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FLOW ASSURANCE

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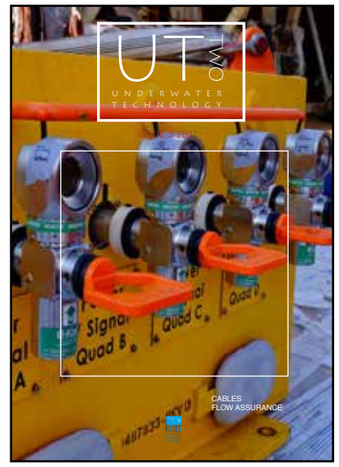


Fault detection hardware
Image: C-Kore

AUTONAUT UNCREWED SURFACE VEHICLE (USV) SELECTED BY PLYMOUTH MARINE LAB

An AutoNaut uncrewed surface vehicle (USV) equipped with a range of scientific sensors has been acquired by Plymouth Marine Laboratory. The state-of-the-art 5m craft is powered entirely by renewable energy and will be the first USV to regularly run scientific missions off the coast of the UK.

The USV is outfitted with a range of meteorological and oceanographic parameters including: weather station, CTD, pH, nitrate, phosphate, irradiance, Chl, CDOM, turbidity, dissolved Oxygen, pCO2 and photosynthetic efficiency and rates. High-definition cameras will also be installed on the mast and sub-surface on the hull.

The AutoNaut USV uses no carbon fuel and is able to independently survey at sea for many weeks at a time. It is propelled by wave energy, using unique wave-foil technology, with solar PV panels and battery pack to power onboard systems and sensors. The USV is pre-programmed to complete missions whilst carefully overseen from facilities in Plymouth.

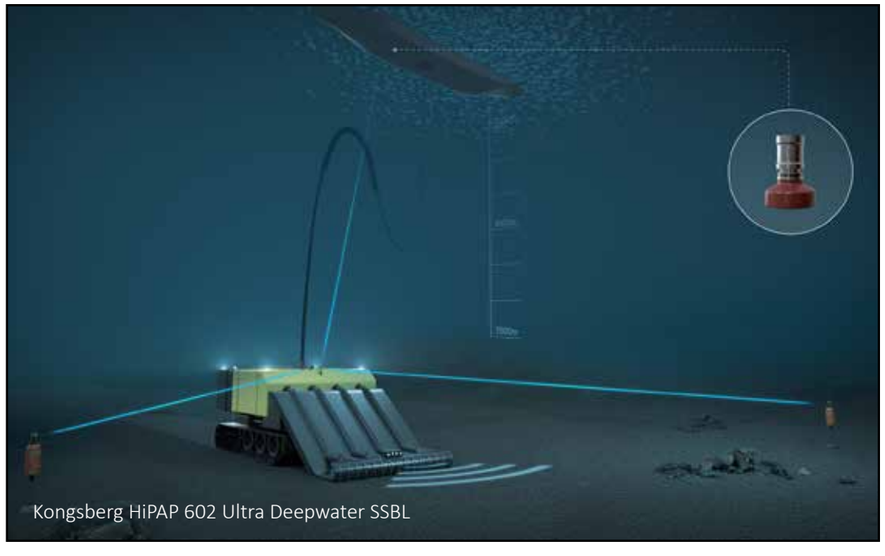
Phil Johnston, Business Development at AutoNaut said: “PML has been a huge supporter since our earliest prototypes so it’s a real pleasure to now deliver our latest USV to them.”

AutoNaut uncrewed surface vehicle (USV)

KONGSBERG DEEPWATER SSBL

Kongsberg Maritime has launched its HiPAP 602 Ultra Deepwater SSBL (Super Short Base Line) positioning tool. The HiPAP 602 has been designed specifically to provide extreme range (up to 7000m+) and accuracy for positioning ROVs and AUVs, and to operate as a DP reference.

To achieve this performance, the HiPAP 602 replaces the spherical transducer used by the HiPAP 502 with a large-diameter, multi-element planar array combined with electronic beam forming and unique signal processing techniques. This enables narrow transmitter and receiver beams to be generated in all directions within the lower half of the transducer, giving the HiPAP 602 high accuracy and long-range capabilities in a cone directly below the unit. This makes it well suited for deep water operation, especially seabed mining.



Kongsberg HiPAP 602 Ultra Deepwater SSBL

HiPAP SSBL systems need only a single hull-mounted transducer and a cNODE transponder on the subsea vehicle to calculate position in three dimensions, by measuring the range from the ship’s transducer to the transponder as well as the horizontal and vertical angles.

The HiPAP 602 system’s enhanced angular measurement accuracy increases the depth that SSBL positioning. It can be used before switching to long baseline positioning techniques (LBL), thereby reducing operational cost. The system is fully compatible with the entire range of existing medium frequency cNODE transponders and modems, with depth ratings available from 100m to 7000m.

ROTOTECH MOU

RotoTech, the company employed in inspection and repair within the offshore wind and oil and gas market, has recently signed a memorandum of understanding with Olympus Singapore. This is aimed at collaboration in non-destructive testing (NDT) for pipelines, piles and jackets.

RotoTech are interested in the “subsea to surface area of pipes and risers especially through the splash zone”. RotoTech are also interested in taking the Olympus’ NDT technology to areas that to date cannot be accessed easily.

RotoTech are currently in the process of installing a marinised Olympus FOCUS PX ultrasonic phased array unit and HydroFORM probe on their Roto Climber cleaning, and advanced inspection module. Subsea testing is scheduled for June 2021.

AMSSI

Following several months of fruitful discussions and dialogue, several French players have announced the creation of the AMSSI (Agora for Maritime and Submarine Sustainable Innovations):

At the core of AMSSI are three partners

- Alcatel Submarine Networks (ASN) Procurement of submarine telecommunication cable systems

- iXblue Global high-tech company recognised for its advanced technologies in the fields of maritime autonomy, inertial navigation, subsea positioning and subsea imagery

- SeaOwl International maritime services operator, pioneer in the implementation of drone-based maritime services

Underwater Vehicle

New French and European members will shortly join them to accelerate the emergence of new innovative projects.

This partnership aims to be a French innovation cluster where members share a desire to combine their know-how and technologies with the objective of bringing to life concrete and innovative industrial projects in the maritime and underwater fields, as well as in the fight against climate change.

AMSSI will promote R&D, innovation and French know-how.

AMSSI has a proactive approach towards the concretisation and implementation of the various technologies developed through its members' R&D programmes, leading to the industrial deployment of its projects.

By combining the expertise of its members, AMSSI will continue to develop an ecosystem capable of meeting major technological challenges and building an effective and relevant community for maritime technologies and services.

Among the developments involving the most advanced technologies of its partners, member companies are already working on an innovative project – the development of a remotely operated hydrographic surface vessel, i.e. a drone capable of carrying out long-distance survey missions.

Other projects related to climate change and marine digitalisation are also being studied.

Remote control system

JUMBO SHIPPING AND SAL HEAVY LIFT LAUNCH JUMBO-SAL-ALLIANCE

Jumbo Kinetic carrying monopiles for Yulin Offshore Wind Farm

Jumbo Shipping and SAL Heavy Lift, have commenced operations under their joint venture as the Jumbo-SAL-Alliance.

Combining their fleets and all commercial activities, SAL and Jumbo say they are gearing up to create a new powerhouse in the heavy lift sector.

The companies believe that this propels them to a greater level of geographical outreach and commercial capacity.

The fleet includes 30 highly versatile project cargo vessels with lifting capacities up to 3000 t SWL, marking it as the largest fleet in the 800t+ sector. This ensures availability, flexibility and the right transport concept at the right time for customers seeking reliable and high quality shipping solutions.

T-CTV CHEMICAL THROTTLE VALVE

Traditionally focussed on subsea valves, Oceaneering Rotator has unveiled a new topside chemical throttle valve. The T-CTV leverages existing field-proven technology to address operational requirements for efficient topside chemical dosing.

T-CTV

The T-CTV delivers a fully automated chemical dosing package combining continuous and accurate flow measurement with automatic flow regulation in a modular, plug-and-play design. The valve boasts ± 0.2% of reading via continuous Coriolis flow measurement. The T-CTV control system uses continuous, live feedback from the Coriolis flow meter to automatically regulate and continuously display flow rates.

TECHNIPFMC AND MAGNORA

TechnipFMC has entered into an agreement with Magnora to jointly pursue floating offshore wind project development opportunities under the name Magnora Offshore Wind.

Magnora holds a strategic position within the renewable energy sector as an owner in offshore wind, onshore wind, and solar development projects and is a key enabler in solar energy technologies.

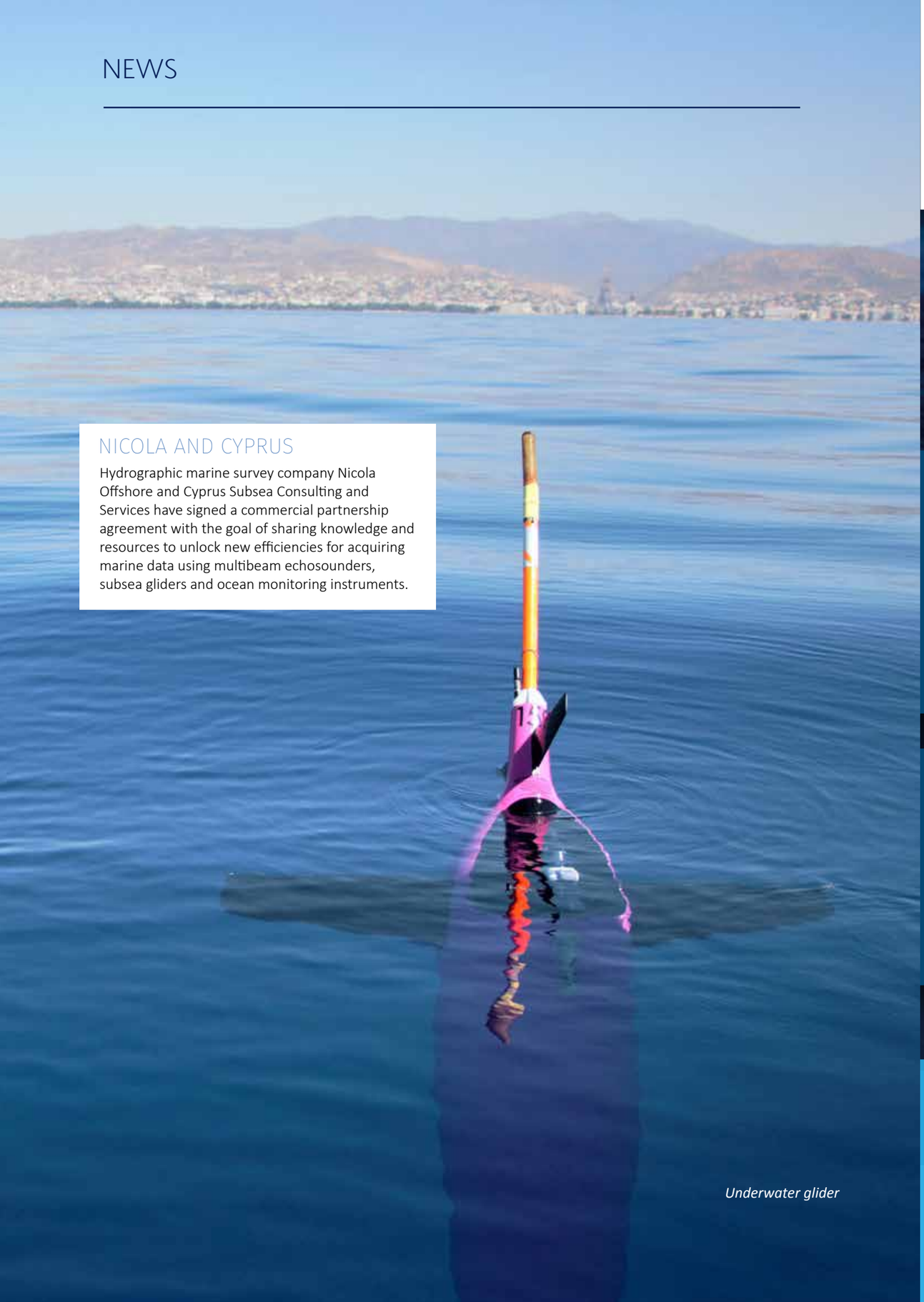
When combined with TechnipFMC's unique technologies, experience delivering integrated EPCI (iEPCITM) projects and its novel Deep Purple initiative to integrate wind and wave energy with offshore green hydrogen storage, this partnership will enable Magnora Offshore Wind to realise significant opportunities in the growing offshore floating wind market.

Magnora Offshore Wind has already commenced operations and started work on an application for the first round of seabed leasing through the Scottish government's ScotWind Leasing program.

In addition, Magnora Offshore Wind will participate in the first offshore wind application round in Norway, which opens in 2021, and will also consider entering new markets in the coming months.

NICOLA AND CYPRUS

Hydrographic marine survey company Nicola Offshore and Cyprus Subsea Consulting and Services have signed a commercial partnership agreement with the goal of sharing knowledge and resources to unlock new efficiencies for acquiring marine data using multibeam echosounders, subsea gliders and ocean monitoring instruments.



Underwater glider

ROTOTECH
Today's Experts in Tomorrow's Technology

ROBOTICS

RotoTech Pte Ltd. Is home to a company developing robotics for **more than** inspection.

Repairs, Phased Array, Subsea Coating, Cutting, Drilling, Cleaning and more.

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

ADVANTAGES

- ✓ Up to 5 times cheaper than conventional methods
- ✓ Much improved HSE
- ✓ Lower Carbon footprint
- ✓ Simple
- ✓ Robust
- ✓ Lightweight
- ✓ Small footprint
- ✓ Modular
- ✓ Easily adjustable
- ✓ Zoned

Control Van with screens and controls.

INDUSTRIES

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

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/**

ARGOS

Argos, the centerpiece of bp's $9 billion Mad Dog 2 project, has arrived in the US after safely completing its 16 000-mile journey from South Korea to the Kiewit Offshore Services fabrication yard in Ingleside, Texas.

The arrival of the new floating production unit is a major milestone towards the completion of Mad Dog 2. Once online, Argos will significantly strengthen bp's high-margin oil and gas business in the Gulf of Mexico. It's also expected to support about 800 jobs during the work in Ingleside and about 250 jobs once in operation.

Argos, a semi-submersible, floating production platform, will be the company's fifth operated platform in the Gulf of Mexico – and the first new platform since Thunder Horse began production in 2008. It will provide bp with growth potential and an estimated 25% increase in production capacity in the region.

bp discovered the Mad Dog field in 1998 and began production there with its first platform in 2005. Continued appraisal drilling in the field has more than doubled the resource estimate of the Mad Dog field to more than 5 billion barrels of oil equivalent, requiring the need for another platform at the super-giant field.

The existing Mad Dog platform is located in 4,500 feet of water about 190 miles south of New Orleans.

INEOS has acquired the HESS subsidiary HESS Denmark for a total $150 million. As part of the deal INEOS will acquire 61.5% of the Syd Arne oil field.

The HESS business in Denmark consists of operated assets focused on the production of oil Approximately 60 people will transfer to INEOS on completion of the deal, which is expected in the third quarter of this year, subject to government approval. INEOS currently operates the Siri field area in Denmark.

By becoming the Operator of Syd Arne INEOS expects to unlock operational and cost synergies between the two assets.

COUGAR FLIES IN TAIWANESE WIND

Especially suited for the offshore wind energy market, the Saab Seaeye Cougar XT Compact robotic vehicle has been chosen for Taiwan's huge offshore wind farm development.

Taiwan's Metal Industries Research and Development Centre (MIRDC) will train ROV pilots to assist in the development and maintenance of the turbines' underwater structures.

The training will be undertaken by MIRDC at the Maritime Technology Innovation Centre created by the Bureau of Energy and the Ministry of Economic Affairs for the cultivation of national offshore wind energy talents.

Created for challenging environmental conditions inherent in shallow water operations the Seaeye low-profile 300m rated Cougar XT Compact is specially designed to minimise the effect of current, with a reduced frame size, buoyancy and weight – and a thinner 17mm tether cable that reduces the effect of drag.

Its six powerful thrusters hold the Cougar steady in strong cross currents and allow it to operate with precise manoeuvrability around structures whilst handling a wide array of equipment that can include cameras, sonar, tracking systems and manipulators.

MIRDC's Cougar XT Compact comes with a Kongsberg colour zoom camera, Blueview multibeam sonar, Tritec SeaKing sidescan sonar, Cygnus ultrasonic thickness gauge,

MIRDC's Cougar XT Compact

CP contact probe and a four-function manipulator. It also comes as a free-swimming option and has its own 16ft control cabin.

At the Maritime Technology Innovation Centre, the offshore wind energy training courses organised by MIRDC will provide training and certification in Taiwan and for the Asia Pacific region.

TRUCK LOCATED WITH SONAR

The James River, tributary of the Missouri River, is roughly 710 miles long and spans over 20 000 miles^2 of North and South Dakota.

The Beadle County Office of Emergency Management (OEM) is responsible for preparing the county for possible disasters, including preparation, response, recovery and mitigation. One tool in their possession is a JW Fishers' side scan sonar system. This system is invaluable for locating downing victims, missing evidence, dumped cars, or ships lost underwater. It becomes especially useful when waters are murky or turbid.

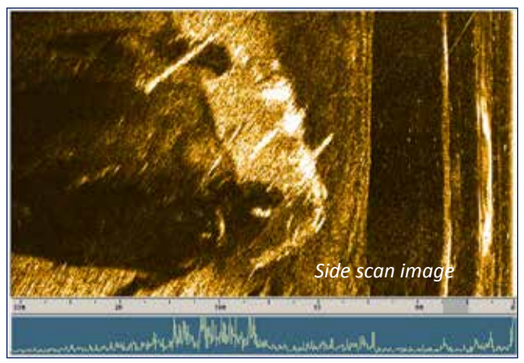
Tom Moeding, Beadle County's Emergency Management Director, experienced this first hand. "We used our JW Fishers side scan sonar to pinpoint the location of a 2014 Dodge pickup that was driven into the James River, our local river here in Huron SD."

The driver behind the wheel ran the vehicle into the river during the middle of the night, but could not remember the exact location.

After scouring the shoreline, tire tracks were seen going into the river and the dive team was deployed to find the vehicle.

"You can see the pickup was found and its orientation was clearly shown to be on its side. Initially we used a smaller side scan to approximate the location, but the object was just shown as a blob on the screen and not a clear image of the pickup."

Once the pickup was identified, Dive Team members deployed a J-hook from a Zodiac boat to snag the truck. The hook lodged in a solid area after several attempts and Lincoln Auto Salvage was able to pull it to shore.



ECHOSCOPE PIPE SEQUENCER

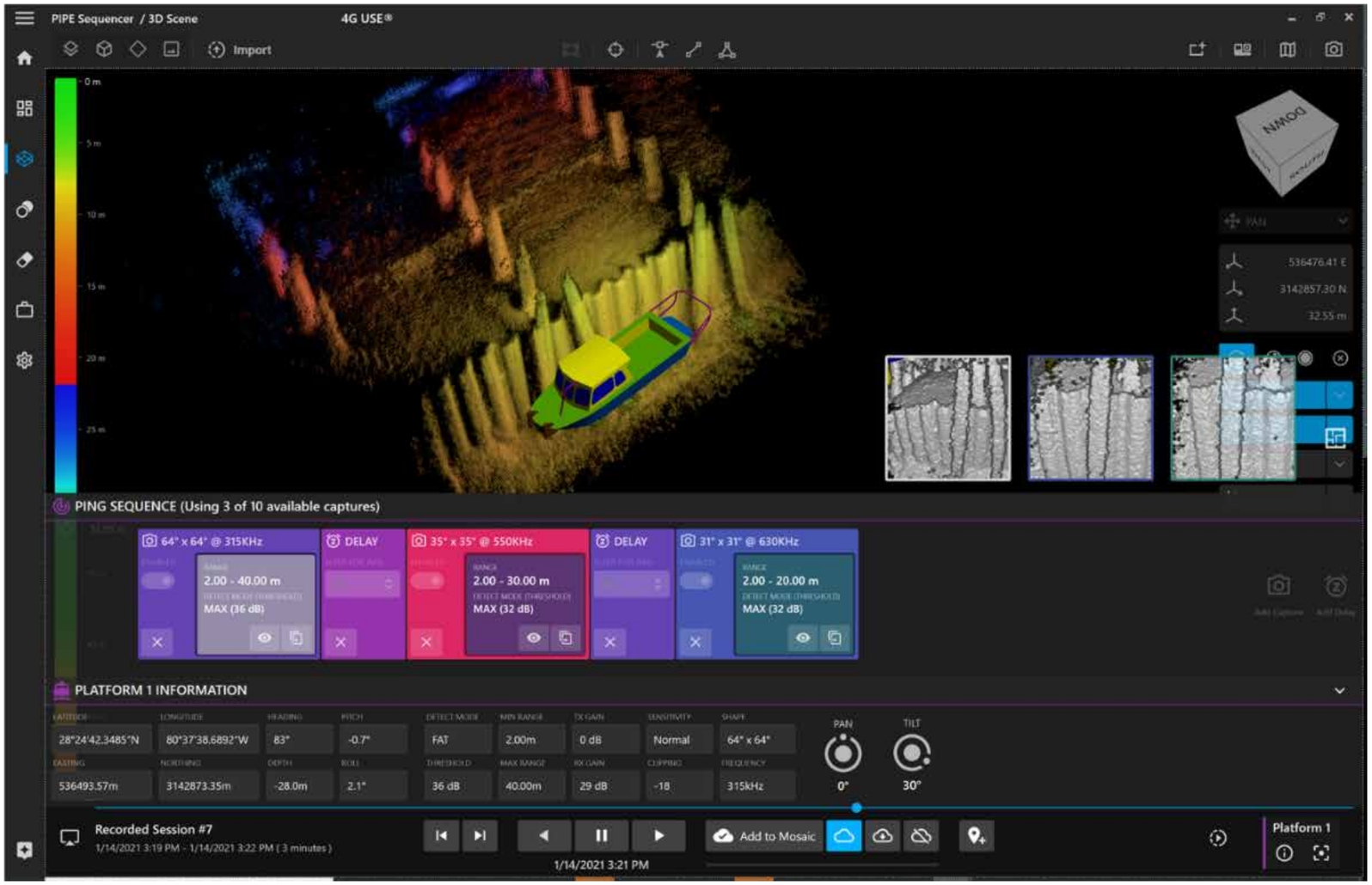
Coda Octopus recently launched its new generation of sonars – the Echoscope PIPE series – which embeds its Parallel Intelligent Processing Engine (PIPE) based on advanced multimodal signal processing.

This is the foundation for the PIPE sonar series' ability to generate and visualise from different angles multiple 4D Images in real time (a shift from its previous generation of real-time sonars which allows users to visualise a single 3D underwater image in real time).

In support of this new generation of PIPE sonars, Coda Octopus has announced the release of its game-changing PIPE Sequencer, a software module, which brings an unmatched cutting- edge capability to underwater operations by providing multiple 3D imaging and multiple 3D view angles of the 3D images, all in real time.

This capability reduces surveying costs and time, reduces the complexity of underwater imaging by using a single sonar for multiple captures at different frequencies etc. and provides increased security through provision for data redundancy.

Sequencer allows users of Echoscope PIPE sonars to pre-program a sequence of up to ten different real-time 3D acoustic data captures using different acoustic and processing parameters such as frequency, range, pulse length, TVG, transmit and receive gain or sonar processing parameters such as filters, bottom detection methods or sidelobe clip levels.



The Software Interface (Capture Cards and Capture Views) with 3 different 3D Acquisition Sets (315kHz, 560kHz and 630kHz) rendered in a single consolidated 3D View

This gives the user the ability to capture and view in real time up to 10 different 3D datasets, with different capture or processing parameters, all of which can be viewed in real time from different perspectives – thus providing a more comprehensive understanding of underwater targets/structures being imaged and visualised in real time. The captured data can also be viewed in the 3D Data Window by multiple users – using independent 3D Data Windows.

Sequencer capability removes the requirement for running the same survey line multiple times at different frequencies or for other acoustic parameters.

It also removes the need for deploying multiple sonars to go over the same survey line and significantly reduces the risks of collecting poor quality data or missing important information about underwater targets/ structures being imaged.

This capability is also ideal for autonomous platforms and missions through the ability to pre-program the sonar using multiple capture and processing acoustic parameters.

The ability to acquire 3D Data in real time using different Capture and View parameters such as range, frequency, and processing filters brings a new and powerful capability to real-time 3D underwater imaging – not only does it reduce the time of these operations but, from a single mission, provides multiple 3D data sets using different data collection or processing parameters, each of which can also be used in real time by different users or for different operational requirements.

In a large number of situations, it removes the need to make decisions around compromise (resolution versus coverage, data density and field of view).

ARGEO AUV

Argeo has placed an order for a newbuild SeaRaptor 6000 Autonomous Underwater Vehicle from Teledyne Gavia with delivery taking place in the beginning of 2022 at a cost of NOK 65 million. The delivery includes several ancillary system components, software and crew training.

In parallel with acquiring the AUV Argeo has secured a deep-water survey in the Pacific region for an un-named scheduled in several projects over a three year period with a total contract value estimated between NOK 30-40 million and potential for further extension.

The design, specification, and procurement of the AUV have been successfully carried out in close cooperation with Teledyne Gavia. The AUV is modular and very mobile (air transportable) with supporting systems which can be strategically placed in our Geomarkets for rapid deployment between regions. All data collected will be processed onboard (the AUV) using onboard-postprocessing and mosaicking software to allow quick turnaround during missions and improved decision making for the customer. The cost of the AUV is approximately NOK 65 million.

The AUV system will be the Company's second vehicle. It scheduled to start work on a deep-sea mineral and environmental impact study campaign in the Pacific region immediately after completing Factory Acceptance Testing (FAT) of the AUV. The Campaign contract value over the period of three years is estimated between NOK 30 to 40 million.

HMC EQUINOR REMOVAL

Equinor has chosen Heerema Marine Contractors for removal, dismantling, and recycling of three offshore installations from the Heimdal and Veslefrikk fields.

The work scope includes the Engineering, Preparation, Removal and Disposal (EPRD) of both the main platform and riser platform from the Heimdal field and the wellhead platform Veslefrikk A, including a subsea pre-drill template. Early engineering will begin directly for the Heimdal platforms and earliest start of offshore executions can be in 2024. The infrastructures to be removed weigh approximately 68 000 metric tons in total.

The Heimdal gas field in the Northern part of the North Sea has produced gas and condensate since 1985. The operator, Equinor, plans to decommission the field, including removing, dismantling, and recycling the main platform topsides and jacket.

The scope also includes the bridge, topsides and jacket of the Heimdal riser platform for which Equinor is the technical service provider on behalf of the operator Gassco. Assignment of the Heimdal riser platform scope is however subject to Heerema being awarded the riser platform contract after expiry of a mandatory standstill period required prior to contract award.

Veslefrikk is an Equinor operated oil field, also located in the Northern part of the North Sea. The field has been in production since 1989, and the wellhead platform Veslefrikk A will now be removed and recycled.

The Heimdal and Veslefrikk platforms will be removed by Heerema Marine Contractors and transported to Aker Solutions' decommissioning facilities at Eldøyane in Stord, Norway. After dismantling at the decommissioning yard, approximately 98 percent of the material will be recycled primarily into steel.

In 2020, Heerema removed 85,277 metric tons of offshore infrastructure across the North Sea and in Canada.

FLOW ASSURANCE

Over the years, the offshore industry has developed a range of remediation strategies for when the wellstream flow becomes either blocked or restricted. Flow remediation company Paradigm's Flexi-Coil system is proving a niche technology to help solve difficult riser-pipeline flow assurance challenges.

Blockages and restrictions within the pipeline and subsea infrastructure can take the form of hydrates, waxes, asphaltenes and other solids appearing in the line. The presence of hydrates is probably the most critical due to the speed at which they can suddenly form, but all can curtail or even fully prevent production.

Success in removing the blockage largely depends upon what it is and where in the system it has formed.

WAXES

Remediation of wax deposits can be achieved through chemical treatment where there is residual flow through the pipeline, with the aim being to solubilise the wax with a dissolving agent, however where a blockage has occurred – and where system pressurization is not an effective solution- more intrusive solutions are usually required at greater cost and higher operational risk.

Paradigm has executed some of the most challenging applications in this arena using its unique Flexi-Coil technology, a miniaturized, flexible coiled tubing-like technology developed specifically for complex riser and flowline interventions.

HYDRATES

Hydrates may form when several conditions are satisfied. They require the conditions to fall into an envelope of high pressure, low temperature and with the presence of water and gas. Conversely, changing one component in the pressure/temperature/water/gas quadrangle causes the structure to decompose.

Deepwater pipelines are often surrounded by low ambient temperatures. At the planning stage, strategies such as insulating the lines or routinely dosing thermodynamic inhibitor chemicals keep blockages from forming, but are immediately ineffective if the field experiences an un-controlled shut-in or the amount of chemicals added are insufficient.

Flexi-Coil deployed under-deck in a very congested area

Hydrates are formed due to pressure and so removing them demands an opposite remediation strategy than for waxes. Increasing the pressure may cause the hydrate to grow or solidify but reducing the pressure below the 'disassociation point' will start to decompose the hydrate.

This presents a difficulty in deep water fields where hydrostatic pressures within thousands of feet of riser, naturally sustain the blockage structure. Nevertheless, initial depressurisation of the system is normally one of the first ports of call.

Some facilities may have been designed with riser base gas lift capability which makes it easier to isolate the riser and bleed-down the pressure. Elsewhere, most

SUBSEA TIEBACKS

As the industry pushes into a new era, economics demand that operators change their approach in the development of new fields. In the Gulf of Mexico, as elsewhere, subsea tiebacks remain the development option of choice.

"In the past, deepwater field designs have often been 'gold plated', designed with future gas lift capability that may not be required for many years, or with twin flowlines that can be routinely cleaned by pigging to remove solids deposits," said Keogh.

"In recent years, however, the design philosophy has changed and reflects the industry's economic backdrop.

Operators are more inclined to reduce their CAPEX cost with simpler field designs in the knowledge that certain flow assurance challenges will arise during operation. They engage with solutions providers early, prepare for these and then solve them at lower cost if and when they occur.

"This is something that we have seen first-hand with Shell who are in the process of bringing on a new tieback in the Gulf. We are working with them to develop an Operational Readiness Plan to ensure that our Flexi-Coil technology can be applied and is applied swiftly in the event that it is required."

layouts have a production manifold that can enable connection of an ROV-mounted skid to bleed-off the fluid subsea and reduce the pressure to below the disassociation point.

Like waxes, the second way is to chemically change the effective melting point. The main challenge, however, is how to get the fluids as close to the blockage as possible. If the flow is simply restricted, the chemicals can flow past and react with the plug, but this becomes more of a problem if the pipe is totally constricted.

FLEXI-COIL

"Flexi-Coil is broadly analogous to coiled tubing, which is commonly used for well interventions," said Kevin Keogh, Commercial VP at Paradigm.

"The key difference is that Flexi-Coil deploys a composite rather than steel tubing, which has very different material properties and resultant capabilities."

Composites are far more flexible than steel, with a minimum bend radius of around 28 inches for the 2⅜in tubing used by Paradigm.

This allows it to negotiate challenging surface pipework and riser configurations, such as those incorporating lazy waves, where using steel tubing would be far too stiff and would damage the inner-wall of the riser.

While steel coiled tubing requires direct vertical access in to the riser, composite based systems such as Flexi-Coil can be positioned remotely, such as on another deck, and not within line-of-sight of the riser or pipework entry point, enabling applications on even the most congested production facilities

Another inherent advantage of composites is their low mass. When introduced into horizontal pipe, steel coiled tubing would gravitate to the bottom, generating frictional drag as it is pushed along.

Because Flexi-Coil is so lightweight, however, it can achieve 'neutral buoyancy' in fluid densities equivalent to that of seawater. The resultant reduction in frictional drag allows it to be pushed considerable distances into the pipeline, even after being deployed through short radius surface pipe bends.

BUT HOW LONG?

Paradigm say that they are confident of running Flexi-Coil to 16,000ft (5km) into a pipeline but believe that this could be extended to 28 000ft (8.5km) in certain applications and with some minor technology developments.

Paradigm is also in the process of delivering an Improved Oil Recovery (IOR) solution enabled by Flexi-Coil that will enable retrofit of in-riser composite gas lift strings on production facilities that are currently unable to apply such methods due to access and challenging pipe geometries.

"The Gulf of Mexico is a mature deepwater basin," said Keogh. "There are a lot of subsea wells that are in or are approaching late-life and getting the wellstream back to surface becomes more challenging due to reservoir pressure depletion. The solution is usually some form of artificial lift technique to either boost the pressure of the wellstream or reduce the back-pressure that is acting against it.

"There are many great technical solutions to this end; subsea booster pumps are an obvious example but these are high in CAPEX and costly to maintain and are therefore unlikely to be economically viable for late-life applications.

"A much more economical yet highly effective solution is to install a gas lift string inside the production riser; injecting gas in to the wellstream near the riser touchdown point (the seabed) will lower the density of the wellstream fluids, thereby reducing the back-pressure acting against the reservoir and allowing it to flow more freely and productively. This can also help where slugging is an issue.

"The challenge here is that this solution requires direct vertical access to the riser in order to deploy steel coiled tubing and that isn't available on a high proportion of production facilities in the Gulf.

"Semi-submersible TLPs are a good example, where there are many pipe bends beneath the water-line that run across the pontoons to where the riser hang-off is.

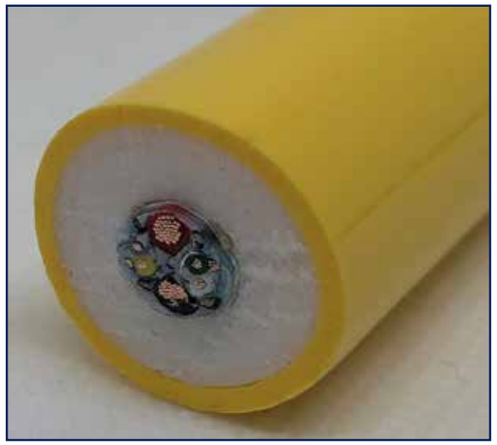
"Flexi-Coil's versatile surface rig-up and ability to navigate these bends mean that it is an enabler for in-riser gas lift on the most congested facilities and in the most complex riser systems."

PURPOSE-BUILT ROBOTIC CABLE FOR UNDERWATER ARCHAEOLOGY

Focusing on design and production of purpose-built cables for marine robotics, NOVACAVI has developed a special slightly floating tether to be connected with a Tether Management System (TMS) used for deep-sea archaeology activities.

NOVACAVI was asked to develop a 3000m depth rated water blocked buoyant mini-ROV cable to exchange data and supply power during accurate observation and intervention in deep archaeological sites with new robotic underwater vehicles.

With engineering expertise, comprehensive knowledge of materials and a high degree of manufacturing, NOVACAVI developed and provided its 6GAX168.



Buoyant mini-ROV cable

C_KORE QUEENS AWARD

C-Kore Systems Limited from Escrick, York have been honoured with a Queen's Award for Enterprise for the second time in 3 years. Following their award for Innovation in 2019, they have now been recognised for their contribution to International Trade.

Now in its 55th year, the Queen's Award for Enterprise is the most prestigious business award in the UK recognising outstanding achievement, with Her Majesty The Queen personally approving all winners. This year C-Kore is one of only 122 companies across the UK who are to receive an award for their contribution to International Trade.

Tim Overfield, Managing Director, commented "Having had a tremendous 2019, winning both the Queen's Award for Enterprise for Innovation and Subsea UK's Innovation and Technology Award, news spread globally on how our innovative products are changing the industry practice on how subsea testing is conducted.

This resulted in an increase in international trade of over 600%. With C-Kore's automated technology it is no longer necessary to use traditional error-prone manual measurement techniques."

IKM ROVS ON AURORA

Nexans Norway and IKM Subsea have signed an agreement for ROV services on CLV Nexans Skagerrak, CLV Nexans Aurora and 3rd party vessel support.

The contract value including options is NOK 200 million and duration term is firm for 3 years + 2 yearly options.

Since 2012, IKM Subsea have supplied a Merlin WR200 Work class ROV's onboard on the ***C/S Nexans Skagerrak***. For the new contract, IKM Subsea's remote operation platform and capacity is a vital part of the service offering. IKM Subsea have, since 2017, operated ROV's remotely from onshore 24/7-365 and gained vast experience on this offering.

IKM Subsea Singapore are currently setting up their own Onshore Control Centre in order to also supply onshore control services in Asia and Oceania.

IKM ROVS ON AURORA

NordLink partners TenneT, Statnett and KfW have now taken over the high-voltage direct current (HVDC) transmission system between Norway and Germany.

NordLink- the "green cable" for exchanging German wind energy with Norwegian hydropower- is a system of two optimally complementary systems.

NordLink is now in the operation phase. The Norwegian and the German energy markets can nopw
achieve supply security and stable energy prices while increasing the share of renewables in the energy mix.

IKM ROV on the Aurora

CABLE VULNERABILITY

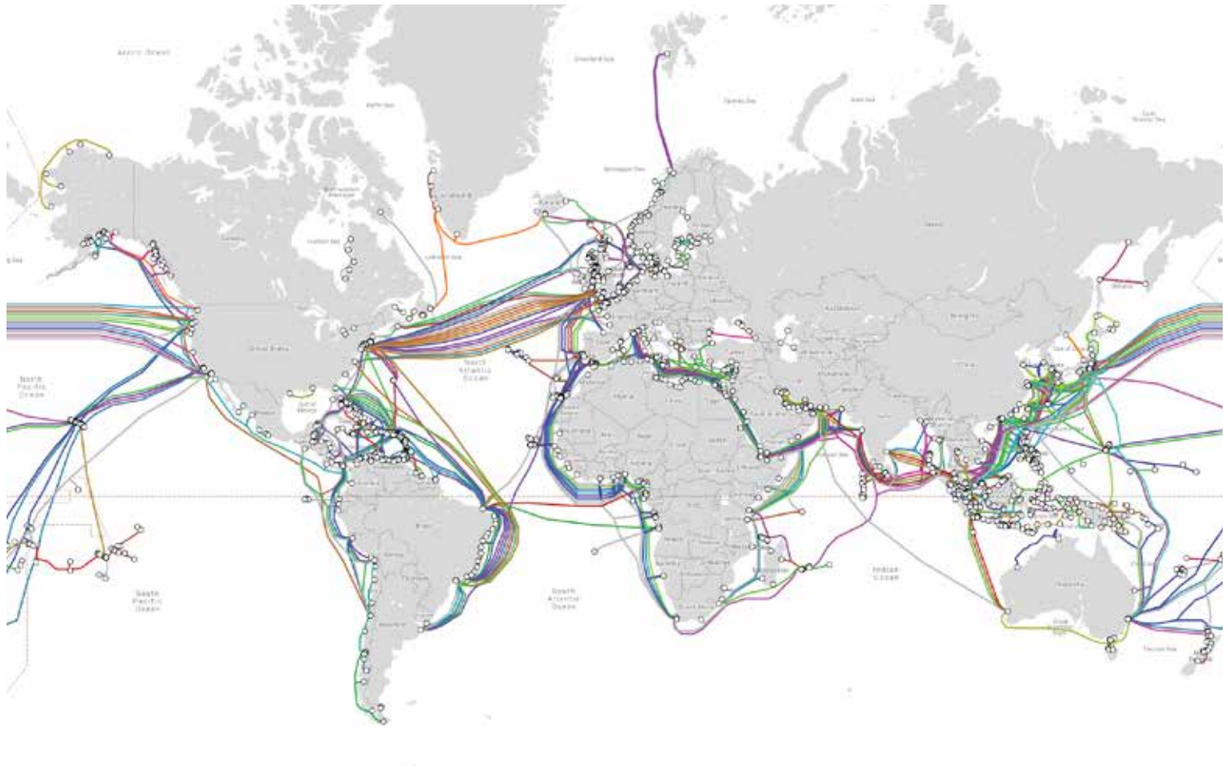
As part of the Defence Review, the UK government plans has announced that it will commission a new Multi-Role Ocean Surveillance Ship which, it claims, will protect the integrity of the UK's Maritime Zones and undersea Critical National Infrastructure.

At one time, ***'critical national infrastructure'*** could have referred to oil and gas pipelines. Today it is an euphemism for underwater telecommunications cables. Similar sentiments about needing to protect communications cables have been expressed by governments worldwide.

As the pandemic looks like changing the way internet services are consumed,especially when working remotely away from the central office, the world is becoming increasingly reliant on communications technology. Over the past few decades, high speed communication has driven globalisation with financial transactions worth over $10 trillion each day being conducted online.

In the not too distant past, companies needed to install physical computing infrastructure onsite. With the rise of cloud computing and high capacity, low latency connections, however, it is often more convenient or economic to use storage and processing facilities located anywhere in the world.

Pete Sandeman of defence analysts NavyLookout provided information for this article. www.navylookout.com



While the US is still the main consumer, between 2004 and 2019, it went from handling half of all internet traffic to just under a quarter.

SUBSEA CABLES

At present, estimates state that up to 97%-99% of all internet and voice traffic around the world pass through a network of subsea cables. To date, more than 1.2 million kilometres of submarine cables have been laid in the oceans of the world, some that run for over 20 000km.

A typical modern subsea cable is made up of up to 200 ultralow-loss fibres, each able to transmit 400Gb of data per second in both directions.

Cables with capacities of 250TB/s are now being used, roughly equivalent to simultaneously streaming 3.3 million 4K-resolution videos or serving 1.7 million small businesses using typical cloud services.

For most of its length, such cables are around the same circumference as a garden hose, although sections closer to shore have thicker sheathing, buried in trenches cut below the seabed or even have mating laid over them for protection.

Some nations are reliant on just one or two cables while some routes have multiple cables. There are at least 19 TransAtlantic cables that connect Europe to the US, offering a measure of redundancy.

DISRUPTION

Cable connectivity disruption could have an immediate effect on the economy, potentially crippling the banking system and halting commerce.

Every year, 150 to 200 subsea cable faults occur. Fishing (especially trawl nets) and shipping (anchor dragging in bad weather) activities

REDS UNDER THE SEABED

According to an analysis editorial by ***Navy Lookout***, cutting submarine cables is a deniable activity that would suit a power operating in the 'grey zone' below the threshold for full-scale war. This kind of attack is low risk and, for a relatively modest investment, could potentially achieve enormous impact.

Intelligence suggests that Russia, amongst other countries, are investing in sophisticated naval assets that could be employed to cut specific cables in a targeted and covert way. Submersibles with arms that can manipulate objects on the sea bed can place taps, cut cables or leave devices that could cut cables upon command in the future.

Many countries have an oceanographic presence but these establishments remain separate from the defence sector. In other countries, however, they are more allied.

The research ship ***Yantar***, for example, is officially classed as Auxiliary General Oceanographic Research (AGOR), with underwater rescue capability. She is tasked by the GUGI (Main Directorate Deep-Sea Research) which is an arm of the Russian Defence Ministry although separate from the Navy.

Yantar has been seen operating close to seabed cables on several occasions by open-source intelligence analysts and is doubtless tracked much more closely by professional naval intelligence. It is not inconceivable that vessels such as these have been engaged in information gathering, charting the location and vulnerabilities of cables and other undersea energy infrastructure should they wish to interfere with them in the future.

The US also maintains a secretive underwater network of sensors (Formerly SOSUS, now known as the Integrated Undersea Surveillance System (IUSS)) used to track submarine activity.

IUSS is increasingly mobile and less reliant on fixed infrastructure but it does still exist and adversaries remain interested in the location of the sensor arrays and supporting cables.

As part of its attempts to dominate the Arctic, Russia is known to be laying its own network of arrays under the ice called HARMONY. Incredibly, the system is believed to be powered by a series of small submarine-portable nuclear reactors laid on the seabed.

The construction of such a complicated system is only possible because GUGI operates the largest fleet of covert manned submersibles in the world.

This fleet includes six nuclear-powered mini-submarines; 2 x Paltus (730t) 3, x Kashalot (1,580 t) and Losharik (2,100t). Supporting them are two large 'mother' submarines that can covertly convey their deep-diving babies over long ranges.

Although the construction of HARMONY may be the initial task, this transporter submarine capability means the Russians can potentially interfere with submarine cables unseen anywhere in the world's oceans.

CABLE INTERFERENCE

Cable-interference is a well-established wartime tactic. Perhaps the most famous example was ***Operation Ivy Bells*** where the US Navy used nuclear attack submarines fitted with lockout chambers to lay cable tapping devices on the Soviet cables that linked the Russian naval base at Petropavlovsk to its Vladivostok headquarters.

The devices recorded conversations on magnetic tapes that were recovered and replaced by regular submarine operations.

SUBSEA CABLES

In February, SubCom completed testing of the Dunant submarine cable. Dunant is the first long-haul subsea cable to feature a 12 (rather than six or eight in past generations) fibre pair space-division multiplexing (SDM) design, which will enable it to deliver record-breaking capacity of 250 terabits per second (Tbps) across the Atlantic Ocean.

It is the second in a series of cable systems that Google has contracted with SubCom

Previous cable technologies relied on a dedicated set of pump lasers to amplify each fibre pair The new SDM technology allows pump lasers and associated optical components to be shared among multiple fibre pairs. This 'pump sharing' technology enables more fibres within the cable while also providing higher system availability.

Last year, Google SubCom announced the Grace Hopper cable with 16 fibre pairs (32 fibres).

are responsible for nearly two-thirds of all faults. Piracy also occasionally occurs.

INTERNET

A working principle of the web is that it is part of the network and if one part is destroyed, signals are automatically re-routed via other parts of the system. If a main cable or even multiple cables are severed the sheer amount of traffic and the, very limited spare bandwidth could cause the system to slow down large parts of the web.

One of the legacies of the pandemic is that there is likely to be an greater reliance upon online connectivity. Many organisations are considering abandoning or downsizing their offices as employees demand to work remotely at least part-time or with only occasional in-person meetings.

WAKE UP CALL

In 2017, Rishi Sunak,now the UK Chancellor of the Exchequer but then in the 'think tank', published a landmark document outlining the threat to undersea cables in a UK.

It named Russia as the primary agency for both developing the capabilities and having the potential motivation to interfere with submarine cables. If the UK was not to be caught sleepwalking into connectivity issues, the government would have to take steps to secure the lines.

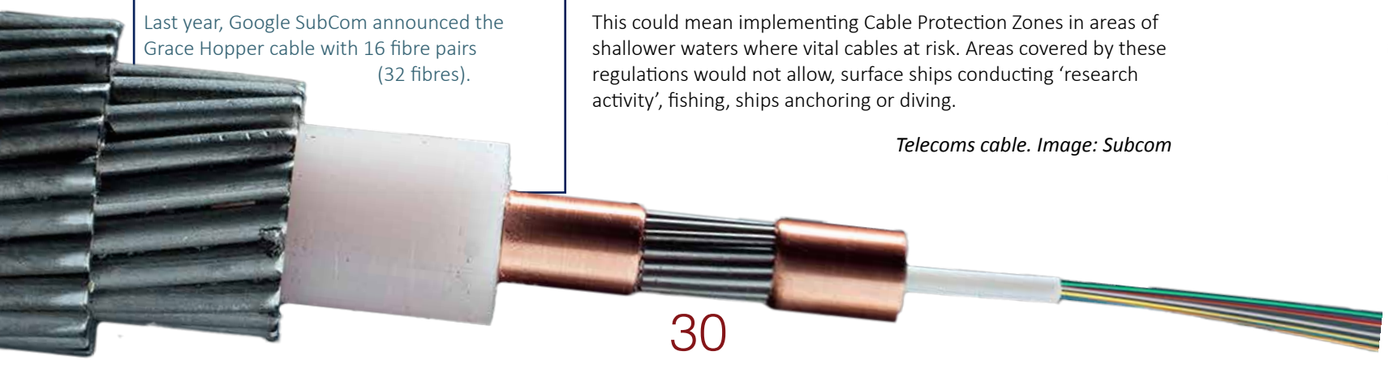
PROTECTION

Protecting cables that stretch for thousands of miles across the deep ocean floor is extremely challenging and potentially expensive but there are three main ways in which security could be improved.

Legal and regulatory. There is limited protection for submarine cables in international law and this could be addressed with a new International treaty with punitive sanctions against any nation proven to have interfered with cables.

This could mean implementing Cable Protection Zones in areas of shallower waters where vital cables at risk. Areas covered by these regulations would not allow, surface ships conducting 'research activity', fishing, ships anchoring or diving.

Telecoms cable. Image: Subcom



Even assuming all nations would be willing to accept a new treaty,the primary difficulty would be to ensure round the clock enforcement.

Capacity and redundancy. Key data traffic routes could be backed up by redundant extra 'dark' cables, ideally not marked on charts and buried as much as possible.

There is already some redundancy in the system as accidental cable breaks occur frequently but there is limited financial incentive to invest large numbers of new cables, capable of providing the level of resilience required if a concerted attack cut multiple connections.

Building this additional resilience would likely require government funding in partnership with cable companies.

Surveillance and deterrence. It is possible to fit the cables with sensors that can detect the sonar frequencies used by submersibles intent on interference and alert authorities ashore. It may also be possible to use fibre optic cables themselves as sensors.

Small or unusual movements in the cable caused by interference may be detectable by analysing the transmission of light through the cable. There are already research programmes underway to investigate using undersea cables to measure distant seismic activity.

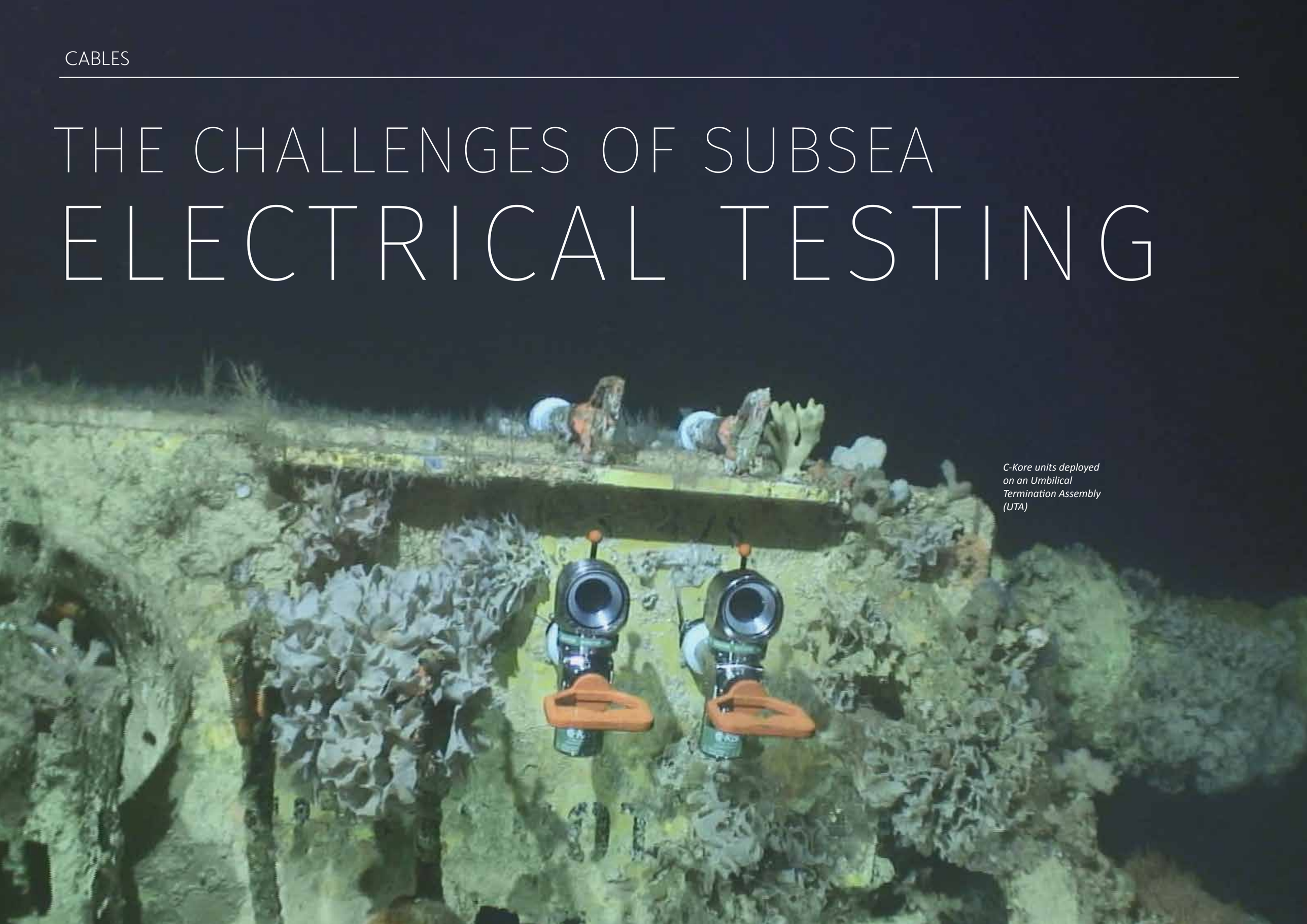
In recent years, the number and capability or unmanned underwater vehicles has grown and the costs have fallen. These could be used to affordably patrol sections of cable.

According to ***Navy Lookout,*** another maturing solution could be Persistent Autonomous Underwater Vehicles (PAUV). These use very little power and are can operate independently for several months are.

The deployment of patrol UUVs and the inspection and rapid repair of submarine cables could be a task for the new Ocean Surveillance/ Research Vessels. This activity cannot be undertaken by the UK alone and would require co-operation with other nations willing to invest significantly in cable security.

Further improvements in anti-submarine and underwater warfare capability for the RN and across NATO is needed. Small steps such as the new RVs and the procurement of the Manta XLUUV technology demonstrator are moves in the right direction but there is much more to be done to secure the backbone of global communications.

THE CHALLENGES OF SUBSEA ELECTRICAL TESTING



C-Kore units deployed on an Umbilical Termination Assembly (UTA)

CHALLENGES OF SUBSEA ELECTRICAL TESTING

How do you fault find an electrical system hundreds of meters below sea level, containing an extensive network of cables and equipment spread out over an area the size of London?

This is a question that subsea engineers in the oil and gas industry wrestle with daily all over the world. C-Kore Systems, a UK company specialised in subsea testing equipment, is helping subsea engineers solve this very problem.

Subsea electrical networks are essential for the production of oil and gas from subsea wells. They are used to open and close subsea process valves and read-back vital instrumentation on pressures, temperatures and flow rates.

The current trend for these systems to become increasingly complex means that if something goes wrong the challenge of locating the fault becomes increasingly difficult.

When the topside Line Insulation Monitor (LIM) starts to warn that the insulation resistance (IR) of the system is dropping, engineers must plan how to find the source of the low IR. One option is to try and test from topside.

Think of this as the old-fashioned string of Christmas tree lights; replacing one bulb at a time until the rest of the string lights up. Start unplugging the subsea equipment and see if the low IR issue goes away or stays.

However, unplugging equipment subsea is not as quick and easy as it sounds. After securing the appropriate vessel with the correct equipment on-board and having all permits in place, either a diver or ROV goes subsea to start the unplugging process.

Before unplugging, the equipment must be isolated to avoid short circuits, then turned back on once disconnected to see if the LIM's readings have improved. If the readings are unchanged, the process is repeated at another location until unplugging the equipment has a positive effect on the IR of the system.

A time-consuming process, that involves repeatedly powering on and off the system, and waiting on permit approval before each test. There is also no guarantee faults further on down the line are identified if testing is stopped once the first fault is found. Repeated intervention also creates its own risk of introducing additional IR problems into the system.

Another option is to test directly into equipment subsea using a down-line (a very long extension cable) connected to testing equipment located on the back deck of a vessel. The subsea system is isolated, the down-line is deployed, an ROV or diver disconnects the subsea equipment and then plugs the down-line into the circuit.

Testing is performed by a technician on the deck of the vessel. This has the advantage of connecting directly to a segment of subsea infrastructure and not having to test through all the connections from the topside location.

The downline, however, will affect the test readings. A faulty down-line will give faulty results and even a healthy downline will have a detrimental im-pact on TDR (Time Domain Reflectometry) readings. Deploying down-lines in deep waters is a time consuming, expensive and high-risk process.

Furthermore, weather conditions will affect the readings of the topside testing equipment. Trying to get reliable IR readings in damp North Sea conditions can be very difficult. Finally, topside test equipment requires specialised personnel to operate, and results are dependent on the correct operation.

Range of C-Kore tools including their Cable Monitor, Subsea TDR and Sensor Monitor

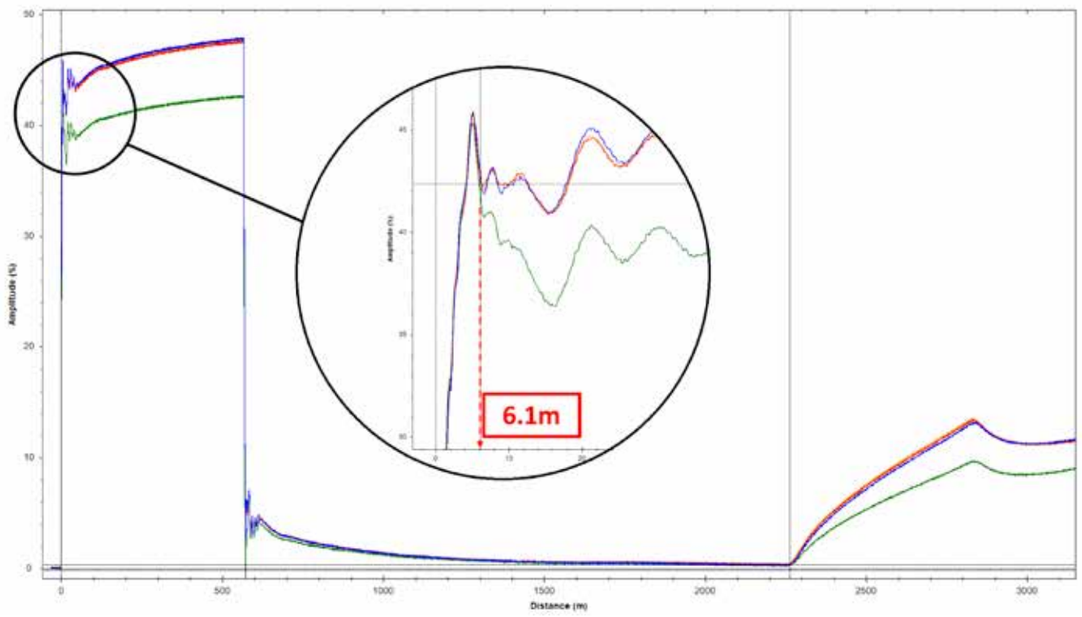


Fig 1 Fault located in subsea UTA

C-Kore Systems has developed a better way to perform subsea testing using a small hand-held testing unit with a wet-mate connector. The C-Kore unit plugs directly into the subsea infrastructure and can be operated by either diver or ROV.

The results displayed and data-logged give the condition of the subsea equipment and are not affected by down-lines or weather conditions.

The units are automated and programmed ahead of time to run the required tests, so no specialised personnel are needed offshore, and therefore the results are not influenced by human interaction.

In fact, the same test program can be downloaded onto the units years later. When plugged into the same equipment subsea, the new results can be directly compared to the earlier results to give a clear indication of any degradation that may have occurred.

Optimising subsea testing campaigns also involves looking at what is important during the operation, such as minimising the number of makes/breaks in the subsea system, minimising the vessel time on-site, or perhaps minimising the vessel movement throughout the field.

All of these factors need to be considered to ensure a quick and efficient work scope is planned.

A subsea field operator came to C-Kore Systems with a typical question: how to best find the source of the low IR that was plaguing their field. They wanted to minimize the makes/breaks of the system and execute as quick a campaign as possible.

C-Kore offered two different testing units to help with the fault-finding campaign. The C-Kore Cable Monitor measures insulation resistance and continuity of electrical lines and can identify which lines contain low IR.

The Subsea TDR unit localises where on the line a fault is, working much like a sonar, but firing an electrical pulse down the cable and "listening" for the electrical echo. By knowing the time it takes for the echo to come back, the distance to the anomaly can be accurately determined.

The combination of both tools allows not only the faulty line to be identified, but the precise fault location along the line's length to be determined.

By reviewing the field's layout in preparation for the mobilisation, C-Kore's engineers were able to advise on the appropriate testing philosophy and tools to achieve the customer's goals.

Going to a central location in the field and using the Cable Monitor to test the IR of the different legs of the field, the customer was able to quickly eliminate equipment that still had

acceptable IR, and identify sectors with problems.

By taking both genders of Cable Monitor tools, one break enabled the customer to test the IR on both sides of the break, increasing visibility with fewer disconnections.

This method of testing quickly indicated that an umbilical and an Electrical Flying Lead (EFL) were both sources of low IR. The EFL could be changed out, but the umbilical posed a bigger question.

Was it possible to recover the end of the umbilical and re-terminate, or would the entire umbilical need to be replaced? The C-Kore Subsea TDR unit answered this question.

Figure 1 (overleaf) shows the result of the C-Kore software overlaying the responses from a known healthy conductor pair in a 2.25km long umbilical with one with a low IR fault. When the C-Kore software is used to zoom in on a feature at the near end of the trace a clear divergence between the faulty and healthy cores is seen at 6.1m, correlating precisely with where a field installable connection has been made in the Umbilical Termination Assembly (UTA).

With knowledge of the precise location of this fault, the customer was able to re-terminate the UTA, bringing their subsea field back to good working order with an offshore campaign that was completed quickly and efficiently with the help of C-Kore.

UXO SURVEY TECHNOLOGY

At a recent meeting of the Hydrographic Society in Scotland/ NOSP looking at ***The Next Steps in UXO Survey Technology & Techniques***, Chris Almond from PanGeo Subsea recently looked at 3D acoustic surveys to mitigate the target visualisation

The first stage of any survey focusses on conducting a desktop study. This collates a variety of information sources, such as known maps of munitions dumps, pipelines, wrecks and other seabed data that has been collected over the years from a variety of sources such side scan sonar, multibeam sonar echo sounders etc..

Armed with this information and the proposed route of the cable to be laid, the operator can commission a geophysical survey. Perhaps the most common tool used is a magnetometer which is towed across the planned area to produce a magnetic anomaly map highlighting ferrous metals on the seabed.

"A wind farm development could highlight targets revealing everything from debris to munitions and cable/pipelines depending on the location" said Almond. ROVs are then sent to carry out visual investigation. In 24 hours, they can look at around 5-10 targets, with more than 90% of targets found not to be UXOs.

A typical identification campaign could last 3 to 6 months and look at thousands of targets. This has prompted companies to use complementary tools to reduce the number of false positives."

PanGeo has developed a 3-D sub bottom imaging tool that produces a continuous high-resolution 3-D volume acoustic image in real-time with a subsea resolution of 5cm.

"The PanGeo Sub-Bottom Imager (SBI) measures acoustic impedance or more importantly, the boundary between different impedances that represents a surface or buried structure. It detects everything from ferrous pipelines and cables to nonferrous bodies such as boulders or concrete mattresses

When coupled with a magnetic UXO survey , the data can be combined to reduce the number of targets.

"It is particularly good at finding the shape and dimensions of the target," said Almond."The accuracy is also dependent on the speed of the survey and the natural distribution of the targets

"With reference to a magnetic anomaly map, it is possible to overlay the three-dimensional acoustic shape map to eliminate targets. It can mean the difference between looking at a munition or a clump of wire.

"One reason that some magnetic data produces false positives is that there was perhaps metal there once, but it has long since corroded away yet some sort of ferrous presence remains. It will still produce a magnetic response although the original metal body has disintegrated.

By acquiring the acoustic data, you are able to confirm that there is no acoustic anomaly associated with the magnetic anomaly, confirming a false positive reading in the magnetic data. Should an acoustic anomaly be present, by comparing the shape and dimensions to known munitions the overall magnetic target listing which requires visualisation can be reduced by a significant volume, driving down the time spent on site and as a consequence, the cost.

"In the Second World War some munitions had aluminium casings. These cannot be detected by magnetometers but can be detected by acoustic systems assuming the exterior is not corroded, said Almond. The presence of non-ferrous munitions is a small but growing issue however these acoustic surveys can and previously have located LMB mines within the sub-seabed.

PanGeo's Sub-Bottom Imager

PanGeo's Sub-Bottom Imager on a ROV

CABLES

At the same event, Matthew Kowalczyk from Oceanfloor Geophysics talked about RM Hypermag, a multi-vector gradiometer for UXO, Cable and Pipeline depth of burial

Canadian company Ocean Floor Geophysics Inc. (OFG) has developed the RM Hypermag, a multi-vector magnetic gradiometer suitable for UXO detection and for locating cables and pipelines and measuring their depth of burial.

Sensitive total field magnetometers are often towed behind vessels or AUVs. OFG originally developed a self-compensating magnetometer that compensated for static and dynamic magnetic field created by the vehicle. This self-compensating magnetometer typically goes inside AUVs, ROVs, and more recently, USVs for shallow water detection.

Now, OFG has developed the much more sensitive RM Hypermag. The system is currently being integrated into an EIVA Scanfish ROTV (actively controlled towfish) for deployment in the USA in May.

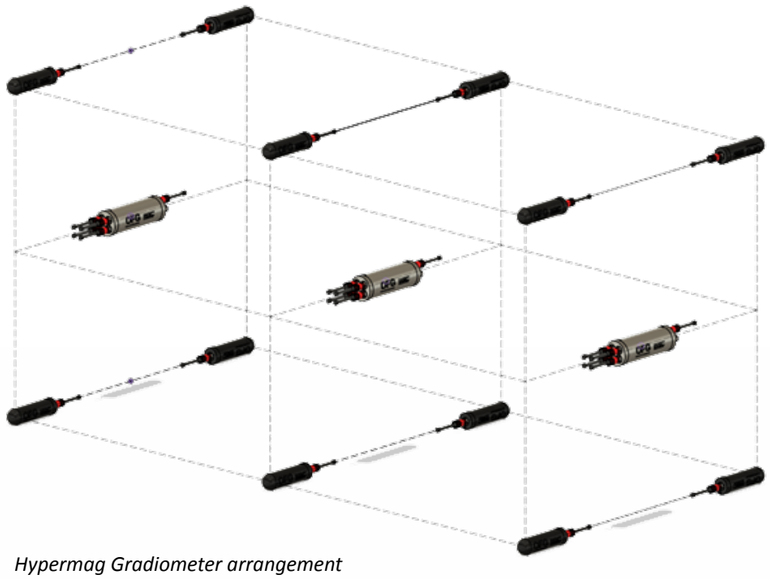
"With the new RM Hypermag, it is possible to deploy multiple magnetometers in an array that gives a combined sensitivity of at 4pTrms/rthz, similar to a caesium vapour towed magnetometer," said Matthew Kowalczyk.

“It is a combination of subsea magnetometer sensor arrays, processor/data logger, calibration procedures, and proprietary software algorithms to provide compensated and corrected magnetic data in real-time. Individual sensors are tightly synchronized to provide magnetic gradiometer measurements.

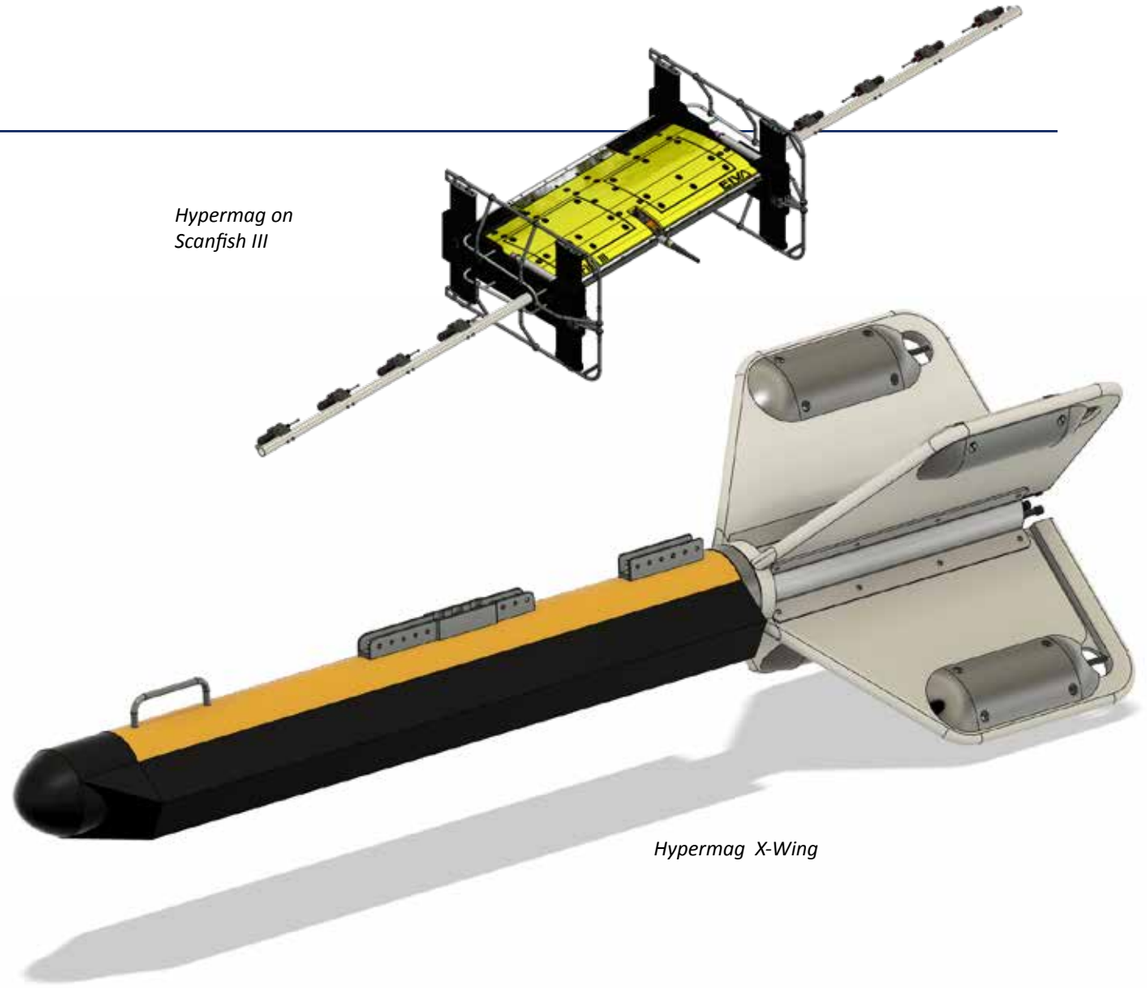
The gradiometer directions are dependent on installation configuration and can be designed for the application, be it vertical, horizontal or inline gradients. Total field and vector field data, without dead zones, is also produced for a comprehensive magnetic data product.

An RM HyperMag array comprises four individual 3-vectormagnetometers, each residing within their own subsea bottle, connected to a central subsea interface bottle, which acquires, processes, and communicates via a high bandwidth protocol to a central receiver or switch. The individual sensing units are very small, and multiple arrays can be combined into larger arrays making the whole system easily scalable.

It also features a 1kHz bandwidth for fast sampling, simple connectivity (Ethernet or RS 232) and very low power, less than 4 W per Hypermag unit.



Hypermag Gradiometer arrangement



Hypermag on Scanfish III

Hypermag X-Wing

Because they don’t have the same power draw as other marine magnetometers, they are well suited to AUVs and other low power systems. As AUVs and active towfish house increasingly more instrumentation, the low hotel load from the RM Hypermag conserves valuable power and enables easy integration into the vehicle systems.

Other options include a single towed body system with an integrated IMU, depth, altitude and USBL responder trigger passthrough for improved positioning at lower costs.

When trying to identify magnetic seafloor objects the absolute sensitivity of a magnetometer is not the only important measure.

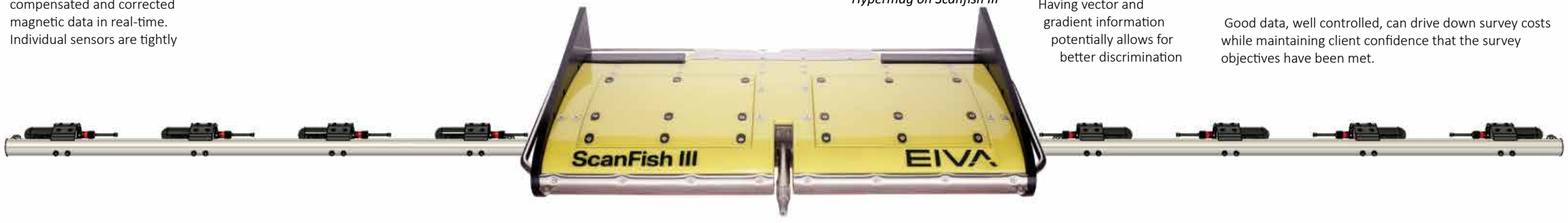
Having vector and gradient information potentially allows for better discrimination of objects such as UXO, cables or pipelines.

An important consideration is the control and measurement of the sensor position. For example, if a magnetometer array is towed on lines behind an ROTV the magnetometers may fly at different or changing heights so measured magnetic field from the objects of interest will change in magnitude.

This can cause errors and artefacts in the data. Operating the RM Hypermag as a strap down instrument on a well-positioned subsea vehicle or towfish and coupling better position control with the additional data from multiple vector and gradient measurements provides excellent target discrimination. It may also allow for wider line spacing.

Good data, well controlled, can drive down survey costs while maintaining client confidence that the survey objectives have been met.

Hypermag on Scanfish III



ROUTE PLANNING

Submarine cables play a vital role in making global connectivity possible. The demand for such cables is forecast to increase substantially over the next few years.

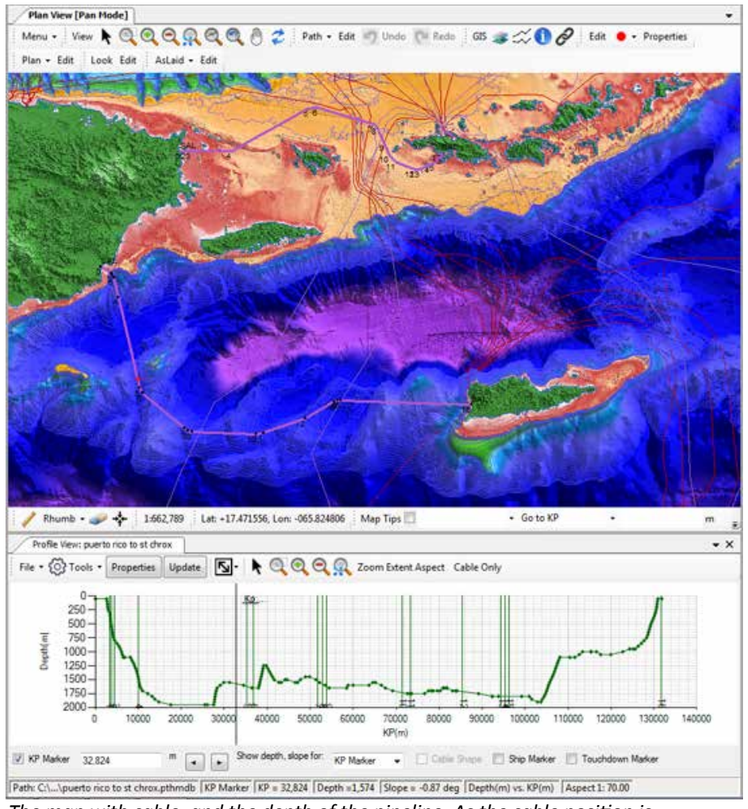
Planning the route of the cables along the seabed was once carried out by intuition and bathymetric maps. The process is now performed, however, with the aid of purpose-built software.

One such package is provided by Hawaii based Makai Ocean Engineering, a company that provides software for various different stages of the submarine cable lifecycle. Its route engineering software MakaiPlan is used for calculating the optimal cable route across the seabed.

Commissioning a transoceanic system is a major infrastructure project comprising several engineering steps from planning to final installation. One company that offers a software suite that services the different steps of the submarine cable lifecycle is Hawaii-based Makai Ocean Engineering.

The software uses Geographic Information System (GIS) data as a background. Far more than a simple map; this comprehensive graphical database incorporates navigational charts, bathymetry, shoreline and soil data. It also contains a record of previous surveys, marine protected areas, the presence of existing cables and any other geographical data relevant to cable route planning.

"GIS data can be considered as a number of superimposed maps



The map with cable, and the depth of the pipeline. As the cable position is altered, the bottom graph changes.

showing various parameters that can be reordered or toggled on and off as required," said a spokesman.

"Once this GIS information is loaded and the start/endpoint of the cable ascertained, the user can start designing the optimal route by dragging waypoints along the cable to a desired position.

"As the user makes changes to this route, MakaiPlan automatically computes important route parameters. By zooming and panning along the route in both the plan and profile views, it is a simple task to modify the route such that it avoids obstacles while minimising cable length."

"Some potential issues might be more apparent in profile view eg, a steep slope or rough terrain. An dual locator links the profile and plan views of the cable path, so that the user can coordinate edits made in one view with the impact of those changes in the other view.

As well as with route selection, it is possible to document cable types, transition points, repeaters, splices, and inline cable bodies. MakaiPlan enables these cable bodies to be precisely located along the route to account for proper distribution of cable slack.

Route planning involves substantial manual processing where the planner makes decisions based on several competing constraints such as seabed slopes, crossing existing cables, navigating environmentally restricted regions, political boundaries, etc.

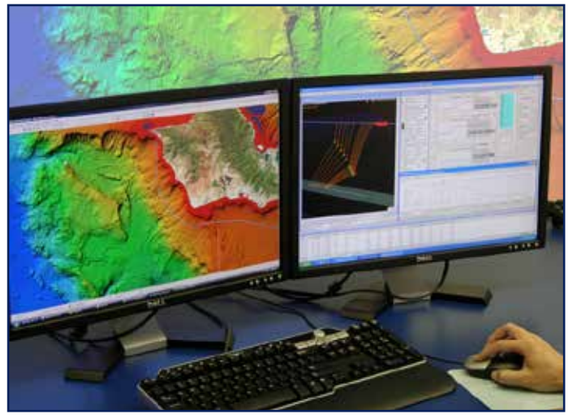
Using a newly developed Automatic Rule Checker tool, the planner can translate these constraints into rules that are continuously checked in the background by the route engineering software. The tool alerts the planner when one of these rules is violated during route changes at any stage of the planning process.

Common constraints that route planners must account for include

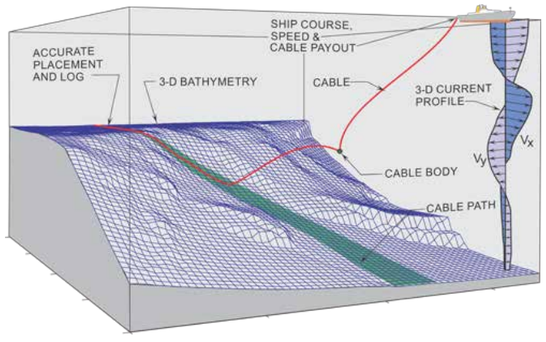
- Proximity of the route to others assets and obstacles in the area
- Proper placement of the inline bodies such as repeaters and their constraints
- Deciding which cable types to use along the route and transition locations
- Avoiding restricted areas (environmental, political, security, etc.)
- Avoiding seabed areas with excessive slopes or rough terrain

"The route position list (RPL) developed from MakaiPlan can be directly loaded into MakaiPlan Pro. Both MPP and MakaiLay include Makai's proprietary cable model that accurately models the shape of the cable in the water column between the vessel and the bottom terrain," said a spokesman.

"MakaiPlan Pro is in-office simulation software used to develop an installation plan or Ship Plan (SPL) while MakaiLay is a real-time at-sea system used to manage and control the installation of the submarine cable with higher accuracy and reliability than previously possible.



Using MakaiPlan Pro, cable operators can quickly simulate an entire cable lay in advance and in the office at up to 50 times faster than real-time. The primary benefit of MakaiPlan Pro is to give the cable operators a deep understanding of the expected cable behaviour during their particular lay.



MakaiLay uses bathymetry, cable and body properties, ship navigation and payout measurements, and even real-time currents to calculate accurate 3D dynamic shapes of the cable.

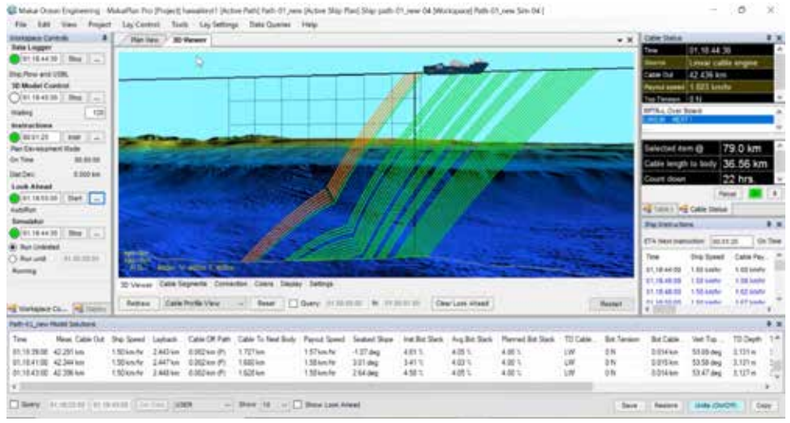
A traditional problem with cable lay has always been that cable installers never knew the condition of their cable once it went overboard.

"The primary purpose of a cable management system is to facilitate the accurate and safe placement of the cable on the seabed. The installer is responsible for laying the cable along a given path, at a designated level of bottom slack (or tension), safely and in minimal time. While they can easily control the ship end of the cable, they are ultimately responsible for the other end of the cable that settles on the seafloor.

No matter how simple or complex, all cable payout methodologies incorporate some method of describing the cable shape between the ship and the seafloor. The degree of success or failure is directly related to the ability to accurately compute the cable shape and cable touchdown conditions.

Cable installations are non-steady roughly between 50% and 100% of the laying time. Cables are non-steady if their shapes vary over time, and this will occur under a variety of conditions.

The ship speed often varies, cable payout is not always steady, the course is not always straight, and the cable often contains in-line sensors, repeaters, and splices. An accurate model that can handle and model all these features accurately is therefore needed for much of the cable lay.



MakaiLay monitors the lay and provides real-time feedback of the cable shape and touchdown conditions during the lay. It interfaces with vessel instrumentation to receive the necessary real-time data to make these calculations.

MakaiLay computes the shape of the cable moving through the water column, typically every minute. Cable shapes in the water column are displayed in three dimensions andthe cable slack (or tension) at the touchdown point is computed.

The software computes cable shapes under all conditions, including:

- Placing a cable with slack on the seafloor
- Placing a cable with tension on the seafloor
- Deploying inline cable bodies on a cable with botom slack or tension
- Stopping and restartng a cable lay Recovering a cable
- Lowering or retrieving a cable free end
- Look-Ahead

By carrying the MakaiLay at-sea analysis one step further, the same accurate cable model can be used to determine future cable shapes.

"Touchdown conditions in the immediate future can be reasonably predicted by the model," said a spokesman. "Having such a prediction is like having a crystal ball – corrections can be made to the installation procedures now to avoid undesirable touchdown conditions in the future.

"In the Look-Ahead, features like ***Auto-Slack*** and ***Auto-Tension*** automatically calculate the desired cable payout schedule for the next 20-60 mins based on the desired target slack or tension respectively. Auto-Position on the other hand can calculate the necessary vessel waypoints to control the cable touchdown location.

C-POWER AND BIRNS CONNECT ON SEARAY AUTONOMOUS OFFSHORE POWER SYSTEM DEMONSTRATION

BIRNS and C-Power have announced a new partnership in support of C-Power's demonstration of its SeaRAY autonomous offshore power system (AOPS) at the US Navy's Wave Energy Test Site in Hawaii.

BIRNS is supplying BIRNS Millennium subsea connectors and cable assemblies for the SeaRAY AOPS being deployed in Hawaii this summer.

The AOPS is an integrated offshore power generation, energy storage, data server, and communications system for support of unmanned mobile and static assets.

BIRNS Millennium subsea connectors

It provides energy and bidirectional data transfer, which are essential for customers seeking to reduce costs, improve safety and unlock a wave of innovative capabilities for resident vehicles, sensor packages, and operating equipment.

BIRNS developed custom electro-optical high-voltage cable assemblies for energy transfer and charging of autonomous underwater vehicles and seafloor data-gathering systems, as well as real-time data delivery for the unique SeaRAY system.

TEKMAR

Tekmar Energy has secured a contract by cable manufacturer ZTT to supply its cable protection system (CPS) for the Gode Wind 3 high-voltage grid connection in Germany.

The 16 km long submarine cable is scheduled for installation in 2023 and will connect the 242 MW Gode Wind 3 offshore wind farm to TenneT's extra-high-voltage grid via the DolWin Kappa HVDC converter station, and the associated DolWin 6 grid connection.

Tekmar Energy's CPS and bespoke Bellmouths will be installed to protect the cable as it transitions from the seabed through the dynamic zone between the Gode Wind 3 offshore substation and the DolWin Kappa platform.

The products will be delivered in 2022 and 2023 from the company's Newton Aycliffe manufacturing facility in the North East of England.

For the Gode Wind 3 connection, TenneT uses a three-phase cable with a conductor cross-section of 1,200 square millimeters the first time.

The cable will transport the almost 242 MW from the wind farm via just one cable system. The route also runs through the operational Gode Wind 1 wind farm.

GLOBAL OFFSHORE ON KRIEGERS FLAK

Global Offshore has completed their cable installation campaign at Vattenfall's Danish Kriegers Flak Offshore Wind Farm.

The initial phase of work saw Global Offshore utilise their multi-purpose PLP240 pre-lay plough, mobilised on the ***Havila Jupiter***, to carry out route clearance totalling approximately 158km.

The second phase included the installation of 72 inter-array cables, utilising ***Normand Clipper***, and the jet trenching of 72 routes using the Q1400 aboard sister vessel, ***Normand Cutter***.

Following the cable installations, the PLP240 returned to site to conduct backfilling operations, the first operation of its kind on an inter-array grid.

Prior to the commencement of the second phase, Global Offshore upgraded the Normand Clipper for power cable work. With the addition of a 4000t cable carousel, two 15-tonne cable tensioners, a 25t quadrant deployment frame and a fully integrated control system, the 127.5m cable-laying vessel enables Global Offshore to provide a flexible and reliable service.

DEEPSEA MINING CABLES

FOR SEABED MINING TO PROCEED SUCCESSFULLY, IT WILL REQUIRE COMPANIES, POSSIBLY ALREADY ACTIVELY SUPPLYING THE DEEPWATER OIL AND GAS INDUSTRIES, TO DEVELOP RELATED PRODUCTS TO MEET THE NEW SET OF UNIQUE CHALLENGES.

DEEPSEA MINING CABLES

SEABED MINING WILL REQUIRE COMPANIES, POSSIBLY ALREADY SUPPLYING THE DEEPWATER OIL AND GAS INDUSTRIES, TO DEVELOP OR ADAPT PRODUCTS. ONE SUCH AREA OF INTEREST IS CABLES.

For many years, the offshore industry has been developing very long cables for tying-back remote fields to a mother platform. These cables lie predominantly on the seabed, often having to be buried 2–3m to prohibit them from moving.

Seabed mining cables, however, require ***very*** different properties.

One company specialising in this dynamic market is DeRegt Cables. In addition to supplying shallow water static cables, the company has also been working on a new generation of deep and ultradeep water dynamic systems to supply underwater tractors maybe 5-6 km down on the seabed, with power and communications.

DYNAMIC

Dynamic power cables long enough to reach ocean depth are very rare. As a general design principle, any fragile components such as optical fibres and copper communications wires for data transfer, are placed at the core. These may be surrounded by a mid-layer incorporating the power conductor.

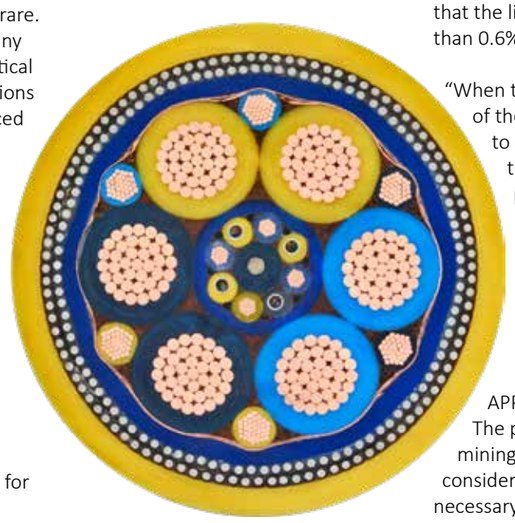
These two functional units are separated by extruded nonconductive plastic sheets while protective strength members are placed towards the outside of the cable.

"Perhaps ***the*** most important property of a dynamic cable, is for it to be able to bend and move while still retaining its internal strength and integrity," said Research and Development Manager, Sander van Leeuwen.

"The most efficient way to provide such flexibility is to lay the components in a helix in the same way that a spring or telephone wire affords controlled movement.

"If all the helical members were laid in the same direction, it would effectively result in the cable revolving along its length when a longitudinal force is applied, so to prevent this, some lines are designed to run down the cable clockwise and others anticlockwise like a Chinese finger in process known as torque balancing.

"This helical angle itself is very important. It is fundamental to the cable design that any is strain taken up by the cable's strength members and not transferred into to the copper and fibre optic components. The outer strength members, therefore, are laid at a much smaller (straighter) helix angle, say, 18deg to limit the stretch, while the core, is wound at a more flexible helix angle of, say, 20deg."



STRENGTH

The long vertically-hanging cable has to support itself or more specifically, the upper sections have to withstand the gravitational pull from the cable mass below it. While steel strength members are common for many cables, in such cases, designers often turn lighter synthetic fibres such as aramids (a popular choice sold under the brand name of Kevlar) to prevent elongation, particularly core elongation.

"A property of copper is that it deforms plastically and that is why the strength members have to ensure that the line does not stretch more than 0.6%," said van Leeuwen.

"When the load is released, the rest of the cable returns elastically to its original form, however, there is nowhere for the permanently deformed copper to go. The pressure, therefore, makes the copper fold in on itself causing ripples often known as Z-kinks inside the cable.

APPLICATIONS

The primary function of a seabed mining cable is to conduct quite considerable quantities of power necessary to drive the underwater tractor as well as a variety of auxiliary devices. It is also responsible for the bidirectional transfer of communication and control signals to the seabed device.

Such a demand is not unique in underwater technology. Some ROVs routinely work in water depths of 5000m. They manage this by incorporating buoyancy into the umbilical, reducing the effective weight and thus the demand for considerable strengthening.

De Regt, however, designed its cable not only supply power, but also, to be able to lift the heavy mining equipment to and from the seabed.

"It is for this reason, that modelling the cable on a deepwater ROV umbilical is inappropriate," said van Leeuwen. "Distributing the significant amounts of energy that a subsea tractor requires necessitates large diameters of copper wire. This metal has a density of 8 kg per metre which is eight times heavier than water.

Making such a copper cable neutrally buoyant would require a considerable amount of syntactic foam. The diameter would increase considerably which would in turn affect other aspects of the operation, particularly the launch and recovery process."

HEAT

Calculating the heat produced is another aspect of cable design. Although smaller than most, Copper has a natural voltage loss due to its resistance and, therefore, it is necessary to supply sufficient voltage at one end of the cable to supply the requisite power at the other.

The heat generated from transmitting large amounts of power needs to be dissipated. All things being equal, the larger the copper area, the less heat is generated.

"Plastics are often used within the cable as insulants and so it is important to control the heat output," van Leeuwen.

"One of the key considerations in any cable's structural design is to keep the core temperature limit under 90deg. If there no alternative to producing very high temperatures, the designer has to start looking at replacing the plastic insulation with fluoropolymer such as Teflon.

"Temperature is not necessarily a problem when the cable is in operation because the deep cold seawater is extremely good at absorbing heat. It does start to become a consideration, however, when the same cable has to pass through warmer shallow waters, through the air and coiled onto reels on deck."

OTHER MATERIALS

Copper is a very good conductor but is relatively heavy and its inelasticity is not ideal in a deepwater dynamic line. What are the alternatives?

"Many companies are looking at Aluminium as a candidate to replace Copper," said van Leeuwen. "The downside of this is that it is 30%-40% more resistive than Copper in an application where conductivity is the single most important property.

HERE'S A MAGIC WAND

If you had a magic wand that could solve one problem in the subsea cable industry, what would you choose?

"In an imaginary world, I would look at changing the resistance of the cable," said van Leeuwen. "That can be done in two ways.

"One would be to apply the phenomenon of superconducting materials that exhibit little or no resistance when the conductor is cooled to around-183°C. Of course it wouldn't be practical but in fact, superconducting materials are already used in coils of some wind turbines where large copper coils are filled with liquid nitrogen to reduce resistance.

"Another material that is said to exhibit very low friction and resistance is graphene. Its properties are only just being understood in the laboratory but this looks very promising.

"We are currently looking at introducing carbon fibre into our cables. The material is lightweight, very strong and can compete with Aramids is some applications. Kevlar is very good in tension but not so good in compression or when the line is kinked. Carbon fibres may solve this.

"A final interesting area of research is in self-healing materials: plastics in which cuts can slowly seal over themselves. It would be useful for cable jackets.

This technology is also at laboratory level research at the moment but the technology is definitely very interesting"

Conversely, Aluminium weighs 2.7 kg per metre making it almost 3 times lighter than copper and is also cheaper.

"Another downside is that it does not a have a great fatigue life. When used in the commercial power transmission sector for overhead high-voltage power cables, it has to be alloyed with steel to improve its own fatigue life.

"It is possible to alloy Copper with other materials to improve properties. Incorporating Magnesium will improve fatigue life and toughness while Cadmium (a particularly nasty material to work with) can result in strength improvements but for the vast majority of applications, unalloyed Copper remains the material of choice."

PROJECTS

DeRegt Cables is currently working on Blue Nodules, a European Union joint venture project aimed at developing a deep-sea mining system. In total, fourteen companies from seven European countries are considering how these nodules can be mined with minimal impact on the environment.

For its part, Royal IHC has built the ***Apollo II***, a seabed crawling device featuring six powerful pumps transport to harvest the nodules. This operation requires about five megawatts of power and DeRegt designed the single cable to provide both power as well as a lifting capability.

During testing, the cable was transported to a subcontractor and wound onto a drum. This inadvertently caused it to stretch and this required repairing. In the event, DeRegt successfully fixed the problem in a couple of days, but it does invite the question that if the line does get deformed, what can be done to remedy any internal problems?

"There are no remedies to return a line back to its exact original state," van Leeuwen. "In practical terms, if the cable gets overstretched once or twice, this isn't really a problem. If this happens too often, however, that is when the issues start. The way to understand the condition of the line and quantify the problem is by measuring the internal components.

"Once a cable is completed, we routinely submit it to a series of factory acceptance tests, measuring the electrical resistance of each components and the fibre-optic attenuation etc. We can subsequently compare a used cable with its baseline values when originally fabricated.

"For various reasons, installed static cables sometimes get dragged across the seafloor and damaged. To rectify this, it is relatively simple to sever the line, retrieve each cut end to the surface, re-join them using a splice and replace the line on the seabed.

"While dynamic cables are far less likely to be subject to such accidents, they can still be stretched, bent and subjected to tension cycles. They are, however, ***much*** harder to repair effectively. Like static cables, it is possible to cut and join the line but this will always be the weak point in the line because a rigid a field joint will affect the cable's dynamic movement.

SPECIFICATION

When specifying a cable for a particular application, it is always necessary to build-in a safety factor within the design. When used for a 20t working of 5km depth, for example, it is normal to include a 2.5-3 safety factor, especially to allow dynamic amplification.

"If the mining equipment gets stuck in the seabed, for example, the cable may have to undergo additional strain in order to overcome the suction within the seafloor muds when pulling the tractor out," said van Leeuwen.

"Another often unforeseen factor example is the increase in load as the vehicle passes through the splash zone and into the air during retrieval to the mother vessel.

"Of course the weight of the vehicle suddenly changes when passing from the more supportive water to air, but once out of water, it still holds volumes of water until the liquid drains off.

"Another consideration of course is that the waves that continually move boats up and down. These can cause shock loads."

SEAREX UPGRADE

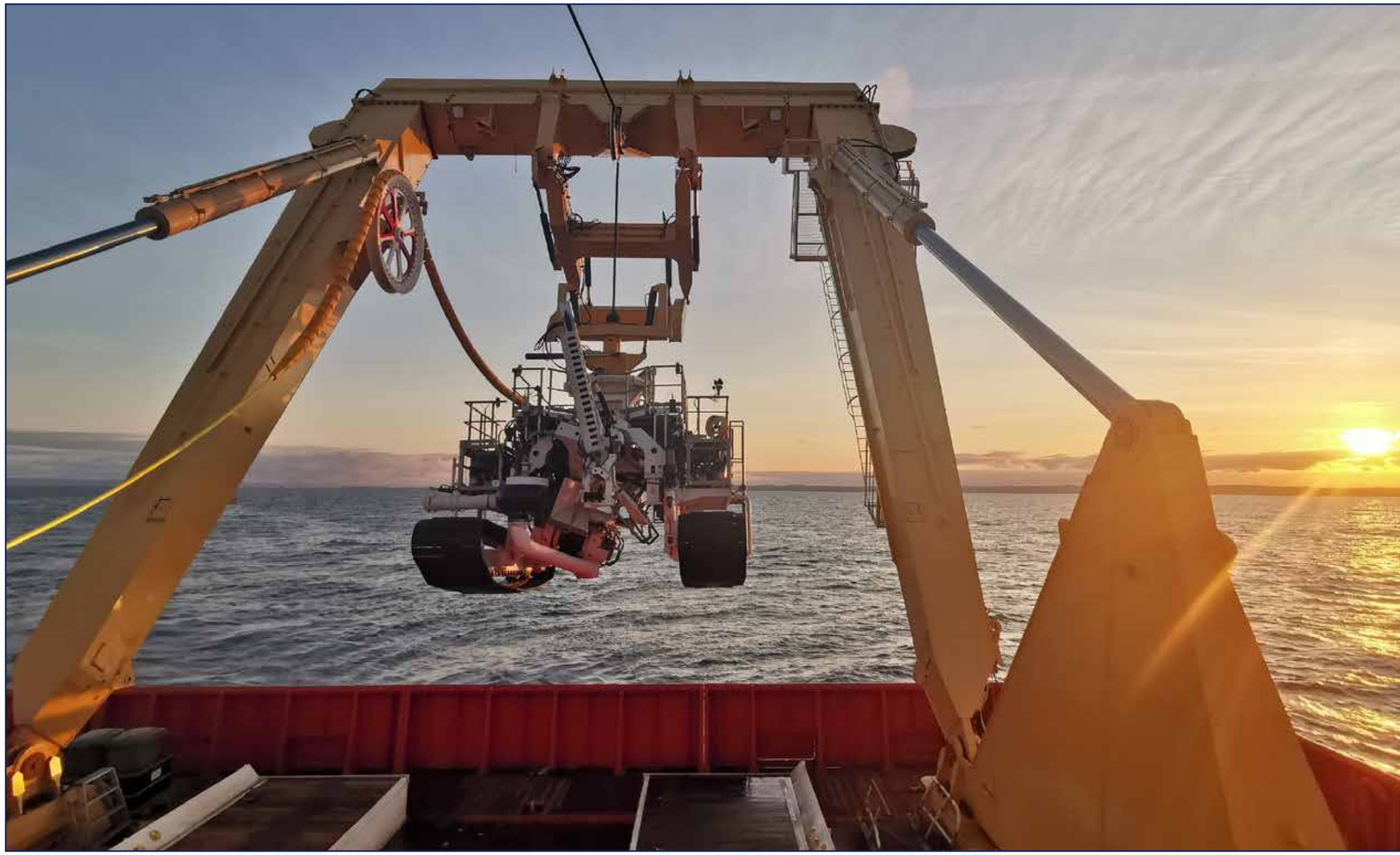
Soil Machine Dynamics (SMD) has delivered a multi-million upgrade to the SeaRex trenching vehicle for Prysmian

The project has seen the delivery of two new state-of-the-art cassettes for the upgraded BT2100 SeaRex tracked vehicle, including a wheel cutter and a chain cutter. This enables the trenching of power and telecommunication cables in ground ranging from dense sand, stiff clay and rock, in both shallow and deep water. The BT2100 SeaRex vehicle was first commissioned by NSW (now part of Prysmian Group) from SMD in 2012.

The new chain cutter cassette, capable of cutting a trench 700mm wide and 2.5m deep, was delivered in August 2020 and has already been deployed on an interconnector power cable between the Greek island of Crete and mainland Greece. The wheel cutter is capable of cutting a trench 450mm wide and 1.5m deep. Both cassettes will handle and trench power cables up to 350mm diameter with a unique loading mechanism that minimises the lifting height and therefore contact stresses on the power cable.

This design has been developed in partnership with Prysmian to handle both light and heavy weight cables for high voltage power transmission. Safe handling of the product is at the heart of any successful vehicle design.

Both wheel and chain cassettes are interchangeable with existing pre-lay tools and these additions have re-launched SeaRex into the trenching market as a very capable and versatile multi-functional tool. The upgrades to SeaRex draw on SMDs 50 years of experience in designing and manufacturing heavy duty trenching vehicles to provide a reliable solution for protecting power cables in hard ground. Its cassette tooling and innovative design allows customers to invest in core vehicles in the knowledge that they can be repurposed in the future.



SeaRex trenching vehicle upgrade

SUBSEA HYDROGEN

HYDROGEN IS LIKELY REPLACE FOSSIL FUELS AS AN ENERGY SOURCE OF CHOICE. WHAT IS IT AND WHAT WILL IT MEAN FOR THE UNDERWATER SECTOR?

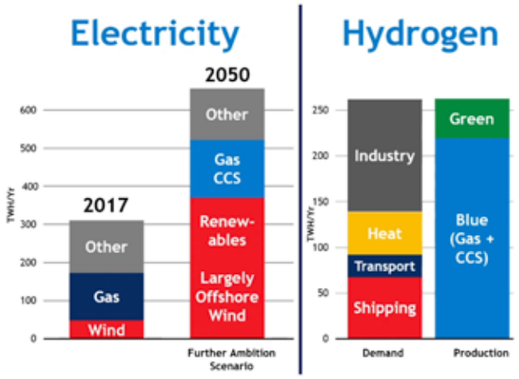
At present, 174 states including the US and China (which together, account for 40% of global emissions) are signatories to the Paris Agreement, a legally binding international treaty to limit global warming to (at least) below 2°C when compared to pre-industrial levels. This essentially requires the limitation and ultimately removal of greenhouse gas emissions.

Greenhouse gasses include Carbon Dioxide (CO_2), Methane, Nitrous Oxide and Chlorofluorocarbons. These can absorb infrared radiation, thereby trapping and holding heat in the atmosphere. This greenhouse effect ultimately leads to global warming.

Of these compounds, the most prevalent greenhouse gas is CO_2. It is currently at its highest levels ever recorded. Its main source is from human activities in the consumption of fossil fuels.

The Paris Agreement will, therefore, require a transition from coal, oil and natural gas to more sustainable low carbon sources. Some people recognise this as renewables-only while others insist that nuclear has an important part to play in the energy mix.

Turning away from hydrocarbons is considerably more challenging than building more wind farms and electric cars that currently steal the headlines. It will mean using non-fossil fuels for much broader applications such as domestic heating as well as powering heavy industry such as energy-intensive cement and steel manufacture as well as running national transport systems, ships and even aeroplanes.



Left Side : Today's electricity production will be very different from the same profile in 2050 if zero levels are to be reached. It notably requires a huge increase in offshore wind. At the moment, the total installed capacity is 10GW but this will increase to-nearer 78-80gW. The energy mix will also need more gas to balance the intermittent nature of renewables. Corresponding CO_2 production will, therefore, have to incorporate a commensurate amount of carbon capture and storage.

Right Side : Balancing the Net Zero energy budget will also require Hydrogen to replace fossil fuels in providing power to the four main consumers Industry, Heat, Transport and Shipping. This will mainly come from Blue Hydrogen.

Images and text: OGTC

Climate Change Committee, Further Ambition Scenario, May 2019

In order to provide the necessary security of supply, it is important that the transition is managed at a sensible and realistic pace. While in recent years, power from renewables has made an important contribution to the energy budget, a well understood limitation is that energy is not always available at times when demand is at it highest.

The wind does not blow consistently and power demand is also cyclical. Typically, the main energy demand is high in the daytime but falls at night where electrical availability may be high.

One of the main reasons that hydrocarbons have been popular, is that they are very easy to store. The reverse is true of electricity which generally requires expensive batteries or conversion to another medium.

At present, hydrocarbons can fill in the energy gap between renewables availability but both governments and industry require a longer-term strategy if the complete removal of fossil fuels is to be successful. Many see the answer in Hydrogen.

HYDROGEN 101

At present, oil is used for transport, gas and oil for heating and gas, oil and coal for both generating electricity and providing the energy for heavy industry.

Hydrogen is probably the only single material that can be used directly or indirectly for all these demands, while still satisfying environmental demands.

It can be used as a fuel to directly drive turbines and, with minor adaptations, any established gas distribution network can be modified to transport the fuel directly to where it is needed. Just as important, however, it can be stored. As such, it works closely ***with*** rather than an alternative to the renewable energy sector.

Hydrogen is actually available in natural accumulations but this is extremely rare. Around 95% of hydrogen is currently produced from fossil fuels.

The main uses of hydrogen in the UK today are in fertiliser production and oil refining to produce low sulphur fuel. There are effectively four major types.

GREY HYDROGEN

Methane can be considered by its chemical formula CH_4. Using well established processes such as Partial Oxidation (PO), Auto Thermal Reforming (ATR) or the most common, Steam Methane Reforming (SMR). Research is ongoing in include plasma- based processes

SMR
SMR involves mixing methane with steam over a catalyst at temperatures of 800°C – 900°C. This produces the hydrogen/Carbon monoxide Syngas. It is then fed onto a water-gas shift reactor to convert water and the carbon monoxide to more hydrogen, plus CO_2.

For each kilogram of hydrogen, it emits 8-10kg CO_2. The Hydrogen is captured and unwanted CO_2 is then released into the atmosphere. Natural gas accounts for over 70% of global hydrogen production.

ATR
This is used in the manufacture of methanol and ammonia. It uses steam and oxygen to form Syngas. It produces a purer, higher concentration form of CO2 than SMR.

BROWN HYDROGEN

Primarily used in China and Australia, Hydrogen is produced from the gasification of coal and lignite. Like Grey Hydrogen, it is associated with high emissions.

BLUE HYDROGEN

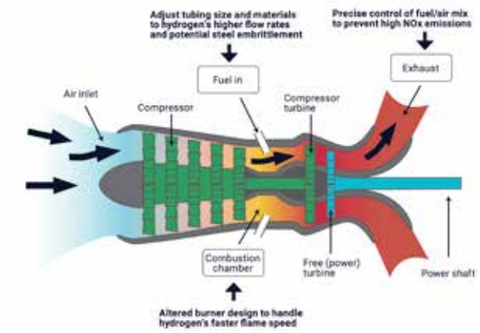
A cleaner version is “blue” hydrogen. This is essentially the same process as grey hydrogen but the carbon emissions are captured and stored through Carbon Capture Utilisation and Storage (CCUS) systems.

BP recently announced that it was it was working on plans for a major facility on Teesside, UK.

DIRECT POWER FROM HYDROGEN

The majority of turbines in the UKCS use gas to mechanically drive compressors or generate power Many of these, however, can already run on Hydrogen blends. Major turbine producers are working on turbines capable of running on 100% hydrogen or multiple fuels.

Hydrogen's low volumetric density and potential embrittlement of some metals mean that changes to ducting, seals and valves are required, as well as possible retrofits for turbine blades so that they can withstand higher flame temperatures.



Required modifications for hydrogen-fuelled turbines Image OGTC

It is currently produced by Quest in Alberta, Canada and by Air Products SMR in Port Arthur, Texas but BP recently announced that it was it was working on plans for a major facility on Teesside, UK.

This plant will produce as much as two million metric tons of carbon dioxide per year. Following a final investment decision in 2024, 500 megawatts of capacity could be in production by 2027

GREEN HYDROGEN

The ultimate clean fuel, thus is created using electrolysis, powered by renewable energy, to split water into oxygen and hydrogen. There are three basic electrolysis technologies.

Proton Membrane systems
The still relatively new PEM electrolysis achieves a significantly higher power density and extremely high power versatility.

The catalyst is relatively expensive bit it has a very rapid response time which makes it particularly suitable to work with fluctuating electricity feed-in from wind power and photovoltaic systems.

Solid Cell Electrolysis
This operates at very high temperatures of around 700°C and it takes time to ramp up to this temperature. These factors make it largely unsuitable to working with intermittent renewables.

Alkaline Systems
Alkaline water electrolysis is a technology that has been established on the market for many years and does not require the use of precious metals. The liquid electrolyte is corrosive and susceptible to leakage however the catalyst systems are cheaper and the systems are well understood.

One company active in the Green Hydrogen business, Siemens, says that in contrast to the conventional method of steam reforming, around 55 MWh of electrical energy is required to generate one ton of hydrogen.

Green hydrogen systems come in at around £600–£720kW although proponents point to the fact that wind systems were once very uneconomic. This changed, however, with early government support and cost reductions through economies of scale. It will almost certainly require some sort of Carbon tax.

This has already been seen in Solar Power and battery development. Reports say that automation and scale- up could reduce costs by 30% In total, advances could reduce CAPEX to between £160 and £240/kW.

One technological venture could see seawater being used for hydrogen production. 200 MW Auto Thermal Reforming system can consume up to 30-40 m3/hr of water. This would be difficult to source in nations where fresh water but readily available offshore.

Electrolysis, however could not only form Chlorine gasses, but also produce salts that cause corrosion. Electrolysis systems may, therefore have to accompanied by water treatment systems- possibly requiring desalination technology. This could increase costs substantially.

STORAGE

One inherent advantage of fossil fuels is that they are easy to store. This is not true of electricity. While batteries can store electricity, these can be very expensive. Storing Hydrogen before converting it into electricity, could be less difficult.

One way of storing hydrogen and transporting is by compressing it to round 50-100 bar and sending it along a pipeline. It can also be frozen to-263°C and stored in cryogenic tanks.

Alternatively, it can be combined with a carrier molecule such as Ammonia. Once the Ammonia is used, it releases the Hydrogen. Alternatively, it can be combined with a reversible carrier molecule such as Liquid Organic Hydrogen Carrier (LOHC) and then released as required.

SUBSEA

In a new industry which supplies power in the surface for use on the surface, it is unlikely that this would have any interest for the subsea industry. The cost of placing equipment or infrastructure offshore is far greater than it would be on land, and the cost of placing anything subsea would be even greater still.

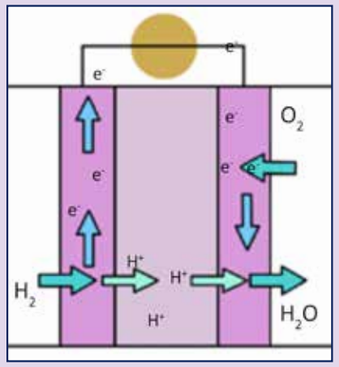
There are areas, however, areas where the subsea sector might take an interest. One such is in carbon capture.

A fundamental part of the Blue Hydrogen requires the capture and store of CO_2

INDIRECT POWER FROM HYDROGEN

One way of converting Hydrogen back to energy is to use a fuel cell. Numerous types of fuel cell exist, but all incorporate an anode and cathode encased in an electrolyte. They can be though of as the reverse of green hydrogen production.

The electrolyte allows only allows selected ions to pass between the anode and cathode. One of the most common electrolytes is a proton exchange membrane. A platinum catalyst on both sides of the membrane, facilitates the reaction of the hydrogen.



The fuel cell splits the hydrogen into H+ and e-. The H+ crosses the membrane while the e- is taken off to provide the power. The two parts are then recombined and Oxygen is added to form water

At the anode, a chemical reaction strips introduced Hydrogen atoms of their electrons. The hydrogen become ionised and the positive charge is allowed to pass across the membrane.

The free electrons, however, are conducted away from the anode to an external circuit to provide the DC electric current.

The free electrons then flow to the cathode where they recombine. Oxygen is introduced, which attracts the Hydrogen atoms to form water. As long as a fuel cell is supplied with hydrogen and oxygen, (also known as the reactants), it can generate electricity.

While individual fuel cells only produce relatively small amounts of power depending on their design and size, numerous individual units can be stacked together to form a much larger cell.

A commercial fuel cell also incorporates the necessary electrical controls required to metre the oxygen and fuel as well as oversee the process. Green hydrogen generation is essentially the reverse of the process within the fuel cell, combining hydrogen and oxygen to produce electrical energy and water.

– now, a relatively mature technology. While captured CO_2 has very limited uses such as refrigeration, dry ice manufacture, aerosol can propellants, use in fire extinguishers, carbonated drinks and in the development of plastics and other chemicals such as fertiliser and fuels, the uses far outweigh the volumes produced.

Once the gas is it is cleaned, compressed and then transported by pipeline or ship to storage sites. Many recognise that the depleted gas reservoirs around the North Sea and could be a very useful place to store carbon. In most cases, the pipelines effectively connecting the reservoir to land are still in place, but it is important to select the most suitable gas reservoir.

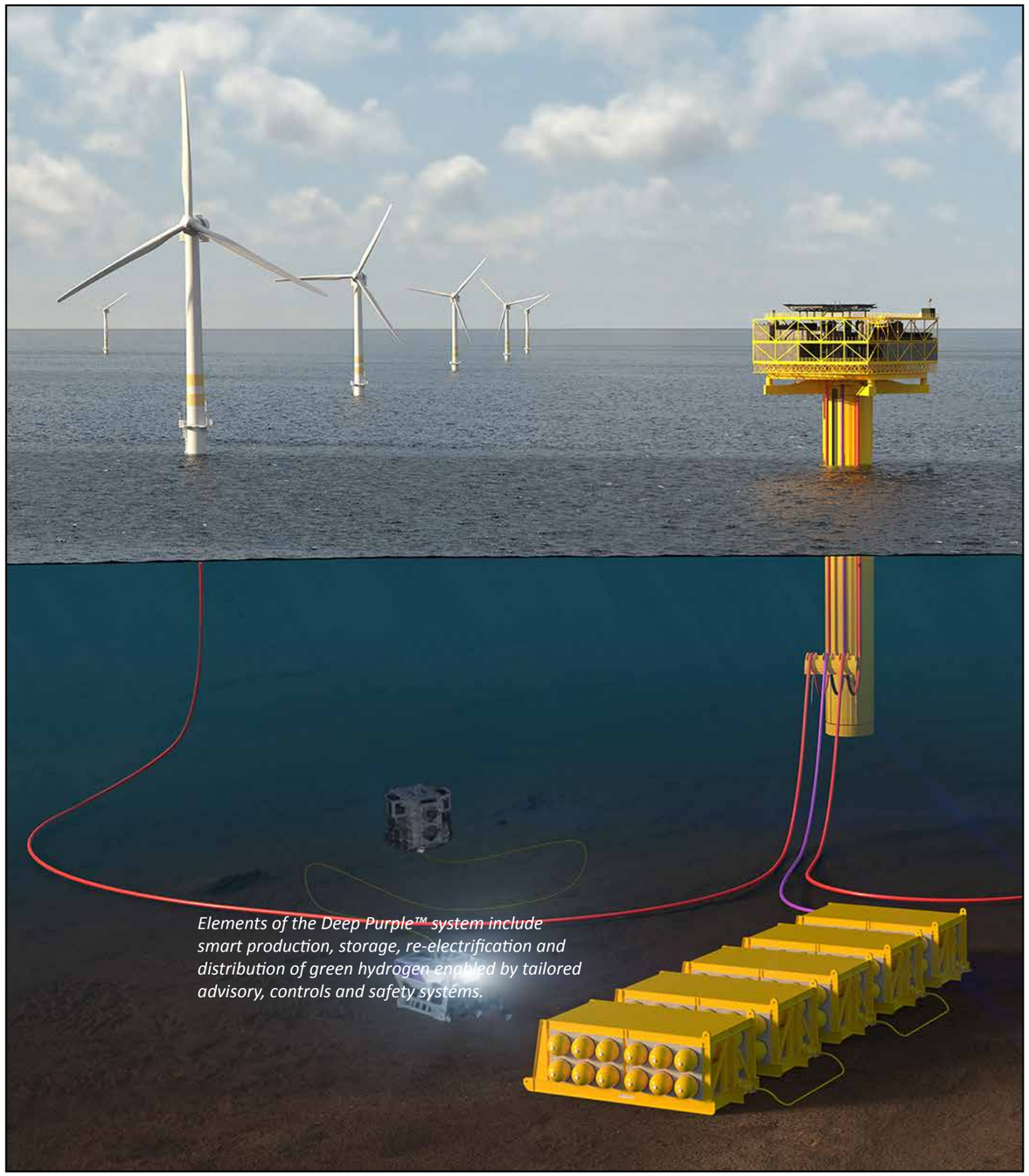
One group very interested in support the oil and gas industry in the acceleration to an affordable net zero North Sea is the OGTC.

One group very interested in supporting the oil and gas industry in the acceleration to an affordable net zero North Sea is OGTC. With more than £160m co-invested with industry in technologies from offshore electrification and net zero decommissioning, to autonomous robotics and renewable power systems, OGTC have screened over 1,000 exciting new technologies, completed or progressed 100 field trials, and generated £15 billion GVA potential for the UK economy.

With £180 million funding from the UK and Scottish Governments, through the Aberdeen City Region Deal, OGTC inspires and accelerates innovation, co-investing in industry-led projects to take new technologies from concept through to deployment in the oil field.

"We have a technology vision which reimagines the North Sea while also working to unlock the full potential of an integrated energy system," said Head of Energy System Integration Martyn Tulloch.

"The problem or challenge with using dis huge reservoirs is that all there are essentially lots of holes in them where from the extraction of hydrocarbons. They have been plugged and abandoned but this technique may not be suitable when the industry wants to re-pressure it with carbon dioxide.



Elements of the Deep Purple™ system include smart production, storage, re-electrification and distribution of green hydrogen enabled by tailored advisory, controls and safety systems.

"Perhaps a more appealing solution is to store the gas Saline aquifers of which there are many in the North Sea. Part of the rock formation contains sheets of impermeable salt. Injecting the CO_2 gas in there would provide a good seal.

"The pipelines and valves would predictably use infrastructure developed for oil and gas, but would probably be tied back to shore rather than is and offshore platform."

Subsea systems may also be used for Hydrogen.

"A typical scenario would mean using wind power generating the electricity and this would be used onshore to make the hydrogen," continued Tulloch.

"One drawback of Hydrogen, however, is that it is highly explosive. Storing this would have to be located on very selected sites. It may be more appropriate to not house these facilities on land, but instead at sea. It could be taken onshore on demand.

The prompted TehnipFMC to develop Deep Purple, a system that uses wind energy to extract green hydrogen from seawater.

The system consists of offshore wind turbines and offshore hydrogen technologies for the production, storage and transportation energy in the form of pressurised green hydrogen. It can also be used to produce, store and deliver hydrogen to consumers at sea or exported in a pipeline to shore.

One of the key elements to manage wind and wave intermittency is to combine renewable energy with energy storage, making Deep Purple a complete, sustainable offshore energy solution.

When the wind is active, wind turbines produce electricity that is delivered directly to the consumer. During periods of excess available power, water is spilt into hydrogen and oxygen by electrolysis.

Fresh water for the electrolysis process is produced from seawater using reverse osmosis. The hydrogen is transported to the seabed, where it is stored under pressure in dedicated tanks. During periods of low or no wind, fuel cells will convert the stored energy back into electricity to satisfy the energy demand.

The company says that its transferable core competencies, pioneering technologies and large global presence make us the partner-of-choice for carbon-free offshore energy projects.

RETHINKING SUBSEA CONNECTOR DESIGN IMPROVES SAFETY IN HARSH CONDITIONS

INNOVATIVE SUBSEA CONNECTOR ELIMINATES BOLTS IN THE LOAD PATH, IMPROVING SYSTEM RELIABILITY AND LONGEVITY

By Scott Ellisor, Dril-Quip

Adapting to the demands of increasingly complex offshore field developments is an ongoing challenge that puts E&P companies in the position of continuously looking for safer, better-performing, more robust systems.

In a constrained market environment characterised by prolonged low prices and weakened demand, offshore companies have more need than ever of reliable solutions that improve performance and reduce downtime and maintenance costs.

This is particularly true for subsea systems that must work reliably in high-fatigue conditions in shallow-water fields as well as high-pressure/high-temperature (HPHT) conditions at great depth, where pulling the tree and/or BOP to replace worn or damaged parts is not only time-consuming but can severely impact project economics.

Understanding the risks

In 2017, Statoil (now Equinor), conducted full-scale testing of subsea equipment, including traditional H4 connector bolts, that identified problems associated with material qualification and quality control of parts. Results included photographic evidence of fatigue cracks in subsea wellheads.

Additional findings showed that the massive bolts at the top of traditional connectors pose the biggest design weakness. Because these bolts take the bulk of the load in the system, they are susceptible to embrittlement and often experience hydrogen-induced stress corrosion cracking (SCC).

The inherent weakness of the H4 connector is its placement of bolts in the primary load path, which subjects the bolts to large bending and tension loads as well as cyclic fatigue loading.

Based on the results of this investigation, Statoil presented a report to API 6A and 17D committee members in 3Q 2017, identifying shortcomings in the API subsea equipment specification, in particular, the lack of API standards for quantifying fatigue resistance in subsea drilling and production equipment.

The Bureau of Safety and Environmental Enforcement (BSEE) produced an earlier report that identified similar safety risks associated with bolts in the wellhead.

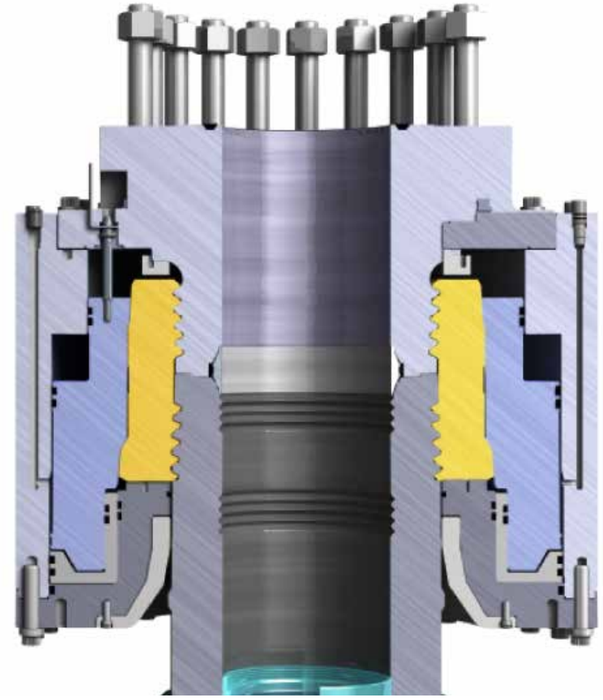
On the basis of its investigation, BSEE required operators to pull connectors from service for inspection to ensure their physical integrity. In complying with the BSEE mandate, companies frequently have found damaged bolts that need replacing, and this has taken a toll on production.

Meanwhile, the number of bolt failures in the H4 connector led to a global recall of connector bolting by the original equipment manufacturer.

Imminent modifications in the BSEE code include specifications for a higher level of performance that will necessitate connector bolt design changes. Most likely, new bolts will be made of premium materials and will have different forging characteristics, which will increase the time required for manufacturing and raise their cost.

Rising to the challenge

Modifying existing designs can deliver incremental improvements, but to deliver substantially better performance, engineers need to reexamine current products, pinpoint weaknesses, and conceptualise designs that eliminate vulnerabilities and shortcomings. In short, to meet today's critical service fatigue applications, new solutions require new thinking.



The design of the DXe connector removes bolts from the load path to improve operational safety and extend field life. Image : Dril-Quip

It is this approach that led Dril-Quip to rethink wellhead connector design to address weaknesses that historically have compromised performance. The first step in the process was to examine stresses in the load path caused by ocean currents, vortex-induced vibration, and high-pressure operating environments and to understand how these factors affect critical components.

Armed with this knowledge, company experts realized that if they were going to design a reliable connector, they would need take a different approach to design.

The tight closed-loop preload path and clamp-like design of the resulting DX connector removes bolts from the load path, which means that the bolting does not experience applied, in-service loads. The only loads the bolts experience are encountered during latching and unlatching of the connector.

First-generation DX connectors have been deployed on offshore assets since the early 1990s. One such connector that was installed on a TLP in the Norwegian North Sea in 1992 was removed from service recently and examined for signs of fatigue and loading.

After nearly two decades of use, the connector showed no visible signs of degradation. To determine the structural integrity of the connector, the Dril-Quip team disassembled it to

the component level and performed NDE inspection on each piece.

This testing revealed no cracks, no defects and no blemishes on or in the DX connector body or latch segments. At the conclusion of the testing program, the connector was re-assembled and returned to service.

To demonstrate the design's suitability for severe fatigue conditions, a complete 18 ¾-inch wellhead system with a DXe profile and wellhead connector was assembled, and the complete system – including the wellhead and wellhead connector – was subjected to more than 90 million cycles, with an applied bending moment of 1,500,000 ft-lbf., over the course of four months of continuous testing.

The company benchmarked the alternating stress level and cycles based on its load histogram data for wellhead connectors in severe metocean conditions. When the wellhead system was disassembled following testing, an examination confirmed that even after sustaining high levels of loading over an extended test period, there were no cracks in or on the connector components or the wellhead or wellhead profile.

LESS IS MORE

The original DX connector has evolved into the DXe wellhead connector, which is designed for use as a BOP stack connector, subsea tree connector, or riser tieback connector.

The DXe connector, when combined with the DXe profile, delivers industry-leading fatigue resistance and versatility that allows it to be configured easily for both the high-fatigue DXe profile and the H4 profile simply by swapping the latch segments.

The connector was outfitted with strain and pressure gauges and tested at its full rated working pressure (20 ksi in the bore) with applied loads in bending, tension and compression. Image: Dril-Quip

The DXe has fewer components than other connector systems, so it has fewer points of failure. Unlike the H4, which has multiple cylinders that must be hydraulically pressurised to activate the pistons, the DXe has a single void.

Modifications to the design were based on finite element analysis that allowed the design team to figure out how to spread the load throughout the connector body.

The result is a connector that is suitable for use in severe bending and high-fatigue service in shallow water and HPHT environments where the sustained pressure on the subsea system approaches 20 ksi. It also can be used in hyper-deep water (15,000 ft/4,000 m).

The key to this improvement in performance is a highly engineered locking wellhead profile with a self-aligning gasket that allows for increased structural bending capacity. The slim gasket has been designed for HPHT and hyper-deep applications and is rated for 20 ksi and 4,500 m (15,000 ft) water depth.

The system uses only latch segments to hold the connector to the wellhead, and these latches are the only part of the system that experiences stress. The connector's design makes it easily configurable for attachment to H4 units as well as others and delivers superior fatigue resistance for a long and reliable service life.

To prove this point, Dril-Quip developed a "No Bolts" test in which all the bolts in the DXe connector were removed before subjecting the system to a full series of tests. The connector was outfitted with strain and pressure gauges and tested at its full rated working pressure (20,000 psi in the bore) with applied loads in bending, tension and compression to the rated capacity as defined by API 16A.

In this case, the load exceeded 8 million ft-lb of bending. Through each of the 21 load tests, which exceeded API 16A 4th edition qualification testing requirements, the system exhibited zero pressure leaks.

The DXe has been approved by BSEE for use in critical HP/HT applications, and multiple systems have been deployed on fields in the Gulf of Mexico.

SAVING TIME AND MONEY

System reliability is the key to helping operators manage costs. When a typical connector fails, replacement requires the offshore asset be shut in for approximately three days. Not only is there no revenue generated from production, but the operator is still paying for the asset, which usually ranges from US $200,000 to more than $400,000 each day.

A complete 18 ¾-inch wellhead system with a DXe profile and wellhead connector was subjected to more than 90 million cycles, with an applied bending moment of 1,500,000 ft-lbf., over the course of four months of continuous testing. Image: Dril-Quip

This expense is compounded by the cost of a vessel to pull the BOP and remain on site to redeploy the system to the seabed once new components have been installed. A straightforward repair can cost more than $1 million.

Eliminating components that can fail is foundational to the DXe design. By removing avenues for failure, engineers have improved the effectiveness and extended the field life of the connector, delivering improved efficiency and better economics.

Adapting to changing times
The current depressed market is driving companies to reassess the functionality and reliability of equipment used to develop offshore fields, particularly in HPHT, high-fatigue or hyper deep environments.

Adaptability is the key to achieving competitiveness in challenging times. Fundamentally shifting the way components and systems are designed puts forward-looking companies in the position to deliver products that will change the face of offshore drilling and production.

OFFSHORE PHOTOS

CHECK OUT THE UT2SUBSEA PAGE ON LINKEDIN EVERY FRIDAY

MICOPERI 7000 1989

The semisubmersible crane vessel was often used to install topsides, but less often used to vertically lift large jackets off a barge because of their height.

The first full offshore lift of a jacket over 5000t was Gyda

The famous "Death Star"

Anybody remember the 'portable Drass Sat Dive system' biggest metal box I'd ever seen! Remember when they finally took the wrapping off the coffee machines onboard!!

In the very early 90s was on the M7000 for the installation of the Brae East 'Y' piece on the Beryl-St Fergus SAGE pipeline. Somehow the Saipem crew managed to break or damage seven ROVs prior to the launch of the 'Y" piece. The installation required good visual monitoring so that the ends of the spool pieces lined up with the main pipeline. The task was completed using two eyeball ROVs- may have been Hawkeyes but am not sure.

SOUTH ARNE

Another pic donated by a reader- this time Stephen Kirby

The construction of the 110m by 90m and 18m-high concrete base was awarded by Amerada Hess to Brown and Root under an engineering, procurement, installation and commissioning (EPIC) scheme.

Because of insufficient capacity of the Danish oil line and the 60m relatively shallow water depths, a floating storage system was largely ruled out and so the designers selected a concrete gravity oil storage base concept. This static platform was more preferable on a chalk reservoir because of the higher frequency of workovers.

The South Arne platform sits on a concrete tank which is used to store oil. It can store up to 550,000 bbls in its 100 individual cells.

s at Nigg- you can tell by Shops 4,5 and 6 in background in this photo

GEMINI 1989

No, not TechnipFMC/Schillings new ROV but another one.

This was owned by Eastport who redesigned the original vehicle for deep water. It successfully recovered some of the wreckage of the crashed South African Airways Boeing 747 in 5411m of water, breaking all water depth records.

Remember this system when at Eastport before going to OI

DRILLMASTER 1978

Pentagone-type semi that went on to become the floating production system for BP's Buchan field.

It was fitted with separation and storage facilities, crude oil loading pumps, electrical distribution equipment, gas flaring and more accommodation. The drilling and pipe handling system was converted for worker only and ut had a riser control system and water handling facilities.

The design was carried out by Matthew Hall.

Pentagon design. Same as the Alexander Kielland Semi disaster from 1980, over 120 fatalities, can still remember the news coming over the radio. Dreadful.

Now that brings back memories. 1984, my first week in the oil industry, RGIT, with a 06:00 flight the next day to Buchan Alpha for a survey of the marine riser compensator. Great first experience, only learned about the Alexander Kielland link when i got back.

Ditto but 10 yrs later, think it was my first trip offshore, remember the weird view of watching the heave compensators pumping up and down, but in fact they were still and I was the one moving, just couldn't feel it in the gentle swell. Also heard of the Kielland some time later.

It was the first installation I ever landed on in a helicopter
Sept or October 78
It was anchored up to Forties Alpha
Working for Scot Catering straight out of uni
No survival suits

I was on the Buchan Alpha back in the late 80's working for JP Kenny on a satellite well tie-back (now reinvented as SURF). I got the impression it was BP's "punishment platform" where you were sent if you screwed up.

Floating production- this was early days. The first "purpose-built" production floater in the North Sea was Sun Oil's "Balmoral".

NORLIFT

With Iolair in the background

Oh the Horror !
I remember joining the Norlift at Foinaven on that job. The weather was perfect, every other boat was rock steady but the good old Norlift was rolling like a good 'un so we had to land on the Iolair and trans-ship by Z-boat. Fun was not the word.

Shortly after, during the lay, they found the pipe kinked at the field joint and we had to go back to Ardersier to unspool it. During the unspooling the pipe broke at the kink and the whole thing uncoiled like a giant broken clock-spring. It was around midnight, shift change, and a bunch of the lads were on deck coming back from the pub. Yet no one got even so much as a scratch- amazing luck.

As I recall, in the end Cal-Dive took it over and then bare-boated it to Mexico where someone blew up the main switchboard and that finished her. CDI went bust a while after and, as far as I know,she's still slowly rotting away there.

ROWAN HALIFAX

Rowan Halifax on Kotter
RIP Rowan. A good company gone to hell now

BRITANNIA TOW BUNDLE

Just some quick photos this week as I am putting the latest issue of UT2 (the magazine of the SUT) out this afternoon.

O Tempora! O Mores!

Here is one for International Women's day. In fact, there were VERY few adverts in offshore magazines with women- I only found 2 or 3 thumbing through years of magazines on my shelves.

Check out the cigarettes!!

Things have changed but let's not erase history just yet

The ash tray is hilarious (now).

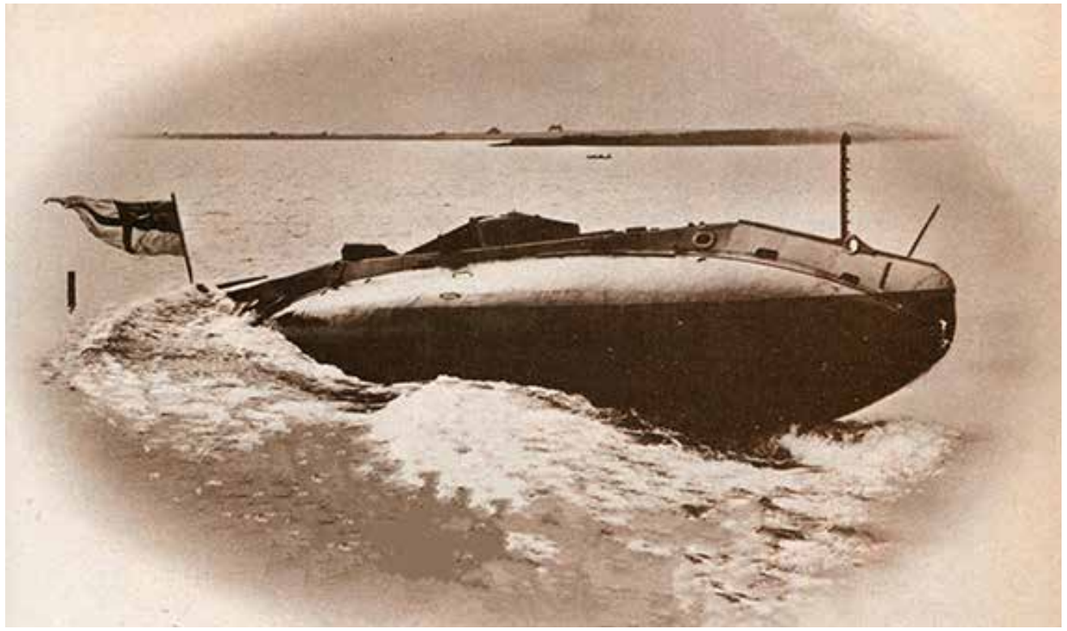
I bet she is a pain in the...

Love it. Even leaving aside how it reads to modern ears, going BACK to that time, it's still a hoot. For one thing: That woman doesn't like you. She's smoked four cigarettes fighting through this miserable date and right now she's looking at you with a camera and contemplating giving up on love entirely.

Next: "the champagne of diesel crankcase oils" doesn't exactly roll off the tongue.

And finally: What's with the !#$& plant?

HOLLAND 1902



I know nothing about this apart from the fact that it was the Royal Navy's first submarine and it was built in Barrow by Vickers Armstrong. I just happened to see it when researching something else entirely.

More info at: https://www.submerged.co.uk/holland/

WEST SOLE 1978

While decommissioning is common today, the very first North Sea to be decommissioned was BP's West Sole BP/48/6-E or simply WE facility. It stood 75km east of the Humber Estuary.

It measured 52m from helideck to seabed, this unmanned single well platform stood for 12 years.

It was removed by Offshore Maintenance Inspection and Service Company (OMISCO) with BP and George Wimpey owning 50% each. This pic shows the Hebelift III shearleg crane, with its 1200t capacity, lifting the 180t top section.

DB30

The 420ft long vessel has a Clyde 7 crane that can lift over 3000t. It also has a 6-station pipelay system. It is moored by 12 25000lb anchors.

THISTLE

In 1977, the Star Arcturus was chartered by Lockheed to incorporate a dry one-atmosphere pipeline welding system.

The operation on BNOC's Thistle platform was the first time dry welding was a carried out in one atmosphere conditions. A team of 12 engineers spent a total of 2000 hours welding 16in pipe inside chambers fixed to the base of the tower at a depth of 160m.

They had these one atmosphere tubes at the base of the risers on Thistle A but I can't for the life of me remember what they are called. Apparently there was a fatality and they stopped using them.

Was at Thistle Platform a few years ago. We had to clear all the scaffold debris that covered the Lockheed chamber and dredge under the chamber to allow for riser expansion and contraction. Was very interesting job!

I worked on the Thistle a few times in the past, nicknamed the Black Pig. Their were two Lockheed chambers at the bottom of structure. We inspected the nodes vertical and horizontal plus all the vertical and horizontal elevations

In the days before the Pioneering Spirit, Sleipner A had to make do with Smit's Giant 2 and Giant 4.

HEYSHAM HARBOUR 1983

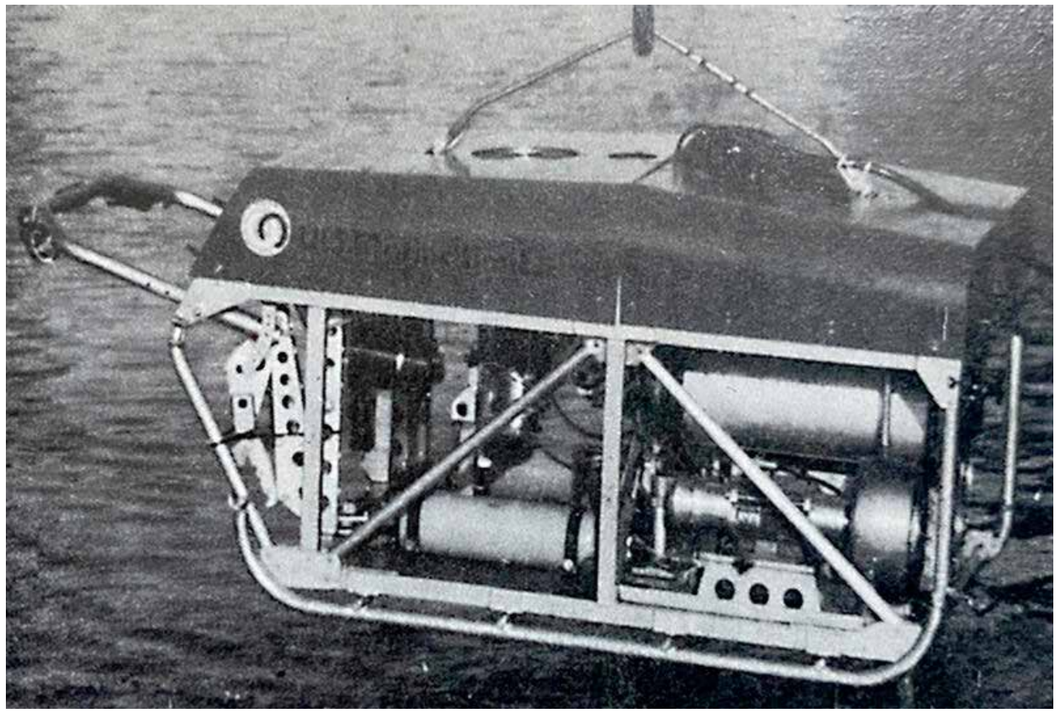
Within a year or so of this being taken, HGB's Morecambe Bay field would be on stream.
That is Western Oceaninc's Apollo 2 in for repairs

The south Morecambe field still producing today, although the gas is now processed through its sister North Morecambe terminal.

Great days of slant drilling for HGB on the Bay driller and M Flame with Bawden drilling.

Remember being on the Appollo 2 in the cold month of February 1982 wild catting

CETUS 1987



The Cetus. ROV, (then called an RCV of course), was used for pipeline inspection, wellhead inspection, clearance etc. The manufacturers said it could operate in currents up to 3kts in force 6 seas 24 hours a day. It could lift weights of over 300bls in depths of up to 1000ft and position to within an accuracy of 2m.

The mean time between failure was 200 hrs

SCORPIO 41

I photo supplied by Steve Bremner this week-
A Scorpio 41 deep system with GE Arm and ISR grabber. They recovered this after an accident offshore

In 1993 I worked with his twin brother, Scorpio 42 here in Brazil when he was mobilized on board the Yatzy platform (SS 37) under contract with Petrobras.

Was one of the best vehicles in the industry. SSI had a lot of them.

JACKET LAUNCH 1981

There are many images of jackets bering launched, but those viewing from inside the launch barge are rather more rare.
The 26,000t Cerveza jacket was launched in 935ft of water

At the time, Cerveza was the worlds tallest one-piece platform. The work was carried out by McDermott

DRAUGEN 1991

The concrete gravity base under construction at Norwegian Contractors, Hinna yard. At the time, Shell's Draugen platform became the deepest water GBS. The 8 cells forming the base of the 285m shaft required 80,000t of concrete.

STADRILL 1978

At the BOC base in Peterhead during annual inspection. The pic shows the bow thruster being lifted out.

BRAE

CANMAR EXPLORER 2

Developed for oil and gas exploration in the Arctic regions.
In 1976 she was rebuilt at Galveston Tx and rebuilt at McKinley Bay NT in 1980.

The Explorer 2 has an overall length of 114.90m and a 30m beam
and was originally designed to drill in water depths of 30m-180m.

EXPLORER II 1987

Heerema's DP vessel for saturation diving, inspection, cable laying, trenching, towing and installation using the 120t heave compensated A-frame

AS SEAWAY EXPLORER. IMAGE: MIKE DERRICK

AS NORTHERN EXPLORER. IMAGE: MIKE DERRICK

CLANSMAN ROV

Just some quick photos this week as I am putting the latest issue of UT2 (the magazine of the SUT) out this afternoon.

Built for the Total (correction, Mobil! Thanks Mike Gray) deepwater work on the Jack Bates with a very heavy ballasted garage and a winch that could do 120m/min! The name didn't go down well in the US as you can imagine so the subsequently slightly larger version was called Hercules. When the two Jack Bates ROVs demobbed they were renamed in line with the smaller version done for Norway called Warrior

Was there a full spare Clansman system on the Jack Bates?
I only did one trip WoS on her but specifically remember a spare sub?
I think Dave Sturgess was one of the SOCs at the time.

Hadn't experienced a garage system before going on there either. " Fly the garage, not the sub" was the mantra when returning and using the outboard facing garage camera

That's What I Remember Fly the Garage Not the Sub

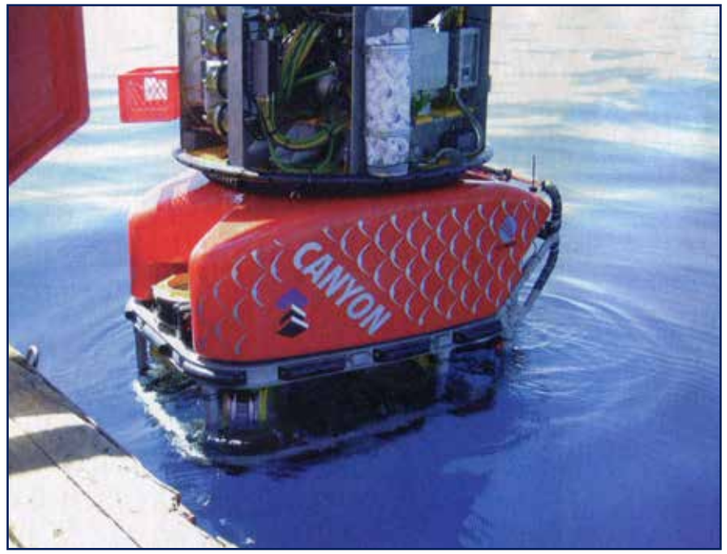
Knew them all well.only problem with the QX was the lessons learned from pioneer and Centurion HDs were not carried over.

That was the first ROV software control system that I knocked up for you Dave. Communicating with the old ISDN control multiplexer on the Pioneer ribbon bus. Needed about 5% of the time that the Examiner software took as I recall. Early RAD GUIs in MSDOS.

Forgot that it was Smaller Flew that Vehicle on Jack Bates Short trip a Lot of Time We Kept it in the Garage From what i Can Remember

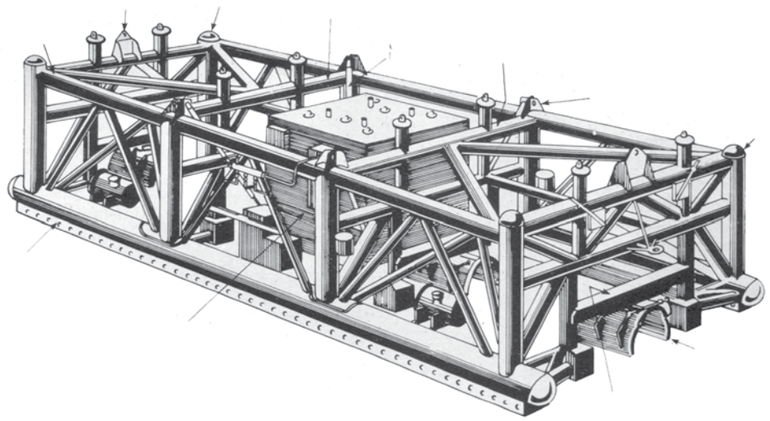
The ROV was designed specifically round the moonpool I was part of rig site site team in Singapore It was to replace an existing Oceaneering ROV currently insitu on the rig the ROV control cabin was built inside the rig in a paint locker that Oceaneering was using as work shop. Should you need any more information pm me I was there from the prequalification, contract award design FATS installation and offshore operations at every well spud in

Clansman turned into Hercules. Bit longer with power boost. Ended up with almost 40 systems. Still delivering on construction and IRM project all over the globe.



ALSTOM SCHILLING ELECTRIC ROV 2000

While many work class ROV companies are offering to electric versions, Schilling started with an electric work class ROV but are now firmly in the hydraulic camp.



SUBMARINE PIPELINE ALIGNMENT RIG (SPAR) 1978

In 1977, the Ekofisk-Teesside oil line was damaged by a ship's anchor. The Phillips/Statoil partnership that owned the pipeline decided it had to be repaired before it started leaking. Brown and Root carried out the work and they subcontracted Taylor Diving to carry out the repair using its dry hyperbaric welding chamber. This was to be done with the line still filled with oil.

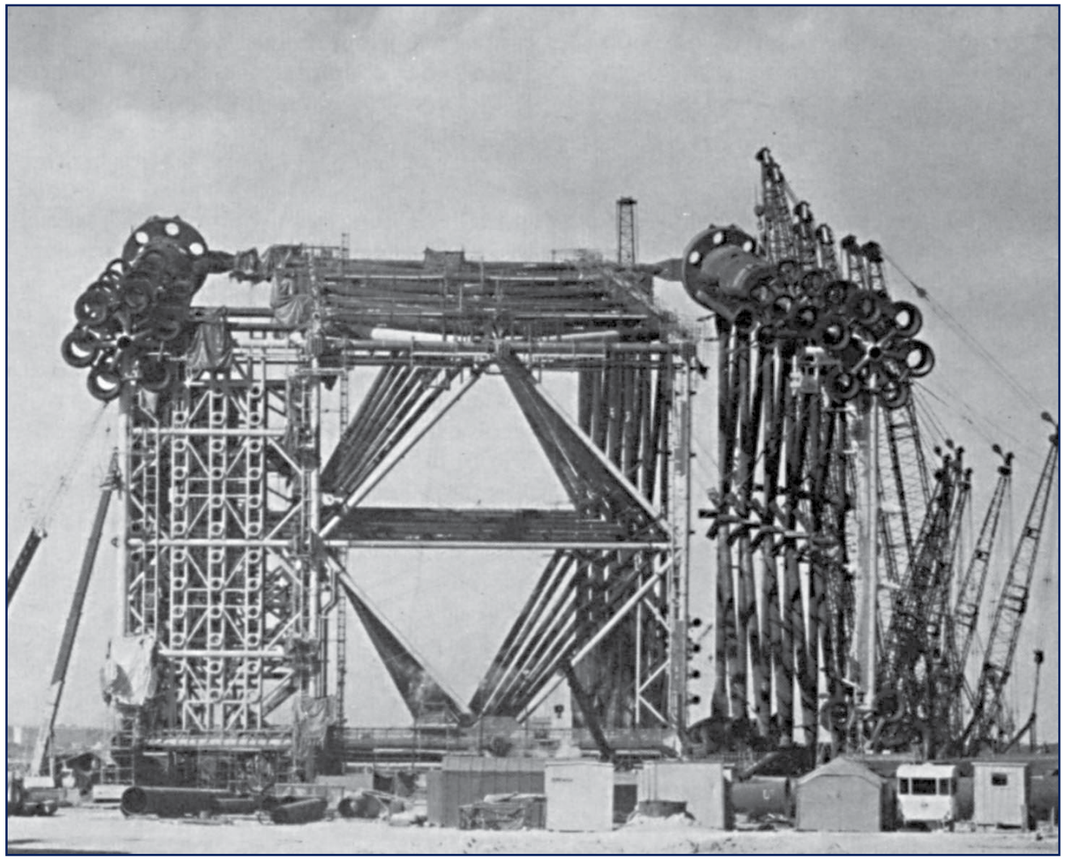
ORELIA

An old favourite of Friday Photos

SEMAC

The SEMAC was built in 1976. The overall length (LOA) is 121.92 meters and the width is 54.86 meters. The image shows the vessel when it worked for European Marine Contractors.
In 2001, Saipem acquired the remaining 50% of EMC from Brown and Root.

CLAYMORE 1976



The jacket was constructed in Cherbourg, France. The 2842t panel (on the right) was rotated to the vertical a 2.5 hour operation and mated within a tolerance of 25mm.

OCEAN NOMAD

In the Verolme Botlek yard to increase stability. This included adding 90t stability columns and a new ballast control system.

ABOVE

JACKET LAUNCH 1981

There are many images of jackets bering launched, but those viewing from inside the launch barge are rather more rare.
The 26,000t Cerveza jacket was launched in 935ft of water

At the time, Cerveza was the worlds tallest one-piece platform. The work was carried out by McDermott

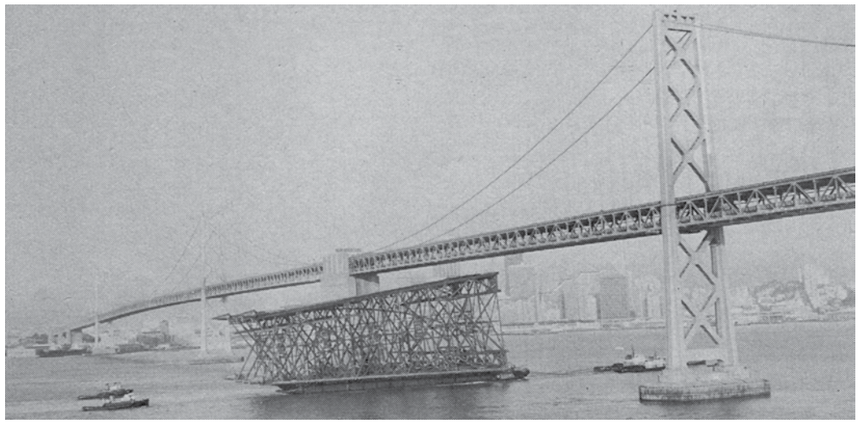
Does anyone remember the load out at methil. The skidway was on a slope,which presented some problems doing the surveys. But I can't remember which jacket it was when they lost it and it became the fastest load out ever!

RIGHT

MR MAC 1989

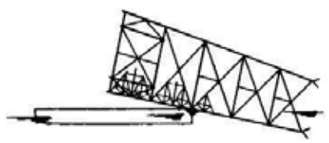
Wait a sec. two helidecks?

No. of course not. The derrick is simply cantilevered over a small platform, namely Amoco Arbroath, to which it provided well services serving in a tender assistance role. Actually, the 680 000kg drilling package became the heaviest ever to be transferred to a fixed platform.



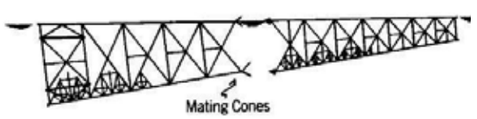
EXXON'S HONDO JACKET 1976

The barge sailing under the San Francisco Bay Bridge (with only 8.5m to spare) is carrying two halves of the world's tallest oil production platform. The 264m high structure was placed in the Santa Barbara channel. The decks, built in Louisiana, were shipped through the Panama Canal.

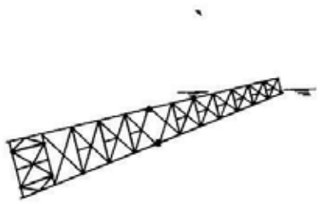


Step 1

Step 2



Step 3



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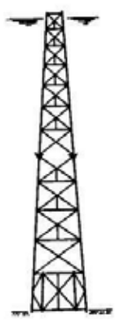

Step 5

Kiphon Kurojjanawong

Real pic during Mating. Courtesy McDermott

Hondo installation concept
From B.C. Gerwick Jr., “Construction of Marine and Off-shore Structures”, 3rd Ed., 2007

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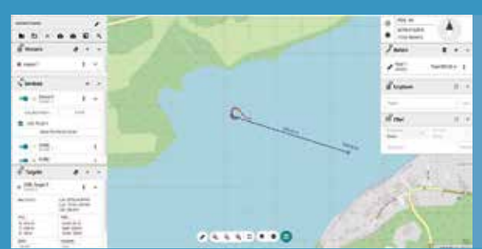

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