TECHNIP FMC

GEMINI

TechnipFMC has launched its new Gemini Workclass ROV. This incorporates a number of innovative features including a tooling carousel designed to be accessed by a pair of newly-developed manipulators.

Over the past few years, a number of major ROV manufacturers have brought out new models. Forum has launched its new XLe Spirit with the intention of extending this new technology across its entire product range, IKM, Oceaneering and Saipem have been busy developing progressing with their electric ROVs for use as seabed- resident systems, SMD brought out its Quantum E, while Saab Seaeye's Leopard has been increasingly predatory in carrying out work previously the domain of hydraulic systems.

Elsewhere, companies have also taken their electric ROVs in another direction blurring the margins between AUVs and ROVs.

And all the time, Technip FMC-owned Schilling Robotics has been disturbingly quiet. Its last vehicle model, the UHD3 was launched in 2014 but since then, the company has been keeping under the sonar, busy perfecting its latest model.

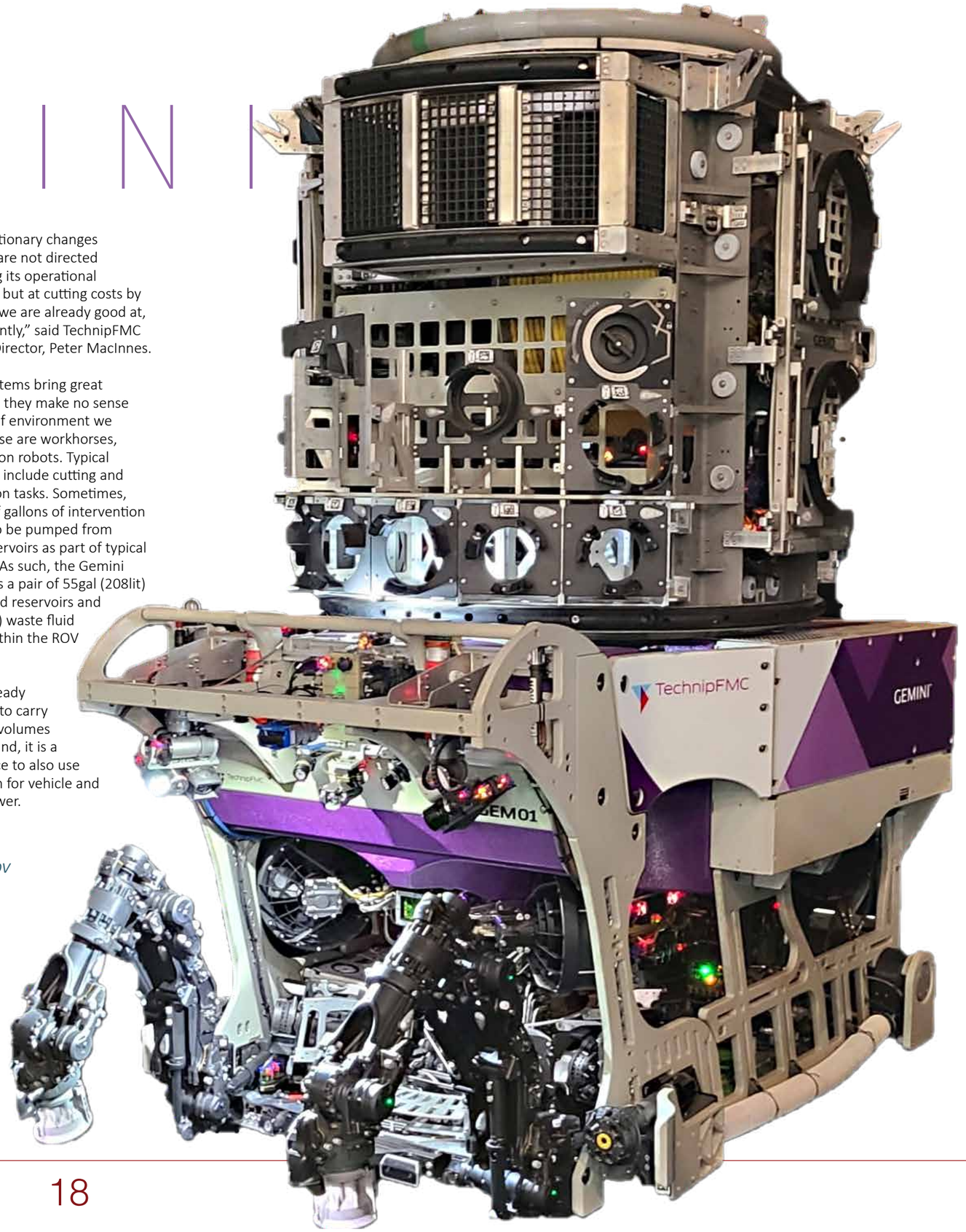
Watching the progressive march towards electric systems from its Northern Californian headquarters, Schilling made the executive decision to travel quite the opposite direction.

It has been unapologetically developing technology to make its hydraulic systems even more effective in conducting intervention operations, further augmenting its position within the heavy duty deepwater harsh environment workspace.

"The revolutionary changes on Gemini, are not directed at extending its operational boundaries, but at cutting costs by doing what we are already good at, more efficiently," said TechnipFMC Marketing Director, Peter MacInnes.

"Electric systems bring great benefits but they make no sense in the sort of environment we inhabit. These are workhorses, not inspection robots. Typical applications include cutting and fluid injection tasks. Sometimes, hundreds of gallons of intervention fluid have to be pumped from internal reservoirs as part of typical operations. As such, the Gemini incorporates a pair of 55gal (208lit) auxiliary fluid reservoirs and 25gal (95 lit) waste fluid reservoir within the ROV body.

"Since it already has be able to carry these large volumes of fluid around, it is a logical choice to also use this medium for vehicle and thruster power.



The Gemini ROV

THE HUMAN FACTOR

Like any machine, its ultimate success, especially in carrying out nonroutine technical procedures, depends on the ability of the operator.

ROV pilots embody a wide variety of skill levels. While there are a many very useful training simulators on the market, these cannot always capture the nuances of carrying out live subsea operations, often on unfamiliar equipment.

There is no substitute for hands-on experience, however, in reality, the operators get surprisingly little time in the real world to practice how to execute these tasks.

"A pilot has to have electronic, electrical, hydraulic skills, mechanical engineering knowledge, spatial reasoning, good communication and even some software skills," said MacInnes. "This is why the pool of excellent pilots is relatively limited.

"There are some pilots that have the ability to consistently carry out highly accurate operations and others less so. The penalties of under-performing can be severe.

"In order to improve overall performance, therefore, a fundamental tenet in the Gemini ROV's design is to find ways of removing or minimising the human factor from underwater operations, enabling the crew to focus on project operations and client interfacing.

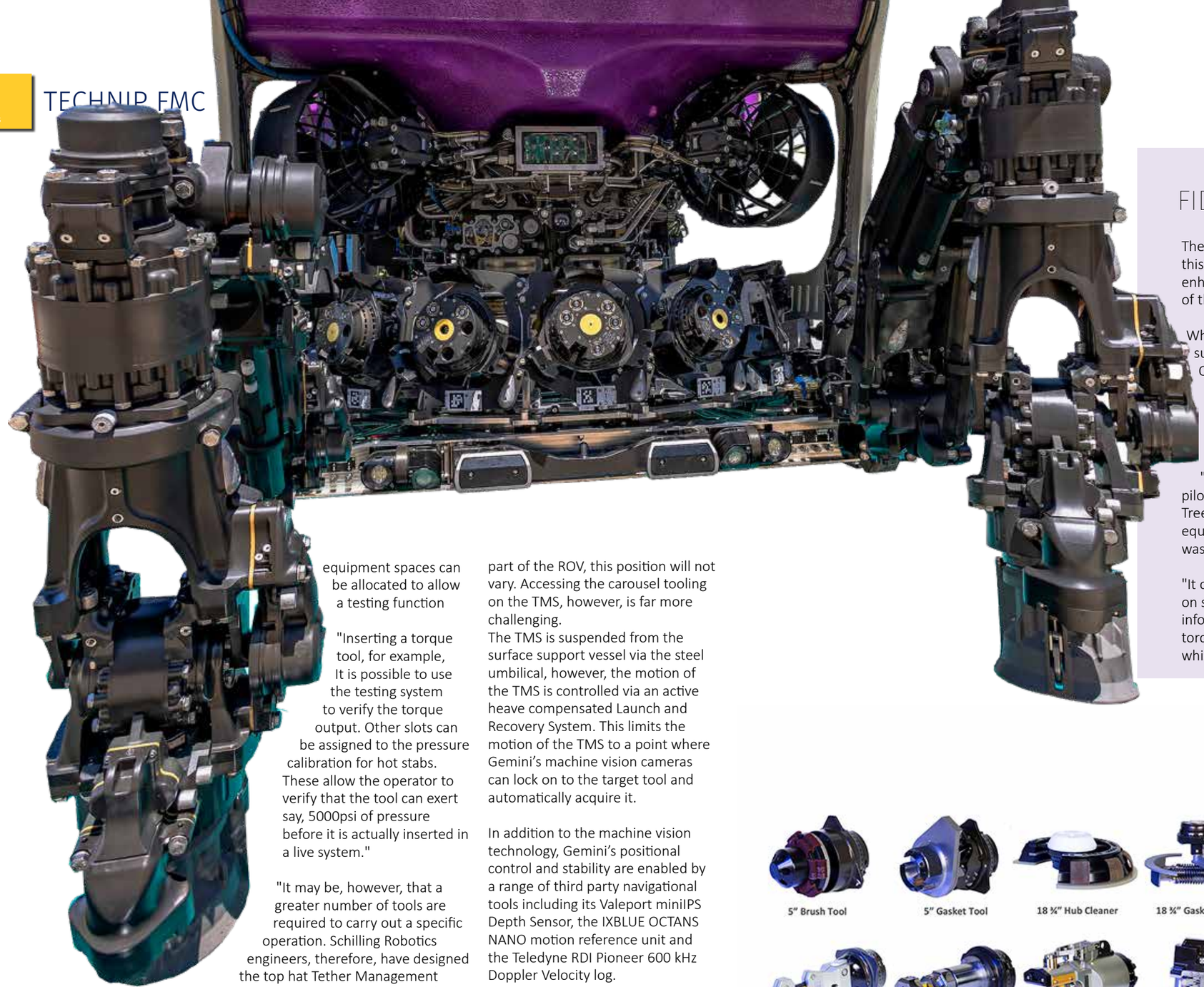
In some industries, this could translate as fully automating operations, but the potential dangers in the deepwater offshore industry, where accidents could have disastrous consequences, are unacceptably high. Gemini addresses this through pilot assistance features, where the operator executes the commands, while being assisted by the automation system.
Conversely, a human pilot or operator assisted by using various pieces of semi-autonomous tooling offers significant safety and efficiency benefits.

TIME IS MONEY

Working at extreme depths, the journey between the surface and the work site can take hours. When at the workface, the vehicle may require a large number of different tools.

Predictably, commuting to the surface support vessel and back to interchange tooling is not an option

TECHNIP FMC



equipment spaces can be allocated to allow a testing function

"Inserting a torque tool, for example, It is possible to use the testing system to verify the torque output. Other slots can be assigned to the pressure calibration for hot stabs. These allow the operator to verify that the tool can exert say, 5000psi of pressure before it is actually inserted in a live system."

"It may be, however, that a greater number of tools are required to carry out a specific operation. Schilling Robotics engineers, therefore, have designed the top hat Tether Management System to be able to accommodate an additional 15 tools around the exterior of the structure."

and the traditional solution is to carry items in a storage receptacle somewhere within the vehicle, typically in between the manipulator and the grabber.

A key feature of the new Gemini ROV, is its novel tooling carousel. This has capacity for up to 15 tools however some of the

On the Gemini ROV the manipulators are located either side of the revolving carousel. This means that the manipulator control software always knows the exact location of the designated slot from which to select the correct tool. As both are part of the ROV, this position will not vary. Accessing the carousel tooling on the TMS, however, is far more challenging.

The TMS is suspended from the surface support vessel via the steel umbilical, however, the motion of the TMS is controlled via an active heave compensated Launch and Recovery System. This limits the motion of the TMS to a point where Gemini's machine vision cameras can lock on to the target tool and automatically acquire it.

In addition to the machine vision technology, Gemini's positional control and stability are enabled by a range of third party navigational tools including its Valeport miniIPS Depth Sensor, the IXBLUE OCTANS NANO motion reference unit and the Teledyne RDI Pioneer 600 kHz Doppler Velocity log.

STATIONKEEP

Maintaining position in the water column requires a variety of sensors feeding to a software-driven control centre called StationKeep. The latest version – StationKeepV2 – incorporates additional ROV sensor inputs and a state estimator, enhancing the overall accuracy.

FIDUCIALS

The ability for the arm to pick up a tool and indeed, the ability to stab this tool, if required, into a receptacle on a piece of subsea hardware is enhanced by machine vision cameras located on the ROV and the wrist of the manipulator.

While the machine vision system enables operations on any existing subsea equipment, the addition of a Fiducial (which resembles a QR code) increases the precision. This QR code helps the machine vision cameras recognise true 3-D perspective allowing more precision. It does, however, afford other potential benefits in becoming an information source for subsea production system equipment.

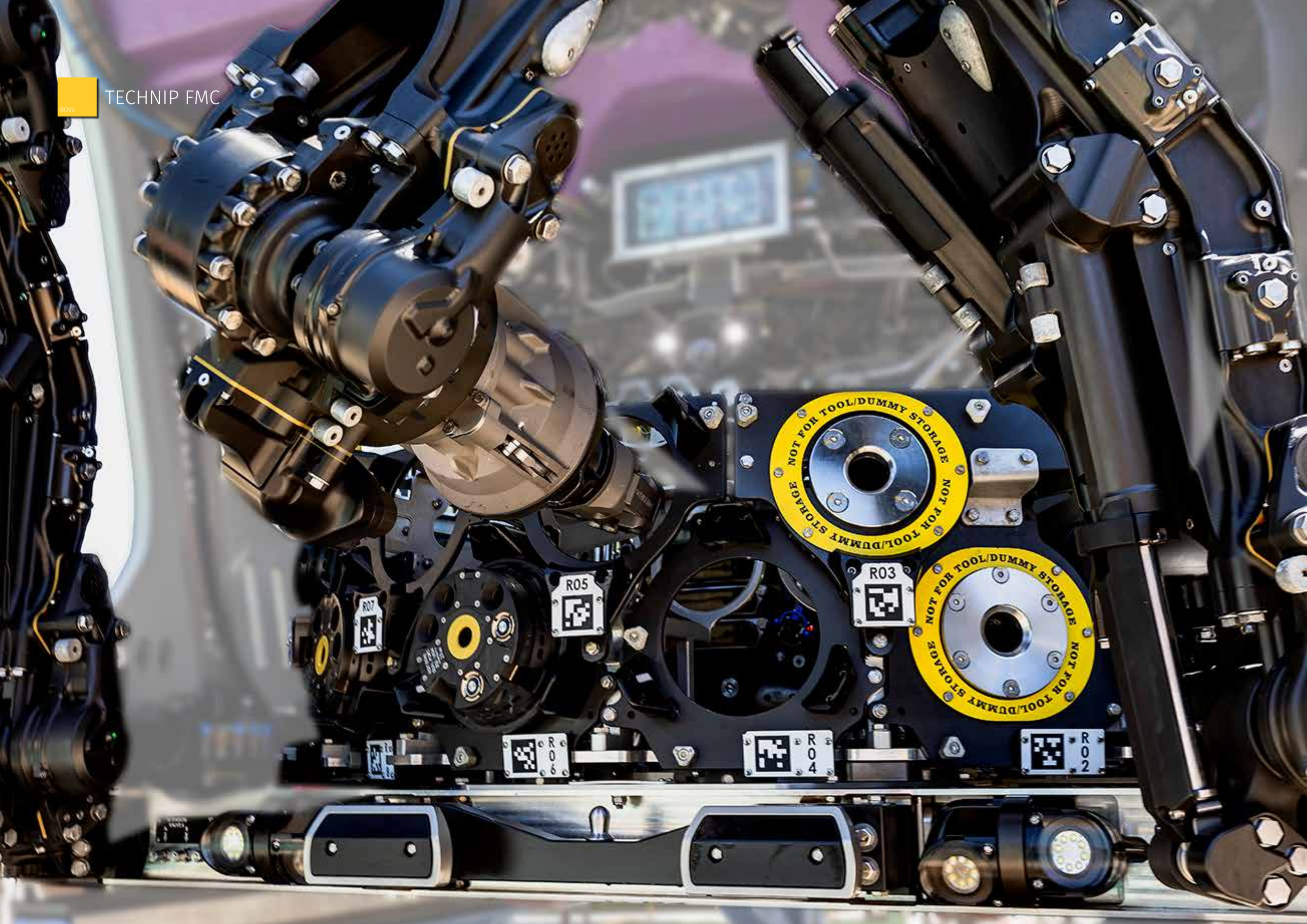
"The code could also automatically link to a database, allowing the pilot to retrieve information pertinent to the target such as a Subsea Tree. The database could then provide a history of that piece of equipment and information relating to the manufacturer and when it was installed".

"It could also be used to identify prior operations that were conducted on such equipment. For example, the database could include information on Tree valve operations and how many turns and what torque was applied. It could also identify when fluid was injected to which port, and what volume and/or pressure was applied".

Interchangeable Tools

ROVs

TECHNIP FMC



"This new Stationkeep system gives a performance improvement by a factor of four in extreme environmental conditions and up to a factor of ten in normal operating conditions," said MacInnes, The result is an extremely stable platform from which high-precision intervention tasks can be performed without the need to anchor and stabilise the ROV to a subsea asset.

"It actually gives the ROV the ability to maintain vehicle position within a 1in (25 mm) watch circle in currents exceeding 2 kts. Once the ROV is stationary, five machine vision cameras on the vehicle, including two on the manipulators themselves, assist in getting the ROV and manipulator in the correct position. The final, decision on precisely when to conduct the actual operation is that of the pilot.

"Once positioned and ready to interface with the target, the system is capable of rapidly acquiring or stowing a tool on the TMS," said MacInnes, " and the designers coined the term 'Cobra strike' for the final, critical action.

An additional new feature is the adoption of a PlayStation-type joystick for manipulator control. It is only necessary for the pilot to concentrate on the tip of the tool and move the joystick in Cartesian mode XYZ axes. In the background, the artificial intelligence in the machine is ensures the rest of the tool is at the correct angle. The pilot is also aided by a visual target engagement indicator. Once a signal light turns green, the system becomes locked on and ready to commence the action and the tool, say, is inserted into the receptacle in seconds.

"It is the ultimate demonstration of the ROV and the manipulator arm all working together under control of marine machine vision technology in the most challenging of circumstances."

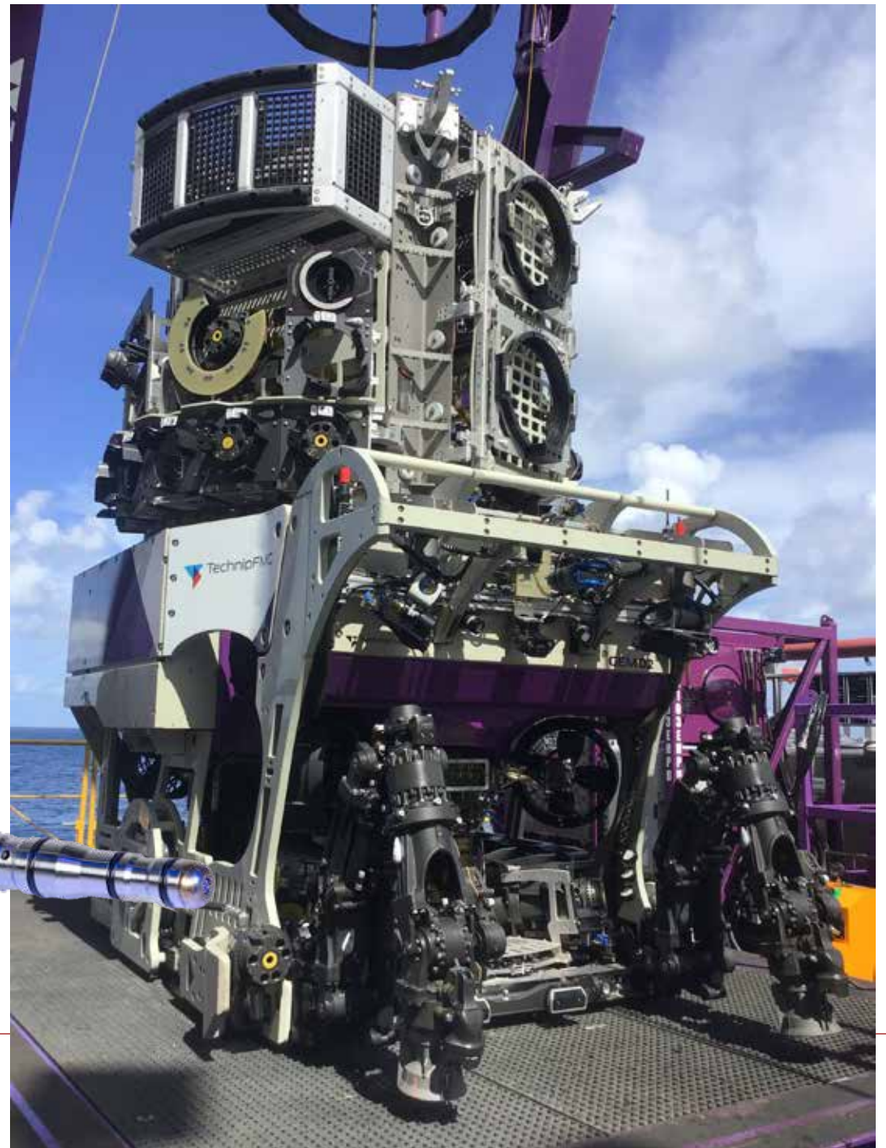
FORCE COMPLIANCE

In the world of animation, the tool will enter the receptacle seamlessly, but in reality the even a slight change in angle in any direction means that pushing against this offset can create a tremendous amount of force, possibly causinges the entire ROV to rebound backwards. Worse, it can damage the hot stab or receptacle.

The solution that Schilling devised to resolve this issue is called force compliance. As the tool is pushed forward, sensors distributed 360deg around the wrist, detects movement resistance. The control system then instructs the wrist to automatically microadjust the tool angle and, using the sensor information, realign it with the receptacle. As resistance falls to zero, the tool can be inserted further. These fine microadjustments are carried out autonomously, leaving the pilot to concentrate on work of inserting the tool correctly.

"It would be possible for the entire procedure to be carried out autonomously," said MacInnes"

Hot stab



but the industry is not yet comfortable to have a robot automatically insert a tool in subsea hardware without human supervision. We therefore call this supervised autonomy.

ISOL-8

Executing the sort of underwater operations that the Gemini is called upon to perform requires both high power and the ability to pump large amounts of fluid. The main HPU is a 250 hp system but the vehicle also houses an auxiliary HPU called ISOL8 a carry over the UHD units

"The isolate pump gives us a tremendous degree of flexibility and what it can do," said MacInnes. The package is about the same size as a briefcase while most competitive fluid intervention systems require an additional skid located underneath the vehicle and weighing two tons. The Isol-8 consists of its eight separate reciprocating pumps that can work in parallel with each other.

If these pumps were required to deliver the pressure and flow desired. If the operator said it needed an output of 50 gpm at 5,000 psi (189 lpm at 345 Bar), sufficient to actuate BOP shear rams, shear and seal, in 45 seconds or less as specified by API 53. The user simply dials the details into the control console and the pump automatically produces that sort of pressure and flow without having to make any mechanical or hydraulic configuration changes.

It can pump hydraulic fluid, water glycol or seawater, thus offering fully independent pressure and flow control of each hydraulic circuit through the onboard Schilling Robotics multi-function valve packs.

SPECIFICATIONS

Working Depth:	3000 or 4000m
Docking InterfaceSWL:	20,062 lbs (9,100 kg)
Through-Frame Lift:	7,716 lbs (3,500 kg)
Weight in Air:	12,610 lbs (5,720 kg)
Dimensions:	3.9 m x 2.5 m x 2.5 m
Payload:	66 lbs (30 kg)
Peak Thrust Performance	
Forward/ Aft/ Lateral:	8,680 ft-lb (1,200 kgf)
Vertical- Up/ Down:	7,233 ft-lb (1,000 kgf)
StationKeep	1in (25mm)
Equipment	
Manipulators:	2) GEMINI
Depth Sensor:	Valeport miniIPS
MRU:	IXBLUE OCTANS NANO
DVL:	Teledyne RDI Pioneer 600 kHz
Lights:	(11) 120 VAC and (3) 24 VDC•
Cameras:	SD and HD Options
Pan and Tilt:	(2) Schilling Electric
Available Valves:	(4) 2 gpm (8 lpm)
Hydraulic System	
Thrusters:	(7) Schilling
HPU:	250hp
Auxiliary:	150 hp
Operating Pressure:	(3,000 psi (207 Bar)