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ON THE COVER

Bird's eye view. Aker Solutions' 240° dome, one of the company's two types of drilling simulators, grants trainees a view from above the driller's cabin - no flight needed. Aker Solutions has simulator training facilities in Norway; the US; Brazil; South Korea; and Singapore. See story page 36.

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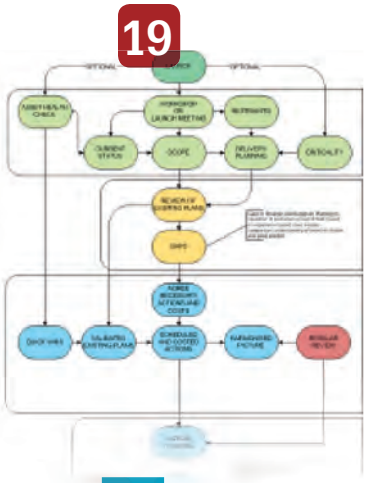
Volume 39, Number 3 March 2014

Departments & Columns

"How far should the digital oilfield go in removing the human element?"



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Online Exclusive

Spotlight on Russia

OE staffers report on various Russian sectors including Siberia, and the Barents and Kara Seas.

What's Trending

Big business

- **Johan Sverdrup plan agreed**
- **Eni ups Congo field estimate**
- **Shell's Olympus starts up**

People

Diamond Offshore Drilling, Inc. appointed Marc Edwards as president and CEO, and as a member of the board of directors, effective 3 March 2014. Edwards succeeds Lawrence Dickerson, who retired after almost 30 years of service to the company.

OE goes interactive!

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Steve Sponseller is a product manager at Kepware Technologies with a strategic business development focus on the oil and gas market. For the past 15 years, Steve has worked in the computer software, industrial automation, and information technology industries, serving a variety of vertical markets.

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Voices

Human resources. OE asked:

"How far should the digital oilfield go in removing the human element?"

I remember being told that the offshore platform of the future would be operated by one man and a dog. The man was there to feed the dog and the dog was there to make sure the man didn't touch any buttons.

I just don't see that becoming a full reality any time soon. We are dealing with an organic environment with subtle differences between each operating well and a very broad dynamic range of considerations to contend with. We can use tools such as case based reasoning, increasingly sophisticated processing power, and better data gathering to refine our modelling and interpretation capabilities but I'm not an advocate of closing the loop just yet. Human judgment and experience and interaction should continue to play a critical part in delivering field performance.

John Donachie
Managing Director
Omega Completion Technology

Technology hasn't advanced to the point where we can remove the human element completely, but the digital oilfield should be automated as much as possible. Automation provides more controls and significantly reduces the risk for human error. Having a good CMMS in place combined with advanced replication will allow drillers to keep track of asset data, including asset condition, to help minimize failure, but it must be used properly. There is no doubt rigs would be a much safer and more reliable environment if we could move to near complete automation.

Jeremiah Woodford
Regional Manager, Oil & Gas
IFS North America

The challenges with the digital oilfield are not how far can technology go but how far does the business want to go? Companies are seeing opportunities from smart data technologies such as using sensor data to predict machine failure, applying augmented reality in maintenance engineering and modelling of efficient oil recovery. All these are possible – but are the people ready?

Professor Ian Allison
Head of the School of Computing Science and Digital Media
Robert Gordon University (RGU)

A prerequisite of removing people from operational facilities is effective enablement of remote operations. Developing a highly available and trusted facility information system provides operators with the content and processes they need to interpret and react correctly to remote events. Making this a reality can be a challenge due to the difficulty in assembling and maintaining accurate asset information, but the goal of reducing costs and enhancing safety is worthy.

Paul Muir
Chief Strategy Officer
McLaren Software

Communications between the site and office have been improving continuously over the last few decades and, today, having experts monitor site operations remotely is commonplace. Where this is business critical, it often involves expensive, bespoke, satellite communications, due to the lack of reliability in commercial communications systems. If their reliability can get to acceptable levels, the scope for monitoring and controlling oilfield operations digitally will expand dramatically.

John Scrimgeour
Executive Director
University of Aberdeen's Institute of Energy

I don't see the goal of the digital oilfield as to remove the human element, but rather to enhance it through a focus on safety and productivity. For example, automating tasks in dangerous zones or area classifications helps keep workers safe. And automating repetitive and predictable operations frees employees for more productive tasks. It's all about increasing operator effectiveness and making our industry an attractive choice for the next generation of engineers and operators.

Brandon Spencer
Vice President, US Industry Group Manager - Chemical, Oil & Gas
ABB Inc.

Go to OEDIGITAL.COM and give us your opinion on this month's topic!

Colloquy

Nina Rach

EnergyQuest and the Court of Last Resort

Raising awareness of the energy industry needs to begin long before students are enrolled in college.

The World Affairs Council of Houston recently held its fourth annual EnergyQuest competition for Houston-area public and private high school students, testing their knowledge of the global energy industry.

WAC-Houston developed the event in 2010, said Education Program Officer Ivana Situm.

The questions are international in scope, testing students on technology, as well as economic and political aspects of energy, in all its forms: fossil fuels, renewables, types of power (nuclear, fuel cells, electric cars). In the oil & gas sector, this included questions on chemical attributes of fuels, vessels, NOCs, IOCs, and service companies.

Teams (of up to 10 students) were expected to prepare for the competition by reading the material posted three month earlier at wachouston.org. The material–29 articles–was drawn from a variety of sources, including articles published by ABC News, Bloomberg, Business Week, The Christian Science Monitor, The Economist, Forbes, Fortune, National Geographic, The New York Times, Time, USA Today, and Wall Street Journal; reports issued by the US Energy Information Administration (EIA) and Casey Research; and locally, the Houston Chronicle and Greater Houston Partnership.

EnergyQuest is structured as a fast-paced quiz game, played in four rounds of twenty questions each. The subject rounds this year were: Sources & Security; Transportation & Technology; Politics & Geography; and Demand & Economics. In the case of a tie, additional questions were available for a Sudden Death round, but that was not necessary in this year's competition.

If a team decided to challenge the wording or scoring of any question (and a few did), they were able to appeal to the "Court of Last Resort," which was judged by Julian Lamborn, Master Docent for the Wiess Energy Hall at the Houston Museum of Natural of Science.

I was impressed by the success rate of the winning teams in each round; top teams often scored 17-18 correct out of 20 questions. This is the next generation of energy professionals!

Individual players on the top three teams received medals; the winning team received a trophy and the winning teacher or school, a $500 cash prize. First place: Dulles High School; second place: Foster High School; third place: Carnegie Vanguard.

The Houston EnergyQuest event was sponsored by the Petroleum Equipment Suppliers Association (PESA) and the Emcees were Pat Bond and Karen Oganowski, assisted by students from the University of Houston.

WAC-Houston's Education Outreach is supported by Albert & Ethel Herztein Charitable Foundation, Anadarko, Aramco Services, Baker Hughes Foundation, The Brown Foundation, Carleton Speed Family, Chevron, ConocoPhillips, ExxonMobil, Marathon Oil, The Powell Foundation, Shell, UHY Advisors, private foundations, and individual members. OE

Students from Carnegie Vanguard High School at EnergyQuest 2014

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ThoughtStream

Hugh Fraser, Andrews Kurth (Middle East) JLT

Intelligent energy in the Middle East

The Middle East has long been associated with "easy oil" and "low tech, low cost" production models. But the volume, scale and complexity of energy projects across the region are creating increasing demand for advanced technology and expertise.

This rapidly changing scenario is being driven by factors including the accelerating need for enhanced oil recovery, sour gas, heavy oil, tight gas, LNG, GTL, "clean fuels" refineries, carbon capture and storage, nuclear, and solar technologies.

This intelligent energy trend, which can be evidenced by Saudi Aramco's drive towards high technology solutions, presents major opportunities and challenges for international companies, in relation to intellectual property acquisition, transfer, and protection, across the region.

The scope and scale of opportunity in the region is exercising a significant pull for IOCs and the global supply chain.

Just over half of the world's proven conventional oil reserves and 42% of the world's proven conventional gas reserves are in the Middle East and North Africa (MENA). The region has 13 of the world's 20 giant oilfields, as well as the largest gas field in the world.

There is an estimated US$3 trillion of projects underway or planned in the six Gulf Cooperation Council countries (Saudi Arabia, United Arab Emirates, Kuwait, Oman, Bahrain and Qatar) plus Iraq and Iran. The majority of these relate to upstream oil and gas, downstream (including refineries, LNG and GTL), petrochemicals and related infrastructure projects.

Industry watchers anticipate that Iraq will overtake Saudi Arabia as the biggest projects market in the region in the next five years, but Saudi Arabia and Abu Dhabi will continue to attract huge capital intensive projects. This represents a major prize for EPC contractors and their supply chain.

While clearly a region of opportunity, those seeking to play to their innovative technology strengths will have to minimize the risks that proprietary technology and knowledge is exploited by others.

The retreat of IOCs from the region, seen in the 1970s, when a major nationalization program pushed them out, has been reversed. Perhaps the most important development anticipated in the region in a generation is the expiration and replacement of the ADCO onshore concessions in Abu Dhabi, which could bring in a host of new IOC operators, including Statoil. The petroleum industry is balancing the politics of "resource nationalism" with the need for IOCs and their technology. It can be expected that there will be an increasing use of enhanced technical services agreement (ETSA) contract models, as a partial solution to this challenge, such as the ETSA Kuwait Oil Co. placed with Shell to develop its tight gas Jurassic Field in the north of the country.

A further drive to advanced technology will follow if the current and prospective Red Sea and East Mediterranean exploration and appraisal programs bear fruit and bring deepwater fields into play in a region dominated by onshore and shallow water production.

While clearly a region of opportunity, those seeking to play to their innovative technology strengths will have to minimize the risks that proprietary technology and knowledge is exploited by others.

Conventional thinking has been to focus IP protection in the US and Europe, but the Middle East provides unique protection for technology, brands, engineering designs, and software. There are a range of options available within the six Gulf Cooperation Council countries and the position is improving in Iran.

As the technology needs across the region become increasingly complex, it will incumbent on companies to ensure that they have the appropriate strategies and protections in place for their IP, as part of their overall risk and reward assessments. OE

Hugh Fraser *is managing Partner at Andrews Kurth (Middle East) JLT, in Dubai. He is a Scottish corporate lawyer, from Aberdeen, and based in the Middle East for 10 years, and with 25 years of experience in the international energy industry. He was the founder and managing partner of Hugh Fraser International Legal Consultancy (2003-2013) and the former group head of legal at John Wood Group PLC (1996-2003). Houston-headquartered Andrews Kurth provides legal services to the global energy industry.*

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Global Briefs

A Shell quits Alaska

Royal Dutch Shell will discontinue its 2014 plans for drilling offshore Alaska. Shell's U-turn on Alaskan drilling follows a profit warning and a court judgment, raising "substantial obstacles" to the company's plans for drilling in the Chukchi Sea, offshore Alaska.

B EnVen plugs gas leak

The US Bureau of Safety and Environment Enforcement (BSEE) announced that weighted drilling fluids pumped into well A-7 stopped the uncontrolled gas flow in Vermilion block 356 in the Gulf of Mexico.

BSEE approved operator EnVen's plan to kill the well with mud, and pumping began 31 Jan 2014.

BSEE still requires additional work at the site, including the setting of barriers.

C Olympus starts up

Shell began production from the Mars B development through Olympus, its seventh and largest floating deepwater platform in the Gulf of Mexico. Combined future production from Olympus and the original Mars platform is expected to deliver an estimated resource base of 1 billion boe.

D Olmeca export delayed

Mexico's Pemex will not begin exporting high-quality Olmeca crude to Europe until 2H February.

Pemex said that exports of the extra-light Olmeca would begin in January, but it announced via Twitter that the start date had been pushed back.

The first shipment to Europe would be sent to Varo Energy's Cressier refinery, a short distance west of Bern, Switzerland, Pemex said.

E Cuba drilling discussed

Cuba's Ministry of Foreign Relations hosted a delegation from the US-based Council on Foreign Relations (CFR). The CFR delegation included a dozen "energy and environmental experts" focused on the safety and potential environmental effects of offshore oil drilling.

The group traveled to Cuba in January for a five-day visit. The delegation is part of a long-term project called the Study Group on the Prevention and Resolution of Marine Disaster, sponsored by the CFR.

F Croatia plans tenders

Croatia's government is planning to publish tenders for oil and gas exploration in the central and southern Adriatic Sea 2Q 2014.

The announcement follows the completion of a 2D multiclient seismic acquisition survey offshore Croatia by Oslo-based seismic services provider Spectrum. The new survey provided about 15,000km of modern long-offset 2D data, covering the majority of offshore Croatia. Final processed products will be available by April 2014.

G OMV completes Black Sea seismic

OMV and its partners have announced the completion of the largest 3D seismic survey in the Black Sea.

The survey covered 7740sq km, in the 1-21 Han-Asparuh block, offshore Bulgaria. It will help define the location for two exploration wells, planned for during 2015 and 2016.

The 1-21 Han-Asparuh block is in the western part of the Black Sea and covers 14,220sq km, in water up to 2200m.

H Record licensing round

Norway's government has offered a record 48 companies stakes in 65 new production licenses in its 2013 Awards in Predefined Areas (APA) licensing round. The move sets a record, both in the number of production licenses offered and the number of companies involved.

The latest round offered for license a total of 103,029sq km, divided into 377 blocks, or parts of blocks. The acreage in the Norwegian Sea was extended by six blocks in the area surrounding Aasta Hansteen, compared to APA 2012.

I Siri back online

After a half-year hiatus, exploration and production in the Siri area has recommenced.

DONG Energy reconnected Siri Knutsen to three of the Siri area's four oil fields on 28 Jan 2014, offshore Denmark. The Nini East field delivered first oil on 4 Feb 2014.

In December 2013, the Danish Energy Agency approved a temporary

production solution to allow for a 1Q 2014 restart.

Operations were placed on hold in July 2013, after a new crack was found around the sponson (nose) area of the Siri platform. The Nini, Nini East and Cecilie fields are slowly returning to full operation, with oil being sent to the Siri Knutsen, instead of the platform.

J QGEP strikes big in Atlanta

Results of the first well drilled in the Atlanta post-salt oil field off Brazil were better than operator Queiroz Galvão Exploração e Produção (QGEP) and its partners anticipated, according to the Brazilian company.

Located in Block BS-4 in the Santos Basin 185km out from the state of Rio de Janeiro, horizontal well (7-ATL-2HP-RJS) is in around 1500m of water. The well was drilled to a section length of 750m and a diameter of 9.5-in. A sand reservoir was found with average porosity of 38%.

High permeability was also confirmed, with an oil quality of 14º API.

K Libra to be drilled

Drilling operations will begin 2H 2014 on two wells in the giant Libra field off Brazil following approval of the field's 2014 working and investment plan.

Located about 23km off the state of Rio de Janeiro in the ultradeep waters of the Santos Basin pre-salt polygon, Libra spans 1,547.67sq km, and is estimated to have 8 -12 billion bo recoverable. Peak oil production could reach 1.4MMbo/d.

Drilling activities on the two wells are expected to conclude 1H 2015. In addition, seismic reprocessing is planned for the entire block, along with studies for a new seismic survey. An extended well test will occur year-end 2016.

L FAR completes testing

FAR Ltd. recently assessed significant hydrocarbon resource potential in its Guinea Bissau 3 blocks offshore, Sinapa Block 2 and Esperanca Blocks 4 A /5 A in West Africa.

The existing East Sinapa oil discovery is estimated to contain contingent resources of 13.4MMbo. East Sinapa is also estimated to contain prospective resources of 7.5MMbo.

The West Sinapa prospect, expected to be drilled by the joint venture in late 2014, is estimated to contain prospective resources of 64.7MMbo. The prospect is assessed to have significant upside with 251.7MMbo.

M Dana surveys Bakassi West

Dana Petroleum has started 2D seismic acquisition operations in the Bakassi West production sharing contract (PSC) area in Cameroon's Rio Del Rey basin.

The survey covers an area of almost 390sq km. Around 350km of 2D seismic will be acquired over the next six months and the first exploration well is planned for late 2015 or early 2016.

N Giant jackup order

Drydocks World (DDW) signed an agreement with Drill One Capital for what it describes as the largest jackup to ever be built.

The Dubai Expo 2020 NS jackup rig will be the first Gusto MSC CJ 80 design rig to be built. It has been designed to be operated in harsh environments. The 101x110m, 5500sq m unit will be classed by DNV and will meet all rules and regulations in the Norwegian and the UK sector of the North Sea. The design draft is 8.5m, with 20m minimum operational water depth and 232m leg length.

O Concession extended

The government of Abu Dhabi extended the concession for the Upper Zakum oil field, off Abu Dhabi to 2041.

The extension adds more than 15 years to the previous term. Upper Zakum is being jointly developed by Abu Dhabi National Oil Co. (ADNOC), ExxonMobil, and INPEX subsidiary Japan Oil Development Co.

Upper Zakum is one of the largest oil fields in the world, covering 1150km, about 80km offshore. Production capacity is targeted at 750,000 bbl/d.

P AMEC consortium on Shah Deniz II

The AMEC Tekfen Azfen (ATA) consortium has been awarded a US$974 million contract for work on the BP-operated Shah Deniz II gas field development in the Caspian Sea.

The contract covers the fabrication, load out, and offshore hook-up and commissioning of the topsides units of the two Stage 2 platforms, including the production and risers platform, and quarters and utilities platform.

Both topsides units will be built at the ATA fabrication yard in Bibi-Heybat, near Baku.

Construction is planned to begin January 2014, with completion expected in 2018.

Q Crude leak off South Korea

Nan Zhou Maritime Pte Ltd.'s *Wu Yi San* tanker collided with a jetty at the Port of Yeosu, causing damage to a pipeline, and leaking crude oil into the sea.

The leak occurred at a quay off Yeosu, over 300km south of Seoul, South Korea, while the 160,000-tonne *Wu Yi San* was preparing to offload crude.

According to Shell, the ship's cargo tanks suffered no damage, and there were no injuries reported by crew members. The amount of crude oil leaked from GS Caltex Corp.'s pipeline has yet to be determined, but the company said that the spill had no impact on refinery production.

R EGPC begins bid round

The Egyptian General Petroleum Corporation (EGPC) has launched a new bid round for exploration licenses in the Gulf of Suez.

Fifteen blocks, five in the Gulf of Suez and 10 in the Western Desert sedimentary basins, will be available, with licenses to be agreed on a production sharing model. The closing date for bids is 19 May.

S Aqualis enters offshore market

Oslo-based Aqualis Offshore, entered the Indian offshore market and is completing its first rig moving operation in the region.

Staff from Aqualis Offshore's Dubai office successfully moved its first jackup rig in India in early February.

The *Jindal Star*, a newbuild MLT 116 E, was towed from Lamprell's shipyard in UAE to an ONGC platform location offshore the west coast of India.

T TGS plans Barrow seismic survey

TGS announced it will conduct a 3D seismic survey off northwest Australia. The Huzzas is a 2100sq km 3D survey that will cover the Barrow sub-basin.

The data will be acquired by Volstad Maritime's M/V *Geo Caspian* using CGG's BroadSeis and BroadSource technologies.

Preliminary data will be available 3Q 2014.

Contract Briefs

Petrobras contracts offshore support vessels

Petrobras' executive board approved contracts to acquire eight support vessels for the company's offshore activities. These OSVs are part of the third fleet renewal plan for offshore support vessels (Prorefam).

In this fifth round, four vessels were contracted from the company Bram, which will build the vessels at the Navship shipyard in Santa Catarina state; three from Starnav, with construction planned for the Detroit shipyard, also in Santa Catarina; and one from Norskan, which will use the STX (Vard) shipyard in Rio de Janeiro state.

Prorefam was launched in 2008 and contains plans to contract 146 vessels in total, over seven rounds.

FMC Technologies awarded US$64 million Pemex contract

FMC Technologies announced a three-year contract with Pemex Exploration and Production for the manufacture and supply of surface wellheads to support its drilling and well maintenance programs in the Gulf of Mexico.

The award is expected to result in approximately $64 million in revenue to FMC Technologies if all of the equipment is ordered. The agreement provides assurance that at least 40% of the contractual value will be ordered by Pemex during the three-year call-off period.

Bumi Armada receives letters of award

Malaysia's Armada Offshore OSV and Bumi Armada received letters of award from Interoil Angola Limitada for the charter of two platform supply vessels (PSV), Armada Tuah 306 and Armada Tuah 302, respectively. The PSVs will be supporting Total E&P Angola on the drilling campaign on Block 32 offshore Angola.

Exmar, PRE order second FLNG unit

Belgium's Exmar and Canada's Pacific Rubiales Energy (PRE), through its wholly-owned affiliate Pacific Midstream Holding, announced they have ordered a barge-based floating LNG regasification unit under a 50/50 joint venture.

The unit will be constructed by Wison Offshore & Marine at its shipyard in Nantong, China.

Delivery is anticipated 4Q 2015. Negotiations for a long-term charter are ongoing and an award is expected by mid-2014.

Technip wins Dubai Petroleum contract

Dubai Petroleum Establishment (DPE) awarded Technip a contract for the engineering, procurement, construction and installation of the Jalilah B field development.

The Jalilah B project is located approximately 90km offshore Dubai in about 60m of water.

Technip's scope of work consists of the construction and installation of the Jalilah B platform, a 900-ton deck, a 500-ton jacket, as well as 13 new risers on existing platforms. It also includes the installation of 110km of pipelines ranging from 6in. to 24in. in diameter.

The project is scheduled for completion by 2H 2014.

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Improving UK North Sea production through targeted maintenance

Targeted maintenance could boost UK North Sea production by 10%, equating to US$18 billion in annual revenue, suggests Alan D'Ambrogio, ABB Consulting's vice president, oil and gas. Meg Chesshyre reports.

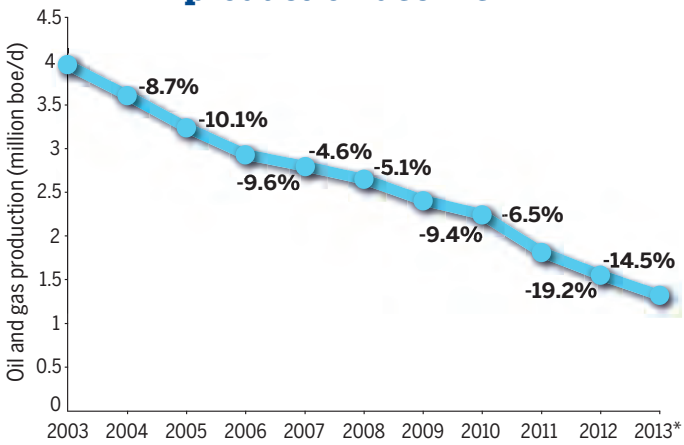
In 2013, the industry invested £13.5 billion (US$22.4 billion) in the UK Continental Shelf (UKCS) facilities. This figure is unprecedented, even during the boom years of the 1970s. Majors ConocoPhillips (the Jasmine project), BP (Clair and Sullom Voe), Total (Laggan-Tormore), Statoil (Mariner) are some of the companies pumping big money into their projects.

With such a staggering level of investment, companies expect stellar production and performance rates in return.

However, the UKCS saw an estimated 22% drop in oil and gas production in 2013, which is the highest annual fall in North Sea oil and gas production on record (Fig. 1).

It was only in 2011 Oil and Gas UK predicted production would start to increase by 2013 (2011 Production Outlook). This continued, record fall in production appears to stem from several factors, including:

Fig. 1: UKCS oil and gas production decline



Source: DECC, Oil & Gas UK
*forecast

- More than 50% of the platforms in the North Sea are at or beyond their design life. The industry has, to date, done little to address the requirement for life extension of these assets. The UK Health and Safety Executive's plant-haging initiative has been a wake-up call. The inspection program was designed to improve how these aging UK offshore installations were managed, especially given the growing demands to extend their use beyond the original design life.
- The UKCS lacks a long-term strategic approach to asset life when compared to other oil and gas hubs use a more stringent approach to assets operating beyond their design life.
- The industry has suffered from several notable major accidents and incidents, which drives a far more cautious and conservative approach to the operations and maintenance of the assets. Most notably, the *Deepwater Horizon* disaster saw BP spend $42 billion.
- There has been unprecedented expenditure on asset integrity and interventions over the last five years. It is estimated that US$1.7 billion was spent in 2012 and 2013 on asset integrity. This spending requires downtime in assets to be implemented, which impacted 2013 performance.
- The global industry skills shortage and turnover in personnel is a key issue. However, the UK appears to be faring worse than other hubs, where oil lift costs tend to be higher and new discoveries tend to be small.
- There have been several significant overruns in platform turnarounds, which have resulted in lower annual production.

The UKCS' major challenge is to see if it can restore production efficiency (a measure

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	2011	2012	2013	2014
Shallow (<500m)	104	75	65	2
Deep (500-1500m)	25	24	16	1
Ultradeep (>1500m)	19	37	28	–
Total	**148**	**136**	**109**	**3**
Start of 2014 date comparison	151	135	98	–
	-3	1	11	3

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 2014-18

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
Brazil			
Shallow	16	738.25	1,060.00
Deep	16	2,615.00	2,515.00
Ultradeep	45	13,176.75	18,030.00
United States			
Shallow	22	109.40	342.00
Deep	24	1,608.11	2,104.57
Ultradeep	33	4,825.50	4,690.00
West Africa			
Shallow	179	4,703.68	22,990.83
Deep	52	6,086.50	7,340.00
Ultradeep	18	2,065.00	3,360.00
Total	**405**	**35,928.19**	**62,432.70**
(last month)	(412)	(38,094.59)	(63,504.70)

Greenfield reserves

2014-18

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
Shallow (last month)	1,377 (1,384)	55,202.67 (55,606.69)	848,802.42 (849,356.76)
Deep (last month)	185 (186)	14,342.48 (15,020.48)	114,756.27 (114,991.27)
Ultradeep (last month)	121 (123)	20,696.75 (21,902.75)	88,847.00 (89,247.00)
Total	**1,683**	**90,241.90**	**1,052,405.69**

Pipelines

(operational and 2014 onwards)

	(km)	(last month)
<8in.		
Operational/ installed	42,258	(41,396)
Planned/ possible	24,420	(25,433)
	66,678	(66,829)
8-16in.		
Operational/ installed	78,858	(78,039)
Planned/ possible	48,254	(49,390)
	127,112	(127,429)
>16in.		
Operational/ installed	90,244	(89,108)
Planned/ possible	47,202	(49,539)
	137,446	(138,647)

Production systems worldwide

(operational and 2014 onwards)

Floaters		(last month)
Operational	276	(274)
Under development	42	(44)
Planned/possible	332	(334)
	650	(652)
Fixed platforms		
Operational	9,634	(9,596)
Under development	117	(118)
Planned/possible	1,390	(1,471)
	11,141	(11,185)
Subsea wells		
Operational	4,474	(4,337)
Under development	380	(431)
Planned/possible	6,256	(6,353)
	11,110	(11,121)

Global offshore reserves (mmboe) onstream by water depth

	2012	2013	2014	2015	2016	2017	2018
Shallow (last month)	5,923.14 (5,941.77)	24,157.76 (26,335.74)	46,925.48 (48,006.10)	42,481.43 (41,942.71)	34,111.82 (33,117.77)	50,672.58 (51,487.35)	31,326.78 (31,588.93)
Deep (last month)	2,821.40 (2,821.40)	471.51 (1,784.63)	4,729.17 (3,967.22)	7,218.27 (7,166.95)	4,816.80 (5,1010.60)	8,311.26 (8,577.10)	9,490.50 (10,606.95)
Ultradeep (last month)	737.15 (737.15)	2,937.44 (3,090.07)	2,826.43 (2,673.80)	2,173.17 (2,264.67)	5,058.07 (4,880.02)	16,359.43 (16,387.06)	9,944.01 (10,432.09)
Total	**9,481.69**	**27,566.71**	**54,481.08**	**51,872.87**	**43,986.69**	**75,343.27**	**50,761.29**

3 February 2014

Fig. 2: The production efficiency challenge

▪ Equipment projected as not fit for purpose ▪ Increased congestion of equipment and removal of redundant equipment ▪ Replacement of obsolete equipment ▪ Operation outside original design or lack of turn down capacity ▪ Reducing equipment and key system reliability ▪ Need to upgrade Safety, Escape and Fire to meet latest standards ▪ Newly emerging deterioration mechanisms, i.e. changes in process fluids, e.g. sand, H2S ▪ Integrity of minor structures (handrails, walkways, ladders) ▪ Integrity of utility systems (air, nitrogen, HVAC, cooling water etc.) ▪ Electrical power limitations affecting current and future operations	**Dependable Assets**
▪ Competencies as against aging workforce retires ▪ Leaner organizations with increased reliance on sub-contractors	**People**
▪ Lack of clarity for ownership of knowledge between operator and sub-contractors ▪ Loss of corporate knowledge and unfriendly documentation systems ▪ Compliance with current and future environmental legislation	**Systems**

of overall availability and reliability of the platforms) back to 80%, its level 10 years ago.

This is still lower than what many other industries achieve and what most other oil and gas hubs achieve. BG Group's 2013 strategy review places the UKCS at the bottom, globally, in production efficiency. That position cost the UK economy US$18 billion in 2012. This underperformance of assets is starting to threaten the viability of the UKCS maximizing hydrocarbon recovery from the basin.

To help restore North Sea production, ABB has worked with North Sea operators develop platform and asset strategy; maintenance targets; and delivery of good shutdowns and turnarounds.

Platform and asset strategy

Alan D'Ambrogio and his colleague Andy Hollins, lead principal consultant at ABB Consulting, presented ABB's views on targeted maintenance at a meeting at the Institution of Mechanical Engineers in London earlier this year.

ABB has conducted a number of asset life studies in the UKCS, which examine how the operator targets its maintenance, to maximize medium term safety, integrity, availability and reliability. Those studies included oil and gas offshore platforms, onshore terminals and onshore gas processing, and they aimed to provide operators and shareholders with clear and justifiable maintenance spend on their assets that will mitigate the safety, reliability and aging issues they are experiencing.

The UK HSE's plant-aging guide (RR509) stated: "Aging is not about how old the equipment is. It's about what is known about its condition, and how that's changing over time." However, too many operators appear to have little strategic approach in how they manage the aging of their assets.

Challenging the maintenance

The second area of notable achievement is the prioritization and targeting of

maintenance. With offshore platforms, the persons on board (POB) limitation is the biggest single bottleneck to the implementation of maintenance. It is difficult, if not virtually impossible, to economically increase the POB on an aging asset. Hence, the challenge and removal of low value maintenance work is essential. All assets in the North Sea would proclaim to prioritize maintenance using a risk-based approach. However, when this is challenged in more detail, less than half of the assets have a transparent and effective maintenance challenge process.

In a recent study for an operator–one of the top five producers on the UKCS–ABB was able to eliminate 50% of maintenance inspection work during a turnaround with no impact on the asset's reliability and integrity. ABB used its newly-developed Risk Based Inspection Revalidation capability (RBI+ Reval). Of the 164 high-hazard pressure equipment studied, ABB reduced the number requiring intrusive inspection to 66, or 40% of the turnaround workscope. The asset had previously undergone an RBI study.

ABB's operationally-led RBI+ Reval reduced the turnaround window for the operator and increased production efficiency. If this approach were to be repeated for the whole of UKCS, it could increase production by between 5% and 10% in the first year alone.

Delivering good shutdowns and turnarounds

The ability of the UKCS to deliver turnarounds on time and cost has not been good. The aging work force, combined with the entry of many more operators into the sector, and the skills shortage, there was a tendency to outsource some elements of turnaround planning and management. Decreased performance was a result across the sector. The introduction of turnaround preparation assessment and readiness reviews will help give senior managers and business leaders early indicators of the likely performance of the turnarounds.

There are several different approaches for these assessments in the UKCS, with the minority of operators having an effective and independent turnaround assessment. ABB advocates a unification of existing assessment methodology into an industry leading standard. This would enable early action to be taken on maintenance turnarounds that look like they will miss their objectives.

The fragmentation of the UK offshore sector is probably the single greatest reason why the above factors have had greatest impact on the UK. In fact when the coalition government came into power in 2010, its first priority was reducing the deficit. Additional taxation was imposed on the industry. The UK's overseas competitors (Norway, Denmark and further afield) take a longer-term view of their oil and gas strategy.

Production efficiency and the UKCS's ability to maximize the hydrocarbon recovery can be achieved by a more strategic and long term view by all stakeholders (Fig. 2). Too much focus has been placed in recent years on capital investment in the sector, and too little on the performance of existing assets.

It is estimated that $1,700 billion will need to be spent in the UKCS over the coming years to maximize hydrocarbon recovery. The industry will only commit to this, if the performance of the existing assets is improved. The reduced level of exploration in 2013 is a worrying indicator, where oil and gas operators have put the brakes on future investment before seeing value from their existing investments and assets. OE

Rig stats

Worldwide

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	411	354	57	86%
Semisubs	192	172	20	90%
Drillships	96	87	9	91%
Tenders	31	21	10	68%
Total	**730**	**634**	**96**	**87%**

Gulf of Mexico

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	90	71	19	79%
Semisubs	30	28	2	93%
Drillships	23	21	2	91%
Tenders	N/A	N/A	N/A	N/A
Total	**143**	**120**	**23**	**84%**

Asia Pacific

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	116	102	14	88%
Semisubs	36	31	5	86%
Drillships	16	12	4	75%
Tenders	23	15	8	65%
Total	**191**	**160**	**31**	**84%**

Latin America

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	8	7	1	88%
Semisubs	42	42	0	100%
Drillships	28	27	1	96%
Tenders	2	2	0	50%
Total	**80**	**78**	**2**	**98%**

Northwest European Continental Shelf

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	46	43	3	93%
Semisubs	46	45	1	98%
Drillships	2	2	0	100%
Tenders	N/A	N/A	N/A	N/A
Total	**94**	**90**	**4**	**96%**

Middle East & Caspian Sea

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	103	90	13	87%
Semisubs	3	3	0	100%
Drillships	1	1	0	100%
Tenders	N/A	N/A	N/A	N/A
Total	**107**	**94**	**13**	**88%**

Sub-Saharan Africa

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	24	21	3	88%
Semisubs	20	16	4	80%
Drillships	25	23	2	92%
Tenders	6	4	2	67%
Total	**75**	**64**	**11**	**85%**

Rest of the World

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	24	20	4	83%
Semisubs	15	7	8	47%
Drillships	1	1	0	100%
Tenders	N/A	N/A	N/A	N/A
Total	**40**	**28**	**12**	**70%**

Source: InfieldRigs

14 February 2014

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

Real-time data collection & analysis

Kepware Technologies' Stephen Sponseller discusses how automation can improve remote drilling operations.

Most of the public is unaware that there is an automation revolution in the exploration and drilling segment of the oil and gas industry. Like most automation endeavors, this revolution is driven by the demand for improved efficiency, accurate reporting, and more stringent safety requirements.

The fast pace of drilling in shale gas exploration and production requires improved process efficiency. Improved efficiency demands are partly due to the wide geographic spread of the plays and the need for multiple wells to drill and hydraulically fracture to tap into the gas trapped in the shale rock. Companies are performing advanced analytics on their drilling operations, allowing them to predict conditions and events before they happen, based on the outcomes of previous operations. Improvements in efficiency have allowed companies to reduce drill time to two weeks for some wells, and set drill time goals closer to seven to 10 days.

The need for accurate reporting ranges from demands for corporate and industry analyses to requirements established by government regulations.

Finally, the *Deepwater Horizon* incident in 2010 has escalated safety concerns in both offshore and onshore drilling operations where several different drilling contractors and service companies may be working simultaneously on a platform or rigsite. Automation can provide means to improve safety in these situations. Also, according to an ARC Insights report issued in 2013 titled "Wireless Strategies for Unconventional Reservoirs," transportation to rigs is a major safety concern. In fact, the leading cause of death among onshore rig workers happens while en route to a rig site.

To satisfy these efficiency, reporting, and safety requirements, companies are now remotely collecting data and monitoring drilling operations 24x7. Corporate drilling centers are emerging in which experienced staff can keep a careful eye on each of the many concurrent operations that are going on at different sites in the field to ensure proper operations from a safety standpoint and to provide instant expert input when needed. These drilling centers allow experts to remain "on the beach" and not have to travel to remote sites every time their experience is needed or an issue arises. Data is continually being collected and stored to empirically develop analytical models that can be compared to the real-time scenarios of a current drilling operation.

Importance of data collection

The underlining key for these initiatives is proper data collection from the sites and communication with the corporate drilling centers. There are many

FIG. 1: Typical remote communications network and components

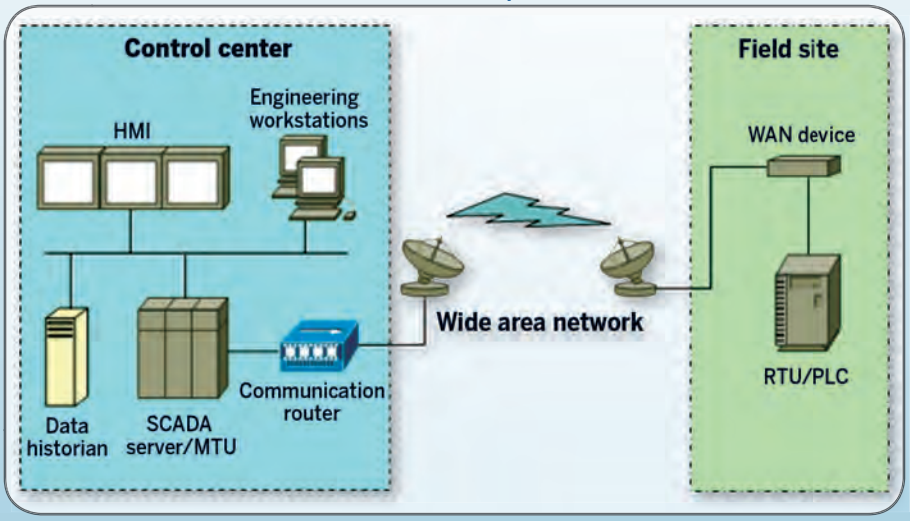
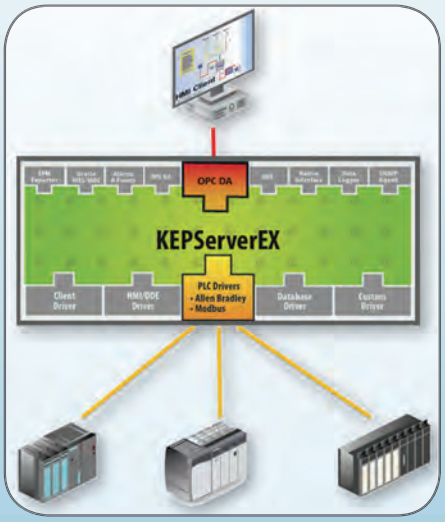


FIG. 2: Device communications with an OPC server and client



components in the data collection chain, starting with the equipment, sensors, and programmable logic controllers (PLCs) on the rigs; the systems and data collector hosts that are communicating with these devices; the communication methods and networks used to transport the data from work sites to shore and the office; and finally, the data storage, analytical tools, and human-machine interface applications that are used to view the data. Each of these components is equally important.

Challenge of collecting remote drilling data

When someone outside of the oil & gas industry thinks of automation, they most likely think of a robot in a factory. When it comes to communicating with that robot, Ethernet networks in factories are relatively easy to set up and they provide very reliable, constant connectivity between the robot and any plant or enterprise application that needs to communicate with that robot. This is not the case in a typical drilling environment, which is often in a remote location and sometimes in harsh operating conditions.

Most drill sites today have local area networks which allow data to flow between equipment and control applications on the rig. The challenge is getting that data off the rig and back to the enterprise where the 24x7 remote monitoring and advanced analytics applications are hosted. Because the rigs are remote, landline communications are typically not an option and companies are left with radio, cellular, satellite or some other form of wireless communication that have low bandwidth and high latency (time delay), especially when compared to an Ethernet network.

Communication outages can result from weather conditions or physical obstructions, such as a crane swinging in the way of a transmitter. The result of an outage is less data than what is desired, often with pockets of missing data. For industry safety and efficiency initiatives, this is unacceptable.

How OPC can help

OPC, or Open Connectivity via Open Standards, is a set of communication standards for industrial automation devices, applications, and systems. The OPC Foundation (www.opcfoundation.org) owns the standards and works with the automation industry to keep standards up to date by revising existing standards and creating new standards when required. The value of OPC lies in its interoperability. OPC enables industrial control devices to communicate with applications that need to send and receive data to and from these devices. An OPC server with a robust platform of device drivers and client connectivity can communicate directly with a wide variety of PLCs and other data sources in a facility, and then serve up the data via OPC. In the general automation industry, this is helpful because it allows applications that need data from various sources to only have to support the OPC standard—as opposed to supporting all the different native device protocols associated with a wide range of vendors. These applications are referred to as "OPC clients."

Remote communications through a wide-area network (WAN) from the enterprise directly to an assortment of devices and data sources on a rig can be troublesome. Serial communications and retries due to unresponsive devices can tie up a network and slow down communications. This issue is compounded when different applications across an enterprise are asking for the same data from the devices, causing redundant requests over the network. An OPC server located on each rig (acting as a data aggregator) would help mitigate these challenges and improve data collection by the enterprise. The OPC server can communicate directly with the devices using their native protocols across the rig's local network. Once data is collected by the server, it can serve it up to all applications in the enterprise that require data in real-time. In this scenario, there are no device retries or redundant requests across the WAN. This alone can improve data collection capabilities between an enterprise and the equipment and systems on a drilling rig.

The OPC specification for historical data access, OPC HDA, can further improve the remote data collection capabilities described in the previous paragraph. In the scenarios presented above where connections back to the enterprise can be dropped for a variety of reasons, data would be lost during those drops if real-time OPC communications were being used. An OPC server on the rig that supports HDA can locally store the real-time data it acquires from the rig devices and play it back to an OPC client application via OPC HDA when adequate communications are available. When communications are not available, the server will continue to store the real-time

FIG. 3: Redundant communications directly between enterprise applications and devices can overburden the devices and network.

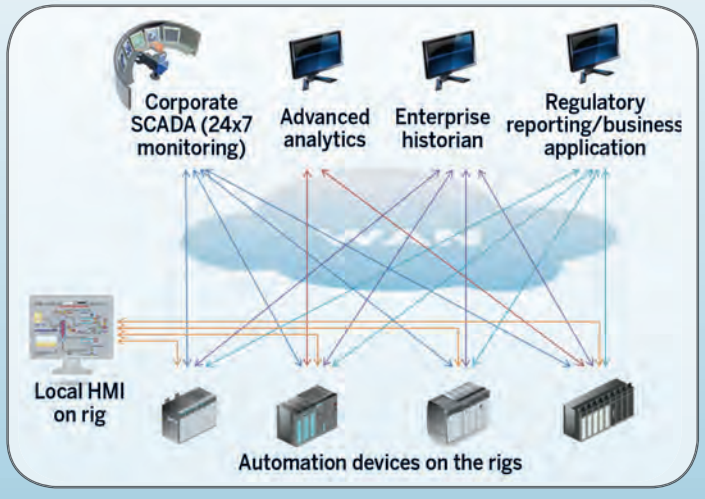
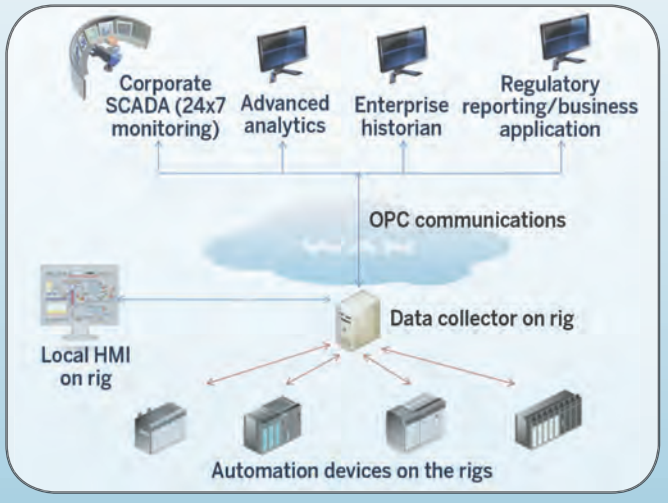


FIG. 4: An OPC server on each rig (acting as a data aggregator) improves data collection across the enterprise.



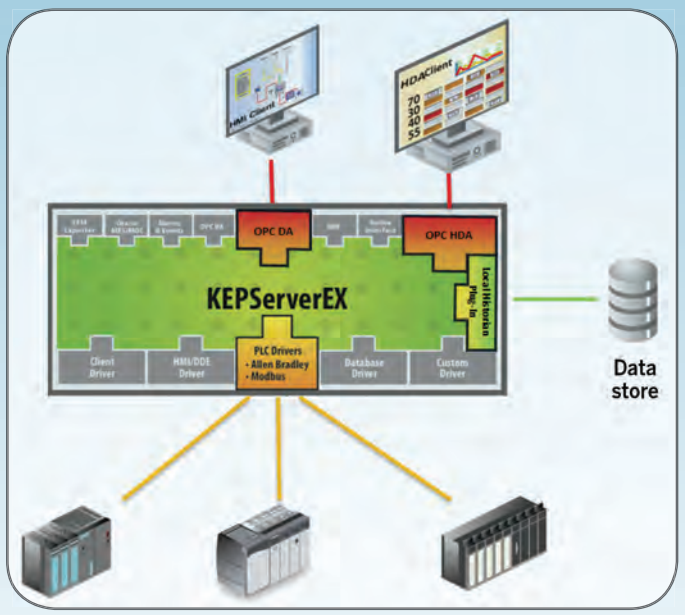


Fig. 5: An OPC server with a local datastore and OPC HDA support.

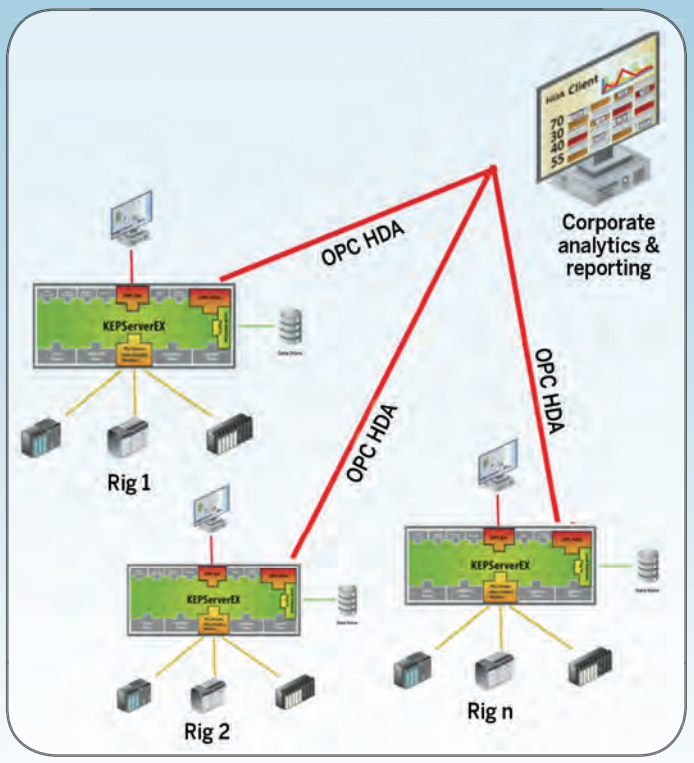


Fig. 6: OPC HDA data collection from several rigs across an enterprise.

data in its datastore repository, and then resume HDA playback where it left off, once communications have improved.

Finally, access out on a rig to the rich applications of an enterprise historian (computer architecture element) can be challenging and too expensive for the task at hand. An additional benefit of having an OPC HDA server located on the rig is that it allows for local operational trending analysis and troubleshooting when coupled with a light-weight OPC HDA application. The relatively low cost and reduced complexity enable engineers closest to the process to leverage historical data. Onsite data visibility improves troubleshooting, reduces risk, and improves operational efficiency.

Field-proven examples

Several companies have working solutions in the field to reliably collect data. One of them is Marathon Oil Corp., which has developed a remote monitoring application called MaraDrill that collects drilling data such as rate of penetration, weight on bit, revolutions per minute, mud flow rate, and torque at one-second intervals. This data is known as WITS, or wellsite information transfer specification, that was specifically developed to support the oil & gas drilling industry. This data is also used for post-well analysis for improved logistics and planning for subsequent wells.

Seadrill is an example of a company that is remotely achieving reliable data collection. Their complex drill ships and ultradeep semisubmersible rigs have many different systems and equipment on board, including dynamic positioning, vessel management, power distribution, driller operations, and subsea systems. Each of these systems typically has its own OPC server. However, in order to reduce satellite communications to the rigs, Seadrill deploys an additional OPC server that acts as an "aggregator." It is in constant communication with all of the OPC servers on the rig, but is the only connection to shore that communicates over the satellite network. This architecture provides the additional safety benefit of completely shutting down the ability to write data directly to the OPC servers on the rig, preventing an accidental command from reaching a piece of equipment that could cause potentially catastrophic events.

Conclusion

Increased demands for operational efficiency, reporting, and safety are driving the automation revolution in the exploration and production segment of today's oil & gas industry. To satisfy these efficiency, reporting, and safety requirements, companies are now remotely collecting data and monitoring drilling operations 24x7. Though remotely collecting this critical data has its challenges, the technology and know-how required to improve communications, prevent data loss, and put critical real-time and historical data in the hands of those who need it most, is available today. This technology is based on OPC standards.

An OPC server coupled with a local datastore and OPC HDA support provides real-time data access at the drill site by moving data collection and storage closer to the data source. This gives on-site operations teams access to local data for troubleshooting production issues and optimizing highly-automated but disconnected rig sub-systems.

Incorporating the solutions presented in this whitepaper requires minimal downtime, as configuration can be accomplished without disrupting established communications. Furthermore, these solutions are cost effective, secure, and field-proven. OE

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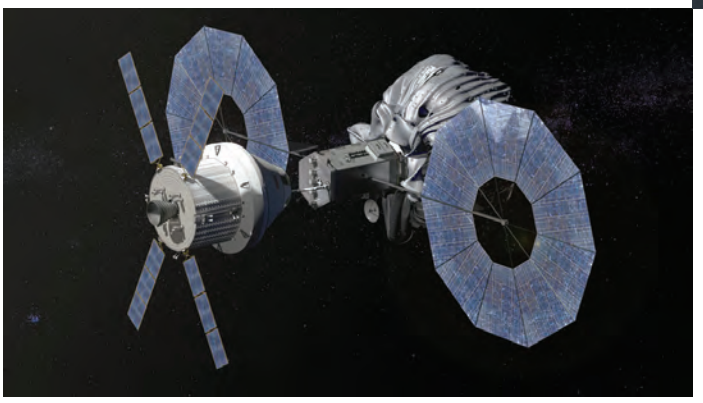


A new partnership between NASA and Deloitte hopes to bring many of NASA's proven technologies to the oil and gas industry, and even some of its unproven ones, too. Audrey Leon speaks with Deloitte's David Traylor and NASA's David Kaplan to discover how artificial intelligence can be used in the oil and gas industry to improve safety and cut risk during remote operations.

Last June, US space agency NASA and New York-based consultancy Deloitte announced a new alliance that will allow the oil and gas industry to benefit from NASA's long-proven technologies, risk analysis programs, and even its safety culture.

One aspect of the NASA portion of the alliance that may be critical to future oil and gas operations is what is currently under development, a remote decision support system. This technology uses artificial intelligence (AI) to augment real-time decision-making during emergency situations. NASA hopes to employ this program, a "NASA in a box" so to speak, on its manned-Orion capsule, due to launch from Earth by 2021. The Orion capsule aims to transport humans to Mars and even beyond. With communication critical, nary a minute can be wasted between transmissions between mission control and the crew should something go awry.

David Kaplan, chief of the quality organization at NASA's Johnson Space Center in Houston, says having a system onboard that could aid teams in the decision making process is critical to mission success when communication between mission control and remote workers is difficult. For NASA, the ultimate goal is a manned trip to Mars, a journey that can take approximately nine months. Once in orbit, communication back to earth can take anywhere from 20 to 25 minutes, Kaplan says.

"So here you are at the most critical part of your nine month journey to Mars, and you're entering the atmosphere to descend and land, and if some off-nominal event occurs you absolutely do not have the ability to radio back to Houston to ask for some insights, assistance or guidance," Kaplan says. "NASA is committed to taking those sensors that we have and developing that expert system knowledge (AI) and placing it onboard the vehicle so that in the immediacy where you have to make the correct call, you have that intelligence with you."

David Kaplan

Kaplan says there's no reason why the same technology couldn't be applicable in a platform in the North Sea. "[It's] the same philosophy of trying to understand data in a very fast manner," he says.

Of course, for NASA, partnering with the oil and gas industry to develop this technology is self-serving, Kaplan says. "We want to be able to have the best artificial intelligence and the best emergency response capabilities when we send humans to Mars, or asteroids, or wherever. We're looking to see if we can partner for everyone's mutual benefit," he says.

Deloitte's part of the alliance is to take both NASA's proven and unproven technologies and discuss with industry executives how the works can benefit current and future operations.

"The (AI) capability is not new, but the application to the sensors that feed information into oil and gas operators is," says David Traylor, a principal at Deloitte & Touche LLP. "AI could be used to assimilate this information, especially as rapidly as it comes into a crisis situation, to help operators make the right decision.

"It doesn't make the decisions, as much as it makes the right

Above left: An animation depicts the Orion spacecraft's trip to and rendezvous with a relocated asteroid.
Above right: Astronauts on spacewalk to collect samples.
Photos: NASA.

decision," he says. "That is something that is not in use right now in the oil and gas industry."

Traylor believes this smart support system is very attractive to the industry.

"This is a natural outgrowth of all the components already existing: the AI, the remote sensors. All the components are there, just using them in this manner is new," Traylor says. "This is almost a certainty that it will be explored and developed."

However, Traylor says, it will take time to teach the systems how to make the right decisions.

"It's not a trivial task. Once we start working on it, we're going to have to define the parameters. It is difficult to put a range of time, but how long it would take is measured in months, maybe not measured in years," Traylor says.

There are many similarities between the oil and gas industry and NASA, a point stressed by both alliance members.

"NASA works with some pretty complicated engineering marvels – the space shuttle (now retired) and space station," Kaplan says. "In many ways those complex engineering entities are not remarkably different from refineries and offshore platforms.

"As NASA has developed, we have found that more and more sensors and information for our station and our shuttles help to assure safe operations, reduce risk, and help engineers foresee trends that need to be interacted with."

One worry for both NASA and the oil and gas industry is what to do with the endless streams of data that pours out of sensors monitoring sensitive equipment and processes.

"(Data) is a huge question for NASA, you have so many sensors and so many pieces of information, and much of it is really noise," Kaplan says. "It doesn't really contribute to understanding the concern that just popped up. So how you store the entire information, but see through to find those things that are relevant to immediacy of the situation, that's a critical technology that NASA wants to help develop."

Traylor says for AI-enabled remote decision support systems to make their way into the oil and gas industry, it would take a collaborative environment amongst industry.

"You have to let the AI know in certain scenarios what information is more important than other information," Traylor says. "Are you seeing things you've never seen before? And what are the possible correct actions? What are the next steps, especially in a crisis situation, to give immediate response assistance to the operators. NASA has some great capabilities in this area. But of course, that needs to be taught to the AI in the oil and gas environment."

He points to recent success of joint research and development that had occurred post-Macondo and the formation of the Marine Well Containment Company to prove the industry can work well together.

"With these types of capabilities – they already share so many operations offshore – it only makes sense for this to be joint research and development," Traylor says. "I don't think this something that is addressed on a company by company basis.

"There is some customization of application within each individual company, especially when it comes to the platforms and drillships they operate, as well as the refineries. But how this gets pursued is perhaps an evolution of cooperation in the research and development environment that we have seen most recently with oil and gas companies," Traylor says. OE

Virtual reality

Current drilling simulators strive to offer operators hazard-free, cost-effective training solutions in a true-to-life environment. Greg App provides an overview of the latest technology.

Trainees can use the DrillSim 5000 to performs drilling and well control simulations as a part of Shell's Advanced Well Control Training Program. Photo: Shell

Some of the most substantial technological innovations in drilling are concerned with safety and economic efficiency. The technological and training developments available for drilling simulators are at the forefront of this philosophy, with today's technology utilizing ultra-realistic virtual reality software in conjunction with rig-specific hardware to create a life-like representation of various offshore drilling scenarios. As a result, those workers in training can obtain a "rig-like experience" before ever stepping foot onto a drilling platform.

National Oilwell Varco

National Oilwell Varco's simulator, the NOV Drilling HIL Simulator, has been on the market since 2010. In addition to representing operational rig models, the HIL can also be used to generate extremely accurate renditions of rig models currently undergoing development. The HIL can play a crucial role in the technical and operational development of these models by providing a safe, relatively cost effective process of highlighting various functionalities that may need improvement.

"The physical equipment and the virtual reality software can be altered to replicate many different offshore drilling platforms utilized by a number of different energy companies, including over 20 drilling contractors," says Erlend Engum, a Product Technical Manager for NOV.

The ability to create such technically realistic simulations results largely from the HIL's virtual reality software, called Autodesk Inventor. The 3D CAD software projects life-like images onto the "half-dome" screen, similar to those used in a planetarium. This software enables the developers to develop 3D images that are mechanically identical to the objects seen from an operator's control cabin. Thus, the physical behaviors and mechanical integrity of these objects are heavily influenced by the digital construction conducted by Autodesk Inventor. After the physical mechanics of these objects have been constructed, the virtual rig equipment is then imported into 3D Studio Max where realistic visual

honouring the past,
shaping the future

Allseas

effects such as shading, texture, shadows, and physics can be applied. The result is a virtual environment that is both visually and mechanically realistic.

In addition to being present in Norway; the US, Brazil, Singapore, and South Korea, The NOV Drilling HIL Simulator can be found at several academic institutions including the University of Texas in Austin.

Shell

While technological innovations are obviously crucial to the development of drilling simulation training, the training methodologies themselves are what transform these machines into effective educational tools.

Since 2011, Royal Dutch Shell has been using a completion and well intervention simulator in conjunction with their Advanced Well Control Training Program and DrillSim 5000 drilling module (both developed by Drilling Systems). Known as the CWI Management Trainer, this revolutionary completion/well intervention simulator is capable of recreating multiple operations including snubbing, hydraulic workover, wireline, and coiled tubing. Because the simulator requires multiple trainees to engage in the scenario (just like in a real-life well control/intervention operation), the associated program places a strong emphasis on collaborative decision-making in regards to unexpected scenarios. These 'unexpected' situations are chosen and implemented by an instructor overseeing the training exercise.

The introduction of these problematic scenarios represents more than just an attempt to "throw off "the participants. They also enable the instructor to observe and evaluate the trainees' behaviors, which cannot be recorded by means of a grade sheet. "A significant part of our training program's competency evaluation is determined not only by the statistical performance of the individual, but the manner in which the trainees behave and operate as a team," says John Grieve, learning manager for wells, Royal Dutch Shell. "These elements include how calmly the team reacts to scenarios that require instinctive action."

Texas A&M in Qatar currently utilizes a DrillSim 5000 full scale drilling simulator to help educate it's students on a variety of drilling rigs being utilized in the area.

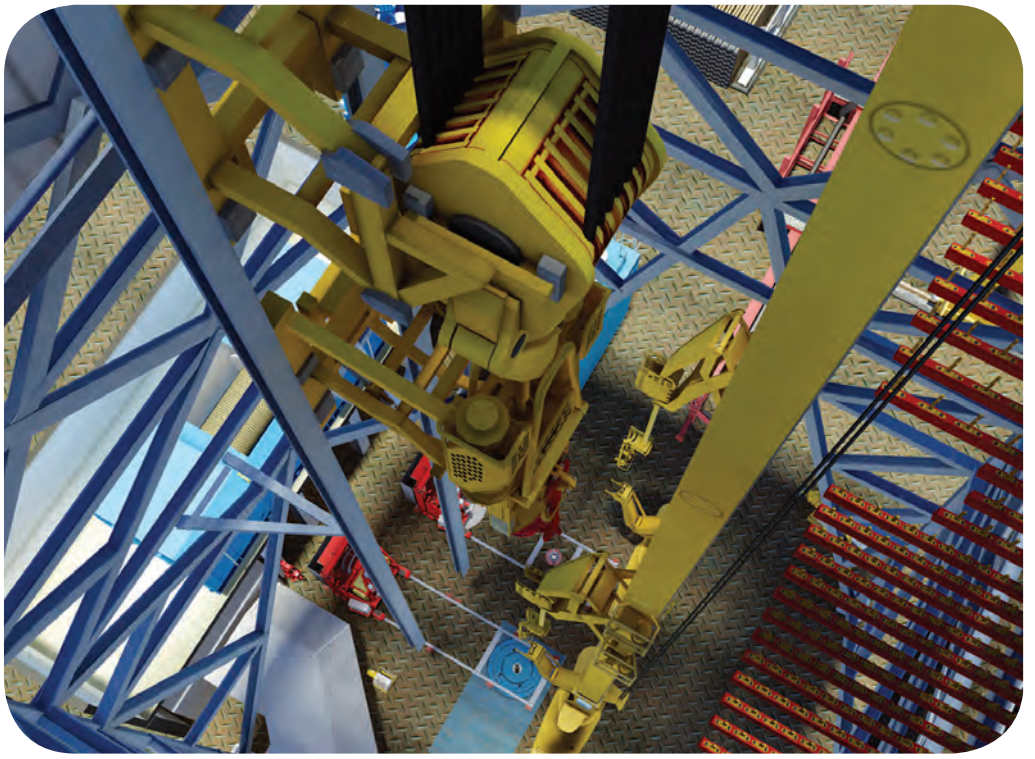
iPad drilling simulator

This is an educational tool that is ideal for both driller and aspiring petroleum engineering students. This unique app provides graphical displays including (but not limited to) fracture and temperature gradients, fluid parameters, type of rig (floating or land rig), surface circulation volume, and hydrostatic calculations. ▪

ARI Simulation

In addition to verbal instructor feedback, many drilling simulators offer visual feedback in the form of digital reenactments similar to "instant replays." ARI Simulation, which offers a variety of offshore drilling simulators for jackup rigs and drill barges, has experienced great success in utilizing this technology. Over the past two years, "this video feedback mechanism enables the instructor to efficiently point out avoidable errors made by the trainees," says Sukanta Saha of ARI Simulation. "This form of immediate visual critiquing has been very effective in showing the operator what went wrong and what improvements can be made in future real life operations."

The ARI Offshore Drilling Simulator has models at the University of Oklahoma and the University of Mexico.



Simulators allow participants to train and learn in a safe environment at a low economic risk.
Photo: ARI Simulation

The future

These simulators represent an ideal opportunity for future petroleum engineers and drilling operators to make a swift and engaging transition from an academic experience to rig exposure. The educational and technological methods of these simulators are developing at an incredible rate. However, some industry experts project that some of the more pertinent future developments in drilling and well control simulation will not only arrive in the form of technological innovation, but also in terms of product accessibility.

Shell's John Grieve predicts that mobile drilling simulation apps have the potential to be a valuable educational tool for today's engineering students. "These mobile simulator apps

Some simulators provide instant reply-style feedback through digital reenactments.
Photo: ARI Simulation

would offer an affordable, accessible way for students to become familiar with many aspects of drilling and well completions," Grieve says. Indeed, today's educational market is seeing an explosion in the amount of students pursuing degrees in petroleum engineering, and the vast majority of them will not have access to full scale drilling simulators until late in their academic career. Apps may never replace the ultra-realism and technicality of most simulators, but they would provide students with an opportunity to become familiar with some of the more basic concepts and terminology. In fact, there is currently a drilling simulator available for the iPad for the very student-friendly price of $15 (see sidebar).

Before the advent of these advanced drilling simulators, formal training programs relied heavily on actual rig time to gauge competency. "Given the nature of an offshore drilling environment, the margin for error is extremely small," Engum says. "One of the major goals of these simulations is to provide a rigorous training experience which elicits responses similar to those in an actual drilling scenario. This results in higher competence levels when the operators step onto the rig for the first time." OE

***Greg App** is an editorial intern at Offshore Engineer. He holds a BS in Business Administration and is currently pursuing a BS in Petroleum Engineering.*

BP uses high-fidelity simulators to develop non-technical skills

Tim Bailey, Director of BP's Global Wells Institute, explains how simulators are used in the applied deepwater well control program.

BP's well control and drilling simulator allows trainees to experience different drilling scenarios in a simulated environment.

Well control has traditionally been taught to individuals with the aim of raising their technical knowledge. The overriding goals have been to increase participants' decision-making abilities and competency in identifying well control situations, so that they can take the correct actions to close in the well and make the basic calculations required to initiate a well kill operation. This remains the case today. However, there is a growing recognition that effective well control incident prevention, identification and kill requires much more than individual knowledge, competence and skills. It requires the ability of the whole team to recognize and understand situations as they develop and to communicate any concerns or observations among team members and support each other to handle them effectively.

The 2012 OGP 476 report on well control training highlighted the need for more scenario-based well control training involving teams. This has been taken on by some drilling contractors, operators and training providers. However, where this has been put in place, the training tends to be focused on one aspect of the team, such as the drilling contractor's personnel or the operator's personnel. In other cases, the two are training together, which is certainly more effective, aligning teams from the two most significant stakeholders.

BP has, through its Global Wells Institute (GWI), taken this a step further to bring together all of the key players within a rig-based team – from the operator, the contractor and others. It seeks to train the full scope of individuals who may be involved in scenarios that could result in or develop into a well control situation. These include the operator wells team leader (drilling superintendent), engineers and well site leader (company representative), the drilling contractor (rig manager, offshore installation manager, tool-pushers, driller and assistant driller) and the service companies (mud engineer, mud logger and cementer). All of these individuals have roles to play to: a) prevent well control situations from occurring, b) to recognize when they do and c) to take proper action during well control kill operations.

Above: BP's simulators replicate the offshore environment, land-based drilling, and well maintenance. Photos: BP.

BP's applied deep water well control (ADWWC) training brings all of these individuals together as a team. This program provides joint understanding of the basics of well control causes and an appreciation of what is occurring down-hole during a broad range of well control situations. Technical skills are then tested in scenario-based training on a state-of-the-art, high-fidelity simulator in which the non-technical skills of situational awareness, communication, teamwork, decision-making, leadership and stress management are factors in how individuals perform, and the team melds to handle often complex situations. For each course, the simulator is programed to tailor the content to specific parameters for the rig and the well being drilled. This makes the scenario "real" and relevant to the team enabling them to obtain a hands-on appreciation of the potential for some events to occur in an

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Crew members of a drillship practice real-world scenarios in the BP drilling and well control simulator.

environment very similar to the one in which they will be operating.

Each individual within the team plays their role in the training exercises, which reinforces the importance of non-technical skills as well as the technical ones. For example, in the simulated scenario, the mud logger must make the decisions to call and advise the driller if there is any deviation in trends of the rate of penetration (ROP) or pit volume, and the assistant driller must challenge the driller or even tool-pusher in a decision or course of action that they believe may compromise a situation with which they are uncomfortable. Relationships between the operator's representative and the drilling contractor's senior person on the rig are tested through real-life examples of planning and operation. These non-technical skills form the elements of what is commonly known as crew resource management (CRM), applied successfully by the airline industry and others to ensure the potential weaknesses of the human factor are mitigated in the operational environment.

The simulator enables the enactment of these skills in an atmosphere as close to real life as possible in an office-based training environment. It is important to have a simulator that represents the equipment used in a realistic layout to make it as lifelike as possible. As training scenarios develop, the simulator becomes the "real world" as trainees become totally absorbed in their work, often forgetting they are not in a real life situation. This makes the training truly effective, as "normal" behaviors come to the fore. People's real selves emerge in tense and stressful situations. This allows us to provide feedback with evidence that allows individuals to recognize behaviors of which they themselves were not aware. Self-reflection on such compelling evidence is encouraged to allow attendees to consider their impact on others and how they can adjust their approach going forward.

The ADWWC program is one of the new strategic programs being implemented by BP through the Global Wells Institute. "Wells activity is increasing dramatically," says Gary Christman, Vice President of BP's Global Wells Institute. "The cost and complexity of our operations are increasing too. BP strives for the best technical and leadership skills. Building those skills in our workforce is an important part of our competitive advantage in the years ahead. The opening of this Institute is the first step in gaining that advantage."

BP created the Global Wells Institute to attract and develop the best people in the industry and to consolidate core and specialty wells training within the company. The goal is to supplement the training of identified BP employees and drilling contractor staff according to our exacting safety standards. The Global Wells Institute (GWI) is part of BP's Global Wells organization – one single, centralized unit within the company – to plan and execute all drilling and wells operations across the globe safely and systematically no matter where we operate.

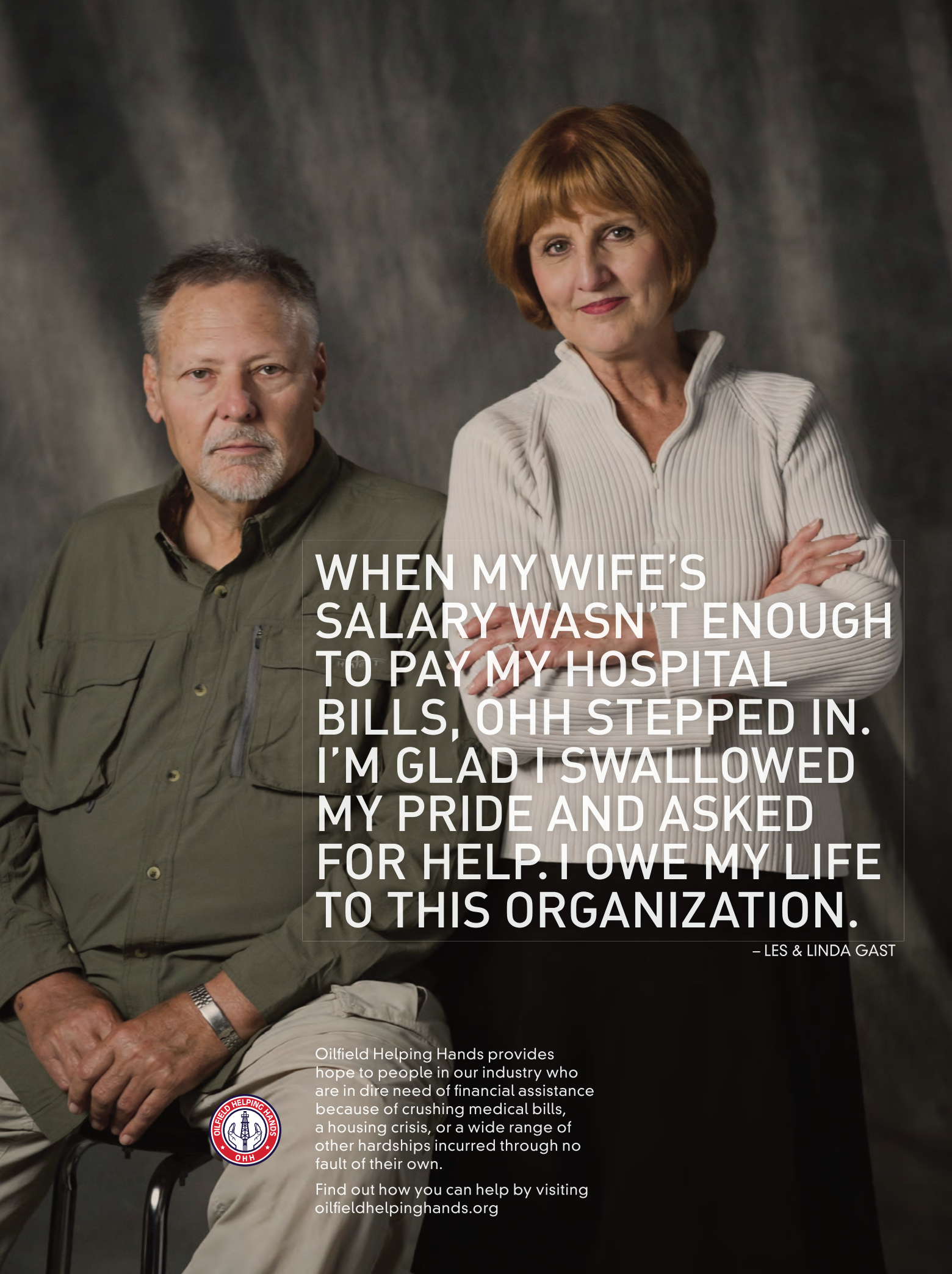
"We need to become even more rigorous and systematic about developing both technical skills and leadership skills in BP people, and this is an important way to do it," Christman said. "The Global Wells Institute is not only a place, it's a philosophy. It promotes our vision of 'great people, great wells.'"

"In our ADWWC course, we get members of wells teams into their comfort zone and then we demonstrate that a comfort zone can be a risky place," said Jim Borthwick, BP's well control simulator operator in the Helios Learning Center, Houston. "The idea is to help prepare these wells teams for the unexpected, not only the ordinary."

The teams work on dynamics and discuss strategies for improving their interaction skills and decision-making abilities. In classroom and simulator sessions, instructors use up-to-the-minute technology to teach the science of drilling and the application of that knowledge to many operational questions.

BP has run its ADWWC training for a large range of its global fleet of deep water rigs, especially for those operating in the deep waters of the Gulf of Mexico. To date, 20 courses have been run for seven rig-based teams; it normally takes three courses to cover one rig team in its entirety. The training is beneficial to all the parties involved. In addition to enhancing individual and non-technical skills, the joint training program acts as a bonding mechanism across the team. Without the simulator we would not be able to train teams in the difficult scenarios which we hope they will never actually face in real life. However, the important thing is they have an increased knowledge of potential scenarios and stronger working relationships across the team to be able to tackle potential issues more effectively if they do arise. **OE**

Tim Bailey *joined BP in 1979 as a mud engineer in the North Sea. He has worked in the UK, Norway, and Colombia. He also served as wells team leader in the new BP Amoco Technology Group, followed by the role of common process director for BP Drilling and Completions. In 2010, he took on the role of Director of the BP's Global Wells Institute to transform capability development for wells personnel. Bailey graduated with a BS in Geology, with honors, from the University of London.*


WHEN MY WIFE'S SALARY WASN'T ENOUGH TO PAY MY HOSPITAL BILLS, OHH STEPPED IN. I'M GLAD I SWALLOWED MY PRIDE AND ASKED FOR HELP. I OWE MY LIFE TO THIS ORGANIZATION.
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Aker Solutions' Kjetil Notodden discusses the benefits of the latest drilling simulator technology, developed in response to new SEMS requirements.

Multi-dimensional

The drilling industry is changing rapidly, and equipment manufacturers are making equipment safer by reducing the possibility of human error. At the same time, the equipment and its operations are becoming more complex. When high-tech and expensive equipment is operated by young and inexperienced staff, the need for proper training through risk-free, simulator-based operating conditions becomes crucial. Training in a simulator is an excellent way to gain experience in a safe environment, without the potential cost or hazard of failing offshore.

Post-2010 requirements

The US Bureau of Safety and Environmental Enforcement (BSEE) enacted federal safety and environmental management systems requirements in response to the deadly 2010 Macondo blowout and oil spill in the Gulf of Mexico. These regulations require employers to provide more safety and operations training, as well as periodic refresher courses. The goal is to make operating a drilling rig easier, cheaper, faster and safer in years to come.

To facilitate operator training Aker Solutions developed a versatile three-dimensional (3D) Drilling Equipment Simulator (Xfactor DES), which generates mathematically correct and accurate replicas of rigs. Each model can be treated as a virtual asset, including the complete drilling package with one-to-one control system configuration. The 3D capability and top-of-the-line software generates realistic visuals that make the simulator experience as close to real life as possible, enabling onshore training and detailed operational planning in virtual environments identical to those offshore.

Simulators around the globe

Aker Solutions has simulator training facilities in Kristiansand and Stavanger, Norway; Katy, Texas; Rio das Ostras, Brazil; Geoje Island, South Korea; and Singapore.

Aker Solutions has two types of simulators: a flat screen version and a 240° dome. The dome is the latest technology and provides a view of what is above the driller's cabin without having to "fly" there via the simulation.

All the simulators offer favorable conditions for learning in a safe and forgiving environment. Not only are the operators trained in procedures and technicalities, they are also trained in interpersonal communications, a vital skill in today's multinational work environment.

Key differentiators

The type of control system is a key differentiator when it comes to simulators. Most simulators in the industry run only on animated software. This limits them to operational training in perfect conditions, without the added benefit of simulating more challenging conditions. Quite a few simulators are unable to obtain real-time feedback on the trainee.

Real drilling operations on a rig are not always perfect, so it is important to practice how to handle deviations. This enables trainees to prepare better for real-life situations that can be expected, and allows them to obtain real-time feedback on how such deviations are handled. This approach is an integral part of training. "At Aker Solutions, our priority is to enhance skills in such a manner that the operations on the rig become safer, smoother, and, of course, faster, as well as to have minimum downtime," says Senior Technical Instructor Manas Goyal. "This is achieved by first collecting the information from real-time situations, and real-time faults and alarms that have been encountered on the rigs in the past, then

Drillers receiving training in an Aker Solutions 240° dome simulator in Katy, Texas.
Photos: Aker Solutions.

re-creating those in the simulator exercises designed by Aker Solutions, so that the training is meaningful and prepares the trainee for handling the problems in a better, quicker and safer way."

When downtime occurs, Aker Solutions devotes a lot of time to trouble-shooting and fault finding. The overall aim is to prevent or reduce downtime by preparing the trainee in advance.

"Our goal is to make them skillful at fault-finding so that they know 'where to look' for a potential problem. Such integrated training and scenarios together are key success factors in maximizing uptime and ensuring safe operation of drilling equipment," Goyal says. "Our simulator (training) exercises are specifically prepared for operators, electrical and hydraulic technicians, to ensure greater emphasis on operations, control systems, and hydraulic systems, respectively."

Avoid shortcuts

Aker Solutions' aim, Goyal adds, is to provide operators with sufficient knowledge of control systems and hydraulics to understand the consequences of taking shortcuts. Operations training also works to ensure that technicians understand how the equipment should work in real-life conditions.

"We consider this to be absolutely critical for safe operations: If operators and technicians have a mutual understanding of each other's problems and limitations, this will promote better team work and eventually contribute to better and safer output."

Simulator-based training has changed the concept of training dramatically, and has become so advanced that simulators can now deliver training to rig personnel while the rig is still under construction at a shipyard.

Due to the advanced technology in Aker Solutions' simulators, they can be used also for things other than training, such as:

- Commissioning: Access to complex information in the form of 3D images helps to simplify project planning and execution and to reduce the time needed for commissioning and risk-mitigation, thereby potentially lowering costs.
- Rig optimization: Software and procedural changes can be tested and verified safely before being implemented on a rig.
- Aid for hands-on training: Every component of the equipment is simulated individually through control systems. This makes it possible to remove layers of equipment to demonstrate the internals of the machine, which are not normally seen by technicians.

Highly advanced anti-collision system

Aker Solutions' philosophy is "No personnel on the drill floor." To achieve this, (internal & external) interlocks are put in place and a Smart Zone Management System is installed to prevent machines from colliding. The simulators provide near-perfect scenarios of such safety features, and they demonstrate what happens if the safety measures are physically bypassed or neglected.

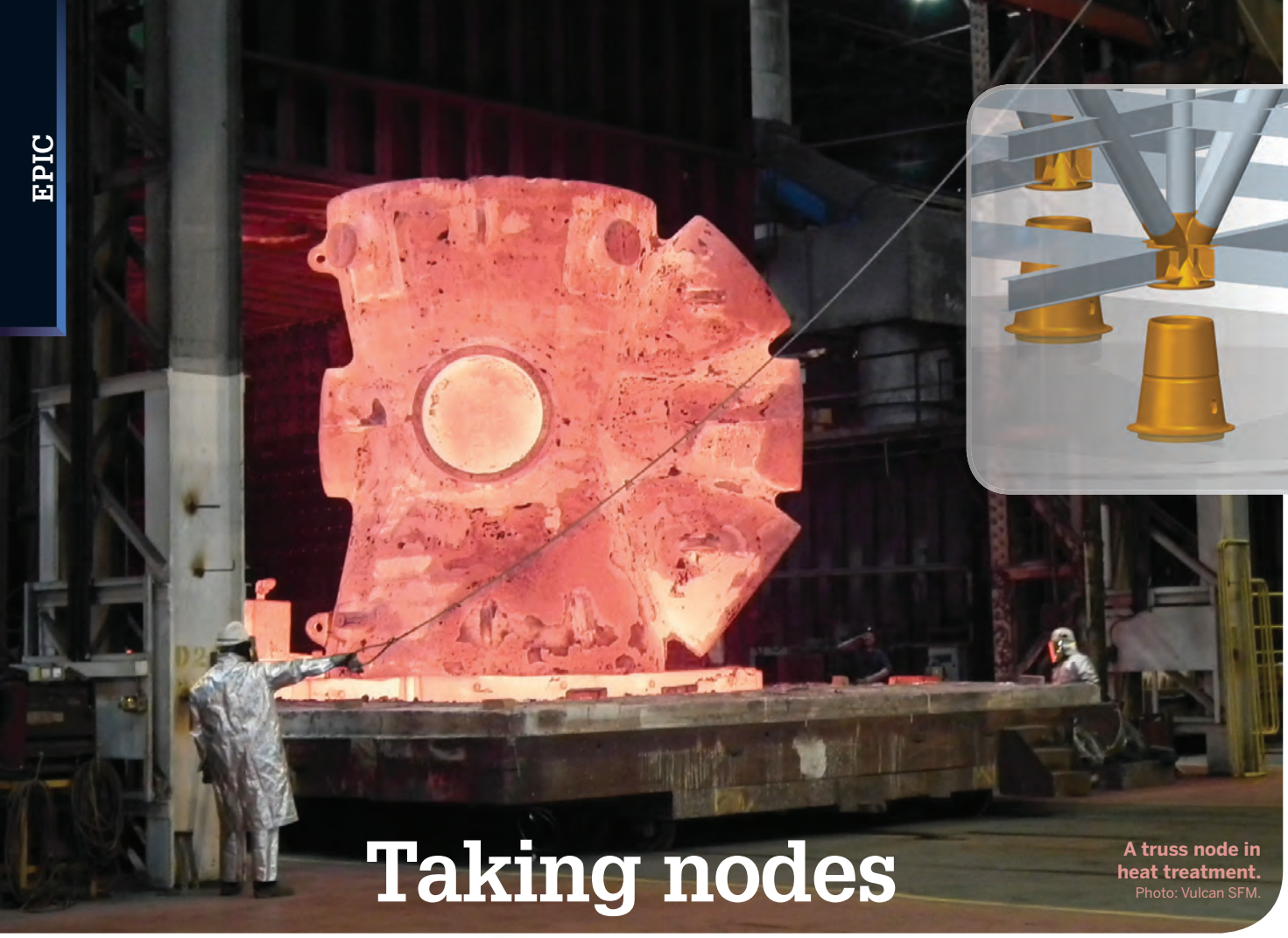
Making affordable mistakes

Simulator training makes rig personnel familiar with the equipment without risk of expensive mistakes on the rig. During training, operators get to try out operations they are familiar with performing, and the equipment gives them instant feedback. This lets them experience the consequences of potentially dangerous situations, without actually causing damage. Operators can afford to experiment and make mistakes in the simulator, but not on the rig.

Today's technology has moved from brakes and handles, to interactive interface screens. So it is extremely important for operators to get used to touch screens and joysticks, and get accustomed to the response times associated with the commands. OE

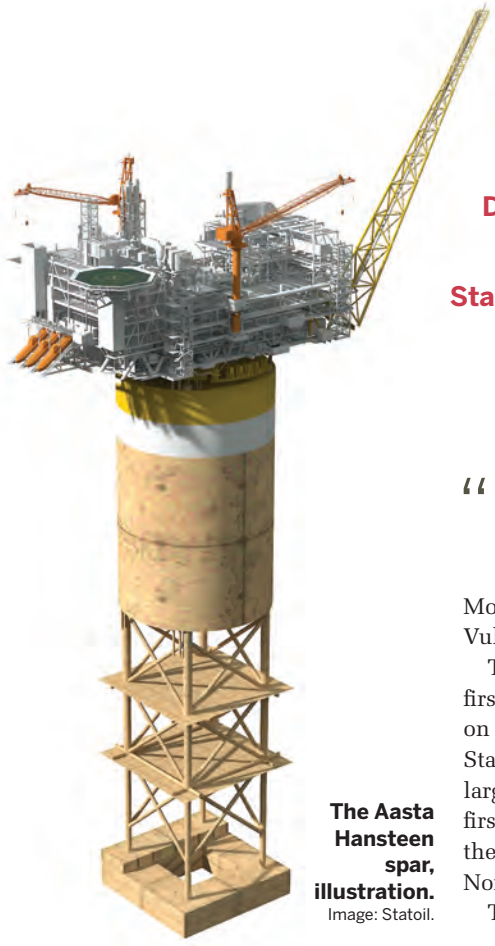
***Kjetil Notodden**, PMP, is manager for technical instructors at the Aker Solutions Drilling Technologies training center in Kristiansand, Norway. He has been a project manager for Aker Solutions for five years. Notodden attended the Royal Norwegian Air Force Academy and is studying for an MBA at Agder University.*

A dome drilling simulator in Rio das Ostras, Brazil, one of Aker Solutions' global training centers.



A truss node in heat treatment.
Photo: Vulcan SFM.

Taking nodes to a new level



The Aasta Hansteen spar, illustration.
Image: Statoil.

Deck, leg and truss nodes have been taken to a new level on Statoil's massive Aasta Hansteen spar development. Elaine Maslin reports.

"Everything on the Aasta Hansteen project is on a different scale," says Paul Mockford, design director at Sheffield's Vulcan SFM.

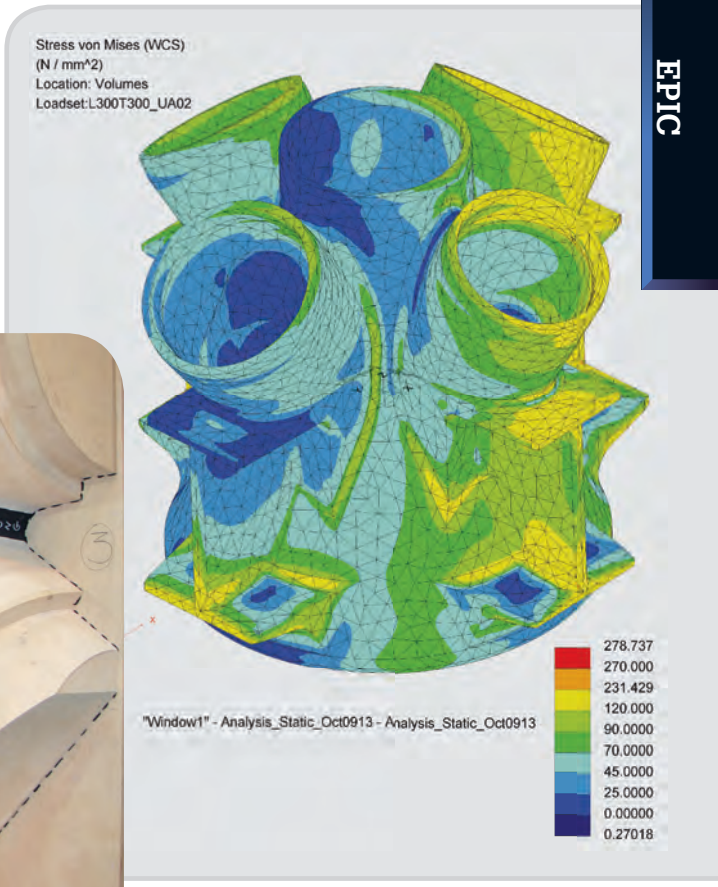
The entire project is peppered with firsts. It will be the first spar platform on the Norwegian Continental Shelf, Statoil's first spar development, the largest diameter spar built globally, the first spar with condensate storage, and the first deepwater field development in Norwegian waters.

The size of the hull, at 198m-tall, has been driven by project requirements–the 1300m water depth, harsh environment, and need for condensate storage.

In turn, the scale has driven further firsts. Supplier Vulcan SFM, a subsidiary of Sheffield Forgemasters International, believes the four cast deck connection nodes it is providing to connect the deck to the hull will be the largest cast nodal joints manufactured to date. Vulcan believes it will also be the first time cast nodes have been used within a spar truss hull.

The largest offshore cast nodes previously supplied by Vulcan were two 110-tonne trunnion nodes, used for lifting Statoil's 9000-tonne Valemon jacket into place in the Norwegian sector of the North Sea, in 2012 (OE: August 2012). They measured 4.6x4.4x3.7m.

"That record was soon broken by the truss nodes (also known as leg nodes or heave plate nodes) in the hull for Aasta Hansteen, weighing 117-tonne



Left: The deck nodes and deck supports in situ, illustration.

Right: Stress analysis on a leg node.

Below: A truss node pattern in construction.

Images: Vulcan SFM.

and measuring 4.6 x 4.6 x 4.6m," Mockford says. "But that was then also broken when we also won the contract to supply the deck nodes (at 120-tonne each)."

In total, Vulcan SFM is providing 36 castings for the Aasta Hansteen spar, from relatively small pull-tube castings, to the ultra-large truss and deck nodes, which it has designed.

The spar

The Aasta Hansteen spar is formed from two main segments, a truss spar hull, and 23200-tonne topside. The topside will rest on the top of the hull via four deck leg supports, and four deck nodes.

The hull section will comprise of a truss connected to the hard tank at the top and the soft tank at the bottom. The main leg and brace tubulars will be connected by eight truss nodes of varying sizes, which also connect to the heave plates. Four nodes connect the legs to the hard tank. Rigid steel catenary riser pipes will run through the truss hull section down to the sea bed, more than 1300m below the platform.

Deck nodes and deck leg supports

The 140-tonne deck leg supports, fabricated from two cast cone sections, are the uppermost component of the hull's union with the topside. They will be spaced 27m apart, from center line to center line, on top of the hull. The most highly-loaded deck leg support has been designed for a maximum vertical, factored design load of 19,300-tonne.

The 120-tonne deck nodes, which will have shaped stubs, onto which the horizontal I-beams will be welded, and connection points for the tubular columns, will form an integral part of the topsides' super-structure. Once completed, the topside will be transported from Hyundai Heavy Industries' yard in South Korea to Norway, and the deck nodes will be mated with the deck leg supports on the hull in a Norwegian fjord.

After initially designing fabricated deck leg supports with cast ring flanges, discussions with supplier Vulcan SFM led contracted hull-designer Technip to opt for a fully-cast flange and cone.

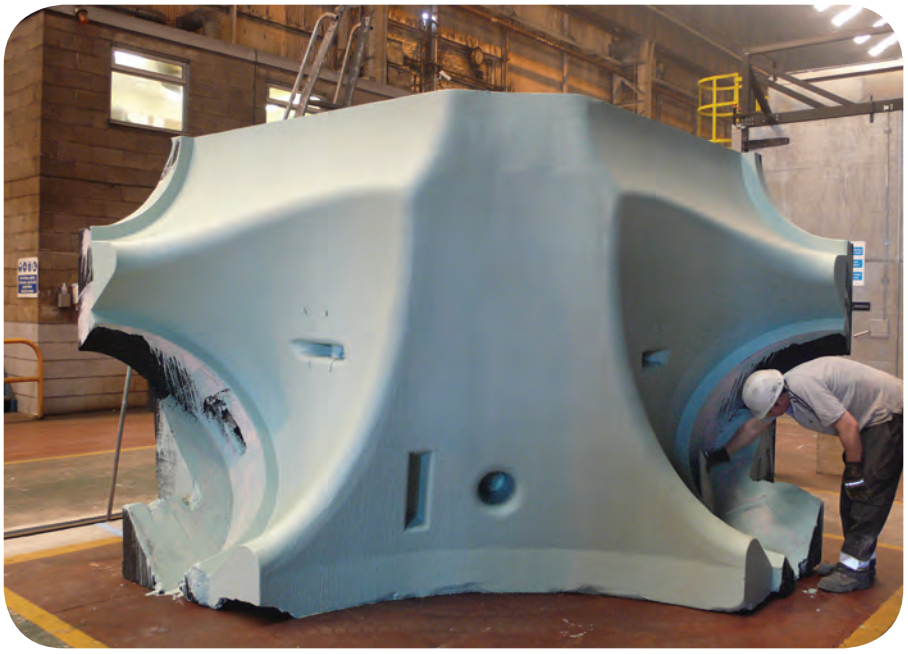
Due to manufacturing and logistical constraints, including road bridge heights, each deck leg support will be created from two cone-shaped castings, with the lower piece coming complete with a 5.9m-diameter flange ring (the flange is usually cast, with the rest of the node rolled plate).

To design the nodes, Vulcan uses critical load data gathered from the client. The data is ran through stress-strain analysis, which allows Vulcan to create a high-quality casting by controlling how the steel flows through the mold, and how it will cool and solidify.

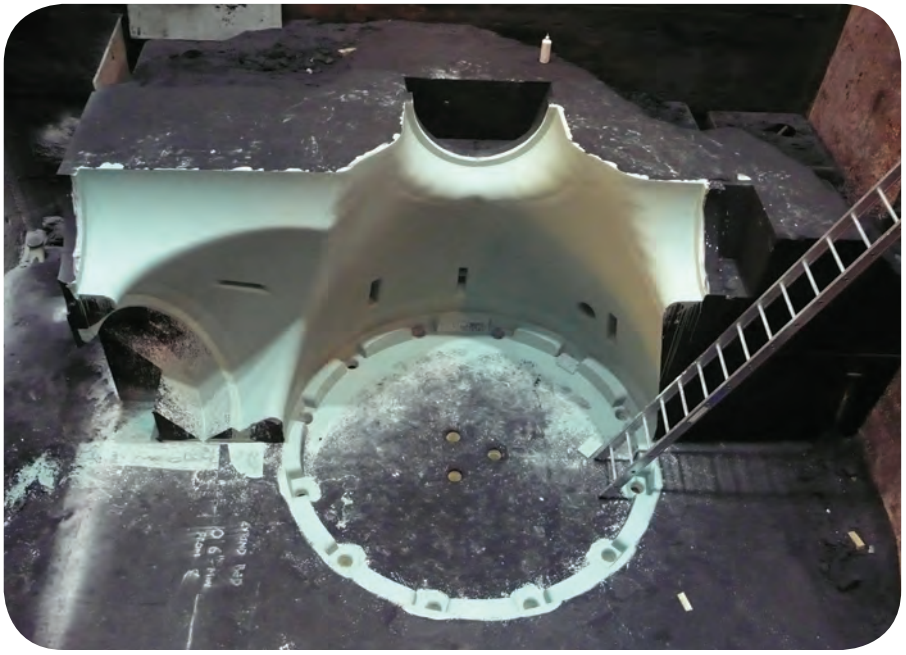
Once cast, the separate deck leg support pieces will transported through the port of Goole, England, and probably Antwerp, Belgium, to Korea, where they will be welded together and integrated onto the hull. To give an idea of scale, the flange rings for previous spars cast by Vulcan have weighed about 7-tonne. On Aasta Hansteen, the equivalent section (ring flange only) would weigh nearly 50-tonne.

Ultra-large truss nodes

The ultra-large truss nodes are more complex to cast. These weigh 70-117-tonne, depending on where they are in the spar truss hull. The largest would occupy a



A completed mold section.



The mold being assembled in the pit. Images: Vulcan SFM.

4.6m-wide cube. They form high-strength and fatigue-resistant nodal joints to connect the main leg and brace tubulars in the truss section of the spar platform. They also connect to the heave plates and the hard tank.

"The truss nodes are difficult castings because of their sheer size and complex geometry," Mockford says. "Up to eight brace stubs connect onto the leg can. It is very important to optimize the method of casting in order to ensure a high quality of casting. The casting method is verified by computer simulation of the flow and solidification of the steel within the casting. This gives us the ability to get each casting right first time."

Casting

The first truss node was cast at the end of June 2013, and the first four truss nodes will have been completed by press date.

The production timescale for a typical large node such as the truss nodes and deck nodes is about eight months, Mockford says. This comprises of: 10 weeks for design and pattern making; 24 weeks for production. Further castings are produced concurrently and completed.

Production time would typically involve: four weeks for core and mold-making; one day for casting; three weeks for cooling; one week burning off the risers and feeder heads; two weeks for an initial heat treatment (normalize, quench and temper); seven weeks for surfance clearning, or fettling, NDT, and weld repair; five weeks for machining; three days for a final heat treatment; and one week for final inspection and release.

Once a cast component is designed, a mold has to be created. First, craftsmen

Norway's first spar – Aasta Hansteen

Aasta Hansteen is 300km west of Bodø and 140km north of the nearest existing offshore infrastructure, Norne.

The deepwater project operated by Statoil on behalf of the partners OMV, and ConocoPhillips, consists of three structures, Luva, Haklang, and Snefrid South.

A consortium between Technip and Hyundai Heavy Industries (HHI), has the engineering procurement and construction (EPC) contracts for the hull and mooring systems, and for the design of the steel catenary risers.

HHI has an EPC contract for the integrated deck, living quarter and flare, with a total dry weight of 23,200-tonne. The engineering contractor is CB&I.

Aker Solutions will provide the subsea production system, including two four-slot templates, and seven subsea trees, in addition to wellheads, controls, workover, and tie-in systems. The first deliveries will be made in the first half of 2015.

Fabrication of flowlines and steel catenary risers (SCRs) will be at Subsea 7's spoolbase in Vigra. Subsea 7 will carry out the tow-out and hook-up of the spar, including its SCR system, and reeled installation of BuBi mechanically lined pipe. Offshore campaigns will take place in 2015 and 2016, with an estimated 350 vessel days.

Deck mating is scheduled for February 2016, with first production 3Q, 2017. ▪

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Three ladles pour the liquid steel into the mold.

A truss node is taken from the furnace for quenching, with the quench tank in the background. Images: Vulcan SFM.

Scan this page with the Actable app to view a slideshow of additional images. See page 7 for more details.

build a pattern, replicating the external profile of the casting, from wood, taking into account the shrinkage of steel as it cools to create the precise finished size. For the larger truss nodes, 19 separate pattern pieces had to be produced.

A mix of black sand and resin is then packed around the pattern pieces, which are contained in large boxes. The sand and resin is then allowed to dry hard, to create components, which will make up the full mold.

The mold components are then assembled into a 5.5m-deep pit, forming the complete mold.

Fascia coming into contact with the liquid steel are coated to prevent any sand breaking loose and to allow for clean separation of the casting from the mold.

Steel-making, which involves heating the steel up to 1700°C, is carried out on site. Liquid steel is then transferred to the mold pit in 90-tonne ladles. Multiple ladle pouring needs to happen at the same time, which means each ladle needs to be heated to a specific temperature so that they are about 1560°C when ready for pouring.

A high-strength steel, CSN 400, has been developed specifically for offshore structural castings. It is compatible with the steel plate used in offshore structures and is readily weldable.

Liquid steel must steadily flow into the mold from below to avoid potential surges created by the pouring process. Once the casting has cooled, the mold is broken away. To cast the same component again, additional molds would need to be created from the original pattern.

Quenching, tempering and fettling

While the pouring takes just minutes, the cooling process can take several weeks, after which the cast piece has to go through a series of treatments.

First, the feeder head and risers, which allow the steel to flow in to the mold, are cut away. The feeder head takes an overflow of liquid steel to "feed" the casting as it shrinks during cooling, so no voids form.

Next, the casting is normalized, quenched, and tempered. During the quenching process, the casting is heated in controlled stages up to 900°C, held for several hours at this temperature, and then water-quenched.

Vulcan's quench tank is 7.4m-wide, 5m-deep, and holds 79,000 gallons of water. During quenching the tank is agitated using impellors and water injection.

This increases the strength of the casting. However, it also makes it more brittle. To improve the casting's ductility, it is then tempered-heated to 580°C and then allowed to air cool.

Fettling – a refined cleaning up process – non-destructive testing (NDT), weld-repairs, and machining are then performed, before the final stress-relieving heat treatment, at 560°C, and air-cooling.

Vulcan worked closely with Technip on the design of the hull castings, and with CB&I, the topside designer and manager, to design the deck node castings.

All castings for the project are due to be complete by the end of May. OE

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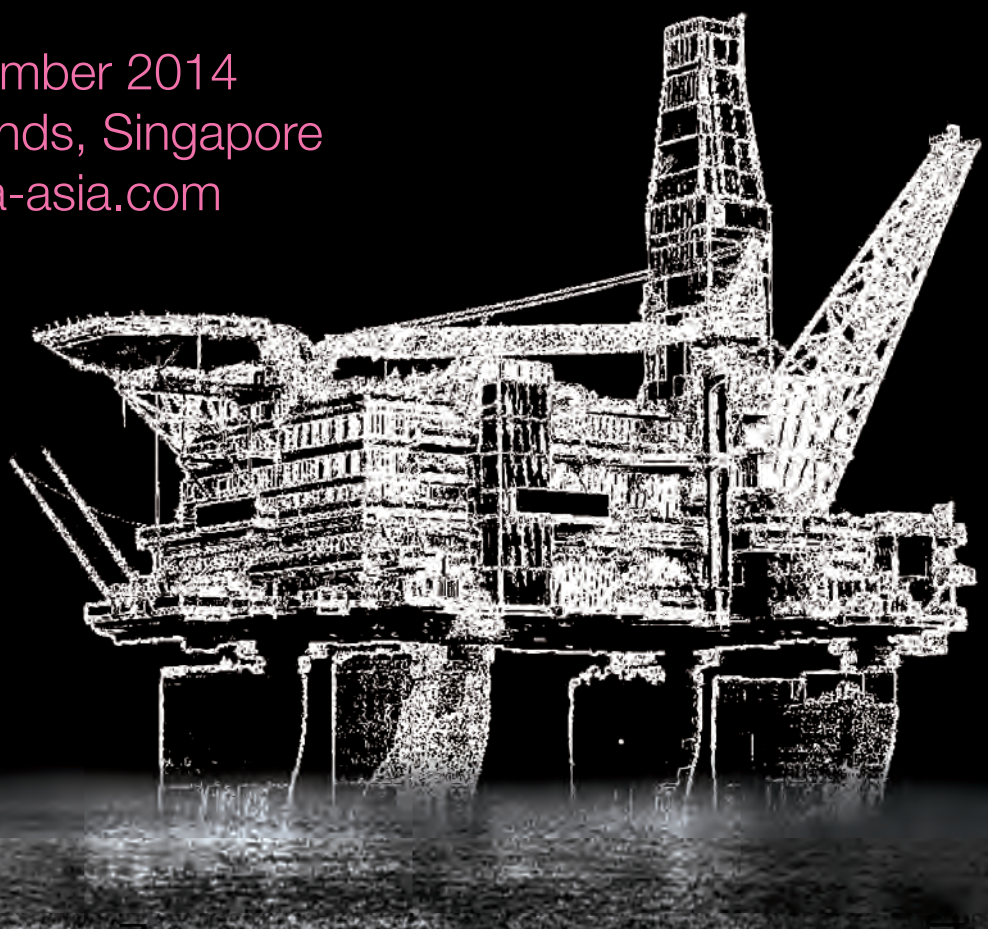

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Autonomous tractoring

The first version of a new autonomous tractor unit for well work, developed by Welltec and BP, undertook its first commercial deployment in January. Elaine Maslin found out more.

Well intervention operations continue to pose significant risk, cost, access, and complexity challenges to operators, regionally and globally.

However, the rewards from well intervention activities through incremental oil or gas rates can be significant, especially when compared to rig based drilling and completion activities.

The spread of well intervention equipment and application methods will largely dictate an operation's complexity and technical challenge, when deploying coiled tubing, hydraulic workover or wireline/slickline methods. Increasing use of light well intervention vessels (LWI), for subsea wells further increases costs and deployment times.

For the well intervention industry, arguably the last true innovation came with the introduction of the well intervention tractor in the mid-1990s, says Callum Munro, senior well engineer, BP.

"Tractors transformed horizontal well interventions from large coiled tubing operations to more nimble wireline operations, using fewer personnel, less equipment, and crucially resulted in less risk," he says. "Tractor operations became 'business as usual' and with it, further innovations helped to increase the applications, from logging operations to a full suite of mechanical services, which includes milling, plug-setting, sleeve manipulation, perforating, and well clean out activities."

BP was aware of several projects, which had started investigating the idea of down-hole robots, or autonomous intervention units (AIU). Development work in the US resulted in a caterpillar-tracked prototype tool running in and out of a US land well, proving the theory, Munro says. The project was developed by IIC, and the tool system was called micro rig. Further development of this system however failed to materialize.

In 2009, BP and Welltec collaborated in a project to further develop Welltec's patented Well Tractor system into an autonomous unit. Additionally, BP trade-marked the term "Wireless Wellwork," for use in all down-hole operations, where a physical link to surface was not used. Welltec also moved to adopt the service "independent well tractoring" or IWT.

The project aligned both company's goals to establish a robotized means of intervention—i.e. carrying out activities without any physical links to surface, while providing data from the tools to surface, and ultimately being able to optimize the tool from an onshore desktop. Further development could result in robots "living" within the well space, to be activated as and when they are required to undertake either mechanical or surveillance functions.

Key advantages of this technology are, according to the project partners:

- Improved safety – with no wireline connections to surface, other than for deployment and recovery; reduced personnel on location; less complex rig uptime and equipment; no requirement for winches or complicated mast units;

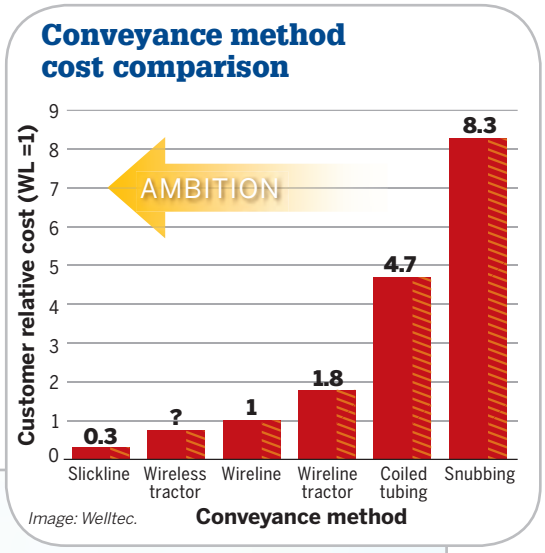

Image: Welltec.

Wireless tractor on catwalk prior to picking up to the rig floor at onshore well test site. *Photo: BP.*

reduced exposure to live pressure control time.

- Increased efficiency – increasing the well access, with multiple entries per campaign; versatility, enabling use in platform or subsea applications, reducing light well intervention times; data to desktop, and real time optimization; reduced equipment footprint; improved access to normally unmanned installations, and single well platform structures,
- Cost benefit – reduced cost, through fewer personnel and less equipment.

"The complexity and technical challenges of the project were not underestimated and as such three development phases/versions were identified, namely V1, V2 & V3," Munro says.

V1 comprised standard tractor assembly, tethered to slickline, with forward drive only, and additional battery and mission controller sections, to control start & stop functions.

Its design was based on Welltec's 2 1/8in. standard tractor system, including the wheels, body, and connections.

The aim was to deploy the tractor in a horizontal well, using traditional slickline methods until "lock up depth" was reached, i.e. the horizontal point where gravity would no longer pull the tools into the well bore. The mission controller would then signal tractor start up and the tool would be tractored into, and along, the horizontal well bore. The tool would then be recovered on slickline.

V1 was yard-trialed at Welltec's R&D facility in Allerød, Denmark, in a 590ft-long, 5 ½in. test loop, then taken to an onshore well-site, where it was deployed and recovered successfully. V1 was then tested in a live well, with 300psi closed-in tubing-head pressure, on slickline. A two-stage bottom hole assembly (BHA) rig up was completed, including permanent circulating equipment.

"The idea was to rig it up, put it in the lubricator, and set it so that, when it sees the pressure test in the lubricator, it goes through a test run–the tractor powers up, the wheels come out for about 30 seconds and then retract," Munro says. At this point the tool is ready to be deployed and run into the well.

The starting system using a pressure switch, which is activated by a set value of hydrostatic pressure, attained or calculated once the tool is in the well. The tractor only stops once battery life is depleted. While operating, the tractor speed can be managed by maintaining back tension on the slickline.

The unit performed two runs, tractoring for about 1600ft, at 35-40ft/min on 40 minutes battery life. Debris in the well meant it couldn't be run to the planned depth, limiting function-testing on the motor controller start stop, and a multi-functional timer.

"Unfortunately due to well debris the tractor didn't reach target depth however important lessons were learned on rig up procedures, battery re-charging time along with speed and battery life of the unit " Munro says.

The goal on V2 was to release the tool, at lock up depth after it had been conveyed there on slickline.-

"It would then tractor in to a desired depth, while recording pressure and temperature data, before tractoring back out to the initiation depth, at which point it would be recovered using slickline or electric line," Munro says.

"V2 was a significant technical challenge for the Welltec engineers, since it required a release mechanism, a reverse tractoring module, additional battery power, and a casing collar locator for depth correlation, in this case Welltec's well hardware scanner (WHS)."

V2 was built and then tested in Denmark and Aberdeen. Despite several glitches with the release mechanism, and the loss of data during the yard trial, V2 was deployed, operated in forward and reverse modes, and recovered using electric line.

V2 was then taken to field trial onshore, for deployment with a memory production logging tool (MPLT), to simulate a full toolstring rig up, and to identify possible handling issues, due to the length of the assembly (>45ft).

The rig up was successfully achieved (in two stages) and preparations made to run the tool, after a slickline run prior to the rig up identified a 950m lock-up depth.

"However, while in the lubricator the tool prematurely released during pressure testing, later traced to a firmware / software interface issue," Munro says. "The back-up tools were then deployed, but failed to release at 'lock up depth.' This was traced to failed insulation on the release device. Time constraints at the well site meant that further operations were curtailed, and the equipment was

The tractor during testing at the onshore live well site, UK.
Photo: BP.

Forward/reverse wheeled sections of wireless tractor. *Photo: BP.*

returned to Denmark and subsequently repaired and retested in Welltec's temperature/pressure vessel successfully."

V3 is now under development, and will include downhole power generation (DPG), so that the unit can recharge itself. The goal for V3, measuring 60ft or less, is for it to be automatically-deployed and retrieved from surface, without slickline, and with shallow wireless communications.

Trials on the DPG were successfully carried out in December, in Welltec's test loop at Allerød. Using a production water flow of 1bbl/minute, 65-70-watt output was generated. Shallow acoustic communications were also trialed at a 180m range. The next step will be to integrate the DPG into the tractor, and for it to recharge the tool's battery packs after depletion of power in the test loop.

The future is V4. This will also be surface-launched, with some limited mechanical services, potentially a stoker, with real time data transmission to surface via wireless communications.

Munro says the key challenges going forward are: battery power life expectancy; wireless communications; and developing a surface deployment system.

"Battery technology for down hole is complicated by temperature issues, but we are looking at other batteries, which would give us a longer charge at higher temperatures," he says.

Reducing the length and weight of the tractor will also be an aim. "We are accepting it is 20m, but once we have proved we are able to charge and operate it, the next step is to reduce the length," he says. "We are looking at composite materials to make the assembly lighter, increasing the battery life, while reducing the battery pack length, and also optimizing the wheeled sections, to make them independently bi-directional.

"Longer term the partners see increasing sub-sea applications for this technology, improving functionality, reliability and cost effectiveness. Ideas also include 'disposable AIU's' and of course permanent AIU's living within the well bores."

V1 has since been used on its first commercial deployment was with Petronas, in January, on a field in Malaysia. OE

Acknowledgements: The 19th SPE/ICoTA Well Intervention Conference, Aberdeen, at which Munro presented the Wireless Wellwork concept.

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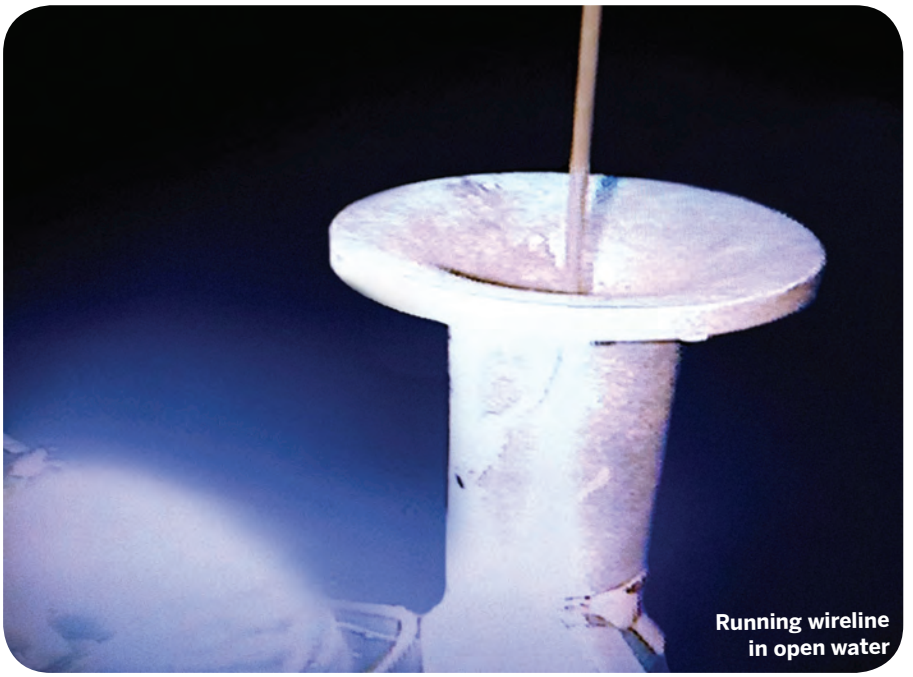

Running wireline in open water

Rigless origins

Rigless intervention hit the scene in 1969 with Abu Dhabi's Zakum pilot program. Reaching Ultra's Fernando Hernandez explains how the technology has evolved to meet new challenges.

The Zakum pilot program was launched in 1969, and with it[1][2], it introduced technology that is only now becoming viable. These ideas were employed and assessed over a three-year span in shallow waters near Abu Dhabi, including the development and execution of processing and separation at depth, with subsea power and controls, and distribution via the world's first–subsea specific–electrical wet mate connector[2].

Furthering the program's significance was the fact that all facets of rigless intervention via wireline, as they stand today, were executed from a vessel[1][2].

Subsea lubricator: Wireline compensation

Of the three methods employed at Zakum, the use of a subsea lubricator to deploy wireline in open water is the most common method used today.

This method works by landing, or mating, a blowout preventer (BOP) with well interfacing components onto a subsea tree. A lubricator, which houses the wireline tool string, is then placed on top of the BOP. Lastly, a sealing element, such as a stuffing box for slickline or a grease injection system for electric line, is mated above the lubricator (installation varies per location and project).

With this completed, thorough engagement of the well via wireline follows. However, the sea's conditions—at present—and at Zakum, can hamper such runs.

To mitigate the sea states at Zakum, a swell-compensating system was developed to better control the wireline's movement[2]. Today's wireline-specific compensators counter both swell and heave. Offsetting unfavorable sea states continues to be imperative when using electric line, for example.

The erratic movement of the wire makes it difficult to accurately perforate at the required depths, which can cause operations to halt until the sea subsides. Rough seas equally affect running slickline, as it can cause the wire to go from being static to being rapidly jerked upward, which can cause slickline tools to engage prematurely. Deepwater further complicates running wireline, since the sea's currents can act on the wire at different depths and opposing directions. Currents can also drag the wireline and disrupt deployment, operability, and general positioning.

Zakum showed that running wireline in open water, including the wireline's extended exposure from surface to depth, did not greatly hamper/affect wireline operations[2]. However, deepwater operations have shown that the sea's swells, heave, and currents are formidable obstacles to mitigate and overcome with exposed wireline.

Subsea lubricator: Grease delivery

Another obstacle experienced with subsea lubricator systems today is the delivery of grease when running braided line for electric line functions: The deeper the well, the more difficult it is to seal on braided line via a topside umbilical.

Because of Zakum's depth, this was not the case. However, if it was deepwater, the authors would have observed the technical challenges associated with sealing on E-Line.

Such difficulty is driven by the fact that topside pumps must overcome hydrostatic pressure, which affects the flow and pressure delivered to create a seal on braided line. The grease's viscosity can be equally hampering. Localized methods are used to circumvent this, which include subsea pumps, and accumulators.

Understanding such delivery at Zakum would have been a key insight for today's operations, and in the process, streamlined the learning curve of sealing via grease.

Authors deemed the lubricator method to be "simple," with a forecasted depth usage of 328ft to 492ft[2][1]. Because the forecasted depths have now been exceeded, new barriers, as illustrated above, have arisen, adding layers of complexity to what was once viewed as a

Recovery of perforating guns after use in open water. Photos: Reaching Ultra.

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"simple" method.

Subsea wireline winch

Also explored was the use of a marinized wireline unit with surface controls that operate directly above the well. The winch also had electronic and power capabilities and utilized a flexible conduit for electrical power and controls[1]. For this reason, it was deemed to be complex and necessitating new methodologies

Presently, running wireline subsea continues to garner interest, as demonstrated via the "riserless subsea intervention [research and development] program" that was initiated in 2003[3], resulting in a fully-submersible wireline system[3].

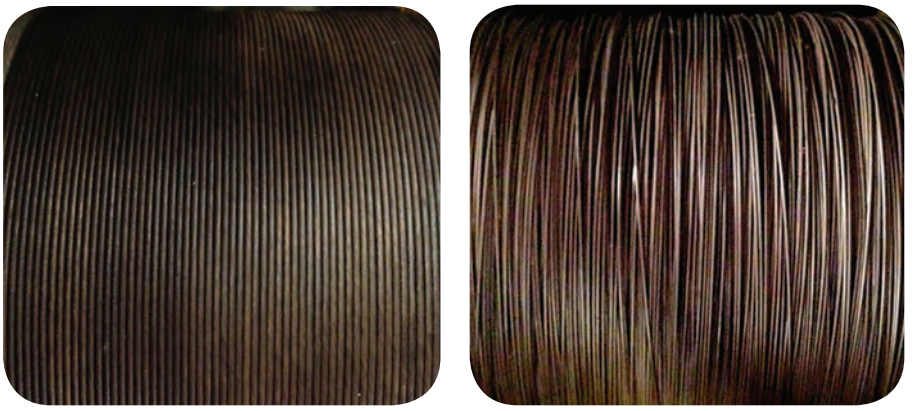
The working system that came to fruition from this research and development program improved upon the design used at Zakum, as it was designed for housing and swapping an array of wireline tools at deepwater depths. The need to trip to surface to swap tools was not necessary, giving the subsea wireline unit an advantage when compared to the subsea lubricator approach. Per the findings at Zakum this method was believed to have the highest degree of success and depth applicability for future deepwater operations: depth limitation was not assigned. Currently, the marinized wireline unit, originating in 2003, has been surpassed by the subsea lubricator method, since after 2013 the marinized approach was no longer being pursued or developed.

Lubricator as a riser

The third method employed was the use of lubricator to function as a soft riser. This approach pressed the question why does "rigless have to be riserless"? It also provided a viable answer[2][4]. Soft risers run lubricator from the vessel to operational depth to establish a ridged through-bore connection[2].

The authors saw the through-bore option as a key feature when compared to the subsea lubricator method, as it allowed for performing more than just wireline work.

Presently, outfitting multi-service vessels (MSV) with ridged conduits continues to be explored. This is exemplified by a heave/swell compensation system that is under development to run riser from a vessel's moonpool[4]. The intent is to retain stability while performing rig-based functions by way of two specialized through-bore, self-compensating, cylinders—"that work in tandem to exert force against each other" via nitrogen charged accumulators[4].



Braided line (left), and slickline (right): both require specific sealing methodology due to their unique composition

Installation-wise, the cylinders are secured above the riser to be run while remaining directly below the moonpool. Furthermore, the cylinders' ID is designed to match the riser of choice, which facilitates, for example, running coiled tubing through the middle of said cylinders. Comparatively, the cylinders' self-compensation design is key, as it foregoes the need to have a mechanical link, as with rig tensioners. The goal of this system is to unlock and redefine the work that can be conducted from a vessel's moonpool in deepwater. The authors believed the soft riser method to be simple[1], with a forecasted depth applicability of 984ft to 2952ft[1], a depth that the heave compensated cylinder is being configured to exceed.

Further vessel considerations

The commonality shared by the aforementioned methods is the use of a vessel, which gave the authors insights into the

Tensioners in operation (colored in blue)

Moonpool on an MSV

future applicability and roles of vessels. The authors opined that future operations that worked "without a central platform" would require larger vessels than the 70ft and 165ft forward bridge vessels used at Zakum[1] [2], in order to carry out "flow testing, acidizing, and remedial work" from future vessels[1].

Today's MSVs are in excess of 400ft in length. They complete the above mentioned functions, fortifying the authors' foresight.

Presently, they are also used to perform the following:

- Plug and abandonment of wells, workovers, and well diagnostics
- Remediating, flushing, and pressure testing pipelines
- Dewatering flowlines and flowbacks

There is an ongoing trend with the build of new vessels. On one hand, they are increasingly being tailored for rigless activities. On the other hand, however, vessels continue to enter the market with general and non-specific intervention templates: Both have their inherited advantage. However, the latter gives vessels greater flexibility as it does not commit them to a set of specific functions.

MSV utilized to conduct rigless work

Conclusion

Rigless technology has yet to become fully accepted and adopted technology. However, the last five years "have seen advances in vessel and deployment technologies," tripling the depth of rigless wireline projects[5], further validating rigless technology. In addition, the lack of available rigs, when in high demand, is also contributing to an uptick in rigless interventions. When this is coupled with the substantially lower day rates associated with vessels, it furthers the attractiveness of rigless interventions. OE

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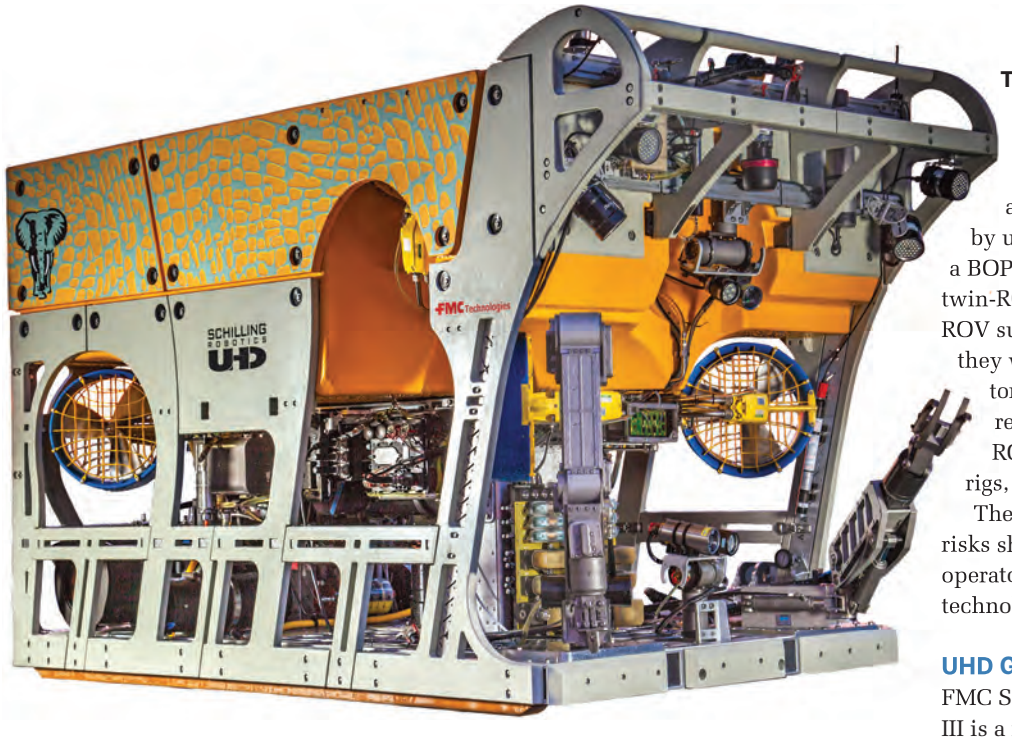
Fernando Hernandez *is the subsea technical advisor at Reaching Ultra. Hernandez speakings three languages and has extensive field experience in the ROV tooling, automated controls, subsea and well intervention sectors.*



The first published image of the UHD Gen II ROV. Photo from FMC Technologies Schilling Robotics.

ROVs take on BOPs

Elaine Maslin attended Subsea Expo in Aberdeen to view the latest in ROV technology and learned of a new model FMC Technologies Schilling Robotics plans to release.

The waters in which exploration and production firms are operating are getting deeper and subsea systems are getting ever more complex.

Remotely operated vehicle (ROV) vendors such as FMC Technologies Schilling Robotics are adapting to meet the growing market and the challenges.

Rising to the demands being placed on ROV technology, FMC plans to unveil a new generation ROV, the UHD Gen III, the company told OE during Subsea Expo. The ROV will be revealed at the Offshore Technology Conference (OTC) this May in Houston.

The new HD ROV unit will meet API Standard 53, which concerns the installation and testing of blowout prevention equipment systems (4th edition, December 2012). The ROV will also be able to perform well intervention tasks, FMC says. The company will launch the new ROV in a buoyant market.

According to the International Marine Contractors Association (IMCA), there were 640 ROVs operating globally in August 2012. Last year, Douglas Westwood predicted that the ROV market would increase from US$1.4 billion in 2013 to $1.9 billion in 2017.

Speaking at Subsea Expo, Marine Richard, associate analyst at Infield Systems, said there had been a record 250 subsea tree contracts awarded in the first three quarters of 2013, with 80% in deep water. Three-quarters of those (188 contracts) were in Latin America.

The trend will continue, she predicted, with an estimated 2000 deepwater subsea equipment installations in the next five years–doubling that of the previous five years. Africa is forecast to dominate the global market, with 37% of subsea equipment spending, followed by Latin America (24%), she said.

Following the 2010 Gulf of Mexico Macondo disaster, greater emphasis is being placed on the deployment and capability of ROVs for secondary intervention on blowout preventers (BOPs) during drilling operations.

Last year, Brian Reid, in Subsea 7's i-Tech7 division, told Subsea UK's ROV conference that Macondo had a big impact on ROV service provision, increasing demand as operators try to manage risks by using ROVs as a back-up, in case a BOP fails. Companies wanted to have twin-ROV systems on rigs, and increased ROV support capability, he said. But they were also looking to ROV operators to meet API Standard 53, which requires operators to maintain the ROV and a trained crew on-board rigs, Reid said.

There have been concerns that such risks should not be shouldered by ROV operators. However, the market for the technology appears to exist.

UHD Gen III

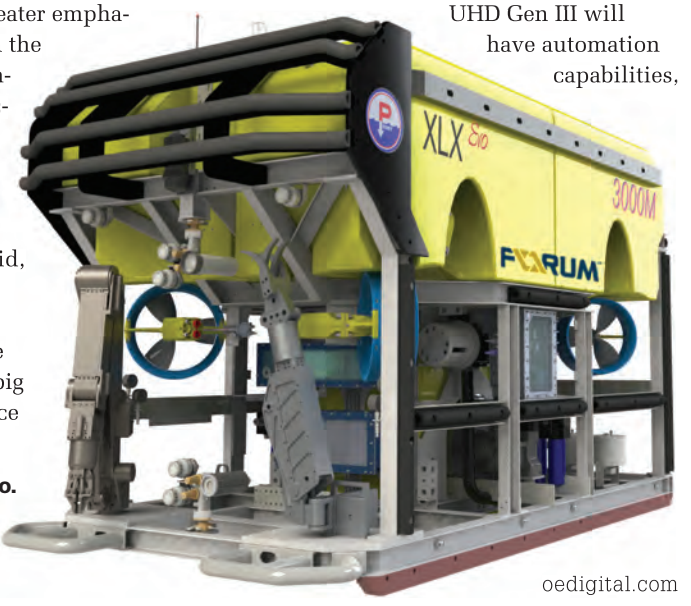
FMC Schilling Robotics says its UHD Gen III is a response to the market for an ROV system able to meet API Standard 53 for secondary intervention on BOPs, which mandates 45-second ram closure.

Developed over the last year, the UHD Gen III includes an integrated auxiliary pumping system able to pump 50gal/m up to 5000psi.

The 250Hp unit, with 150Hp auxiliary hydraulic output, is currently being pool-tested at FMC Schilling Robotics' manufacturing facility in Davis, California. Offshore trials are due start in the Gulf of Mexico in 2Q 2014, for three months. Commercial systems will be available after that.

FMC Schilling Robotics said the ROV will be able to carry 100gal of intervention fluid, and will be able to provide enough hydraulic power for BOP intervention, as well as the typical range of fluid intervention tasks such as connector actuation, seal testing, and hydrate remediation.

UHD Gen III will have automation capabilities,



Forum Energy Technologies' XLX Evo. Photo from Forum Energy Technologies (FET).

incorporating visual recognition technology, the company's StationKeep technology, for position control accuracy of 10cm, and a power management system.

Intervention tooling can be automatically acquired by the ROV manipulator, and the position of the tool can be maintained accurately, relative to a tooling interface panel.

FMC Schilling Robotics has also maintained its 60-min. maintenance philosophy on the UHD Gen III, based on Tyler Schilling's belief in leveraging the principles of modern automotive and aircraft design to enable maintenance of major subsystems in under 60-min.

"I believe the ROV industry is beginning to enter a new phase… based on how ease of use," Tyler told the September 2013 ROV conference.

New models on show

Also exhibiting at Subsea Expo was Forum Energy Technologies, which has two new Perry work-class ROVs: the heavy work-class 200hp XLX Evo, and the new XLX-C medium work-class 150hp ROV.

Just after Subsea Expo, Forum sold its first XLX-C ROV to Subsea 7, which ordered six, for three newbuild pipelay support vessels for the Brazilian market. Subsea 7 also ordered two XLX Evo ROVs for its newbuild vessel, the *Seven Arctic* (*see p.60*). The eight ROVs are due to be delivered 2014-2015.

Forum's XLX range of ROVs use the company's own ICE (integrated control engine software), real-time control system, with no subsea processor, control tray or pressure vessel. Core and survey junction boxes utilize separate plug-in data and power channels. Newer features on the XLX Evo (also available at 150hp) include integrated thruster feedback, allowing additional automatic control modules with no need for calibration, and full redundancy in case of sensor failure. Both have heading, depth, altitude, park and dynamic positioning, and braking control modes.

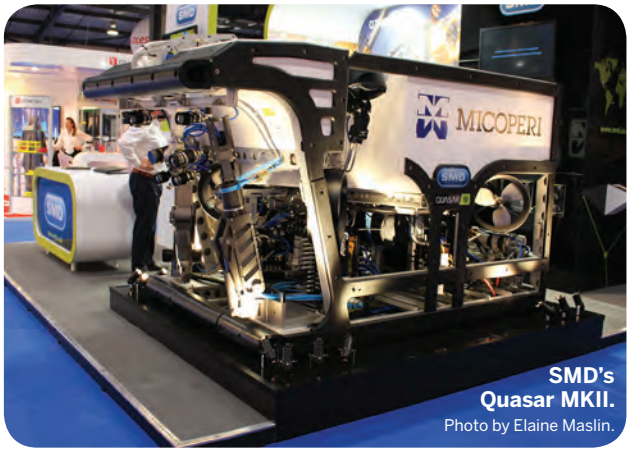
Forum has focused on reducing system complexity and maintenance times, consolidating system parts, and making control and operation easier, with no need for calibration.

The XLX-C ROV is rated to 3000m operating depth, has a rationalized hydraulic power unit, integrated compensators, integrated retractable tooling basket, and meets Statoil specifications.

Also exhibiting their latest ROVs, featuring modular and easy to maintain and access systems, were SAAB Seaeye and Soil Machine Dynamics.

SAAB Seaeye, based in Hampshire, UK, and part of the Swedish SAAB group, had its new Leopard ROV on show.

SAAB Seaeye's Leopard. Photo by Elaine Maslin.



SMD's Quasar MKII. Photo by Elaine Maslin.

The Leopard is an electric work-class ROV, which sits between the firm's Panther and Jaguar units, in size. It can produce a half-tonne of forward thrust, via seven or 11 vectored, Seaeye SM9 500v, brushless DC thrusters, providing 6-axis control, to 3000m depth.

It has Seaeye's iCON integrated intelligent control and power distribution system. This works from a central electronic pod, but with each component having its own microprocessor. This enables an advanced autopilot system, including pitch and roll stabilization, as well as built in diagnostics, redundancy, and remote internet access for upgrades and technical support.

Newcastle-based Soil Machine Dynamics (SMD) had its latest MKII Quasar at the show, specifically, a unit due to be shipped to Italian marine contracting firm Micoperi.

The 150Hp MKII Quasar has been designed for accessibility and ease of maintenance, SMD says. The latest version incorporates the DVECS-S advanced positioning system, designed with Edinburgh's SeeByte, which enables advanced piloting functions.

The first three Quasar MKII ROVs with DVEC-S are being assembled and are due to be delivered this year. Two are for Aberdeen-based subsea installation contractor Bibby Offshore and one is for Brazilian ROV service provider Sistemas de Acesso (SISTAC).

Through communication with commonly fitted ROV instruments, DVECS-S can accurately control the position of the ROV throughout the water column, using different flight modes.

In auto-fly mode, the system allows the pilot to simply point-and-click on the map screen to move the ROV. In auto-fly survey mode, the ROV will follow a set of waypoints specified by the operator. In cruise mode, the ROV moves at a constant forward velocity, plus constant depth/altitude and heading.

At any time, the pilot can adjust all settings and trim lateral thrust.

Using BlueView multi-beam imaging (MBI) sonar, DVECS-S allows object-relative positioning in the MBI sonar tracking flight mode. The pilot can control the ROV relative to objects in the workspace with advance/retreat; ascend/descend; orbit clockwise/anti-clockwise. DVECS-S functionality can be extended to provide a mid-water dynamic positioning mode for vessel following.

Fugro Subsea Services had its 200hp FCV 3000 on display. The FCV 3000 work-class ROV has been designed to assist deepwater drilling and completions, subsea oilfield and construction support, and inspection, repair and maintenance operations. Tooling packages can be installed through standard interfaces–both mechanical and control–without needing to open pods and rewire.

Fugro uses its own control and communications system, based on single-mode, fiber-optic technology, including Fugro's SMFO multiplexer. This can handle up to 12 conventional cameras (eight simultaneously) and provides a range of data protocols. OE

The blend of iCON technology and 11 thrusters in the small footprint Leopard, illustrates how intelligent architecture is advancing underwater vehicle design to bring greater operational benefits to the market at a lower real cost.
Photos: Saab Seaeye.

Underwater intelligence

Saab Seaeye's Matt Bates discusses the evolution of ROV and AUV intelligence.

Intelligent underwater vehicles are bringing new opportunities and savings to offshore operators.

Behavior-based architecture means a vehicle can effectively think for itself.

Such dynamic decision-making offers a greater range of possibilities for a vehicle to operate independently–on programmable missions, for instance–and if damaged, stay alive by re-allocating systems.

Important for operators is that intelligent architecture also means more equipment can be carried on a smaller vehicle, than would otherwise be the case.

But more kit needs more thruster power, and this combination needs intelligent architecture for best control of the system and to create a stable and maneuverable platform for working at remote tasks and coping with strong currents.

Yet, while operators welcome smarter technology that is able to handle more kit with more power, they still want a vehicle to stay inside a small footprint.

With components getting smaller and smarter, and such innovative design concepts emerging, the footprint challenge is being met. The design of the new Leopard is a case in point.

Fitted with 11 thrusters it is the most powerful ROV of its size in the world, yet can handle more tooling, cameras and survey equipment than any other ROV in its class.

Nevertheless, it still fits into the minimal deck footprint combination of a 20x8ft, single lift A-Frame and winch LARS, and a 20ft control cabin–for easy transport and rapid mobilization.

The emergence of intelligent architecture, embodied in developments like the iCON control system, across ROVs, AUVs and AUV/ROV Hybrids, is a key development in the industry and is introducing ever more innovative technological solutions.

Take the Hybrid for example, which combines the autonomous remote operation characteristics of an AUV with the work capability of an ROV. In this case, on-board intelligence allows programmable missions to be undertaken and will also let the vehicle adapt automatically in response to external influences.

In free-swimming mode, its 360° maneuverability means it can enter structures and undertake work tasks without fear of tether entanglement.

Being programmable, intelligent and maneuverable, a Hybrid can undertake a number of complex tasks. Asset integrity and environmental monitoring of oil and gas installations are some examples.

This is well-illustrated by a project developed by Eni Norge and Tecnomare, called Clean Sea (continuous long-term environmental and asset integrity monitoring at sea). The Clean Sea team sought to overcome the shortcomings of environmental monitoring and inspection of oil and gas infrastructures, typically restricted to an annual undertaking and involves supply vessels and various underwater systems.

They recognized that the industry is moving into more challenging development areas–possibly in remote, hostile or environmentally-sensitive places–where conventional methods may be unsafe or unsustainable.

For the task they picked the Sabertooth AUV/ROV Hybrid, not just for its 360° maneuverability and hovering characteristics–necessary to operate in the proximity of structures, while undertaking inspection and monitoring tasks–but that its intelligent open-interface architecture meant the Clean Sea team could fit interchangeable modules, which they call E-PODs.

Each E-POD module is dedicated to a particular task that can include automatic water sampling, hydrocarbon leakage detection, chemical analysis, visual inspection and acoustic surveying.

The advantage of a modular concept is that a number of E-PODs can be readied for environmental monitoring during all phases of field development.

A selection of E-PODs can typically include: baseline monitoring before activity takes place; along with environmental impact monitoring during exploration and production; post-incident monitoring to record effects and environmental recovery; general spill and hydrocarbon leakage detection; also visual inspection of structures, manifolds and associated equipment.

The hybrid's intelligence can modify a pre-programmed mission in real-time, so that in response to the detection of a leak it will autonomously pinpoint the leak by subsequent analysis of gas measurements

The Sabertooth AUV/ROV Hybrid fitted with the iCON intelligent control system, with its behavior-based architecture, offers decision-making and self-diagnostic capabilities for long-range programmable or operator-controlled missions. Future possibilities also suggest it can be left in operation at remote locations for a year.

and move towards the leak source and film it.

Standard environmental sensors can be fitted to include temperature, conductivity, dissolved oxygen, fluorescence for chlorophyll and organic matter, turbidity, dissolved methane, PAH, pH and ORP.

In future, the Clean Sea team see the potential for locating E-Pods on the seabed alongside the Sabertooth at a remote underwater docking station, where it will remain resident for a year ready to be deployed as needed.

This will give year-round access to locations normally inaccessible due to ice or exceptionally harsh weather, and offer safer monitoring in geographical regions prone to insecurity.

Such intelligent technology applied to ROVs, AUVs and Hybrids, and matched with miniaturization of systems and components, is opening up new opportunities, and making life easier for operators.

For instance the networked design of the iCON control system has refined the main electronics pod into an intelligent power distribution and data hub, and relocated the brains of the system into sensors and actuators. This provides greater information for the user and makes maintenance far simpler and quicker.

This innovation also avoids the need to partially dismantle the ROV to reach its electronic heart–and offers building-block simplicity for equipment changes, along with remote internet access for upgrades and support.

Through an intelligent control system, the pilot also gets clear and enhanced information while also independently managing each device on the vehicle, including auto redundancy, that will keep the ROV working even after suffering multiple equipment damages.

The benefit of intelligent control is that the continued evolution of smarter vehicles incorporating innovative and miniaturized technology is set to grow exponentially and will bring operators ever greater performance for less real cost. **OE**

***Matt Bates** is a director at Saab Seaeye, which he joined in 1993.*

His primary responsibility is the overall management of the sales and marketing and after-sales support activities.

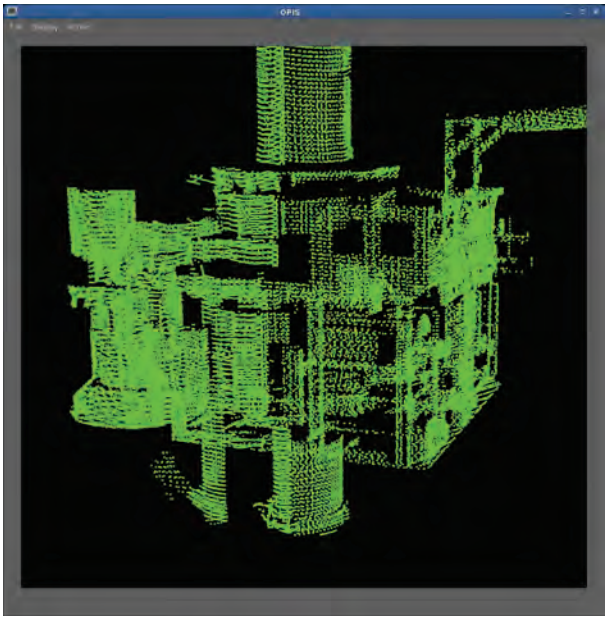
He previously held the position of engineering manager, during which time his achievements included the development of the Seaeye Tiger, Lynx, Panther Plus and Seaeye Falcon.

In 2002, he took over the position of Sales and Marketing Manager. In 2003, he became Managing Director of Seaeye Marine and in 2008, took on the role of Sales Director.

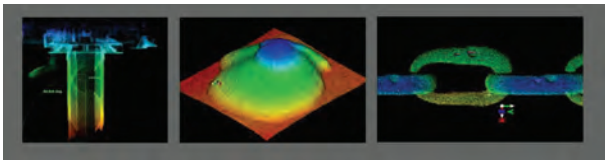
Matt has an Matt has an Honours Degree in Engineering Systems.

AUV-based 3D laser imaging

Lockheed Martin's John Jacobson and Dan McLeod explain the company's latest tool for subsea integrity management.



Simulated 3D laser image of a subsea tree



Results of simulated underwater 3D laser-imaging from a moving AUV Images: Lockheed Martin.

Recent advances in underwater 3D laser imaging and autonomous underwater vehicle (AUV) technologies hold the potential to deliver revolutionary capabilities for subsea structural integrity management. Underwater 3D laser sensors now offer the angular resolution, range, and scan rate to deliver dense, 3D-point cloud images of subsea structures with millimeter resolution at tens of meters of standoff distance, while also opening the door for the application of a wide range of software tools from the terrestrial survey industry.

At the same time, state-of-the-art AUVs now include real-time 3D modeling and change detection using high-resolution 3D sonar. Lockheed Martin, supported by funding from Research Partnership to Secure Energy for America (RPSEA), is merging these technologies through a two-year, four-phase project, now in its final stage.

Using an underwater 3D laser developed at Depth LLC, this new project will enable autonomous, real-time, millimeter-resolution 3D modeling, change detection, and structural integrity assessment. Results will be delivered while offering improved safety, higher-operating efficiencies, and reduced costs to the field operator.

Project objectives include demonstration of 3D mapping and change detection using an AUV-based 3D laser. This will include high-resolution imaging of underwater structures from a moving AUV, generation of high-resolution, geo-registered 3D models of subsea structures, and detection of changes against a priori structural models.

Progress to date has included development of performance requirements and interface specifications between Lockheed Martin's Marlin AUV and the 3D laser; the design, build, and test of the 3D laser; and integration of the laser into the Marlin. A critical aspect of this development is the real-time fusion of the 3D laser and sonar data with the vehicle's navigation and control systems to produce high quality, motion-compensated 3D models.

In order to verify proper performance prior to offshore testing, extensive high-fidelity simulation of 3D laser imaging from a moving Marlin AUV platform was conducted in Lockheed Martin's simulation laboratory located in the company's West Palm Beach, Florida, facility. Simulation was conducted against a range of operational scenarios developed in conjunction with a project working group team consisting of members from six major deepwater operators.

Simulation testing included the following scenarios which were deemed to be of high interest by the Working Group:

- Measurement of wellhead verticality
- Performance of jumper metrology
- Measurement of anode depletion on manifolds and pipelines
- Detection and measurement of pipeline dents, pitting and concrete coating damage
- Measurement of spoils volume
- Performance of structural inspection against a baseline model
- Detection and measurement of mooring chain pits and chain link wear

Simulation testing uncovered several interesting findings. As an example, assume an AUV was swimming at 2 knots at approximately a 5m-standoff from the target. After insertion of simulated noise for timing, sensor calibration, sensor errors, and representative navigation errors, the results of simulated measurement of wellhead verticality were less than 0.08° from ground truth.

Excellent results were also obtained for measurement of dimensions and/or volume for jumper metrology (<0.5% error), anode depletion (2-4% error), and spoils volume (<2% error), which all fall well within the desired operational accuracies for such inspections.

Simulation test cases involving detection and measurement of dents, pits, and cracks generated errors ranging from 2% to 40%, driven by laser sensor characteristics and depending on the geometries used for measurement. Further work is required to understand these errors and assess the AUV and sensor operational parameters that optimize these results, but given the range of size of flaws being measured (1-3cm depth, 1-7cm width) these results may be acceptable in many structural integrity management applications.

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During this final phase of testing, offshore testing of the prototype 3D laser imaging hardware and software are being conducted in local offshore waters adjacent to Lockheed Martin's Palm Beach facility. The objectives are to demonstrate 3D laser images from a mobile AUV with accuracies at the sub-centimeter scale, and to prove that AUV-based 3D laser imaging is a viable alternative for inspection of subsea structures such as trees, jumpers, pipeline end terminations, manifolds, pipelines, flowlines, risers, and mooring lines. Tests include AUV-based laser imaging of mock-up test fixtures and/or local wreck sites using the Marlin AUV that represents the same operational test cases as those evaluated in Lockheed's simulation laboratory. AUV-based 3D laser imaging can perform a wide range of inspection tasks, including generation of geo-registered "as-built" models of structures on the seabed or in the water column, periodic survey of subsea infrastructure and comparison against a baseline model, and autonomous detection of structural defects or other out-of-spec conditions that exceed threshold values.

Once an out-of-spec condition is detected by the AUV's onboard perception autonomy software, a preprogrammed "revisit" maneuver can be invoked to reposition the AUV and obtain more video, sonar, and/or laser data. Additionally, such conditions can be automatically flagged to the operator upon completion of the inspection mission. This provides the dual benefit of (1) more rapid and accurate identification and review of critical conditions by integrity management engineers and (2) reduction in operator fatigue and subsequent operator errors caused by long hours of monotonous review of inspection data.

The future implications of this technology for structural integrity management are wide-ranging, with numerous potential applications in deepwater fields. An example of a potential application would be an AUV pipeline inspection conducted with 3D laser imaging, feature-based navigation, and real-time 3D modeling and change detection. As another example, a new survey would be able to autonomously detect and measure movement of the pipeline, changes in pipeline contour (potential buckling or over-bending), changes in scour, berm and free span conditions, anode depletion since the last survey, changes to pipeline surface conditions (pits, cracks, dents), and new anomalies or debris that may impact pipeline safety using a reference model of the pipeline and seabed obtained from a previous baseline survey.

Lockheed Martin's Marlin AUV will be outfitted with a 3D laser for offshore trials 1Q 2014. Photo: Lockheed Martin.

Marlin Mk3 preliminary specifications

Payload capacity	Wet weight – 350lb (160kg) Volume – 20ft³ (0.57m³) Power – 4kw peak
Endurance	33 hours (mission dependent)
Speed	0-5 knots
Range	100nm (185km)
Depth rating	13,124ft (4000m)
Length **Width** **Height**	17ft (5.2m) 3ft (0.9m) 4ft (1.4m)
Weight in air	5500lb (2500kg)

Similar scenarios could be expected for AUV-based laser inspection of risers, mooring lines, and other subsea infrastructure. In addition, the ability to conduct subsea installation and construction tasks such as high-accuracy seabed bathymetry, jumper metrology, and wellhead verticality measurements from a moving AUV could offer significant advantages.

Building on the success of its 300m rated Marlin AUV, Lockheed Martin is currently developing a new Marlin variant, the Mk3, which will be capable of operations in water depths up to 4000m. In addition to carrying a full suite of conventional survey and inspection sensors such as multi-beam sonar, side scan sonar, and HD video, the Marlin Mk3 will employ high-resolution 3D sonar and 3D laser sensors to perform autonomous pipeline inspection and deepwater facility inspection.

When completed, the Marlin Mk3 is expected to provide deepwater operators with 3D laser imaging capability that will provide a next generation tool for structural integrity management.

The long-term benefits of AUV-based laser imaging for structural integrity management could be significant. First, the field operator reaps the benefits that AUV inspections can offer over current ROV inspection methods for deepwater fields, including smaller vessels, smaller crew, and elimination of the ROV umbilical. These benefits translate to lower overall life-of-field cost for structural integrity management, and will enable more frequent inspections at an affordable cost. Autonomous 3D modeling and change detection can also positively affect accuracy and operational efficiency. Not only do inspections become more efficient, but also, factors such as human fatigue and inspection data overload are eliminated from the equation.

The availability of detailed 3D models from prior surveys can benefit structural analysis and defect evaluation, and the application of third-party software tools from other industries, such as terrestrial survey, will also enable increased operational efficiency.

AUV-based 3D laser imaging has the potential to become a transformational tool for structural integrity management, enabling autonomous, real-time high resolution 3D modeling, change detection, and structural integrity assessment while offering significantly improved safety, higher operating efficiencies, and reduced costs to deepwater field operators. OE

John Jacobson *is a senior program manager for Lockheed Martin's Offshore Systems and Sensors program and is based in Houston, Texas. He holds a Bachelor of Science degree in Physics and a Master of Science degree in Computer Engineering from the University of Southern California.*

Dan McLeod *is the deputy director of Offshore Systems & Sensors at the Lockheed Martin, Riviera Beach, Florida. Mission Systems & Training Business. He holds a Bachelor of Science degree in Ocean Engineering from Florida Atlantic University.*

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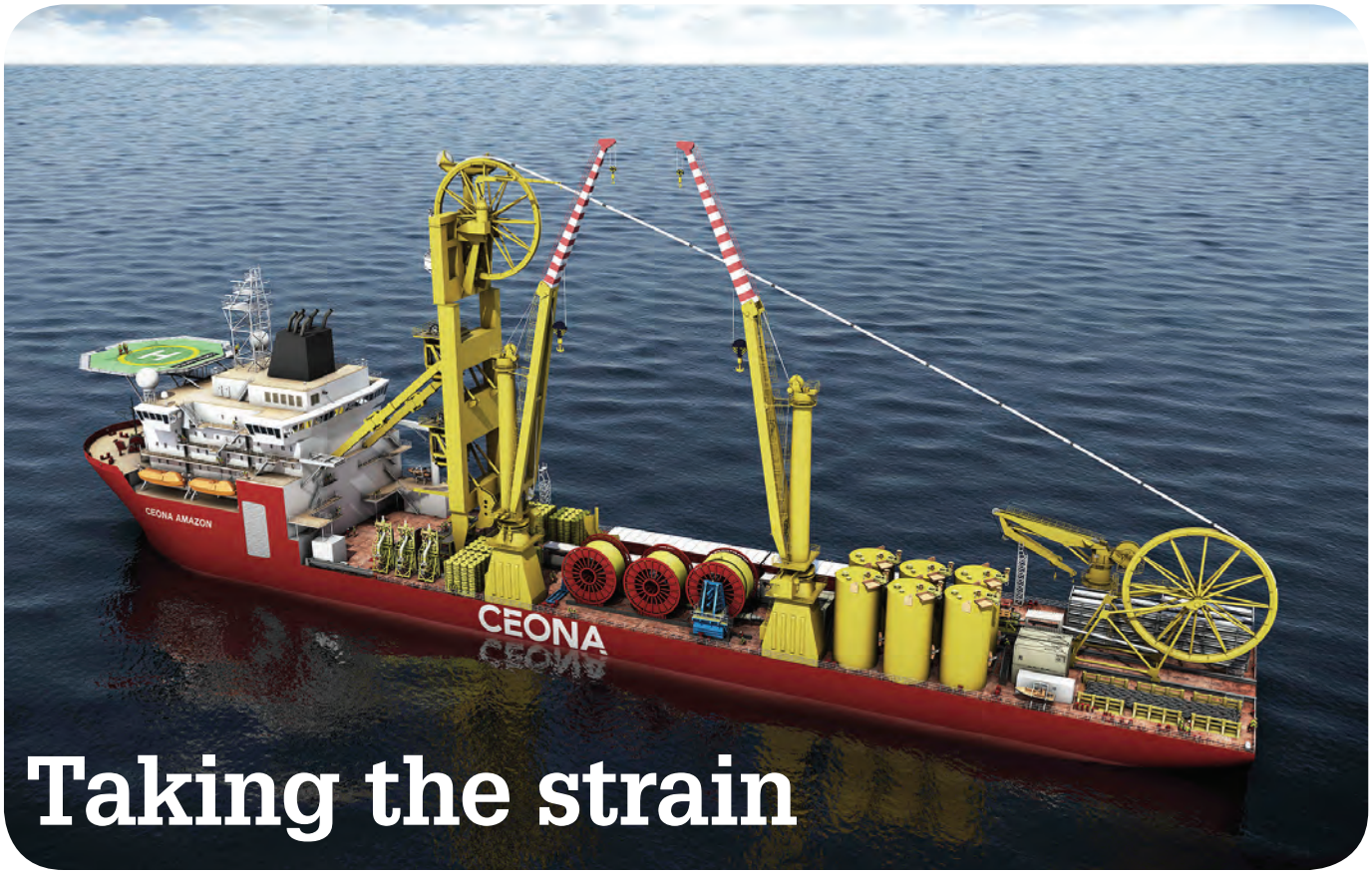


Taking the strain

A newbuild vessel, the *Ceona Amazon*, is due to enter the pipeline installation and construction market late in 2014. Ceona's Vibor Paravic explains stress and strain considerations for pipelay vessels.

The *Ceona Amazon* is London-based Ceona's new concept in laying rigid pipe. The vessel's design is based on existing s-lay and j-lay technologies, but with a new approach to how they are arranged on board the drill-ship style vessel.

The 200m-long, 32m-beam, *Ceona Amazon* is a multi-construction vessel, able to install 16in. pipelines in up to 2500m water depth as well as accommodate pipe-in-pipe systems.

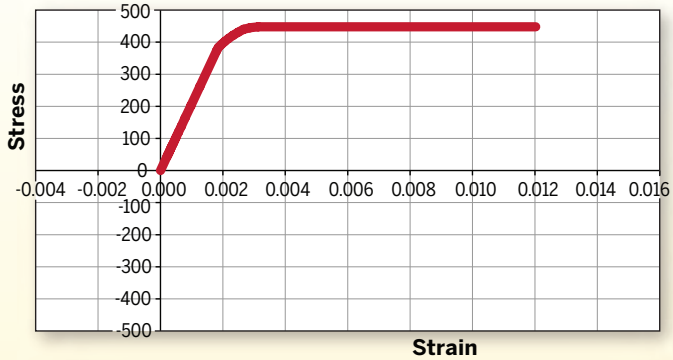
The vessel will enter service in 1Q 2015, nine months after its flex-lay sister vessel, the *Polar Onyx*, entered Ceona's fleet.

The *Amazon's* hull was built at the Gdansk Crist Shipyard in Gdynia, Poland, before being shipped to Lloyd Werft Bremerhaven, in Bremerhaven, where the vessel is undergoing finishing. It will then move to Huisman's yard in Schiedam, the Netherlands, where its two, 400-tonne capacity, heavy load cranes, and the 570-tonne pipelay tower will be fitted.

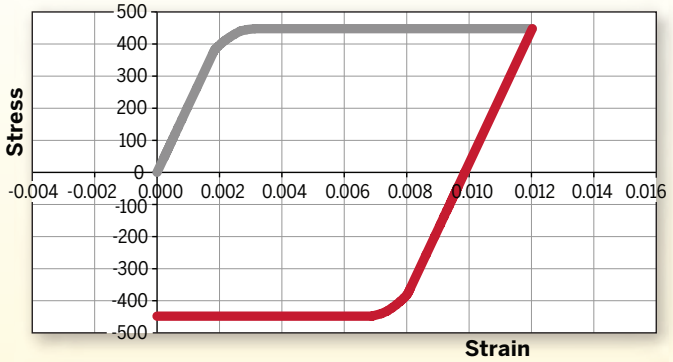
***Ceona Amazon* (3D model) in full field development configuration with rigid and flexible pipe.** Images: Ceona.

The *Amazon* has been designed to combine proven s-lay and rigid-lay construction equipment, in a configuration that optimizes deck space and efficiency.

Forming around deck aligner wheel



Straightening in the free-span between aligner wheels



S-lay

The vessel will be able to carry 8500-tonne of rigid pipe on/below deck, like an s-lay barge, which is 50% more than its nearest competitor. Instead of laying the pipe over a stern stinger, it will be deflected forward, around a deck aligner wheel.

The pipe is then guided up and over a second aligner wheel, at the top of a dual flex-lay/rigid-lay tower. The pipe is straightened, in a conventional straightener, and then handled by two tensioners, with a combined 570-tonne top tension capacity.

S-lay construction, where pipe stores are regularly replenished by barge, ensures maximum operational pipe-laying time at sea, and eliminates costly spoolbase construction and maintenance costs, and associated vessel transits.

Rigid-lay

In rigid-lay, the *Amazon* will have a 2-4km/day lay rate. The vessel's 200m length and 32m-beam, combined with the dual-tensioner tower, situated over a central moonpool, will maximize the operational sea state envelope, and provides access for handling cumbersome pipeline, end terminations and inline tees.

The aft deck area space created (with carousel below) is then suitable for construction tasks, using two active heave compensated deepwater mast cranes, with an 800-tonne combined lifting capacity.

Stress strain considerations

The most important consideration for a pipelay vessel is the extent of accumulated plastic strain that the pipeline experiences, as it is repeatedly bent and straightened. This should be as low as possible, particularly for deepwater applications.

The extent of the accumulated strain and ovalising of the pipeline cross section depends upon the radius through which it is bent and the number of times it has been bent. The larger the bend radius, the smaller the ovalization and strain.

Accumulation of plastic strain is best illustrated graphically, using a basic strain formula to evaluate the cumulative plastic strain arising from the repeated bending and straightening cycles to which the pipe is subjected during the spooling-on and associated lay processes.

On the *Amazon*, following s-lay welding, the pipeline is moved aft by its 75-tonne deck tensioner and is bent around the 18m-diameter stern deck aligner wheel (O-A). During this forming process, the stress and strain in the pipeline increase in a linear elastic fashion, until the yield point is reached. After this point, the stress remains more or less constant, but the strain continues to increase, until the pipe bend radius matches that of the aligner wheel.

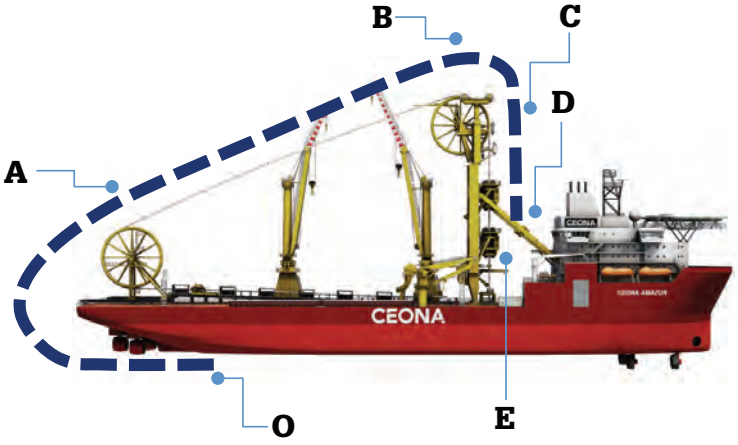
The pipe is held to the formed radius of the deck aligner wheel by the tension in the pipeline. If that tension were to be removed, the pipe would elastically spring back slightly but would not be straight, i.e. it would retain a residual curvature.

As the pipe continues to move around the aligner wheel, and into the free-span section, it is then effectively pulled straight by the line tension (A-B). First, the elastic stress is relaxed and then the stress again increases (in the negative direction), as the pipe straightens, until the yield limit is reached. Thereafter, the strain continues to increase to a maximum that depends on the tension applied. As such, the pipe forms plastically, from its bent shape, until it almost looks straight, effectively reverse bending using the pipeline tension.

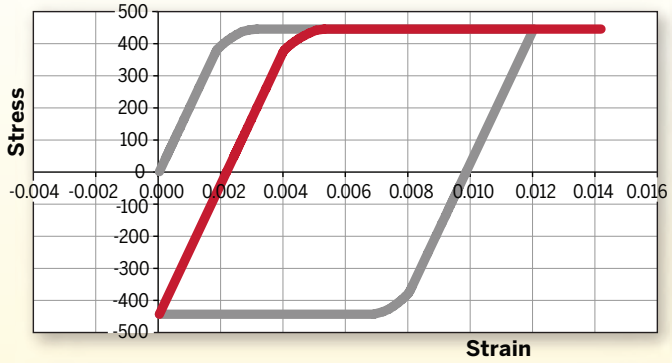
The wheel-forming process is then repeated as the pipeline passes over the tower aligner wheel (B-C). Finally, the pipe is drawn from the aligner wheel (C-D) and then passed through the straightener (D-E), inducing the correct degree of reverse bending to entirely remove the remaining residual curvature. When the pipe exits the straightener, it is straight, and both the stress and the strain have come full circle back to the starting point.

The accumulated plastic strain is a record of the sum of the plastic strain elements experienced by the pipeline

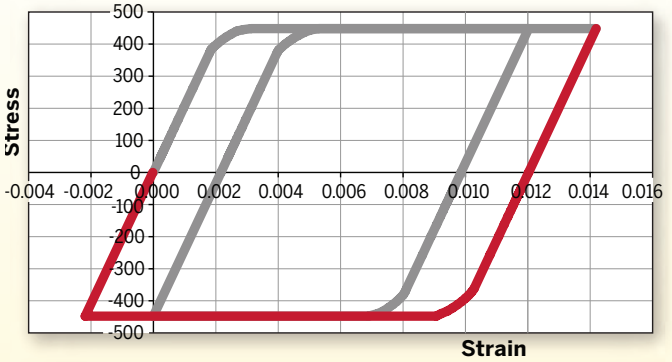
The *Ceona Amazon*'s pipe path key points

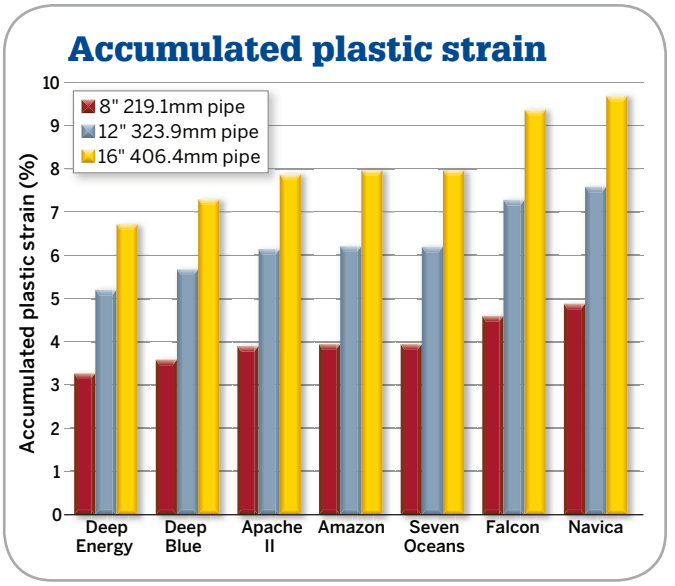


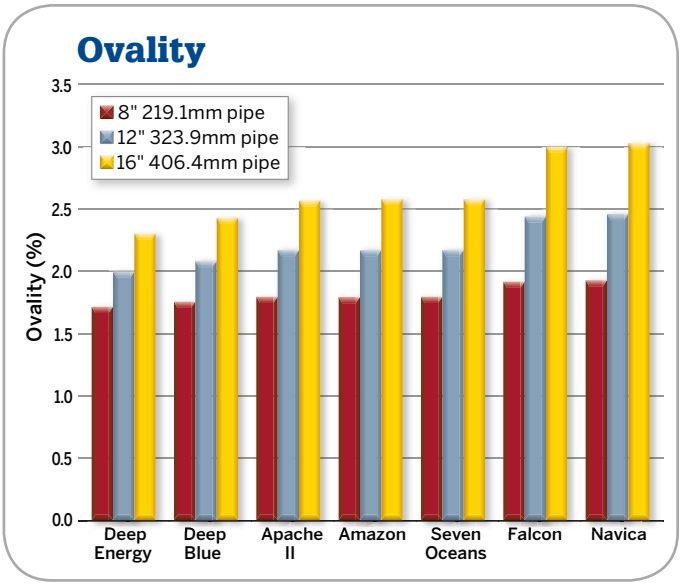
Forming around the tower aligner wheel



Straightener reverse bending







during the cycle. The strain magnitude depends on the number of, and diameters of, the forming equipment items involved.

These strain steps also occur in reeling vessels, forming onto the reel (O-A), unreeling to the tower aligner wheel (A-B), passing over the aligner (B-C), passing into the straightener (C-D), and being straightened (D-E).

Because these steps are similar, the *Amazon* can be compared to other vessels in the current fleet, in terms of how much strain and ovality is put into the pipe by the installation vessels.

The *Amazon's* deck aligner wheel and tower aligner wheel are identical, with an 18m diameter, equal to the reel of the *Seven Oceans* and greater than most other pipelay systems.

The existing vessels were all compared using their respective wheel/reel diameters and aligner wheel diameters. Classical and first principle formulas were used in order to ensure the comparison was on equal footing.

Calculations show that for the three pipe sizes considered, the three Technip vessels (*Deep Energy, Deep Blue* and *Apache II)* generate the lowest accumulated plastic strain, and that the *Amazon* and *Seven Oceans* return identical results, almost matching that of the *Apache II*. The *Falcon*, *Seven Navica* and remaining vessels, produce progressively larger accumulated plastic strains, due to the smaller reel/aligner diameters.

The ovalisation experienced by the *Navica* and *Falcon* borders the industry accepted 3% for the largest pipe size considered of 16." The *Amazon* and *Seven Oceans* match closely with the *Apache II,* and all three produce ovality levels close to the industry leaders *Deep Energy* and *Deep Blue.* OE

Vibor Paravic *is Vice President Technology at Ceona. He has more than 20 years' engineering experience. He has been involved in all aspects of subsea engineering including detail design, subsea construction, and pipelay, covering projects globally. He has an MSc in Mechanical Engineering from the University of Houston.*

Petrofac takes on pipelay

London-listed service provider Petrofac has unveiled a new design for a deepwater derrick lay vessel, to be built at the Shanghai Zhenhua Heavy Industry Co., Ltd (ZPMC) yard in China.

The 215m-long, 49m-beam unit will be based on a customized ULSTEIN SOC 5000 design, developed by Ulstein Sea of Solutions, a Netherlands-based subsidiary of Ulstein.

The vessel has a combination of a 600-tonne Remacut S-lay system via a center firing line below main deck, and a 2000-tonne IHC Engineering Business J-lay system via a moonpool,

"This double deck configuration, a distinctive feature in Ulstein Sea of Solutions designs, allows for a large, unobstructed deck area and below deck pipe fabrication," Ulstein says.

Petrofac has placed the first long-lead orders for the vessel, which it says will be available for construction and installation activities in early 2017.

The vessel will be DP3, have a service speed of 12kn, six 8,500kW generators, eight-point mooring capability, ice-class Finnish Swedish 1C, and be able to accommodate 399 people.

Kongsberg Maritime, Norway, is supplying electrical and control systems. National Oilwell Varco, USA, will provide a 5000-tonne revolving main crane and four deck cranes.

Remazel Engineering, Italy, will supply two deepwater 750-tonne winches, and Remacut, Italy, will supply the 600-tonne S-lay tensioners and pipe handling equipment. Classification will be provided by Lloyds Register Group ■

–Elaine Maslin

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Russia limits access to Arctic

Rosneft president Igor Sechin.
Left image: Rosneft; right image: Gazprom.

Global oil majors continue to lobby concessions for operations on Russian Arctic shelf; Eugene Gerden reports.

Amid the fierce critics from global environmental organizations, the Russian government continues to create conditions for the attraction of foreign investors for the development of the national Arctic shelf.

Following the unprecedented tax benefits that were granted to Rosneft and its foreign partners for the development of the Russian Arctic shelf at the end of last year, the Russian government is currently considering approving additional measures, aimed at creating more a favorable regime for the company's operations on the domestic Arctic shelf.

The need to provide additional benefits for Arctic offshore projects was announced in February by Igor Sechin, head of Rosneft, in an official letter addressed to Russian President Vladimir Putin.

According to Sechin, amid the forthcoming active development of the domestic Arctic shelf, Rosneft and its foreign partners, in particular, ExxonMobil, Eni and Statoil, are not happy with the existing national legislation covering shelf development, which restricts some of the planned activities of the partners.

According to Rosneft, operations on the domestic Arctic shelf still require a large number of formal approvals from ministries and departments, which need to be granted at various stages of the companies' work. Rosneft says the receipt of approvals for some of the activities may take up to two years and require more than 60 approvals from different state agencies.

Rosneft formally commented:

"Simplification of the procedures does not mean their abolition. We are talking about the acceleration of completion of these procedures. Currently their total number is about 60, while their completion may take up to two years."

Sechin believes that some issues hamper the development of the national Arctic shelf and should be resolved as soon as possible. These include the problem of importing drilling waste to Russia, the long procedures of passport and visa control for workers on offshore drilling platforms and ships, and the existing ban on foreign companies using their own equipment for operations on the Russian Arctic shelf.

According to the Kremlin's press service, Vladimir Putin has already received the letter from Rosneft and generally supports the latest claims of Rosneft. It is reported that Putin has sent them for further consideration to the Chief of Presidential Administration, Sergei Ivanov, and to Prime Minister Dmitry Medvedev.

Russian analysts believe that the pressure of Rosneft and its foreign partners on the national government is quite understandable. According to Valery Nesterov, a senior analyst of Sberbank CIB, one of Russia's leading agencies in the oil and gas market, the partners have focused on the fight for licenses. However, now that all the licenses have been distributed, the companies are trying to eliminate other obstacles that may prevent full-scale development of the shelf.

If the latest claims of Rosneft and its foreign partners to be met, this will be a second major success of the shelf's operators for the last several months and will make the Russian shelf one of the worlds most favorable and liberal, in terms of taxation and ecology.

The latter will be also mainly due to the recent adoption of the federal law, On tax and customs tariff stimulation of production of hydrocarbons on Russia's continental shelf, approved by the Russian Parliament late last year and which divided all of Russia's offshore projects into four categories based on the level of complexity.

Unlike to other offshore projects, where mineral extraction tax is set at 30% of the cost of raw materials, in the case of the Arctic projects, this rate is set at the record low figure of 5%.

In addition, all operators of Arctic offshore projects will receive a guarantee of permanency of the tax regime for up to 15 years, and will be exempted from payment of export duties, as well as import duties and VAT on imported technical equipment. The law also exempts operators from property and transport tax.

In return, the companies have provided guarantees for the start of production on the shelf beginning in 2016.

The Russian government explains the decision for the provision of such preferential tax regime to the companies is based on harsh climatic conditions of the Arctic region, which is associated with high production costs for them and require investments, estimated at a total of $700 billion.

The decision to provide benefits to the companies was taken despite the opposition of Sergey Donskoy, Russia's Minister of Natural Resources, who also proposed to introduce tax on additional income for the companies. The proposal, however, has not received any support from the Russian government.

According to an official representative of the Russian Presidential Administration, providing these benefits will create conditions to encourage more active participation of foreign investors in the development of the Russian Arctic shelf.

This have not gone unnoticed by major partners of Rosneft in Russia, and in particular ExxonMobil, which recently announced plans to leave similar Arctic

projects in Greenland, in favor of the Russian Arctic, due to cost issues.

ExxonMobil decided not to participate in a bid round of 50,000sq km of Greenland shelf area, where reserves are estimated at 31MMboe.

Instead, the US company, together with Rosneft, plans to focus on developing the North-Kara, North Wrangel-1, and East Prinovozemelsky-1 oil-prone areas. These are spread across nearly half a million hectares of three protected areas: Great Arctic, Wrangel Island, and Russian Arctic, which has brought criticism from many ecology organizations.

If the first projects are successful, Exxon has not ruled out the possibility of expanding cooperation with Rosneft in the Arctic region, taking into account that at present Rosneft owns 46 licenses for exploration and production of hydrocarbons in the Russian Arctic shelf, with total reserves of 34.6 billion tons of oil equivalent.

In addition to Exxon, other major IOCs, such as Statoil and Shell, apparently prefer Russian projects to similar projects in Alaska and Norway.

But constant concessions to oil majors from the national government has sparked protests from many Russian and global environmental organizations, as well as some Russian officials.

According to a representative of the World Wildlife Fund (WWF), Rosneft plans to start developing the Arctic shelf without having any technologies to contain and clean up oil spills.

WWF says that Rosneft is not even able to utilize associated gas produced from traditional oil fields, and must flare, although this is not really comparable with liquidation of oil spills in ice conditions.

An official representative of WWF, comments:

"There is no doubt that requirements for operations on the Russian Arctic shelf should be tightened…due to high threat of floods and especially in the protected areas. Russian environmental regulation currently remains one of the world's most liberal in this field, which attracts foreign investors."

In the meantime, Rosneft said that the company and its partners use the latest and the most modern technologies in oil and gas production. They say that dealing with a possible oil spill is an integral part of the company's corporate program for environmental and industrial safety work on the Arctic shelf.

Analysts of the Russian Oil Union believe that global majors' interest in the national Arctic shelf will continue to grow, due mainly to recently tightened legislation for offshore oil production in the US and other countries.

They also believe that, thanks to big political influence of its top management, Rosneft will be able to lobby its latest claims announced by Sechin.

The investments of the consortium of Rosneft, ExxonMobil, Eni and Statoil in exploration work on the shelf is estimated at $14 billion, while the total investments in the first phase of the shelf's development is $500 billion.

So far, Rosneft and ExxonMobil have identified the first structure to be drilled in the Kara Sea, known as Universitetskaya. Work is scheduled to begin this year using the *West Alpha* semisumbersible drilling rig.

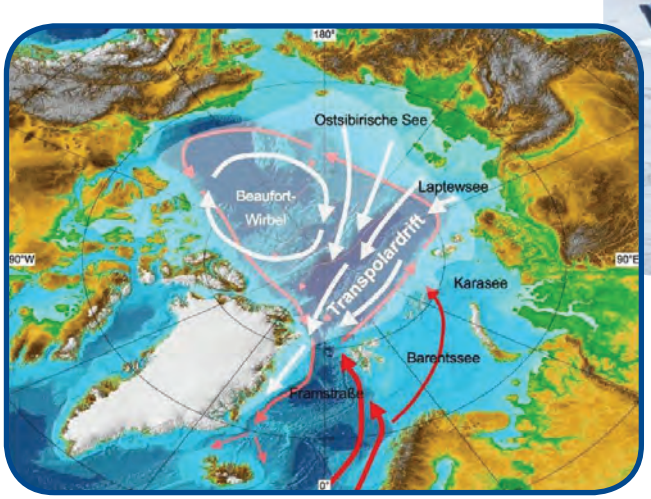
According to the partners' plans, drilling the Universitetskaya structure may lead to the discovery of a new petroleum province on the Arctic shelf, with potential reserves of more than 35 billion boe.

According to Igor Sechin, Exxon has already promised to fabricate most of the equipment needed at local production facilities and shipyards.

Yuri Shafranik, chairman of the Union of Oil and Gas Producers of Russia said that cooperation with foreign partners is very important for the Russian fuel and energy complex, as local companies currently experience a lack of technologies to develop the Russian Arctic shelf. OE

Eugene Gerden *is an international writer based in St. Petersburg, Russia. Since 1999, he has written for Downstream Today, Oil and Gas International, Chemistry World, and other oil and gas industry publications; he is also a correspondent for WardsAuto, Aviation Pros, and Shepherd Media. Gerden can be reached at gerden.eug@gmail.com.*

The Laptev Sea:
Beginning of the Transpolar Drift



Schematic of the Arctic surface circulation including the Transpolar Driftal.

By Markus Janout

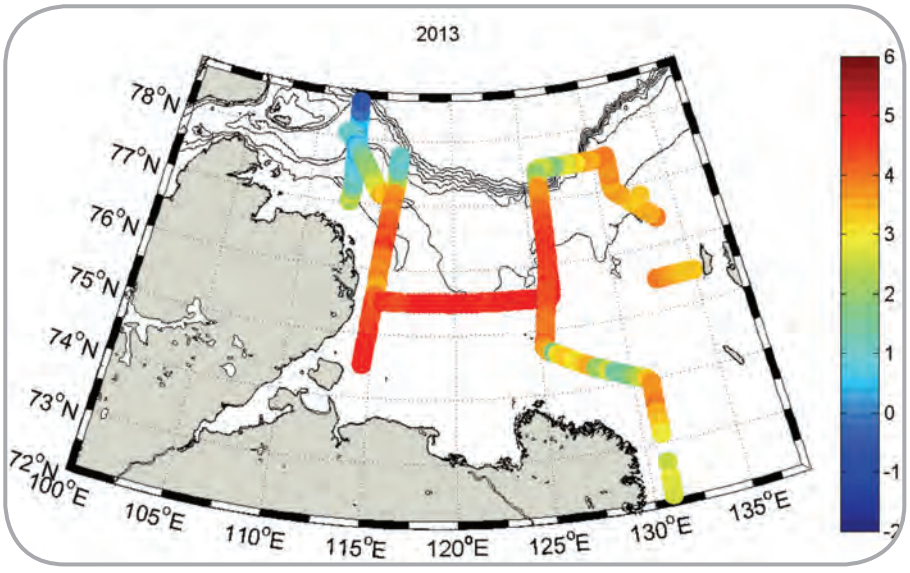
The Siberian shelves are vast and shallow, seasonally ice-covered, and receive more than 80% of the Arctic freshwater input, in particular from the Ob, Yenisei, and Lena, three of the largest rivers on earth. These rivers shape the hydrographic and biogeochemical environment in the region. Nevertheless, the Siberian shelves are among the least studied shelf seas on the planet and host a complex series of processes impacted by freshwater, warm Atlantic-derived waters in the Arctic basin, considerable tidal currents and sea ice. The Laptev Sea, as a representative of the Siberian shelves, features vast areas that are covered by immobile (landfast) sea ice in winter. Along the landfast ice edge, offshore winds during winter and spring frequently move the pack ice cover to open up leads (so-called polynyas), where new sea ice is formed when open water is exposed to extremely cold air temperatures. Owed to the large ice formation rates observed in the polynyas, the Laptev Sea is also referred to as the "sea ice factory" of the Arctic and the beginning of the Transpolar Drift system, which transports sea ice from Siberia across the North Pole to exit the Arctic through the Fram Strait, East of Greenland.

Laptev Sea project

The Laptev Sea has been a focus of Russian-German partnerships since the 1990's, under a variety of projects with science questions focusing on sediment transport, sea ice formation and the role polynyas for the ocean circulation and ecosystem. "The Transpolar Drift System of the Arctic Ocean," a new multi-disciplinary project was launched in spring 2013, with the goal to assess the processes that dominate the Laptev Sea shelf at present in order to predict the fate of the Transpolar Drift (TPD) System under a changing climate. Scientists from different Russian and German Research Institutes participate to investigate sea ice and ocean circulation, biological and chemical properties of the water column and the sea floor as well as aim to improve the understanding of the region's geological past. Additionally, the central Arctic as well as the Fram Strait region are investigated as well for a comprehensive picture of the TPD.

Laptev Sea expedition Transdrift 21

During more than 20 years of Russian-German Laptev Sea research, a total of 21 (Transdrift) expeditions were carried out, most of them shipboard summer expeditions, but also some helicopter-based winter expeditions. The most recent expedition, Transdrift 21, was carried



Laptev Sea surface temperature (°C) during Transdrift 21 in early September 2013.

The Russian research vessel *Viktor Buynitskiy*.
Photo courtesy of the captain of the icebreaker *50 Years of Victory*.

out August-September 2013 aboard the ~50m-long Russian-flagged vessel *Viktor Buynitskiy*. The science party boarded the ship in Arkhangelsk and sailed along the Northern Sea Route across the Barents and Kara Seas into the Laptev Sea. As was often the case in the recent years, the passage was largely ice-free, except a small region in Vilkitsky Strait, a narrowing passage between the Kara and Laptev Seas. The expedition was guided into the study region through the Strait in a convoy of four vessels, lead by the Russian nuclear icebreaker *Yamal*.

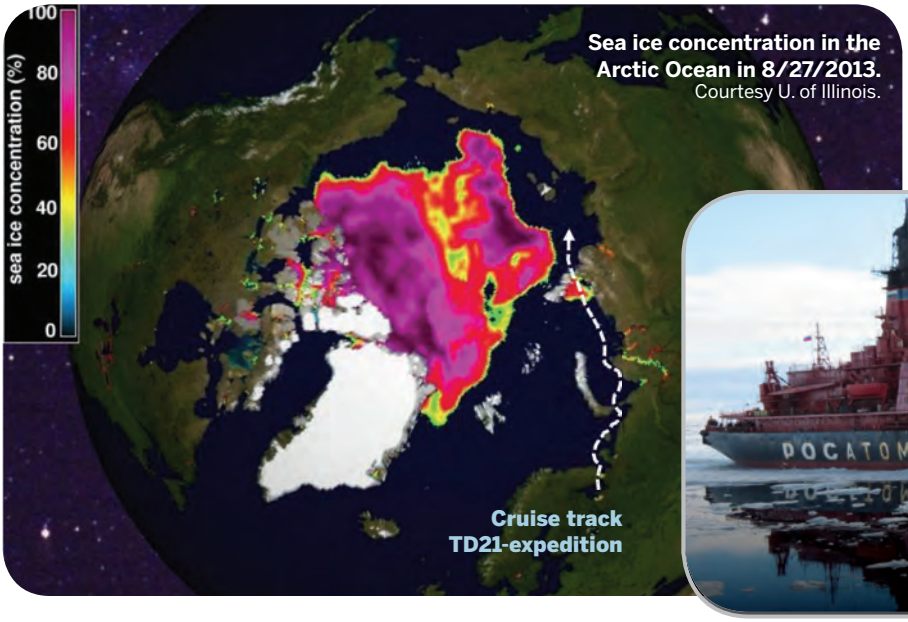
The Laptev Sea shelf features extreme fronts and gradients between the different water masses that are characterized by the Lena River outflow and the warm and saline water masses that are found offshore along the continental slope. The different water masses are not only characterized by differences in temperature and salinity, but also carry their own chemical signatures in nutrients and isotopes, and have a strong impact on the organisms that inhabit the water column and dwell on the sea floor.

One aim of the expedition was to map the major physical and biogeochemical parameters, which can then be compared with conditions found during previous expeditions in order to determine the variability in the region. The sampling strategy is such that the vessel occupies selected stations throughout the region. Each station then follows a clear plan of action: First, temperature and salinity of the water column are measured with a CTD (conductivity-temperature-depth) device, attached to a water sampling rosette, which allows researchers to take water samples from selected depths for subsequent analysis of the basic geochemical parameters. Biologists take net samples to determine the amount and species of organisms that are found in the water column, as well as sediment cores of the seafloor with a heavy multicoring device. The full procedure takes several hours to complete.

Besides the usual station work carried out during the expedition, the project takes measurements from year-round oceanographic moorings (seafloor observatories). The procedure is to anchor oceanographic instruments on the seafloor and in the water column, which record parameters such as temperature, salinity or ocean currents in half-hourly intervals until the following year, when instruments are recovered and data are downloaded for analysis. Mooring work in difficult environments such as the seasonally ice-covered Laptev Sea is quite risky and loss of instrumentation is not unusual, but previous successful deployments in combination with shipboard expeditions lead to significant advancements in the understanding of how the ocean interacts with sea ice and the atmosphere.

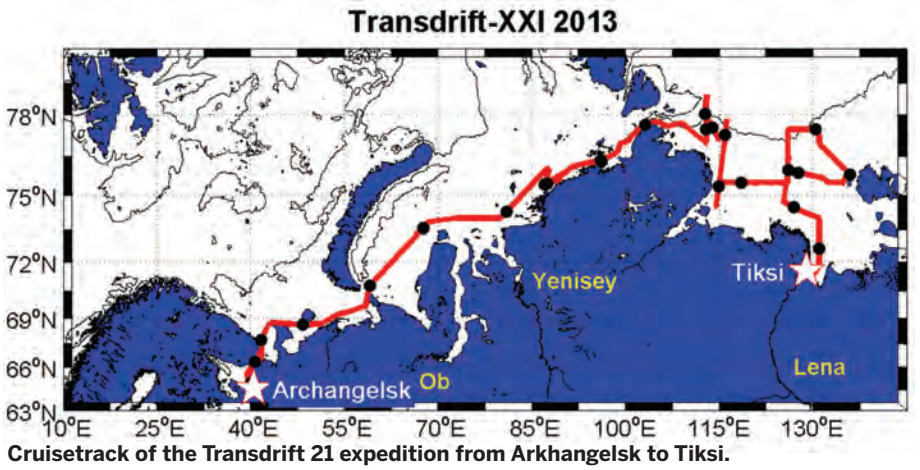
The reduction in Arctic Sea ice opens up new opportunities for shipping along the Northern Sea Route and other offshore activities, but can certainly complicate the research from mid-sized vessels. Storms that periodically move over the region generate large waves and swell, as the ice edge is far to the north, and may interrupt the sampling or at the least make life on board less comfortable.

A novelty applied during the Transdrift 21 expedition was the use of an UnderwayCTD system, which allowed to profile temperature and salinity of the water column in rougher seas and while the ship is en route. The underway sampling complemented the station work to provide a more comprehensive and high-resolution picture of the region's water masses. The Lena River water, for



Sea ice concentration in the Arctic Ocean in 8/27/2013.
Courtesy U. of Illinois.

Russian nuclear Icebreaker *Yamal*.
Photo by Markus Janout.



Cruisetrack of the Transdrift 21 expedition from Arkhangelsk to Tiksi.

instance, was found in the north-east of the Lena Delta, several hundred kilometers away from the source. The extent is surprising, but it follows a general trend in the recent past which is characterized by longer open water seasons; the ocean's temperature was up to 6°C throughout much of the region. This can be considered quite warm for an Arctic shelf sea, and the amount of heat that is stored in the water column likely has consequences on the organisms and may further delay the onset of sea ice in the fall.

Along those lines, some of the scientific questions that the project pursues is to identify the processes that help to vertically distribute water properties in order to understand, for instance, 1) the rate at which the Lena River water is mixed downwards, which has implications for the stratification, i.e. the layering of the ocean; 2) the vertical redistribution of warm surface waters may store heat in the water column or near the seafloor, which may have implications for subsea permafrost, methane and seafloor organisms; or 3) the upward mixing of nutrients, which are often enhanced near the seafloor, which generally enhances biological productivity. Some of the important mechanisms that help the mixing and vertical redistribution of properties include mixing due to tidal currents and the effect of strong winds, and in particular the wind mixing may play an increasing role in the Laptev Sea System, if the trend towards longer open water season continues.

The Transdrift 22 expedition is scheduled for late summer 2014, during which the scientists plan the recovery of the seafloor observatories and hope to identify more pieces of the Laptev Sea puzzle for a clearer understanding of the fate of the Laptev Sea and the Transpolar Drift System under a changing climate. OE

Markus Janout *is a physical oceanographer at the Alfred Wegener Institute (AWI) for Polar and Marine Research, Germany, specialized in oceanographic processes on high latitude continental shelves and slopes. Janout completed a PhD in Physical Oceanography at the University of Alaska, Fairbanks in 2010, where he focused on heat and freshwater controlling processes in the Gulf of Alaska and the Bering Sea, before transitioning to AWI to join the Laptev Sea group.*

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Gazprom makes Arctic advances

Sarah Parker Musarra examines the offshore developments that helped make 2013 a banner year for Russia's Gazprom.

Located in one of the richest hydrocarbon countries in the world, a cursory glance at Gazprom's performance in the second half of 2013 shows it aggressively pursuing more difficult, technically advanced projects.

Russia is home to the world's largest natural gas reserves, according to the US Energy Information Administration. It is the world's second-largest producer of dry natural gas and third-largest producer of liquid fuels. Yet, with two of last year's larger projects, the company went to great lengths - and depths - to draw first oil.

In the case of the Sakhalin III project's Kirinskoye field, that meant Gazprom became the first Russian company to install and successfully test a subsea production facility.

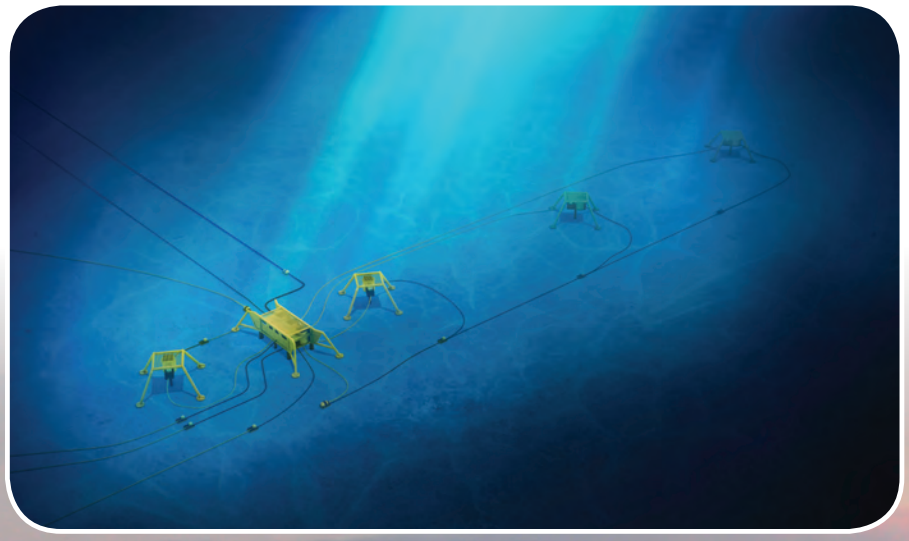
In the case of the Prirazlomnoye field, that meant Gazprom Neft Shelf (Gazprom's wholly-owned oil subsidiary) ground through a grueling 10-year development before striking first oil on 20 Dec 2013.

As one of only two companies currently eligible to operate on the shelf under Russian Federation law, and as the holder of 30 licenses on the Russian Arctic Shelf, Gazprom then became the first Russian company to produce in the Russian Arctic.

"In every area of our activities we are aiming for the future, for the long term," Gazprom's CEO Alexey Miller said in his year-end column.

Prirazlomnoye and Prirazlomnaya

Discovered in 1989, the Prirazlomnoye field is on the shallow Pechora Sea shelf, in 19-20m water depth. It's 60km off Russia's north coast and south of the



Left: A rendering of Kirinskoye's subsea processor, a first for a Russian company.

Below: The Prirazlomnoye field contains around 72MM tons of oil. Gazprom is the first Russian company to produce in the Russian Arctic.

Photos: Gazprom

Novaya Zemlya archipelago. Gazprom calls the development "an essential element of Gazprom Group's oil business development strategy."

Costs for the project are estimated to be US$4-5 billion.

The company says the field contains around 72MM tons of oil, setting it up to achieve a peak annual production rate of 6.6MM tons after 2020.

While the absence of a platform is a distinguishing feature of the Kirinskoye field, Prirazlomnoye's platform is a noteworthy addition to the already-landmark development. Gazprom Neft says the Prirazlomnaya platform is the first stationary platform to produce hydrocarbons in the region, and that it was engineered for drilling, oil production, storage and offloading. The company says it is resistant to strong ice loads and can operate year-round.

"We became the pioneers of Russia's Arctic development," Miller said when first oil was struck.

Designed for Gazprom, the platform was under construction for 15 years at Severodvinsk. The project was mothballed for six years, and changed course when Gazprom bought the topsides of Conoco's Hutton TLP, built in 1984 and retired from the North Sea. Sevmash Production Association incorporated the Hutton topsides and the resulting platform is nearly 144m-long and weighs about 506,000 tons. On 18 Nov 2010, eight tugboats and two vessels towed the Prirazlomnaya more than 800km from Severodvinsk to Murmansk, the first time in Russian history a towing operation of such scale occurred. The 140m-wide platform, which weighs around 120M tons (net of concrete ballast), arrived on 27 Nov 2010.

Gazprom said it will drill 40 wells with slanted wellheads, which will be located inside the platform so that its foundation would barricade it from surrounding the fragile environment and marine life in the event of a spill. The controversial project has been delayed for nearly a decade due to internal issues; safety and environmental issues have been the most pervasive challenges.

Prirazlomnaya's design has been under works since the 1990s. The first set of delays arose from shareholder changes: as the projects' investors rotated, so the design plans changed.

When it came to light that the structures were recycled from a decades-old project, activist and environmental groups charged that the metal on the Hutton topside was too aged to function safely.

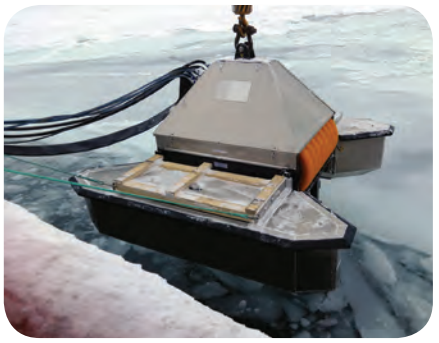
Greenpeace then delayed the start date with fervent protests held against Gazprom's involvement in the project; against the platform's stability, and against drilling in the Arctic.

In August 2012, 30 members of Greenpeace, including its executive director, boarded the platform to protest Gazprom's expired spill plan. The Russian Ministry of Emergency wrote to Greenpeace to inform them that a new spill plan has been neither submitted nor approved.

The "Arctic 30" were arrested by Russian authorities and jailed for two months on piracy charges before being granted amnesty by the Russian parliament.

However, production is in full swing, as Gazprom Neft's Deputy CEO Vadim Yakovlev announced 5 Feb 2014 that beginning 1Q 2014, one tanker per quarter would carry 331,000 tons of oil from Prirazlomnoye to Rotterdam.

Sovcomflot's *Mikhail Ulyanov* and



An operator launches an oil skimmer during a training exercise near the Prirazlomnaya platform.

Kirill Lavrov ice-class tankers will shuttle produced oil year-round to the FPSO *Belokamenka*, located 1100km west, in Kola Bay, in the Barents Sea.

"Gazprom is Russia's outpost in the Arctic … There is no doubt that Gazprom will continue advancing in the Arctic," Miller said.

Kirinskoye, Sakhalin III, and the Far East

Situated 28km off the coast of the Sakhalin Island in the Sea of Okhotsk, Gazprom says the Kirinskoye gas and condensate field contains reserves of up to 162.5 billion cu m of gas and 19.1 tons of gas condensate. Six wells are planned to be drilled with a projected gas production rate of 5.5 Bcf/yr.

Water depths in the field reach 90m, which the company says is only 4m deeper than Moscow's deepest subway. Production began 23 Oct 2013, when Gazprom also celebrated the successful testing of Russia's first subsea processing facility. Russian Federation President Vladimir Putin issued the order to commence Kirinskoye's production.

"The subsea production technologies allowed avoiding significant risks in adverse natural and climatic conditions, for instance, typhoons in [southeast] Asia and icebergs offshore Canada. Freezing seas of Russia with navigation period [of] only 3 to 4 months long simply have no other option but these subsea systems," Gazprom Head of the Directorate for Offshore Fields Development Technology Vladimir Vovk said of the decision to pursue subsea processing in an interview Gazprom released in 2010.

Kirinskoye is located in the Kirinsky Block, one of four blocks that comprise the Sakhalin III project. Along with Kirinsky, two other Sakhalin blocks - Ayashsky and Vostochno-Odoptinsky – were discovered by and licensed to Gazprom. Russian-held Rosneft holds the license to the remaining Veninsky block.

Gas from Kirinskoye traverses a 28km-long pipeline to reach land, where it is treated and pumped through a 139km-long pipeline to the main compressor station of the 1800km-long Sakhalin-Khabarovsk-Vladivostok gas transmission system (GTS).

This GTS is part of the larger-scope Eastern Gas Program of East Siberia and the Russian Far East, currently under development. Approved by the government in 2007, the plan enables and ensures gas production and supply to the far eastern regions of the country, with an ultimate goal of gas export to China.

The Russian Federation government appointed Gazprom as the program execution coordinator.

Gazprom's recent activity shows that it will go to great lengths to secure its position as countries eye and circle the Arctic as one of oil and gas' remaining frontiers. OE

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1. What is your main job function?
(check one box only)

- ☐ 01 Executive & Senior Mgmt (CEO,CFO, COO,Chairman, President, Owner, VP, Director, Managing Dir., etc)
- ☐ 02 Engineering or Engineering Mgmt.
- ☐ 03 Operations Management
- ☐ 04 Geology, Geophysics, Exploration
- ☐ 05 Operations (All other operations personnel, Dept. Heads, Supv., Coord. and Mgrs.)
- ☐ 99 Other *(please specify)*_____

2. Which of the following best describes your company's primary business activity?
(check one box only)

- ☐ 21 Integrated Oil/Gas Company
- ☐ 22 Independent Oil & Gas Company
- ☐ 23 National/State Oil Company
- ☐ 24 Drilling, Drilling Contractor
- ☐ 25 EPC (Engineering, Procurement., Construction), Main Contractor
- ☐ 26 Subcontractor
- ☐ 27 Engineering Company
- ☐ 28 Consultant
- ☐ 29 Seismic Company
- ☐ 30 Pipeline/Installation Contractor
- ☐ 31 Ship/Fabrication Yard
- ☐ 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

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

- ☐ 101 Exploration survey
- ☐ 102 Drilling
- ☐ 103 Sub-sea production, construction (including pipelines)
- ☐ 104 Topsides, jacket design, fabrication, hook-up and commissioning
- ☐ 105 Inspection, repair, maintenance
- ☐ 106 Production, process control instrumentation, power generation, etc.
- ☐ 107 Support services, supply boats, transport, support ships, etc
- ☐ 108 Equipment supply
- ☐ 109 Safety prevention and protection
- ☐ 110 Production
- ☐ 111 Reservoir
- ☐ 99 Other (*please specify*) _____

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S31OS1

Offshore construction gets heavy treatment

Subsea 7's new heavy construction vessel, under construction in South Korea, is set to make a splash when it joins the company's fleet in 2016. The company gave Elaine Maslin a look at the new vessel.

As operators build larger and more complex subsea equipment in deeper, and more remote waters, contractors and vessel operators are striving to stay ahead, including Subsea 7.

The company has launched a new heavy construction vessel, the *Seven Arctic*.

The 160m-long, 32m-wide, vessel is due to be delivered in early 2016, from Hyundai Heavy Industries' (HHI) yard in South Korea.

Its main equipment includes a new-design, 900-tonne, Huisman rope-luffing, knuckle-boom crane, and a 7000-tonne MAATS underdeck basket, for storage of flexible pipe or umbilicals.

Vice President, Technology and Asset Development Stuart Smith says the vessel's scope is partly driven by an increasing focus on subsea processing, particularly in areas like Norway, where Statoil is deploying the industry-leading Åsgard subsea compression project.

Contained within projects like Åsgard are multiple modules, weighing up to 300-tonne a piece, and requiring installation, replacement, and, eventually, removal. Industry predictions suggest the weight of modules will reach up to 450-tonne, says Smith.

Norwegian energy analysts Rystad predict the subsea processing market will grow from US$500 million a year today, to $8 billion by 2020.

Developments are also moving into deeper and deeper waters, with subsea infrastructure growing in size to meet the demands placed on it by the higher pressures. "We see subsea lifts getting heavier and deeper," Smith says.

"Spool pieces are getting longer and more difficult to handle. Umbilicals and cables are getting longer and heavier, and project load-outs are getting heavier, with more equipment.

"Heavier lifts are required for manifolds, and subsea processing plant, caissons, and suction piles. We wanted a versatile vessel to carry out all these tasks."

Key features of the new vessel are a new active heave compensation subsea construction crane, developed by Huisman, with Subsea 7, and the vessel's capacity—it could load out with 5000-tonne in its under-deck carousel and 4500-tonne up to 5m high on deck.

Knuckle boom crane

"We spent a lot of time on the crane, looking at the weights that are going to

be lowered down to 3000m water depth, having a large radius, and higher lowering speeds for greater efficiency," Smith says.

The crane employs a knuckling system on the main boom, which is actuated using wire ropes, or "rope luffing," rather than hydraulic cylinders. Smith says it also allows for a higher lifting point for lifting tall, heavy loads.

The crane is primarily designed for subsea construction in single and double fall configuration, but will have triple for capability, with some limitations.

In single fall mode, the crane's radius can cover the entire deck, with up to 300-tonne load, in double fall mode, the crane will be able to install a 580-tonne module to 2000m water depth, covering a 29m radius and lower to 3000m, due to having 6000m of hoist wire.

In double fall mode, the crane also has a hook system and wire handling system to ensure twisting is prevented. In triple fall, the main hoist capacities is up to 900-tonne, with 21m radius.

The main hoist can lift 600-tonne out to 30m radius, in harbor, and the same subsea, but at a slightly lesser radius, subject to the physical size of the load.

Hoisting speed is 14-18m/min in single fall, and 20-40m/min in twin fall mode. Wire diameter has been kept to 109mm to avoid the heating and subsequent degradation problems associated with heave compensation on larger diameter wires, Smith says.

Deck and marine equipment

The vessel has two additional cranes, for efficient deck operations, and complex or simultaneous operations. One of the additional cranes, and the bulwarks, are removable for long overhanging items.

"Some additional simple features include extra deck strengthening, for additional capacity, and the 7000-tonne under-deck umbilical and flexibles carousel," Smith says. "Most comparative vessels have 5000-tonne, or less, capacity. To help install these umbilicals and flexibles, stored onboard, we have a 325-tonne vertical lay system."

Preliminary vessel design was conducted jointly by Subsea 7 and Wärtsilä, with detailed design and construction to be completed by HHI.

The vessel is DP3, can transit at 15knots and operator in up to 4.5m significant wave height. It is special Purpose Ship code compliant, has a Norwegian specification helicopter-deck, and accommodation for 132 people.

It has a 2600sq m deck area and 4500-tonne deck load capability at up to 5m above deck, combined with a large strengthened deck area for load outs of large heavy equipment.

It also features an ice-strengthened hull and winterization features, including de-icing equipment on deck, to extend the operating season in the far North, and air conditioning for operation in tropical regions.

The vessel has two shaft-driven propellers, with diesel electric drive, and a total installed power capacity of 25MW, split between two engine rooms.

The new vessel will increase the capacity in Subsea 7's fleet. Its existing heavy construction vessels mostly have up to 400-tonne capacity cranes, Smith says.

"This vessel gives us either 600-tonne capacity, a 50% increase, or 900-tonne. It has also increased the hoisting speed compared to other vessels in the fleet," he says.

"It also has very good loading capacities. It can cope with 5000-tonne under deck with 4500-tonne up to 5m above deck." OE

Activity

Kayleigh Cummings, of Robert Gordon University, Aberdeen, designed the OAA trophies. Her "split sphere" design features the award details in a glass disc concealed between the two hemispheres. She is pictured with the prototype of the trophies.

OAA finalists announced

By Elaine Maslin

The 2014, 28th Offshore Achievement Awards are due to be presented in Aberdeen this month, with a crop of talented individuals and companies shortlisted.

The awards, organized and hosted by the Society of Petroleum Engineers Aberdeen Section, and supported by Offshore Engineer, celebrate safety innovations, technology breakthroughs, company successes and more, both through individual achievements, and collaborative working.

Ian Phillips, director of energy business consultancy Pale Blue Dot Energy Limited and the SPE Aberdeen board member responsible for organizing the OAAs, said: "This year's judges were extremely impressed by the talent that the UK industry has to offer."

The finalists for the 2014 Offshore Achievement Awards are:

Export Achievement
- EnerMech
- EV
- Tendeka

Safety Innovations
- AMEC
- Stork Technical Services - ERBAS
- Viper Subsea

Emerging Technology
- Aubin Group
- Guardian Global Technologies
- Ocean Power Technologies

The Innovator
- Paradigm Flow Services
- Tendeka
- Viper Subsea

Great Small Company
- Accord Energy Solutions
- Coretrax Technology
- Viper Subsea

Great Large Company
- DOF Subsea
- Hydrasun
- Wood Group

Working Together
- Alba Power/ Petrologistics
- Britannia Operator
- The Underwater Centre

Young Professional
- Liam O'Neil, AMEC
- Duncan Chedburn, Maersk Oil
- Raymond MacKenzie, Nexen Petroleum UK

Inspiring Leader
- Doug Duguid, EnerMech
- Steve Nicol, Halliburton
- Trevor Jee, Jee

Environmentalist
- Cape Environmental Services Offshore
- Stork Technical Services
- TWMA

An award for Significant Achievement will be announced during the evening. ▪

Maersk Drilling names two drillships

Maersk Drilling's second and third ultra-deepwater drillships were named morning in a ceremony held at the Samsung Heavy Industries (SHI) shipyard in Geoje-Si, South Korea.

Lisa Lance, wife of Ryan M. Lance, chairman and chief executive officer, ConocoPhillips, had the honor of naming *Maersk Valiant*, and Annell R. Bay, Vice President Global Exploration, Marathon Oil Corporation, had the honor of naming *Maersk Venturer*.

Maersk Valiant and *Maersk Venturer* are the second and third in a series of four ultra-deepwater drillships to enter Maersk Drilling's rig fleet.

The four drillships represent a total investment of US$2.6 billion and will be delivered from the SHI shipyard in 2014.

Gulf Coast Shipyards joins Port of Gulfport

US-based vessel manufacturer Gulf Coast Shipyard recently signed a three-year lease with one-year options with Port of Gulfport, located in Mississippi.

Gulf Coast Shipyard Group will use 400ft of the Port's dock space and 15,000sq ft of warehouse space to outfit dual-fuel LNG-powered vessels for Harvey Gulf International Marine. The Port of Gulfport is undergoing a US$570 million restoration and is about 18 months from completion. Gulf Coast Shipyard expects the first vessel to be at the Port of Gulfport in mid-March.

Prysmian Group sets up new Houston office

Milan's Prysmian Group has established a new headquarter office in Houston under new Head of Subsea Umbilicals, Risers and Flowlines (SURF), Robert Conners.

Prysmian will manufacture umbilicals and flexible pipes in Vila Velha, in Brazil's Espirito Santo state. Josè Luiz Dacal Castro will temporarily support the business handover before taking the lead of the Brazilian operations.

Petrobras awarded Prysmian a new frame agreement for umbilical products worth approximately US$260 million with 50% minimum purchasing commitment and call-off orders to be placed within a two-year period. The Brazilian company also extended an existing frame agreement for flexible pipes until 2016. The contract is worth a total of US$95 million, of which US$20 million have already been called off for the Macabu, Jubarte and Marlim Leste fields.

Downhole video technology specialist EV has recorded significant international growth by opening a new base in Australia.

MacArtney France adds pressure test facility

MacArtney France is enhanced its Rousset workshop with a fully-equipped

Subsea excellence recognized

By Elaine Maslin

Aberdeenshire-based Bibby Offshore picked up the Company of the Year award in Subsea UK's ninth annual business awards, held February in Aberdeen February.

The event, attended by more than 800 people from the subsea sector, was held during the Subsea Expo conference and exhibition.

Aberdeen-based ROV specialist ROVOP, secured the New Enterprise award.

The innovation and technology award went to Portishead-based Viper Subsea. The firm developed a method of combating water penetration, which results in system failure and loss of production (OE: January 2014).

The award for emerging talent was won by Richard Bell of Aberdeen-based Apollo Offshore Engineering.

The innovation for safety award was awarded to St Andrews-based Photosynergy for Lightpath, a low-power light source that provides guide path illumination for a number of subsea applications with battery back-up to provide a fail-safe system in the event of mains outage.

Expro Group won the award for exports and Glasgow-based European Circuits, which provides integrated electronic assembly solutions, won an award, supported by UK Trade and Industry, which recognizes companies who are enhancing their competitiveness and providing tangible economic benefit to the UK from trade development activity.

This year's outstanding contribution award went to John White, of VerdErg, formerly FUEL. See story on page 80.

pressure test facility

Powered by a newly-installed pressure vessel system with a height of 1100mm, an internal diameter of 650mm, and a pressure capacity of up to 600bar, the test facility is able to submit underwater connectors, cables, moldings, junction boxes and other types of equipment to extensive ocean depth pressure tests. The pressure vessel system is can be pre-programmed, with all measurements undertaken and recorded in real-time.

With the new test facility, MacArtney France becomes the fourth MacArtney Group location to offer professional pressure testing services to local and global customers.

McMurdo Group launched

McMurdo Smartfind S10 Personal Automatic Identification System Beacon.

Orolia has combined its Positioning, Tracking and Monitoring division, including Boatracs, Kannad, McMurdo and Techno-Science Inc. into one cohesive brand: McMurdo Group. McMurdo Group was launched to provide a single-vendor provider of end-to-end life-saving and tracking solutions including distress beacons, satellite connectivity infrastructure, monitoring/positioning software and emergency response management. With more than 140 years of collective experience in emergency preparedness, vessel management and rescue operations, McMurdo Group will focus on three key strategic areas:

- Search and Rescue – improving the rescue chain to further expedite recovery times
- Maritime Domain Awareness – driving convergence of fleet/vessel management, intrusion detection and coastal surveillance solutions to improve operations and enhance security
- Technology Partner Solutions – integrating technology, componentry and software platforms into third-party solutions to extend SAR and MDA systems into new markets and geographies

Halliburton constructs completion center

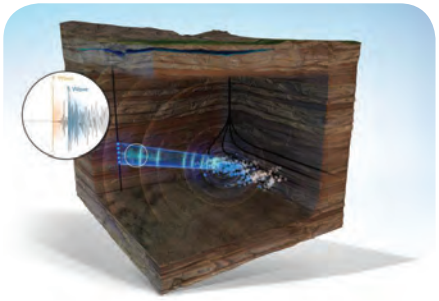
Halliburton announced plans for a new Integrated Completion Center in New Iberia, Louisiana. The company broke ground on the facility in spring of 2013, with occupancy scheduled 4Q 2014.

The new facility will expand the company's resources and capabilities for deepwater completion tools while continuing to focus on service alignment, equipment maintenance, preparation and job execution for its Gulf of Mexico (GOM) customers.

It will house more than 250 employees, will be located on 103 acres on Admiral Doyle Drive. It will include a 219,000sq ft maintenance facility, a 30,000sq ft administration building, an operations command center and several learning auditoriums for training. Halliburton is investing about US$45 million in land and building costs.

The company will be consolidating some of its GOM operations from Houma and five locations in New Iberia, Broussard and Lafayette at the new center.

MicroSeismic picks up RII's US assets



Houston-based MicroSeismic Inc. purchased the US assets of Calgary's Reservoir Imaging Inc. (RII). The acquisition includes geospace equipment, wireline units, and equipment for downhole microseismic data acquisition services.

The new downhole acquisition capabilities are complemented by MicroSeismic's downhole EventPick processing technology and can be used on a standalone basis or in conjunction with MicroSeismic's surface microseismic products and services. This combination enables MicroSeismic to offer a full suite of completions evaluation services to its customers, allowing them to optimize production through an understanding of the discrete fracture network, estimates of stimulated reservoir volume, and fracture geometry and azimuth.

Solutions

MAN compressor installed offshore

MAN Diesel & Turbo in Zurich was awarded a contract to deliver a HOFIM (high-speed, oil-free, integrated motor) compressor to Det norske oljeselskap ASA. It is MAN's first hermetically-sealed compressor to be installed on an offshore production platform. The compressor will process gas produced from the the Ivar Aasen field in the Norwegian North Sea to shore.

The HOFIM compressor features a high-speed motor and active magnetic bearings. The absence of the dry gas seal system and of the complete oil system reduces the complexity and this leads to the improved system reliability.

www.man.eu

Flowrox announces new product to manage pipeline scaling

Industrial valve manufacturer and service provider **Flowrox** introduced the Flowrox Scaling Watch, designed to precisely measure scale in pipelines and other fluid control environments. The Flowrox Scaling Watch is a wafer piece of pipeline, inserted between two flanges, that allows the detection of scale, hardened mineral deposits that can reduce the flow of fluids through a pipeline.

The device uses electrical capacitance tomography (ECT) technology, which allows operators to see inside piping systems without stopping the process or opening up the pipeline. It enables 3D-imaging and measurement of non-conductive media inside process pipelines and tanks. ECT utilizes a patented algorithm that creates a 3D image of the process fluid in the piping and generates trend data and also calculates free volume inside the pipe and the growth rate of the scale over time.

www.flowrox.us

North Atlantic Drilling selects GE BOPs for semisub upgrades

Offshore drilling contractor North Atlantic Drilling (NAD) purchased two **GE Oil & Gas** SeaONYX™ blowout preventer (BOP) control systems, upgrading control spreads onboard NAD's semi-submersible *West Venture* and drillship *West Navigator*.

The SeaONYX BOP control system extends system availability by incorporating multiple redundancies and hot-swappable components to keep operations online. In addition to improved uptime, SeaONYX is a keystone of GE's predictive drilling management technology, which helps drillers to address issues before they occur.

The SeaONYX BOP control system is available as an upgrade to existing GE BOP controllers and is included in all new GE Oil & Gas BOP stacks for floating drilling rigs.

www.ge.com

PPE develops elastomer sealing solution

Precision Polymer Engineering has developed EnDura E90SR, a new ethylene propylene diene monomer (EPDM) elastomer material that provides high-temperature steam resistance.

EnDura E90SR is available as O-rings, T-seals, and custom-molded geometries and is used in pumps, valves, turbines, geothermal tools and drilling equipment.

It can withstand temperatures to 550˚F and high pressures, and is resistant to rapid gas decompression. It can be used in anaerobic high-temperature environments, such as those encountered in geothermal and enhanced oil recovery applications.

www.prepol.com

Maersk chooses Tenaris

Maersk Oil Angola selected the **Tenaris**Hydril Blue connections for the 9 5/8-in production casing in its Chissonga 4 well offshore Angola. Tenaris reported nearly 214 joints of Blue connections were used in running the 9 5/8-in string.

Offering a 100% pipe body rated seal, the TenarisHydril Blue is designed specifically for deepwater, challenging environments and high-pressure, high-temperature drilling. Its parabolix seal contact pressure profile minimizes galling risk and improves sealing performance stability.

Its internal and external pressure metal seal is also 100% rated.

www.tenaris.com

SeaBotix introduces ROV system

SeaBotix containerized delivery system (CDS) is a self-contained, single-point-pick observation ROV system. With depth ratings to 4000m, it can be used for deepwater observation or light-duty work. CDS can be operated by two persons from a vessel as small as 40m.

CDS can maneuver deepwater with a variety of sensors such as sonar, high-resolution cameras, grabbers and more. All components, including the control room, are housed in a single container for efficient mobilization.

www.SeaBotix.com

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Advertiser Index

Spotlight

By Elaine Maslin

What lies beneath — an outstanding contribution

John White has seen many changes in the oil and gas industry over his 40 years in the business.

Subsea infrastructure has become increasingly diverless and remotely operated vehicles (ROVs) have enabled work in deeper, harsher environments.

But White did more than just witness these changes. He co-founded Furness Underwater Engineering (FUEL) in 1979. It was one of the first specialist subsea engineering companies.

He led the design of the Diverless Maintained Cluster (DMaC) field architecture, adopted by BP in the 1990s, for the Foinaven and Schiehallion fields, and subsequently the Quadrant 204 development, all in the harsh waters West of Shetland.

His efforts were recognized with an outstanding contribution award at Subsea UK Business Awards, during Subsea Expo, in Aberdeen, in February.

"White developed a subsea engineering philosophy in which the connector, the ROV, the ROV tooling, and the installation vessel, were each inter-dependent components of an integrated system," said Peter Roberts, chairman, VerdErg.

"This philosophy of tailoring the subsea hardware to suit the functional requirements of the project, rather than the project configuration being adapted to standard 'catalogue' hardware, was revolutionary in its day and remains the most effective way to implement frontier projects."

White is a graduate of City University, London with a BSc in Mechanical Engineering.

In 1974, he joined Vickers Oceanics, which owned and operated manned submersibles. As a project engineer, White's task was the design, manufacture, commissioning, and operation of submersible tooling systems.

By 1978, as general manager of Vickers Underwater Pipeline Engineering, he then pioneered the development of diverless pipeline repair techniques and equipment. In 1979, as manned submersibles gave way to ROVs, White left to co-found FUEL.

John White

FUEL was involved in several pioneering subsea field developments, including the Central Cormorant Underwater Manifold Centre for Shell Expro. The company went on to develop and test an integrated subsea production system, and then an ROV-maintained cluster well/manifold system for Esso Exploration and Production UK.

These frontier technologies eventually became the DMaC field architecture, adopted by BP in the early 1990s, for its Foinaven and Schiehallion fields, and now the Quadrant 204 development.

One feature of the DMaC field architecture was a requirement for all equipment, including the manifold, to be capable of deployment through a drilling vessel moonpools. To produce a sufficiently compact manifold, connections had to be spaced at only 1m centers. The result was a lightweight, compact-design field manifold and DMaC connector, both of which remain class-leading to this day.

During the 1990s, White also led FUEL through the transition from pure consultancy to virtual manufacturer, when FUEL was asked by BP to take responsibility for the detail design, testing, and manufacture of the key component of the DMaC field architecture–the DMaC diverless connector and its innovative drag-to-place ROV tooling.

In 2005, a management buyout saw FUEL become VerdErg Connectors, with White serving as operations director. Since then, the company has experienced a five-fold growth.

It opened a new 40,000sq ft assembly and testing facility, at Bromborough, on the Wirral, Merseyside, in 2012. Work is scheduled to complete on a new 10,000psi gas and hydro test chamber at the Bromborough facility in February.

The business also recently opened an office in Houston. White, a chartered engineer, and a Fellow of the Institute of Marine Engineers, recently became technical development director, VerdErg, to oversee technical integrity of new and existing products.

Commenting on White's award, Neil Gordon chief executive of Subsea UK, said: "John's recognition tonight is thoroughly deserved. Having co-founded Furness Underwater Engineering (FUEL) in 1979, as one of the first specialist subsea engineering companies, he has become a well-respected figure in the industry.

"John led the design of the Diverless Maintained Cluster field architecture which was adopted by BP in the nineties for the Foinaven and Schiehallion fields, and subsequently the Quadrant 204 development, West of Shetland. Due to his strong leadership he has facilitated the five-fold growth of VerdErg since 2005." OE

See who the other Subsea UK Business Awards winners were on page 77.

Editorial Index

Numerology

6.6MM Gazprom's estimated annual production oil potential for the Prirazlomnoye field. ▶ See page 70.

US$1.9billion Estimated value of the ROV market in 2017. ▶ See page 52.

900tons

Weight of the deck on the Jalilah B platform, off Dubai. ▶ See page 14.

54rigs were counted offshore the US, according to Baker Hughes' 14 Feb weekly report.

6000m The length of hoist wire on the crane aboard Subsea 7's *Seven Arctic* construction vessel. ▶ See page 74.

50% or more of North Sea platforms are at or beyond their design life. ▶ See page 19.

120tonnes The weight of the deck nodes on Statoil's Aasta Hansteen spar development. ▶ See page 38.

US$974MM Value of the contract awarded to the AMEC Tekfen Azfen consortium for work on Shah Deniz II. ▶ See page 16.

15 offshore blocks are available in the Gulf of Suez Egyptian General Petroleum Corp.'s active bid round for exploration licenses, held simultaneously with EGAS bid round. ▶ See page 16.

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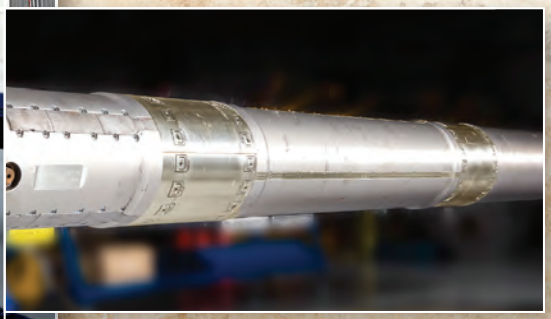

Sonic LWD data enables accurate time-depth conversion to reduce uncertainty in surface seismic.

An operator in Malaysia used the SonicScope service to acquire consistent compressional and slow shear data at up to 960 us/ft in shallow, soft formation reservoirs. The service's unique data processing technique helped accurately identify reservoir sweet spots within the gas-bearing sands.

Read the case study at
slb.com/SonicScope

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