

NAVIGATION AT SEA IN THE NEW MILLENNIUM

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Abstract:

The technological innovations in the field of electronics, computers, communications and information technology brought a sea change in the concept of navigation at sea. A brief review of the developments in the fields related to navigation at sea from conventional methods to modern methods using navigational charts is presented.

The concept of Electronic Navigation Chart (ENC) and Electronic Chart Display and Information System (ECDIS), the need for the changes in navigation methods are discussed. Current trends and the status of ENC and ECDIS introduction to the Maritime community is explained.

The scenario in the next millennium on board a vessel to provide safe navigation at sea is presented.

INTRODUCTION

The technological advances in the field of electronics, computers, communications and information technology in the past one and half decades paved the way for better navigation at sea providing safety to the men and material at sea. World Trade is largely dependent on sea routes for moving the cargo from one place to another place. Ships of large size to carry bulk cargo/oil/chemicals are built. These very large vessels need safe passage while moving across the oceans and various sea routes. International Organisations such as International Maritime Organisation (IMO) and International Hydrographic Organisation (IHO), regulate, coordinate and oversee the standardization of equipment, personnel and data required for maritime community. These are essential to safe guard the interests of the maritime operations and protecting the marine environment from disasters at sea due to collision and accidents to the ships.

Prior to introduction of electronic equipment and computers on board ship, the navigator on the bridge of the ship used conventional methods for navigation at sea. The induction of electro magnetic devices for position fixing, Echo sounders for depth measurements and other sophisticated devices such as gyro, radar and communication systems, improved the navigation at sea. The concept of Electronic Navigation Chart (ENC) was conceived few decades back but could not be brought to reality due to hardware limitations at that time. A whole new intelligent shipboard electronic navigation system was introduced with the availability of Global Positioning System (GPS), supported by other radar navigation techniques, computer technology and digital chart.

BACKGROUND

Paper chart has been a legal document of navigation for more than a century. Its significance and role has been well defined in the International Convention for the Safety of Life At Sea (SOLAS). By convention all the ships navigating at sea must carry the charts. The digital era of 80's and 90's has compelled the International Organisations to look in to this aspect for a change without prejudicing the interests of the mariners at sea.

During 80's, attempts were made to combine the ship's position fixing system such as Loran-C, DECCA with the radar image on computer having in background scanned or digitized paper chart. This exercise gave encouragement to integrate various other sensors in to one single unit for displaying parameters required by the navigator on the bridge for navigating the ship safely. This gave birth to the Electronic Chart Display and Information System (ECDIS). ECDIS is part of

the bridge system that combines technology, procedures and operator through an efficient human-machine interface. It will increase the safety, because of one-person navigation bridge, and there is only one decision maker.

ECDIS system concept gained popularity and several developed countries in close collaboration with the industry tested the efficacy of such system. North Sea Hydrographic Commission, Canadian Hydrographic Service, US Government Agencies in collaboration with Equipment Manufacturers and Shipping giants have conducted independently tests for the system in Europe, Canada and USA respectively. The outcome of such test bed was well documented revealing the need for standardization of various aspects of such system for induction in to the normal use.

IMO and IHO realized the importance of such system and set up committees to define the specifications and standards for such system and the data. The details of such standards and current status of ECDIS and ENC are discussed in the following paragraphs.

ELECTRONIC NAVIGATION CHART (ENC)

Electronic Charts have emerged as a new navigation tool that can provide significant benefits to the navigation on the bridge in terms of safety and more precise navigation at sea. It is not only a display of paper chart, but combines both spatial (geographic) and external information in to a readily useful operational tool. It is an automated decision aid capable of continuously determining the ship's position in relation to charted objects, aids to navigation and subsurface hazards. Electronic chart is a real time navigation system that integrates a variety of information that is displayed and interpreted by the navigator. The most advanced form of electronic chart is the ECDIS. All other types of electronic charts can be considered as Electronic Chart Systems (ECS).

As per IHO definition of ENC, " Electronic Navigational Chart (ENC) means the database, standardized as to content, structure and format, issued for use with ECDIS on the authority of the Government authorized hydrographic offices. The ENC contains all the chart information necessary for safe navigation and may contain supplementary information in addition to that contained in the paper chart which may be considered necessary for safe navigation".

In addition, IMO Performance standards for ECDIS stipulate, " The chart information to be used in ECDIS should be latest edition of that originated by a government authorised hydrographic office" and conform to the IHO standard.

IHO STANDARD FOR ENC

IHO after examining test bed results of ECDIS, constituted Committee On Electronic Chart (COE) to define the specifications for the content of ENC and what ECDIS should display. The sub committees of COE in consultation with several experts conducted several meetings. After these meetings and deliberations, the COE has prepared the following documents:

- a) Transfer Standard for Digital Hydrographic Data (IHO S57)
- b) Specifications for Chart Content and Display Aspects (IHO S52)

All the government agencies who are producing paper charts are to produce the digital data for use in ECDIS to conform to the IHO S –57 standard. All the manufacturers are to comply with the IHO S 52 Specifications for chart content and display aspects.

Several commercial agencies producing digital charts were not following any specific standard format while designing the ECDIS system. This naturally leads to inhibit inter platform transfer of the data. To overcome this problem, IHO stipulated the above standards for uniform data structure across the platforms.

RASTER CHARTS

Each hydrographic office has to produce the digital data to conform to IHO S 57 standard. To create such a database, they need resources in terms manpower and funds. Some of the Hydrographic offices have suggested as an interim measure to use Raster Charts (as a replica of paper chart) to be used as back drop in ECDIS display. However, such display of image will not have the intelligence of vector charts. They have also proposed to IHO and IMO to define the standards for Raster Chart Display System (RCDS). The RCDS use in lie of paper chart gaining support among the developed countries such as USA, UK and Australia. RCDS will only serve as mere display of paper chart and cannot be used for navigational function like ENC data.

ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEM (ECDIS)

ECDIS is a real time Geographic Information System (GIS) in marine environment that is capable of integrating different navigational positioning systems and ship sensors with the ENC. ECDIS provides more information, faster and more accurately than navigational methods used earlier. It displays ENC, which is legal equivalent of paper chart issued by hydrographic offices of the world and is likely to replace paper charts on all SOLAS class vessels. Its automatic position tracking, safety features like various alarms, ability to set a safety contour and updating capability, relieve the navigator of many time consuming duties and allow him concentrate on the navigational and ship management decisions. The greatest advantage of ECDIS against the conventional paper chart is the dynamic display of temporally variable information essential for navigation, which is frequently not sourced, or controlled by the hydrographic offices.

Figure 1., shows various components of an ECDIS on board ship. The ECDIS consists of a colour display (with options for additional display units), ENC, SENC, Updates of ENC, inputs from Navigational sensors, Gyro, Compass, Echo Sounder, Radar/Arpa and any other navigational data.

You may observe there is an ENC and SENC, the difference between these are as follows:

ENC is the data base produced by the official government agency and is validated and updated by the hydrographic offices.

SENC is the System Electronic Navigation Chart. It is the database resulting from the transformation of the ENC by the ECDIS for appropriate use, updates to the ENC by appropriate means and other data added by the mariner. It is the database actually accessed by ECDIS; and is equivalent to an up-to-date paper chart. The SENC may contain information from other source.

Even though an ECDIS cannot be considered as an Electronic Navigation System without ENC, it is the SENC that is derived from ENC, which is displayed. ECDIS fulfills the compliance of SOLAS V/20(4) only after merging the ENC contents and updates in to SENC. To comply with the IMO Performance Standards, ECDIS should have the following conditions adhered to in respect of SENC:

- a) ECDIS should provide a means of ensuring that ENC and all updates to it have been correctly loaded in to SENC.
- b) The chart information to be used in ECDIS should be the latest edition of information originated by Government authorised Hydrographic Office, and conform to IHO S57 standard.
- c) The contents of the SENC should be adequate and up-to-date for the intended voyage, as required by regulation V/20 of the 1974 SOLAS Convention.
- d) It should not be possible to alter the contents of the ENC.
- e) Updates should be stored separately from ENC.

This means SENC is the component in ECDIS, which achieves SOLAS V/20 compliance in respect of nautical chart equivalence. It is also necessary that regular official updates are available to the mariner from the authorised Government agencies producing ENC. IMO ECDIS Performance standards stipulate the use of official updates.

OTHER INTERNATIONAL STANDARDS FOR ECDIS

IMO PERFORMANCE STANDARDS FOR ECDIS

IMO has developed and adopted carriage requirements for certain ship borne navigational equipment and also performance standards for such equipment. Performance standards have also been developed for electronic navigational equipment for which there is at present no carriage requirements. IMO work on electronic charts has resulted in resolution A.817 (19) on Performance Standards for ECDIS. For an electronic chart to be considered as an ECDIS, it must comply with the performance standards which specify the components, features and functions of a system, the primary purpose of which is to contribute to safe navigation, including functional requirements for back-up arrangements for ECDIS.

These performance Standards permit National Maritime Safety Administrations to consider ECDIS as the functional equivalent to the charts required by regulation V/20 of the 1974 SOLAS convention. IMO has specifically requested that the member governments have their National Hydrographic Offices produce ENCs and the associated updating service as soon as possible, and to ensure that the manufacturers conform to the performance standards when designing and producing ECDIS.

IEC TESTING STANDARDS

At the request of IMO, the International Electro technical Committee (IEC) developed an IEC ECDIS Performance Standard that identified and described the necessary performance tests and checks for an IMO compliant ECDIS. The draft standards were submitted for approval and this is now referred as IEC Publication 61174. This will be basis for type approval specifications related to operational methods of testing and required test results for an IMO –compliant ECDIS.

OTHER ELECTRONIC CHART RELATED STANDARDS

The IMO/IHO Harmonisation Group was entrusted to look in to the additional aspects concerning electronic charts:

- a) The development of Performance Standards for Raster Chart Display System (RCDS)
- b) The development of guidelines for non- equivalent electronic chart systems (ECS).

The Group has prepared draft recommendations on the above two aspects. Further, based on sea trials of RCDS and the opinions of IHO Member States, these were modified and were submitted for IMO Sub committee on Safety of Navigation. In addition to the Performance Standards for RCDS, the Group has prepared Draft Safety of Navigation (SN) Circular that advises the mariners on the “ Difference Between RCDS and ECDIS”.

ACCEPTANCE BY THE USER

The ECDIS was introduced in late 80's; mariner at sea is still not familiar with the system. It takes time to change the mindset of the user for any new technology. Similar resistance was observed

when Radar was introduced in 50's. The mariners of present generation are receptive to new technology and are positive towards the concept of ECDIS. However, they need to be trained in the usage of the system and its efficacy, which in long run benefit them in safe navigation and prevention of disasters at sea. Major shipping companies have already been switching to the one-man bridge system for navigation, which will be greatly helped, by ECDIS system. The mariners plying in Great Lakes realized the advantage of using ECDIS, and rely on features of ECDIS such as head-up chart display, relative motion, multi window display, review capabilities and radar overlay. ECDIS systems with these capabilities have contributed to the improved levels of safety and efficiency while transiting during poor visibility and weather conditions.

Mr. Michael Grey, Editor Lloyd's List Press Ltd, in his article " Into The Electronic Age – User Perspective" emphasizes that the user,(Navigator on board ship) would like his views to be sought by the regulators, the Hydrographic Offices and equipment manufacturers, so that he can be part of the design loop of such modern technology before induction of such tools in to his working environment.

In October 1983, Mr. R.M. Eaton of Canadian Hydrographic Service delivering his keynote address to the workshop on Electronic Chart gave a thought provoking scenario of a voyage of a tanker in year 2000 using ENC and ECDIS. He described the use of NTMs being received through communication line, which are fed to "Electronic Chart storage Controller" and thus the chart gets automatically updated. The Captain of the ship notes the real time chart display shows a strobe flashing on the Virgin Rock, with a warning that on the present course and speed made good the vessel will pass within 2 miles of the 30m contour in 18 minutes. Then captain calls for the ephemeris on auxiliary display for assessing next day's sun rise and Sun's true bearing, for gyro check and so on for tracking his cruise plan. This is becoming reality in the new millennium except that the Updating of ENCs taking a different approach.

FUTURE

The ENC is likely to replace the paper chart in the new Millennium, but initially in SOLAS class vessels and later in all ships over 300 Gross Tonnage. ECDIS, which can display the ENC, is becoming a reality. It has been accepted for navigational merits and also for ship management capability. It has the ability to show dynamically the time variable Marine Information Objects (MIO). Some of the ECDIS manufacturers have already providing tidal overlays for ECDIS. Other thematic overlays will also be provided to ECDIS to make it a multi dimensional, dynamic display of the real world and thus enhance the safety of navigation.

One of the advantages of ECDIS is its ability to be used as a Marine Geographic Information System (GIS). There are many types of navigational data available and all of which cannot be shown on a paper chart due to scale limitations and clutter of the details. The user can selectively overlay required information in ECDIS unlike a paper chart there by reducing cluttering of the display.

Similarly, for military applications, the information can be overlaid for specific requirement.

CONCLUSION

The thought provoking keynote address to the workshop on Electronic Chart in 1983 by Mr. Eaton has become reality at the end of this century after 16 years. The International agencies dealing with maritime operations have set the standards for the DATABASE and equipment to be used for safety of navigation.

All the organizations concerned with the maritime operations realized the importance of this new technology in providing safety of navigation at sea. The technological developments in the new

millennium will pave the way for cost effective solutions in making this tool a common factor on the bridge of system. At present updating the ENC database on board ECDIS is still in formative stage. The induction of communication satellites to cater the needs of offshore vessels, should provide cost effective solutions in updating the ENC database on board vessels in the near future. The E- Commerce concept prevailing in other areas will play significant role in marketing the ENC data to the users at sea and on shore. The Regional ENC (RENC) centers will be taking care of providing the facilities for updating and distributing ENC data sets produced by Hydrographic offices in the Region. The methodology for coordinating such activities is being worked out in close cooperation of the member Hydrographic offices and IHO.

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ECDIS COMPONENTS

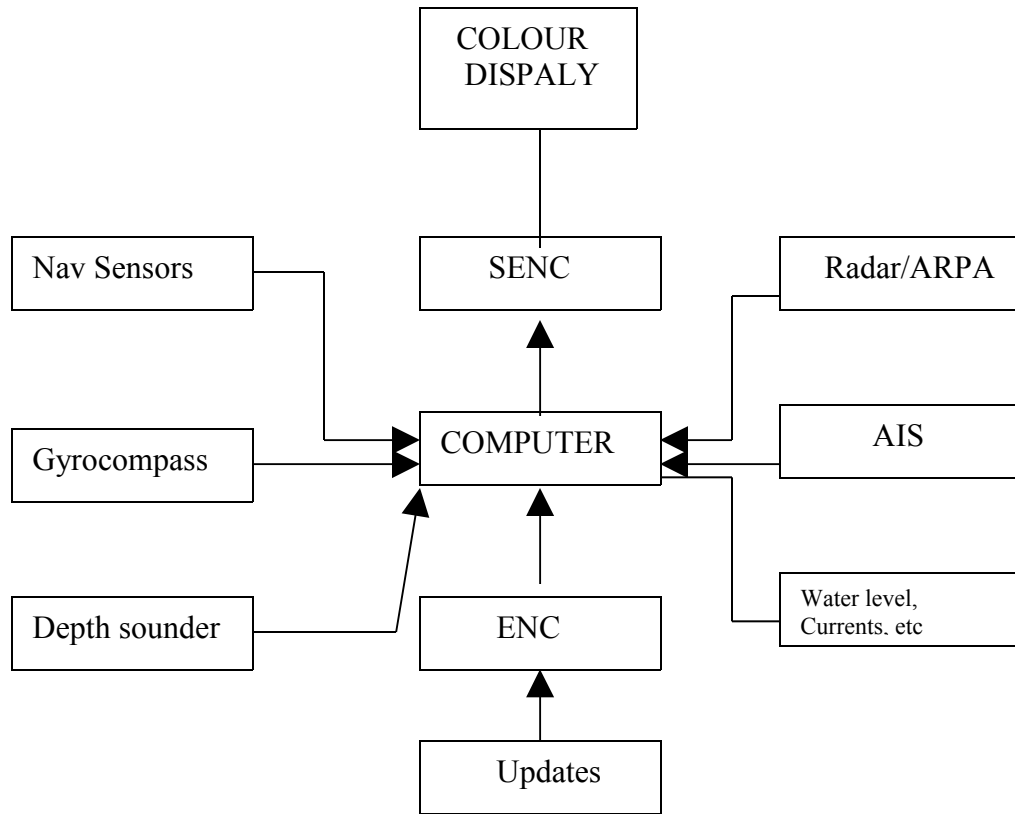


Figure: Basic Components of ECDIS