Efficiencies in Data Acquisition and Transformation

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SUMMARY

For many hydrographic offices, the introduction of electronic nautical charting has created two production streams: traditional (hardcopy) chart production and electronic (softcopy) or ENC (Electronic Nautical Chart) production. Until recently, survey technology and methodologies were designed to support the acquisition of data by providing deliverables suited to hardcopy chart production; additional data transformation including the creation of spatial objects and attributes were required to satisfy IHO standards for ENC production. Cartographic development has lead hydrographic offices to consider the use of a common digital data source for the production of both paper and electronic publications. Similarly, tools and methods have been developed which enable the hydrographic surveyor to support and perhaps expedite the process of common source chart production.

This paper provides an overview of the processes and survey deliverables involved with capturing and transforming hydrographic features into spatial objects accordance with the IHO S-57 (Special Publication No. 57) standard.

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FORWORD

The subject of this paper is a series of processes presently under development, within the various regional offices of the Canadian Hydrographic Service (CHS), Fisheries and Oceans Canada. The Central and Arctic Region of CHS, with direction from the (CHS), Technical Services Working Group and Hydrographic Product Database Working Group is endeavouring to implement new techniques for hydrographic data acquisition and subsequent transformation of field data into S-57 objects. Our ability to implement changes in the way we capture and manipulate spatial data in the marine environment has been enabled by technological advances in survey electronics, which yield higher resolution and greater accuracies and by commercially available hydrographic software applications which transform data into spatial information. These processes represent a departure from the traditional approach to surveying at 2-3 times product scale in order to "bury" systematic errors and positioning system accuracy limitations within the scale of the product.

Users of hydrographic information are demanding super scale detail and therefore greater positional accuracies are necessary to support such detail. Metadata records to describe source information and its fitness of use are needed to capture the sort of information which would otherwise be included in the title of a plan of survey. This paper recommends that in the vector product world of Hydrography, spatial object attribution should not solely be the domain of the Electronic Nautical Chart (ENC). For surveyors, the approach to capturing data as objects while in the field gives rise to a new approach to managing field notes and multimedia used to describe survey observations. Developing a means to expedite the process of transforming data into graphic information and the implementation of new transformation techniques requires the ability to work outside of current practices.

Quality control milestones are not specifically identified in this paper, but workflow stages would suggest that some form of quality assurance be implemented at specific steps in the overall process.

1. WORKFLOW

1.1 Pre-Survey Preparations

The base file for project planning and for data acquisition begins and ends with a Hydrographic Object File (HOB) which is a quasi (editable) S-57, ENC file. This can be the existing official chart file with or in the case of new charting, a base file containing all available and relevant source information such as previous surveys, topographic base mapping and/or remote sensing imagery. In both cases, the latest maintenance items attributed to sources such as Notices to Mariners, proposed and existing plans describing changes to shoreline, Hydrography or aids to navigation would be incorporated.

1.2 Data Collection

To aid planning and execution of the survey project, a provisional ENC file is used as background for navigation in hydrographic and topographic surveys. Soundings are collected at a resolution which will support largest anticipated scale of depiction in the end product. Due consideration should be given to the presentation of data as it will appear as charted object information; particularly the "SCAMIN" value of an object (an ENC term describing the scale at which specific objects will be shown on an Electronic Chart Display (ECDIS). With the exception of "super-scale" ENC products, Topographic and hydrographic features are captured at a resolution which will support legibility of objects (points, lines and areas) at the official published chart scale. Although a so-called paperless approach to note keeping would be ideal, there is merit in keeping redundant notes and a logbook of survey as an aid to resolving problems during data processing. With the exception of soundings and data collected from peripheral sensors, data are captured as objects and coded in the field using an S-57 Dictionary. S-57 uses metadata objects to describe (navigational) position quality ("M-QUAL") and reliability ("QUAPOS"). Metadata records which describe a specific S-57 survey deliverable would be consistent with the above metadata objects insofar as describing the specific "fitness for use" of the hydrographic objects as source information.

1.3 Data Processing

At present, any value added to our survey deliverables through the application of S-57 and metadata standards will most likely be lost when having to share these data with non-navigational clients who will require information in a specific format. Obviously Notices to Mariners and/or Notices to Shipping would be generated and forwarded for immediate dissemination where safety of shipping is of concern. Tidal and current observations would be forwarded to those responsible for analysis and archival and if necessary to support post-survey datum adjustments. A case-in-point is where aids to navigation albeit collected as objects, must at present be forwarded in a non-object format suitable for use by the authority responsible for their maintenance. In Canada, the Canadian Coast Guard is a special operating agency of Fisheries and Oceans which works closely with the CHS to support and deliver the above mentioned services to the marine community.

1.3.1 Bathymetric Data

Sounding data sets are cleaned for presentation and subsequent post-survey data transformation as shoal-biased, statistical, "gridded" surface(s). Key to this process is that shoal depths must be preserved. Metadata record(s) associated with the bathymetric data are produced in accordance with International Standards Organisation (ISO) 19115 and the Content Standard for Digital Geospatial Metadata (CSDGM), also known as the Federal Geographic Data Committee (FGDC) standard for metadata.

1.3.2 Non-Bathymetric Data

As mentioned, data contributing to navigational information such as aids to navigation, are described, tabulated and forwarded to those responsible for review and dissemination. Data collected in support of chart products are validated, coded and input into the new or existing HOB maintenance file. Additionally multimedia (digital photos, raster images etc.) would be included within the HOB file marker layer as a means to support the new source data. Photographs in particular would be included as a "PICREP" attribute for specific objects. For example a lateral buoy, coded as "BOYLAT" could have a photograph attached to it. Metadata record(s) associated with non-bathymetric data would be produced in accordance with ISO 19115 and FGDC standards and guidelines.

1.3.3 Data Management

A plan for quality Assurance, data and metadata archival is a key factor in the transition of data to information, from "field-to-office", as a milestone towards product production. Ongoing networking between CHS working groups has thus far revealed that existing processes can easily be adapted to accommodate the implementation of new forms of source information especially given the implementation of a Hydrographic Production Data base (HPD).

1.4 Post-Survey Production

1.4.1 Bathymetric Data

Statistical shoal-bias surfaces are used to thin (suppress) and generate desired sounding presentations. The "base" bathymetric surface is also used to develop smooth contours and depth areas to support specific chart products. The depth areas or "DEPARE" (an ENC term used to describe a polygon enclosing a specific depth range) would in turn be assigned to a specific layer within an HOB file. Information selected as source for specific chart products would subsequently be loaded into the HPD. Inputs as such would be the validated HOB file (containing points lines and areas) as well as the selected sounding data. It is assumed that cleaned bathy data, available at the original survey resolution (or a density as practical for storage) would be archived in a source (point data only) data base. Prior to incorporation, the metadata associated with the source information would be reviewed against the product for fitness of use. The metadata itself would be made available through a data management scheme for publication via a data clearing house. In Canada, we have a "store-front" for spatial information called Geoportal.

1.4.2 Non-Bathymetric Data

As described above, the survey deliverable HOB file would be loaded into a production database. Multimedia information contained within a marker layer (to aid cartographic decision making), would be used augment information from the non-bathymetric source data. Prior to loading, the associated metadata would be reviewed to assess the fitness of use,

particularly data coverage, currency, positional quality and accuracy. Additionally, multimedia such as photographs etc. attached to objects within the HOB file could contribute to the creation of value-added hydrographic mapping products. Such products could serve as the basis for collecting other marine information suited to commercial interests, environmental, cadastral or oceanographic programs.

2. CONCLUSION

In conclusion, the efficiencies of this workflow will be realized when, we can reduce the number of times we have to "handle" data in order to transform it into information and in the larger scheme, a decrease in the turn-around time between survey and product delivery occurs. The processes described in this paper are being implemented (and obviously tested) by CHS survey parties and cartographic production units. This workflow was described without the intent to endorse specific commercial software products or to identify specific brand names. It represents a sort of "two-way street" as it forces Hydrographers to think more about the level of detail and content of the final product and how the final product would affect the level detail and accuracies required to adequately support chart work in a specific project area.

The approach described herein is multidisciplinary in nature whereas the personnel involved with the survey end of the program also play a significant role in the subsequent validation and transformation of the data to meet specific client needs. This allows for first-hand knowledge of the project area and provides an increased level of confidence to the cartographic decision making process. The author would like to acknowledge the contributions of those members of the CHS's Technical Services and HPD working groups as well as CARIS (Canada).

BIOGRAPHICAL NOTES

A graduate of Humber College's Hydrographic Survey Technologist program, **Andrew** has been surveying for 17 years, with varied experience in topographic, cadastral, offshore/industrial and hydrographic surveys for nautical charting. He is a commissioned Canada Lands Surveyor and is presently serving as the Hydrographer-in-Charge of the Eastern Arctic Survey, Canadian Hydrographic Service, Central and Arctic Region. He is president of the CHA, member of the Canadian Institute of Geomatics (CIG) technical council, and chair-elect for FIG Commission 4.

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