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Shipyards – The Netherlands

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Heusden
Kinderdijk
Krimpen aan den IJssel
Sliedrecht

Shipyards – P.R. of China

Dalian

Shipyards – Serbia

Belgrade

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IHC Systems

Dedicated to Efficient Dredging



*Dredger Control Systems
(DCS)*



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

IHC Systems' Dredger Control Systems (DCS) were developed over decades of use in practice. The 1960s saw the installation of individual controllers for winches and other equipment on the bridge. In the 1970s, control desks and relay boxes were designed and manufactured for specific vessel systems such as the hydraulic dredging installation. In the 1980s, these designs acquired even greater functionality, as PLC systems arrived on the stage. In the 1990s, the next step in evolution led to completely integrated PLC-SCADA installations with touch screen control and partial automation. At that time, the span of control included the entire dredging installation - sometimes including other platform functions. In the first decade of the 21st century, successful automation and artificial intelligence emerged, allowing for the world's first one-man-operated bridge and the intelligent DP/DT system for trailing suction hopper dredgers. The Automatic Cutter Controller with fully automatic functions for the swing process and mixture transport control for long discharge distances was the mirror development for cutter suction dredgers.

Now, in the second decade of the 21st century, we are tuning our technology to the insight that dredging vessels are socio-technical systems, including personnel, technology, organisational structures and an external environment. Simplification of routines, intuitive operation, safety and enhanced ergonomics are keywords. The benefits of our experience make themselves felt in every new integrated DCS system:

- No separate functional units and automation systems required, dispensing with the need for, among other things, a separate suction tube position monitor, dredge profile monitor or automatic cutter controller.
- Integrated data communication and decentralised I/O cut back sharply on hardware and cabling.
- Less vulnerable to cable failure and/or redundant installation for optimum security.
- No data overlaps, gaps or overload. Once a setting has been entered in the system, it is available for all sub-functions, minimising work, mistakes and subsequent failures.
- Specific ergonomics and functional integration adapted to the human mind's capacity

to absorb and process data: no operator data overload.

- Modular design easily incorporates operator specific preferences - *dredging à la carte* - and integration with other sub systems.
- Easily adaptable for altered operational requirements.
- Robust, reliable sensors and automatic control of every imaginable on board sub-system prevent damage and injuries, while enhancing production. Examples: automatic control of draught (ADC), spud carrier step, light mixture overboard (ALMO), dredging depth and swell compensator position, pump speed (APC) and sequence control of suction pipe.
- Extended data logging and diagnostic properties enhance the availability and uptime of the equipment and enable preventive maintenance.
- Artificial Intelligence (AI) and model-based 'virtual sensors for measurable and immeasurable parameters' such as soil particle dimensions, critical velocity, pump efficiency and overflow losses (OLE) or the temporary replacement of a failing sensor by calculations.



DCS operator station on IHC Beagle TSHD



DCS console on CSD Quibián I



One man-operated bridge on TSHD Brabo

Typical Functionality

IHC Systems DCS supports the instrumentation, control and automation of a range of on-board sub-systems in so far as they are available, relevant and agreed upon. The modular arrangement allows for several levels of sophistication and redundancy. Examples of sub-systems supported are:

For trailing suction hopper dredgers:

- Suction pipe movement function, comprising suction pipe, winch, gantry, swell compensator and draghead measurement and control. Suction pipe automatic winch control and automatic sequential control can be included as well as automatic draghead control.
- Hopper loading and unloading function, including dredge, jet and self-emptying system gate valves, upper doors, bottom doors, overflow duct and bow coupling. Automatic dredge/jet pump valve setup for several operational stages. Full instrumentation of the hydraulic installation and control of deck winches and other auxiliaries are part of this function. Measurement and automation of soil production, draught and loading, dry solids, fuel and water tanks, overflow losses as well as automation of draught control and ALMO valves complete this function.
- Pumping process and degassing function, incorporating pressure, flow, level, torque and power monitoring for dredge pumps, jet pumps, gland pumps, degassing pumps, lubrication

pumps and auxiliary equipment. Automatic dredge pump, gland pump and jet pump control are possible.

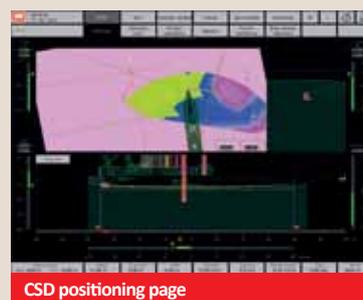
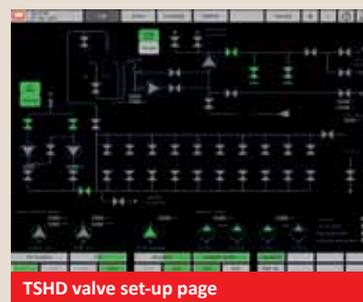
- Vessel positioning measurement and presentation function based on DGPS, radio tidal, draught and gyrocompass information supports the presentation and control of the other functions and allows for the fully geographical presentation of the dredger in a digital terrain model obtained from in surveys and updated by the actual dredging activities.
- Remote access and 'smart dredger' AI control function by satellite, see brochure on IHC Connect.

For cutter suction dredgers:

- Ladder, cutter, swing winch, spud and spud carrier movement function, comprising ladder, spud, spud carrier and anchor position measurement, cutter and winch load and speed measurements, including control and automation (ACC function) of these systems.
- Pumping process function, incorporating pressure, flow, level, torque and power measurements for dredge pumps, gland pumps, lubrication pumps and auxiliary equipment. Automatic gland pump and dredge pump control are possible, the latter in several degrees of intelligence, culminating in Artificial Intelligence-based control of a chain of booster stations behind the dredger (ACC function).

Automatic valve setup, full instrumentation of the hydraulic installation and control of barge loading and deck winches are part of this function.

- Pontoon positioning measurement and presentation function based on DGPS, radio tidal, draught and gyro compass information. This supports the presentation and control of the other functions and allows for the fully geographical 3D presentation of the dredger in a digital terrain model, including soil density in situ and spillage detection, obtained from in-surveys and updated by the actual dredging activities. Extension to Dredge Track Presentation (DTPS function) is available.
- Remote access and 'smart dredger' AI control function by satellite, see brochure on IHC Connect.



Typical DCS System Architecture

The typical DCS System Architecture incorporates four basic functional subsystems:

- Human-Machine Interface, basically consisting of a predefined number of UPS-powered PC SCADA touchscreen controls. The monitors present coloured process values and status indicators with the help of diagrams, symbols, bar graphs, imitated analogue indicators, numbers and words, defined in the *IHC Merwede SCADA library document*. The functions can be initiated and controlled on the screens. SCADA servers, viewers and touch screens are of the rugged and marinised type. Software includes licensed Windows and SCADA packages. SCADA communications are available in several degrees of redundancy. Automation functions run on IHC Digisys platform PCs, incorporated in the DCS communication structure. A separate AI computer advises the operator about the online optimisation of several settings, parameters and control algorithms.
- Signal Processing equipment, basically consisting of Programmable Logic Controllers (PLC) with decentralised I/O locations in steel cabinets. The number of processors, I/O numbers, galvanic isolation and locations, and the type and degree of redundancy of PLC communication is agreed upon at the outset of a project.
- Field equipment like sensors, transmitters, solenoids, electric motors, etc.
- Operator stations or control consoles, housing conventional control and presentation components. Cabinets housing PCs and other auxiliary equipment.

Other conventional control and indication components such as control levers, push buttons, switches or signal lamps are strictly limited to those considered necessary by the builder and those prescribed by the regulatory bodies. These conventional control components are hard-wired and/or connected to the automation, control and instrumentation system according to classification rules.

The high-quality properties of IHC Systems DCS have been implemented with the future in mind. Dredgers usually last for three or more times longer than automation systems. The 'laws' of Moore, Microsoft and Intel mean that computers have to be replaced every five years or so. When that happens, older programs will not usually run on newer machines or newer Windows platforms. So new PC hardware implies opting for modern software packages. This phenomenon accompanies the benefits of modern and comfortable control. Control equipment is going the way of cylinder linings - it needs to be replaced routinely according to a schedule. The quality of the current solutions from IHC Systems, however, considerably mitigates the future pain: marinised hardware for about ten years of life, experienced specialists, versatile control philosophies and display conventions, and the incorporation of new insights during retrofits keep 'old' dredgers in a modern state, ready for another decade of uninterrupted work, something which has been proven many times.



Human Machine Interface properties

The basic property of IHC Systems' HMI is that any presentation and control video page can be presented on any connected touch screen depending upon operator preference. This is achieved by simply selecting those pages on the touch screen itself. Pages are designed with the comfort of the user in mind, and combine the presentation and control of sub-systems accompanying the present operational stage. Information density is restricted to the information required to perform the current operation optimally. Data behind this basic information can be retrieved by fingertip in pop-ups.

The SCADA system also presents extended fault diagnosis tables and alarms on diagnostic screen pages, internally combining all relevant signals, and start and running conditions. This feature allows for rapid fault-finding and error correction, accelerating start-up, and enhancing remote problem-solving and vessel uptimes.

Example of screen pages for a TSHD

The degree of sophistication of a trailing suction hopper dredger determines the number of screen pages. They break down into the following functional clusters:

- pages for suction pipe(s), gantries, swell compensator(s) and draghead(s);
- pages for hopper loading, unloading and production, shore discharging and rainbowing;
- pages combining suction pipe, hopper loading/unloading and production functions;
- pages for dredge, jet, flushing and self-emptying valves;
- pages for upper doors and bottom doors;
- pages for hydraulic and electric power systems;
- pages for winches and other auxiliary systems;
- pages for the geographical orientation of the dredger, including bathymetric information;
- pages for data logging, calibration, setting, alarms, diagnosis and fault-finding.

Example of screen pages for a CSD

The dimensions and degree of sophistication determines the number of screen pages, which break down into the following functional clusters:

- pages for the geographical orientation of the dredger, including bathymetric information, dressed wire models of the vessel, anchor positions and status information;
- pages for the cutting process and related systems;
- pages for the swing winches, spuds, spud carrier and related main process systems;
- pages for full dredging process automation;
- pages for the pumping process and related systems;
- pages for gate valves, auxiliary winches and other auxiliaries;
- pages for hydraulic and electric power systems;
- pages for data logging, calibration, setting, alarms, diagnosis and fault finding.



Full overview of the process at a single glance



Relevant data for dredging with a CSD



Quick equipment status survey

Integration with other onboard systems

The design of IHC Systems' DCS allows for easy gearing-up to other vessel systems, like platform automation, navigation and conning systems, survey systems, diesel engine and ECR control, alarm and monitoring systems, power management systems, DP/DT systems and the like. Serial and NMEA links, industrial bus systems like PROFIBUS and MODBUS, Ethernet connections and I/O provisions for such gearing up are available to any imaginable extent.

Basically, there are five approaches and configurations - or mixes of them - for gearing:

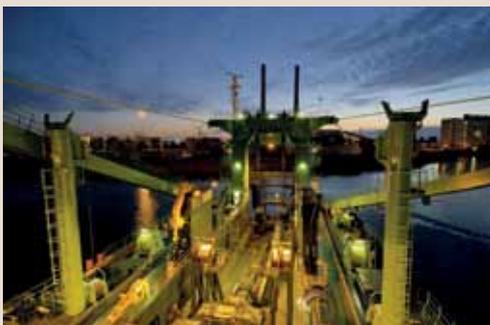
- exchange of information only to improve the functioning any of the geared-up systems;
- exchange of information only to improve DCS functioning;
- exchange of information and control algorithms in which the DCS is subordinated to the connected subsystems, e.g. platform automation and power management system;
- exchange of information and control algorithms in which the connected sub-systems are subordinated to the DCS, diesel engine control being one example;
- evolution of the DCS to take over functions of sub-systems and to develop into a totally integrated vessel control system, providing instrumentation, presentation, control and automation of the total ship and all her sub-systems. This results in more user interface

screens depending on the degree of sophistication of the vessel.

Examples of these screens include:

- pages for diesel engine monitoring and control, the fuel oil and cooling systems;
- pages for the CPP installation, propeller shaft sealings and bow thruster systems;
- pages for auxiliary machinery systems;
- pages for the main switchboards and power management systems;
- pages for the navigation, conning and DP/DT/trail speed control systems;
- combination pages for the functions listed above;
- pages for the tank sounding systems;
- additional pages for data logging, calibration, setting, alarms, diagnosis and fault finding.

Of course, with integration of this kind - which has been performed in practice - the DCS is extended to include the necessary HMI and signal processing equipment, transmitters and sensors, and control consoles and operator stations respectively. The benefit of this solution is that all connected on-board systems benefit from IHC Systems DCS's advanced diagnosis, data logging and fault finding facilities. Another benefit is the limitation of spare-part stocks and the exchangeability of system components throughout the ship.



Benefits for vessel operation, and sustainable and efficient dredging