
UT TWO
UNDERWATER TECHNOLOGY
VORTEX SERIAL NO
VMST-02-HP
4
4
3
ISSUE 4 2023
SUT
Society for Underwater Technology
MTS
marine technology society

SUT
Society for Underwater Technology

SOCIETY FOR
UNDERWATER TECHNOLOGY

Vol 17 No 4

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

Editorial Assistant:
Herb Garden

Production:
Sue Denham

Advertising:
Zinat Hassan
UT3subsea@gmail.com

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

Published by UT2 Publishing for and on behalf of the Society for Underwater Technology.

MTS marine technology society

Vortex: High pressure gas sample tool

ROTOTECH TDC SUBSEA MOU

TSC Subsea, a technology-enabled inspection vendor that specialises in challenging subsea NDT, has announced the signing of a significant memorandum of understanding (MOU) with Rototech.

Singapore-based company Rototech has an expertise in marine robotics, focusing on inspecting and repairing various types of marine assets.

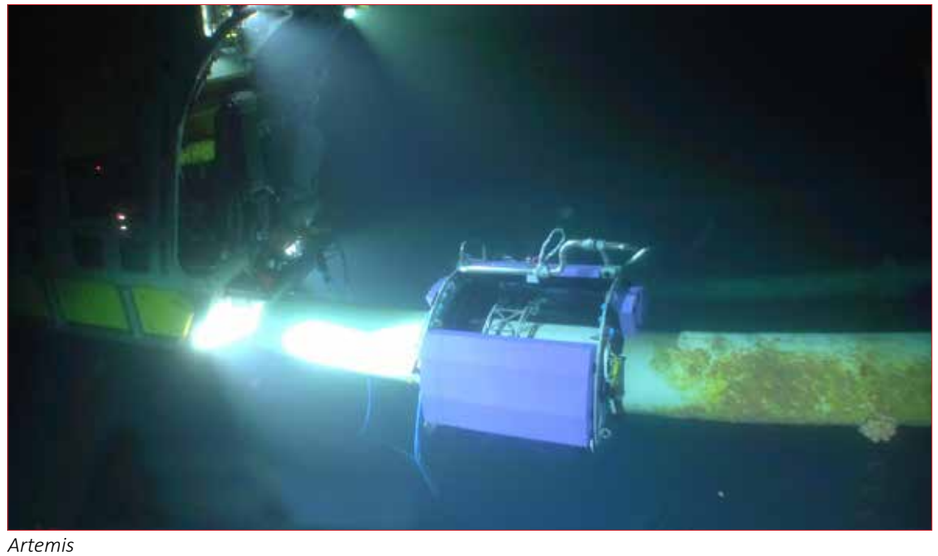
This strategic collaboration brings together TSC Subsea's proprietary inspection technology and Rototech's cutting-edge automated robotic carriers. The joint efforts of both companies are directed towards offering subsea asset owners across the globe, a solution for efficiently cleaning and conducting non-destructive testing (NDT) on their vertical risers.

Notably, this collaboration enables high-resolution inspections even when dealing with thick neoprene and composite coatings.

Simon Hartog, the Managing Director of Rototech, expressed his enthusiasm about the partnership, stating that combining TSC Subsea's advanced NDT inspection technology and Rototech's innovative robotic carriers will prove to be a winning solution to subsea asset owners worldwide.

Jonathan Bancroft, Sales Director of TSC Subsea, said that the new collaboration opens up new horizons for its proprietary advanced technologies, including Acoustic Resonance Technology (ART).

"Having a solution which operates in the splash zone that can automatically crawl, clean and inspect vertical risers will bring many benefits and cost savings to customers," he continued.



Artemis

MACARTNEY RENEWS TELEDYNE AGREEMENT

MacArtney has recently renewed and expanded its distributor agreement with Teledyne Marine for ODI connectors. This strategic partnership aims to offer comprehensive connectivity solutions to customers in maritime industries.

With a focus on adding value to the ODI products, MacArtney aims to leverage its existing client base and explore new opportunities.

COVERING THE ODI RANGE

The products included in this partnership are all Teledyne ODI products, including Electrical, Fibre Optic and Hybrid Connectors and Cables, Penetrators, Field-Installable Termination Assemblies (FITAs), Field Assembled Cable Termination (FACT), and related ancillary products.

MacArtney is leveraging its connectivity solutions with ODI.

The ODI connector range is available through MacArtney operations in Australia, Canada, Denmark, Germany, France, Benelux, Italy, Norway, Sweden, Singapore, the UK and the USA.

The connectivity programme includes complete system solutions, project management expertise and moulding and production capabilities.

Furthermore, MacArtney's pressure tanks now have up to 1400 bar capabilities (full ocean depth), adding a 30% safety factor to absolute max water depth enabling them to meet the increasingly demanding requirements of underwater applications.

STATS

STATS Group has been acquired by Mitsui. The takeover is complementary to Mitsui's medium term management plan for "transformation and growth" and specifically its intention to establish a strong presence in the pipeline maintenance market as a service provider.

The transaction, is subject to regulatory competition clearances.

TENARIS

Tenaris has acquired the oil and gas division of the company isOplus, a producer of pre-insulated pipeline systems for district heating and anti-corrosion coatings in Europe.

The $10 million acquired business unit, will now come under the name of Tenaris Coating Italy, which specialises in anti-corrosion coatings for oil and gas pipelines.

FRAZER NASH

Frazer-Nash Consultancy has joined forces with change management business Harmonic as well as digital transformation specialists VIMA Group.

The move will create a combined workforce of around 1300 in offices throughout the UK, and will see an increased focus on innovation and the creation of new strategic advisory capabilities.

Frazer-Nash, Harmonic and VIMA were acquired by KBR across 2021 and 2022.

BRAZILLIAN CONTRACT

C-Kore Systems recently delivered their automated subsea testing tools for a large subsea construction campaign in Brazilian waters.

The C-Kore tools will be used to perform the subsea electrical verification of new umbilicals after installation.

C-Kore's subsea testing tools are used by operators and installation contractors around the world on both installation campaigns and fault-finding operations. The Cable Monitor unit confirms the insulation resistance and continuity of the electrical lines while the Subsea TDR unit localises anomalies along the line.

C-Kore's new Subsea Optical TDR can now verify the subsea fiber optics as well. With C-Kore's automated units and live online training, no additional offshore personnel are required to operate the equipment.

Diego Baraldi, Sales Manager – South America for C-Kore commented, "After our successful work on the Mero 1 project, we are delighted to work on this important campaign. Our tools are easy to use and do not require any specialist offshore personnel, saving our customers time and money on their offshore operations".

Cynthia Pikaar, Sales Manager for C-Kore continued, "We are very excited about the continued work we are doing in Brazil as it is an important market with its deeper water projects.

It is great to see the acceptance of our technology by operators and installation contractors. The automation of our tools simplifies the subsea testing for our customers. We look forward to the continued cooperation with our Brazilian customers."

OFFSHORE WIND CONTRACT

Offshore energy supply chain company, Balmoral, has adapted and transitioned a number of its proven buoyancy and protection solutions for use in the fixed and floating offshore wind sector.

A recent multi-million pound contract award for a fixed wind cable protection system (CPS) in UK waters has further enhanced the company's order books and demonstrates customer confidence in Balmoral's technology, according to sales director, Gary Yeoman.

OFFSHORE WIND CONTRACT Contd

He said: “While our oil and gas activity remains robust, more than 60% of current enquiries relate to renewables projects while over the past year around 40% of order intake has come directly from the offshore wind sector.

“Proven technologies such as our cable protection systems, distributed buoyancy and tether clamps have been welcomed by the renewables industry and, as such, we are well placed to meet local content criteria for the forthcoming Scotwind and INTOG projects with discussions continuing at pace with developers, installation contractors and cable suppliers.”

These core products have been readily accepted by the wind sector that is keen to build an experienced and reliable supply chain.

Engineering and projects director, Fraser Milne, said: “It is understood that the offshore wind sector is at the early stages of development with many challenges to overcome. We believe our track record of innovation and entrepreneurship positions us well to assist in this process.

“Being able to offer our clients support and advice on their projects including 3D modelling, hydrodynamic engineering and finite element analysis, as well as laboratory and testing services, puts us in a unique position”, Mr Milne said.

“We utilise our 40+ years’ experience in offshore product design and manufacture to ensure our portfolio meets the distinctive demands of offshore renewables. This is supported by a roadmap of new innovations being released with the Balmoral HexDefence scour protection system being a recent example.

“Offshore wind is currently receiving most attention but our products are designed for the wider sector including wave and tidal current energy.

“Being ‘Fit For Offshore Renewables’ (F4OR) accredited, on top of our ISO 45001:2018 and ISO 9001:2015 certification, instils a high level of confidence in our design, manufacturing and testing capabilities.”
Balmoral is also certified by Bureau Veritas in accordance with API 17L and uses this as a basis for its renewables portfolio. Although this is an oil and gas specification the renewables sector recognises it due to a lack of current standards in the developing market.

OCEANTECHJOBS

A new recruitment business focussed on OceanTech has officially launched buy OceanTechJobs.com was founded by career Ocean Technologist Martin Stemp (also CEO of RS Aqua) and career technical recruiter Matt Rickett

Called OceanTechJobs.com, this new online platform and recruitment business is focused on Ocean Technology only, with the sole purpose of connecting job seekers with the world’s leading OceanTech employers.

The company says that it will change the way professionals access the job market, apply for the latest roles and to thrive in the Ocean Technology Sector.

With a user-friendly interface and powerful search tools, the platform makes finding the perfect OceanTech job simpler and more efficient than ever before. Ocean Technology employers can advertise roles through OceanTech Jobs, and can also utilise the Executive Search (head-hunting) services.

It boasts an extensive database of job openings across the ocean technology sector, including: marine robotics, ocean engineering, renewable energy, ocean science, with positions ranging from graduate to executive roles.

There is also a section where applicants can gain valuable insights into leading companies and organisations at the forefront of ocean technology. Learn about company culture, mission, projects, and growth prospects to make informed career decisions.

JAPAN WIND ENERGY

Japan’s expanding offshore wind industry has added a further Seaeye Falcon underwater robot as a key operational resource for working in complex environments.

Tokyo based systems provider Marimex says Japan’s wind power construction operators value the Falcon for being a compact and powerful robot that is ideally suited for shallow waters and strong currents.

The small footprint of the metre-sized Falcon is also important for offshore energy operators as construction is carried out using fleets of small service vessels needed in shallow waters.

Growth in Japan’s offshore wind power construction comes as the Japanese Government seeks to achieve carbon neutrality by 2050.

Marimex says that the Falcon’s broad operational capability means that not only can it be used for preliminary surveys, but also for post-construction maintenance monitoring and many other applications.

As the world’s top selling robotic vehicle in its class, the Falcon has a reliability record covering over a million hours underwater.

The success of the highly portable Falcon comes from combining intelligent control architecture with five powerful thrusters to enable precise manoeuvrability in turbulent waters amongst complex structures, whilst loaded with a wide range of cameras, sensors and tooling, typically found on much larger robotic vehicles.

ARCTIC-BOUND

Ocean Warrior

VALEPORT SUPPORTS THE OCEAN WARRIOR PROJECT TO EXPAND MARINE SCIENCE FRONTIERS WITH FOUNDATION EXPEDITIONS

A unique voyage to build a greater scientific understanding of the marine environment in the Arctic and the impacts of global climate change will see a team of scientists and 'citizen scientists' setting sail from Svalbard at the start of September aboard Europe's largest wooden schooner.

Ocean Warrior is the brainchild of internationally-renowned explorer, Jim McNeill, who has been running scientific expeditions to the Arctic for over two decades and has acted as a consultant for natural history programmes such as the BBC's Frozen Planet.

Designed to collect critical scientific measurements from remote areas of the Arctic Ocean in order to build up an improved picture of the changes taking place due to climate change and other factors, Ocean Warrior will also help to 'ground-truth' data collected via satellites.

For the first ten-day leg of the expedition (departing Svalbard on September 1st with a subsequent departure on September 11th), the 18-strong team, including crew members, scientists and citizen scientists are tasked with building an understanding of the vessel and her capabilities, in order that the potential for scientific data capture can be maximised.

The expedition aims to install and test scientific and technological equipment such as weather stations, FerryBox, CTD, Bathymetry, Communications, and Safety. Additionally, an online dashboard will be created to convey the findings and capture stories through digital and broadcast content capture.

The project is being supported by Plymouth Marine Laboratory (PML), Valeport, (which designs and manufactures oceanographic and hydrographic instrumentation), Mole Energy, Dartmoor Brewery and Henri Lloyd.

Travelling to seldom-visited areas of the Ocean each year between June and October, Ocean Warrior intends to cover 10,000 nautical miles each year, over the next ten years, collecting data on a range of key 'indicators' – in areas such as water quality, plankton, eDNA, salinity and ocean acidity.

This will help scientists gain a clearer understanding of the pace of changes taking place, their impacts on marine ecosystems, and what the future may hold for the Arctic region and the wildlife, populations and economies which depend upon it.

Guy Frankland, Head of Marketing at Valeport, said:"We understand the pressing importance of expeditions such as this, and are proud to be supporting Ocean Warrior with the provision of our leading-edge marine sensing and monitoring equipment.

On board the project team will be using our SWiFT CTDplus profiler to gather important data. High quality, precision data is fundamental to the expedition's success, enabling the team to measure and benchmark environmental change as the project develops."

IN-LINE BUOYANCY

MOORING DEVELOPED FOR FLOATING WIND AND SURF SECTORS

Balmoral's in-line mooring buoyancy system is designed to secure floating wind turbines and other structures to a seabed anchor whilst providing uplift to the mooring line. It can also act as a connection point between the bottom and top sections of the line while allowing trajectory and tension to be controlled within the water column.

Traditional mooring systems feature a pendulum fixture using a tri-plate and buoyancy module secured via a padeye at the base of the steelwork which gives an offset centre of buoyancy.

Balmoral's engineers identified that the biggest vulnerability of this system was fatigue failure due to the offset loads so, to mitigate against this and change the load transfer characteristics, developed a proprietary in-line mooring buoy.

The company's in-line system features a dynamic connection interface that allows the different sections of the mooring lines to be tethered securely and responsively without adversely loading the buoyancy structure.

Central steelwork passing through the dynamic connection, with buoyancy elements mounted on either side, results in the key interface between components being at the centre of the assembly.

This brings a number of unique advantages that include movement minimisation, buoyancy load transfer isolation, fatigue reduction and a distinctly more stable solution for floating wind turbines, FPSOs and other subsea tether connections.

The company's engineering manager, Craig Sharp, said: "Our robust design process considers the combination of material characteristics and associated design controls, derived from detailed analysis, which allows us to supply the most cost effective and fit for purpose solution.

"Our in-line mooring solutions are designed in accordance with all relevant industry standards while we have also worked hand-in-hand with clients to deliver their third party approved designs across a number of projects.

"As they are provided in modular fashion our mooring buoyancy systems can be configured to suit specific project uplift requirements."

IN-LINE MOORING BUOYANCY BENEFITS

- Lower number of components and connections
- Increased reliability with fewer potential failure points
- Reduced risk of wear
- Decreased dynamic loads on mooring points compared to traditional pendant line connection
- Improved fatigue life characteristics
- Easier handling with lift points acting through the centre of mass eliminating unwanted bending loads
- Enhanced access to mooring connections for inspection during service life

Balmoral's in-line mooring system features a dynamic connection interface that allows different sections of the mooring lines to be tethered securely without adversely loading the buoyancy structure

SUBSEA DREDGING

WORLD-CLASS SOLUTIONS DELIVERED BY VORTEX INTERNATIONAL

Joe Goodin is a classic entrepreneur and out-of-the-box thinker. An engineer by trade, Joe first had the idea of starting his own business when working as an ROV Operator off the west coast of Taranaki, New Zealand. Here, he experienced the need for a more powerful and effective dredge solution to assist with the excavation of seabed sand, gravel, clay and rock – essentially an underwater vacuum cleaner.

Joe said: “The performance, portability and variety of dredge solutions to choose from back then just weren’t available in the market, and based on my inquisitive nature and passion for solving problems, I embarked on developing my own dredge system with the intention of being far superior to anything else out there.”

After years of hard work and the development of many prototypes, the Vortex ROV dredge was born. Today, the Vortex ROV dredge is available in a range of sizes from 2-8ins and is exclusively available from Ashtead Technology.

Ashtead Technology first partnered with Vortex International in 2009 to further strengthen its subsea equipment rental fleet and specifically its ROV tooling capability. Vortex was looking for a rental partner to take its new ROV dredge unit to market and selected Ashtead Technology based on its reputation and international reach.

Joe said: “I learned hard lessons about choosing the best company to partner with and selected Ashtead Technology as it is well regarded for having the most modern, high-performing equipment fleet in the industry and has locations in all key offshore energy hubs. That was back in 2009, and now, through Ashtead Technology, Vortex has access to all of the tier-one energy companies around the world as well as the fast-growing offshore wind market.”

A key feature of the Vortex dredge is the patented Vortex venturi which through years of development has proven to be one of the most powerful and effective in the market with 100kpa of inlet suction. Higher suction and water flow provides greater productivity leading to a typical reduction in overall operating costs. Joe developed numerous prototypes which were each rigorously trialled in the water or in test tanks to prove their removal rates.

This extensive real-world testing has resulted in the high-performance Vortex venturi which forms the base technology for all of their dredge systems whether electric or hydraulic driven.

He added: “Having a point of difference is critical in any market and holding claim to the most powerful dredge in the world has not been without challenges over the years so investing in maintaining patent protection has been extremely valuable for Vortex at the highest levels of contestability.”

THE VORTEX EVOLUTION

Vortex has grown in size and capabilities over the years, more than doubling inventory and revenue as even more innovation flows out of their New Zealand-based operation. Now over 15 years on, Vortex’s subsea

8in Black Hole dredge with patented Vortex Venturi. They are simple reliable and powerful

High pressure gas sample tool. There are single and multiple bottle models

tool range for ROVs has grown extensively to include winches that carry 3D scanning, survey tools and cutting equipment for the decommissioning of oil fields and offshore wind farms and marine growth samplers to capture and assess biology on natural and manmade structures.

Joe said: “We only release a new tool if it performs a task better or more efficiently than what is out there currently. The range is changing all the time and if there is a need and it doesn’t exist, we will engineer it.

"Based on the nature and size of our business and the accessibility of our equipment through Ashtead Technology, we can respond immediately to a specific customer requirement, developing custom solutions to meet any operational challenge. This is particularly pertinent to the growing offshore wind market where speed, reliability and cost efficiency are crucial.

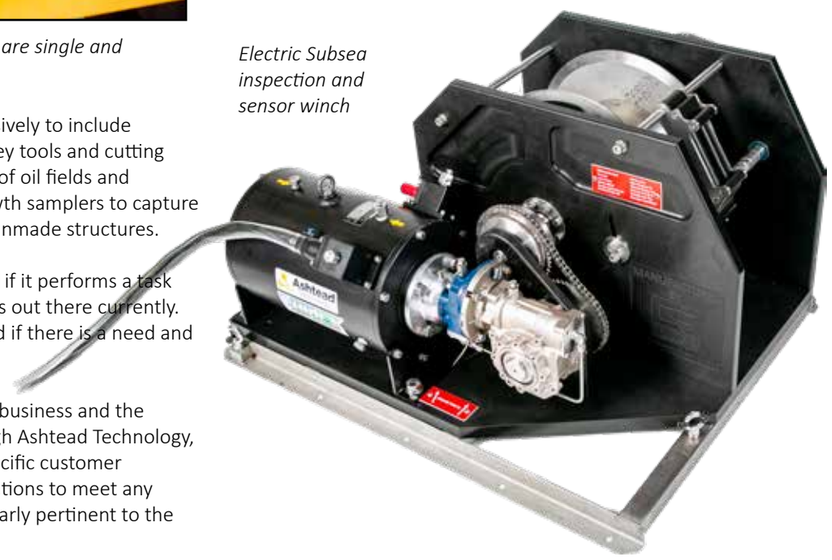
“A great example of this is when Ashtead Technology approached us to develop a survey winch with sensors suitable for subsea use. Nothing existed in the market already to fit the exact nature of the requirement and we designed a product using acetal and stainless steel to reduce the weight of the winch whilst increasing its strength and reliability.

"Based on market demand, there are now three different models of this winch which play a critical role in offshore wind farm construction, the inspection of wellheads and the lowering of sensors and cameras into dangerous voids where the ROV or diver can’t reach.

“The development of our gas sample tools is another example of our ingenuity in action which help to capture and recover high pressure gas samples in single and multiple bottles.

"We have had numerous calls from customers wanting to capture gas samples for decommissioning purposes which when using the Vortex gas sampling tools, can ensure the safe and efficient capture of gasses in their natural state for high accuracy scientific analysis.”

Electric Subsea inspection and sensor winch



UNDERWATER UNDERWRITING

SPECIALIST INSURANCE FOR A ROBOTICS MARKET

For many years, Lloyd's Underwriter Keith Broughton has been underwriting for Beazley Leviathan and providing specialist cover to the underwater robotics market. He recently discussed how he approached formulating policies in this niche sector.

"The basic aim of subsea insurance is to provide financial protection to underwater equipment operators working in some of the most difficult environments," he said. "We insure anything that goes under the water to carry out a task but doesn't occupy a fixed location. This typically translates as vessels or vehicles, crewed or uncrewed, and working in the area of oil and gas, research, development and harvesting (although not deep sea mining).

"There is no such thing as a standard marine insurance policy and conversely, not all marine insurance companies insure against the same risks. At the outset, it is vital that everyone involved is clear about what we are trying to insure against and to do this, we have to recognise of all the other things surrounding it that can affect its normal operation.

"Often, this not only means looking at equipment or vehicle items themselves, but quite possibly the hulls (vessels) that deploy them. The policy might need to incorporate general third-party liabilities.

"Most of our inquiries are probably from clients looking to insure their ROVs, however, this covers a large range of vehicles. Some are very small handbag-sized devices, however, the same term describes enormous 350t, tracked, diamond mining machines. In most cases, the vehicles do not look the same, are deployed differently and have to carry out very different tasks but at some point, they are all grouped as 'underwater equipment'. To complicate matters, some vehicles are large enough to deploy their own vehicles and operators may wish cover them on the same policy.

"In order to provide suitable cover, we have to fully understand the areas of work in which they operate and specifically, what they will be required to do.

Over the years, their use in the telecoms, renewables, oil and gas, research and sometimes even in the military, have become quite well understood, but as technology improves, vehicles are often asked to do more and operate beyond their conventional sphere of work, which in turn requires extra attention.

"Most subsea equipment we are asked to underwrite is ship-deployed. The rules governing this are based on a major piece of legislation- the 1906 Marine Insurance Act. This means that we are essentially looking to cover a maritime risk although if the equipment is located on the seabed and particularly if used to for hydrocarbon development, the law changes."

PERILS

One of the most important considerations is to understand the potential hazards that the equipment is likely to face.

"One way to approach this is to list the 'named perils' that the policy explicitly needs to cover," said Broughton.

"In a domestic policy, for example named perils may simply encompass fire or theft. As underwater specialists, however, we may have to include items such as water depth, tide, current, weather, fire and crew negligence as named perils, perhaps with additional clauses to cover collisions, etc."

In recent years, the opening of the renewables sector and the need to connect the wind turbines to shore by running cables across the seabed has increasingly uncovered an old peril that has come to the fore- namely, unexploded ordnance.

This is particularly relevant to work around the UK coast and the East Coast of the US which not only saw enemy bombs and mines dropped into the sea to disrupt shipping, but also later at the end of both WW1 and WW2, becoming the site of munitions dumping. The West Coast of the US and throughout the Asia Pacific region are also often challenging areas from a UXO perspective.

"Because ship-deployed systems may have a large number of perils to deal with, it is common to use a bespoke or 'all- risks' form, said Broughton.

"The main difference between an 'all risks' form and a 'named perils' form is that on the former, the burden of proof lies with the Underwriter to disprove a claim not for the owner to prove his claim, and unless a peril or proximate cause is specifically excluded, coverage will be there."

INSURANCE TERMS

KNOCK FOR KNOCK

An arrangement where each party assumes liability for loss of or damage to its own property and liability for personal injury of their own employees.

"It is designed to protect against small damages," said Broughton. "Parties are fundamentally saying they won't pursue the other for consequential loss although this sometimes differs and consequential loss may be excluded unless the service contract contains a financial cap on the on the contractors liability

CONSTRUCTIONAL RISK

Another type of insurance is the Construction All Risks (CAR) policy- a limited form of liability. Specifically, offshore and subsea contractors may want some sort of marine employer's liability cover for their own employees arising from marine and offshore activities. That cover may be excluded under contractor's insurance.

The CAR policy would include liability for liquidated damages or other financial losses that may rise from the construction activities but exclude liability coverage arising from the deployment of watercraft assets.

Sometimes, insurance is arranged by the client operator to extend for the benefit to contractors, subcontractors and everyone involved in the construction projects. It is often, however, not as clear as it could be in terms of the rights of the constructors and subcontractors under that project insurance.

The Lloyds of London Building

RISK ASSESSMENT

"In assessing a risk, we have to use our experience to either speculate or calculate what can possibly affect the operation. Water depth is particularly important," continued Broughton.

"Many ROVs are capable of working in 3000m waters. While once unimaginably deep, working at 3000m has become relatively common on the oil and gas sector, eg, installing a wellhead. Deep diving is also practiced in the scientific sector eg, looking at a black smoker. All things being equal, a coverage for equipment used in the oil and gas industry are seen as less high risk simply because of the greater structure of procedures and the experience of the operators.

"At those water depths, if something is lost, we have to think about retrieving the vehicle as quickly as possible. If dissimilar metals are immersed for too long and the amount of corrosion will increase.

"Retrieving the vehicle, therefore, becomes important. In one example, an ROV was lost in hot springs in Sicily, 1800m below the surface. After 18 months, it was eventually recovered and still relatively unharmed but this is the exception not the rule. Normally, this would be encrusted in barnacles and marine growth but not in this case. We were able to pass it to the owners who were able to repair and return it to work.

"In the deeper oceans, however, we have to deal a marine environment in which we are transgressor. As such, we have to be completely aware of the damage that we can cause marine life and that they can cause us. In one case, a shark bit into an umbilical and unfortunately electrocuted itself but in doing so also destroyed the ROV. These sort of incidents are difficult to predict.

"In general, the more innovative the equipment is the more inventive we have to be to think of what can go wrong but more importantly, how we can learn from it.

"One example, an AUV – at the time representing very new technology – was perfectly programmed to carry out a task. The master of the support vessel was also totally aware of what it was doing, but the two effectively weren't told the same story.

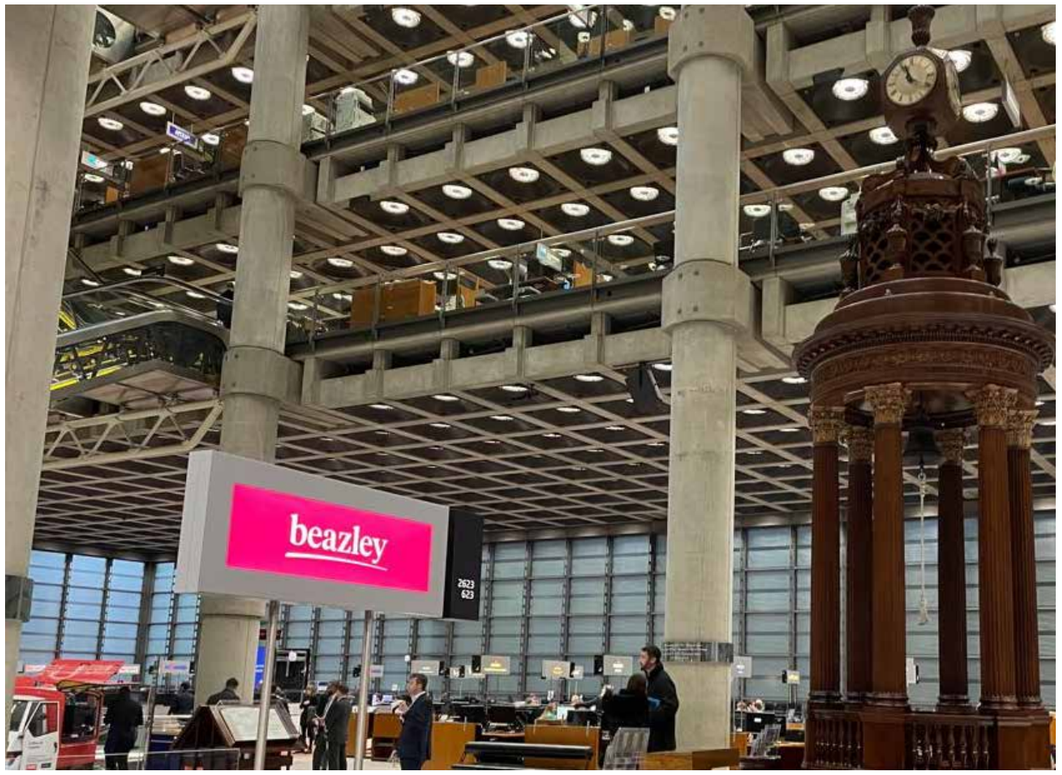
"As a result, the vessel did exactly what it should have done, as did the AUV. Unfortunately, the underwater vehicle collided with the ship's propeller. It was in the water for 90 seconds and we paid out $2.5 million, for a new one. Fortunately, they never made that mistake again.

"The burden of proof in an 'all risk' form is on the underwriter to pay. Importantly, we don't cover 'wear and tear' or if failure to perform was due to the design having a latent defect and it was just not ready to go in the water in the first place.

"What we do cover, however, is negligence.

"It is also important to be flexible. Even though some policies have named exclusions, it is often possible to negotiate. We wouldn't want to cover an ROV operating near a blow-out, but we could negotiate up to a point where it may be used to monitor the blow-out."

The Beazley desk at Lloyds



AUTONOMY

"In order to look at the most appropriate way to insure someone, we have to understand what they are trying to achieve. This specifically becomes important when we're looking at autonomy," said Broughton.

"We had some poor results in the early days of insuring equipment because we didn't really understand what the end users, were trying to achieve from autonomy. We soon found that the equipment was actually better than the people who were operating it.

"We are now going through the same learning phase with autonomous surface vessels as we did with autonomous vehicles although now, the general understanding from everyone involved is significantly greater and the consequent risk is less.

SUE AND LABOUR

Most policies only cover damage, however, there is an element in the 1906 Marine Insurance Act called "Sue and Labour". This extends the insurance to cover costs incurred by the policyholder in preventing a loss from occurring or reducing one that could not be avoided.

"If the unit is damaged beyond repair, we would pay the value of the unit but we would not pay for the removal of the wreck."

CORROSION and Bluestream have launched the 'ICCP-SAM' for the sustainable protection of XX(X)L monopile foundations against corrosion worldwide.

The ICCP-SAM is specifically designed to remotely install ICCP anodes on monopile foundations of all sizes, anywhere on the foundation and even in the roughest ocean conditions.

The ICCP-SAM (Subsea Assembly Method) is extremely compact and can be transported and deployed with minimal resources from the topside of the offshore foundation.

The ICCP-SAM is operated remotely and maneuvers the anode underwater into the designated foundation entry hole. The anode is then secured to the foundation using the same tool. One of the biggest benefits is that an anode can be replaced in the same way throughout the lifetime of the foundation. Even more important, it eliminates the need for diving.

In addition to its infinite applicability to protect monopile foundations of all sizes worldwide, this method of installation leads to major savings in time and money.

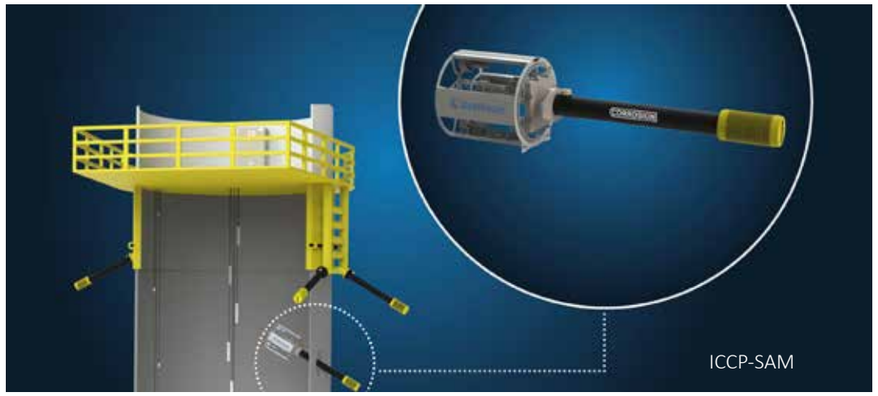
Unlike traditional methods which require larger installation vessels and a significant amount of secondary steel or a vulnerable CPS construction, this new installation method comes only with a few design requirements and does not require large supply vessels. Another major advantage is that every type of monopile can now be protected in an environmentally friendly way during its entire lifespan.

NATIONAL SUBSEA CENTRE COLLABORATES TO DELIVER AI

The National Subsea Centre (NSC) and Robert Gordon University (RGU) have teamed up to deliver a data project to transform how subsea inspections are carried out.

The Subsea AI Body of Knowledge project, also referred to as SAIBOK, has been carried out with the support of the Net Zero Technology Centre (NZTC) and is the result of a collaboration between the NSC and RGU's School of Computing, alongside industry partners TotalEnergies, BP, Chevron, Intel and Xodus.

With the NSC and RGU's expertise in advanced Artificial Intelligence (AI) and its neutral position for stewarding industry data, paired with industry experts by NZTC, SAIBOK has leveraged cutting-edge AI and machine learning technologies to accurately train algorithms to detect and interpret anomalies within a group of subsea inspection images.



Automation is the direction of travel for offshore surveys in the drive to reduce emissions. This project could result in the deployment of automated unmanned vehicles with real-time anomaly detection and interpretation capabilities driven by the SAIBOK algorithms.

Aggregating and anonymising datasets from various sources has enabled for a broader training dataset for AI than what would otherwise have been possible within individual company silos. This is an example of successful data sharing within the energy industry and the mutual value that can be achieved from such partnership.

The result of joining forces underscores the importance of data sharing, demonstrating the potential to greatly propel AI advancements in the energy industry and facilitate the digital transformation of ongoing practices into more data-oriented and intelligent solutions.

Professor John McCall, NSC Director said: "We're aiming to bring together industry datasets in a way that will accelerate our capability to understand subsea and marine activities, including supporting infrastructures and surrounding environments, using the full range of state-of-the-art platforms and sources for data acquisition, visualisation, analysis, interpretation and prediction".

INSTALLATION

Bubble curtains

Over the past few tens of millions of years, whales discovered that if they swam down to the seabed and encircled shoals of small fish while slowly exhaling, they could produce a wall of bubbles. This would confine the fish to a restricted cell allowing them to be devoured *en masse*.

Today, bubble curtains are used for quite another reason entirely although coincidentally equally beneficial to whales and other aquatic mammals.

The global renewable industry has seen the recent introduction of offshore turbines to harness the wind energy. These are normally installed by placing a steel monopile onto the seabed and hammering it down a measured distance until it forms a stable foundation on which the turbine can be placed. The sound of this percussive hammering can pose a problem.

“Underwater sound can travel extremely long distances,” said Jonathan Schmidt of acoustic mitigation consultancy Hydrotechnik.

“Sound is essentially a pressure wave but in water, this can travel distances of many tens of kilometres with the volume (amplitude) only barely diminished. The unfamiliar sound can attract curious sea mammals, particularly whales, possibly disorienting them and this has been linked to the deaths of many cetaceans, particularly along the North American coast."

Underwater noise has been logged as a potential problem for marine life for many decades.

Hoses deployed from surface vessels that, when submerged, form the bubble curtains

“The technology surrounding underwater acoustics is very complicated,” said Schmidt.

"Companies have recently developed ‘near-field systems such as pile hammer dampeners and noise mitigation sleeves that envelop the monopile being installed, but for many years, the cheapest and most universal strategy of reducing noise is the use of passive or ‘far field’ systems, namely, bubble curtains."

Bubble curtains are produced from tubing pre-laid on the seabed. When pumped with air, these produce a wall of bubbles that inhibit the passage of acoustic waves through them. The actual technology was invented some time ago by the underwater decommissioning and demolition industry for underwater explosives to remove rock.

“We used bubble curtains routinely to contain the sounds and protect our underwater machinery” said Cay Grunau of Hydrotechnik.

“About 12 years ago, the German government wanted to licence the first wind farms and in preparation, planned to build a scientific station approximately 80km from the coast to conduct tests. It soon discovered that this planned structure lay in the heartland of the breeding grounds for whales. The scientists immediately realised that they needed to protect the young calf whales from these sounds.

“We got a telephone call on Friday morning from the government and by Friday evening, we had people in our workshop where I could explain to them how it could be done,” said Grunau. "Within six weeks, we were ready with the first bubble curtain."

EQUIPMENT

“The bubbles are formed using perforated flexible hose that is pre-laid on the seabed,” said Barry Craig of ScanTech Offshore, the James Fisher subsidiary focussing on offshore services. “Nozzles on this hose are directed outwards at various angles so no matter how it ends up on the seabed, air can always escape.

“The hose consists of several layers of rubber with a steel inlay. In order to allow a sufficient pressure rating, eternal steel straps are often added to always keep the line under tension.

"It is normally spooled off the stern of the vessel, but in operation, the air-filled line is positively buoyant, and it is often necessary to add more weight.

“The air comes from compressors on the boat. For years, we provided generators, pumps compressors to the offshore industry and were looking to find ways to enter the renewables market. Working with Hydrotechnik has proved to be a good fit.

“Our equipment already met the necessary environmental compliance – the compressed air that we can put into the water has to be free of oil, so we have established filter systems that basically guarantee

there's no contaminants, even fumes in the air or water. We build our own systems rather than having to buy the compressors in.

“Owning and having full control of the entire process train has let us constantly improve the system. This effectively translates as getting as much air in the water as possible because this leads to better noise mitigation. There are some things, however, that experience has told us that we can’t control. This includes the size of the bubbles.

“Any diver who has worked and maintenance for permanent installations where bubbles escape into the water will testify that as soon as the compressed air has left the hose or the nozzle, it is difficult to influence anymore.

"The air bubbles change as they rise through the water column because the hydrostatic pressure decreases causing the gas to expand. The bubbles, however, can coalesce to form larger bubbles or conversely, divide into smaller bubbles.

“A more effective way to improve noise mitigation, is to have more than one bubble wall ¬ an inner and outer curtain. This double arrangement is now very popular and required by law in German waters.”

It is one thing for the sound to go from the dense medium, (the water), into the bubble water mixture but for this to repeated and to go back into the water and then into another curtain has a notable effect on the pressure wave.

“There is still some doubt about exactly how the bubble curtain mitigates the sound,” said Schmidt, “but it is likely to be a combination

Hoses being deployed from surface vessels

of air ‘wall’ disturbing the passage of the sound across the bubble barrier and reflecting the sound backwards. The bubble is also constantly vibrating and able to absorb the pressure but putting more air into the water definitely improves the noise mitigation.”

“A variation in bubble sizes also works to our favour,” continued Grunau, “because bubbles are mitigating sounds of different frequencies. A noise is a spectrum of frequencies. We are very effective with noise frequencies and can reduce up to 95% of the noise emission

DEPLOYMENT
"The water depth at which fixed-bottom offshore wind foundations become uneconomic, and floating systems start to appear is typically anywhere between 40 and 80m. “In theory, we could make bubble curtains in much deeper waters, but this would require a commensurate pressure to reach the seabed in order to introduce the air to the hoses. This would put even more demand on the compressor sets. It would need more space on the vessel,” said Craig.

“Another important consideration is that the deeper the waters, the more time there is for the rising bubbles to drift horizontally in response to any underwater currents that may be present.”

“We are constantly evolving our systems as the industry changes,” continued Grunau. “The diameter of the monopiles being installed is consistently increasing. Around 6-7 years ago, the pile diameter was perhaps 5-6m diameter. Today, some are closer to 10m, and it won’t be too long before they reach 12 or 15m. The noise produced by installing these will increase accordingly and as a noise mitigation supplier, we also need to improve and come up with new solutions. And this is exactly what we are doing.”

So, are bubble curtains mandatory?
“Whales naturally usually don't stick to German waters and migrate up through the North Sea”, said Schmidt. The Germans started with bubble curtains and the Netherlands, Belgium and Denmark quickly followed by other countries.

“It is now common in Taiwan and the recent cases with whales beaching in the northeast USA. The UK is a major exception where bubble curtains are "not required" to be used. There is an option within their legislation.

“We are not sure why, but this reason seems obscure. We have prepared on a number of times to be ready for these projects and somehow, they're getting 'some form of noise verification' back that confirms that the bubble curtain is not required anymore in the UK for this certain project.”

3D PRINTED CONCRETE MOORING

3D printing is becoming a very well-accepted technique for manufacturing bespoke structures. It has been used to print items in various grades of plastic and the concept was adapted for companies to manufacture items such as large crane hooks in metal. Elsewhere, companies have used the general technique for building houses in concrete. Recently, technology company RCAM Technologies has begun developing 3D concrete printing for subsea moorings.

"With costs rising and projects being cancelled, the wind industry has to change the way it operates and part of the equation is reducing costs," said Jason Cotrell, CEO of RCAM. "The wind sector can't afford to fail and this means looking for ways to carry out traditional operations more economically, possibly by introducing already proven techniques from other sectors.

“Project economics all comes down to cost and inflation. This takes in such subjects as commodities, interest rates and labour. We can't really do much about interest rates, but we can develop products that use less expensive materials and that are developed with less labour.

"The cost of offshore wind structures are largely driven by steel which makes up about 90% of the materials used in a wind plant. This has seen quite a bit of cost fluctuations and variability because of Covid and Ukraine.

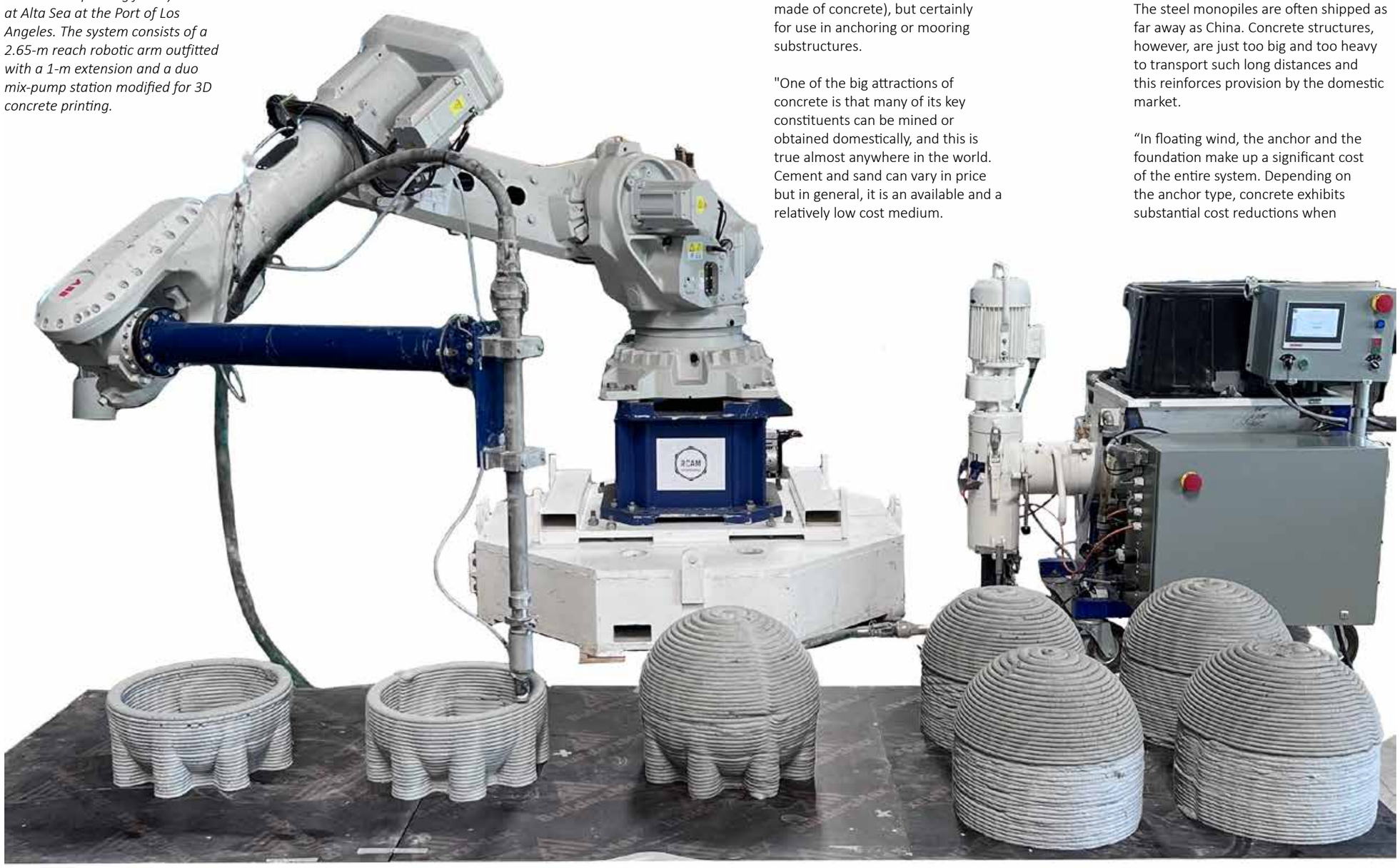
"Out vision is to use lower cost concrete materials instead of steel for some offshore wind components– not necessarily for floating hulls (although floating hulls have been made of concrete), but certainly for use in anchoring or mooring substructures.

"One of the big attractions of concrete is that many of its key constituents can be mined or obtained domestically, and this is true almost anywhere in the world. Cement and sand can vary in price but in general, it is an available and a relatively low cost medium.

“Most of the components that make up a wind farm will have to be imported. The steel monopiles are often shipped as far away as China. Concrete structures, however, are just too big and too heavy to transport such long distances and this reinforces provision by the domestic market.

“In floating wind, the anchor and the foundation make up a significant cost of the entire system. Depending on the anchor type, concrete exhibits substantial cost reductions when

RCAM's research and development 3D concrete printing facility located at Alta Sea at the Port of Los Angeles. The system consists of a 2.65-m reach robotic arm outfitted with a 1-m extension and a duo mix-pump station modified for 3D concrete printing.



compared with its traditional steel equivalent. We believe we that concrete can come in at one-fifth to two-thirds the cost of steel depending on the anchor type.

“One of the main drawbacks to concrete anchors is that they are unproven. The technology developed by the oil and gas industry has been transferred to the wind sector and this has vastly helped in reducing costs. The offshore sector, however is notably conservative and this ethos has also been adopted, making it difficult to introduce new systems.

"At RCAM, we are working hard to de-risk these technologies. So far, the research and development has taken the use of concrete moorings from high to moderate risk. We have successfully developed a portfolio of many products including anchors, floating foundations and subsea energy storage.

CyBe Construction's manufacturing facility in Oss, Netherlands testing a 10-m x 10-m x 4-m (L x W x H) gantry 3D concrete printer. A similar, more advanced gantry-robot system is currently being constructed by CyBe and will be installed at RCAM's printing facility in Q1 2024

"This includes gravity anchors, suction anchors, torpedo anchors, and within those we have some variants of those ideas. We can build these in any size to suit any application.

"The concrete 3D printer we are purchasing can make structures up to 10m in diameter. Once we have carried out trials to see how that the anchors will work, we believe it will be quite a compelling value proposition. "

The 3D printing describes a combination of methods – it includes both extrusion and spraying. RCAM is developing products that employ both of those methods. It is also looking to introduce cast materials that can be poured between walls of structures that are 3D printed.

“What's really powerful is when you combine these methods and you use the right one in the right place. We have a couple of new powerful tools in our toolbox that we're combining with more traditional methods."

Subscale prototype of RCAM's torpedo anchor which highlights the ability to manufacture complex stay-in-place formwork that can be casted in with a denser and higher strength concrete reducing both cost and carbon emissions.

RCAM

RCAM started up in 2017 to carry out work funded by the California government to look into building bigger wind turbine towers. A couple of years later, we became interested in anchors and were funded by the Scottish government and the Floating Wind JIP in a competition administered by the carbon trust to allow us to explore these ideas for a 3D printed suction anchor
Concrete is inherently a lower carbon material. Pound for pound concrete contains about half the carbon dioxide as steel. If we can manufacture anchors of the same mass, the carbon of these structures can be cut in half as well as the cost reduced.

"Our next funding came from the National Science Foundation in a project we have just concluded focussing on the PadEye connection

"Concrete is very good in tension but not as good in compression, so one of the big challenges is how do you design a pad eye into the system. The solution to withstanding high loading is introducing reinforcement. And we have very experienced, extremely experienced civil engineers helping us design that connection. The next step is to test it.

"We are conducting detailed design, and carrying out more finite element analysis and structural testing in a laboratory on a variety of concepts from concrete suction anchors to torpedo anchors.

" Concrete is inherently heavy and this lends itself to anything installed by gravity. The concept has been proven by Petrobras because they've been doing this out of steel and they've installed well over a thousand, units. These steel anchors however, are expensive with some anchors containing a hundred tons of steel within them.

“Commercial concrete is around $75 a ton. We buy concrete premixed and ready to pour in small batches for like $500 a ton or less although this cost is presently dropping. This is expensive for concrete because it's basically small volumes for 3D printing. Steel is nearer $1000 a ton, but what's interesting is the finished cost. We

1:8 subscale prototype of RCAM's 3D concrete printed suction bucket anchor for floating offshore wind.

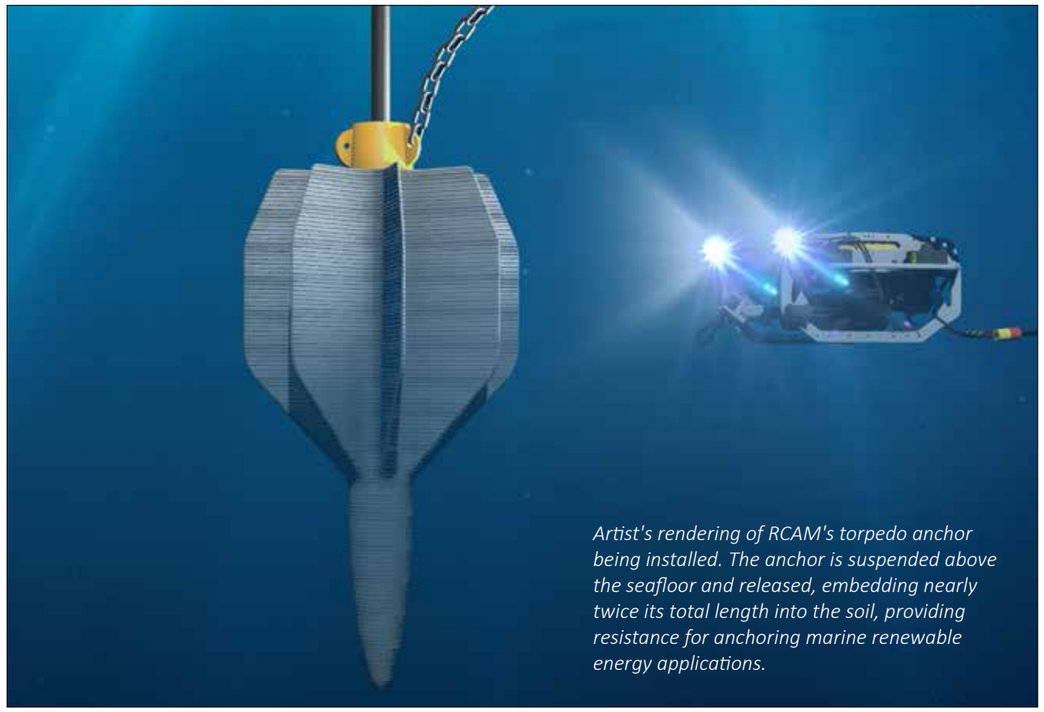
believe we will be able to manufacture finished concrete products for about $500/ton.

"Offshore grade steel structures that are fabricated welded painted and inspected could cost around $3,000 a ton.

"If we can use 3D printing to bring in the finished structure in at US$1000 or less per ton, we're looking at cost reductions of a factor of three.

“3D printers look very simplistic but this can be misleading. It is vital to ensure the rheology of the concrete is correct.

"Toothpaste is said to be thixotropic in that it is a non-Newtonian fluid that changes viscosity when loaded by



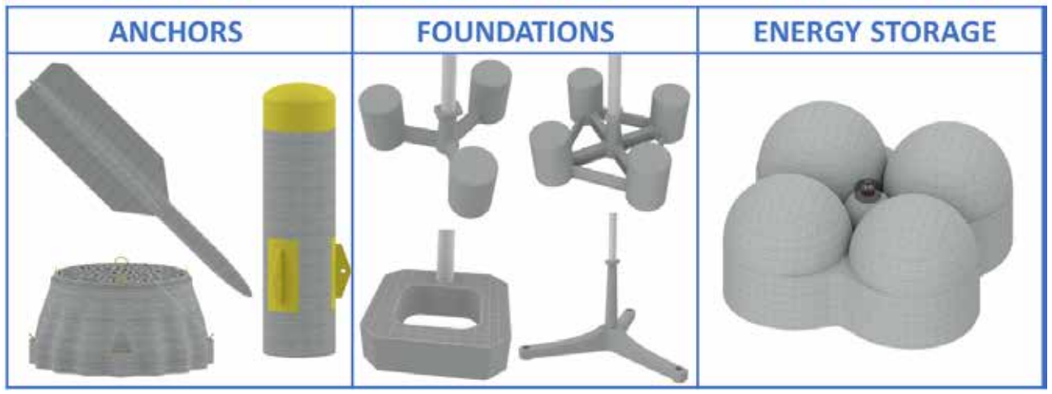
Artist's rendering of RCAM's torpedo anchor being installed. The anchor is suspended above the seafloor and released, embedding nearly twice its total length into the soil, providing resistance for anchoring marine renewable energy applications.

stress. Extruded concrete has to be fluid as it's being pumped through the pump and the hose nozzle but needs to solidify in order receive the next layer. Around 80% of the research on concrete printing is focused on is mixes, rheology and reducing the cost/increasing efficiency.

"The other main challenge is how to introduce reinforcement into the design and what type of reinforcement is best. Another good 10% of the research budget goes on the reinforcement. Traditionally, this is carried by re-bars, and so if the process is to be totally automatic, how can these be added automatically.

"So there's a number of firms, startups and academics kind of looking at how do you automate the bending and incorporation of reinforcements. Another way to do it is incorporate reinforcements in the spraying.

"A third way to do it is to design structures with voids which can allow steel tendons to be inserted in a process called post-tensioning. And after the concrete sets, tensioning that tendon effectively squeezes components together and keeps it in compression.



Artist's rendering of RCAM's portfolio of 3D concrete printed products for marine renewable energy applications

DYNAMICALLY INSTALLED ANCHORS

The Norwegian installation company Deep Sea Anchors is looking to apply the use of Dynamically Installed Anchors (DIAs) to the renewables sector. The company says that should be possible to make over 30-35% savings when compared with conventional deepwater anchoring solutions

The renewable wind energy industry has progressed extremely rapidly over its relatively short lifetime. This is in no small part due to the fact that it has been able to access technology previously developed and tested for the oil and gas industry. This has not only allowed it to slash the time frames that it would normally take to develop and certify technology, but it has also been able to access the experience that was invested in producing the original equipment.

"The offshore industry is well known for being conservative," said Jon Tore Lieng, Managing Director of Deep Sea Anchors. "While it was prepared to fund research and technology projects, these didn't always find their way into everyday use. One example concerns GIAs also called gravity-installed anchors. In the 1990s and forward we brought our anchor concept to an advanced state of testing and development. While they were shown to exhibit considerable savings, they never really superseded the more accepted and traditionally used suction anchors.

"The global situation has now changed. There is a greater need to drive down costs in the renewable sector, and this has caused many to revisit some of these fully certified technologies."

Deep Sea Anchors are hoping that their anchors, Deep Penetrating Anchors (DPAs) will find a place in the floating wind industry. They are suitable for both taut leg and centenary moorings.

ANCHORS

Dynamically installed anchors come in a variety of specific shapes and sizes, but these are generally described as quasi-tubular body forms with stabilising fins. Near the tail, is some sort shackle that provides an attachment to the mooring line chain.

Anchors on deck

Dynamically Installed Anchors (DIAs)

INSTALLATION

During In installation, a DPA anchor is placed in an Anchor Handling Frame, over-boarded and lowered to approximately 75m above the seabed. At that point, the motion is dominated by the hydrostatic stability margin (the distance between the centre-of-gravity and the centre-of-buoyancy).

"The installation height above the seabed depends on the size of the anchors," said Lieng.

"Typically, the installation height is around six times the length of the anchor and this allows the anchor to achieve velocity of about 100kph, which provides a considerable amount of kinetic energy to be taken up by the soil. In soft seabed clay sediments, the anchor will penetrate deeply but in stiffer clays it will travel less deep although in both cases will have approximately the same holding capacity."

An acoustic release is used to free the anchor and penetrates typically 20-30m deep into the cohesive clay sediments. It provides sufficient holding resistance to secure the floating wind installation and prevent it from drifting.

"The suitability of DPAs is largely dependent on the seabed lithology" said Lieng. "They are most suitable for cohesive clay sediments but fortunately, these are a common feature of the sort of deep water areas (150-350m) in which many potential floating wind farms sit. The anchors are unsuitable for use in areas with granular materials such as sand or rocky outcrops.

"One of the most significant advantages of these type of anchors is that they are solid and uncomplicated and as such, relatively cheap to manufacture. Around 65% of the anchor's main body is manufactured from high-grade steel while the remaining 35% (that accounts for the mass) consists of inexpensive ballast material, such as steel grit."

Deep Sea Anchors' anchor design is dart-shaped with pronounced fins and a rounded front tip representing a compromise between a cone and a sphere. This ellipsoid shape gives it it's fundamental advantage.

"At the moment of release, when the anchor vertical velocity is near zero, the anchor is in an unstable state e.g., strong current forces may give the anchor a slight initial rotational acceleration. It is therefore important that there is a good separation between the Centre of Gravity and the area centroid of the anchor. If so, the anchor will be able to dampen the pitch velocity out and correct any initial tilt.

The rounded tip allows for less rotational resistance during this process. The more pointed the anchor tip is the greater hydrodynamic resistance to directional changes and will cause the anchor to tend to slice through the water phase making it difficult to correct any pitch or yaw", said Lieng.

"We carried out 1:3 scaled, three-ton anchor tests in Trondheim Fjord, Norway in 2003 and found that the water currents can be strong due to tidal effects.

Anchor movement was logged in association with the Norwegian Geotechnical Institute (NGI), by installing a monitoring unit, which incorporated a data logger, 3D accelerometer, pressure gauge and battery pack inside side of the anchor shaft.

The anchor was subjected to pitch and roll movement since the anchor has a large fin area at the top end. We observed that the anchor initially rotated slightly due to large current forces, but it quickly regained verticality after few meters travelling distance.

The instruments logged the anchor's velocity, pitch and yaw throughout the whole drop phase as well as its final penetration depth and inclination with reference to the horizontal plane.

"Data showed that the flow separates at the trailing end of the anchor, resulting in a low-pressure wake. This contributes to the total drag although attached chain helped to reduce this low pressure wake.

ADVANTAGES

"Many deep water moorings are based on suction anchors deployed from large crane vessels and take a long time to install, typically between 6 –12 hrs depending on anchor size, water depth and seabed sediments. Deep Penetrating Anchors, however, can be installed in a fraction of the time and the operation is also less weather sensitive.

DPAs are also less costly to fabricate and transport than suction anchors. Pilot tests at the Gjøa field with two 80t anchors gave DNV approval and is qualified technology at Equinor.

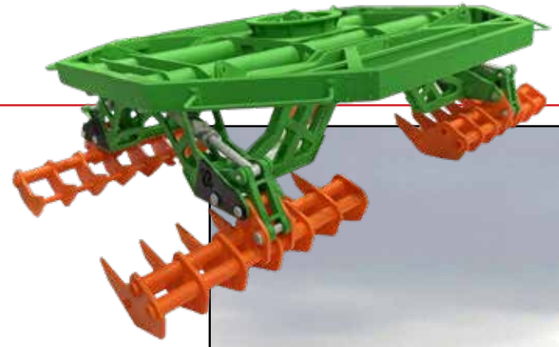
"One way for reducing the necessary equipment and materials, in addition to keeping marine operation time, effort and costs to a minimum, is anchor sharing. Each anchor point is shared by maybe 2-3 three wind turbines.

This will reduce the total number of anchoring points, but the anchors become more massive and require large installation vessels.

"Floating wind turbines are getting increasingly bigger with some future designs possibly exerting 1000t design loads or more on each mooring line.

As a rule of thumb, a typical DPA will have a mass equal to or slightly less than one 10th the required design load if considering typical load rate effects. This is well within the capacity of Deep Penetrating Anchors. "

Ready for deployment



Even before the 2008 Energy Act was passed, companies were developing various tools and techniques to decommission the offshore structures that had brought oil and gas to the UK.

Decommissioning is now entering a vital period. According to the industry body Offshore Energies UK, around £20bn will be spent on decommissioning North Sea oil and gas installations over the next decade with a particular surge in activity over the next 3-4 years. The group estimates that around 2100 North Sea wells will be decommissioned – around 200 per year – at an average cost of £7.8m per well.

In 2021, a tenth of UKCS oil and gas expenditure went into decommissioning. This proportion rose to 14% in 2022 and is set to rise further to 19% by 2031. In the next 10 years the next decade, expenditure on decommissioning is predicted to total £19.7 billion, with well decommissioning comprising nearly half of this spend.

Earlier this year, analysts Research and Markets said that the *global* offshore decommissioning market is expected to grow from $5.38 billion in 2022 to $5.82 billion in 2023 at a compound annual growth rate (CAGR) of 8.2%. It is expected to grow to $7.82 billion in 2027.

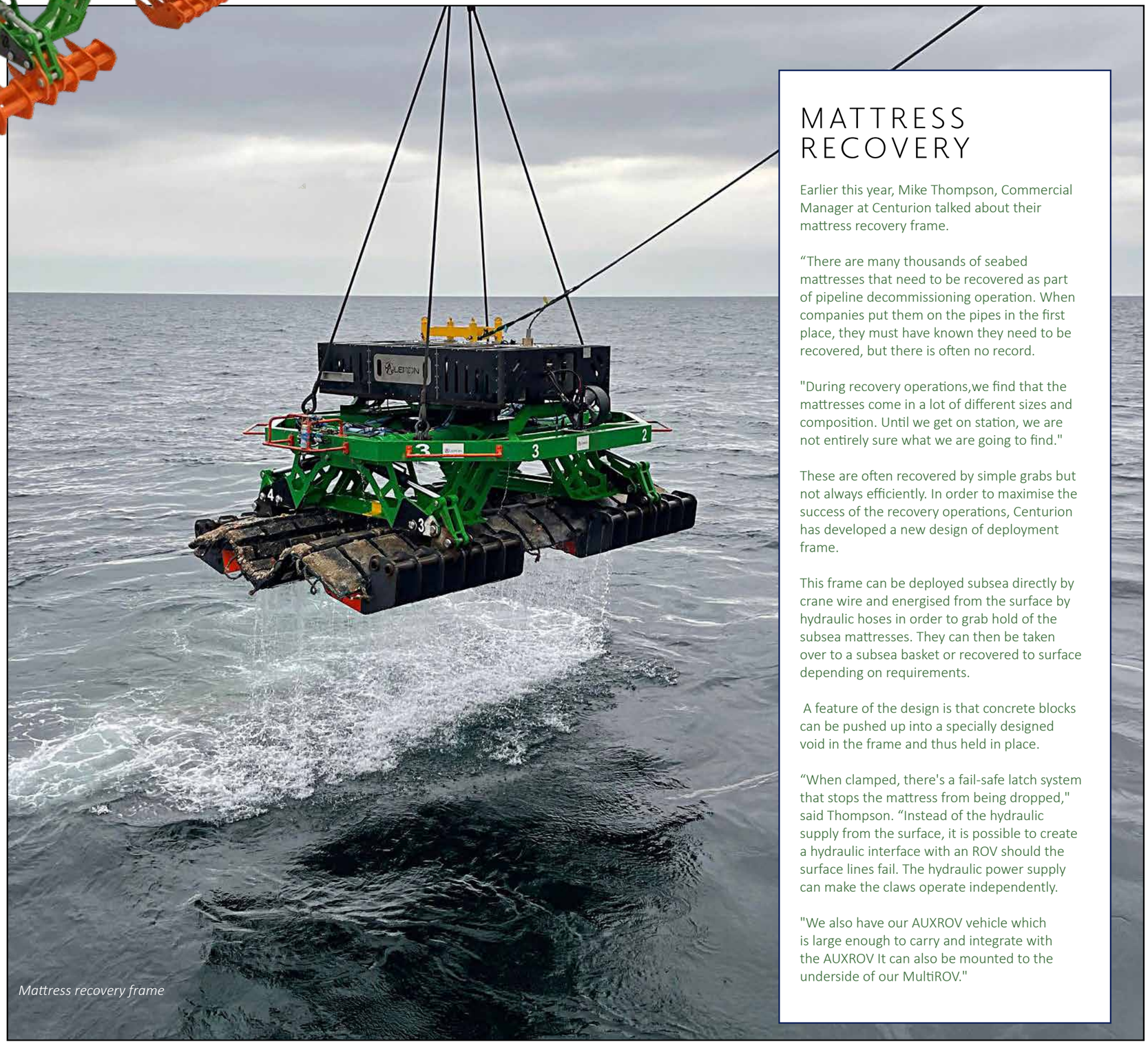
It said that the Russia-Ukraine war disrupted global economic recovery from the COVID-19 pandemic while economic sanctions on multiple countries, a surge in commodity prices and supply chain disruptions has caused inflation across goods and services sector.

The first part of many decommissioning projects commences with getting access to cables pipelines, components or other subsea foundation that spent their life being buried or protected. This has to be done while minimising disturbance to the surrounding environment.

CFE

There are a number of ways of uncovering buried lines and equipment but perhaps the most efficient is based on directing high-volume jets of water downwards to fluidise and remove sediment, soil, or other materials. The sediment is carried away in suspension.

This is called controlled flow excavation (CFE) a



Mattress recovery frame

MATTRESS RECOVERY

Earlier this year, Mike Thompson, Commercial Manager at Centurion talked about their mattress recovery frame.

“There are many thousands of seabed mattresses that need to be recovered as part of pipeline decommissioning operation. When companies put them on the pipes in the first place, they must have known they need to be recovered, but there is often no record.

"During recovery operations,we find that the mattresses come in a lot of different sizes and composition. Until we get on station, we are not entirely sure what we are going to find."

These are often recovered by simple grabs but not always efficiently. In order to maximise the success of the recovery operations, Centurion has developed a new design of deployment frame.

This frame can be deployed subsea directly by crane wire and energised from the surface by hydraulic hoses in order to grab hold of the subsea mattresses. They can then be taken over to a subsea basket or recovered to surface depending on requirements.

A feature of the design is that concrete blocks can be pushed up into a specially designed void in the frame and thus held in place.

“When clamped, there's a fail-safe latch system that stops the mattress from being dropped," said Thompson. “Instead of the hydraulic supply from the surface, it is possible to create a hydraulic interface with an ROV should the surface lines fail. The hydraulic power supply can make the claws operate independently.

"We also have our AUXROV vehicle which is large enough to carry and integrate with the AUXROV It can also be mounted to the underside of our MultiROV."

multipurpose technique with a range of applications including pipeline and cable trenching, backfilling, freespan rectification, sandwave remediation, seabed preparation, shallow water / shore approach excavations, rock dump dispersal and channel deepening.

A typical CFE device is based on a large underwater propeller lowered from a support vessel. These are normally hydraulic-based systems with large pumps at the surface.

Some push water down a tube, possibly a drillstring, to drive the underwater rotor after which, the water is discarded. A more agile alternative features the surface pump feeding hydraulic fluid to drive a hydraulic motor directly coupled to the excavation propeller. This method requires a return line to bring the hydraulic fluid to the surface.

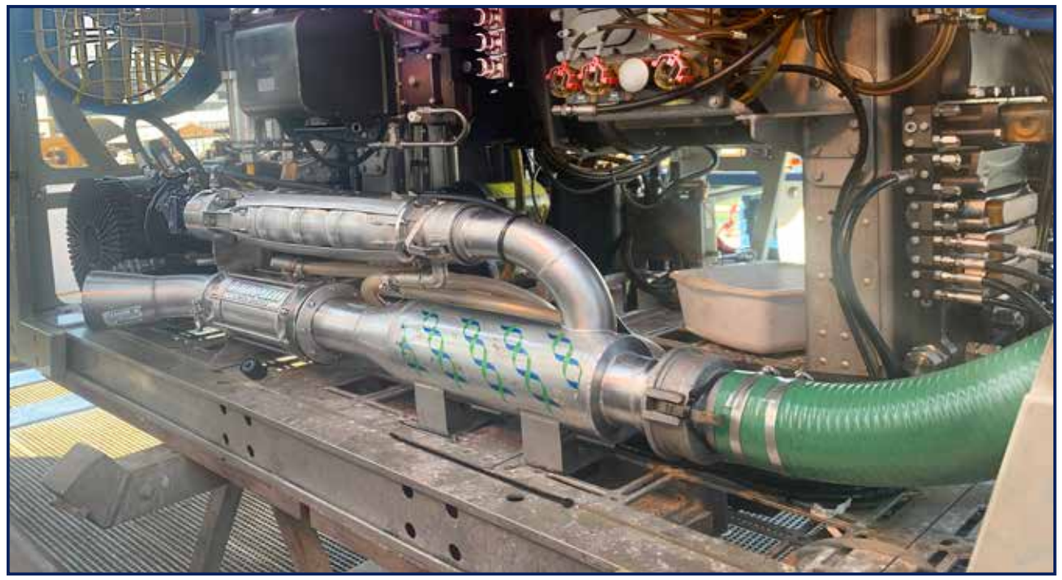
When a propeller pushes against air, it encounters little resistance but this is not true when pushing against water. Obeying Newton's 3rd law of motion, the blade pushing against the water in one direction causes the entire motor body to rotate in the opposite direction.

Over the years, the industry has developed a number of useful strategies to mitigate this including mounting large fins on the motor body to provide resistance against rotation, using a pair of contra-rotating propellers or installing the turbines in pairs on a skid, each balancing the other.

An inherent advantage of CFE is the reduced risk because there is no physical contact with the subject being uncovered. The result is no damage, increased productivity and enhanced safety. The technique can be remotely operated, further enhancing safety.

It may be that the area of required deburial is relatively small or concentrated, in which a more localised tool would be preferable. There are a number of suction excavator dredgers on the market small enough to be carried by an ROV or operated by divers. These work in broadly the same way, although some have novel features such as electric rather than hydraulic motors or being manufactured from titanium to reduce weight.

The motor normally driven by high pressure hydraulic fluid supplied from and returned to the ROV in a closed circuit. This motor is directly



Parts of the CFE system

connected to multicomponent rotors.

Sea water sucked into the intake causes the turning rotors to accelerate the flow towards the end of the pump section, whereupon the flow turns in a flow-friendly 180 deg arc of to enter the second stage – the ejector section.

At the front of the ejector tube lies a venturi- essentially a constriction. When large volumes of incompressible fluid are forced through the smaller diameter bore of a venturi, the flow rapidly accelerates through to the exhaust. As it passes, it essentially pulls the flow of dredge water and any entrained sediment through the ejector section with it.

One design by Vortex has a helical element front of the venturi which is introduced into the flow pattern to give the device its independently proven 100kpa of suction.

Vortex says that it is not simply a matter of rotating the water. The pitch angle and the length of the rotation is important, but they say the system performs at least 20 to 30% better than systems without this technology.

UNDERWATER LASER CUTTING

Many years ago Underwater Cutting Solutions (UCS), began working with The Welding Institue on its SubseaLASE project develop a, high-performance subsea laser cutting tool. This was estimated to offer over five times faster cutting speeds than current-generation abrasive technologies.

Tested to 200m water depth, the internal pipe cutting system features a laser head which rotates 360deg during the cutting process.

In addition, there would be no consumables required compared to abrasive cutting, making it an attractive proposition for operators looking for a solution harmless to the underwater environment.

Moreover, fibre delivered, underwater laser cutting has the potential to develop a system that can cut installations at extreme water depths. UCS was acquired by Ashtead Technology in 2019.

ASHTEAD

Ashtead Technology is the exclusive rental partner for Vortex's subsea dredge systems and is a leading player in the decommissioning space.

"A big advantage is that we can offer an extensive range of different types and sizes of subsea cutting technology solutions," said Richard Lind, General Manager for Ashtead Technology's mechanical solutions service line based in Aberdeenshire. "Some companies may recommend certain tools because that is all they have, while conversely, we have a *very* large inventory.

"This allows us to use what we believe to be the best tool for any specific job. If we don't have it, we custom-develop something, carrying out the engineering in-house. This gives us a bespoke solution for each client if needed."

At some point, the decommissioning process is likely to require some sort of cutting. One of the most effective methods of cutting is to use mechanical abrasion and this is typified by submerged waterjet cutting also known as underwater abrasive jet cutting.

WATERJET

This is based on directing a slurry include of water and abrasive particles (such as garnet) at high pressure usually in the region of 20 000 to 30 000 psi.

This abrasive mixture passes through a specialised nozzle that shapes and guides the jet onto

ELECTRIC EXCAVATORS

Later this year, SEAJET will take delivery of its *Hydromole* electric controlled flow excavators (E-CFE) which, the company claims, will be the most advanced and powerful units of its their type on the market.

Instead of being powered by hydraulically – the standard arrangement typically adopted by the industry– the new excavator device will be driven electrically. This confers on it considerable performance advantages as well as meeting all new environmental requirements.

“Perhaps its most important feature is that electric systems exhibit no power losses when compared with conventional hydraulic assets,” said SEAJET Managing Director Faisel Chaudry, “and this helps to make it particularly attractive as may mean the difference between having to conduct multiple passes or not.

“Embracing the energy transition is something of which we wish to stand at the forefront. Our E-CFE systems offers a 40% reduction of CO2 and is more efficient in terms of less fuel being consumed. In departing from hydraulics we have also eliminated any risk to the marine environment from high pressure, high volume oil spills. Also, there are no hydraulic equipment filters, rags and clean up mats to dispose of at the end of the project.

Furthermore, Electric-based systems have other intrinsic advantages.”

Hydromole electric controlled flow excavator

The common alternative features a pump at the surface feeding hydraulic fluid to a hydraulic motor directly coupled to the excavation propeller. A second line returns the hydraulic fluid to the surface, with a third line dealing with ‘case flow’, making the umbilical heavy and cumbersome.

“Eliminating the use of hydraulic hoses on the back deck removes the manual handling of heavy bundled hoses with the consequent health and safety benefits,” said Chaudry

“The single thinner electric line can be easily fed off a winch allowing operating depths of up to 2,500m without any losses whatsoever.”

One practical advantage of the electric line is that the power umbilical can also carry control signals.

“The advanced control system on the HYDROMOLE is like something never been seen before in this application,” said Chaudry. “We are instantly able to monitor subsea and topsides and show how the equipment is performing in real time. The most important metric is the availability. The client will see a fraction of the amount of downtime when compared with hydraulic assets.

Testing the Hydromole

"We have such an advanced control system, that we can fault-find immediately, know where the system is not performing and exactly what's happening.

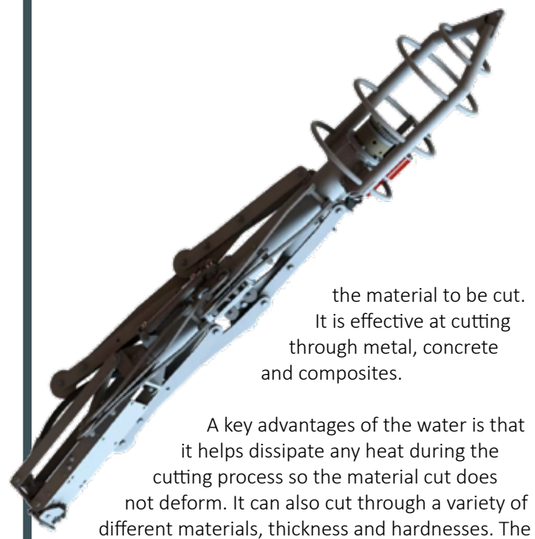
This means that we can plan the maintenance accordingly, or quickly swap out a part because we know exactly where the problem is. Power and signals can be sent down to the tool but the ability to receive data allows us to conduct in-situ monitoring and carry out in-situ surveys.

There is a trend in some quarters for ‘over the horizon” operations. This describes the potential to control and operate this equipment from a remote onshore base via satellite link, thus limiting the need for people on the back deck of the vessel. Electric systems make this very possible.

“In development testing, we are definitely finding these systems are going to be exponentially more reliable that alternative systems,” said Chaudry. “This means that while the upfront costs might be a little bit higher, it'll be much cheaper to operate and maintain throughout the asset life cycle.

“We are now getting ready for the assets to enter into the market later this year,” said Chaudry. “Its development path has been difficult because, in the aftermath of COVID, there has been an industry-wide bottleneck in the availability of electronic components while the worldwide supply chain has been hit badly.

“We’ve been working on this for the last two years and it's now coming to fruition in line with our business model. The development is very much a technology partnership between us and Soil Machine Dynamics (SMD).



the material to be cut. It is effective at cutting through metal, concrete and composites.

A key advantages of the water is that it helps dissipate any heat during the cutting process so the material cut does not deform. It can also cut through a variety of different materials, thickness and hardnesses. The disadvantage is the relatively slower cutting speed.

The majority of underwater mechanical cutting is carried out by saws or mills. Ashtead Technology offers a comprehensive range of cutting systems which includes patented diamond wire and dual cut bandsaws, chop saws, hydraulic shears.

These can be configured for diver or ROV-deployed use, as many customers move away from traditional methods of diver installation in favour of remote operations.

MECHANICAL CUTTING

SHEARS

One of the most destructive method of underwater cutting is to use shears. These provide the greatest destruction for the least effort.

Shears typically consist of a static body which incorporates the lower cutting jaw. At the back of the jaw is the articulated hinge that allows the upper jaw, to swing downwards and thus, the cutting heads on each jaw to close to together. The blades vary depending on the materials being cut. They may

Ashtead Technology's range of Shears

have different shapes and configurations to optimize efficiency.

Important parameters when selecting the shear is the opening and depth of the cutting jaw, the size, weight and cutting force. Some shears have a cutting pressure of 2500t. Conversely, others are small enough to be mounted on remotely operated vehicles.

"Shears however are not always the most suitable tool. Even when cutting a large 20in pipe, for example, there are numerous parameters that need to be taken into account such as grade of the steel, the thickness of the steel, coating which can all change the way the shears react during the cut process. Thus although it may take longer, saws are often the best solution."

SAWS

The majority of underwater cutting is carried out by saws.

"The two main types are a wire saw and a circular saw. A lot of the time, the selection is down to client preference," said Lind. Each has a cutting element but importantly, some sort of clamp or grab to hold the pipe while the cu1862t is completed. This provides the stability and is also used for drawing the pie into the cutter.

DIAMOND WIRE SAWS

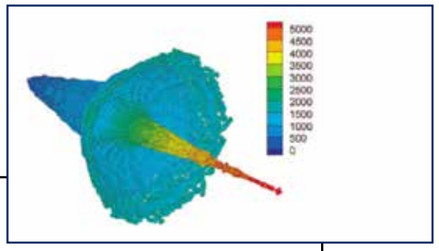
"Diamond wire saws can be quick. Some can cut through a 10in pipe in only 6 mins but the downside is that the lines may need replacing at some point.

"We've got different types of wires for different applications and they are all highly efficient fur cutting pipe, concrete filled multi string bundles and coated products."

One of the main risks to diamond wire cutting is the wires jamming, and to mitigate this happening Ashtead Technology's diamond wire saws have a built-in auto-feed system.

"The patented system regulates cutting progress to minimise any possibility of broken wires and

Diamond wire saw



EXPLOSIVE CUTTING

Explosives are a very quick and efficient way of cutting metal. Indeed, these were often the tool of choice when removing early platforms in the Gulf of Mexico. The armed forces had already discovered that forming the charges into specific shapes and detonating them, these effectively formed a directional explosive blade rather than an uncontrolled destruction, and this could be placed against metal sheeting to produce accurate cutting.

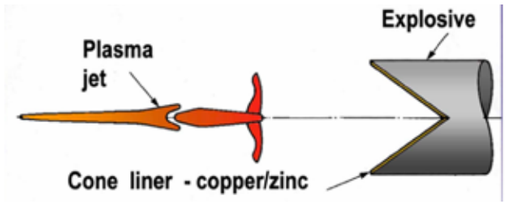
Despite considerable early uptake, these systems are not used for decommissioning.

Steve Vernon of subsea contractors Eodex, explains

“We commonly use low order deflagration shape charges on a number of different classes of unexploded ordnance (UXO) and have had considerable success so far, however these linear charges are not particularly suitable for the sort of tubular structures common in the offshore industry. The old method used in the gulf of Mexico involved lowering a large amount of explosive charges inside the leg of a platform and detonating them. If this leg was under the seabed, the explosive basically mushroomed the leg, effectively anchoring it in place. Conversely, cutting the tubular above the surface is often contrary to legislation.

“Many explosive experts conducted investigations into applying shaped charges to cut tubulars, but the experimentation has shown that, when applied around the circumference of a tubular, the apex of the cone for the shape charge does not efficiently lend itself into turning it into an inner circle. It has resulted in a few successes but it's not presently consistent enough to be realistic solution.”

Research is still being carried out however, but is not a commercial priority at the moment with companies such as Eodex concentrating on neutralising unexploded ordnance.



ELECTRIC SAWS

Most diamond wire saws are powered hydraulically, but there are electric versions. One such was built by Dutch company Sea Tools. During the development of this saw two criteria were of paramount importance.

"Firstly: reliability," said Johan Sol, Business Development Manager. "The saw needs to perform at any time.

"Secondly: flexibility. The saw must be able to make a cut in any situation, irrespective of water depth, material, diameter, or object orientation. This resulted in an all-electric underwater diamond wire saw, executed with a high degree of cutting automation."

It was designed originally for emergencies- to help cut the connection between seafloor and platform but with its maximum depth being 3000m, it could have specialist applications in the decom market.

Electric diamond wire saw

The saw's mechanical design allows the operator to cut objects under any inclination and separate the clamp from the saw in order to cut through several successive objects without the need for recovery.

Furthermore, the technology in combination with the saw's automated control system facilitate cuts through any type of material, irrespective of design and material.

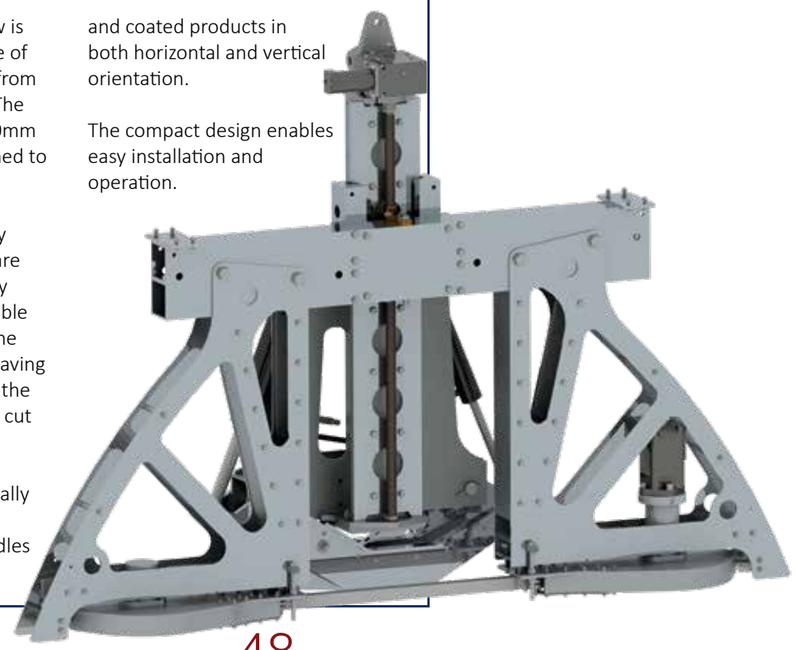
DUAL CUT BAND SAW

The patented dual cut band saw is designed to cut through a range of materials of various diameters from 4-30in using a single saw unit. The precision dual cut provides a 30mm wide coupon that can be returned to surface for inspection.

The reaction loads generated by each of the simultaneous cuts are cancelled out, resulting in a very smooth, vibration free and reliable cut. On completion of the cut the 30mm wide coupon falls out, leaving a gap between the two ends of the pipe for ease of recovery of the cut section.

The dual cut band saw is especially good for cutting pipe in pipe, concrete filled multi-string bundles and coated products in both horizontal and vertical orientation.

The compact design enables easy installation and operation.



removes human intervention to produce industry leading cutting times," said Lind.

"Wire saws are designed to be small and agile. Some are small enough to be transported by remotely deployed by an ROV. Adding bigger motors increases torque but there comes a point where other cutting technologies become more effective.

Rotary Saw

RECIPROCATING SAWS

Reciprocating pipe saw

E.H.Wachs has developed a family of Guillotine pipe saws designed to cold cut 2in – 32in pipe, as well as solids such as bar stock, rails and beams.

"The Goliath Autoclamp and Autofeed reciprocating pipe saw cuts solids, multi-stranded casing strings and nested materials from 16in – 32in or up to 30in on ductile pipe, with a choice of vertical or horizontal mounting.

Reciprocating saws work by driving a blade backwards and forwards in the same way that a handsaw or hacksaw works. It is powered by a powerful, sealed twin hydraulic drive system, user selectable autofeed rate.

ROTARY SAWS

Another type consists of a rotary hardened tooth blade that cuts away at the metal on impact. This is sometimes called a chop saw.

A chop saw is used to sever pipelines and jacket members during offshore applications including salvage operations and where efficient cutting is required. Blade sizes can range up to 60 inches and can cut syntactic, plastics, concrete, hard steels, and exotic metals.