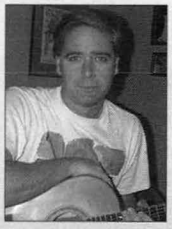

Developing a Print on Demand Service in the Canadian Hydrographic Service

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Recent events found the Canadian Hydrographic Service at a crossroads. A number of concurrent pressures seriously challenged the organisation's ability to produce, print, correct and distribute nautical charts, both from a financial perspective as well as a human resource perspective. While facing some difficult decisions, it became apparent that a number of relatively recent technologies could be combined to allow many of these challenges to be met. This paper describes the events that transpired, how the challenges were addressed using new technologies, and what the future may hold, as opportunities to refine and augment the application of new technologies are identified.

Recent History

Since the mid-1990s the Canadian Hydrographic Service (CHS) has faced a growing number of fiscal challenges. The major driving events were government downsizing and the concurrent rise in demand for Electronic Navigation Charts (ENC) and raster electronic charts. The end result was a major reduction in the chart printing budget. Furthermore, the Canadian Coast Guard (CCG) initiated a modernisation of the navigation aids system in Canada resulting in numerous changes to the buoys and other aids. This led to a huge increase in the number of amendments to paper charts in the inventory, amendments that had to be made by hand. The volume quickly became too great to be effectively managed by the chart amendments team. Although all these issues are interrelated, it is this latter one - the increase in the chart amendment load - that was the principal driver for change in paper chart service delivery. The CHS found itself in a situation where even doubling the chart amendments staff would not solve the problem. The sheer number of chart amendments resulted in too much chart clutter. In a number of cases, the cost to hand amend a chart outpaced the revenue generated from the sale of the chart. This in turn created pressure to reprint charts, thereby shifting the problem back on to the significantly reduced printing budget. The situation was going to force CHS to let some charts go unprinted and out of stock. This unacceptable situation provided the catalyst for change.

Technology

Fortunately, a number of technologies have converged to allow innovative solutions to the printing and delivery of paper charts. These are solutions that serve

to alleviate, at least partially, some of the current challenges.

Large-format inkjet plotter technology has fallen in price by an order of magnitude[1] since the mid-1980s, yet has dramatically increased in speed, and advanced to the point of good quality and durability. Charts can be printed individually or in batches, to match forecast sales. A single full-size chart can now be printed in just over four minutes, as compared to 40 minutes just two years ago.

The latest generation of raster editing systems allows the creation and maintenance of digital raster versions of paper charts to take place faster, and at lower cost than has previously been the case. Due to client demand, almost two-thirds of the CHS chart folio is already in raster form, to support the raster electronic chart product line. Raster charts can be used for printing on the traditional lithographic printing presses or can be output on large-format inkjet plotters.

New technology can also improve speed of delivery. Traditional delivery and management of hardcopy paper products is costly and slow. The faster the delivery the higher the cost. At present, CHS spends a substantial amount of money mailing charts to customers and chart dealers. The Internet provides the ability to move digital chart files quickly, safely and inexpensively from where the information is produced and maintained to where it is needed. In cases where the customer can plot their own charts this represents a rare situation where delivery times can be shortened and fully up-to-date charts ready to be machine generated can be provided.

These three enabling technologies, large-format inkjet plotters, raster editing systems and the Internet, have allowed the organisation to meet client demand for paper charts, maintain a closer pace with changes to the marine navigation aids system and to work within the existing printing budget.

In addition there was the opportunity to follow a broader vision of how this technology can address related issues. Consider that rather than printing and warehousing large quantities of charts to satisfy demand over several years and updating them by hand prior to distribution, a digital file can be maintained and a fully up-to-date chart printed only when needed. In the future, chart dealers may acquire the same large-format plotter technology, making it possible to deliver and print charts much closer to the customer: when and where required. In fact, CHS now has a web-based service to do exactly that, working with major government partners including the Canadian Department of National Defence (DND), Canadian Coast Guard, the US National Imagery and Mapping Agency (NIMA) and the United Kingdom Hydrographic Office (UKHO). Using this approach, clients take care of the printing in return for the convenience and speed of fast, on-site delivery of fully up-to-date charts.

In the trial implementation, Print On Demand (POD) was considered for all charts that had a distribution of fewer than 50 charts annually. As a response to the arrival of the newer technology, and a reduced printing budget, this level was increased. CHS now generally uses POD to print charts that distribute fewer than 600 copies annually. The final decision on whether a chart it printed lithographically or by POD is based on a decision-support formula that compares a variety of costs and factors. They include printing costs, chart format, sales and distribution volumes, predicted life cycle, cost of patches and tracings, labour for hand amendments, plotter operator cost, and available budget.

There is a limited market for nautical charts in Canada and POD provides a good fit in serving this market. For example, only 55 of 948 Canadian charts have a distribution greater than 500 copies per year. Of those only 35 have a distribution of more than 1,000 copies[2].

While the quality and durability of POD charts are not quite as good as lithographically printed charts, POD charts, when processed correctly, are high quality products. The technology, paper and ink are continually tested to ensure an acceptable degree of robustness and that the product is fit for the intended purpose.

[1] The first Versatec electrostatic plotters used by CHS cost around CDN $120,000. Today's generation of inkjet plotters cost CHS about CDN $16,000

[2] Distribution figures from both CHS distribution centres for fiscal year 1998-1999

Benefits of Print on Demand

This new approach to the delivery and maintenance of paper charts benefits customers in a number of ways:

- More legible and less cluttered charts because there are no hand-inked corrections but rather each chart has all updates incorporated digitally
- Charts do not sit on warehouse shelves and become outdated prior to being hand amended then sent to chart dealers
- More timely delivery to plotters situated increasingly closer to the customer
- No requirement to spend the average CDN $1,200 on producing negatives for every chart to be printed[3]
- A chart is available as soon as it is released, putting the chart in the hands of the customer up to eight weeks faster than by traditional delivery
- A less expensive way to print those charts which sell in low quantities since charts are printed based on forecast sales for the near term (i.e. Just In Time); ultimately POD printing will be based on actual orders
- Spreads the printing cost out over the life span of the chart thereby helping the budget challenge
- Charts do not go out of stock, so rather than stock issues being a major driver for chart production, more focus can be directed to producing new charts and new editions
- Customers may eventually have the option of purchasing charts on special paper

These solutions provide partners and customers with more options and greater flexibility in the management, maintenance, delivery and printing of paper charts. They allow an evolution from the batch-style approach of lithographic printing, which is really printing 'just in case', to one of continual printing or "just in time."

Limitations and Challenges

As with the transition to any new technology, there are some challenges to overcome, both in the technology itself as well as in the attitudes towards how a hydrographic office conducts its business:

- Part of the savings are offset by the need for staff to do updating on digital files and to operate the plotters
- There is a slight loss of quality and product durability
- The highest volumes of charts are presently just out of range of the current technology
- Plotter lifecycles can only be estimated at this time and there must be a plotter replacement programme
- The trend towards printing on the back of charts cannot be easily supported in a POD environment
- POD files must be managed in a rigorous way
- New licensing arrangements must be defined before chart dealers adopt POD services
- Quality standards are ill defined as they apply to charts that are printed remotely

Testing Techniques for Ink and Paper

Testing paper and ink to ensure that the finished product is fit for the intended purpose is an on-going activity. These tests although somewhat subjective provide an indication of durability. A number of chart users are currently working with the CHS in the real-world use of POD charts and are sharing their experiences and insights.

[3] At present there is a CDN $450 cost to convert vector output to high resolution TIFF, but an in-house solution should eliminate this cost in the near future

The tests performed are felt to be reasonable representations of what a paper chart may be subjected to in real world situations. The testing includes:

- Water Test: approximately 1/8 cup of water is poured on a location on the plotted chart. This water may be warm or cold. Paper towels are used to sop up the water without swiping the product. Once the water is sopped up, the chart is checked to make sure that the information is still legible. In addition, attempting to poke a hole though the product while it is still wet tests the strength. When the paper dries it is examined for wrinkling and water staining
- Coffee Test: the water test is repeated on another portion of the plotted chart but coffee is used instead of water
- Tear Test: the edge of the paper is tested manually to determine resistance to tearing. While the test is subjective, 35 pound heavy-coated paper is compared to the similar standard chart paper used for lithographic printing. The POD paper is less resistant to tearing but not appreciably so
- Dunk Test: a lithographic chart and a POD chart are immersed in a tub of water for 3-5 minutes. This test has demonstrated that the POD paper is stronger as it is being pulled from the water, as it is more resistant to ripping. The reason is the coating on the paper providing this strength. The POD paper is subject to some bleeding and some image transfer if the chart is folded on itself, but the amount is not significant. In terms of image durability on back printed POD charts, the image does not bleed through to the other side. Both types of charts, when dry, return to their original level of tear resistance
- Outdoor Test: a POD chart was stapled to a piece of plywood and left facing the sun for two weeks, with part of the chart shielded from the sun to check for fading; the chart was left out in rain storms and had puddles form on it. The paper was weak where the puddles formed, however it could be gently picked up and air-dried. The results showed some fading of the magenta, the grey areas became green; the blacks and blues held their colour quite well and the paper remained strong, once dry

The issue of the quality of POD charts has been discussed with CHS Chart Dealers and there have been no negative comments received. As well, representatives of the Department of National Defence have also indicated that POD charts perform satisfactorily.

Product Management

The raster production technologies currently employed are used to support lithographic printing, POD and raster electronic chart production. The CHS collaborates with its private-sector partner Nautical Data International (NDI) to produce and distribute raster charts in the BSB format. To date these products and the data sets that drive them are not managed in a complete database environment. *A critical issue is how these will be managed.* The CHS Product Database is considered the solution. Although this database was designed to manage S-57 ENCs it already offers most of the features required for management of raster files. It provides functions such as sign-in/sign-out, version tracking, management and archiving of historical copies, update tracking and so forth. With some extensions, which are currently being developed, the Product Database will provide a structured method for managing this information. It will provide the security necessary to preserve the integrity of the data holdings, allowing shared access between CHS offices and NDI.

Chart Distribution

POD charts are currently distributed using a password protected web page. This provides an easy-to-use interface for POD users. One of the evolutionary steps on the horizon is providing access to chart dealers. In fact, a number of chart dealers have already expressed an interest in POD technology. To move ahead a number of issues require further investigation:

- Wholesale chart cost structure
- A pay-per-use technology to track how many charts are plotted

- Standards for plotters, paper inks and colour ensure uniform output quality
- Dealer incentives such as a lease-back programme wherein CHS supplies the plotter and the dealer leases it back from CHS
- What liability is transferred to the printer

The distribution system currently used by the two CHS distribution offices is a commercial system called TRAVERSE®. It performs inventory control, dealer network management, invoicing, etc. CHS is in the final stages of implementing a business to business e-commerce link that will allow chart dealers to place their orders over the web, with a direct connection into Traverse. This will speed up the ordering time for dealers since they will be able to place their orders 24 hours a day, seven days per week. There will be less need for staff to enter these orders into the system based on phone, fax and hand-written orders. Subsequently, plans are to connect TRAVERSE® to the plot server. This would mean that as orders are entered into TRAVERSE®, it would automatically generate the chart. Once complete it will be the dealer who issues a chart order using a World Wide Web interface, which is then passed to TRAVERSE®, which in turn issues the plot – all automatically.

Updating

The files that drive the POD and BSB products require regular updating for Notices to Mariners. The Product Database has the potential to become the single repository for all raster files, in turn allowing a level of burden sharing between all parties, wherein the work is done once on the master version of the chart, and the results shared for different products. The situation of the same update being applied to different instances of the same chart, for example a POD and a BSB version of a chart, must be avoided.

However the future unfolds, service standards must be met. This means that charts must be updated and posted on the web site within two working days of the Stop Order[4] being issued. The updating effort must include quality control checks of the updated files.

To achieve established performance standards the intent is that the existing amendment team will maintain POD files for Notices to Mariners. Essentially it will be digital files that are maintained rather than a stock of paper charts held in a warehouse. Only the tools will change. The POD files will be updated for Notices to Mariners using the raster system, whether the charts come from a vector or raster source, in order to eliminate lengthy delays and the introduction of possible errors during conversion from vector to Postscript files.

The updating and quality control prior to being posted in the web site will be done weekly. Charts that are printed lithographically from a digital file are also made available on the POD site, for other government clients such as DND and Canadian Coast Guard, to print their own.

Maintaining a suite of up-to-date files also allows CHS to migrate towards new and better delivery mechanisms for chart updating and to move beyond the traditional notices to mariners. With new systems, updates can be extracted in the form of tiles and posted to the web site, in a few short steps. CHS customers would be able to print the tile and cut and paste it onto their chart(s). Rather than expect customers to be, in essence, cartographers and having to interpret written drawing instructions in Notices to Mariners they can instead simply perform a cut-and-paste operation to update their charts.

Cost of POD

One of the most common debates with respect to POD is to do with cost. While it is in fact true that lithographic printing is less expensive, POD becomes a more cost effective choice when it is not necessary

[4] Stop Orders are when weekly updates have been received and processed through Notices, at which time the amendments staff must apply all of those corrections to each and every chart affected by those notices; the amendments must all be completed by the edition date of every Friday of each month

to print larger quantities normally associated with press runs, and where hand amending lithographically printed charts is required. From an overall cost standpoint, POD is the favoured technology when low distribution volumes or high amendment loads are forecast.

Conclusion

CHS intends to continue to take a balanced approach to printing, based on the cost effectiveness of the technologies available, and considering the relevant cost factors. Forecasting where technology is heading is difficult at best, and it will be important to continue to monitor and research developments in plotter, ink, paper and related technologies.

To build on early successes in POD CHS must strive to continuously improve the process. In the near term this means implementing a robust file management system and formalising a standards package geared to POD technology.

In the medium term, the issues will be tying business-to-business e-commerce links to plot servers, in an effort to continue traditionally high levels of service. For that all-important issue of service after the sale, these same technologies can provide the means to deliver graphic updates to charts, extracted from the working file in the hydrographic office, and delivered to the customer to print and apply to their charts.

Over the longer term, the technology will move farther down the distribution pipeline so that eventually it is the chart dealer who prints charts. This will have the effect of putting the most up-to-date data in the hands of the user and will allow CHS to reduce the amount of warehouse space it uses.

This combination of technologies is allowing rare events to unfold, wherein a hydrographic office can lower costs and improve the delivery of its products and services.

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Biography

Paul N Holroyd has been with the Canadian Hydrographic Service since 1982. He graduated from the geography programme at Carleton University in Ottawa, with a speciality in Geographic Information Systems, cartography and computer science. Since joining the CHS he has served in a variety of functions including cartographic research, software development and system support, Manager of Electronic Charting and most recently Manager of Nautical Publications & Distribution. Mr Holroyd sits on the CHS Products & Services Committee, the CHS Marketing Working Group, the CHS Hydrographic Information Network (HIN) Working Group and, along with colleagues in the Canadian military, represents Canada on the Digital Geographic Working Group Technical Committee (DGIWG TC). He is married to Shelley and they have two young daughters, Amanda and Jessica.