REDEFINING HIGH-DENSITY ENC PRODUCTION

Hands-off ENC Production

Imagine piloting a 398m container ship into port TODAY using an ENC updated with survey data collected YESTERDAY. Isnâ€™t this order of turnaround time the ultimate dream of any ENC production agency? Modern echo sounders are able to provide a staggering amount of sounding data. Managing, and storing, the ever increasing volume of survey data is becoming a hot item on the agenda of many ENC producing agencies, including port and river authorities who have taken on the responsibility of creating and maintaining their own ENCs. Processing this data into high-quality, high-density ENCs requires a powerful, flexible and easy-to-use ENC production platform. QPS, in collaboration with Dutch Oracle Spatial specialist Atlis, has developed a flexible database solution that combines a â€˜bathymetric warehouseâ€™ with a â€˜nautical warehouseâ€™ for ENC data to form an easy-to-use ENC production platform collectively known as Qarto.

Profitability

More and more port and river authorities around the world are striving for greater safety, efficiency and, above all else, profitability. Achieving increasingly narrow under-keel clearances without compromâ€“ising safety increases earnings for everyone. A key factor in realising these goals is the availability of highly accurate and extremely up-to-date ENCs. With an accurate ENC depiction of current port and river conditions at hand, along with real-time tidal information, the authority is able to plan for earlier port arrivals and departures and shorter turnaround times. Pilot organisations increase utility of Portable Pilot Units (PPUs) and advanced onboard GNSS docking and approach systems when they are supplied with accurate and up-to-date charts with which to navigate.

Triple Solution

In the absence of readily available, truly current ENCs from national hydrographic agencies, QPS and Atlis have developed an ENC production platform to allow authorities to prodâ€“uce and update their own charts with a typical turnaround time from survey to finished charts of 24 hours or less. The solution comprises three co-operating data warehouses, namely: a â€˜Bathymetric Warehouseâ€™, a â€˜Nautical Warehouseâ€™ and a â€˜Customer Warehouseâ€™. The combination of these warehouses allows a clear separation of processes and responsibilities, while automated integration of data on the production side requires minimum user interaction.

Bathymetric Data

Storing bathymetric data requires a dynamic and expandable solution. This can be achieved using a file-based system combined with a metadata engine, or by using a commercially available database with a spatial extension, such as Oracle. The clear advantage of the latter is the intrinsic characteristics of a RDMS that supports enterprise-scale applications in a very robust way. Both solutions use a metadata structure accessed using industry-standard SQL statements. This provides for a flexible method of exporting bathymetric data both for ENC production and other users. To speed up the storage and retrieval of bathymetric data a combination of spatial metadata is used; for example, concave hull representation of the survey. For intelligent data reduction an advanced, high-resolution tiling mechanism is used in which the combination of survey accuracy (IHO S44 95% Confidence Level and TPE) and seafloor resolution is not jeopardised in any way. So that only 5% to 10% of the original dataset has to be archived.

Nautical Data

The key part of an ENC production process is, of course, the ENC itself. As the S57 format is based on usage and non-overlapping cells within the context of diverse usage it is tempting to create a nautical warehouse in which each cell is stored on its own usage layer. This provides us with a simple and complete way of warehousing the data but will result in a maintenance nightmare for the producing agency. The solution that we have chosen is modelled roughly on the idea of a GIS database built specifically for S57 data. The spatial skeleton in S57 was translated to spatial primitives used in the GIS industry, extended with administrative records used to define necessary relationships between the S57 geometry. A similar solution was created for S57 features, existing as a collection of metadata and linked to the geometry using relation records. Surprisingly, the S57 model facilitates a solution like this with relative ease.

Maintenance Layer

As the ENC data is stored in a single layer, maintenance will require significantly less time and is also far less error-prone. During maintenance the user will select one or more cell definitions for which the data is retrieved from the nautical database. This will always result in a slightly larger area being retrieved, because all intersecting geometry must be available to the user. Altering the contours of a coastline, for example, needs to done only once . All ENCs produced after this change and containing the coastline will automatically incorporate the alteration.

Customer Warehouse

Streamlining the delivery of finished ENC products to various customers with different needs requires a flexible, customer-oriented warehouse. For example, ENCs for pilots, inland shipping and Solas vessels all require differing content. So an automated ENC production system is not complete if it is capable only of generating ENCs for multiple usage. Various groups of clients using these ENCs in their daily

operations will have a differing perspective on the data in the ENC and its presentation. Pilots primarily concerned with under-keel clearance will want high-density 10cm contours so that changing tide values are reflected in a dynamic safety contour. On the other hand, VTS operators may be satisfied with the 0, 5 and 10m contour, since they are primarily concerned with horizontal separations. But what these users do have in common is the rest of the data in the ENC. And all customer groups share the need for a fast turnaround time of updated ENCs based on accurate, identical data.

Cell collections can be created or automatically generated using customer-specific settings like agency, usage and compilation scale. These general settings are supplemented with specific settings for SCAMIN attributes that can be used for improving the presentation of the generated ENC products. Variable SCAMIN values for bathymetric objects (contours and spot soundings) can be used for controlling the number of S57 objects visible at different display scales in ECDIS or ECS navigational software. For example, metre contours will receive a higher SCAMIN value than decimetre contours. A similar approach can be applied to spot soundings by generating clusters of soundings of variable spread. A third option is to apply SCAMIN values to specific feature classes. It is also possible to produce customised ENCs for specific needs, e.g. charts with decimetre contours for pilots, or Inland ECDIS charts for river navigation.

Automatic Production

The combination of the three warehouses allows close monitoring of cross-references between key production parts of an ENC. So when adding a new buoy to the maintenance layer of the nautical warehouse all affected cells are automatically marked as â€˜needing an updateâ€™. Similarly, a newly loaded bathymetric dataset will prompt the user to produce new editions of all cells covered by this survey (depending, of course, upon priorities). After completing the required production steps, all produced editions and updates are ready to be distributed in an exchange set.

Editions

Producing an ENC combines input from all three warehouses. A number of customer-specific settings for the ENC are read from the Customer Warehouse. ENC data is then extracted from the single layer of the Nautical Warehouse using a â€˜cookie-cutterâ€™ method. This data is then enriched with bathymetric data extracted from the Bathymetric Warehouse based on priorities (for example, multi-beam over single-beam) and dates, creating a high-quality â€˜de-conflicted Navigation Surfaceâ€™. Contours and sounding are generated mathematically from the de-conflicted navigation surface rather than requiring a specialist to do this manually in a traditional set-up. A number of contour-generation methods are available and can be summarised as shoal-biased, regular mean-based grid, and uncertainty-corrected grids (using CUBE). The surveys utilised in the ENC cell provide users with accurate quality of data (MQUAL) and survey reliability (MSREL) meta-features.

Updates

Producing ENC updates from the Nautical Warehouse probably seems the most straightforward step in the whole process, i.e. a simple accumulation of all changes within a cell since the previous production. However, experience has taught us that many modifications are made to the same objects and geometry. Therefore it seems more logical to have software find the differences between the current and the previous situation, optimising the update size and complexity and minimising problems occurring in common â€œOops, I was not finishedâ€ halfway situations. In some cases the operator is prompted to produce a new edition rather than an update. This is done automatically by the system, which decides on this course of action when bathymetry updates have occurred, a Group 1 object been modified or if the update just becomes too complex.

Distribution

The Nautical Warehouse keeps track of all editions and updates produced. When the next shipment for a customer is prepared all files needing distribution are selected automatically and included in an exchange set which may be either a complete set of edition and updates or an incremental set of updates and new editions only.

Concluding Remarks

By using a combined database solution for storing bathymetric and electronic chart data bundled with a set of powerful client applications it is possible to create a flexible and easy-to-use ENC production platform that contrasts sharply with existing tools which are both complex and cumbersome. These new tools allow much shorter turnaround times from actual survey to distribution of the ENC, as evidenced by current users. For example, turnaround times for the Scheldt River and the Rotterdam port area are now set at a maximum of seven days, which is easily met. Ready availability of up-to-date ENCs, combined with accurate tidal data, leads to increased safety and profitability for port and river authorities. The single maintenance layer cuts ENC maintenance by the differing usage the agency needs to provide, freeing time to focus on quality rather than quantity. Automatic notifications reduce administration to an absolute minimum and provide a good overview of current status for everyone working within the same arena, easing transfer of responsibilities.

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https://www.hydro-international.com/content/article/hands-off-enc-production