THE INDUSTRY'S RECOGNIZED AUTHORITY FOR DESIGN, ENGINEERING AND APPLICATION OF EQUIPMENT AND SERVICES IN THE GLOBAL OCEAN COMMUNITY

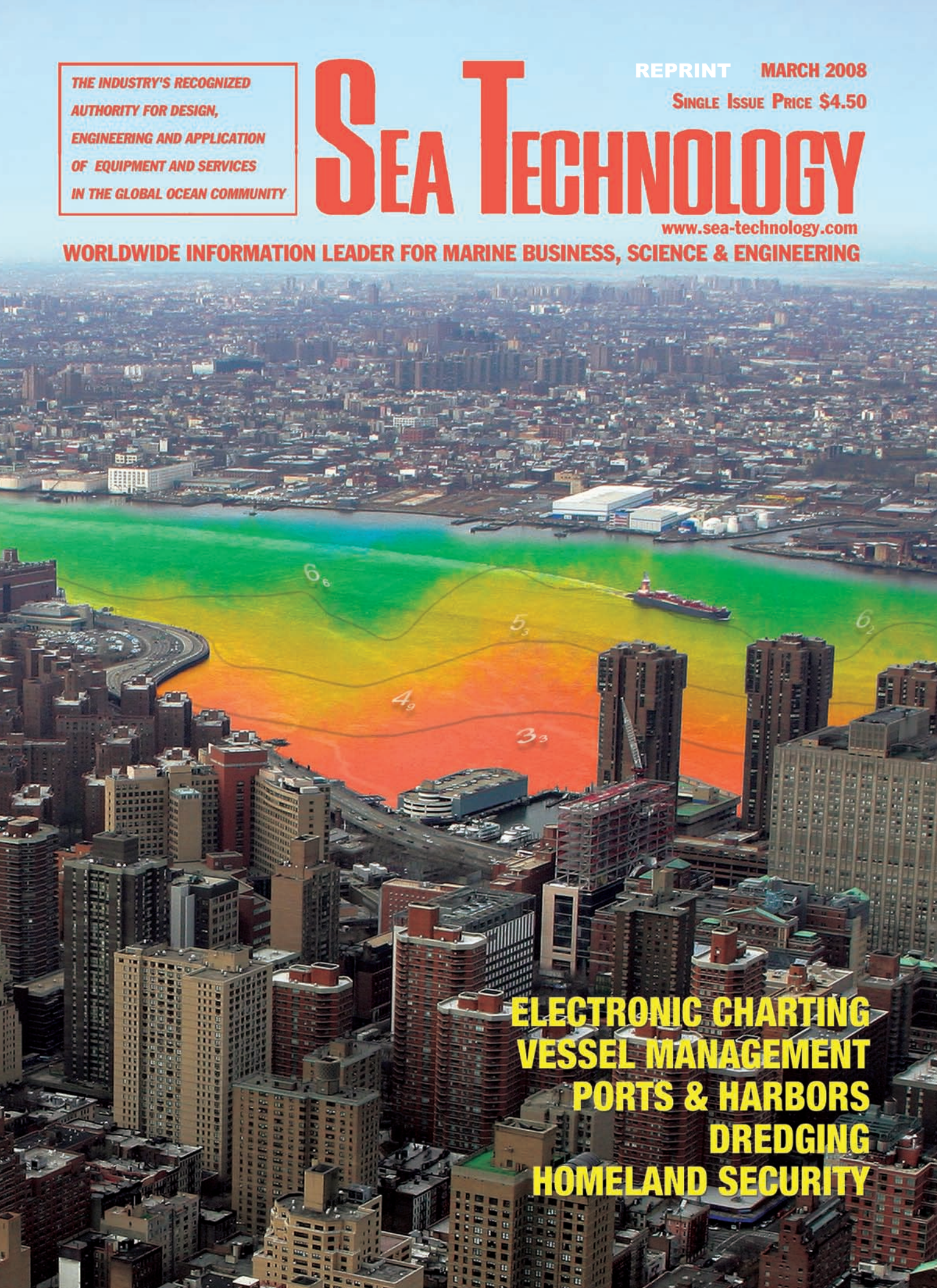
REPRINT MARCH 2008

SINGLE ISSUE PRICE $4.50

SEA TECHNOLOGY

www.sea-technology.com

WORLDWIDE INFORMATION LEADER FOR MARINE BUSINESS, SCIENCE & ENGINEERING



ELECTRONIC CHARTING
VESSEL MANAGEMENT
PORTS & HARBORS
DREDGING
HOMELAND SECURITY

Addressing the Need for Bathymetric Data Management

Assessment, Storage and Management Needs for Bathymetric Data Push Hydrographic Organizations to Find New Solutions

By Frederic Lavoie
Hydrographer
Canadian Hydrographic Service
Mont-Joli, Canada
and
Karen Cove
Product Coordinator
CARIS
Fredericton, Canada

Hydrographic organizations, port and waterway authorities and other large holders of bathymetric data have a need to assess large volumes of these data coming in from various sources for possible threats to safety of navigation. When the data are deemed valid, tools are needed to prepare and format these data prior to storage. CARIS Bathy DataBASE is a bathymetric data management system that provides these kinds of tools along with an effective retrieval and distribution system.

The storage and management of data sets within a single repository facilitates the distribution of all the bathymetric resources in an area to the most clients within and outside an organization. Users can connect to a single source and determine what resources they want to access. Ideally, data are stored at optimal resolution, not limited to set levels of resolution. The maintenance of the data at their optimal resolution allows the data to be exploited for the greatest number of applications, including applications such as engineering work, coastal studies and navigation. A bathymetric data management system can provide the underlying infrastructure needed to make the delivery of products more flexible and efficient.

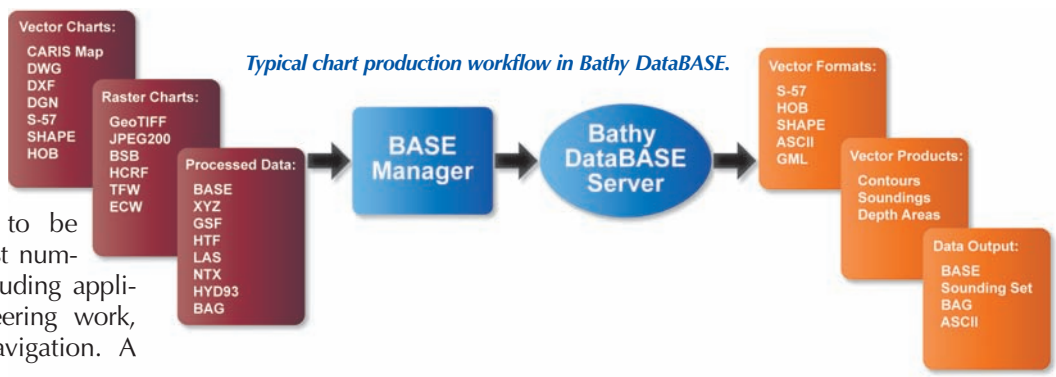
The Canadian Hydrographic Service (CHS) has a mandate to manage hydrographic data and make them accessible to its clients. Like other hydrographic organizations, CHS is facing increasing size and coverage of multibeam echo sounder (MBES) systems, increased demand for and distribution of products and a desire to make use of new and historical data in the creation of products. In an effort to continue to meet this mandate, they are looking to CARIS database-driven technology. CARIS Hydrographic Production Database (HPD) has been implemented for the management of hydrographic features, while Bathy DataBASE is being considered for the management of the source bathymetry from which features are derived.

Ping-to-Chart Processing

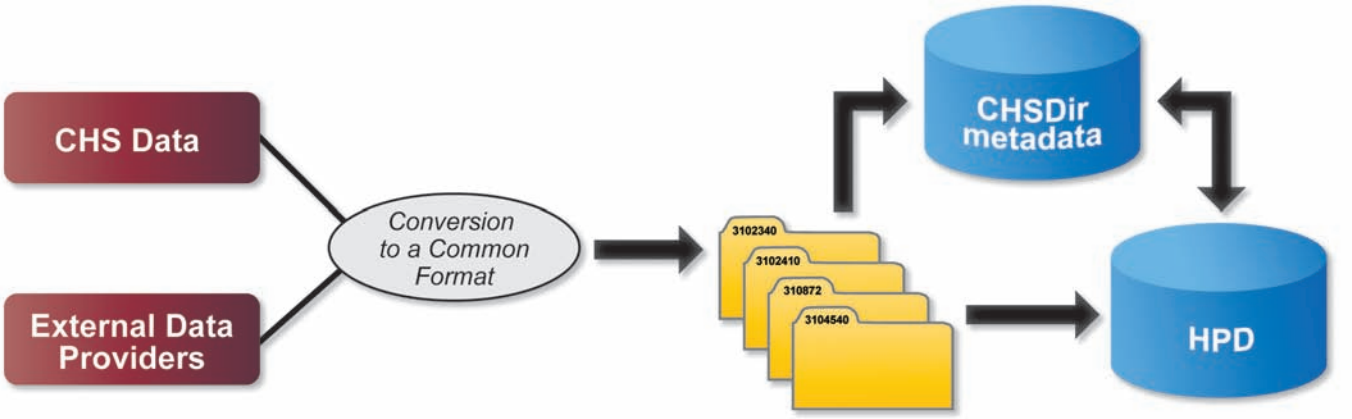
The need for tools that streamline the flow of hydrographic information from acquisition through to the creation of products has been brought forward by the hydrographic community over the last several years.

Bathy DataBASE addresses the need to store and manage surface density bathymetry. In the ping-to-chart workflow, Bathy DataBASE sits between data processing and validation and hydrographic data management and production.

During the development of a bathymetric data management system, CARIS focused on the management and storage of bathymetric surfaces that represent the data in a gridded format at the resolution that best reflects the spatial accuracy of the sensor used to acquire the data. The system was also designed to support the storage of data in non-gridded format. This storage format would be appropriate for the storage of sparse and/or randomly spaced collections of soundings—for example, single point, trackline data or digitized chart soundings. This allows for the integration of over-sampled data from modern multibeam and lidar systems with the under-sampled sources often found in historical archives.

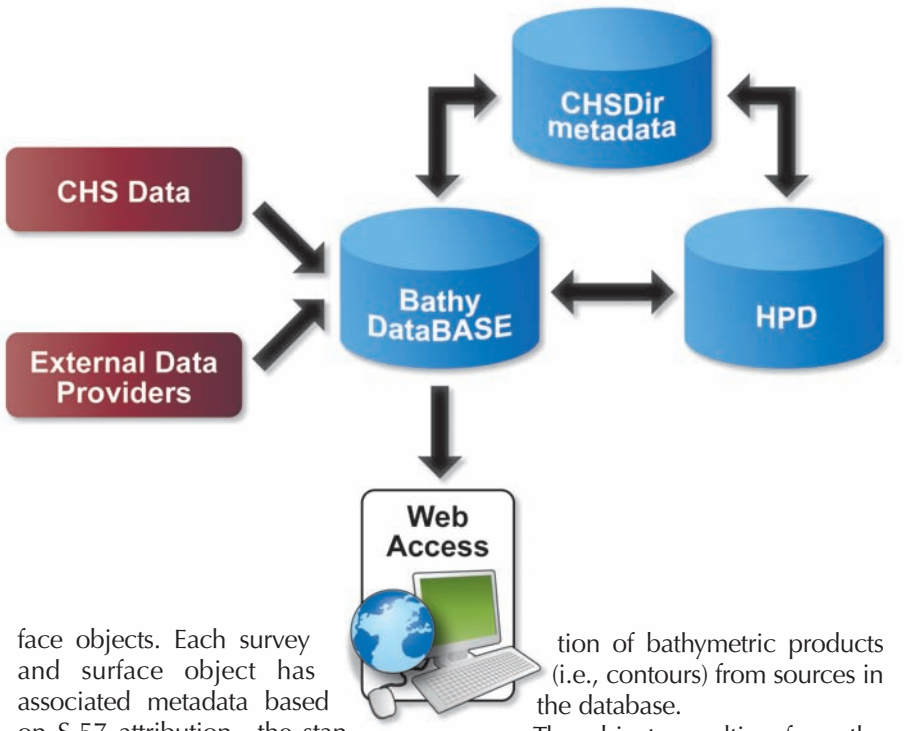


Typical chart production workflow in Bathy DataBASE.



(Above) A simplified representation of the file-based workflow for the bathymetric data management.

(Right) Bathy DataBASE and HPD workflow.



Bathy DataBASE Solution

Bathy DataBASE is a software suite composed of a client application, database server and database administration tools. The processing tools available in the client application can also be accessed as a standalone desktop application.

Workflow. An intrinsic part of the Bathy DataBASE system is the flexible tool set provided to evaluate and edit data sets from third-party sources, preparing the data to meet the standards of an organization so they can be used to enhance the organization's data holdings and coverage. All valid data can potentially be used in the creation of products such as nautical charts.

A typical chart production workflow would have data coming into the system from various sources, with some data preparation and validation taking place using the tools in BASE Manager. Validated data and metadata would be loaded into the Bathy DataBASE server. Measurements such as soundings, contours and depth areas would be generated from the source data.

Database Architecture. The Bathy DataBASE system is based on a client-server design. The system supports the storage and management of bathymetric data in the BASE Surfaces, bathymetric attributed grid files and sounding set formats.

Data are loaded into the Bathy DataBASE server as survey and surface objects. Each survey and surface object has associated metadata based on S-57 attribution—the standard used for the exchange of digital hydrographic data between national hydrographic agencies and for distribution to stakeholders. The catalogs defining the objects and their attributes are in extensible markup language format and are customizable by the user.

The object metadata and system-generated bounding polygon coordinates are stored in the database. The server software manages all interactions between the client application and the objects in the database. It handles transactions requested by the client application (the primary client being BASE Manager) for data loading, data extraction and object editing. Server resources are also used in the creation of generalized and de-conflicted surfaces and the generation of bathymetric products (i.e., contours) from sources in the database.

The objects resulting from the de-confliction process are also stored in the database. Both the resulting surface and the supersede decisions defined for the de-confliction are maintained, the surface is stored as a surface object and the supersede decisions are stored in a product profile object. The product profile object carries information about the area that has been superseded and the parameters of the supersede decision.

The Bathy DataBASE solution was designed to be scalable in terms of accommodating the types and volume of data currently being surveyed with multibeam and lidar systems. The scalability also addresses the need for coverage on a global scale as needed by some organizations that have a mandate beyond sovereign waters.

"The logical extension of any data management system is the distribution of those resources to clients."

Distribution. The logical extension of any data management system is the distribution of those resources to clients. Due to the massive improvements in communication systems over the past several years, delivery via the Web has become an efficient mechanism for disseminating geospatial information.

The CARIS solution for spatial data distribution on the Web is Spatial Fusion Enterprise. This technology provides an interface to spatial data, including hydrographic information and bathymetric data. Via the Web interface, the user has the ability to view, query and select data sources.

Spatial Fusion Enterprise implements the Open Geospatial Consortium Inc.® (Wayland, Massachusetts) specifications for Web map service. This allows data to be easily shared among organizations and allows connections to external Web sites for viewing additional sources of data.

Pilot Project: CHS Quebec Region

As part of a larger initiative to adopt database-driven technology in the processing and management of bathymetry and hydrographic data, CHS's Quebec, Canada, region is evaluating Bathy DataBASE.

The CHS Quebec region is in the early stages of evaluating Bathy DataBASE to improve the management of the bathymetry results from various types of surveys. Sources of bathymetry include new and historical single-beam, MBES, lead line and other systems. CHS has a mandate to manage all bathymetry sources for Canada and to provide these data to its clients. The goal of investigating new ways of managing these data is to be able to respond in the most efficient way to all requests from its clients. Using a bathymetry data management system like Bathy DataBASE allows bathymetry extracts to be tailored to meet a specific set of criteria. The criteria may include specifications for epoch, resolution and attribution. The data are provided to a wide variety of clients for applications in navigation, science and engineering.

File-Based Workflow. The current practice in place for the management of bathymetric data is the use of NTX files—CARIS exchange format files. All data are converted to a common datum and cartographic projection to make the future analysis easier. In the case of multibeam data, there is an extra step in the process. The original file is decimated to a sounding density that makes the files usable without losing too much detail. After the conversion to a common format, analysis is done by comparison to files that cover the same area. A decision is made to modify the status (suppressed or not suppressed) of data if a change is required.

Once this analysis is complete, the new file is accessible to other users. All the steps need to be recorded manually in the CHS metadata database (CHSDir) for tracking. To access the data, the user needs to utilize CHSDir to make a query on the attribute that they are looking for (type of survey, geographic query, etc.). Even if only a small area of a large file is needed, the entire file needs to be imported. The user needs to manipulate the files to access the area of interest.

Interaction with CHSDir makes the management complex and restrictive in terms of access and distribution to all clients. The file management is restricted in the interaction by the database, which provides only one-way communication.

Bathy DataBASE Workflow. The goal of this pilot project is to explore the possibilities offered in the new CARIS technology to complete the ping-to-chart workflow in a production environment. CHS would like to improve its bathymetric data management by developing interaction with its internal databases (two-way communication) and improving accessibility to the community.

A bathymetric data management solution must have some basic qualities in order to fit into the CHS workflow process: interaction with existing databases (CHSDir, CARIS HPD), seamless integration with the technologies used in adjacent processes (upstream [host-based intrusion-prevention system] and downstream [HPD]), datum adjustment (management), minimal loss of information (as close as possible to the source), traceability of data from source to product, easy access to the data for internal and external users (Web access), performance and robustness of the application and evaluation of the export formats by the clients.

Investigation of Bathy DataBASE. The effective management of bathymetric data is crucial to CHS. The development of new tools and data management solutions allows CHS to explore new opportunities to upgrade or adjust workflow practices.

Two principles exist for the management of data: load data as a navigation surface (BASE Surface) or a point stored file (sounding set). CHS tested both possibilities to evaluate which of those two would best address its needs.

The area coverage selected for the tests was limited to Quebec Harbor, which contains around 50 source documents, from lead line to multibeam data. Before loading both test databases, all files were converted to a common datum and coordinate system.

Historical sparse data were converted to a sounding set and BASE Surface format. Data with enough sounding density were converted directly to BASE Surfaces. After the conversion, a survey was created for each of the files, and metadata were added manually using information contained in CHSDir.

The data were loaded into the database attached to the previously defined survey. Once the data were completely loaded into both databases, testing began on the superseding rules at the extraction.

While access to the data proved efficient and easy, initial tests did not give the anticipated results. CHS had expected that conflicts would be solved at a data-set level instead of at the node level. Further review of the results now must be completed in order to determine if the old methods are still valid or necessary. Discussion with other CHS regions or even other

"While access to the data proved efficient and easy, initial tests did not give the anticipated results."

hydrographic organizations will also be necessary to establish how to proceed.

New methods usually come with new technology implementation. A meticulous analysis of needs will be necessary before asking for any modifications, if needed, to the application.

Future Developments

Some additional work remains to be completed for the evaluation of the criteria previously defined: datum adjustment (transformation and management), interaction with databases in CHS (CHSDir and CARIS HPD), performance and robustness of the application and Web access to the data.

All the criteria will need to be examined to make sure that the implementation of this technology at CHS Quebec will improve the management of bathymetric data and complete the ping-to-chart workflow. /st/

Visit our Web site at www.sea-technology.com, and click on the title of this article in the Table of Contents to be linked to the respective company's Web site.

Frederic Lavoie graduated with a bachelor's degree in geomatics from Laval University in Quebec, Canada, in 1998. He began his career at CHS in 1999 as a hydrographer, and he has been in the technical support and development division of CHS Quebec Region for five years.

Karen Cove graduated from the University of New Brunswick in 2005 with an M.S. in engineering from the Department of Geodesy and Geomatics. She joined CARIS as a product coordinator in the Canadian office in 2005.