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ENC PRODUCTION EXPERIENCE OF A SOUTH AMERICAN COUNTRY

Paper by Chile

I. Objective:

We think that this paper could be considered as a useful reference material for those initiating the challenging technological change from paper to electronic chart. Its content provide the experiences and knowledge gathered during several years, starting from the very beginning of SHOA's ENC project.
Through this paper, the Hydrographic and Oceanographic Service of the Chilean Navy – SHOA, wants to share its experiences with other Hydrographic Offices that might be starting the development of an ENC production project.
Anyone needing more detailed or additional information is welcome to approach SHOA. It is our aim to act as a supporting partner to increase international cooperation on ENC issues having safety to navigation as the final objective.
A Spanish version of this paper can be requested to shoa@shoa.cl.

II. History and background:

SHOA formally started ENC production in 1996. That year SHOA acquire three IBM PC Windows NT 3.5.1 based workstations and an equal number of CARIS/GIS 4.2.5 licenses.
As a preliminary step, SHOA's Cartographic Department had digitized three 1:100.000 and one 1:30.000 scale charts, covering the eastern route of the Strait of Magellan and Punta Arenas harbor, respectively.
Between March and October 1996, SHOA started the basic training steps on ENC production, consisting in two and a half-month period for each of the three groups established of three people each. Training was obtained at Nautical Data International (NDI) facilities in Newfoundland, Canada. The objective of this training was to get the basic skills in ENC production that could allow SHOA to become self-sufficient.

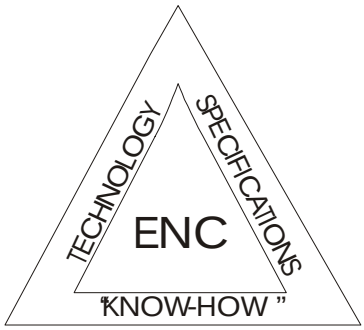
The digitized charts were taken to NDI to be used as source information for training. In addition, charts belonging to the western route of the Strait of Magellan were scanned at NDI facilities, as a training complement.
It can be considered that in 1997, SHOA had already established a minimum ENC production infrastructure, a work-plan and the necessary human and technological resources to start production.
But it was in 1999, after three years of intensive work and study, that SHOA decided to released the first ENR (Electronic Navigational Route), covering the Strait of Magellan (six 1:100.000 scale charts) and two large scale charts, Canal Jerónimo (1:50.000) and Punta Arenas (1:30.000), for the use of the national and international mariner.
Since then, SHOA has produced four more ENRs that, at different scales, contribute to safety to navigation.
These routes are:

- Route 10 – " Arica to Strait of Magellan"
- Route 20 – " Arica to Taltal"
- Route 30 – "Caldera to Valparaíso"
- Route 40 – "San Antonio to Ancud"
- Route 70 – "Strait of Magellan"

These five routes contain 55 ENCs updated to August 2001. All of them available for navigation and although these cells cover the major part of our oceanic territory, there's still so much to do.
Important areas mainly at the southern part of Chile are not currently covered by ENCs due to the absence of a consistent geodetic network that could permit SHOA to convert the current paper charts to ENCs or to make new editions of the current paper ones.
The general policy of SHOA is to provide the maritime community only with ENCs produced from new hydrographic surveys or from rich paper charts with well-known datum (PSAD-56, SAD-69 or WGS-84).
Areas covered by charts with local datum or containing old hydrographic data are considered not reliable, and new hydrographic surveys have been programmed and /or in progress, aiming to have ENC coverage in the near future.

III. ENC production infrastructure:

The current ENC production infrastructure at SHOA is based into the following general scheme:



Technology: From SHOA's perspective, technology consists in the correct use of the appropriate updated hardware resources, software tools and source data. Through the availability of these components, the scheme remains consistent.
While hardware and software are always the result of investment decisions taken at the any moment, the third component is rather different and therefore is recognized that "the fuel of any ENC".
Without an available, selected and updated source data, an ENC cannot be produced.
If hardware or software are not the most updated, the only variable of the system that could be affected is the development time, keeping ENC quality not affected.
SHOA has developed an ENC production line. In this context, the ENC lab, part of the Digital Cartography Section of the Cartographic Department, is currently composed of five workstations some dedicated to digitizing and others to attributing activities.
Digitizing stations are responsible for the scanning, digitization, georeferencing (control points) and the edition of charts. When editing and in order to standardize the source NTX data (used for the production of Computer Assisted Nautical Paper Charts – CANPC, and ENCs), SHOA has been utilizing the DCFS 2.1 specification since 1996. This specification has facilitated SHOA to keep a homogenous base of cartographic data to be used either for CANPC and/or ENC independently of operators, processes and technology.
Attributing stations are responsible for the generation of the final ENC. They use the last standardize NTX data to generate the ENC itself. When the ENC is produced, it is saved into the departmental Windows NT 4.0 SP6a server until the final release take place.
The Head ENC lab Cartographer is responsible for applying the Notices to Marines to the ENCs before they are released and also to those that have been sold. The provision of this information is provided via e-mail to each customer and a client database is kept updated.
As briefly mentioned before, SHOA has taken the decision of going through a scheme based on Windows NT 4.0 Operating System consisting in production workstations and a couple of servers, each with CARIS/GIS and/or CARIS/HOM licenses. In addition, professional third party software has been incorporated in order to improved Quality Control and Quality Assurance to the ENC.

International specifications: In the context of this paper, we would like to highlight that the correct use on IHO and IMO specifications is fundamental.
At the time SHOA started the development of ENC production, the S-57 version 2.0 was in force. During the training period at NDI in 1996, all the ENC production steps were learnt using S-57, version 2.0.
In November 1996, IHO released S-57 Edition 3.0 that was in force until November 2000 when complemented with Edition 3.1 nowadays in use.
Fortunately for SHOA, S-57 Edition 3.0 fitted in a 100% with the internal chart production scheme. The change from fixed to variable size cells (Version 2.0 to Edition 3.0) allowed SHOA to produce ENCs equivalent in scale and coverage to current paper charts.

Some Hydrographic Offices with large number of ENCs into the market in Version 2.0, had to develop specific software applications to convert Version 2.0 cells into Edition 3.0 cells, resulting in a huge effort and resources investment.
International specifications that condition ENC production are fundamental because of these reasons:

- They allow productive organizations such as SHOA, to establish international standards on their processes.
- Quality controls and quality assurances are not based into local criteria but into international standards.
- Distribution media are internationally known, accepted and under permanent regulation.
- Organizations can make processes not person dependent, making production infrastructures durable and permanent in time.

Quality control and quality assurance:

From quality perspective, an established ENC S-57 data structure must be followed in two steps:

- Quality Control (technical certification): This quality control step verifies the ENC structure itself with respect to S-57 Object Catalog, Attribute Dictionary, Use of the Object Catalog and the ENC Product Specification. This check can be done using third party application software, checklists or internationally accepted procedures.
  QC step also is responsible for the validation of the correct use of DCFS 2.1 mentioned before and the applying of the specifications for codes, layers and topology listed into that document.
- Quality Assurance (administrative certification): Who respond for the correct ENC content? Who signs and certificates as the responsible for the digital data?
  In our case, SHOA becomes responsible for the released data.

For Quality Control steps, SHOA uses internationally recognized third party software from Sevencs (ENC Analyzer and ENC Optimizer) and Hydroservice (dKart Inspector 4.0 SP1) in conjunction with proper CARIS Hydrographic Object Manager internal filters and QC tools for ENC.
Quality Assurance of ENC at SHOA consists in two basic steps:

- Internal processes: The ENC is internally reviewed at the Cartography Department to check if “all the data that should be in is really in”. No sensible information must be left out from the ENC so it is quite important to assure that 100% of all source information used to produce the ENC is part of the ENC as it should be.

Printed (from dKart Inspector) and source ENCs are sent to all other SHOA's Technical Departments for reviewing and corrections application if necessary before the final data is released.

- External processes: In November 1999, SHOA installed on board AP41 "Aquiles" an ECS Aldebaran II navigation platform from ICAN (International Communications and Navigation Ltd., from Canada).
  Since then, that system has been used for on board ENC validation and real-time updating check. All ENCs produced by SHOA are loaded into that system in order to make sea tests and get the necessary feedback, if there is any.
  The continuous use of this on-board ENC validation platform has permitted SHOA to verify positioning parameters for chart quality improvement. Input devices for this system are GPS (DGPS when available), Gyro, Radar and Speed log.
  SHOA has another system known as "a carry-on ECS" for use on vessels of opportunity. This last system in configured into a Panasonic Toughbook 71, specially designed for outdoors use and oriented to ENC validation by SHOA. This platform has the same Aldebaran II software using the GPS as the only external device.

Know-how: The know-how extracted from the experiences listed before has permitted SHOA the identification of three clear, consecutive and overlapped phases.

- Instruction: Although the initial phase in which SHOA took the necessary training at NDI was in 1996 having the chance to know about the administrative and technological procedures in order to produce ENCs, the core knowledge about "system technology" started in November 1994 when an Universal System Limited (USL) engineer, provided SHOA personnel involved in future ENC production with a one-week training period to show the capabilities, characteristics and performances of CARIS/GIS.
  This training was quite important as SHOA's technical personnel were faced to a technical evaluation and comparison of alternatives available at that time. SHOA's Director took the decision to go through CARIS for IHO S-57 accomplishment.
- Understanding: Once the basic training ended, it was necessary to compile and gather all the information, making the necessary local and on-site arrangements to start producing ENCs.
- Knowledge: Just a couple of words are enough to describe this last phase; self-sufficiency and feedback.

Self-sufficiency: SHOA has gotten a self-sufficient basic training capability in order to provide training to new personnel incorporated to the Cartographic Department and to the Officers of the International Course on Hydrography and Oceanography.
The personnel that attended NDI training in 1996 have been the "seed" supporting human resource for increasing the number of personnel involved in ENC production nowadays.
This training self-sufficiency can be reflected in some examples provided next:

- The Cartographic Department has an equipped classroom (computers, whiteboard and other facilities) to give training to internal and external students. As an example, in mid 2000, a delegation from Equator (one officer and one enlisted man) attended a one-month training period at SHOA in Computer Assisted Compilation (CAC) and ENC Production with CARIS tools.
  The training programme developed by the Cartographic Department was sent to CARIS headquarters in Fredericton, Canada, for comments and improvement by CARIS Technical Staff.
  The only comments SHOA received were congratulations for the well design programme.
- The Instruction Department at SHOA has the responsibility for the training of internal and external people. Internal personnel courses have been developed mainly for enlisted personnel who receive the basic skills into the technical disciplines that SHOA works with.
  The external personnel include students attending the international course mentioned before.
  During the course, they receive cartographic training in CAC and ENC production, specifically focused in general theory and hands-on practice separately in two consecutive subjects entitled Digital Cartography (CAC production) and Geographic Information Systems (ENC production), respectively.
- The new Cartographers and other professionals of equivalent disciplines that are incorporated to the CANPC or ENC labs receive the appropriate training in an approximately two-week period. After this, they are capable to start producing under close supervision by senior personnel.
- Trainees are permanently attending to international seminars, meetings and committees such as CHRIS, WEND, CARIS Conference and others related to Hydrography.

Feedback: The ENC production lab developed a CARIS-oriented ENC production and instruction document called “ENC Coding Guide – Content Specification and Product”.
This guide has been used since the beginning of 2000 by the Cartography Department not just for the instruction of the new people but also as a tool to make ENC production simple, easy and straight.
The basic idea of the guide is to provide the Cartographer in charge of an ENC with the sequence of commands and steps that should be performed in order to get the final product, making no difference if he or she, is in conducting a digitizing or attributing activity.
The guide is structured in three main chapters:

- Related references and scope: Through a general introduction this first chapter explains the environment in which this guide should be used, making the accent that this guide does not replace any international specification nor procedure like S-57 or S-52. This guide is a value-added information that should be taken in

conjunction with all the S-57 documents and official publications and it never should be used as the only source for ENC production.
The guide also explains some general aspects about the ENC Product Specification and cell coding.

- Data capture (source data to be used for the ENC): This chapter details the various ENC's data sources and provides guidance to the cartographer on how to make best use of it.
- Data editing (digital specifications): Once data is selected and compiled, this chapter refers on what should be the sequence to follow in order to digitize each information layer. Guidance on what should be done first, second and last, and what to do once all of them are ready, is provided. Topology specifications are included in this chapter.
- Attributing: This chapter explains about the attributing steps in addition of QC and QA actions.

The guide also includes a number of the most common and used commands and a list of related documents and publications that could be used to better complement the final product.
Although this guide was designed just for SHOA, a more standardized version is being currently produced in order to make it permanent in time and independent of technology and specifications. An English version is also planned.

IV. Summary and conclusions:

In this paper SHOA has detailed not also the number of cells produced and the routes that contain the different ENCs available. It has also unveiled some important aspects of the general ENC production infrastructure and the processes currently in use.
SHOA hopes that this paper could be used by any organization or agency that, as said at the beginning, is starting to give the first steps on an ENC production project.