OPTIMIZE YOUR DREDGING OPERATION BY USING 3D SOFTWARE

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MARINE SURVEY SOLUTIONS

Abstract

Precision dredging in marine environments is a challenging task. However, it can be done in a safe and productive manner with the right tools. The operator must be able to see the bucket movement in real-time relative to the seabed and the design grade. The dredging platform is often not static, so sensors must also monitor the pitch and roll of the barge to effectively position the excavator bucket. Precise sensors and visualization software are essential components in a marine excavator or wire crane system doing this high precision work. This paper introduces two cases of marine dredging operations using an excavator and wire crane, and describes how using 3D visualization ensured the optimization and a near instant progress reporting of the job's progress.

The first case covers the combination of EIVA NaviSuite Uca dredge software with Trimble GCS900™ sensors, and outlines how one of the users experienced an approximately 20% productivity gain while obtaining additional information on the progress of the dredging operation.

The second case covers the integration of EIVA's dredge software with a wiring crane using a clamshell for dredging in deep water at the foot of the Norwegian mountains. This dredging contractor shared with the developers how this 3D view helped to keep the operation productive and provide confident results from machine data. Additionally, the challenges encountered during the system integration are also covered.

This paper will enable readers to understand the productivity benefits of using 3D software to enable the operator to see the progress of the dredging in real time. With better information being obtained during dredging operations, future projects can be planned more efficiently and progress can be tracked at every stage of a dredging project.

Keywords: Dredging, Volumes, Excavator, Clamshell, Wire Crane, Trimble GCS900™, Grade Control System, Machine Data Logging, Real-time 3D.

Introduction

The demand for dredging, remediation, and land reclamation activities is growing on a global level, and ways to optimize these work operations is more in focus than ever before. The global growth in this area, according to IMF, was 3.1% in 2016 and is expected to increase to 3.4% in 2017 (IMF 2015) and is expected continue increasing in the coming years. This paper will outline the optimization of two types of dredging operations by using real-time 3D software.

3D Software with Trimble GCS900™ Grade Control System

At the current stage, many dredging contractors are using simple 2D software or no software at all on the dredge machine. Important information is lost in this case, such as showing where the bucket or clamshell is being placed and the update of the theoretical removal of sediments compared to the design model. Often the challenge for the operator is to know where the bucket went into the water last, and where the material was removed at the seabed.

Additionally, the need for having a good overview of the dredging operation is limited due to the simple 2D display which does not allow for multiple views of the operation in a customizable display view.

The customer VEIT based in Minnesota, USA was trying to overcome these challenges and was looking for a way to optimize their dredging operations through better visualization for the excavator operator. It was important for them to keep the existing Trimble GCS900™ Grade Control System which they already had purchased and installed on their excavator.

VEIT was experiencing the same challenges mentioned by having a simple 2D display, which did not allow for any display customization. The data gathered was 'dirty' from the low resolution of the terrain model. This was due to the memory restriction in the control box inside the excavator cab. The current processing time of their daily progress reports was an area that could be greatly improved upon.

VEIT was looking for a solution:

- Able to handle large data sets
- Integration with Trimble GCS900
- Shows 3D real time visualization of the material being removed
- Customizable mapping, color and visualization

- Cleaner mapping data than their current 2D view
- Clamshell supported guidance and mapping
- Faster daily progress reports

VEIT was searching the market for dredging software solutions and found the 3D Dredging software from EIVA which allowed for full integration with Trimble GCS900™ system.

The software solution from EIVA provided all the functionalities VEIT was searching for. However, the 3D visualization demanded more data power and a larger display, which they solved by installing a stronger computer connected directly to the serial output from the Trimble CB460. The computer was placed out of the way of the operator's area and connected to a large rugged display placed in the right side of the cabin allowing the operator to view the operation in 3D while still having a clear unobstructed view of the work area.

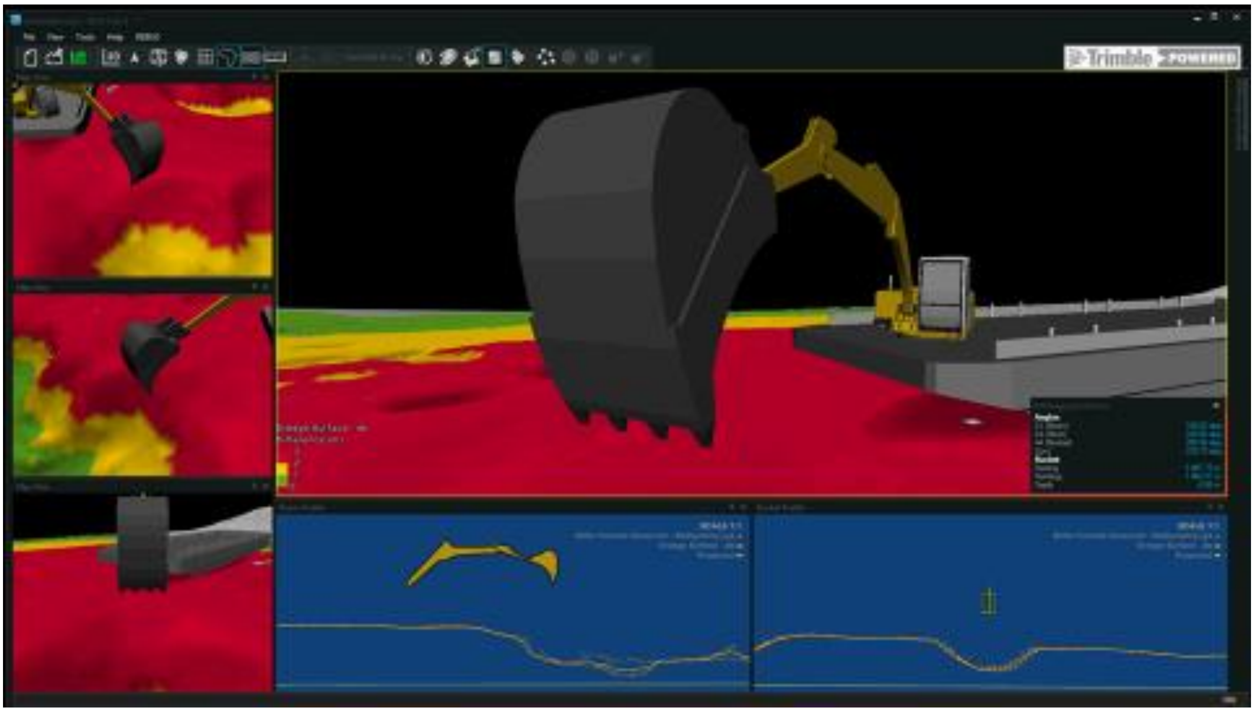

Figure 1 – 3D dredging software allowing for customizable views.

After the installation of the system the operator was able to know exactly where the bucket should go each time since the software would map and visualize as soon as the bucket was breaking the seabed surface and thereby eliminate the risk of placing the bucket in the same position as in the previous dig. By using a Windows based PC instead of the control box with limited memory, they could use the Multibeam progress surveys as the dredge surface that would be updated as the job went on, displayed in figure 2.

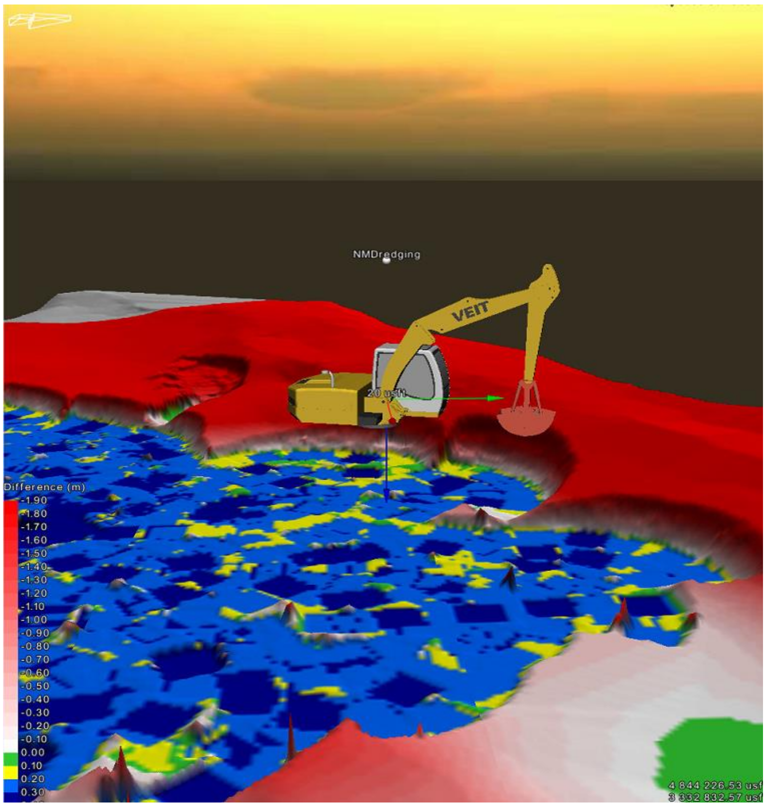

Figure 2 – 3D dredging software, mapping in real time.

This helped VEIT to obtain an improvement of the dredging operation by approximately 20% overall compared to previous similar operations they had performed simply based on the 2D visualization within the control box.

Knowing Your Continuous Progress

Another challenge VEIT was experiencing was the time it took to prepare a progress report. This was typically prepared after each condition survey during dredging operations. Because these condition surveys were done infrequently throughout the project, it was difficult for VEIT to estimate when they would finish an operation. By reducing this time significantly, they could monitor the job's progress more frequently and make better estimates on budget, equipment needs and personnel schedules.

Ideally VEIT was looking for a solution that could provide a daily progress report of the operation and have this be suitable at the end as documentation for the end-client.

The EIVA NaviSuite Uca 3D dredging software offered the possibility for instant mapping compared to the DTM from the pre-survey, condition surveys, and the design grade. The different color shading of the DTM showed clearly the amount of material above the design, allowing the operator to know when the target depth is met while also staying within paid over-dredge depths.

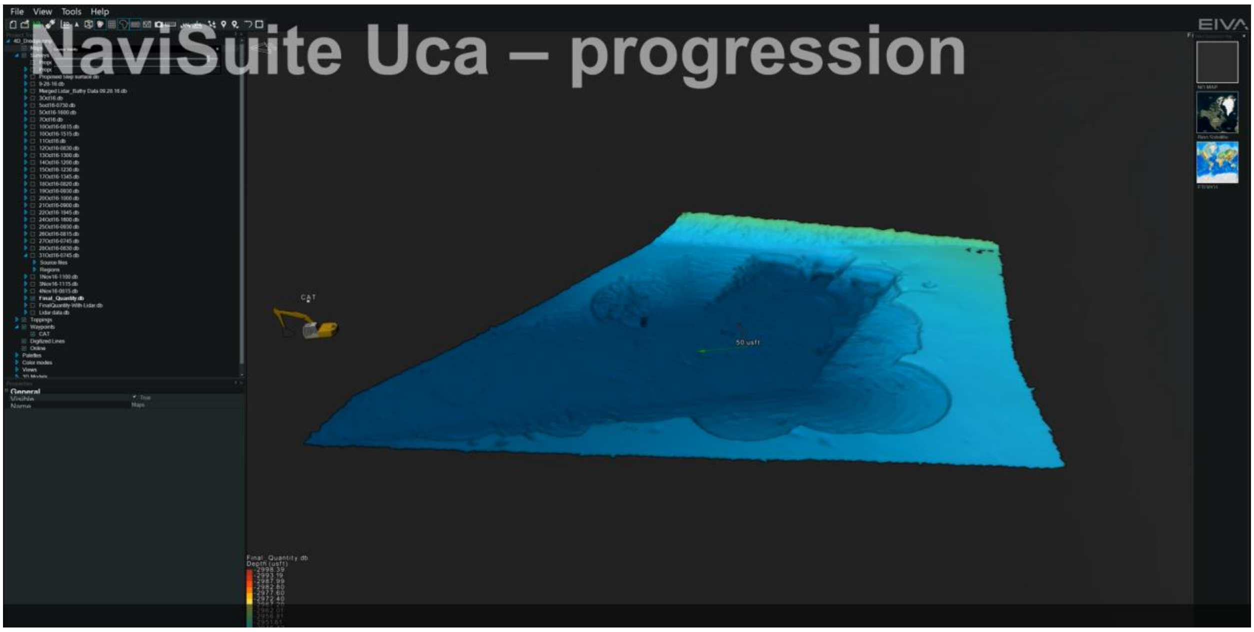

Figure 3 – Progress report day by day

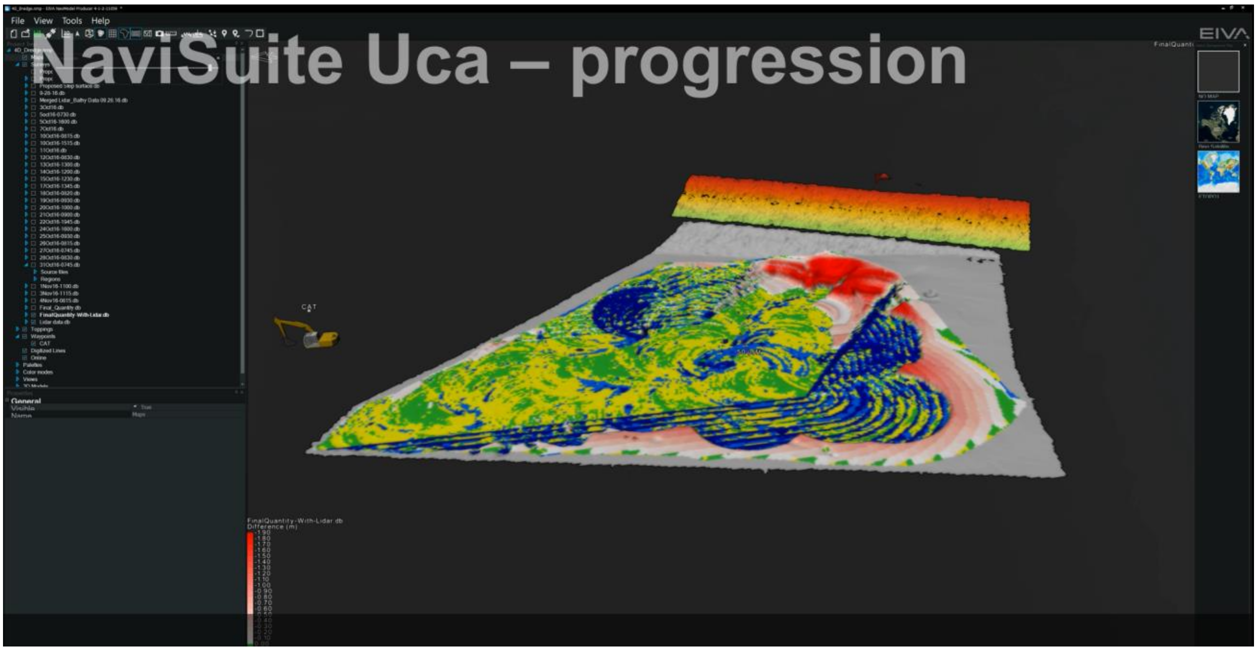

Figure 4 - Progress report by customizable color coding.

By using faster reporting techniques, VEIT began generating daily volume reports to show how much material that had been removed and how much material was remaining. These types of volume calculation previously would take hours using their established methods. By using the same software suite to log the machine data (and report the volumes), the time needed to generate the final progress report for the end-client was reduced to 30 minutes.

Another advantage that helped the project manager at VEIT to optimize their operation was the possibility to follow the real-time dredging work via the Trimble Connected Site or

TeamViewer functionality, where the operation could be monitored from a remote location. See the planned design below in figure 5: the software was constantly making a comparison between the surveyed surface and the design grade.

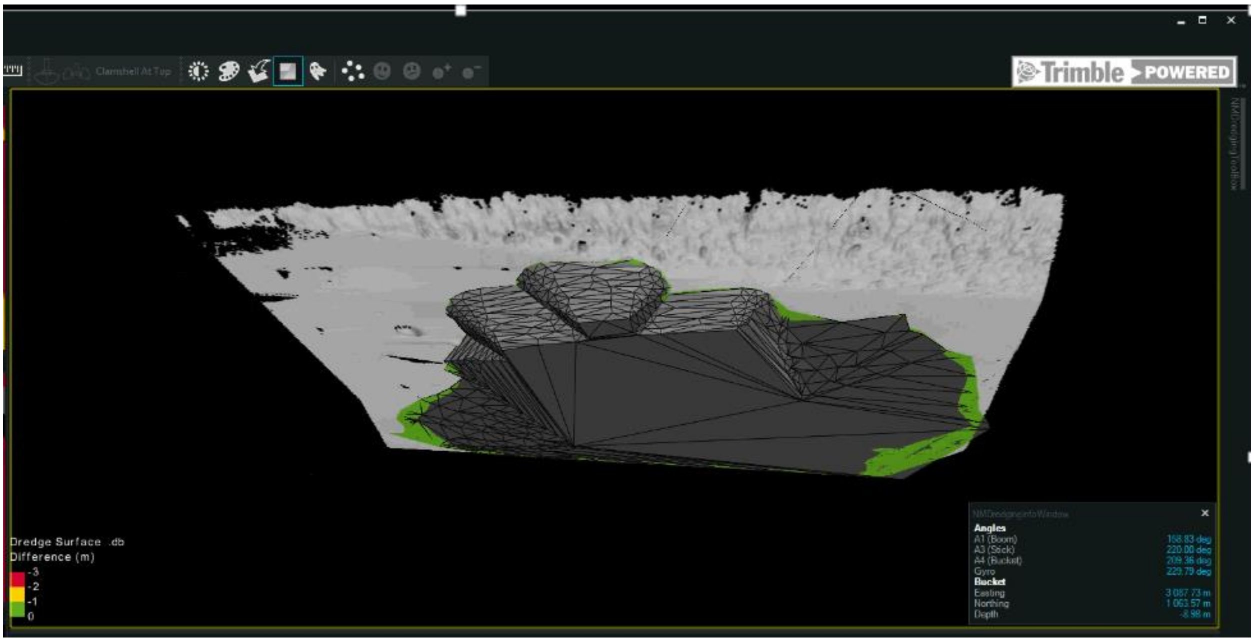

Figure 5 – TIN target dredge model.

The result is a significant increase in dredging performance and bottom line savings impacting the time needed for the barge spread and the excavator, but also the time needed for the land support equipment, excavator, trucking, dumpsite equipment, etc.

3D SOFTWARE WITH WIRE CRANE AND CLAMSHELL

In Norway, at the foot of steep mountains, a dredging contractor was challenged to ensure efficient performance during a dredging project using a wire crane and clamshell bucket. They were searching the market for a dredging solution which would provide a clear visualization of the clamshell's location as it entered the water and contacted the seabed. Previous experiences showed that as soon as the clamshell was submerged, the operator would run the operation on pure intuition, not being able to see the seabed, the clamshell, or where material already had been removed.

Their priority was how this could be properly visualized, allowing the operator to systematically work the area from one end to the other. Decreasing the amount of barge movement and giving the project managers more confidence that the seabed had met the design grade without missing any high points.

They contacted EIVA directly and explained the challenge, describing how a solution could be prepared meeting their needs for visualization and accuracy. The time frame from the initial contact to delivery deadline of the solution was tight, so the process needed to be based on a close dialogue to get a ready-to-use solution in place. Suitable sensors that could help register the open and closing of the clamshell as well as the payout of the cable for lifting and lowering were searched and found. The location of the sensors was discussed in close dialogue between the Norwegian contractor and EIVA, and it was determined that two cable counting sensors would deliver the best results. One monitoring the cable connected to the clamshell, the other monitoring the cable that controlled the opening and closing.

It was a challenge to place the sensors so that they could operate but still be protected during the operations. Figure 6 shows the installation of the sensors on the cable drums.

Figure 6 – location of cable counting sensors.

Another challenge appeared during system development was the geometry of the cable from cable drum to the position of the XYZ position of the clamshell as the boom was lifted or lowered. Characteristics of the boom geometry were found from the manufacturer and the algorithms were adjusted to fit the specific setup.

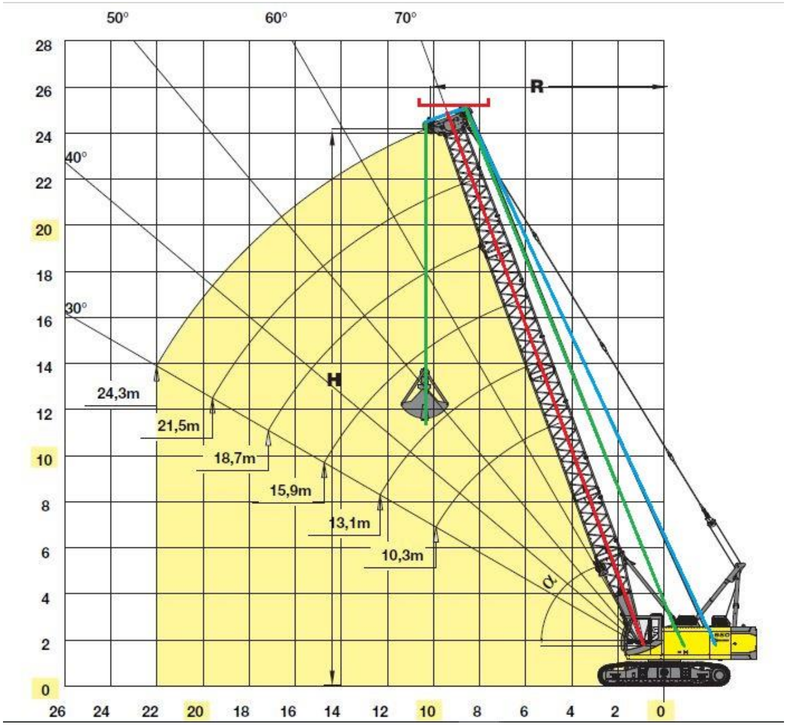

Figure 7 – Boom angles and crane reach

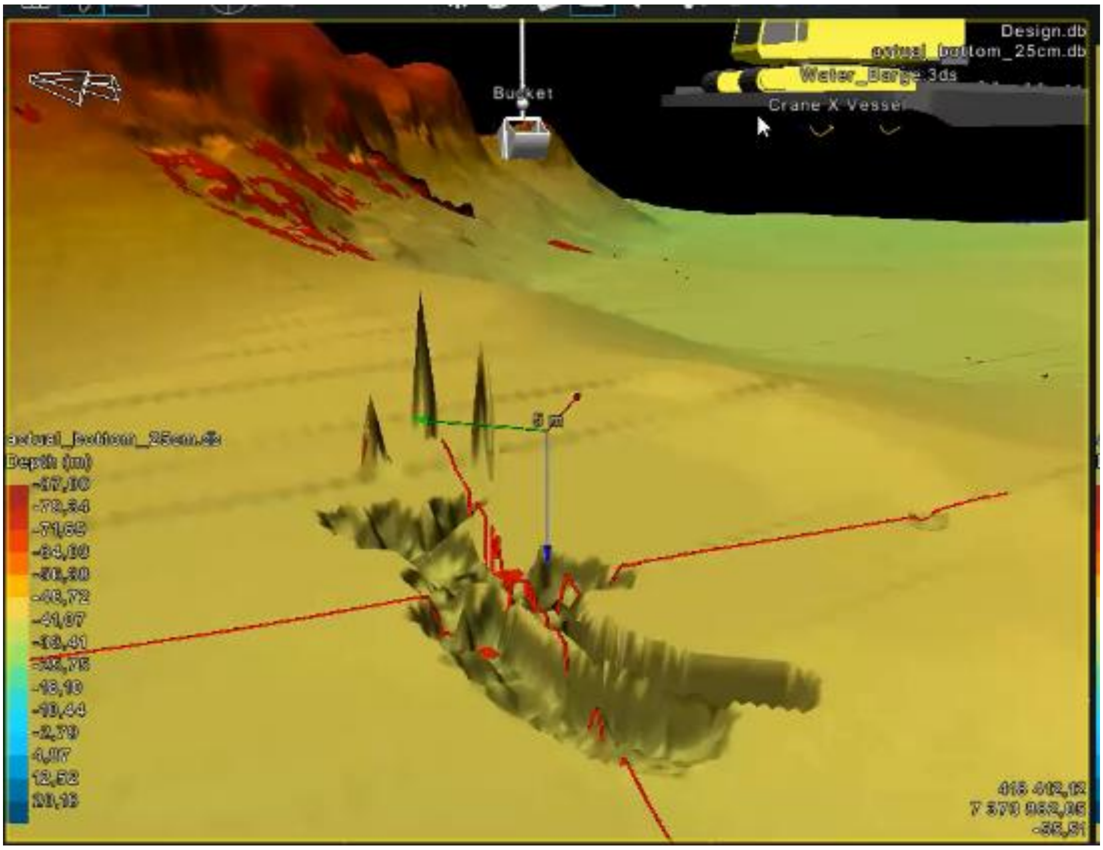

Figure 8 – 3D visualisation with cross profile.

The system setup was mobilized and configured in the 3D software, followed by the development of features within the software to enable visualization of the cross profile at the seabed to better understand where the clamshell would land. This would enable the operator to carry out and follow the operation on a 3D display installed in the right side of the cabin. No matter where the crane was positioned, the cross profile would be visible at the seabed and the operator would know exactly where to place the clamshell bucket next.

The operation took place at a depth of 20 meters, and without the visualization, according to the contractor, it would have been almost impossible to finish using the previous methods. The 3D visualization with a clear cross profile is shown in figure 8 and 9.

Equally important for the dredging contractor was how easy it would be to import large DTM models and to prepare the operation using the DTM and the design grade model. Even if the entire operation was carried out much more effectively, the software's ease-of-use was equally important. The EIVA dredge software offered these functionalities and enabled the dredging contractor to run the entire operation with extremely large data sets consisting of millions of points without any memory errors or computer down-time for the operator during the project. The operator was able to see the entire operation at a glance. This is shown in figure 9.

In Figure 9, the clamshell is breaking the surface and instantly mapping the progress. Side and angled views of the bucket are shown in the small windows while the overview of the project area is shown in the main view.

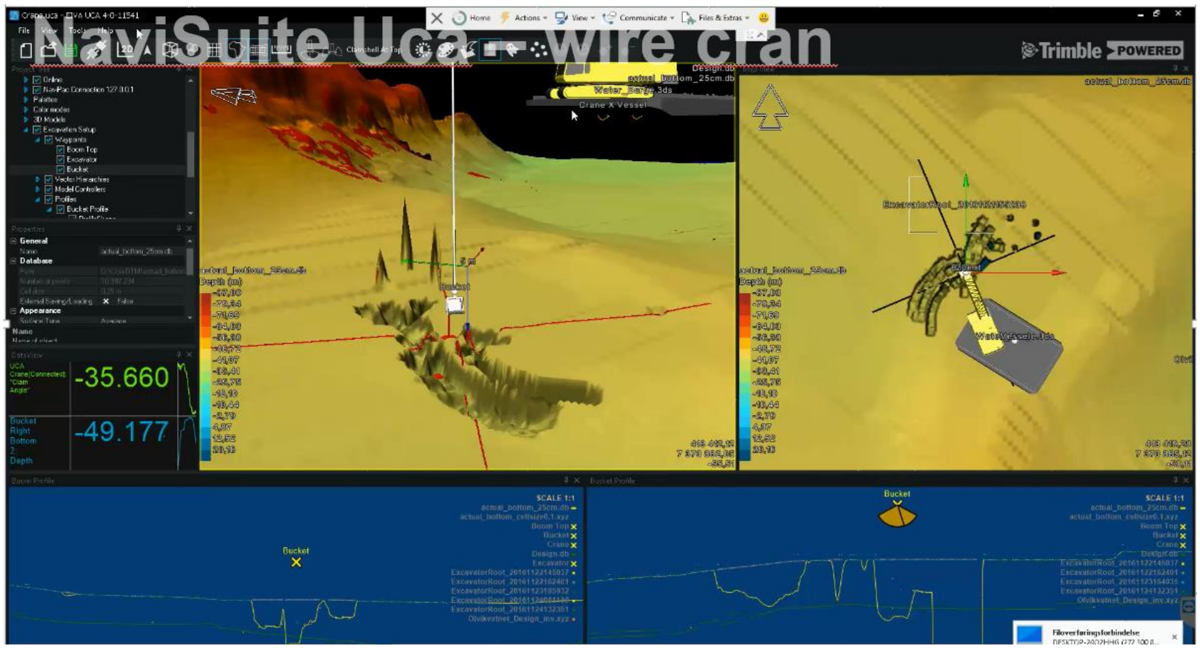

Figure 9 – Wire crane and clamshell solution.

Conclusion

The difficulties involved in precision dredging can be overcome with 3D visualization software that has already been developed for dredging operators that use excavators or wire cranes. The ability to know where the sediments have been removed, and where there is still work to be done has proved vital in increasing efficiency while decreasing the time it takes to report the progress. As the dredging, remediation, and reclamation market continues to grow it is expected that multiple software companies will begin to support 3D features in place of their current 2D displays as the demand from the dredging operators starts to shape the software products and deliverables requested by the end clients.

The next logical step would be to develop similar 3D dredging software for all current popular dredging methods including cutter suction heads on excavators and swinging ladders. For more difficult areas where sediments can slide or where high currents transport material that cannot be estimated by machine data alone, additional integrations of multibeam or 3D scanning sonars to update the dredge surface in real-time will be the clear solution to this challenge.

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