Surveying with Objects – Efficiencies in Data Acquisition and Transformation

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Abstract

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.

Introduction

The processes described in this paper are presently under development, within various regional offices of the Canadian Hydrographic Service (CHS), Fisheries and Oceans Canada. The Central and Arctic Region of CHS, with guidance 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, however a process involving peer review and end-of-line supervisory checking has been implemented in Central and Arctic Region.

Workflow

Pre-survey Preparation

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, bathymetry or aids to navigation would be incorporated.

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 (meta object) to describe (navigational) position quality ("MQUAL") 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.

Data Processing

At present, any value realized through the application of S-57 and metadata standards will most likely be lost when having to share these data with clients who will require information in a non S-57 data exchange format. For example, some scientific and engineering applications will only require an ASCII *x,y,z* data set with no attribution data. A separate metadata document would provide the client with valuable information on the data's fitness for use and lineage etc. In cases where there is an immediate requirement for hydrographic information to be disseminated for safety reasons (e.g. Notices to Shipping and Notices to Mariners) geo-information is communicated in plain language text. Survey data describing aids to navigation while captured 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 within

the Department of Fisheries and Oceans which works closely with the CHS to support and deliver these services to the marine community.

Bathymetric Data

Dense sounding data sets (eg. Bathymetry collected by multibeam sonar systems) are cleaned for presentation and subsequent post-survey data transformation as shoal-biased, statistical, "gridded" surface(s). Sounding data for cartographic purposes is exported from the surface as sounding objects to a shoal-biased sounding selection. 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. The geographic limits of a meta object describing a specific sounding data set would correspond with the bounding polygon or "g-ring" defined within the metadata record.

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 are included as a "PICREP" (pictorial representation) attribute for specific objects. For example a lateral buoy, coded as "BOYLAT" could have a photograph attached to it. Metadata record(s) used to describe non-bathymetric data are produced in accordance with ISO 19115 and FGDC standards and guidelines.

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 data acquisition and cartographic production processes can easily be adapted to accommodate the introduction of HOB-format source information with the use of a Hydrographic Product Database (HPD). Metadata records are validated using on-line tools and uploaded to CHSDIR (Canadian Hydrographic Service Directory).

Post-Survey Production

Bathymetric Data

Statistical shoal-bias surfaces are used to thin (suppress) and generate desired sounding presentations. The "BASE" (Bathymetry Associated with Statistical Error) 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. Source data as such could be the validated survey deliverable in HOB file format (containing points lines and areas) as well as the selected sounding data. Although under development for nearly two decades, the CHS source data base may soon serve as the source for validated bathymetric data, available at the original survey resolution (or a pre-assigned density chosen as practical for storage).

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. 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.

Data Management

Prior to retrieval, the associated metadata would be reviewed to assess the fitness of use, particularly data coverage, currency, positional quality and accuracy. The metadata itself would be made available through a data management scheme linking CHSDIR to an external a data clearing house. The national "store-front" for marine geospatial information is called Geoportal. A survey locator tool for browsing CHS source and metadata is called M270.

CONCLUSION

In conclusion, the efficiencies of this workflow is realised 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/client 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 vendors.

Object data capture software is now available for mobile applications. The concept of capturing data as objects when applied to traditional survey applications serves to provide the surveyor with a data logging tool combined with a digital notebook. While there is merit (and in some cases a legal requirement) in producing hardcopy field notes of survey, by employing tools for object and attribution capture, metadata and associated photographic and/or pictorial descriptions can be recorded in one digital field note record of survey. The efficiency of this process allows for transformation of the graphical field notes (HOB) file into a plan of survey (CHS Field Sheet) deliverable.

This workflow presents "two-way street" as it forces hydrographers to think more about the level of detail and content of the final cartographic product and how the final product would affect the level of detail and accuracies required for a plan of survey 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 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 19 years, with varied experience in land and hydrographic surveying. He is a commissioned Canada Lands Surveyor and an Engineering Project Supervisor with CHS, Central and Arctic Region. He is Chair of FIG Commission 4.