Data Collection, Analysis and Presentation

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ABSTRACT: The current discussion on the future of electronic navigation is focusing on the expansion of ECDIS by integrating additional data streams, like AIS or real-time tide information. While this are important aspects, which will be touched on in the paper, it is important to note that the ENC data layer is the necessary data layer to enable advanced data display.
The ENC paradigm needs to take in account that data use in ENCs is generated by a variety of different stakeholders in the community. With the migration to near real time data access in various areas of modern life, an increase collaboration and data sharing is needed in the collaboration of those stakeholders
The current focus on ENC production has a limited view on coverage within scale bands and on datum code. While this allows concentrated efforts to produce the necessary country coverage to meet the timeframe of the IMO ECDIS mandate, future mariners will require a more solid basis of chart data for their electronic navigation needs. The IMO e-Navigation discussion and the discussions in related the IALA e-Navigation Committee are starting to join efforts with the new IHO S-100 and S-101 standards as well as the developing S-10X series of standards. The Hydrographic community needs to take that in account when preparing for the future of electronic navigation to increase safety of navigation in a rapidly changing environment with larger ships and more traffic in areas with specific navigational challenges.
The paper will focus on the following topics:
– The ENC data layer as the basis of electronic navigation
– Closing gaps and overlaps in ENC coverage by adjusting cell boundaries
– Moving from a cell based data structure to a seamless database structure
– Integration of Scale-Independent and Scale-Dependent objects
– Adaption of harmonized and flexible data models – an S-10X outlook
– Enabling integration of advanced data streams – an e-NAV outlook
– Collaboration of key stakeholders in the data supply chain

1 THE LANDSCAPE OF ELECTRONIC NAVIGATION

In different organizations, involved in safety of life at sea, aspects of navigating a vessel from port to port are discussed. The importance of navigation is highlighted by the International Maritime Organization (IMO) in the “Safety Of Life at Sea” (SOLAS) regulation, especially in chapter V. The discussion on safety of navigation is key to the IMO Maritime Safety Committee (MSC). Because MSC realized this important aspect of SOLAS, it created the “Safety of Navigation” Sub-Committee (NAV) focusing on exactly this.

The discussion in NAV centered for years around the “Electronic Chart Display Information System” (ECDIS). In 2010 MSC, on request of NAV, has approved a new regulation, which outlines the mandates of ECDIS on defined SOLAS-Class ships in a phased-in approach starting 2012 and reaching all desired vessels by 2018.

While IMO focuses on the regulatory aspects to ensure and improve safety of navigation at sea, the International Hydrographic Office (IHO) since its establishment in 1921 focuses on the cartographic aspects of safety of navigation as well as associated activities.

On its websites the IHO defines its goals as follows:

“The object of the Organization is to bring about:
– The coordination of the activities of national hydrographic offices
– The greatest possible uniformity in nautical charts and documents

– The adoption of reliable and efficient methods of carrying out and exploiting hydrographic surveys
– The development of the sciences in the field of Hydrography and the techniques employed in descriptive oceanography
(www.iho-ohi.net)

TIMETABLE FOR ECDIS CARRIAGE REQUIREMENTS			
Ship type	Size	New ship	Existing ship
Passenger ships	≥500 gross tons	1 July 2012	No later than 1st survey after 1 July 2014
Tankers	≥3,000 gross tons	1 July 2012	No later than 1st survey after 1 July 2015
Dry cargo ships	≥50,000 gross tons	1 July 2013	No later than 1st survey after 1 July 2016
	≥20,000 gross tons (new ships) 20-50,000 gross tons (existing ships)	1 July 2013	No later than 1st survey after 1 July 2017
	≥10,000 gross tons (new ships) 10-20,000 gross tons (existing ships)	1 July 2013	No later than 1st survey after 1 July 2018
	3-10,000 gross tons	1 July 2014	No retrofit requirements to existing ships <10,000 gross tons

Table 1 – from “ECDIS – What you need to know”, Jeppesen

Key components of these objectives are the standards for the "Electronic Nautical Charts" (ENCs). Especially the current S-57 standard defines those ENCs, which are, per ECDIS performance standard, the only vector data sets, which allow operating an ECDIS in its so called ECDIS mode, and as such to perform primary navigation with electronic systems.

IMO has looked at the Hydrographic Offices (HOs) around the world, represented by IHO, to provide adequate ENC coverage before adapting the ECDIS mandate. The IHO has confirmed to IMO-MSC and IMO-NAV that by 2012 adequate ENC coverage will be available.

All of the above highlights that both IMO as well as IHO see ENCs in ECDIS as the foundation and primary data set for electronic navigation.

2 THE "E-NAVIGATION" CONCEPT

Following its initiative on ECDIS, IMO has launched another initiative: "e-Navigation". The "e-Navigation Correspondence Group" identifies details on "enhanced Navigation", which is intended to integrate shore based and ship based systems and data streams to increase situational awareness in any phase of sailing and as such increase Navigational safety even further. The discussion circles around concepts like integrated AIS (Automated Identification System), different system overlays on board, automated information exchange between shore and ship, like sharing Vessel Traffic System (VTS) data and so on.

The IMO e-Navigation development and the discussions in the related e-Navigation Committee of the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) are starting to join efforts. Within the last few months various working groups have taken great efforts to align the development in IHO, IALA and IMO and to harmonize the view of the future of electronic and enhanced navigation. In those meetings the organizations, the industry and individual expert contributors could reach agreement that the new IHO S-100 and S-101 standards and concepts as well as the developing S-10 X series of standards should be used to build the bases for the new marine data models. This includes the usage of the IHO "GI-Registry", the "Geographical Information Registry", which supports the harmonization of GIS-Data Models across the maritime industry and its initiatives. This development provides the necessary harmonized platform for integrated systems. The hydrographic community starts to take the initiative preparing for the future of electronic navigation to increase safety of navigation in a rapidly changing environment with larger ships and more traffic in areas with specific navigational challenges.

The concept of e-Navigation is evolving the understanding that future navigation will need constant innovation, and as such will need to change how performance standards are handled. It is widely understood that the current ECDIS performance standard is restricting innovation. Its update and certification concept is not geared up to meet the needs of e-Navigation.

The currently being developed new concept defines a framework in which a growing number of data streams are integrated and harmonized to allow the creation of the necessary information for increased Situational Awareness in an environment of growing complexity.

The on board and on shore systems to be developed within this framework will have to create a compelling need for their usage by increasing safety and security of navigation (compelling need for coastal administration) and improved efficiency of voyage (compelling need for ship owners and operators)

The dominant argument unifying all stakeholders to move towards common structures and towards the IHO originated model is the fact that the implementation of S-100 and its related standards is well underway and will materialize shortly. As a consequence ENCs will follow this data structure, so are associated data streams, like "Inland ENCs" or "Marine Information Overlays". As all stakeholders agree that the ENC layer will build the foundation of any kind of advanced navigational systems, it was a natural development to try to align other data stream with this foundation. But looking from the other side this development again verifies that ENCs, or better Hydrographic Vector Chart Data Layers, are the necessary ingredients for any navigational display now and in the foreseeable future.

3 MIGRATION FROM A "CHART CENTRIC" TO A "SITUATIONAL CENTRIC" CONCEPT

The traditional hydrographic work to create the necessary tools for mariners to navigate safely is utilizing classic cartographic concepts.

An early chart from the year 1603 illustrates that cartographic art work is used to allow the knowledgeable navigator gaining sufficient information for a safe passage.

In the "paper" or "analog" world, this has developed over hundreds of years as the best practice to transport the necessary information. The current paper charts of HOs around the world are in most cases beautiful artwork, well developed to help navigate ships.

Even in the electronic world, this concept started to materialize with the usage of "Raster Charts" in displays, with ARCS (Admiralty Raster Chart Service) as a prominent example. The stakeholders then realized that the full potential of electronic navigation cannot be explored with this raster charts. Vector cartography showed new opportunities of increased

situational awareness by utilizing capabilities of data links, full zooming capabilities without "fading" and a growing number of other advantages. While the first vector charts had been developed unregulated by key stakeholders in the industry, the now already often mentioned ENCs have made their way on bridges of SOLAS class ships as the only official electronic navigational chart.

While this development was the necessary next step in electronic navigation, the current ENCs, based on the S-57 standard, are not reaching far enough. These ENCs are "cell based", which means they are still looking at a certain "chart", a defined rectangle on the globe. As a consequence, what is today offered is not a real "Hydrographic Database", but rather a collection of associated charts in a central data repository. The HOs try to harmonize the cells to create a kind of "seamless" appearance in the ECDIS display. But as the view of each cell in the creation is still often a "chart by chart" view, this harmonization is not always successful. An addition complication in harmonizing such a chart centric view on ENCs is the fact that the current system is in general focusing on a "scale band" concept. Here the hydrographic data is composed by cartographers in a certain cell to be for optimal use on a certain zoom level. As this is on a cell by cell and scale band by scale band level, harmonization is not only necessary between cells of the same scale, but also across scale bands. Because of the high level of complexity this harmonization is mostly omitted. Data conflicts and as such display conflicts are the results when moving from cell to cell on a "moving map" display as a ship travels, but it also creates conflicting information as a navigator is zooming in or zooming out and with that moves the focus of the ECDIS from one independently developed scale band to another scale band.

As we can see the chart centric ENC production process, while it generates a great improvement, it is almost impossible for the process to generate an increased situational awareness with as little confusion as possible to the mariner. Even within the responsibility of one single HO. As SOLAS ships have the tendency to cross borders, the ECDIS systems are dealing with data sets from different countries. This increases the complexity and in consequence issues like overlapping data, data gaps or mismatching of adjacent cells.

Where "Regional ENC Coordination Centers" (RENCs) are used, those RENCs are also trying to help harmonizing the ENCs, but of limited success, given the complexity of the task.

The current focus on ENC production has a limited view on coverage within scale bands and on datum code. While this allows concentrated efforts to produce the necessary country coverage to meet the timeframe of the IMO ECDIS mandate, future mariners will require a more solid basis of chart data for their electronic navigation needs. The above discussed data issues needs to be addressed and resolved in order to gain confidence of mariners in electronic navigation.

The issues I have highlighted are well known and endless discussions around the globe took place and are conducted right now trying to find solutions. S-100, fully developed, will help mitigate some of those risks. S-100 will move the hydrographic data collection towards a GIS (Geographical Information System) oriented data concept, away from cell based thinking. The future concept will move more and more data sets from scale dependant data storage towards the scale independent data concept. In this concept a natural object, like a buoy or a shallow area, will be stored in its real-world location and dimensions. The database will contain the object only once and the rendering engine will compose the display, based on detail rendering and deconfliction rules, rather than using an artwork-like cartographic view.

In a full database centric hydrographic data collection, cell boundaries may still exist, but they are created to break up the data sets in manageable pieces, but will no longer be developed as individually composed data sets. The hydrographic data will be manager as a complete set, rather than individual puzzle pieces, which are stitched together like a patchwork quilt to create an individual coverage. This underlying data layer will be rendered based on situational needs, i.e. zooming level as desired by the mariner, and as such will result in a situational centric display.

4 COLLABORATION FOR INCREASED DATA INTEGRATION

Navigation from port to port, navigation at sea requires a variety of complex and correlated information. Save decisions can only be made, if a navigator has clear information about his or her vessel and the local maritime conditions, as well as a range of details that can affect the sail or manoeuvre plan.

At present a variety of different organizations are providing this data. Harbour masters, Port Authorities, Coastal Administrations, Hydrographic offices and other are collecting data needed for situational awareness.

In 2011 various countries of the European Union under "Interreg IVB, North Sea Regional Program, have collaborated with private industry on a specific project to review this issue and come up with workable prototypes. One of the outcomes of the project "BLAST – Brining Land and Sea together" delivered a prototype of an interactive collaboration tool. MDCS, the Maritime Data Collection System, is a portal which demonstrates a single-point-of-reporting

from mariners to the maritime and hydrographic agencies in each country. It improves the collection of real time experience for the associated organizations. By using a streamlined approach among the North Sea countries, vessels in this area will only need to become familiar with one reporting environment, consolidated reporting forms and consistent language across the region.

The MDCS portal is allowing reporting of diverse information such as nautical chart and publication updates and inconsistencies, planned operations and exercises in the territorial seas and proposed renovations in harbour areas between different stakeholders for quicker decision making.

The portal will also allow mariners to stay updated on immediate and ongoing activities that may affect their navigation, such as harbour renovations that are not yet incorporated into harbour pilots or nautical charts. The individual countries' Notices to Mariners and Nautical Chart Updates can be accessed in real time. The portal is intended as prove of concept that future development can provide a critical resource for both mariners and maritime agencies – as a supplement to existing resources, and not as a replacement of them.

CONCLUSION

The current development of usage of electronic cartography in the maritime world has taken a step towards situational awareness and as such has matured away from simple chart display. This development will intensify and as such will require in future a change in how electronic maritime cartography is developed, composed and stored. The future will focus on data streams to support data integration and situational centric rendering.

In addition the financial and organizational pressure on HOs will require optimization of workflows and better utilization of capacities.

To support these changes a harmonized database of hydrographic data, a harmonized ENC database is paramount.

REFERENCES

IMO, 2009, SOLAS (Consolidated Edition)

Jeppesen, 2010, ECDIS – What you need to know

IHO, 2000, IHO Transfer Standard for Digital Hydrographic Data, Edition 3.1

IHO, 2010, IHO Universal Hydrographic Data Model, Ed 1.0.0

IHO, 2011, www.iho-ohi.net

IHO, 2011, Operational Procedures for the Organization and Management of the S-100 Geospatial Information Registry, Ed 1.0.0

BLAST, 2011, www.blast-project.eu