Adam WEINTRIT*, Krzysztof STAWICKI
Gdynia Maritime University, Department of Navigation
ul. Jana Pawła II str. 3, 81-345 Gdynia, Poland
**Corresponding author*. E-mail: weintrit@am.gdynia.pl

OPERATIONAL REQUIREMENTS FOR ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEMS (ECDIS). RISK OF OVERRELIANCE ON ECDIS

Summary. Navigating with Electronic Chart Display and Information Systems (ECDIS) is fundamentally different from navigating with paper charts. The paper is addressed to model course on training in the operational use of ECDIS. It presents problems related to the risk of over reliance on ECDIS.

WYMAGANIA OPERACYJNE DLA SYSTEMÓW ECDIS. RYZYKO ZBYT WIELKIEGO ZAUFANIA DO SYSTEMU ECDIS

Streszczenie. Prowadzenie nawigacji w oparciu o system ECDIS zdecydowanie różni się od nawigacji prowadzonej na podstawie papierowych map nawigacyjnych. Artykuł odnosi się do modelowego kursu obsługi i wykorzystania systemu ECDIS. Prezentuje zagrożenia związane ze zbyt wielkim zaufaniem nawigatorów do systemu.

1. SAFETY RISKS

Due to its capability to integrate a wide variety of graphic and textual information, the electronic chart system is becoming the central navigational instrument on the bridge of a ship. However, for all its capacity, there are also some limitations. The electronic chart should not be totally relied upon or lead the Watch Officer into a false sense on safety and security. Over-confidence must not result from the fact that the ship's position is automatically shown on a chart. The Watch Officer must be always wary as to how the system is actually performing in regard to accuracy and reliability. This requires an awareness of the deficiencies and risks of the overall system and its components. It must be recognized that the quality of the sum of the information is essentially dependent on the reliability of the each component of data and technology. Similar to any system, an ECDIS is not infallible. It has the same shortcomings that exist in any technical device [1].

It is recognized that the widespread reliance on Global Navigation Satellite Systems (GNSS) as the primary means of position fixing and ECDIS as the primary means of route monitoring and anti-collision has encouraged some mariners to navigate in areas where, and under conditions in which, they had not previously ventured - for example, close inshore, at night and in reduced visibility.

More generally, any future strategy needs to take into account the evolving shipboard practices and training requirements of seafarers. Traditional navigational skills sometimes appear to be superseded by over-reliance on new technological advances and automated features, for example, the Electronic Chart Display Information System (ECDIS) and Integrated Bridge Systems (IBS).

2. RISK ASSESSMENT METHOD FOR ECDIS

The champions of ECDIS correctly claim that, when properly understood, its use increases the safety of navigation. Its critics point out that it is a complex tool which, used in ignorance, can actually increase risks. This criticism is partly due to the proliferation of different chart formats and the fact that each ECDIS type interacts with the charts in a subtly different way.

The application of Risk Assessment has been used for a number of years to assist in safety procedures in various aspects of the running of a vessel. Until now, it has not been extended specifically to ECDIS and all its functions. This chapter deals with the key issues associated with the practical application of risk assessment. Despite the well-known benefits of electronic charts over paper charts, the maritime community has been rather slow to adopt ECDIS. There are a number of reasons for this. They fall into three basic categories:

- Production of approved charts has been extremely slow; even now many vessels cannot complete their usual trading route using only official electronic data,
- Shipping companies shy away from the complexities of integrating charts from a number of different sources - bearing in mind that there is no uniformity in updating frequency, permit types and so on,
- There are risks associated with transition from the well-understood and robust area of paper charts (which are still an approved method of navigation) to the rapidly evolving environment of electronic charts.

As many mariners are discovering, no computer package is experienced as truly intuitive by one with little or no prior knowledge of computers.

2.1. Risks and Legislation

Maritime Authorities are aware of this reticence on the part of ship-owners to migrate more quickly to electronic navigation and have attempted to make the prospect more attractive. In 1998, the IMO Maritime Safety committee agreed to allow a ‘dual fuel’ approach, whereby official Raster data could be used to ‘plug the gaps’ between areas of ENC (Electronic Navigational Charts, specifically in S-57 format) coverage, provided the mariner maintained ‘…an appropriate portfolio of up to date paper charts’. It was left to the flag states to define what constitutes ‘appropriate’. Certain maritime authorities set up pilot projects to encourage local ship-owners to start using electronic charts and gave their permission for those vessels to navigate with a minimum number of paper charts. The Netherlands and the UK Authorities permit both Raster charts and ENCs to replace paper. Other Authorities, particularly those in the Baltic, insist that only the use of ENCs with 2 type-approved ECDIS will result in a reduction of paper charts.

The pilot projects did not lead to greater numbers of ship-owners applying for the same dispensation and a more formalised approach was set out by the UK MCA (Maritime & Coastguard Agency) in 2001 in MGN 133. This required all ships seeking permission to operate using ECDIS or RCDS (Raster Chart Display System) without paper chart backup to formally assess the risk of electronic navigation and to submit their risk assessment for approval by the MCA. In early 2002, this was augmented by the release of MGN 194, which set out in detail the definitions of risk and the preferred method of completing such an assessment, including a list of suggested hazards to be considered.

2.2. Risk Assessment Definitions

For the purposes of this discussion, the following definitions have been used:

- Hazard: a source of navigational error with potential harm or damage to personnel, own ship, other ship or environment,
- Risk: the likelihood of the hazard occurring, combined with the severity of the hazardous event.

2.3. Areas of Risk

The hazards associated with the use of ECDIS fall into three categories:

- The equipment itself (both hardware and software) may suffer from potential virus infection, power outages, loss of input of sensory equipment (depth, gyro, speed),
- The charts themselves are at risk from permit expiry, out-of-date charts being used, updates not applied correctly, excessive zooming (in the case of Raster charts), inability to open the next chart required (Raster charts). Most of these hazards can be mitigated or even eliminated, if bridge crew are properly trained in the use of ECDIS,
- The particulars of these risks are unique to each vessel, crew and equipment, and can only be assessed on a case-by-case basis. Other factors, such as area of operation and nature of cargo, will also have a bearing on the severity of the hazard and therefore the risk.

2.4. Assessment Process

This has four stages:

1. Establish the Hazards
   This should include hazards specifically associated with operation in RCDS, and others which refer to ECDIS in general. The limitations of RCDS are well-known: it is a chart-based system (which affects look-ahead capability); it will not trigger alarms; there may be datum shifts between charts; it cannot be interrogated; it is not possible to select safety contours; orientation to 'course up' is often not practical,
   Hazards associated with ECDIS failure would comprise: hardware or software failure, power failure, incorrect application of chart corrections, input failure (e.g. GPS, depth), virus infection.
2. Determine the Risk
   This should be determined by estimating both the potential severity of the hazard occurring, and then the likelihood of such an occurrence. These should be estimated separately and then combined to produce the risk factor itself. Risk assessment is a subjective process and therefore the vessel should provide documentation or other proof to back up any assumptions made regarding these estimations. Take the case of virus infection. Although a virus designed to wipe clean the computer hard drive presents a critical hazard, if the procedure used on a vessel always virus checks (with up-to-date anti-virus software) all received files, and the ECDIS is not networked to the PC with Internet / e-mail access, the likelihood of the hazard occurring is extremely low.
3. Decide if the Risk is tolerable
   Using the combination of factors described above, a risk matrix is applied and the risk is categorised at one of five levels, from trivial to intolerable. A substantial or intolerable risk would indicate that better procedures need to be implemented before any reduction in paper charts should be considered.
   In our case of virus infection, this represents a moderate risk. It may be possible to improve procedures in order to further reduce this.
4. Controlling the risk
   This is the opportunity to improve onboard procedures and to develop a 'best practise' method of operation with which all crew involved are familiar with the ECDIS. They will reduce the likelihood of the identified hazards occurring, and thus the overall risk factor. This also allows for the provision of emergency procedures, should any unlikely hazard occur, to further mitigate the severity of its impact on the ship, its crew and the environment.
   Once the procedures have been formally assessed and appropriate supporting documentation gathered, you are now in a position to present your petition for a reduction in the number of paper charts carried on board.

2.5. Practicalities

The above procedure outlines the guidelines produced by the MCA. They also recommend that the best qualified person to conduct such an assessment is someone who is familiar with the vessel, her trading pattern, onboard procedures and the ECDIS. This means, of course, the master or second officer would have to add it to the list of their duties. There is help available. Kelvin Hughes worked closely with the MCA to interpret the guidelines and transform them into a practical service which assists the mariner complete the assessment from collation and assessment, through actions and control procedures and finally on to the presentation and application itself. Lloyds Register Fairplay have a generic Risk Assessment programme for the marine industry, and other independent consultants with knowledge in the field may be able to provide advice. Certainly, for the novice the process is a minefield.

2.6. Benefits of Risk Assessment

Conducting a risk assessment for a ship involves recognition of potential shortfalls in migrating from paper to digital navigation and helps focus attention on removing these shortfalls, therefore increasing safety (and decreasing frustration on board!).

It should also accelerate the migration to electronic navigation and thus bring forward the benefits associated with digital charts, such as easier navigation, greater accuracy, quicker correcting, and the cost savings inherent in reducing the number of paper charts required. It is clear that there are a number of difficulties associated with starting to use electronic charts, such as relatively poor coverage of chart data, complexity of integrating charts from multiple sources, complexities of flag and port state control requirements, and the additional cost of maintaining two systems during the transition period.

A risk assessment will help to recognise and manage these risks. It should lead shipping companies to ensure that their staff receive adequate training in the functionality of their particular ECDIS, with the type of charts they have chosen to use. The use of electronic charts is set to increase and early understanding of the issues and risks will help crews prepare for this. Formally documenting the procedures will further lead to adoption of best practice methods, simplifies the training of new crew members and makes a job simpler for the new master who boards the vessel shortly before leaving port.

3. PRODUCERS OF ELECTRONIC CHARTS AND EQUIPMENT: POTENTIAL EXPOSURE TO LIABILITY

3.1. Introduction

As the conventional paper nautical chart is being supplemented, if not replaced, by sophisticated electronic charting systems, maritime products liability law finds yet another application. This chapter will 1) provide an overview of the United States maritime products liability law, 2) sketch out the possible nature and scope of the liabilities of producers of electronic charting system equipment, software and databases, 3) offer some direction to the producer in shielding itself from liability, and 4) suggest possible defences to the producer who is faced with a claim. Primary consideration is given to the manufacturers of electronic charting equipment with less emphasis placed on the risk faced by chart database producers. With respect to producers of equipment, this analysis primarily considers their liabilities and defences for claims arising out of manufacture and sale of the products and does not specifically address possible claims arising out of negligent installation of the products.

3.2. An overview of the products and the risks faced by producers

A quick glance at any major marine equipment catalogue will reveal the scope of electronic charting products currently on the market. Very simply, an electronic nautical chart is a digitized version of a government-issued, conventional paper chart. The chart can serve both as a plotting device and as a navigation device when combined with a positioning instrument such as a Global Positioning System (GPS) or Loran. When used for navigation, the system permits the navigator to see on a display screen a representation of his vessel's current position and intended future positions in relation to the channel, aids to navigation and hazards.

Several configurations of electronic charting systems are currently produced. A system may consist of charting software installed on a laptop computer or other CRT to which chart database cartridges from one of the major database producers are added for the geographical area desired. Electronic charting units are also sold to connect to existing radar devices, sounding devices, gyro compasses, video monitors, etc. which will combine chart data from database cartridges with the main device's usual display. Simple flat-panel-display systems with a combination of pre-installed charts and cartridges are available to function independently or in conjunction with a positioning device. Finally, there are combinations of electronic chart and GPS displays for use with chart cartridges which may also include a limited number of pre-installed charts. In the event of an accident allegedly caused by a defect in the electronic charting system, therefore, claims may be directed against the producers of the hardware, software, and/or chart database. Claims might relate, among others, to the presence of an unknown physical defect in the product, to the producer's failure to warn the user of a known defect or its failure to instruct the user in its proper use and handling, or to inaccuracies in the underlying data.

Claims arising out of defective navigation systems of whatever kind have the potential to be quite large as they may arise out of groundings or collisions. When electronic charting is used on larger vessels as part of integrated navigation systems combining not only GPS, radar/ARPA, AIS, and autopilots but also other sophisticated instruments, the potential for minor malfunctions to trigger large-scale damages increases. To complicate matters, the range of equipment combinations possible in integrated navigation systems could make it difficult to pinpoint the "defect" which caused the malfunction. Litigation may involve cross claims among a variety of manufacturers, each denying that its device or component part was the source of the breakdown.

While the size and complexity of claims may easily be imagined, however, the lack of judicial precedent considering the liability of the electronic charting system producer is unfortunately coupled with an absence of clear industry standards for design and manufacture, making it difficult to evaluate the producer's potential exposure with accuracy.

3.3. Conclusions

As with every other advance in modern technology, the development of electronic chart systems presents producers and suppliers not only with new opportunities for profit, but also with new and/or expanded potentials for liability. One producer the author spoke with is resigned to the fact that after any substantial casualty, his company will be sued if there is the slightest link between his equipment and the casualty. His company's position is that the costs of insurance and litigation are simply part of the cost of doing business. These costs, undoubtedly, are passed along to the purchasers.

In this handbook, I have outlined the applicable law and the limited legal protection available to the producers and suppliers of electronic chart systems. The U.S. Congress is reportedly working on legislation to set limits on product liability suits and on punitive damages. Perhaps some relief will become available this way, but it cannot be counted upon.

In the meantime, the producer should continue to do what he reasonably can to ensure that his product is not defective and will not fail at an inopportune time or be misused. Accident avoidance remains the best defence, for example: *Royal Majesty* grounding, *Rockness* capsizing, *Norwegian Sky* grounding, *Gdynia - Fu Shan Hai* collision.

4. TRAINING IN OPERATIONAL USE OF ECDIS

4.1. Course Description

The aim of the course is to enhance navigation safety and efficiency by training the Watchkeeping Officer in the safe operation of ECDIS. This is achieved by: developing a knowledge of the generic principles of ECDIS and other chart systems; understanding the capabilities and limitations of ECDIS; awareness of the potential errors and interpretation and risk of reliance on ECDIS; understanding the regulatory requirements of ECDIS: appreciating the value of ECDIS [3].

The aim of the ECDIS course is to enhance navigation safety and efficiency by training the Watch-keeping Officer in the safe operation of ECDIS. This is achieved by developing an understanding of the generic principles of ECDIS and other chart systems, and by understanding the capabilities and limitations of ECDIS. The course also covers awareness of the potential errors and risk of reliance on ECDIS, and understanding the regulatory requirements of the system. The updating regimes and differences between various systems are all covered allowing future operators to fully appreciate the value of ECDIS and maximise its numerous safety benefits.

4.2. Risks of over-reliance on ECDIS

The training in ECDIS operational use should address [2]:

- the limitations of ECDIS as a navigational tool,
- potential risk of improper functioning of the system,
- system limitations, including those of its sensors,
- knowledge of principal types of ARPA/ECDIS/AIS, their display characteristics, performance standards and the dangers of over reliance on ARPA/ECDIS/AIS,
- hydrographic data inaccuracy; limitations of vector and raster electronic charts (ECDIS vs. RCDS and ENC vs. RNC), and
- potential risk of human errors.

Emphasis should be placed on the need to keep a proper look-out and to perform periodical checking, especially of the ship's position, by ECDIS-independent methods.

4.3. Detection of misrepresentation of information

Knowledge of the limitations of the equipment and detection of misrepresentation of information is essential for the safe use of ECDIS. The following factors should be emphasized during training [2]:

- performance standards of the equipment,
- radar data representation on an electronic chart, elimination of discrepancy between the radar image and the electronic chart,
- possible projection discrepancies between an electronic and paper charts,
- possible scale discrepancies (overscaling and underscaling) in displaying an electronic chart and its original scale,
- effects of using different reference systems for positioning,
- effects of using different horizontal and vertical datums,
- effects of the motion of the ship in a seaway,
- ECDIS limitations in raster chart display mode,
- potential errors in the display of:
  - the own ship's position,
  - radar data and ARPA information,
  - different geodetic co-ordinate systems, and
- verification of the results of manual or automatic data correction:

  - comparison of chart data and radar picture, and
  - checking the own ship's position by using the other independent position fixing systems,
- over-reliance on the automated features of the integrated bridge system.

False interpretation of the data and proper action taken to avoid errors of interpretation should be explained. The implications of the following should be emphasized [2]:
- ignoring overscale of the display,
- uncritical acceptance of the own ship's position,
- confusion of display mode,
- confusion of chart scale,
- confusion of reference systems,
- different modes of presentation,
- different modes of vector stabilization,
- differences between true north and gyro north (radar),
- the same data reference system,
- appropriate chart scale,
- using the best-suited sensor to the given situation and circumstances,
- entering the correct values of safety data; and
  - the own ship's safety contour,
  - safety depth (safe water), and
  - events, and
- proper use of all available data.

Trainees should be able to analyze nautical alarms during route planning and route monitoring as well as sensor alarms. They should be able to assess the impact of the performance limits of sensors on the safe use of ECDIS and to appreciate that the back-up system is only of limited performance. They should be able to assess errors, inaccuracies and ambiguities caused by improper data management. Thus, they should be aware of errors in displayed data, errors of interpretation and the risk of over-reliance on ECDIS and be able to take proper action.

5. CONCLUSIONS

Properly trained navigation officers should determine what is appropriate in terms of alarms and navigation parameters according to the characteristics of the vessel and other prevailing conditions. Lack of training can lead to dangerously incorrect usage and/or over reliance.

Navigators must remember that ECDIS is only a tool that helps a mariner safely and effectively navigate a ship. It is not the end-all be-all to ship navigation. One of the biggest risks with the transition to ECDIS is an over reliance in the information provided.

ECDIS is a revolutionary navigation tool that can fix and plot a position with accuracy anywhere on earth and thereby enables increased productivity, efficiency, knowledge and safety. However, reliance on ECDIS without proper integrity monitoring by services such as GPS or DGPS, can cause physical and financial loss. Another factor may be that the industry's over-reliance on technology is undermining the development of the experience and skills needed for sound decision making.

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