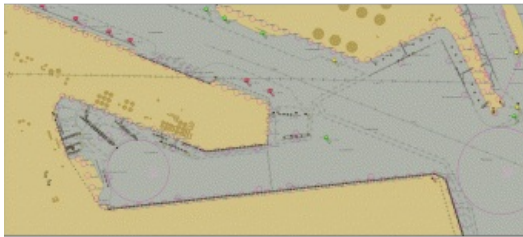


ENC PRODUCTION TO THE MAX

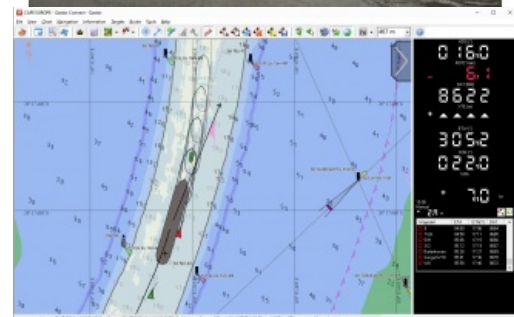
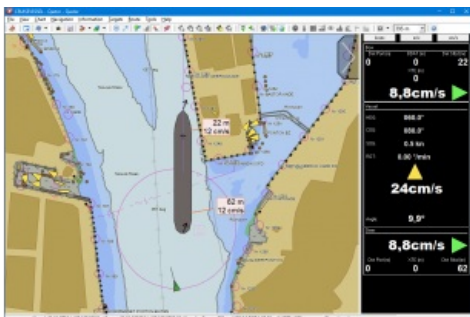
Port of Rotterdam â€™ Innovative Hydrography



The Port of Rotterdam is a leading global port and by far the largest seaport in Europe. The port is situated in the Rhine delta and with its direct connection to Europe's largest industrial region, the Ruhr area, it is a key entry point to the European market. Understanding the depths throughout the 40km of the port's waterways is critical to the day-to-day running of the port. Because the Netherlands Hydrographic Office only produces Electronic Navigation Charts (ENCs) for harbour usage, the port investigated the possibility of producing 'Berthing' ENCs containing high-density depth data to support decision-making within the port.



The Port of Rotterdam started a pilot project to produce S-57 ENCs of the area covered by the port more than ten years ago. The goal of this project was to produce daily high-density ENC updates that incorporated daily hydrographic surveys of the area. This product was to contribute to efficient port planning by taking advantages of accurate depth data and available 'over-depth' in the port's basins and fairways, which minimise under keel clearance (UKC)



requirements. The 'over-depth' is the vertical distance between maintenance and actual dredged depths when the actual bottom is deeper than the maintenance depth.

It took nearly three years to take the high-density ENC into production due to many conversion tools that had to be developed and performance problems in creating depth areas at a contour interval of only 10cm.

In 2013, the port partnered with Esri to implement PortMaps. PortMaps, built by using the ArcGIS platform, is not only an asset management system, but also provides the framework for hydrographic production. The core element of PortMaps is the ENC production module built around QPS Qarto (Figure 1).

PortMaps went live in 2015. Nowadays, harbour masters, asset managers and marine pilots have access to the data needed, via Esri Maritime Chart Server (MCS). MCS provides the port with the most recent ENCs available, including ENCs created with depth information surveyed that same day. The port operates a fleet of dredgers to keep the port open all year and for safe navigation. In addition, two survey vessels, equipped with the latest multibeam echo sounder systems, survey the port. It is not uncommon for three surveys to be conducted per day.

The Hydrographic Survey Service

Hydrographic surveys of the port are conducted daily according to a survey plan generated from siltation rates. The port operates two survey vessels equipped with the latest multibeam echo sounder systems and with the help of QPS QINSy (Figure 2).

The multibeam surveys contain overlapping tracks to distinguish seabed objects from unwanted noise/spurious soundings. The survey data is processed onboard the vessels on the same day to a 1x1 metre grid. On slopes of bottom protection rock dump areas, a mean of 0.5x0.5 metre grid is created to maintain detail of the seabed. Once the survey has been fully processed it is sent to the Data Management department as a clean digital terrain model (DTM). The survey vessels are connected to the Port of Rotterdam local network by high speed connections. The surveys are copied to the network drive which is monitored by the PortMaps data team. The Data Management office converts the DTM from an ASCII file into a GeoTiff containing two bands: depths and date of survey. After a quick visual inspection, the GeoTiff is registered with the ArcGIS BIS.

The port maintains a complete bathymetric surface model for its jurisdiction using the ArcGIS for Maritime solution. When new surveys are registered with the BIS they are overlaid onto the existing data into a seamless bathymetric surface based on a set of filters and rules. The ArcGIS for Maritime solution uses ArcGIS mosaic dataset functionality to combine the individual surveys into a seamless surface based on the rule 'most recent surveys data on top'. The Port of Rotterdam's surface model is updated daily with the latest surveys to ensure the most up-to-date data is included in the port ENC's.

The survey data recorded by the port's survey vessels are not only used to produce ENC's but are also used by the port's dredging team. Their task is to analyse the survey data against a port design model. Products like surface difference charts and volume reports are generated to monitor the siltation of the port. This information is used to instruct the dredging vessels where the maintenance dredging is required. This process will guarantee the port's accessibility 24/7.

ENC Production and Updates

The Port of Rotterdam ENC and IENC (Inland ENC) production is almost close to perfection using the latest versions of ArcGIS, QINSy Processing and Qarto. Thanks to a joint operation by Esri, QPS and the Port of Rotterdam the ENC production process is improved by the following steps (Figure 3):

- ENC and IENC production from the ArcGIS product library
- The ArcGIS S-57 validation utility
- The QINSy Processing generalise DTM utility
- Qarto depth contours and depth areas have quality and performance improvements
- Qarto date-of-survey areas (M_SREL) auto populated from DTM metadata
- The Qarto S-58 validation utility

When an ENC update is required, the base ENC's can be exported from the Nautical Information Server (NIS) using the Nautical S-57 tools. The Nautical S-57 tools use an ENC cell coverage layer to select and batch export ENC cells that need to be updated. The complete port area can be exported as ENC's in less than an hour. At this stage of production, the exported ENC's do not include bathymetric information. To complete the S-57 ENC Qarto is used

The Qarto workflow is completed within just a few mouse clicks. From the Bathymetric Information Server (BIS) Qarto receives a 5x5 metres sounding grid based on the shallowest depths including the date of the survey, as well as features from the NIS. With this information Qarto creates the depth contours at 10cm intervals (for depths less than 25m), depth areas and spot soundings. Finally, it takes the GIS exported ENC (base cell) and integrates this with the depth model.

In other words, a new ENC set is produced, populated with the most up-to-date nautical information and the latest hydrographic data. Once the ENC's have been made available they are published to a wide variety of different users in the Port of Rotterdam.

Maximise Port Accessibility and Goods Throughput

The aim of all ports is to increase the throughput of goods by maximising the accessibility for vessels under all circumstances. The two principal ENC users at the Port of Rotterdam are the Port Authority and Marine Pilots group (Loodswezen). Both groups use the information in different ways to assist in safe navigation of ships with marginal UKC. The use of high-density ENC's or bENC's (Bathymetric ENC) by marine pilots is a critical factor in this part of the operation. The bENC's show exactly where it is safe and where it is not safe for navigation, taking the vessel's draft and the real-time tide level into account.

Any vessel that is limited to the fairway by its draft must call into the Port Authority at least 48 hours beforehand. When the vessel calls in, the Harbour Coordination Centre (HCC) checks the fairway and berth depths using MCS. In the MCS user interface the HCC officer can enter the vessel's draft, UKC and tide level. The safety contour will be derived from this information and shown automatically in MCS. During this time, the pilot will update his Portable Pilot Unit (PPU) with the same ENC's and MCS to prepare the vessel's transit to the berthing location (Figure 4 and 5).

The Port of Rotterdam has produced almost 300 usage band 5 (Harbour) and 6 (Berthing) ENC's. The usage band 6 cells all have depth contours with an interval of 10cm to give it a bENC or high-density ENC character. Based on the latest surveys the new editions of the cells are selected and produced overnight. In other words, what was surveyed yesterday is available as a bENC today. The bENC's are in use by pilots, harbour masters and potentially even captains (with pilot exemption) of the ferry services that have daily schedules to and from Rotterdam.

Conclusion

QPS and the Port of Rotterdam have been hydrographic partners for many years. The delivery of hydrographic data is critical for the port operations. The introduction of PortMaps enables the Port of Rotterdam to produce a wide variety of information products in less than 48 hours. By combining the GIS activities of all asset management departments of the Port into PortMaps, errors are significantly reduced and data is synchronised.

Future Developments

The success of the PortMaps project and the easy accessibility of information products has meant that the user group is still growing. In fact, the demand for other information products is growing.

As the port has reached the initial operating capability, the next phase of the project is to optimise the automation and streamline the workflow. Web services can be introduced to serve clients. Shipping companies and agents will be able to reduce turn-around times if they can access the latest depth information.

Due to the legislation in some countries the method used by the Port of Rotterdam is not always accepted. In these countries, marine pilots are obliged to use the official ENC's produced by the country's Hydrographic Office, although a bathy overlay ENC in combination with the official ENC is allowed instead of a complete chart. For the next version of Qarto, it will be possible to generate bathy overlay ENC's (Figure 6).

More Information

- 2015 US Hydro Proceedings. The Port of Rotterdam: A Modern Hydrographic Workflow. By Jeroen van Reenen, Port of Rotterdam, Rotterdam, The Netherlands. Co-author Caitlyn Raines, Esri, Redlands, CA.

<https://www.hydro-international.com/content/article/port-of-rotterdam-innovative-hydrography>
