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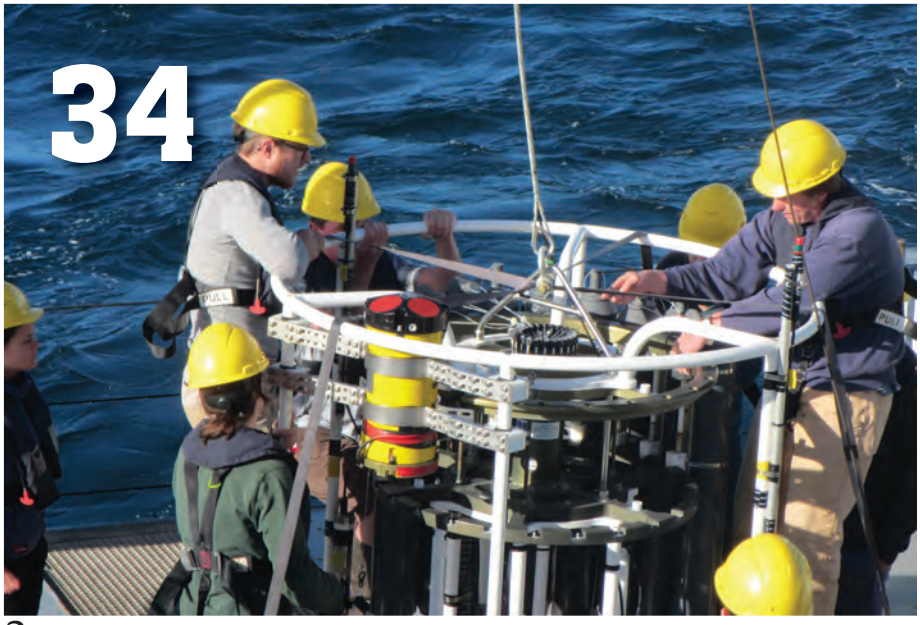

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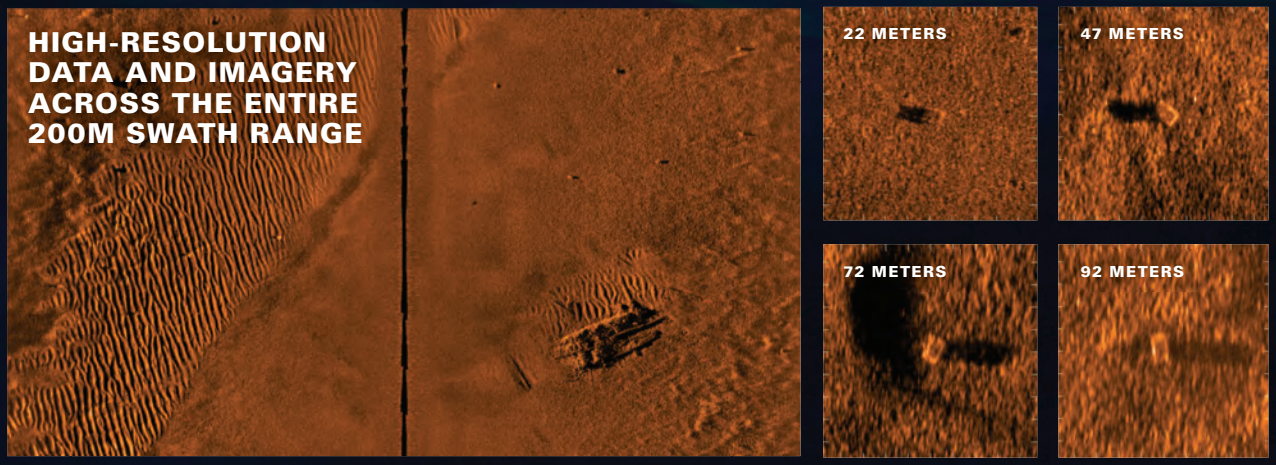

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Editor's Note

Despite the fact that I am not a fan of the winter, professionally December is undoubtedly my favorite time of the year as I get to slow down, think and re-group. I am coming off a manic travel swing which saw me on the road eight out of nine weeks, crisscrossing the country for a number of exhibitions, conference, symposia and one-on-one company meetings, with a stop in Cincinnati in early November to celebrate my parent's 62nd anniversary. No matter how busy the schedule stacks up, you can't disappoint mom and dad!

Added to the mix is a new addition to the New Wave Media family, as earlier this autumn we completed the acquisition of Atcomedia out of bankruptcy, and have been pushing hard to relaunch its flagship title, Offshore Engineer magazine and OEDigital.com. While the offshore industry is still 'challenged' to put it mildly, we are a long-tenured publisher in this maritime/offshore/subsea space with a long-term view, and with that we are decidedly bullish on the prospects offshore in the coming 20 years. While much of the talk surrounding offshore energy (rightfully so) centers on oil and gas, a slew of insightful presentations on offshore wind at Blue Tech Week in San Diego, followed by a riveting conversation with Jim Bennett, BOEM's Chief of the Office of Renewable Energy, at the Maritime Security Conference at Oak Ridge National Laboratory has me decidedly bullish on near-term future and rapid growth of offshore wind here in the United States.

Europe has a well-recorded 20+ year lead on the U.S. in terms of producing energy from renewable sources, a case made abundantly clear when comparing the U.S. Atlantic Coast with the North Sea offshore wind potential. According to stats from BOEM, the areas (U.S./North Sea) are roughly equal in population (51.6mil/42.4mil), length of coast (600nm/700nm). But they are drastically unequal in the number of active projects (14/37), production start date (2020/1996), active production (0MW/8,174MW) and anticipated production (10,118MW/43,878MW).

But in the big picture, acceptance of offshore wind as an energy source is growing, and will continue to grow in the near term as technology matures and public opinion starts to support the benefits.

You will read much more about the offshore energy sector and its impact on the subsea industry in these pages, print and electronic, in 2019 and beyond. Until then, I offer a sincere 'Thank You' to all who support Marine Technology Reporter throughout the year, with best wishes for a happy, healthy holiday and New Year.

Gregory R. Trauthwein
Associate Publisher & Editor

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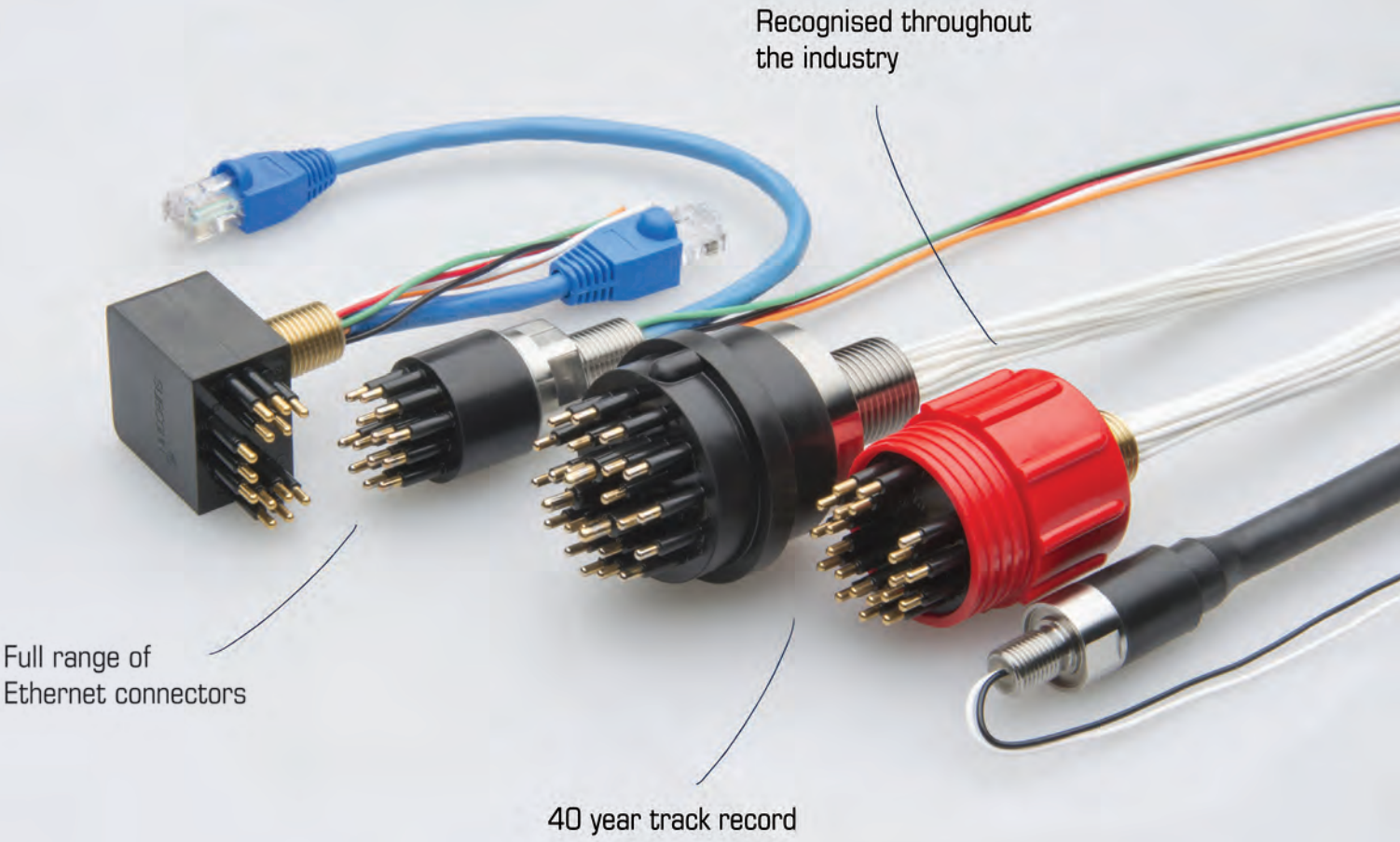

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UUV: Meet the Bluefin-9 Carlo Zaffanella and Michael Guay discuss the new Bluefin-9.

RE2 Robotics' New Manipulator Arm
RE2 Robotics offers a electro/mechanical manipulator. Travis Schneider explains.

Greensea Systems Expands
Marybeth Gilliam, COO, discusses the Greensea Systems value proposition.

Abkatun-A2 Sail Away

McDermott

The largest oil platform to be constructed in Mexico in the last decade has left McDermott International's fabrication yard in Altamira, Tamaulipas, Mexico. The 15,000-metric-ton PB-Abkatun-A2 platform was scheduled to be installed for PEMEX in November 2018 in Mexico's Bay of Campeche in 38 meters of water.

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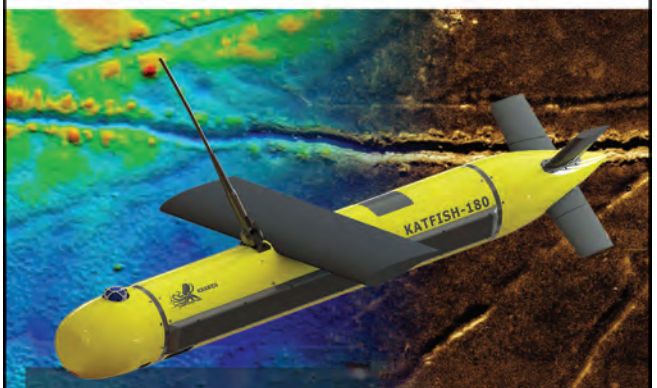

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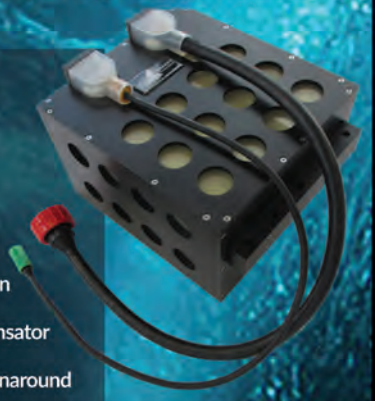

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Heastie

As Oceanology International celebrates its 50th Anniversary in 2019, Marine Technology Reporter visits with show director Jonathan Heastie of Reed Exhibitions for his insights on the development an direction of the organization's Oceanology Americas event, scheduled for February 25-27, 2019, in San Diego.

By Greg Trauthwein

Thank you for taking the time to talk to us. Oceanology International Americas 2019 is set for San Diego. Give us an overview of the exhibition... by the numbers... from the 2017 event. What are your expectations, in numbers, for 2019?

Well, we're hugely excited to be working with our partners, including local host, The Maritime Alliance, to deliver this next edition of the event in San Diego in February, and our plans are coming together really well. We've added a second exhibit hall this time, welcoming around 200 exhibitors of the latest ocean technology, up from 150 last time.

I am also thrilled that we have managed to gain access to the water at the rear of the convention center – and thanks to the Port of San Diego for their help – so we will be providing a selection of on-water demos allowing attendees to see and experience the technology in action.

In terms of actual attendee numbers, we were delighted to connect 1,775 unique attendees from around the world at the inaugural San Diego event, many from across the U.S. and Canada and from a variety of ocean-based industries. Although that was a solid start, we are eager to mirror the growth of the London event, and plan to attract 2,750 from across the Americas and beyond next year.

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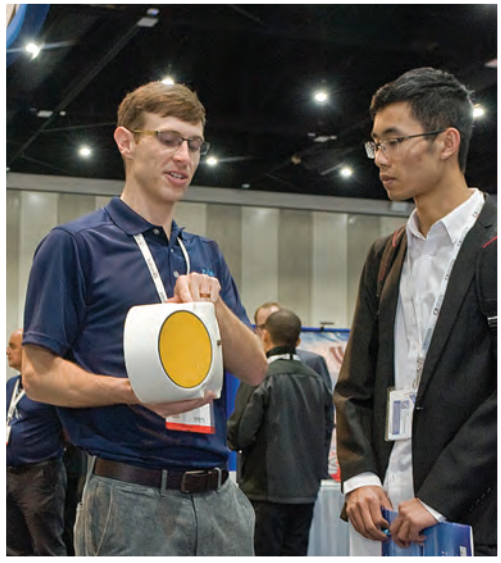

What do you consider to be your best 'lessons learned' in the wake of the first OI NA in San Diego?

I would like more attendees to come… and that's exactly what we are working on now, at least doubling our marketing activity and reach from last time. 1,800 quality attendees for a launch was a decent first outing, indeed many established events get that year-in, year out… but we want to better that considerably by replicating the value and scale of our London event. Now, that takes time – London's had 49 years at it! – but we aim grow our attendance for San Diego 2019 by an extra thousand to almost 3,000, and our plan is for 4-5k by 2021.

Unlike other events, the USP of Oceanology International is that it brings together buyers from multiple industries and geographies, unified by their interest in ocean technologies. Although the events were created from a marine science perspective, they now derive attendance from up to 17 different

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ocean tech-buying industries including offshore energy, aquaculture, defense, ports, telecoms, utilities, and many more. This is the template we are working towards for Oi Americas, and it's the reason why industry stakeholders asked us to create the event here in the first place: to provide a one-stop shop where everybody can meet, do business, learn, educate, socialize and improve their organizations. That's what we're striving to achieve… but, to do that, and to provide those exceptional benefits to everyone, we need the same commitment and support from the industry as well. I do hope people reading this will take the opportunity to attend and play their part in delivering, and gaining, these benefits.

The Oceanology International brand is obviously well-established with the London show, which celebrates a historic 50th anniversary milestone in 2019 – the 25th edition in London is in 2020. How is the San Diego event similar to OI London?

Yes, it's great to draw on half a century of expertise and heritage, and transplant the best bits of the world's leading event in marine science and ocean technology into its San Diego-based sibling. The events are really very similar, offering an exceptional platform for the leading technology providers and industry leaders to showcase their solutions and latest learnings, all under one roof at one time.

Like London, the most popular topics and technologies will include Unmanned Vehicles, Vessels and Robotics, Ocean Observation and Sensing technologies and Hydrography, Geophysics and Geotechnics. We're also reprising our "Catch the Next Wave" program from London, organized in association with The Explorers Club, which highlights how the spirit of exploration drives forward science and technology. Speaker pairings, comprising a leading explorer with a scientist or technologist, will once again examine the role technology plays in exploring environments on the seafloor, in the oceans, on the oceans, over the oceans and into space, pushing the boundaries of what is possible. Our speakers, and we've got some great ones lined up, will also cast a look at how emerging technology will make 'waves' for ocean exploration over the coming decades.

Aside from location, how is it different?

It's fair to say there is a greater focus in San Diego on the growing Blue Economy and its impact on Blue Tech, with particular focus on emerging markets and industry growth. For example, we are seeing greater interest in the nascent markets for aquaculture and marine renewables for the U.S. market, and both will feature in our strategic Ocean Futures Forum program that examines the future trajectory of the Blue Economy and its future science and technology needs. We also expect our Latin attendees to want to learn from their North American cousins as they develop their own Blue Economies and Blue Tech requirements. This is one of the reasons why we've expanded our scope and name to include them, and very much provides this event with its raison d'etre – to be the regional forum that connects ocean technology users from across these important Continents.

Is there anything new that visitors to OIA '19 can expect as compared to the last event here?

There certainly is… lots of new and interesting stuff. There's new content in the technical program, led this year by the Society of Underwater Technology in Houston, highlighting ma-

rine pollution and environmental stressors and the tools and techniques needed to address and mitigate these challenges; plus, at the time of writing, we are close to finalizing a very interesting new workshop about advanced image analysis and A.I. Check out the website in the coming months for more information on this and the other great content on offer.

On the exhibit hall floor, there are plenty of new features unique to the Americas event to help attendees, including a Marine Institutes pavilion hosted by Scripps and welcoming at least 10 institutes and academic hubs from around the Americas; a brand-new Future Tech Hub showcasing some of the newest technology seen since the last show, and many from small, innovative companies which don't often exhibit; and we're currently drawing up plans for a new "Meet the Buyer"-style program of networking events with attendees from the Navy and related Government agencies, marine science, offshore energy, ports and more.

The exhibition and conference schedule – as you know better than any – is crowded. Assuming that you will attract the same high-level quality and quantity of exhibitors, what are the most compelling reason(s) you can give to OI visitors to come out to the San Diego event?

In simple terms, we're delivering the world's flagship event as a dedicated regional edition for those across the Americas to meet, learn and see the latest technologies. The London event regularly attracts a healthy proportion of North American visitors, but this Americas event brings together five times more people, and adds in those from Latin America and the Caribbean too. Many people can't afford the time and cost of crossing the pond to London, but San Diego is a far easier proposition for most – and delightfully warm in February! – which is why we generate a sizeable 98% unique audience to this new event. What a great chance to make brand-new contacts, learn new things and find that all-important innovation you never knew about! We are thrilled to play such an important role in the global market, connecting tens of thousands of ocean professionals to help them improve their strategies for measuring, developing, protecting and operating in the world's oceans. Our next event in this global calendar is San Diego in February, and I extend an open invitation to anyone and everyone who wishes to play a role in shaping the science and technology needs of the Blue Economy, and sharing in that exciting journey.

Oceanology International turns '50'

As Oceanology International gets set to celebrate its 50th Anniversary milestone, *Marine Technology Reporter* is partnering with Reed Exhibitions to produce a pair of "50th Anniversary Special Editions", the first to print in conjunction with the January/February 2019 edition of MTR and distribute at Oceanology International North America 2019 in San Diego, the second to print in conjunction with the January/February 2020 edition of MTR and distribute at Oceanology International in London.

For information on participating in these special editions, contact Rob Howard at: howard@marinelink.com.

'Recovery' *Led by OSVs with Engineers On Board*

By William Stoichevski, Oslo, OEDigital.com

A report back in 2014 from numbers crunchers Rystad Energy — about the timing of an upturn for subsea engineering — appears to be proving largely true. Recovery, it said, would begin haltingly in two parts: first subsea services and then subsea equipment.

The reason was noted by this reporter after a visit to Statoil, now Equinor, in Oslo. The offshore operator said it had created a vast new cataloging and storage system for subsea equipment. Looking to cut costs, it said those stored subsea trees would be used before any new equipment was ordered.

Photo: Eidesvik Offshore

With 80 percent of Norway's offshore acreage and goodly share of active U.K. licenses, it was clear that subsea services in Northern Europe would pick up before subsea equipment. The cost-cutting shakeup was not lost on a subsea construction segment and became part of the impetus for mergers of subsea equipment makers and offshore contractors.

Worse, Rystad and Equinor's warnings were, in 2014, accompanied by a broadside in Moscow from BP chief executive Bob Dudley, who warned the World Petroleum Conference that "the end of stable oil prices" was at hand. Now, as these lines are being written, oil is stepping back after a year of solid gains.

Fleets Divided

For offshore fleets, the timing of this halting recovery is proving right-on. In Oslo on Tuesday, with shares in offshore construction outfit DOF plunging nine percent, the company's leadership could point to tangible improvements in the offshore market, especially in the North Sea. With its fleet working the world's deepwater oil provinces, they added that the only caveat was that anchor-handlers (AHTS) and platform supply vessels (PSV) weren't feeling much uptick.

That trend has been so strong for so long now, that industry analysts like Clarskson Plateau keep their watch separate: OSVs and subsea vessels. The latter indicates ships with engineering on board.

With the day rates paid for all offshore vessels by offshore oil and gas companies still subdued, the subsea and construction vessels are at least seeing a revival in fleet utilization. It's fueled, in part, by wind installations.

"The activity level within the oil and gas industry is increasing due to the improved oil price," wrote Viking Supply Ships CEO, Trond Myklebust, in a note to shareholders on November 9. He added that while better oil prices had been helping put more rigs to work, the OSV segment (of AHTs and PSVs) was "far behind" that usage cycle.

"We expect that the general OSV market will continue to be impacted by the huge oversupply of tonnage, which makes the market still challenging." Indeed, Clarksons has the number of OSVs in operation at 5,301 with 600 more newbuilds on order. With that, Mykelbust — who has just sold the company's last remaining PSVs — said Viking would focus on its ice-classed vessels, for which demand is expected to grow (especially after new cold water licensing rounds in Alaska, Canada, the U.K. and Russia). Myklebust is a former Bourbon Offshore chief exec and was the first CEO to warn of the "bloodbath" that would eventually hit the AHTS and PSV market.

Recovery Path

For offshore fleet owners whose vessels wield an engineering component —- like DOF, Subsea 7 or Bourbon Offshore

— there's at least the forecast upturn, as stockpiled subsea kit is used up. While the recovery is still nascent in subsea, it's statistically stronger than what the rig market and its associate OSV market are seeing.

Already, the mixed fleet operators are saying that however tough, 2018 has been much easier than 2017, whatever the numbers. The gearing for new markets long ago begun, turnkey offshore wind projects now mark "the ongoing transformation of business models," Bourbon said this week, as it juxtaposed vessel "overcapacity" with the "end of decline". It regretted only that long-term contracts were being locked in at "persistently low" rates that were still some nine percent lower than last year for all OSV types. Still, the company was seeing "renewed growth in the number of tenders," as exploration in Mexico, Nigeria, Angola and the Middle East picks up.

It was in subsea services, where Bourbon, with its 500 OSVs, posted the strongest gains. Subsea revenues were up over 25 percent, as floating offshore wind farms became a business stream with that first turbine installation off Scotland. Offshore engineering heavyweight Subsea 7 reported similar tangible improvements. Oilfield maintenance has picked up in Africa and the North Sea, and with it spot duty for all offshore construction vessels (OCV).

"With oil prices set to remain well above $60 a barrel, our clients are recovering leeway," Bourbon reported this week. They've also squeezed leeway out of ship operators, as average day rates are down about a quarter for subsea services and a third for AHTSs and PSVs.

Subsea 7, meanwhile, has just reported that its order backlog has hit $5.1 billion with projects in all the world's oil provinces, including new awards at Buzzard and Triton in the U.K. North Sea and at Katmai in the U.S. Gulf of Mexico.

In three months, it earned revenues on oil-gas engineering jobs alone of $1.1 billion. Wind added another 10 percent to that. Of Subsea 7's 34 OCVs, 32 pipe-laying, construction, heavy-lift and other vessels are under contract.

That sounds like busy times for offshore engineering if not for OSVs dependent on rig hires. So, if anything, the offshore "recovery" is production-based rather than exploration-based.

William Stoichevski *is* Offshore Engineer's *correspondent in Oslo, reporting weekly at* ***OEDigital.com****.* Offshore Engineer *is a sister-publication to* Marine Technololgy Reporter.

Mubadala *Picks Up Second Deal in Offshore Egypt*

By Shem Oirere, West Africa, OEDigital.com

The Abu Dhabi-based international oil and gas company Mubadala Petroleum has scored a second win in its drive to entrench its upstream investments in Egypt after signing a sale agreement with Italian giant Eni for a 20 percent stake in the Nour North Sinai Offshore Area concession.

Eni holds an 85 percent stake in the block in partnership with Egypt's first joint stock petroleum company, Tharwa, which owns a 15 percent stake.

Mubadala Petroleum, a wholly subsidiary of Mubadala Investment Company, had earlier in June made its debut in Egypt's upstream space when it acquired from Eni a 10 percent participating interest in Shorouk concession, which hosts the world class Zohr gas field that is thought to be the largest deposit in the Mediterranean Sea with natural gas reserves estimated at at 30 trillion cubic feet.

Musabbeh Al Kaabi and Claudio Descalzi at the signing cerimony. Photo: Eni

The transaction between Mubadala Petroleum and Eni is subject to the fulfillment of certain conditions and all necessary authorizations from Egyptian authorities.

"This investment enables Mubadala Petroleum to further expand our position in Egypt while deepening our strategic partnership with Eni, the operator of both the Shorouk and Nour concessions," said Musabbeh Al Kaabi, CEO Petroleum & Petrochemicals at Mubadala Investment Company and also Chair of the Board of Mubadala Petroleum.

"This exploration block complements our existing investment in Zohr, supports our growth strategy in Egypt and holds the potential to unlock an additional resource base that could add to our business in the longer term," he said.

The 739 square kilometer Nour block is operated by Eni's subsidiary IEOC in the prolific East Nile Delta Basin of the Mediterranean Sea and is located approximately 50 kilometers offshore in the Eastern Mediterranean in water depths between 50 and 400 meters.

Currently, Eni and Tharwa are implementing a $105 million two-phase well drilling works in the Nour field over the next six years with the first well initially set to spud in September of this year.

Eni's CEO, Claudio Descalzi, said, "This transaction strengthens our partnership after the successful relationship in Zohr and confirms Mubadala Petroleum's trust in Eni's robustness as operator, both in projects development and exploration activities."

For Eni, which had also previously divested 30 percent of its stake in the Shorouk concession to Russia's Rosneft, and 10 percent to BP, the disposal of a portion of its Nour asset falls within the company's now preferred 'Dual Exploration Model', which allows it to "simultaneously fast-track development of discovered resources and the partial dilution of the high stakes retained in exploration leases to monetize in advance part of discovered volumes."

But for Egypt, the deal between Mubadala and Eni goes a long way in boosting the country's ongoing efforts to narrow the huge gap between hydrocarbons production and consumption levels.

More petroleum industry majors, independents, small and large capital companies appear to be falling for the ongoing petroleum sector reforms pursued by President Abdel Fattah el-Sisi's government including the gradual removal of sub-

sidies and enforcing policies that make it easier to transact mergers and acquisitions in the country's upstream space.

With an increase in new investments especially in exploration and development, Egypt hopes to fast-track the replacement of the many maturing fields and also increase production from existing locations to cut back on gas imports and halt diversion of export-destined gas to the local market.

Moreover, Eni, which is 64 years old in Egypt, with hydrocarbon production volumes of 230,000 barrels/day, an equivalent of 13 percent of the company's total annual production, continues to exert its increasing role in shaping trends in Egypt's upstream operations, both as a leading player in exploration and production and as one of the most active companies in the increasing upstream mergers and acquisitions in the country's petroleum industry.

In addition, Egypt's position as the largest oil producer in Africa outside the OPEC and third largest gas producer after Algeria and Nigeria looks assured especially with the increasing attraction of international oil and gas companies eager to push for the development of new gas discoveries as Egypt strives to achieve self-sufficiency in gas that has seen consumption surpass the 802,000 b/d mark with an annual demand growth of 16 percent.

If recent activities in Egypt's upstream sector are indicators of future trends in the highly-attractive petroleum industry, then this North African country is on the path to achieving a sustainable balance between oil and gas production and the rapid consumption growth.

Shem Oirere *is* Offshore Engineer's *correspondent in West Africa, reporting weekly at* ***OEDigital.com***. Offshore Engineer *is a sister-publication to* Marine Technololgy Reporter.

Shipwreck

Oil Removed from WWII Shipwreck

A U.S. Navy led team has removed 229,000 gallons of oil from a sunken World War II era German heavy cruiser that has been resting on the seafloor near the Marshall Islands for more than 70 years.

After being transferred to the U.S. as a war prize, the cruiser Prinz Eugen was loaded with oil and cargo and used to assess survivability of warships during the Operation Crossroads atomic bomb tests in the Pacific. The ship survived two atomic blasts before being towed to Kwajalein Atoll, where it capsized and sunk in December 1946.

Now, 72 years later, a project team led by Stephanie Bocek of the Navy's Supervisor of Salvage and Diving (SUPSALV) and sponsored by the U.S. Army Space and Missile Defense Command / Army Forces Strategic Command has performed the unprecedented removal of oil from up to 173 tanks of a heavy cruiser warship.

The operation required two years of research and planning. Prior to removal of oil, SUPSALV's Emergency Ship Salvage Material oil spill response team worked to select, assemble and deploy the right combination of equipment, tools and consumables to support the planned operation.

The load-out included "hot tap" oil extraction systems, submersible pumping systems, oil spill response resources, tank close-out and patching supplies, and other innovative diver tools.

A market search was conducted to identify and charter a commercial oil tanker to collect the recovered petroleum product transport it for disposal or recycling at the conclusion of the opera-

U.S. Navy photo by LeighAhn Ferrari

tion. The oil tanker vessel Humber was selected.

Humber, along with Military Sealift Command's (MSC) USNS Salvor were positioned directly above the ex-Prinz Eugen in order to effectively conduct the oil removal. This task was challenging because of the close proximity of the wreck to the neighboring shoreline which would not allow the ships to drop the shoreward anchors due to shallow depth. Ultimately, SUPSALV arranged for use of the U.S. Army Garrison - Kwajalein Atoll's harbor tug Mystic to collect the anchors at the pier and drop them in place this allowed the ship to successful finalize their four-point moor over ex-Prinz Eugen.

Each oil-filled, accessible tank was hot tapped, pumped free of recoverable oil, and sealed with a permanent, tamper-proof dome assembly to prevent any subsequent leakage of residual oil clingage left in the tank.

These actions ensured that the wreck, a popular dive site, is safe for continued recreational diving and the Atoll is safe from the risk of significant oil spill from ex-Prinz Eugen.

"This project was an incredible opportunity to showcase the U.S. Navy Salvage community's capabilities. SUPSALV had prior experience with sunken vessel oil removal on ex-USS Chehalis and USS Missessinewa, so we were well positioned to lead this project," said Capt. Keith Lehnhardt, Supervisor of Salvage and Diving. "This also serves as an example of exceptional partnership for future oil spill responses, salvage operations, and other emergencies."

U.S. Navy photo

U.S. Navy photo by Stephanie Bocek

Flooding Rivers *& Floating Top Marks*

Grupo Lindley was approached by Administração dos Portos do Douro, Leixões e Viana do Castelo in Portugal to improve the reliability of the aids to navigation in the Douro River. Along this stretch of navigable waters there are many piles that when the river floods become totally submerged.

In conjunction with Instituto Hidrográfico (Portuguese Navy), Almarin together with sister company Lindley in Portugal has been working on a topmark that performs as a buoy floating off from the pile in high water. The goal was to design a day mark that would function normally during the navigation season, however, it would also have a greater chance of survival during the winter floods.

The result of a successful implementation will be lower operational costs of the channel whilst increasing safety to navigation.

Flooding Rivers

In channels or rivers marked with piles as aids to navigation beacons, where the water level variation is high, defining focal plane is not straight forward. A high focal plane increases cost and may hinder night time visibility. Beacons with a low focal plane run the risk of being fully submerged when the water levels rise.

During flooding above focal plane the beacons will not be visible and the waterway will no longer be navigable under these conditions as the beacons themselves become submerged obstacles. Top marks and lights will probably be damaged and, following the floods, beaconing must be inspected and repaired to restore full navigability of the channel, which implies cost and delay in the river operational navigation.

Grupo Lindley / Administração dos Portos do Douro, Leixões e Viana do Castelo

The use of buoys vs. floating top marks

Buoys are an excellent solution for river channels with a constant flow as their mooring can be designed with a long scope and their movement perpendicular to the axis of the channel will be minimal.

In the Douro River Balizamar buoys work perfectly with 3 knots of current. However, when flow is not constant having buoys on long mooring scopes may present a problem due to their swing radius, particularly where there are narrow channels and cross winds.

For this reason, in the Douro River piles are being used in the shallower and narrower parts of the channel, buoys in the deeper and broader parts of the river. Generally, the narrow and shallow sections occur close to dams on the downstream side and deeper water close to dams on the upstream side.

The development hinges around the concept of a floating top mark that acts as a buoy when moored to the top of the pile. When water level rises the impulse of the top mark-buoy will release the unit from the pile at which point it will float away down river until the mooring line is taught.

The unit will then act as a buoy remaining vertical and upright when afloat in low current speeds, although it is improbable the unit will remain vertical in strong currents as the use of counter weights had to be avoided to facilitate replacement. Once water level subsides the maintenance team will have to replace the units on their piles.

Resulting design

This innovative buoy works as a fixed and floating mark and it's designed for rivers or channels with a high water level variation whilst maintaining a high precision when water levels are low.

The project was selected for presentation under the conferences' innovation section at the 19th edition of IALA Conference in Incheon (South Korea), which took place in May 2018, and it was presented by Almarin's general manager and technical director, Patrick Lindley.

Almarin, an IALA industrial member since 2008, presented its new AtoN catalogue too, with a wide offer of buoys, beacons and towers for ports, lantern rooms and solutions for the marking of bridges and structures under navigation channels.

SISTAC

Brazil´s Homegrown Subsea Service Provider

By Claudio Paschoa, Brazil

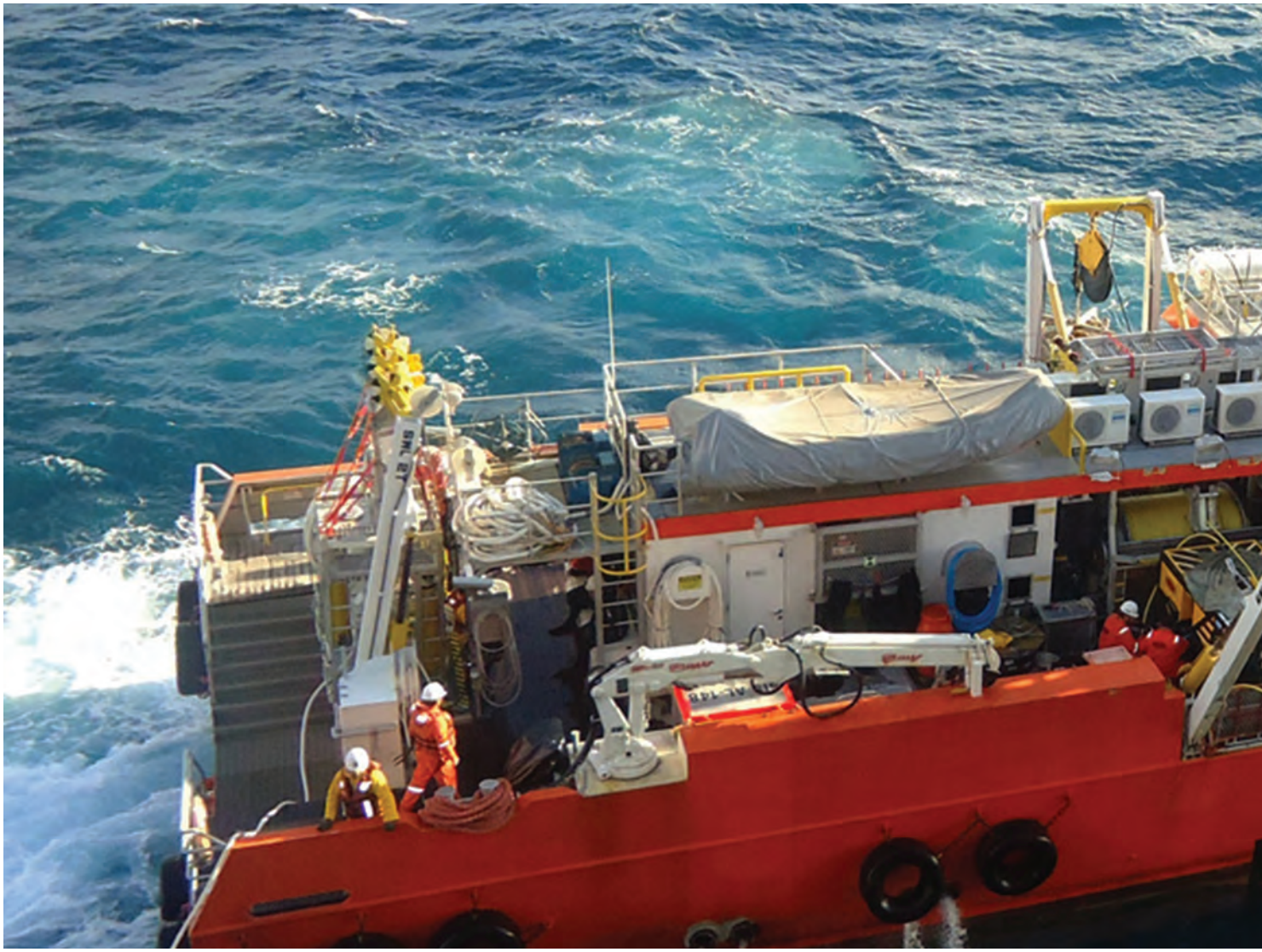


Photo: Sistac

Sistac is an established local offshore service provider in two subsea areas (ROV and Diving), along with its distinguished position as a pioneer in rope access services, which only enhances their value and importance to the national offshore growth effort. Marine Technology Reporter *spoke to* ***Felipe Gutterres****, CEO of Sistac about is history and operations in Brazil.*

Gutterres joined Sistac in 2016. He is the former CFO, Investor Relations Director and International Board Member of Wilson Sons Limited – one of the largest listed port and maritime logistics providers in Brazil – where he held his first position as Investment Manager in 1998. From 1994 to 1998, he served as planning and finance executive at Shell Brasil. Gutterres holds a diploma in General Management from Harvard Business School, a MBA from COPPEAD, and graduation in Economics from UFRJ. "I saw a lot of potential in the company, good and engaged people, good assets, good positioning and with possibilities growth in a challenging market. I quickly learned that Sistac is composed of adventure professionals, with divers and climbers and I identified with that. I am motivated by challenges and by actions that can have a positive impact on people and on the society," said Gutterres.

Sistac is a leading player in offshore oil & gas IMR services in Brazil. Founded by a former saturation diver, Mario Gonçalves (currently board member of the company), who had been operating in the oil & gas industry since 1979. Headquartered in Niteroi, the company has its operational sites in Itaboraí and Macaé, both Northeast of the city of Rio and its own shipyard in Angra dos Reis on the South Coast (where its vessels were built). Sistac was founded in 1995, by Mr. Gonçalves, in the search for alternatives to improve IMR in the country. That same year, Sistac had already innovated in the market by mak-

ing demonstrations of services to Petrobras using the Industrial Climbing technique, in addition to bringing the recently launched welding inspection technique by ACFM (Alternated Current Field Measurement).

In 2005, the company innovated once again and pioneered in Brazil by performing submerged repairs for Petrobras, without interrupting production. The projects did not stop there. In 2009, Sistac built an offshore support vessel for diving operations. The project was a success and in 2015 the company's most modern vessel, Sistac Vitória was launched. That project was a great solution to meet Petrobras` needs in several ways: with the support of the vessels, it was no longer necessary to take up space on the platforms to house equipment or employees. The history of Sistac was marked by entrepreneurship and innovation that their founder imprinted very successfully in the company's DNA, in the course of Sistac`s 21 years.

In 2017, Sistac concluded a dive contract to support pull-in / pull-out operations on Modec's MV-26 FPSO. It is a relevant contract, with a duration of approximately 30 days, and it meant winning over important competitors who had current contracts with Modec. Sistac has a long history of diving and ROV operations with Petrobras and also significant operations with Chevron. "We have five pillars that are the basis of the company and will guide all our actions in the next years. They are: security, commercial courage, efficiency, financial solidity and professionalism. To provide engineering solutions in inspection, and subsea maintenance and repair in the offshore oil and gas in Brazil, seeking the integrity and life of our customers' assets, through security, quality, sustainability, ethics and high commitment from our employees, operations and businesses. Our vision is to be in five years the first choice of our customers in inspection, maintenance and repair solutions both for surface and subsea services in the oil & gas segment in Brazil, growing in a safe, sustainable and profitable way, where our employees will develop their potential in an environment conducive to the collaboration, teamwork and innovation," said Gutterres. Sistac business units are composed of:

- **Air diving:** nondestructive testing – visual, thickness measurement, ACFM, magnetic particle and electrochemical potential measurement – thruster and hull repairs, etc., performed by divers breathing compressed air (50-meter depth limit).

- **S-DSV:** vessel operation, used as a launch base for diving, inspection and ROV services. All of Sistac's vessels have

Sistac Esperança Deckhouse

Photo: Sistac

been built by the company in its own shipyard.

- **ROV:** ROV operation, used for visual inspection and electrochemical potential measurement on platforms, including Work Class ROVs.

- **Rope access:** nondestructive testing – visual, thickness measurement, ACFM, magnetic particle and penetrating liquid – maintenance and lifting gear inspection. Rope access techniques performed according to International Rope Access Trade Association (IRATA) standards. Qualified personnel who access remote and exposed points on the platform structures.

- **Pull-in/pull-out:** connection and disconnection of risers and/or umbilicals coming from the well to the platform or FPSO, using winches and divers or ROVs. Last task before the well starts producing oil.

Sistac`s Shipyard is located in Marina Verolme, Angra dos Reis-RJ, it is specialized in aluminum constructions, such as: S-DSVs, containers according to IMO – MSC 860, Dive and ROV LARS, helicopter decks and other offshore structures.

The Vessels

Sistac Vitória was developed from stem to stern to be a dedicated DP-2 capable diving support vessel, featuring fully integrated ROV launch and recovery, dive compressor and decompression chamber.

The vessel was constructed at the shipyard in Angra dos Reis, Brazil, and delivered to Sistac in the second half of 2014. A spacious wheelhouse is located upstairs, with forward and aft facing vessel control stations, ROV and dive control workstations. Overhead Windows are fitted both fore and aft for high-angle visibility.

The aft deck features a large working deck, which houses the ROV crane and reel, a pair of dive platforms and two deck cranes. Inside the main deckhouse are functional areas such as toilets and showers, dive shop (housing compressor and decompression chamber) and ROV shop.

Below decks are accommodations for the remaining 33 crew members, in a mix of two, three and four-berth cabins. 4 Scania D13 main engineers, each producing 410kW, power the vessel.

The DP-2 capability ensures the vessel can hold station in the event of a failure in any single component of the system, enhancing both safety and reliability.

Sistac crewmember preparing dive helmet

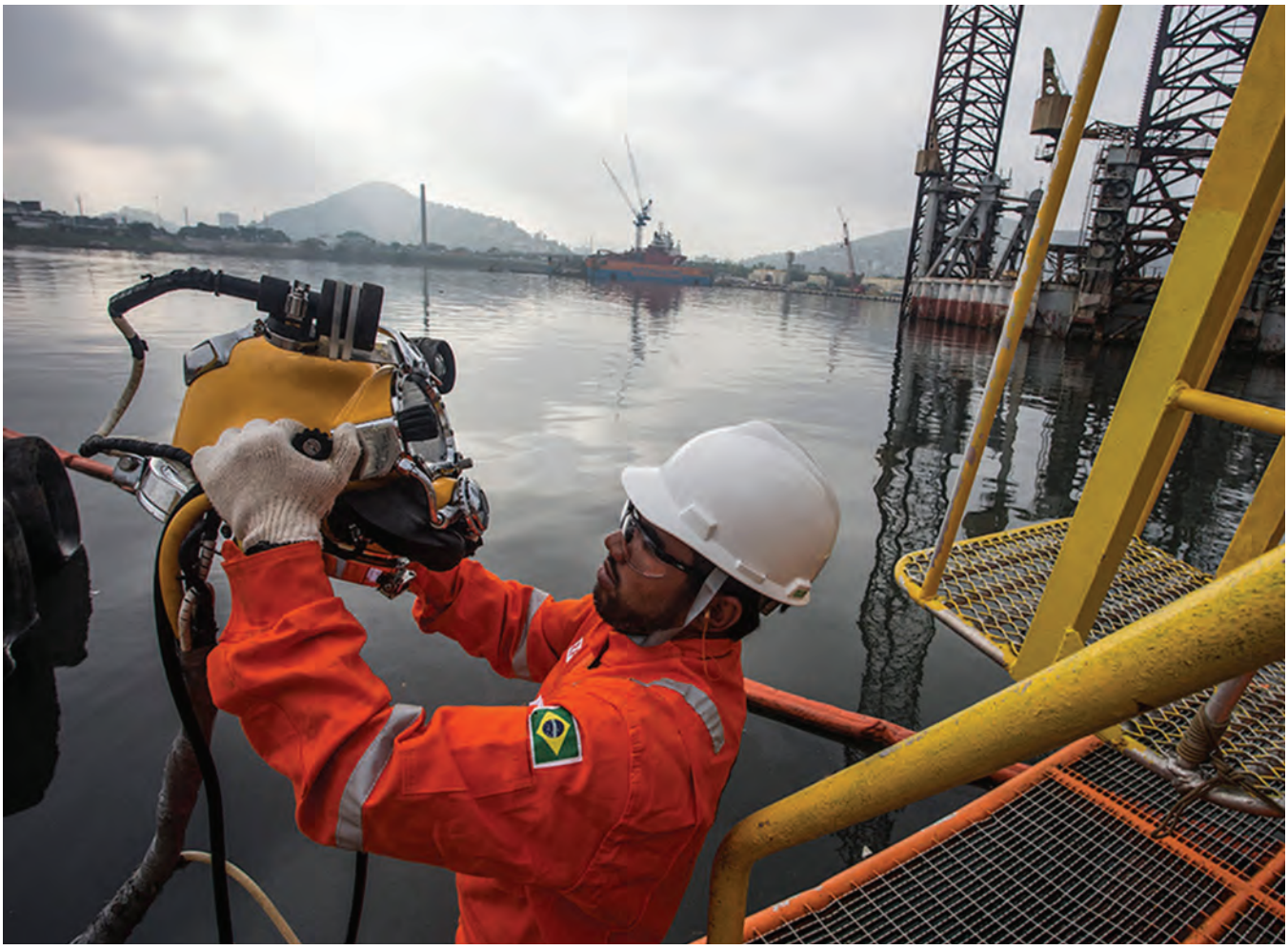


Photo: Sistac

Sistac Vitoria launching ROV

Photo: Sistac

Main Particulars

Length, o.a.	42.5m
Length, waterline	38.5m
Beam	9.3m
Draft (hull)	1.85m
Fuel Oil Capacities	112,000 liters
Fresh Water	20,000 liters
Personnel	36
Flag	Brazil
Type	S-DSV, Offshore Support
Propulsion Performance	
Speed (Service)	13 knots
Speed (Max)	15 knots

As well as being efficient, the vessel's new-generation hull form gives it excellent sea keeping characteristics, enhancing the functionality of the vessel in harsh offshore operations.

Sistac Esperança is a 25-meter, aluminum Shallow Diving Support Vessel (S-DSV) which has proven to be an easier and faster way to perform IMR services.

In addition, it provides a safer way of putting the diver in the water. In December 2010, the Esperança started operations through a contract with Petrobras.

Length, o.a.	25m
Length, waterline	23.3m
Beam	6.4m
Draft (hull)	1.34m
Fuel Oil Capacities	20,366 liters
Fresh Water	6,188 liters
Personnel	16
Flag	Brazil
Type	S-DSV, Offshore Support
Speed (Service)	13 knots

New projects

"In view of Sistac's excellent performance in the technological development project in partnership with SENAI and Shell in Bahia, we were invited to a new technology development project. These R & D projects are very important to the company and receiving an invitation of this type is a privilege for recognizing Sistac's effort to stay current in technologies. In 2016 we built the so-called Paths of the Future, which is nothing more than the strategic planning that Sistac must pursue to improve more and more. In particular, the Efficiency Project is one of many initiatives of our "Pathways of the Future".

Photo: Sistac

Left: Sistac Diver ready for action.

The main objective of the Efficiency Project is to seek to optimize the use of company resources through: conscious consumption of inputs; search for better suppliers with more competitive prices and reflection on the ways in which activities are currently carried out. The Efficiency Project focuses on our costs and expenses, except personnel costs and expenses," said Gutterres.

The Efficiency Project will act in waves. The first wave will focused on the most relevant costs and expenses, which represent about 80% of the total, and the second wave focuses on the remaining 20%. The first wave is already underway and the second wave began in the second half of 2017. In addition, the Efficiency Project is subdivided into nuclei, each with a person responsible for monthly monitoring of the evolution of the initiatives that are operated by the owners of packages, which is a grouping of costs and expenses with similar characteristics. The Efficiency Project attained the goal of achieving a reduction of more than $800,000) in 2017.

"In an unstable political and economic scenario, such as Brazil faces now, I believe that the company should prepare to continue growing by seeking to operate safely, explore the high quality of our services, focus on the needs of our customers and through continuous search for efficiency. We will work very hard on these themes to continue in our trajectory of growth," said Gutterres. According to Marcos Passos, Commercial Director and of Sistac's New Businesses, the economic crisis and political context of Brazil negatively influenced the oil and gas market and many companies have suffered this impact.

Even with this turbulent scenario, Sistac remained stable and managed to extend three contracts with Petrobras: services such as industrial climbing, diving contracts and implementing services with divers and ROV with support from Sistac Esperança. In addition, we signed two more diving contracts (long-term), one with a new customer, Equinos (former Statoil), and another with Ensco. These achievements are a reflection of the value of the company, together with the commitment of all employees and quality of our services. The commitment from everyone was instrumental in getting this positive result during the crisis. Sistac has over two million professional diving hours to its credit, along with over 2,000 offshore interventions by its vessel. The company is present in the Campos, Santos and Espirito Santo Basins, along with Basins in Northeast of Brazil.

Full-Depth Current Profiling Around the Global Ocean

Three Decades of High Pressure for Lowered ADCPs

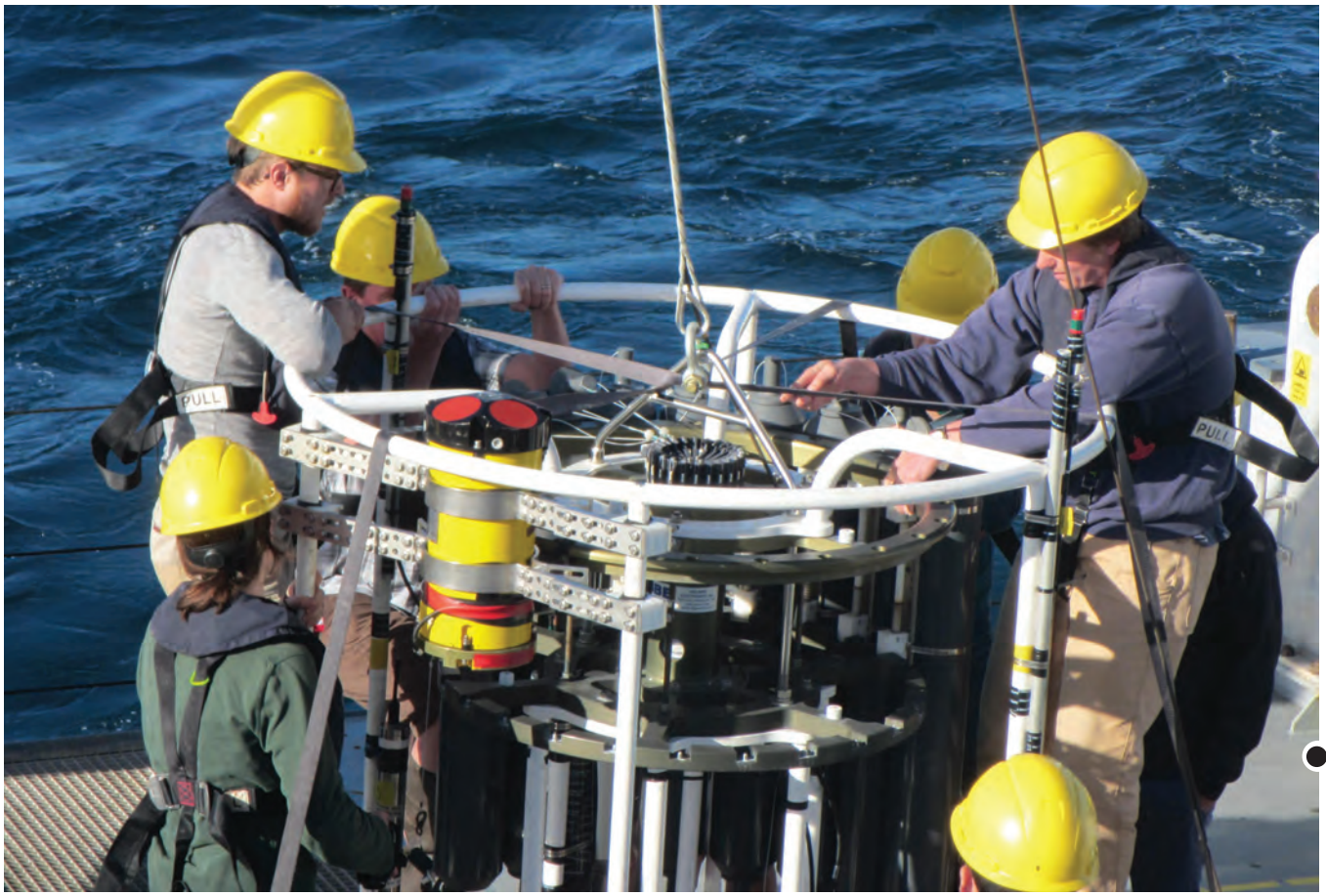
By Peter Spain Ph.D., Teledyne RD Instruments

INTRODUCTION

Ever since the unexpected motions of the first deep-drifting floats, oceanographers have worked to lift the veil on deep currents. Direct current measurements have come in various guises. Neutrally-buoyant floats and their profiling offspring revealed deep pathways. Current meters on moorings showed changes in time. Free-falling probes allowed a profile view—closely-spaced measurements showing water current velocity versus depth. And lowered ADCPs (LADCP) have provided well-resolved, full-depth current profiles since the early 1990s.

Deep currents store, carry, and redistribute important properties for life in and out of the sea. For example, oxygen and nutrient levels are vital where the deep waters upwell to supply the

Fig. 1



ocean's food chain. Yet until the mid-1970s, deep currents rivaled the dark side of the moon for mystery. Stimulated by findings from improved observations, there is now intense interest in how deep currents take part in the global climate system. Especially important are the changing heat and CO2 content of the deep ocean.

Methods for observing the deep sea below the upper seasonal layer are established. For measuring deep currents, scientists worldwide attach compact ADCPs to hydrographic packages. These packages are routinely lowered to the seabed to catch water samples and to measure water properties.

In this report we look at various findings from LADCP work around the global ocean. LADCP measurements were initially looking at deep currents in equatorial regions and in tropical and subtropical oceans. Features included deep currents, undercurrents, and eddies. More recently, LADCPs have supported scientific studies at high latitudes, such as exploring overturning circulations in the subpolar N. Atlantic and calculating widespread intense mixing in the Southern Ocean.

HYDROGRAPHY

Ship-based hydrography measures water properties from the surface to the seabed. Results come from lowering a continuous-profiling CTD and collecting discrete water samples. These "hydro" casts are unrivaled for observing the deep ocean—especially below 2000 m. At the same time, this method also reveals hot-spots for atmospheric exchange with the ocean.

The hydrographic data see wide-ranging uses. Their span includes ocean properties, processes, and pathways. Long-term records exist for carbon components, nutrients, freshwater, heat, and more. These records reveal oceanic changes attributed to atmospheric trends—global warming and enhanced CO2 levels.

VELOCITY PROFILING

Vertical profiles of water current velocity and shear show how water moves and mixes. They help describe how water properties change and disperse. These properties include heat and energy as well as organisms, nutrients, chemicals, debris, and pollutants.

For studying deep currents, scientists want velocity profiles to have long reach yet keep a fine-scale view of how currents change with depth. This data type has revealed ocean facets from internal waves to jets, eddies, and undercurrents. And the information is widely used, from scientific discovery to operations aboard offshore rigs.

Before ADCPs, velocity profiling needed specialized teams and tools. Their use of ship time and non-recoverable equipment made the measurements expensive. Scientists sought a method that was more economical, easier to use, and available to a wider audience.

Over several years, a handful of experts adapted ADCPs to meet this demand. They devised the LADCP method and processing (https://goo.gl/1TGXBn). Key input came from staff at the University of Hawaii and Lamont Doherty Geological Observatory in USA and IFM Kiel in Germany.

LOWERED ADCP METHOD

Deep current profiling measures below the acoustic range of ship-mounted profilers. Attached to a lowered hydrographic package, compact self-contained ADCPs pass through the water column. During descent and ascent, the ADCP continues to measure current profiles with ranges to 100 m. Later these short segments—with their fine-scale vertical resolution—are stitched together to produce a full-depth profile.

Fig. 1: Teledyne RDI ADCP attached to a hydrographic package before lowering to great depths.

Credit: J. Lemus (U. Hawaii). https://goo.gl/VfvYn1

Careful processing of LADCP data incorporates various inputs. Current profiles from ship-mounted ADCPs are used to validate LADCP profiles where they overlap. Corrections are made for ship's drift and the varying attitude and motions of the lowered package. Near the bottom of the cast, acoustic echoes scattered by the seabed reveal the ADCP's motion. Often, dual ADCPs are used—looking up and down.

One key advantage of the LADCP method is that it does not add to ship time and running costs; the velocity profile is completed during scheduled hydro casts. Specialized technicians are not required although successfully operating the LADCP entails training and diligence. The ADCP's compass should be calibrated carefully.

WINDS OF CHANGE

Adding ADCPs to hydro casts caused a sea change. Deep current profiling was available to a much larger community. Data collection was regular and widespread. And supplementary information about deep currents informed other studies, such as tracer measurements.

LADCPs gained traction on hydrographic cruises during the World Ocean Circulation Experiment (WOCE, 1990-2002). By the early 2000s, improved LADCP data quality came from improved methods of measurement and processing. And the last two decades have seen routine use of the LADCP method around the global ocean.

Extensive collections of these full-depth measurements are available. And accumulating LADCP sections from many cruises opened the door to statistical descriptions. In short, LADCPs provide a unique and developing view for studying the global ocean—from large-scale circulation to small-scale mixing.

DEEP UNDERCURRENTS

A key motivation for knowing more about deep currents is to clarify the global thermohaline circulation. Along the western edge of all major ocean basins, narrow, swift undercurrents have been observed at depth. They have distinct water properties and flow counter to strong surface currents.

Using LADCPs off southern Africa, UK scientists identified an unknown undercurrent. The substantial Agulhas Undercurrent, which surprisingly is not evident in hydro data, flows equatorward at 1200 m depth. Found alongside the continental slope, this deep current carries ten times the volume of the world's largest river. Later studies confirmed the Undercurrent's discovery and its unexpected water properties.

Many of these undercurrents hug the steep topography of the continental slope. At these sites, full-depth LAD-

Fig. 2

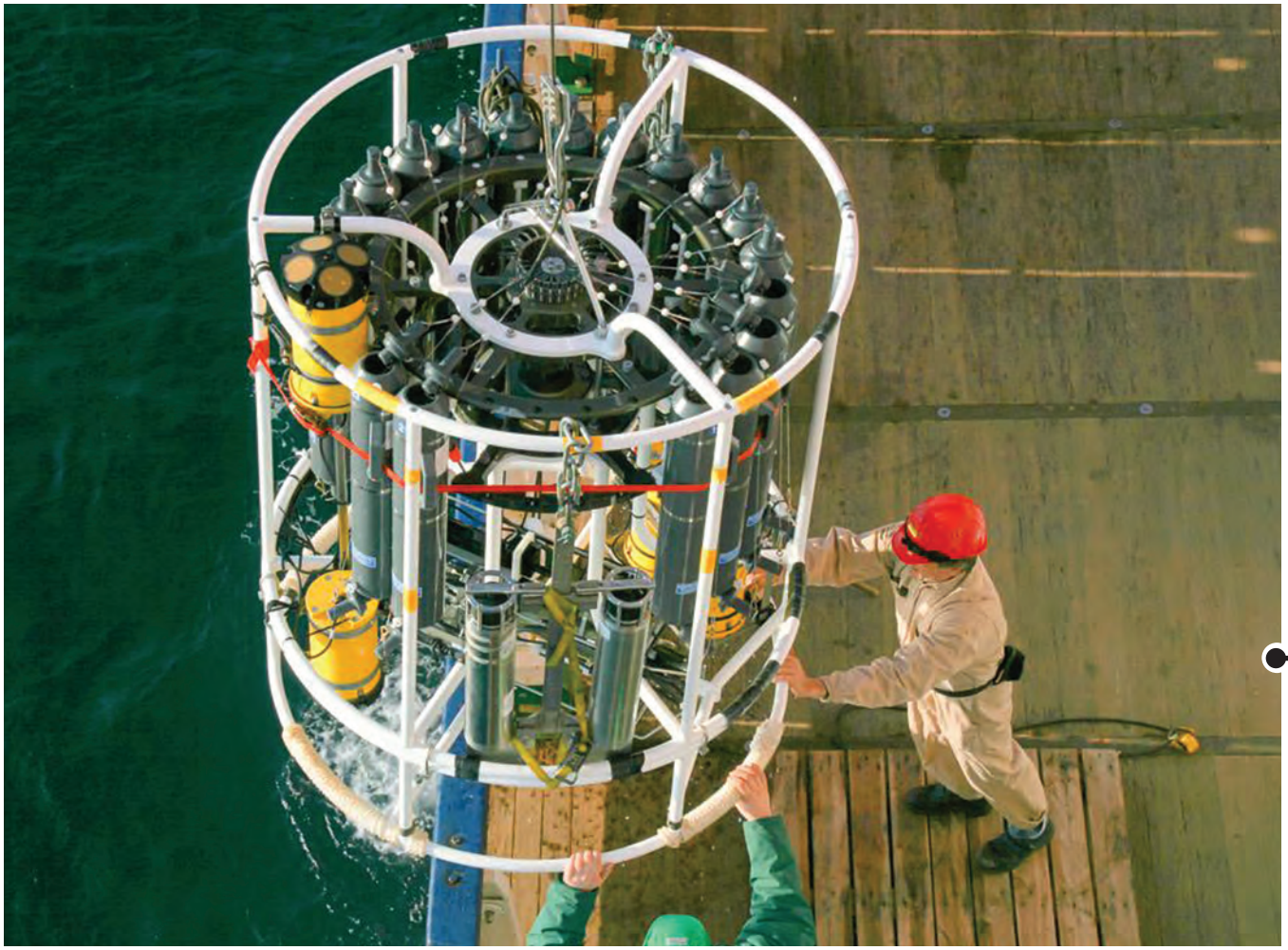


Fig. 3

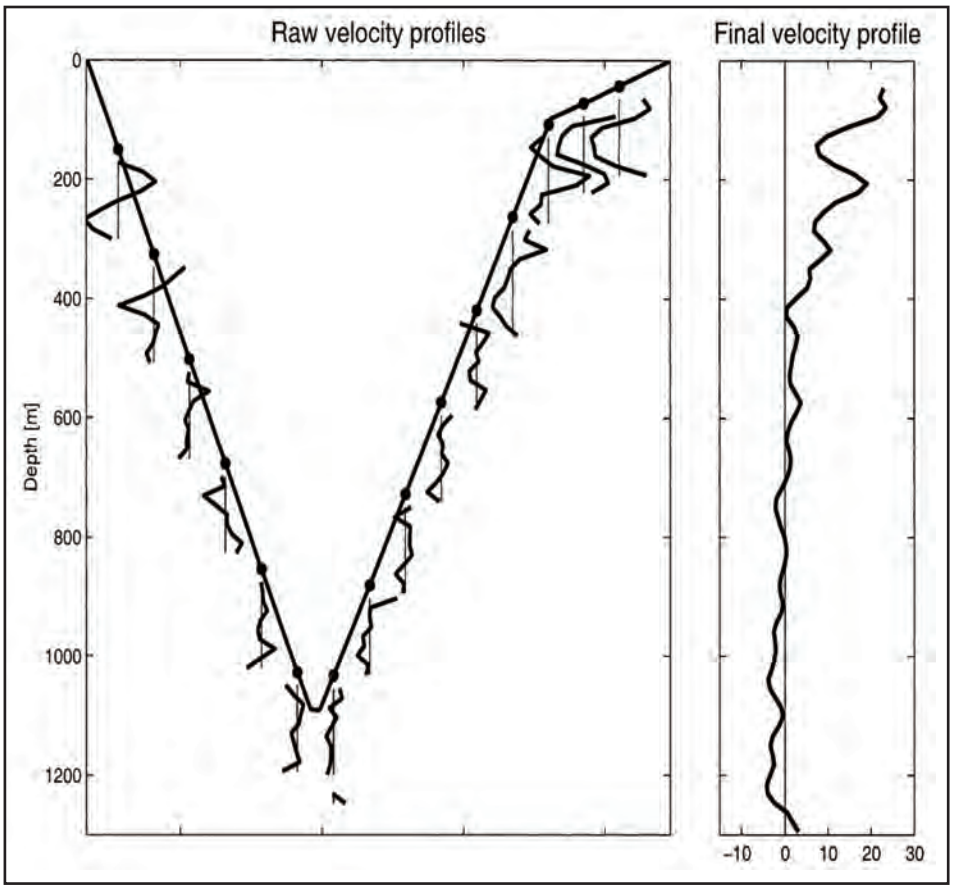


Fig. 4

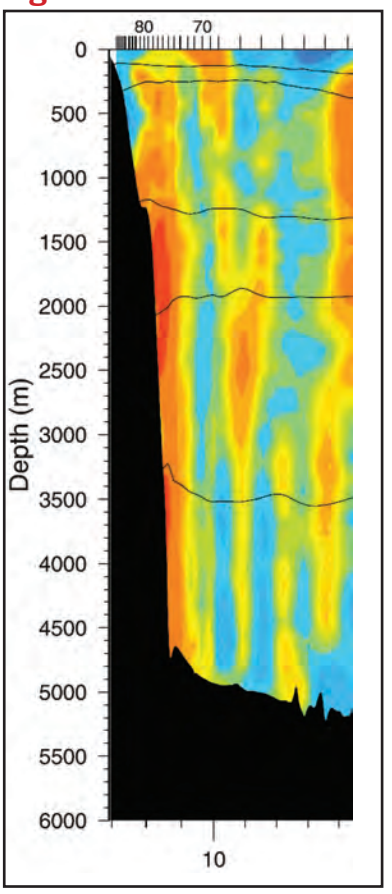


Fig. 3: ADCP profiles are stitched to form a full-depth profile. Speed (cm/s).

Credit: M. Visbeck (GEOMAR, 2002).

https://goo.gl/kftcJ3

Fig. 4: Deep undercurrent flowing equatorward (orange) along a steep continental slope. Units: Depth(m), Distance(deg).

Credit: Hall et al. (2004)

https://goo.gl/4QB6xs

Fig. 2: Up- and down-looking Teledyne RDI ADCPs (colored yellow for highpressure rating) are attached to a hydrographic package.

Credit: T. Wasilewski (IFM Hamburg).

https://goo.gl/q7XGKK

Fig. 5

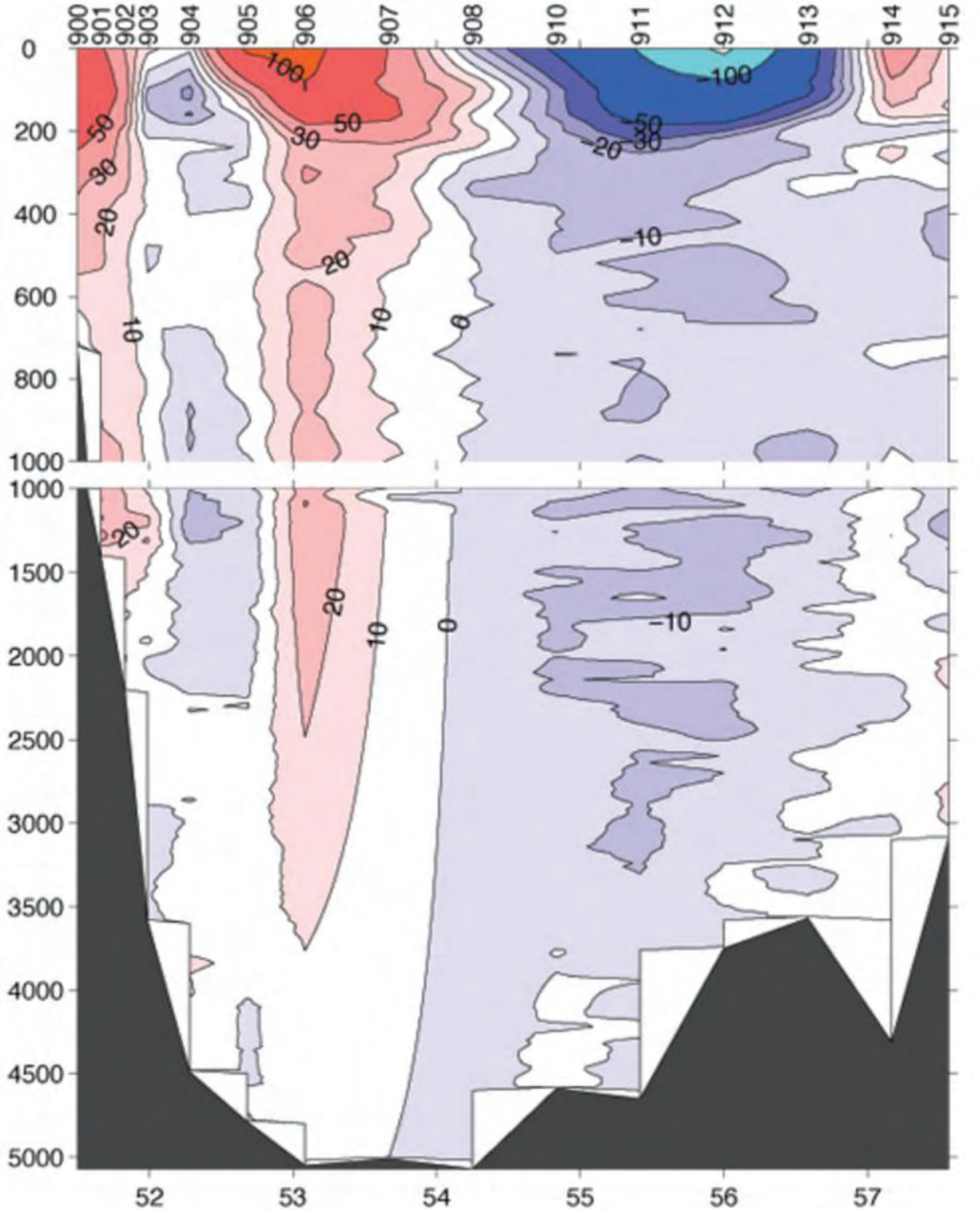


Fig. 5: LADCP data show the deep extent of the Great Whirl, a large intense gyre off Somalia. Units: Depth(m), Distance(deg).

Credit: T. Chereskin (Scripps Inst. Oceanography) https://goo.gl/WsmhuV

Fig. 6

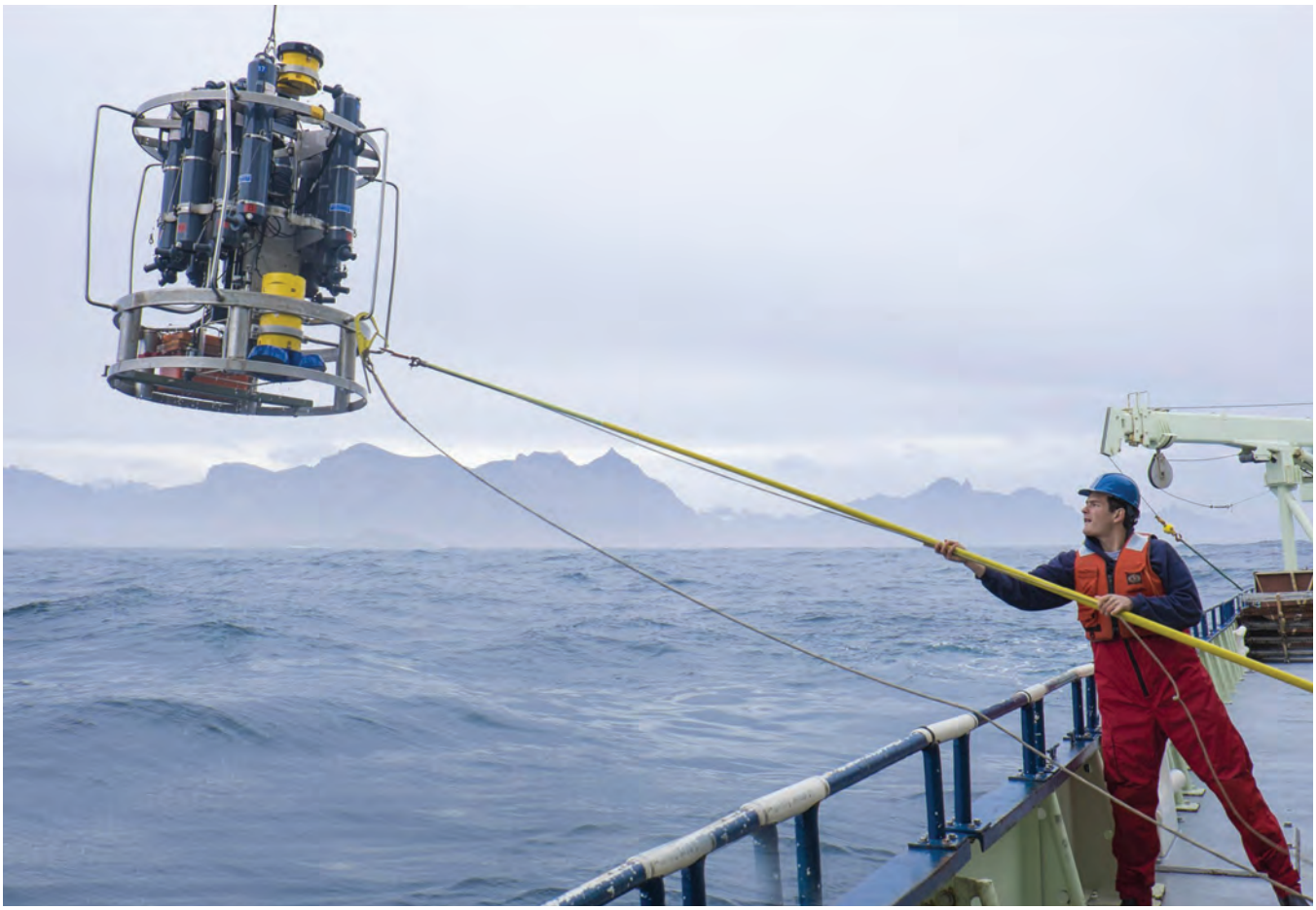


Fig. 6: Hydrographic package with dual Teledyne RDI ADCPs (yellow) in action off Greenland.

Credit: C. Nobre (WHOI). https://goo.gl/HJLq5m

CP profiles can be especially valuable. Over steep slopes, transport estimates for deep currents calculated from the density field can be low caused by gaps in the data. LADCP currents provide a solution.

Furthermore, LADCP data are 2-D velocity vectors—not just the cross-track component. This difference becomes more important where the hydro section cuts the current field at an oblique angle.

DEEP-REACHING CURRENTS

The UK scientists also found LADCP stations helpful offshore of the Under-

current. The velocity signal of the main Agulhas Current persists to great depth. Deep flows without shear are not evident in currents calculated from hydrographic sections. As a result, the traditional method can underestimate water volumes transported by deep-reaching currents. Addressing this issue was a common early use of LADCP data.

Farther north in the Indian Ocean, impressive oceanic changes follow the onset of the southwest monsoon. A well-known reversal of strong surface currents occurs in the Somali Current. Stacked jets of currents with opposing directions are found at depth. In addition, a large intense gyre spins up off Somalia over a month's duration. Called the Great Whirl, the gyre reaches 500 km wide. It persists for three months and then dissipates as fast as it spun up.

An impressive feature of the Great Whirl is its deep extent to 3000 m. US scientists collected LADCP data on two visits separated by 3 months during WOCE. The depth of the Great Whirl's currents increased from 200 m to 2500 m. Due to the deep reach of these currents, the volume of water moving in the Great Whirl matches the flow of the Gulf Stream off Cape Hatteras. The deep reach of the Great Whirl is one proposed explanation for reversals in the abyssal circulation below. These too were observed with LADCPs.

DATA BLENDING

Oceanographers explored new ways to merge the LADCP information with water properties observed during the hydro casts. Ocean currents transfer water properties. For a closed region, the exchange of water properties must satisfy conservation laws, such as mass conservation. An analysis technique called inverse modeling blends different data types subject to these laws.

Away from coasts, slowly-changing currents can largely be described by the hydrographic data. But the interpretation can be equivocal due to subjective choices about deep motions. When added to an inverse model, the LADCP data constrain possible solutions for the missing deep currents.

LONG-TERM SECTIONS

For two decades, German researchers have monitored boundary currents off Canada at 53°N. Across their persistent section defined by 3–5 moorings, the scientists repeated 12–15 LADCP stations during 13 cruises. As a result, data from 150 LADCP stations supplemented the moorings to describe the overturning contribution from the Labrador Sea. Strong currents were seen at various levels. In particular, the LADCP data showed a high-speed core near the deep-sea floor. Its waters had originated in the Nordic Seas.

Full-depth LADCP profiles are well-resolved vertically and can have finer horizontal spacing than a moored array. The flexibility of LADCP locations allows better definition of the inner and outer edges of the boundary current. Thus scientists can calculate more accurate transports from moored data. At 53°N, the boundary current was 120 km wide and had stable spatial structure. The volume of deep water exported southward was 30 million cubic meters per second—about the same as transport through the Florida Straits to supply the Gulf Stream.

OCEAN-WIDE SECTIONS

An ongoing multi-year, international research initiative is titled Overturning in the Subpolar N. Atlantic Program (OSNAP). Working across the width of the Atlantic at high northern latitudes, OSNAP includes many researchers with prior programs in the region. Their joint focus is ocean-wide transport of heat and freshwater as part of the global climate system.

A recent report described two crossings of a composite ocean-wide hydrographic section, observed in 2014 and 2016. The sections span several basins that show strong boundary currents. Results for the deep velocity field merged currents from the density field with a deep reference velocity from LADCP data.

The researchers noted that the LADCP data are particularly valuable in narrow boundary currents and undercurrents. Accurately measuring these features relies on high horizontal resolution; they tend to be underestimated and underresolved by satellite-based options. In fact, the report quantified this discrepancy for the combined transport of deep undercurrents around the subpolar gyre.

ESTIMATES OF MIXING IN THE OCEAN

Scientists also tapped LADCP profiles for looking at internal waves. More specifically, they wanted to quantify the effects of internal wave breaking.

Motivating this effort was a desire for more data about mixing in the ocean. Mixing had been theorized to be a significant factor in maintaining the ocean's thermal profile. Yet studies of mixing in the ocean had been limited to a few specialized teams and tools. And those results could not be extrapolated to represent the global ocean.

In the late 1990s, scientists tested the shear from LADCP profiles as input to a statistical description of mixing in the ocean. The method blended the velocity shear with complementary data from concurrent CTD profiles. For calculating mixing across more widespread regions, the geographical distribution of LADCP profiles from WOCE was appealing. In particular, LADCP data were available in anticipated hot spots for mixing where experts had not measured.

The Southern Ocean was a prime target. Using the LADCP-based method, an international team reported results of widespread intense mixing near Drake Passage. High rates were seen over rough topography for thousands of kilometers. The implication is that mixing is an essential factor in the large-scale overturning circulation at high southern latitudes.

The use of LADCP data in such mixing studies has gained traction—even "exploded" per a recent paper. For example, one group of scientists proposed an alternative approach to quantify mixing. They included LADCP data from five diverse dynamic regimes: equato-

Fig. 7

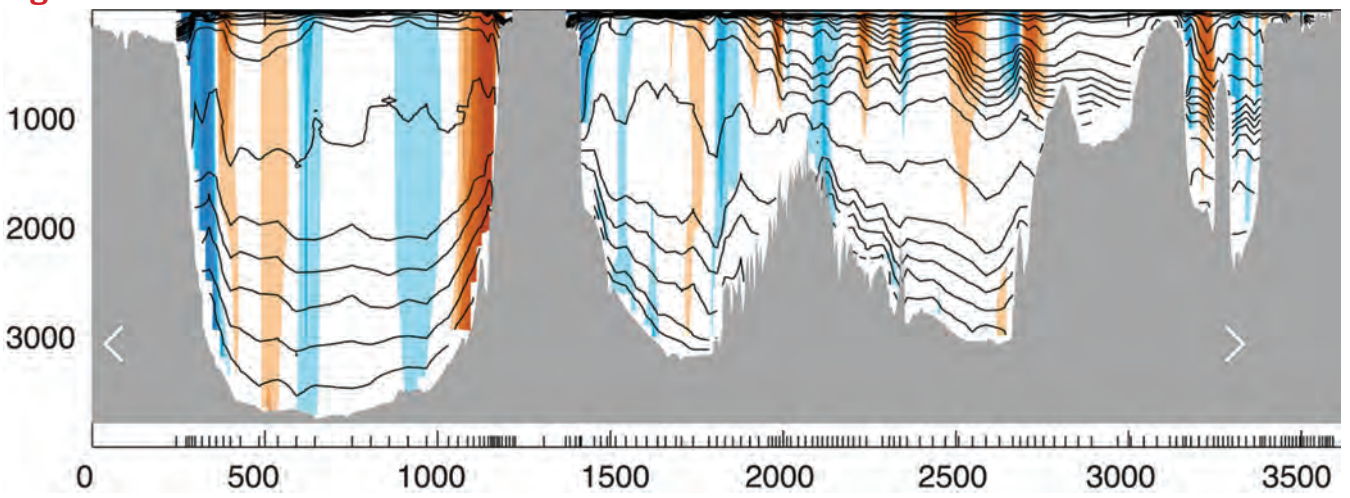


Fig. 7: Ocean-wide section of north/south currents in Subpolar N. Atlantic in 2016. Currents: North(red), South(blue). Units: Depth(m), Distance(km).

Credit: Holliday et al. (2018) https://goo.gl/3YAE8X

rial waters, East Pacific Rise, Luzon Strait, South Pacific, and Drake Passage.

LOWERED ADCPS: GREAT UNDER PRESSURE

Velocity profiling provides a fine-scale view of how ocean currents change with depth. The method began with specialized teams and tools. Later compact ADCPs were lowered to the seabed. Over several years, a cooperative effort among experts devised and refined the LADCP method and processing.

The Lowered ADCP has spread to be a standard technique used worldwide by the ocean research community. They have used it to lift the veil on deep currents from internal waves to jets, eddies, and undercurrents. And after three decades of gathering, full-depth LADCP velocity profiles span the global ocean. They are being applied across a wide range of issues: from local to global in scope, and from days to decades in duration.

Data Credits

Fig. 3: M. Visbeck (2002) Deep velocity profiling using lowered Acoustic Doppler Current Profiler: Bottom track and inverse solutions. DOI 10.1175/1520-0426(2002)019<0794:DVPULA>2.0.CO;2

Fig. 4: M.M. Hall, T.M. Joyce, R.S. Pickart, W.M. Smethie Jr., D.J. Torres (2004), Zonal circulation across 52°W in the North Atlantic. https://doi.org/10.1029/2003JC002103

Figs.5: L. M. Beal, and K. A. Donohue (2013), The Great Whirl: Observations of its seasonal development and interannual variability. https://doi.org/10.1029/2012JC008198

Fig. 7: N.P. Holliday, S. Bacon, S.A. Cunningham, S.F. Gary, J. Karstensen, B.A. King, F. Li, E.L. Mcdonagh (2018), Subpolar North Atlantic Overturning and Gyre-Scale Circulation in the Summers of 2014 and 2016. https://doi.org/10.1029/2018JC013841

Domestic Dredging

U.S. Dredgers Weigh in on Infrastructure, U.S. Capabilities and the road ahead.

Domestic dredging firms face many challenges in the coming months and years. At the same time, opportunities abound in a market and political climate that seems to beg for infrastructure upgrades, especially when it comes to harbors and inland waterways. Weighing in this edition on all of that – and more – are three U.S.-based dredging firms; Callan Marine, Cashman Dredging, and Weeks Marine.

Cranford, NJ-based Weeks Marine, Inc. (WMI) is a family-owned company with roots on the New York City waterfront extending back to 1919. Today, WMI has offices and repair yards in the North Atlantic, Gulf of Mexico, Hawaii, and Ontario, Canada. Eric Ellefsen is the President of Weeks. The company has three key divisions – Construction, Dredging and Marine Services – as well as two major subsidiaries, Healy Tibbitts Builders, Inc. and McNally International, Inc.

Jay Cashman is the Founder and chairman of the board at Cashman Dredging. Cashman Dredging's history dates back to the late 1800s. Over time, the company has evolved and began performing marine construction in the 1970s after the Blizzard of '78 destroyed seawalls and jetties throughout New England. Soon, Cashman was performing multi-million dollar projects such as construction of a new marine facility for the Martha's Vineyard Steamship Authority. Today, Cashman Dredging and Marine Contracting provide an array of integrated solutions ranging from navigational, maintenance and environmental dredging, to pond and industrial dredging.

Maxie McGuire is President of Callan Marine, LTD. This Texas-based and family-owned dredging business was founded in 2009. Callan Marine performs dredging projects for both private and public clients by providing services to restore berthing depths for ship docks and navigation channels. This year, Callan is partnering with Great Lakes Dredge & Dock Corporation on the San Jacinto River in Houston, TX. Through the ongoing construction of the General MacArthur,

We are finishing design plans on a new 5,000 cubic yard hopper dredge. We intend to begin construction on the first of two 5,000 cubic yard hopper dredges in the spring of 2019.

Jay Cashman, Founder, Cashman Dredging

The U.S. industry has proven it is large enough to complete all of the nation's maintenance dredging and new work dredging in our ship channels. Land reclamation, mostly shore protection on the beaches.

Eric Ellefsen, President, Weeks Marine

Callan Marine will enter into the large dredging market in the areas of major waterways, beach reclamation, and wetland restoration. Separately, the recent acquisition of Bean Coastal and their management team will allow Callan Marine to continue its penetration into the dredging industry, as it establishes new standards for efficiency and effectiveness.

Does the U.S. have the collective dredging capacity to accomplish all of the maintenance dredging and the increasing number of deepening projects that are being started in the response to the Panama Canal Expansion?

Jay Cashman: Yes, we do. The dredging industry is continuously building vessels and equipment. We keep up with demand.

Maxie McGuire: Yes, there is adequate fleet capacity as well as a significant amount of new builds in progress and recently entering the market due to the increase in funding for our nation's infrastructure investments. We're able to make investment decisions that will carry based on a level of certainty that we are comfortable with.

Eric Ellefsen: The U.S. industry has proven it is large enough to complete all of the nation's maintenance dredging and new work dredging in our ship channels. Land reclamation, mostly shore protection on the beaches, has also been a growth market that the industry continues to respond to. In fact, navigation interests will benefit from the ongoing industry investment to better serve the reclamation market. There will always be either unforeseen, or unprepared for, challenges that might produce a short-term hopper dredge shortage on occasion. In the winter, when every entrance channel in the South Atlantic must be maintained over a four-month period due to an environmental window, coupled with a simultaneous rise in the Mississippi River, sometimes puts a little stress on the hopper dredging sector. However, industry works closely with the Army Corps of Engineers (Corps) to mobilize dredges from other projects to address these national needs. Today, the Corps Ready Reserve dredge Wheeler supplies that fire truck response in the Lower Mississippi. In the future, we believe the Corps could save money by using a private sector solution; for example, using a proven ready reserve approach. We are working with the Corps and other interested parties on an industry first solution.

What's your fleet renewal strategy and are you planning any newbuilds in the near term? Tell us about your newest assets and what's coming next.

MM: We are currently building a large market cutter suction dredge, the General MacArthur, for new work, land reclamation, beach renourishment, and maintenance dredging. It is expected to be commissioned in Q2-Q3 2019. Our other assets are new, as well, dating back to 2018, 2017, and 2009 respectively. The General MacArthur is currently under construction at C&C shipyard in Louisiana.

EE: Weeks has been making major investments over the last decade, both in dredging vessels and all the support equipment necessary to perform major dredging projects. Ancillary equipment, including boosters, barges, boats and miles of discharge pipeline are an essential component of any dredging operation. Every Weeks dredge makes use of advanced automation, and ever more powerful and fuel-efficient engines to drive both propulsion and pumps. Our newest hopper dredge, MAGDALEN, just went to work on the Atlantic Coast this year (2018). She was built in Eastern Shipyard, Panama City, FL, and is the size of our two existing hopper dredges combined. She is fast, shallow draft, and can pump out over long distances, thereby reducing the need for booster pumps. We are very happy with her early performance and look forward to seeing all that she will do the years ahead. Both the modernized and highly automated BE Lindhom and

RN Weeks will continue to be an important part of our workhorse hopper dredge fleet. We are also building another large sea-going pipeline dredge at C&C Marine in Belle Chase, LA. While Weeks has a large fleet of cutter suction dredges, the JS Chatry will be the most advanced. In July 2012, the CR McCaskill entered our ocean-going cutter suction pipeline dredge fleet. For the last six years, she has been working almost non-stop on projects around the country. The Chatry builds on the capabilities built into the McCaskill and will join our fleet sometime next year.

JC: We recently completed major upgrades to our fleet. We are finishing design plans on a new 5,000 cubic yard hopper dredge. We intend to begin construction on the first of two 5000 cubic yard hopper dredges in the spring of 2019. We've already begun machinery acquisition and started the procurement process for long lead-time equipment.

Describe your fleet and operational equipment mix. Do you specialize in one form or dredging over another?

JC: Cashman is the premier bucket and environmental dredging company in the United States. We have bucket dredge sizes of four yards to 50 yards; two backhoe dredges of five yards to 18 yards; one hopper dredge; and five environmental bucket dredges. We're proud to have completed the largest environmental remediation dredging project in U.S. History – the Upper Hudson River PCB remediation project for GE. Aside from environmental, Cashman does all types of dredging including navigation (Arthur Kill Channel for access to Port of NYNJ), beach renourishment (Florida) and pond & industrial work (Maryland).

MM: We own three small cutter suction dredges (General Pershing (18", 1,565hp), General Patton (16", 3,000hp), and

Weeks Dredge Magdalen. Photo: Weeks

We are currently building a large market cutter suction dredge, the General MacArthur, for new work, land reclamation, beach renourishment, and maintenance dredging. It is expected to be commissioned in Q2-Q3 2019.

Maxie McGuire, President, Callan Marine, Ltd.

General Eisenhower (12", 1,500hp), sized 18", 16", and 12". Our dredges have the capability to dredge to 56' and have dual dredge pumps for maximizing efficiency. We specialize in deep draft ship dock dredging; both new work and maintenance.

What is the most pressing issue on your plate during this calendar year?

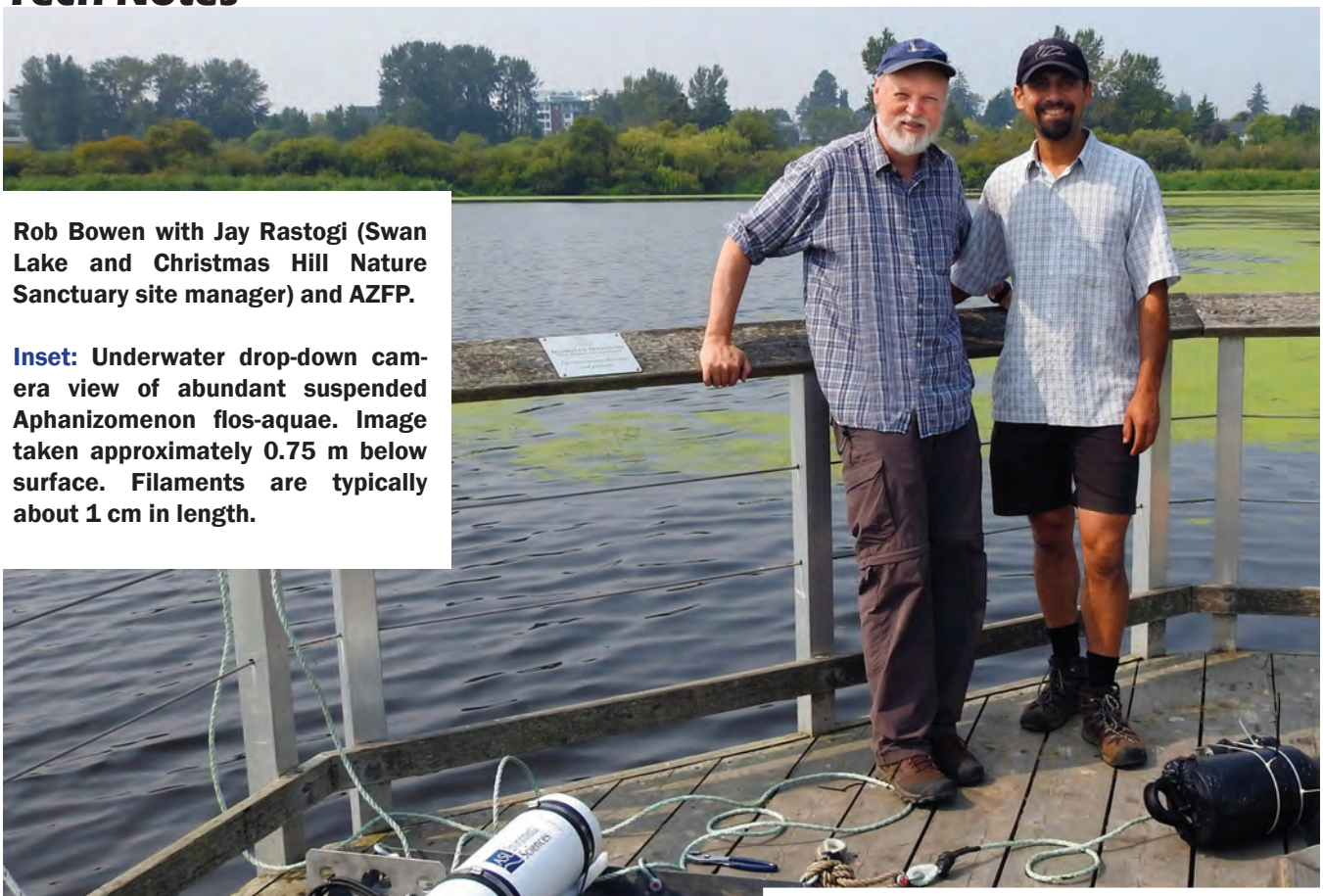
MM: Given the very low unemployment rate, recruiting is a big issue.

JC: We are always looking to innovate at Cashman. We recently developed and presented to industry the Scow Geofence System (SGS). Out split-hull scows will not dump unless they are within the predetermined geofenced ocean disposal area. That's something we've just completed. What comes next is even bigger as we turn our attention to hopper dredge design and construction.

The USACE performs a good portion of U.S. dredging, yet the private sector is a critical part of the equation. Where do your projects emanate from – government or commercial?

JC: It's really a combination of all types of dredging depending on the year. For instance, we just kicked off the second phase of the Boston Harbor deepening project and we're using the largest crane and bucket dredge combination in North America. We're also working on the Flushing Bay dredging project cleaning out the southern portion of the East River for the New York City Department of Environmental Protection. We do it all.

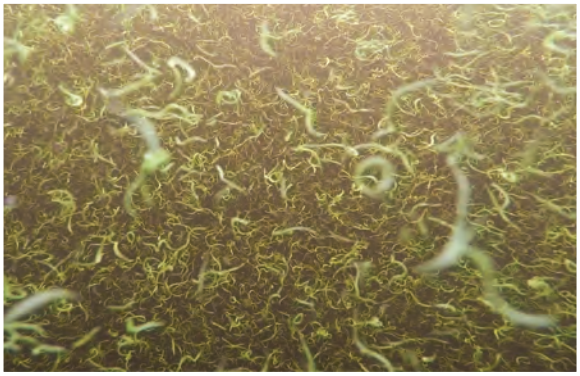
MM: Our work is a mixture of government and private work, with private being approximately 75% of our work this year. In 2019, that will shift to a 75% government share, given the size and production capacity of the General MacArthur.



Rob Bowen with Jay Rastogi (Swan Lake and Christmas Hill Nature Sanctuary site manager) and AZFP.

Inset: Underwater drop-down camera view of abundant suspended Aphanizomenon flos-aquae. Image taken approximately 0.75 m below surface. Filaments are typically about 1 cm in length.

Photo credit: Matt Stone



New Application of Acoustic Zooplankton Fish Profiler Used to Examine the Onset of Hypoxia

Urban freshwater environments are often being exposed to nutrient loading through groundwater movement and runoff of potent fertilizers. These nutrients impose imbalances that influence biological and chemical processes. The impacts are generally negative, causing onsets of algal blooms and widespread fluctuations in oxygen levels. Through an ongoing monitoring program, Rob Bowen of Diversified Scientific Solutions has been conducting surveys of dissolved oxygen, pH, oxidation-reduction potential, temperature, nitrogen and phosphorous at Swan Lake, in Victoria, B.C. Cyanobacteria play a key role in the oxygen production in this system as there is an abundance of the species Aphanizomenon flos-aquae. Over the last three years, it has been observed that the lake experiences a dramatic collapse of oxygen in the late summer leading to hypoxia and fish kills. Using a drop-down camera, pre-hypoxic conditions have shown an abundance of Aphanizomenon flos-aquae throughout the water column. Once hypoxia is established, Aphanizomenon flos-aquae die and drop to the bottom of the lake. In this study, an ASL Environmental Sciences' Acoustic Zooplankton Fish Profiler (AZFP) will be deployed over the late summer to collect data during this transitional period. There are a growing number of successful ocean deployments for this instrument to detect zooplankton and fish presence and abundance. Because Aphanizomenon flos-aquae are relatively large acoustic targets, it is hopeful that this new application of the AZFP will provide valuable insights into the dynamics of this freshwater system.

www.aslenv.com

Sonardyne Leads Ocean Autonomous Project

Sonardyne has initiated a collaborative project to drive a major step change in ocean system autonomy for long-endurance autonomous underwater vehicles (AUVs). The ambition of the Innovate UK-supported Precise Positioning for Persistent AUVs (P3AUV) project is to enable AUVs to operate at high levels of navigation performance with less surface support and for longer periods.

With partners L3 ASV and the National Oceanography Center (NOC), Sonardyne will focus on longer-term navigational accuracy for AUVs in deep water, while reducing power requirements and increasing autonomy in marine operations.

The P3AUV project will involve trials using Sonardyne's underwater positioning technology on the NOC's Autosub Long Range (ALR) and L3 ASV's C-Worker 7 autonomous surface vehicle (ASV). The project, which will include trials in Loch Ness next month, is due to run until late 2019.

NOC's Autosub Long Range (ALR) with ASV's C-Worker 7, at Loch Ness, where they will be deployed again this December, as part of the P3AUV project.

The project will focus on three key areas. One will be increasing long-duration navigational accuracy by integrating low- and high-power Inertial Navigation System (INS) sensors. "The accuracy of low-power sensors degrades over time and AUVs consequently often have to surface to reinitialize with a GPS fix," said Geraint West, Global Business Manager - Oceanographic. "However, by including high-performance, high-power navigation instruments, like our SPRINT INS, and integrating them with the low-power instruments to dramatically reduce power consumption, vehicle operators will get the best of both worlds, which will enable longer-duration independent deployments."

Second, Sonardyne will improve positioning accuracy while underwater vehicles descend and ascend through the water column, through the integration of Doppler Velocity Log (DVL) current measurement capabilities and INS technologies with on board processing of data. "Our SPRINT-Nav instrument, which combines our SPRINT INS sensor, Syrinx DVL and a high-accuracy pressure sensor in a single housing, can measure water current as well as velocity relative to the seabed," said West. "SPRINT-Nav will be able to use the water current velocity to reduce the dead reckoning mid-water navigation error, important to improving accuracy during both the dive and surfacing phases of an operation."

The third area will be enabling ASV deployment of seafloor positioning transponders. "Autonomous low-cost deployment of seabed transponders by an ASV is attractive to the offshore energy industry for AUV operation, as well as a wide range of scenarios throughout the whole life of a field, including exploration," added West. "Combining all of these capabilities will bring about a step change in AUV operations, providing a disruptive capability in the subsea monitoring and inspection space."

Behrens

MacArtney

Cattaneo, Laurenson & Pretty

ROVCO

Levedahl

Olis Robotics

MacArtney Hires Behrens, CCO

Michael Behrens has been named chief commercial officer of subsea technology provider MacArtney Underwater Technology from November 1, based at the company's headquarters in Esbjerg, Denmark.

Rovco's Team Grows Its Team

Rovco has established a dedicated business development team to support its growth plans as it looks to increase its presence in key international markets. Paolo Cattaneo, Brett Laurenson and Alex Pretty collectively bring more than 40 years of business development experience to the company.

Olis Robotics Hires Levedahl

Olis Robotics expands with the hire of Dr. Blaine Levedahl. Levedahl is a graduate of North Carolina State University with a Bachelor of Science in Aerospace Engineering. Following his Bachelor of Science, Levedahl received two Masters, one in Aerospace and another in Electrical Engineering. He then went on to obtain his PhD in Aerospace Engineering.

ABS: First Jack-up Certified Cyber Secure

ABS said it has awarded a Cyber Security-Ready (CS-Ready) Notation to a jack-up drilling rig built by Sembcorp Marine, marking a first-of-its-kind certification for an offshore facility. ABS Chief Digital Officer, Howard Fireman, said the CS-Ready Notation facilitates new assets in achieving full ABS Cyber Security Notations. "Leveraging the ABS FCI Cyber Risk model in applying the CS-Ready Notation means valuable offshore assets are already down the road towards a robust degree of protection on delivery," Fireman said.

NKT Names Andersen CEO

Cable manufacturer NKT said that its CFO Roland M. Andersen will step in as interim CEO of NKT as Michael Hedegaard Lyng steps down as CEO. The appointment became effective November 16, the company's Board of Directors announced. Chairman of the Board of Directors, Jens Due Olsen, said the search for a new CEO has been initiated.

Lomax Joins TEMS Intl.

Aberdeen-headquartered TEMS International has appointed Nicola Lomax to the newly created role of QHSE manager. Lomax will be responsible for developing and managing the firm's health, safety, environmental and quality systems and procedures in accordance with ISO 9001, 14001 and 45001 standards. She will support commercial and procurement activities, oversee the creation of an internal audit scheme and develop and deliver a QHSE training program for employees.

Anadarko Leadership Changes

Anadarko Petroleum announced that Bob Gwin, formerly EVP, Finance and CFO, has been named President. In addition, Benjamin M. Fink, formerly Sr. Vice President, and President and CEO of the general partners of Western Gas Partners, LP and Western Gas Equity Partners, LP, will succeed Gwin in the role of EVP, Finance & CFO.

Finlayson New VP Engineering

Dr. David Finlayson has been promoted from Chief Scientist to Vice President of Engineering at Chesapeake Technology.

Hydroid Bags Japan AUV Order

Hydroid, Inc., received an order for a New Generation REMUS 6000 AUV from the Japan Agency for Marine-Earth Science Technology (JAMSTEC). The order is part of the Strategic Innovation Promotion Program (SIP): Innovative Technology for Exploration of Deep Sea Resources, within the framework of the Cross-Ministerial Programs undertaken by the Cabinet Office of Japan.

Fugro, L3 ASV to Advance Autonomous Survey

Fugro signed a joint development agreement with L3 ASV to create the next generation of autonomous vessels for the commercial survey market, a partnership focussed on the joint development of a variety of fit-for-purpose

FIreman

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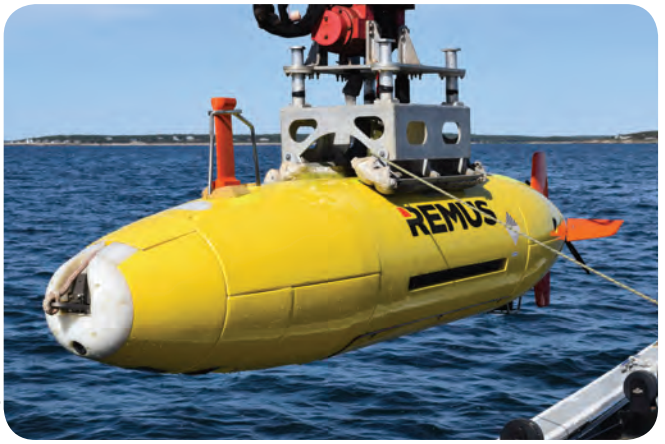
TEMS International

Hydroid Bags Japan AUV Order



Hydroid

unmanned surface vessels (USVs). Delivery of the first USV, designed for medium- to large-scale hydrographic survey applications, is scheduled for Q2 2019.

Sensor Technology Expands

Sensor Technology Ltd. has expanded its manufacturing to Nova Scotia at the Center for Ocean Ventures & Entrepreneurship (COVE), a collaborative facility for applied innovation in the ocean sector. Sensor Technology provides custom hydrophones and sensors to industries including marine, fisheries, defense and oil and gas.

PGS Wins S. America Contract

Norwegian seismic firm PGS entered into a contract for a 3D survey in South America. PGS did not reveal the name of the client, but said the contract value is estimated to be in excess of $75 million. The company plans to use two Ramform Titan-class vessels for an estimated total duration of approximately 13 vessel months. Acquisition is scheduled to start in the second half of November.

Aquabotix Gets U.S. Patent

UUV Aquabotix Ltd was granted a United States Patent for its Remotely Operated Vehicle Camera Apparatus. Aquabotix developed a fully rotatable camera apparatus for attachment to its own or other vehicles. The camera apparatus can be mounted to the side of a vehicle and configured to rotate, enabling an operator to have a completely unobstructed 360-degree view in an underwater environment. This connector can also be used for mounting rotatable underwater light sources.

RBR Opens Office in China

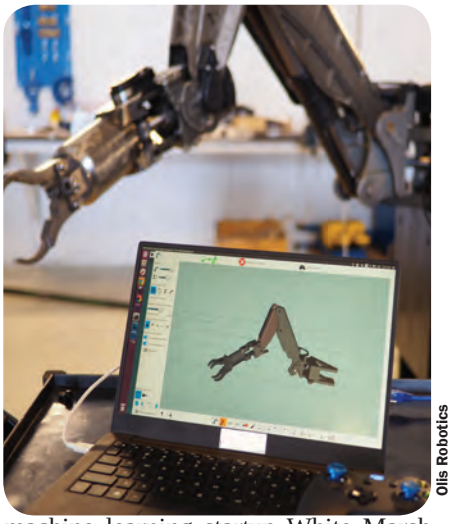
RBR opened RBR China in Qingdao. RBR China is a wholly-owned foreign enterprise under the direction of RBR Ltd. (Canada) and has been established to more efficiently support the growing customer base and collaborative business development activities in China. Following the grand-opening of RBR China at Oceanology International in Qingdao, customers and parters in China attended a technical workshop focused on advancement of understanding RBR sensors, loggers, software, and deployment best practices.

SGS Acquires Muldoon

Commercial diving company Subsea Global Solutions (SGS) said it has acquired Muldoon Marine Services (Muldoon), a commercial diving firm based in Long Beach, Calif.

Olis Robotics Acquires Machine Learning Startup

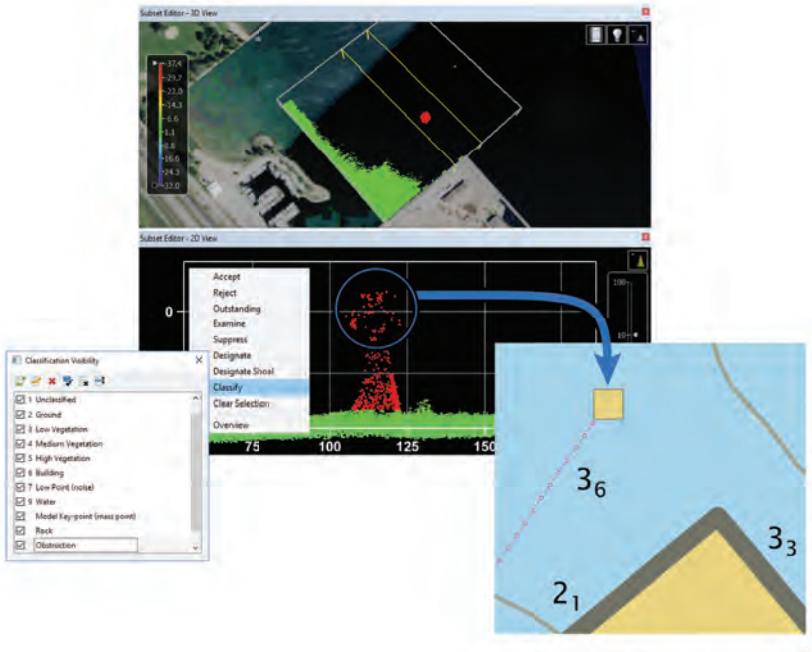
Olis Robotics, developer of next-generation remote robotics software, announced it has acquired Seattle-based machine learning startup White Marsh Forests (WMF). Olis, formerly BluHaptics, has created a next-generation software platform built from the ground up that expands the capabilities of pilot-controlled service robots in the energy and space sectors and other harsh operating environments. The firm's technology is designed to enable improvements in robotic dexterity, precision, efficiency and overall mission success.



Olis Robotics

Nexans Wins Hornsea 2 Deal

Nexans secured a contract to supply of over 200 km of the high voltage alternating current (HVAC) subsea export cable system for the near shore section of the world's largest offshore wind farm. The contract, from Danish developer Ørsted, is worth more than 150 million euros.



Teledyne CARIS Bathy DataBASE 5.2

Bathy DataBASE 5.2

Teledyne CARIS released Bathy DataBASE 5.2, which introduces enhanced tools for validating and creating chart features from lidar surveys as well as new bathymetry compilation techniques. This version includes an updated workflow process found in BASE Editor designed for performing both quality control and feature set building from lidar data. Bring LAS/LAZ data into the BASE Editor environment to assess quality, adjust classification, and compare against other sources. Identify relevant features in the point data and imagery, and easily model as S-57 features directly in the area-based cleaning tool. Build a DEM using CUBE or other gridding methods and combine with data from other sensors to generate a full picture of the seabed and shoreline. Building on BASE Editor's toolkit to compile bathymetry for electronic navigational charts, two new surface smoothing techniques have been added along with several workflow improvements.

www.teledynecaris.com

2KR's Portable Cable Reels

Portable Cable Reels

2KR Systems released its second generation of air-shippable Portable Cable Reels (PCRs) for quick deployment of small diameter oceanographic cables. 2KR Systems cable reels are used with towed devices such as side scan sonar (SSS), u/w and surface cameras, antenna systems and hand deployed sensors. "Anyone handling long cables in a marine environment especially shipboard wants a tangle-free solution to safely deploy and store electrical or fiber optic cable," said Chris Dundorf, 2KR Systems' President. PCRs are designed to better protect cable and connectors during transport. Other uses are storing and deploying tethers for ROVs and UUV Hybrids.

"PCRs can be used for static storage-only applications or equipped with optional electric or fiber optic slip rings for dynamic situations where both ends of the power/data cable remain plugged into equipment while the storage drum rotates," Dundorf continues.

www.2krsystems.com

EdgeTech 2205 Sonar Image

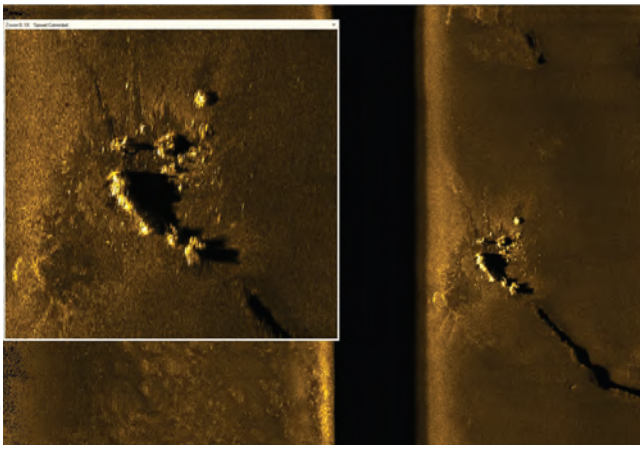


Image credit: Ocean Infinity

EdgeTech helps to Find Sub

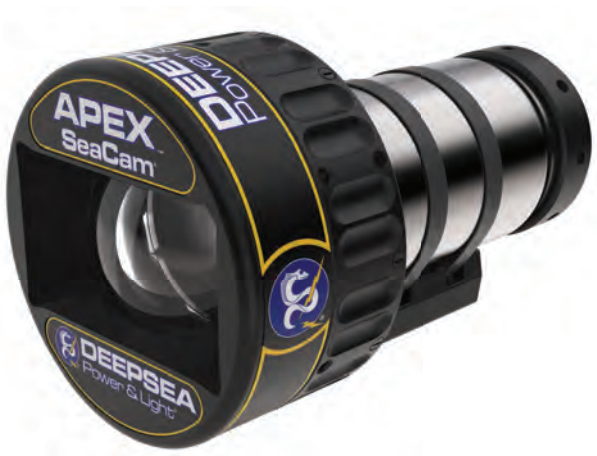
EdgeTech side scan sonar technology was used to help find the missing Argentine submarine, ARA San Juan. The deepwater search was performed by Ocean Infinity and it's fleet of 6,000 meter rated autonomous underwater vehicles (AUV) equipped with EdgeTech 2205 Side Scan Sonars. EdgeTech's tri-frequency side scan sonar frequency combination of 75 / 230/ 410 kHz enables the host AUV to perform long range searches in deep water, with the middle and higher frequency providing added resolution for better target identification. The ARA San Juan was imaged by the EdgeTech sonar operating at a frequency of 230kHz and a 400m range scale. The submarine, which has been missing for one year, was discovered in over 900m of water.

www.edgetech.com

4K UHD Capable SeaCam

DeepSea Power & Light has added the IP Apex SeaCam for network streaming in 4K UHD. This subsea camera

DeepSea Power & Light



Blueprint Subsea's M-Series & MD-Series

Blue Robotics' Lumen Subsea Light

Ultra-Compact Pan & Tilt

leverages the same proprietary corrector optics as the Apex SeaCam to provide superior imaging performance with a low-distortion 70° HFOV and 12x optical zoom. The h.265 and h.264 compression engine minimizes streaming bandwidth, and standard 256 GB onboard solid state memory enables up to four days of continuous high quality 4K recording. Tested with over 10,000 pressure cycles to 6,000m during the design process, the titanium housing and glass dome represent the pinnacle of performance and reliability in subsea applications.

www.deepsea.com

Blue Robotics' Lumen Subsea Light

Blue Robotics new Lumen Subsea Light has several key improvements including aluminum screws to prevent galvanic corrosion, a built-in mount for a more convenient and secure attachment, a wider brightness range and better low-light output, and a more robust sealing with redesigned cables and penetrators. The new Lumen Lights are rated to 950m and are a drop-in replacement for the original version.

www.bluerobotics.com

Ultra-Compact Pan & Tilt

Arctic Rays, LLC has released Hammerhead for use on multiple platforms, including ROVs, HOVs, ASVs, landers and fixed platforms. Hammerhead provides a rated torque of 6.8 N-m (5 ft-lbs) and a stall torque of 12.2 N-m (9 ft-lbs) in a compact envelope measuring only 5.45" (138mm) tall x 4.06" (103mm) wide x 2.5" (63mm) deep. Hammerhead features absolute position feedback and unlimited rotation in both axes at speeds up to 5 rpm (30 degrees/sec) with user-settable soft-stops and turns counter for precise control. It is made of 316 Stainless Steel and available in a 1,000-meter rated air-filled version, or a 6,000-meter oil-filled version. In-air weight for the oil filled version is 2.7 kg (6.0 lbs.), with in-water weight being 2.0 kg (4.4 lbs). Electrically, Hammerhead can accept an input voltage of 10 to 50 VDC and draws 120mA per axis un-loaded, and 425mA per axis stalled. Multi-drop RS232 control with soft-addressing allows up to 250 units on a single serial port.

"Many who had purchased our LED lights were dismayed at the lack of a simple, low cost pan and tilt solution for actively moving the lights in-situ.", said Lee Frey, co-owner and engineer for Artic Rays. "It seemed ridiculous to move a $2,000 light with a $15,000 pan and tilt, so we developed Hammerhead", continued Lee.

www.arcticrays.com

Oculus M-Series & MD-Series

Building on the success of its existing 300m depth rated Oculus M-Series, Blueprint Subsea now uses the same tried and tested sonar technology to make the Oculus MD-Series, a new range of 4,000m depth rated multibeam imaging sonars. Long range navigation and situational awareness or image critical inspection tasks, Oculus sonars are designed with versatility in mind. Available in single and dual frequency mod-

Nav Cam from Forssea

Schlumberger's Well Testing Tech

Downhole Sensing System

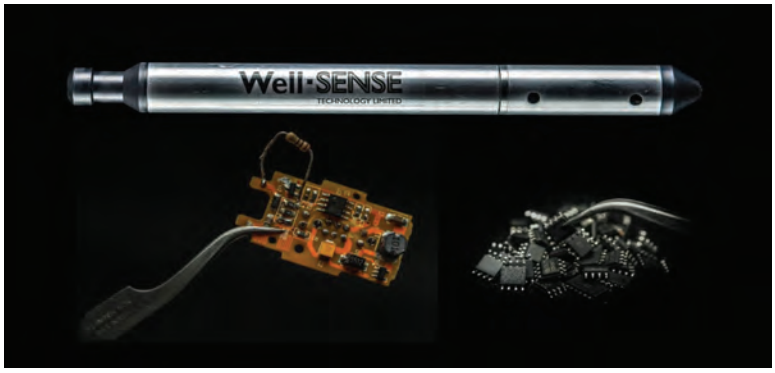


Image: Well-SENSE

els ranging from 375kHz to 2.1MHz. The compact size and rugged construction of the Oculus allow it to be confidently integrated across a wide variety of underwater applications from mini inspection-class ROVs to heavy duty work-class vehicles.

www.blueprintsubsea.com

NAV CAM

FORSSEA will soon release the NAV CAM (Navigation Camera), an innovative all-in-one ROV/AUV visual based navigation control center, with high grade calibrated optics, embedded image treatment capacity, pressure sensor and IMU. The NAV CAM has been designed to as a ROV plug-and-play system. It will be compatible with Gyros for survey applications such as subsea asset's altitude and heading monitoring.

www.forssea-robotics.fr

New Well Testing Technology

Schlumberger has introduced well testing live performance technology at the Abu Dhabi International Petroleum Exhibition & Conference (ADIPEC). The new technology, called Concert, brings real-time surface and downhole measurements, data analysis, and collaboration capabilities to well testing.

In the Concert performance ecosystem, all well test data are digitally integrated via wearable technology, wireless sensors, and video cameras. Robust software drives web dashboards, accessible anywhere customers specify, with separate teams able to view the same data.

The new technology was used in testing the first development wells of a major offshore gas condensate field in Australia.

www.slb.com

Downhole Sensing System

Downhole sensing technology specialist Well-SENSE has launched its latest FiberLine Intervention (FLI) development, Active FLI at ADIPEC.

Active FLI adds a range of discrete measurement devices to Well-SENSE's fiber optic downhole data acquisition system, including single point temperature and pressure sensors and the addition of a casing collar locator for depth correlation. The tools are located in the FLI probe to capture measurements as it descends downhole and complement the distributed sensing which takes place along the length of the fiber optic lines deployed in the well by FLI.

The combination of single point and distributed data provides enhanced well intelligence and allows events occurring in the well to be precisely located, verified and quantified via different data sets.

www.well-sense.co.uk

Two MVP30-350 Systems for Geological Survey of Ireland

The Geological Survey of Ireland (GSI) has purchased new Moving Vessel Profilers (MVP) in a move that aims to improve the productivity, safety and data quality of survey operations, Canadian manufacturer AML Oceanographic announced. The two MVP30-350 systems were ordered for installation aboard a pair of 16-meter survey catamarans that

Two MVP30-350 Systems for Geological Survey of Ireland

Image: AML Oceanographic

will help complete a large scale project to map all Irish waters by 2026. GSI is working on the project in partnership with the Marine Institute of Ireland under the joint program INFOMAR. The first of the two systems was commissioned aboard RV Mallet in November 2018, with delivery of the second MVP30-350 for RV Keary to occur in 2019.

www.amloceanographic.com

Targetless Laser Sensor for Offshore Wind Farms

The SceneScan Monopole laser sensor has been developed for offshore wind farm applications to eliminate the need for installing fixed reflective targets. This technology was designed and developed by Guidance Marine (acquired by Wärtsilä in 2017) to increase safety on board service operation vessels (SOVs), since vessel positioning sensors that rely on targets fixed to the structure, are often unreliable because of poor placement, poor quality and obscurement by workers on the platform.

Targetless Laser Sensor for Offshore Wind Farms

Photo: Wärtsilä

Advanced software allows the measurement of range and bearing to the offshore wind turbine, independent of the use of targets and GPS.

The first SceneScan Monopole was delivered in summer 2018 for a Chinese SOV newbuild project carried out by GE Power Conversion, a subsidiary of General Electric.

The system underwent sea trials earlier this year on board the purpose-built SOV Windea La Cour owned by Bernhard Schulte Offshore. The vessel is fitted with other Wärtsilä sensor solutions, including the RangeGuard Monopole, the first targetless local position reference sensor based on radar technology.

www.wartsila.com

Persistent Profiling of the

Greater Agulhas Current

EDITOR'S NOTE: Due to a mishap in production, this article, which originally published in the October 2018 edition of MTR, is reprinted here in its entirety.

Two Decades of Moored ADCPs off Southern Africa

By Peter Spain Ph.D., Teledyne RD Instruments

For the last two decades, the energetic and deep currents off southern Africa have seen persistent scrutiny. Found on the western edge of the South Indian Ocean, the Agulhas Current system exhibits complex circulation patterns—retroflection, meandering, and rings. They show large variability from year-to-year. Plus these flows mediate exchanges between three of the world's major oceans: Indian, Atlantic, and Southern.

Even more important, the Greater Agulhas Current is now suspected to influence the global climate system. Its role is to precondition waters that later enter the downwelling part of the global overturning circulation.

Measuring these currents has been challenging. To capture their extent, measurements need to reach deep. To resolve changes over time, measurements need to be sustained. And to survive, persistent measurement methods need to withstand the energy of these powerful currents. For example, surface drifters, floats, and gliders are quickly swept away.

Programs making long-term measurements of major ocean currents rely on resilient moorings. And for measuring strong currents in the upper ocean, these moorings carry ADCPs.

In this report, we review several consecutive campaigns over two decades that used Teledyne RDI ADCPs to measure the Greater Agulhas Current. To help capture this incredibly dynamic system, each campaign fixed ADCPs atop mooring lines and on the seabed as part of extensive observational arrays.

For a decade, Dutch scientists focused on the strength, variability, and structure of upstream flows feeding the Agulhas.

Later, off the south-east corner of South Africa, US researchers completed the Agulhas Current Time-Series Experiment (ACT) that monitored for three years. One use of their data was ground-truth to create a long-term satellite-based index for changes in the Agulhas Current.

And now, an ongoing multinational program continues the work—Agulhas System Climate Array (ASCA). It is collecting persistent observations for at least five years to explore regional and global impacts—notably climate matters.

Extensive & Persistent Current Monitoring off Southern Africa

The Agulhas Current streams poleward off the east coast of southern Africa. This major current exerts diverse influence—locally and globally. For southern Africa, the Agulhas affects things from marine transport and regional weather to local biodiversity. More globally, the Agulhas water properties are now linked to earth's climate system.

About one-sixth of the volume carried by the Agulhas leaves the Indian Ocean for the Atlantic. Paleo studies suggest that amount has varied over eons. Below the tip of South Africa, meanders in the Agulhas close off and morph into large-diameter rings. These rings propagate far westward into the central S. Atlantic. They provide a source of warmer and saltier waters to the returning limb of the global overturning circulation.

The upshot for climate studies is a heightened interest in how these rings vary. Related research has considered what triggers their antecedent—meanders in the Agulhas. In turn, this fixed attention on eddies entering the Agulhas system farther upstream.

To unravel this complexity, the Greater Agulhas Current system has been scrutinized with extensive and persistent moored arrays for the last two decades. A critical element was capturing the volume transported by strong currents in the upper ocean. For this reason, many of the mooring lines were topped with uplooking Teledyne RDI ADCPs.

On a side note—ADCPs have a long history in these waters. In the mid-1980s, Prof. Fritz Schott (University of Miami) made early use of uplooking ADCPs atop moorings off Africa, including the E. Madagascar Current.

Credit: J. Vorneveld in Morris et al. (SAEON) 2017

Agulhas Current Sources Experiment (ACSEX): 2000-2001

By the late 1990s, scientists were uncertain that a continuous boundary flow existed off Mozambique to supply the Agulhas. To clarify the issue, Dutch scientists conducted the Agulhas Current Sources Experiment (ACSEX) in 2000-2001. The study was performed by NIOZ (Netherlands Institute for Sea Research) and its partners. The project focused on the strength, variability, and structure of currents.

Seven moorings spanned the Mozambique Channel for one year. Uplooking ADCPs were installed at 500 m depth on the western side where a boundary current might be expected. A compelling finding was that the amount and direction of water transported through the Channel fluctuated remarkably—much larger than the year-long average value. The researchers concluded that there was no persistent Mozambique Current.

Water mass and property transport through the Channel were due to a regular train of large (300-km diameter) eddies moving southward. The passage of these eddies was clear in the ADCP and current meter data. This helped interpret satellite data.

The combined analysis reinforced ideas that eddies drifting southward were dynamic catalysts. Not only do they spark mesoscale variability in the Agulhas Current but they affect the volume of water transferred into the Atlantic.

Long-term Ocean Climate Observations (LOCO): 2003—2012

Due to its intriguing findings, ACSEX became a springboard for a much longer observational study. This was a component of the Dutch global-research program titled Long-term Ocean Climate Observations (LOCO).

Beginning in 2003, NIOZ and its partners installed seven deep moorings at 17° S, across the narrowest part of the

Fig. 1

Teledyne RDI ADCPs seated in Top Buoys of ASCA Mooring Array.

Credit: SAEON Egagasini Node. http://asca.dirisa.org/

Mozambique Channel. The LOCO project redeployed the extensive mooring array several times. The full array was sustained for seven years and a reduced array even longer.

The upper 500 m contained the strongest currents. In the initial array design, six of the moorings were topped with upward 75 kHz ADCPs from Teledyne RDI. On the western side of the Channel, moorings had near-bed ADCPs to see an Undercurrent, which is directed equatorward.

The data set spans many years with consistently impressive spatial coverage across the Mozambique Channel. As the available record lengthened, the Dutch scientists examined different facets of volume transport through the Channel. In particular, this longevity is needed to see links with remote current systems in equatorial and Indonesian regions.

The researchers discerned that variability in the transport could be sorted into three categories. For shorter time scales, the recurring large eddies passing southward dominate changes in transport. These estimates became more statistically reliable when based on the longer data record.

For seasonal periods, modest changes in flow volumes were linked to wind-stress patterns over the Indian Ocean basin.

At interannual time scales, changes much larger than seasonal variations were found. These swings in volume transport were attributed to large-scale climate fluctuations. The latter are identified by a regional climate index—IOD (Indian Ocean Dipole).

Exposing the details of this subtle climate connection was possible due to the long duration of the data set. Notably, a lag of almost 12 months was found between changes in the IOD climate index and corresponding variation in water volumes supplied to the Agulhas Current.

Agulhas Current Time-Series Experiment (ACT): 2010—2013

Farther south, another extensive moored array spanned the Agulhas Current from 2010 until 2013. This project was the US Agulhas Current Time Series Experiment (ACT), led by

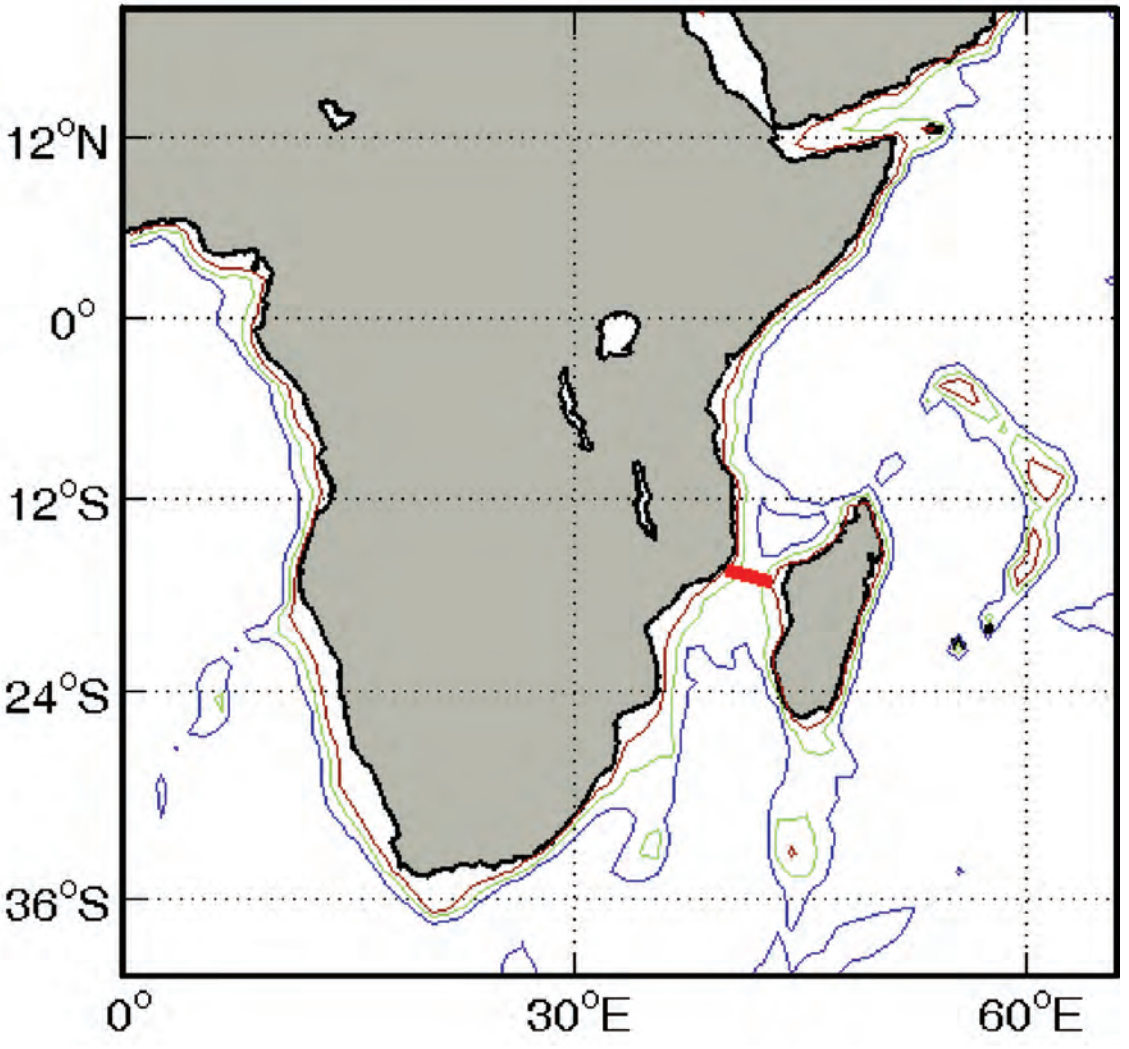


Fig. 2
Location of LOCO moored array in Mozambique Channel.

Credit: H. Ridderinkhof (NIOZ) 2006. https://goo.gl/FrCL2b

Prof. Lisa Beal of University of Miami. Located at the south-eastern coast of South Africa, in waters to 4700 m depth, the ACT section was set along a ground track of a satellite altimeter.

The mooring array comprised seven full-depth moorings. Initially, each mooring was topped with an uplooking ADCP to monitor strong flows in the upper 350 m. Peak speeds were almost 2 m/s. In a later deployment, moorings near the core of the Current were terminated deeper. They carried an uplooking 75 kHz Long Ranger ADCP to measure currents in the upper 500 m.

The Current was about 200 km wide and reached 3000 m depth. The water transported was 84 million cubic meters per second. A similar discharge was reported for the upper 2000 m of the Gulf Stream where it leaves the US coast.

In addition to quantifying the volume of water carried by the Agulhas, the mooring data revealed how that transport changed with season. These observations provided ground-truth that supported prior satellite-based results. Previously, the latter had been questioned. The phase of their annual cycle was "nearly opposite" to results from computer modeling and to observations farther north in the Mozambique Channel.

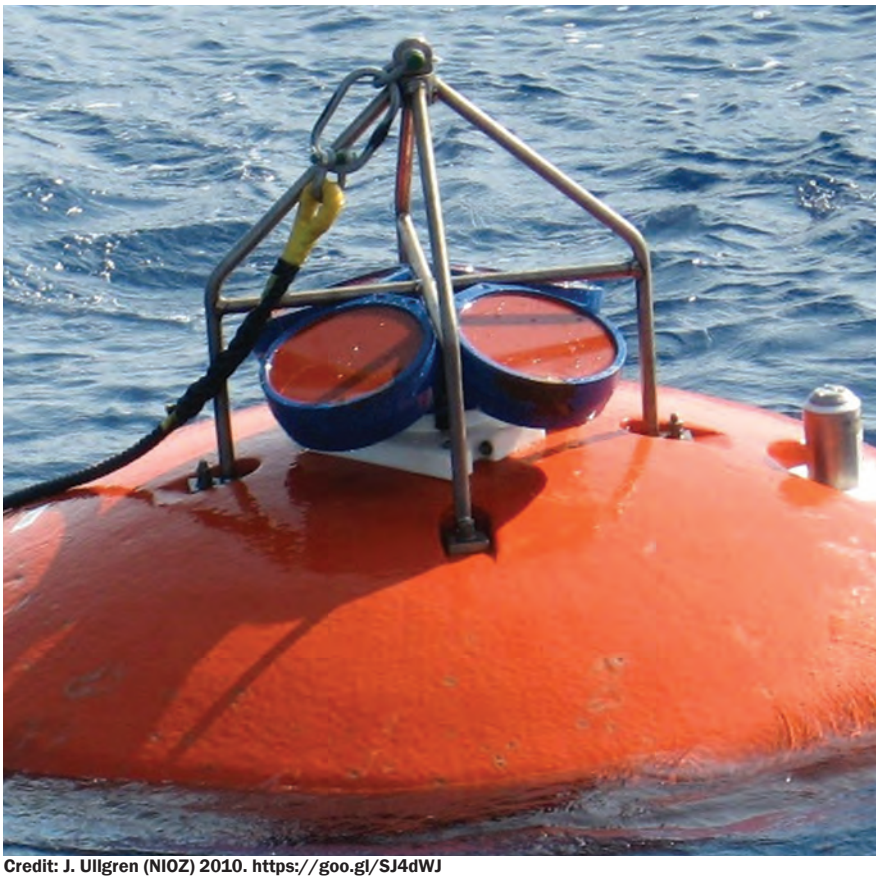
This validation with the moored measurements was essential for the scientists to be able to use the altimeter data as a 20-year index of the Current's transport. This index offered a much longer record for examining seasonal and interannual changes in the Current.

Of significance was the response of the Agulhas to intensifying global wind patterns since the 1990s. The mean flow of the Agulhas has not increased. This finding is at odds with some theoretical expectations. Rather, the distribution of the current field is now broader—attributed to enhanced eddy action. One knock-on effect is greater exchange of water properties with coastal waters. Such changes in the nutrient supply could affect regional fisheries.

Agulhas System Climate Array (ASCA): 2015 - present

Beginning in 2015, the Agulhas System Climate Array (ASCA) occupies the same transect as ACT, near 34°S. The project includes scientists from several nations. They aim to collect persistent observations of the Agulhas Current for at least five years.

The ASCA array includes nine moorings reaching 200 km offshore. In deep water are seven tall moorings to 4500 m. Closer to shore are two seabed moorings near 100 m depth. The latter use 300 kHz ADCPs whereas the deep moorings carry 75 kHz Long Ranger ADCPs.



Credit: J. Ullgren (NIOZ) 2010. https://goo.gl/SJ4dWJ

The Greater Agulhas Current system has been scrutinized with extensive and persistent moored arrays for the last two decades. A critical element was capturing the volume transported by strong currents in the upper ocean. For this reason, many of the mooring lines were topped with uplooking Teledyne RDI ADCPs.

These time series will document variations in the fluxes of water properties as well as the volumes transported by the Current. Two aspects attracted special interest: changes over several years and exchanges with coastal waters important for fisheries. In addressing its climate aspect, the ASCA project will consider a basin-wide context. Oceanic transport of heat will be emphasized.

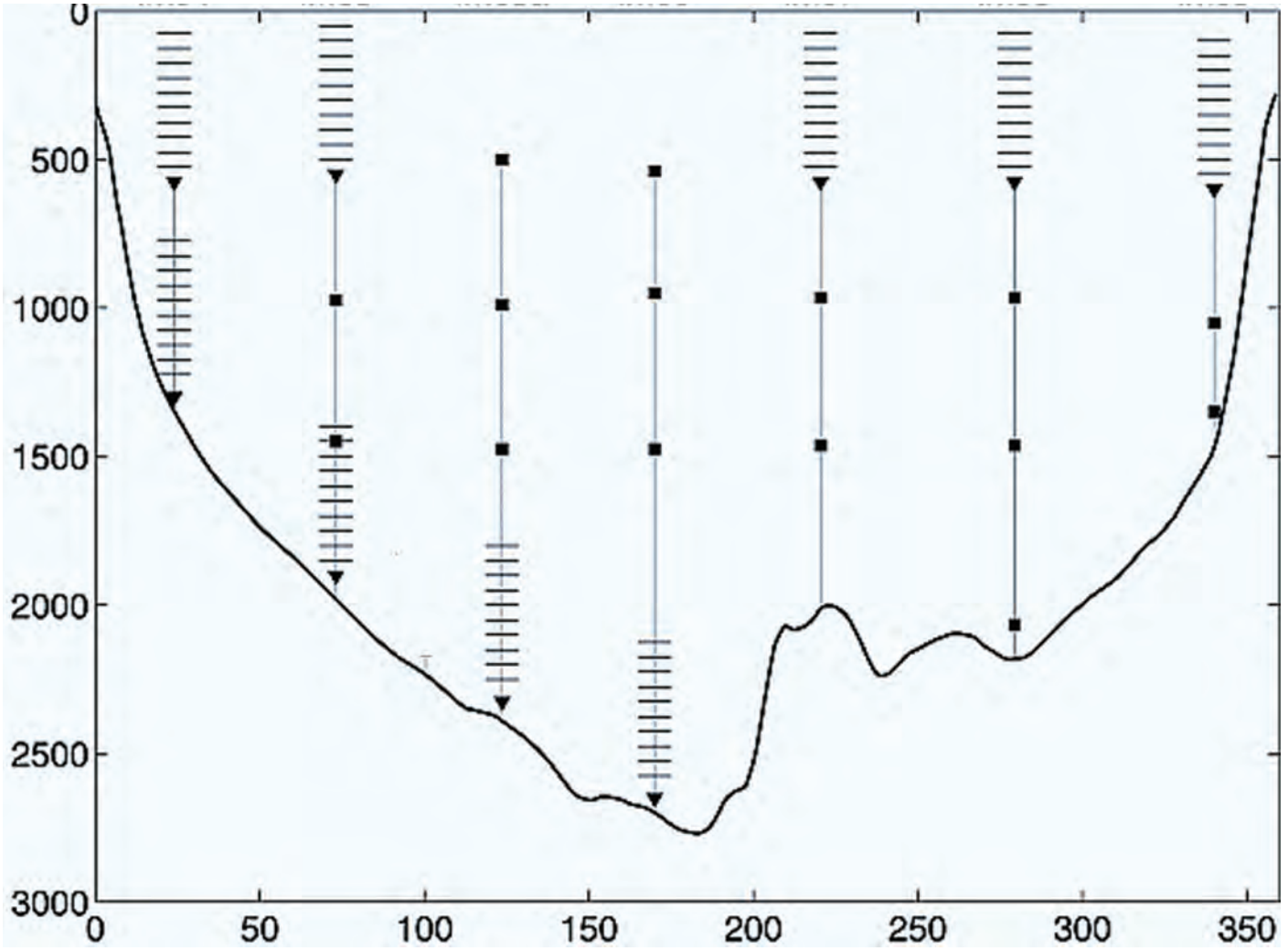
The ASCA scientists plan to merge results in the Agulhas Current with information from the interior. The latter come from satellites and Argo profiling floats. These other sources will quantify large-scale mechanisms (e.g., wind, remote ocean circulation) that are suspected to cause variability in the Agulhas system. Scientists especially want to examine ideas about the response of the Greater Agulhas Current to a changing climate—notably global wind systems.

Looking Ahead

The influence of major ocean currents on our living environment—from hurricanes to earth's climate—is now more widely appreciated. Yet developing this understanding has been—and remains—challenging. A mix of methods is needed to clarify the long-term effects of global warming. Moored arrays in major ocean currents provide an essential ingredient. Insights have come from researchers using computer models and satellite-based observations. And drifters, gliders, and floats can provide snapshots. Yet there is no substitute for hanging around in these deep and energetic flows. For scientists to see long-term trends and large-scale connections, these moored arrays must collect sustained time series. Their instrumentation and mooring lines must be resilient. And high-speed upper-ocean currents must be measured. For all these ocean-observing requirements, Teledyne RDI ADCPs remain a uniquely relevant solution.

Fig. 3

A later setting of LOCO moorings in Mozambique Channel. ADCP profiles are indicated. Scales: depth (m), distance(km).



Adapted from H. Ridderinkhof et al. (NIOZ) 2010. https://doi.org/10.1029/2009JC005619

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- time, space and cost-saving solutions
- low power consumption for autonomous operations
- advanced data delivery algorithms, addressing and networking, remotely configurable settings
- extendable platform with multiple configuration options: power-saving Wake Up module, acoustic releaser, additional sensors, custom solutions, OEM versions availableh

USBL POSITIONING SYSTEMS

simultaneous positioning and communication - no need to switch between positioning mode and modem mode

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: up to 0.04 degrees

UNDERWATER ACOUSTIC MODEMS

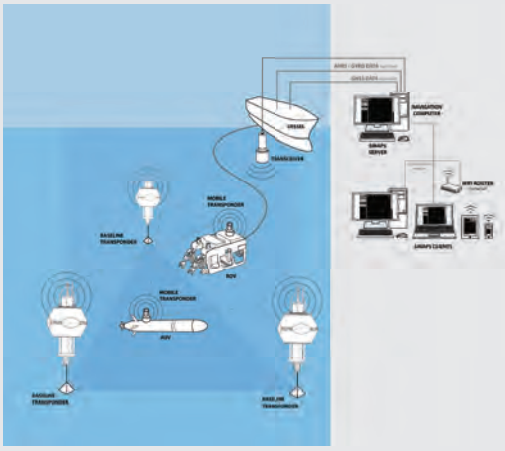
reliable data transmissions even in adverse conditions, customizable R-series modems, light and compact M-series "mini" modems, **new S2CM-HS high-speed modem**, special editions for developers, S2C communication and positioning emulator - remote access or standalone device

- range: up to 8000 m
- depth: up to 6000 m
- data rate: up to 62.5 kbps

LBL POSITIONING SYSTEMS

highly accurate, precise and stable performance, simultaneous positioning and data transmissions

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: better than 0.01 m



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NAVIGATOR

A one man navigation and sonar reconnaissance unit

SHARK MARINE TECHNOLOGIES INC.

The Navigator, a second generation Sonar Imaging and Navigation system, designed by Shark Marine primarily for MCM and SAR use.

Proven

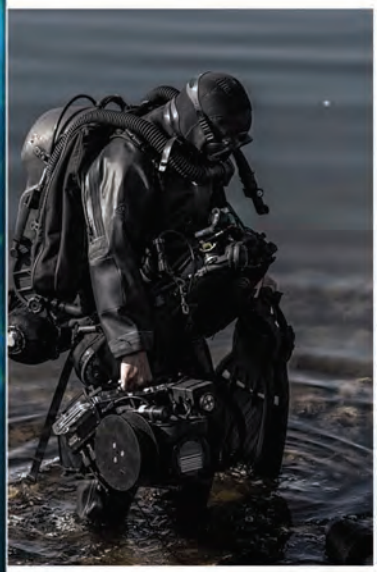
Tested and proven, the Navigator is the trusted choice of 17 Navies, as well as Law Enforcement, Search and Rescue Teams and Scientific Researchers spanning the globe. The Navigator has become a critical part of the Standard Kit and has reshaped SOPs. The modularity of the system and numerous advanced sensors available allow the Navigator be to become a force multiplier, enabling smaller groups to cover more ground efficiently with increased safety.

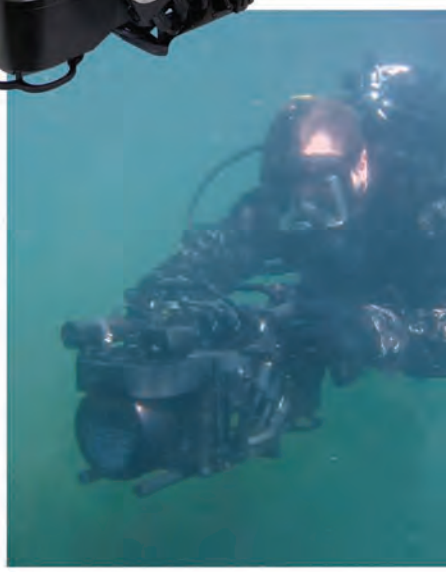
Mission Ready

The Navigator is the most modular system of its kind, enabling it to be quickly configured for any application.

Intuitive

Shark Marine's DiveLog software controls all operations of the navigator and its accessories, operators need only learn one software to master all their equipment.





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