MARINE TECHNOLOGY REPORTER

April 2017
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Can Digitization Save Offshore Energy?

Region Report Norway
Signs of Recovery

Buoyancy
Deepwater Drilling Riser

Preview
SeaPerch

Volume 60 Number 3


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Contents

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Editorial

Gregory R. Trauthwein
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Questions regarding the future price direction of energy come less frequently these days, seemingly as the collective industry has settled on the so-called 'new norm.' (Though personally, I think that is somewhat of a misnomer, as in the business of energy production there is no 'norm.') Regardless of your station in the offshore energy business chain, be assured of two things: the low-price pain points will continue for the foreseeable future, particularly as more cost-efficient land-based methods continue to be found ... those able to morph their business model and cost structure accordingly will prosper, those who don't, likely won't; and just when everyone has settled on the new reality, something will blow up – literally or figuratively – that will send the price soaring again.

In this edition I'm happy to share two targeted features that examine the offshore energy sector, both of them rather buoyant in nature. Starting on page 21 William Stoichevski, our man in Oslo with decades of experience reporting on the energy sector, finds signs of recovery and innovation in Norway's offshore sector. As most of you already know well, the Norwegians are quite clever, innovative and collaborative when it comes to anything maritime or offshore energy, and the country's financial strength lies in energy. Stoichevski found a resilient spirit to the manner in which the country is adjusting to the 'new norm' in energy pricing.

Another area of offshore energy is renewables, and despite the pervasiveness of cheap energy today, offshore wind in particular seems to be gaining strength in several key sectors. Kira Coley, a regular contributor to our pages print and electronic, takes a look at the efforts being undertaken to digitalize offshore energy in the name of increasing efficiency and profitability. Her story starts on page 26.

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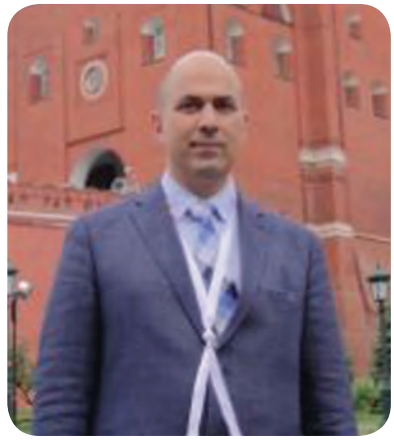
Stoichevski



Coley
Kira Coley is a freelance science writer and regular contributor to *Marine Technology Reporter*. She is a lecturer in science communication and a PhD researcher.

Stoichevski
After honing the media campaign of Norwegian green group Bellona (current fuels advisors to the European Commission), William Stoichevski began working for the Associated Press in Oslo. In 2003, he left the AP to oversee and write for a number of print and electronic energy industry publications in the Norwegian capital. He has written thousands of offshore-focused reports from his North Sea vantage point. Hard-to-match access has granted him interviews with hundreds of industry captains and policy makers across the globe. William lives and works in Oslo. He started writing for Marine Technology Reporter in 2014.

21

Cluster Focus

Norway Recovers

Signs of recovery and innovation from Norway's offshore sector.

By William Stoichevski

Photo Harald Pettersen Statoil

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Maritime Jobs	46,961
Maritime Logistics Professional	31,807
Maritime Propulsion	23,378
Maritime Reporter & Engineering News	63,864
World Energy News	51,176

All stats from 02/14/2017

... In case you missed it, highlights from marinetechnologynews.com and the Marine Technology Reporter ENews ...

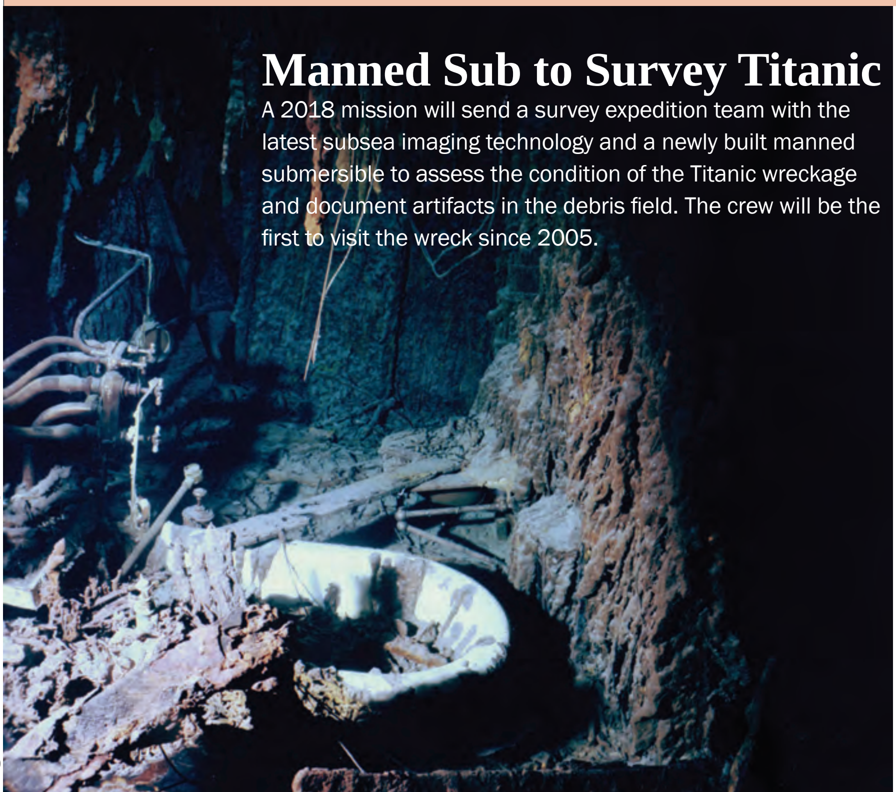


Image: Lori Johnston, RMS Titanic Expedition 2003, NOAA-OE.

Manned Sub to Survey Titanic

A 2018 mission will send a survey expedition team with the latest subsea imaging technology and a newly built manned submersible to assess the condition of the Titanic wreckage and document artifacts in the debris field. The crew will be the first to visit the wreck since 2005.

http://www.marinetechnologynews.com/news/manned-survey-titanic-wreckage-546197

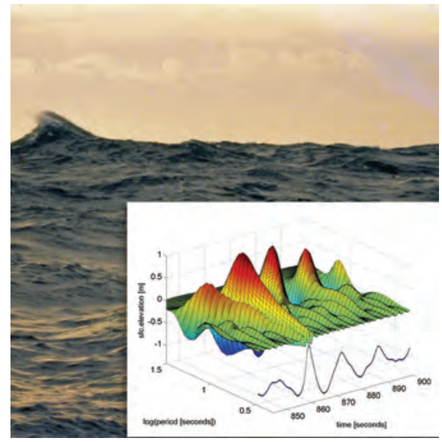
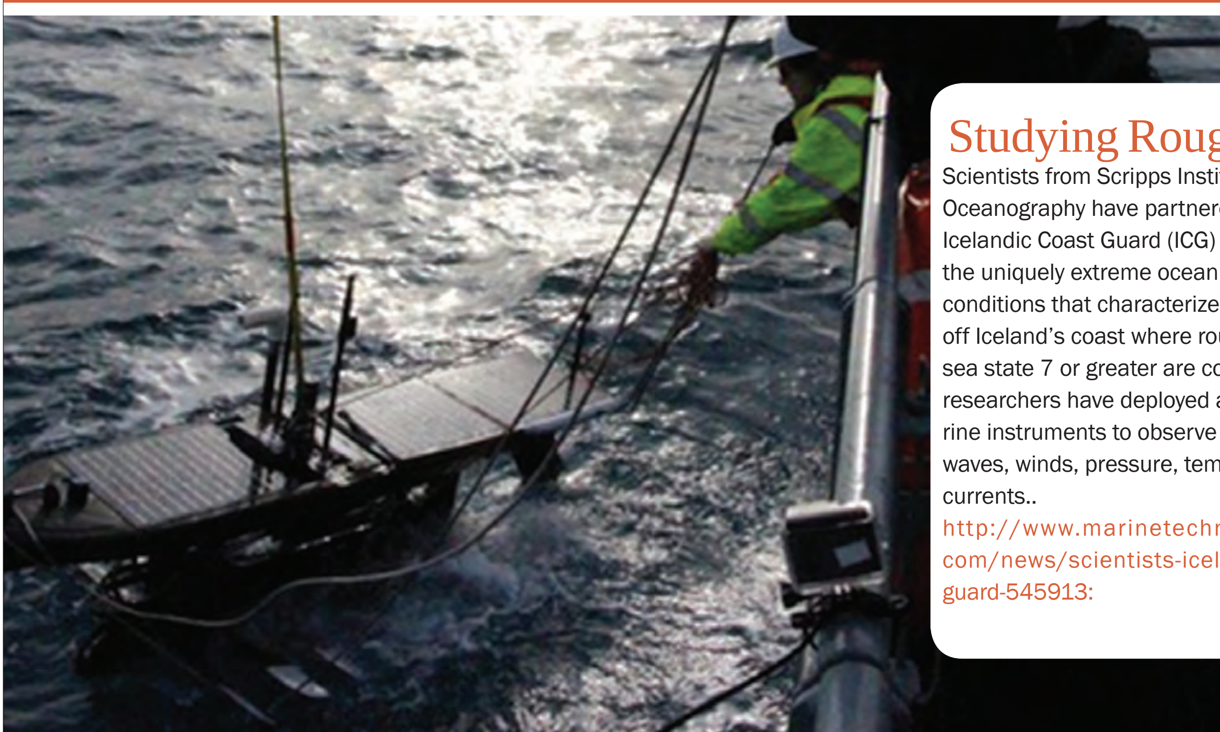


Photo: H. Mitsuyasu; Inset: Donelan, et.al.

Rogue Waves

Researchers provide an explicit formula for the encounter probability of rogue waves and answer critical questions regarding rogues in the design and operation of ships and offshore structures: how high can rogues be and how frequently they occur.

http://www.marinetechnologynews.com/news/large-rogue-waves-common-546008



(Photo: Scripps Institution of Oceanography)

Studying Rough Seas

Scientists from Scripps Institution of Oceanography have partnered with the Icelandic Coast Guard (ICG) to study the uniquely extreme ocean surface conditions that characterize the waters off Iceland's coast where rough seas of sea state 7 or greater are common. The researchers have deployed a suite of marine instruments to observe the region's waves, winds, pressure, temperature and currents..

http://www.marinetechnologynews.com/news/scientists-icelandic-coast-guard-545913:

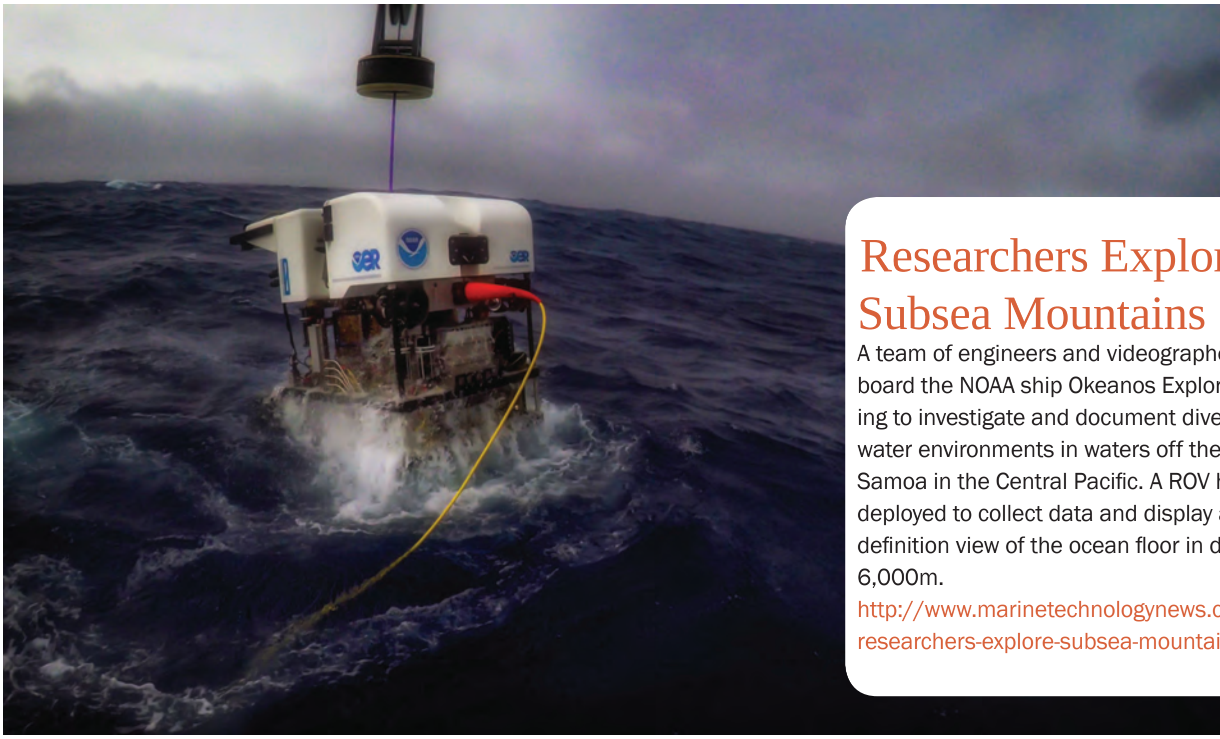


Photo: Art Howard/GFOE

Researchers Explore Subsea Mountains

A team of engineers and videographers on board the NOAA ship Okeanos Explorer are helping to investigate and document diverse deep water environments in waters off the American Samoa in the Central Pacific. A ROV has been deployed to collect data and display a high-definition view of the ocean floor in depths up to 6,000m.

http://www.marinetechnologynews.com/news/researchers-explore-subsea-mountains-545572

People & Companies

Eley

Bannerman

Gillespie

Eley to take CEO Helm at Polarcus
Polarcus Limited has promoted Duncan Eley from chief operating officer to chief executive officer, replacing Rod Starr who has resigned following a two year reorganization period. Eley has a Bachelor of Science and Bachelor of Engineering from Monash University in Australia. In 2006, he completed his MBA at Erasmus University in Holland.

Oceaneering Names Larson CEO
Roderick A. Larson has been designated to succeed Kevin McEvoy as CEO of Oceaneering International, Inc., effective May 5, 2017.

MSRC Names Dulisse CEO
Marine Spill Response Corporation (MSRC) has named Carmine Dulisse as its new president and CEO. Dulisse joins MSRC after more than 30 years with ExxonMobil in various roles.

Bannerman New CFO at M² Subsea
M² Subsea has appointed Stuart Bannerman as the company's new chief financial officer.

ESS Appoints Gillespie as MD
Ecosse Subsea Systems (ESS) has appointed Mark Gillespie as managing director. Gillespie has more than 25 years' experience in the oil and gas industry.

Wingart Joins Greensea
Greensea appointed Kevin Wingart as quality control engineer. In this role he will lead the quality control department and is primarily responsible for designing and implementing methods for process control and quality assurance.

Marine Energy Business Launched
DCNS has created DCNS Energies, a new marine energy business which will be fully financed by a fund managed by Bpifrance and supported by Technip and BNP Paribas development groups. It will devote its activity to the industrial and commercial development of three marine energy technologies: in-stream tidal turbines, ocean thermal energy conversion (OTEC) and floating offshore wind.

Bibby Names Nairn Diving Director
Bibby Offshore has promoted Allan Nairn to Director of Diving.

Nairn joined Bibby Diving Services in 2010 as offshore project manager with over 30 years' experience in the subsea sector.

Mair Joins Ashtead
David Mair has joined Ashtead Technology's senior management team as business development director. Based in Aberdeen, he will be responsible for Ashtead's global business development activities.

Gaeg Joins OceanWorks
OceanWorks appointed Richard Gage, P.Eng to the role of director of the project management office (PMO). Gage's experience is directly in line with OceanWorks' growing subsea technology business in oil and gas, submarine rescue and ocean observing systems.

OceanWorks Promotes Fether
OceanWorks International has appointed Jonathan Fether as atmospheric diving system (ADS) product line manager. A trained submersible pilot and experienced OceanWorks HARDSUIT pilot, Fether will work closely with OceanWorks customers carrying out the training and support for the ADS.

Engaging Leaders for Ocean Tech
OceansAdvance Inc. (OA), the ocean technology cluster of Newfoundland & Labrador, has collaborated with the Oceans Learning Partnership (OLP) for "Into the Deep: Ocean Technology R&D and Commercialization for Youth" held March 9, 2017.

The one-day event gathered science students from schools in the St. John's Metro Area and was live video broadcasted to various school

Greensea

Wingart

Bibby Offshore

Nairn

Ashtead Technology

Mair

classrooms throughout Newfoundland and Labrador. Also participating was Memorial University of Newfoundland and Labrador (MUN), SubC Imaging and Agile Sensor Technology, all members of the OA Cluster, who provided presentations, tech demonstrations, and Q&A sessions throughout the day.

Subsea Repair Companies Merge

Lariat Partners announced that its portfolio company Subsea Global Solutions (SGS) has acquired All-Sea Underwater Solutions (All-Sea), merging two companies specializing in underwater ship maintenance, repair and marine construction.

Subsea 7 Acquires SHL

Seaway Heavy Lifting, a 50/50 joint venture between Subsea 7 S.A. and K&S Baltic Offshore (Cyprus) Limited, is now a wholly-owned subsidiary of Subsea 7. Subsea 7 acquired the remaining 50% shareholding in Seaway Heavy Lifting Holding Limited.

Photo: Liquid Robotics, a Boeing Company

Sean Halpin

Senior Director, Global Energy Market Business Development & Sales, Liquid Robotics

From a sunken ship on Penobscot Bay to working with the world's top oil and gas companies, Sean Halpin has always had a love of the ocean. Learn about his start and his perspectives on the role autonomous systems play for the future of offshore operations.

From a sunken boat to becoming a geoscientist?

I have always loved the ocean. My parents have pictures of me as a kid on a beach in Florida with a wild look in my eyes as I stared at the crashing waves. To this day, the ocean still has an incredible effect on me.

My first overnight boat trip was when I was 18. Our job was to map Penobscot Bay, Maine with an old EG&G 272 sidescan sonar. The weather was awful, the boat stunk, and I ran the towfish into the seabed, but I absolutely loved it! I knew then that I wanted to work on, in, or near the ocean for the rest of my life. I went to sea for about eight years as a hydrographer and a marine geoscientist for a defense contractor and oil and gas companies. During this time, I was exposed to autonomous underwater vehicles (AUVs) as a tool for deep-water mapping. Just prior to joining the Liquid Robotics, I was the Global AUV Manager for DOF Subsea and was responsible for spear heading high tech subsea developments for the company and for building the AUV business.

What are the market conditions driving demand for autonomous systems?

It may sound counterintuitive, but market conditions have caused an increase in demand for autonomous systems and for Wave Gliders, Liquid Robotics' long duration Unmanned Surface Vehicles (USVs). This is for good reason. In order for the Oil and Gas industry to adopt new technologies there must be a very compelling reason to do so. Unfortunately, the compelling reason was to survive the oil and gas market depression that forced companies to slash operational budgets and cut thousands of jobs. But the work remained for greenfield and brownfield operations and operators are compelled to look for more cost effective solutions. Operators are turning to autonomous systems to replace and/or augment conventional vessels and technologies that are significantly more expensive to operate.

So 2017 could be seen as an inflection point of sorts for autonomous systems in oil and gas?

In a recent presentation I delivered at Underwater Intervention Conference in New Orleans, I called 2017 the 'inflection year' for unmanned autonomous systems in oil and gas. I think 2017 represents this inflection point because it is the first time that market demand will meet technological maturity.

From an industry perspective we have never seen more pressure to reduce cost. Supply chains have been compressed past maximum and the industry has shed a significant amount of cost over the last two years. Unfortunately, this time tested tactic (cut cost and people) in boom/bust markets hasn't provided enough of a compensatory shift in overall service price to satisfy the market. If we look back on what the industry has done in similar circumstances we see that these tough times were actually inflection points for technology. Adoption of innovative technology allows companies to remonetize the cost of services. Remotely operated vehicles (ROVs) are an excellent example of this. Once considered fringe tools, ROVs now dominate the robotics oil and gas subsea landscape.

Discuss how autonomous systems are evolving from 'novel' systems to workhorses.

Over the past years marine autonomous technologies have matured to the point where robots have transformed from novel systems to industry workhorses. From ROVs to autonomous underwater vehicles (AUVs) to unmanned surface vehicles (USVs), these systems have been gone through years of sea trials, global missions and have been used across to expand exploration, reduce costs and increase operational safety.

During this time, Wave Gliders have gained invaluable experience traveling over 1.2 million nautical miles at sea. Systems have operated through dynamic and sometimes brutal ocean conditions. For example, they've operated through extreme storms (cyclones, hurricanes and typhoons) and in remote, harsh locations such as the Artic and Antarctica. Operating in the Nordic Seas, Wave Gliders have collected real time Meteorological and oceanographic (METOC) data providing situational awareness of real time weather and current conditions around offshore oil rigs. In addition to METOC missions, Wave Gliders are being used by the oil and gas industry for environmental monitoring, maritime security and seismic surveys. This experience allows us to continually enhance the

Photo: Liquid Robotics, a Boeing Company

platform to make it more robust, reliable and to increase operational safety. Moving forward we see marine autonomous systems having a substantive impact on the oil and gas in three major ways:

*1) **Increasing the efficiency** of vessels by incorporating autonomous systems in offshore operations*

*2) **Increased insights and in-depth analysis** based on dramatically higher data density rates*

*3) **Reduced risks to humans** and high value assets especially during severe or harsh weather conditions*

Today, this transformation is evident in the work companies are doing harvesting subsea data and reporting back in frequencies previously not feasible without autonomous systems. By sitting at the surface of the ocean at the air/sea interface, acting as a data collection and communications hub, Wave Gliders provide companies near real time access to high resolution, high-density data over time periods and coverage areas cost prohibitive with traditional vessels. This, in turn, enables better modeling and science ultimately resulting in a safer and more efficient oilfield.

An example of this subsea to surface communications is work being done by Scripps Institution of Oceanography to monitor seismic activity in the deep ocean. Wave Gliders are replacing ships to collect critical seismic data from seabed sensors to provide real time seismic alerts for advance warning of tsunamis. Scripps is taking it one step further to utilize the towing capability of the Wave Glider to place long duration seabed seismic nodes in the deep ocean instead of utilizing large ships for deployment. This greatly reduces the costs and risks are greatly reduced while enabling a new ability to autonomously place and monitor deep ocean seabed sensors.

What are some of the critical design tenants for autonomous systems?

In my opinion, an unmanned autonomous system must be reliable, have an excellent duration power index and must be able to be configured for diverse systems to work well together.

• **Reliability:** Reliability is king. A few years back I was giving a talk at an AUV users conference. My presentation was about how technology has advanced to a level where users conferences no longer talk predominantly about platform issues and focus more on operational payloads. This is an excellent indicator of reliability levels reaching operational requirements.

• **Long Duration/Energy:** Few autonomous platforms are ca-

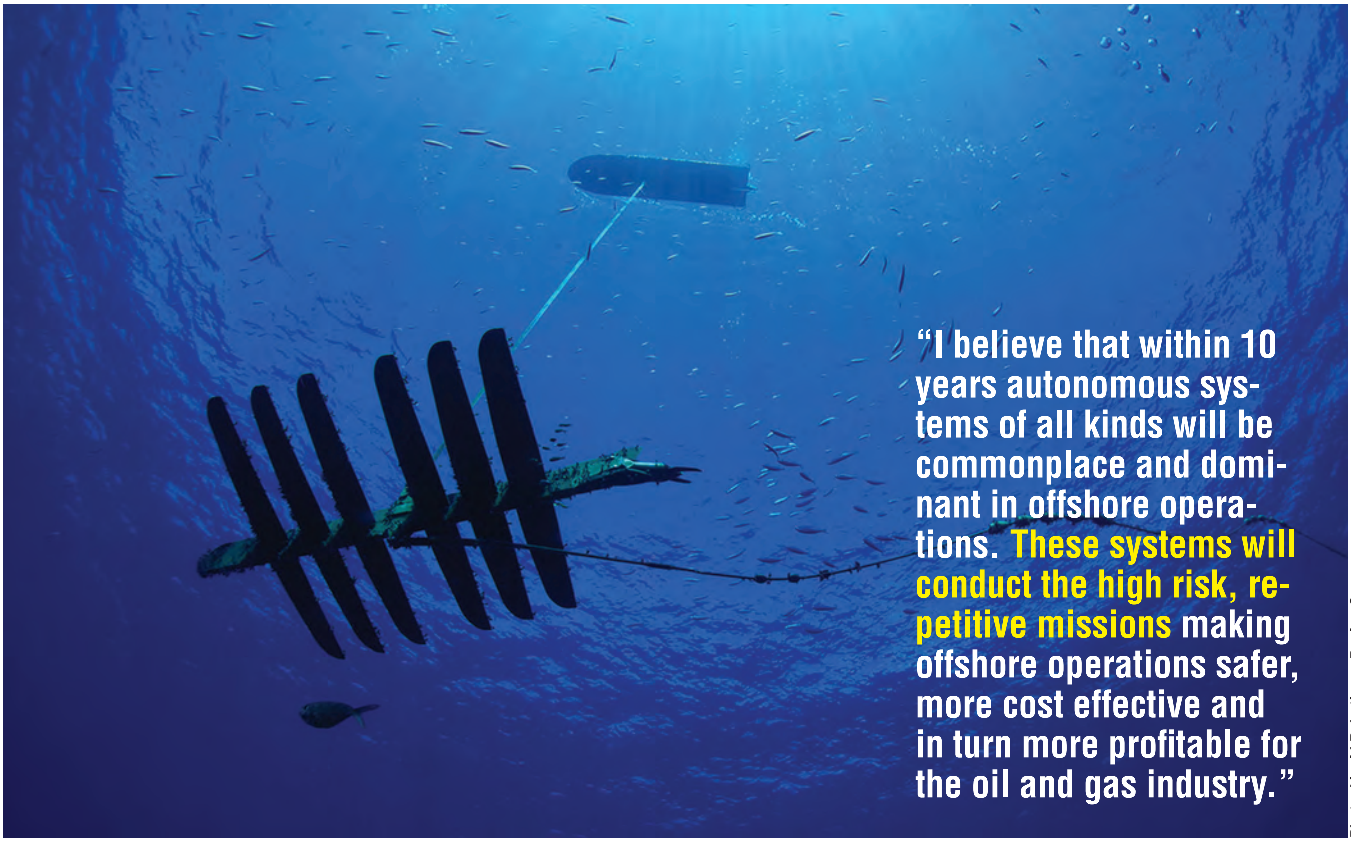


Photo: Liquid Robotics, a Boeing Company

pable of long duration at sea. By long duration, I am referring to many months not weeks. In order to achieve long duration operations, systems must harvest renewable energies, have robust reliability and optimize sensor payloads. It's important to consider not only how long a platform can stay at sea, but also how much power it can provide at the same time.

• **Power Index:** To achieve long duration operations we must utilize a low power budget (with today's solar generation technology, microchip technology and energy density paradigms) for onboard sensor payloads, computing and communications.

• **Interoperability/Connectivity:** This is critical to a forward-looking marine robotics vision. In order to advance offshore operations and ocean exploration in general, I believe greater interoperability and connectivity between manned and unmanned systems is fundamental.

Our vision for this is the Digital Ocean. Onshore our lives are digital – mobile phones provide a constant connection to information highways and many people simply can't live without this. We believe the same type of digital revolution will occur at sea where manned and unmanned systems are connected in a "system of systems" providing instant access to ocean information. This will allow us to communicate and exchange data in real time from the seafloor to the surface to onshore operations. This will dramatically improve our knowledge of the ocean and of offshore operations, ecosystems and environmental conditions.

From your perspective, discuss the future for offshore ops.

In the future, offshore operations will see more people moving onshore, fewer vessels, replaced by ocean robots offshore. Looking ahead, there's optimism as the market recovers and the innovation that companies have invested in during the depressed market will pay dividends. I believe that within 10 years autonomous systems of all kinds will be commonplace and dominant in offshore operations. These systems will conduct the high risk, repetitive missions making offshore operations safer, more cost effective and in turn more profitable for the oil and gas industry.

Many of the topics I covered can be considered critical applications. The oil and gas industry has a very low fault tolerance for critical applications. Therefore a big challenge is to ensure that we as a community demonstrate that our autonomous systems contribute positively to solving problems. As an industry, we need operators to play an active role in communicating the true needs of the oilfield so that we can design the best robots and payloads to solve some of the big issues facing the oil and gas industry today.

Photos: AUVSIF

SeaPerch

Seventh National SeaPerch Challenge Underwater Robotic Championships

By Phil Kimball

Next month, more than 1,500 students, teachers, coaches/chaperones, family, friends, volunteers, judges, invited guests, speakers and committee members will gather in Atlanta for a fun weekend of learning, sharing, competing and excitement. The Seventh National SeaPerch Challenge, hosted this year by the Georgia Tech Research Institute (GTRI), will take place May 20, 2017. On the line will be the title of National SeaPerch Champion with additional trophies being awarded in all three competition events, as well as special awards in a variety of categories.

More than 200 middle and high school student teams will participate in the underwater robotics competition held at the Georgia Institute of Technology (Georgia Tech) McCauley Aquatics Center in the Campus Recreation Center. The CRC is a 300,659 square foot, state of the art home to the McCauley Aquatics Center – a unique expansion of the existing swimming and diving venue built for the 1996 Olympic Games.

The record number of student participants will be grouped into teams comprised of regional winners from middle and high schools as well as from 4-H, Boy Scouts, Girl Scouts, home schoolers and other groups who have earned the right to compete against their peers on the national stage. Team participation has dramatically increased since the launch of the competition. The first National SeaPerch Challenge was held in 2011 in Philadelphia with 187 students grouped into just 38 teams.

This year the weekend's events will be divided between Georgia State University and Georgia Tech. The two schools are located only a few miles apart and will be conveniently connected by shuttle bus for the student teams. Registered participants and spectators will be housed at Georgia State University's dormitories, and will be treated to the "college experience" while also enjoying the entire weekend's activities, such as the Friday Night Social, Saturday's in-pool competition, and – new this year – the Engineering Notebook competition, followed by the Awards Ceremony.

SeaPerch is the innovative K-12 underwater robotics program sponsored by the Office of Naval Research (ONR) and managed by the Association of Unmanned Vehicle Systems International Foundation (AUVSIF). It offers teachers and group leaders the opportunity to inspire their students to build their own remotely operated vehicles (ROVs) following an academic curriculum consistent with the Next Generation Science Standards supporting science, technology, engineering and mathematics (STEM) subjects with a marine engineering-based theme. The program promotes hands-on learning of engineering and scientific concepts, problem solving, teamwork and critical thinking while introducing students to potential

Photos: AUVSIF

and rewarding career opportunities in naval architecture, marine, ocean and naval engineering.

"With guidance afforded by AUVSIF and ONR's continuing commitment to SeaPerch, the program has grown exponentially, reaching over 350,000 students since its inception in 2007," said Susan Nelson, Executive Director of SeaPerch. "Over the years, nearly 22,000 teachers and mentors have committed to supporting student learning through this stimulating and fun hands-on activity which promotes student discovery and excitement about STEM subjects leading to a potential future career path."

SeaPerch reaches a diverse population, and the National Challenge frequently include students from inner cities, remote rural areas of the country, Native American reservations in Minnesota, and the Pacific islands. All of these participants have been introduced to STEM though SeaPerch. The 2017 competition will welcome teams from beyond the continental U.S. with groups from Puerto Rico, Hawaii, the Cayman Islands, the Virgin Islands and New Zealand.

Georgia Tech, via a contract with the Georgia Tech Research Institute (Georgia Tech's non-profit applied research arm), is this year's event partner and co-host. Georgia Tech is a leading research university that provides a focused, technologically based education to more than 21,500 undergraduate and graduate students. Ranked as the seventh best public university, Georgia Tech offers degrees through the colleges of Design, Computing, Engineering, Sciences, the Scheller College of Business, and the Ivan Allen College of Liberal Arts. The competition will be coordinated by GTRI's STEM initiative – STEM@GTRI, which aims to inspire, engage and impact Georgia educators and students by providing access to experts in the fields of science, technology, engineering and math.

About the Schedule

May 19: Arriving teams and chaperones will first check into their assigned dorm rooms on the Georgia State campus and get settled. Then they will head over to registration for check-in and submit their SeaPerch vehicles for a compliance check to verify their safe operation and conformity to the rules. For those vehicles requiring adjustments and/or repairs, a triage station with spare parts and tools will be available for the duration of the competition. Friday evening dinner will be served at the University's dining hall followed by the Night Social at University Commons where students from all over the country and beyond can meet, mingle and compare their design enhancements and innovations as well as their challenges along the way. All participants will receive National SeaPerch Challenge T-shirts and giveaway bags filled with items contributed both by the SeaPerch program and its corporate sponsors.

May 20: Competition day will take place at the Georgia Tech Campus Recreational Center, where Mistress of Ceremonies Susan Nelson will preside over the opening ceremony, which features a number of notable speakers and last minute technical instructions for the teams. The ceremony will be accompanied by photographers, videographers and local media, as well as web streaming of the day's activities for the benefit of classmates, friends and parents back home.

May 21: A free day for the teams to explore, on their own, the rich cultural history and outdoor activities in the greater Atlanta environs including local historic sites, parks and other attractions, as well as the Georgia Aquarium.

The Competition

The Underwater Events

An underwater remotely operated vehicle (ROV) must be able to maneuver successfully under its own power to perform its designated mission. Consideration of optimal maneuverability as well as control and speed must be given when constructing the SeaPerch, including thruster placement and orientation, tether attachment, buoyancy, ballast, and the control box. The in-pool technical competition consists of two events: the Obstacle Course and The Challenge.

The Obstacle Course

The submerged obstacle course involves a series of five large 18" diameter rings, oriented at various heights and in multiple planes, through which the vehicles must travel. Teams must navigate their ROV through the obstacle course, surface, re-submerge and return through the course again to the end. Scores are based on the fastest time for successfully navigating the obstacle course.

The Challenge

Every year the second in-pool event changes, requiring the students to design their vehicles specifically to meet the designated mission. For 2017, The Challenge consists of an 'Origin' station where three rings and three cubes will be located within a fixture. Each of these objects must be retrieved one at a time by the ROV and transported to the 'Platform' station for the determination of points. The clock stops when the team identifies they are done by surfacing and touching the pool wall with their vehicle, whereupon the maximum number of points awarded in the shortest time will determine the winner.

The Engineering Notebook

Introduced for the first time this year, the third competition event will provide an opportunity for competitors to share their learning experience, innovations and science understanding through the development of an Engineering Notebook, which more closely aligns with the engineering aspects of the National SeaPerch Challenge. Use of an Engineering Notebook provides an excellent learning experience and allows students to demonstrate their understanding of engineering principles and design concepts. It is used to measure the team's ability to document the engineering development process used to design and modify their SeaPerch vehicles to meet the pool challenges as opposed to simply recording the steps involved in the construction of a standard ROV.

Teams use the physical notebook throughout the SeaPerch project to document the specific steps they take in the engineering design and modification process, similar to what they would be asked to do as a working engineer. Some of the items documented could include consisting of hand sketches, photos, handwritten notes, graphs, charts and computer-aided design (CAD) drawings.

Prior to the National Challenge, teams must submit their Engineering Notebooks electronically via a PDF file, in accordance with required content, format and limitations. The Notebook will be examined by a group of qualified professionals. The identified top teams will then be invited to present their ideas and notebooks in person to a juried panel of judges on competition day.

Approximately 150 judges and volunteers are anticipated to be in attendance on Saturday in order to adequately oversee and judge the day's competition events and to ensure a rewarding and memorable day for all participants, attendees and guests.

On Saturday evening the Awards Ceremony will take place at the Recreation Center. Trophies will be presented for first, second, and third place in each event for each of middle school, high school, and open classes. The special awards and the naming of the 2017 National SeaPerch Champions will all be presented by Susan Nelson and special invited guests followed by photographs with each winning team. After the last trophy has been awarded and the last photo taken, all registrants will return to Georgia State University for a festive dinner in the University's dining hall. The Georgia Aquarium will stay open late for students, who will have the opportunity to explore the facility at a significantly discounted rate.

Speakers representing corporate sponsors, local and state congressional representatives, ONR, U.S. Navy, U.S. Coast Guard and other military branch personnel have been invited to take part in the day's activities. They have been encouraged to arrive early and observe the competitions, judge various events and speak firsthand with the students before addressing them that evening about the importance of STEM to their future careers. All student members of the teams will receive participation medals and will be photographed with their team for the benefit of their families and schools back home. Additionally, Certificates of Participation are available both for student participants, teachers and advisors to download following the National Challenge.

Sponsorship opportunities are still available for individual, local and corporate funding, and can be viewed on the SeaPerch website. You may contact Susan Nelson at susan@seaperch.org about how to become a sponsor for this event.

For news and updates concerning the National Challenge, be sure to visit the SeaPerch website. Please contact Cheri Koch at koch@auvsifoundation.org for logistical questions.

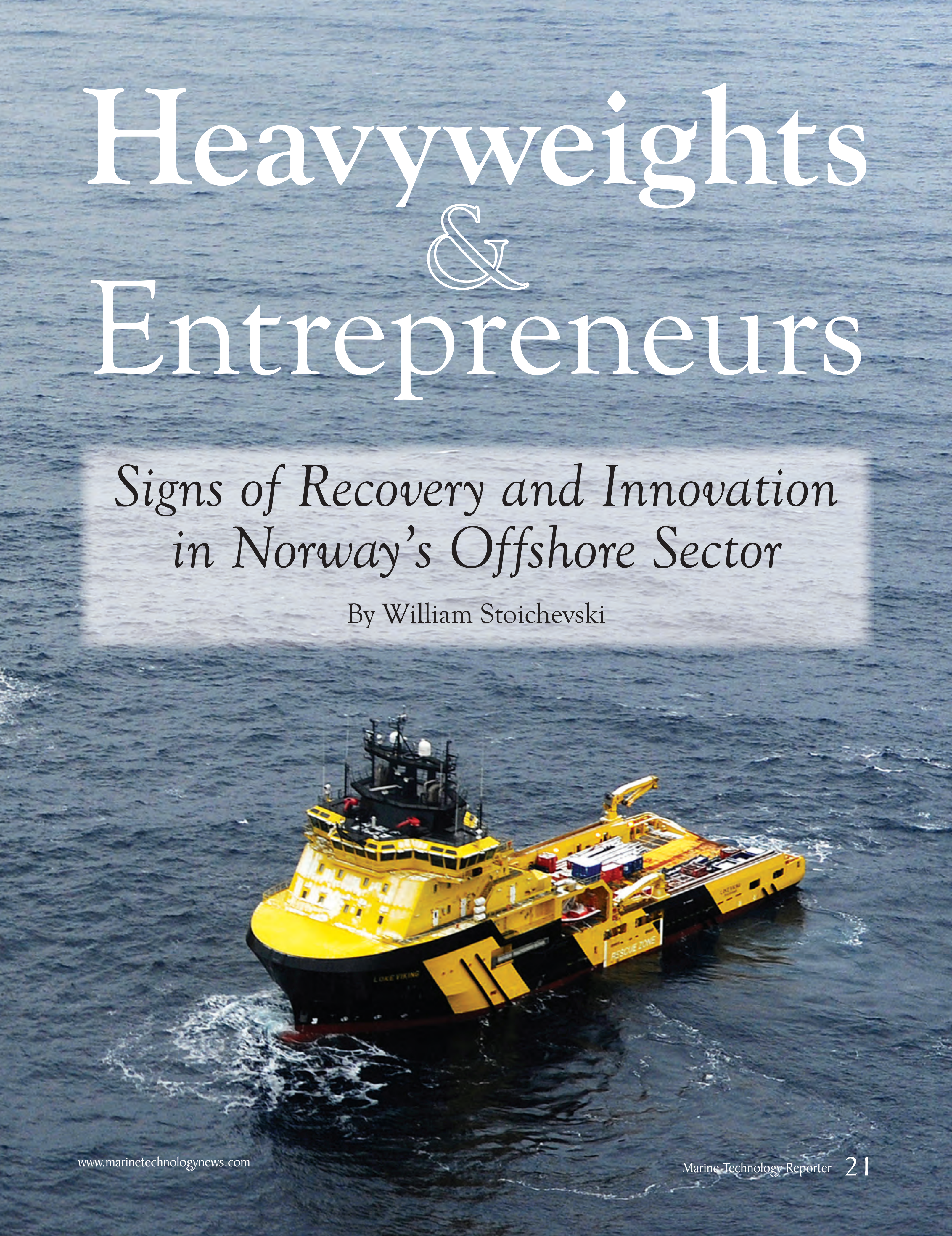
Arctic drilling:
the Polar Pioneer in Norway's arctic waters

Photo: Harald Pettersen, Statoil

Heavyweights & Entrepreneurs

Signs of Recovery and Innovation in Norway's Offshore Sector

By William Stoichevski



Big lender Swedbank's chief economist, Harald Andreassen, isn't "too hopeful" about the long-term prospects for the oil price, but then again, "I'm less certain of this than I've ever been as an economist," he tells a floating production conference in Oslo. After two-and-half years of oil-price collapse followed by layoffs in the thousands; stacked oil rigs and order freezes for offshore shipping, price insecurity itself is a partial expression of confidence.

Beneath some palpable yet halting movements toward recovery in 2017 (like rig hires), there's 2016's rigorous cost-cutting by, among others, Statoil and its subsea supply chain. Lower oilfield cost estimates have been proclaimed (and engineered), and this has fed assertions that pricy technology and extra engineering drove costs until operators backed out of "decision gate". Andreassen says he doesn't blame the technology companies. "It was the (oil) demand destruction when oil prices were high" that gutted the oil price and stacked rigs. After seeing companies operate "in debt hell" with inflation pinching, Andreassen now sees "the comeback from hell". "If you've survived this far, then you'll come back next year." He then offered a long-term, ballpark "balance price" for oil at about $60.

That's twice what oil was in January 2016 and enough for just about everyone. Rystad Energy partner, Lars Eirik Nikolaison, says that when he headed up the number-crunching firm's New York office (until very recently), he heard the repeated refrain that shale's $35 breakeven oil price so outpaced deepwater oil and gas, that people kept saying, "Will offshore even be part of the future mix?"

Deepwater's assumed breakeven of $65 made Norwegians ask, "Have we been priced out of the equation?" Nikolaison says he's had to tell people that up until 2016, "Shale producers had only been drilling their best wells and spreads," and that has been shale's early price advantage. "We're seeing that the shale costs base increases over the next few years," although, "As (the industry) recovers, prices will inflate." Mergers between "SURFS and SPSs" — or subsea service companies and subsea vendors — have eliminated "PLEMS and PLETS," those costly pipeline end points. Nikolaison has seen that the deepwater costs-curve was down 15 percent between third-quarter 2016 and Q1 2017. (North Sea rim) offshore projects are now competitive at about $57 oil. At that price, "There are lots of breakeven tiebacks in the North Sea."

More activity:
a subsea manifold lowered offshore Norway

Start-up Spirit

Near Oslo, a handful of offshore startups entered the fray just as the still-painful downturn was at its gloomiest. Part of an incubating program called Techmakers, these startups are being carefully watched by operators Statoil and Lundin as well as supplier-contractors Aker, Kongsberg, TechnipFMC and Aramco Energy Ventures.

Founded in 2016, NEO Subsea offers optical photo equipment for AUVs and ROVs, including high-resolution camera stills and a long-range, laser-guided 3D camera. Founder Erlend Leirset told Norwegian publication enerWE, "It's an important supplement to sonar systems by giving better resolution which in turn permits higher underwater speeds. Oliasoft started up in 2015 by building apps for drilling engineers. Funcom founder Andre Backen is at Oliasoft's head, and he seems to be on to one of the stronger but paradoxical trends in the offshore business off Norway: a record number of wells were drilled in 2016, according to the government's oilfield investment entity, Petoro, which acts a field partner with bottomless pockets. Nearly all were infield drilling (production wells).

New Rig Company

New rig entity Borr Drilling — formed by Tor Olav Troim, a former business associate of ship and rig mogul, billionaire John Fredriksen — is extra bullish on Onshore. Borr will pay $1.35 billion to buy Transocean's 15 jack-up rigs, including associated debt, five newbuilds and their drilling order book. The new company will own 17 rigs. Earlier in 2016, Borr agreed to buy two Hercules Offshore jack-ups.

The Petoro document that confirms there's been lots of drilling off Norway lately also adds that much of it has been and will be from oil platforms. Fixed installations are fine for newbie Well Genetics' DNA-based tracer technology to help oil companies better track reservoirs for increased oil recovery and lower costs. Many oil companies have already reportedly signed with Well Genetics. Many are also cheering the use Big Data monitoring to save cash. After so much automation and "smart fields" digitization, conditions are right for condition-based riser monitoring: enter Vinterfjord, the start-up baby an industry veteran.

Riser installations and maintenance are set to continue apace in Norway, with pipelines — what risers connect to — the

Photo: Photo: Oyvind Hagen, Statoil

only type of investment that did not dip in 2017 over the previous year. Overall, the industry surveys of Statistics Norway put oilfield investments for 2017 at 149.5 billion kroner, 13 percent less than in 2016 on cancelled exploration wells but less a dip than expected. The numbers are seldom weighted against the boomtime 70 per cent hike in investments off Norway between 2010 to 2014. Still, spending fell off 27 percent between 2014 and 2016 and we're on course for 13 percent less in 2017.

Massive Spend

The big dip between 2015 and now was mostly operator cost-cutting. Today, Statoil's traveling presenters report the average breakeven oil price for its projects has dropped from $70 to below $30, helped by the roughly $20 oil-price breakeven made possible by economies of scale at the giant Johan Sverdrup field, where the first subsea infrastructure, a water-injection template, has just been installed, the first of many. Supplier fortunes are expected to rise in capital-intensive Norway on coming investments in the arctic floating producer, Johan Castberg; the heavily subsea Snorre Expansion project; another gas train at the arctic Snøhvit field and the Troll Phase 3, Part 1 of subsea frames and pipelines.

To help an operator like Statoil gain full oversight of all those projects, new outfit Avito Loops has an integrated cloud solution that lays it all out in plain, detailed view: projects, portfolios, campaigns, business. Avito shows "your current state" and "your desired state" … A bit like Google Maps, it says, by showing where you are and where you need to go.

For aging installations in mature areas, Western Norway newbie, Connector Subsea Solutions, has developed a technique to remotely do pipe repairs in deep water, and contracts with BP and Shell are already bringing in some earnings. While clamping a repair on a horizontal pipe is hard enough, Connector, or CSS, has managed to get its tool to remove the coatings of and then repair a vertical pipe, or riser.

"We're bullish on offshore," affirms Rystad's Nikolaison, emphasizing that, "That's different than "Goldman. Deepwater, he notes, will see the benefits of the supply chain's efficiency work to date. There'll be a rising number of investment decisions by year-end 2017 and rig rates will rise. To be sure, constrained budgets have caused some unusual cost-cutting — "We're cannibalizing pressure pumping equipment," for one — but "$80 to $90" oil is in sight. Norway will do fine at $60 oil, he says, as most four-slot subsea fields are near infrastructure: oil at $50 to $60 works fine for subsea tiebacks.

In the remoter Barents Sea, where costs are affected by environmental concerns, the Norwegian outifts of foreign-owned oil companies are also making their mark. Austria's OMV is developing the Wisting project as part of its 33 license portfolio. "Hopefully we'll grow even further," says Norway boss, Lars Drag. He has his hands full with Wisting concept studies, in which a subsea tieback with manifold, water and injection and floating storage for production from 18 wells ought to produce the targeted 110,000 barrels per day. By April, when these words appear, that study will be well underway ahead of concept selection in 2018 and an investment decision in 2020. Front-end engineering and design work will be awarded in 2019.

Not far away, at the Ghota discovery, is the offshore acreage of Lundin Petroleum, partner in the giant Sverdrup field it's geologists discovered. Lundin is now trying to develop Ghota's 150 MM barrels of oil equivalent, likely with two structures or a subsea spread. Lundin engineers might be looking at a novel, "all-electric" subsea concept at Gotha or Alta. "We haven't seen any feasibility issues. It's feasible," says Lundin field development boss, Erik Sverre Jenssen.

Lundin — which grew rapidly to become Norway's second-largest license owner — is content in arctic Norway, where oil tankers and shuttles transfer oil, and the same vessel will be used to move oil at Ghota, Alta and another new project, Johan Castberg, where a concept choice is expected at year-end. "We're set up for optimum growth," Jenssen says. "We have great ambitions here."

To help those ambitions, Norway's March offshore acreage round offered energy companies a combined 195 blocks in the Norwegian and Barents Seas.

Photo: handout

Upturn:
TechnipFMC well intervention equipment


SWL 250 KG
NO SEA FASTENING
GROSS7350

To Create a Sustainable Future – *Digitalize Offshore Energy*

By Kira Coley

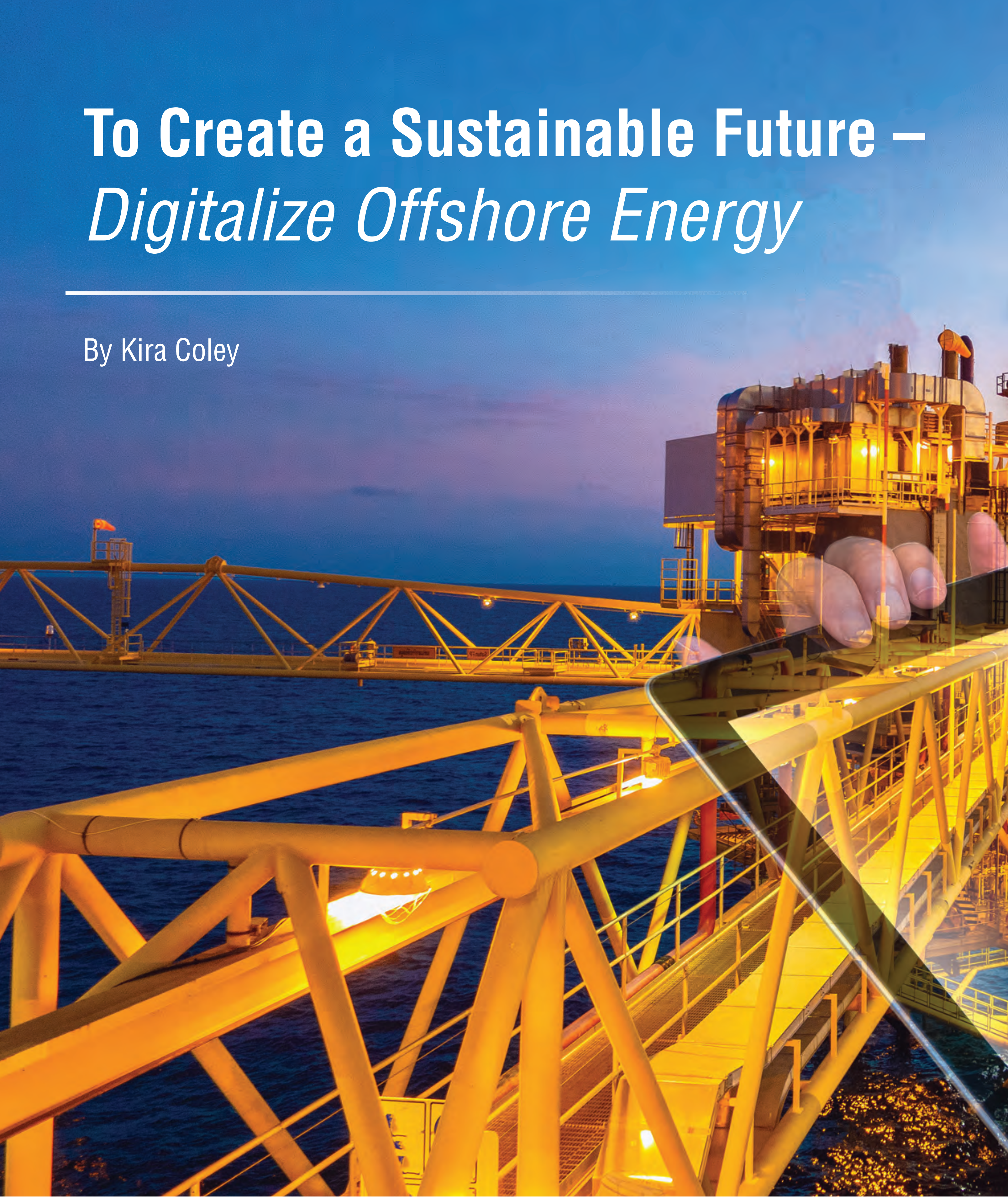


Image: © Theerapong / Adobe Stock

"By integrating technologies, such as autonomous underwater vehicles and advanced sonar technology, we will gain new insight into the condition of these subsea assets."

- David Flynn, Director of Herriot-Watt's Smart Systems Group (SSG)

Surrounded by some of the world's most productive seas, the U.K. generates more electricity from offshore wind than any other country. Developments over the last 12 months suggest a promising future for the UK's leading green energy sector. In 2016, capital spending commitment reached recorded levels, and the cost of offshore electricity fell by nearly a third in four years. Alongside this prevailing success, the operation and maintenance (O&M) of wind farms has the potential to form an industry worth $2.5 billion annually by 2025. Hindered by "primitive" methods, there is a lack of consensus on how best to maintain these high valued assets. To ensure a sustainable future, the industry must embrace innovative O&M strategies and a digital monitoring approach. Research groups from five U.K. universities have been awarded a $5m grant to create novel "human-robotics hybrid solutions" which will not only propel the growth of the U.K.'s market, but strengthen the its position within Europe for generations to come.

"The U.K. government has set ambitious decarbonization targets, increasing the present 5GW generated by offshore wind farms to 40GW by 2050. The costs of achieving these targets have, until now, focused on the capital outlay for wind turbines, but budgets have largely ignored the operation and maintenance of wind farm assets including subsea cabling," explains David Flynn, director of Herriot-Watt's Smart Systems Group (SSG).

"By integrating technologies, such as autonomous underwater vehicles and advanced sonar technology, we will gain new insight into the condition of these subsea assets."

Not only will an improved O&M strategy help increase the lifetime of the underlying U.K. offshore wind asset base worth $149 billion, but also see benefits in reduced running costs to tax- and bill-payers.

The new research grant is made up of $3.7m from the UK Engineering and Physical Sciences Research Council and a $1.2m contribution from Dong Energy, Siemens Wind, GE Energy Solutions, Scottish Power Energy Networks, the Offshore Renewable Energy Catapult, Hydrasun, Nova Innovation, British Approvals Service for Cables, JDR Cables and the European Marine Energy Centre.

The Holistic Operation and Maintenance for Energy from Offshore Wind Farms (Home-Offshore) team will include scientists and engineers from Manchester, Warwick, Cranfield, Durham and Heriot-Watt universities. Over the next three years, Home-Offshore will create an advanced holistic model of offshore wind technology (OWT) infrastructure, using previously inaccessible data from advanced sensing technologies, and robotic and autonomous systems. In addition to reducing the O&M costs, which influence the final cost of energy to the public, they also aim to reduce the risks associated with human intervention and inspection.

"To date, we have no consensus on how to monitor and maintain these assets. The time for a consensus in now. Given the growing influence of OWT in our national energy infrastructure, we want to develop a prognostic model that treats the OWT as a holistic asset. We will create advanced sensing technologies, models of the OWT system, and a hybrid human-machine means of undertaking O&M, with a focus

on reducing costs. This can also enhance the future design of next-generation systems," states Flynn.

To better predict the remaining useful life (RUL) of wind farm subsystems, such as gearboxes and generators, an innovative 'fusion prognostics' approach will be taken. Combined monitoring methods will be used alongside innovative sensor technology, robotics and autonomous systems. The project will enable a new capability in human interaction with the remote and relatively inaccessible parts of offshore sites.

Within the final six months of the project, there will be an exhibition of robotics and autonomous systems, working with engineers to deliver the next generation of offshore asset management.

High Costs and Low Safety

At present, most asset management is still undertaken manually on site. Flynn explains, "Currently the monitoring of cables, for example, focuses on internal 'health' parameters, mostly electrical - an effect called partial discharge (PD) that occurs when the dielectric material begins to degrade.

"The data on cable failure over fifty years indicates that 70% of failures are based on corrosion, abrasion and third party impact. Therefore, the failures work from the outside inwards which are undetectable by current PD monitoring and internal fiber optics methods.

"When cables fail, they need to be replaced. So, teams of engineers will then spend on average two weeks locating the cable and point of fault. They will then either join the needed piece of the cable via an iron collar to the remaining healthy cable or simply install a new cable. During this time, backup generation is required on land, and any offshore generation is lost."

Offshore infrastructure is inherently complex. Consequently, maintenance is expensive and potentially dangerous since often human intervention and inspection is required at present to manage this complexity.

Another problem is that, at present, monitoring tends to have a specific subsystem focus as opposed to understanding the holistic health of the entire offshore wind technology system. Also, the state of the art technology of today still suffers from regular false alarms.

"In current OWT monitoring you have around 20 false alarms a minute, and not all of the critical subsystems can be monitored remotely – for example, blade inspection is done via a technician on ropes using a hammer! Current OWT monitoring systems are subsystem focused, so they don't capture interdependencies between the interconnected subsystems. Due to these reasons, even with a supposed 25-year design life you only get a five-year warranty. So, it's a complex system in a remote and challenging environment."

Creating a Sustainable Industry

According to the Crown Estate, typically, 80-90% of the cost of offshore O&M stems from the need to get engineers and technicians to remote sites so that they can evaluate and take remedial action. Minimizing the need for human intervention offshore is an essential route to maximizing the potential, and reducing the cost, for an offshore low-carbon generation.

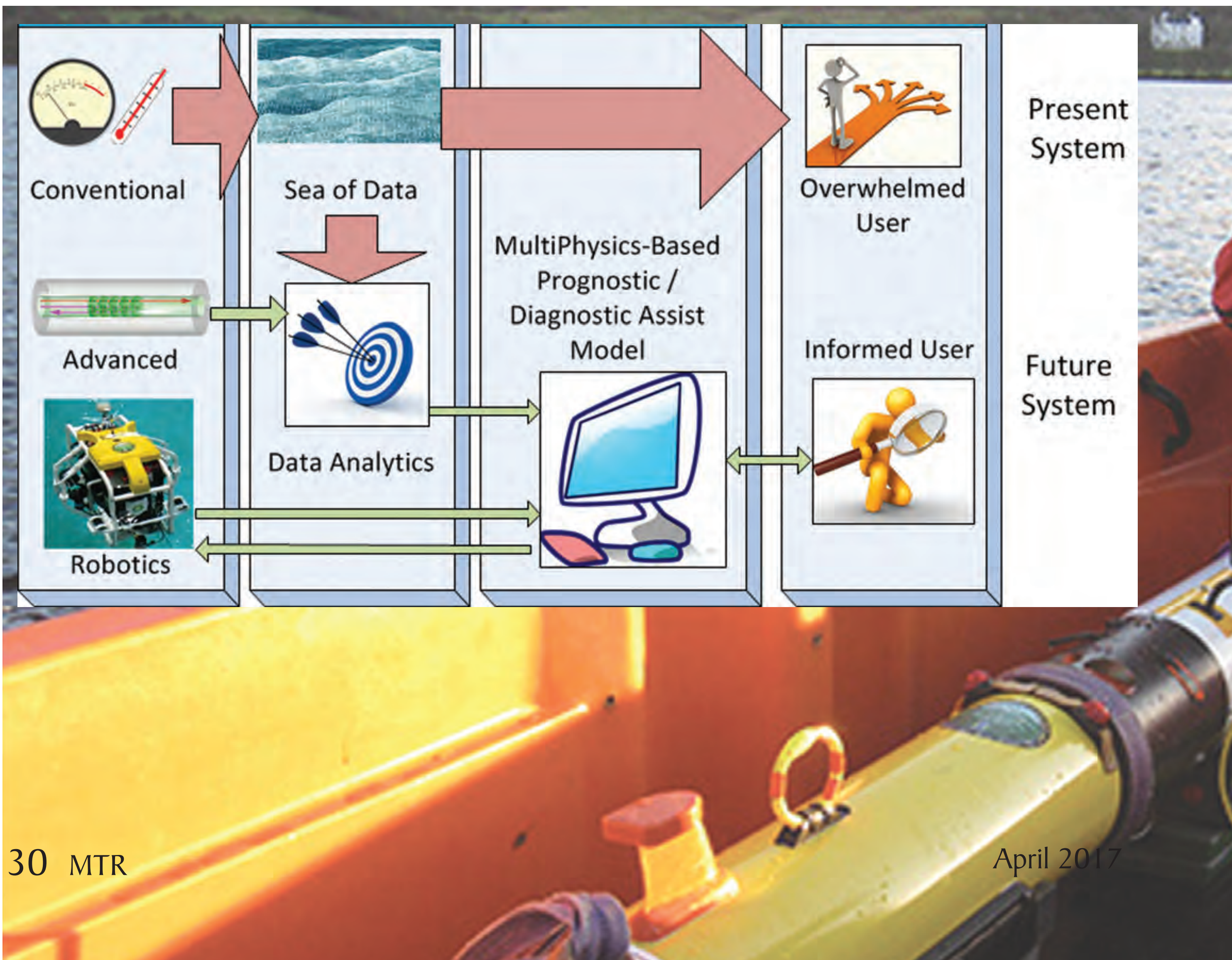
This will also ensure potential problems are picked up early before significant damage has occurred and when maintenance can be scheduled during a good weather window.

"A significant element of the cost and risks in offshore asset management is the deployment of engineers. Robotics with embedded (human) intelligence will be able to remotely inspect and communicate information back to their human colleagues. The collaborative effort between remotely autonomous vehicles and humans will safeguard the security of supply, and deliver energy that is more affordable," said Flynn.

While aspects of the techniques required in this offshore application have been previously used in other fields, they are new for the complex problems and harsh environments in this offshore system-of-systems. 'Marinizing' these methods is a substantial challenge in itself.

Digitalizing Offshore Wind Technology

Low frequency, dolphin inspired sonar, that will enable acoustics with color is just one example of the innovative solutions the Home-Offshore team will develop over the proj-



ect's lifetime.

"Continuing the cable example, for OWT that is far from shore such as in the case of the larger 10MW devices, a remotely operated vehicle (ROV) typically is fitted with a camera and visual inspection is performed. This provides very limited insight to sections of cable that are visible e.g. the cable circumference in contact with the seabed is concealed.

"Using the low-frequency sonar, we will be able to see into the cable and, given the optically challenging environment of the seabed, have an improved line of sight over traditional subsea cameras. Therefore, the low-frequency sonar has the potential to enable analysis of buried sections of cable, providing access to previously inaccessible data. The sonar will also give us see into the various layers of the cable structure and give an indication of its condition, or health. This means we can determine the rates of degradation throughout the cable length, provide a prognosis on the cable condition and take proactive action."

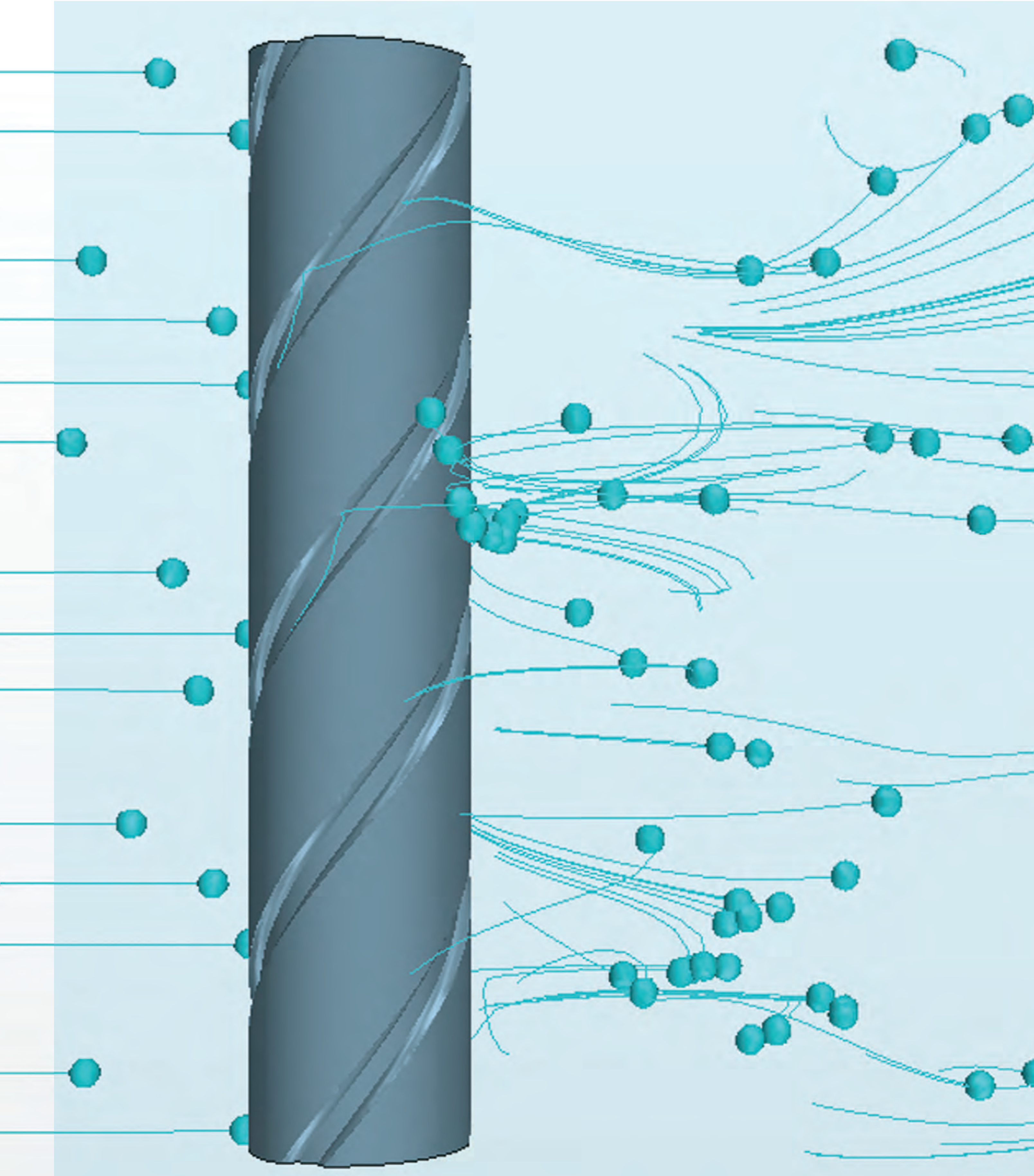
Another challenge is the remote and dangerous environment of high voltage substations. With the use of drones undertaking a coordinated inspection, O&M managers can reduce the need to place people into these dangerous situations.

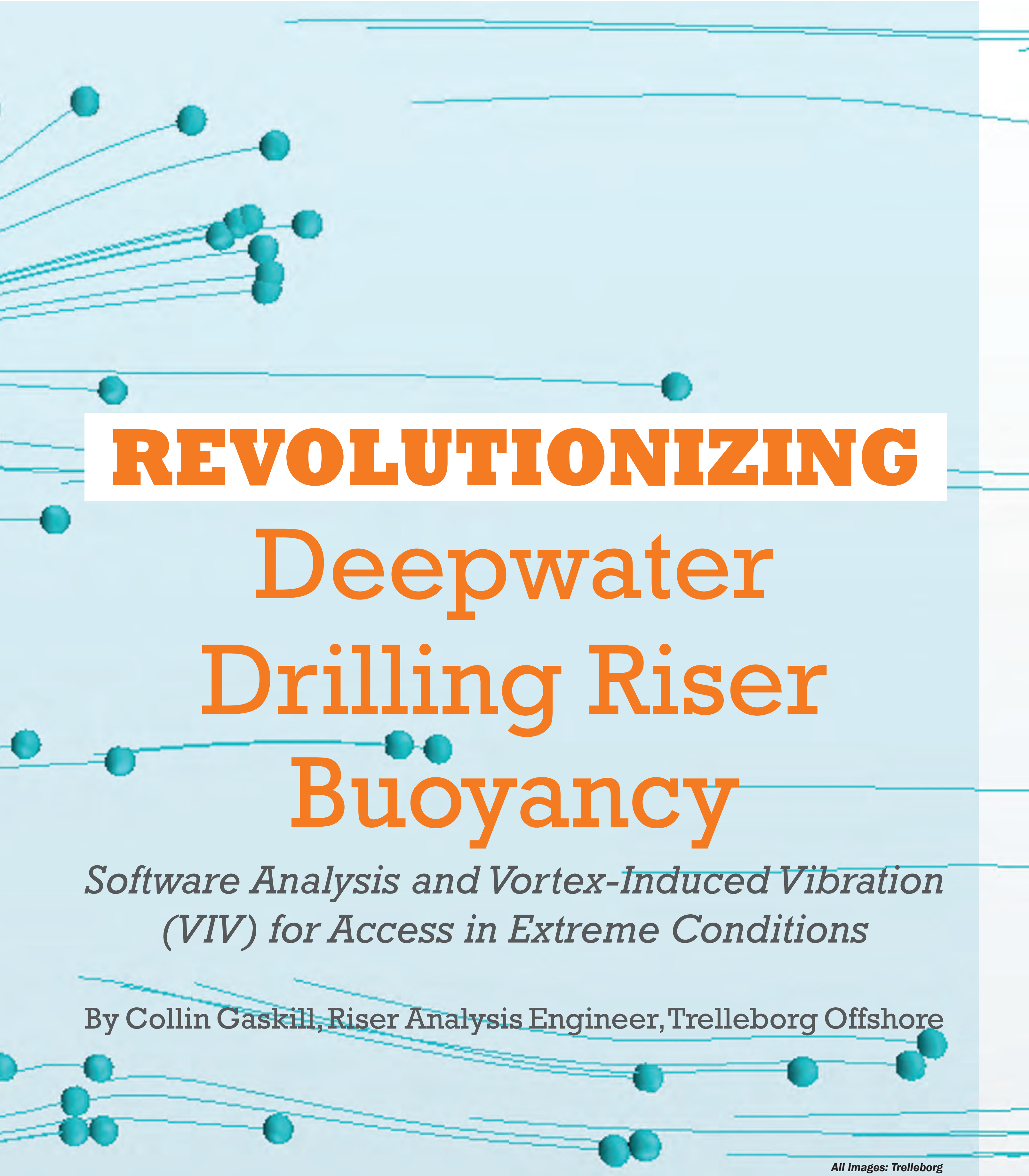
"Although beneficial, operating remote autonomous systems in such a hazardous environment, be it subsea or within a high voltage substation, will have significant challenges. And, with the data that these systems return to us, there will be problems in converting that data into actionable information. Technically there will be a trade-off between computational efficiency and accuracy," explains Flynn.

Once developed and tested, the applications for these systems will go beyond that of offshore wind farms. Other offshore energy sectors will have similar complex environments and the associated challenges with maintenance and monitoring. The oil and gas industry, as well as wave and tidal, will also benefit from a new generation of offshore technology and new methods to monitoring the U.K.'s existing subsea infrastructure.

Fusion Prognostics will support the digitizing of offshore wind technology - not only providing a prognosis on the current health of the OWT system, but allow managers to understand how these assets age under varying loading conditions.

"Resilience and sustainability are critical to our energy system in the U.K. There must be a global adoption of prognostics into energy systems and significant shift in policy. We need to place emphasis on vendors delivering technology and services based on lifecycle economic drivers, as opposed to short-term 'boom and bust' construction," said Flynn.



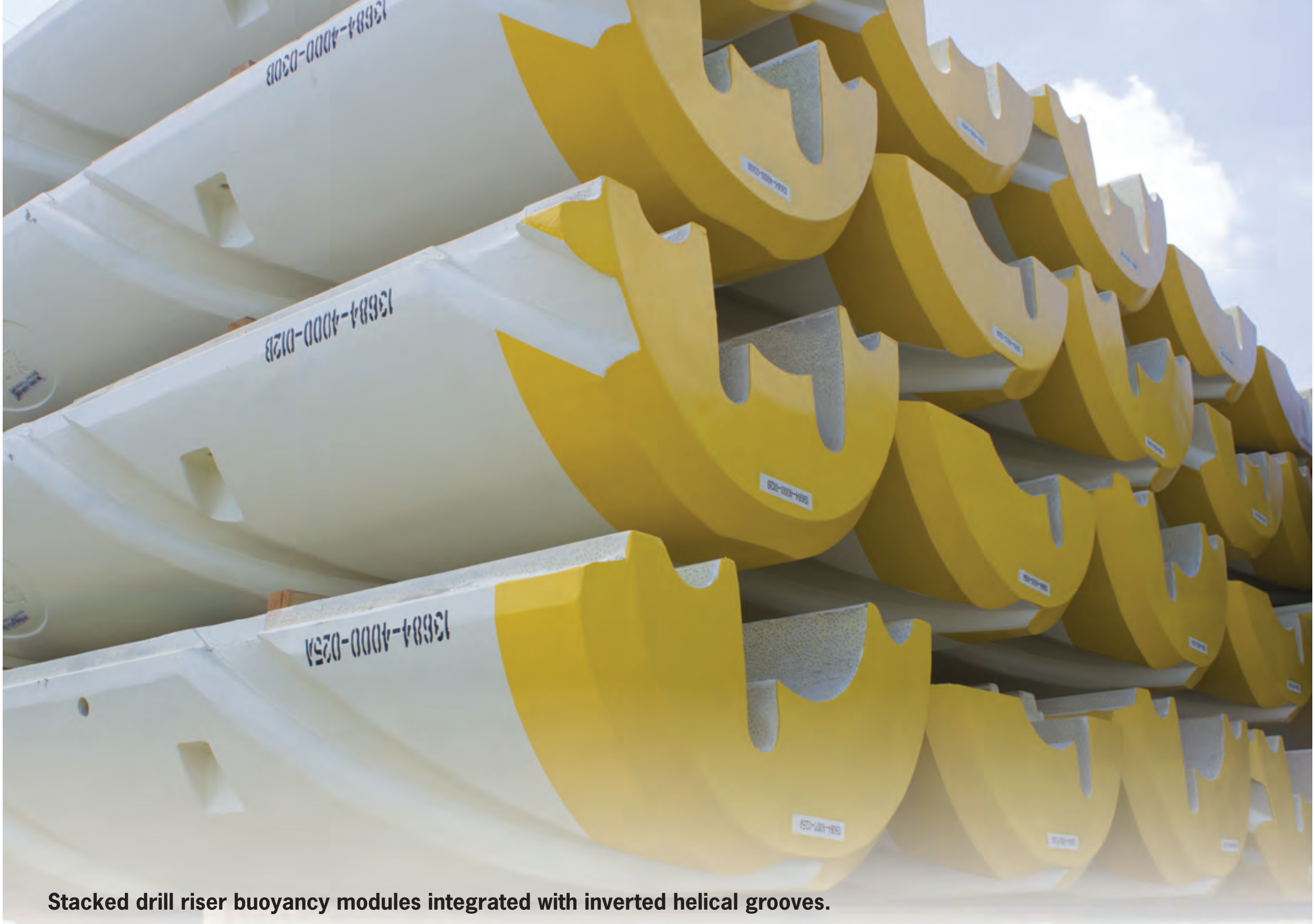


REVOLUTIONIZING Deepwater Drilling Riser Buoyancy

Software Analysis and Vortex-Induced Vibration (VIV) for Access in Extreme Conditions

By Collin Gaskill, Riser Analysis Engineer, Trelleborg Offshore

All images: Trelleborg



Stacked drill riser buoyancy modules integrated with inverted helical grooves.

The ability of advanced software analysis capabilities to produce high performance, robust and dependable solutions is revolutionizing deep water drilling and production. By increasing the performance of products before they even enter the water, companies using software analysis capabilities are able to provide the solutions needed to combat the increasing harsh environments presented by the offshore world.

Maximizing Efficiencies

As exploration of offshore oil and gas continues to move into deeper waters, the demands for drilling operations to be performed faster and more efficiently, providing cost savings and safer well completions, persists.

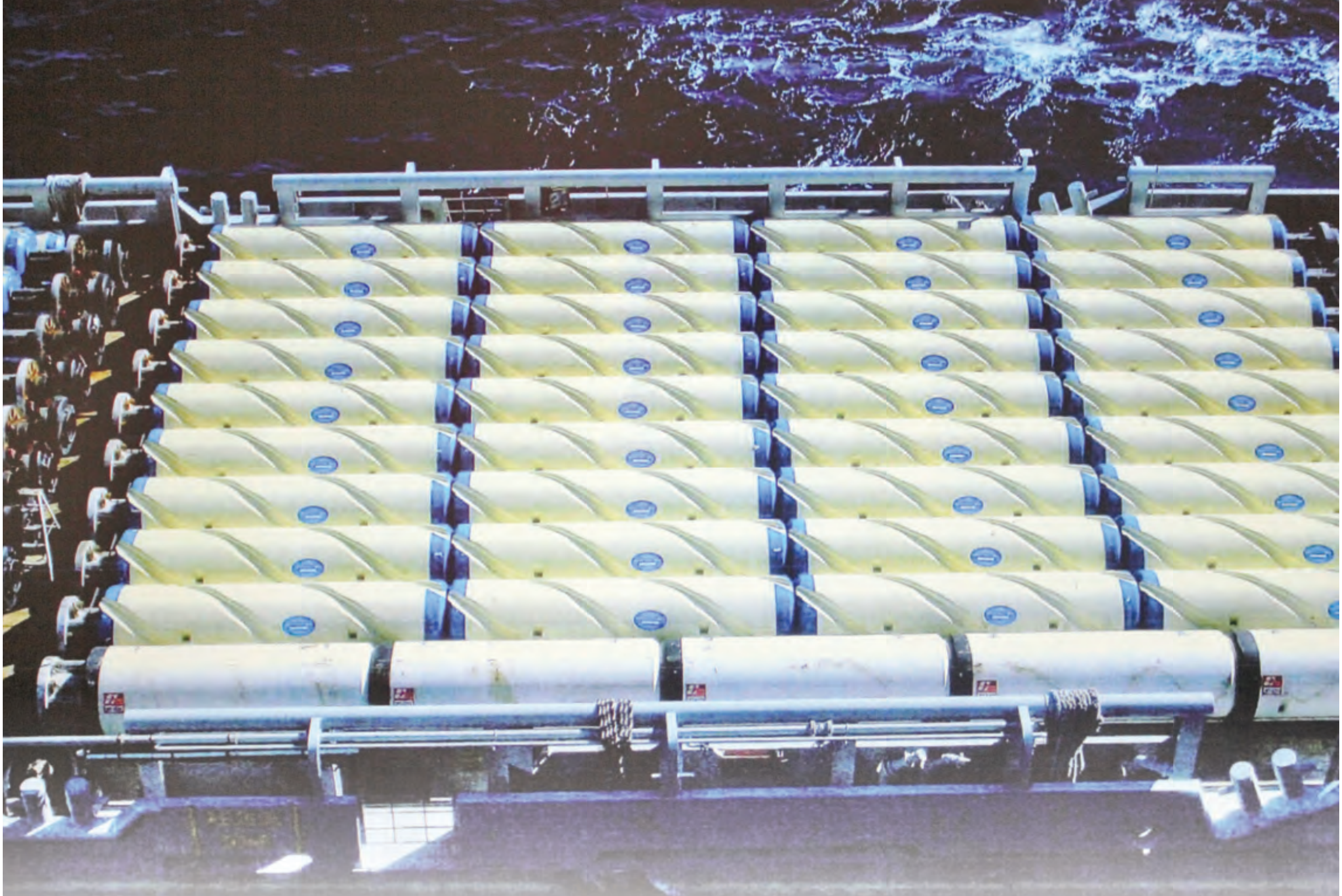
As companies move to water depths past 12,000 feet the technology they use has evolved. Extensive engineering design work is now performed using specialized software to produce local and global finite element (FE) and computational fluid dynamics (CFD) analysis to develop optimum designs. The ability to model equipment and system responses to environmental forces helps advance product development and design opportunities to maximize operational efficiency, resulting in cost savings, increased service life and multi-functional designs.

Companies with in-house analysis teams can simulate offshore drilling and production operations, offering customers solutions considering a fully coupled vessel to well approach. These riser studies can specifically be used to assist clients in defining operational methodologies and structural system limitations for offshore drilling and production operations.

Drilling Deeper

Offshore oil and gas exploration requires drilling vessels to deploy thousands of feet of steel drilling riser through the water column to safely and effectively drill offshore production wells. Drilling campaigns in deep and ultra-deepwater locations can see millions of pounds of riser and equipment deployed and suspended from the drilling vessel required to be kept in tension to avoid buckling failure. For decades, the offshore drilling industry has utilized drilling riser buoyancy modules (DRBMs) to reduce the overall riser weight and required top tension. DRBMs are highly effective at adding necessary uplift to drilling risers however, the associated drawback is increased overall outer diameters which subsequently increase the magnitude of loading experienced by the riser due to hydrodynamic forces.

Increased hydrodynamic diameters reduce the magnitude of environments that drilling vessels can safely operate. Additionally, consequences from the phenomenon of riser vortex induced vibration (VIV) developing from a complex interaction between the riser structure and the flow field around the


Sea transport of drill riser buoyancy modules integrated with inverted helical grooves.

riser coupled with the occurrence of drag is amplified for larger structural diameters. These forces induce periodic oscillations or vibrations of the riser, which transmit large amounts of dynamic strain from the riser system to subsea equipment. With exploration extending into deeper waters and locations with onerous environmental conditions occurring year around, the offshore drilling market requires solutions that allow for large magnitudes of buoyancy uplift without the penalty of increased drag and VIV forces.

Multifunctional Designs

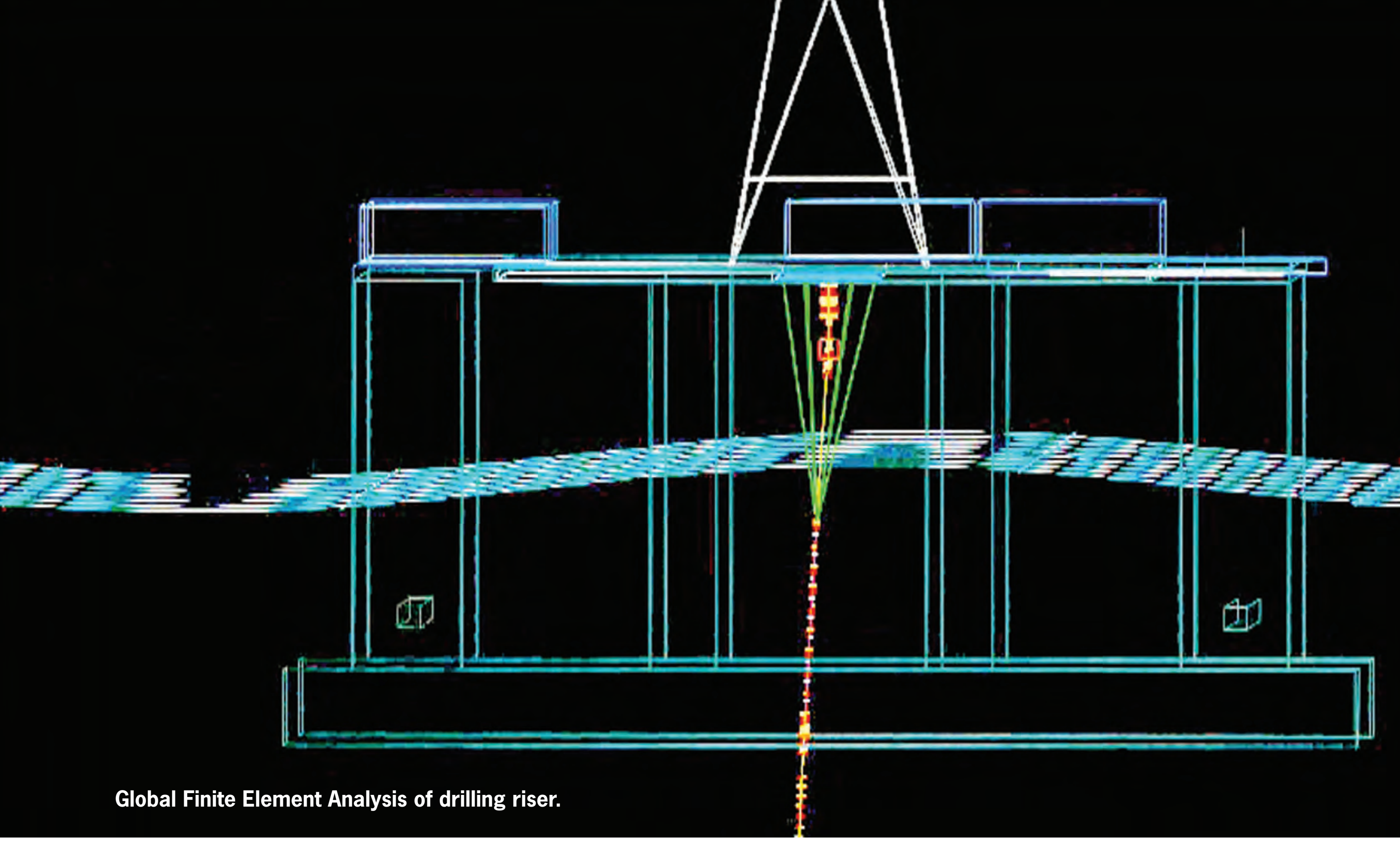
A new multifunctional buoyancy solution has recently been developed to integrate drag reduction and VIV mitigation into DRBM equipment, reducing the necessity for auxiliary suppression equipment and alleviating complicated and time intensive riser running and retrieval procedures.

Inverted helical straking of drilling riser buoyancy modules allows for in-line drag reduction and VIV suppression of drilling riser systems through the use of a tri-helical groove design molded into the outer profile of the buoyancy modules. The origins of the design stem from external helical strake designs, which have been used in the offshore industry since the late 1970s to suppress VIV of slender structures. However, the inverted strake design, unlike its externally protruding predecessor, does not increase the overall hydrodynamic diameter of drill riser buoyancy modules and therefore VIV suppression comes without the undesirable penalty of increased in-line drag.

Obtainable VIV mitigation properties of the inverted tri-helical buoyancy design with the elimination of required auxiliary equipment simplifies and increases the running and retrieval times of the riser compared to traditional suppression technology. Numerous locations across the globe are subject to the sudden onset of onerous weather, requiring drilling vessels to be able to respond quickly in order to transit out of forecasted storm paths. If these fields are subjected to high current or VIV inducing metocean conditions, as many of them are, operators may opt out of drilling in these locations at certain points of the year or entirely, as retrieval of the riser and vessel transiting speeds are not adequate with the increases in joint handling time associated with auxiliary VIV mitigation equipment. With the adaptation of the strake design to an inverted tri-helical groove, incorporated into the buoyancy itself, suppression of riser VIV and reduction of riser drag is obtainable without an increase in riser retrieval time, offering a solution for well sites with volatile environmental conditions.

Analytical Modeling

Extensive engineering design work has been performed on the inverted helical groove geometry through numerical modelling in computational fluid dynamics (CFD) software pack-



Global Finite Element Analysis of drilling riser.

ages to develop the optimum design. This effort is reflected in a solution that corresponds to a minimal loss of buoyancy uplift, due to a minimal removal of material to facilitate the inlaid groove, while still retaining vortex suppressing properties. Similar to external strakes the inverted design disrupts the continuity of fluid flow around the outer diameter of the buoyancy modules by introducing variances in the cross-sectional geometry at each new cross section along the axis of the riser. Discontinuities in external geometry profiles along the axis of the riser lead to variances in the separation point of the flow around the outer diameter of the drilling riser which disrupt the organization of forces due to vortex shedding, the driving force responsible for larger magnitudes of riser response and subsequent dynamic strain.

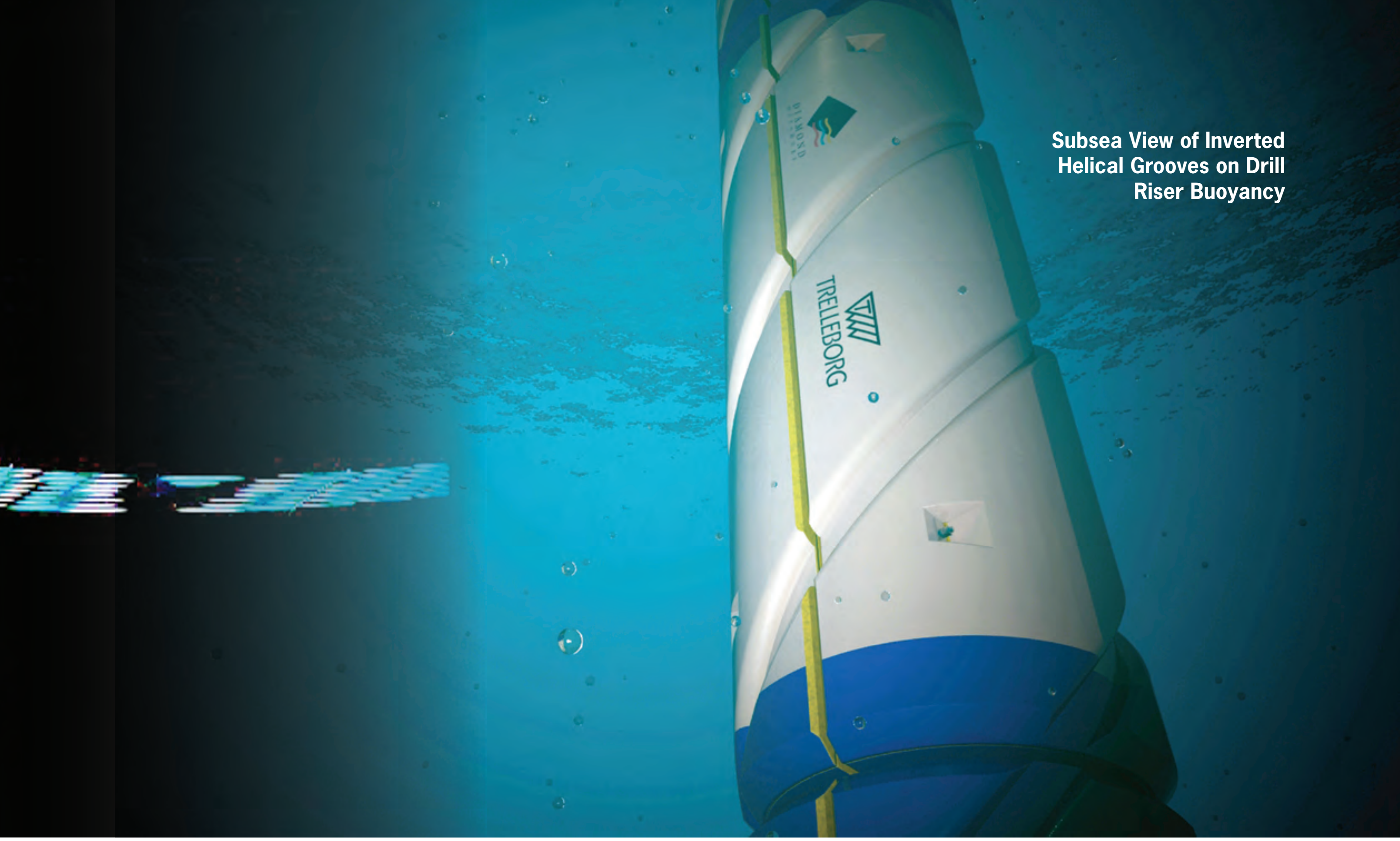
Three dimensional finite element models developed for use in CFD analysis help to illuminate additional benefits realized from the inverted helical design. In contrast to traditional buoyancy modules where fluid flow paths occur almost exclusively in the horizontal plane, looking down the axis of the riser, axial flows induced by the inverted helical groove introduce turbulence into the downstream wake profile of the drilling riser. Axial flow paths result in forces that act out of plane of cross flow lift forces and in-line drag forces disrupting the cyclical rotation of these forces on the downstream side of the riser.

Reducing VIV and Inline Drag

Reduction of riser motion due to VIV in the in-line and cross-flow directions can limit the amount of dynamic loading transferred to subsea equipment and conductor casing programs from the riser. Overall decreases in cyclical loading may lead to increases in the integrity and life span of critical well containment equipment. Possible benefits of the reduction of riser drag and VIV by means of reengineered drilling riser buoyancy are numerous, with the potential to enhance overall performance of drilling vessels and the economic feasibility of accessing reservoirs in increasingly challenging environments.

Drilling operability envelopes, or the connected vessel distance away from directly over wellhead that is still deemed safe to drill, are frequently limited by allowable mean and maximum flex joint rotation angles, requiring the suspension of drilling activities at higher rotations. With a decrease in the in-line drag loading and overall deflection of drilling riser systems, upper and lower flex joint rotations are reduced for certain environmental conditions and riser system configurations. This can correspond to increased time frames where rotation of the drill string within the riser annulus is permissible, without the danger of key seating the riser joints. This potentially allows offshore wells to be drilled faster as windows of time where operations are suspended due to riser deflection are diminished.

Benefits extend beyond the expansion of drill string rotation envelopes; decreased in-line drag and riser deflection can enable deployment and retrieval of the riser in higher current environments. Additionally, reductions of overall deflection along the riser can lead to a reduced possibility of clashing between



Subsea View of Inverted Helical Grooves on Drill Riser Buoyancy

the riser system and the vessel or other various deployed equipment from the auxiliary rotary or cranes. Higher vessel transiting speeds, with a riser string deployed, are also potentially achievable in certain scenarios, as maximum allowable velocities, limited by riser stresses and the potential of riser clashing, are increased. Finally, decreased riser drag can improve riser disconnect performance as horizontal excursion of the riser due to current loading is reduced after disconnect occurs.

Conclusion

By using advanced software analysis, companies can continue to revolutionize deepwater drilling and production in increasingly demanding and previously inhospitable environments. Software analysis coupled with the advancement of riser drag reduction and VIV suppression technology, provides an integrated solution to progressing drilling riser buoyancy and opens the door for resource exploration in areas previously deemed inaccessible. Extended lengths of risers in ultra-deepwater applications are more susceptible to the complications arising from higher current velocities and the necessities of increased buoyancy uplift due to the increased weight of deployed steel riser joints. The inverted helical drill riser buoyancy module design combats both of these important issues without increasing required equipment and rig operation times. Solution-specific engineering of the inverted helical module will facilitate the ability of drilling vessels around the globe to continue to deliver the energy needs of the future.

WORK

An invaluable resource for the marine industry, remotely operated vehicles (ROVs) perform a multitude of tasks, from pipeline inspection to subsea construction, often equipped with an array of cameras, sonars, sensors, manipulators and other tools to go to work where divers cannot. Power and payload, ruggedness and reliability: these are crucial to the heavy class ROVs examined here in part 2 of MTR's *ROV technology series.*

DOER Marine

DOER's H3000 is a midsize work class ROV. Designed for multimission use from a variety of platforms, the H3000 is well suited to underwater tasks where station keeping, maneuverability and power are key. Typical applications include deep-water survey, sampling, documentary filming, search/recovery/salvage, submersible support/rescue, ocean observatory support, oil/gas/alternative energy support, tunnel and aqueduct inspection. H3000 is rated for 3,000m standard. This versatile, powerful vehicle is designed to take advantage of changing technology to provide years of service and upgradability.

DOER's Ocean Explorer 1,000m is a mid size electric ROV. Its open frame architecture is designed to accommodate various sensor and tools with minimal integration effort. Typical applications include survey, sampling, search/recovery, tunnel/pipeline intervention and inspection. Ocean Explorer is rated for 1,000m standard.

DOER's H6500 is a working class ROV. Designed for multimission use from a variety of platforms, the H6500 can be used for underwater tasks including survey, sampling, search/recovery, NDT and inspection.

ECA

The ECA Hytec H800 is an 800m depth rated ROV for subsea inspection and light work, offering ease of handling and installation, due to compact size and reasonable weight. It incorporates a high performance viewing system, with both a color/zoom TV camera (mounted on a full pan/tilt unit) and a B/W very low light TV camera. The single, ergonomic hand controller operates both the ROV and a five functions manipulator arm and the control unit incorporates the power supply unit, and offers a PC screen with either video only, or the combination of video, sonar display and digital still control.

Forum

Perry XLX-C work class vehicle has a depth rating of 3,000 (4,000) msw with 150 hp power. The control system has GHz Optical Link, Ethernet telemetry and graphical diagnostics.

Saipem's new Innovator 2.0 ROV

CLASS

Photo: Saipem

The vehicle has dynamic positioning with a payload of 200kg.

The Perry XLX Evo ROV represents the latest evolution of the Perry XL series. The XLX Evo features enhanced performance across the full range of demanding intervention and survey tasks. The Perry XLX Evo offers extensively reconfigured vehicle control system components. The user power supply system has also been re-designed to eliminate the need for a one atmospheric control can and to allow ease of configuration. The Perry XLX Evo also features an enhanced and fully integrated survey system with interfaces compatible with all modern survey equipment, including sub bottom profilers, multi-beam sonars, etc.

Saab Seaeye

Saab Seaeye has a number of vehicles in all classes. The Cougar Compact is the deepwater version of the compact, highly flexible and extremely powerful Cougar-XT. With all the benefits of the XT and the full range of optional quick-change tool skids, the Cougar-XTi also features a new concept in power distribution, self-diagnostics and a newly designed modular control system.

The panther XT is a development of the successful Seaeye Panther Plus ROV, which was developed in partnership with ROVTECH whose requirements were to minimize the system's weight and deck space requirements, while increasing the thrust and performance envelope to allow operations in the most demanding conditions encountered during IRM operations.

The Sabertooth is a merger of the Double Eagle SAROV (Saab Autonomous Remotely Operated Vehicles) and Saab Seaeye technologies, resulting in a hovering hybrid AUV/ ROV with deep water capability, long excursion range and six degrees of freedom control system.

The 2,000/3,000m Seaeye Leopard is a powerful electric work class ROV in a compact chassis, producing a half metric ton of forward thrust, with 50% more payload, three times the tooling power and double the depth rating of its predecessor the Panther XT-Plus, while maintaining the same deck footprint. The Leopard is suited to work tasks including drill support, pipeline survey, exploration, salvage, cleaning and deep water IRM.

Saipem

Saipem's new Innovator 2.0 ROV is a heavy work class vehicle used for oil field maintenance and construction, including in ultradeep waters, and for monitoring the seabed and gathering data to design of oil fields or subsea pipelines. Its electrical motor can provide 210Hp which, ensuring a bollard pull of 1,100 kg in each direction, a maximum speed of 3.5 knots and the ability to lift a weight of over 600 kg hooked to the frame. The ROV's umbilical cable and tether have been redesigned to transmit the ship's onboard power to the subsea vehicles. Innovator 2.0 is equipped with a 6,600V power supply which allows the ROV to operate effectively even with cable lengths over 7,000 m. The ROV has obtained a declaration of compliance with Norsok U102 standards, as well as DNV-GL certification.

SMD

Soil Machine Dynamics Ltd (SMD) is organized across a number of key business streams including work class ROVs, subsea trenching, submerged mining and marine renewables. The company was originally founded in 1971 and has served a number of market segments including oil and gas, telecommunications, military, scientific and mining. In 2003 they acquired Hydrovision and entered the work class ROV market. SMD's ATOM ROV is an ultra compact work class system. It is suitable for drill support, survey and light construction, and can be mobilized with minimal deck space. They have several offices including in Europe, the U.S. and Singapore.

Oceaneering

Oceaneering is a global oilfield provider of engineered services and products primarily to the offshore oil and gas industry, with a focus on deepwater applications. Through the use of its applied technology expertise, Oceaneering also serves the defense, entertainment and aerospace industries. Oceaneering's business offerings include remotely operated vehicles, built-to-order specialty subsea hardware, deepwater intervention and manned diving services, nondestructive testing and inspection and engineering and project management.

The company has several work class systems including the Millennium series.

The MILLENNIUM Plus ROV is a side entry cage deployed, dual manipulator 220hp heavy work class ROV. The cage and Tether Management System (TMS) supplies an additional 110hp, is capable of powering skids and also has thruster control and auto heading features.

H3000

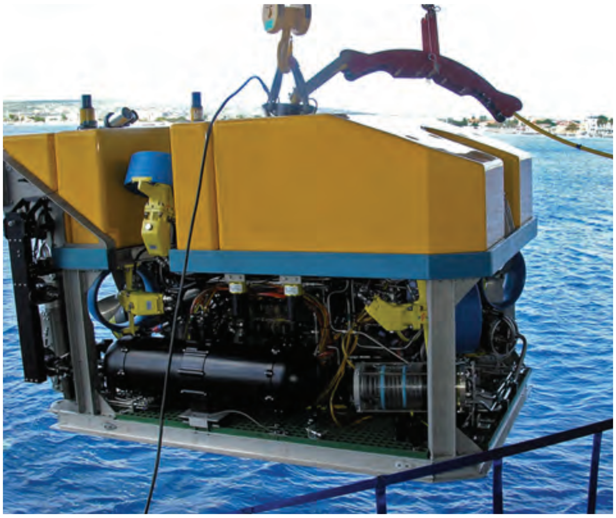


Photo: DOER Marine

Leopard

Photo: Saab Seaeye

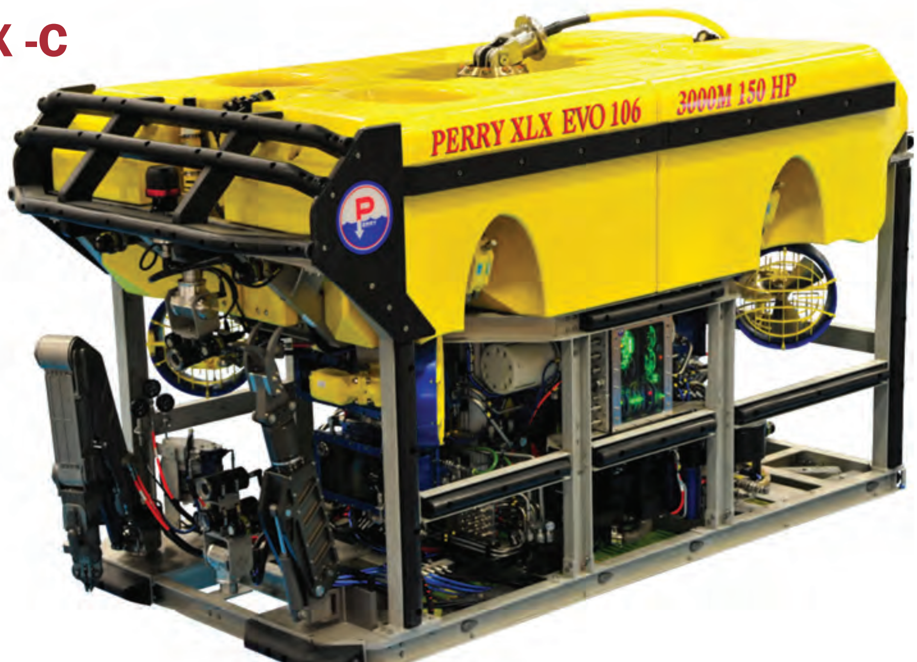
Millennium

Photo: Oceaneering

H2000

Photo: ECA

XLX -C



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	FEATURE	MARKET	TECH
JAN/FEB AD CLOSE 1/20	Underwater Vehicle Annual: ROV, AUV, and UUVs	HD Cameras & Sonar for Vehicles	Underwater N
	MTR White Papers: Oceanographic - February 2017 Bonus Electronic Edition Publication Date: February 27, 2017		
MAR AD CLOSE 2/28	Oceanographic Instrumentation: Measurement, Process & Analysis	Fiber Optic Connectors & Slip Rings	Ocean Bus Southampt
APR AD CLOSE 3/30	Offshore Energy Annual	Subsea Engineering: Subsea Field Architecture	Buoyancy Tec
MAY AD CLOSE 4/28	Underwater Defense	Offshore Renewable Energy: Wind, Wave & Tide	Magnetomete
JUN AD CLOSE 5/25	Hydrographic Survey	Comms, Telemetry & Data Processing	GPS, Gyro Co Motion Tracki
JUL/AUG AD CLOSE 7/28	THE MTR 100 - The 12th Annual Listing of 100 Leading Subsea		
	MTR White Papers: Hydrographic - July 2017 Bonus Electronic Edition Publication Date: July 15, 2017		
SEP AD CLOSE 8/25	Ocean Observation: Gliders, Buoys & Sub-Surface Networks	Research Vessels	Seafloor Engi Operations
OCT AD CLOSE 9/22	AUV Operations	Harsh Environment Systems for Arctic Ops	ROV Technolo Micro System
NOV/DEC AD CLOSE 12/1	Acoustic Doppler Sonar Technologies ADCPs & DVLs	Fresh Water Monitoring & Sensors	Offshore Insp Maintenance
	MTR White Papers: Unmanned Marine and Subsea Vehicles - November 2017 Bo Publication Date: November 7, 2017		

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avigation	Scientific Deck Machinery	The Atlantic Canada Subsea Cluster	Oceanology Intl North America Feb 14-16 San Diego, CA Underwater Defence & Security March 6-8, 2017, Portsmouth, Uk TUSEXPO Amsterdam, Netherlands
			Delivered to Over 30,000 Recipients Worldwide
siness 2017 ton, UK	Sonar Systems & Seafloor Mapping	Southern California Subsea Cluster	Ocean Business Apr 4-6, Southampton,UK Sea-Air-Space Apr 3-5, National Harbor, MD
hnology	Work class ROV's & Seafloor Trenchers	The Norwegian Subsea Cluster	OTC May 2-5, Houston, TX AUVSI XPONENTIAL May 8-11 Dallas, TX USA
rs & Streamers	Subsea Housings	Subsea Mining: The Time is Now	UDT 30 May- 1 Jun, Bremen, Germany MAST Asia Jun 12-14, Tokyo,Japan
mpasses & MEMS ng	Interconnect: Underwater Cables & Connectors		Oceans 2017 Jun 19-22, Aberdeen, Scotland
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gy: Workclass to s	Underwater Tools & Manipulators	The Southeast U.S. Subsea Cluster	OTC Brazil Oct 24-26 Rio De Janeiro,Brazil
ection, & Repair (IMR)	Underwater Imaging: Lights, Cameras & Sonar	The 2018 Subsea Market Planner	Underwater Intervention 2018

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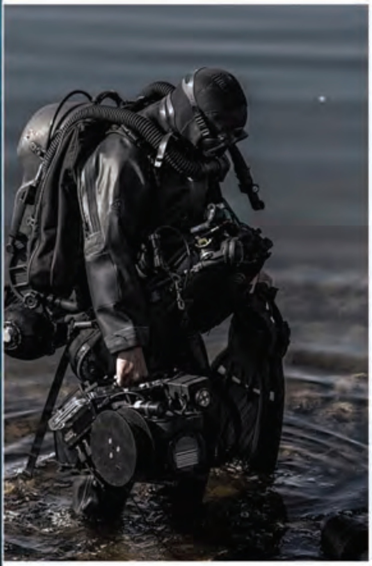

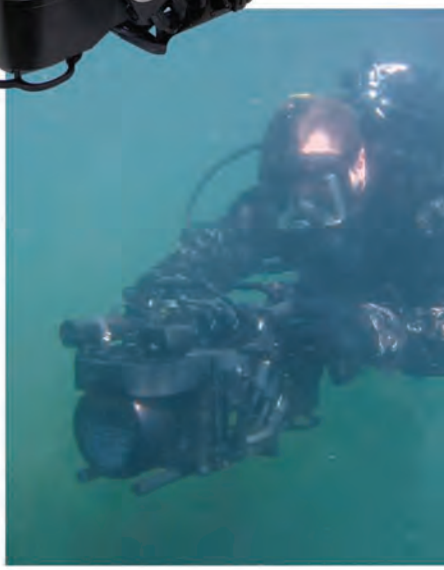

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