Insight

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In pursuit of accuracy

A SHIP'S LAUNCH
What actually happens behind the scenes?

MOTION COMPENSATION
Customised solutions to mitigate risks

JACK-UP DESIGN
An integrated approach for the offshore wind market

The technology innovator.

Insight

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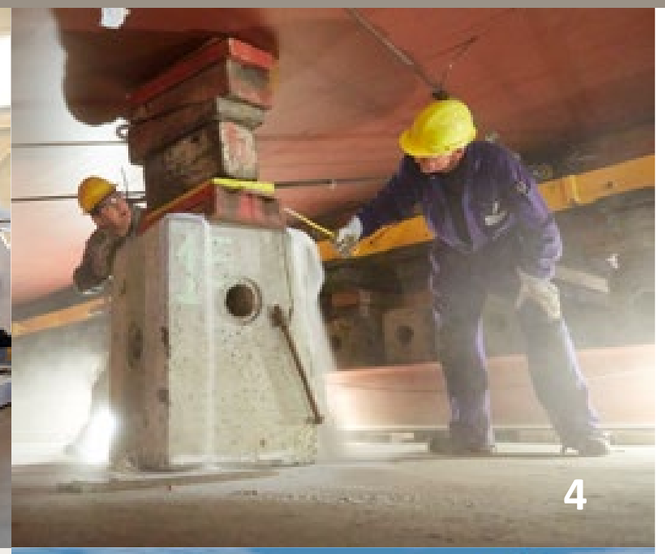

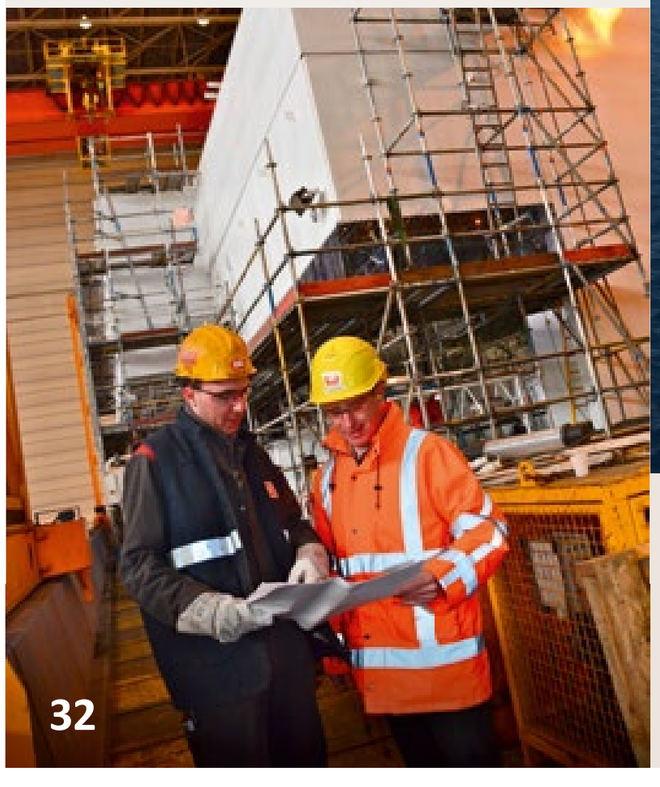

Welcome

Dear reader,

In this issue of *IHC Insight* we take you behind the scenes of a vessel launch at our shipyards (pages 4-9), with exclusive interviews highlighting the meticulous planning and careful calculations carried out by our skilled employees, as well as the emotions that run high for all involved.

The report from South Africa on pages 16-19 about our work with TNPA also stirs up a sense of pride. In line with the country's vision to develop its economy and empower its people, Royal IHC created a social development plan to further improve its dredging industry. In partnership with TNPA, we are developing local suppliers and enhancing the skills of their employees.

Equally inspirational from a teamwork point of view is the story of how IHC Services overcame several challenges to successfully complete a project for a new customer earlier this year (pages 32-35). A narrow timeframe, a third-party design and the first project of its kind for our Kinderdijk shipyard meant that teamwork between our departments and with the customer was vital for success.

Teamwork underlines the new integrated approach we are taking in the development of jack-up vessels for the offshore wind market (see pages 36-41). By combining our in-house capabilities and extensive experience in this area, we can offer greater flexibility and cost-effective solutions to customers in this growing market.

Other exciting developments for the offshore wind industry include the innovative PIME (pile inclination measuring equipment) by IHC IQIP. Find out how it improves accuracy, which is vital during the installation of foundation piles, on pages 10-15.

Royal IHC's motion compensation systems are under the spotlight on pages 26-31. Used to increase safety and efficiency in activities within the offshore, and oil and gas industries, they can be customised to meet requirements or for use in challenging operations.

Finally, read about how Royal IHC has strengthened its position in the minerals processing market by merging with Australia-based Robbins Technology Group on pages 20-25. The collaboration fits perfectly with our IHC2020 strategy by further developing opex activities and extending our equipment offering.

We hope you enjoy this issue, and if you're attending the Offshore Technology Conference in Houston this year, please come and visit us on stand 2625.

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Behind the scenes of a ship's launch

Launching a ship can be an emotional experience for all concerned, but the event happens only with weeks of practical preparations, meticulous calculations and technical expertise. It's a huge responsibility, shared by several key players at Royal IHC. Here, four experienced members of our dedicated team explain what really happens at the launch of a vessel.

1. HM Queen Máxima — then HRH Princess Máxima — of The Netherlands was invited to name the VOX MÁXIMA

The launch of a ship is a joyful event in the life of shipbuilders, the culmination of a lengthy design and construction process. On the day of the launch, this all comes together into what can be compared to the birth of a child: the vessel appears from the hall in which she has been built, for the first time she is entering her element and must float on her own. Throughout the history of Royal IHC, the festival atmosphere of launches has been emphasised by handing over a little present to all employees and by inviting members of local communities to witness the event. Usually they appear in large numbers.

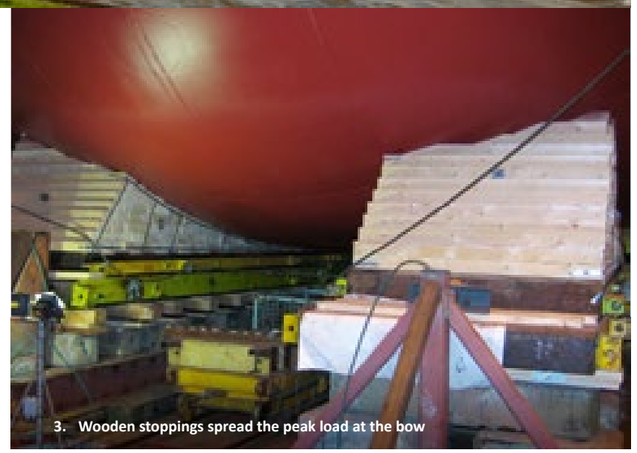
Ship owners also share in the joy of the launch. For them it is an opportunity to watch the future addition to their fleet and to be positively presented in the media. For the owner's building team it is the reward of much hard work. The owner invites a female guest, a so-called 'godmother', to name the ship. This is felt as a great honour. Therefore, not only relatives of the ship owner act as godmothers, but also ambassadors, even princesses and queens (*figure 1*). It's not unusual for godmothers to develop a lifelong relationship with the ship's crew.

When the launching day dawns and all preparations have been made, such as inviting guests, media and organising security and catering, the ceremony starts. The slipway is decorated, there are podia for the guests and music is played, including national anthems. Then speeches are delivered on behalf of the shipyard and the vessel owner. After that the godmother wishes the ship and her crew all the best and names her by breaking a bottle of champagne or rose-water against the hull.

Then the pressure builds: specialists remove the static supports of the ship. She now fully rests on the slipway and the godmother operates a so-called 'trigger' that has kept the vessel in place. Then the vessel starts sliding along the slipway, appearing from the hall and entering the open. Her air whistle sounds for the first time, accompanied by those of the waiting tugs, which catch her and moor her along the completion quay.

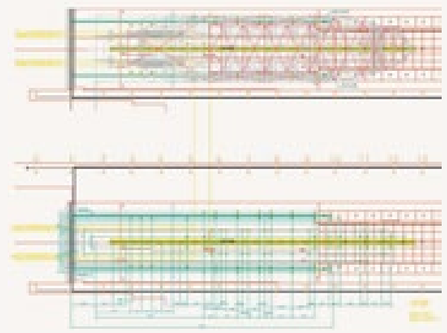
People outside of the hall can also feel the tension. How big will the initial waves be? Will I keep my feet dry? (*figure 2*) Will she float and not capsize? Can she be held in time before hitting the dike at the other side of the river? Even deep emotions are felt. One of the late aunts of the author used to say: "Every time I see a ship launched I feel my heart move. After all, my husband has worked

2. Keeping dry feet can be a serious issue


3. Wooden stoppings spread the peak load at the bow

4. If the calculations cannot provide sufficient security, model tests are conducted


6. Pillars, sandboxes, blocks and wedges support the ship under construction


5. The ship is carefully founded according to the floor plan


7. Care is taken to protect the precious paint layers

on her too". Similar feelings are shared by many of the waiting employees and the local inhabitants – and followed by feelings of relief: after all, nearly every launch is successful. So, launches can be characterised by words that express emotions: joy, celebration, tension, relief.

Careful preparation

Such emotions and successes conceal that a launch is the outcome of practical craftsmanship, accurate mathematics and careful preparation. *IHC Insight* spoke with the passionate team that actually performs all launches at IHC shipyards: Fred Zoeteman, Arie de Jager, Harry van Meerkerk and Arend de Groot. Fred is responsible for the general organisation, naval engineer Arie does the theoretical preparation and mathematics. Harry is the foreman for the slipway and maintenance of the auxiliary equipment; Arend is in charge of the mooring and therefore on board during launches, busy with 'steering' and manoeuvring the ship to the completion quay.

These people and their crew work together so closely that it seems as if they are one and the same – and they have to, because the launch is full of risks that can only be coped with by operating in such a way. Of course, this is more pertinent to large ships approaching the hall and harbour dimensions than for small ones. In addition to their 'technical' tasks, the quartet also maintains constant communication before and during the launch with the security department for the safety of guests and employees, the Dutch Directorate of Waterways (*Rijkswaterstaat*) for temporary stopping of all naval traffic on the river, and the captains of the assisting tugs.

Weight and weight distribution

Arie is the first member of the team to get involved. In the pre-contract stage he has to calculate the ship's weight and weight distribution in order to determine the slipway and hall floor load in the building and launching stage – and consequently the launching costs. The loads must carefully be calculated in order to locate the supports on which the vessel is built, which must comply with the allowable floor load, determined by concentrations of pilings under it – no luxury in the bog and river clay soil on which IHC's halls are founded. Another aspect is the allowable load of the grease layers that facilitate the launch (see below).

The weight distribution determines what the vessel will do when she starts to enter the water while partly still on the slipway. If she is too heavy in the aft ship, she may topple if not appropriately ballasted in the fore peak. This can cause severe damage to the hull bottom and the slipway. In some cases additional (temporary) strengthening is necessary. If she is too heavy in the fore ship, the floor structure may be overloaded when the stern starts floating, resulting in cracking piles. In case of ship designs with an engine room in the fore ship, ballast in the aft ship is necessary to avoid excessive pitching when the bow passes the end of the slipway. In addition, unevenness of weight distribution in the lateral direction can occur – for example, consider vessels with one suction pipe. Additional weight and/or filling tanks must be used to compensate for this.

To spread the huge peak load at the bow when the stern starts floating, wooden stoppings are fitted (*figure 3*). Under the stern of larger ships, a cradle is necessary to spread the static loads over a sufficient area of the slipway. This is to avoid trickling of the grease during the period when the stern can no longer be supported by pillars.

Hydromechanical issues

In sufficient time before the launch, hydromechanical issues must be considered. This is particularly important for launches at the Kinderdijk shipyard, which has an asymmetric harbour obliquely intersected with the relatively narrow river, and small margins to the water level at which launches can be performed. With respect to the latter: if the wind is easterly, launches sometimes must be delayed for an hour or even a whole tidal cycle. The asymmetric harbour – which cannot be remedied – introduces the problem of different water velocities at the starboard and port side of the vessel under launch. As everybody knows: different medium velocities cause pressure differences. It is the principle on which aeroplanes fly. In our case it causes an inclination of the moving ship to misalign with the slipway's direction and to collide with the wall of the smallest part of the harbour. This brings a major risk of damage to the vessel, the hall and the harbour. To prevent this – and the ship becoming stuck in the other side of the river – ingenious calculations and measures must be undertaken (discussed below). In some cases, the calculations' outcome cannot provide sufficient security. Then model tests are conducted in cooperation with the Maritime Research Institute Netherlands (MARIN) in order to validate predictions (*figure 4*).

Founding the vessel

Once the basic calculations have been made, Harry and his crew erect supports according to the slipway floor plan (*figure 5*) for the particular ship. The support bases are concrete pillars and on top of each one is a sandbox (*figure 6, yellow component*). It is filled with sand made of grinded shells, the only 'sand' type that does not coagulate under humid conditions. On top of the sandboxes, wooden blocks and wedges adapt the support to the vessel's shape. Many more supports than strictly necessary are installed in order to prevent hull deformation caused by minor irregularities in the hull and slipway floor.

The precious paint layers are protected by sheets of fat-free paper that are self-removing and float after the launch: they can easily be dredged up (*figure 7*). All sections are placed and fixed on these foundations in the course of building the ship.
When it's time to launch the vessel, the sandboxes are opened and emptied by Harry's and Arend's specialist teams, leaving an open space between the pillars and the wooden auxiliary pieces. In this way the whole ship is quickly freed from the supports and lowered a few centimetres until it fully rests on gutters and sledges.

The slipway package

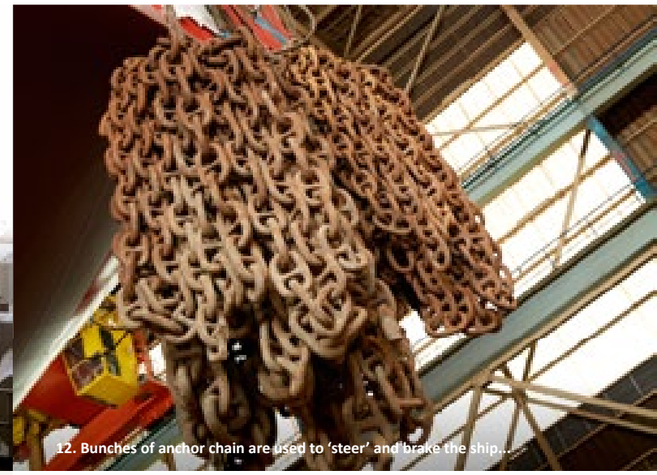
In the weeks before the launch the 'true slipway' is pressed closely between the concrete slipway floor and the hull bottom. It requires a tight time schedule, because many things must be in place before: the hull must be fully painted; ballast tanks must be ready and duly conserved; the bearing housings for the propulsion shafts must have been bored; etc. etc.

8. The slipway package, ensuring a smooth and safe launch

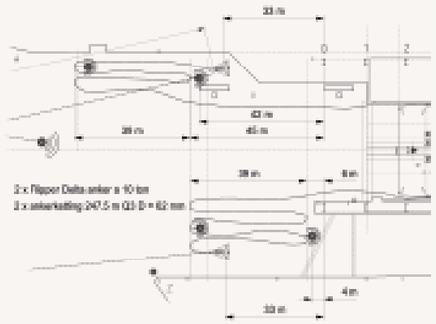
9. The Basekote is applied at a temperature of 160°C

10. The ingenious trigger ensures launching at the right time

11. And... action!



12. Bunches of anchor chain are used to 'steer' and brake the ship...



13. ...sometimes assisted by pre-calculated anchoring

The 'true slipway' comprises an accurately aligned package of two layers. The static bottom layer, which is kept on the concrete floor by gravity, is built up from six metre-lengths of gutters, massive Red Ironwood beams, enclosed by protruding steel strips (*figure 8, yellow*). These function as guidance for the second, dynamic layer, named sledges. Every gutter is filled in advance with a centimetres-thick layer of solid grease (*Basekote, figure 8, brownish layer*) that is applied at a temperature of approximately 160°C (*figure 9*). Over this layer a second layer of soft – and more lubricating – grease is applied (*Slipkote, figure 8, transparent strands*). The grease layers decrease the friction force and allow the sledges – loaded with the full weight of the ship – to slide over the gutters under 'controlled braking' speed, without unwanted development of heat.

The sledges consist of Oregon pine beams, bolted together into massive tablets that can move through the gutters' protruding strips (*figure 8, just visible below the centreline skeg*). The sledges are girded to the hull bottom by paint-friendly synthetic ropes, with an intermediate layer of whitewood planks for levelling the local unevenness of the ship's bottom and for protecting the paint. The sledges are removed directly after launch, just before the vessel is moored.

The purpose of the entire arrangement is to secure the alignment of the slipway and to prevent damage to the hull bottom during the launch. Up to three of such 1.2 or 1.75m-wide slipway packages can be positioned over the transversal axis of the hull. This number depends on the length, width and weight of the ship in relation to the carrying capacities of the slipway floor and the grease layers – and the point where buoyancy has been calculated to take over part of the vessel's weight. The used greases have been developed in cooperation between IHC and a specialist supplier to be biodegradable in order not to pollute the river.

Trust in the trigger

Once the sandboxes have been emptied and the ship set free, waiting is required for the correct river water level (or in some cases: zero current velocity) and the actions of the godmother. This waiting time can't be too long, because then the sledges would 'fall through the grease', which would hamper the launch. Fortunately the grease layers allow some tolerance. On the other hand, the ship should not 'escape' before zero hour has really dawned. Therefore shipbuilders trust in an ingenious apparatus, the so-called 'trigger' (*klink*).

The ship's weight, once set free, develops a force in the direction of the river due to the slope of the slipway. If no other means were available this could initiate an uncontrolled launch. To prevent that, the trigger is installed as an integrated part of the slipway package. This nullifies the need to weld hooks, brackets or gear racks to the vessel's hull. Placed at about a third of the way from the aft ship on the dry slipway floor, it is able to temporarily hold the longitudinally directed force. The trigger has been constructed with an arrangement of levers-on-levers in such a way that a whole ship, weighing thousands of tonnes could easily be held by hand, in fact. It is usually operated by a simple pneumatic cylinder – or even by a person equipped with a sturdy wrench (*figure 10*).

This trigger is operated by the godmother from her control desk. However, in fact, it is Harry, kneeling under the ship, reading a lamp signal from the control desk and truly operating the trigger cylinder – or in an emergency, the wrench. This procedure was developed to prevent what once happened: the lever on the godmother's desk was set inadvertently and the ship escaped at the wrong time. For the same reason, the trigger is secured by a padlock until every person under the ship has done his job and has disappeared to the safe area.

Hydromechanics in practice

Once the trigger is dropped, the ship starts moving toward the river, gradually reaching a speed of approximately six metres per second (*figure 11*). Then all preceding calculations and measures are tried out. The influence of all factors such as water level, current, vessel speed, harbour asymmetry, gutter length, greasing and counter measures must cooperate, just in order to prevent course deviations and damage. This is where Arend and his men come in. They are on the deck of the ship and according to the plan made by Arie, they purposely drop bunches of anchor chain (*peuren*) from the main deck (*figure 12*). These then slip over the river bottom and function as brakes, correcting misalignments. With large vessels this is supplemented by prepositioned anchors and chains (*figure 13*). For additional damage prevention, flexible, rolling fenders are installed at the small side of the harbour. If vessels hit these, their six metre-high construction and flexible founding warrant the least possible damage to the hull and painting. Having passed the harbour mouth, a physical phenomenon provides help: the current catches the vessel and lets her sway. This does more for braking the speed than anything else. So, tugs can pick up hawsers and moor the ship (*figure 14*). At this moment, the people involved can also feel relief: another fine example of their craftsmanship has been delivered.

Better left unsaid...

What has been described above is only about rather straightforward launches. Nothing has been said about difficult decisions on prolonging the slipway period, launching a ship ahead instead of astern (*figure 2*), the need to dredge the harbour, fenders that are too small and burst, about leg-thick sledges breaking like a match – we have seen them – and more things besides. They are left in the competent hands of the launching team.

A perfect launch

After every complicated launch a full report is drawn up, evaluating the process, collecting and analysing movies and data, and drawing lessons. In practice every launch is a unique event accompanied by the risk that some unexpected details go wrong, not visible for the public, but surely apparent to Fred, Arie, Harry and Arend. "All lessons of the past must be utilised to make improvements," say the team. "Once thousand tonnes of steel are moving, nobody can even think about controlling it. Therefore, you have to take care that everything is in the right place beforehand. Only then, the 'miracle' of a perfect launch can be repeated time and again."

14. After perfect 'steering' the vessel can be picked up by the assisting tugs

PIME: efficient and accurate pile installation

Hydrohammer S-2000 at work on the Gemini offshore wind farm

Ensuring the accuracy of pile straightness is becoming more and more important for the installation of foundation piles, particularly monopiles for the offshore wind industry. In order to measure the inclination of monopiles during installation, IHC IQIP has developed PIME (pile inclination measuring equipment). *IHC Insight* takes a close look at this innovative technology, and outlines the advantages it brings for the industry

IHC IQIP supplies innovative equipment and smart solutions for foundation, installation and decommissioning projects in the oil and gas, offshore wind, and coastal and civil markets. Combining experience and expertise with a passion for service and innovation makes IHC IQIP ideally positioned to meet the demands of its broad customer base, which includes offshore wind farm developers, installation contractors, design companies and government authorities.

With offshore wind construction projects such as new wind farms seeing an increase in size and complexity, companies operating in this evolving field are becoming more aware of the importance of maintaining an accurate installation from the ground up. It's vital to ensure accuracy – but this often has implications for time and money.

As monopiles for wind turbines are constructed from a number of connected sections, the key is to guarantee a level top section, which will in turn ensure optimum performance for the wind turbine itself. IHC IQIP's PIME has been designed to measure piles during installation from inside the sleeve, monitoring and calculating the angle and inclination of the top section.

An instant success

In 2012, IHC first developed a concept for a new inclination measuring system that would offer a faster, swifter and more effective solution than others on the market. "We very quickly made a design featuring two beams, with one sensor in each beam," explains Robin Nagtzaam, project leader responsible for PIME. "On the first project using the equipment, the technology was an instant success and everybody involved was very pleased with the outcome."

During the project, and those that have followed, the team was given the opportunity to assess some critical feedback from service colleagues and customers, and saw where improvements had to be made. So, in 2013, the design was progressed. "We made it more robust, and added one extra sensor per beam so the system is able to do a self-checking routine," adds Robin. "With just one sensor, it's impossible to accurately check if a certain value is 100% correct or not. With two, each sensor is able to constantly check the other in order to confirm values. In that regard, PIME is self-checking."

In 2014-15, over 300 monopiles were installed using the PIME system. Each was completed within a stated tolerance of 0.05 degrees, achieving 95% operational reliability for the equipment. The system was able to diagnose any minor problems so that other solutions could be easily presented to ensure a 100% accurate installation. "During these projects, the system proved to be very reliable," says Griedo Bel, Project Engineer for PIME at IHC IQIP. "It's an excellent tool for installation purposes."

Feedback from the field

To date, all feedback from the field has been positive, with customers reporting that the PIME system offers an effective solution for accurate pile driving. "The only issues reported were those related to the human element," explains Robin. "Due to the complexity of the equipment, we have improved the workflow of the system to ensure that operators must follow the correct procedures – it's now difficult to make mistakes or rush the process."

Close cooperation with customers is vital to understanding where improvements can be made to the system in order to maximise its

Hydrohammer S-1200 ready for deployment/hoisting operations


Piles in storage on Van Oord's AEOLUS


Pile load out/preparation


Hydrohammer S-2000 on Van Oord's AEOLUS

Testing PIME at IHC's yard in Kinderdijk

potential. Griedo has worked on five offshore projects using the equipment, each time helping to train the service engineers while ensuring the PIME technology worked correctly. "The feedback from these projects has been integrated into the latest designs," he explains. "And IHC IQIP's training facility ensures operators arrive on site with the knowledge required to carry out their jobs using the equipment correctly."

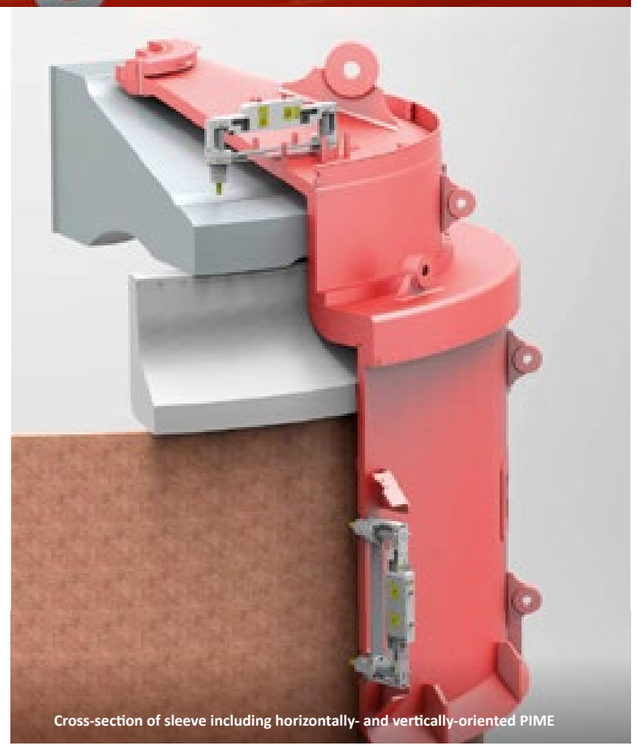
"Our relationship with customers is defined by their willingness to trust us," continues Robin. "And they only trust us when they see evidence that our equipment is measuring data correctly. When PIME has been tested against older, more expensive methods, it has been found to be highly accurate. Once a customer trusts us, they're happy to use our single system instead of two, three or four separate pieces of equipment!"

Operational principles

Griedo summarises the operational principle of the equipment: "We carry out a calibration on the sensors before the hammer is used in order to ensure a correct readout and process without any sensor deviations. Once any necessary adjustments have been made, we pile for one metre, then we take another inclination measurement. The process is then repeated at regular intervals to ensure the pile is driven correctly and within installation tolerance."

The first PIME design featured only a vertical system. It was soon discovered that this was not the optimum approach for certain monopile constructions, because some elements – such as rough welded surfaces – led to a miscalculation of the inclination. "For monopiles with top flanges, we prefer to use a horizontal system," explains Robin. "With this technique, we take measurements against our own anvil, which is always perfectly aligned with the top flange's surface."

In horizontal configuration, two beams on top of the sleeve are used to measure the surface of the anvil, which is in the same horizontal orientation as the monopile's top surface. In vertical orientation, the beams are mounted on the side of the sleeve, directly measuring the pile wall's surface.


Cross-section of sleeve including horizontally- and vertically-oriented PIME

Two types of data are combined during the measurement process. Since PIME's sensors use the gravity-based horizon as a reference point, each beam determines the absolute angle (X and Y), while the software combines several measurements in order to determine the final inclination, or relative angle.


Hydrohammer S-1200 on pile during Kentish Flats extension project

All measurement data is reported directly to an IHC IQIP laptop, which is installed inside the control cabin along with the hammer controls, camera monitors, survey information, and other useful equipment. Specialised software immediately calculates the current angle and orientation of the monopile, providing a detailed and accurate report to the end user.

The software also acts as a reliable diagnostics tool. An additional benefit of using two sensors is that the system is able to quickly identify any problems, and relay this information to the end user, which also results in reduced downtime. "It's very important that the system is working as well as it possibly can," says Robin. "The inclination of the monopile can only be adjusted until it reaches a depth of around 10m, after that it's set, and it cannot be corrected without major reworks."

A successful track record

"The key thing, and one of the main advantages of PIME, is that you are able to measure directly at the top section of the pile in order to guarantee reliability," says Robin. "PIME is the best interface for consistently measuring the straightness during the piling process.

"Another way to do it would be to retract the hammer when piling, and use a different set of tools such as a water level to measure these readings. But this takes up so much time, and every hour of operational time comes at a major cost. PIME is able to save both time and money, as well as decreased hoisting operations thanks to a more integrated approach."

An example of these benefits can be found in the 2015 installation of monopiles for the Gemini offshore wind farm, one of the largest projects of its kind in the world. In total, the work involved the installation of 150 4MW-capacity turbines, and the spread also included IHC's S-2000 hammer with 5.5m sleeve.

"The first pile took 11 hours to install using other measuring systems beside the PIME," says Griedo. "But by the end, once we had refined the process using the PIME system, this was reduced to an average of just two hours. Other inclination measurement systems were simply not necessary anymore or were not operational. At one point, we installed six monopiles in just one week."

Examples of successful installations can also be found in earlier North Sea projects, including the Westermeerwind offshore wind farm, in which 48 3MW turbines were installed using IHC's S-800 hammer with a 5m sleeve, and a similar project with 97 6MW turbine installations also testing the new equipment – with positive results.

Future applications

PIME is also capable of taking measurements underwater, making the system well suited to all types of piling operations – on- and offshore. While the standard PIME set-up can be easily installed on sleeves ranging from 108" and upwards, it can also be adapted for smaller sleeves.

"Using PIME, we will also be able to measure the inclination of anchor piles and jackets, which are used extensively in the oil and gas industry," Robin predicts. "There is a lot of potential in the future for using PIME across a number of different applications, and each would offer the customers the same effective results."

Partners for local development

1. The TSHD ILEMBE at the quay in Sliedrecht, completed three months ahead of schedule

Royal IHC has had a long association with the South African national port authority, TNPA. Its most recent delivery, the TSHD ILEMBE, was accompanied by a far-reaching social development plan. In line with the country's vision to develop and empower its people, the plan aims to further improve its dredging industry. It is also a perfect example of the CSR and services strategies of IHC and its ability to act in partnership with its customers.

In January this year – three months ahead of schedule – Royal IHC delivered the ILEMBE to Durban, South Africa, for Transnet National Ports Authority (TNPA). The 5,500m^3 trailing suction hopper dredger (TSHD), the largest vessel of its kind in the country, is the latest addition to TNPA's IHC-built fleet, which includes the TSHD ISANDLWANA (delivered in 2010), and the grab hopper dredger ITALENI (delivered in 2014). The ILEMBE (*figure 1*) will help to maintain South Africa's eight main commercial seaports as well as assist TNPA with its capital dredging programme.

When it initially set up the tender process for the design, construction and delivery of this vessel, TNPA requested that suppliers use the project to contribute to the long-term development of the South African dredging industry, with proposals for local production, training and extensive life-cycle support after delivery.

Carl Gabriel, Executive Manager of Dredging Services, TNPA, explains: "The requirements to be awarded this contract were not just compliance to technical specifications, previous shipbuilding experience and general commercial criteria (delivery time, guarantees etc). There was also a pre-qualification criteria worth 25% of the contract value, set by TNPA, for supplier development. The supplier development plan consists of initiatives aimed at promoting localisation, skills transfer and training."

The contract between IHC and TNPA was signed in March 2014 and the keel laid on 8 January 2015. The ILEMBE left the Kinderdijk shipyard on 9 December 2015, which is a very short turnaround. Senior Project Manager Philip van den Broek says: "We had a limited slot on the slipway, so we had to do what would normally take seven to eight months in just four and a half! It put a lot of pressure on engineering and production to complete it successfully, but it shows what IHC is capable of in such a short period of time. The ILEMBE, a sister vessel of the ISANDLWANA, was relatively straightforward for us to build. The main focus of the contract was the supplier development (SD) plan and 25% obligation."

This is where Business Development Manager Bert-Jan de Keijzer came in. He helped to develop the specifications of IHC's SD plan, which had to be accepted by the Enterprise and Supplier Development group of TNPA's parent company, Transnet SOC Ltd., and then helped to implement it. "Realising a plan such as this fits in fully with IHC's internationalisation and CSR strategies, and our role as partner to TNPA," he explains.

IHC's SD plan consisted of three elements: setting up a dredging school (the first of its kind in South Africa); outsourcing parts to local suppliers; and using the local supply chain for spare parts and increasing local service capacity.

Supporting local suppliers

Most parts of the ILEMBE's dredging installation were fabricated in South Africa. These included the bend pipes, branches, nozzle, actuating mechanism bottom valves, self-emptying doors, overflow, dredge pump, suction pipe including drag head, service frame, gate valves, gantries and dredge pipes. A twelve-metre dredging support vessel workboat, the INYOSI (*figure 2*), was also completely outsourced in South Africa.

"We looked for suppliers that were suitable and had the right facilities," says Bert-Jan. "We trained them with the help of our supervisors and production specialists, explaining to their workers what kind of product they were making, and what it is used for, so they have a greater understanding of its function."

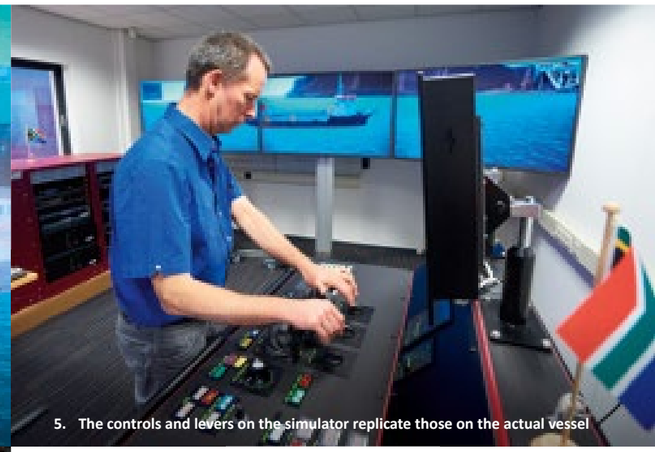
As IHC intended to develop a sustainable programme, it connected the spare parts market to its activities in South Africa. “If TNPA orders a spare part from IHC, the item will be fabricated locally,” says Bert-Jan. “This way, we can maintain the relationship, and continue to transfer knowledge.”

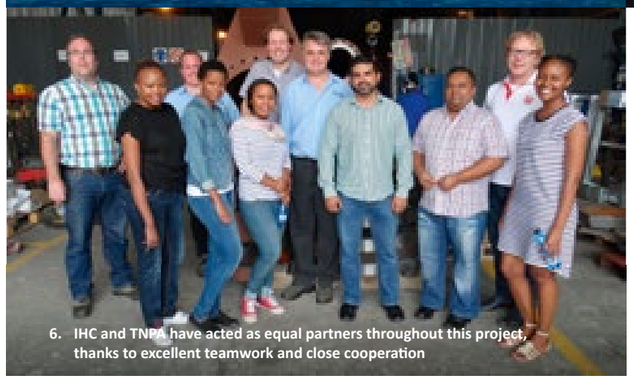
One of the local suppliers involved with IHC was MITAK, which produces wear-resistant castings. Initially, IHC used its foundry to fabricate items for TNPA, but then began ordering additional pieces for its customers in Europe. “The majority of castings on board the ILEMBE were casted and fabricated by MITAK,” says Bert-Jan. “We also ordered additional pieces for other customers in Europe, therefore exporting out of South Africa and creating a substantial volume for the foundry. This is a good example of how we developed a supplier together with TNPA,” he adds.

2. The INYOSI DSV workboat during sea trials


3. TNPA and IHC representatives enjoy a preview of the simulator during testing


4. Animated TNPA home port on the simulator’s exterior view


5. The controls and levers on the simulator replicate those on the actual vessel


6. IHC and TNPA have acted as equal partners throughout this project, thanks to excellent teamwork and close cooperation

IHC’s commitment to developing and improving the South African industry is highlighted by the fact that it went over and above what it had agreed to do in the original SD plan. MITAK supports an orphanage in Thokoza, Johannesburg, which required furniture and equipment for computer classrooms. IHC made a financial contribution to the orphanage and donated refurbished computers from its ITC department in The Netherlands. Sent on the ILEMBE, they arrived earlier this year.

Dredging school

The third part of the SD plan was to set up a dredging school in partnership with TNPA. By developing and enhancing the competences of new and existing dredging personnel, the operational efficiency within the South African industry will only improve.

Over the last two years, the IHC Training Institute has been working closely and sharing knowledge with Transnet, which has its own Maritime School of Excellence, to achieve this goal. Project Manager Nicoline de Ruiter explains: “We needed to create something that would fit with Transnet and was unique to their company. We also had to consider the level of education in South Africa – the school should help them get their people to the next level. They already have the marine training there, the dredging curriculum is an extension to the courses already on offer.”

The overall aims were to create a formal dredging course accredited by the South African government, and a training centre for the current crewmembers of Transnet’s dredging division. The course will consist of both theoretical and practical modules to bring the next generation of pipe operators to a completely new level.

“There are two possible routes through the school,” says Nicoline. “One for new dredge operators, possibly employed outside of TNPA, who are required to attend for the entire duration of the course. The other is a training route for the existing dredge operators of the dredging division. The IHC Training Institute’s Dredge Operator Competence System (DOCS) is currently rolled out within the dredging division. This system is used to assess and track the abilities of the current operators in order to design a tailor-made training programme for each of them, and help them develop the specific skills that require improvement.”

The school is due to welcome its first group of students when it opens this summer. Transnet and the IHC Training Institute are currently finalising the curriculum, the duration of the school’s programme, and course modules and materials.

The school’s teachers will be trained by IHC in both The Netherlands and South Africa. Four weeks of theory and didactic skills training at the IHC Training Institute in Kinderdijk will be followed by practical training on the simulator (*figure 3*) in South Africa, when it arrives in May.

Practical training

The simulator will be used in the practical modules for both the schooling and training routes. This is provided by IHC Systems, which also supplied the ILEMBE’s dredging control system. The simulator features dredging and navigation trainee consoles, a trainer desk, wide fore and aft exterior-view displays, a classroom projector and screen for fellow trainees, and the accompanying hardware and software.

To focus on specific aspects of dredging and navigating, the trainer is able to adjust all video presentations within the system. Free movable “cameras” offer detailed bird’s-eye views and simulated CCTV images of the vessel and the surrounding environment, and the water can be “drained”. The trainer can also influence process parameters or introduce equipment failures in order to improve the students’ capability to cope with extraordinary situations. In addition, the weather, sea state, tide, and sun’s position on the exterior view can all be controlled by the trainer. These options contribute to a realistic scenario, as does the animated presentation of six of South Africa’s main ports (*figure 4*). The trainer interface is also used to prepare training sessions in particular operational areas.

Governing a dredger requires a broad knowledge of technical systems, their influence on production, and how to use them in order to prevent damage, injuries, downtime and other risks. For this purpose, an operator benefits from a wealth of manual and automatic instrumentation, monitoring and automation tools on board the actual vessel – as does the trainee on the simulator (*figure 5*). In this way he can improve efficiency and craftsmanship for operations such as dredging, shore discharging, rainbowing and dumping.

“We are integrating the ILEMBE and the ISANDLWANA in the simulator so that users can train using both vessels,” says Bert-Jan. As the PLC/SCADA simulation of multiple TSHDs can be loaded, other dredgers can be added in the future.

Long-term commitment

TNPA has set out a long-term vision to develop the South African dredging and manufacturing industries, raising levels of operational efficiency and improving the capabilities of those employed in these sectors. IHC is proud to play its part in making this vision a reality, using an integrated approach that will reap benefits for the country’s industry and economy for years to come. The success of this plan highlights IHC’s commitment to sustainable development and its role as a partner to customers such as TNPA (*figure 6*).

Carl Gabriel concludes: “We’re very happy with the final product that is currently operational in Durban and performing well. My personal experience working with Royal IHC has extended over 10 years, and everyone we have dealt with there has had a high level of expertise and has also been a pleasure to work with. This has fostered very good teamwork between IHC and TNPA.”

Making gains in the mining market

Artist's impression of an IHC circular jig

In November 2015, Royal IHC merged with Robbins Technology Group to offer customers fully integrated, turnkey and cost-effective solutions for the entire mining cycle. The two companies explain the reasons behind their collaboration and the exciting developments it will bring to the market, such as a unified service for customers, covering all aspects of the supply chain.

An IHC-built alluvial gold processing plant

Based in Brisbane, Australia, Robbins Technology Group (RTG) is a multi-disciplined technology group specialising in the design of wet and dry processing plants for the mineral sands industry. Recognised globally as an important market leader, it has worked on a number of key projects in collaboration with major producers in the field across 12 countries.

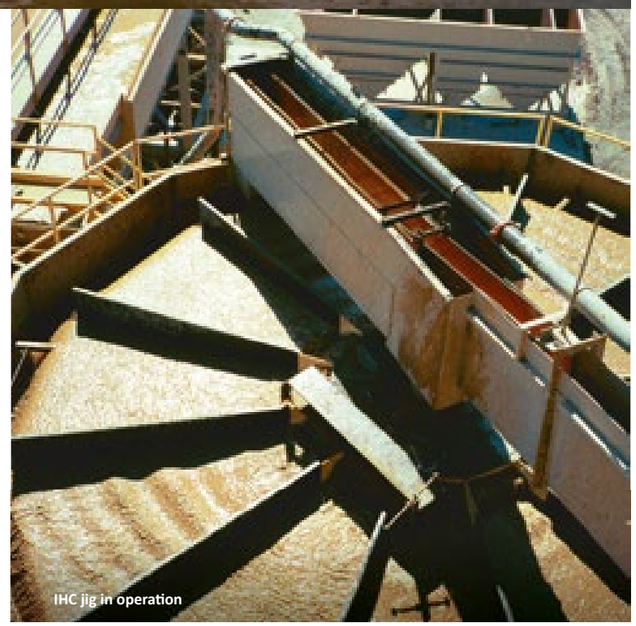
The decision to merge with RTG fits perfectly with IHC Mining's long-term strategy, part of which was to expand its services into the mineral sands market. Having identified recurring issues relating to incompatibility between, for example, processing plants and dredgers, it became clear that there is scope to offer customers a unified service, covering all aspects of the supply chain.

The merger also complements the IHC2020 strategy, by further developing opex activities and helping to reduce the company's dependence on the volatile shipbuilding industry.

Highly skilled

Founded in 1987 by Reg Robbins, RTG was initially conceived as an engineering, design and project management company, but in recent times has established a mineral laboratory for front-end exploration test work.

In addition to its core staff of 15 employees, RTG works with a number of highly skilled sub-contractors on a project-by-project basis. The group's operations are separated into three distinct business units, covering all aspects of metallurgical test work, design engineering and project management, and the supply of process equipment.



IHC jig in operation

Launched in 2010, Robbins Metallurgical focuses on laboratory testing and project development, and carries out some 250 assignments each year. It provides customers with a complete range of services including the analytical study of ore samples derived from drill programmes to the processing of bulk samples for mineral process flow sheet development.

The test work phase

"There are two aspects to the work we do at Robbins Metallurgical," explains Matt Robbins, Operations Manager and Board Member. "First there's the analytical phase, where we assess drill samples derived from exploration using heavy liquid separation tests to determine the valuable heavy mineral content. That might consist of, say, 5,000 individual samples."

If the customer considers the project to be worthwhile, the team will move on to scoping, pre-feasibility and definitive metallurgical tests using a larger, composite sample. Its laboratory has the capacity to process anywhere up to 80 tonnes of bulk samples, using either full-scale commercial equipment or genuinely scaled equipment to provide accurate results.

The end result of these tests is actually the delivery of a proposed process for operations. "We design a process flow diagram which can be used in the engineering phase," says Matt. "The analytical phase leads to our engineering department and is translated into the actual design of the plant, including operating cost budgets and so on – it's all linked."

A bespoke service

As with the RTG group in general, Robbins Project Engineering offers a bespoke service, and is recognised for its capacity to customise and tailor its plant designs to meet specific customer requirements, as well as its ability to adopt new concepts and developments.

"Our mineral sands processing plant designs can take the form of a straightforward turnkey package, or through EPCM (engineering, procurement and construction management)," says Brad Robbins, Engineering & Business Systems Manager and Board Member. "We offer an extensive range of plant possibilities, based on modular-based design options. This allows us to react quickly and economically to our customers' project requirements."

Robbins Project Engineering also develops products for a number of niche markets, for example those suited to zircon refractory operations in China and the USA. As Matt explains: "If a customer has an issue with materials handling in their plant, our engineering staff will visit the site, gather data and provide a report with our recommendation.

"Depending on the outcome of the audit, this may lead on to an opportunity for us to supply customised equipment to the plant in order to rectify any problems. Some further examples of the kind of equipment we already supply to our customers include: hot acid leaching (HAL) reactors, process bins, quenching tunnels and surge bins."

Equipment solutions

In addition to the solution-based supply model as offered by Robbins Project Engineering, separate equipment can be supplied through Robbins Process Equipment. This offers customers a number of off-the-shelf product ranges.

"Our main product range consists of around 10 key products," Brad explains. "Following the merger with IHC, we're currently in the

An IHC jig and scrubber

process of agreeing which should be advanced first, and which are best suited to the current market conditions."

The new collaboration

As a result of its successful business strategy, RTG decided to look further afield in order to expand its horizons. "We were looking for a company that complemented our services in terms of global ability and reach," says Matt. "IHC fitted the bill perfectly."

It's a symbiotic relationship. RTG is able to strengthen and expand IHC's offerings to the market, while IHC brings its innovative engineering and equipment capabilities to the new collaboration – along with financial muscle.

John Feenan, Director Asia Pacific IHC Mining and RTG Board Member, highlights how RTG's integrated knowledge and experience of the mineral sands industry will complement IHC's expertise: "For us, mineral processing is just one of our activities, but it is RTG's core business. They are totally dedicated to the field, in all aspects from design to supply and installation."

IHC high-recovery jigs

One exciting future development of the merger is the potential integration of IHC's high-recovery jigs – which are already used in the alluvial gold mining sector – with RTG's mineral processing plants. As both technologies are based on similar physical separation techniques, there is scope for a combined solution.

Gravity concentration is a straightforward and widely employed technique used to separate mineral grains of different specific gravities – a proven technology based on natural processes. A number of devices have been developed to carry out these activities, although the jig is considered to be the most versatile.

"We have carried out tests in the past to investigate the possibility of using jigs for mineral sands processing operations," says Taco de Boer, Manager IHC Dredge Mining Consultancy and Mineral Processing. "The results were promising, and the technology could add to the total package of processing equipment we offer our customers."

Matt elaborates: "IHC has been producing jigs for many years, whereas it's something we'd never considered. Likewise, IHC have dedicated test facilities for jigs and we have test facilities for minerals sands equipment, so there's synergy there for a crossover with our research and test work."

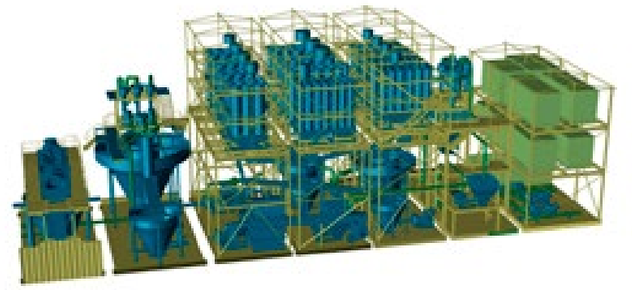
Mutual understanding

Although still in the early stages of the collaboration, both IHC and RTG are looking forward to other opportunities for utilising their mutual understanding of the full life cycle of mineral deposits. For example, it enables IHC to be more involved in the design phase.

"Previously with mineral sands projects, we would only enter at the purchasing or tendering phase," says Taco. "But now we can be involved in studies with RTG, which enables us to mitigate a lot of risks for our customers. Accurate analysis and effective studies can prevent problems down the line during a project."

RTG is also examining the possibility of utilising IHC's fabrication centres, for example those in South East Asia. Better access to such facilities will enable the company to become more competitive; first in the Australian market and then further afield.

Example of mineral sands



Technical drawing of an RTG mineral separation plant

In addition, there is the potential for using IHC's training facilities for process plant training as opposed to dredging training. By providing a high standard of training to operational staff, RTG positions itself as not only a strong supplier, but one with the ability to offer customers a way of enhancing and improving their production capabilities.

"A lot of projects rely heavily on operational personnel," says Matt. "But there tends to be a high turnover in, for example, remote locations, and so skills have a tendency to degrade over time. This affects the performance of the plant, which in turn directly affects the revenue of the mining company.

"The ability to continually develop our customers' operations through training programmes while helping to improve their overall project through our collaboration with IHC can only be of benefit to the companies who operate in our markets."

An RTG mineral separation plant

A long and productive relationship

Through this new partnership with IHC, RTG will strengthen its international presence while retaining its headquarters in Brisbane. "We're a well-known company in this industry," says Reg Robbins, RTG's Principle Mechanical Engineer, Board Member and founder. "Our strategy is to support our customers throughout the entire mineral sands process – and I think we do a very good job of this, as evidenced by the strong, long-standing relationships we have built over the years."

From IHC's point of view, the collaboration strengthens its position in the minerals processing market. "We already had experience working with RTG on various studies," concludes Henk van Muijen, Managing Director IHC Mining and RTG Board Member. "This merger is a very natural way to proceed, and we're all very happy with how things are developing. Collaboration between the two companies will provide our customers – old and new – with the best equipment solutions available at competitive prices. We look forward to a long and productive relationship."

An RTG surge bin

Customised solutions for motion compensation

Operating in dynamic sea states often results in uncontrolled motion of the payload – which in turn leads to slack wires and large snap loads. Royal IHC's motion compensation systems help to mitigate these risks, enabling customers to work safely and more efficiently. They can also be customised to meet any number of requirements or challenging operations.

IHC has a long history of delivering passive and active heave compensation systems to customers operating in the offshore, and oil and gas industries. They are now widely used around the world to ensure a load remains motionless, increasing safety and efficiency in a range of operational activities.

The technology can be categorised into two distinct types. A passive heave compensation (PHC) system acts as a shock absorber, with a hydraulic cylinder storing and releasing the energy transmitted by incoming waves. It is a standalone system and as such requires no external power, representing a lean and simple method of compensating for wave motions.

A more sophisticated solution is the active heave compensation (AHC) system, which is able to take highly accurate, real-time measurements from an external motion reference unit before compensating for any movement. AHC systems benefit from the ability to actively control any oscillations at a specific point, using active power to improve accuracy.

IHC is able to help customers define their system requirements, and offers the complete package for the delivery of advanced and efficient motion compensation systems, from engineering and analysis through to fabrication, installation, commissioning and life-cycle services.

Custom-built systems

Motion compensation technology offers a number of important benefits to companies engaged in any kind of lifting or hoisting activities. It enables operators to work for longer periods of time at high sea states, minimise downtime, and extend operational weather windows.

"I think many companies are coming to recognise the advantages of an integrated, tailor-made motion compensation system designed for a specific application," says Arjan Jansen, Senior Sales Manager Motion Control and Automation. "For example, we are seeing an increase in subsea activities, and more traditionally surface-based projects are being relocated subsea. As a result, offshore inspection, repair and maintenance work is starting to increase."

Interest in motion compensation systems in general has also seen an increase. This is in part due to the far-reaching applications of the technology that extend beyond traditional lifting and loading operations, many of which are a response to growing safety concerns in the offshore industry.

"Many of the companies developing motion compensated gangways have had a lot of success recently," explains Bas Kockmann, Account Manager Winches. "This is very interesting from our point of view, because the industry is becoming more aware of the possibilities. Where else can we apply this kind of technology?"

A project completed for Shell demonstrates this. Arjan explains: "It involved a jack-up platform with an onboard crane, for use in offshore applications. A foundation monopile was required to be lifted from a moving vessel, and so we deployed an offshore load tensioning system.

"The system transferred the load from the vessel onto the crane in three steps, with a motion compensator positioned in between the hook and the crane's load. An additional boost function avoided the load colliding with the vessel, and the installation was a complete success."

In the field

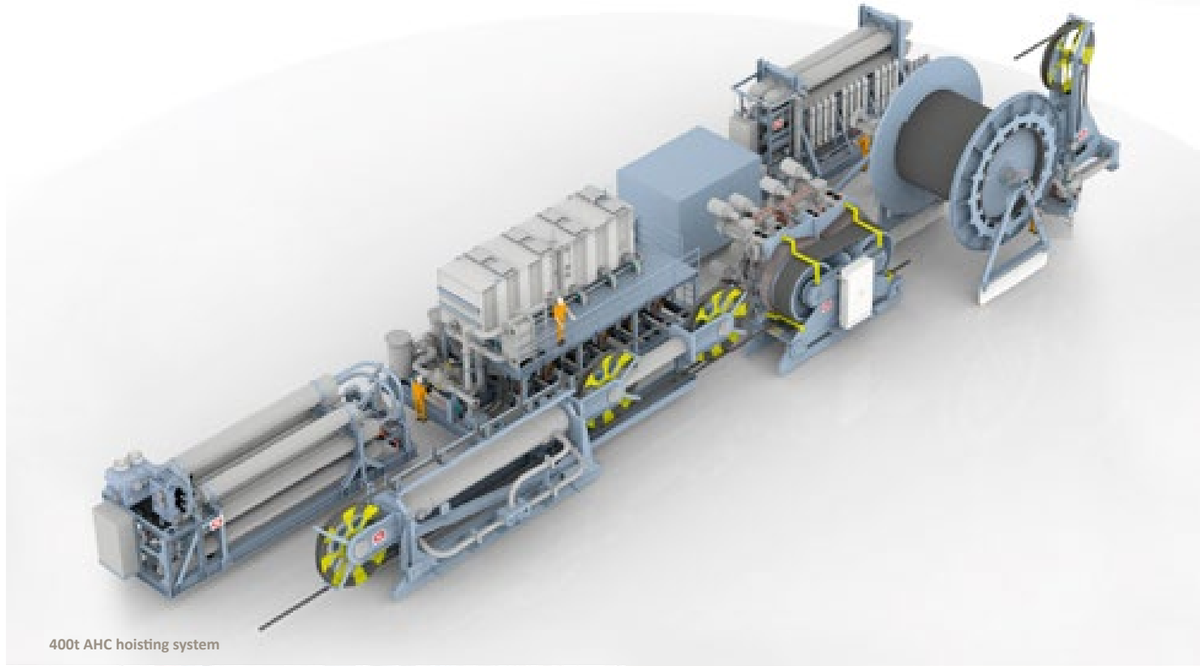
Further examples of IHC's activities in the field can be found in the delivery of AHC systems for a range of dredging vessels for Van Oord, the latest in this line being the VOX MÁXIMA, and the EPC (engineering, procurement and construction) delivery of a system for the YANTAI 5000, a heavy lifting/pipelaying vessel constructed for the Yantai Salvage Bureau by Shanghai Zhenhua Heavy Industries Co., Ltd. (ZPMC) in China.

Designed for the installation of 400mT loads at water depths of up to 3,000m with minimal energy consumption, the system for ZPMC allows the vessel to perform more installation jobs each year, maximising returns on the asset investment.

The integrated delivery consisted of an extensive range of equipment, including a storage winch for 3,500m of wire rope, the complete drive and control system with motion reference unit, and controls cabin.

Because instant wire load changes occur when entering the splash zone, IHC's AHC system keeps the hoisting wire tensioned and minimises uncontrolled motion. Meanwhile, typical frequencies are neutralised in order to avoid resonance without unwanted side effects, and a stepless and controlled descent ensures a safe landing.

PHC tensioner



400t AHC hoisting system

Heave compensator in Module handling system

Another notable project was the delivery of a module handling system on the MSV SEAWELL for Helix Well Ops UK, a vessel dedicated to the intervention of subsea wells in the North Sea area. The system features an inline heave compensator for the main hoist and several AHC winches combined with PHC tensioners. In addition, it is equipped with a cursor system with two constantly-tensioned cursors to guide the payload through the splash zone.

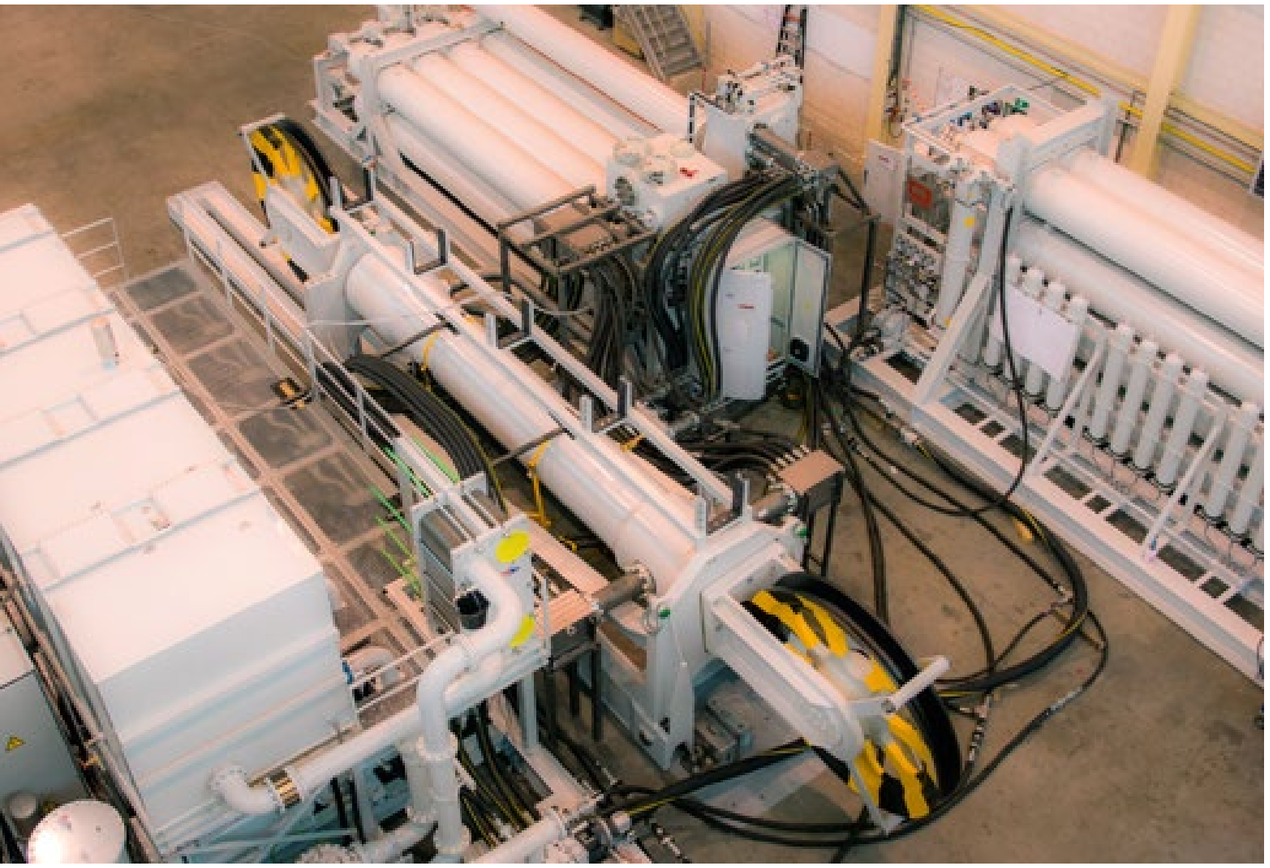
Functionality and safety

The AHC systems supplied for both of these projects were designed with an integrated spring-loaded hydraulic cylinder, which makes the system partly passive itself.

Most of the load is absorbed by the spring, but a separate active system runs in parallel to actually control the cylinder and maintain its exact position while compensating for motion.

The result of this is that only a small amount of energy is required to make the system work. "For example, the system we produced for ZPMC required around 2.4 megawatts of electricity," explains Bert Knol, Hydraulic specialist. "Without the integrated passive spring in the cylinder, it would have required four times this amount."

"In terms of functionality and safety on the MSV SEAWELL Module handling system, we included PHC as a backup measure in the event of an AHC system failure," says Jurgen Zijlmans, Lead Engineer Integrated Mission Equipment.



Rental fleet

Due to the success of a number of projects using IHC's integrated motion compensation equipment, there was a demand from the market for an increased range of options. In response to this, IHC developed the MaXine PHC, which can be used for single lift operations, and can handle dynamic loads varying from 50-500mT.

"We have developed a range of standard, catalogue products," says Marc Beldman, Managing Director IHC Vremac Cylinders. "These models are ideal for use as part of a rental fleet, so if an operator needs to carry out hoisting work and the weather window is condensed, or there is a need for increased safety measures, he can choose to rent a system quickly."

The range is available for worldwide use and the equipment does not require the installation of any special lifting frames.

Research and development

In order to estimate the total overall performance capability of a system before it is actually manufactured, dynamic models are used for simulation and evaluation purposes for different offshore scenarios.

"One of the problems we observe at great depths is the oscillation of the hoisting wire," says Jacco Osnabrugge, Manager R&D Motion Control and Automation. "Under normal circumstances, motion would only be compensated at the hoisting point, but despite that we still see payload oscillations of several metres at depths of 3,000m. You must also compensate for the dynamics of the entire cable system, and we strive to understand that behaviour and remove the oscillations by developing advanced compensation controllers."

There is also potential for applications such as drilling and riser-tensioning. "We are seeing new ideas being generated with the aim of reducing costs in the offshore industry," continues Jurgen. "There's an increase in requirements for custom-made tensioning systems, for example vertical top-tensioned riser tensioners for drilling and production risers but also lateral retention systems for drill risers.

"When large structures are being towed from their production location to a specific site, safety and security is of the highest importance; if a rope breaks then this could cause damage to the tugboat or, in the worst case, harm to a person. We're working on a system that can be installed on existing vessels to help solve this problem using motion compensation technology."

Another avenue is in large crane vessels used for the installation of foundations for wind turbines. Normally, the vessel is anchored, but this can have large time and cost implications. "We looked at the use of spud poles to 'anchor' and stabilise the vessel in a very fast and safe way," says Jurgen. "This involved the use of a motion compensation system. The result is a floating vessel but with very limited motion. We are also evaluating the potential for using fibre rope on high loads for deep-sea lowering applications, although this is still in the early feasibility stage."

Maxine PHC

Nitrogen skid

New opportunities

IHC's strength lies in its ability to provide solutions for a wide range of different scenarios, and is able to advise its customers when to use PHC, AHC, or a combination of the two. Through its integrated approach and extensive knowledge base, it is able to supply complete motion compensation systems that enable customers to work safely and more efficiently, as well as maximise a vessel's operational timeframe.

"The offshore wind market is growing," says Arjan, "not only in The Netherlands and Germany, but also in the UK and the US. We're also seeing a rise in floating wind turbines in southern Europe and Japan – we're working on a few of these large projects already.

"What we are starting to note on a regular basis is that our customers need high-quality motion compensation equipment on their assets in order to be compliant for participating in specific tenders for projects. It might not be used regularly, but that feature gives them an advantage over the competition. In addition, IHC is able to provide training services to ensure operators can receive the skills required to use the equipment safely."

Jurgen adds: "We are also starting to integrate these systems with existing vessels, as work is moving deeper underwater but operators don't have the dedicated equipment required to work safely and efficiently. My feeling is that we will start to see a need for modular systems that will be used for specific tasks or problems, which can then be removed once work is complete."

Outside the comfort zone

The first project of its kind at the Kinderdijk shipyard, for a new customer, with a third-party design, and in a remarkably short timeframe – the upgrade of DCV BALDER posed many challenges for IHC Services.

During a coincidental conversation last summer, Jeroen Kortenoeven found out that Heerema Marine Contractors (HMC) was seeking a partner to build superstructures on one of its vessels. He immediately identified this as an opportunity. “I saw a chance for us to work with a new customer, and to create work for our production facility at Kinderdijk,” says Jeroen, Production Director for Royal IHC.

The work involved building, installing and commissioning four pipe processing stations, or ‘shelters’, on a deepwater construction vessel, as part of its PHMJ (pipe handling and multi-jointing) installation. The BALDER is one of two vessels in HMC’s fleet capable of laying rigid steel pipes. These are welded together in the shelters to create pipes up to 70m long, before being installed using a J-lay tower.

HMC required an upgraded pipelaying installation for the BALDER. Two shelters were to be renovated with a number of modifications and freshly installed piping and electrical equipment. A third was to be newly built, and the fourth 50% renovated, 50% rebuilt.

Realising the potential scope of the project, Jeroen contacted the IHC Services department, which quickly gathered all of the relevant IHC business units together to prepare a quote: IHC Metalix, IHC Piping, IHC Drives & Automation, IHC Hytop and the shipyard itself. The steel frames, electrical and hydraulic installations, lifting equipment, alarm systems, ventilation – everything would be provided by IHC.

As Douwe Renkema, Project Manager (EM) for HMC, explains: “HMC was looking for a partner that could start building on a partly finished design, and one that is used to supplying workshop types of steel constructions, completely outfitted with overhead cranes, hydraulic doors, electrics and utilities such as welding gas, water and air.”

In addition, the vessel’s pipe handling modules (also part of its PHMJ) had already been designed and delivered by IHC SAS (acquired by IHC in early 2015 – as reported in the Spring 2015 issue of *IHC Insight*, ‘Laying foundations for the future’, p18-23). IHC SAS had been awarded the contract to commission the pipe

handling installation on board, so IHC Services also liaised with them to ensure their schedules were in alignment.

Quoting for the project was the job of Key Account Manager Michiel Verzijden and Proposal Manager Dick Stander. “We had a lot of unknowns – how many hours it would take, how many issues there would be, it was a true challenge,” says Michiel, “but because of the cooperation between all the business units, we were able to share those risks.”

Into the unknown

The uncertainties were largely due to the fact that the design for the shelters had been supplied to Heerema by a third party. “We are used to working with different business units and getting them aligned when it is our own product design – then everyone knows exactly what they have to quote for. This was different, because we had to quote from a design that we didn’t make ourselves and the system was new. It was unknown territory,” adds Michiel.

“Normally we quote for an amount of steel – we have a rule of thumb for the weight and time required. But this design was different – the material was lightweight, so we couldn’t measure it in this way, and the scale of the project was quite big.”

One thing that was certain was the delivery deadline. “The BALDER is employed on a multimillion dollar contract, so if it is late, penalties will be incurred,” says Dick. “It also had to travel from the Gulf of Mexico to Rotterdam for the work to be completed, so there was pressure to deliver on time.”

To account for this, IHC Services approached the tender as if they had already received the order. “That way, if we were successful, we would be ready to go – so we put in some hours on the engineering, and did some preparations in advance,” says Michiel. He believes this approach helped IHC Services to win the order: “We were asking Heerema so many questions on a detailed level, I think their confidence in us grew a lot at that stage.” Sure enough, in August 2015, IHC was appointed preferred supplier, a letter of intent (LOI) was received on 16 September and the contract was awarded on 25 September. The shelters were due for delivery in February 2016.

Short delivery time

The pace of the project was unprecedented at the Kinderdijk shipyard. Primarily used for shipbuilding, its projects take an average of one-and-a-half to two years, whereas this was to be completed in three-and-a-half months.

Director of IHC Services Wouter Kruijt explains: “The speed of services is two to three times faster than shipbuilding, which makes for a competitive market. The speed of response and operation are vital. It requires a change of mindset.”

As this was the first construction of its kind to be built at Kinderdijk, IHC mobilised its wealth of offshore experience from within the group and assembled a dedicated team on location. The project

management and production teams were assembled next to each other, helping to create faster lines of communication and decision-making, to tackle the short delivery time.

Time constraints weren’t the only challenges, however, as the project got underway. During both the engineering and construction phases, the design of the shelters continued to develop and evolve, resulting in many changes that had to be incorporated, and an increase in requirements from HMC.

To tackle this, IHC drew from its in-house expertise and also took on additional responsibilities to realise the design safely, on time, on spec and within budget. For example, IHC Services had a large procurement scope to speed up the process, so parts such as cranes, lights, floor grating and ventilation were procured for HMC on a reimbursable basis.

Close cooperation

The high level of cooperation between IHC and HMC also helped to deal with changes and resultant issues, and was essential for the project’s success. “Not all of the details were finalised on the LOI from Heerema and we understood this,” says Dick. “So we tried as much as possible to incorporate what they required, within the timeframe allowed. We managed Heerema in that respect, IHC was in the driving seat.” Michiel adds: “We were both aiming for the result, and not playing the role of customer and supplier.”

Douwe agrees on the importance of close cooperation to the end result: “The goal was achieved by working closely together, looking for opportunities, challenging standard methods of working, and subcontracting when required. Working with the IHC Services project team was pleasant and constructive, and we saw it as a positive that they had an open mind for changing the IHC safety procedure to the Heerema practice where possible.”

Such cooperation meant frequent meetings to discuss details extensively, and planning to a high level of detail. The delivery date shifted twice but was still in line with the overall planning because the BALDER itself was also delayed.

Despite the numerous challenges presented in this project, by the end of February, three of the four shelters were ready to be installed on the BALDER in Rotterdam’s Caland Canal. The final shelter remained in Kinderdijk, requiring further modifications, and was due to be completed by mid-March.

IHC had demonstrated its capability to cope with challenges in design, construction, installation and commissioning. By developing an effective project management structure, and service and supplier network, it helped HMC to upgrade the BALDER to a high standard, and in the shortest possible time.

“HMC is satisfied as the shelters were delivered completely outfitted in time for installation on the BALDER, and the quality of the work was good,” says Douwe. “Some additional items are still to be solved, which IHC will take care of on board the BALDER.”

“We needed to prove what we could do,” says Michiel. “You can only prove it by doing it, and I think trust was gained. We wanted to form a partnership, and hope that we can work together on future projects.”

Dick adds: “Heerema was looking for a trustworthy party, flexible with locations and sourcing capacity, and with skilled employees. IHC meets this criteria, we understand the scope and know how to manage such projects. By connecting the available resources within IHC we met the challenging deadline.”

According to Douwe, the advantage of working with IHC was an understanding of the work involved, “and that knowledge on all aspects of the work was available and mobilised easily. The turnkey, all-inclusive approach makes IHC Services unique,” he adds.

Growth potential

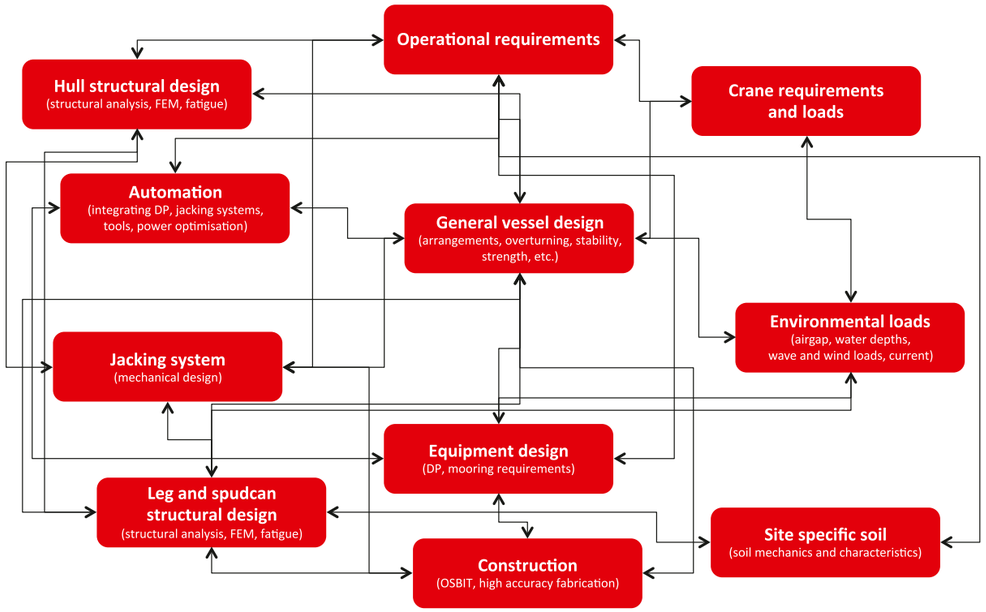
The success of this project for HMC is an exciting development for IHC Services, which contributes 20% of the IHC group’s annual revenue. The department has expanded significantly in recent years and further growth is predicted.

IHC Services has a unique offering to customers, as Wouter explains: “Our USP in this market is the combination of our shipbuilding and engineering knowledge and experience, our mission equipment portfolio, and a worldwide network of service centres that can deliver turnkey projects anywhere in the world.”

A fresh approach to jack-up design

Impression of the jack-up developed for the Taiwanese market

The offshore wind industry continues to flourish, and it has experienced significant growth in Europe in the last five to ten years. Growth is also visible in Asia (China, Taiwan and Japan), where Royal IHC already has an active presence. The company now provides an integrated approach to jack-up design, which is helping to facilitate further expansion into this market.



Visualisation of the interaction between the different knowledge groups

Today, there are 84 offshore wind farms spread across 11 European countries. The completion of six further offshore projects will take the collective offshore capacity in the region to 12.9GW. According to the European Wind Energy Association (EWEA), 419 new turbines were erected around Europe in 2015, bringing the cumulative energy production across the continent to 11GW.

The EWEA also reports that, in financial terms, investments in offshore wind farms hit a record level of €18 billion in 2015, which highlights the confidence of investors in renewable energy. This has also been bolstered by a reduced perception of risk, opening further avenues for financing. The demand for renewable energy shows no signs of abating, and other countries around the world are expected to follow Europe's example.

China is a very fast-growing market, and has set itself a concrete target of 10GW by 2020. This is a substantial ambition considering that the average output is around five megawatts per turbine. There are 44 allocated projects, and prospects exist for IHC to supply not only an integrated package, but also critical components. It is probable that demand will take wind farms further offshore into higher wind speeds, or deeper waters. In Japan, there is a market for nearshore offshore wind, and floating offshore wind in deep waters.

For nearshore operations, jack-ups will take on a different operational profile than those in Taiwan or Europe, where the wind farms operate further offshore in deeper waters, and in harsher conditions.

The USA is also predicted to develop its wind market ambitions and start with smaller solutions. This will most likely see the conversion of barges into jack-ups at first, a scenario comparable to Europe 15 years ago. In both Japan and the USA, potential offshore wind farms will have to factor in deeper waters, so floating wind turbines will be the most common solution.

S-4000 Hydrohammer®, the latest in the IHC IQIP range

At all times, the challenging targets that exist globally must balance with the need to reduce costs. This will eventually create an industry free from its reliance on subsidies.

The correct tools and equipment

Royal IHC has consistently developed its capabilities in renewables, and offshore wind activities in particular, over the last 10 to 15 years (although IHC-built jack-ups can also be deployed in the oil and gas industries). Multiple IHC units have long been involved in either jack-up design, construction of components and/or turnkey jack-up vessels, or specific tools, as well as marine operations engineering for specific projects.

Within these, IHC Motion Control & Automation is constantly researching higher levels of integration for automated systems on board vessels. This will help to reduce the total power requirements, among other benefits.

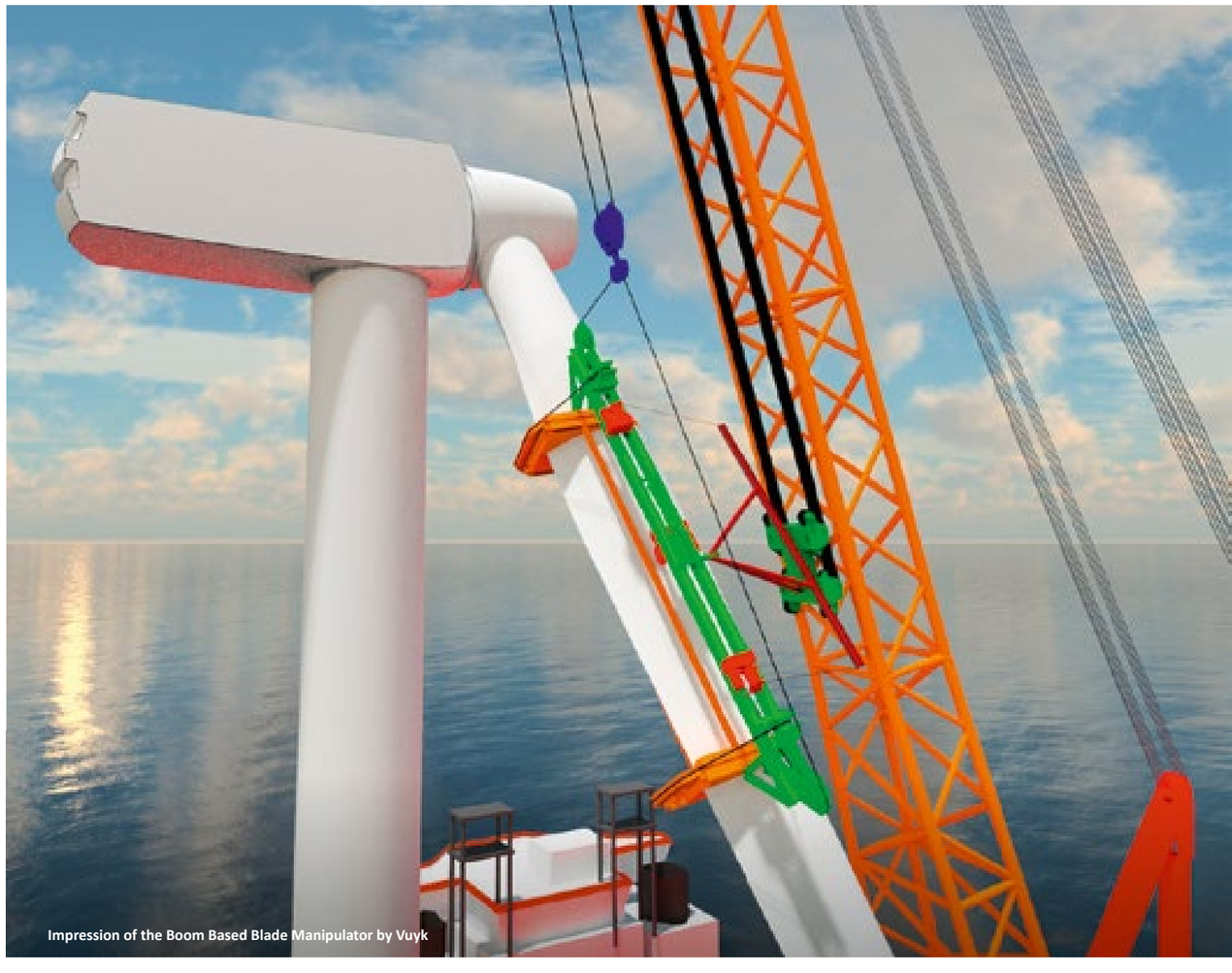
In addition, IHC IQIP delivers state-of-the-art Hydrohammers®, with a long track record in offshore wind projects. It has consistently developed hammers with increasing diameters and power capabilities, which makes larger monopile foundations for offshore wind turbines feasible.

This also applies to IHC IQIP's developments in handling equipment for wind turbine foundation installation. Its most well-known equipment includes tools for upending monopiles, and grippers for holding them upright in the first stage of driving them into the seabed.

With the increasing demand to protect the environment during turbine installation, IHC IQIP has developed a noise mitigation system (NMS) to comply with legislation to protect wildlife during hammering. Its system provides the highest levels of protection for nature in the market, and has evolved from being purely an NMS, into a handling system in its own right.

Vuyk Engineering Rotterdam (Vuyk) has also been active in the offshore wind market over the past 14 years, mostly in engineering for turbine installation. Its activities have grown from initially providing operational drawings, motion analyses, floating and jacked stability checks, mooring analysis, support and sea fastening.

It is now able to produce the concept and basic design of complete jack-ups, including jacking systems, leg and jacking house design. The challenge has always been how to cope with the ever-increasing size and weight of wind turbines and their foundations, combined with the need to transport more of them per trip.



Impression of the Boom Based Blade Manipulator by Vuyk

Vuyk's involvement in project engineering has led to innovative designs such as the first floating vessel concept capable of transporting and installing six completely assembled wind turbines. Its latest innovation comprises a patented blade installation tool (the Boom Based Blade Manipulator), which provides a higher level of control of the wind turbine blade. This is due to its connection to the crane boom, allowing blade installation in higher wind speeds. This is now a recognised part of IHC IQIP's portfolio.

In addition, Vuyk has worked closely with IHC Offshore & Marine to develop a jack-up for the Taiwanese wind market, for which Vuyk delivered the concept and basic design.

More so than floating vessels, a jack-up can benefit significantly from high levels of integration purely because it is jacked up offshore. The jacking system and legs need to be able to lift the full weight (plus cargo) out of the water and to be able to withstand a 50-year storm while jacked.

Therefore, it is clear that the legs, jacking system and integration in the hull come at a relatively high cost. Reducing the dimensions and weight of the jack-up and appropriate tools is paramount. Furthermore, the legs and jacking system are highly integrated with the vessel structure and systems.

Either towed or self-propelled, a jack-up vessel fully integrates naval architecture, and hydrodynamic, structural, mechanical, hydraulic and automation systems. An integrated approach is necessary for a fully functioning jack-up, especially in offshore wind where it also serves as an offshore transport and installation vessel. IHC offers in-house availability of all these skills, and extensive experience in the activities of jack-up vessels and the correct tools. It was a logical progression for IHC's business units to pool their resources and create a combined approach to jack-up development.

A fresh approach

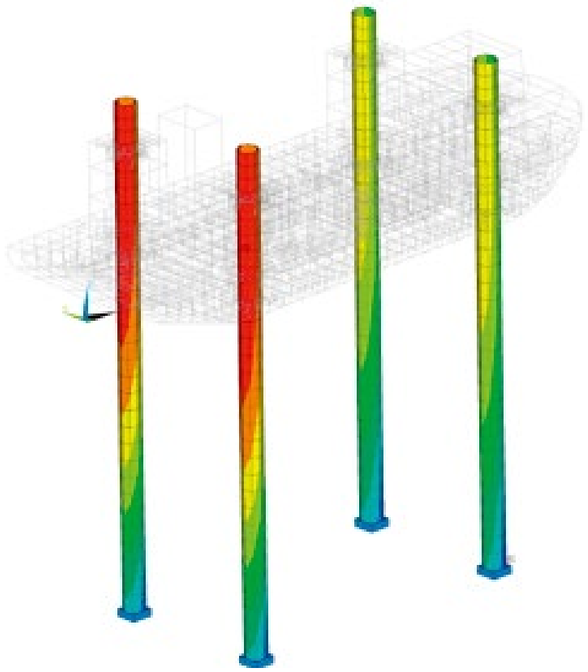
IHC's proposition allows for the fully integrated design of any jack-up to be realised in-house. This starts with advising potential customers on the required dimensions and capacities, covering both the jack-up construction and the key systems.

The company has expertise in all aspects: specifying the requirements, designing, building and offering services such as modifications or upgrades, but also training. This means that IHC can cover the full range of jack-up systems and jack-up activities. Its vision is that, from the first stage of the design process, all of the company's capabilities can be seamlessly integrated to offer a complete package.

IHC has the expertise to assess the exact requirements for any situation or condition. It can also draw up plans for the structural elements in the design of the jacking system, identify adequate tools for installation and integrate these in the design.

Specific tools and engineering practices are required to ensure the jack-ups are suitable for offshore wind turbine and foundation installations. Marine operations, including the supply of project specific tools – such as piling hammers, NMS and lifting and upending tools – can also be delivered by IHC. This means that IHC can ensure that the jack-up will be able to withstand the varying loads of any equipment.

To enhance cost effectiveness, IHC's combined knowledge can be introduced at the earliest possible stage of the design process, encompassing both structural and mechanical design, and automation and electrical systems. The latter makes it possible to identify areas within the system where interfacing can be accommodated, which is becoming a common practice. Ultimately, this can reduce crew requirements, power output and total vessel weight, while maximising uptime.



ANSYS FEM structural model by Vuyk

Added value

One of the main advantages is flexibility. IHC can deliver these services separately and efficiently through its different business units or provide a completely integrated solution. Moreover, IHC can either build a new jack-up at one of its yards in The Netherlands or manage the build abroad to supply integrated packages. When building abroad, IHC's experience in managing the build of complicated vessels guarantees the on-time delivery of a high-quality vessel.

The latest development in bringing IHC's integrated process full circle comes from MTI Holland (IHC's technology development centre). This concerns an advanced tool for site specific assessment. The results it yields will provide an improved model for analysing difficult and multi-layered soils, allowing for more accurate predictions of soil complexity. This is the last area of expertise relating to jack-ups, and will add vital geotechnical understanding to IHC's existing skills.

Wind turbine blade rack designed by Vuyk, which also made the operational lifting drawings

This knowledge has potential implications in the optimisation of jack-up design, or operation, by taking into account leg fixity in the design. This is opposed to the standard approach of a pinned model where the leg support on the seabed is assumed to be a hinge. Although leg fixity results in lower leg bending moments, it also results in a lower natural period of the jacked-up vessel. Depending on the distribution of wave periods, this may result in higher leg loads.

IHC's existing knowledge, in combination with comprehensive understanding of seabed support capacity will allow the company to further optimise the jack-up.

Global presence

IHC's strongest leads for its services are currently in the Far East, with interest from companies in Taiwan and Japan. In particular, the proposed offshore wind project for a Taiwanese contingent was the catalyst for IHC's integrated approach. The result is an ABS-approved jack-up design, and IHC is in negotiation with the same companies for supply.

If completed successfully, the project will see IHC take responsibility for 90% of the building installations: the crane integration, systems, housing, legs, generator, engine, electrical systems and hydraulics.

"This will really be a big step for us," says Richard Agema, Product Manager Heavy Lift. "This project covers the whole jack-up and sees all aspects coming together: services, design, electrics and hydraulics. We also offered the customer a training package. One of the reasons they chose IHC was because we could take them from the beginning of the process through to operational status."

IHC could potentially supply the tools for this project, in addition to the Hydrohammers® IHC IQIP rents out for the installation of the customer's met mast.

A positive outlook

IHC has confidence in both the renewables and offshore wind industry, and its integrated approach is already garnering interest from several quarters. Building on a proven track record in delivering all the key elements for jack-ups, the company is now mobilising its accumulated knowledge.

The teamwork between all IHC units will also be an important factor in the success of the proposition. Offering the full range of processes under one roof, and guaranteeing flexibility to customers will ensure the company is a leading player in jack-up design, engineering and building as the offshore wind market continues to expand and cost reductions need to be established.

Two pipelaying vessels for Subsea 7

The Krimpen aan de IJssel shipyard hosted a double celebration in January for the naming and launch ceremony of the SEVEN CRUZEIRO, and the naming of the SEVEN SUN. Designed by Royal IHC in close collaboration with Subsea 7, both are dynamically positioned pipelaying vessels, capable of operating in depths of up to 3,000m and suitable for operations worldwide.

SEVEN CRUZEIRO was named by Mrs Sally Rosa, wife of Mr Ricardo Rosa, Chief Financial Officer at Subsea 7. SEVEN SUN, which was launched in December 2014 at Kinderdijk, was officially named by Mrs Lilian Camozzato, wife of Mr Guilherme Camozzato, Director of Operations, Subsea 7 Brazil. They are the second and third vessels in a series of three to be ordered by Subsea 7 and will operate in Brazilian waters.

Each is equipped with a vertical (tiltable) lay system with a 550t top tension capacity, which is permanently installed for the deployment of a range of flexible products with a diameter of 50-650mm. The lay tower can operate at up to 10° from the vertical and is fitted with two wire centralisers and two tensioners, each with a 275t capacity, that can be retracted clear of the firing line. The pipelaying systems of both vessels are supplied by Huisman.

"Over the years we have worked closely together with Subsea 7 on a total of eight vessels," says Arjan Klijnsoon, IHC's Executive Director Shipbuilding. "IHC is proud of its long-standing relationship with Subsea 7 and the confidence they have in our ability to deliver high-quality vessels on time."

Valuable CSD orders secured

Royal IHC has received orders worth €14million for cutter suction dredgers (CSDs) in recent months, from both new and existing customers. This includes a 716kW booster station, sold to Baggerbedrijf De Boer – Dutch Dredging, and an order for a 900kW CSD that can dredge up to a depth of 35m, from Zhejiang Dredging in China.

It also includes Van Oord's order for a modular IHC Beaver 65 DDSP. Built at the yard in Sliedrecht, the BIESBOSCH was delivered in April 2016 and immediately started work on the Zeetoegang IJmuiden project. This is part of a locks programme carried out for the Dutch Department of Public Works.

This model is the largest of the standard range of CSDs built for stock and measures 64m in length and more than 12m in width. The IHC Beaver® series has proved to be very successful for more than 50 years. One of the benefits of these vessels is that they can be customised with standard or bespoke options to meet individual customer requirements.

The BIESBOSCH, named after one of the largest national parks in The Netherlands, is equipped with a submerged dredge pump, and an IHC Spud Guard© to increase safety and enhance performance when operating at sea. Suitable for working in coastal areas, it is also fitted with two accommodation units. Equipped in accordance with Van Oord's safety and environmental requirements, the BIESBOSCH has been built with IHC's high-quality standards and excellent fuel efficiency. It will make a significant contribution to Van Oord's sustainability targets.

IHC Beaver 65 DDSP – BIESBOSCH

Successful launch for TSHD JUN YANG 1

The naming and launch ceremony of the trailing suction hopper dredger (TSHD) JUN YANG 1 was held in December at Royal IHC's Kinderdijk shipyard. The 21,028m^3 dredger will be the largest vessel of its kind in China at the time of delivery, and will enable CCCC Guangzhou Dredging Co., Ltd (GDC) to carry out capital dredging and land reclamation jobs on the international market in an efficient way.

To achieve this, the JUN YANG 1 is equipped with two suction tubes, each with a submerged dredge pump, for a highly efficient dredging performance. Both suction tubes have a dredging depth of up to 40-60m, and the starboard suction tube can be extended to a dredging depth of 90m. Two inboard dredge pumps have been installed for efficient shore discharging and rainbowing. The TSHD has a high level of automation, designed and supplied by IHC, for highly productive dredging operations.

IHC cooperated closely with GDC in the design of JUN YANG 1, which is the 19th vessel to be built by IHC for GDC over the last 40 years. In four decades IHC has developed a diverse portfolio of dredging vessels ranging from TSHDs to cutter suction dredgers and wheel dredgers. These dredgers were constructed either on the IHC slipways in The Netherlands, or in partnership with shipyards in the People's Republic of China.

"The very long-lasting relationship between GDC and IHC reflects the mutual trust and appreciation between the two companies," says IHC's Executive Director Shipbuilding, Arjan Klijnsoon. "This has resulted in extremely close cooperation on the construction of the largest TSHD in China."

The contract for the design, construction and delivery of the vessel was signed between GDC and IHC on 1 November 2012. The keel of the vessel was laid on 16 January 2015 at Kinderdijk. The JUN YANG 1 is scheduled for completion by the end of July this year.

Expanding offshore and mining activities

Royal IHC has expanded its offshore rental fleet with the acquisition of Fraser Hydraulic Power (FHP) in the UK. It has also gained a stronger foothold in the mining market following a merger with Robbins Technology Group (RTG) in Brisbane, Australia.

Founded in 1986, FHP designs and builds systems for laying subsea cables and umbilicals with tracked engines and tensioners, cable carousels, and drum handling systems in its product range. These are supplied to the subsea telecoms, renewables, and oil and gas industries.

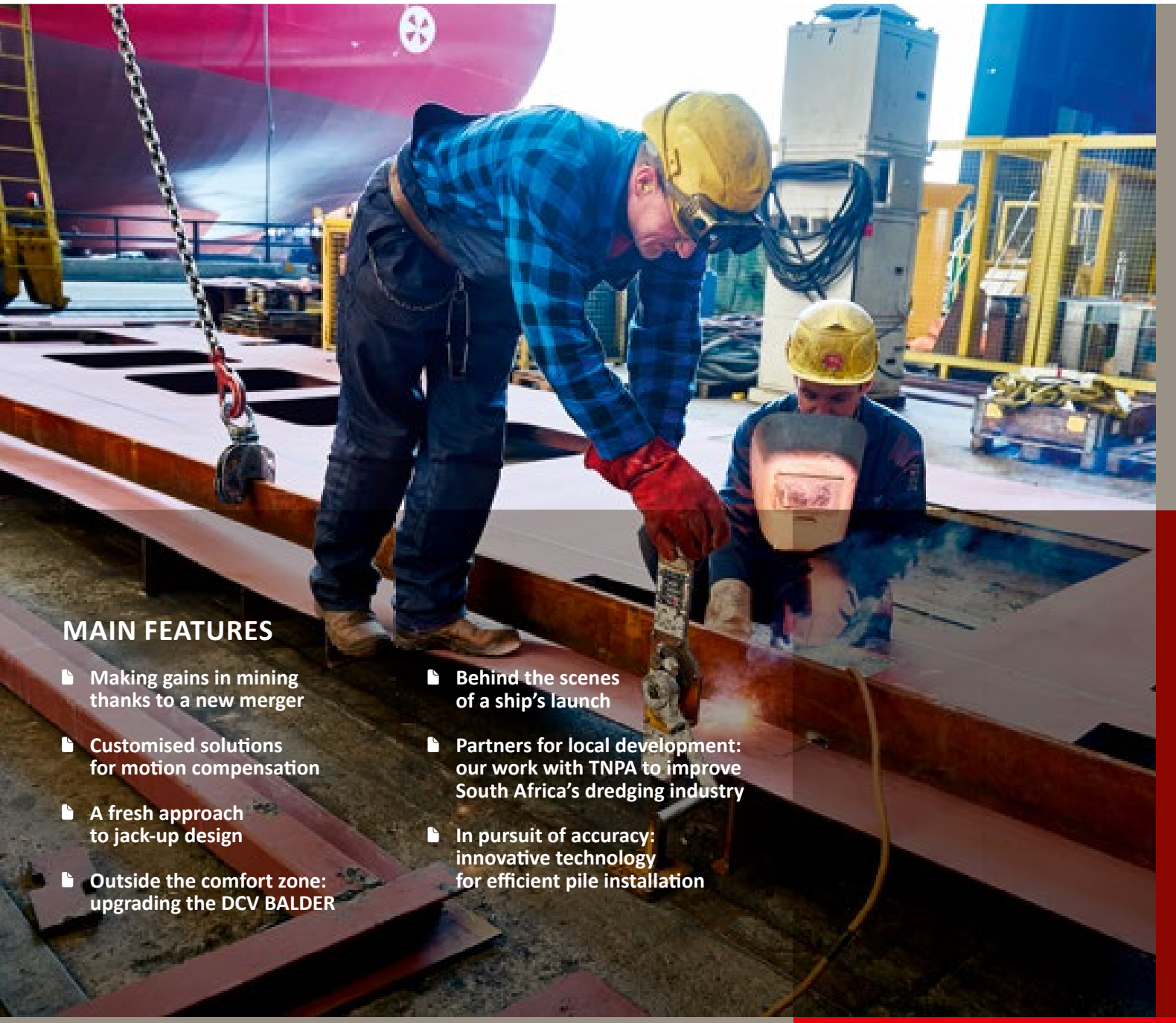
FHP operates from the Neptune Energy Park in Walker, Newcastle, which is perfectly located to support its customer base of offshore marine contractors. This new facility also offers an ideal opportunity for IHC to strengthen its position in these markets, centralise and further expand the offering of rental equipment, and provide a broader service offering to these customers.

RTG is a multi-disciplined technology company specialising in providing services to the mineral sands industry. It focuses on the design and construction of mining and mineral processing plants, and the manufacture of specialist equipment, as well as assaying, metallurgical test work and circuit development.

With this merger, IHC brings innovative engineering solutions to the industry with the opportunity to provide fully integrated mining and processing solutions to customers. In addition, it strengthens IHC's position in the downstream minerals processing market for heavy mineral sands, as well as other commodity activities in which IHC has vast knowledge and experience.

IHC CEO Bram Roelse says: "These acquisitions fit perfectly within IHC2020. The overall aim of this strategy is to reduce IHC's dependence on the volatile shipbuilding industry by developing opex activities."

Read an in-depth report about the acquisition of RTG on pages 20-25.



MAIN FEATURES

- Making gains in mining thanks to a new merger
- Customised solutions for motion compensation
- A fresh approach to jack-up design
- Outside the comfort zone: upgrading the DCV BALDER
- Behind the scenes of a ship's launch
- Partners for local development: our work with TNPA to improve South Africa's dredging industry
- In pursuit of accuracy: innovative technology for efficient pile installation

ABOUT ROYAL IHC

Royal IHC:
Innovative solutions for maritime service providers

In an ever-changing political and economic landscape, Royal IHC enables its customers to execute complex projects from sea level to ocean floor in the most challenging of maritime environments. We are a reliable supplier of innovative and efficient equipment, vessels and services for the offshore, dredging and wet mining markets.

With a history steeped in Dutch shipbuilding since the mid-17th Century, we have in-depth knowledge and expertise of engineering and manufacturing high-performance integrated vessels and equipment, and providing sustainable services. From our head office in The Netherlands and with 3,000 employees working from sites and offices on a global basis, we are able to ensure a local presence and support on every continent.

Dredging operators, oil and gas corporations, offshore contractors, mining houses and government authorities all over the world benefit from IHC's high-quality solutions and services. With our commitment to technological innovation, in which sustainability and safety are key, we strive to continuously meet the specific needs of each customer in a rapidly evolving world.

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