Renewing the dredging controls of US hopper dredger ESSAYONS

In the United States of America, the US Army's Corps of Engineers (ACE) is responsible for maintaining ports and waterways. As such, the ACE has a vast experience in keeping US waters navigable and safe, and has significantly contributed to progress in dredging technology.

In recent decades, the Corps' role has been evolving from full responsibility for all hopper dredging work to acting as contracting officer for dredging work. Their fleet of 16 hopper dredgers in 1976, when Congress decided to partially privatise hopper dredging, has been reduced to four in 2003. Yet, also in 1976, the ACE got permission to build three new hopper dredgers: one Shallow Class Hopper dredge (YAQUINA), the Large Class Hopper (or Lower Mississippi Valley) Dredge (WHEELER) and the Medium Class Hopper Dredge (MCHD). Only one of the four planned MCHD's was ultimately built. Its name was derived from the Corps' motto: **ESSAYONS, let us try!**
The Corps' Washington Headquarters ordered at that time the Marine Design Center of the Corps of Engineers to quickly formulate specifications for state-of-the-art dredgers, which would have to be capable of carrying out all types of projects all over the world. The larger dredgers were designed for dredging at depths of 20m and 29m, fitted with suction-tube mounted pumps to port and starboard, and with inboard dredge pumps as back-up and for shore discharge. The specifications included requirements for the latest dredging instruments, controls and automation systems for handling the two suction tubes, submersible and inboard dredge pumps, four adjustable overflows, gate valves for eight different dredging modes, jetting, pump-out equipment and related auxiliary equipment.

IHC Controls (nowadays IHC Systems), through the Dredge Technology Corporation (DTC), IHC Holland's US office, delivered in the early 1980's the dredge instrumentation, controls and automation in addition to the dredging equipment for the Corps' three new hopper dredgers.

In the past twenty years these three dredgers, belonging to the first ten in the world with such a high level of dredge automation, have carried out a wide range of tasks. At the time of issuing the contracts for construction, the Corps realised that these specifications, designed for navigation officers simultaneously acting as dredger men, were far ahead of contemporary dredgers. The officers had already been trained in modern electronics, which was indispensable for their dual role. The operation proved to have truly pushed technology forward in all fields: control philosophy, instrumentation and computer technology.

Yet, at the same time the Corps management saw its active dredging role reduced. Two hopper dredgers are now assigned a reserve status, but Congress allowed the ESSAYONS to operate for 185 days per year. This 6,000 cubic yard (4.600m^3) dredger, delivered in 1983 and nowadays managed by the Portland District of the Corps, mainly serves ports on the US West Coast. At times, she carries out jobs in Pearl Harbour and Alaska, and in the spring regularly assists in the lower Mississippi. As usual in the dredging industry, the ESSAYONS has in the past decades been adapted for specific tasks. This involved hardware and control philosophies but unfortunately not the automation system, which was then still based on microprocessors with burned EPROMS. Their numerical code systems were considered state-of-the-art at the time of purchase, but their microprocessor manufacturer ceased supporting the systems already in 1987. This saddled the Corps with control systems that rapidly reached vintage status with the fast pace of the computer

Hopper dredger ESSAYONS

Old installation, dated 1981

revolution. The dredgers automatic control systems were rigid and lacked any flexibility to be adjusted for any hardware modifications which commonly occur during the life of a vessel. Still, the ship was designed and built to last at least another 20 years, and has been excellently maintained throughout its life. It was obvious a comprehensive modernisation of the vessel's nervous system would certainly pay off.

In the new millennium, the Portland District received permission and funds to modernise its dredger's controls. The District and the USACE Philadelphia Marine Design Center conducted a worldwide technical and commercial scan for the most suitable replacement of ESSAYONS' dredging process controls.

A specification was issued to a number of competitors qualified for such a complicated job. After competitive bidding the project was awarded to the Cascade General, Inc. shipyard in Portland Oregon, with DTC/ IHC Systems as subcontractor for replacing with a modern fully integrated bridge the equipment it had delivered two decades earlier. The critical factors that landed IHC Systems with the job were its proven record and its renowned qualities of standard design and long-term support regarding training, maintenance and repair.

In carrying out the project, the team had to work around the operational requirements: the client needed the dredgers for its full allotment of assigned dredging days during the dredging season. That put planning, logistics and maintenance schedules in a tight framework where the nine hours' time difference between client and shipyard in Oregon, and IHC Systems in the Netherlands was another factor to work with. One of the many subjects in which close communication with the client was needed, was the need to figure out exactly what had been modified and adapted in the equipment IHC had delivered 20 years ago, what the original function was and the Corps' modified requirements, which were not always documented. Yet, despite these hurdles, last year, the major part of the dredge control system was successfully replaced with equipment of the latest technology offered in the market.

The client had stipulated congruity of the vessel's new automation system with the original USACE-designed operational features, but of course it had to be made significantly more efficient with a dedicated dredging programme.

New art of operations

With the Corps staff, especially the experienced crew of the dredger, the functional specification was critically evaluated and, in mutual cooperation, further developed into a truly state-of-the-art control system. The crew managed to step within a year from the handles, pushbuttons and needle indicators they were used to operate, to keyboards and monitors.
A shop demonstration and test was included in the handing-over process, to present the final results of the integrated system.
A helpful change from 20 years ago: even during the test, the system could still be modified with the client's feedback.
Unknown in the 1980's were of course the new automation system's diagnostic pages, improving the maintenance and repair management of the dredge control system. This modern control software, developed over the last 14 years, has had time to mature in a range of new hopper dredgers, built by IHC and others.
Another novelty, SCADA (Supervisory Control And Data Acquisition), offers remarkable progress in dredge-client transparency. Its logging capacity saves all relevant dredging process data and these can be read from a shore based computer. The Corps of Engineers uses this remote SCADA control system to verify compliance with contractual requirements of its hopper dredgers.
It is dubbed the "Silent Inspector", a term introduced by Portland's North Pacific Division, when it evaluated the potentials of the ESSAYONS' automation 20 years ago. SCADA is a world apart from the old, paper-fed, multi-channel recorder as a tool in dredging process management.

Jurassic automation of the 1980's

The basic setup of the old system was to collect all inputs, including those from sensors, pushbuttons and handles, as well as return signals and status signalling, to the bridge consoles for processing by a combination of logical printed circuit boards and multiple Motorola 6800 and Texas instruments TI990 micro processors (pre-PC-age technology). From there, commands were relayed to relay boxes in the fore ship, with relays controlling the directional valves on two

central hydraulic skids serving port and starboard side.
All this, directly wired, needed so much cabling that the naval yard, building the ESSAYONS 20 years ago, qualified cable density to exceed that of a modern aircraft carrier.

New system description

In the functioning of the new Dredge Control Monitoring System (DCMS) three levels can be recognised: first the man-machine operation and monitoring by PC; secondly server intelligence for the automation by PC; and finally PLC (Programmable Logic Controller) for carrying out hydraulic commands and other interfacing to the outside environment.

The system allows on-the-spot modifications, based on the crew's experience with the ship and the adaptations for specific jobs the dredger will carry out. This new technology, with its serial signal transmission and high-redundancy networks between the bridge and hydraulic units in the forward part of the ship, sharply reduced cabling demand and cable costs.
The DCMS Automation System are in fact two separate systems, seamlessly connected and act as one DCMS consisting of:

* SCADA system
* PLC system.

The SCADA system works as a supervisory control and Man-Machine Interface with the SCADA workstations. The servers are connected to the PLC system via Ethernet, suitable for bi-directional data acquisition.

The PLC system operates as a direct control system where all the process control functions take place. All the field equipment and instrumentation of the vessel are connected to the remote I/O (input/output) racks of the PLC.

Scope and size

To give an idea of the project's extent, the major components that were replaced as hardware, or, if possible, software function include:

- control desks and PLC interface to the hydraulics
- automatic suction-tube handling and monitoring
- automatic draghead winch controller
- production measurement calculators
- draught and loading monitoring
- oil-insulating system control for overside dredge pump
- valve setup for the dredging valves and jet water valves
- self-emptying, pump-out and dumping system
- the logged experience of the old system.

Compared to building a new ship, replacing the old, rather rigid, control system with a much more flexible system was considered an interesting experience for the engineers involved.

Renovation, involving removal of old equipment and replacing it with dramatically different hardware, inevitably springs surprises. Within the tight framework allotted, this required lots of perseverance and original thinking on the part of the team.
The project could become a success by having all team players working to one goal, including a cooperative and flexible shipyard, with a thoroughly professional view on keeping tight schedules.

The IHC personnel, together with the yard and Corps personnel, tackled the re-fit job within the schedule and budget agreed, and proved again that such jobs can be done when working closely together at different sites in the world.

Risk and reward

The modernisation of the dredging controls on ESSAYONS was a challenging project, which forced the joint team to constantly bear in mind what exactly the size and scope of the project was supposed to be. The ship now has a new state-of-the-art flexible dredge-control installation to serve her for a long time. The modern instrumentation, automation and presentation of information, and the SCADA data logging, have parachuted the ESSAYONS in line with the modern efficient dredgers again, with a transparent system few will have believed to be possible a few years ago with the pre-PC and -Ethernet system still on the bridge.
The ESSAYONS has leapt 20 years forward and is once more living up to her name. Vintage dredgers can get a highly economic new lease of life with up-to-date instrumentation and automation, ***if you only try.***

Dredge operators' new controls