‘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.
Operators of cutter suction dredgers (CSD) continuously juggle numerous processes, such as the swing process in relation to the anchor positions and the desired dredging depth/profile, the cutting process, the pumping process and the field of forces around the spud carrier. Even when managing all these factors, the operators also have to maintain high production rates throughout the shift. And on top of manning this ‘technical’ interchange, operators also need eyes in the backs of their heads to watch out for passing traffic. It’s a daunting challenge.

The basic version of the IHC Systems Automatic Cutter Controller (ACC®) cures at least three of these headaches. The full version cures all but the traffic headache, and also maintains dredger production at constant high levels. The ACC® includes an array of instrumentation, hard- and software, presentation, functional and operational facilities that allow operators to divert their attention from the stressful – and sometimes monotonous – tasks and to concentrate on the efficient functioning of the dredger and the output of the process as a whole. So the ACC® is a practical tool for beginning operators, allowing them to make a success of the job proper. Experienced operators can achieve major yield improvements with the ACC®: as much as 30% in ideal circumstances. The corresponding reduction in mental pressure helps to facilitate the easy monitoring of the traffic, which results in improved safety.

The ACC® monitors and controls the individual processes and the links between them unremittingly. It establishes the best combination using conventional control methods and – even more importantly – Artificial Intelligence (AI) and Model Based Control (MBC). The soil mechanics expertise supplied by IHC Merwede’s research institute MTI, and the operational and technical experience with IHC Systems’ dynamic CSD training simulators, were also called in to maximise dredger performance and optimise dredger processes at the lowest possible cost. Installing the ACC® results in major reductions in fuel costs, subsequent emissions and wear and tear.

ACC® can be used for control wheel dredgers (AWC) and bucket dredgers (ABC) as well. The different versions can be easily adapted to the different operational and technical requirements of both the dredging and the alluvial mining industries.

In conclusion, the ACC® makes the most of sustainable dredging and mining operations at highly competitive cost levels. It accelerates the return on investment, not only for the ACC® itself, but also for the dredger as a whole.
The Automatic Cutter Controller

The IHC Systems ACC® draws on proven hardware and software, including a redundant programmable logic controller network (PLC) monitored by a fast PC-based, server-client, supervisory, control and data acquisition (SCADA) network.

The core of the system is a separate, dedicated PC – which can be supplied in a redundant version – containing the ACC® algorithms and models. These run on a shared Microsoft Windows and IHC Systems’ Digisys platform. The software is dongle-protected to prevent unauthorised use.

The PLCs manage the standardised signal isolation and signal processing to and from the connected instrumentation and sensors, and the drives for the cutter/dredge wheel, swing winches, ladder winch, dredge pumps, vacuum relief valve, spuds and spud carrier. The PLC system also generates the sequential routines for the dredging patterns.

If required for the distribution of signals, the PLC I/O units can be spread to appropriate locations on the ship, or even be included in an IHC Systems integrated monitoring and control system that provides many other functions.

The SCADA system – which can be supplied in a redundant version – includes two touch screens or video screens, and keyboard-trackball combinations for the dredge operator. Other viewers may be added optionally for desired locations such as the dredger’s office. Depending on the specific system configuration, one or more PCs can also provide connections with logging printers, remote support modems and navigation equipment.

The SCADA system acts as a human-machine interface (HMI). It provides the operator with five or more process pages, and a number of calibration, service and diagnostic pages, depending on the number and nature of installed options, and on agreements made during the commercial stage.

In summary, the operator has at his disposal:
- Two 19” video screens or touch screens, depending on the agreed extension
- Two keyboard-track ball combinations
- One standard ASCII keyboard
- A number of discrete push button-signal lamps for dredge pattern coordination

In life, the ACC® is tested in real-life simulators.
Automatic motion control includes swing motion control, ladder motion control and spud carrier motion control, which are geared to one another by the pattern coordination function.

- Swing motion control automatically controls the swing speed by exerting a desired torque on the swing winches within the boundaries of maximum swing angle, maximum permitted swing speed, slope constraints and horizontal stepping limitations. Active oscillation damping stabilises the swing speed.
- Model-based anchor position estimation, which advises the operator about unfavourable anchor positions and anchor dragging. It also improves the performance of the swing speed controller.
- Ladder motion control steers the ladder along the desired profile in box cut mode or in slope following mode. It can also steer on the basis of a survey profile to prevent the dredging of water. Depth layers, over-depth layers and clean-up can be set and are taken into account by the pattern coordination function.
- Spud carrier motion control allows the spud carrier to make relative steps in selectable follow-up modes. The selectable dredge pattern generator provides several options for interrupting or terminating the movement, for clean-up strokes and for resuming previous strokes. Spud carrier advance correction facilitates dredging using several radiiuses.

Automatic pump control governs the flow in the discharge pipeline for a maximum of three dredge pumps, with the desired mixture velocity and the intermediate pressures of the inboard pump(s) as parameters. The inlet pressure of the – possibly submerged – first pump is protected by steering the vacuum relief valve.

Mixture transport control: the Artificial Intelligent (AI) mixture velocity controller module controls up to three pumps and the swing speed, with the discharge pressure as the leading parameter. Mixture transport processes are considerably influenced by average grain sizes, the dredging depth, and the mixture velocity and mean density. When the mixture density in the pipeline exceeds the maximum permitted value, the dredge pumps become the limiting factor. This results in a loss of mixture velocity and, eventually, clogging of the pipeline. It is almost impossible for a human operator to regulate this process; not for the AI controller. In addition to the online estimation of the average grain size, pump wear and the pump solids effect, it maintains the mixture velocity at which production is maximised. The inlet pressure of the first (submerged) pump is protected by steering the vacuum relief valve.

Extended mixture transport module for the remote control of four booster pumps operating in discharge pipeline chains of up to 15 kilometres.

Production control sets a swing speed for the optimal production given the maximum cutter load, swing wire speed, mixture density, average pipeline mixture density, pump inlet, intermediate and outlet pressures and permitted spud carrier force. Master controllers steer using these parameters, calculating the maximum permitted swing speed and kicking in as overrides when necessary. The controllers have been paralleled with monitoring models (“observers”) that estimate the process gain with extended Kalman filtering techniques, allowing adaptation to the different soil types and spillage at the cutter head.

Functionality

The ACC can be supplied in two versions. Both include a dedicated mix of the functionalities below, tailored to the deployment of the dredger.
Human-Machine Interface (HMI)

The two colour video display units form the heart of the HMI system, where five pages group the information in an orderly way, bearing in mind the human capacity to absorb and process data. So there are ‘technical’ pages which supply detailed information about process parameters and the activity of controllers, and ‘process’ pages for understanding ongoing processes such as swinging, mixture transport etc. The process pages supply ‘metadata’ that allow operators to acquire an intuitive grasp of the whole process. Of course, developments in this field never stop. So IHC Systems is continuously absorbing new ergonomic insights and feedback from dredging operators and implementing them in new SCADA designs. The only thing we can be sure about is that, by the time you read this brochure, the SCADA designs shown here will be already yesterday’s versions.

In addition to the visual information, operators have three options that allow them to understand, calibrate and control the ACC®’s operations:

- The usual swing-related sequences grouped under the term pattern coordination can be easily controlled with conventional push-button/signal lamps with clearly designated functions such as: swing, horizontal step, vertical step, return to first layer, pause, stop, etc.
- One or more of these automation functions can be engaged or adjusted using the functional keyboard-track ball combinations and/or the optional touch screens in a natural and intuitive way. The same approach is used for retrieving reporting and diagnostic pages in the SCADA system.
- For set-point adjustment and system calibration, there is a logical and understandable windows-like menu structure in which the ASCII keyboard is used for number entry, checking boxes and so on.

The benefits of the IHC Systems ACC®, the proven instrumentation, the hardware and software solutions, the high-end functionality and the tailoring to operator needs make it a valuable investment.
Equipment geared to performance

The ACC® works in conjunction with an array of other equipment on board. So that equipment has to be in place and operational. The vessel herself and her power systems must also be adequate to process ACC® commands promptly and without excessive loads in order to fully benefit from the automation.

In many cases, with new dredgers that have been automated from scratch, these conditions can be met without difficulty. In other cases, for instance during retrofits, IHC Systems can conduct the relevant feasibility studies and deliver all the equipment needed.

In the case of a real project, customers will receive fully detailed specifications relating to this equipment. In broad terms, the equipment needs to manage the following tasks:

• Delivery of information about the positional status of the dredger, such as ladder angle, spud carrier position, tidal information, global position, gyro angle, etc. In general, this information can be delivered by an IHC Systems’ Dredge Profile Monitor (DPM®) or by an integrated control and monitoring system fed by the correct sensors.

• Delivery of information about the dredging and pumping process. This includes: pump inlet and outlet pressures, mixture density and velocity and more. IHC Systems’ range of instrumentation covers the requirements in full.

• Delivery of information about speed, power, and typical characteristics for all relevant power consumers such as the cutter or dredge wheel drive, dredge pumps and winches, and the capacity to translate ACC® signals, without filtering, into the appropriate movements of these power components. Modern electronic diesel governors, hydraulic control equipment and electric frequency drives usually manage such functions. Extensive handshaking routines have a major impact on the configuration of these power control systems, but ensure safe and untroubled operations.