



### Shipyards – The Netherlands

Hardinxveld-Giessendam  
Heusden  
Kinderdijk  
Krimpen aan den IJssel  
Slidrecht

### Shipyards – P.R. of China

Dalian

### Sites – The Netherlands

Apeldoorn  
Delfgauw  
Dordrecht  
Emmeloord  
Goes  
Hardinxveld-Giessendam  
Heusden  
Kinderdijk  
Slidrecht

### Sites – Europe

Blandford Forum – United Kingdom  
Belgrade – Serbia  
Komarno – Slovakia  
Riding Mill – United Kingdom  
Rijeka – Croatia

### Sites – USA

Houston, TX  
Wayne, NJ

### Representative offices

Beijing – P.R. of China  
New Delhi – India  
St. Petersburg – Russia

### Regional IHC Organizations

#### worldwide

Dubai – United Arab Emirates  
Lagos – Nigeria  
Mumbai – India  
Singapore – Republic of Singapore  
Tianjin/Tanggu & Guangzhou – P.R. of China



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# IHC Systems

*Dedicated to Efficient Dredging*



*eXcavator Position Monitor &  
Automatic eXcavator Controller  
(XPM & AXC)*



an IHC Merwede company

**The technology innovator.**

# *Efficient Dredging...*

'Efficient Dredging' helps contractors to make the most of their dredging equipment: to generate high economic and ecological benefits, achieve optimal utilisation rates, reduce dredging time, make the dredging process smoother, simplify fault diagnosis, reduce downtime and wear, prevent under- and over-dredging, and maximise crew satisfaction.

Even after a shipbuilder has built reliable and efficient equipment, and even after contractors have optimised equipment utilisation, the **Efficient Dredging** concept continues to make a significant contribution, providing dredgers with extra 'senses' and 'hands & feet'.

Relatively modest investments in instrumentation, automation, surveying and simulation techniques produce major improvements in efficiency and accuracy. Automation under dredge master supervision can enhance production by up to 30%.

IHC Systems draws on all kinds of conventional and innovative control, automation, communication and presentation technologies. We also make the most of the knowledge and resources of the entire IHC Merwede group.

The concept is honed in close alliances with contractors and worked out in specific products, systems and services for every category of dredger and in every field. The products can cope with all dredging and mining conditions.

Our knowledge, expertise and experience are dedicated to reducing over-dredging, spillage, energy consumption, emissions, turbidity, ecological side-effects and operational costs. They represent our contribution to a sustainable future for all our stakeholders.

*...our contribution to a sustainable future*



## Benefits

Dredging a profile or placing/breaking rock below the waterline with an excavator dredger efficiently and accurately is almost impossible. The position of its tool (backhoe, clamshell, orange peel, rock hammer) in the working area depends on several, constantly varying, angles of machine components: slew angle, boom angle, stick angle and tool angle, not to mention the position of 'point zero': the slew-bearing centreline as part of a moving pontoon

So without auxiliary equipment, the only way to comply with job specifications is to dredge or to handle rock with large tolerances, working with estimates and relying on extensive survey and verification activities. However, this approach is not always acceptable for customers or authorities, and it considerably increases the verification and cleaning-up costs of dredging for the contractor.

To solve this problem, IHC Systems developed the eXcavator Position Monitor (XPM), a Windows-based, rugged and marinised computer system extended with a set of robust sensors. After the success of the first versions, dredging contractors found

their way to IHC Systems and offered to cooperate in the gradual further development of the system into a convenient and easy-to-use operator tool. As a result, the number of operational XPMs worldwide is now into three digits.

XPMs measure any and every angle of excavator dredger components and include them in models that can be adjusted to the specific dimensions of the excavator and tools involved. These models feed a dedicated graphic interface, which combines the accurately calculated tool rim or teeth position with a digital terrain model (DTM) of the dredging profile – if necessary in combination with DGPS and tidal information in a shared local grid. The DTM and the required dredge profile can be inserted by hand or imported from survey data. Once dredging or rock placement have started, the XPM updates the original DTM with the positions it has been working on. These data – with accuracies in the centimetre range – are used for dredging job records and/or proving conformity with specifications. Basic functionality and optional extensions are described on pages 5 and 6 of this brochure.

In conclusion, the XPM has proven to be a very welcome 'underwater pair of eyes' for owners and operators, enhancing not only safety but also dredging accuracy and efficiency. The spin-off is a sharp reduction in survey and job verification costs, spill, fuel consumption and emissions; in short, of operational costs. And it also means a major contribution to the sustainability of dredging operations.

'Additional hands' are also available: the XPM has reached a level of maturity at which several safety and job-easing automatic routines can be included as options. They help the operator, for example, to prevent pontoon damage and excessive acceleration and forces, or to follow a dredging profile accurately. Even fully automatic cycle dredging is possible with the addition of the Automatic eXcavator Controller (AXC) option described on page 7.



Komatsu PC3000 Aquadigger



IHC Merwede/Liebherr backhoe dredgers



Demag with IHC Hydrohammer® rock breaker

## Typical XPM System Arrangement

Hardware on board excavator dredgers needs to cope with extreme conditions such as intense vibrations and temperature variations, shocks and variations in sunlight capture on the cabin-mounted equipment. In addition, it is necessary to eliminate the risks of wear and damage to sensors and transmitters resulting from invisible obstructions below the waterline. The XPM hardware has been hardened successfully to cope with these conditions. A typical XPM arrangement consists of:

- A rugged and marinised PC main station, arranged with signal condition/input and output processing units in a robust housing for mounting in the operator's cabin;

- A static inverter and main switch box for the power supply to the main station;
- Two 17-inch high-brightness TFT LCD screens with sun roofs on vibration-damping support;
- An industrial keypad for data insertion and screen page control;
- Three boom, stick and tool angle transmitters with dedicated mechanical interface parts;
- Slew angle transmitter with dedicated movement transmission parts;
- Tilt angle transmitter;
- Interface junction box for connecting the transmitters;
- Optional: positioning system.

A USB flash disk, dongle and Bluetooth connection complete the system and provide versatile communication, the guarantee that the appropriate software is loaded, and protection of the system against unauthorised use. With a second dongle inserted, the system can be used in "office mode" for offline training sessions.



Impression of the typical relations between XPM system components and the real excavator

## Main functionality

The XPM's main function is the presentation of the excavator and its tool in the operational setting. Basically, this includes a top view and a side view of the machine in a grid of local coordinates, and the position of the tool in relation to a prepared dredge profile and the waterline, which are also located in the grid. The grid also contains bathymetric information presented as colours and/or alphanumericly. Software has been included for drawing plan lines and profiles easily.

The display consists of a 2.5D wire-model of the pontoon, the machine outlines and, in particular, the boom, stick and tool, all on the basis of dimension parameters, and related to the local grid. Operators can zoom in on the tool rim or teeth.

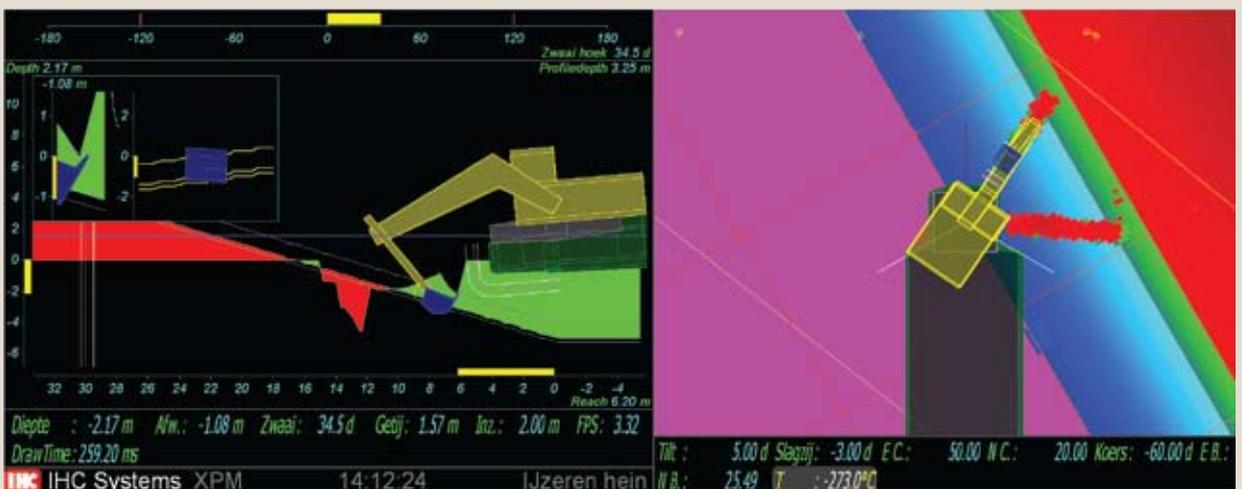
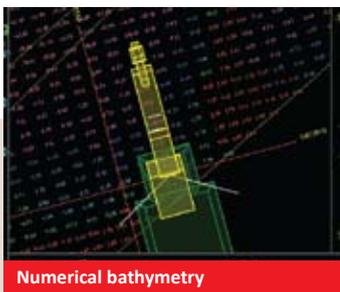
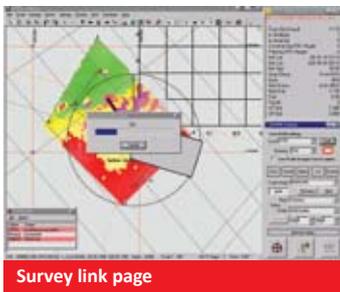
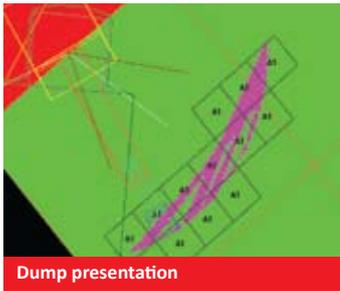
The theoretical digital terrain model (DTM) is built up from the local grid and bathymetric information. It can be inserted by hand, loaded from a USB stick, or entered directly from a serial link with positioning systems such as the IHC Systems Dredge Track Presentation System (DTPS), if available. Multiple dredge profiles can be included in the DTM and retrieved one by one.

The XPM keeps records of the

progress of the dredging work by presenting an overlay on the DTM showing the positions where the tool has been digging and adapting the original bathymetric information. This feature is also available for rock placement or soil dumping, where the operator has to push a button after every dump. This feature can also present different soil/rock types defined before the job starts.

Of course, warning messages are displayed if anything goes wrong. A replay facility is in place for demonstrating the quality and quantity of the executed job, including digging depth tolerances, etc.

In the basic functionality the 'link' between the XPM local grid and a geographical grid such as WGS 84 or UTM has to be inserted by hand. That means that the pontoon's bearing, draught, list and tidal information can be inserted in the system using the keyboard. These routines can be automated if the pontoon has been provided with a DGPS system, a tidal receiver, a draught sensor, a list sensor and a gyro compass or if, alternatively, these data can be obtained from DGPS RTK equipment.



XPM main presentation: side view and top view in local grid with indication of bites taken

## Extended functionality

### I/O and software extension

This option includes analogue and digital inputs or serial links for the connection of, for example, pontoon draught & list sensors, DGPS systems, survey systems, gyrocompasses, dump-mode switch, radio tidal receivers and pontoon spud carrier position measurement. Preparations have also been made for the incorporation of these data in XPM calculations.

Optional software allows the XPM to process multiple data formats and geographical grids from the survey system. It can also import borehole information and multiple pre-programmed dredge profiles.

### Sensor extension

Optional sensors for extended functions are available. They include pontoon draught sensors with certified sea inlet, list sensors, spud carrier measurement 'Sprinter' and submersible connectors for easy sensor inspection and maintenance. See our Sensors & Transmitters brochure.

### Positioning information processing

The geographical position of the excavator's central rotation axis – which is point zero for all XPM calculations – can be obtained in several ways: either from DTPS or another positioning system, or directly from a DGPS RTK system,

the latter providing accuracies in the centimetre range.

IHC Systems delivers the relevant equipment for optimal tuning to the current operation for all possible combinations.

### Automatic protection and control

Based on its calculations and settings, XPM can provide a number of optional automatic controls. If they are included, there is also an associated control junction box for the excavator's hydraulic proportional valves. It is connected to the XPM with easily interchangeable quick connectors. The operator can enable the relevant control modes with key switches on the front of the XPM:

- Automatic swing limitation gradually stops the slewing movement at predefined points in order to protect spuds and, for example, cabins of barges moored alongside the pontoon.
- Outreach limitation stops the boom movement at a predefined outward line in order to protect, for instance, buildings, quay walls, vulnerable landscape elements and so on.
- Pontoon damage limitation stops the stick if the tool rim comes too close to the pontoon and gradually steers it to a predefined safety line.

- eExcavator Profile control (XPC) steers the tool rim exactly along the predefined dredging profile by automatically steering the boom. The operator controls the stick and the tool only.

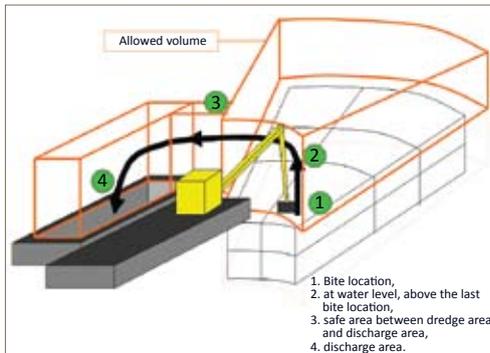
- eExcavator Bucket control (XBC) keeps the teeth of the tool at a constant angle to the dredged profile to optimise the cutting forces in relation to the production.



Simply turning a key and entering some settings extends the operator's options considerably

## Automatic eXcavator Controller (AXC)

The idea behind the AXC option is that the excavator can be taught dredging cycles by the operator and then continue them routinely. This control philosophy is the outcome of simulated jobs on IHC Systems' excavator simulator by real operators. The aims are to prevent dredging over-depths and leaving white spots, to relieve operators from routine tasks and fatigue, allowing them to concentrate on safety and accuracy, and to guarantee continuous fast cycle times in homogenous soil types. In short: to optimise operational costs.



AXC's safety philosophy

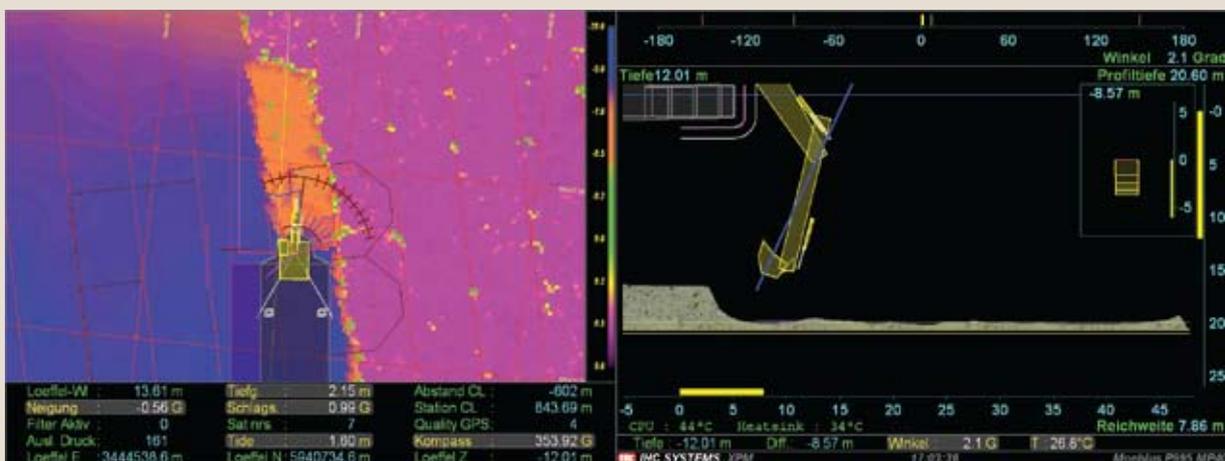
Dredging jobs are broken down into a bite pattern: a prepared plan for dredging a certain area efficiently. Operators use these plans to ensure they don't miss any part of the job. The AXC observes the operator dredging and learns where the operator is moving the bucket in the bite pattern and above the barge. After two learning cycles, the AXC decides where to continue, which direction to move in, and informs the operator that it is ready to start. The 'informed' bite pattern tells the automation where to place bites and where to dump.

If the operator has not followed the pre-determined bite pattern exactly during the learning cycle, the automation adjusts and still tries to reduce the travelling time of the bucket. Even if the operator engages in a manoeuvre to dig out obstacles like large rocks, the automation system feeds back information for the position of the next bite when activated again.

A virtual space is created as a safety aid and protection. The excavator is allowed to move only within defined spaces above the dredging area, in a corridor, and in an area above the barge. If, for some reason, the excavator moves outside these safe areas, the automation stops. This 'permitted volume' protection, once established, is used for manual operations as well.

There is a major focus on operational safety. If the operator steps on a pedal, automatic movement starts. The foot pressure determines the maximum speed. Releasing the pedal, or touching the manual control levers, stops the automation and returns full control to the operator. When the operator steps on the pedal again, the AXC resumes. The foot pedal also includes a dead-man's switch functionality. The system has watchdogs on the software and the sensors. An independent unit stops the machine if there is a failure in the AXC switch gear. Otherwise, the switch gear can be overruled within minutes by changing quick connectors, so manual control can always continue if the AXC is down.

AXC proves that the automation of excavators is possible by focusing on the operators, and by integrating the automation with their work. The benefit is that the interaction between automation and the operator maintains operator skills instead of replacing them. So the art of dredging stays where it belongs – with the true artists, the operators.



Clear presentation of the bite pattern and the permitted volume lines