Bathymetric Data Management for the Future

The Canadian Hydrographic Service (CHS) is involved in the definition and experimentation with S-100, the next standard for high-definition bathymetry. This new standard will enable hydrographic offices to deliver bathymetry to a level of detail never seen before. Implementing the standard into production will pose many challenges for data producers. Those high-definition bathymetry files need to be created, distributed and updated. New technologies and processes must be adopted and refined, and many critical issues must be resolved to ensure maximum production efficiency.<P>

The mandate of the CHS is tomaintain a portfolio of navigation charts and provide water level information all across Canada. High-resolution surveys are part of CHS' usual business, which comes with increasing pressure to deliver high-resolution bathymetry to a wider audience. Developing new products involves much work and putting it into production will be an enormous challenge. The S-100 product specifications are now at the final draft stage. The CHS has realised some test projects for high-resolution bathymetry through which they have been able to experiment with the S-100 standard as it pertains to the bathymetry layer.

Multi-beam Data to S-57

In 2006, the St Lawrence Seaway Management Corporation approached the CHS to transform its multi-beam survey data into S-57 files. Requirements were 10-centimetre contours and sounding selection every 5 metres.

Initial steps were taken to ensure the quality of the source data. Data processing methods were reviewed and amended so that the resulting S-57 files would be high-resolution as well as continuous, so that the contours would be consistent from one file to another.

Streamlining Bathymetric Processes

The CHS determined that the 'navigation surface' concept from the Center for Coastal and Ocean Mapping and Joint Hydrographic Center (CCOM/JHC) would be the best method for production of the files. The navigation surface processing workflow offers a new approach to managing, archiving and creating multiple products from hydrographic survey data.

The requirements of the Seaway Corporation for 10 centimetres posed the first challenge for the CHS. While it would be feasible, the output would be jagged contours with an enormous number of vertexes for every contour. Moreover, the resulting files would exceed the S-57 standard limit of 5MB.

Using CARIS BASE Editor software, the CHS began producing product surfaces using generalisation and defocusing tools on the grids to generate smooth contours and selected soundings while maintaining the highest resolution supported by the original data. Figures 1–3 show results of surface generalisation.

Further challenges lay in the need to achieve continuity between the S-57 files. To do so, the contours must be derived from the same surface. BASE Editor was used to validate, prepare and compile full-density bathymetric data from all the surveys and to create an 'optimal'-density bathymetric surface from which the CHS could extract contours and soundings.

Hurdles in S-57 Delivery

The S-57 files were cut following the survey zones of the Seaway Corporation, roughly 1 kilometre along the navigation channel, and the files were named according to existing survey zone numbers.

The S-57 files generated for Seaway Corporation adhered to the S-57 spatial reference frame but the product surfaces or grids used were all projected. This highlighted a distinct obstacle for the delivery of high-definition bathymetric data to the end-user community since mariners, pilots, harbour authorities, federal agencies and other stakeholders do not want the data to be limited to any single projection or any non-regular chart scheme.

The only way forward was to generate grids on a geographic reference frame. It was not practical to grid at 1 metre, but rather at 0.000020. File extent issues would prevail if gridded beyond this. The extents of the files completed for Seaway Corporation were approximately 1 kilometre long; however, it is recognised that this will not be applicable in all situations. Every organisation involved in hydrographic survey uses different survey zones. The CHS did not want to deliver a product to Seaway Corporation that would not be useful everywhere.

Usages as a Way Forward

The draft release of the S-101 ENC Product Specification (August 2007) may show a way forward. S-101 presents three usages. The CHS is currently pushing forward to work with rectangular geographic cells under the following scheme: ?SBItHarbour entry: current approach and harbour scale data sets combined (navigation from the pilot point to berth). Proposed extent = 0.02°×0.02°?SBItCoastal: medium-scale continental shelf (for coastal navigation and approach to pilot points). Proposed extent = 0.1°×0.1°SBItOverview: small-scale world (route planning and oceanic passage). Proposed extent = 1°×1°.

This arrangement fit the S-57 spatial reference system (max. resolution 0.0000001). Working with multiples of 0.0000001, the CHS will maintain a coherent schema. Using this scheme, the CHS will not require any specific survey zone frame and the geographic rectangular cells will eliminate many complications.

Putting it into Production

Creating products using a scheme such as this will allow the implementation of automatic processes for product creation. Data must be held in a data warehouse in which all survey surfaces at maximum resolution will reside. The CHS has selected CARIS Bathy DataBASE to bring all available bathymetry source data together in one repository, along with background files and imagery,
The data warehouse then becomes the central repository from which users extract data, combine surfaces, generalise and defocus using parameters suitable for the product usage. Finally, the geographic cells are used as a template to generate products. This simplistic methodology is ideal in the management of the impressive number of cells to be generated.

Updating grids in a timely manner will be a challenge. Working with cells will help. Every new survey coming in will have a survey extent. Using that extent, it will be easy to know which cells will need updating. Updating the bathymetry layer will be quite different from what we know from S-57. A cell update means a new cell will need to be computed and put in the product warehouse. Efficient data processing and quality control from the end of a survey to final cell update will be the key to fast output. Manual intervention must be kept to a minimum.

Internet-based Product Delivery

It is recognised that internet distribution will be the most effectivemeans for the CHS to meet the mounting demands for delivery of multiple-format, multiple-resolution bathymetry.
For the CHS, the ability of Bathy DataBASE to connect to a web service was critical as they look ahead to the distribution and update of high-resolution cells. Figure 5 shows the CARIS bathymetric data management workflow with web distribution. Web-mapping software will provide an interface to spatial data, including hydrographic information and bathymetric data. Through the web interface, the user would have the ability to view, query and select data sources.

Integrated database and web-mapping technology will enable data providers to share data within their organisation and across departments, combine multiple data sources in a single interface, deliver hydrographic and chart data via the web, and support marine spatial data infrastructure initiatives.

Further Exploration

The St Lawrence River is one of the test areas for the next standard for gridded bathymetry, with seamless vertical datum, water level models, squat models, high-density source data, frequent surveys, etc. all in place. Throughout the Seaway Corporation project, it was paramount to deliver a total solution, from survey to chart. Many challenges were met and overcome yet more remain to be addressed as the S-100 product specification is implemented and evolved. Selected solutions must use new and emerging technologies to ensure efficient and secure workflow that can be adapted throughout the transition.

References

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