INSTALLATION

ROCK ANCHOR

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

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

INSTALLATION

ROCK ANCHOR ALTERNATIVES

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

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

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

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

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

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

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

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

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

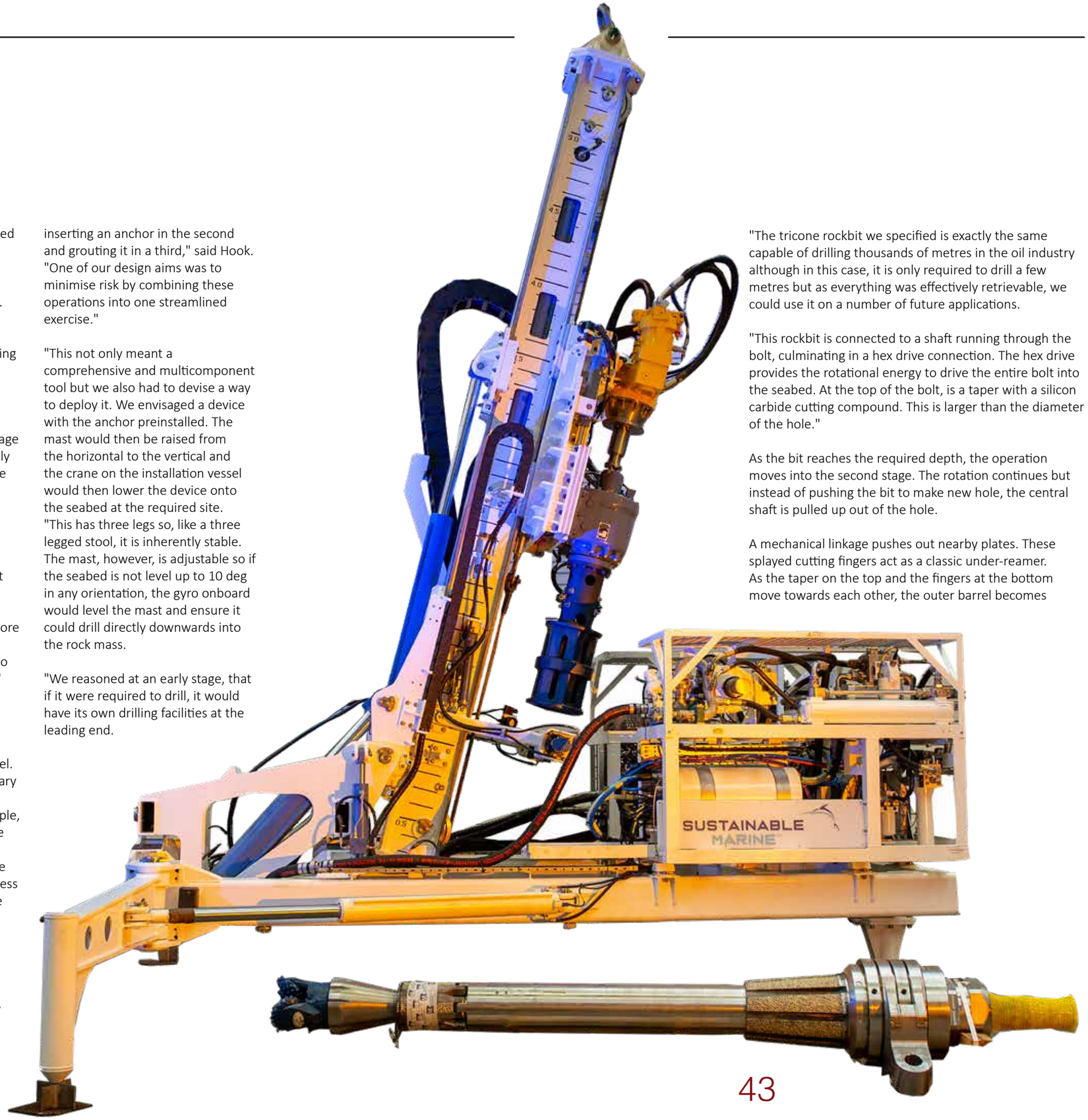
ROCK ANCHOR

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

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

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

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



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

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

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

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

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

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

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

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

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

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

The RIT tool