Teamwork Makes Rotor® Tug a Success

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Abstract

When Dutch tug company Kotug began operating in the German port of Bremerhaven in January this year it was a big moment for founder and president, Ton Kooren. Not only did his crews have to assist dedicated car carriers through the narrow locks and the swing-bridge of the terminal, without ever having worked there before, but they were also scheduled to use his revolutionary Rotor® tug. Up to then the tug had only been tested in simulation trials. The fact that the movements went smoothly was a tribute to months of preparation involving a close-knit team of Kotug personnel, the three shipyards, and Schottel GmbH, who designed and built the new tug command console and thrusters, staff of the Marine Safety International Rotterdam (MSR) simulator centre and the car carrier lines.

'It was impossible to get any practice in Bremerhaven,' says Ton Kooren. 'We had to do everything from scratch on 1 January 1999. We'd never performed any real manoeuvres in that port before. Now, nine months later, we have completed over 2500 assists with no more than minor hiccups. The clients are very satisfied.'

At the heart of this new venture is Ton Kooren's patented Rotor® tug design, which he calls a 'three-legged' tug, playing on the Dutch name of 'five-legged sheep' for a multi-purpose solution to a difficult set of requirements. By using three fully azimuthing propulsion units, each driven by a separate main engine – two forward, as on Z-propeller tractor tugs and one aft as an active skeg – the Rotor® tug combines a massive 78 tonnes bollard pull with a high degree of manoeuvrability and reliability in a compact design.

POWER, MANOEUVRABILITY AND RELIABILITY

A major advantage of this combination is that it can reduce the number of tugs needed for many jobs. And this means significant savings for clients. 'Using 30 tonne bollard pull Voith Schneider tugs,' says retired Rotterdam harbour pilot Daan den Braber, consultant to Kotug and MSR, 'the very big car ferries operating in Bremerhaven

Figure 1
Busy times in Bremerhaven

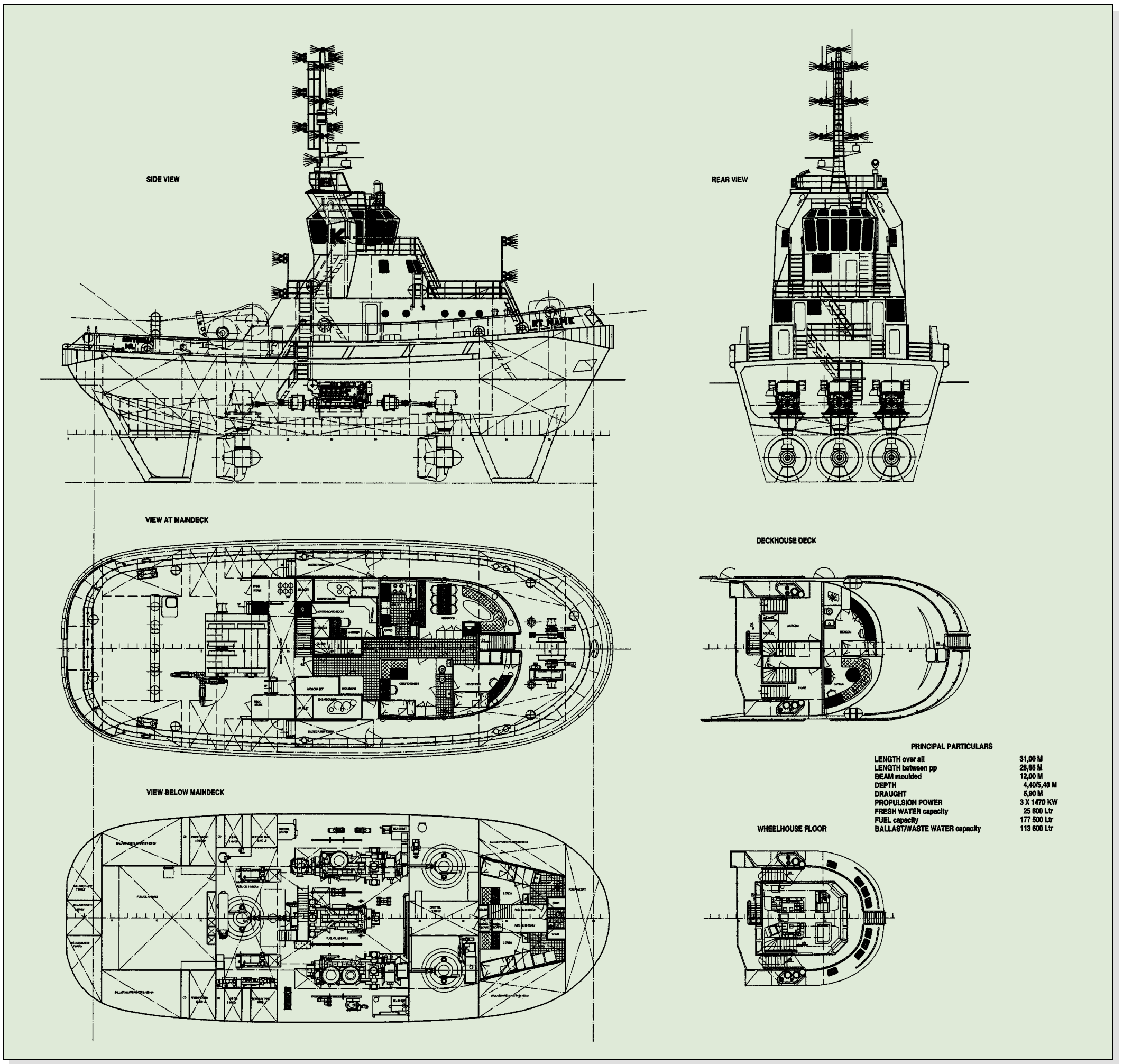

Figure 2
General arrangement plan

always use three or four tugs – one on each side of the stern and one or two at the bow. We argued that a very strong tug of 78 tonnes bollard pull at the correct angle can produce the same sideways forces as a separate tug on each side. So instead of paying for three or four, you pay for two.' And the design of the Rotor® tug means that the power can be delivered by rotating the thrusters rather than the tug itself, which saves space and manoeuvring time. In a narrow lock or bridge passage, this is a real advantage.

The Rotor® tug design is also proving itself in other situations. When manoeuvring high-windage vessels, such as container carriers and VLCCs, pilots often prefer to have an extra tug available if they expect high winds. The power reserve of the 78 tonnes bollard pull Rotor® tug means this is no longer necessary. And, even if one of the thrusters should fail, there is still approximately 50 tonnes bollard pull available from the remaining two. This can be critical in remote ports, where repair facilities or assistance may be two days' sailing away. And the ability of the tug to stand up in dry dock on the struts protecting the thrusters means that a much smaller dry dock can be used than would be expected for its draught. 'Now, instead of laying idle, we can continue to operate and only go for repair when the dock is ready,' says Ton Kooren.

The power and reliability of the Rotor® tug has led to it being frequently used on rig moves and deep-sea towages.

RISK-TAKING AND TEAMWORK

The idea for the Rotor® tug came a few years ago when Kotug was responding to a call for tenders for the port of Milford Haven (UK). Ton Kooren had already been the first to operate powerful Z-propeller tugs in European ports, so was familiar with their operation and advantages. In a flash of insight that woke him in the middle of the night, he realised that the existing Z-propeller tractor design could be greatly improved by replacing the large

aft skeg with a third Z-propeller. Although Kotug did not win the Milford Haven contract, Ton Kooren went ahead to build his new design anyway.

To turn his dream into reality, Ton Kooren needed to carry out extensive modelling and testing that involved close teamwork. Backed up by Kotug's engineering Superintendent Leen Warnaar and with input from Kotug captains and crew, Kooren entrusted much of the drawing and design work to the Padmos Shipyard at Stellendam (Netherlands). The Netherlands Maritime Research Institute (MARIN) in Wageningen carried out extensive tank testing, generating models that were further refined by Dr Johan Wulder, a naval architect and head of research and development at Marine Safety International. As the project progressed, MSR carried out intensive simulation work in co-operation with Schottel GmbH, covering all aspects of the vessel's operation. Tug skippers, pilots, car carrier owners, port authorities and pilots from Bremerhaven, where the first tugs were to be stationed, took part in three days of extensive simulation trials.

Spanish shipbuilder Astilleros Balenciaga SA delivered the first two Rotor® tugs – RT Innovation and RT Pioneer – early this year, just over eleven months after signing the contract. Meanwhile, Construcciones Navales P Freire SA of Vigo, Spain delivered RT Spirit and the hull and all the major steelwork for RT Magic, which was fitted out by the Padmos shipyard.

THE ROTOR® TUG CONCEPT

At the heart of the Rotor® tug concept is a unique tractor tug propulsion system, using three fully azimuthing propulsion units, each driven by a separate main engine. Two Schottel SRP azimuthing propulsion units are positioned forward of the centre-line in the normal tractor location, with a third identical unit aft, replacing the traditional skeg. Fore and aft open-frame guard plates and struts ('chairs') are fitted for protection and for docking.

Three Caterpillar 3516B DI-TA main engines provide the power for the Rotor® tugs, each developing 2100 bhp at 1600 rpm. Each engine drives a Schottel SRP 1212 fully azimuthing propulsion unit, incorporating a five blade fixed pitch propeller of 2.15m diameter, rotating

Figure 3
Underwater configuration

Figure 4
RT Magic at full speed

Figure 5
6 knots sideways, shown by RT Spirit

Figure 6
Layout of the bridge, with Master pilot control and independent thruster control handles

Figure 7
Narrow passage in Bremerhaven

in a Kort nozzle. Power is transmitted through Twin Disc Marine Control Drive (MCD), type 3000-2LD units. The main engines are situated in line across the engine room, with the outboard engines coupled to the forward Schottel units and the centre engine driving the aft unit. The free end of the port engine is used to provide power for a fire pump, while the remaining pair drive hydraulic pumps supplying the deck machinery.

On sea trials the Rotor® tug's total 6300 bhp produced a bollard pull of 78 tonnes ahead and astern, with a free running speed of 12 knots. This makes it one of the most powerful in the world for its compact 31.63m x 12.00m size. And, while sterndrive tractor designs achieve 30% bollard pull when moving sideways and Voith Schneider tractor tugs 60%, the Rotor® tug design yields upwards of 95%. The design also enhances reliability, since, in the unlikely event that one of the propulsion units should fail, trials showed that the remaining two units still produce a bollard pull of over 50 tonnes and a free running speed of 9.5 knots. This, says Ton Kooren, is the most that is required in ninety percent of situations.

Meanwhile, the Rotor® tug's propulsion system makes it highly manoeuvrable, able to turn 90 degrees on the spot in only six seconds and 360 degrees within its own length in just 24 seconds. The free running speed sideways is 6 knots. This, combined with the high bollard pull, makes these tugs ideal for working in confined areas like the locks in Bremerhaven where Kotug now operates three Rotor® tugs – RT Pioneer, RT Innovation and RT Spirit – alongside four tractors and one Voith Schneider.

The wheelhouse design is also original, with the tugmaster controlling the tug from a position between two large ergonomically designed consoles housing most of the propulsion, winch, communications and navigation equipment. Three manual controllers give the tugmaster control of the thrust direction and propeller speed of each propulsion unit. A fourth Master pilot controller gives control of any combination of units in unison. The Anschultz Pilotstar D autopilot can be coupled to one, two or all three propulsion units. So, at sea, for example, the two forward propulsion units are connected to the autopilot, while the stern unit is fixed in the straight-ahead position.

All Kotug Rotor® tug captains received simulator training at MSR before the vessels were delivered, using a real console (from RT Magic) interfaced with the Marine Safety International Rotterdam bridge simulators acting as a car carrier model in a digitised simulation of the port of Bremerhaven, under the most difficult scenarios.

SIMULATOR PROVIDES ADDED-VALUE TRAINING

During an informal social meeting with Kotug's Vice President, Ard-Jan Kooren and MSR's General Manager, Henk Regelink, Kotug's president, Ton Kooren challenged MSR to provide interactive simulation training for the Rotor® tug, operating with car carriers in a new port – Bremerhaven – and involving all the different actors. Henk Regelink not only took up the challenge, but MSR completed the training on time and within budget. The exercise involved groundbreaking co-operation that has resulted in a permanent tugboat simulation training facility being installed at MSR in a three-way partnership between MSR, Kotug and Schottel GmbH. 'If I had not had the training here,' says Kotug tugmaster, Capt. Cees Aalbers, 'it would have taken weeks.'

First of all, explains Dr Johan Wulder, a naval architect and head of Marine Safety International's R&D department, it was necessary to fine-tune the hydrody-

namic data from the MARIN tank model trials. Then came the complex task of interfacing the MSR simulator with the Rotor® tug console. As it happened, the console of RT Magic was used, while the tug was being fitted out. For Schottel-Werft, who supplied the console, this interfacing was a new experience. Working closely with MSR's technical department, engineers connected the twenty-three relevant electronic outputs (out of over 140) from the RT Magic console to MSR's purpose built interface unit, sending all the relevant control data to the bridge simulator network. Kotug's tugmasters then put the Rotor® tug through its paces on the simulator.

Meanwhile, MSR's visual database developer digitised the port of Bremerhaven, integrating material supplied by Capt. Daan den Braber, a retired Rotterdam harbour pilot, with assistance from a former Bremerhaven pilot. Then, with co-operation from car carrier lines, Wallenius, Wilhelmsen, HUAL and NYK, Kotug invited ten of their Masters, along with Bremerhaven harbour pilots, the harbourmaster and his deputy, to join Kotug tugmasters from Germany and the Netherlands in three days of training. The scenarios used included some of the worst conditions that could be expected, such as a four knot flood tide with a westerly wind up to Beaufort Force 8 at the lock entrance. For these trials, Kotug used two Rotor® tugs, instead of the three or four Voith Schneider tractors usually used by Bremerhaven pilots – an opportunity to prove that it could be done.

Says Henk Regelink, 'We were taking a big risk, stepping into the unknown.' And the objective of the three-day simulation was much more than training to use the new tug. 'We applied the ASK methodology: attitude, skills and knowledge,' he says, 'putting the car carrier masters, pilots and tugmasters into teams, as in real conditions.' And, says Daan den Braber, 'All the parties concerned were astonished at what we could do. And it turned out perfectly.' And, he adds, 'The seeds for the two-tug configuration were planted here, especially for the German pilots.'

For Henk Regelink, the risk has paid off. 'This was a good example of operational research leading to added-value training for shipmasters, tugmasters and pilots,' he says. 'It has enabled us to go further with interactive training. We have gained valuable experience in interface design and have upgraded and fine-tuned the models.' The proof of this success is not only the 4500 successful assists by Kotug in Bremerhaven since January 1999, but also the three-way partnership between Kotug, Schottel and MSR to install a permanent tug-training simulator at MSR's Rotterdam simulator centre.

Figure 8
Two of Kotug's Captains, Capt C Aalbers and Capt K Roos acting in virtual reality at MSR's training facility

Figure 9
Two Rotor® tugs in action

SALES STRATEGY

The Rotor® tug concept has already proved itself in numerous assists of sea-going vessels in port and locks, together with sea towages. The tugmasters are discovering new possibilities offered by the Rotor® tug design almost every day.

For Kotug's President, Ton Kooren, the Rotor® tug is the tug of the future. 'The Rotor® tug is able to handle the 12000-18000 teu container vessels, such as Suez-max and Malacca-max that we are hearing so much about,' he says. 'With a length of only 35 – 36 metres, we can install 10,000 bhp, while retaining the advantages of towing safely over the stern and bow, and being able to manouevre within her own length.'

And, says Ton Kooren, 'because container vessels like Suez-max and Malacca-max are only able to call at ports with enough water depth and space, shipowners could consider a stationing a number of powerful

Figure 10
Over 300 tons bollard pull in action

Rotor® tugs to assist these big vessels, rather than going to the great expense of installing powerful bow- and stern thrusters. Even when these are installed, the vessels will still often need to use tugs anyway.'

A Rotor® tug can also be built as a tractor tug with two thrusters and a skeg installed, instead of a third thruster. It is always possible to install the third thruster if a stronger tug is required later.

Construction and sales of the Rotor® tug are managed by Kooren Shipbuilding and Trading BV.

FUTURE

Ton Kooren is already looking for ways to improve the Rotor® tug, holding monthly meetings with his crews, where every small design detail is reviewed. Meanwhile, his son, Ard-Jan Kooren, Kotug's Vice President, is busy looking for opportunities to exploit the tug's innovatory features in new markets. 'We have the patent and we are already one step ahead of the competition,' he says. RT Magic is now operating in Rotterdam's Europoort, where its manoeuvrability and power come into their own when assisting high-windage vessels. The new containerships with bow and stern thrusters can operate with just one Rotor® tug, he says. 'These tugs are also excellent for escort duty,' says Ard-Jan Kooren, 'because their high bow makes them well-adapted for sea-going missions.' The tugs also have the facility to install dynamic positioning, making them well-suited to single buoy mooring and work with oil rigs. Now, a new company within the Kotug group, Kooren Shipbuilding and Trading BV, is presently selecting yards world wide to build future Rotor® tugs under licence.

MSR will soon be receiving delivery of a Rotor® tug console as part of the permanent tug simulator facility they are installing in a three-way partnership with Kotug and Schottel. The simulator can also mimic Voith Schneider and tractor tugs easily and so can be used for interactive training in a wide range of scenarios.

ABOUT THE AUTHOR

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