

# Dredge simulators; an exciting tool for dredge training



Simulation by night

## Introduction

Until some 20 years ago, the job of dredging operator was learned almost entirely on the job.

The knowledge of how to operate dredging equipment was passed on from generation to generation, and operators learning the trade normally gained their experience by trial and error, on real dredgers and under real operating conditions.

However, with both dredgers and dredging projects becoming rapidly more complex, the awareness grew that there was a need for another kind of training facility.

Furthermore, with it becoming increasingly financially important to have the dredging equipment efficiently operated at all times, the room for trial errors on real dredging projects was reduced to almost zero.

It was soon recognised that the alternative would be training in a virtual environment, using simulators, a technology that was made possible by the development of computer systems, during this period.

In the late nineteen seventies and early nineteen eighties, the first modest steps were taken towards the

development of training simulators for the dredging industry, a process that has not ceased since that time, and that has continued to witness exponential growth in the technical possibilities available right up to the present day. Over the past 20 years, IHC Systems has played a leading role in the development of training simulators for the dredging industry.

## The basic training simulator

In 1977, IHC started development of automation systems for the dredgers being built by the company.

In order to test these systems, computer models also had to be developed, and certain clients frequently asked whether these models could also be put to use for training purposes.

In 1986, these requests led to the construction of the first cutter training simulator. The simulator was identified as 'Basic' and did not yet generate the complete handling capabilities and dredging process of a cutter suction dredger. The system was however able to simulate the swinging process of the dredger, allowing an operator to practise optimising the production of the dredger.

Within this 'Basic' simulator, a computer model presented a rough approximation of the hydraulic process of the cutter suction dredger. The 'Basic' cutter training simulator was used for many years by the Training Institute of Dredging (TID), the department of IHC specialising in every aspect of training for the dredging industry, and it was incorporated in several of the institute's training courses.

## The Dynamic Positioning/Dynamic Tracking system (DP/DT)

The next step in the development of dredge training simulators was taken in 1996, when the DP/DT system was introduced. In order to test the performance of DP/DT systems, including time response and accuracy, IHC produced a model jointly with Imtech Marine Offshore that was capable of simulating a sailing and trailing hopper dredger.

This model made it possible to position hopper dredgers, for example for unloading the hopper, and to follow predefined tracks in steering the draghead, during dredging and normal sailing, according to the DP/DT system that had to be tested.

This model was also subsequently provided to dredging companies, for training their dredging crews.

The model developed for the testing of DP/DT systems today constitutes the basis of the software package that is generally employed in simulators for sailing dredgers.

## Tunnel boring machines

In 1998, IHC was involved in the development of a new special Tunnel Boring Machine (TBM) together with several contracting companies. Unlike the traditional method of tunnel boring, where prefabricated concrete tunnel segments are used to make up the tunnel, the new system was based on a continuous process consisting of pumping a cement mixture directly behind the TBM, where it could harden and create an uninterrupted concrete tunnel construction.



*Integrated Simulator in Zeebrugge*

In line with this development, IHC developed two complicated simulation models. Firstly, a model was produced for the in situ excavation of the material by the TBM and the hydraulic transportation of the mixture of this material, using bentonite. A second model was made to simulate the hydraulic supply of the cement mixture and the process of pouring the cement behind the TBM.

Although not directly related to dredging, these models represented a major step in the development of simulation models for hydraulic transport, and would subsequently prove to be of enormous significance for future models used for simulating the hydraulic process on board cutter and hopper dredgers.

#### **Hopper simulator for Jan De Nul**

A hopper simulator delivered in 2001 to Jan De Nul was the first dredging simulator in which IHC incorporated its experience with the development of the TBM models.

The simulator was built as a precise

copy of an integrated bridge, as fitted on many of the company's modern trailing suction hopper dredgers. The simulator has advanced models of all the dredging processes involved in trailing suction hopper dredging, including:

- the excavation process with the drag head
- the hydraulic transport of the mixture from the suction pipe to the hopper
- the loading and discharging of the hopper
- pumping ashore and rainbowing.

Since hopper dredgers vary considerably in both size and configuration, the hopper simulator makes it possible to alter a large range of parameters, for all types of training situation.

It is for example possible to choose between types of draghead parameters, different pipeline configurations (with the possibility of adding an extra submerged dredge pump) and between electrically or directly diesel-driven dredge pumps.

The simulator for Jan De Nul was built

mainly for the simulation of the dredging activities of trailing suction hopper dredgers, but it also can be interfaced with a DP/DT system to simulate the movement of the dredger. A similar unit is available at IHC Systems, which is used for training purposes and demonstrations.

#### **An integrated simulator in Zeebrugge**

A another major step forward in the development of simulators was taken in December 2004, when a new integrated bridge simulator was opened at the Centre for Maritime Education in Zeebrugge, Belgium. This training simulator is intended for training the navigational skills of officers, on a large variety of vessels.

As well as normal, free-sailing ships, in which only the hull interacts with the sea water, it is also possible to give training in the navigation of hopper dredgers and fishing vessels. These two latter examples are very specific, since these types of ship can have their suction pipes or their fishing

nets respectively interact with the water and the seabed, creating an extra level of difficulty for the navigating officer. To make it possible to train for the specific situations on board hopper dredgers, IHC has provided the simulator with an elaborate model, including all the relevant dredging parameters.

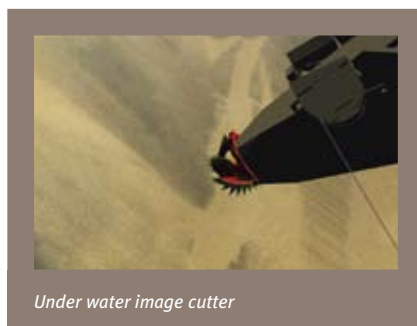
The importance of this simulator for the dredging industry lies in the fact that it is the first in the world in which the navigation and the dredging aspects of a hopper dredger have been combined. The Zeebrugge simulator is currently being used by several Belgian maritime organisations, educational facilities and the two leading dredging companies, DEME (Dredging, Environment and Maritime Engineering N.V.) and Jan De Nul. Hopper dredgers with hopper capacities ranging from 5,000m<sup>3</sup> to 16,000m<sup>3</sup> can be simulated, in Zeebrugge.

#### **A cutter simulator for DEME**

Once the Belgian DEME group had issued the order to IHC Holland Merwede, in 2004, to build the new and revolutionary heavy duty cutter suction dredger D'ARTAGNAN, it was not long before they took the decision to have a cutter simulator built as well, that would enable the company to train the operators of this kind of dredger. DEME expressed the wish to acquire a simulator focused mainly on cutting and the hydraulic processes. To simulate the cutting processes and mixture forming and spill at the cutter head, a complex model of the breaching of the ground in front of the cutter was developed. This model was developed in close cooperation with DEME by IHC Systems and MTI Holland. It makes it possible to adapt the parameters of material to be dredged on a 10 x 10cm grid. The hydraulic model of the cutter simulator is based mainly on the earlier hopper simulators.

The new feature of this simulator, in comparison with the first 'Basic' cutter simulator back in 1986, is the models that simulate most of the secondary systems on board a cutter suction dredger, including spuds, anchors, anchor booms and winches. DEME's cutter simulator was installed in September 2005 at the Group's brand-new training centre in Lambertsart near

Lille, in Northern France, and was christened the 'Constance Bonacieux'. The system is able to simulate almost all the cutter suction dredgers in the DEME dredging fleet, with the exception of the D'ARTAGNAN. These vessels include the AL MAHAAR, the RUBENS, the VLAANDEREN XI and the VLAANDEREN XIX; in addition, a standard IHC dredger of the type Beaver 6518 has been added to the facilities. The 'Constance Bonacieux' has now been part of DEME's training facilities for several months, and trainees have suggested on numerous occasions that the simulations are so realistic, that they often forget they are not on board a real dredger.



#### **A cutter simulator for Jan De Nul**

The development of cutter simulators is still continuing, and IHC Systems delivered a new simulator for the Belgian dredging group Jan De Nul as recently as 2006.

This new simulator includes the same

features as its predecessors, but also offers far more elaborate 'outside' image facilities, including the presentation of 3-dimensional objects. This new 'outside' image was developed entirely by IHC Systems, and amongst the realistic images it displays will be the breaching of the material to be dredged, both above and below the water. This feature will allow the user of the simulator to actually view the behaviour of the ground in front of the dredger as a result of the cutting, spud carrier performance and swinging motion. To achieve this imaging, the model required to simulate the composition of the ground to be dredged will be the most complex and advanced currently available. Another new aspect of the simulator for Jan De Nul, is the possibility of simulating the impact of sea and ocean waves on the hull of the dredger, and the subsequent response of the vessel. This latest simulator went into service in July.

#### **TID's Beaver cutter suction dredger simulator**

Based on the technology described above, IHC also constructed a dredge simulator based on an IHC Beaver dredger, for TID. This simulator contains all the latest features, and it was installed in early 2006 at the TID premises in Kinderdijk. Since that time, the simulator has successfully been used for a number of training sessions.

