1. The CONGO RIVER: outside-view example of the DEME simulator

IHC training simulators for dredging and offshore

IHC Systems has recently added three projects to its successful training simulator track record [1]. The first was ordered by DEME for the simulation of multiple trailing suction hopper dredgers (TSHDs). The second accompanies the delivery of the cutter suction dredger (CSD) AL BAHAR for Huta Marine Works (page 22). And the last is a simulator for training of pipelay operators on board the five 550t pipelaying vessels (PLV), which have already been delivered and/or are under construction for Sapura Navegação Marítima (page 8).

These reflect IHC's capability to supplement every delivery in the company's main markets with simulators. They provide added value to IHC's customers in light of the ongoing retirement of many people within the industry and the subsequent scarcity of well-trained crew, as well as the high capital costs and risks involved with training inexperienced personnel in the field.

Generic arrangement

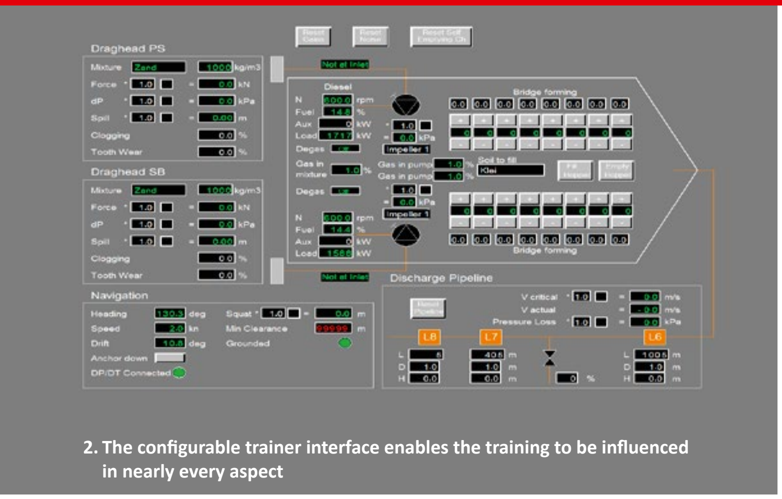
IHC Systems' simulators – irrespective of whether they are for TSHDs, CSDs, excavators or offshore vessels – have a generic basic set-up:

- trainee consoles, which are 90-99% identical to those on the vessels for which the training is intended
- a trainer desk, on which the trainer can influence the behaviour of the simulator and the process
- large fore and/or aft outside-view displays, providing the perception that "I am on the bridge"
- a classroom projector and screen for co-trainees attending a colleague's training session
- the adjacent computer hardware and software, network and network switches.

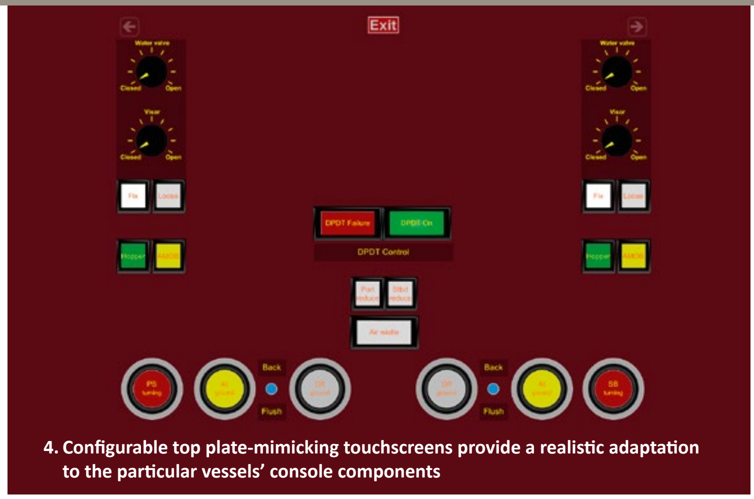
The trainer – a staff member of the customer – should be accustomed to every aspect of the training, processes and equipment to be taught. On his or her desk, equipped with one or more flat-screen displays, the trainer can alter every video page of either the simulator or the outside views to accommodate every location within the arrangement. The water in the outside views can be "drained", enabling the underwater situation to be "viewed". By means of freely moving "cameras", detailed bird's-eye views and simulated CCTV images can also be added to the outside view. In this way, the attention of the trainee and/or co-trainees may be drawn to specific situations or educational targets.

The recently renewed trainer interface (*figure 2*) – of which all simulators benefit – enables the trainer to influence a configurable set of process parameters or values. He may also introduce failures, such as a broken or clogged pipe, a leaking hydraulic cylinder or a stalling diesel engine, for example. This is a perfect means to provide the trainee with knowledge and resolution to resolve extraordinary or emergency situations.

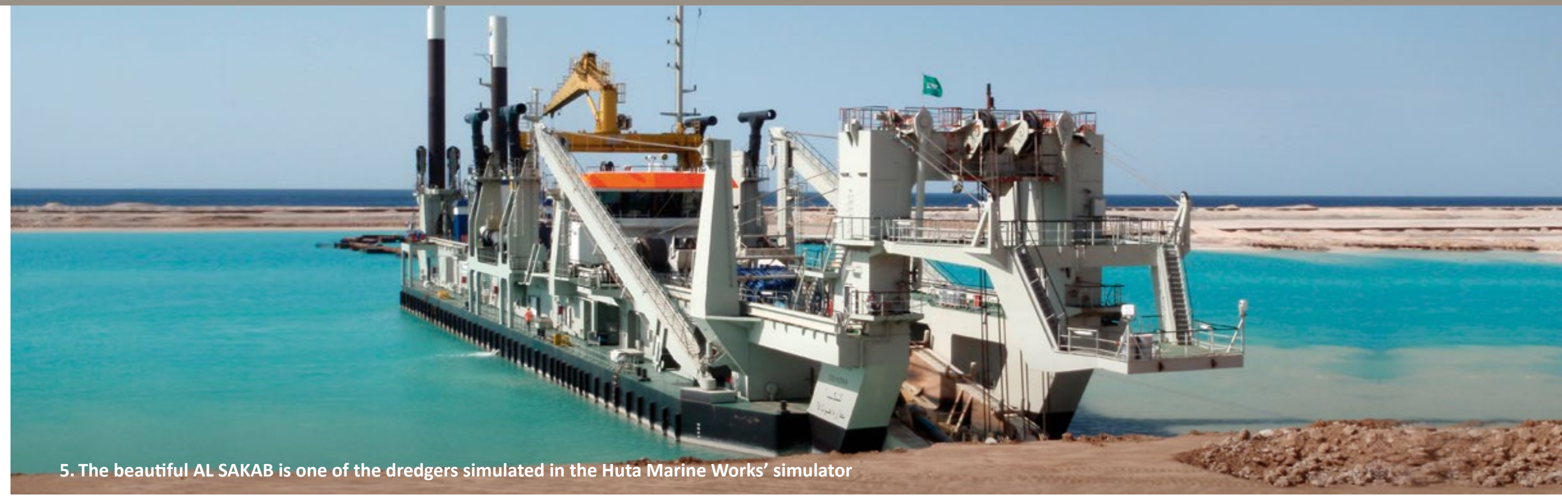
In addition, the trainer can influence the weather (sunny, cloudy, rainy, snowy or foggy), sea state, tide, and sun azimuth and altitude. These environments appear on the outside view in the phenomena of light, moving shadows, visibility and vessel movements. He may also configure the path, speed and draught of up to 10 additional vessels – or dolphins or birds – surrounding the "working" vessel and can therefore alter the amount of traffic to influence the trainee's decisions. These are realistically modelled from ships in the owner's fleet or IHC-built vessels. The various options contribute to the feeling of a realistic scenario (*figure 1*).



2. The configurable trainer interface enables the training to be influenced in nearly every aspect



4. Configurable top plate-mimicking touchscreens provide a realistic adaptation to the particular vessels' console components



5. The beautiful AL SAKAB is one of the dredgers simulated in the Huta Marine Works' simulator

3. The basic part of the DEME trainee console reflects those of the MARIEKE, BRABO and CONGO RIVER

6. A process page on the AL BAHAR's SCADA system

The trainer interface is also used to prepare training sessions. "Operational areas" – reflected in the outside views and bottom profile – can be prepared offline, without the need to run the simulator. They can be uploaded as scalable digital terrain models (DTMs), derived from a variety of real survey systems, such as IHC Systems' DTPS [2] for example, and easily located in the real geographical world. Detailed obstacles, quay walls or real harbour environments can be added too.

TSHD simulator

The optimal operation of a TSHD is governed by a combination of navigational accuracy, trailing speed, draghead positioning, dredge pump behaviour and overflow regime. This involves many pieces of auxiliary equipment, such as flushing, gland and jet pumps, gate valves and suction pipe gantries, winches and swell compensator, as well as bottom and self-emptying doors.

Controlling these processes implies a huge knowledge of technical systems and the influence of their behaviour on TSHD production. Even the relationship between dredging and sailing times can be decisive in the efficiency and profitability of the vessel – not to mention the necessity to prevent damage, injuries, downtime and risks. To influence this intertwined combination of factors, numerous manual and automatic instrumentation, monitoring and automation tools are integrated and installed on board.

The purpose of DEME's new simulator is to make navigators/operators aware of all this and teach them to achieve optimum performance from such costly equipment. It enables operators to be trained for three types of vessel in the fleet, for which the MARIEKE (5,600m^3), BRABO (10,890m^3), and CONGO RIVER (30,000m^3, two suction tubes) are typical. As these have one-man operated bridges, the navigator and dredge operator functions are integrated. The BRABO's and CONGO RIVER's DP/DT systems are also simulated. During training for the MARIEKE, it is used as a sailing simulator.

Operations such as dredging, backfilling, free sailing, loaded sailing, shore discharging, rainbowing and dumping can be exercised on the simulator, either in several DP/DT modes or without DP.

One particular feature is that the trainee console automatically adapts to any of the three vessels without replacing any hardware component. Components that differ between ships are not fixed in the steel top plate, but instead are displayed in top plate-mimicking touchscreens (*figures 3-4*) that are reconfigured accordingly as soon as the simulator is loaded. The impression of touching these components is surprisingly close to reality, except for turning knobs. Trainees have expressed positive impressions regarding this feature.

The simulator software has evolved with certain key features. It now enables the user to load the entire PLC/SCADA simulation of multiple vessels instead of loading one and then scaling it for other ships, as with the older 'semi-multiple-vessel' version. The physical models have evolved in response to recent developments, especially the draghead and hydromechanical models. The soil model allows for a second layer of different soil under the surface of the sea floor. Boulders and other obstacles can of course be located in these environments.

The system has hugely benefitted from the excellent relationship and extensive collaboration between IHC Systems and DEME. It has been installed in the latter's newly built simulator room in Zwijndrecht, Belgium. It is currently in full service and DEME has chosen not to apply the classroom part.

CSD simulator

Not entirely different to TSHDs, the optimal operation of a CSD is governed by a combination of positioning accuracy, swing speed, and cutter and dredge pump behaviour. This involves such pieces of equipment as flushing, gland and jet pumps, gate valves, a number of winches and anchors, and last but not least, the spuds and spudcarrier, and the discharge pipeline.

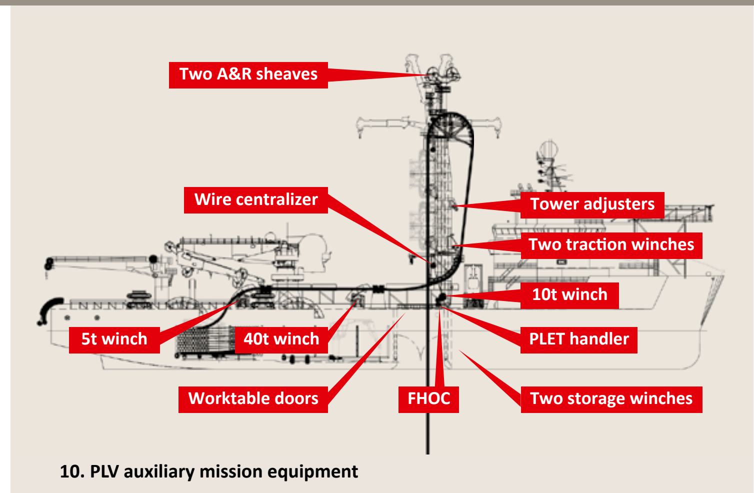
In a similar manner, these systems influence the efficiency and profitability of the dredger, and should serve to prevent damage, injuries, downtime and risks. Not surprisingly, Huta Marine Works – which has added three modern-operated CSDs to its fleet – ordered a CSD simulator that accompanies the delivery of the 23,545kW AL BAHAR C/D HUTA 12 (page 22). It also enables training for the operation of the 16,500kW AL SAKAB C/D HUTA 9 (*figure 5*) that IHC delivered in 2010, and the existing 15,871kW HUTA 14, which will soon receive a similar modern control system (*figure 6*).

All of the usual CSD operations can be exercised, including: breaching in, starting up, continuing and shutting off the discharge process; dredging different soil types; shifting spud positions; and anchoring. In addition, the spud-tilting process between the working and transportation positions, and *vice versa*, is explained in detail.

The trainee console (*figures 7-8*) is a copy of the AL BAHAR dredging console, which sufficiently covers the consoles of the other two dredgers. However, the multiple-vessel simulator software is used fully.

Special features include the trainer's ability to block the discharge pipeline and the presentation of the discharge site in the outside view, including bulldozers and other auxiliary vehicles. It allows the trainee to "see" the outcome of his actions. Another specialty is the presentation of the diesel engines' fuel consumption, expressed in relation to the amount of material transported. This will certainly enhance

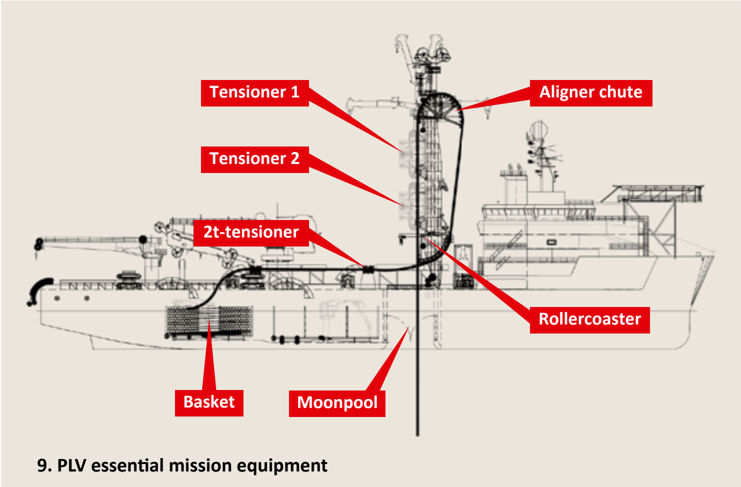
7. The trainee console for the Huta Marine Works dredgers reflects the AL BAHAR dredging console...



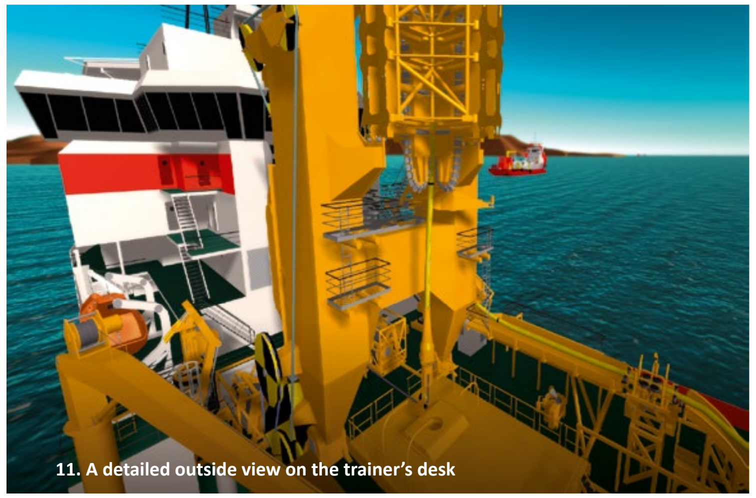
10. PLV auxiliary mission equipment

12. Pipelay operator trainee console and outside view

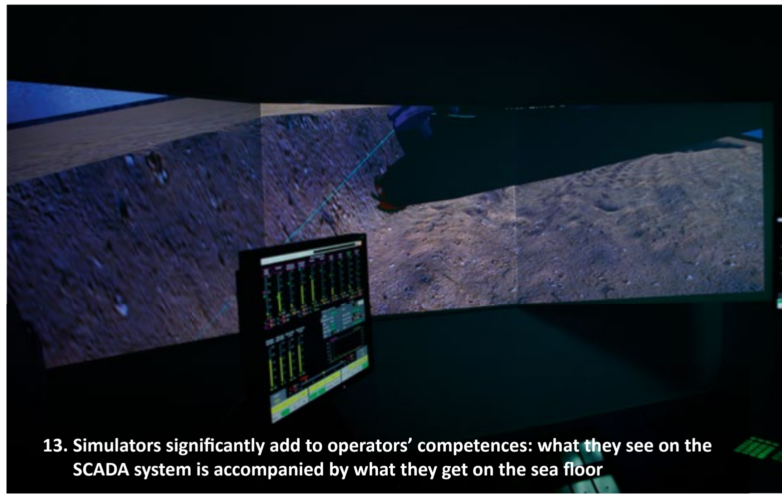
8. ...and is a fine place for Mr Tag Saleh, Huta Marine Works' Director for Dredging, Reclamation & Marine Facilities, to demonstrate his skills



9. PLV essential mission equipment



11. A detailed outside view on the trainer's desk



13. Simulators significantly add to operators' competences: what they see on the SCADA system is accompanied by what they get on the sea floor

the operators' sense of efficiency. As the AL BAHAR has IHC Systems' 3D-Viewer on board, this is also presented on the trainee console.

The features of the generic arrangement and the benefits of the enhanced models also add to the value of this simulator.

PLV simulator

A pipelaying operation – once initiated by the operations room – involves the close cooperation of the pipelay control room (PCR) and many deck crew, manually controlling such equipment as the storage basket, roller coaster, worktable doors, aligner chute and several winches, among others (*figures 9-10*).

In these operations, the operator in the PCR is the spider in the web. He controls the pipelay tower with its two tensioners and abandon and recovery (A&R) system, and monitors nearly all of the pipelay equipment, using SCADA screens. From the PCR and with the help of the vessel's communication system, he commands the other crew. Their task is generally to guide the pipe from the basket to the tensioner, which is the starting point of further transportation by the pipelay tower.

Such operations involve high levels of risk. They require the pipes to be repeatedly taken over by ropes, winches and tensioners, which are almost all man-made operations. If not properly tensioned, swaying pipe ends – up to diameters of 648mm – and/or leg-thick steel ropes may damage structures or equipment and cause downtime, injuries or even fatalities. Wind, weather and sea state may only add to such risks. Another example is the loss of a pipe, which generates extremely high costs for recovery.

Consequently the PLV simulator – designed in collaboration with Sapura Navegação Marítima and delivered at the end of October 2014 – differs from the above dredge simulators in that its main goal is not optimisation of productivity. Instead, its primary purpose is to gain awareness of, and experience with, the detailed procedures and protocols concerning operational safety and the prevention of downtime and pipe losses. This may of course improve productivity as a spin-off, but that is of secondary importance – safety is the keyword.

The nature of multiple-person operations also dictates a different role for the trainer. He not only coaches the trainee, but also takes up the role of the deck crew. Subsequently the trainer interface is not only equipped with generic simulation-influencing facilities, but also with a number of "soft push buttons" with which the trainer can "control" deck and underdeck equipment and actions in a simplified way.

Examples are the aligner chute, wire centraliser and "connecting" or "disconnecting" ropes to and from the pipe. The PCR trainee calls for these actions by telephone, which replaces the vessel's communication system in the simulator. Indeed, developing the operator's communication skills is also a goal. More experienced trainees may use a trainer interface repeater to "execute" the deck crew actions.

Failures initiated by the trainer have the purpose to show the trainees how to correctly diagnose and either to intercept by themselves, or correctly command the "deck crew" (the trainer) to do so.

The trainee exclusively controls the PCR functions. For that purpose, a 99% exact copy of the equipment in the PCR is at his disposal. This includes the pipelay control console for the IHC EB lay tower, including its tensioners (*figure 12*). Two large outside-view displays simulate the view from the PCR's windows. The usual CCTV displays are also installed and simulated, however they are controlled slightly differently.

In an interactive training session between the operator and deck crew, many pipelay operations may be learned, such as:

- pipe initiation
- pipe abandonment
- pipe recovery
- pipe-to-pipe connection
- and adding begin or end PLETs (pipeline end terminals).

The building of this simulator succeeded thanks to extensive collaboration between the owner, IHC Offshore & Marine, IHC Systems, IHC D&A, IHC Engineering Business and SAS Offshore. IHC Systems' Project Manager confirmed the extremely satisfying nature of this collaboration. It provided an accurate understanding of what the owner would require to be trained – and what vessel functions purposely should *not* be simulated.

In addition, the technical and accuracy requirements could be mutually established. It resulted in an ultimately accurate simulation of (swaying) pipe and rope behaviour, at least to the astonishment of the author of this feature, who saw an insufficiently tensioned pipe ruin a deckhouse wing. Fortunately, it was only on a video screen...

Conclusion

By supplying three innovative simulators, IHC has again proved that the company always has the benefit of its customers in mind. It adds considerable value by offering systems that significantly contribute to the optimisation and safety of their operations with its baseline products (*figures 11-13*).

References

[1] For example refer to the issues E166, E171 and E179 of *Ports and Dredging*. IHC Merwede, Sliedrecht, The Netherlands, 2006-2012.

[2] "3D-Viewer: innovative tool for improved subsea operations". *IHC Merwede Insight E4*. IHC Merwede, Sliedrecht, The Netherlands, 2014. 32-35.