rig here it is on location in Norway was good times



MM All Rowan rigs built in Vicksburg left the yard with only a starter round of legs and no derrick in order to be able to transit under the bridges on its way into the Gulf. Still a tight fit in some cases depending on hull depth and level of the river during transit. They were then legged up and had the derrick installed in Sabine Pass

RM We used to Jack the legs down a bit and use two Tugs when going

through Bay of Biscay because of the gydro-style swell.

ML Well built heavy metal rigs, they still had the old navy blankets on the beds though, made ya itch just looking at them, and the tannoy system that you heard even in the cabins!. Gorilla 4 had all the Newfie boys off Gt. Yarmouth after the 2 sunk on tow to the N.S. Early 80's Rowan still crew changed the roughnecks outta the US of A!!

Cranes and Derrick not up yet either. Newly out of yard.

JW One of the excellent features missing is the Lee C Moore 2,000,000 SHL Derrick with the Rowan Drilling gorilla logo on the wind walls.

BR My first rig which I joined in June 2000 shortly after this picture was taken. Spent 5 good years on that rig. She's on her way to Sabine Pass for legs and the drilling package.

KOTTER

Lancelot on Kotter

I always smile reading people's anecdotes about working in the extravagant luxury of Lancelot. Here it is providing support to the K/18 Kotter platforms with the Rowan Halifax on the left skidded over the deck.



Malampaya 2001

Shell's Malampaya project featured a deck floatover... onto a concrete gravity base substructure.



Argyll

The pioneer of subsea separation. In 1989, the 56t Pilot was installed subsea by British Offshore Engineering Technology (BOET). Argyll was getting close to the end of its life at the time and was producing around 80% water.



CASTORO SEI

Just completed a major refit.
That was the year it laid the 10in and 12in line for Britoil's Amethyst and the 33km 30 in line for Occidental's Piper field.



112

CLEETON.

One of BP's Villages fields in the Sole Pit Basin
That's about it



113

PENNZOIL K-13/D

In 1988, Pennzoil's K/13-D wellhead platform became the first platform to be removed in the Dutch sector of the North Sea. It was originally installed in 1978.

Upon removal, it was refurbished by Grootint and installed on Pennzoil's L/8-H platform



Sedco 711

Once of the workhorse semisubs of the 80s and 90s.

Brother involved in the build of 711 in Korea, the 713 became the Sea Explorer which I worked on for a number of years from 1985

701, 707, 710, 711, 712 & 714...great Rigs. Many great work memories for my dad and myself supporting Sedco, Schl. Sedco Forex, and latterly Transocean with crane inspection and maintenance services. Great

crews. The good old days The first rig I worked on in 1987 for BP. Great introduction to the oilfield and great crews on board.

Two amazing years (1990-1992) running the 711 on secondment from BP. A center for continuous learning and the fastest wells in the CNS at the time. I have a souvenir from her scrapping.

711 = 713 = sister vessels on long term contract to BP in North Sea from @ 1983-85?

711 owned by Sedco built in Korea much quicker than 713 built at Scott Lithgow much more slowly and owned by BP initially. 713 was named Sea Explorer and BP created an independent rig contracting company. Management buyout proposed- never achieved. Both rigs represented cutting edge drilling technology in that era.





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