Ports and Dredging

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IHC Holland Merwede is expanding

In the dredging industry, there is a tendency towards larger and wider ships. To meet this demand – and also because the slipway capacity at the IHC’s shipyards is being used to the full – IHC Holland Merwede opened a fourth shipyard in 2006 at Krimpen aan den IJssel. In 2007, two further shipyards were added, at Hendrik-Ido-Ambacht and Heusden.

**Shipyard Krimpen aan den IJssel**
On the slipway, ships with a length of up to 240m and a beam of 38m can be built. The outfitting quay offers sufficient length for completing vessels launched from the slipway. The location has direct access to the open sea.

**Shipyard Heusden**
On slipway West vessels up to approximately 35.5m wide and 185m long can be built. On slipway East vessels can be built up to 25.5m wide and 185m of length. Both slipways can be lengthened by 20m, respectively 10m.

**Shipyard Hendrik Ido Ambacht**
The slipway (90m x 25.3m) will possibly be used again. On the grounds of the yard a cutting hall, a preparing hall, a section hall and an office annex are located. The outfitting quay is 110m long.
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Cover: one-man operated bridge of the REYNAERT
Introduction
Dredging is an industry that is constantly transforming. It has changed significantly over the last decade. Traditional dredging activities like construction and maintaining ports and harbors, desilting of drainage and irrigation channels, keeping reservoirs at depths and removing sediments from waterways still are important. Yet these activities are now surpassed by other applications of dredging technology. Reclamation is an important example in this respect, but other applications, such as infrastructural work for offshore winning of oil & gas, environmental clean-up, mining of valuable minerals and aggregates from inland and offshore deposits deserve mentioning here as well.

All of these dredging applications require specific equipment and with changing circumstances and constraints, the design and use have undergone tremendous changes also. Just think of the enormous scale-up of equipment and tools, but also operations under more difficult circumstances, higher selectivity and efficiency demands and innovative design and construction methods. All of this would not be possible without a better understanding of the dredging processes involved, which goes hand in hand with more focused research on dredging fundamentals.

What will be the future for dredging? Will we witness a continuation of the past decade’s developments in dredging application and equipment technology? As world market leader in design and supply of dredging equipment IHC has been and will be at the forefront of innovations in this respect and it is our aim to play a proactive role. Where will the dredging industry go? This depends on developments in the world around us. As always it is difficult to predict the future, but in this article we will try and outline what IHC expects will happen over the next decade. Based on developments in dredging applications of the past decade, expected trends for future use will be highlighted and the required dredging technology development to enable such use will be summarized.

Changing conditions and new trends
We can define several important business drivers that already have changed dredging requirements. Many of these drivers, however, are expected to continue to play a role in time to come and will certainly influence future developments in dredging application, thus influencing the required dredging technology as well.

On the other hand the availability of innovative technology allows for other types of dredging applications. In other words, market pull versus technology push. Both are important trends, but their true significance depends on the world around us. Migration towards coastal zones and population growth leads to a demand for new land. Land reclamation is one of the main areas of interest to the dredging industry. Another important trend is globalisation. Given the continuous economic growth this has resulted in an unparalleled requirement for sea transportation of goods that require new port and harbour facilities as well as waterways (fig. 1).

Expected climate change requires more coastal protection and measures to be taken along rivers and waterways. Economic growth also leads to increased recreational requirements. Developments in Dubai form a striking example in this respect. An increase in energy consumption requires more exploration and exploitation activities in offshore environments at increasing depths. The same is true for a continuous growth in commodity demands like minerals and aggregates. Another major trend that can be identified is the necessity for a reduced impact on our ecology. Together with economic growth, this goes hand in hand with the development of sustainable dredging technology.

Dredging projects and costs
Another important trend seen over the past decade is the reduction of dredging costs. For hoppers, the cost price per cubic meter of dredged material was nearly halved in the period between 1980 and 2000 (fig. 3, page 6).

Evidently, using new technology will not always result in lower initial investment costs for modern dredging equipment. Nevertheless, the investment part in the total price per cubic meter of dredged
material will be more than compensated for by a reduction of other cost components and improved operational efficiency. In the end this will result in lower life cycle costs.  

There is a growing tendency towards an integrated project approach. Combining several objectives into one dredging project reduces overall costs as well. Examples of this include combining deepening entrance channels and the use of the dredged material for reclamation work at the same time, or combining coastal zone defence with improving beach quality for recreational use or adding new land.

Reduction of dredging costs has also enabled other types of dredging projects as the financial dynamics changed. New land can be sold at interesting profits. This allowed the large reclamation projects in the Far East and Middle East, to name one example.

**Hoppers – scale up effects**

On many locations throughout the world, expansion of coastal areas by land reclamation projects is desired. Although this has been a dredging activity for a long time, the scale-up we see today is new. Hongkong, Singapore and Dubai are some examples of extensive land reclamation projects of recent times. All over the world, many millions of cubic meters of sand have to be dredged, transported and dumped to create new land.

Trailing suction hopper dredgers play an important role in these projects. Hoppers are used in different sizes. Project constraints determine the most feasible size. Environmental, geological and political considerations may result in long sailing distances and the need for dredging in deeper waters. These constraints call for large Trailing Suction Hopper Dredgers (TSHD’s) with high dredging capacity and efficiency (fig. 2).

Today, a number of large TSHD’s allows for deep dredging to depths around 130m for trenching or the creation of so called glory holes for the protection of oil and gas winning structures at the ocean floor.
Reaching to these depths requires long suction pipe lengths. Handling large moving constructions such as these is only possible with a proper design of the installation as a whole. Scale-up also demands larger capacities to fit within an efficient economy of scale. Therefore depth generally goes hand in hand with larger pipe line diameters. To reach this depth and maintain sufficient inlet pressure for the dredge pump, high efficiency submerged pumps have been fitted with pipe diameters up to 1,400mm. These submerged dredging pumps require high-powered drive systems up to 6,500kW. Scale-up effects also present an enormous challenge with respect to engineering ingenuity and have led to integrated design methodology.

**Hoppers – cost effective designs**

In addition to the economy of scale that it offers, innovative technology has allowed the use of more cost effective designs. As an example, this can be shown by the capacity change of 85m sized vessels. Within a period of 12 years the dead weight of these vessels has nearly doubled, leading to increased loading capacities resulting in a more cost effective use of these dredgers.

Another example of cost effective design are the improved hull designs that can reduce sailing resistance to a significant extent. The design of the bow is of special importance. On many large ships, a so called “bulb” (i.e. artificial nose) is mounted onto the hull at the waterline. The bulb changes the flow around the hull in such a way that the resistance is reduced because of the reduction of induced waves (fig. 4).

An optimized hull design will result in significant power savings. This effect is
not only established by using a bulb stem. The experience with the design of ship hulls in terms of CFD calculations resulted in a special shape of the stern of vessels as well. The stern is designed for an ideal approach of the flow to the propellers resulting in less vibration and a higher efficiency of the propellers.

**Hoppers – operational constraints**

Operational constraints and soil conditions have also changed over the past years. A challenge for hopper application is dredging extreme fine hard packed soils. Modern conventional dragheads are equipped with jet water supply and cutting knives or cutting teeth in a movable visor. This proves to be sufficient for normal soils. In very fine compacted sands the penetration of the knives or teeth can be insufficient, even with the conventional supply of jet water. This results in low production.

Studies and model investigations have led to the development of the so called IHC Wild Dragon® draghead (fig. 5). In this design jet water is added through the teeth, with an optimized balance between volume and pressure. Studies have shown interesting results that were proven by full size tests in the entrance channel of Shanghai.

An additional advantage is a further reduction of the specific dredging energy. The Wild Dragon® drag head allows for TSHD operation in material conditions that before were only possible with cutter suction dredgers. Especially when dredging in busy ports and entrance channels, the maneuverability and operational flexibility of hopper dredgers is an advantage as compared to stationary dredgers.

**Hoppers - automation and control.**

Operating the hopper accurately at a set position or track is often a necessity, particularly when trenching, dumping or pumping ashore. It is not just that the dredging efficiency of a TSHD can be improved: in some cases a Dynamic Positioning and Dynamic Tracking (DP/DT) System is even a requirement to pre-qualify the dredging equipment for an offshore or ports maintenance dredging job.

Integrated control systems monitor many parameters during the dredging process, using advanced measurement and automation systems. Automatic control of the different process parameters results in an optimized performance, while reducing fuel consumption and wear.

Data presentation and control of all functions within an optimum, operator-friendly working environment are important objectives. The final improvement is the use of the one-man operated bridge. This is an answer to decreasing numbers of dredging people, one that is only possible, however, with modern automation and control devices.

**Cutter suction dredgers – development trends**

As with the hopper dredgers we also saw a demand for a new generation of cutter suction dredgers. This especially applies for the larger sizes, the so called jumbo cutter suction dredgers. Most of the cutter dredgers, however, are smaller and have a total installed power that is lower than 1,000kW.

For both dredger sizes different technology development trends can be defined. For the smaller units there will be a focus on lower initial investment costs and a reduction of the payback period. As for the larger cutter dredgers one must focus on operational use and efficiency, as well as reducing total costs during the life cycle.
Heavy duty cutters operating in swell
Construction and extension of ports like that of Qatar require hard digging capabilities. The same is true for a lot of offshore oil and gas applications. Heavy duty cutter suction dredgers like the JFJ DE NUL and the D’ARTAGNAN are able to exert large cutting forces. Often operations have to be performed in swell (fig. 6a/6b).

Earlier designs of larger cutter suction dredgers used sturdy spud constructions to allow for high cutting forces under these conditions. Installing higher cutting forces made it difficult to come up with strong enough designs for the spud systems. This led to the design and use of flexible spud installations that allow high cutting forces in sea conditions with a swell of up to 1.5 – 2m.

Large cutter dredgers – automation and control
As with the hopper dredgers, automation and control of cutter dredgers have changed over the years as well. Especially for large cutter suction dredgers similar technology is used to optimize the operational efficiency in order to lower operational costs (fig. 7).

Smaller cutters – standard concepts
For smaller cutter suction dredgers standardization is of the essence to keep initial investments low. IHC developed two standard Beaver cutter suction dredger ranges. The classic or conventional range with inboard pumps is still available as it allows long-distance pumping thanks to the directly driven inboard pump.

The new generation Beaver cutter suction dredgers use a submerged pump that allows for a higher operational efficiency. This way a selection of lower cost standard designs can be made, based on project requirements.

Another example of innovative use of standard concepts is applying the same design to different dredging depths. The IHC 6516 Beaver type has a standard dredging depth of 16m. Within the design configuration, dredging depth can be changed to different depth executions and it can go as deep as 25m. Application of a submerged pump allows for this. Thus a client can select a dredge that operates at similar capacity ranges, but with different dredging depths. The standard design configuration keeps investment costs low.

Cutter dredgers – operational efficiency
For cutter suction dredgers, improving operational efficiency is possible by enhancing dredging tools, components and systems. For both larger and smaller cutter suction dredgers, the use of wear-resistant material is important. Different types of wear-resistant applications have been developed, ranging from liner material for pipelines to harder wear resistant materials for
pumps. Cutter heads for different soils have been developed, as well as high efficient drive systems for cutter heads and submerged pumps.

**Future thoughts**
All the examples outlined above are developments of the past decade. The trends that inspired this enormous leap forward are actually ongoing and we expect this to continue for quite some time. Within our global economy, IHC's supply chain policy will evidently be affected as well. Components are already being manufactured under IHC quality label in other parts of the world and we intend to proceed this outsourcing at an even larger scale. Naturally, this requires proper protection of our Intellectual Property Rights and it also requires a change of working relations.

As mentioned before, sustainability is an important phenomenon these days and environmental impact receives a lot of attention before a dredging project is approved of. We will contribute to sustainability and take our share in the development of fundamental knowledge on dredging effects to the environment. Based on this knowledge, however, we will also take our responsibility by doing further research and through the development of sustainable dredging technology.

**Future challenge for life cycle support**
Over the past few years, the reduction of life cycle costs received growing attention in the dredging industry. Other industries are far ahead, but gradually this issue gets more attention in the dredging industry. IHC took up this challenge and is currently paying a lot of attention to the development of life cycle support services. In the vicinity of our clients' main project sites we established IHC service centers, which allow us to respond fast to questions from the field. These centers allow us to stock inventories for faster delivery, local repair and maintenance assistance according to the IHC quality standards. Depending on global demand, IHC will further invest in service centers.

Life cycle support activities also comprise maintenance engineering, monitoring and advice on mitigating actions. Predictive software development for life cycle costs and wear processes further enhance our support to the dredging world.

Crew and staff competence is crucial to the proper deployment of the operational capabilities of modern dredging technology. Training services to enhance competence is regarded as an important life cycle support service. IHC's own Training Institute for Dredging (TID) provides this service the world over and we intend to expand this significantly. Investments in training methods and training aids like simulators are on hand.

**IHC's future as market leader for the supply of dredging equipment**
Following an outsourcing strategy alone is not enough to maintain a position as world-wide market leader for the supply of dredging equipment. We believe that maintaining our position with designing and construction facilities in The Netherlands is of great importance. A positive sign in this respect was the recent opening of new IHC construction yards in the Netherlands, adding over 50% to our building capacity. Within a globalizing economy, however, keeping up operations in the Netherlands is only possible with innovations in production processes. Important considerations in this respect are integrated design procedures, improved construction methods and a focus on chain integration. We will seek to combine activities with our suppliers to optimize our way of working and to reduce risks.

Our continuous strive for improved operational efficiency to reduce costs per cubic meter of dredged soil calls for more than the development of innovative technology. In some cases the developments of the past decades brought us near the maximum physical dredging process possibilities. This requires more fundamental R&D efforts and may even lead to entirely different ways of dredging. IHC's intention in this respect can be proven by the fact that research and development is one of our main focus areas as defined in IHC's company strategy for the coming years (fig. 8).
A major dredging project
130 million cubic meters to be moved for a deepened and widened Panama canal that can pass larger vessels

25 October 2006, in a referendum, the Panamanian population approved of its government’s proposal to spend 5.25 billion US Dollars on expanding the canal.

This 80km long canal is regarded as one of the world’s main engineering achievements and its creation really speaks to the imagination.

Around 1880, at the age of 74, Ferdinand de Lesseps, the architect of the Suez Canal, started his attempt at his second canal. This attempt for a sea level canal failed, fell in the hands of promoters and speculators, and ten years later the French company filed for bankruptcy. Thousands of people had perished during the effort due to diseases such as malaria and yellow fever.

After this, the U.S. supported a revolution in Panama against Columbia, who owned the territory and did not want a US canal. In 1903 Panama became an independent nation. In 1904 the Hay-Bunau Varilla Treaty allowed the U.S. to build a canal and provided the U.S. with perpetual control of a zone of five (5) miles on either side of the canal.

The U.S. Army Corps of Engineers led the construction effort. One no longer pursued a canal at sea level, but a raised passage especially through the mountains, using locks. The Chagres river flowed from the mountains into the Atlantic Ocean. A dam was placed in the river and the flooding of the area created a large artificial lake, i.e. Gatun lake. During nine months of the year heavy rainfall on the narrow Isthmus of Panama between the Pacific and Atlantic Oceans, the lake collects enough water, i.e. draining off allows for the locks on both sides of the Canal to operate on that principle. In a historic effort of cutting the canal through the mountains, thus creating the Gaillard (or Culebra) cut, many millions cubic meters of rock were dynamited and removed in a major logistics operation. The Canal was completed and in 1914 the first vessel passed through it. Since then the canal has been maintained, widened and repaired due to landslides.

In 1977 US President Jimmy Carter and President Omar Torrijos of Panama signed a Treaty agreeing that the US would transfer the Canal to the Panamanians by 31 December 1999. Both countries are to protect the interests in the canal.

Since this transfer, the Panamanians have worked hard to upgrade the Canal. Tolls were raised to finance plans. The canal is being straightened for safety reasons as well. Scheduling efforts since 2000 resulted in an increase of 20% in the passing capacity of the Canal.

The locks, however, remained unchanged. They were built in 1913 and had a size of 1,000ft long and 110 feet wide (304.8 x 33.5m). They include the Miraflores and Pedro Miguel locks on the Pacific side and the Gatun locks on the Atlantic site, and to date they still never fail to impress visitors.

The width of the locks, 110ft (33.5m) became a shipbuilding dimension. Ships built to that width comply with the 100ft width permitted are classed as “Panamax” vessels. A Panamax container ship can carry about 4,000 TEUs (20’ containers). World trade, however, created a need for larger vessels. Today an increasing number of vessels that exceed Panamax dimensions are being built and the market research of the Panama Canal Authority has shown that Post Panamax vessels that do not fit their locks were taking other routes around the globe.

<table>
<thead>
<tr>
<th>In million m³</th>
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<tbody>
<tr>
<td>Capital Dredging</td>
<td></td>
</tr>
<tr>
<td>French Construction 1881-1903</td>
<td>59.7</td>
</tr>
<tr>
<td>US construction 1904-1914</td>
<td>177.4</td>
</tr>
<tr>
<td>Improvement Dredging 1930-2002</td>
<td>92.1</td>
</tr>
<tr>
<td>Maintenance Dredging</td>
<td></td>
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<tr>
<td>1915-1978</td>
<td>461.7</td>
</tr>
<tr>
<td>1979-present</td>
<td>20.8</td>
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<tr>
<td>Emergency Corrective Dredging</td>
<td></td>
</tr>
<tr>
<td>Landslides 1904-present</td>
<td>61.7</td>
</tr>
<tr>
<td>Total volume moved</td>
<td><strong>873.4 +</strong></td>
</tr>
</tbody>
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*ACP: WEDA conference 2006

CSD JFJ DE NUL sailing through the Panama Canal
To secure the leading position of the Canal and to maintain this waterway as a route of choice the Panama Canal Authority developed a plan to widen and deepen the canal and create new, wider locks. Such locks would consume so much water that they could no longer solely be fed by rainwater from the Gatun Lake. A new system using water saving basins was designed for the 180ft wide and 1,400 feet long locks (55 x 427m) preserving the locks drain water. These locks will be able to pass post Panamax vessels carrying 8,000 TEUs.
Canals for the new locks will be dug, parallel to the existing locks, which also are intended to continue to serve the water traffic. The lake’s level will be raised and widening and deepening of the Canal will involve the Gatun lake, the Culebra or Gaillard cut through the mountains, as well as both Ocean entrances of the Canal outside the locks. For the new locks, the entrances and the canal itself 133 million cubic meters of material are planned to be removed. Once completed, more than one billion cubic meters will have been moved for this Canal!

The Master Plan of the Panama Canal Authority shows more detailed plans for its excavation efforts. It is estimated that about 50 million cubic meters of the 133 million cubic meters to be moved will be dredged. Hopper dredgers are planned to remove about 7 million cubic meters of silt and rock; cutter dredgers almost 33 million cubic meters of gravel, clay through hard rock, while 10 million cubic meters of drilled and blasted material will be loaded by dipper and backhoe dredgers into barges.

Deepening of the entrance channels outside the locks has already started. Over the last year the TSHD BARENT ZANEN (Royal Boskalis Westminster) has been working on the Pacific side and on the Atlantic side the heavy duty cutter suction dredger J.F.J. DE NUL has been active. Both dredgers were built by IHC.

Inside the locks, in the canal the Panama Canal Authority is doing the dredging itself and it presently operates its dipper CHRISTENSEN, the cutter suction dredge MINDI and drill barges THOR and BARU for drilling and blasting rock mainly in the Gaillard cut, supported by barges and tugs for the transport of the excavated material. The ACP is seeking to improve this capability.

The 3.2 million Panamanians have approved of the expenditure for the Canal, but the Canal will not just be expanded, a new port on the Pacific side is to be created as well, as Panama’s free trade zone is booming. Panama City continues to grow at a rapid pace. Panama is on its way to becoming a bustling center of trade for Central and South America.

The Panama Canal Authority’s Master plan is aiming for the widened Canal to be completed by 2014, as this is the year in which the Canal will celebrate its 100th Anniversary.
Navigational channel and locks excavation volumes
In million cubic meters (MCM)

1. Deepening and widening of the Atlantic entrance channel = 7MCM
2. New approach channel for the Atlantic Post-Panamax locks = 9MCM
3. Atlantic Post-Panamax locks with 3 water saving basins per lock chamber = 18MCM
4. Raise the maximum Gatun lake operating water level = 16MCM
5. Widening and deepening of the navigational channel of the Gatun lake and the Culebra cut = 5.5MCM
6. New approach channel for the Pacific Post-Panamax locks = 53MCM
7. Pacific Post-Panamax locks with 3 water saving basins per lock chamber = 14MCM
8. Deepening and widening of the Pacific entrance channel = 6MCM

Total excavation = 128.5MCM
(original 1914 construction = 205MCM)
One man-operated bridge
How dedication succeeded in starting a new era in dredging

A fascinating history
For long years Mr. Etienne Clymans, Manager Newbuilding Department of DEME, had observed that safety, reliability and efficiency of dredging ships was seriously harmed and put under stress by the (relatively) large number of crew involved in operations, carrying inherently the risks of misunderstood commands, wrongly executed actions, colliding operations and a lot of things more. Suddenly there it was, this new insight: trailing suction hopper dredgers should be operated by only one person, who co-ordinates all ship’s movements and operations without confusion in a natural way! Naturally, all of this is directed by one single human mind. He realized that this idea could only succeed when a lot of communication was brought up.

In his own words: ‘This is a case of one percent of technology and ninety-nine percent of communication.’

So, serious communication started at DEME’s. The Safety Department was to assure that only one person could simultaneously navigate and dredge in busy ports. Classification Societies were approached on certifying. Management and crews were to be brought over natural human fears on a seemingly abundance of tasks and responsibilities. People must be reconciled with the prospect that diminishing crews in the short term would generate more jobs in the long term. Fortunately, there was a broad consenses for the one man-operated bridge. At that time, nobody knew exactly how this concept could be implemented.

It is there were IHC enters the story. The remnant one percent of technology became their ‘one percent of inspiration and ninety-nine percent of transpiration’. It was the intention to introduce the innovation on two dredgers to be built as identical daughters of eminent PALLIETER, commissioned 2004, MARIEKE and REYNAERT – names inspired by renown Belgian author Felix Timmermans’ roman Pallieter of 1916.

First of all trust was at stake. DEME had to order ‘copy’ ships with a large technological blank spot, to fill in during building. IHC had to have enough self-confidence that they really could colour this spot. And all that within normal budget and construction time of ‘copy’ ships, and without any flaw, as
even the slightest bug should ruin the ‘public’ opinion on the case and set back the idea for decades – a well known phenomenon around innovations. Well, IHC Dredgers and DEME ventured to enter the risky thing and signed the building contract, based on these fine human values: trust and dedication. And they won – as the trace of this story will prove.

Filling in the blank
Naturally, there were some broad outlines of the one man-operated bridge from the beginning. First of all: the operator should concentrate on navigation, as vessel- and environment-safety could never be subject of any discussion. Then the crucial element was introduced: Normally the navigating officer onboard of trailing dredgers is responsible for geographic position and load of the vessel. He (or possibly she) then determines start and end of dredging operations as well as related manoeuvring. During manoeuvring the navigating officer utters some verbal commands to the dredging operator, for example: ‘pipe overboard’, ‘pipe before inlet’, or ‘pipe on ground’. The dredge operator is then assumed to follow these commands appropriately ... in the way they were understood and interpreted. The very innovation was now to shelter these ‘commands’ in very sophisticated so-called ‘macro keys’. And instead of giving a verbal command, the navigating officer should only touch these macro keys. The ship and her installation should then adapt presentation and perform these ‘commands’ automatically as if she herself was an infallible dredge operator. This was the starting point of technical design.

Now a new ‘officer’ enters the ‘bridge’. Mr. Marc Fransen, experienced merchant captain, navigating officer and dredge operator was to define precisely how ‘the ship’ should react so perfectly on macro-key commands. Meticulous discussions with DEME’s crew exposed the proverbial difference between theory and practice: Dredgers of DEME have been equipped with modern IHC-made presentation and automation systems. However, it proved out that in some cases the crew did not use them, sometimes for personal reasons, sometimes due to confusing behaviour of automation or malfunctioning sensors. On a more hidden level, some vigilant myths even circulated, for example: ‘do never block the swell compensator; at release it will rocket to the moon’. These facts – only suspected, not known, by the technical staff of builder and contractor – were lifted to the surface.
As it was a *conditio sine qua non* that the one man-operated bridge should work flawlessly at the first sea trials, the input of the crew was validated into improvements on automation systems, establishing links between automation systems, enhancing crucial sensors and diagnostic analysis of errors. An important innovation was installed on the swell compensator installation.

**Automation people @ work**
At the end of this stage, there was a clear impression of how the ship should react on macro keys, and what it would require from automation and presentation. Generally spoken: the operator only should concentrate on navigation, and dredging was to be an issue of reflexive and intuitive actions. Nevertheless it should be performed perfectly. Now IHC Systems comes in. Naturally they had assisted and backed in colouring the white spot, but from now they are the main players for a certain time. They firstly developed a brand new integrated dredging and navigation console. Seated in front of it, the operator has all apparatus for both...
functions within natural range of view and easy reach, ergonomically situated and ready for reflexive and intuitive action.

Main features of the console are:

- Application of large, 20" video presentation screens for Radar, ECDIS, Dredge Track Presentation System, Yield Indicator, Suction Tube Position Monitor, Draught and Loading Monitor and so on. An interesting new feature is, that some of these systems can be combined or can produce overlays of each other on the screen of another one, so condensing information into formats with which the human mind can cope more easily.

- Inclusion of a technology for allocation of any presentation page at any desired location of the console. Naturally, the functional keyboard and tracker ball adjacent to that presentation are switched also. The operator can find them intuitively under their 'own' monitor.

- As working with functional keys and tracker balls is not always the thing to act quickly in operational situations, dedicated pushbuttons were added, with which presentation can be re-allocated with only one touch, within split seconds.

- Very helpful: one of the video screens can function as a CCTV for a large back view of the vessel, starting from the bridge location - call it a sophisticated rear view mirror.

- The macro-keys were given a prominent place in front of the operator. You will read more about them.

- Last but not least: As the whole vessel can be operated by using keyboards, tracker balls and presentation screens, a first try was done to strip the control console of any component that could indeed be missed without danger.

Employees of more than one IHC business unit developed the idea of the macro keys into a workable ‘thing’. Standard pushbuttons were altered until they had to do nearly nothing with a common pushbutton yet! And they may no longer be named ‘pushbuttons’ according to DEME. An illuminated ring appears around the button itself, obtained by integration of a redundant dimmable sophisticated LED ring in the top cover of the console. This outer ring then lights up when it has sense to touch the adjacent key. The decision whether such operation has any sense is made by a diagnostic program which continuously scans all related signals and operational conditions, and processes them by dense logics. When a macro key-initiated action is underway, an inner light blinks, shifting into continuous illumination when the action is ready. And there is more yet! The macro-keys very helpfully produce approving or disapproving sounds, so
assisting that other operator’s sense, the ears.

A Radio Control panel, normally used for assistance at hopper self-emptying operations, was further developed into a miniature ‘spare dredge console’ for the cases that bad weather, busy traffic or any circumstance would require the deployment of a second hand. Such a person is always ready on board for calling up. This miniature dredge console gave the intended crew an enormous feeling of back-up safety and reassurance, and largely helped them to overcome fears about over-responsibility and overburden.

So strong is this feeling that in dredging practice they seldom use this apparatus.

Now some features, more common to IHC crew, as they are one of the pillars under their leading position in dredging shipbuilding, are worth mentioning:

- The system rests on a solid control concept which applies decentralized PLC’s. These PLC’s communicate over redundant connections. Hierarchically situated ‘above’ the PLC network a redundant Human Machine Interface System ends in rugged PC’s, running under Windows and SCADA software.
- Some properties of automation, irritating DEME’s crew, were stripped ruthlessly. Then automation systems were further developed in the new context. Automatic Setup Control allows the operator to bring the whole vessel in the required mode within seconds.
- IHC data logger software provides reports and possibilities to trace the vessel’s behaviour. Furthermore it informs external data loggers and the so-called BIS System, required by Belgian Waterways Authorities on board of dredgers.
- Diagnostic presentation is part of IHC’s automation systems. It provides information on start- and running conditions of the vessel’s subsystems. Malfunctioning sensors are detected, uphold conditions marked. So the operator can easily do from the bridge anything that facilitates economic and safe operation of the ship. This software was extended considerably, giving yet more facilities to do the job undisturbed.
- As usual, IHC sensors and measurements form the backbone of robust and reliable information provision to all ‘higher’ systems.

Extensive simulation and Factory Acceptance Tests gave the prospect that no circumstance on board should harm the concept or would disappoint operators. Components and systems got the green light for installation and commissioning aboard of MARIEKE, which was the first ship to to take advantage of the new phenomenon.

The future of the one man-operated bridge seemed certain.

MARIEKE, proof of the pudding

Setting foot on MARIEKE’s or REYNAERT’s bridge, one is struck with amazement for the first minutes. No long rows of control consoles with all those blinking lamps, switches, pushbuttons, control levers, buzzers fluorescent mimic diagrams and anything that made dredgers’ bridges so intriguing in the past! Naturally, chart tables, VHF, radars, gyrocompass and that kind of stuff is present, but the general impression is one of plainness and tranquillity. There is only that massive, though harmonious U-shaped
console with the steering wheel at the centreline, its dim video monitors and then, indeed, some control components, nicely ordered in rectangulars. So far so good, let’s return to the story.

The proof of the pudding is in the eating, as the proverb goes. The basin trials of MARIEKE saw all involved people gathering again, unanimously dedicated to make a success of the new thing. The crew were intensively trained and assisted to venture dredging with such a revolutionary concept. Commissioning- and software-engineers did the last adjustments and made it entirely sure that nothing could ground the system. At the backstage, Mr. Robert Engels, DEME’s long trusted dredgemaster had entirely and heartily grasped the innovation. Appointed to train DEME’s crew members he spoon-fed them with it, taking away human hesitations and fears, so encouraging them to dredge with vessels like MARIEKE and REYNAERT – and their successors!

The days of sea trials came. MARIEKE’s installations were thoroughly commissioned, loaded, adjusted and improved where needed. As to the one man-operated bridge, nothing is to say. It simply worked!

After MARIEKE was transferred to her owners some maiden trips were made – and became successes. MARIEKE and her crew easily won the ecological and economic competition with such a first rate ‘mother’ like PALLIETER and her well experienced crew. As there is no other difference between the ships than the one man-operated bridge, conclusions are obvious and need not to be told here.

The granddaughters of PALLIETER MARIEKE’s crew became accustomed to the merits of the one man-operated bridge and began to request for further developments. They will see them without doubt. DEME and IHC are already analyzing a next generation. This generation will bring further improved presentation and diagnosis. It will provide information with yet more sense for relevancy and more eye for the human being. The number of presentation displays will be reduced. Before all things, a search will be done to remove all things from the bridge that can be removed. Highly interesting is a feasibility-study on so-called adaptiveness. Adaptiveness is a mathematical method with which the number of required adjustments is being reduced, while software learns them from itself. A nice first example is the system on MARIEKE which does ‘informed guesses’ on overflow losses.

The next generation of the concept will take the best of abilities of people, so dedicated in developing MARIEKE en REYNAERT, since DEME already ordered two following sister-vessels. These ‘granddaughters’ of PALLIETER, to be named BRABO and BREYDEL, will be the terrain of their extended exercises within a year.

Outcome and perspective: a new era in dredging
It goes without doubt that the successful introduction of the one man-operated bridge will foster new developments. Crews will grow accustomed with the concept and the method of operation. Inventive as humans are, they will without doubt find methods to improve the success. IHC will build new vessels for DEME and the exchange of fascinating ideas will continue flowing. As one main player in the process postulates it: ‘This is not the time to lean back. It is not the end, it is only the beginning. The beginning of a new era in dredging.’ – as is the strong feeling of all people involved. And they may be right! Anyone with affinity to dredging will understand that this innovation is a challenge to dredging contractors and dredging shipbuilders for coming years.

A story of dedicated people.
This is the story of beginning a new era in dredging. Indeed, it is a story of enterprises sitting on large amounts of knowledge, practice and experience. Yes, it is a story of organizations who have a long track record of cordial and lasting relations. And yet, above all it is the story of dedicated people who surpassed beyond all that. People who were wise enough listening to their intuition, people who had the moral courage to build on mutual trust, people who adventured to expose myths and apparently hidden failures and – to dredge with a totally different ‘feeling’ ship. Dedicated people, mentioned and not mentioned, who took the risk to go with each other without knowing where they would come out. One may be sure that such an approach carries a lot of innovative promises for the whole dredging and shipbuilding world: a new era indeed!
One-man operated bridge
Historic perspective
Early experiments
Throughout the 20th century various attempts have been recorded where manufacturers, for a variety of reasons, experimented with the application of dredging wheels. One of the yards that later on formed the IHC group also developed and patented such an application.

The dredger used this wheel in the Albert canal in Belgium where on the backswing a cutter proved to be ineffective. The conventional cutter rotates in one direction. In one swing direction the cutter’s cutting performance is at its peak, in the other direction it is far from ideal. If the cutter rotation would not be lengthwise but athwartships, the full cutting force could be exercised in both directions. The system proved its value. Reliability was a problem, though.

While a cutter can be mounted onto a long shaft with its drive in the dry, the wheel drive needed a submerged gear and the seals of these gears were not reliable in those days.

Open pit mine successes
Later on, the successful use of large wheels applied in open dry mining pits drove the dredge equipment suppliers to the mining industry to investigate such a wheel. The mining wheels fully excavate terrain, without much spillage.

The demountable wheel dredger SCORPIO

The classic bucket chain ladder dredger had a proven record in the dredge mining offering the same advantage: it could clean out a mine site to bedrock. However, a mechanical dredger such as the bucket ladder dredger only cuts and lifts the material above water surface. Contrary to the hydraulic dredgers, the mechanical dredger needs an additional means of transportation, such as barges or conveyors, which brings extra costs with it.

Ongoing development
The reliability of submerged drives was no longer a problem. In the sixties submerged hydraulic drives for cutters had been developed that became very popular in the seventies on demountable diesel hydraulic driven dredgers. Interest in the wheel revived. Bucket wheels derived from that dry mining concept were developed by replacing the discharge chute and conveyor belt by a suction mouth and suction line. The conventional wheel, as applied in open pit mining did not yield the intended results. It performed reasonably well in sand, gravel and marl, but clogged in sticky materials such as clay.

The shape of the rounded buckets was designed to cut as well as convey the soil and in more sticky material this combination did not work. It clogged the buckets, as also IHC had to conclude from tests with a test unit developed in the late seventies.

A true R&D Story
This was not the wheel IHC was looking for. In a concise effort and a true partnership of Research and Development, MTI, IHC’s R&D laboratory, in cooperation with IHC Holland Beaver Dredgers, continued to work on a dredging wheel.

This systematic R&D development led to a new wheel, which proved to work in wet deposits.

Late 1981, a quarter of a century ago, IHC delivered its first wheel dredger, the IHC Beaver 4000 SCORPIO that is still successfully operating in Australia. Since then IHC has supplied a significant number of wheel dredgers to many parties in a wide variety of segments in the dredging market. Today we can conclude that the IHC wheel has evidently made its mark in the dredge market. This article tries to summarize.
The resulting IHC wheel differed from other wheels in that the buckets have neither a bottom nor a back side. The IHC dredging Wheel in fact consists of two parallel rings connected by a series of bottomless buckets.

- When a number of buckets are mounted into a ring, the enclosed area becomes part of the suction mouth.
- After being cut the material arrives in the suction area and is then exposed to the pump’s vacuum. As a result spillage is very low.

To prevent buckets from clogging, a fixed lip extends from the suction mouth into the buckets. If a bucket is clogged, the rotating wheel lets the bottomless buckets pass the lip, which then forcefully removes the contents clogging the bucket.

The suction mouth and the lip have been a separate R&D interest. The space inside the ring with buckets is large and lips were tested in several executions. The diameter of the rings depends on the size of the drive on one side, while the suction mouth is placed on the other side of the wheel.

The neck of the impeller of the dredge pump, were the longitudinal slurry flow is accelerated into a radial movement, forms the critical space to pass larger pieces. By spacing the buckets at a slightly smaller distance than the space in the impeller’s neck, a good level of safety is added to the pipeline to protect from pump blockage through larger pieces being pumped up.

The IHC Dredging Wheel concept provided very interesting new features: the ability to dredge very sticky clays without clogging and a very compact wheel unit. As production was no longer governed by bucket volume but by flow through the buckets, the new concept resulted in increased cutting efficiency at a given power rating.

With these features IHC’s research and development had arrived at a point where the wheel was considered ready for the market. The Zanen Verstoep company (in 1987 acquired by BosKalis) ordered the first wheel dredger 25 years ago by IHC Holland.

Continuous R&D

In the early eighties the MOD Dredging consortium received an order to create 170km canal in the Mid-East with a narrowly defined profile, totaling 43 million cubic meters of heavy soil containing a variety of materials but including cohesive clay to be removed. This clay had already been clogging cutters of other dredgers. Model testing at Delft University of Technology tested a number of suction mouths. The shape of the suction mouth impacted the spill encountered. A suction type was selected that allowed the wheel dredger to run with its cutting tool only partly submerged thus reducing the quantity of backhoe operation required for shaping the sides of the canal. Three dredgers were delivered and these successfully completed the canal not only by dredging the sticky clays but also by working their way through compact sandstone layers.

In 1984 IHC did tests with a Beaver 750
and compared the wheel with the cutter, testing new suction mouth and lip designs at the same time. The IHC dredging wheel had earlier shown its capabilities for dredging with very high concentrations of average 50% by volume. The tests were targeted at developing suction designs that, when paired with a submerged pump, could result in high concentrations as a design feature for the wheel dredgers. This tedious development labour in fact resulted in wheel dredgers that are performing with such a high concentration on a day to day basis. The high concentration and excellent controllability are features especially important to mining applications. In mining the dredger often operates on a fixed distance from a treatment plant and is not limited by the pump power as defined. The less water the dredger needs to create and transport its mixture, the less water the treatment plant needs to remove in order to separate and produce the minerals or sand fractions.

In 1986 and 1987 IHC compared the rotation direction of the wheel, using model testing. IHC had patented both rotation directions, as both directions were considered to have certain advantages. The model test did not document a preference for either direction; each had its specific areas of application. Consequently dredgers with wheels with an upward as well as downward rotation direction have been delivered by IHC. The test did prove that the optimum position of the suction mouth was directly related to the rotation direction.

**Double Wheel**

After the early experiments with the dry mining wheel and IHC's patented single wheel, different dredge equipment suppliers returned again to the double wheel, already investigated earlier in the century. Also IHC's patent of the 1930's described two wheel halves being driven independently and the cutting wheel half guiding the mixture via a flap valve into the suction pipe. Some recent designs included such a flap valve, others did not. The model as well as practical tests and practical experience prove that the non-cutting edge also picks up material it could not deliver if a flap valve were installed. If this is not the case, the non-cutting edge is adding a low density slurry "water" to the suction process, diluting the density of the cutting edge. Furthermore IHC later tested a double wheel, specifically targeting the aggregate industry. It did not outperform IHC's classic wheel. An important disadvantage of a double wheel is that it is difficult to step forward as the front of the wheel does not have a cutting edge. This disadvantage becomes more prominent when the space between the two wheels is wider. Also in view of the advantages of IHC's single wheel - it cuts in a controlled fashion, does not clog in plastic materials and allows a controlled, and higher concentration - IHC did not pursue the double wheel any further.

**Examples of successful applications**

**General Purpose dredgers**

Twenty-five years ago Zanen Verstoep acquired the first “modern” IHC wheel dredgers, two Beavers 4000. General contractor Zanen Verstoep applied these tools in various environments, including sixty entrances in Nigeria, where the wheel also had to deal with trees and rocks, and in creating an accurate outfall channel in clayey silt in the UK. When in the Netherlands the Rotterdam-Antwerp Canal was widened, wheel dredgers handled the widening of the canal in clayey Zuid Beveland.

In general-purpose dredging the contractors prefer their general purpose workhorses, the cutter suction dredgers to be applied throughout because of their versatility. Wheel dredgers have proven to be a successful tool when applied where plastic clays are encountered.

**IHC Beaver 750W digging plastic clay in China**

In specific areas of China, cohesive plastic clay is present in abundance. Cutter dredgers fail, as the cutter gets clogged and clay balls are formed. When plastic clays are encountered, these materials tend to clog cutters...
rapidly, and it is a specific area of dredging where the IHC wheel excels. A classic Beaver 750 wheel dredge was the first dredger by the end of the eighties and following the success of this dredger a number of other wheel dredgers followed.

SAMSUNG NEW PIONEER
This heavy duty general purpose dredger delivered in 1996 can be equipped with either cutter or wheel and it can be converted from one mode into the other within 24 hours. The SAMSUNG NEW PIONEER was also fitted out with an electrically driven wheel, as opposed to the wheels previously delivered, which were hydraulically driven.

Handling clay seams in sand and gravel pits and achieving high concentrations
It is becoming more and more difficult to obtain permits and licenses from inland aggregate pits. A substantial number of pits have been abandoned in the past because clay seems or layers were encountered. In several areas, including the Netherlands and Croatia, wheel dredgers were delivered to sand and gravel operators, which pits contained clay layers. In addition to its ability to handle the clay layers easily, the wheel’s performance can be more precisely controlled than that of a cutter, so that an accurately defined optimum performance of wheel with pumps can be established. The combination of wheel with submerged pump proved to be capable of delivering densities (by weight) exceeding 1.7.

Heavy Minerals industry
In the dredge mining industry, specific segments have benefited from the wheel dredgers. This is especially true for the heavy minerals segment (rutile, zircon and titanium oxide). In coastal areas on different continents, the sea has left concentrated deposits of these materials. Artificial lakes are created in which a dredger mines and directly behind the dredger a floating process plant removes the minerals.

The separation process is the most successful if it is fed by one continuous high density flow of slurry. The suction dredger, both cutter and wheel dredger, produces a cyclical process of swinging-turning-swinging, which is regularly interrupted by a re-positioning of the spud. A dredger’s production fluctuates and a surge bin is placed in between the dredger and the plant as a buffer. Still, the bin has volumetric limits, in both directions.

A proper combination of pump and wheel has proven capable of providing a better controlled flow of higher density than cutters, to ensure the continuous flow demanded by the plant. Fully integrated dredger automation systems linked to the plant ensure that the dredger is feeding the plant with the required mixture. It should come as no surprise that in the heavy minerals industry the IHC dredger wheel is the preferred tool and the IHC wheel has earned a solid reputation in this market segment.
In the 30 years of its existence Richards Bay Minerals has become world leader in the production of heavy minerals. Richards Bay Minerals operates five mining ponds in the dunes of Natal, South Africa. Its dredge technology is supplied by IHC and now includes 6 mining dredgers. Richards Bay Minerals recognized the interesting features of the wheel dredger back in 1985 and currently operates two cutter dredgers and four wheel dredgers for mining the dunes. These wheel dredgers mine 3,000 ton/hr 24 hrs./day 365 days/year at very high availability rates and have contributed to the rapid development of the company into the world’s largest heavy minerals mining that it is today. 25 years after the first wheel dredger was delivered IHC is in the process of delivering a wheel dredger for a heavy minerals site in India, while in China a civil contractor’s dredger is being built, to be fitted with another model of the IHC wheel.

A niche for the wheel
The wheel continues to be chosen and it is applied in specific applications with great success. As a proof of successful continuous development, recent steps taken by Richard Bay Minerals, one of IHC’s high technology customers in the heavy minerals mining industry, may serve as proof. Over the past few years, RBM ordered three new wheels of the new make, designed with adjustable Pelican suction mouth with integrated scraper, new seals and IHC teeth, to upgrade the existing dredgers.

Another esteemed heavy minerals miner, IRE from India, for whom IHC built a cutter suction dredger a few decades ago, took delivery of an IHC built wheel dredger for its Indian Heavy Minerals site in 2007. For a Chinese client, one of the largest diameter dredging wheel units made by IHC, a model BW 4970, is currently being manufactured. This dredger will have the option to mount either a cutter or a wheel module, as both have been ordered. The wheel is intended to be applied in clay deposits, an assignment in which the IHC wheels have performed...
remarkably well, and not just in China. Based on the surveys of similar bottom conditions, in 2006 a 6016W with a dredging wheel BW 4458 was delivered to Russia.

For a small type of dredging wheel unit IHC has developed an extremely wear-resistant suction mouth that lasts many times the life of a normal suction mouth. The surfaces that face the dredging mixture are shielded by the wear resistant material MaxTop®. IHC is studying how this type of suction mouth can be applied in dredging wheel units of other sizes as well. Something that underpins the ever-growing appreciation for the wheel is the fact that over the past few years a number of major international research institutes have ordered lab-sized wheels for laboratory testing to find out what these wheels are really capable of in specific, new areas of dredging.

The wheel in 2007
This concise history documents that the IHC wheel has earned its distinct place among the dredger tools. It is a tool that has been developed with dedicated and targeted R&D and that has proven to have a unique ability to handle plastic clays and to deliver high densities by weight in aggregate sites in combination with a submerged pump. Its ability to deliver a controlled performance has made the IHC wheel a preferred tool in the mining industry. The wheel dredgers delivered by IHC have moved more material than all the other wheel dredgers combined. In the 25 years that the IHC wheel has been on the market, it has earned a solid position in specific niches of the dredging market and dredger commissions. And the product continues to convince clients of its specific values.

More information about the IHC wheel is available on our website www.ihcholland.com under the heading P&D 167.

While the IHC wheel has proven to be an excellent tool for the heavy minerals miners, the wheel has proven its worth in other mining applications as well, e.g. in salt mining

End of 2006: the wheeldredger for IRE being lowered into the river for docktrials
The market trend in China to go for an increase in scale of dredgers first became apparent in the mid nineties with the new building of cutter suction dredgers for a Chinese Waterway Bureau. These dredgers were designed for a nominal production of 1750 m$^3$/hr and they were the first dredgers in China to be equipped with spud carriers. The submerged dredge pump application was considered optional and was realised at a later stage. It was the prelude to a change in the market from small-scale dredging to operations at a large to huge scale. The trend can be described as: large dredging depth; great discharge length; high production output and sufficient accommodation for 24 hours operation and a sturdy seaworthy hull allowing for bad weather conditions.

In 1999 IHC developed its first ideas to beat this existing design with a better performing concept, and at that particular time - with respect to the ratio of European currency versus the RMB - a competitive option was possible. It was too early, however, to convince the market at that time.

BEIYA 1 HAO
Around 2004 Tianjin Dredging purchased a second-hand dredger that came close to the design as mentioned above. The client was also aware of the earlier design of IHC, however, and in the course of 2004 IHC received the inquiry. By giving the design extra technical advantages compared with the existing designs in the market IHC was awarded with the contract by the newly established Chinese contractor “Qingdao North Asia Construction Engineering Co Ltd” of a dredger with a production of about 2,300 m$^3$/hr and an accommodation for 13 persons.

This dredger, named BEIYA 1 HAO, was delivered in January 2006. Immediately afterwards the BEIYA 1 HAO was put to work in one of the many big dredging projects near the city of Tanghai (in Hebei Province), together with about 35 other dredgers from different dredging contractors.

This dredging project of the BEIYA 1 HAO was part of the “Business development plan” in the Bohai Sea. Around Tianjin, in several ports development works were and are carried out simultaneously. Dalian, Tianjin and Qingdao were assisted by the ports of Qinghuangdao, Yingkou and Yantai and together formed a mega ports group. Qinghuangdao is the main port in the province of Hebei. It is surrounded by satellite ports like Huang Hua Port and Jingtang, which handle bulk goods. The port of Cao Fei Dian will become the specialised port with a deep water berth for ore and crude oil. In Cao Fei Dian a new facility is also being developed for the Capital Steel Factory which is scheduled to be moved from Beijing to the coastal area, requiring the reclamation of about 300 km$^2$ land; 150 km$^2$ of this has to be reclaimed at Tianjin Port.

Another development area is Tang Gu Ling Gang, an industrial area where 12 km$^2$ of land will be reclaimed. These are just some examples of the many projects in this area that create an enormous boost in the dredging market, attracting many dredging contractors. These dredging contractors are partly experienced and partly without experience, both trying to benefit from these developments.
In 12 months’ time the BEIYA 1 HAO had a production of over 10 million m$^3$. The dredged material was silty sand that had to be pumped over 6km. The average dredging depth was about 20 meters. The client remains very enthusiastic about the performance of the BEIYA 1 HAO.

**IHC 7025 MP orders**

Since the contract for the BEIYA 1 HAO was signed, IHC closed several contracts for this type of dredger. The dredger was designated an IHC 7025MP cutter suction dredger, which can be explained as follows: the first two digits refer to the suction diameter in centimetres and the last two digits refer to the dredging depth in meters. The letters “MP” refer to Mono Pontoon Execution.

So far 13 dredgers have been contracted for delivery in 2007 and 2008, 2 of which are already in operation. The clients are based in Guangzhou, Tangu and Beijing. Guangzhou Dredging already invested in a Dredge Wheel application. With the exception of the reputed dredge company Guangzhou Dredging, all other contractors are new players in the market.

Though all dredgers are based on the same concept and dredge systems, IHC has made adjustments based on the individual wishes of clients. With the modular design approach of IHC this option can be fulfilled. Clients pay a licence fee for the use of a package of standard drawings.

**Design of the IHC 7025MP**

The design of the IHC 7025MP focuses on typical Chinese requirements, such as large dredging depth, strong side winches to enable dredging in current, large accommodation (to facilitate working in remote areas) and many cost-reducing features such as a basic instrumentation and control package and the application of locally purchased auxiliary equipment.

The IHC 7025MP is a hydraulic dredger, meaning that besides the spud carrier, the cutter drive and all winches used for dredging operations are diesel-hydraulic driven as well.

The idea behind the design is to work with modules which in itself represent proven technology and can be combined in various different ways to meet the specific demands of customers. By using the same basic design short delivery times for design drawings can be achieved.

A General Arrangement with the main dimensions of an IHC 7025MP with a dredging wheel is shown below.

There are two different types of accommodation for the IHC 7025MP, one for 12 persons and one for 21 persons. Both accommodation units are placed on vibration dampers for increased comfort onboard.

Because the IHC 7025 MP is designed
for dredging in river estuaries where strong currents can be encountered, the IHC 7025MP is equipped with strong swing winches.

The pumping hearts of the IHC 7025MP cutter suction dredger are two high-efficiency dredge pumps, one single walled submerged dredge pump and one double walled inboard dredge pump. Both the inboard and submerged dredge pump are of this same type, allowing for the interchanging of impellers and some other wear parts, limiting the number of spares to be kept on board of the dredger. All wear parts of the pumps are made of wear-resistant materials such as Maxidur 5, resulting in a long life. For an increased discharge length (up to 12km) IHC has also designed a land based-booster station. The submerged dredge pump is electrical driven; the electric engine is positioned on the upper part of the cutter ladder. The inboard dredge pump is driven through a special integrated gearbox-bearing assembly which reduces the length of the drive train.

The dredgers are designed and built in compliance with the rules of the China Classification Society (CCS) and meet all current international rules and regulations as far as relevant to this type of vessel. Even though the IHC 7025MP has become a standard dredger, for every IHC 7025MP contract specific client requirements were incorporated.

To keep investment costs as low as possible, the IHC 7025MP cutter dredger is equipped with a basic instrumentation and control package, consisting of an Automatic Pump Controller (APC), Production Calculator (PRC) and a Swing and Depth Indication System (SDI). But if required, a more sophisticated level of automation, for example an Automatic Swing Control is available. A further option is the installation of a management tool, consisting of a shore-based monitoring system of the production rate, fuel consumption, downtime etc.

Feedback during the construction, commissioning, operational experience and suggestions of our clients have been used to improve the basic design. An example of this comprised the increase of the spud carrier stroke from 4.8m to 6.2m without changing the main dimensions of the dredger. A larger spud carrier stroke contributes to a higher efficiency of the dredger as the stepping procedure requires less time. Other improvements include a local control near the cutter head for inching the cutter motor for mounting and dismounting of the cutter head.

**Dredging wheel option**

The IHC 7025MP can be delivered with two different types of cutter heads for different soil conditions. For soft soil an IHC cutter head is delivered with flared teeth, for compact sand and soft rock a cutter head with narrow teeth is provided. A special advantage of this dredger is that it can also be equipped with an IHC dredging wheel. This dredging wheel is interchangeable with the cutter ladder lower piece and enables dredging of sticky clay with a minimal investment. All existing IHC 7025MP dredgers can be equipped with a dredging wheel, making it a versatile piece of equipment suitable for various soil conditions.

**IHC Scope of supply**

China charges high import taxes and in order to meet the market demand for a good quality dredger at a feasible price, the scope of supply is based on a practical demarcation of system liabilities. For the contracts concluded all yards respect the intellectual property rights of IHC Holland and signed nondisclosure agreements. As a lot of know-how is contained in some dredge components which are not under the normal quality survey of CCS, IHC produces these items as ready-to-fit modules in China at their premises.
The IHC scope of supply for the IHC 7025MP cutter suction dredger consists of a design (software) and a hardware package. The design package comprises an extensive drawing package including drawings and calculations required by the Classification Bureau (CCS). The hardware scope of supply includes all the dredge components and key systems that are of importance with respect to the performance of the dredger, including the commissioning of this equipment. All special dredge components such as the cutter ladder upper and lower part (with cutter drive), the complete spud-handling installation, the swivel unit, anchor booms and dredging valves are delivered by IHC. The IHC delivery also includes the major drive systems for the submerged and inboard dredge pump, the hydraulic power generation with the hydraulic distribution panels as well as all hydraulic winches. Besides the optional instrumentation package, dredging wheel and other options above, the scope of supply can also be extended with a complete hydraulic piping package.

Commissioning
A crucial part of the scope of supply of IHC is the commissioning of the dredging equipment of the IHC 7025MP. This is carried out by a qualified team including mechanical, hydraulic, electrical and electronic engineers, a dredge master and a general supervisor. Commissioning starts by witnessing the inclining test, checking the proper mechanical installation of the main components, flushing of the hydraulic systems, checking the electrical connections etc. and usually ends after successful dredging trials and is followed by handing over the dredger to the client. The commissioning team consists of IHC engineers from both Holland and China.

Customer and Product Support in China
As explained above there are many newly established dredge contractors with a varying degree of dredging experience. The actual experience available is rooted in a limited group of technical crew and staff, educated in the state-owned dredge companies. This source however is quickly drying up. The scarce availability of experienced staff is one of the biggest concerns in the dredging industry in China.

The increased demand combined with short delivery time requirements demands a stronger focus on logistics. The increased value of the goods as a result of the larger scale limits the capability of the newly started companies to make significant investments. The high cost of fuel also takes up a large proportion of the cash. In addition to the cost element there is the increased pressure of investors to complete the costly infrastructure within the planned periods of time and preferably earlier. At other places, trends are similar and therefore IHC has made it a priority in its market approach to pay close attention to the lowest cost of dredger operation. This can be achieved by hiring high qualified crews, training the crews and by improving the logistics of the delivery of spare parts.

In China, IHC has invested in a logistic center in Tianjin where spare parts and consumables are kept in stock. 24/7 maintenance assistance can be provided by service engineers from the service center in Tianjin, supported and trained by experts from the Netherlands.

A Life Cycle Support programme has been implemented to provide customers with targeted support when maintaining their ships and equipment. However, still new in the dredging world this concept already has greatly matured in other capital-intensive industries (for instance the aviation industry). The service provided by IHC Holland covers more than just building ships and systems. It includes the supply of spare parts, training, service and advice for renovation. The range of service is extensive. To provide support for this on a global level, IHC has an ever-growing network of service centers throughout the world. In 2007 IHC starts with a training center for CSD dredge masters in China.

Conclusions
With the introduction of the IHC 7025MP cutter suction dredger a new standard is set for a medium-sized cutter suction dredger that meets the requirements of the Chinese dredging market. Considering the recent developments, which require a higher standard of professionalism, IHC is investing in training in China and in providing 24/7 service with local engineers and supplying spare parts from our stock in China.
In 2005 IHC Holland Parts & Services began the development of a new pump series: the IHC TT-unit. The letters TT are short for Tom Thumb, since it is the smallest pump series produced by IHC. The IHC TT dredging units are a complete range of compact and cost effective dredging units that have been developed to be used for a wide range of smaller scale dredging projects.

The illustration (picture 1) shows the general layout of the TT-Unit. Transport of mixture with the TT-Units is carried out hydraulically by means of a dredge pump. The unit has been furnished with a robust pump with a highly wear-resistant pump casing with a wide working range, a large sphere passage and good suction properties. This will allow the unit to operate over a broad range of dredging projects. The graph shows the performance of the TT-Units. The output of solids volume per hour is shown against the discharge length per TT-Unit. Depending on the required output this graph can help in choosing the right TT-Unit for the job at hand.

The dredge pump is driven by a hydraulic motor that is directly mounted onto the dredge pump shaft. The power supply can be realized by connecting the available hydraulic feed by means of standardized couplings.

The suction and discharge line mounted onto the TT-unit will create the connection between the mixture and the dumping ground. The TT-Unit is also furnished with a jet water system. The jet water is supplied directly to the suction mouth, thus increasing the production of the TT-Unit. A hydraulically powered cutter head is also available for use in more compact material that would be impossible to dredge without mechanical assistance.

Finally a protective casing shields the unit from damage that could occur when dredging.
The TT-Unit’s standard configuration includes an impeller and wearing plates making the TT-units suitable for use in even the most extreme applications.

The combination of its compact build, standardized hydraulic fittings and the possibility for mounting on existing excavation equipment or simply suspending on lines, allows for the TT-Unit to be used in a variety of dredging project types without need for complex adjustments.

The TT Unit in use
The TT-Units are available in different sizes; ranging from a suction diameter of 150mm to 350mm with a maximum power consumption of 65 to 375kW respectively. The pressure at the duty point ranges from 4.2 to 5.3 bars, which makes it possible to use the unit with a discharge length of over 2,500m. Dredging depth is only limited by practical aspects. When suspended from a crane the dredging depth can be up to hundreds of meters.

Specifications of the complete series are shown in picture 2.

The TT-Unit can be used in a variety of dredging projects. Most commonly TT-Units are used for loading and unloading of hopper barges, sand and gravel mining operations and dredging in restricted areas. Other applications such as maintenance dredging, trenching operations and deep suction dredging are amongst further, almost unlimited possibilities with the TT-Units.

TT-Units can be tailored to requirements. They can be furnished with high impact resistant part materials for rock removal. An electrically driven unit is also possible. The heart of the unit, the pump, can be used in a booster station.

Optionals
Several additional features can be delivered to fit the clients’ needs:

- Wearing parts with different properties, ranging from medium hard, impact resistant materials, to very hard, very wear resistant materials.
- Complete (booster) units, including diesel driven hydraulic power packs, jet pumps and skidding frame.
- Monitoring and control equipment
- Discharge pipes and/or hoses, hydraulic hoses, jet water hoses and signal cabling.

Finally, the complete TT unit can also be rented for a short period, for a special project a customer has. In the near future, standard TT unit will be kept on stock, to ensure a very short delivery time to the customer.

Resuming, the TT pump is a further addition to the pump range offered to the dredging business by IHC. It is a versatile tool, easy to handle and adjustable to the clients’ specific needs.

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Artist’s impression of the 5,600m³ TSHD ordered by Royal Boskalis Westminster
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*DMPT 3000 for Kazakhstan*
Beaver 3800 ALYASAT (02435) at work in the UAE

CSD 6525C (02428) for India going on transport

GANG HANG YUN 08
Impression of the building of the TSHD ABUL

↑ Quay side of NMC Works: turning aftship section of TSHD ABUL into mounting position, with floating sheerlegs “Ajax”

← River Lek near Nieuw Lekkerland. Aftship section of TSHD ABUL in tackles of floating sheer legs “Ajax”, ready for loading on the barge.
Slipway entrance door: aftship section hoisted by floating sheerlegs “Atlas” and 2 slipway cranes.

Slipway of the IHC yard in Sliedrecht: cross section of engineroom TSHD ABUL, ready for fitting aftship section.

Aftship section almost in position on slipway.
Ports and Dredging is published by IHC Holland to inform the dredging industry of new developments in dredging technology, vessels and other dredging equipment, and of user experience all over the world.

IHC Holland develops and applies new technologies that are used in a wide range of technologically advanced products and services: custom-built and standardised dredgers, dredging installations and components, instruments and automatic control systems, engineering and consulting, research and development, overhauling, operator training and after-sales service. IHC Holland provides the best possible solutions for problems facing the dredging and alluvial mining industries.