UT TWO

UNDERWATER TECHNOLOGY

UNDERWATER POWER
FLOATING WIND
INSTALLATION

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MTS marine technology society

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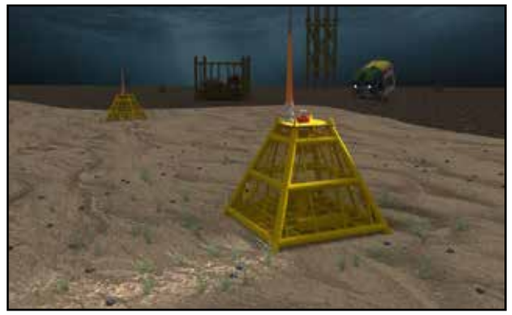
Teledyne Subsea Supercharger preparing for AUV charging demonstration in Lake Michigan

CO_2 MANAGEMENT PLATFORM

Aquaterra Energy has unveiled a new CO_2 management platform that will allow for long-term monitoring and sustained integrity of underwater carbon capture and storage (CCS) sites.

The integrated solution provides monitoring of both sub-surface fibre optic seismic arrays as well as dissolved CO_2 gas detection via self-powered (solar or wave), remote data transmission nodes between the seabed and surface – ensuring this carbon monitoring technology does not create more carbon emissions in the process.



CO_2 management platform

Deployed in remote locations within the injection site block, permanently installed shallow bore hole fibre optic arrays allow repeat seismic surveys to be completed on demand.

This process will provide evidence that the storage site is performing as expected against the baseline engineering and seismic data, during and post CO_2 injection.

The CO_2 plume can be tracked and its migration within the formation compared against predictions and storage site expectations. Should any deviations arise, it allows for proactive measures to be taken such as reducing or stopping injection or diverting injection to alternative well centres.

The addition of dissolved gas sensors offers a further layer of security. A reactive alarm system identifies actual CO_2 leaks into the water column, through a patent-pending approach.

The sensors will detect and compare dissolved gas percentages combined with current speed, direction and other node location data to identify the location and extent of a suspected leak.

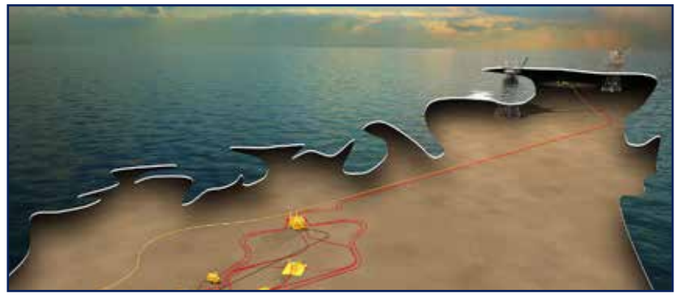
The data is transmitted onshore via satellites for analysis and verification. This host sensor array can be customised with additional sensors to cover any site specifics.

The system is a fully end-to-end service that offers reassurance to the industry and society that the CO_2 is being managed and stored securely.

NCS CO_2 STORAGE ATLAS

The Norwegian Ministry of Petroleum and Energy recently announced acreage suitable for long-term and secure CO_2 storage. This has resulted in a CO2-storage atlas for the Norwegian Continental Shelf. All areas announced for storage on the Norwegian shelf are identified in the atlas.

CYPRE



Subsea7 announced the award of a contract to Subsea Integration Alliance to support the development of bp's Cypre project, a gas development located offshore Trinidad and Tobago. Subsea7's scope of the awarded Subsea Integration Alliance contract is substantial.

Subsea7's scope covers the concept and design, engineering, procurement, construction and installation of a two-phase liquid natural gas tieback to the Juniper platform through dual flexible flowlines and a manifold gathering system, along with topside upgrades.

Design, engineering, and project management will commence at Subsea7's offices in the USA, with offshore installation planned for 2024.

DEEP OCEAN

DeepOcean has been awarded substantial contracts from Equinor, ConocoPhillips and BP worth a total of NOK 2 billion.

The awards involve subsea IMR (inspection, maintenance and repair), subsea construction, removal and recycling of subsea equipment and subsea survey scopes in the North Sea region, until the end of 2026.

"This will enable us to continue accelerating our ongoing technology initiatives, which are aimed at achieving more efficient work execution, greener operations, support the energy transition and our ambition to reduce cost level for operators in the ocean space," says Rolf Ivar Sørdal, DeepOcean's commercial director in Europe.

exail

Those waiting with baited breath to discover the name of the new name of the company combining the talents of the ECA Group and iXblue.....exail.

Owners Groupe Gorgé says that the combination will lead to the rise of a European high-tech industrial champion in the fields of robotics, maritime, navigation, aerospace and photonics.

The two companies will benefit from a global workforce of 1500 people and will achieve an annual turnover of €250 million. Together, iXblue and ECA Group will provide customers with a unique offer ranging from components to complex systems to support critical missions in severe environments.

slb

Schlumberger has announced its new name—SLB.

The legacy Schlumberger brand and nearly all of its affiliated brands will unify under the new SLB brand, which introduces a refreshed visual identity, including a new logo for the company.

GENERAL OCEANS

Tritech has become part of General Oceans: an umbrella company specialising in underwater technology.

The deal has been in the make for some months and will see Tritech joining Nortek, Reach Robotics and Strategic Robotic Systems as part of the common holding company.

FIFTH FALCON FOR HUON

Huon Aquaculture, Australia's second largest salmon farmer, has purchased another Saab Seaeye Falcon underwater robotic vehicle to support its marine and environmental operations.

This brings Huon's Falcon fleet to five. Huon sees the Seaeye Falcon as a vital farming tool for surveying and monitoring their marine leases in South East Tasmania, Australia.

Huon purchased its first Falcon in 2015 and, since then, has been operating Falcons 24 hours a day, seven days a week.

Dr Shea Cameron, Huon's Subsea and Remote Systems Manager, said the Saab Seaeye model is invaluable to the company's farming operations:

"Our dive and mooring teams use Falcons to inspect and maintain our critical subsea farm infrastructure."

He said their Falcons spend more time in the water than any of the others in Huon's large fleet of remotely operated vehicles that range from large specialist net cleaning vehicles to smaller eyeball class systems.

Dr Cameron adds that the Saab Seaeye Falcons have consistently proven to be a tough and capable platform, easy to service and with excellent manufacturer support.

"They can be rebuilt and repaired quickly and sent back out to work" Dr Cameron said.

Saab Seaeye Falcon

Swift Anchors, the anchoring and mooring business of *Sustainable Marine* has been sold to a newly formed subsidiary of its largest shareholder and long-standing partner, SCHOTTEL.

AIS has acquired CRP Subsea to add to its growing range of subsea offerings.

Based in Skelmersdale, England, CRP Subsea (formerly Trelleborg Offshore UK) are specialists in polymer and syntactic foam-based buoyancy and protection products for the offshore renewables and oil and gas industries.

International subsea equipment rental and solutions specialist Ashtead Technology has further expanded its mechanical solutions service offering with the acquisition of Hiretech.

Established in 2011, Hiretech is a management owned, Aberdeenshire-based equipment rental, service and maintenance company serving the international offshore renewables,decommissioning, and conventional energy markets.

Through its multi-purpose fleet of marine and subsea equipment rental assets and skilled personnel, the business boasts an excellent offshore renewables and decommissioning-focused support services.

IMPACT SONAR

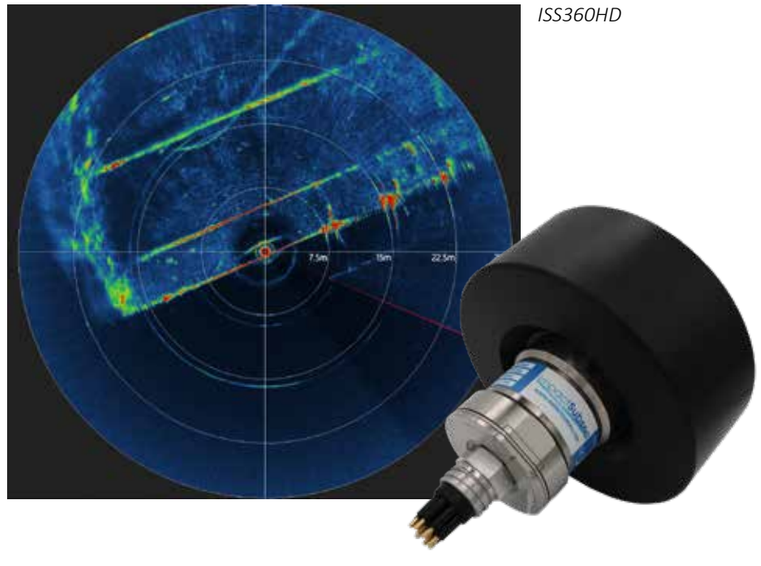
Impact Subsea has announced a new addition to the ISS360 Sonar range- the ISS360HD. This offers a 1deg acoustic angular resolution, 2.5mm range resolution and a distance measurement range in excess of 100m/328ft. The sonar is depth rated to 6000m / 19 685ft and comes in a very compact form factor.

The ISS360HD has a very wide operational acoustic bandwidth capability; 600 to 900kHz which is fully utilised through CHIRP (Compressed High Intensity Radar Pulse) technology. The wide bandwidth linear CHIRP allows for an good range resolution of 2.5mm when using the full bandwidth.

A narrow acoustic beam, combined with a very short range resolution allows for extremely high definition imagery to be produced. This makes the ISS360HD ideal for work class ROV operations with excellent range capability and ability to identify targets in zero visibility. The form factor of the sonar also opens this capability up to even the smallest of observation class ROVs.

In addition to the long range and high resolution capabilities, the ISS360HD benefits from an inductively coupled transducer. This means there are no slip rings within the sonar – so there are no components to wear out and require periodic replacement.

The sonar optionally comes with an integrated pitch and roll sensor, allowing accurate attitude readings to be provided. This is a very useful capability when deploying the sonar using a tripod to ensure level positioning. The integrated pitch and roll sensor is also a useful additional sensor reading for some underwater vehicles.



ISS360HD

SENSOR INVESTIGATION CAMPAIGN SAVES AUS $1M

C-Kore Systems successfully completed another subsea intervention campaign in Australian waters for a major operator.

Their C-Kore Sensor Monitor unit interrogated a wellhead pressure and temperature sensor to prove the well's correct operation when feedback wasn't available from the subsea control system. The use of the C-Kore unit saved the operator over Aus$1 million on the subsea operation.

C-Kore Systems has a range of subsea testing tools used globally by operators and contractors on de-commissioning, fault-finding operations and new installation campaigns. The tools are easy to deploy and are operated without the need for C-Kore personnel being present, providing rapid and accurate feedback.

This combination of simplicity, accuracy and reliability introduces significant operational savings to testing campaigns.

A Subsea Engineer from the operator commented, "Using the C-Kore Sensor Monitor unit simplified our whole testing campaign. We were able to quickly confirm the pressure/ temperature transducer was still operational without having to pull the SCM, saving us over Aus$1M!"

Greg Smith, Operations Director at C-Kore commented further, "We designed our testing tools to be easy to use. T,he automated operations allow our customers to quickly get the data they need to make their maintenance decisions, without needing to deploy downlines or take extra offshore personnel.

DVL PACKAGE

Nortek has launched a combined DVL package that delivers a suite of integrated underwater navigation sensors at a size, weight suitable for smaller subsea vehicles

"New technology is enabling electronics in the subsea navigation space to become both smaller and more capable," said Rory Findlay, Business Development Manager for Nortek's DVL group.

"It's not just a DVL. It's an AHRS (Attitude and Heading Reference System) that tells you where you're pointing, how you're moving. It's a pressure sensor that tells you how deep you are. It's an altimeter that tells you how far above the seabed you are.

"We have not only developed a small DVL, we have provided all the things you need to control your vehicle, in one compact package."

The Nucleus1000 is more than just a small DVL for navigation: it provides everything needed to control a small subsea or surface vehicle, in one compact package.

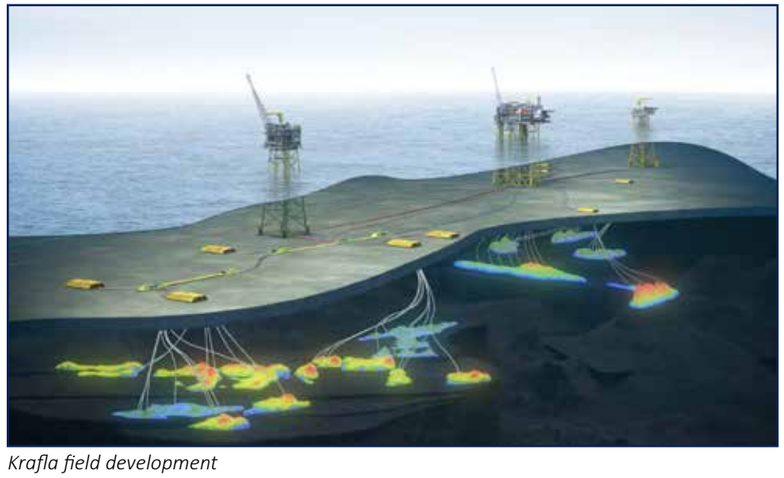
It brings together a full suite of high-specification sensors in one combined navigation package and reduces development and engineering time.

KRAFLA

Aker BP has made an investment decision to submit a plan for development and operation for Krafla to the Minister of Petroleum and Energy. The company will be developing Krafla along with the Fulla and North of Alvheim discoveries in the same area.

Krafla was proven in 2011 and recoverable resources are estimated at 325 million barrels of oil equivalent. Total investments for Krafla are approx. NOK 46 billion (2022-NOK).

The unmanned Krafla platform is the first of its kind. It will be remotely operated from shore and will be built without a helicopter deck, living quarters and lifeboats. Access and stays at the platform will be accomplished using service operation vessels. Systems and functions have been reduced to the bare necessities in order to realise the unmanned concept. The solutions are simple, robust and can be run without manual operations.



Krafla field development

With power from shore, Krafla will be a world leader in low CO2 emissions from production, calculated at 0.4 kg per barrel of oil equivalent. Information: Equinor.

LADYBUG 6

Teledyne FLIR Integrated Imaging Solutions has announced the Ladybug6 as the latest addition to its field proven Ladybug series.

The Ladybug6 high-resolution camera is designed to capture 360deg spherical images from moving platforms in all-weather conditions. Its industrial grade design and out-of-the-box factory calibration produces 72 Megapixel (MP) images with pixel values that are spatially accurate within +/- 2 mm at 10m distance.

"The Ladybug6 is designed for mobile mapping and all-weather inspection projects requiring high image quality and high resolution," said Mike Lee, Senior Product Manager at Teledyne FLIR. "We can now offer spherical cameras with higher resolutions ranging from 30MP to 72MP."

Building on the field proven Ladybug5+, the Ladybug6 captures, compresses, and transmits 8-bit or 12-bit pixel data delivering outstanding images across a wide range of lighting conditions with excellent colour response, low noise, and a high dynamic range.

The Ladybug6 features a wide operating temperature range, support for additional Global Navigation Satellite Systems, and trigger control by hardware or software with advanced APIs for complete camera control.

Ladybug6

SUBSEA

SUBSEA POWER

Over the last few decades, both commercial and government operations have increased the number of systems and amount of infrastructure deployed at considerable ocean depths. From oil and gas, port and harbour security, to advanced military deployments, needs are mounting for unmanned, self-sustaining ecosystems for vehicles and platforms.

In response to this demand, Teledyne Energy Systems (TESI) developed the Subsea Supercharger (S2C) fuel cell based power delivery system. This energy storage and delivery solution enables untethered power to subsea ocean infrastructure, autonomous underwater vehicle (AUV) recharging stations, and resident remotely operated vehicles (ROVs).

Current subsea infrastructure power solutions require a long cable connected to either a surface ship, platform, or land-based station (i.e., tethered power). Alternatively, batteries are used to provide untethered subsea power. For example, batteries may be stored on board a subsea vehicle to provide power, but then are frequently brought to the surface to recharge due to the limited energy density of the system storage.

Furthermore, if these battery systems are rechargeable, even when brought to the surface, they require access to charging power. Another limitation of battery power is scalability for applications requiring large energy storage. Using oxygen and hydrogen fuel cells and submersible, reusable gas storage flasks, the S2C can easily scale to large scale energy storage applications. This will enable future subsea platforms, AUVs, and ROVs to operate independently of any other infrastructure or resources thus providing operators with unparalleled flexibly, efficiency and savings.

SUPERCHARGER

In early December 2022, TESI demonstrated what is believed to be the first time an AUV was charged subsea using a hydrogen fuel cell. As part of a Phase II demonstration for NOAA Great Lakes Environmental Research Laboratory, TESI partnered with Hibbard Inshore to demonstrate the ability to repeatedly recharge an AUV while performing its mission to collect scientific data under ice.

The tests involved a SAAB Sabertooth AUV which made use of Hibbard Inshore's electric charging dock on the bed of Lake Michigan.

The Sabertooth was able to successfully dock, charge, and undock multiple times demonstrating the ability to extend the underwater mission duration. Currently, NOAA's ability to conduct science in The Great Lakes during winter is limited because iced over conditions keep surface vessels from leaving the dock.

Using the Subsea Supercharger in conjunction with the Saab Sabertooth and Hibbard Inshore's charging dock will enable the AUV to conduct extended missions under ice," stated Dave Malak, Vice President, Hibbard Inshore. "We believe that extended duration AUV missions can unlock new data to advance science."

The S2C system is modular and can be kitted for varying power needs and configurations.

"This system test fully demonstrates the capability to provide persistent and sustained undersea power and is an important industry milestone enabling extended underwater missions without need of surface support." stated Dwight Warnock, TESI Vice President and General Manager.

The S2C base unit is rated for a depth of 1000m and configured for 400kWh but is scalable to meet project specific requirements.

Above and below: The Subsea Supercharger (S2C) fuel cell undergoing testing

TWIN HUB

The first phase of the survey works for the stepping-stone project TwinHub has been awarded to Aratellus Offshore. The company has recently subcontracted the geophysical work to Sulmara Subsea.

The results of the final project will be used to progress the Front End Engineering Design for the TwinHub project, which has been developed by Hexicon and supported by Bechtel. It will also see the deployment of Hexicon's patented TwinWind technology which is expected to be the first duel turbine floating foundation deployed at large scale globally.

TwinHub secured a 15-year revenue support from the UK Government for the first floating offshore wind project in the Celtic Sea. The TwinHub Floating Offshore Wind Farm site is located 16km off the coast of Hayle in Cornwall, United Kingdom.

The investigation works represent a significant milestone for the project, which is set to be the first ever floating offshore wind farm to be built in the Celtic Sea, having been successfully awarded a Contract for Difference in July's auction round. The survey vessel *Vos Sweet* mobilised from the port of Falmouth on the 17th of August, with field operations anticipated to last between 2-3 weeks.

The goal is to make it possible to plan subsea routes, inspect existing cables, and perform FEED and detailed design of mooring anchors and chains. A Side Scan Sonar (SSS), Sub-Bottom Profiler (SBP), Remotely Operated Vehicle ROV, and Magnetometer will also be used.

FLOATING WIND

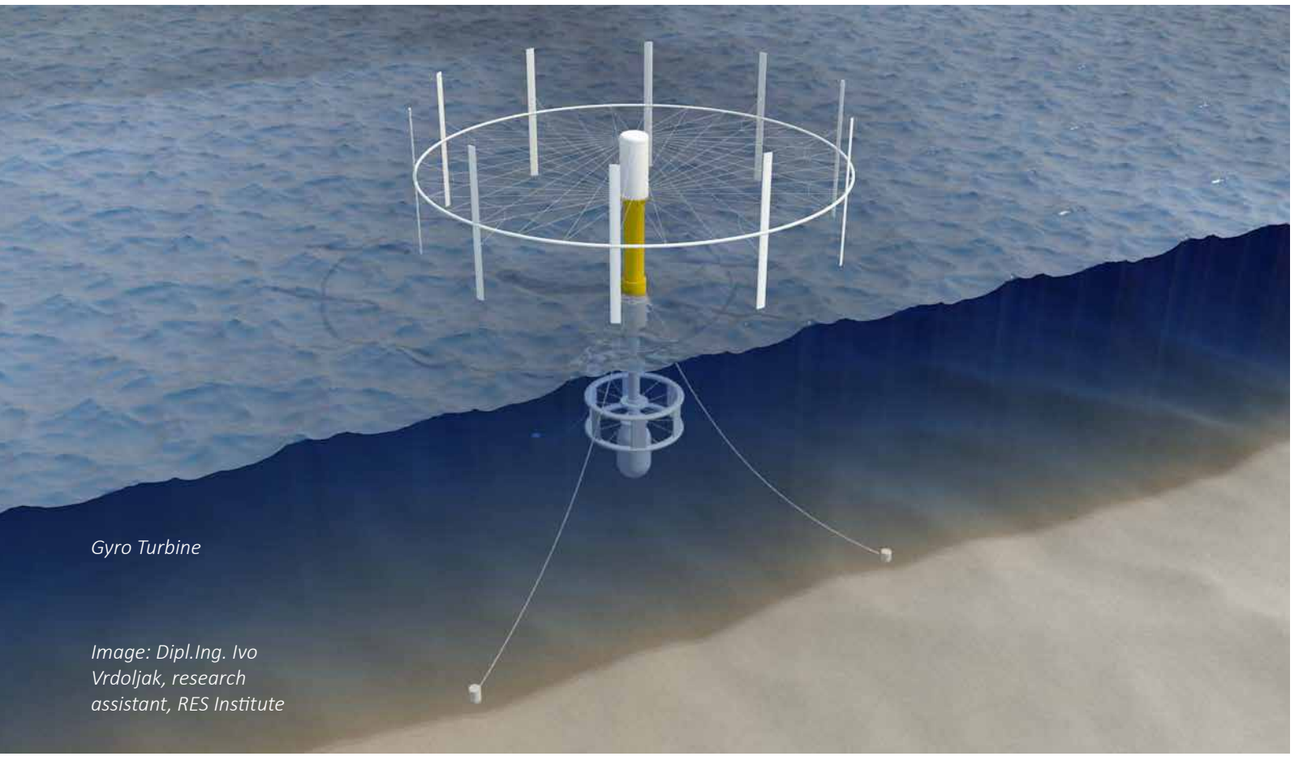
AN OCCASIONAL LOOK AT NOVEL DESIGNS

GYRO TURBINE

An ingenious floating wind energy converter, the *Gyro Turbine*, has been developed by Prof. Friedrich Grimm from the RES-Institute in Germany. This novel turbine uses the mass inertia caused by gyro forces to stabilise the turbine around the vertical axis of rotation.

"Coaxial and concentric to the axis of rotation, the hub of the horizontal spoked wheel is connected about 70m above sea level to a rod-shaped buoy, the extended lower end of which is designed as a ballast body," said Grimm.

"Ten rotor blades arranged parallel to the axis of rotation are designed as cantilevers and project 50m upward and downward from the rim of the spoked wheel, which has a radius of 150m



Gyro Turbine

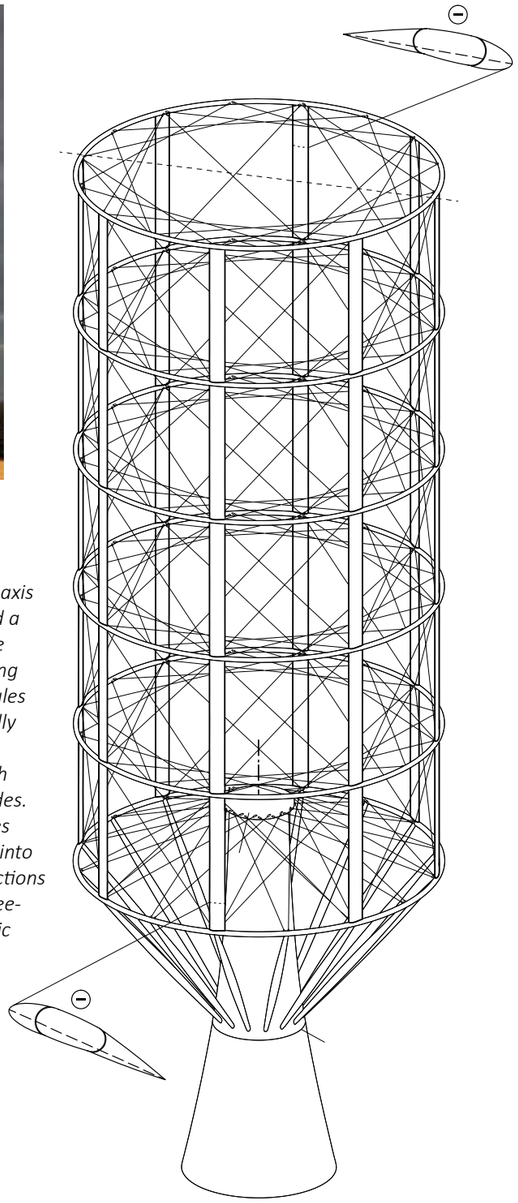
Image: Dipl.Ing. Ivo Vrdoljak, research assistant, RES Institute

"Supporting and tensioning cables stabilise the rotor as radial spokes and, together with the hub and rim, form a lightweight structure that meets the Buckminster Fuller tensegrity structure criteria."

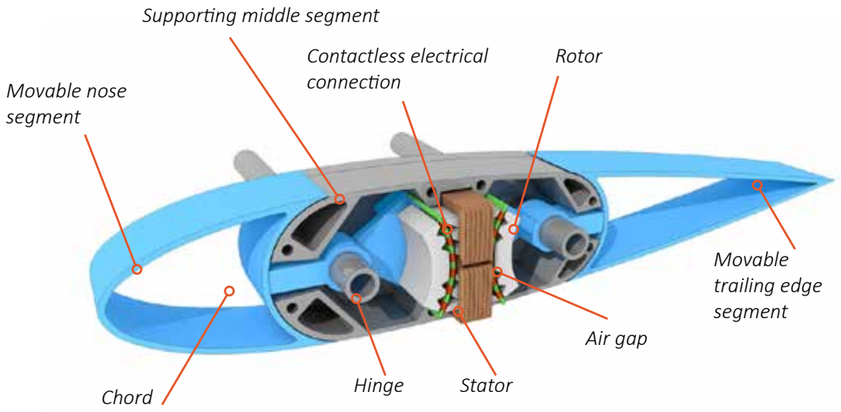
"Below the water surface, a much smaller water turbine, also of spoke-wheel construction, rotates in the opposite direction around the rod-shaped buoy to compensate for the precession of the upper gyro. The water turbine is driven by the tidal current or by the current of a flowing water.

The peak power of both turbines sums up to more than 50 MW, so that one buoy can replace seven of today's most powerful floating offshore wind turbines with horizontal axis of rotation.

Also much less material is needed to build this structure, drastically



A wind turbine with a vertical axis of rotation, and a base-side spoke wheel supporting five rotor modules stacked vertically one above the other, each with eight rotor blades. The rotor blades are subdivided into longitudinal sections and have a three-part asymmetric airfoil



lowering production costs for electricity," he said.

One particularity interesting part of the design is the rotary wing blade itself which has an asymmetric profile specifically designed for a turbine.

The rotor blade consists of three parts: a movable nose segment, a supporting middle segment and a movable trailing edge segment. The supporting middle segment is an abutment for the movable nose and trailing edge segments formed by the stator of an integrated electric motor.

The rotor of the electric motor is connected by a hinge and separated from the stator by an air gab revealing a contactless electric connection between the three parts of the rotor blade.

In one design, eight rotor blades are spaced at a radius from the vertical axis of rotation and are each connected at their upper and lower ends to a circumferentially subspanned ring beam. Unspecified photovoltaic cells cover the surfaces of the three-part airfoil sections of the rotor blades and are oriented

alternately on the inside and outside of the orbit toward the sun as the rotor modules rotate.

The base-side ring beam has sixteen compression bars connecting the rotor formed by the five stacked rotor modules to the lower pivot bearing of a hub, while sixteen pairs of V-shaped tension spokes are braced to the upper pivot bearing of the hub in such a way that a vertical lever arm is formed between the upper pivot bearing and the lower pivot bearing to dissipate the tilting moment of the rotor via the hub into a base of the wind turbine formed as a cantilever arm.

"The wind turbine's inflow area of 14 000m^2 corresponds to the rotor diameter of a conventional 7MW wind turbine with a horizontal axis of rotation, so that up to a wind speed of 12 m/s, the wind turbine can also generate a peak output of 7 MW, while when the speed of a conventional wind turbine already has to be throttled at wind speeds of more than 12 m/s, it can achieve double to triple the output in comparison," said Grimm.

"The wind turbine, which stabilises itself as a gyroscope, requires only half the design weight compared to a conventional wind turbine with a horizontal axis of rotation due to consistent lightweight construction technology with predominantly axially loaded load-bearing elements."

Another wind turbine features ten rotor blades with an asymmetrical airfoil profile, supported by a horizontally arranged spoke wheel forming one large rotor module. The rotor blades are connected to an outer ring beam, which is connected to a hub by means of a plurality of radial spokes.

The spoke wheel has a diameter of 300m, the rotor blades being divided by the ring girder into two halves, each 50m long.

A flexurally rigid connection formed by a cable tensioning system is formed between the ring girder and the longitudinal girder of the three-part airfoil. The hub of the spoke wheel, which is arranged coaxially and concentrically to the vertical axis of rotation, is rotatably mounted by means of an upper pivot bearing and a lower pivot bearing on a central support structure which accommodates at least one motor generator in the area of the hub.

By means of the lattice tower, which extends towards the foundation soil, the wind turbine can be anchored in a foundation soil both offshore and onshore. With an inflow area of 30,000 square meters, the wind turbine is layed out for 30mW peak.

HUBLESS VERTICAL WIND TURBINE

American Offshore has developed a low-cost floating Vertical Axis Wind Turbine (VAWT) concept incorporating a combination of 'tension and compression' design principles to result in a stiff lightweight structure that can scale up to large sizes.

"Vertical axis turbines have a number of advantages, particularly when used in some floating applications," said Drew Devitt, founder and CTO at American Offshore.

"Horizontal axis turbines and their large heavy gearboxes are normally located on top of towers, some up to 80m tall. This requires a very strong support tower. In direct contrast, vertical axis systems tend to be much smaller and fabricated with lightweight materials.

"Because the rotating equipment is located nearer to ground-level, the turbines become much easier to manufacture and install. They can be towed out, moored and plugged in with no seafloor foundation or offshore assembly required."

Most vertical axis turbines rotate around a central shaft. This is directly linked to the generator to create the electric power. A notable feature in the American Offshore's novel design, however, is the very lack of this central hub structure.

Instead, the design consists of a basal disc and another on the top. In earlier versions of the design, the two discs were separated by a number of rigid fibreglass blades running between the base and the top ring, also fibreglass. Steel wires add integrity to the lightweight stiff cylindrical shape and provide support.

After witnessing the wave-capturing abilities of sails in the Americas Cup yacht races,however, a later iteration, saw the blades with sail type air foils - representing the lowest cost/ft^2 and the lightest weight possible.

These have an advantage that they can be automatically reefed to fit conditions or completely furled for hurricanes.

"The wind-harnessing ability derives from the sail mast/blade being connected to the upper section of the basal disc so that the entire assembly above the surface revolves as the wind catches.

Below the revolving section is the stationary component, also a disc which is, in turn, connected to a mooring system anchored to the seabed. When the upper part rotates around the lower fixed body, the relative the movement generates power. Importantly, this direct drive generation at the perimeter effectively eliminates the whole drive line and gear box.

The design means that the Foundation requirements are minimised as moment loads from the wind are spread across the large base circumference of the structure.

BEARINGS

The enabling technology that allows the system to work,however is the novel bearings arrangement.

The original design had fibreglass blades

"We have developed a set of virtually frictionless air bearings support the rotor at the perimeter," said Drew Devitt. "Hydro turbines and steam turbines both use hydro bearings to support their rotors so it is not totally surprising that wind turbines could be supported on air bearings.

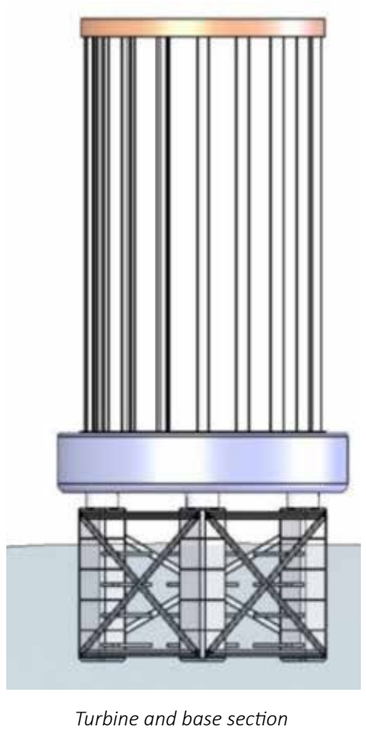
"There are three bearing points. Like a three legged stool, it will not rock and always present a plane for the rotor. The bearings are mounted on gimbals so that they self-align to the rotor. This simplifies assembly and avoids the requirements for rigid structures.

"The resulting mechanical system is simpler and much less expensive to maintain, exhibiting around 100 times less friction.

These advantages result in a 50% cost reduction per megawatt, a

Turbine with sails

FLOATING WIND

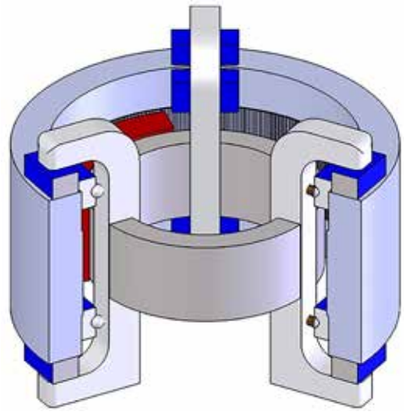


Turbine and base section

delivery of six months instead of two years, a simple mechanical system that is inexpensive to maintain.

"Because the turbines float, no foundation is required on the seafloor. This opens up over 1000 GW of wind resource in deep water. Turbines positioned 30 miles from the coastline would not be visible or audible from the shore.

The vertical turbines would be built on shore, towed out to a field of mooring anchors, tied up and plugged in. No crane or assembly would be required at sea. If necessary the turbine could be towed back to land in a day for major service.



Bearings and generator

Thus, marine VAWT Installation will be less expensive than land HAWT installation. Transportation and maintenance costs are dramatically reduced. Ocean transportation and sighting combined with low turbine speed enable huge scalability.

AERODYNAMIC TURBINES

Wind turbines employ one of two basic principles to capture energy from moving air.

Impulse turbines use drag to harvest energy. A water wheel would be an example of a horizontal axis turbine while an anemometer- used for measuring wind speed describes a vertical axis impulse type device. Importantly, impulse turbines can never spin faster than the wind is blowing.

The second is the aerodynamic turbine that uses low pressure lift (like an airplane wing). Perhaps unsurprisingly, almost all utility scale wind turbines manufactured today follow aerodynamic horizontal axis designs. They typically employ three blades connected to a horizontal spindle mounted on top of a pole or tower. These are over twice as efficient as impulse-based vertical axis counterpart.

“An objective look, however might consider other issues and constraints in addition to turbine's efficiency," said Drew Davitt. “An important consideration in the location of any device is the wind speed.

"The blades represent a small percentage of the swept area so aerodynamic blades require a relatively high wind speed just to start spinning. Combined with the friction from the gearbox and bearing systems,therefore, horizontal axis wind turbines are not very effective in low wind speeds. They may well have a 45% efficiency for the wind speed of 14 m/sec but if this fell to 5m/sec it would not even move.

"The wind speed seldom blows at a constant speed and since the tip speed of a conventional horizontal turbine is directly governed by this, there is often a significant variation in the speed of the rotor. This causes huge 'on again - off again' loads that stress the longevity of gear boxes.

"The speed change is on the wrong end of the gear box," continued Davitt. "A small change in the rotor speed (say, 18 to 20 rpm) will result in a large change at the generator (200 rpm). These combine to make the frequency of current generated highly variable and erratic. This is expensive electricity to condition for the grid.

"Thus, there are capital costs, efficiency losses, cooling systems, power quality problems and maintenance headaches that must also be taken into account.

"A 100m swept area has a 314m circumference and at 20 rpm the tips travel 104m per second which calculates to around 370kph. There is, therefore, a fundamental limitation on the scalability of horizontal axis as the tip speed for larger swept areas is limited by the speed of sound and the specific strength of the blade material to withstand the centrifugal forces.

This speed presents fundamental risk for birds and from fatigue forces over time causing catastrophic blade failure.

VERTICAL AXIS

"All vertical axis turbines employ an impulse configuration, which enjoys a relatively high efficiency in lower wind speeds because of their higher blade areas a percentage of swept area.

While demonstrably not as efficient, this design will make power most of the time the wind is blowing. There are efficiency cases, therefore, for both types of turbine given the location.

For floating applications, there are other advantages to vertical axis turbines. Because the rotating equipment is located at ground-level, it becomes much easier to manufacture and install. They an be towed out, moored and plugged in with no seafloor foundation or offshore assembly required.

This is particularly true for floating applications. Where they are less expensive and faster to build.

ACOUSTIC CORER

Coring is a useful geotechnical tool that can be used to examine the subsurface of an area prior to installing a structure on it. This is traditionally carried out using a specialised barrel on the end of a drill string.

As such, this either requires some sort of drill ship or a sea bed-located structure able to carry out specialised drilling operations.

Such operations can be quite expensive, requiring niche tools or a fully staffed drillfloor and vessel.

Kraken Robotics' subsidiary PanGeo Subsea subsidiary Recently entered the market with novel acoustic system which it says, competes with machanical coring systems.

Called the Acoustic Corer (AC) creates a high-resolution 12m wide core penetrating the sub-seabed to depths greater than 40m. The AC provides a 3D image of stratigraphy layers and anomalies across the entire foundation footprint.

It bridges the technology gap between cone penetrometer tests and narrow-focused boreholes, eliminating subjectivity from those localized data sets.

The Acoustic Corer collects over 20,000 data points per second to de-tect AC mitigates the installation risk of offshore infrastructure by identifying subsea stratigraphy and buried geohazards.

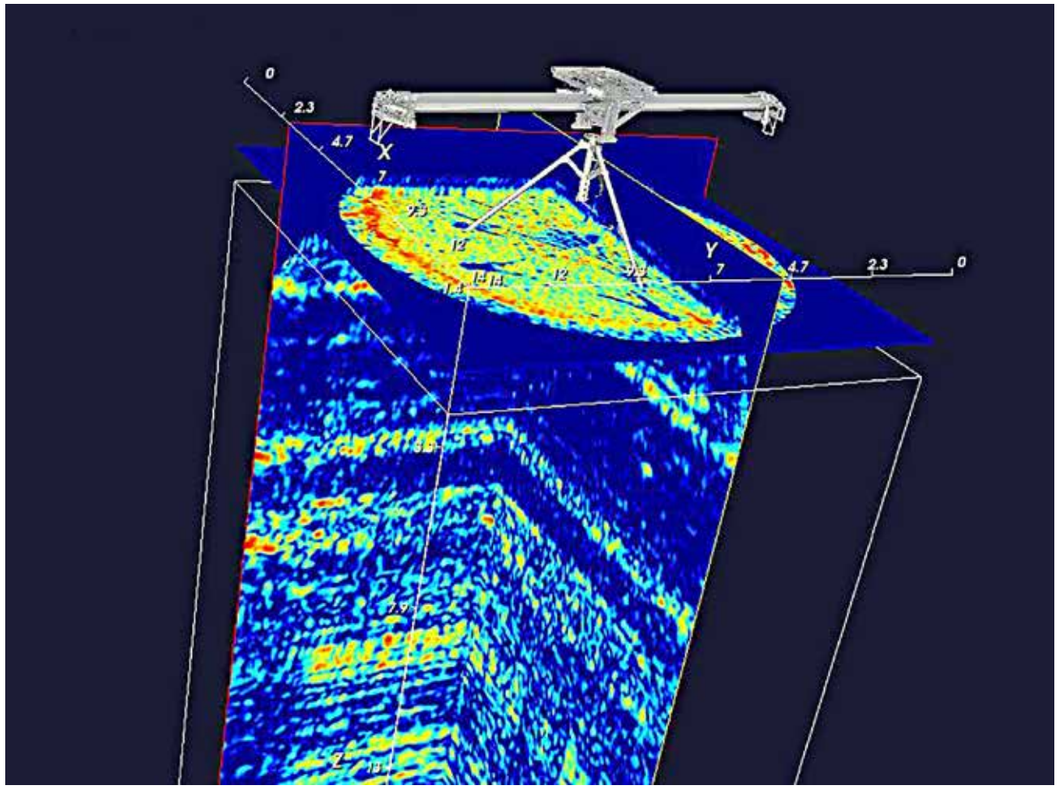
The AC images provide quantitative information (position and sizing) on features such as:

- Buried anomalies
- Infrastructure
- Stratigraphy layers
- Gassy soil layers

“The rise of offshore windfarms in complex seabeds has led to increased levels of risk during foundation installation,” said PanGeo’s CEO Moya Cahill.

The AC mitigates risk to pile driving by identifying geohazards

Above and below: Acoustic corer



pre-installation providing confidence in foundation design and placement. The AC provides risk mitigation solutions for Foundation locations, Jack-up punch through, as well as resolving infrastructure decommissioning and geotechnical ambiguity.

Pan geo recently completed an Acoustic Coring campaign for ONE-Dyas in the North Sea- the company's second Acoustic Corer (AC) survey at ONE-Dyas's GEMS development, supporting foundation engineering of the N05-A gas platforms.

The system was used in a campaign that took place during the summer aboard the *M/V Dina Star*. PanGeo was the prime contractor for the project.

The scope of work was to acquire an acoustic core at each of the 6 legs of the platform foundation, and an additional core centred on the wellhead. PanGeo high-resolution data will identify geohazards such as buried boulders of 0.3m diameter and larger to 40m below the seabed.

PanGeo also correlated the acoustic data to pre-existing geotechnical data and extrapolated the geotechnical properties across the entire foundation footprint.

"PanGeo's geoscientists will now assess the collected AC data to identify buried boulders that could cause pin-pile refusals and prevent additional costs and installation delays," said Moya Cahill

INSTALLATION

Saitec-manufactured DemoSATH floating unit

PILE GRIPPER

Huisman has been awarded a contract by Heerema Marine Contractors to deliver a Motion Compensated Pile Gripper. This will be the third Motion Compensated Pile Gripper to be built by Huisman.

This technology plays a significant part in enabling the energy transition, making possible the construction of tomorrow's offshore wind farms.

The Motion Compensation Pile Gripper will enable Heerema to install monopiles up to 12.5m in diameter, with a length of up to 115m and a weight of 3200t.

The Gripper is designed specifically for Heerema's *SSCV Thialf*, where it will be positioned on the side of the vessel.

The design and construction of the gripper will be a combined effort carried out at Huisman's locations in the Czech Republic and in the Netherlands.

DEMOSATH

Mammoet has completed the transport and load-out of what will be the first grid-connected floating wind turbine in Spain.

The Saitec-manufactured DemoSATH floating unit is a prototype for energy is part of a floating offshore wind pilot project that aims to prove the viability of creating large-scale offshore wind farms in deep waters.

Mammoet was asked by Noatum Logistics, Saitec's subcontractor, to transport and load-out the floater while fitted with a 2MW wind turbine. Mammoet had collaborated since the beginning on ideas and solutions for the jacking, transport and load-out of the floater to make sure the transport vessel and supports would stay sufficiently high in the water during the launch.

Once Mammoet identified the best transport path, the floater was transported on SPMTs from its place of manufacture to the quay.

The project was carried out during two operations over one tide, so the barge was at the right level to load out the floater and offload the SPMT back onto the quay.

MOTION COMPENSATED PILE GRIPPER

Monopile gripper

Huisman has been awarded a contract by TOA Corporation and Obayashi in Japan for the delivery of a Monopile Gripper that can upend and install monopiles without using a separate upending bucket, improving safety and efficiency of operations on board.

The Huisman Monopile Gripper will be the first of its kind to be used in Japan. The gripper will be installed on TOA and Obayashi's Self Elevating Platform (SEP), which is outfitted with a 1,250mt Huisman Pedestal Mounted Crane. This Huisman mission equipment will play a significant role in Japan's transition.

The gripper will be capable of handling monopiles of up to 8 m in diameter, fully utilising the capacity of the SEP. Huisman has paid special attention to optimising the upending process, in which the gripper and crane control software communicate with each other to ensure the system operates within its limits.

WEDGE CONNECTION

Installing monotowers in offshore wind farms can be challenging. They often consist of a monopile foundation connected to a transition piece. Connecting the two involves bolting the two flanges together.

C1 Connections and Heerema Marine Contractors recently tested a novel C1 Wedge Connection offshore. This high-capacity connection that can be installed faster and safer than the conventional bolted flange connections. The installation of the tower on board *Thialf* was performed as part of the preparations for the Arcadis Ost project, for which Heerema will install 27 wind turbines for the Belgian developer Parkwind.

The C1 Wedge Connection can deliver the high capacity that is required as the next generation wind turbines continue to which continue to grow in size and are installed on sites in increasingly harsh environmental conditions or on floating platforms.

"Conventional bolted L-flange connections are reaching their capacity limits and are complex to design, install and maintain," said Jasper Winkes, Managing Director, C1 Connections "This is where the C1 Wedge Connection will make a significant difference.

Wedge Connection

"Offshore test demonstrated that the C1 Wedge Connection enables a safe disconnection of the tower from a grillage on a barge. The alignment and quick connection of the tower was successfully performed without any personnel below the suspended load.

The Connection features pre-installed fasteners and, therefore, only lightweight tools are needed to finalize the connection. Prior research and testing demonstrated that the C1 Wedge Connection delivers a very high fatigue and ultimate capacity.

Installing the foundation

INSTALLATION

Preparing to mate the two parts

VITRUVIAN

The larger next generation Offshore Wind Turbine Generator (WTG) units (15-20MW) could start to become available in 2024-2030. These will be installed in water depth of 40-70m. Research has suggested that as many as 80% will be installed on monopile foundations. These will, therefore, require the next generation of XXXL monopiles.

This will need to be around 100–130m long with a 12-15m outer diameter and 3000t up/to 5000t of weight. It is likely that the current generation of Wind Farm Installation Vessels would be able to install these structures.

This prompted OffshoreTronic to envisage what the next generation of installation vessels might look like.

"Vessels could be obsolete before they even start to make money, so the design needs to be made future-proof," said Jeroen Berkhout, Founder and Project Director at OffshoreTronic. "Today's solution is to build larger Monohull Installation Vessels with Single Crane units. We recognise, however, that there are various technical and operational limitations to the safe handling of the 3000t XXXL monopiles far over 3000t, as these require more support points during the transport and installation process.

"Key design objectives are a future proof, cost efficient and simplified vessel designed for with a fast track building programme to be available at very short notice.

Above: Installation vessel

Below: Loading the monopiles

It would require the lowest possible CAPEX and OPEX and a 'Green Vessel' power plant with Zero Emissions.

"Solutions offered today are ostensibly very large monohull Vessels with price tags far exceeding US$ 500 million (including the very expensive mission equipment needed for these Vessels.)"

VITRUVIAN
OffshoreTronic has developed such a vessel in the form of *Vitruvian* which its designers say, could be at least 40-50% more cost efficient than a new conventional mono-hull.

"The basis of the design is tailor-made to safely perform transportation and installation of three 3000t or two 5000t monopiles," said Berkhout. "The innovation lies in the structural design that allows jacking and lifting operations under a larger weather window than other Installation Vessels on the market and safe horizontal handling of the mono-piles.

"We see that the existing and planned monohull and semi-sub vessel designs are still based on lifting these massive monopiles with lifting-slings and/or other lifting and transport tools that will result in extensive risks of damaging monopile units far over 3000 mt.

"Massive modifications and even larger mission equipment will be needed and will negatively impact the OPEX of these vessels.

"The innovation we bring with our new vessel lies in the safe horizontal handling of the monopile starting at the fabrication yard and we will safely roll-on to our installation vessels by SPMT transporters. Risk-full crane liftsbwill not be required in the port and/or at the offshore locations and the monopile will always stay supported over the full length.

"To roll the monopiles onto the deck, we have installed innovative roller on the tilting and lifting beams to allow a smooth roll-on and roll-off at the offshore location.

"This new transport and installation process will produce the optimum support positions for heavy monopiles and eliminate risk of buckling and getting any other major damages on monopiles over 3000 mt.

"We aim to build our units for under the US$250M range while already contemplating a large monohull vessels nearer US$500M with large and expensive mission equipment".

Vitruvian

WINTER PILING

After the successful completion of Moray East for Ocean Winds in 2020, DEME will be back in the Moray Firth installing the foundations for another offshore wind farm in Scotland.

In an industry breakthrough, however, this challenging project will be the first time XXL monopiles will be installed in the winter period,

After the successful completion of Moray East for Ocean Winds in 2020, DEME will be back in the Moray Firth installing the foundations for another offshore wind farm in Scotland.

In an industry breakthrough, however, this challenging project will be the first time XXL monopiles will be installed in the winter period,

and DEME will deploy its double-staged, motion-compensated pile gripper. Moray West will also be the first time a vibrohammer will be utilised for the XXL monopiles to overcome weaker soil layers.

As well as the XXL monopiles and transition pieces, DEME will perform the bolting and grouting works for the monopile/transition piece connections.

The revolutionary floating DP3 offshore installation vessel *Orion* is set to install the monopiles and jack-up *Apollo* will be deployed for the installation of transition pieces.

DEME's expertise regarding this exceptionally challenging project will be combined with its high-tech fleet and specialised equipment, to ensure that the installation campaigns in 2023-2024 can be carried out efficiently.

Moray West is set to make a vital contribution to Scotland's renewable energy and climate change targets, supplying low-carbon electricity to approximately 640,000 homes.

Ocean Winds, the company that awarded DEME Offshore the Moray West contract is principally owned by, two energy utility companies, EDP Renewables and ENGIE. A small minority stake is held by UAB Ignitis Renewables.

Floating installation vessel Orion

CABLE BURIAL TRENCHER

Osbit has successfully delivered a subsea trenching vehicle to Luxembourg vessel operator, Jan De Nul. The high-powered vehicle, named Swordfish, is a purpose-built cable burial tool for the efficient protection of subsea cables that will be used on current and future wind farm projects.

Swordfish is powered by 1200kW of subsea electrical power combination of direct drive and hydraulic distribution to provide operators with maximum versatility when applying power to bury cables in the ocean. Boasting an array of cutting-edge features, Swordfish can be quickly reconfigured into a variety of settings, enabling the vehicle to tackle a wide variety of soil conditions found across planned windfarms and export routes.

A team of specialist Osbit engineers completed the detailed design, manufacture, assembly, and test of Swordfish in just over a year. The machine was delivered out of the company's assembly base at the Port of Blyth in Northumberland.

By virtue of its high power, Swordfish can bury the cables deeper and at higher progress rates while its innovative mechanical chain cutting configuration Swordfish can also tackle more challenging soil conditions, including hard clays up to 400 kPa.

INSTALLATION

ROCK ANCHOR

The mooring and anchoring specialist company Swift Anchors was recently sold by Sustainable Marine to its largest shareholder and long-standing partner, SCHOTTEL. With it, went the next-generation, remotely operated rock anchor installation system AROV2. This will be used to install anchors for Sustainable Marine's Pempa'q Project in Nova Scotia, Canada —the world's largest floating tidal array.

"Rock anchors were originally designed to meet the unique installation challenges of tidal sites," said Michael Hook, Business Development Director at Swift Anchors. "Many are characterised by very large volumes of water moving at speeds up to 8-9kts through relatively small channels. These can leave a very small window of opportunity for working. The slack tides (the low-velocity transition between the tides coming in and going out) sometimes last only 45 mins.

ROCK ANCHOR ALTERNATIVES

A number of alternative technologies exist for anchoring structures to rock.

One way is to install large gravity base concrete anchors. Operations could dictate placing hundreds of tonnes of concrete on the sea bed to react against typical loads. This concrete can damage the sea bed, is expensive, has a very high carbon footprint and require large vessels to install. This concrete typically remains after the structure it anchors, is removed.

Another way is to drill a hole in the rock and install a rock bolt. The bolt would then be grouted in. This too causes potential issues. The drilling, anchoring and grouting are conducted in separate operations leaving the possibility of problems occurring at the interface between stages.

The grout can be pre-mixed but the material is governed by very strict setting times. This may be incompatible with the general unpredictability of offshore operations that depend on environmental stability and human factors.

Alternatively, it can be mixed offshore but this requires a complex and expensive spread to produce it and there is always a risk of it starting to cure prematurely Importantly it is difficult to verify that the grout has gone off in the hole after placement.

Lastly, in practical terms, the drilling and grouting method can be restricted by water depth.

Many tidal sites are characterised by the presence of a rocky sea bottom and companies have looked for ways of anchoring infrastructure in such locations. Swift Anchors was set up to develop technology in order to exploit opportunities and in doing so, devised a novel anchoring technique suitable for a rocky underwater substrate.

"Rock anchors have the advantage that they can be installed quickly using smaller, lower cost marine assets such as 26m multi cats," said Hook.

"Over the last few years, the technology has continued to evolve to a point where it is not only suitable for the wave and tidal sectors, but also for other applications from floating offshore wind to large scale fish farming where they require the ability to withstand high mooring loads."

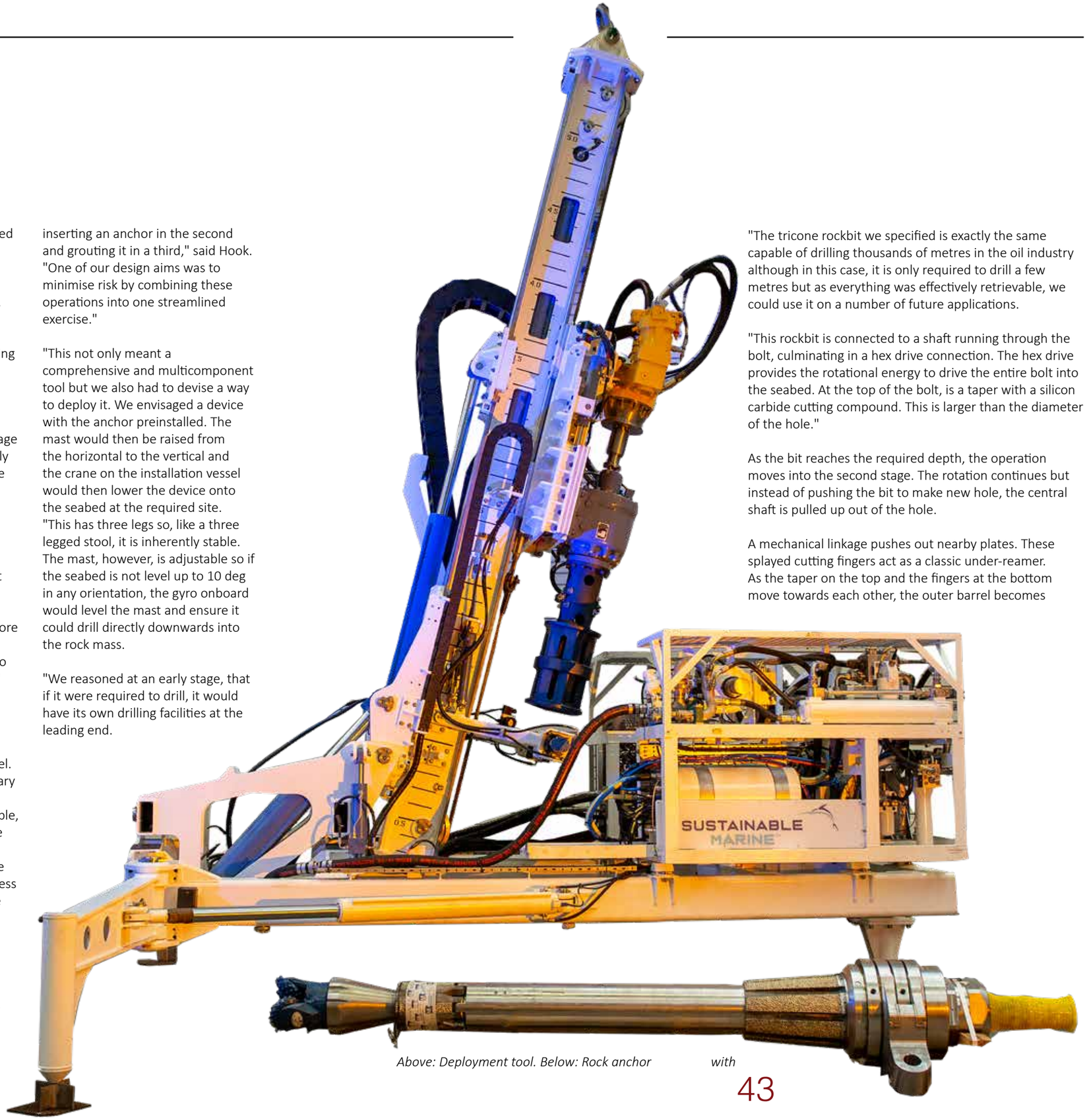
ROCK ANCHOR

The rock anchor is a purpose-designed structure fabricated from super duplex stainless steel. The scale of the rock anchors vary depending on the loads that it needs to resist, but as an example, one that weighs only one tonne can withstand 175 tonnes of load when pulling at 30deg. The anchors are designed for in excess of 20 years life to align with the duration of most renewable energy projects.

"Alternative grouted anchor technologies are based on drilling a hole in one operation, inserting an anchor in the second and grouting it in a third," said Hook. "One of our design aims was to minimise risk by combining these operations into one streamlined exercise."

"This not only meant a comprehensive and multicomponent tool but we also had to devise a way to deploy it. We envisaged a device with the anchor preinstalled. The mast would then be raised from the horizontal to the vertical and the crane on the installation vessel would then lower the device onto the seabed at the required site. "This has three legs so, like a three legged stool, it is inherently stable. The mast, however, is adjustable so if the seabed is not level up to 10 deg in any orientation, the gyro onboard would level the mast and ensure it could drill directly downwards into the rock mass.

"We reasoned at an early stage, that if it were required to drill, it would have its own drilling facilities at the leading end.



Above: Deployment tool. Below: Rock anchor with

"The tricone rockbit we specified is exactly the same capable of drilling thousands of metres in the oil industry although in this case, it is only required to drill a few metres but as everything was effectively retrievable, we could use it on a number of future applications.

"This rockbit is connected to a shaft running through the bolt, culminating in a hex drive connection. The hex drive provides the rotational energy to drive the entire bolt into the seabed. At the top of the bolt, is a taper with a silicon carbide cutting compound. This is larger than the diameter of the hole."

As the bit reaches the required depth, the operation moves into the second stage. The rotation continues but instead of pushing the bit to make new hole, the central shaft is pulled up out of the hole.

A mechanical linkage pushes out nearby plates. These splayed cutting fingers act as a classic under-reamer. As the taper on the top and the fingers at the bottom move towards each other, the outer barrel becomes

disconnected from the rotational forces. Instead of the load going through the stem, it goes through the rock. The rock effectively becomes the anchor.

As part of the final sequence, there is a nut which is tightened to a given pretension and the rock anchor is self-installed. At the top of the anchor, it is possible to install different interfaces such as a single or a dual line padeye arrangement for the subsequent connection of a mooring shackle.

A key part of the design is that the entire system is retrievable.

"We have also designed a remote intervention tool (RIT) which is essentially a remotely operate vehicle with a manipulator arm for a host of tasks," said Hook. "Importantly for future operation and maintenance and ultimate retrieval, there is a subsea tensioner on the RIT that forms part of the process to remove the tension at the point of decommissioning. Once slacked off, the anchors are relaxed and the body can be pulled straight out of the hole.

"We have carried out extensive work, drilling around 50 different anchors or variations as part of the testing."

It will soon drill its first testing in Halifax or close to Halifax (Nova Scotia) and will then go off to install anchors for a tidal project as soon as the weather windows open in 2023.

The RIT tool

AHC WINCHES

Degra and Seatools have jointly introduced a standardised range of active heave-compensated hoisting winches. The AHC winch range features unique control technology and will come available through a rental pool – making heave-compensated winch technology more accessible than ever before.

The range's initial offering contains winches with hoisting functionalities including Constant Tension (CT), Active Heave Compensation (AHC), and Render Recover (RR).

Thanks to its intelligent control system which features a self-learning algorithm, on-site commissioning becomes a straightforward matter.

After the operator enters only a limited number of situational parameters the intelligent control system will automatically configure and optimize itself. The obvious benefit being a minimum of commissioning time, in addition to high-performance and high-reliability heave compensated winch technology becoming widely accessible in the offshore market.

Degra's offshore hoisting winch designs served as a basis for the development of this product range. To achieve proper dynamic behaviour during active heave compensation mode, Degra devised a novel hydraulic system design. Individual component selection played a crucial role during this process.

Moreover, detailed winch system simulations enabled analysis of the system's behaviour, parameter setting and control strategy optimization, and testing of system response during mode transitions, extreme circumstances, and failure cases.

Simulations furthermore included vessel motions, mechanics, electronics, hydraulics, and controls to ensure correct performance of the system once deployed. The simulations were closely followed by test results from hardware tests.

RECOVERED WEAPON CONNECTED TO ATTEMPTED HOMICIDE

Crimes are committed on a daily basis across the globe. Regardless of the end result, the main goal of any search and recovery department is to locate evidence to bring perpetrators to justice.

A common weapon disposal technique is to dump the evidence in a local river, lake, or body of water that is close to the crime scene.

Many times, the waters create a perfect “hiding spot” for the evidence as it can quickly be covered by silt and debris on the bottom of the waterway and lost forever. That’s where JW Fishers’ underwater search equipment becomes the Right Tool for the Job.

The Pulse 8X is the top-of-the-line hand held underwater metal detector sold by JW Fishers Mfg.

The unit has been rated top by US Homeland Security and continues to be the “go-to” product for those looking to own a commercial-grade detector. Sales to military, police, search and rescue dive teams, public safety dive teams, commercial businesses, and recreational divers constitute the majority of sales year after year.

In the summer of 2022, the Department of Underwater Operations of the Investigations Police of Chile was called to help locate a weapon that would have been used by an individual to end the life of a 64-year-old sugar loaf farmer.

The details of the crime are unknown, but the investigation into the attempted homicide led detectives of the La Serena Homicide Brigade to the Monumental Lighthouse and the Río Elqui River Wetlands. The task of locating the firearm was complex due to the location being in a flooded area and in a natural environment far from civilisation.

According to Commissioner Sebastian Morales “the criminal analysis and police intelligence work that we carried out in the wetland area in conjunction with detectives from the homicide brigade had positive results.”

The team uses various types of equipment to locate missing evidence, particularly the Pulse 8X underwater metal detector and especially when suspected dumped evidence is in local waterways.

Arriving on the scene with the Pulse 8X, the team was able to locate and identify a long weapon that was submerged with its ammunition still loaded.

“A Laurona 12mm, double barreled shotgun was found, which coincides with the characteristics stated in the defendant’s statement and within the area where the firearm would have been discarded.

The team collected the evidence, sent it to the Regional Crime Laboratory for analysis and concluded it was the missing weapon” stated Deputy Commissioner Gary Ortega.

The experience of the team in the Homicide Brigade and in-depth knowledge of the technological equipment on hand were key to the location of the weapon.

FRIDAY PHOTOS

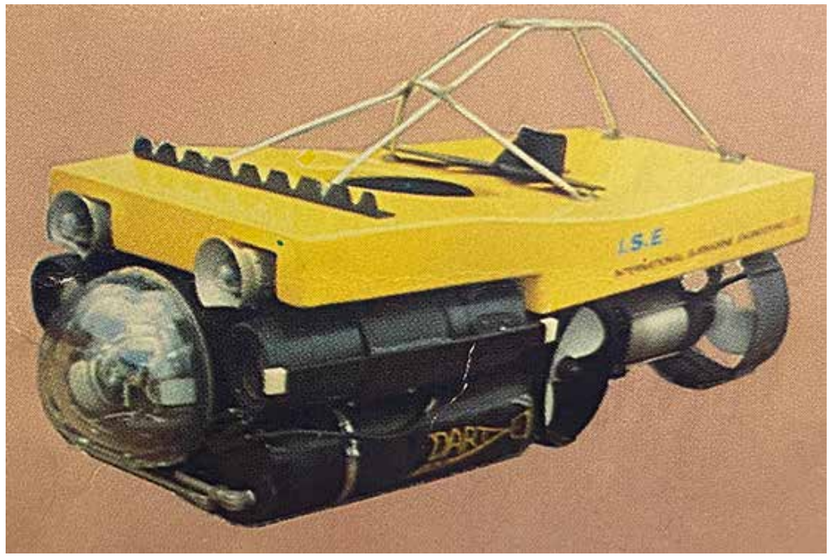
This was on Linkedin

JIM McFarlane

"James (Jim) Ross McFarlane, (1934 - 2022), founder of International Submarine Engineering Ltd. (ISE) died recently. He was one of the great pioneers in underwater remote operated vehicles (ROVs), human occupied submersibles and autonomous underwater vehicles (AUVs).

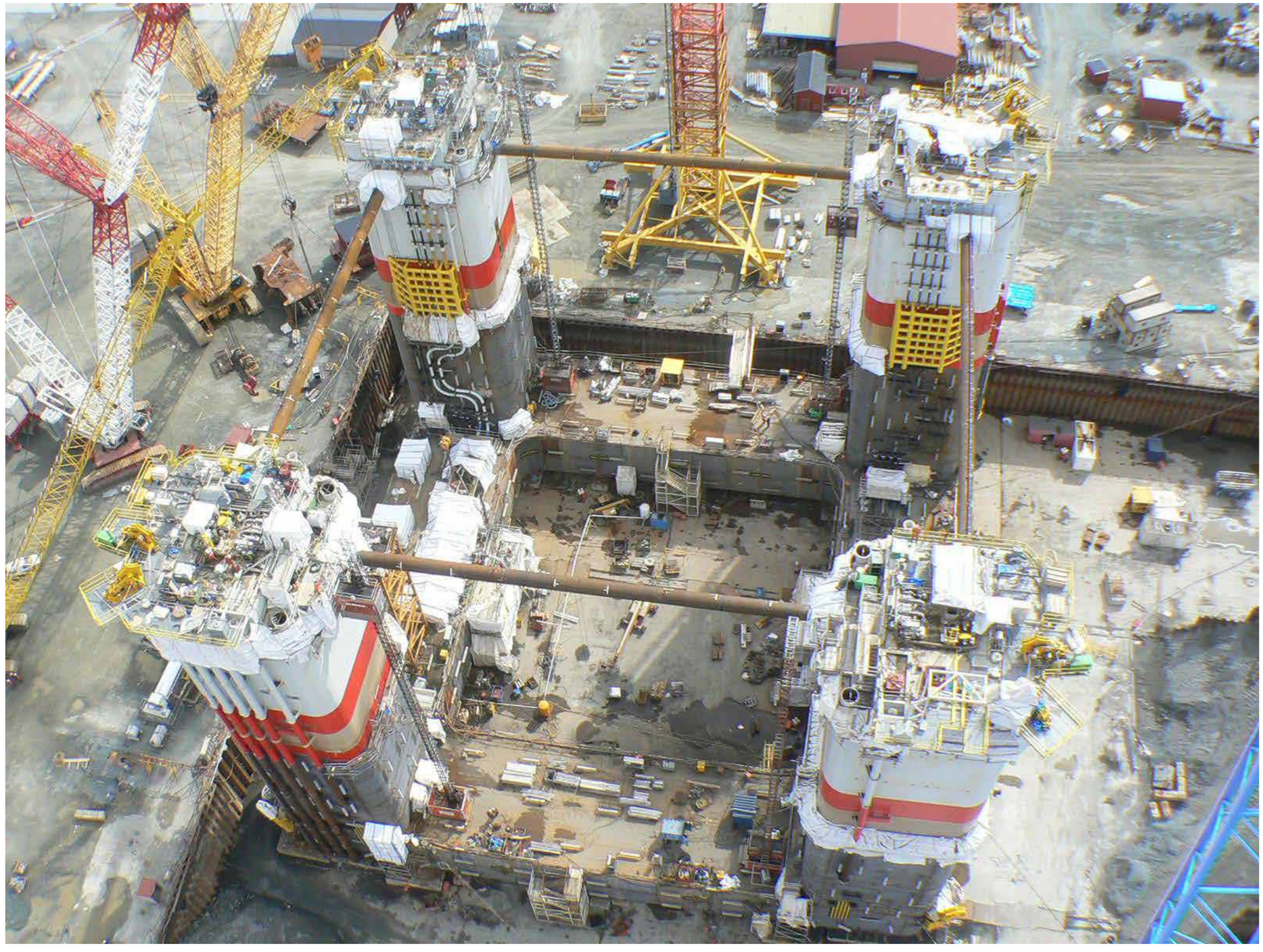
Much of Jim's story is told in the recent excellent book "Deep, Dark and Dangerous" by Vickie Jensen. This photo shows a Klein Side Scan Sonar mounted on TROV, an ISE ROV. The operator sent this photo to tease me about how they dissected our transducers to discover their secrets."

The Deep Access Reconnaissance Television was built by ISE in Canada. in total, 23 were constructed. They had an operating depth of 366m and weighed 32kg in air with positive buoyancy supplied by PVC .
It was 94cm in length and could travel at speeds of 1 to 1.3kts.

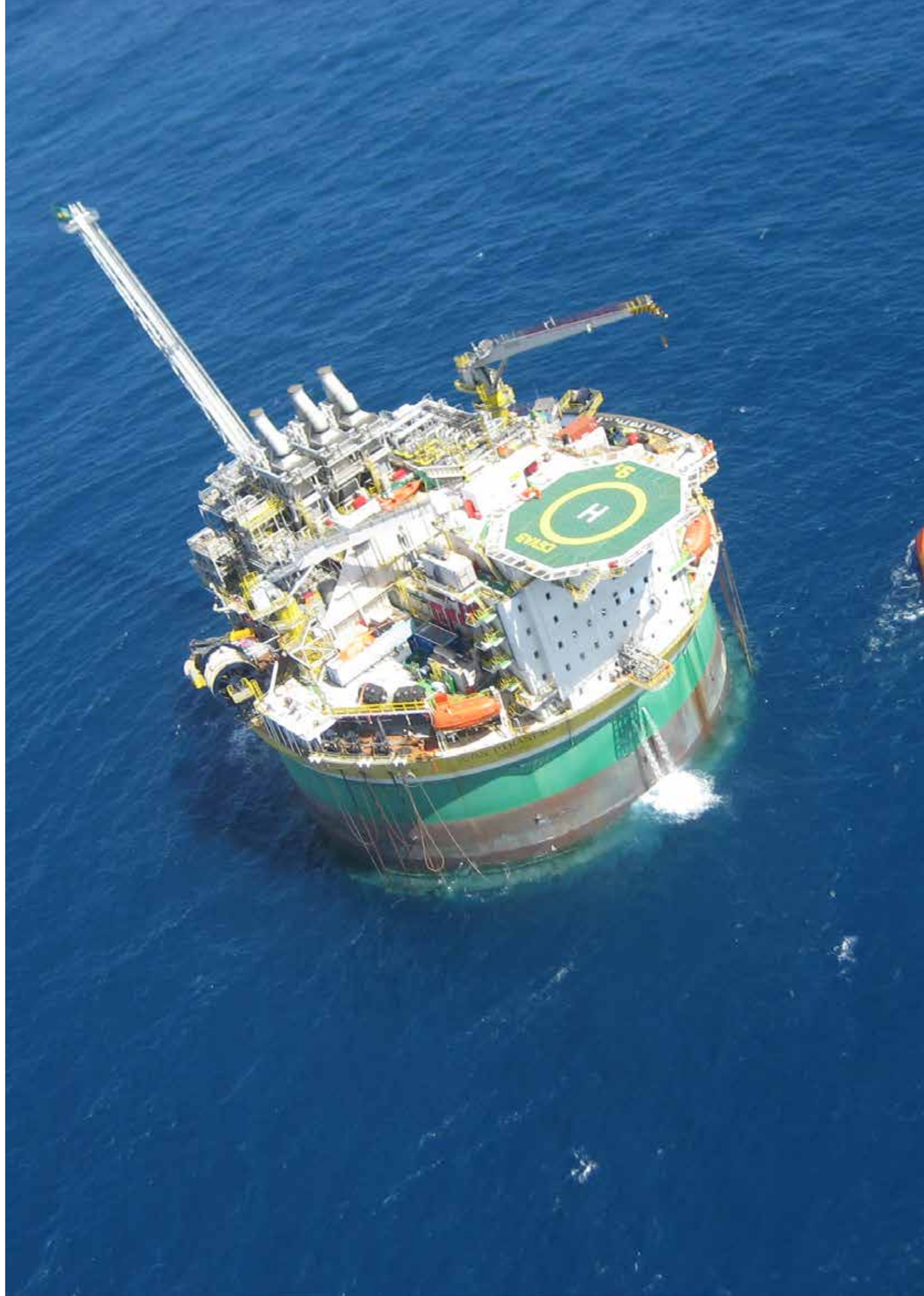


Blind Faith

Blind Faith was discovered by Chevron in 2001 . The Blind Faith development was based on a subsea system tied back into a deep draught floater.



Piranema SSP



Ekofisk

We haven't had a photo of Ekofisk for ages. Here's one!
In this, the project was already 10 years old.

LR2

I was looking for photos for #profbobstone of early Vickers Oceanic vehicles. I think this was my first or one of the very first Friday Photos. We are looking for photos of the inside.

Ravenspurn

What is this photo?
I will send another in an hour or so with the image panned out
Oh.. it was taken in about 1989

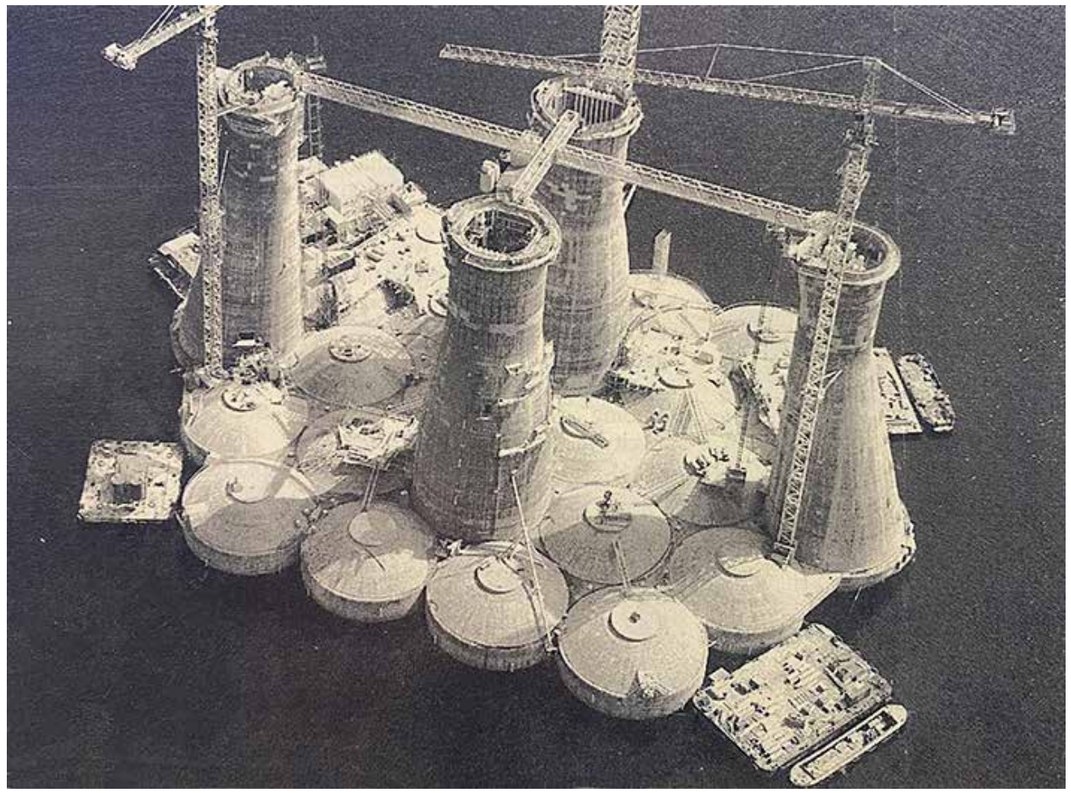
I put out what I thought was a pretty obscure image of a structure and asked anyone to identify it. Apparently it was not obscure enough- well not obscure enough for Amit Ghosh who got it immediately.Skandi Arctic

Sleipner 1991

Sleipner A's structural concrete weighed about 220 000t and there was another 240 000t of concrete ballast that filled the lower 15m of the base cells. The 24m diameter base cells were 54m high with 4 extending upwards as towers.

The sudden rise of water into the 3 drilling tower triggered the catastrophic events.

The rest is history



Scott

Was sent this by reader Andrew McBeth They are off the Skandi Artic in the North Sea Schilling UHD17 gen3 in the North Sea at the Scott platform

How cool is that?

SPIDER

The spider was an advanced one-man atmospheric vehicle produced in cooperation between Slingsby Engineering Limited (then part of the BUE group) and 2WT. It was capable operating at a depth of 610m. (2000ft). It was designed to be mobilised rapidly onto drill rigs or barges and carry out underwater tasks requiring observation and manipulative abilities, allowing the diver to dispense with breathing gases decompression chambers and large support crews.

Asgard

Friday photos: Asgard
At the time thre Asgard subsea production system was installed in 1998, it was the world's largest based on 59 subsea wells. This is the first of two pipe bundles installed by Rockwater as part of the project- 3.8 kilometres long and within a 44 inch carrier pipe.

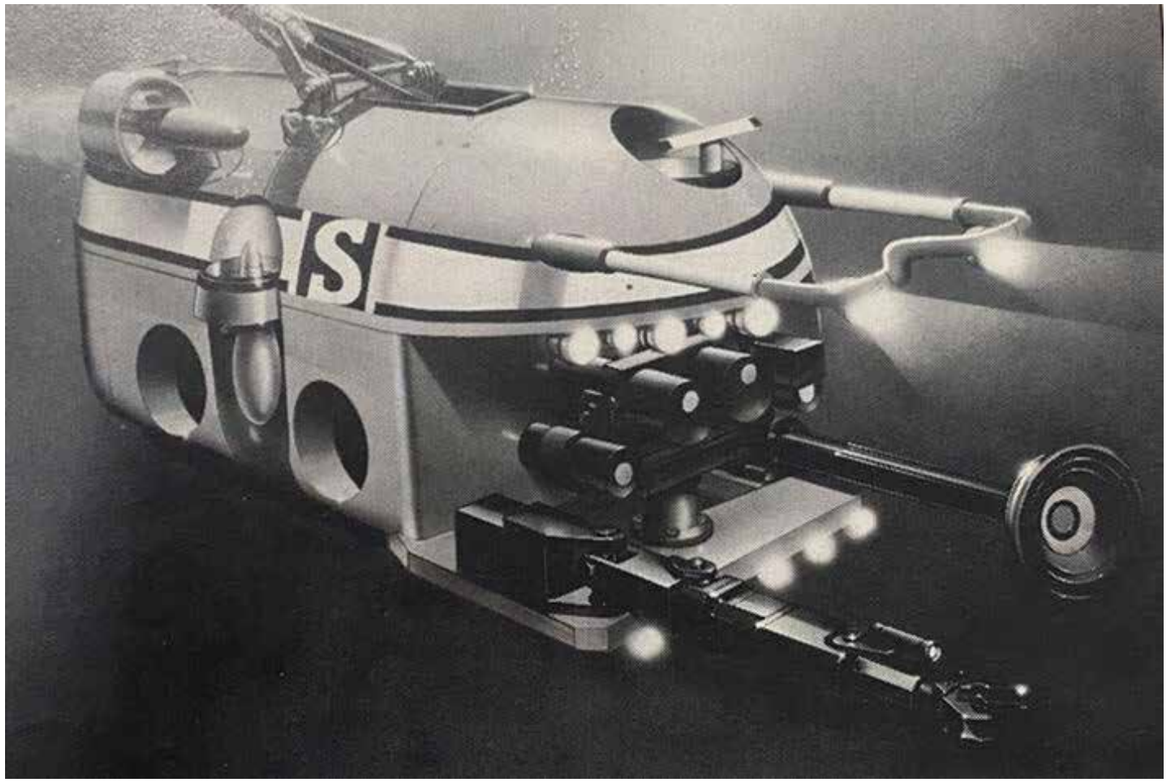
Viking 1984

Viking was built in 1974 but soon after, underwater inspection as part of new statutory requirements, discovered crack like defects in the legs. They also discovered scour as deep as 4 m in some places. Initial programmes to remedy this included fitting braces and a gravel dump as well as welded repairs in hydro boxes.

Upon closer investigation, became clear that parts of the structure were under stress and that axial loads were the greatest contribution to this crack growth. The solution was to install a pair of tripods either side of the main jacket. The photograph shows them being piled.

SOLO 1984

Slingsby Engineering



I was interviewing somebody this week, and after we had finished, he thanked me for some of these images. He used to work for Slingsby engineering. I have hunted this one out for him

Launched in 1984, Slingsby engineering's SOLO ROV was one of the first– if not the first – Remotely Operated Vehicle to have a fibre optic data link incorporated in its umbilical.

The vehicle weighed about 2t and was just over 3m long. It was positively buoyant and used its vertical thrusters to control the depth. It could move forward at 4 kt and working 1.75 kt currents. It worked by six thrusters, two vertical two forward reverse and two lateral.

Right... Ready for some old names? It came with an Osprey pan and tilt TV camera and viewing lights as well as a stills camera, an EDO scanning sonar, a Colinbrook current meter, a Grundy acoustic velocimeter, an Ulvertech pitch and roll sensors and altimeter, Digiquartz depth sensor, and an OAR transponder pinger and strobe. It also had a Robertson north-seeking gyro.

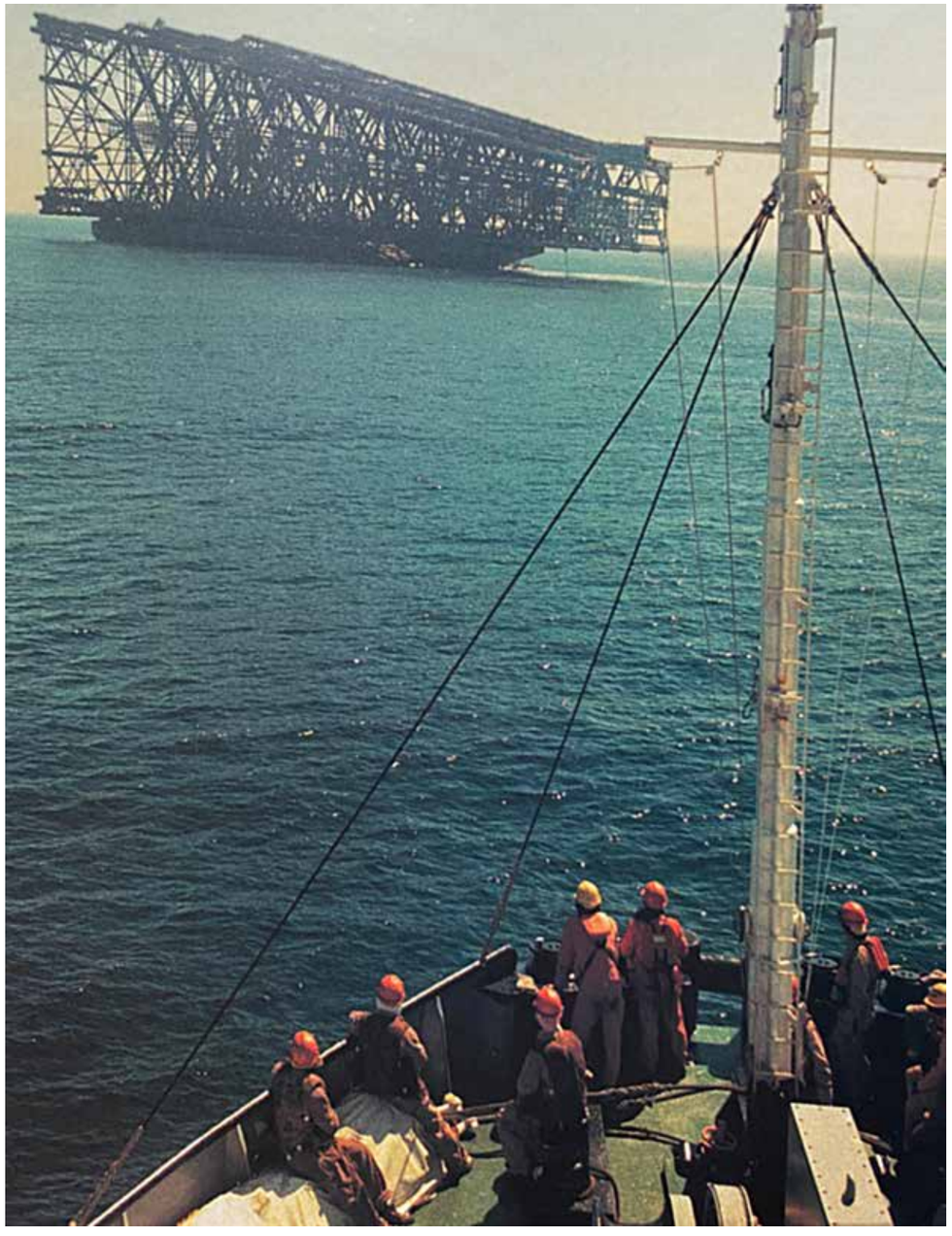
It had a seven function manipulator with three- function grabber although this early artist's impression had a suction pad. Is it just my imagination or is there a bit of a Dalek in here somewhere?

BALMORAL

Balmoral came on stream in November 1986. The Floating Production vessel was the first of its kind. It also received additional oil from Glamis and Stirling to feature one of the largest subsea production complexes in the North Sea

Harmony 1989

Exxons harmony jacket, leaving Koreak for a month-long sea tow to California. It was installed in 366m of watr because of the great tow distance and petential for sever wether, much of the design strength was dictated by the towconditions. Around 13% more steel was added



Raising a Vessel

Raising a vessel

I am afraid I know nothing about this except I thought it was a captivating photo

Mr Mac 1986

The 17 500t Transworld Gorilla class jackup launched at UIE's clydebank yard. It was then towed out under the Erskine bridge for the final installation of its 160m legs.

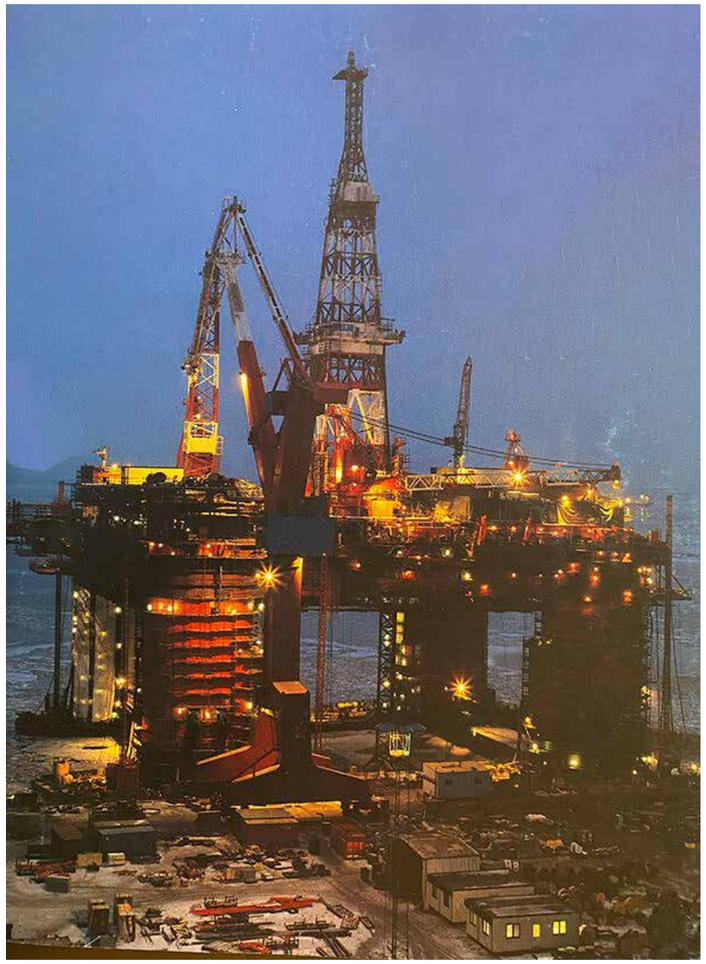
FPSO VI

Installed in 1985, this jacket/soft yoke combination was build by SBM for Ashland Oil and Gas in 135ft of Nigerian waters. It could store 1.75 million barrels of processed oil.

Murchison

Straddling the UK/Norwegian Median Line, it came on steam in 1980.

Balmoral



We had a pic of Balmoral the other day but since then, I found this one of the floating unit nearing completion of quayside outfitting at the Gothenburg construction yard

Atlantis

The hull leaving a Korean shipyard on a submersible transport vessel Check out what I think is the Odyssey in the background.

Neddrill 3

Rig 257

Friday Photos. Rig 257 in The Caspian Sea
Drilling in shallow waters has its own difficulties but adding occasional sea ice makes it even more challenging.
The Parker Rig 257 was converted from a drilling barge in Nigeria to an ice-resistant grounded barge

Snorre 1992
The Snorre TLP near Stavanger ready to be towed onsite.

Castoro Otto

. This was taken in 1998 although it was built in 1976. The pipelayer had a
carrying capacity is 10450 dwt and could work in 7m deep waters.

Garden Banks 142

When I wrote this, the WP auto corrected it to Gordon Banks.

In 2003 ATP oil and gas had Vermillion, its shallow Gulf of Mexico field nearing the end of its life and two others nearby that we're ready to be brought on stream. Vermilion was producing from a three-leg platform in 365 feet of water. The new fields in Garden Banks 142 and Ship Shoal 358 were in 542 and 419 feet of water respectively.
ATP decided to place a prefabricated subsea plinth on Garden Banks, to allow the original Vermillion platform to be cut, transported 50 miles, and be positioned on its top to make the correct height.

Lancelot and Guinevere

Friday photos: Mobil's Lancelot and Guinevere Platforms
Being transported to site.
That's about it