Steering the draghead by interactive use of IHC Systems DP/DT system

Introduction

Dredging with a suction hopper dredger means that the dragheads have to deal with very varying interaction with the bottom. The force on the suction pipes can change in several seconds from zero to higher than nominal, which can force the draghead into unwanted directions. This is troublesome, particularly during the last phase of the dredging – the clean-up – when the last underwater mounds and ridges have to be removed.

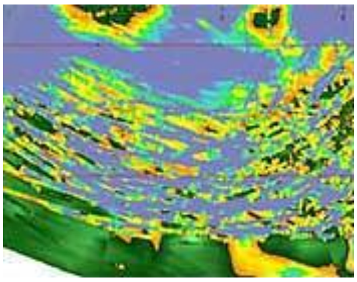

Fig 1: removing mounds

A systematic attempt to deepen the bottom before clean-up is always made. If work has to be done in parallel tracks, due to the width of the work, there is a natural tendency for the draghead to follow the previously made track. The result is that the bottom develops longitudinal ridges. An attempt is made to steer the draghead over these ridges, but - as stated - the head will often shift alongside. One remedy is to dredge obliquely over the existing ridges, though there must be enough space and mounds of soil will ultimately remain behind. Dredging will therefore end in removing these mounds. This article describes how this can be effectively done by interactive use of a DP/DT system.

The role of the DP/DT system

A DP/DT system cannot be expected to give a flat bottom fully automatically (or a bottom with a desired profile). The draghead has a natural tendency to follow the tracks already made, even when operating automatically.

Shifting into an earlier made, adjacent track can happen very suddenly, so that the DP/DT system will be unable to correct it quickly enough. Correction occurs indirectly by moving the ship aside, which in itself takes a few minutes. The head by this time will already be several metres past the ridge so, even if it is automatically steered back, a piece of the bottom would still be missed. Exactly the same thing would happen the next time, which will result in an even bigger mound, or rather a deeper pit next to the mound.

Fully automatic dredging with a DP/DT system will therefore not solve the problem. The above is less true for "trench-dredging", where it is desirable for the head to dredge continually in the vicinity of the previous track. This article is limited to the making of large areas on the bottom.

The current state of the art does however make it possible to provide a bottom with a specifically desired slope more quickly than if manual dredging is performed. This uses the navigator's experience and insight in combination with the use of a DP/DT system.

Concerted action between the navigator, and the DTPS and DP/DT systems

If the navigator has a good idea of the bottom profile, he can predict – partly from the previously dredged tracks – if the draghead can again shift next to the ridge or mound. The requirement is for him to have an up-to-date bottom profile and to see the actual place of the head in that profile (e.g. via a Dredge Track Presentation System). Shifting can be predicted from this visual data. As soon as this actually happens, the navigator can order the DP/DT system to bring the ship about into a suitable position, so that the head can be moved back.

The navigator therefore concentrates on the movement of the head, whilst the DP/DT system brings about the change in the ship's position and speed that is desired by the navigator.

How to compensate for the head shifting

Many attempts have been made to directly steer the draghead in the past: using carriages, water jets, etc. These methods are less economically attractive. The head can be steered via the DP/DT system by moving the ship sideways, which will probably happen too slowly. In practice it has appeared that compensation is also possible by rotating the ship several degrees.

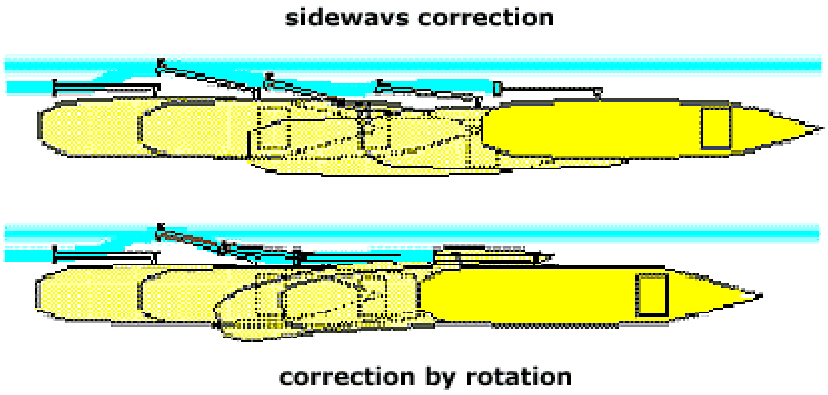

Fig 2: correction of draghead shift

The ship will turn twice as fast as it will move sideways. The lifting arm can for instance be moved aside five metres:

- in 45-60 seconds by turning and
- in 90-120 seconds by moving sideways

A sideways force is exercised on the draghead by the ship's turning movement, whilst its (suction pipe) inlet remains moving over the desired track. The DP/DT system is able to move the inlet forwards over the planned track, whilst the course – at the navigator's indication – can be freely chosen. The draghead's movement can therefore be corrected more quickly.

Fig 3: practical experience on the Nile River

Practice

The above method was "discovered" during the DEME's first dredging job with the Nile River. This was the clean-up of the bottom of Monaco Harbour. A foundation for a new (350 metre long) pier was made on this bottom. The profile of the bottom to be provided was determined by the underlying rock formation, which meant that the desired profile was fairly complex.

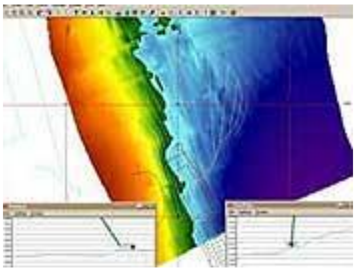

Fig 4: actual profile at online updated DTPS image

The desired profile via the IHC Systems Dredge Track Presentation System (DTPS) is visible on the Nile River, as is the actual profile and the draghead's position. The actual bottom profile is automatically updated during dredging using the most recent draghead depths. This gives the navigator an actual picture of the bottom profile and the draghead's position in it. The navigator can see where the natural tendency of the draghead to shift will lead to on the DTPS after several tracks have been made. He can enter this in the DP/DT system on time to prevent it from happening, e.g. by rotating the ship with the effect described above. This ship can be rotated using a knob on the DP/DT control panel. The ship's forward speed can also be increased or decreased via another knob. The speed knob is mainly used to sail faster when enough dredging has been done and more slowly where there is still a lot of soil left.

Fig 5: Simple operation by 2 knobs for heading (left) and speed (right)

Less trouble for the navigators

The interactive use of the DP/DT system in combination with the DTPS made it possible to perform the work with the Nile River that was about 30% faster than originally planned. Navigators also found the method less troublesome than fully manual dredging.

This was partly due to the fact that the work was done by dredging ahead for roughly 200 metres (in automatic track-mode or the DT mode), and by sailing fully automatically back at the end of the track to the beginning of the next track. This back-sailing process is done in DP mode, which means that the ship stops exactly at the spot where the next track has to start. This means saving an appreciable amount of time. The navigator could even relax during this automatic back-sailing time (drink coffee, plan the next tracks, etc), so that he could start on the next track in a refreshed frame of mind. Hours of dredging are in this way less tiring, so that the navigator, in combination with DP/DT and DTPS, was able to perform much better.

Relieving the navigator of the actual task of steering the ship leaves him enough time to check the ship's position in relation to for example adjacent buoys – because this information is also shown on his monitor screens and automatic steering gives him time to occasionally walk to the edge of the bridge to visually check the ship's position. This saved the need for a look-out on the Nile River.

Accuracy of the DP/DT system

Virtually no mounds or ridges were encountered at the start of the work. The accuracy of the DP/DT system could therefore be measured well at that moment as the navigator had to take little interactive action.

Figure 6 shows two dredging tracks, where dredging was performed every time 200 metres in the DT-mode, followed by sailing back in DP mode. This is more clearly expressed in the time graph below, figure 7. The accuracy of both the DT and DP modes is expressed in the Figure 8.

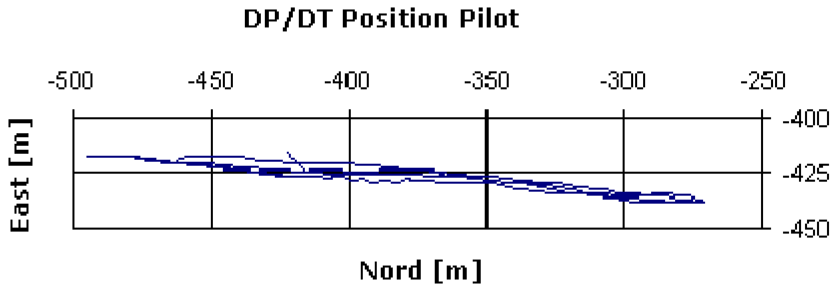

Fig 6: Back and forth tracks East / North plot

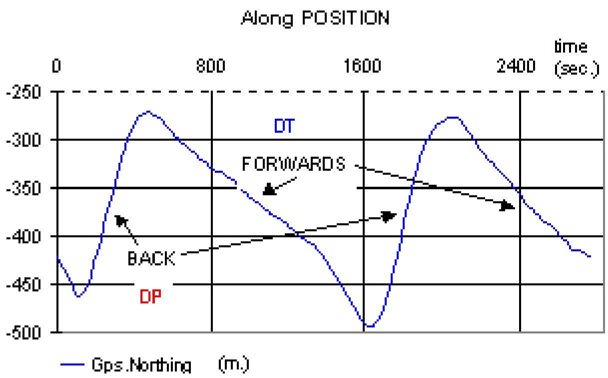

Fig 7: Back and forth tracks along position

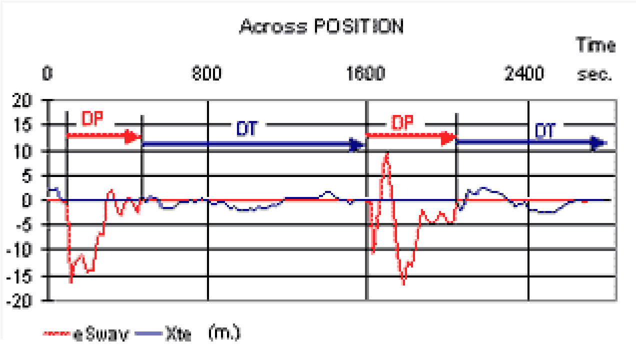

Fig 8: Accuracy of the DP / DT system

The "cross track error" in the DP-mode is greater at the start with a larger "along-error" than in the DT mode. This is because reversing with a suction hopper dredger in the DP mode is more troublesome than sailing forwards. The across error therefore receives less priority than with a large along-error. The accuracy of the DP mode approaches that of the DT mode when close to the desired DP position (i.e. at the starting point for the next track). The forward accuracy (in the DT mode) is better than 2 metres.

Conclusions

The Nile River's first dredging job showed that a navigator making interactive use of a DP/DT system in combination with the DTPS can achieve much more than without these systems. The DTPS gives him an insight into what the interaction is between the bottom and the draghead, so that deviations from the desired track can be corrected by steering the ship into another position via the DP/DT system. This interactive use gives the navigator greater control over the draghead's behaviour and therefore sufficient job satisfaction.

A comment from one of the mates was: "I can now use these systems to steer the draghead to the position that I want".

The navigator has to pay hardly any attention to steering the ship. He can spend much more time on planning the ship's movements, can communicate better with the dredging master and can act as the look-out himself.

The DTPS and DP/DT systems of IHC Systems described here were developed over the last few years by very close co-operation with DEME. This has resulted in two unique systems.

So far, the DP/DT system on board suction hopper dredgers for example is only used for trench-dredging. The Nile River has shown that this system can also be very effectively used to dredge accurately defined profiles.

The DP/DT and DTPS systems are irreplaceable, and interactive use of both gives great job satisfaction. The navigator can now steer the draghead instead of the ship.