THE USE OF ECDIS IN MODERN NAVIGATION

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ABSTRACT

A good navigator gathers information from the electronic aids like Chart Display & Information System (ECDIS), evaluates this information, determines a fix, and compares that fix with his pre-determined “dead reckoning” position. By using the ECDIS a navigator constantly evaluates the ship’s position, anticipates dangerous situations well before they arise, and always keeps “ahead of the vessel”. This paper intends to emphasize the manner in which the modern navigator must also understand the basic concepts of ECDIS, evaluate its output’s accuracy, and arrive at the best possible navigational decisions. But navigation must be done by keeping in mind that successful navigation cannot be acquired only by using electronic aids like ECDIS. Old fashion navigation is still needed. Therefore, our final objective is to show the benefits of using ECDIS but also to point out the importance of traditional navigation.

Keywords: *electronic aid, navigation, modern, ECDIS.*

1. INTRODUCTION

Electronic integrated bridge concepts are driving future navigation system planning. Integrated systems take inputs from various ship sensors, electronically display positioning information, and provide control signals required to maintain a vessel on a preset course. The navigator becomes a system manager, choosing system presets, interpreting system output, and monitoring vessel response.

In practice, a navigator synthesizes different methodologies into a single integrated system. He should never feel comfortable utilizing only one method when others are available for backup. Each method has advantages and disadvantages. The navigator must choose methods appropriate to each particular situation.

With the advent of automated position fixing and electronic charts, modern navigation is almost completely an electronic process. The mariner is constantly tempted to rely solely on electronic systems. This would be a mistake. Electronic navigation systems are always subject to failure and the professional mariner must never forget that the safety of his/her ship and crew may depend on skills that differ from those practiced generations ago. Proficiency in conventional piloting and celestial navigation remains essential.

For some years a new concept has been making its presence felt in shipping circles: ECDIS. Better known under the term electronic nautical chart, all kinds of nautical chart presentations on computers are often called ECDIS, not just by landlubbers but also by seafarers and the equipment suppliers.

2. ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEM (ECDIS)

2.1 Historical Background

Since 1983, when the first electronic sea chart with radar overlay was demonstrated in the USA, electronic navigation charts have gradually been taking precedence over paper charts for use on the ship’s bridge.

In 1988 IHO published the first standards for harmonized Electronic Chart Display and Information System (ECDIS).

There are standards and specifications that precisely define for professional shipping. What an ECDIS is, what are its component parts, who supplies the chart data, what standards have to be met, who uses ECDIS and nature of an item of equipment that may be designated ECDIS and is intended what advantages it offers are the questions we answer below.

2.2 The ECDIS Short Presentation

ECDIS is thus more than an “electronic nautical chart”. Nautical charts are in fact presented electronically, but in principle all kinds of charts: aviation charts, street maps, and railway maps etc. – could be presented on a computer display using the same methodology. However, we shall restrict ourselves to comment on the electronic nautical charts.

Electronic chart presentation is only one aspect of ECDIS. ECDIS is also an information system. As an information system, ECDIS enables the user to call up information on the items displayed in addition to the graphics presentation.

2.3 The Components of ECDIS

For the user, i.e. the navigator, ECDIS is only one item of equipment among many on the bridge of a modern ship. Operating the ECDIS is thus not the main duty of a ship’s officer. Rather, the system replaces the conventional chart table and is intended to permit all types of work traditionally connected with the paper nautical chart and to make these activities easier, more precise and faster. These include route planning, entry of observations, instructions and notes, position determination and, last but not least, updating charts with the aid of the Notices to Mariners (NTM).

ECDIS represents an item of equipment consisting of hardware, software and the data. The hardware of the ECDIS is generally a computer with graphics capability, a high performance PC or a graphics workstation installed in a console linked with other items of ship's equipment. Thus, ECDIS obtains the course from the gyro compass, the rate of turn from the turn indicator, and the ship's speed through water from the log (the ship's "speedometer"). Key features are the links with the position sensors of the ship (Decca, Loran, transit satellite navigation system) and in particular with the GPS (global positioning system, a satellite based positioning system), supplying via the NMEA interface a constant stream of highly precise position data (NMEA National Marine Electronics Association; NMEA0183 Standard for Interfacing Marine Electronic Devices, data record). Even radar pictures can be superimposed, either as raw data from raster scan radar, or as synthetic ARPA (automatic radar plotting aid) radar information.

The software that makes the computer an ECDIS consists of the user interface (UI) and the so called ECDIS kernel, the software that makes it possible to read the data and display a chart. This software is also called "function library". In addition to the chart picture, the user interface shows buttons and keys for operating the nautical chart.

The official original data (S57) of the electronic nautical chart is usually supplied on CD-ROM or, in case of updates, via digital telephone or satellite communication system. This original data is also called electronic nautical chart (ENC).

The chart database is organized in cells that cover the entire earth's surface without overlapping. The cells store all nautical chart objects as well as objects created only during the operation of the system, such as waypoints and leg lines, notes, positions of own ship and of other vessels, etc. The data in the System Electronic Nautical Chart (SENC) is generated from the original data of the ENC. The ENC has to be kept unaltered in order to be able to reconstruct the SENC data if this is unintentionally damaged or destroyed. In SENC, the chart data is stored a proprietary file format designed by the ECDIS manufacturer for speed and reliability.

3. THE ADVANTAGES OF ECDIS

An ECDIS satisfying all the above requirements is not only an adequate replacement for the paper nautical charts but also a system containing all information important for navigation that can be called up at any time and without delay.

Today, this information is still scattered about in various publications, and manual search procedures are laborious and time consuming. ECDIS also offers the possibility of automatic anti-grounding alarm, which is not possible with any other navigation aid.

In 1989, the "Exxon Valdez" ran aground in Prince William Sound in Alaska as a result of prematurely changing course due to false identification of an island. It leaked oil, causing a major environmental catastrophe. If "Exxon Valdez" would have had an ECDIS on the bridge, she could have avoided running aground.

With a continually updated display of the position of the ship, the premature change of course would have probably never occurred. Moreover, the ECDIS anti-grounding function would have produced an alarm when the vessel was approaching the shallows, warning the officer on duty of the danger.

A further advantage of ECDIS compared to all other navigation aids is the individual adaptation of the chart picture to the particular requirements. This is possible because the chart picture is produced only during operation. It is possible to produce the relevant shallow water contour for a super-tanker with a draught of 25m or for a ferry with a draught of only 3m. The presentation library controls this via adjustment of the safety depth/safety contour. Automatic updating is much faster, easier and also less prone to error than chart adjustment currently laboriously carried out manually with considerable time lag. Updating can even be called up on a digital telephone or via satellite, and incorporated instantaneously. ECDIS makes seafaring easier and thus also safer.

4. METEOROLOGY FOR ECDIS

One of its future aims is to start working on interfacing meteorological and oceanographic parameters with ECDIS, leading to creation of new Marine Information Objects (MIO) necessary to provide a most up-to-date image of these phenomena. This will make ECDIS a more versatile tool to assist the mariner in decision-making, and in making navigation more efficient and safer as a result. It will also promote cost effectiveness of shipping and better protection of the environment.

There are several meteorological parameters essential for safety of navigation and it was agreed that the basic display of meteorological data on an ECDIS screen should follow the mandatory requirements of the Global Maritime Distress and Safety System (GMDSS): wind, sea state, visibility and significant weather.

4.1 Wind

Wind information is provided as a surface (10m height) means value – direction and speed (in knots or m/s) and as gusts – direction and speed.

The wind field data for the surface wind is derived from numerical models, the gust information from forecasts and real-time observations. There are WMO (World Meteorological Organization) symbols for the mean wind values which ECDIS is expected to use, but no separate symbol for gusts. This is a matter that ECDIS developers will need to look into and continue to confer with WMO on the subject. One of the options is an operator switch able symbol, another – alphanumeric display alongside the standard wind symbol, but other solution is also possible.

There is also a question of interpretation of the gust information: Is the gust the same as maximum speed?

The WMO definition of a gust is "a sudden, brief increase of the wind in a period of at least 3 seconds, where the value exceeds the mean wind speed by more than 10 knots or 5 m/s" (International Meteorological Vocabulary, WMO No. 182). However, it was felt that mariners are interested in what is the maximum possible value of the gust.

4.2 Sea State

Sea state information is provided as direction seas (sea waves), period of sea waves and height of swell.

At present, these data are represented in form of continuous lines for the sea waves and of dotted lines for the swell; both supplemented by alphanumeric information alongside. It is proposed that ECDIS should follow these principles with an addition of isoclines in a global view and of pick reports for the single point data. Another possibility for graphical representation of swell forecast is to plot arrows showing direction of swell with their length depending on the height of the swell.

Significant wave heights are usually disseminated by the NMS. Additional information for the sea state in form of wavelength and maximum wave height is generally available at the NMS, but not disseminated widely at present. They are made available for site-specific operations. Some new symbols may be needed to display this information by ECDIS if there is a requirement for it by the mariners.

4.3 Visibility

Visibility data is usually a time and location specific information at the point of observation (e.g. ship report). Interpolation or data smoothing is not viable.

When visibility information is forecast, the predictions apply to an area. It is possible to draw a parallel with the aviation visibility forecasts where general, occasional (i.e. temporally variable) and isolated (i.e. space variable) and isolated (i.e. space variable, e.g. fog patches) conditions are predicted for a given area with the following thresholds of visibility:

- > 5nm – good
- 2-5 nm – moderate
- 2 nm – poor
- < 0.5 nm – very poor

WMO has developed a very comprehensive symbology for point data on fog/visibility. Its symbol for an area affected by fog is solid shading in yellow which is the same as the land areas in ECDIS, thus requiring development of a different method. One option is enclosing the affected area in a frame of different colour for different fog conditions (occasional, isolated, etc.). Another one is using a yellow kind of different kind for each type of conditions enclosing an area with additional point data symbols inside. The final solution will have to be protected by the ECDIS developers in cooperation with the WMO.

4.4 Significant weather

Significant weather data can be considered as one meteorological parameter which provides additional values to the general weather information (e.g. description of precipitation: rain, showers, drizzle, squalls, etc.). WMO symbology applied to the affected area will need to be used in ECDIS, possibly using the frames of various colours do delimit such areas.

General weather information for mariners is provided in form of warnings (for gales, storms and tropical cyclones), and of weather forecasts. The requirements for both these forms, as well as for the SAR operations are very precisely described by the WMO Technical Regulations.

The warnings are normally transmitted in plain language, and at present there is no facility of translating this into a graphic representation. The mandatory GMDSS requirements for the weather forecasts are as mentioned above, and at present sent in plain written language and as weather fax which can be adapted for ECDIS. Any other 5 information is optional for general forecasts; however it may be of value to SAR operations, and is then provided.

ECDIS should follow the WMO requirements and symbology in every case.

4.5 Integration of MMSI/GMDSS Data and Meteorological Alarms on ECDIS

The GMDSS mandatory set of information should form the basis for the meteorological input to the ECDIS overlay. The format of data transmission to vessels is open for discussion.

WMO provides several standards for data transmission (ASCII, binary, Weather fax), but there is no provision for a format readable by ECDIS at present. S-57 format is a possibility; however some countries responsible for data transmission in their GMDSS areas of responsibility may find it impossible for financial reasons. The cost of satellite transmission of large data files for graphic display may be considerable and would have to be borne by these countries, as provision of meteorological data is at present free to the end users. As from 1 Feb. 1999 Inmarsat C onboard receivers are mandatory for all SOLAS class vessels to enable them to receive the GMDSS messages. These plain text messages may be interfaced with ECDIS after format conversion. It is possible that graphic images can be transmitted in the future. If transmission of these images using S-57 format is too costly, then the existing WMO formats may have to be used for transmission, with format conversion being performed within the onboard ECDIS.

Interaction of meteorological data with the ECDIS functionality offers a possibility of alarms raised when certain threshold are reached or exceeded. The most important is a storm alarm. This would inform the navigator that the vessel is likely to encounter storm conditions within a preset number of hours. Both the number of hours and the threshold of e.g. wind speed or wave height should be selectable within the ECDIS equipment by the operator. Specialized alarms could also be provided, e.g. when certain air/water temperature levels are important for vessels transporting fragile cargo.

5. ECDIS FOR VTS

More and more VTSs are using custom electronic vector charts with associated custom databases, although relatively few have so far adopted ECDIS. There are arguments for adopting ECDIS as a standard for VTS, although significant modifications will be needed, for example:

- The same information is available on board and in the VTS. This could be especially beneficial for shore-based pilotage and navigational assistance operations;
- Charts are standardized, using performance standards as agreed by IHO/IMO;
- Updates are possible;
- Different VTSs would use the same chart standards and could exchange display data easily.

The standard "IMO-ECDIS" needs to be modified for use in VTS. On the one hand some items are not needed. VTS operators are familiar with their area and do not need the detailed labels available in the standard ECDIS data set. On the other hand VTS operators need information not contained in the standard IMO ECDIS, for example:

- Radar target tracking acquisition zones;
- Radar target tracking reporting lines;
- Navigable space, e.g. Fairway boundaries (often differently defined for VTS purposes than in the IMO-ECDIS);
- Fairway centre lines (in Germany also called the "Radar line");
- Additional text notes (Temporary notes for dredging activities etc.);
- Areas of responsibility for VTS operators;
- VTS areas limits;
- Harbour responsibility area limits;
- Details related to harbour management;
- Positions of other VTS related objects;
- Other details which still emerge with each new VTS project and in the course of technical and technological VTS development.

Meanwhile, the VTS display is designed to be watched for long periods, so the VTS ECDIS should use a palette of colours that is not tiring for the operator. VTS charts also need to integrate local information for example on water depths, which are usually more up-dated than the more data supplied by IHO for ECDIS.

A solution would be to provide special overlays for VTS containing the appropriate VTS objects sets for each area. Compared to IMO ECDIS, some of the more obvious VTS ECDIS requirements include the ability to customize the data set:

- A reduced background data set;
- A chart editor;
- An object editor (lines, symbols, etc.);
- A colour editor.

There are also some functional modifications for operational purposes, such as:

- VTS specific automatic alarms and alerts;
- VTS specific new chart details, such as automatically tracked buoys;
- VTS specific chart details, such as additional text bodies, temporary chart objects.

6. CONCLUSIONS

Internationally the future of ECDIS depends on several factors, the most significant of which is the lack of ENCs. This lack, in turn, is suppressing demand for ECDIS with the result that interest in setting up an infrastructure to distribute ENCs and updates has stalled. Given the international trend toward smaller government it doesn't seem likely that the production of ENCs will dramatically increase in the near future.

ECDIS is influencing the way mariners and navigation service providers (typically Coast Guards) approach the safe and efficient management of shipping.

There is no doubt that ECDIS, supported by ever faster and smaller computers and higher resolution video displays will continue to revolutionize marine navigation for many years to come.

7. REFERENCES

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