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Offshore Technology Outlook

page 20

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Offshore Technology Outlook

3D printing. Photo from iStock.

Features

ON THE COVER

A leap forward. This month's cover illustrates some of the technology (robotics, 3D printing, automation) soon to be embraced by the offshore industry. See page 20 for more. *Main image from iStock. Inset images: Total, iStock, and RDS.*

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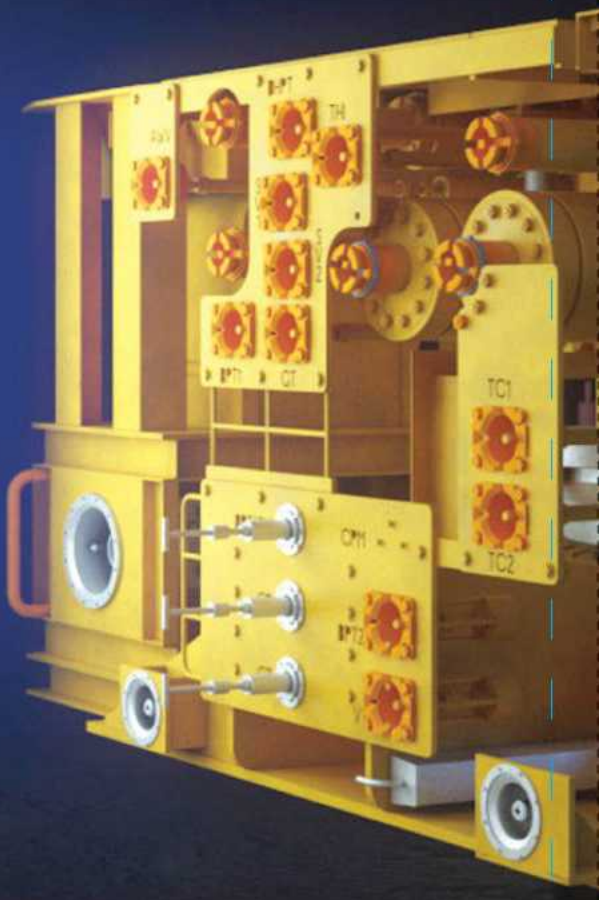

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What's Trending

Raising stakes

- *Pioneering Spirit* completes record offshore lift
- US will evaluate Atlantic G&G
- BP, Kosmos in major Senegal find

People

Miller chosen as Halliburton CEO

Houston-based oilfield services provider Halliburton has selected its current president, Jeff Miller, to succeed CEO Dave Lesar, effective 1 June 2017. Miller will serve as both president and CEO.

People

Angelle named BSEE director

Former Louisiana Secretary of the Department of Natural Resources Scott A. Angelle was picked to lead the US Bureau of Safety and Environmental Enforcement (BSEE) last month (May).

Undercurrents

A whole new (digital) world

A new lexicon is entering the upstream oil and gas business, one word at a time.

While the words themselves might raise a few eyebrows (and take a while to unpack) – digitization, digitalization, edge analytics, servitization – the potential they are offer is being embraced by many.

Supermajor BP has talked about "digitalizing" its business by 2020 (*OE*: May 2017). Late May, Norway's Statoil set out its road map to a digital business by 2020 (the same year Statoil was aiming to have its Subsea Factory running).

What is really exciting is the pace of change, or the potential for it. As younger people enter the industry – digital natives – the rate of change will increase.

Statoil says that it will invest US$120-240 million in its digital road map, in areas such as improving efficiency in operations and using advanced data analytics for better decision making, as well as robotics and remote control. It's already making in-roads into the latter, with one of Robotic Drilling Systems' drill floor robots being deployed on Odfjell's *Deepsea Atlantic* (currently working on the massive Johan Sverdrup field) (*OE*: November 2016), as well as other innovations.

Part of the reason why it is taking so long to automate drilling is not because the automation piece is so difficult: it's making the different systems communicate together. Part of Statoil's plan is a digital center of excellence, to bring all its work in this space together, to create something greater than just the sum of its parts.

For this month's issue, *OE* went out to the industry to ask what are the areas of technology to watch in coming years. Common themes raised were the digital world, data analytics, machine learning, edge analytics (being able to process on the spot), and augmented reality.

Even the use of block chain, a distributed timestamped database secured from tampering, infamous for its distribution of Bitcoin, was suggested. Read more in this months' Global Offshore Technology Outlook on page 20.

GE Oil & Gas has been promoting the digital twin for some time, and has its Predix software used by BP. Such ideas are gaining traction, with the likes of Kongsberg joining the party with its Kognifai platform.

There are challenges, of course. This is a conservative industry used to dealing with steel, spread sheets stored on a single desktop, and even scans of PDFs that are of no use to man nor regulator (*OE*: February 2017). It's also a fairly straight-talking industry – hence the raised eyebrows when words like digitalization are used. Some of the words, such as servitization, are also unhelpful – they just attempt to dress up business models that already exist, in a bid to make them sound new or sexy. Selling a turbine for less than it's worth, but recouping the cash through a service contract doesn't need an "-ization" added to the end of it.

What is really exciting is the pace of change, or the potential for it. As younger people enter the industry – digital natives – the rate of change will increase. We already have drones ready to fly out and conduct 3D laser surveys, but composites and other materials are coming. 3D printing is introducing unique geometries and solutions, and then, there is the potential to use nanotechnology downhole. This is still a fabulously interesting industry, with or without the "-izations." OE

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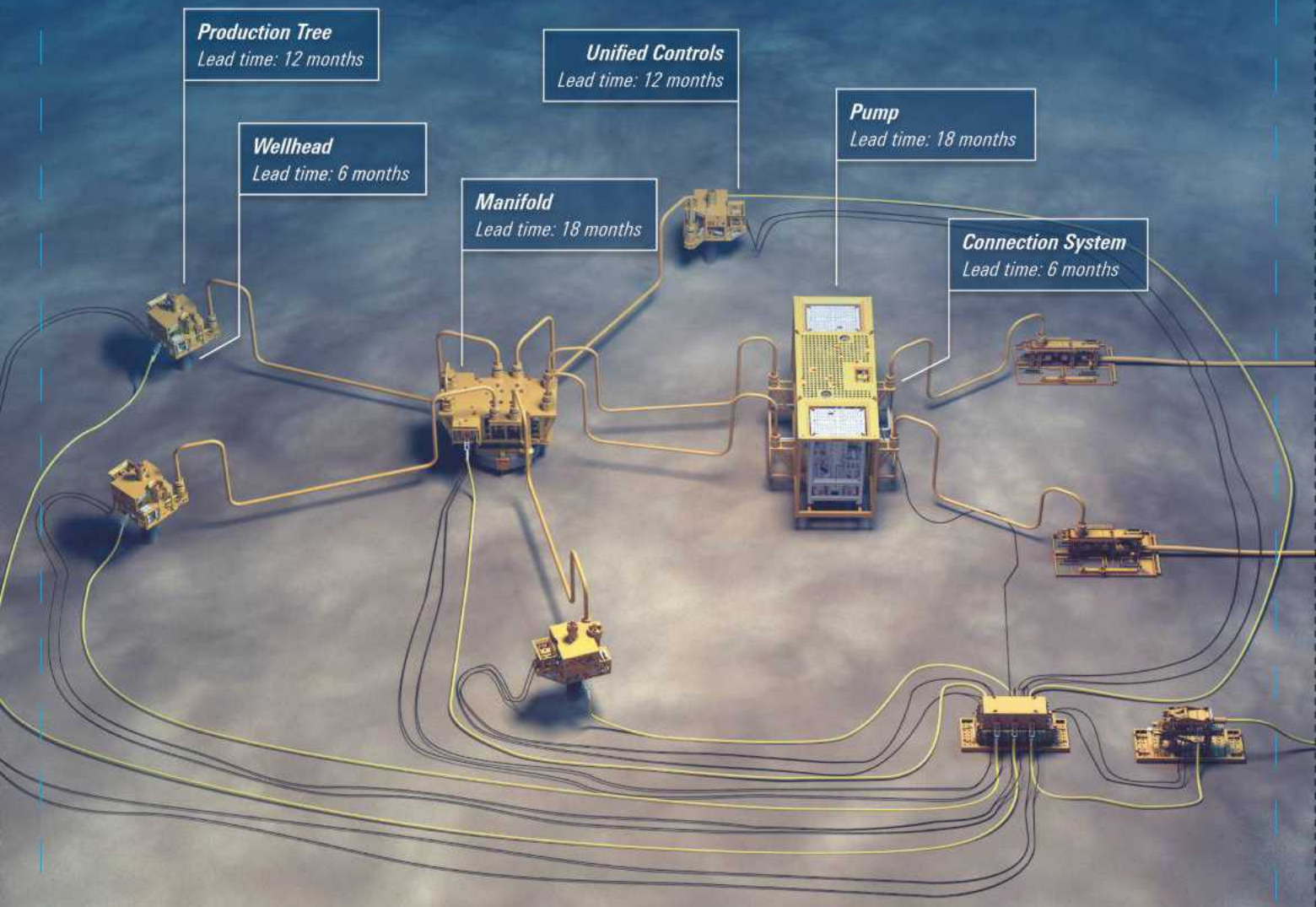

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Global E&P Briefs

A New 3D shoot off Newfoundland

TGS and PGS will conduct two new multiclient 3D seismic projects, East Flemish Pass II 3D and Harbour Deep 3D, offshore Eastern Canada.

East Flemish Pass 3D Phase II is a 1950sq km extension of a survey that was acquired in 2016 in the Eastern Newfoundland region. The survey will extend eastwards into block EL1150.

Harbour Deep 3D will comprise a minimum of 2700sq km of 3D GeoStreamer data in the Eastern Newfoundland region covering a mix of held and open acreage to be included in the November 2018 licensing round under Newfoundland Labrador's Scheduled Land Tenure system.

B Alaskan tracts open

The Alaska Department of Natural Resources, Division of Oil and Gas opened its Alaska Peninsula Areawide 2017 (APA 2017) and the Cook Inlet Areawide 2017W (CIA 2017W) oil and gas lease sales.

APA 2017 sale includes 1.75 million gross acres of offshore waters. CIA2017W encompasses about 4.2 million gross acres divided into 815 tracts ranging in size from 640-5760 acres. The deadline for bids is 19 June.

C BHP spuds Wildling-2

BHP Billiton spudded the Wildling-2 ultra-deepwater well in the Gulf of Mexico and expects results in September 2017.

At the Wildling-1 well, BHP encountered mechanical difficulty and had to plug and abandon it, leading to the spudding of Wildling-2. BHP says that Wildling is expected to establish the scale of the Caicos oil discovery.

D Gorgon hits pay

Anadarko made its third find off Colombia, the Gorgon deepwater well, hitting 260-360ft net gas pay. Partner Ecopetrol said the well showed gas presence in two different exploration targets. Anadarko's two previous discoveries in the area are Kronos-1 (2015, 1584m water depth) and Purple Angel-1 (2017), in adjacent blocks to Gorgon. Anadarko holds 100% interest in the Gran Col area (Blocks Col 1, Col 2, Col 6 and Col 7), where Gorgon was found.

E Talos spuds Mexican probe

Talos Energy spudded the Zama-1 exploration well in Block 7 in the shallow water Sureste Basin, offshore Mexico, in late May.

The well's principal target is the low risk Zama prospect with supportive direct hydrocarbon indicators in the Tertiary clastic reservoirs.

The Zama structure is estimated to have a P90-P10 gross unrisked resource range of 100-500 MMbbl. The well is expected to take up to 90 days to drill both the Zama prospect and the secondary target, Zama Deep.

The partners in Block 7 are Talos Energy (operator, 35%), Sierra Oil and Gas (40%) and Premier (25%).

F Lula Sul starts production

Petrobras started oil and gas production from the Lula Sul field, in the Santos Basin pre-salt, offshore Brazil with the *P-66* floating production and storage offloading (FPSO) unit. Lula Sul is some 290km off Rio de Janeiro state, in concession BM-S-11, at 2150m water depth. The *P-66* FPSO has the capacity to process 150,000 bo/d, compress 6 MMcm/d of gas.

G Spectrum shoots off Argentina

Spectrum began a 35,000km multiclient 2D seismic survey covering 435,000km off Argentina, in deepwater, in cooperation with YPF and Argentina's Ministry of Energy and Minerals.

Data is being acquired with a 12,000m streamer with continuous recording. The data will be processed with PSTM, PSDM and Broadband products with first deliveries in early Q4 2017.

H Quad 204 onstream

BP started production from Quad 204, a redevelopment of the 1 billion bbl+ Schiehallion and Loyal fields, west of Shetland on the UK Continental Shelf. Discovered in 1993 and 1994 respectively, both fields have already produced 400 MMbo since starting production in 1998. The redevelopment seeks to tap a further 450 MMbo and extend field life beyond 2035.

Production is expected to ramp up through 2017 to a plateau of 130,000 b/d via the newbuild *Glen Lyon* FPSO.

I Faroe spuds Brasse appraisal

Faroe Petroleum spudded the Brasse appraisal well 31/7-2S in the Norwegian North Sea in late May. The Brasse appraisal well will target a seismic

anomaly about 2km to the southeast of the main discovery well and has the potential to de-risk further reserves upsides beyond the existing uncertainty range.

J Kosmos hits off Senegal

Kosmos Energy and BP have made a major gas discovery at the Yakaar-1 well offshore Senegal. The Yakaar discovery is estimated at 15 Tcf gross Pmean gas resource, in-line with pre-drill expectations, according to Kosmos.

Yakaar, which is in the Cayar Offshore Profond block about 95km northwest of Dakar, was drilled in nearly 2550m water depth to 4700m total depth using the *Atwood Achiever*. The well intersected a 120m gross hydrocarbon column in three pools within the primary Lower Cenomanian objective and 45m of net pay.

K BP's West Nile Delta online

BP has achieved first gas from two fields – Taurus and Libra – in the West Nile Delta (WND), off Egypt.

The WND project consists of five gas fields across the North Alexandria and West Mediterranean deepwater offshore concession. Plans are to develop them as two separate projects to accelerate gas production to Egypt. When fully onstream in 2019, combined production from both projects is expected to reach up to almost 1.5 Bcf/d.

M Ophir dry at Ayamé

Ophir Energy's Ayamé-1X exploration well offshore the Ivory Coast found oil, but not in significant quantities.

The well, in block CI-513, reached 5394m true vertical depth subsea. The well targeted a number of turbidite channel complexes of Santonian and Turonian age. Full analysis and interpretation of the data is ongoing but the well will be plugged and abandoned as a dry hole.

N Eni to explore Oman

Eni signed a memorandum of understanding (MoU) with Oman Oil Co. to jointly explore opportunities in oil and gas, including an offshore block awarded to the two companies following an international bid round held last October.

Oman's Ministry of Oil and Gas awarded the two companies exploration rights to Block 52 offshore Oman. The largely unexplored block covers 90,000sq km, and has water depths ranging from 10-2000m, according to Eni.

O Red Sea seismic extension

Magseis successfully completed the initial part of Saudi Aramco's Red Sea seabed seismic survey together with

L Repsol's Shaw online

First oil flowed from Repsol Sinopec Resources UK's Shaw field, part of the firm's Montrose Area Redevelopment (MAR) in the UK Central North Sea.

Shaw was developed as a subsea tieback to a new bridge-linked production platform added to the Montrose Alpha facility. Two other fields Godwin and Cayley, are also being developed as part of the MAR project. Cayley will also be a subsea tieback, with production expected by the end of Q2. Godwin was developed via an extended reach well from the nearby Arbroath platform.

Global E&P Briefs

its partner BGP, and is now starting an extension project.

Following a short yard stay and mobilization, the crew has started acquisition on the extension of the previously announced Red Sea survey using Magseis' ocean bottom seismic technology (MASS) and BGP's transition zone expertise to cover the deep and shallow marine environment.

Total brings Badamyar online

Total has started production from the offshore Badamyar project, 220km south of Yangon, Myanmar.

The project will enable an extension of the Yadana gas field's 8 Bcm per year production plateau beyond 2020.

The Badamyar project involved installing a new wellhead platform, connected to the Yadana production facilities, and drilling four horizontal wells to develop Badamyar gas field as a satellite of Yadana.

Eni's Jangkrik online early

Eni has started gas production at its deepwater Jangkrik development project offshore Indonesia.

Jangkrik consists of two gas fields – the Jangkrik and Jangkrik North East, which are in the Muara Bakau block, in the Kutei basin – in the deepwaters of Makassar Strait.

Production from 10 deepwater subsea wells, connected to the newly built floating production unit (FPU) *Jangkrik*, will gradually reach 450 MMcf/d, equivalent to 83,000 boe/d, says Eni. The gas, once processed onboard the FPU, will flow via a dedicated 79km pipeline to the onshore receiving facility, both built by Eni, and then through the East Kalimantan Transportation System, finally reaching the Bontang gas liquefaction plant.

Bualuang sanctioned

Ophir Energy reached a final investment decision (FID) for the fourth phase of its Bualuang oil field in the Gulf of Thailand, with investment expected to be US$145 million.

The development will consist of a 12 slot bridge-linked wellhead structure with additional power generation.

The development will include the drilling of up to 14 wells and an expansion of the water disposal capacity on the Bravo platform, says Ophir. First oil is set for 2H 2018.

Australia offers 21 blocks

The Australian government's annual Offshore Petroleum Exploration Acreage Release has been announced with 21 areas on offer.

The areas are across eight sedimentary basins in Commonwealth waters offshore of Northern Australia, Western Australia, Tasmania, Victoria and the Ashmore and Cartier Islands. Twenty areas are available for work program bidding and one area for cash bidding.

The areas are in 25-4200m water depth and vary in size from 161-2465sq km and also vary in level of existing geological knowledge.

Contracts

Heerema to build Peregrino II jacket

Statoil awarded Heerema Fabrication Group a procurement and construction contract for the Peregrino II jacket, which will measure 135m tall, have a footprint of 66m x 53m, and will weigh 9300-tonne (excluding 12 piles).

Construction is due to start in November at Heerema's Vlissingen yard, the Netherlands, with sailaway in October 2019.

The jacket will support a 25,000-tonne topside with drilling and process facilities, utilities, power generation, living quarters and a helideck. It will also support the storage of fresh drill water, with caissons for submerged pumps connected to such storage tanks.

TechnipFMC, Aker to study Cara

Engie E&P Norge awarded contracts to TechnipFMC and Aker Engineering and Technology for feasibility studies of the Cara project in the Norwegian part of the North Sea.

The work will consider whether the Cara discovery could be tied into existing Gjøa infrastructure through a subsea solution.

TechnipFMC and Aker Engineering and Technology will conduct two feasibility studies, comprising two separate and parallel studies to identify various subsea solutions. The work will be completed in June 2017.

Ramboll wins Al-Shaheen pre-FEED

North Oil Co. (NOC) has picked Ramboll to carry out a pre-FEED study for three new wellhead platforms at the giant Al-Shaheen field, offshore Qatar.

Ramboll has previously carried out detailed brownfield design on Al-Shaheen, which has been operated by Maersk Oil from 1992. In July 2017, NOC, a joint venture between Qatar Petroleum and Total, will take over as operator for 25 years.

Oceaneering wins Appomattox work

Oceaneering International will support the design, fabrication and installation of ancillary flowline hardware at Shell's Appomattox development in the Gulf of Mexico.

Under the contract, Oceaneering will procure and install pre-lay and post-lay crossing mattresses, flowline jumper fabrication and installation and manifold installation.

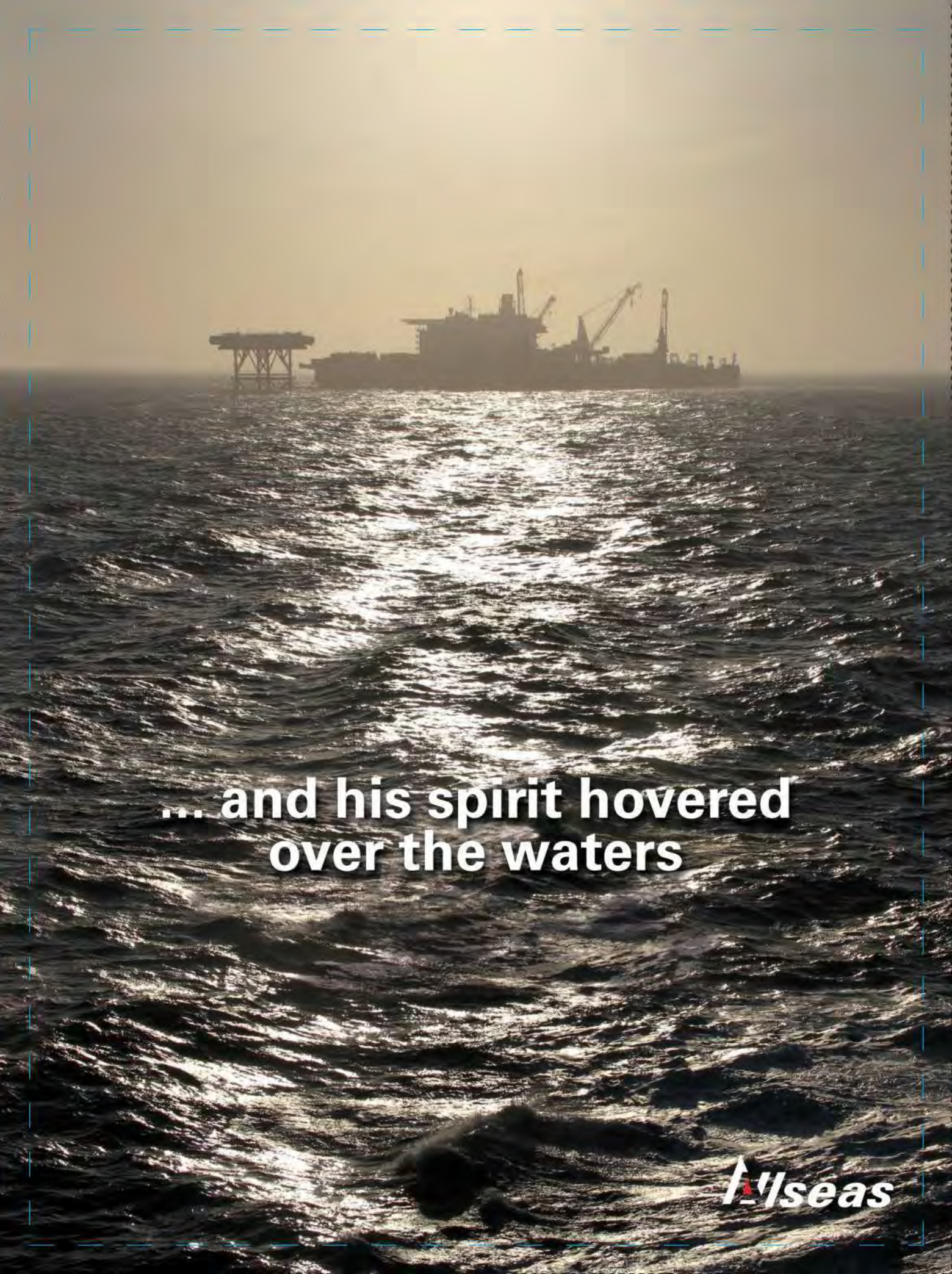
The company also will design, procure, fabricate, and install subsea buoyancy for flowline thermal expansion.

Oceaneering expects to use *Ocean Evolution* for the phases of offshore installation work. Work is scheduled to begin late this year and end sometime in 2019.

Wood Group wins Tigris, Anchor work

Wood Group has signed a 10-year master services agreement (MSA) with Chevron that allows them to deliver conceptual engineering, pre-FEED, FEED, and detailed design and procurement services across Chevron's global asset portfolio.

Contracts to provide topsides conceptual and pre-FEED for two semisubmersible platforms on the Tigris and Anchor developments in the Gulf of Mexico (GoM) have been awarded as the first work orders under this new agreement.


... and his spirit hovered
over the waters
Allseas

An artist's impression: Alta Gohta. Image from Lundin.

Northern Lights

Lundin believes the future is in the north. Elaine Maslin reports on the firm's plans for the Alta Gohta development.

Norway's far north, in the Barents Sea, isn't the easiest place to be a hydrocarbon explorer. It lacks infrastructure, is cold and very dark in winter (and the opposite in summer), has tricky reservoirs, and is subject to the same environmental regulation as in other parts of the North Sea.

The Barents Sea still has a prize to hunt, however. Half of the remaining recoverable undiscovered resources on the Norwegian Continental Shelf are estimated to be in the Barents, according to the Norwegian Petroleum Directorate. With project development experience (Edward Grieg) and Barents Sea exploration experience (Alta, Gohta, Neiden and Filicudi discoveries – all on the Loppa High) under its belt, Lundin thinks that it has what it takes to create a high north hub.

Lundin also has a trick up its sleeves. The firm is hoping to go all-electric on its Alta Gohta development, a project that can become a hub for further discoveries, such as Filicudi.

"We believe that the future in Norway is in the north," said Lundin's Tom Wideroe at the Subsea Valley Conference in Oslo in early April. "There is a challenge, the lack of infrastructure, and icing of structures. The Polar lows are hard to predict and it is dark in winter and light in summer."

Exploration activities are also highly regulated and environment-related restrictions are tough. "Although there are no special environmental restrictions in the Barents Sea, we have to have high focus on it," Wideroe says.

However, despite the cold and dark in this region, it's not as bad as it could be. Wave height and wind are generally calmer than in the North Sea, water depth is generally less than 500m, and while icing is an issue, sea ice is not in this area of the Barents Sea, although conditions worsen as you go east. "We [will] maybe have ice every 10,000 years," Wideroe says. "Johan Castberg is designed for some ice. Wisting [an oil field, discovered by OMV in 2013, in the Hoop area, further east] will have more ice. Korpfjell [further east again, close to the maritime border with Russia] has more ice than that. Temperature falls dramatically as you go northeast," Wideroe says.

Even so, operators are targeting these areas, including Statoil. The Norwegian oil firm is planning to drill on the Korpfjell prospect, a huge four-way closure covering 800sq km in the very northeast of the Barents Sea, this year. Tim Dodson, executive vice president of exploration at Statoil, told Bloomberg

earlier this year that he would be happy to prove up 500 MMbbl to 1 billion bbl in Korpfjell, while other estimates have suggested it could contain more.

On a Loppa High

Lundin made the Gohta discovery in 2013, followed by the Alta discovery in 2014. The two fields are estimated to contain 216-584 MMboe. Further exploration and appraisal drilling in the area found the Neiden (25-60 MMboe gross resource) and Filicudi (35-100 MMboe gross resource with "significant upside potential") fields. Filicudi (also the name of an island off the north coast of Sicily) is 30km northwest of Alta and Gohta, while Neiden is 20km east of Statoil's Johan Castberg field.

Lundin's initial development idea for Alta Gohta is a floating production, storage and offloading (FPSO) vessel linked to a subsea production system comprising five subsea templates, two at Gohta and three at Alta, with injection (gas lift at Alta and water injection in Gohta) and production wells with 5in or 7in vertical Xmas trees. A pipe-in-pipe production pipeline could be used, not due to temperature considerations, but for stiffness because the seabed is complex, with craters from leaking methane and cracks from icebergs, Wideroe says.

While flow assurance, per se, isn't a challenge, siting of the FPSO will be a consideration, due to having shallow seafloor in certain areas, which could cause issues around slugging. Winterization of the topsides will also be a significant factor in the design, Wideroe says.

DCFO

All-electric systems for subsea equipment have the potential to reduce costs, increase flexibility and lower the environmental footprint, Wideroe says.

Wideroe adds that DCFO (DC electricity and fiber optic) communications is an interesting alternative for subsea power and communication. This would see Lundin follow Statoil's lead. The Norwegian major is pursuing a DCFO scheme on its Johan Castberg FPSO development (*OE*: August 2016). "We think the time has come for the all-electric system," Wideroe says.

"DC takes the communication [cables] out of the umbilical and uses standard telecommunications cable. Everything will be standardized, cable and connectors can be bought more easily. Combine that with all-electric and you can take most of the umbilical out. This is really interesting and flexible and you have more reserves, in terms of available current [power]." Pursing this approach would be, "good learning for us and the rest of the industry," Wideroe says.

Whether the FPSO would be powered from shore is yet to been seen, and different power solutions will be studied in accordance with guidelines from the authorities, Wideroe says.

> **"We believe that the future in Norway is in the north."**
>
> **Tom Wideroe, Lundin**

Other options are being considered for the surface production system, which would be smaller than the Johan Castberg FPSO. Options include a cylindrical FPSO, a semisubmersible unit or even a concrete floater. "It could be interesting to build in concrete again," Wideroe notes. Another option could be subsea storage, "which we think will be available," he says. A tension leg platform could also be used if dry wellheads are needed. Finally, a spar buoy could be used, but the water depth might be too low, he says.

Karstified carbonates

One of the challenges on Alta Gohta is the subsurface. The Alta and Gohta reservoirs are in Karstified carbonate rock, which contain vugs (a cavity in rock lined with mineral crystals) and caverns created by fresh water dissolution. While this can improve permeability, it can be a challenge to drill through it. Alta and Gohta will be the first reservoirs of this type to be commercialized offshore Norway.

"We are doing a lot to minimize the risk of drilling," Wideroe says. "We have implemented measures in the short-term to handle the appraisal drilling. We are also looking at what to do long-term. To put this in perspective, more than 50% of the world's reserves are in this type of reservoir. But, this is the first offshore the Norwegian Continental Shelf."

A version of managed pressure drilling (MPD) called pressurized mud cap drilling (PMCD) could be one technique that could help drill these reservoirs.

Until recently, PMCD has not been a recognized drilling technique in Norway.

There are also uncertainties concerning what is in the reservoir, which also means uncertainty around how many wells are needed. This is why Lundin intends to build in flexibility. "We have an idea but... the drilling department is working on this. We might end up needing a solution with dry wellheads," Wideroe says.

Seeing subsurface

New seismic will be shot over 1748sq km of the area this year. It will be the first time a new method called TopSeis will be used. Lundin's geophysicists developed TopSeis with French geoscience firm CGG to better visualize the subsurface – not least the difficult to see Karstified formations in which Alta and Gohta sit. It means towing the receivers underwater, in a banana-shape with one vessel and a buoy, while a separate source vessel sails directly over them carrying the air guns.

Lundin also plans to conduct an extended well test, next summer [2018], to further reduce uncertainty. "We will have a horizontal section produce for a couple of months," Wideroe says. "[Possibly] one on Alta and one on Gohta, for two months each. We need to do this before we can move on." Lundin is also drilling two appraisal wells in the summer, one in the north of Alta, and one in Gohta.

Announcing the Filicudi discovery in February this year, Lundin said the find had 25% reduced the risk on two high-graded prospects within PL533: Hufsa, containing 286 MMboe gross unrisked prospective resource; and Hurri, with 218 gross unrisked prospective resource. No doubt there will be more to come from Lundin in the high north. **OE**

In-Depth

The new business of deepwater

Deepwater is ready for a comeback. Operators at this year's Offshore Technology Conference sang the praises of a new below US$50/bbl world. Audrey Leon reports.

If one had to choose an official anthem to encapsulate this year's Offshore Technology Conference (OTC), it would have to be the Journey classic, "Don't Stop Believin."

Operators were on hand to sing the gospel of a new competitive deepwater business at US$40/bbl. BP even held a panel discussion to show how it lowered the costs associated with its Mad Dog 2 development in order to achieve a final investment decision (FID).

"The economics for deepwater investments make as much sense today as they did back in 2001 when BP sanctioned Thunder Horse," said Richard Morrison, Gulf of Mexico regional president, BP.

Making changes

Morrison discussed how BP set out to fundamentally change to the business to make money during these "lower for longer" times.

"We refocused and paused our exploration drilling program," he said. "We terminated a long-term rig contract, allowed two others expire, and warm-stacked another. We reset our approach to logistics. We nearly halved our fleet of vessels and helicopters, and nearly halved our Gulf of Mexico workforce since 2014, primarily onshore.

"We worked closely with our third-party suppliers to capture deflation in the market and other efficiencies," he added. "We continued investment to boost our operating efficiencies of our production wells and our facilities. We tripled investment in well work to generate cash in the short-term. We listened to our teams and contractors and reduced the BP requirements when we were bidding for new equipment and services."

Morrison said BP is more profitable now than the old days of high oil prices.

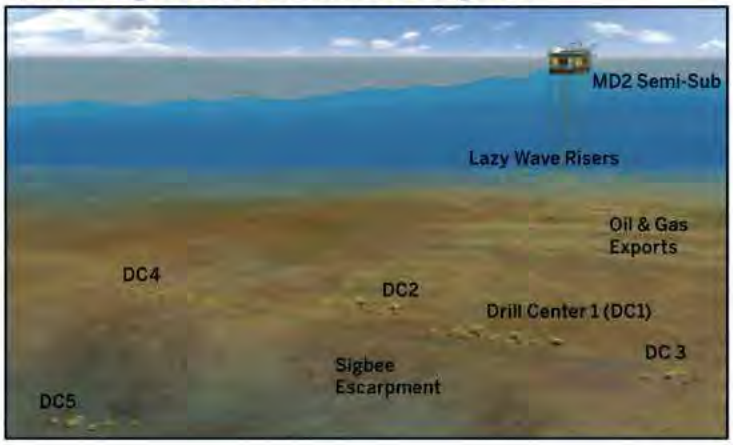
"Today, our cash margins in the Gulf of Mexico are better than they were when the price of oil was $80/bbl," he said. "Because costs have come down and continue to decrease. Execution and operational efficiencies have improved substantially."

New breakthroughs

Just days before OTC began, BP announced a breakthrough in seismic imaging that could help identify more than 200 MMbbl of additional resources at BP's Atlantis field in the deepwater Gulf of Mexico, and aid drilling accuracy, not just in the Gulf of Mexico, but in other regions as well.

The technology can enhance the clarity of images collected during seismic surveys.

Mad Dog Phase 2 Subsea Layout



Above left: BP's Mad Dog platform in the Gulf of Mexico on June 12, 2013. Photo from BP's Flickr.

Left: Mad Dog Phase 2 subsea layout. Photo from BP.

particularly areas below complex salt structures, which were previously obscured or distorted.

Morrison told the OTC crowd that there's much more to be done. "A much-needed step change is already underway related to the cost of exploring for new resources," he said. "Through a combination of fit-for-purpose design, execution efficiency, and some of the reduced rig rates we have seen recently, we're are seeing some really good things.

BP's Richard Morrison speaks at OTC 2017. Photo from BP.

"For example, the average cost to drill an exploration well in the Gulf of Mexico rose to $200 million this decade. We have now seen multiple wells drilled in this industry under $100 million and as low as $50 million.

"This is transformational for the exploration and production business."

Mad Dog Phase 2

Mad Dog Phase 2 has been a very long journey for supermajor BP, but the development has potential to be a tremendous success story. The project, which reached FID in December 2016, is now slated to cost $9 billion – but, at one point was expected to cost approximately $20 billion.

"From an exploration standpoint, we went through 15 very emotional years opening a new play; opening a new play is never easy," said Cindy Yeilding, senior vice president, BP America. "It requires perseverance, creativity, but also good science married to very good business insights. The technology is also critical."

BP's Cindy Yeilding holding up a chunk of salt while discussing the supermajor's new approach to seismic imaging.
Photo: OTC/Rodney White.

Discovered in 1998, the Mad Dog field, which has Miocene sandstone reservoirs, is considered one of BP's largest discoveries in the deepwater Gulf of Mexico. In production since 2005, the current Mad Dog truss spar facility – moored in Green Canyon 782, 100mi south of Grand Isle, Louisiana, in 4500ft of water – can produce 80,000 bo/d and 60 MMcf/d of gas. BP operates Mad Dog along with partners BHP Billiton and Chevron.

According to BP's fact sheet on the field, Mad Dog is thought to contain approximately 4 billion boe. But, Doris Reiter, vice president, performance management, BP, told the OTC crowd that better imaging has shown that there could be nearly

In-Depth

Quick stats

OE's at-a-glance guide to offshore hydrocarbon reserves and key offshore infrastructure globally is updated monthly using data from leading energy analysts Infield Systems (www.infield.com).

New discoveries announced

Depth range	2014	2015	2016	2017
Shallow (<500m)	76	57	31	8
Deep (500-1500m)	31	19	12	1
Ultradeep (>1500m)	13	11	7	3
Total	120	87	50	12
January 2017 date comparison	127	114	72	12
	-7	-27	-22	

Note: Operators do not announce discovery dates at the time of discovery, so totals for previous years continue to change.

Reserves in the Golden Triangle

by water depth 2017-21

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
Brazil			
Shallow	14	350	2649
Deep	12	829	2495
Ultradeep	35	10,783	12,756
United States			
Shallow	3	27	71
Deep	20	750	1237
Ultradeep	17	2558	2195
West Africa			
Shallow	118	3749	16,224
Deep	25	2165	3600
Ultradeep	13	1761	2518
Total	243	22,622	41,096
(last month)	(246)	(22,892)	(41,256)

Greenfield reserves

2017-21

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
Shallow	902	35,441	344,813
(last month)	(904)	35,400)	(340,024)
Deep	130	5390	96,952
(last month)	(131)	(5755)	(97,156)
Ultradeep	76	16,307	47,132
(last month)	(75)	(16,172)	(47,117)
Total	1108	57,138.00	488,897.00

Pipelines

(operational and 2017 onwards)

	(km)	(last month)
<8in.		
Operational/ installed	41,514	(41,724)
Planned/ possible	22,290	(22,283)
	63,803	(64,007)
8-16in.		
Operational/ installed	82,335	(82,620)
Planned/ possible	47,116	(46,776)
	129,451	(129,396)
>16in.		
Operational/ installed	95,142	(95,171)
Planned/ possible	46,765	(44,677)
	141,907	(139,848)

Production systems worldwide

(operational and 2017 onwards)

Floaters		(last month)
Operational	307	(307)
Construction/ Conversion	46	(43)
Planned/possible	289	(292)
	642	(642)
Fixed platforms		
Operational	9039	(9087)
Construction/ Conversion	83	(79)
Planned/possible	1296	(1299)
	10,418	(10,465)
Subsea wells		
Operational	5090	(5089)
Develop	337	(321)
Planned/possible	6356	(6361)
	11,783	(11,771)

Global offshore reserves (mmboe) onstream by water depth

	2015	2016	2017	2018	2019	2020	2021
Shallow	21,263.41	32,083.32	32,393.42	11,182.31	12,065.06	16,124.58	24,438.45
(last month)	(21,263.21)	(32,083.32)	(32,422.22)	(11,512.61)	(12,078.41)	(16,683.86)	(22,621.04)
Deep	958.84	1411.48	4324.15	2965.09	2504.24	4908.87	7778.66
(last month)	(972.89)	(1411.48)	(4324.15)	(3082.72)	(2480.71)	(5088.23)	(7906.17)
Ultradeep	2015.69	3075.34	1633.94	4082.03	3851.47	9609.94	5439.84
(last month)	(2015.69)	(3075.34)	(1633.94)	(3962.03)	(3833.83)	(9609.94)	(5439.84)
Total	24,237.94	36,570.14	38,351.51	18,229.43	18,420.77	30,643.39	37,656.95

Source: InfieldRigs 5 May 2017

Rig stats

Worldwide

Rig Type	Total Rigs	Contracted	Available	Utilization
Drillship	86	59	27	68%
Jackup	402	224	178	55%
Semisub	110	62	48	56%
Tenders	27	15	12	55%
Total	625	360	265	57%

North America

Rig Type	Total Rigs	Contracted	Available	Utilization
Drillship	28	20	8	71%
Jackup	25	6	19	24%
Semisub	9	6	3	66%
Tenders	N/A	N/A	N/A	N/A
Total	62	32	30	51%

Asia Pacific

Rig Type	Total Rigs	Contracted	Available	Utilization
Drillship	10	3	7	30%
Jackup	117	69	48	58%
Semisub	30	12	18	40%
Tenders	20	12	8	60%
Total	177	96	81	54%

Latin America

Rig Type	Total Rigs	Contracted	Available	Utilization
Drillship	22	17	5	77%
Jackup	51	24	27	47%
Semisub	23	18	5	78%
Tenders	2	1	1	50%
Total	98	60	38	61%

Northwest European Continental Shelf

Rig Type	Total Rigs	Contracted	Available	Utilization
Drillship	N/A	N/A	N/A	N/A
Jackup	50	30	20	60%
Semisub	37	20	17	54%
Tenders	N/A	N/A	N/A	N/A
Total	87	50	37	57%

Middle East & Caspian Sea

Rig Type	Total Rigs	Contracted	Available	Utilization
Drillship	1	1	0	100%
Jackup	118	81	37	68%
Semisub	3	3	0	100%
Tenders	N/A	N/A	N/A	N/A
Total	122	85	37	69%

Sub-Saharan Africa

Rig Type	Total Rigs	Contracted	Available	Utilization
Drillship	19	15	4	78%
Jackup	18	7	11	38%
Semisub	3	1	2	33%
Tenders	5	2	3	40%
Total	45	25	20	55%

Eastern Europe

Rig Type	Total Rigs	Contracted	Available	Utilization
Drillship	2	0	2	0%
Jackup	N/A	N/A	N/A	N/A
Semisub	N/A	N/A	N/A	N/A
Tenders	2	0	2	0%
Total	2	0	2	0%

Source: InfieldRigs 8 May 2017

This data focuses on the marketed rig fleet and excludes assets that are under construction, retired, destroyed, deemed non-competitive or cold stacked.

5 billion boe at the field, giving BP plenty of reason to stay committed to bringing phase 2 into development.

Salty dog

Technology has been a huge part of unlocking the Gulf of Mexico's vast deepwater resources. Yeilding said that in the 1980s when big discoveries like Mars and Ursa were found, the industry rushed into the area and drilled seven dry holes in a row.

"The industry went after this play and we got it dead wrong," she told OTC. "It caused a lot of contemplation and humility, but it also caused people to call it the 'Dead Sea.' But, BP gave us a second shot instead of firing us."

Yeilding says BP went back to the basics of good science and looked for the structural highs. "Petroleum high grades up into anticlines. Our big shift was to look for structures," she said, adding: "There are many layers of salt canopy, and it really complicates the imagery. We had to come to grips with that.

"We are no longer running from the salt, we are running to it," she told the crowd, later holding up a large block of salt for the crowd to demonstrate how hard it is to see through. "We had to drill the original Mad Dog structure on a lot of faith." She further added that good geological principles, despite the poor imaging, indicated the potential in the area. Yeilding said from that 1998 Mad Dog discovery, the Atlantis and Thunder Horse discoveries soon followed in 1998 and 1998, respectively.

Yeilding discussed early existing seismic imaging and how the industry and BP needed to work with what they had to ensure that appraisal wells were positioned in the right spot. But, improvements still needed to be made.

"We knew we were in this for the long haul with the number of sub-salt discoveries made. We worked with our technology team and with the geophysical industry to develop a new acquisition type called wide-azimuth towed-streamer (WATS), which we field trialed in 2005-2006 at Mad Dog. This lead to the beginning of significant imaging breakthroughs."

Reiter detailed other challenges that Mad Dog endured along the way, such as production being interrupted by Hurricane Ike in 2008, which blew the rig off the platform – this put the drilling program on hold from 2008-2013, added Aleida Rios, vice president, Gulf of Mexico Production Operations, BP. In 2011, the Mad Dog facility was shut-in for rig replacement, prep, and deck repairs, Rios said. It was a 16-month outage and the challenging part was the lift needed to replace the rig, but Rios added that the facility resumed production in 2012, and the rig restarted in 2013.

Reiter noted that the WATS gave the BP team a lot of insight that enabled the formation of its appraisal drilling plan on the southwest and west side of the field. She called Mad Dog "Big Dog" – a monster that was meant to have 33 wells. The current view, she said, is 32, not 33 wells.

"The $20 billion [price tag] clearly wasn't the answer," Reiter said. "The team had to go back to the drawing board. We took some time out to refocus. The demand became 90% of the resource estimate for 60% of the cost. And I can tell you we did a lot better than that."

Reiter said that taking that pause in 2013 allowed BP to

Concept image of the Mad Dog 2 platform. Photo from BP.

leverage new technologies. And the plan is to leverage LoSal technology on Mad Dog, she said.

Reiter said seismic will continue to play a big role in Mad Dog's total development, noting that BP will acquire an ocean bottom node survey later this year. "Who knows, we might find another little field like Atlantis," Reiter concluded.

Independents still believe

"Shale cannot meet global demand," said Roger Jenkins, CEO, Murphy Oil, at an OTC panel entitled, "Deepwater still works!" He continued: "Shale cannot compete. Now is the time for deepwater to comeback."

Jenkins shared that his company Murphy Oil plans to ramp up its global exploration. "Now is a good time to do that because there's less competition, lower costs, better terms," he said.

For some independents, offshore is integral to cash flow for other parts of the business. "The offshore business primarily provides cash for onshore to grow," Jenkins said. Anadarko announced a similar strategy back when the Houston-based firm purchased the offshore assets of Freeport-McMoRan for $2 billion last year, which at the time, CEO Al Walker said would allow the company not only to grow in the Gulf of Mexico, but to add rigs to its onshore shale acreage.

Jenkins added that Murphy Oil has a competitive advantage by being in offshore with half of its production coming from there. However, both Jenkins and BP's Morrison noted (during his own session) that there have been notable companies that have left deepwater, such as ConocoPhillips, Marathon, and the aforementioned Freeport-McMoRan – which had come into the Gulf of Mexico with much gusto after a combined $9 billion purchase of Plains Exploration and Production and McMoRan exploration in 2012. But, the times (and priorities) have changed for some. Others, like BP and Murphy, have dug their collective heels deeper into deepwater and offshore.

For example, Jenkins said Murphy Oil was excited to explore Mexico's frontier deepwater Gulf of Mexico..

In December, Murphy Oil won Block 5 (operator, 30%), in Mexico's deepwater Salina basin, in consortium with Ophir (23.33%), PC Carigali (a subsidiary of Malaysia's Petronas - 23.34%), and Sierra Offshore Exploration (23.33%).

The block covers 2573sq km in 848m water depth, with an estimated 467 MMboe. Jenkins called the basin in which the block is located "prolific." **OE**

Pemex ponders partnerships

By Melissa Sustaita

Pemex CEO José Antonio González Anaya speaks at OTC about the next five years following Mexico's historic energy reform.
Photo: OTC/Todd Buchanan

Mexico's state-owned oil company Pemex has come a long way since the energy reform was enacted, however, there's still a lot of work to do, the firm's CEO José Antonio González Anaya told an audience at the Offshore Technology Conference.

Pemex has stabilized its finances, and has targeted an average production 1.95 MMb/d for this year. González Anaya believes that Pemex can return to overall profitability by 2020.

Moving forward, González Anaya said that Pemex will take advantage of the energy reform and is planning an aggressive farm-out strategy, and creating partnerships. Pemex's first farm-out, the Trion deepwater field with new partner BHP Billiton, was announced in December 2016.

"We are trying to accelerate [farm-outs] in many, many ways," González Anaya said. "The signal that we want to send is that we are actively looking for partners in all of the areas."

"The way I see it is that my successor, if he doesn't believe in these things [partnerships, farm-outs], he better have $11 billion to develop one of these fields, because otherwise, he's not going to be able to do it," he said.

"We are investing a lot on exploration this year. Our target for repositioning reserves for this year is almost 1 MMbbl," he said. "In regards to what we feel comfortable with, the answer is simple: the more the better. The more we find, and as long as it fits within our finances, we will try to increase our reserves."

Increasing production is one of Pemex's top priorities. And, while production from Mexico's legendary Cantarell field has fallen steeply from 2.1MMb/d 12 years ago to just 200,000 b/d today, González Anaya noted that non-Cantarell production has increased 54% during that same period.

"The issue is that nature was generous with Mexico. But, it wasn't eternal. It came with one Cantarell field," he said. "We invested $50 billion pesos ($2.71 billion) in 2000; and we now have to invest $300 billion pesos ($16.2 billion) to get the oil out." ▪

The digital revolution is now

Embracing a digital vision. Image from DNV GL.

Elaine Maslin and Audrey Leon look at how digitalization stands to make a big splash in the offshore industry.

OE introduces a new feature called Offshore Technology Outlook, which seeks to check the industry's pulse on where technology is heading, and how it can help alleviate costs, streamline processes and make everything more efficient.

Often when digitalization is mentioned, you will get an eye roll and skepticism. And yet, this is an area that has already transformed the way we live, from how we communicate and consume media to how we navigate and control our home heating. The likes of Uber and Airbnb have businesses based purely on data, with market valuations of around US$50 billion and $30 billion, respectively.

As we covered last month (*OE*: May 2017), BP has set out a plan to digitalize its business by 2020 (that's under three years away). It sees the value of digitalization, but also the huge breadth in scope such a term covers. Digital includes sensors, telecommunications networks, analytics, artificial intelligence and machine learning, simulation and optimization, and robotics, which, coupled with advanced condition monitoring and computational power, enables major changes to the way we work. It could even be block chain, which has the potential to be used to overhaul the way the industry tracks inventory, orders or payments, via a single distributed ledger.

"Digital technologies have more widespread potential than any other technology area to transform energy production, supply and end use," BP says.

Just like Uber and Airbnb, the oil and gas industry already has a high volume of data. The often-quoted statistic is that a typical offshore facility has 30,000 sensors capturing millions of data points and yet fewer than 1% of it is used for decision making and only 40% of it is stored.

Justin Daarud, president, Americas, operations manager of Asset Integrity & Development Solutions, Lloyd's Register, calls it the "big data burden." When it comes to asset integrity, it can be hard to drown out the noise.

"We have owner/operators that collect a million points of data, just for inspection," Daarud says. "We go in and look at that and say, 'that's great, but we only needed 10,000 of those pieces of information.' How much time, resource and money do they spend taking all those readings? We only skim off the top of what is necessary."

Those costs add up. Graham Bennett, vice president at DNV GL – Oil & Gas, adds: "Poor utilization of existing information is often a hidden cost, accounting for up to a fifth of operational budgets, while a single unscheduled downtime can cost millions of dollars per day."

The digital twin

What has been lacking is a way to store, manage and then apply analytics to the information created in the oil field. Enter the digital twin. It's perhaps one of the major industry buzzwords of the past year, led initially by GE Oil & Gas, but with others, such as Kongsberg, now introducing platforms that enable operators to have a "digital twin" of their assets. Here, all existing and live data about a facility (or multiple facilities) is kept and can be used for simulations, modeling, analytics, in order to prevent downtime, predict maintenance requirements, and optimize operations, from drilling to decommissioning.

"This virtual image of an asset is maintained throughout the asset lifecycle and is easily accessible from multiple locations at any time," Bennett says. "It is a central part of the digital asset ecosystem and will enable a new generation of advanced predictive analytics, enabling real-time optimization. The concept integrates data from many different software products and will enhance information management and collaboration, where the experts and operators can work together, preventing costly mistakes and rework."


Justin Daarud


Graham Bennett

With 4G – and soon 5G – networks opening offshore, electrification of subsea assets, fiber optic sensing and communications, remote vehicles (subsea, platform-based and airborne), and mobile devices to access information and analytics, the potential for smart, remote working and operations opens up.

Luca Corradi, Innovation Network Director, the Oil & Gas Technology Centre, says that computational power and analytics, which are helping to provide real-time predictive maintenance is one advance, but combine that with automation, which can act upon the predictive analytics, and machine learning, "and you have a totally different industry," he says. "The convergence of big data, computational power, the cloud, telecommunications (4G and 5G), and the integration of IT and OT (operations technology), would make the big breakthrough. We are not there yet, but it's coming fast."

An area where these technologies are now coming into play is in the use of mobile devices, thanks to the arrival of 4G offshore. "A few years ago the conversation about mobility devices offshore was a non-starter because there wasn't Wi-Fi, only satellite, which was limited. Now there is a 4G network. It is a different story.

Here, the potential is for augmented reality (AR) to take operations to a new level. "I could be next to a valve, point my phone at it and get a drawing, information about the last time it was maintained, what it looked like compared to now, make an order for a replacement, see inventory levels, etc.," Corradi says. "I could be connected to a subject matter expert, who can see what I can see and we can have a discussion on the spot about it and talk through what to do about it."

Augmented and artificial reality are also helping in training – getting staff ready for a job faster. "Massive progress is being made in using AR for training, reducing cost, also mission preparation – i.e. flying drone in a virtual FPSO hull before the real thing," he says.

Robotics

Take this vision a step further, adding machine learning and artificial intelligence, and you could have a robot helping to do these tasks, Corradi says. While the offshore industry is quite far behind others in its adoption of robotics, this means there's massive potential to make a leap forward, he adds.

"Robotics could be used for inspection work, perhaps reaching into difficult or hazardous places, such as pressure vessels or separators, for example, where otherwise humans might have to go," he says. "Snake- or crab-shaped robots might be able to inspect pipe-wall thickness, or carry sensors able to detect leaks, etc."

There is already some experimental work in this area – topsides robotics. We've recently covered Total's Argos Challenge (*OE*: May 2017), and work to develop inspection robots for North Sea installations (*OE*: April 2017). Others are creating robots to take the human off the drill floor, with deployment offshore Norway this year (*OE*: November 2016).

"Short-term, we will not have robotics operating offshore," Corradi says. "Will we be there in 10 years? Possibly. Having a robot that can tap in to the cloud, use artificial intelligence, real-time, super-fast computation, and you potentially have something super-flexible and reactive that can interpret what's going on and react to it."

Living on the edge

Dealing with the shear amount of data available and getting it to where it can be used quickly, is still a challenge. This is where edge analytics comes into play. This concept decentralizes analytics.

"Today, we tend to think and build from the bottom-up, object-orientated software programs and Internet of Things ideas lead to a focus on individual data points and equipment," says Liane Smith, vice president, Digital Solutions, Wood Group. "Data is gathered into centralized databases, whether on a grand scale in a central repository or distributed in different systems interfaced together. The prevailing concept is to pull data from objects to a data repository, which may create the bottleneck for maximizing value for

A digital twin. Image from DNV GL.

the offshore industry of the future."

Future data architecture could be very different. "Data generated by sensors in the future could have properties of being self-curating and self-evaluating," Smith says. "Presently, we judge the significance of a data point or trend in hindsight, algorithms can clean up data as it goes into a historian, removing error signals and failed calibration of sensors, but we still have to collect the readings before reaching these conclusions. Data of the future will be aware if it is trusted and significant, so that we get what is needed and cut out all the noise. It could then be used at source for immediate action, and objects could transfer data and commands to other objects directly without the step of needing the centralized database."

The dawn of edge analytics within the energy industry will combine engineering design and operational expertise into sensor systems thus allowing complex data analytics to be performed within the sensor array.

"Changing the mindset from thinking about objects and data parameters and one dimensional problems to complex interaction of all the components in a complete offshore installation will force further innovation in the whole concept of 'data,'" Smith says.

Liane Smith

Weatherford shared its thoughts on edge technologies in *OE*'s March 2017 issue, discussing the firm's edge device WellPilot ONE, a life of well controller used for artificial lift.

"There are refrigerators now that can tell you when you need to buy milk. The fridge in this case has edge technology built into it," said Steven Seale, global director – automation hardware, Weatherford Artificial Lift Systems, at the time. "Information from the fridge can flow up into the cloud and an online retailer can enable you to make a decision to buy the milk and have it delivered.

"There are some control algorithms that [Weatherford] has developed for the controller, and we are better able to manage the injection gas, and the performance curve of the well," Seale told *OE*. "Therefore, we don't inject too much gas into the well. We inject just enough to get to get the oil lift as you need it."

Drilling automation

Going digital, or automating, sounds easy enough, but it is a painful process, as illustrated by the long road towards a goal for automated drilling operations. This slow process hasn't put Statoil off. It has been putting all the pieces of the puzzle together, through targeted investment, including putting robotic units offshore.

"We're investing in companies that will bring automation to the business," says Erik Jakubowski, Investment Analyst at Statoil Technology Invest. "Statoil has an ambition of automating drilling operations. Our contribution is investing in companies that provide a small or large piece of automation to the drill floor."

Statoil Technology Invest is investing in companies including Sekal, which provides trend analysis and drilling process automation; Raptor Oil, which is developing a signal processing system using acoustic signals to enable faster transfer speeds from the well bore; and Intelligent Mud Solutions, which intends to automate measurement of drilling and wellbore fluids. Robotic Drilling Systems (*OE*: November 2016) is this year deploying drill floor robots on to the *Deepsea Atlantic*, which is drilling on the Johan Sverdrup field.

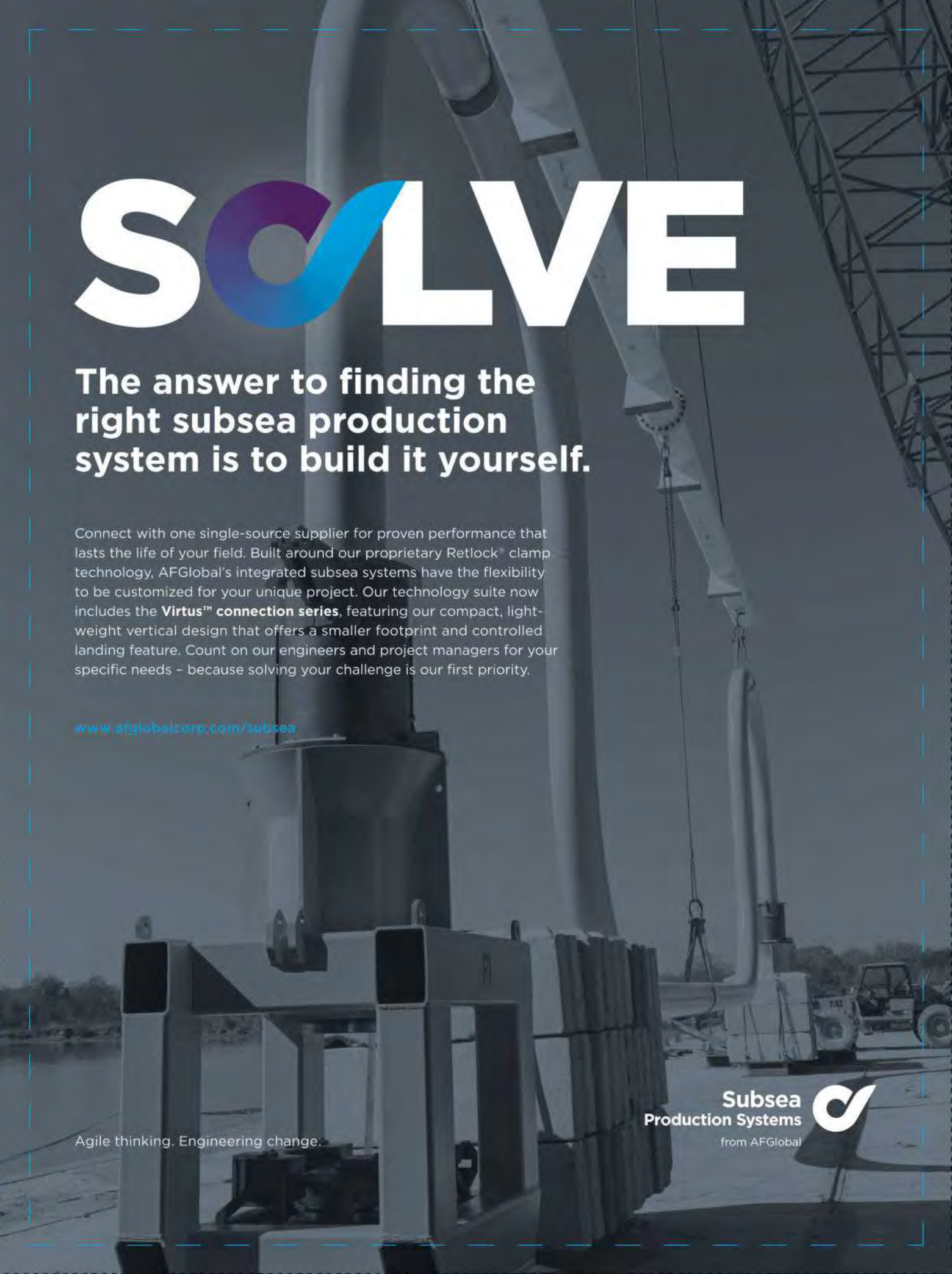
"The overall aim is drilling operation that's more efficient, predictable, safer and cheaper," Jakubowski says. But, full automation isn't likely until after 2020, he says. While the pieces are there, the biggest big is having integration between all the pieces.

Digital by design

Leveraging IT can also improve design and construction, says Alistair Hope, Shell's project director for the Brent decommissioning project. This involves building a catalog of standard design modules, platforms, etc., that can be more quickly packaged together, making concept engineering faster, and enabling more focus on interfaces.

"Instead of repeating design, we can leverage the cloud and modern IT to improve the way we do engineering," Hope says. "I'm really excited about it."

Shell has already been using this process in its unconventional shale gas facilities. "It reduces cycle times, modules plug together quite quickly. It reduces cost, increases consistency, and is better for safety and design as well. That's



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a potential game changer, particularly if this is across the industry, instead of one operator. For subsea, that's the way things are going, a standardized subsea catalog with an IT package that can put it together."

This also feeds into the construction process. Compared to other industries, oil and gas industry construction productivity has fallen. Using IT for track and trace systems, for hire equipment, for example, or using bar code technology to automatically update construction and design models, "so you know exactly where you are in design and construction, which helps construction optimization," Hope says. "You can foresee problems and clashes more easily and optimize as you go."

Taking this a step further, during commissioning, how tight a bolt has been torqued (as an example) can automatically be fed into a cloud-based system, from the tool itself, instead of a spread sheet that might never see the light of day. "It would have had to be checked before you start production. Now, you can put a sensor in the torque wrench, which records data into the cloud and populates the system automatically. It is more consistent and takes less time."

Duncan Baillie

Scott Lehman

Duncan Baillie, business development manager, at oil and gas technology firm, Lux Assure, gives another example: "Subsea chemical analysis can now be conducted and automated for the pre-commissioning of pipelines. This not only reduces costs and improves safety by removing the need for divers and boat time, but increases efficiency of decision-making, as operators can access chemical analysis information quickly to sign off pipeline commissioning."

Block chain

Block chain can do a lot to simplify, automate and increase transparency from logistics to automating transactions. End users can find where a spare part is located, where it came from, what condition it's in, and the information can become more sharable and traceable, editable, and could lead to potential savings.

Block chain will not remove stuck drill from pipeline, but if it can optimize the logistics, it could potentially improve a lot of inefficiency in entire system (in recording and tracking, and the duplicating information). There are companies supplying suppliers, supplying operators, and every time information goes into a different system, a mistake can be made or be late processing payment. Automating what can be automated would remove a lot of administrative costs.

Scott Lehmann, vice president, Product Management & Marketing at Petrotechnics, a software solutions provider, says the key is having a "common currency" so that data otherwise hidden away in silos and can be extracted and meaningful relationships between previously disparate data sources can be found. "Relating them in a common way allows us to see their combined risk impact in terms of barrier impairments and the potential of a major accident hazard such as fire and explosion," he says.

"Ultimately, the promise of digitalization is to help everyone make better, more informed operational decisions that reduce risk, increase productivity and cut costs. The data has to be brought together in a meaningful and routine way."

Asset integrity

With so much digital data being collected in the industry, it can be hard to drown out the noise, and apply findings that truly benefit operations, but Lloyd's Register has taken a hard look at analytics collection in order to help their clients make sense of it and enhance their operations.

"Engineering based decision programs – which include, for example, risk-based inspection or reliability-centered maintenance, take specific sets of information: operating issues, maintenance procedures, etc., and they take the best out of it all and try to eliminate the over necessity or over-collection of information," Daarud says. "We have seen an 80% reduction in unnecessary inspections in delivering a higher quality asset integrity management program that is safer and way more cost-effective."

Additionally, last year, Lloyd's Register acquired a company called RTAMO, which specializes in a cloud-based software aimed at optimizing maintenance programs (*OE*: January 2017).

"[RTAMO] optimizes how to manage the mechanical and maintenance integrity of assets, and it avoids unnecessary shutdown to manage one piece of equipment – it helps reduce over maintaining and the subsequent backlog. Many operators find it hard to justify their maintenance strategy and by evaluating and manipulating the data you can alter the maintenance plan and potentially extend the frequency by a month or two, if not longer. This results in a host of opex benefits such as reduced hours, eliminating unnecessary tasks, and less maintenance. This approach ultimately reduces the maintenance budget by 30-40% for an entire asset or facility," Daarud says.

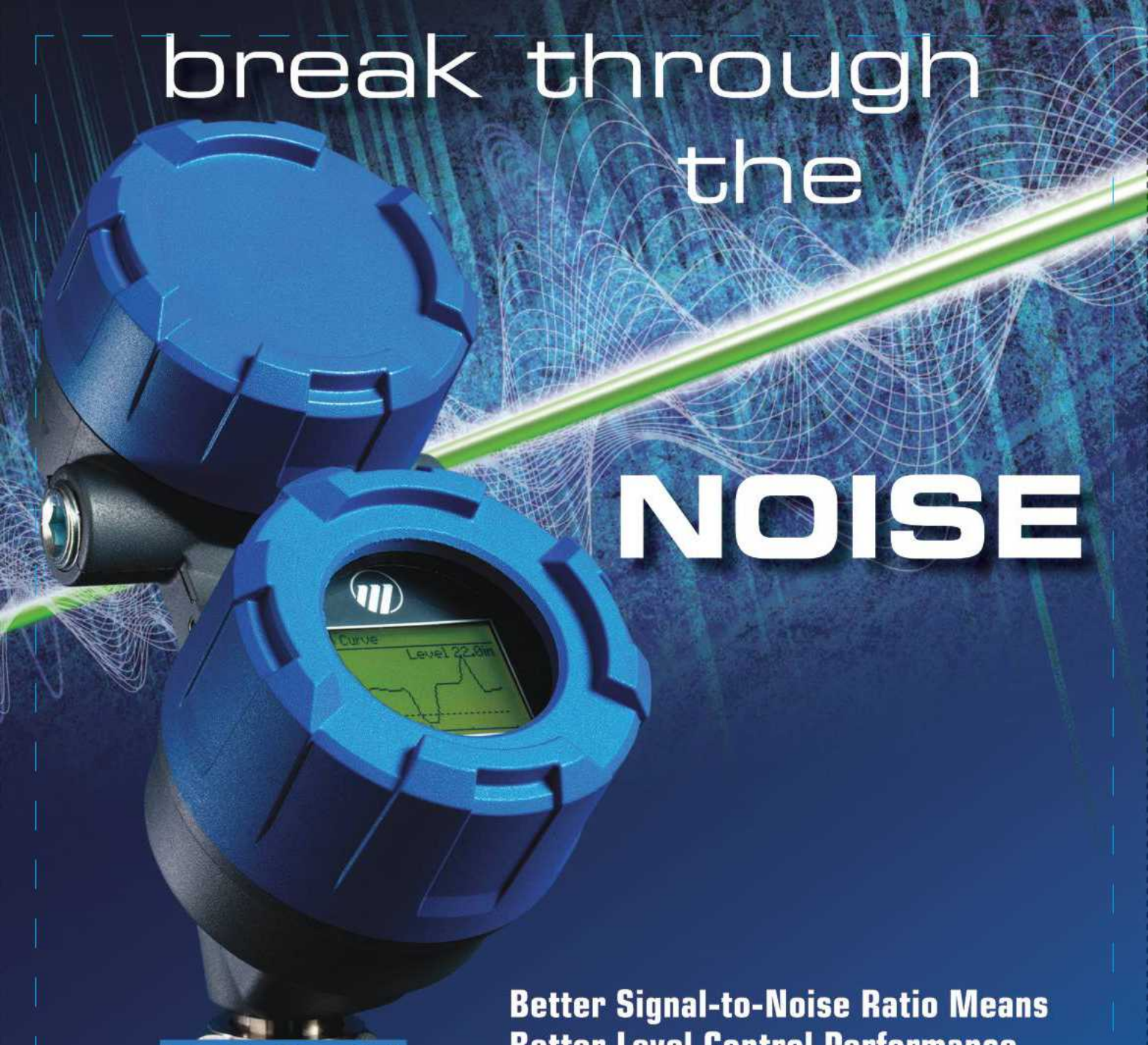
In a Houston press conference in mid-May, Carri Lockhart, senior vice president – US Offshore, Statoil, also highlighted the important role automation could play within the offshore space, in terms of facility management.

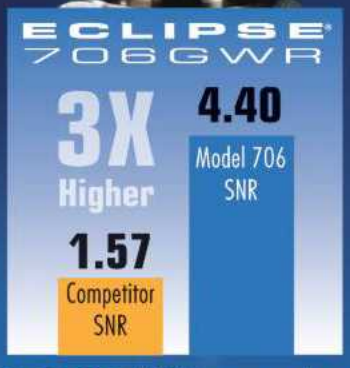
"We have driverless cars in Silicon Valley, California," she says. "Can we implement some of this technology offshore? It may not be that you go completely automated – perhaps, just some pieces of equipment that help run the facility to a certain threshold." Lockhart said that operational excellence and execution is one of four tenets Statoil has for offshore to compete with onshore resources. "If you can keep things running and plan your work out, and have high reliability, it's actually some of your best barrels coming out of the ground."

What would Lockhart like to see automated specifically? "The whole thing," she said, with a laugh.

"To me, if you can have a computer make on the fly adjustments that keeps your kit running, if you have a computer that can run the analytics that say you need to be between this threshold and that because that is the optimal performance, it's very fluid. It keeps the equipment from breaking down as much... But, doing this holistically, and having each system integrated and automated, it's pretty powerful. Automation is hugely exciting. It is a different challenge." **OE**

break through the NOISE





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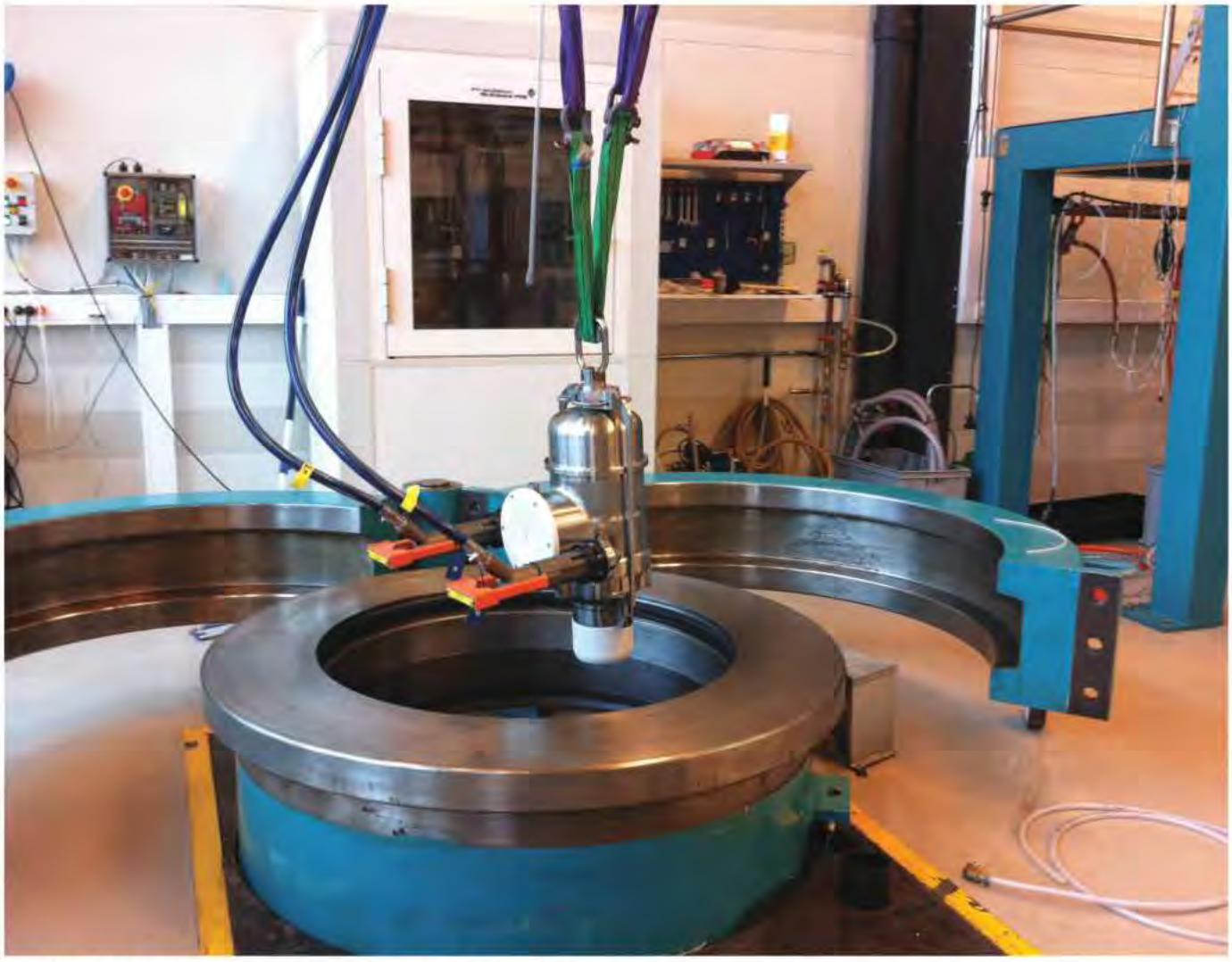
Elaine Maslin dives deeper into the all-electric subsea equation.

Moving toward all-electric

The Asgard subsea gas compression system, complete with eActuators and electric process control valves. Image from Statoil.

All-electric subsea installations have been on the agenda for years, if not decades. While it's still not quite a reality, it's closer than it's ever been, with all electric actuators proven and in use, the first all-electric subsea Xmas tree installed and operating (*OE:* September 2016) and qualified subsea power distribution systems.

"The future is all-electric," says Einar Winther-Larssen, product manager for all-electric and new products at Aker Solutions. "We see huge interest from customers working towards this type of technology."



Left: The K5F-3 subsea all-electric Xmas tree from OneSubsea. Photo from TEP NL (Total E&P Netherlands).

Above: A hyperbaric test of Aker Solutions' subsea rotary electric actuator, simulating 4000m water depth. Photo from Aker Solutions.

All-electric systems mean hydraulic lines and the hydraulic production units to support them are not required, cutting umbilical costs significantly, especially on longer step-outs. Controls and communication architecture can also be more flexible, enabling a different way of thinking, and easier expansion and or integration into other facilities, Winter-Larssen says.

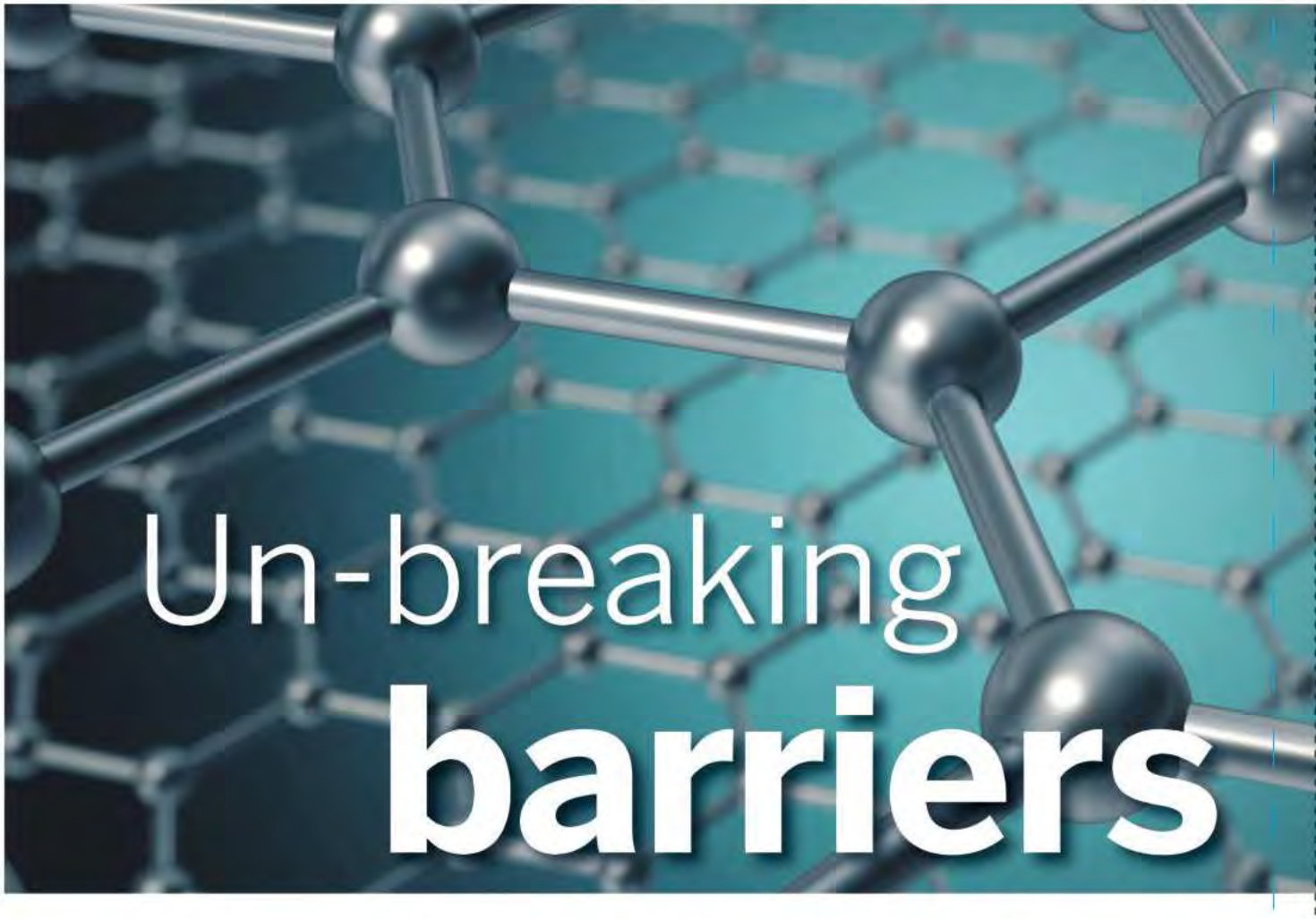
Using distributed controls architecture, distributing Logic, increasing functionality on electric actuators, a central subsea electronics module (SEM) could be taken out of the system and enable such systems to merge into a brownfield without effecting the infrastructure around it, he adds. "Get rid of the SEM and you can reduce the size of the Xmas tree and manifold," he says.

In the digital era, electrification also has its benefits. "Electric actuation and (Aker Solution's) Vectus (subsea electronics module) enables you to get data off site, do field monitoring and optimize functionality and processes, including on Xmas trees and valves.

"Moving Logic or other type of computers closer to the valve we can get more information from the source. We can monitor the valve and know much more about it. We can have more data points, which can be used for making information or visualize something better."

An all-electric world could also incorporate autonomous subsea vehicles in a more efficient way. "The first step will be all-electric systems with all the functionality we have today," Winter-Larssen says. "The next step will be how we optimize it using remote operated vehicles (ROV) and autonomous underwater vehicles. You still want to maintain the pressure barrier and have the functionality you need to shut it down in the system. Auxiliary systems, pigging loop valves and manifold loop valves, could be managed by a sea snake (*OE*: May 2016) or an ROV.

"Those types of system can bring value by reducing the number of functions on the subsea production system. I don't think we will use those types of solution on a safety solution," Winter-Larssen says. **OE**



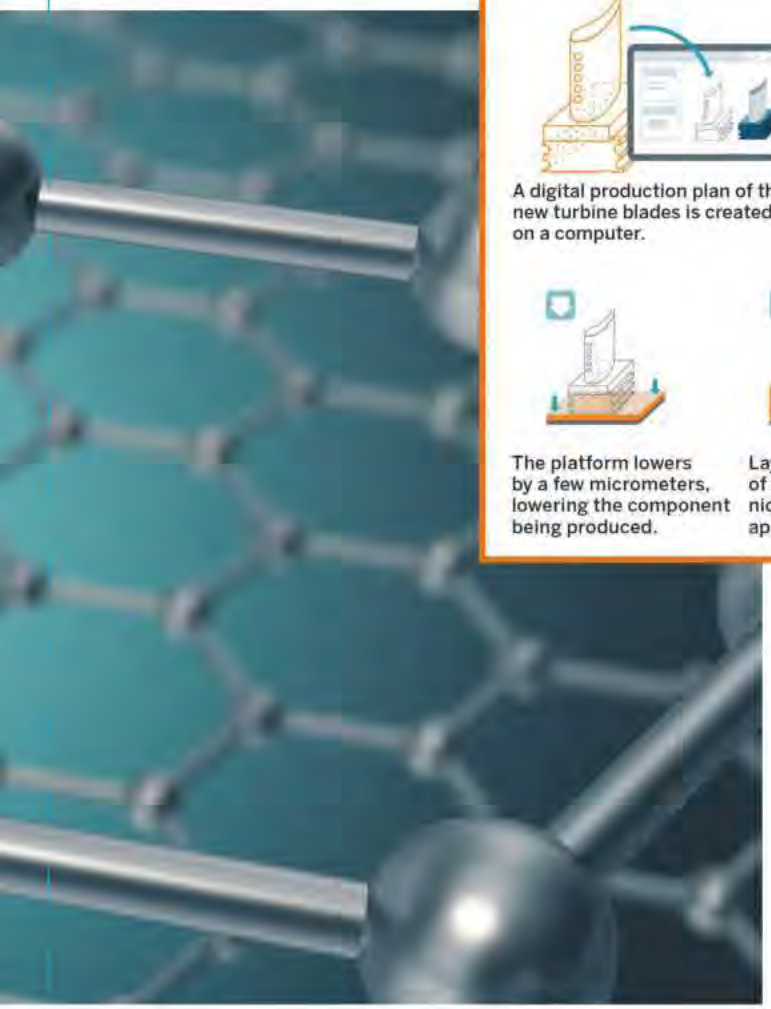
Un-breaking barriers

Materials development is pushing the boundaries of how things are currently done in oil and gas. Elaine Maslin looks at some of the research underway, including 'smart' materials that could potentially heal themselves, and additive manufacturing.

Everything we touch is material, in both meanings of the word, and ever more so as the industry moves toward more challenging arenas, such as high temperatures and pressures, or more corrosive or erosive products. There is potential for new materials to help push these boundaries, from using graphene for subsea separation to using composites for flowlines and even risers, saving weight, material and manufacturing costs.

Andrew Low, global technology director, Intecsea, says traditional materials and welds are being pushed to the limit of their operating envelope in some of the applications they're being used in today.

"Alternative solutions are required," Low says. "A shift in mindset, over the last few years, has seen consideration of materials technology and innovation move forward. We only need to look at the increase in the use of composite pipes from organizations like Magma Global and Airborne Oil & Gas, where they provide an alternate solution to steel jumpers or hybrid systems, to realize that times are changing. Removal of welded joints; often an area of such focus in pipeline installation activities, by using mechanical connectors from the likes of GMC also eliminates a potential failure mode where the



Additive Manufacturing

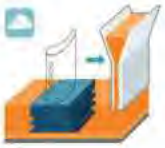
Turbine blades manufactured with 3D printing: the high performance gas turbine components are produced using Additive Manufacturing.

A digital production plan of the new turbine blades is created on a computer.

A thin layer of a powder of high performing superalloy is applied.

A fiber laser beam fuses the powder, thereby creating the first layer of the turbine blade.

The platform lowers by a few micrometers, lowering the component being produced.



Layer by layer new coats of the polycristalline nickel superalloy are applied and fused.

The laser traces the outline of the digital production plan on every coat.

At the end a heat-resistant turbine blade emerges out of the powdered superalloy.

Earlier this year, Siemens announced a breakthrough in 3D printing: an international project team with contributions from Siemens engineers in Finspång,Sweden; Lincoln, UK; and Berlin, Germany, together with experts from Materials Solutions in Worcester, UK, successfully finished performance testing under full-load conditions of the first gas turbine blades ever to be produced using additive manufacturing. Infographic from Siemens.

weld may be pushed to its limit due to strength, material incompatibility issues with the environment, or even traditional welding defect issues."

DNV GL launched an industry project to help qualify the likes of thermoplastic composite pipe (TCP), made by Magma and Airborne, more cheaply. DNV GL says composites like these – in which plastics are combined with other materials for added strength, flexibility, fatigue resistance, etc., is relatively mature in other sectors, such as aerospace. The Boeing 787 Dreamliner aircraft's complete structure is made of the stuff, for example.

Using a different material to steel, something more readily reusable, or that could be assembled and reassembled, could lend itself to repeat deployments, opening a more economic route to develop small pools, suggests Luca Corradi, Innovation Network Director, the Oil & Gas Technology Centre.

Smart materials

Other areas, such as smart materials are also coming into focus, Low says. Smart materials are those that have one or more properties that can be significantly changed in a controlled fashion by external stimuli, such as stress, temperature, moisture, pH, electric or magnetic fields.

This area is under focus at BP. The oil major firm set up the BP International Centre for Advanced Materials (BP-ICAM), involving the University of Manchester, University of Cambridge, Imperial College London, and the University of Illinois, to look at the potential of materials that are stronger, lighter, "intelligent," and even "self-healing."

For BP, a core focus is on corrosion prevention. BP-ICAM researchers are developing new materials that are resistant to corrosion and can reliably extend the lifetime of oil and gas infrastructure. University of Illinois researchers are creating self-healing coatings for metals and pipelines that can sense damage, stop it from worsening and even self-repair, without any external intervention. The coatings have tiny microcapsules embedded within them that release a healing fluid to repair the material as it starts corroding.

One project includes investigating whether an alloy can be designed to prevent hydrogen embrittlement by designing it with properties that trap and react with the hydrogen to make it unreactive so that it doesn't make it the alloy brittle, lengthening its life.

Dealing with existing coatings and making them last longer has pushed Shell in the UK to try new methods, including using CO_2-based dry ice to blast away old paint or corrosion, instead of using grit blasting, before applying longer lasting coatings. This method has recently been made the default for Shell.

New coatings on top of this, such as sprayed aluminum, on top of which paint can then be applied, to create a 25-year-life coating, can help to minimize future maintenance requirements, says Alistair Hope, Shell, on existing facilities, but also on new ones, like Clair Ridge.

m-pipe in production. Image from Magma Global.

Graphene

Graphene hit the headlines in 2010, when researchers who characterized the two-dimensional and strong material won a Nobel Prize. It's a two-dimensional, very strong form of carbon, structured in hexagonal lattice.

The potential for applying graphene in the oil and gas industry could spread across drilling and oil spill clean-up to gas-water-oil separation and osmosis membranes, Low says.

He gives possible examples, such as dynamic graphene filters for selective gas-water-oil separation or for desalination. "Could its superior strength and small size take it downhole to improve the drilling process," he poses. "If it's stretchable, could graphene provide an answer for an engineer with an idea that will take directional drilling to the next level? Could graphene balls improve completions, carry corrosion inhibitor or boost production?"

Corradi also mentioned nanotechnology – or carbon tubes – which could change refining technology.

Additive manufacturing

3D printing could have wider benefits for the oil and gas industry. GE has been investing heavily in this space, including recently buying German firm Concept Laser, which is focused on the aerospace, medical and dental industries, as well as automotive, while also developing items like fuel injection nozzles for engines.

Rolls Royce has also been investigating this technology, using electron beam melting and electron beam welding, in turbines, to avoid the need for casting or forging. Yet, a late 2016 report, Additive Manufacturing UK, by the UK Additive Manufacturing Steering Group doesn't mention offshore or even renewables as a sector catered for.

Low thinks 3D printing of spares from powder is likely to increase and save costs from not having to carry inventory. Other benefits include being able to rapid prototype and print quite complex geometries, otherwise not possible through traditional manufacturing methods. And, because complex fabrication facilities are not required, manufacturing possibilities are opened up to smaller firms.

"With additive manufacturing, you can produce shapes you cannot make with more traditional forms of manufacturing," Corradi says. "Combine that with using different materials and artificial intelligence [in the design process] and there is the potential to unleash new creativity."

Stuart Ferguson, CEO at relatively new start-up FrontRow Energy Technology Group, says that 3D printing is already transforming the creation, development, marketing and production of new products.

"For even the smallest companies, 3D printers enable the conversion of ideas into functional prototypes at a cost and speed that would have been unthinkable 10 years ago," Ferguson says. "One FrontRow company, Well-Sense Technology, used 3D printing extensively to develop its fiber-line intervention (FLI) technology; a method for disposable optical sensing. From the initial FLI concept to the first test of a working prototype in a well took only a few months, with many design iterations along the way.

Stuart Ferguson

"3D printing also allows shapes to be created that are difficult, if not impossible, to make using conventional machining," he adds. "Furthermore, complexity tends to reduce cost in printed parts, as the cost depends only upon the volume of material used, rather than the material that is removed and wasted."

Ferguson says that FrontRow is already using printing of high-nickel alloys for ultra-compact well intervention tools. Within a few years, he adds, the oil industry can expect to see very large printed structures being used as a matter of routine.

However, this technique doesn't have to be limited to the design and new manufacturing space. "I'd love to see additive manufacturing make an impact on repair work," Corradi says. "Could you put a 3D printer on a pipe to repair the pipe? It is possible with laser cladding, but, today, this requires a controlled environment. The next step is creating a mobile version." **OE**

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North Sea awe

The awe inspired during the early days of the North Sea industry was back and in full force for the world's heaviest offshore lift. Elaine Maslin reports.

They say good things come to those who wait. On 28 April, a lucky few witnessed a long-awaited, historic lift, 186km northeast of Shetland in the UK North Sea.

After 40 years of production (and more than 900kg annual cheddar cheese consumption), Shell's 24,300-tonne Brent Delta platform topsides was lifted off its massive concrete legs in one piece by Allseas' *Pioneering Spirit*.

Just three days later, the Brent Delta topside had travelled, in one piece, some 380mi to off the coast of Hartlepool, England, where it was transferred to a barge to be skidded on to Quay 6 at Able Seaton Port, for dismantling.

This huge feat of engineering harkens back to the pioneering days of the offshore industry, when the four massive Brent platforms were first installed, three on concrete bases and one on a 31,500-tonne steel jacket. Like then, the scale of the work and the engineering involved made headline news and captured the popular imagination.

The big difference, however, was that Allseas' *Pioneering Spirit* was able to lift out the platform – which had been installed in modules – in one piece, a feat that many thought couldn't happen. The alternative, taking it apart offshore, in a reverse installation, would have been "a nightmare," according to Alistair Hope, Brent decommissioning project manager, Shell.

Also unlike then, Allseas has access to sophisticated simulators, in Delft, Netherlands, to "trial run" the lift. But, what has driven the ability to perform such a lift (and, in theory, lifts up to 48,000-tonne), using the 382m-long, 124m-wide *Pioneering Spirit*, is the sheer scale of the hydraulic and compressed air system on board the vessel, combined with dynamic positioning (DP) and powerful controls and computing power to make it all work together – active heave compensation (AHC) on steroids.

A Delta challenge

Brent Delta's topside has three main levels (module support frame, module deck and drilling deck) sitting in 142m water depth, and measuring 74m x 47m, and 44m high to the helideck and 132m-high to the flare tip.

To remove the topsides, the *Pioneering Spirit* 's eight sets of lifting beams – each with four fast lift cylinders and two hydraulic AHC cylinders, totaling 6000-tonne lifting capacity – worked with the vessel's DP system and vast 700,000-tonne capacity ballasting system (comprising four pump rooms connected to 87 ballast tanks) to remove the topside from its legs within 12 hours.

After moving the vessel's bow slot around Brent Delta's legs (with about 5m tolerance each side), each set of beams was moved into position and connected, via yokes (two weighing 80-tonne and one 135-tonne), with the topside, where it maintains position using the three-way movement AHC system.

A Kongsberg positioning system (driving 12, 4.7m-diameter, 80-tonne-a-piece thrusters) guided by GPS keeps the vessel within about 1.5m of its position. The topsides lifting system, using an optical gyroscope to see where the platform is, compensates for the rest of the motion to within centimeters. All of this is run via remote control, and using huge computational power, to combine all the relevant positioning data – including live and predicted metocean data – and process it live in order to maintain the system's accuracy.

Once all beams were in place, the vessel started lifting, first through ballasting, to about 80% of topside weight. The final 20% was lifted using compressed air, achieving a "fast lift," to clear the

Able Seaton Port

To accommodate the Brent topsides, Able Seaton Port Quay 6 had:

- **1242** piles weighing almost **10,500**-tonne installed
- **4500**-tonne of additional steel re-enforcement
- **40,000**cu m of concrete
- Quay 6 has a **45**-tonne/sq m load capacity

Photo from Able.

Pioneering Spirit, closing in on Brent Delta. Photo from Allseas.

Lift learnings

The first time doing anything offers scope for learning – the Brent Delta lift will help make the future Brent lifts easier. Elaine Maslin reports.

topside from the concrete legs in 11 seconds, with quick drop ballast tanks being used to follow the motion through in three minutes. The operation is powered by eight, 11.2MW engines across four engine rooms for redundancy.

While it has been a long wait for Allseas, and Shell, to get to the Brent Delta lift, there's no rest for the *Pioneering Spirit*. The vessel, which consumes around 200-tonne of fuel a day while steaming and 70-tonne a day while positioning, is contracted to lift the other three Brent topsides, including the 31,000-tonne Brent Charlie platform, as well as installing the huge Johan Sverdrup topsides (weighing 19,000-26,000-tonne) for Statoil, offshore Norway. Immediately following the Brent Delta project, however, the vessel went back to its base in the Maasvlakte, Rotterdam, to mobilize for her next job, laying the TurkStream pipeline in the Black Sea. In 2018-19, *Pioneering Spirit* will also join *Solitaire*, laying the twin-pipeline Nord Stream 2 over 1200km through the Baltic Sea. OE

FURTHER READING

Watch the Brent Delta lift: www.oedigital.com/component/k2/item/15269-pioneering-spirit-completes-record-offshore-lift

Being overly cautious might be an understatement, but also understandable, when it comes to being the first operator to put the world's biggest vessel to test, lifting some 24,200-tonne of steel off its legs out in the harsh northern North Sea.

However, lifting the Brent Delta platform has also given Shell and Allseas a chance to see how the next three Brent platforms can be taken out more efficiently, from re-assessing the structural reinforcement required to redesigning lifting points.

"When we started, single lifting was completely new for everyone," says Allseas' founder Edward Heerema. "Calculations of reinforcements were initially made with the same great conservatism as for a newbuilt structure that has to withstand the seas for 40 years, which is more than what's needed for removing a facility. We have learned big lessons. There's a lot of strength in the topside already. It can be allowed to deform during a lift and during transport, as long as it stays safely together."

On Brent Delta, eight cruciform lifting points, weighing 120-tonnes in total, were added to the underside of the platform, for the mating with the *Pioneering Spirit*'s lifting arms. Structural reinforcement was added to the lower decks and three shear restraints, at around 12m-diameter and weighing about 36-tonne each, were installed in each leg, to hold the platform in place after leg cutting.

Bravo on the horizon

By reassessing the engineering codes and allowing a degree of plastic deformation during the lift, the amount of reinforcement work required can be reduced. A lot of this work will be done on Brent Bravo this summer. Spacers will also be fabricated to go on top of the lifting yokes, so that the lifting arms can reach the lifting points on the taller Brent Bravo facility.

"With Delta, we had a very

And we have lift off. Photo from Allseas.

Ready for lift off. Photo from Allseas.

conservative design: eight lifting points, when we would only need six and a lot of steel reinforcement work," says Alistair Hope, project director of the Brent Decommissioning project, Shell.

Hope says that the learnings from Delta will mean that only about a quarter of the work will be needed for Bravo. "The beauty of this project is that we get to do it four times. Bravo will be considerably more efficient, and so it will be after Bravo," he adds.

Furthermore, for Bravo, Shell's engineers came up with an idea to use concrete, for the lifting points, instead of steel. This will be much easier to install, says Duncan Manning, business opportunity manager for Brent, Shell, instead of 15-tonne of steel for each lift point. Welding onto 1970s steel panels isn't an easy process, he says, having to pre-heat the steel, etc. Instead, creating a box and pouring in the concrete would save time, cost and logistics. "It's been quite a game changer," Manning says.

Taking a more realistic approach to what safety margins need to be met will also reduce scope, Heerema says. "You don't plan for having a storm with 7m wave height on the way to shore, as you know that will not happen," i.e. if there's a storm coming, the lift will not take place.

More lessons will be undoubtedly learned on Bravo, and then Alpha, before Charlie – the only Brent facility still in production – is decommissioned.

For Allseas, the learning will continue, as every platform will offer a unique challenge. "Years ago, I thought, once we've lifted one it would be easy to adapt to the next one," Heerema says. "But in fact, every platform is different to the other. Every time there is so much to think about, problem solving, getting the yokes in the right place, fitting them without spending too much money on them. Making use of the intrinsic structure of the topside. The difficulty is that composition of each platform is different. Some are strong, some are flexible and weak." OE

End of an era

According to Shell, annual consumption on a typical Brent platform was:

- 190,000 tea bags
- 4800 packs of chewing gum
- 792kg of haggis
- 8000 toilet rolls
- 900kg of cheddar cheese
- 12,159 litres of fresh milk
- 42,000 canned drinks
- 69,120 eggs
- Over 150,000 meals served
- 7560kg of chicken breasts

Those who dare, win

It could be easy to understate the conviction it takes to see through the design and build of a vessel the size of *Pioneering Spirit*.

Each step of the build, inauguration and then launch of the *Pioneering Spirit* has felt like this mega-vessel's major milestone – until the next one.

Having broken the record for the heaviest offshore single lift with the Yme platform (13,400-tonne), offshore Norway, in 2016, and then the Brent Delta topsides in the UK (24,200-tonne), in late April 2017, work will quickly shift to *Pioneering Spirit* 's next job: its first pipelay project, TurkStream. After that, it will then be the three Johan Sverdrup topsides (19,500-26,000-tonne) installations – the first in 2018 and the second and third in 2019 – which will set yet more milestones for this mega-vessel. The *Pioneering Spirit* also has work on Nord Stream 2 lined up, and the Brent Bravo lift, setting another record, at 26,000-tonne, which will later be outdone by the Brent Charlie removal, at 31,000-tonne.

Work on the vessel also continues. Next year, an additional 5000-tonne tub-mounted crane will be added to her deck. Fabrication work on its 20,000-tonne capacity jacket lifting system is due to start this year, with installation expected in 2019.

For Allseas' founder Edward Heerema – who has spent nearly 30 years working on the concept, design and then build of the *Pioneering Spirit* – the first lift, Yme, could be viewed as the most significant – finally proving the concept. Yet, every project offers new challenges, and the insatiable engineer has even bigger-yet challenges he would like to tackle, such as *Amazing Grace*, a single lift vessel that would dwarf *Pioneering Spirit*.

It's been a long journey since Heerema set up Allseas 32 years ago, with a single pipelay vessel – *Lorelay*, the first DP pipelay vessel in the world. Allseas has grown and has had no qualms about outstripping its own capacity in the past: *Pioneering Spirit* doubles the pipelay capacity of Allseas' *Solitaire*, which had been the biggest pipelay vessel in the world.

Pioneering Spirit has been in gestation a long time. "We had the idea 30 years ago, when we were a small company. We just had *Lorelay* and no other money than borrowed money," Heerema says.

Now, in addition to putting *Pioneering Spirit* to work, Allseas continues work on *Amazing Grace*. "We are steadily continuing the design," Heerema says. "The size of the ship, the dimensions and motion compensation for that ship, is a lot different to *Pioneering Spirit*, and it takes years to work out a solution you're happy with." He says that it's not just a case of have 50% larger beams, it has to be thought through differently.

There are few companies that could take on such a challenge. "If you have an individual owner, if he decides to take a risk, it's his risk," Heerema says. "If you have a big company on the stock market, with analysts only interested in quarterly results, bringing a large and daring concept to life doesn't fit the mentality and culture of a big corporation. I'm a real engineer, almost only an engineer, so I can go very far in gauging if something can work well or not, and I can combine that with taking the full responsibility on myself. That's the privilege I have."

However, he also credits having a creative nucleus – hinting at the group effort behind this vessel, as well as the creativity involved in finding solutions for its multitude of systems. **OE**

Mega-vessel, mega facts

- **190,000**-tonne of steel was used to make *Pioneering Spirit*
- The vessel is **382**m-long, **124**m-wide
- It has **95MW** installed power

- The vessel has accommodation for **571** people
- Maximum speed is **14**kts
- **2.5** million litres of paint was used to paint the vessel
- **2800**km of cable winds its way around the vessel
- **500**km of cable is used for the topside lifting system
- The vessel has **280**km of installed piping
- More than **16** million Korean worker hours and **1** million engineering and project management hours were used in its construction, at Daewoo Shipbuilding & Marine Engineering
- Crew members come from **40** nationalities
- **1500-2000** meals are being served on board daily
- **250**kg of rice and **7000** eggs per week are eaten
- The freezers can store up to **50**-tonne of meat and **15**-tonne of fish.

Photo from Allseas.

A monster facility

How it will look: Johan Svedrup, illustration. Image from Statoil.

Johan Sverdrup is the largest ongoing project in the North Sea. Elaine Maslin looks at Statoil's progress, cost reduction and technology use on the development.

Trond Stokka Meling, technical director on the Johan Sverdrup mega-project, calls the facility, "one of the largest hotels in the North Sea." Indeed, with more than 560 beds, it's large.

Johan Sverdrup is a massive project. Some 14,000 people are currently working on the facilities construction project at 23 different sites across the globe. So far, 29 million man hours have been spent on the project, Meling told the Subsea Valley Conference in Olso, in early April, with a total of 100 million expected to be reached when the project's first phase completes in late 2019.

The Johan Sverdrup field is 155km west of Stavanger. The field was found in 2010, with the Avaldsnes discovery in PL501, by Lundin Norway, followed by the Aldous discovery in PL265 by Statoil in 2011.

Once complete, Johan Sverdrup Phase 1 will comprise a field center, with four, bridge-linked platforms, with 35 wells, and three subsea satellites for water injection, all in about 120m water depth. Phase 1 will include power from shore for the Johan Sverdrup field.

Phase 2 will add another 28 wells, 18 of which are due to be satellite wells, and an additional process facility, to increase production capacity by 220,000 b/d, from about 440,000 b/d, to 660,000 b/d, amounting to 25% of Norwegian oil production. It will also add in power from shore for the wider Utsira High. In all, the development of the 200sq km field is expected to tap some 2-3 billion boe and potentially more. As part of its drainage strategy, Statoil is planning permanent seismic monitoring across 80% of the field. The operator also has a commitment to at least trial polymer flood on the medium-oil viscosity field.

Statoil also plans to make Johan Sverdrup a digital oilfield. "We are going digital," Meling says. "There's a lot of data gathered in the planning and operation phase. We are looking at how we can use it and maximize value." The ambition is to create a fully integrated "digital twin" of the Johan Sverdrup field and development, on which analytics can be run.

Progress report

Phase 1 of Johan Sverdrup is being built at a cost of US$11.35 billion (NOK97 billion), or $20/bbl breakeven, compared to the $14.39 billion (NOK123 billion) original estimate. Phase 2, on which an investment decision is due in 2H 2018, with first production in 2022, will be $30/bbl breakeven, costing $4.68-6.44 billion (NOK40-55 billion). Full field breakeven is expected to be below $25/bbl.

Early April, the Phase 1 project was about 40% complete, Meling says. Two topsides are under construction at Samsung Heavy Industries in South Korea; three of the jackets and the 19,500-tonne living quarter topside are being built in Norway, by Kvaerner. The latter is expected to be installed offshore in 2019.

The Phase 1 drilling platform, with 48 slots, is being built by Aibel at three sites: one in Thailand and two in Norway (Haugesund and Grimstad [Nymo]). It will weigh 21,500-tonne and measure 40m x 83m. Its parts will be assembled in September this year in a fjord in Norway, creating a 147m-tall topside, which will then be positioned outside Haugesund, Norway, until it's installed offshore in summer 2018. Pre-drilling is ongoing using Odfjell's *Deepsea Atlantic* semisubmersible, where eight producers are pre-drilled and pre-drilling of 10 water injectors at subsea satellites are ongoing.

Drilling on Johan Sverdrup. Photo by Kjetil Eide, from Statoil.

The riser and process platform topsides are being built at Samsung Heavy Industries in South Korea. The riser platform – the largest of the four platforms constituting the Johan Sverdrup field center – will be the first of the Johan Sverdrup topside to be installed in 2018. The platform will be 124m-long, 28m-wide, 42m-tall, and weigh some 23,000-tonne. The process platform will be 100m-long, 23m-wide and weigh 26,300-tonne.

For Phase 2, which will target the Avaldsnes, Geitungen and Kvitsøy reservoirs, Statoil is assessing an unmanned wellhead platform, with 12 slots available, plus subsea satellite wells. However, it could also be all subsea satellite wells, which can offer more flexibility with well locations (as Statoil learns more about the reservoir's subsurface and hones its Phase 2 plans), Meling says.

Phase 2 is yet to be sanctioned, but startup is planned for 2022. Decision gate 2, or concept select, was in March this year. A development plan is due to be submitted on 1 September 2018.

Cost reduction

"It is a huge area to develop and a lot of infrastructure and investment," Meling says. But, he adds: "We cannot afford to fail on this project."

While the oil price has been hurting a lot of projects, Statoil's focus on making Johan Sverdrup work has made it a "robust project" at today's oil prices, he says, and it's not been about squeezing suppliers. "There has been a lot of news in the media about how we have been pushing our suppliers. But, we are dependent on everyone making a profit or we would be short-sighted. The way we work with contractors and suppliers is key."

Securing deliveries and quality, improving collaboration with suppliers and contractors, simplifying the concept and reducing the number of wells needed have all helped to reduce costs, he says.

"We have worked hard to simplify technical requirements and we have improved the quality of specifications and worked with suppliers so they understand what we are requesting, being there and solving issues when they are coming up," he says. Reusing designs from Phase 1 in Phase 2 will also help reduce costs by being able to use the same designs documents, he says.

Drilling performance on the *Deepsea Atlantic* has also helped reduced costs: eight wells have been delivered in what has been considered "perfect well time" under Statoil's "perfect well" program, meaning they were completed in almost half the time of the original plan.

The decision to use Allseas' *Pioneering Spirit* to install three of the topsides has also reduced costs, he says. "Usually, we would use the *Thialf* or *S7000*, with 10,500-tonne [lifting] limitation and have to lift in modules and then connect, hook-up and commissioning [after that]. This [the *Pioneering Spirit*] has up to 48,000-tonne topside weight [lifting capacity] in one piece.

"We have gone through an extensive qualification program, to safeguard that this vessel will operate as intended, [that the] lifting beams, controlled by a computer system, work as intended together with the DP system, keeping the vessel in the correct position," Meling says. Allseas has run offshore tests with *Pioneering Spirit* installing and removing a dummy topside, also in rough weather, and the vessel "worked perfectly," Meling says. "It has done [the] Yme [removal] and Brent [Delta removal] in May," he says, further reducing risk for Statoil. "At almost 1 million-tonne displacement, with a [pipelay] stinger and jacket lifting [system], it's a fantastic vessel and it is a very efficient way of doing this [topsides installation]."

Technology

Meling says that there has not been much new technology on Johan Sverdrup, but mentions, in addition to using *Pioneering Spirit*, use of automatic inflow chokes on wells to reduce the number of wells needed is thanks to better control. The project is also using VisiTrak reservoir navigation to improve the placing of wells, to more efficiently drain the reservoir.

Statoil is also looking to use its Cap-X subsea template concept, which reduces the size of subsea templates, with one suction can instead of four, and uses glass fiber. The firm plans to use Cap-X on the Njord and Bauge fields, and was ready to be used, following qualification, Meling says. "We need to collaborate with industry to get it [Cap-X] built," he says. **OE**

Breaking records

Facilities transport records have been broken and broken again by Dutch marine contractor Boskalis' Dockwise business. Elaine Maslin reports.

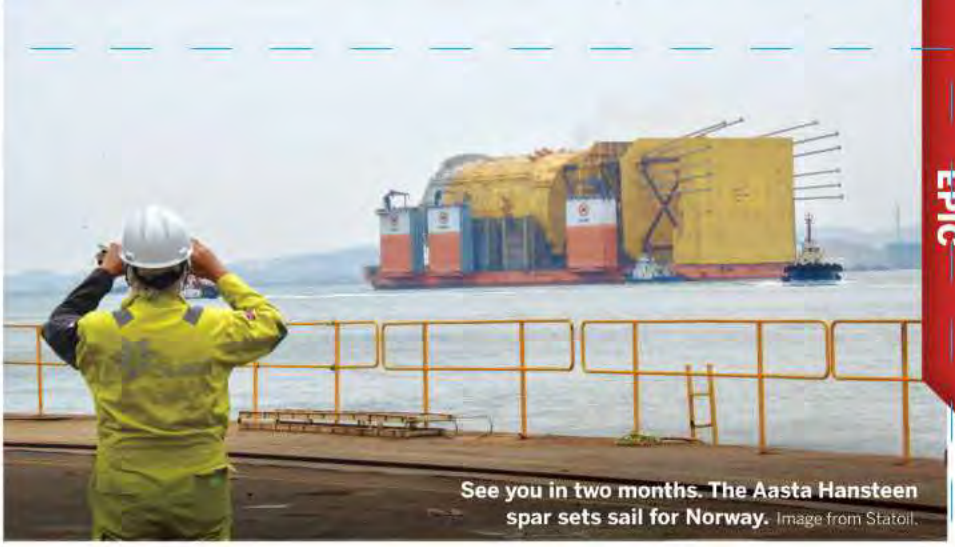
Above and left: Statoil's Aasta Hansteen spar being loaded onto the *Dockwise Vanguard* in South Korea, late April. Images from Statoil.

Since its launch in 2013, the *Dockwise Vanguard* has been making waves, but not of the wet variety. The vessel, owned by Dockwise, part of Royal Boskalis Westminster, has been consistently making records in heavy lift transport with every new job it takes.

Its latest job is transporting the spar hull for Statoil's Aasta Hansteen project, the world's largest spar facility and the first spar off Norway. It was a job for which the world's largest semisubmersible heavy transport vessel was built.

The *Dockwise Vanguard* was designed to be able to transport floating production units (FPUs). The vessel, which came onto the market in 2013, performed the first ship-shaped floating production, storage and offloading (FPSO) vessel transport in 2015, with the transport of Bumi Armada's 60,000-tonne, 254m-long, *Armada Intrepid*, previously known as the *Schiehallion* FPSO, from Europe to Indonesia.

Next came the transport of Eni's 64,000-tonne, 107m-diameter *Goliat*, a Sevan-design cylindrical FPSO, from Hyundai Heavy Industries' yard in



See you in two months. The Aasta Hansteen spar sets sail for Norway. Image from Statoil.

An FPSO first – the *Armada Intrepid* aboard the *Dockwise Vanguard* – a ship shipping ship. Image from Boskalis.

Total's Moho Nord FPU *Likouf* as it was loaded onto the *Dockwise Vanguard* in South Korea in 2016. Image from Boskalis.

Geoje, South Korea, to Norway, which broke and held the record for the largest cargo transported, until late last year.

In November, the vessel transported Total's 80,500-tonne, 250m-long, and 60m-wide *Likouf* FPU meant for Moho Nord. The FPU was transported from Ulsan, in South Korea, to Port-Gentil, Gabon, West Africa.

In fact, the *Dockwise Vanguard* is designed to take even greater loads. Its load capacity is given as in excess of 110,000-tonne, on an open-end, free deck space measuring 275m x 70m. The absence of a raised bow and conventional forward superstructure means that cargo overhang, either forward or aft, is possible.

However, with an initial 58m gap between the ship's casings, it wasn't possible to float the Moho Nord FPU onto the deck. Dockwise decided to widen the gap to 70m, leaving 4m space between each side of the Moho Nord FPU once loaded. This meant outriggers had to be fabricated and fitted to the *Dockwise Vanguard* onto which the vessel's casings were moved.

The move has had a bonus impact: moving the casings not only enabled the Moho Nord transport, but made the *Dockwise Vanguard* more flexible, enabling the transport of the enormous Aasta Hansteen spar hull from South Korea to Norway. The vessel set sail on 21 April from Hyundai Heavy Industries and is expected to take two months to arrive in Norway. **OE**

Advancing e-ROVs

Permanently stationed underwater vehicles are almost a reality – in Norway, at least. Elaine Maslin reports.

The eNovus. Photo from Oceaneering.

Statoil is working with Oceaneering on a project that could at least achieve a stepping stone towards the goal of having permanently stationed underwater vehicles.

The firms are working on an e-ROV (remote operated vehicle) skid, which could comprise a subsea garage, with a 100kw battery pack and tether management system, with surface communication and control via a buoy with antennae (connected to the skid with a Kevlar and fiber cable), to enable an ROV to work remotely for periods of time on the seafloor. If there is communication available on a nearby subsea template, this could be used instead. It could also link up to a drilling rig, whose activity it could be supporting.

An e-ROV skid set up. Image from Oceaneering.

Having ROVs deployed without the need to be attached to a vessel achieves, at least for certain periods of time, the ability to "do away" with the need for a support vessel. ROV operators could be based onshore, communicating with the ROV using the 4G network now installed in the Norwegian North Sea, and operate multiple units at a time.

"The main reason we can do this now is that we have a 4G mobile network that was placed on the Norwegian Continental Shelf two years ago," says Pål Atle Solheimsnes, leading advisor – subsea intervention and diving, Statoil, at Subsea Valley in Olso early in April. "That means we can transfer enough data to operate it from shore. The latency is so small. 3G had too much latency. In 2020, 5G is coming. Then the latency will be reduced by 90% again and it will be really, really good. We can use it on all subsea production systems in the North Sea."

A deployment concept has been developed, involving Subsea 7's *Seven Viking*, with several e-ROV skids onboard, almost doing a milk round, deploying the skids via its moon pool to the seabed. Another concept has the *Normand Ocean* deploying one skid and then going off to do others jobs and returning to collect the e-ROV when it's completed its work.

Solheimsnes says that the battery pack could be scalable and updated as battery technology improves. A standard buoy will be used.

As of early April, Oceaneering was building a pilot system in Stavanger, Norway, and was due to test it in May at the Troll field. Oceaneering's eNovus ROV is being used. The garage was already built and the battery pack was being built up.

"We will see if it's working, what to do better, then make a complete specification for a complete eROV we want to build," Solheimsnes says. "If successful, it will be in the tool box for an IMR [inspection, maintenance and repair] vessel to use when it wants to." Solheimsnes says that the idea would be that the system could be rented by Statoil, rather than owned. OE

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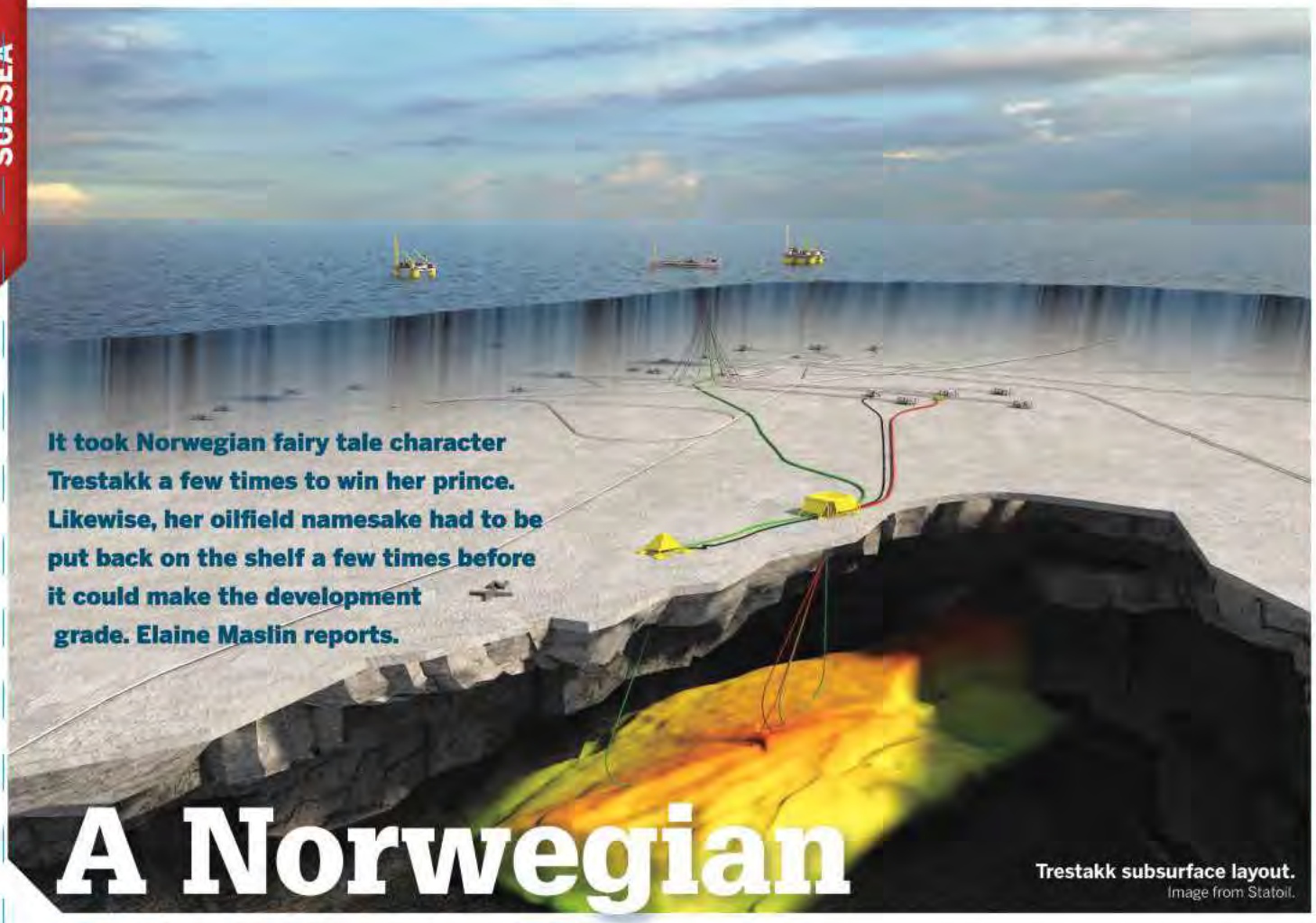


It took Norwegian fairy tale character Trestakk a few times to win her prince. Likewise, her oilfield namesake had to be put back on the shelf a few times before it could make the development grade. Elaine Maslin reports.

A Norwegian Cinderella

Trestakk subsurface layout.
Image from Statoil.

Statoil's Trestakk field has become so synonymous with its namesake – the Norwegian, Cinderella-like fairy tale character Kari Trestakk ("Katie Woodencloak") – that those involved in the field even call the 76 MMboe field a "she."

They've certainly had long enough to get to know her. Discovered in 1986, it wasn't until 2015 that Statoil had a viable development concept on the table. Then there was a year of project optimization (reducing costs) required before Statoil could sanctioned and submitted a plan for development and operation (PDO) for Trestakk.

The result, outlined Håvard Stensrud, project director, Statoil, is a project with 50% reduced costs, a recovery rate 30% higher than initially thought, and 60% higher value (net present value). The field breakeven is also down more than half now, he told the Subsea Valley Conference in Oslo, early April. A true Cinderella story, indeed.

Lonely Trestakk

Trestakk, an oil field with some associated gas, was discovered and then appraised in 1986-7, on the Haltenbanken, in block 6406/3, in the Norwegian Sea, in about 300m water depth. The field, which sits 3900m beneath the seabed, is being developed as a 25km tieback to the Åsgard A production vessel, with a four-slot template and an attached single well satellite. Three of the wells will be producers, with two gas injectors, for reservoir support.

Statoil sanctioned the project last year – it's largest project sanction in 2016 – and the PDO was approved early April 2017. The development is now in detailed design with fabrication expected to start this summer. All the main offshore operations will be in summer 2018, with drilling in the Fall, and first production in 2019.

"We have been struggling with Trestakk for a long time, not making it fly," Stensrud says. "We share more with the fairy tale than just the name. It is a long story and it is the same with Trestakk. It's about an underdog that never quits."

When Trestakk was discovered, there was no other infrastructure on the Haltenbanken, Stensrud says, and it was thought to contain 50 MMboe, which didn't support a full field development and platform. "We had to keep it in a drawer for a while," he says.

In 1999, Åsgard A was brought on stream and then, towards 2010, Statoil started looking at Trestakk again, Stensrud says. Åsgard A was chosen as a host, but the facility was quite busy at the time, so the project didn't play out. Then, the field was looked at again, including the possibility of developing it with Wintershall's Maria field (due on stream in 2018, as a tieback drawing on four nearby facilities for services and export. (See

OE: November 2016). It didn't work out, however, due to economics, reservoir properties and other uncertainties, Stensrud says.

As more wells came on at Åsgard, however, more was learned about Trestakk and, early in 2015, Statoil set back concept select on Trestakk, believing it could "do it differently" and make it a commercial project.

Cost savings

The initial investment estimate for Trestakk was about US$1.17 billion (NOK10 billion), which was reduced to $820 million (NOK7 billion) when the concept selection was made in January 2016. Since then, additional improvements and concept adaptations reduced the estimate to about $640 million (NOK5.5 billion).

Every element of the project was examined through 2016, Stensrud says. "We improved each part, sometimes beyond the targets we had set ourselves. This isn't about taking advantage of the market going down and companies struggling. It's about sustainable solutions."

Cost savings were achieved through raw materials and rig rates, including shortened drilling time, optimized well strategy, and increased volumes in the development.

New, improved seismic was acquired to gain a better understanding of the reservoir and de-risk a segment of the field that is currently unproven. "The new seismic made us look more carefully to optimize well placement and gave us more confidence there are hydrocarbons [in the second segment] and de-risked that segment," Stensrud adds. "We also have over the years increased our understanding of the regional trends, plus production data from other wells at Åsgard."

The new seismic also helped reduce the number of pilot wells planned and optimize the wells and the well paths, reducing the number of meters needing to drilled – and therefore drilling days. Batch drilling was also looked at, and drilling and well services requirements were reduced to what was actually needed.

"We [also] looked at how we could be more efficient, having a standardized [tree and well] design, open hole completions, and standardized well solutions," he says. Learnings from Statoil's perfect well program will also be used.

Subsea layout

Another saving has been around the subsea layout and solutions, which was revisited and simplified towards concept selection, then further simplified when the Forsys joint venture (now TechnipFMC), came onboard for front-end engineering and design studies. The firm has since been contracted to supply the flexible riser, production flowline, gas injection line, flexible jumpers, and umbilicals for Trestakk, as well as the subsea production system — including subsea trees and completion system, a manifold, wellheads, subsea and topside control systems.

We share more with the fairy tale than just the name. It is a long story and it is the same with Trestakk. It's about an underdog that never quits.

"One of the first thoughts (we had) was can we use the infrastructure at Åsgard better," Stensrud asked. The system had included dynamic and static umbilicals. Changing the technical solution from connecting the umbilical to Åsgard A, and instead having a tie-in towards one of the existing templates nearby took out the dynamic umbilical and saved about 10km of static umbilical. Also, the original plan for two templates was simplified to one standard template and a satellite, so an additional gas injection line wasn't needed.

More direct pipeline routing reduced scope and meant less seabed intervention. Laying the production line, umbilical and service line with inline Ts and flexible jumpers meant metrology and rigid spools could be cut out, saving about 40 days' marine campaign, Stensrud says.

The vertical subsea tree and the template design are both a copy from Johan Sverdrup project, to reduce engineering hours.

Topsides

Further costs savings came from using existing and now available topside facilities and capacities on Åsgard, such as for the separators. In fact, Åsgard decided to move its low pressure wells to one separator so Trestakk fluids can be put through only the other separator, meaning a saving on metering and associated instrumentation and controls. The local equipment room, heating, ventilation and air conditioning, and hydraulic power unit scopes were also removed, because the timing was right to use capacity on Åsgard, Stensrud says.

Execute and repeat

Taking the lessons from Trestakk to make other existing and future discoveries near existing infrastructure could help the Norwegian shelf maintain its production levels, Stensrud says. "I don't think Trestakk is unique. We have a lot of these fields near other infrastructure. The question is, can we use what we learned on Trestakk on other fields?"

It's seen as an urgent issue on the Norwegian Continental Shelf, as in the UK North Sea, where existing infrastructure is now available, but may not be for much longer as producing fields deplete. The volumes from Trestakk will help Åsgard A keep running until at least 2030, which will also give time to maximize production from the field and give flexibility in the drainage strategy, Stensrud says. Without Trestakk, Åsgard A's life could have been shorter and recovery less.

On Trestakk's PDO submission, Kalmar Ildstad, the Norwegian Petroleum Directorate's assistant director for development and operations in the Norwegian Sea, said: "The Norwegian Petroleum Directorate expects that all profitable projects are developed and that plans will take surrounding infrastructure into account."

Statoil appears to be onboard. This year, four of Statoil's Norwegian exploration discoveries have been near other installations, Stensrud says. Other, past, discoveries are also being looked at, to see how they can be made into further future Cinderellas. **OE**

Tapping into AUVs' potential

The true potential of AUV capabilities have not been fully realized, according to a technical session at this year's Offshore Technology Conference. Karen Boman reports.

An Oceaneering AUV. Photos from Oceaneering.

The capabilities of autonomous underwater vehicles (AUVs) have matured, but their full potential for offshore oil and gas operations remains untapped.

Twenty years ago, Andy Hill, global geohazards technical authority with BP, called for the oil and gas industry to adopt AUVs because he believed AUVs offered an effective way to address operational inefficiencies of deepwater survey and the inadequacies of towing equipment; the growth of exploration and production in deepwater and complex offshore terrain; and need for better data quality at a reasonable price.

"Initially, contractors balked at AUVs, believing it would make survey vessels obsolete overnight," Hill said at the Offshore Technology Conference in Houston this May. But, Hill and BP persisted with their message. As a result, AUVs first became commercially available to the oil and gas industry in 1999. But, it would take a commitment from a contractor outside of mainstream oil and gas to deliver these first AUVs.

After an initial period of experimentation in the early 2000s, the sustainability of the AUV market increased from 2005-2014. During this time, the choices for AUV vehicles for nearshore and deepwater, AUV payloads, and reliability of AUV technology increased. Since October 2012, DOF Subsea says that more than 320 dives yielding 25,000km of data have been carried out, delivering less than 4% downtime on eight different vessels for six different clients, said Leonard Ricketts, AUV offshore manager for DOF Subsea, during the OTC session.

Autotracker technology also has been developed and proven for AUV pipeline inspection, Hill said. This technology is be available. Except for the Caspian Sea, however, oil and gas companies have not adapted this technology for inspection, preferring to stick with existing tools such as vessels and remotely operated vehicles (ROVs), Hill stated. BP is seeking to change that with its 2017 Internal Challenge, where BP aims to cut pipeline inspection costs 50% by 2020.

BP is looking to new technology to achieve this goal. But, companies also need to know how to locate all of their data, the quality of data needed, resolution and repeatability, and gross or centimetric accuracy, Hill explained. The ability to provide instantaneous access to multiyear point data also will be necessary.

Emerging technologies such as machine learning, subsea Internet of Things and robotic swarm technology machine learning could enable automated inspection. The Holy Grail of AUVs – autonomous subsea intervention – has yet to the reached. The technologies to accomplish this feat exist, but operators haven't consistently pursued them, Hill said.

"Just as 20 years ago it took a contractor from outside of mainstream oil and gas, it may take another company outside of the mainstream" to push further adoption of these technologies, Hill said.

Value-approach needed

While technical challenges such as ROV tether management systems created initial interest in AUVs, commercial and quality demands drive AUV survey demand now, Ricketts said. AUVs have proven not only to be reliable, but to be a low-cost solution. However, AUVs are struggling for their own identity, Ricketts said.

In the late 1990s and early 2000s, AUV service providers drove down operational costs so that AUVs would be adopted by the oil and gas sector. While this strategy succeeded, it had a downside. It fostered a cost-based approach to

AUV surveys instead of a value-based approach. Because of tight margins, the cost-based approach makes it difficult to invest in upgrades and maintenance of AUV technology, Ricketts said.

The legacy of 'cost per kilometer' tendering means that the industry still does not take full advantage of what AUVs can offer, Ricketts and co-author Christopher Ordonez stated in an OTC paper, "Project Cost Reduction and De-Risking with Large-AUVs for Hydrographic and Pipeline Surveys." For example, many clients still opt to minimize line kilometers by opening up the line spacing to the point where a digital terrain model is only just achieved without any gaps. This forces the AUV to fly at a higher altitude, compromising data resolution.

Companies that own larger class AUV submarines also are often heavily invested in ROV assets, creating indecision for their own business development teams, Ricketts and Ordonez said. This issue is typical of a market in the midst of technological transition and diversification.

"We are at the stage where acoustic pipeline surveys are being executed more efficiently with an AUV rather than an ROV," Ricketts and Ordonez said. Intervention, repair and maintenance will still be the domain of ROVs for some time. But, at this point, clear market slots for each technology appear to exist. AUVs appear to be making headway in a traditional ROV domain, acoustic pipeline surveys, due to their speed, quality and repeatability.

Ricketts believes that service providers need to make a better case for the values of fully utilizing AUV capabilities. This includes data quality, one of the primary advantages offered by AUVs in survey work. Today's largest survey class AUVs carry a range of instruments and sensors, including side scan sonar, chirp seismics, multibeam sonar, backscatter, leak detection, high resolution color photography and laser scanning. Data gathered can be seamlessly accepted into the emerging and rapidly advancing technology of data fusion. As a result, powerful 3D visualization datasets such as pipeline photo mosaics draped over high resolution laser micro-bathymetry, can be created.

Due to improved reliability, AUV technology itself is no longer a bottleneck. Going forward, data management and storage must be considered. Ricketts said the biggest possible challenge is creating a data visualization platform that permits the client to work with higher resolution data without investing in expensive software or hardware.

An alternate view of an AUV.

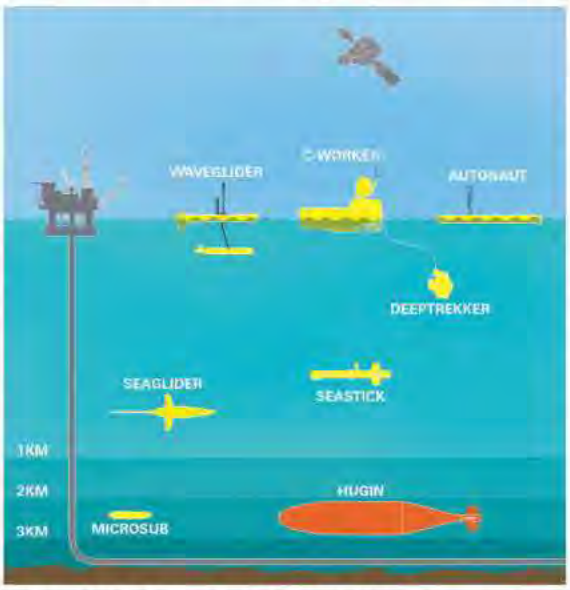


Illustration of ocean monitoring robots. Image from BP.

"If people can use their iPhones to look at data, why can't they do the same with survey data," Ricketts said of having tools like Google Maps and Google Earth to look up survey data.

Setting records off West Africa

Total E&P and Oceaneering officials offered an example of their record-setting use of AUVs in deepwater subsea pipeline inspection offshore West Africa. In recent years, AUV-mounted high resolution sensors such as lasers and subsea cameras, as well as conventional sensors, have become more widely available. These tools allow operators to conduct baseline surveys, field monitoring, and inspection purposes, according to a paper presented by Sébastien Ghis, geomatic & positioning specialist at Total E&P, and Eric Fischer, project manager at Oceaneering, "Record-Setting AUV Pipeline Inspection in Deepwater West Africa."

For the offshore West Africa surveys, data gathered through both conventional and unconventional sensors was integrated into a geographical information system (GIS), which provided a better baseline picture of the installation and areas that needed to be addressed.

The survey results found that AUVs will not completely replace conventional ROVs in deepwater pipeline survey work. While ROVs can be used to achieved all pipeline inspection work, an AUV's limited maneuverability means that a horizontal safety distance must be maintained between the AUV and all subsea structures. As a result, the AUV cannot achieve the whole scope of pipeline inspection, and is limited to survey 96% of the flowline/pipeline lengths.

For the large majority of pipeline surveys, however, AUV pipeline inspection surveys not only take five times less than ROVs to collect survey data from the same feature, AUVs pipeline surveys also are five times cheaper than ROV pipeline surveys, and minimize HSE (health, safety and environmental) risk by limiting worker exposure to the offshore environment, Ghis and Fischer said.

"The development of a GIS-based data reviewer in close collaboration with end-users, combined with the use of WebGIS, provides access to a subsea layout with an optimal spatial resolution," Ghis and Fischer stated. "The data provides solid GIS products for subsea inspection, repair, maintenance planning and further dedicated ROV detailed investigation." It also provides a database, which could be used for a "time lapse" approach to detect subsea geohazards and subsea equipment modifications over a field's life. **OE**

The Tao of subsea

Ocean floor mapping is being completely re-thought, with the help of drones, swarms of underwater vehicles and unmanned surface vehicles. Elaine Maslin reports.

Team Tao's BEM concept.
Images from SMD.

We know more about the surface of Mars than we do about the ocean floor, and that's not good enough, says supermajor Shell. To spur technologies that could help understanding of the deep, Shell launched a US$7 million competition, the Shell Ocean Discovery XPRIZE.

The challenge is to create technologies that could autonomously map the seabed down to 4000m water depth – at super-fast speed. Round 1 will see teams attempt to survey 20% of a 500sq km seafloor competition area in 16 hours, in 2000m water depth, then produce a high-resolution map (at least 5m horizontal resolution and at least 0.5m vertical resolution).

Teams must also bring back five images of an archeological, biological, or geological feature, as well as an image of an object specified by Shell. They must deploy from the shore, with no humans allowed in the competition area.

"To put this challenge into perspective, it can take days to map 500sq km of the ocean using current state-of-the-art technologies," says Jyotika Virmani, XPRIZE's senior director for Energy & Environment. "If you want 5m accuracy, mapping can take over a week and requires going out on a ship, which can easily cost over $60,000 per day."

Existing technologies cannot operate at the large scales needed to cover the ocean, unless they make substantial compromises in mapping, resolution, power and weight of sensors.

Following Round 1, 10 of the 21 semifinalists, selected from 32 initial entries, will go through to Round 2. The second round will challenge them to go down to 4000m, map at least 50% of the 500sq km competition area at 5m resolution, and identify and image at least 10 archeological, biological or geological features at any depth – all within 24 hours. Again, deployment must be from the shore, reaching up to 100km out to sea.

The winner takes a $4 million prize. Two runners up will receive $1 million each. The National Oceanographic and Atmospheric Administration has set a $1 million bonus for the team that can detect the source of chemical and biological signals underwater.

Technologies to be tested in Round 1 include various air and water drones, autonomous underwater vehicles (AUVs), robot swarms, artificial intelligence and data processing platforms. "Some are proposing to use drones as a mechanism to drop subsea instruments into the water, while others are proposing to use drones that not only go through air, but then dive into the watery depths," Virmani says. "Non-aerial entries include autonomous surface vehicles (ASVs) carrying subsea robots that will return to the 'mothership' when their work is done, as well as vehicles and robots that will remain beneath the sea surface from the moment they leave the shore."

Team Tao at work.

Team Tao

The only UK-based semifinalist, a collaboration between subsea equipment specialist Soil Machine Dyanmics (SMD) and Newcastle University, is Team Tao. In 2015, Dale Wakeham, team leader and industrial design engineer for SMD, put the idea to parent company, China's CRRC Times Electric, which is backing the team's XPRIZE entry. "By August 2016, we were in China trying to work out ways to solve the problem – mapping 500sq km within 24 hours, with an autonomous system, which could fit into a 20ft container," he says.

Team Tao is working with Chinese state institutes as well as with UK- and US-based organizations. After seeing what was already available and finding nothing – they looked at a swarm-based approach," Wakeham says. "Imagine a colony of ants working together and very effectively."

In a typical AUV deployment, one AUV is lowered into the water, does its mission, then is brought to the surface and

the data downloaded. Then, the AUV is recharged and sent off again. Team Tao's approach would have a swarm of units, which they've called bathypelagic excursion modules (BEM), deploying continuously from an ASV. The BEMs would build a picture of the seabed by each taking a snapshot, then returning to the surface for data download and processing. The idea is to have up to 20 BEMs on an ASV, with an aerial drone providing air support and communications.

Team member Hua-Khee Chan, a research associate at Newcastle University's School of Electrical & Electronic Engineering, says that traditional AUVs are too big and expensive. "To map the same amount of area would cost around £10 million ($12.9 million) for 24 hours," he says. "Using a swarm of BEM AUVs could cost £1.5-2 million ($1.9-2.6 million) and if one BEM fails, the survey will keep going. Using a swarm approach, you can have a cyclic, continual operation without any system downtime."

Team Tao's BEMs are quite unlike traditional AUVs – they travel vertically, with their nose pointing up and a thruster mounted on a gimbal at the base for directional control. The BEMs, measuring about 1m-long and weighing 10kg, would be transported on a ASV and dropped sequentially, at set location. Cycle time would be 30 minutes, instead of eight hours for a traditional AUV. "The inspiration is from marine life," Wakeham says. "We are taking as much as possible from nature."

Each BEM would have an onboard altimeter and gyro to maintain heading. Each BEM also knows where the others are, thanks to ultra-short baseline acoustic positioning connected to a single surface beacon on the ASV. Onboard the ASV, there would be a built-in data processing system to strip data from each unit when they surface.

"One of the beauties of making the swarm travel vertically instead of horizontally is that we can leave out a lot of complex technology because dive time isn't as long," Chan says. "We have smaller batteries, smaller, cheaper technologies and consumer-grade electronics." Because the BEMs are smaller, the surface handling system will also be less expensive.

Work at the university on small and low-cost sensor arrays, which leverage software to improve performance, will be brought to bear on the system.

To address the challenges of communicating with an unmanned system up to 100km offshore, the team may initially use satellite systems. However, they are trying to build as much autonomy into the ASV as possible, so that only needed data is sent via satellite back to the shore.

Subsea, programming and naval architecture students from Newcastle University are helping on the project. UK firms are producing the sonar system and the positioning system. Lenovo has provided IT equipment and computational capacity. Fablab in Toulouse, France, is developing a prototype launch and recovery system (LARS).

Team Tao will be able to use the university's research vessel for sea trials. But first, the team will build a half-scale LARS, then test it in the nearby River Tyne. The team's base at the university's Tyne Subsea Technology Centre has a large pressure chamber for testing the BEMs down to a simulated water depth of up to 6000m. Should the team be one of the 10 selected to go into Round 2, it will – as will the others – win $100,000 and have a further year to develop the system. **OE**

Engaging with the subsea industry

Pat Oakley, of the Umbilical Manufacturers Federation, highlights initiatives brought forth from a recent workshop with operators.

Umbilicals are an essential and critical link in subsea production systems. Over the past three decades' umbilical designs have increased in complexity and functionality, with products being installed around the world, and in depths of up to 3000m.

It is therefore important with the developing trend to deeper waters, higher pressures, longer tieback distances, and with subsea production moving into increasingly hostile environments that the technical aspects of this sophisticated product are well understood by subsea system designers, manufacturers, installers and end users.

To facilitate this knowledge transfer the Umbilical Manufacturers' Federation (UMF) continually seeks to engage with the industry by means of workshops, JIPs, and the publication of technical guidance notes addressing issues not covered by existing standards

The UMF maintains close dialogue with oil and gas operators in order to explore how the reliability and functionality of umbilical systems can be maintained and improved upon. During a UMF workshop with major international operators including BP, Chevron, ConocoPhillips ExxonMobil, Shell and Statoil, their experience in the use of umbilicals and future design trends were explored. Several issues were identified from these discussions giving rise to various UMF initiatives.

UMF guidance notes and annual statistics on control umbilical supply volumes are free, and can be downloaded from the organization's website: www.umf.as/downloads

The UMF's current initiatives include generation of a further guidance note on umbilical impact testing in order to address gaps in this topic in international standards. Also a technical note is under preparation on umbilical installation tensioner guidance and pad design. Both documents will be freely available from the UMF website in due course. OE

	Operator concern	UMF initiative
	Existing umbilical standards may be inadequate	The UMF has closely engaged with API regarding the forthcoming revision of the API 17E subsea umbilical specification. The UMF technical committee has made several submissions to API aimed at improving the range and quality of the standard. The UMF continue to seek opportunities to improve the scope and relevance of umbilical specifications including a new revision of its GN03 guidance note on super duplex tubing.
	UTA electrical termination component reliability and design life	The UMF is currently conducting a review of current industry JIP activity aimed at subsea low voltage terminations and connectors. Consideration is being given to a UMF sponsored JIP on this topic.
	Scope for improvement in definition of umbilical installation parameters	Umbilical installation is a technically complex operation and it is important that the key characteristics of the product are communicated between the manufacturer and installer. After considerable dialogue with major installers the UMF generated a standard template to facilitate this information exchange. The template in the form of a guidance note (UMF GN07), identifies key umbilical data to be provided. This includes product data such as dimensions and weight in air and water, plus a wide range of handling characteristics.

	Operator concern	UMF initiative
	Need for definition of responsibilities during umbilical load-out	The handover of product from the manufacturer to the installer takes place at the load-out stage when the umbilical is transferred from the production facility to the installation vessel. The UMF developed a guidance note (UMF GN05) on the subject which defines the typical respective considerations of both the manufacturer and installer in respect of load-out, development of the installation procedure(s) and manufacturer support to installer during load-out, installation and commissioning of the umbilical system.
	Need for guidance on short- and long-term storage of umbilical products	When there is to be a period between completion of umbilical manufacture and installation the umbilical may be stored on a reel or carousel. It is important that appropriate storage conditions are in place and that the umbilical is tested at the end of the period to ensure it remains in optimal condition for installation. To address this issue UMF issued a guidance note (UMF GN06) recommending conditions and test parameters for both short term (<6months) and long term storage.
Blockage Avoidance in Subsea Injection and Control Systems BASICS A Joint Industry Project	Need for guidance on umbilical fluid conduit blockage prevention and remediation	The UMF has previously initiated the launch of an industry JIP on this subject known as BASICS (Blockage Avoidance in Subsea Injection and Control Systems (basics-jip.com). The JIP has resulted in two API publications API 17TR5 and API 17TR6 covering the design of subsea systems to prevent blockages and the specification and handling of chemicals for use in such systems.

Detecting corrosion through data

Riser and slip joint on a semisubmersible oil rig. Photo from iStock.

Matt Jones and Jim Sokolowski, of Tessella, show how data analytics can give insight into corrosion rates to reduce risk and maintenance costs.

Corrosion is a fact of life in offshore environments, and offshore production costs are significantly impacted by it. It is often a known unknown, and this makes business and investment decisions that need to consider its impact harder and riskier.

This offers an even trickier proposition when facilities are nearing the end of their life and alternatives, such as carbon capture and storage (CCS) in depleted reservoirs, are being considered.

Such an alternative was being considered by an operator in the North Sea. But, the firm wanted to understand the possible causes of corrosion on its existing facility, to be able to predict future corrosion accurately. These insights could be used to make other decisions, such as how to optimally plan expensive corrosion re-measurement campaigns.

The company had just less than 10 years of historical eddy current data about surface casing and conductor corrosion from scheduled measurement campaigns, as well as original spud data. However, there was a need to truly understand what this data meant. The data showed that some wells had significantly worse corrosion than others that appeared to be "similar," but they were unsure why.

As mentioned, some of the historical data was eddy current measurements – a common corrosion test by which a magnetic field is applied to the material, and variations in the electrical conductivity and magnetic permeability are used to map corrosion – and there were significant questions about the validity of these measurements. Taking accurate corrosion measurements like these are complex and often the uncertainties and errors can be so large that the measurement ranges from useful, to useless.

Tessella started a first principles analysis to deepen the understanding of the root cause of corrosion by exploring 20GB of data acquired from historical operational measurements from the PI historian, captured over nearly 20 years. The data did not require special processing or cleaning prior to use.

Our data scientists explored the time histories of all the operational data for temperatures, pressures, production rates and water rates, and used a range of statistical techniques (principal component analysis, dimensionality reduction and cluster identification) to find structure in this history. They examined whether any of these clusters correlated with the corrosion levels, then drilled down into the underlying variables to understand what element in the historical record was driving this.

By applying knowledge of corrosion chemistries and environmental mechanisms that accelerate the corrosion process, the operational details from the historic data could be used to determine possible likely causes of the high corrosion in the affected casing.

Next, Tessella's data scientists focused

on estimating the future corrosion of casings in a new study in a depleted field, to help assess its potential long-term use in a CCS capacity.

This work had started from a scientific publication in 2005 that had presented a methodology to estimate corrosion rates more effectively. The approach assumes a particular stochastic corrosion model, and then uses Bayesian probability techniques to estimate the associated parameters, such as mean corrosion rate.

The analytics team then enhanced this Bayesian approach to be more appropriate to the issue of interest. This required analyzing and modeling the errors in the corrosion measurement process, developing a new understanding, as well as leveraging prior information using data from previous fields.

The resulting models were able to predict mean corrosion rates of well casings across the second depleted field, as well as associated uncertainties and also sensitivities of the results to the various assumptions made. This allowed our data scientists to understand how far existing infrastructure has corroded, and predict the associated future lifetime, and hence suitability, for use in the CCS context.

In addition, the analysis showed the ability to optimize future corrosion measurement campaigns based on individual well corrosion predictions and uncertainties, with associated cost savings.

The key to successful data projects

There are several factors that made this data project a success. First, there was a clear objective and business question. The approach was then focused on using the data to look for the insight needed.

Second, those involved understood the business, scientific and engineering challenge, as well as the data. Meaning, the context of what the data was telling them was understood, and they could hypothesize about what correlations mean, and then rigorously test them to establish causation.

Finally, the project looked at how data could quickly address a specific problem and in a timescale of weeks, not years. By taking the right approach, data analytics can deliver real business value, quickly. OE

Multiphase gaps

Michael Reader-Harris, of NEL, outlines the risk that absent multiphase flow measurement standards pose to industry.

Michael Reader-Harris

While accurately measuring a complex mixture of oil, water and gas is a major challenge for the oil and gas industry, production from aging fields with reducing reserves has increasingly made it a necessity. Multiphase flow meters were developed in the early 1990s to support more economical development of marginal, deeper and more complex fields, and they will play a major role in the shift to subsea production in deeper waters.

While industry recognizes the vital role that these meters will play in the future, no ISO (International Organization for Standardization) standards have yet been published. This expanding meter market lacks the ISO guidelines that assure both operators and authorities of consistency. Also, international standardization lowers barriers to trade and provides confidence in the product.

A lack of multiphase meter standardization could therefore have a substantially negative impact on accuracy in allocation or well testing for the industry, and discourage introduction of a technology that is required for the development of marginal fields.

However, work has started to fill the gap in international standards. Using the Norwegian Handbook of Multiphase Metering from 1995, which NFOGM has permitted ISO to use as its basis, the new ISO Technical Report, ISO/TR 21354 will provide up-to-date guidance. It will contain sections on multiphase flow, multiphase meter technologies, the aims of multiphase flow measurement, the production envelope, performance specification, testing, field installation and commissioning, and verification during operation. It will also include an annex on inter-comparison between laboratories, which shows the level of agreement between laboratories and reduces retesting.

This Technical Report will show how using a two-phase flow map to plot the trajectory (production envelope) of wells, and then overlaying the measurement envelope of possible multiphase meters, can ensure that the correct one is chosen; moreover, appropriate maintenance and verification strategies will be introduced that will save cost and increase reliability for the user.

ISO committee, ISO/TC 28/SC 2/WG 4: TC 28/SC 2, is responsible for oil flow measurement, within it WG 4 oversees metering and meter calibration. To develop ISO/TR 21354, WG 4 members include myself, and experts from China, France, the Netherlands, Norway, the UK and the US. Some of the experts work for major operators and are including reliable information that has arisen from their experience. Such information, for instance on performance testing requirements, will reduce the risk of poor performance, and ultimately failure, in the field.

The intention is that the technical report will be published in 2018. Then there will be an internationally agreed document that avoids both inaccuracy through inadequate specification and excessive cost through over-specification. OE

Managing stick-slip

Mats Andersen, Stephen Forrester, and Andrew Creegan, of NOV, discuss how to overcome potentially damaging stick-slip issues and improve drilling performance rates.

Stick-slip, a mode of drilling dysfunction characterized by a cycle of the bit coming to a stop and accelerating to speeds greater than the mean bottomhole assembly (BHA) speed, has become an important risk element in oil and gas drilling operations. Awareness of stick-slip, which is largely a vibration-related phenomenon, has increased in part due to the rise of polycrystalline diamond compact (PDC) cutters that drill through rock with sheer rotary force. When stick-slip occurs at the end of a drillstring, the resultant release of accumulated energy causes extra twist in the string, which can cause severe bit damage. This can happen during both torsional and lateral vibration during the stick and slip phases.

Combating stick-slip is critical to improving performance, increasing drilling efficiency, and enhancing equipment life. Stick-slip can cause significant wear to the outer cutters of drill bits and excessive heat checking, leading to more bit runs per section and a higher frequency of bits that are damaged beyond repair. Overall drilling performance can be decreased due to persistent stick-slip, as the amount of energy transmitted from the topdrive to the bit is greatly diminished. Cutters engage with less consistency and torque-on-bit fluctuates, while rate of penetration (ROP) decreases and mechanical-specific energy increases. Premature bit wear, measurement while drilling (MWD) tool failure, and motor failure are also potential problems due to the damaging vibration seen in the slip phase. To deal with the issue of stick-slip and increase drilling efficiency, National Oilwell Varco (NOV) developed and commercially deployed the SoftSpeed II stick-slip mitigation system.

Stick-slip mitigation system

NOV's SoftSpeed II system is a software application added to the topdrive controller that manipulates topdrive RPM to absorb torsional energy transmitted to surface and reflects only a portion of the energy back. After several iterations of this, vibrations are dampened and the string becomes stable. Generally, increases in torque yield decreases in RPM, and vice versa, which is known as destructive interference. When the driller activates the SoftSpeed II system, the system's analyzer continually identifies, quantifies, and alerts the driller to torsional vibrations. If the stick-slip severity indicator on the driller's screen shows a degree of stick-slip, the driller can activate the SoftSpeed II system to provide optimal damping to mitigate those stick-slip occurrences.

The conventional method of mitigating stick-slip is increasing RPM and/or decreasing weight on bit (WOB), which is inefficient and can induce bit-damaging lateral vibration. By using the SoftSpeed II system, higher WOB can be achieved at a given RPM before stick-slip foundering occurs (Fig. 1).

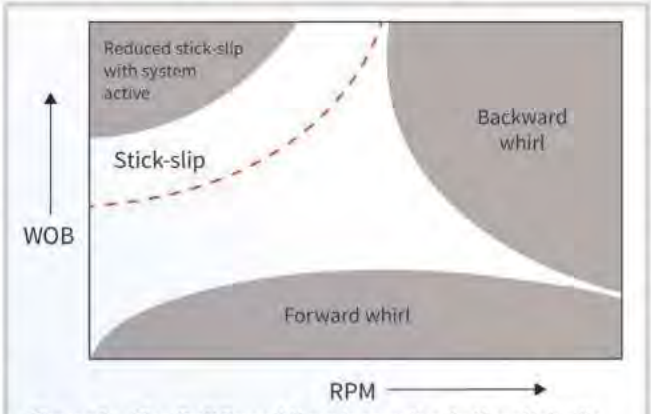


Figure 1 – The SoftSpeed II system extends the stick-slip envelope and allows for higher WOB at a given RPM before stick-slip occurs. Images from NOV.

In addition, using the system eliminates the need to employ more traditional methods of mitigating stick-slip. In the past, bit design would be made less aggressive, with smaller cutters and more blades leading to depth-of-cut limitations and increased back rake. The BHA could also be redesigned with fewer stabilizers, or parameters could be manually manipulated by the driller to increase RPM and decrease WOB. While these methods proved somewhat effective, they frequently resulted in decreased ROP and higher overall well costs.

Alternating current (AC) topdrives apply the appropriate amount of energy needed to maintain an RPM setpoint, while the drillstring acts as a transmission line for torsional energy waves. The SoftSpeed II system tunes the drive to catch such waves by absorbing them, which is possible due to the stick-slip period having been predicted by the system's calculations. The system determines the stick-slip period by modeling the drillstring as a torsional spring-and-mass system and calculating stick-slip

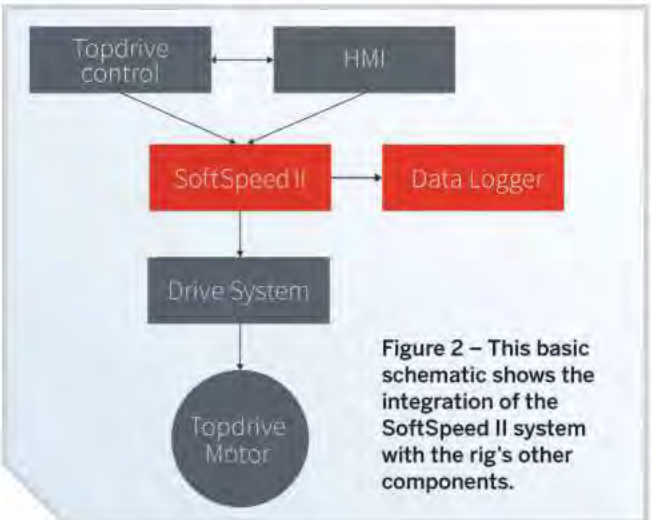


Figure 2 – This basic schematic shows the integration of the SoftSpeed II system with the rig's other components.

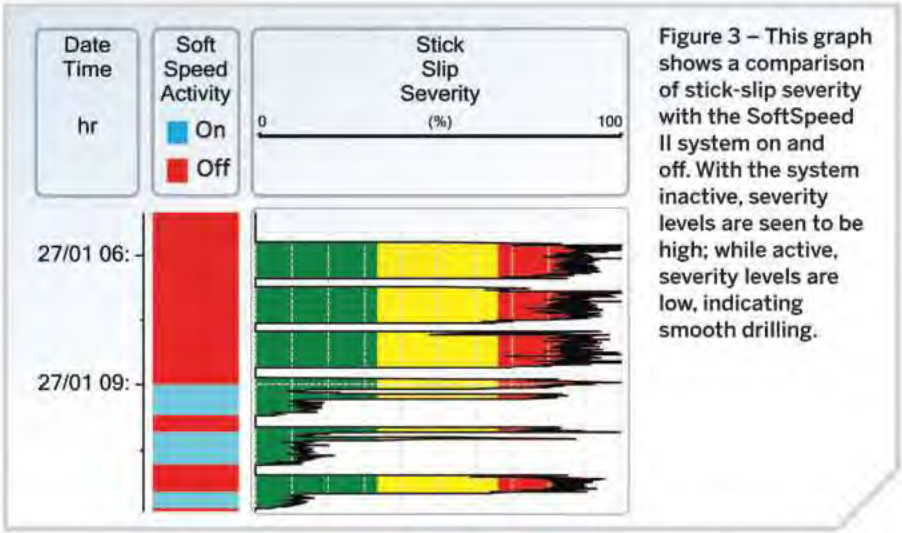


Figure 3 – This graph shows a comparison of stick-slip severity with the SoftSpeed II system on and off. With the system inactive, severity levels are seen to be high; while active, severity levels are low, indicating smooth drilling.

frequency, which is modified based off of torque feedback. The stick-slip period is determined automatically, and the system informs the user of the estimated BHA speed.

Case history

An operator drilling in the North Sea was suffering periods of extreme stick-slip in their 8½-in. horizontal section. Stick-slip severity was seen to be at a level indicative of true stick-slip for an extended period of time before initializing the SoftSpeed II system. System activation allowed the rig to drill in a much more efficient manner, thus increasing ROP, decreasing downhole equipment fatigue, and lessening the risk of a catastrophic event such as a drillstring twist-off.

Rig components/software integration

The North Sea client had the SoftSpeed II system integrated into the rig's topdrive controls, which then synchronized with other components across the rig. The full system, outside of the SoftSpeed II software algorithm itself, on the subject rig is as follows (Fig. 2):

1. Human-machine interface (HMI): The HMI is part of the Amphion integrated control system, which allows operation of the SoftSpeed II software, visualization of drilling parameters, and input of pipe tally values.
2. Topdrive control: This is the control system for the topdrive.
3. Drive system: The drive system is a variable frequency drive (AC) that controls the topdrive motor.
4. Topdrive motor: The topdrive motor reads the inputs from the SoftSpeed II system and provides the necessary output to vary pipe rotation to automatically mitigate stick-slip based on the software model.
5. Data logger: The data logger records relevant topdrive and SoftSpeed II system parameters at 100 ms/10 Hz for diagnostics and performance checks of the system, making the data available for further analysis.

Commissioning

A dedicated commissioning and setup procedure was developed for this project. NOV deployed a field-service technician and project engineer to the rig site to install the software, map the visualization channels, and commission the system. This required access to the topdrive without pipe in it and was accomplished during scheduled downtime. During commissioning, the engineer remained with the drilling crew to ensure proper training on the system's functionalities. Upon completion of this phase, the software was linked to a real-time technology center to enable constant monitoring of the system, allowing onshore engineers instant insight into performance metrics. Having this knowledge helped NOV provide the client with daily reports, which included information such as stick-slip severity by depth and calibration and tuning specifics, to their office. In addition, the reports confirmed that WOB, ROP, torque, and RPM properly correlated with downhole conditions.

Implementation and results

Upon implementation of the SoftSpeed II system, the rig saw a marked improvement in drilling performance. With the system largely inactive, stick-slip severity levels were seen to be near 100%. This level of drilling vibration, which represents a true stick-and-slip cycle, is known to be damaging and inefficient. The rig coped with this level of stick-slip for 39 hours, drilling at an average ROP of 19m/hr (62.3ft/hr). The decision was then made to run the SoftSpeed II system consistently, with vibration levels greatly mitigated as a result. Over the next 24 hours, the rig saw stick-slip severity levels drop to "Level 1," which indicates smooth downhole rotation. It was also noted that the ROP for this period had increased by 2m/hr (6.6ft/hr) to 21m/hr (68.9ft/hr). This allowed the rig to drill approximately one and a half extra stands in that day compared to the prior drilling rate, when vibration was high and drilling less efficient. **OE**

Mats Andersen *leads strategic sales for NOV's ReedHycalog division in Europe and West Africa. He has worked in the oil and gas industry since 2000, joining NOV in 2008 as part of Grant Prideco. He holds a Bachelor's degree in petroleum technology from the University of Stavanger, Norway.*

Stephen Forrester *has worked at NOV as a marketing/technical communications writer since 2014. Before joining NOV, Stephen worked for the oil and gas division of Lloyd's Register as a technical editor. Stephen holds both a BA and MA in English from the University of Houston.*

Andrew Creegan *serves as a product line manager at NOV, where he has worked since 2013. He has worked in the past as a drilling optimization engineer and MWD/LWD field engineer prior to focusing on several specific product lines, which include drilling performance software such as SoftSpeed II, at NOV. Andrew holds a BS in petroleum engineering from the University of Oklahoma.*

Mediterranean & N Africa

Hot air

High hopes are pinned on gas as a transition fuel and there being markets to sell it to in the gas-rich Mediterranean. Elaine Maslin reports

The gas discoveries made in the Mediterranean since 2009, notably Leviathan (Israel) and Zohr (Egypt), have propelled the basin into one with worldwide relevance – according to those with a stake in it.

These huge fields and others have the potential to turn-around fortunes. In Egypt, the Zohr discovery could help return the country to a gas exporter, instead of an importer with idle export infrastructure.

Such countries hope that carbon-reduction commitments, not least those made in the 2015 Paris agreement, will see natural gas used to help the world transition to a lower carbon future, as well as addressing energy security concerns, helping those with it find ready markets for it. Egypt also hopes it can become a gas hub, to export neighboring countries' finds, such as Lebanon and Cyprus.

The Paris agreement was a watershed moment for Innocenzo Titone, president of the Offshore Mediterranean Conference (OMC), held in Ravenna, Italy, in late March. "Things will never be the same as they were before," he told the event, which had visitors from 30 countries and 650 exhibitors over 30,000sq m. "In the transition, the oil and gas industry has a role to play. No transition will be achieved without integration of renewables and fossil fuels, specifically gas. The huge potential in the Mediterranean can act as a driver for this."

Gilberto Dialuce, director general for energy supply security and infrastructure, Italian Ministry of Economic development, told OMC that development of the eastern

***Maersk Discoverer* drilling in Egypt's Eastern Med Sea for BP.**
Photo from BP's Flickr.

Mediterranean's gas could be positive for energy security, drawing countries in the region closer together. A more diversified gas, as well as electricity, supply and infrastructure could also improve the life of those on the southern shores of the Mediterranean, by improving their energy supply and security, and even ease issues such as migration, he said.

Eni CEO Claudio Descalzi at OMC 2017. Photo from Eni's Flickr.

Game changer

Until relatively recently, upstream offshore development was in stasis offshore Egypt. The uprising in 2011 saw President Hosni Mubarak overthrown and resulted in a period of uncertainty, as well as unpaid debt to international oil companies mounting into billions.

Tarek El-Molla, Egypt's Minister of Petroleum and Mineral Resources told OMC how the country, after 2011, fell fast into gas shortages, resulting in blackouts and factory stoppages. "We were paralyzed," he says. It wasn't until 2013 that a decision was taken to build LNG import infrastructure in place, so that the country, which is 92% reliant on fossil fuels for its energy, would have the energy it needed. Meanwhile, the country has some 19 Bcm/yr of idle LNG export capacity, says Manfred Hafner, professor at Johns Hopkins University and associate fellow at Fondazione Eni Enrico Mattei. Zohr will go a significant way to putting that export capacity back to use.

"Zohr is a game-changer," El-Molla says. "We have been, since 2011-2013, having difficult times... changes of regime and instability: politically, in security and economically. A great discovery like Zohr has made a lot of changes for us. Zohr is the biggest discovery in the Mediterranean and one of the major discoveries in the world and for us this is the beginning.

"We will be self-sufficient [in gas] by 2018 and, by 2019, we will be in a position to resume export by existing LNG plants," he adds. "We may go beyond that, with expansion of [our] LNG plants with additional trains. [there could be] other strategic plans for fertilizers and petrochemicals, that would need gas in parallel to exports."

Zohr, slated to be one of the longest subsea tiebacks in the world, was found in 2015 in one of 15 blocks awarded by Egyptian state-owned company Egas in 2012. Until then, exploration in the area hadn't yielded significant results (*OE:* April 2016). IHS Markit says Zohr holds in-place resources of 32 Tcf of dry gas, with possible recoverable resources of about 20 Tcf. A development plan for the field was approved in 2016 and first gas is expected late 2017. Meanwhile, in July 2015, Eni also discovered Nooros, which was brought online in September the same year.

"In a few years we are going to fulfill all domestic needs for Egypt for gas," said Claudio Descalzi, Eni's CEO at OMC.

Raccortubi expands

Before and through the downturn, Italy's Raccortubi Group has been expanding through acquisition and setting up new subsidiaries. The firm set up subsidiaries in Dubai, Singapore and São Paulo, Brazil, in 2013, acquired specialized butt weld fittings manufacturer Petrol Raccord in 2014, and then Raccortubi Norsk (then Norsk Alloys) in 2015.

The moves broaden the firm's geographic spread but also mean the firm's traditional production of butt weld fittings, from 1/2in to 16in from Tecninox, a part of the group since 1988, complemented with seamless and welded fittings up to 56in.

Last year, Raccortubi also introduced Titanium Gr 2 into its manufacturing and stockholding range, together with all the relevant base material. This means the firm can react quickly to orders and deliver complete packages, says Luca Pentericci, Raccortubi Group's President. The same ethos cuts across the whole business.

Luca Pentericci

"Due to the extensive raw material availability, we can work on tight schedules for specific projects but we are also able to guarantee a fast-track service to meet any urgent request from our customers," he says, adding that the firm's business model is to offer the flexibility of a stockholder while having the expertise of a manufacturer. "In Petrol Raccord, not only have we included in manufacturing welded elbows in two halves, but we have also implemented a new quick production line to rapidly manage orders even within a few weeks. This, of course, thanks to extensive raw material availability, [including] sheets/plates up to 50mm-thick in duplex, superduplex, 6Mo and titanium."

It should put the firm in good stead, when orders start to pick up. "We expect a global recovery when the oil price reaches a level at which companies will be able to arrive at a convenient breakeven point and restart investing," Pentericci says. "Of course, oilfields are very different to one another, but if the general situation is not expected to change rapidly, the methods for extracting crude oil will remain more or less the most traditional, without looking for complex solutions in terms of neither technology nor materials." ▪

Mediterranean & N Africa

"Egypt is consuming 55 Bcm/yr at the moment and growing, because the economy is growing. The plan is to reach more than 80 Bcm [production]."

Meanwhile, the hunt for the rest of the estimated 200 Tcf in Eastern Mediterranean waters continues, across Cyprus, Lebanon, and Israel. Egypt's broader vision is for the gas found to come to Egypt, which would then act as a regional gas. "We could help others monetize their gas," El-Molla says, with gas sent via existing or new pipelines to Egypt for consumption or re-export. El-Molla says that dialogue with Cyprus is already advanced, and there were also ongoing talks with Israel, Lebanon and Jordan.

Cyprus

Cyprus will be a key focus, said Luca Bertelli, Eni's chief exploration officer, at OMC, thanks to Zohr. "The Zohr play can contribute to the discovery of more gas," he says, having highlighted a new play, attracting the likes of ExxonMobil and Qatar Petroleum to Cyprus, alongside Eni and Total, in turn bringing competition to the region, with Total planning to drill in deepwater block 11 this year.

Yiorgos Lakkotrypis, Cyprus' Minister of Energy, Commerce, Industry and Tourism, says that Cyprus is "a country in its (E&P) infancy. But, with Zohr, the geology has been illuminated once again." Yet, monetizing what is found will mean regional cooperation.

Map of Block 11 offshore Cyprus.
Image from IHS Markit.

The country's small domestic market for gas – 0.7 Bcm/yr, rising to 1 Bcm in a decade – has meant while fields in neighboring Israel are being developed (Tamar, Leviathan and Zohr), while Cyprus' 4 Tcf Aphrodite gas discovery remains untapped. "Cyprus' market is too small on its own to support Aphrodite," Lakkotrypis says. "[Fields like] Aphrodite and others [to be discovered] will be for export." Cyprus' options include pipelines to Europe, onshore LNG and even compressed natural gas. But, the optimal way appears to be sending it to Egypt, he says. "The key will be cooperation. If there's no Eastern Mediterranean cooperation, then we will get nowhere," he says. Furthermore, export relies on there being market demand, which could be "unpredictable," especially from Europe, he says.

Starting from scratch

Lebanon's first bid round could finally play out in 2017 with five blocks on offer.

The country's Minister of Energy and Water, Cesar Abi Khalil, told OMC, "It is better to come late than never at all." In 2013, 26 operators prequalified for the first round. "Unfortunately, back then, the prime minister resigned. Now we have a new president and prime minister, and a new licensing round. Things are different," this time, Khalil says. Additional companies have also been invited to pre-qualify and the country has acquired 2D and 3D seismic data.

Lebanon Licensing Round Map. Image from Lebanese Petroleum Administration.

Khalil says that there is 122 Bcm of gas in the eastern Mediterranean, with about a third of it expected to be offshore Lebanon. The domestic market, which consumes 0.2 Tcf/yr, will be the first priority when it comes to getting the gas to market, due to the country's $1.5-2 billion deficit. Lebanon wants to rely less on gas import for power generation. But, he hopes that gas can be exported, too.

There are existing pipeline projects, such as the Arab gas pipeline, which was supposed to go to Turkey and reach Europe, but it is unfinished. "We hope once the Syria crisis is finished we will be able to utilize this," Khalil says. And he says that, realistically, it will be 4-6 years before any production is achieved.

Early in April, Lebanon extended its deadline for its second pre-qualification round to 28 April, to give companies more time to respond to requests from the Lebanese Petroleum Administration (LPA). As of 31 March, nine new companies sent applications to take part in the licensing round, including India's ONGC Videsh; Russia's PJSC Lukoil; Malaysia's SapuraKencana Energy; Algeria's Sonatrach International Petroleum E&P; Qatar Petroleum International; Egypt's Advanced Energy Systems; Iran's Petropars; JSC Novatek; and the trio of Vega Petroleum, Edgo Energy, and Petroleb.

The new nine join a list of 14 companies that were already prequalified in 2013, when Lebanon first tried to launch its offshore licensing round. The round will open up five blocks for bidding: 1, 4, 8, 9, 10. Winners are set to be announced by the end of the year.

Turkey

Turkey, which has also been keen to reduce its reliance on Russian gas, in particular, is eyeing the potential in its waters. It started seismic work offshore Turkey this April, using the

Leviathan looms

First steel was cut on Noble Energy's Leviathan natural gas project early March, with first gas targeted for 2019. Leviathan is 130km offshore Israel, in 1600m water depth. It is estimated to contain 22 Tcf of natural gas. Leviathan's initial development includes four subsea wells, each capable of flowing more than 300 MMcf/d of natural gas. Initial proved reserve bookings are estimated to be 9.4 Tcf gross. ▪

seismic exploration vessel *Barbaros Hayrettin Paşa*, and has said it will explore its segment of the Mediterranean and the Black Sea this year.

Instability

Regional instability remains, however. There are concerns over Libya, which has various factions fighting for power. Tunisia has also faced unrest, Descalzi says. It's an issue, "with 500 million people in the region and a 20-30% predicted increase in population, it's a region that needs stability."

Massimo Nicolazzi, ISPI (Institute for International Political Studies) Energy Watch, points to broader concerns; stagnant energy consumption in Europe; redundant gas transport infrastructure; a decline in production from some current major suppliers; uncompetitive LNG markets; and increasingly liquidity in the market impacting pricing. All of which could make it harder for new entrants.

Thanks to recent LNG mega-projects, Nicolazzi expects LNG to be oversupplied for a while. "Entering the [LNG] market doesn't just mean substituting someone out of production, but displacing existing suppliers," he told OMC. This could mean a price war – the bottom line will be an ability to compete on price, he says.

Hafner argues that linking the likes of Leviathan and Aphrodite, as well as Zohr, could create enough capacity to restart existing Egyptian LNG export facilities – i.e. the 19 Bcm Idku and Damietta plants, which Egypt, as a country, has contractual obligations to supply with gas. "Bringing together underused and scalable export infrastructure would be key to unlock [economic] regional gas export once more gas is found in Eastern Mediterranean," he told OMC. "There are other schemes that can be looked at, like a pipeline from the Eastern Mediterranean to Greece and one to Italy to export gas to Europe by pipeline." This could avoid the waves in the LNG market, but, while "Europe prefers pipeline infrastructure," European gas demand is uncertain. "With LNG, we will always find a market. Geopolitical projects are difficult. The quickest option would be to use idle capacity in Egypt."

El-Molla adds, "Time is of the essence. The solutions are there. We have the market, if it's not export it is there to be used. Momentum is there, alignment is becoming more clear, we are starting to hear new comers (upstream) in Cyprus, and we pray also in Lebanon. Then, this will mean business." **OE**

Italian decommissioning

As elsewhere, Italy has offshore facilities, some of which are nearing the end of their economics lives as oil and gas producers. The potential for their reuse was discussed at the Offshore Mediterranean Conference in Ravenna, in March.

In Italy, there are 136 offshore sites, including platforms and similar infrastructure (93 within 12mi of the coast), of which 16 will be ready for decommissioning by 2020, according to Franco Terlizzese, general director at Italy's Directorate General for Safety of Mining and Energy Activities – National Mining Office for Hydrocarbons and Georesources at the Italian Ministry of Economic Development.

What is done with them is up for debate. Just as in the North Sea and offshore Australia, discussions around leaving platforms in place to become natural reefs have been held. In Italy, there's also a discussion about how to put them to use for other purposes.

Fabio Fava, professor at University of Bologna and Italian representative of Blue Growth in Horizon 2020 and strategic board of the BlueMed initiative coordinator, suggests repurposing for renewable energy production, hydrogen generation, energy storage, environmental monitoring, aquaculture, and tourism, among others.

Indeed, the Paguro (hermit crab in Italian) platform that lies on the seabed 25m deep, 12km off the Adriatic coast, has become a popular destination for sports divers. The Agip platform exploded and sank following an accident during the drilling of a new methane well in 1965. Aquatic life has sprung up around the facility and, in 1995, the Paguro Association was founded to control visits to the wreck and for the protection of the biology in the area (it's even used by a wine producer as a place to age their wine, at least according to its marketing).

Nicola Mondelli, chief operations officer at Basis Engineering, said his firm has been looking at extending the use of platforms in the Adriatic Sea for energy storage and power generation from renewables, including solar and wind, in some cases combined with hydrogen generation from seawater.

Ravenna's Mayor Michele de Pascale says that scientific research would also make economic development and the environment compatible. He suggests that Ravenna could be the center for new technologies that could make use of former platforms.

"Decommissioning may not be a funeral for the offshore, but a switch to new investments," says Franco Nanni, chairman of Ravenna Offshore Contractor Association (ROCA). Indeed, Eni's CEO Claudio Descalzi has hinted at the potential to give a second life to offshore facilities (OE: May 2017) and, in fact, Terlizzese says, "Eni has confirmed its readiness to finance a second life of the offshore sites."

However, there's work to be done, not least on the impact on the environment of these facilities. Environmental groups have requested that decommissioning guidelines are drawn up for Italy – just 47.7% of the facilities within 12mi of the Italian coast have been covered by an environmental impact assessment, Nanni says.

It also might not be so easy to bring new lives to offshore facilities, however. Tobias Rosenbaum, managing director of BD Gas and Infrastructure at DNV GL, says that such activities could involve a lot of effort and cost. Andrea Bombardi, chief commercial officer at RINA (the Italian classification and verification society, agreed. ▪

Mediterranean & N Africa

Collaborazione

All all-Italian team is hoping to offer the offshore industry smarter and more efficient solutions, by bringing their heads together. Elaine Maslin reports.

Led by Italian shipbuilder Fincantieri, Pollo Offshore has 11 member companies, each bringing their ideas to create integrated solutions – or as Fincantieri sees it, building a ship around equipment, instead of the other way around. Giuseppi Coronella, executive vice president for Fincantieri's offshore business, says this approach doesn't pave the way for proper integration of systems. "Six years ago, when we decided to start developing the [Proxima and Overdrill] drillship(s), most of the solutions we were providing were motivated by small oil tanker vessels, ballast systems, physical integration that was not that advanced, so the center of gravity was high. To support that load at a high level you needed a huge hull. This led us to develop a vessel around the system.

"We needed competence and to think differently from standard conservative thinking in oil and gas," Coronella says. "Very often, the excellence of companies is around single people who create an environment. They create capability for thinking ahead. But maybe don't have the power or tools. We have an approach of a system integrator using specialist companies with special capabilities, creating the environment to develop new solutions. We have gone through several projects, Overdrill, Proxima and other projects in midstream, also a CNG (compressed natural gas) carrier, what we lacked was a way to cooperate."

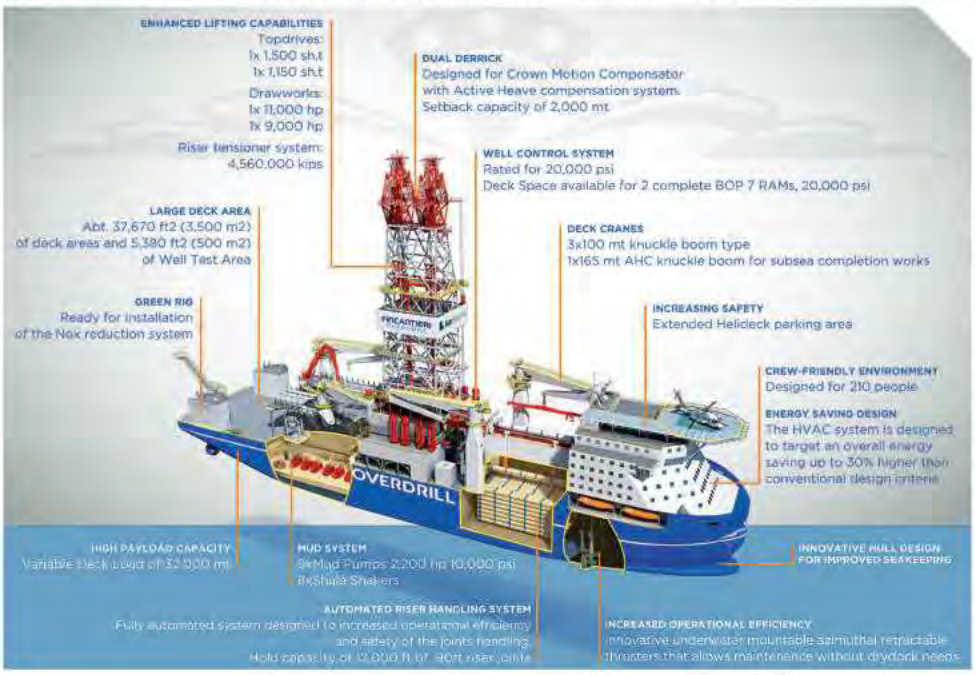
With Pollo Offshore, a way to work together as an integrated service was created. Members include drilling equipment firm Drillmec, fabricator Rosetti Marino, cable firm Prymsian, and pipework, electrical, engineering, process and naval architecture firms.

"Our members cover the entire world, which gives us a capability to be close by the major fields and activities," Coronella says. "This means we can act quickly. It's not just matter of making integrated equipment, making it connect to the system, connected to other systems inside the vessel."

Some of this ethos has already been put to work in a project for Petrobel, which has involved creating a condition based maintenance program for a navy. The system has been installed and tested and will help improve reliability and enable future predictive maintenance, Coronella says. "This also allows us to be closer to the client, to help understand their needs propose improved tools for future efficiencies."

As well as bringing varied expertise to bear on drillship designs, the firm is also proposing to market floating production vessel concepts, initially starting with the building of process modules and or installing pressure vessel. "This requires process design competence, it's a matter of integrating with other companies," Coronella says, who adds that he has already spoken with some of the floating production vessel leaders. "The difference in the past was that companies were involved, but off the process line. This behavior [i.e. Pollo Offshore] is a more democratic way to work. It's more profitable in terms of ideas and efficiency of solutions."

Fincantieri is working in Brazil, with Petrobras, and has shipyards there, i.e. Promar, which is now producing its first vessels, specifically, LPG (liquefied petroleum gas) carriers for Transpetro, plus and offshore support vessel. Fincantieri also owns Vard in Norway. OE



Overdrill. Photo from Fincantieri.

Ready for **prime time**

With some of the biggest recent gas discoveries on its doorstep, the Southern and Eastern Mediterranean could be prime to grow into a gas export hub – if the countries in the region can cooperate. EIC's Andrew Scutter sets the scene.

Installation operations at West Nile Delta. Photo from BP.

The downturn in the oil and gas industry over the past couple of years has led to a decrease in offshore developments. However, the Eastern Mediterranean has been the anomaly, seeing an increase in activity which has offered significant opportunities to the supply chain. This activity is a result of successful exploration of the Eastern Mediterranean Continental Shelf. Several major gas discoveries have been made across Egypt, Israel and Cyprus that, once in production, will surpass domestic needs and allow the region to become a hub that can feed into the European gas market.

Early 2015, after years of delays, BP's US$12 billion West Nile Delta development in Egypt, the biggest project in the region, finally received the green light. BP fast-tracked the project to meet Egypt's gas shortages. And, in May 2017, BP announced first gas from the first two fields – Taurus and Libra – eight months ahead of schedule. The second phase of the West Nile Delta project, involving development of the Giza, Fayoum and Raven fields, is currently ahead of schedule and below budget, BP says, with first production slated for 2019.

Likewise, Eni's 30 Tcf Zohr discovery, offshore Egypt, is a game changer in the region that has the potential to convert Egypt from a net importer back to the LNG exporter that it was 10 years ago. The two-phased, fast-tracked project is targeting first gas by the end of 2017, by drilling six wells this year and tying them into existing nearby infrastructure.

The recent success of Egyptian exploration has hindered development of Israel's Leviathan field and Cyprus' Aphrodite field. Egypt was due to be a major customer of gas from these fields, however, the Zohr field has the potential to cover a significant part of Egypt's domestic gas demand, leaving Israel and Cyprus to seek markets elsewhere.

The $7 billion Leviathan floating production, storage and offloading development has recently been scrapped in favor of a cheaper fixed platform solution. According to the new plan, half of the 21 Bcm/year of gas production is destined for Israel and neighboring countries, while an additional platform exit point will be made for potential export opportunities to new markets. Wood Group announced in March 2017 that it had completed the front-end engineering and design studies for the project and that a final investment decision is now expected in the coming months from Noble Energy.

The Aphrodite field, meanwhile, has been delayed due to continued disputes between Cyprus and Israel, with Cyprus asserting that only 1% of the field lies in the neighboring Israel Yishai license, while Israel claims it is a much larger volume.

With Egypt not expected to require gas imports from 2022, for its domestic needs, exporting to Greece or Turkey may be a more attractive option for Cyprus and Israel. In March this year, an agreement was made between relevant ministers to construct 2000km of subsea pipeline to connect offshore Israel and Cyprus with Greece, which could influence the development decisions for Eastern Mediterranean fields. Provided that there is better cooperation between the countries and improved political stability, the next decade could see the region emerge as a major gas exporter to meet Europe's growing gas demand. **OE**

***Andrew Scutter** is the upstream sector analyst at the EIC, and covers this remit globally. He has a degree in geology from the University of Leeds and a Master's degree in petroleum geoscience from the University of Aberdeen. Scutter also has experience working with an international operator, CNR.*

Solutions

Red Meters launch density meter

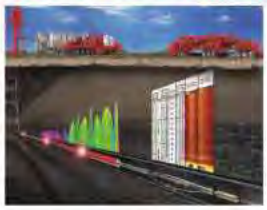
Red Meters' real-time exact density meters continuously measure full-volume density safely and precisely. They are built to withstand abrasive slurry environments and do not employ nuclear mechanisms or other hazardous technologies. Built into the slurry pipeline with an internal pipe diameter range of 2in to 60in (50mm to 1524mm), RM Series products also calculate mass flow when incorporated with a flow meter, and measure a high range of percent solids. With the elimination of sample and lab testing, process automation and control is readily achievable.

Each meter uses a wear-sensing cartridge, which flexes microscopically from the weight of passing materials and snaps to its original state near-instantaneously. A Class 2 industrial laser reads deflected weight, sampling 20 times per second. With a 50-millisecond response time, the laser readings ensure a steady, continual assessment.

Raw data is channeled through an easy-to-read 7in touch-screen human machine interface (HMI). A custom-tailored algorithm translates the data – compensating for temperature, pressure, and vibration – and displays live figures onto the HMI screen. Operators choose which figures are displayed, including: density, pressure, percent solids, totalized mass, and more. The output can be set to graph figures for easier review. Each HMI can be connected via ethernet or wirelessly to a main server for data transfer.

Each Red Meter comes with an insulated housing to shield the cartridge and laser from environmental variables. All Red Meters are equipped with an alarm system in the event of suspicious changes in pressure, signs of pipe leaks, or significant wear of the in-line cartridge. Cartridges are easily replaceable, keeping maintenance costs low. **www.redmeters.com**

Halliburton offers FUSION service



Halliburton launched the SPECTRUM FUSION service, a new offering in the SPECTRUM family of real-time coiled tubing services.

The SPECTRUM family of services is designed to capture data such as weight on bit, pressure, temperature, and acoustics, with casing collar locator and gamma ray for depth correlation in real time. However, the FUSION service uses hybrid cable technology that combines fiber-optic and electric to provide downhole communication and continuous power. The cable is conveyed through coiled tubing to deliver intervention, diagnostic and reservoir assessment services in one trip downhole.

The SPECTRUM FUSION service integrates full wireline capability with downhole intervention tools. The FUSION service combines the existing insight from fiber-optics inside the coil with power from the surface creating versatility in selecting logging tools. It also enables customers to diagnose wellbore conditions in real-time and customize the wellbore treatment or intervention operation using the data transmitted to the surface.

www.halliburton.com

Sercel releases Sentinel HR

Sercel, the equipment business of CGG, released the Sentinel HR – a high-resolution solid streamer designed to meet the specific imaging needs of shallow-target applications, such as oceanology, civil engineering and reservoir characterization, as well as high-resolution 3D (HR3D) seismic surveys for detailed mapping of geological features.

The Sentinel HR has been developed with a close channel separation of 3.125m to achieve reliable and cost-effective high-resolution surveys. Recent enhancements available in Sercel's new-generation Seal 428 marine seismic recorder allow a higher channel count, enabling up to 6km of Sentinel HR to be deployed with full data and power redundancy to provide non-stop acquisition, opening up new possibilities for HR3D survey configurations.

The Sentinel HR adapts to all types of survey spreads, from comb deployment to larger configurations integrating the Nautilus steering system. In addition, the Sentinel HR can provide marine mammal monitoring when combined with QuietSea, Sercel's revolutionary Passive Acoustic Monitoring system, which is integrated into the seismic streamers. **www.sercel.com**

SKF debuts wind turbine spherical roller bearings

SKF has introduced new wind turbine main shaft spherical roller bearings. The firm says the self-aligning bearings provide will meet service life needs of more than 25 years.

The newly developed bearings have been tailored specifically for wind applications. Features not needed in this sector, such as the ability to handle speeds up to 600 r/min, have been eliminated to focus on those that are, including improved radial and axial

robustness, for best in class operation.

The adapted design includes a significant weight reduction, an optimized internal geometry and improved lubrication capabilities to ensure lower contact pressures and enhanced load carrying capacity. **www.skf.com**

Rolls-Royce delivers hybrid subsea crane

Brazilian shipowner CBO chose Rolls-Royce to equip its platform supply vessel *CBO Manoella* with a new patented dual draglink (DDC) subsea crane, which will be the first subsea crane able to use either fiber or steel wire rope.

The 76.7m-long, 17m-beam *CBO Manoella* went into service in 2009 and is currently being converted to a ROV support vessel. The crane is a hybrid DDC crane with a lifting capacity of up to 50-tonne and an operating depth of up to 3000m. It will be equipped with wire rope for its first subsea assignment, off Brazil. However, being able to change to fiber rope offers flexibility, says Rolls Royce. The light weight of fiber rope means deck load capacity can be increased by about 100-tonne.

The cable tractions control unit (CTCU) forms the crane winch and is at the crane's main boom, saving space. The horizontal elbow derrick movements provide active heave compensation (AHC), reducing wear and heat buildup in the lifting line, compared to when the AHC is part of the winch.

Delivery from Rolls Royce is expected in Q3 2017. It comprises a complete DDC crane system including the CTCU, cabin and control system.

www.rolls-royce.com

Bosch Rexroth readies split hoist system

Bosch Rexroth has developed a 'split hoist' heave compensation system, which combines active heave compensation (AHC) and passive heave compensation (PHC) elements with a control system enabling AHC functionality to be added to new and existing hoisting installations.

Using a modular and mobile design, the system is interesting for use with existing multi-part reeved hoisting equipment and can lower down to 2000m and could potentially be used for loads above 1000-tonne.

A passive in-line heave compensator supports the load and passively compensates for some of the ship's movement. The passive in-line system is hoisted and held by an existing winch or crane. Meanwhile an actively controlled winch, typically mounted on the ship's deck, then compensates for the remaining movement of the load. A motion reference unit measures movement of the vessel, and the system reacts to control the load's position relative to the seabed. In this way, the system requires only 20% of power compared to conventional AHC systems, the firm says.

A first prototype has been built and tested with the help of Seaway Heavy Lifting. In June, further testing will be carried out, with Seaway Heavy Lifting, for offshore deep water operation using the crane vessel *Oleg Strashnov*.

www.boschrexroth.com

Activity

New subsea alliance formed

Halliburton, Trendsetter Engineering and C-Innovations have formed a strategic alliance to offer technologically advanced, integrated offshore well intervention packages in the Gulf of Mexico.

The alliance leverages the companies' strengths to create subsea solutions for hydraulic interventions. The combined packages will improve operator efficiency while addressing in-field production and subsea challenges.

"Our combined approach has already resulted in successful campaigns that have reduced project costs, enabling operators to conduct more work and create value in a traditionally high-cost environment," says Mario Lugo, chairman and CEO, Trendsetter. "To date, the alliance's projects have included complex hydrate remediation, large acid stimulations, pipeline flushing, and inspection, maintenance and repair work in water depths up to 10,000ft."

The alliance has fitted the multipurpose supply vessel *Island Venture (pictured)*, owned by Island Ventures and built and designed by Ulstein, with equipment from all three companies, says Dino Chouest, CEO of C-Innovation. ▪

ABB gets subsea power project funding

The Research Council of Norway has awarded ABB a US$1.16 million (NOK10 million) research grant to develop subsea technology for use on the Norwegian continental shelf and the Barents Sea.

This is the third award for ABB as part of the Council's DEMO2000 initiative. ABB is currently engaged in a five-year joint industry program (JIP), which started in 2013, to develop pressure-compensated electrical and control equipment as part of a drive to move oil production systems from surface platforms to the sea bed.

ABB has moved from laboratory testing of physical principles to manufacturing sub-assemblies and prototypes. The first installation of the subsea power products in the real offshore production site is expected to begin in 2020.

ABS, DSME sign FLNG agreement

Classification society ABS signed an agreement with Daewoo Shipbuilding and Marine Engineering Co. to support safety and apply class guidance to a conceptual floating liquefied natural gas (FLNG) unit. The 12-month project is expected to start at the end of May. ABS will review the conceptual design to the applicable class requirements and provide guidance to support safety during development.

Siemens, Aker BP in digital partnership

Siemens will deliver advanced digital solutions for Aker BP's future field development projects as part of a long-term partnership between the two companies focused on the design, supply and installation of electrical, instrumentation, control and telecom systems – from the preliminary phase to first oil. The framework agreement builds on Siemens' existing work for Aker BP providing data-driven condition monitoring on the Ivar Aasen offshore project.

2G, Sonardyne collaborate on laser mapping

Subsea technology companies 2G Robotics and Sonardyne International have entered a formal collaboration agreement to develop and promote a dynamic underwater laser mapping solution to significantly reduce the time needed to survey seafloor sites and offshore structures.

The new agreement centers on the integration of Sonardyne's acoustically-aided inertial navigation system for underwater vehicles, SPRINT-Mapper, with 2G Robotics' ULS-500 PRO dynamic underwater laser scanner. Until now, attempts at mapping from dynamic platforms have largely involved multi-beam imaging sonars being fitted to ROVs, AUVs and manned submersibles equipped with inertial, Doppler, acoustic positioning and depth instrumentation. While large areas can be quickly surveyed, only up to 10cm relative accuracy can be achieved.

Using 2G Robotics' ULS-500 PRO laser scanner, to capture high density point clouds, and SPRINT-Mapper hardware, to record acoustic and inertial navigation data, on and ROV or AUV, and then merging data from the two in processing, a geo-referenced 3D point cloud can be created from which centimetric level or better engineering measurements can be taken.

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WELCOME 2017

Welcome to the preview of SPE Offshore Europe 2017 being held on 5-8 September in Aberdeen, the energy capital of Europe.

I am delighted to chair the 2017 edition of the conference with a central theme of "Embracing New Realities, Reinventing our Industry".

Following the toughest downturn of the past 30 years, as we start to see signs of recovery, this event is a fantastic opportunity for the oil and gas sector to embrace new technologies and ways of working, rethink collaborations and business models that will lead to new sustainable outcomes.

The Executive Committee is doing an extraordinary job gathering quality speakers for the opening plenary, keynote panel and technical sessions. Combined with business breakfasts and topical lunches it will provide a unique opportunity to debate our future and share inspirational examples and testimonials.

I am looking forward to an exciting event that will allow individuals and companies from multiple horizons to network, think beyond our traditional frontiers and debate our successful industry future.

Catherine MacGregor, Schlumberger
Chair, SPE Offshore Europe 2017

> As we start to see signs of recovery, this event is a fantastic opportunity for the oil and gas sector to embrace new technologies and ways of working...

On behalf of the Society of Petroleum Engineers, I would like to introduce this year's programme highlights for SPE Offshore Europe 2017.

Now celebrating its 22nd year, SPE Offshore Europe is the largest and technically foremost offshore E&P conference and exhibition outside North America. Under the theme "Embracing New Realities: Reinventing our Industry," we will explore how the industry is reinventing itself and finding new ways of working in a prolonged low oil price environment.

OE offers every feature you would expect in this pre-eminent conference, including free-to-attend conference sessions. The outstanding keynote sessions will be supported by the technical programme which offers high calibre presentations on:

- Data Driven Decision Support
- Decommissioning
- Pipelines
- Improvements in Safety and Environment
- Subsea Technology
- Unlocking the Remaining Potential: Resolving Reservoir Uncertainty Real-time with Geo-steering
- Advanced Condition Monitoring and Maintenance
- Reinvigorating Drilling: Challenging What is Possible
- Emergent Platform Inspection Technologies
- Well Automation and Analytics

A new feature this year, is the Decommissioning Zone. Alongside the specialist exhibits, the zone will feature a dedicated conference programme presented in association with Decom North Sea, ITF, SUT and IMechE.

I am excited about the CEO plenary session that will open the conference and hearing their unique perspectives on our industry in these challenging times.

SPE Offshore Europe is the place to be inspired by new technology, as we move into our industry's new chapter. Keep checking the conference website for more details.

I look forward to seeing you at SPE Offshore Europe!

Janeen Judah, Chevron
2017 SPE President

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- **Read more on pages 8–10.**
- **View the Exhibitor List at www.offshore-europe.co.uk/directory**

FOUR-DAY CONFERENCE

FREE!

NO NEED TO BOOK!
Just turn up!

You are invited to attend the 2017 Conference programmed by SPE. This year's theme is "Embracing New Realities: Reinventing our Industry."

– PLENARY SESSION

Hear senior global representatives from industry including **Ben van Beurden**, CEO of Royal Dutch Shell plc, **Bob Dudley**, Chief Executive of BP, **Pedro Parente**, CEO of Petrobras and **Robin Watson**, CEO of Wood Group in the Plenary Session.

– KEYNOTE PROGRAMME

Top industry figures tackle the topics the industry is facing as it adjusts to the realities of the 'new normal' in our eleven keynote sessions.

- **View the programme on pages 11-13.**

– TECHNICAL PROGRAMME

65 technical presentations, selected by the Programme Committee at an exceptionally high level, will address topics including Improvements in Safety and Environment, Pipelines, Drilling, Well Automation and Analytics and Data Driven Decision Support. Two interactive 'Special Sessions' will also be addressing topics in Subsea Standardisation and Small Pools.

- **View the programme on pages 14-15.**

DECOMMISSIONING ZONE

NEW!

Visit 20+ decommissioning technology and service provider exhibitors, and hear dedicated conference content, organised in association with key industry associations Decom North Sea, IMechE, ITF and SUT and visit the featured Project from Independent North Sea operator, Fairfield Energy.

DECOM North Sea · Institution of MECHANICAL ENGINEERS · itf · SUT Society for Underwater Technology

- **Read more on page 10**

TECHNOLOGY ZONE

NEW!

IN PARTNERSHIP WITH The Oil & Gas Technology Centre

The OGTC's Technology Space at this year's show presents new innovative technologies through presentations to make the industry think differently. In addition, the Technology Zone will also host a village of start-ups and SMEs, encouraging operators and big companies in the supply chain to look at the solutions they have or are developing.

- **Read more on page 16**

TechTrek

NEW!

This year we have launched TechTrek to make it easier for you to find genuinely new technologies, products and solutions from the last 12 months at the show. Just follow the TechTrek logo visible on the website exhibitor list, app and catalogue and look out for them on the stands.

- **Find out more at www.offshore-europe.co.uk/tech-trek**

For fast-track entry, register at www.offshore-europe.co.uk/preview

BREAKFAST BRIEFING & TOPICAL LUNCHES

Join our Breakfasts and Lunches at which leading industry figures will discuss specialist topics while you dine. This is a high-level exclusive networking and learning opportunity and a chance to host your clients at a company table.

• View the full programme page 18.

www.offshore-europe.co.uk/BreakfastsLunches

OTM INVESTMENT WORKSHOP

otm

oiltech Investment Network

If you are an innovative technology provider or E&P entrepreneur seeking funding, make sure you attend our popular Investment workshop, on Wednesday 6 September, brought to you by Oiltech and facilitated by OTM Consulting. The workshop connects innovative technology providers with Oiltech's investor members and gives entrepreneurs industry-specific advice on seeking partner funding.

• Find out more on page 16

MEET THE INVESTOR

By application only

Looking for direct investment? A limited number of companies will be invited to one-to-one meetings on the afternoon of Wednesday 6 September to discuss investment projects with various grant, early seed and direct industry funding providers. Entrepreneurs are invited to submit a brief application form to compete for places at this event.

• Find out more on page 16
• Visit www.offshore-europe.co.uk/investmentworkshop to download the application form.

DIT COUNTRY BRIEFINGS

FREE!

DIT Commercial Officers and buyers from key international regions will be running a series of free-to-attend country briefings, including Brazil, Norway, Mexico and Saudi Arabia.

Department for International Trade

• Find out more on page 18

MY EVENT

FREE! FOR REGISTERED VISITORS

To make the most of your time at the show, register for the event in advance and you'll be able to access our exclusive online planner. Browse the exhibitor and visitor directory, schedule meetings, receive tailored recommendations and favourite conference sessions and exhibitors to visit.

DOWNLOAD your personal show planner

• Download your personal Show Planner

• Find out more at www.offshore-europe.co.uk/about-myevent

OE & Me

We have launched a new interactive feature to celebrate SPE Offshore Europe.

Visit www.offshore-europe.co.uk/oeme to see, hear and read views, news and memories surrounding the show from past and present visitors, exhibitors and speakers – and share your own!

• Read more on page 20.

EMBRACING **NEW REALITIES**

This year's SPE Offshore Europe is taking place as confidence begins to slowly rematerialise following the longest and most serious downturn in decades.

As the 2017 conference chair and Schlumberger's Drilling Group President Catherine MacGregor comments: "The industry's technical and financial performance has been challenged for some time now. Learning the lessons from the most severe downturn for the past 30 years, there is no doubt that the industry has to reinvent itself.

The traditional industry response to market downturns, which has included halting exploration investment, decreasing development activity, pressing for price reductions throughout the supply chain, and letting talented people go, is no longer viable."

The conference chair and her executive committee of 17 senior international industry figures drawn from operators, major service companies, industry bodies and top advisory firms have put together a focused and hard-hitting keynote programme that will tackle the topics the industry is facing as it adjusts to the realities of the 'new normal'.

Eleven panel sessions will cover the gamut of topical issues that are relevant in the current climate: from people safety, big data, cyber and physical security, transformative technologies, sustainability and decommissioning to new business models for mature basins, making capital work, the talent pool, breakthroughs in supply chain effectiveness and learning from other industries.

Over four days, under the central theme Embracing New Realities: Reinventing our Industry, a further 65 free-to-attend technical presentations and a programme of business breakfasts and topical lunches, will provide opportunities to debate, knowledge-share and take new courses of action that will shape the future of the industry.

The opening plenary session promises a packed hall with the most top-level line-up of oil major CEOs in several years. **Ben van Beurden**, CEO of Royal Dutch Shell plc, **Bob Dudley**, Chief Executive of BP, **Pedro Parente**, CEO of Petrobras and **Robin Watson**, CEO of Wood Group will address the hundreds of day one visitors attending the opening plenary.

SPE Offshore Europe 2017 has the strong support of leading industry figure Sir Ian Wood who has kicked off a new campaign ahead of the event to encourage visitors, exhibitors and speakers to share their experiences of OE past and present.

Sir Ian was the first contributor to OE & Me, a new online hub which invites people to share their stories of SPE Offshore Europe. Short-style video footage is the preferred medium but written or photo contributions are also welcome. Joining Sir Ian in the first tranche of contributors are DNV GL, ITF, OPITO and Xodus Group. To share your story visit the OE website: www.offshore-europe.co.uk/oeme

Another new event feature for 2017 is the Decommissioning Zone, which will include a themed exhibition hall and conference space. More than 20 decommissioning technology and service providers will exhibit in the zone and a conference programme is being organised in association with Decom North Sea, IMechE, ITF and SUT. Independent North Sea operator Fairfield Energy, which is in the process of decommissioning the Greater Dunlin assets, will share details of progress.

The exhibition floor is seeing a diverse range of companies booking space for the first time and the return of major players such as Wood Group and Petrofac after absences of several years. Other operators and large service companies committed to date include ABB, Aker Solutions, GE, Siemens, Schneider, Schlumberger, Shell and Total. The OE website has a new library of case studies from previous

exhibitors including Aker Solutions, Balmoral Group, Diaquip, DNV GL, Expro and Hanson Springs laying out the reasons why OE works for them.

A large international exhibitor presence will be at the show with 20 national and international pavilions booked so far including Canada, Italy, Netherlands, Nigeria and USA. These pavilions will bring a wide range of companies from their countries to showcase their products and services. There will also be a large number of delegations present again in 2017 including from Brazil and Mexico.

Another first for 2017 is TechTrek, which will highlight genuinely new technologies, products and solutions launched within the last 12 months. Gareth Rapley, SPE Offshore Europe exhibition director commented: "One of the recurring comments from visitors has been that they would like a way to easily find new technologies and innovations among all the exhibition stands. We are launching TechTrek as a way to highlight these features and enable visitors to find what's new, more easily." Each exhibitor is invited to submit up to three products for consideration. The final trail selection will be made at the discretion of the organisers.

With significant global headcount reduction, one of the fallouts from the downturn and the industry experiencing a generational change as large numbers of experienced personnel leave or retire, attracting and motivating younger people is crucial to the future health of the sector.

The SPE will be running its 'Inspire' programme which will cater for individuals from ages 14-35 with tailored content to engage the next generation of talent. A wide range of events and workshops will be held throughout the week, supported by OPITO and the industry.

SPE Offshore Europe 2017 promises to be an agenda setting conference and exhibition, embracing the topics that will shape the industry for the next ten years and beyond. As Sir Ian Wood says: "If you decide not to go there, you are actually missing on probably the biggest learning opportunity in terms of changing your business."

DECOMMISSIONING **ZONE**

DECOM North Sea · itf · Institution of MECHANICAL ENGINEERS · SUT Society for Underwater Technology

This new free-to-attend zone at SPE Offshore Europe 2017 will include 20+ decommissioning technology and service providers in the free to attend exhibition, and a conference theatre with over 12 hours of unique content, programmed in association with the industry's key associations, including Decom North Sea, ITF, IMechE and SUT.

The zone is set to bring together 11,000+ highly targeted technical, business and government industry professionals.

Decommissioning in the North Sea looks set to grow over the coming years with the sector forecasted to be worth £50 billion*.

Decommissioning Zone 2017

Taken from UKCS Maximising Recover Review: Final Report

TUESDAY 5 SEPTEMBER 1430 – 1630

ITF: Well Abandonment Technology Solutions to Increase Efficiencies and Reduce Costs

WEDNESDAY 6 SEPTEMBER 1000 – 1200

Decom North Sea: European Regulator Focus

WEDNESDAY 6 SEPTEMBER 1430 – 1630

SUT: Please check the website for the latest information

THURSDAY 7 SEPTEMBER 1000 – 1200

Decom North Sea: Global Late Life and Decommissioning Practitioners

THURSDAY 7 SEPTEMBER 1430 – 1630

SUT: Please check the website for the latest information

To keep abreast of programme updates, visit
www.offshore-europe.co.uk/Decommissioning-Zone

FRIDAY 8 SEPTEMBER 1000 – 1200

IMechE: Integrating Late Life into Decommissioning – Resulting in the Extension of Late Life and the Reduction of Decommissioning Facility Running Costs

KEYNOTE **SESSIONS**

Tuesday
5 September 2017, 1430-1630

01 NEW BUSINESS MODELS TO ADDRESS MATURE BASIN CHALLENGES | *Gordon A*

Whilst activity has undoubtedly declined of late, the waters around North West Europe continue to hold a significant prize, which can be accessed through optimising mature fields and infrastructure or unlocking the technical limits in IOR/EOR, HPHT and heavy oil. To achieve this, we must embrace the new realities and support the reinvention of our industry. Alongside technical advances and productivity improvements, what new or adapted business models can be introduced to maximise economic recovery in a mature basin and improve the overall capability of the Operators and Supply Chain? What thoughts can we take from or share with other mature offshore basins?

Moderator **Neil McCulloch** (pictured), Chief Operating Officer, EnQuest

Speakers

- **Dan Cole**, Senior Expert, McKinsey & Co
- **Jeff Corray**, MD, Head of Energy Private Equity, Simmons & Co
- **Oyvind Eriksen**, Chair, AkerBP
- **Jonathan Roger**, CEO, Siccar Point Energy

02 MAKING CAPITAL WORK IN THE NEW REALITY | *Gordon B*

Capital invested in the upstream industry has not generated competitive returns for a number of years. Attracting new capital is difficult in the current environment, and allocating limited available funds to develop existing resources and for exploration is challenging. The panel will explore what potential sources of capital are available and how the oil and gas industry can compete for capital against other industries in the global market.

Moderators **Roger Ader** (left), Partner and Global Head of Energy and Power, Rothschild; **Simon Flowers** (right), Chairman and Chief Analyst, Wood Mackenzie

Speakers

- **Russell Alton**, Head of Finance, Statoil
- **Simon Eyers**, Managing Director Energy, Warburg Pincus
- **Lucas Herrmann**, Managing Director, European Equity Research, Deutsche Bank

Wednesday
6 September 2017, 1000-1200

03 DISRUPTING & DIGITISING OUR INDUSTRY: HARNESSING TECHNOLOGIES TO SHAPE AND TRANSFORM ALL ASPECTS OF OUR BUSINESS | *Gordon A*

Whilst recent economic forces have disrupted our business causing financial hardships and major structural changes, advancing technologies offer many opportunities to transform what we do and how we do it. Innovations in hardware and software are coming together in new ways allowing us to measure, control, automate and deploy intelligence in a wide range of systems. We are entering a truly digital age where many systems will be augmented by intelligent agents. Automation has broken out of the factory, out of machines and into software systems. Devices are communicating in unprecedented ways. Focusing more on the hardware, in this session, we will look at the transformation so far, the benefits accrued and the changes we need to make to maximise the value and impact. Drawing on the experience of other industries, we will look at future trends, what the future could look like and what we need to do to achieve it from technology to people. We will highlight links to other sessions including the security challenges and value of big data.

Moderator **David White** (pictured), Senior Technology Adviser, Schlumberger

Speakers

- **Elyse Allen**, President & Ceo, GE Canada
- **Rob Atkinson**, Head of Productivity & Technical Support, Rio Tinto
- **Colette Cohen**, CEO, The Oil & Gas Technology Centre
- **Judy Marks**, CEO, Siemens USA
- **Gokturk Tunc**, VP Technology, Schlumberger Land Rigs
- **Peter van Giessel**, Senior Venture Principal, Shell Technology Ventures

04 CYBER AND PHYSICAL ATTACKS – UNDERSTANDING & MANAGING THE RISKS | *Gordon B*

The risk of cyber and or physical attack is ever present for our industry and both have the potential to put our people, processes and property in danger. An overview of the global threats in existing and emerging E&P markets forms part of this panel, which will examine trends and developments to offshore operations worldwide. There is a multitude of risks and dangers from terrorism, war, corruption, piracy and maritime crime. How, where and when these attacks could happen will be explored in this session, which will also offer advice on how best to protect the workforce, assets and infrastructure from physical and cyber threats.

Moderator **Deirdre Michie** (pictured), Chief Executive, Oil and Gas UK

Speakers

- **Dominic Armstrong**, President, Herminius
- **Frank Gardner**, BBC Security Correspondent
- **David Stupples**, Director of Electronic Warfare Systems Research, City, University of London

KEYNOTE **SESSIONS** *continued...*

Wednesday
6 September 2017, 1430-1630

05 DESCRIBING A FUTURE E&P BASED ON INNOVATIVE DIGITAL SOLUTIONS AND BIG DATA | *Gordon A*

The E&P industry has always been an industry of data gathering, management and analysis. Now, with our ability to not only continuously gather enormous amounts of data but also analyse them in more and more sophisticated ways, in self-learning algorithms, the industry itself will change. In combination with innovative digital solutions in all forms and the Internet-of-Everything, what will a future E&P industry look like?

Moderator **Janeen Judah** (pictured), Chevron, 2017 SPE President

Speakers

- **Ahmed Hashmi**, Global Head of Upstream Technology, BP
- **Ashild Hanne Larsen**, CIO & Senior VP Corporate IT, Statoil ASA
- **John Larson**, VP & Global Leader Advanced Analytics, IHS Markit
- **Tor Jakob Ramsoy**, Founder & CEO, Arundo Analytics Inc

06 IT'S ALL ABOUT US - THE HUMAN FACTORS BEHIND SAFETY STATISTICS | *Gordon B*

2015 saw an increase in Oil and Gas related fatalities as reported by IOGP's membership from the previous year, bucking a multi-year trend of falling Industry fatalities. Squeezed margins, job uncertainty, doing the same (or more) with less could all be pinned on this unwanted statistic, but are environmental factors really to blame? If we consider that in general there are no "new" accidents, instead of blaming the environment, economic or otherwise, is there a deeper issue of failing to learn – or failure to adequately implement learnings from previous incidents?

Moderator **Gordon Ballard** (pictured), Director, IOGP

Speakers

- **Rhona Flin**, Professor of Industrial Psychology, Aberdeen Business School
- **Dik Gregory,** Director, GS Partnership
- **Lee Stockwell**, General Manager Deepwater Safety & Environment, Royal Dutch Shell

Thursday
7 September 2017, 1000-1200

07 A SUSTAINABLE FUTURE? FINDING, DEVELOPING AND RETAINING TOMORROW'S TALENT | *Gordon A*

Our industry has just gone through the most severe and longest downturn since the mid-1980s, with significant headcount reductions across the global industry, across all levels of technical and functional delivery. The industry is also going through a generational change with large numbers of experienced, senior personnel leaving or retiring from the industry and unlikely to return as activity levels recover. It is important to look at how the consequences of this downturn have affected the perception of our industry, locally and globally. Has the "hire & fire" culture become the face of oil and gas? What level of attraction does our industry have for the next generation of talent joining the world of work? It will be interesting to understand what challenges will the increased focus on renewables have on our talent attraction and retention. What, in the opinion of the panel, can the sector now do to make our industry attractive to the digital generation?

Moderator **David Clark** (pictured), Regional President EAF, Aker Solutions;

Speakers

- **Huda Al Ghoson**, Executive Director Human Resources, Saudi Aramco
- **Vera Kirikova**, HR Director, Rio Tinto

08 BENEFITS OF ADOPTING 'BEST PRACTICE' FROM OTHERS | *Gordon B*

The oil and gas industry can be dismissive of work from other industries, however, transferable it may be. As an industry, we have been reluctant to survey other industries for smart and innovative ideas to creatively adopt and adapt.

Successful oil and gas companies should broaden their thinking, learn, and where appropriate, adopt relevant 'best practice', processes and technological solutions that have been successfully employed by other industries to perform better.

We can exploit successful thinking and proven solutions from many other industries and apply them everywhere from operations methodology to creative supply chains, to technology, people and service models. It takes creativity (and practice) to extract something from one industry down to its functional core so that it can be "exported", but the payback from doing so can be tremendous. In the environment we are in where we are looking in every corner for efficiency and effectiveness in operations, this is ever more important.

And so we argue that the oil and gas industry, instead of being insular, should promote a broader mind-set, adopt and adapt, applying change into meaningful, continuous action, encouraging exploration of other industries.

Moderator **Troy Stewart** (pictured), Divisional Manager, Lifecycle Services, Process Automation, ABB

Speakers

- **Steve Cartwright**, Equipment Standards & Controls Manager, Jaguar Land Rover
- **Jon Cooil**, Head of Engineering, SANOFI
- **Bill Hui**, Group Head of Safety & Risk, Sodexo Justice UK&I
- **Ian Phillips**, CEO, Oil & Gas Innovation Centre

Thursday
7 September 2017,
1430-1630

09 HOW ARE WE GOING TO EMBRACE AND DELIVER SUSTAINABILITY IN THE SECTOR? | *Gordon A*

The sustainability agenda is extremely diverse and involves an ever increasing number of stakeholders. Companies, individuals and a broad group of non-industry stakeholders' perceptions of sustainability are shaped by personal and institutional priorities. These priorities are strongly influenced by the context in which they arise. What is clear is the increasing importance of sustainability to our industry's ability to both operate and finance upstream oil and gas activities in ever more challenging environments. The opportunity of this session is to bring together a diverse group of industry and non-industry stakeholders to discuss how we are doing as an industry in embracing sustainability.

Moderator **Valérie Marcel** (pictured), PhD, Associate Fellow, Energy, Environment and Resources Department, The Royal Institute of International Affairs, Chatham House

Speakers

- **Theo Ahwireng**, CEO, Petroleum Commission of Ghana
- **Lance Crist**, Extractives Director, IFC
- **Daniel Litvin**, Founder & Managing Director, Critical Resource Strategy & Analysis Ltd
- **Susanne Schmitt**, Extractives & Infrastructure Manager, WWF

10 BREAKTHROUGH IDEAS IN SUPPLY CHAIN EFFECTIVENESS | *Gordon B*

The upstream oil and gas business has achieved amazing technical feats to access hydrocarbons, but we have struggled in significantly modernising and revolutionising our supply chain. The panel will discuss new ideas in alignment and focus of supply chain practice and theory to offer new ideas and areas we should consider changing to deliver a better outcome. Our supply chain covers a spectrum from commodities all the way through to value adding technology and services that have to deploy to a global market. Questions around how to implement best in class approaches to business relationships as well as use of modern technologies and systems that can help deliver a different result will be core to this panel's content. As an industry, we can gain from the challenge of breakthrough ideas in this session from best in class performers inside and outside of our industry.

Moderator **Leigh-Ann Russell** (pictured), Vice President - Global Wells, BP

Speakers

- **Hope Anderson**, VP Supply Chain, NOV
- **Ole Eyvind Evensen**, Upstream Strategy Leader, IBM WW Chemical & Petroleum Unit
- **Steen Karstensen**, CEO, Maersk Supply Service A/S
- **Evelyn Maclean**, VP Global Supply Chain, Hess Corporation

Friday
8 September 2017,
1000-1200

11 DECOMMISSIONING: ARE WE THINKING BIG ENOUGH OR IS THE CHALLENGE SMALLER THAN WE THINK? | *Gordon A*

As planned decommissioning activities increase, there is a growing debate on how to make the processes more efficient, and cost-effective. Oil and gas companies are already sharing lessons learned, and working closely with the regulator, to maximise wider understanding of the issues, and the nature of the challenges faced in end of field life management, and cheaper decommissioning in a low oil price environment. There are key recurring themes that are important to efficient decommissioning, with a focus on: an understanding of the UKCS context and perspective; skills and capabilities; the path to delivery; improving the P&A process and timescales; preparing for decommissioning through late life asset management; the use of innovative technologies; and how Society views the potential options.

Sector experience is growing as more decommissioning projects are either completed, or are progressing, providing opportunities to view these activities across a timeline, learning from what has been already been done (e.g. Murchison) and from ongoing activities (e.g. Brent, Miller), and considering how regulations may change over time.

Moderator **Steve Phimister** (pictured), Vice President UK and Ireland, Shell UK Ltd

Speakers

- **John Allan**, Manager, International Development & Decommissioning Projects, CNR International (UK) Ltd
- **Pauline Innes**, Decommissioning Director, BEIS
- **Peter Hayes**, Marine Scotland
- **Jan-Pieter Klaver**, CEO, Heerema Marine Contractors
- **Greta Lydecker**, Managing Director, Chevron Upstream Europe

TECHNICAL **SESSIONS**

Tuesday
5 September 2017, 1430-1630

01 DATA DRIVEN DECISION SUPPORT | *Fleming Auditorium*

Oil and gas field development planning and management has always been built on a foundation of decisions informed by data. With the exponential pace of increased computing power and decreased relative cost described by Moore's Law the oil and gas sector's ability to leverage its data sets to better inform and accelerate decision making can have a material impact on business performance. In this session a number of cases are presented that demonstrate how increased computing power can:

- Bring new insights and fully exploit existing data sets.
- Better describe complex physical processes that need to analysed.
- Improve the reliability of predictions by integrating more sensor data to constrain simulations.
- Optimise overall system performance rather than individual domains.
- Provide real time decision support to improve drilling performance.

Session Chairs Jonathan Copp, Chevron and Ian Phillips, OGIC

02 DECOMMISSIONING | *Forbes Room*

North Sea decommissioning is currently a £2 billion a year business, forecast to grow to at least £3 or £4 billion a year over the next few years. Decommissioning generates little or no value, so the focus on cost efficiency is paramount. In this session we will hear about three innovative solutions that have helped drive down decommissioning costs. We will also hear about an initiative in the Netherlands that aims to create efficiencies of scale by bringing together decommissioning projects from multiple Operators and optimising the overall decommissioning programme.

Session Chairs Jostein Kvale,

Wednesday
6 September 2017, 1000-1200

Shell and Richard Neilsen, University of Aberdeen

03 INNOVATION IN PIPELINES AND RISERS | *Fleming Auditorium*

This session will present the latest advancements in the design; modelling, installation and operation of pipeline systems. The presenters have embraced the challenge to provide technology solutions to progress the demand for cost-effective pipeline project solutions. Themes focused on range from flexible risers through composite pipe & pipe-in pipe solutions to pipeline management systems.

Session Chairs Zander Bruce, BP and James Woods, Shell

04 IMPROVEMENTS IN SAFETY AND ENVIRONMENT I (SAFETY) | *Forbes Room*

Please check the website for details of this session.

Session Chairs Steve Rose, Total and Paula Webber, BP

Wednesday
6 September 2017, 1430-1630

05 SUBSEA TECHNOLOGY | *Fleming Auditorium*

The subsea technologies used in the recovery of Oil and Gas reserves have consistently evolved in response to challenges, since the first subsea oil reserves were tapped in the early 1900s.

Major step changes in technology, in particular, have been achieved during times of significant industry depression, as subsea technology providers fast track innovation in an attempt to achieve differentiation by implementing novel enabling technologies. The current industry climate is ripe for innovation focused on cost reduction.

The objective is to reduce the start-up capital costs and minimise operational costs, enabling the economics of field developments to achieve their approval thresholds against a backdrop of low oil prices. One current technology trend is 'all subsea' or the 'subsea factory' which could influence offshore developments for years to come.

As more technology building blocks such as all electric subsea wells are developed and process equipment such as subsea storage reservoirs, pumps and separators are placed on the sea bed, the capital costs of topside processing equipment and associated infrastructure are reduced and subsea field development become more cost competitive and efficient.

Session Chairs Alan Dobson, Technip Umbilicals LTD and Drummond Lawson, Subsea Technologies Ltd.

06 IMPROVEMENTS IN SAFETY AND ENVIRONMENT II

Forbes Room

Managing carbon emissions is a major focus of our industry and this session will present material relating to the challenges and opportunities this presents an operator in the mature North Sea basin.

Saving fuel consumption on ships by utilising battery technology and other potential applications in the offshore industry will be discussed as will how changes to biological activity resulting from climate change may affect marine infrastructure. The session will also include operational experience on the use of ceramic membrane technology to effectively treat produced water emulsions.

Session Chairs Nada Jamal Abuissa, Maersk Oil and Richard Wyness, Shell

Thursday
7 September 2017, 1000-1200

07 UNLOCKING THE REMAINING POTENTIAL: RESOLVING RESERVOIR UNCERTAINTY REAL-TIME WITH GEO-STEERING

Fleming Auditorium

This session opens with a paper about an exciting industry led initiative that has developed a strategic plan to optimally unlock the remaining potential of the Outer Moray Firth Basin. The strategy has had the active engagement of the circa 50 licensees of the basin, and includes a range of activities and tasks such as super-hub developments, data access and technology enablers. Three North Sea case studies follow which demonstrate how advanced logging-while-drilling (LWD) technology combined with geo-steering drilling avoids costly side-tracks or pilot holes, or avoids entry into a high pressure gas reservoir prior to casing set as close as possible to the reservoir. For one of these case studies, the use of advanced LWD technology enables accurate well placement and identifies the positions of inflow control devices to maximise reservoir sweep and enhance oil recovery from the reservoir. The case studies include some industry first implementations.

Session Chairs Kerri Hall, ConocoPhillips and Patrick O'Brien, ITF

08 ADVANCED CONDITION MONITORING AND MAINTENANCE

Forbes Room

Please check the website for details of this session.

Thursday
7 September 2017, 1430-1630

09 REINVIGORATING DRILLING: CHALLENGING WHAT IS POSSIBLE

Fleming Auditorium

This session presents a number of offshore drilling field case studies at industry extremes including deep water, ultra high-pressure-high-temperature (HPHT) wells, drilling into complex reservoirs, and shallow reservoirs requiring high inclination drill paths.

The session includes an overview paper on joint industry initiatives to challenge planned well designs for alternative solutions that significantly improve drilling and well construction efficiency.

The session presents many industry firsts including the first ever 20,000 psi BOP on a HPHT well and the world's first rotary steering system BHA for large hole sections at high inclinations in ultra-soft formations. Through these projects there has been significant lessons learned in relation to HPHT drilling, critical ECD management with very narrow mud windows, and the broadening application of managed pressure drilling technology. The session demonstrates commercial achievements too, describing initiatives that demonstrably make deep water drilling competitive and the experience of efficient rig upgrade for ultra-HPHT use without impacting ongoing drilling operations.

Session Chairs Kerri Hall, Conocophillips and Patrick O'Brien, ITF

10 EMERGENT PLATFORM INSPECTION TECHNOLOGIES | *Forbes Room*

Please check the website for details of this session.

Session Chair Rebecca Allison, OGTC

Friday
8 September 2017, 1000-1200

11 WELL AUTOMATION AND ANALYTICS | *Forbes Room*

A vibrant, exciting and sometimes controversial session here with a common thread encompassing the challenges of instrumentation, effective data utilisation and cultural resistance applied to wells, market dynamics and offshore operations. Advanced research into to the age old problem of reliable downhole power generation (inspired by the electric eel!) is offered.

An artificial intelligence 'crystal ball' to allow analysis and forecasting the Offshore Rig Market. Local innovation with a self-disposing fibre optic deployment method for distributed sensing and finally a look at why we see geographic 'laggard' behaviours in the uptake of automated running of tubulars.

Session Chairs Annabel Green, Tendeka and Colin Higgins, Siccar Point Energy

SPECIAL SESSIONS

We are pleased to announce key Special Sessions at SPE Offshore Europe where industry leaders will share their ideas on Small Pools and Subsea Standardisation, and promote discussion in these unique sessions during the conference.

High levels of podium/audience interaction will make these Special Sessions a different and highly interactive experience–allowing for stimulating discussion with a better exchange of ideas.

Get a full rundown of all our Technical Sessions at www.offshore-europe.co.uk/ConferenceProg or scan the QR code (left)

INVESTMENT **WORKSHOP**

BROUGHT TO YOU BY oiltech Investment Network otm

This one day programme connects Oiltech's investor members with innovative technology providers, giving entrepreneurs industry-specific advice on seeking partner funding and providing access to funding opportunities.

INVESTMENT WORKSHOP SEMINARS

On the morning of 6 September, make sure you attend these drop-in sessions, where you can hear industry experts share their guidance on getting your technology to market in the fastest and most effective way, and offer advice and expertise around seeking partner funding.

All morning presentations are free to attend – for the latest programme visit www.offshore-europe.co.uk/investmentworkshop

Time	Description
1000 – 1005	**Introduction to the day and the Oiltech Investment Network,** *OTM Consulting*
1005 – 1035	**Investing in O&G technology,** *Jan Morten, Investinor*
1035 – 1105	**Current technology needs in the O&G sector,** *Operator perspective*
1105 – 1135	**Filing Trends for Oil & Gas Patents and Holding Strategies,** *HGF IP Specialists*
1135 – 1205	**OTM perspective**
1205 – 1215	**Presentations wrap up**

MEET THE INVESTOR

A limited number of companies will be invited to one-to-one meetings on the afternoon of Wednesday 6th September to discuss investment projects with various grant, early seed and direct industry funding providers. Entrepreneurs are invited to submit a brief application form to compete for places at this event.

To apply, download the application form from www.offshore-europe.co.uk/investmentworkshop

For further information please contact Sally Marriage at OTM Consulting at sally.marriage@otmconsulting.com or on 01372 631950.

TECHNOLOGY **ZONE**

What do robots, composite materials, additive manufacturing and augmented reality have in common? They are all sorely underutilised in offshore oil and gas, despite being part of a general industrial transformation in other industries.

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In addition, the Technology Zone will also host a village of start-ups and SMEs, encouraging operators and big companies in the supply chain to look at the solutions they have or are developing.

A series of short presentations and a Q&A by the Centre's leadership team and board members about the strategy, plans, and operating model of the Centre completes the programme.

To find out more visit:
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BREAKFAST AND LUNCH **SESSIONS**

Tuesday Lunch
Re-inventing the UKCS to Maximise Economic Recovery
- Tuesday 5 September 1300 – 1430

Moderator Gordon Ballard, Executive Director, IOGP
Speaker Andy Samuel, Chief Executive Officer, Oil and Gas Authority

Wednesday Lunch
Topical Lunch
- Wednesday 6 September 1300 – 1430

Details to be announced

Thursday Lunch
Topical Lunch
- Thursday 7 September 1300 – 1430

Details to be announced

Thursday Breakfast
Oil Price Scenario and Industry Macro Economics
- Thursday 7 September 0730 – 0930

Moderator
Deirdre Michie, Chief Executive Officer, Oil & Gas UK
Speakers Bassam Fattouh, Oxford Institute for Energy Studies and Eirik Wærness, Senior Vice President and Chief Economist at Statoil

Friday Breakfast
Industry Shifting Trends
- Friday 8 September 0730 – 0930

Speakers Andrew Gould

Book online at www.offshore-europe.co.uk/BreakfastsLunches

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During the course of the week at SPE Offshore Europe DIT will be holding free to attend country briefings on the oil and gas sector in Azerbaijan, Brazil, East Africa, India, Kazakhstan, Mexico, Nigeria, Norway, and Saudi Arabia* with commercial officers and specialists presenting on the current state of the market and opportunities for the UK supply chain.

***Final programme, times and dates will be confirmed in due course**

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- ❑ 50 Engineering
- ❑ 51 Exploration, Geology, Geophysics
- ❑ 52 Drilling, Production, Operations
- ❑ 53 Executive & Other Senior, Mid-Level Mgmt
- ❑ 54 Field Operations
- ❑ 55 Consulting
- ❑ 56 HR, Staff Recruitment
- ❑ 99 Other *(please specify)* _____

2. Which is your company's PRIMARY BUSINESS ACTIVITY *(check one box only)*

- ❑ 20 Oil / Gas Company, Operator
- ❑ 24 Drilling, Drilling Contractor
- ❑ 30 Pipeline/Installation Contractor
- ❑ 25 EPC, Main Contractor, Subcontractor
- ❑ 36 Engineering, Consulting
- ❑ 31 Ship/Fabrication Yard, FPSO
- ❑ 32 Marine Support Services
- ❑ 33 Service, Supply, Equipment Manufacturing
- ❑ 34 Finance, Insurance
- ❑ 35 Government, Research, Education, Industry Association
- ❑ 99 Other *(please specify)* _____

3. Do you recommend or approve the purchase of equipment or services? *(check all that apply)*

- ❑ 700 Specify
- ❑ 701 Recommend
- ❑ 702 Approve
- ❑ 703 Purchase
- ❑ 704 N/A

4. Which of the following best describes your personal area of activity? *(check all that apply)*

- ❑ 101 Exploration Survey
- ❑ 102 Drilling
- ❑ 110 Production
- ❑ 103 Subsea production, construction (including pipelines)
- ❑ 104 Topsides, Jacket Design, Fabrication, Hook-Up & Commissioning
- ❑ 105 Inspection, Repair, Maintenance
- ❑ 106 Production, Process Control Instrumentation, Power Generation etc.
- ❑ 107 Support Services, Supply Boats, Transport, Support Ships etc.
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- ❑ 111 Reservoir
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1988 Begin partnership with Society of Petroleum Engineers

2013 40th Anniversary

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FIND OUT MORE

OE & Me is a new online initiative to allow visitors, exhibitors and speakers to interact with OE, and each other. OE & Me will focus on what visitors will be looking forward to at the event, cutting-edge content that speakers will be presenting and products and solutions that exhibitors will be showcasing on the exhibition floor.

We are dedicated to sharing your stories about past SPE Offshore Europe shows and your projected ambitions for the much awaited event in 2017.

To be involved, simply send us your videos, stories and pictures by visiting www.offshore-europe.co.uk/oeme.

Visit us online to view our interactive map and look at the stories already submitted.

Sir Ian Wood,
Sir Ian urges the industry not to cut back on sales and marketing during a downturn

Patrick O'Brien,
Chief Executive, ITF;
Patrick O'Brien has been attending SPE Offshore Europe since the 1990s

Hari Vamadevan,
Head of UK Oil and Gas, DNV GL: "Offshore Europe is a vital event for the company to showcase our capabilities to advance safety and sustainability across the industry, both locally and globally.

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Tue 5 Sep 2017: 0930 - 1800
Wed 6 Sep 2017: 0930 - 1800
Thu 7 Sep 2017: 0930 - 1800
Fri 8 Sep 2017: 0930 - 1400

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THE INSPIRE PROGRAMME

Following on from OE 2015's theme of 'how to inspire the next generation', the 2017 edition will once again open its doors to a younger audience, offering a range of organised activities as part of the 'Inspire programme' through which they can learn about and engage with the industry.*

Highlighted within the keynote session on Tomorrow's Talent, the challenge of sourcing skilled, innovative and motivated people, remains essential for the industry to be successful in meeting demand. As David Clark, Regional President EAF, Aker Solutions, and a member of our Conference Committee says, "Ultimately, the industry needs to change how it approaches its skills needs. The oil price drop has forced us to look hard at our delivery structures, cost base and business models. We now need to take the opportunity to put as much effort and focus into rethinking our approach to finding, developing and retaining tomorrow's talent for the future of our companies and our industry." As part of the Conference at OE 2017, representatives from across the industry will participate in a panel discussion on Tomorrow's Talent.

The 'Inspire programme' will include sessions specifically designed for school students, university students and Young Professionals. Running throughout the four days of the event, it will include a programme of lectures, targeted interactive games and networking. The programme is organised by SPE Offshore Europe through its panel of local industry representatives, including industry body OPITO, and its Young Professionals network.

***To find out more visit:**
www.offshore-europe.co.uk

Please note, all of the 'Inspire' programme is pre-arranged and no under 16s are permitted entry to SPE Offshore Europe without prior permission.

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Subsea aspirations

Karen Boman discovers how Glasgow's shipbuilding industry eventually led McDermott International's CEO David Dickson toward a career in subsea.

Growing up, McDermott International President and CEO David Dickson was always interested in ships and floaters. The shipbuilding industry in his hometown of Glasgow, Scotland, would inspire Dickson to initially pursue naval architecture and offshore engineering at university.

Dickson said that he was fortunate enough to start his shipbuilding career working on nuclear submarines for the UK Defense department. But, the decline in the shipbuilding industry – and an emerging opportunity Dickson saw, in the early 1990s, in subsea oil and gas – prompted him to change careers to subsea engineering. Early in his subsea career, Dickson was involved with many, at that time, deepwater frontier projects, such as BP's Foinaven, off Shetland. His work primarily focused on the North Sea, but Dickson also worked on subsea projects offshore West Africa. These early experiences provided him with knowledge of the pipelaying and diving business.

Seeking further deepwater opportunities, Dickson came to the US in 2002 to work for Technip, where he worked on well-known Gulf of Mexico deepwater projects such as Na Kika (BP) and Perdido (Shell). These projects gave Dickson valuable experience not only in ultra-deepwater technology development, but project risk management, the drive for better safety, and the importance of getting it right the first time in deepwater.

The Na Kika project actually lost money, but gave Dickson and the project team the opportunity to design new

David Dickson

things. "Everything was a first of its kind, and it wasn't like there was a book with the answers," Dickson says. "We had to build everything from scratch."

In 2005, he was promoted to head of Technip's subsea business, and in 2008, headed Technip's US and Latin America business unit. In the latter position, he helped grow the company with his role in the acquisitions of Global Industries and Stone & Webster and the formation of Technip's alliance with Heerema Marine Contractors.

Dickson likes to measure the progress that Technip made during his time there by its office buildings. When he started there as a subsea engineer, Technip occupied one tower in west Houston. By the time he left Technip, the company occupied four towers.

In October 2013, Dickson came to McDermott from Technip (he can see Technip from his current office).

Under Dickson's leadership, McDermott has defied the current oil and gas industry downturn and is now thriving. After incurring losses of US$76 million in 2014, and $18 million in 2015, the company recorded net income of $34 million for 2016. McDermott also achieved total shareholder returns of 120%, and ended 2016 with $3 billion of its projected 2017 revenue in backlog and total backlog of $4.3 billion.

Of the many milestones in his career, Dickson can't name only one of which he is most proud. Instead, he's found something meaningful in all the projects in which he was involved, such as Na Kika.

Dickson is proud of the number of people he has brought on board when he joined McDermott. This influx of great talent helped bolster the company's performance. In fact, Dickson credits much of his success to the people working around him.

"I'm not the smartest engineer or best financial person, but my strength has been surrounding myself with talent."

The market downturn forced McDermott over the past two years to focus more on national oil companies, and specific countries such as Saudi Arabia and Qatar, where McDermott knew their customers would keep spending. McDermott has supplemented this activity by growing its business bases in India and Mexico.

Dickson is optimistic about the company's future not only because of these strategies, but because major oil companies aren't spending. Once they start spending, McDermott will have even more opportunities. **OE**

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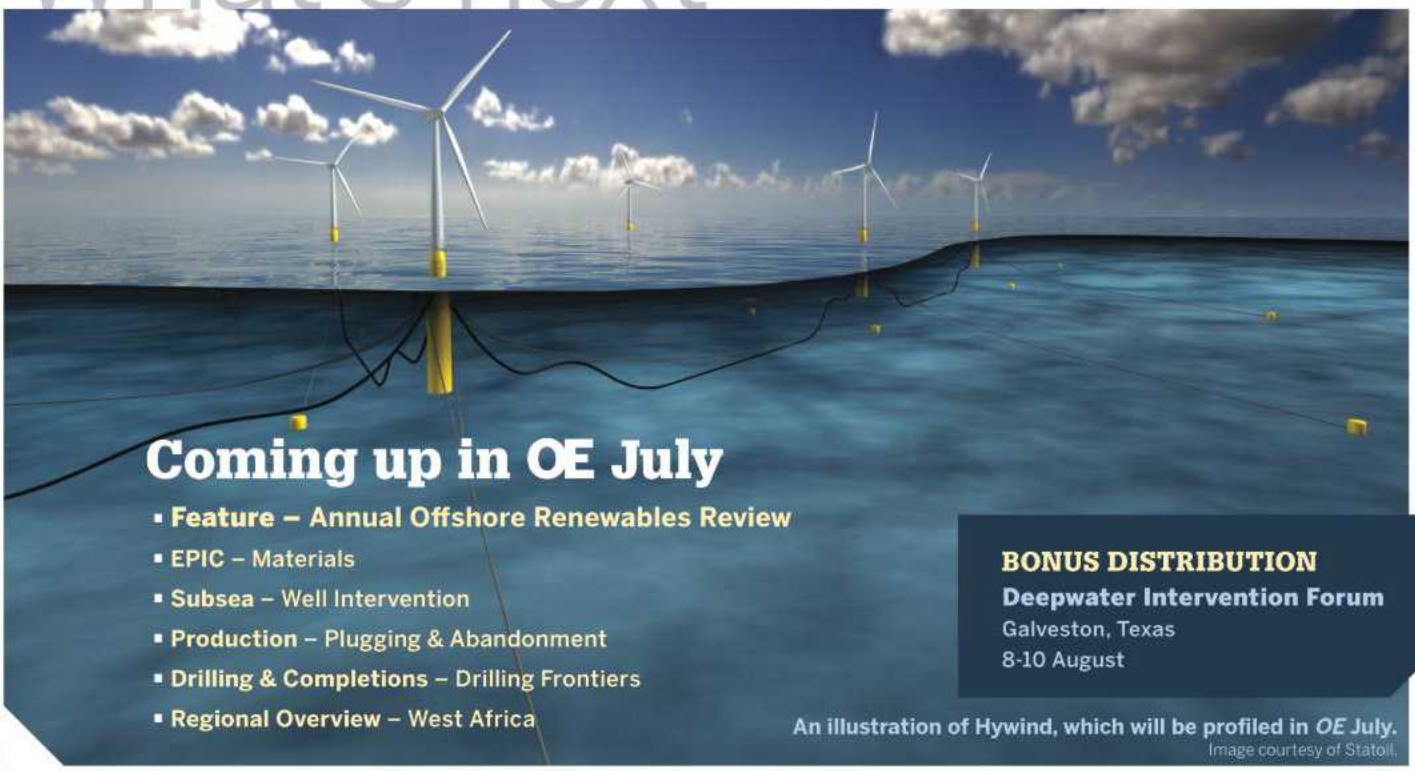

Coming up in OE July

- **Feature** – Annual Offshore Renewables Review
- **EPIC** – Materials
- **Subsea** – Well Intervention
- **Production** – Plugging & Abandonment
- **Drilling & Completions** – Drilling Frontiers
- **Regional Overview** – West Africa

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An illustration of Hywind, which will be profiled in *OE* July.
Image courtesy of Statoil.

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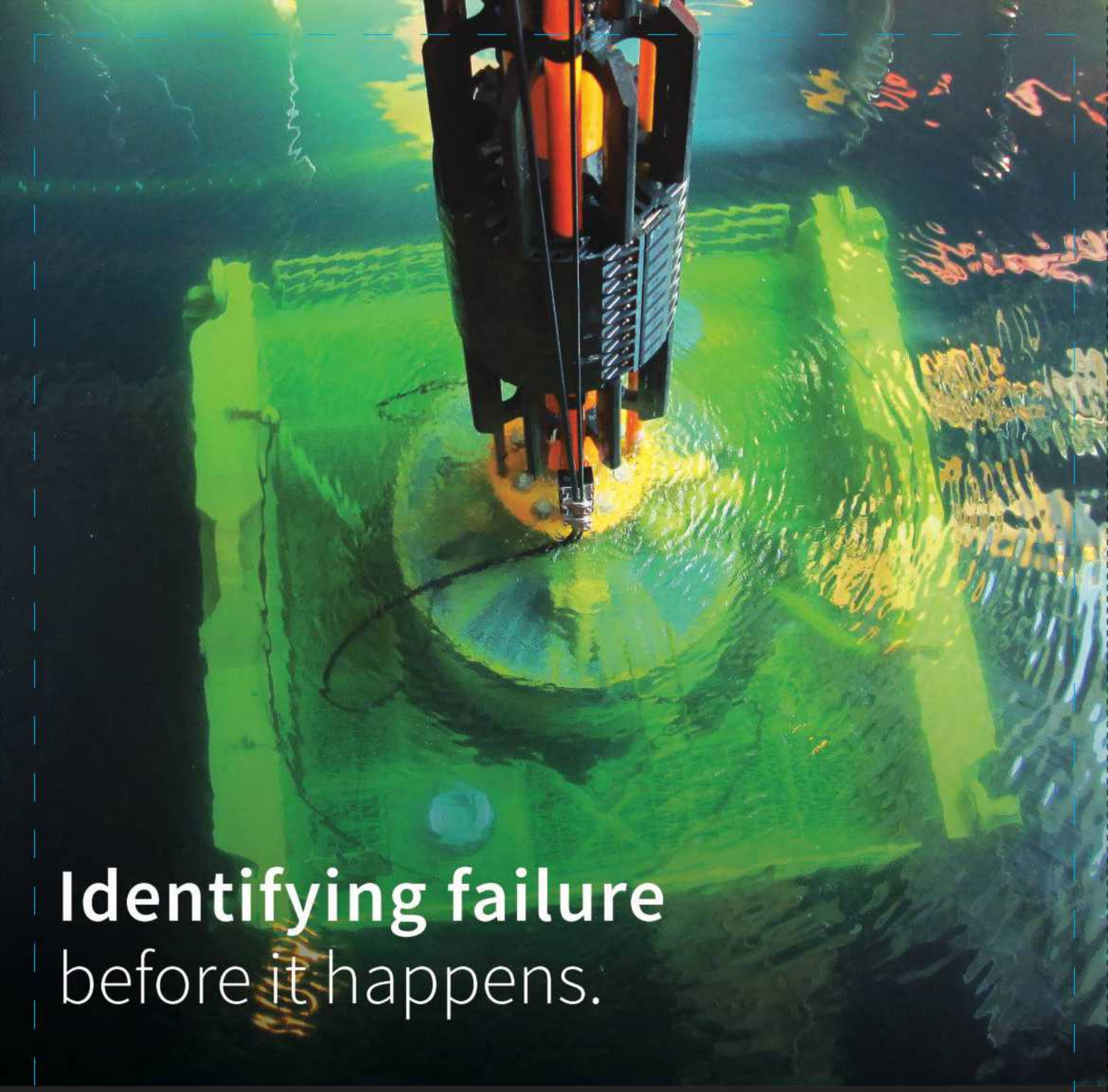

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