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UNDERSTANDING INFORMATION SYSTEMS

ABSTRACT

Electronic Chart Display and Information System became one of the main devices on navigation bridge. ECIDS supports navigation by gathering information and automating some process like plotting of position of own ship and other objects on the scene. ECDIS as every equipment has got advantages and limitations. Their understanding should help navigators to perform watches in a safer way. This article presents discussion about some deficiencies of ECDIS. Discussion is underlined by two accidents which show when misunderstanding or overreliance may lead to catastrophic consequences.

Keywords:
ECDIS, Navigation Information System.

WHEN INFORMATION SYSTEMS IS MISUSED

In recent time we noticed several accidents involved ships which have been caused mainly by improper use or misunderstanding of onboard information systems. Generally in every accident a number of factors (errors) are involved leading to instability of whole system. In this work let us focus just on information systems — like ECDIS, VMS, ENC. Let us firstly shortly explain meaning and purpose of mentioned systems.

ECDIS — Electronic Chart Display and Information System is a computer--based navigation information system which can be used as an alternative to paper nautical charts, required by Regulation V/19 of the 1974 IMO SOLAS Convention.

ENC — Electronic Navigational Chart is an official database created by a national hydrographic office for use with an ECDIS. An electronic chart must conform to standards stated in Publication S-57 by International Hydrographic Organization (IHO) before it can be certified as an ENC. Only ENCs can be used within ECDIS to meet the IMO performance standard for ECDIS.

VMS — Vessel Monitoring Systems are used in commercial fishing to allow environmental and fisheries regulatory organizations to monitor, the position, time at a position, and course and speed of fishing vessels.

Regulations of mandatory carriage of Electronic Chart Display and Information Systems (ECDIS), under SOLAS convention (chapter V Safety of Navigation), were agreed to by the Sub-Committee on Safety of Navigation (NAV) at its 54th session.

Ships engaged on international voyages shall be fitted with an Electronic Chart Display and Information System as follows:

1. Passenger ships of 500 gross tonnage and upwards constructed on — 1 July 2012, existing — 1 July 2014.
2. Tankers of 3,000 gross tonnage an upwards constructed on — 1 July 2012, existing — 1 July 2015.
3. Cargo ships, other than tankers, of 10,000 gross tonnage and upwards constructed on — 1 July 2013, existing — 1 July 2018.
4. Cargo ships, other than tankers, of 3,000 gross tonnage and upwards but less than 10,000 gross tonnage constructed on — 1 July 2014.
5. Cargo ships, other than tankers, of 50,000 gross tonnage and upwards constructed before — 1 July 2016.
6. Cargo ships, other than tankers, of 20,000 gross tonnage and upwards but less than 50,000 gross tonnage constructed before 1 July 2017.
7. Cargo ships, other than tankers, of 10,000 gross tonnage and upwards but less than 20,000 gross tonnage constructed before — 1 July 2018.

Furthermore IMO minimum requirements for ECDIS (ECDIS performance standards) are defined in the IMO Resolution A.817(19), MSC.64(67) and MSC.86(70).

Fig. 1. Pride of Canterbury [7]

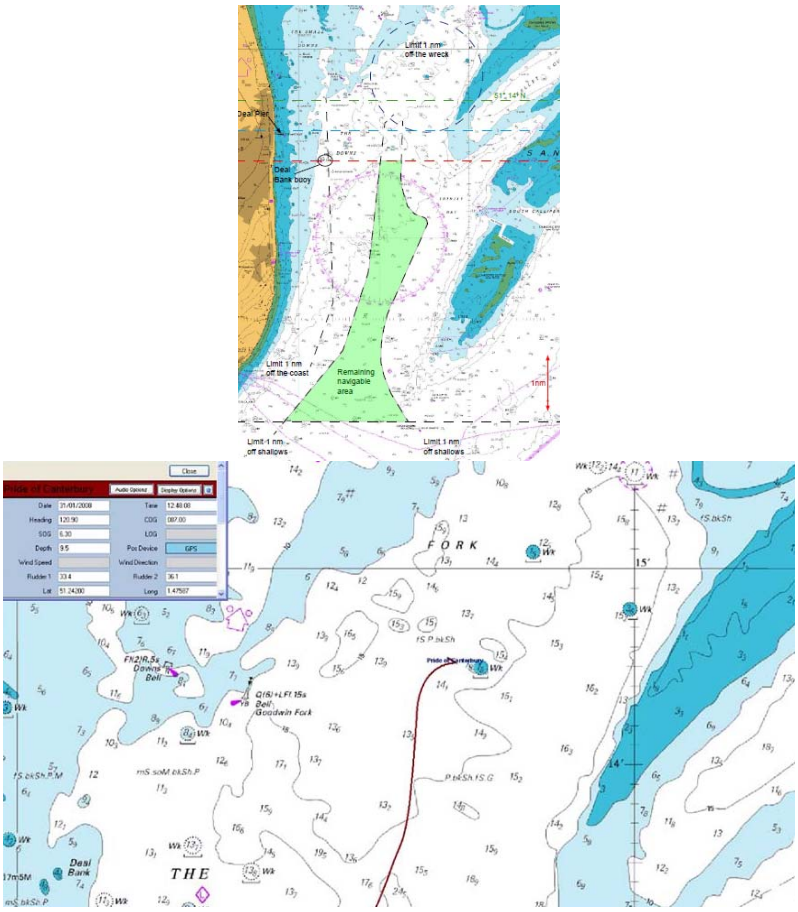

Fig. 2. Track of Pride of Canterbury while running into wreck [7]

On 31 January 2008, the Roll on Roll off Passenger ferry, Pride of Canterbury (Fig. 1), grounded on a **charted wreck** while sheltering from heavy weather [3].

The vessel had been in the area for over 4 hours when she overshot the northern limit of the allowed safe area (Fig. 2). The officer of the watch (OOW) **became aware that the vessel was passing close to a charted shoal, but he was unaware that there was a charted wreck on the shoal**. The officer was navigating by eye and with reference to an electronic chart system which was sited prominently at the front of the bridge, but he was **untrained in the use and limitations of the system**. The wreck would not have been displayed on the electronic chart due to the user settings in use at the time. A paper chart was available, but positions had only been plotted on it sporadically and it was not referred to at the crucial time.

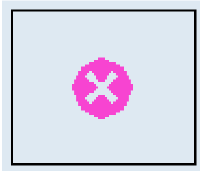

Fig. 3. Isolated danger of depth less than the safety contour: wrecks, obstructions, under water rocks [source: IHO publication S-52 Appendix 2 Addendum to Annex 2, Part I, Users' Manual Edition 3.4 2008]

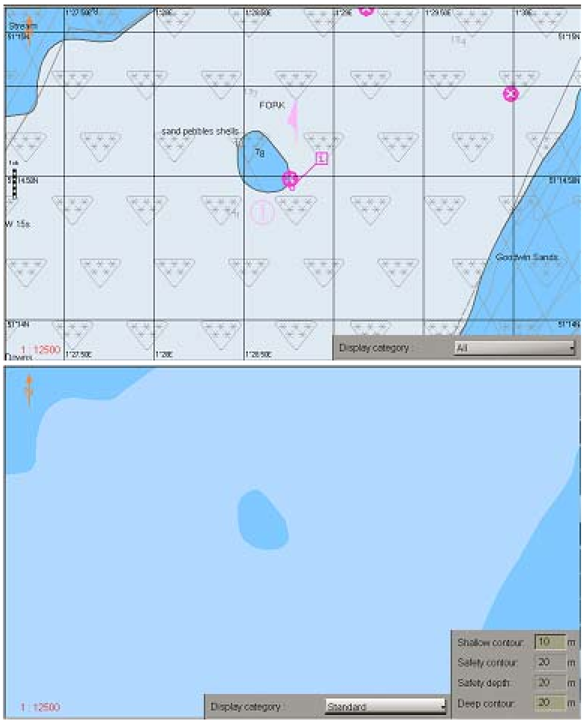

Fig. 4. Extract from ECDIS 3000-i showing alternative display settings for ENC charts for area in question: a) wreck visible, b) wreck not visible (improper setting: shallow and deep contour) [own study]

In that case the lack of proper training in the use of ECDIS possibly led to the wreck being undetected. It is possible that the wreck on the shallow patch was displayed, but that the ECDIS symbol was misunderstood. Display options permit differences between the symbols displayed on paper charts and on ENCs (Fig. 3). Another explanation, which is also linked to a lack of proper training, is that the 'misapplication' of certain user settings may resulting a dangerous underwater obstruction not being displayed on the screen (Fig. 4). If the initial value for the safety contour is selected without understanding the constraints and the option for display of obstructions is set inappropriately. An ECDIS may not display the underwater hazards with sufficient clarity to alert the navigator. If a passage plan had been drawn using the Voyage Management System (VMS), and the VMS safety check function had been used, the presence of dangers on the route would have been automatically highlighted.

Earlier same month on 2 of January 2008 another ship, 6170 TEU container m/v Cortesia ran aground on the Varne Bank in English Channel [3]. In good weather conditions the officer of the watch misjudged the navigational situation. He made non necessary evasion maneuvere leading through shallow water just between cardinal buoys marking it. Due to inverse color allocation in night mode and activation of paper chart symbols, the boys and boundaries of shallow water were difficult to recognize. Following that circumstances OOW put ship in imminent danger, he misunderstood alarms issued by VMS. Finally being aground he was not aware about this fact.

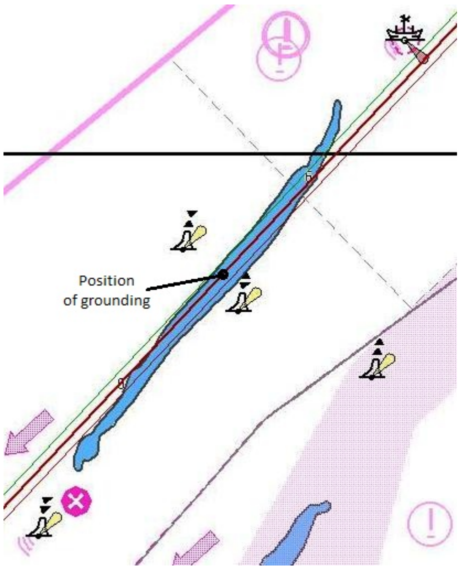

Fig. 5. Plotted evasion maneuvere by m/v Cortesia
through buoyed shallow water [own study]

Investigation showed that during a bridge watch, the OOW relied too much on the ECDIS displays and navigated solely ‘according to the computer’. Such navigation entails extreme risks (focusing just on screen by OOW happened also in collision between m/v Gdynia and Fhu Shan Hai [6]). Furthermore even so, mistake could have been avoided if handling of the information system and the interpretation of the chart display would have been correct. If OOW had selected a better night display or had chosen a 2-color display in conjunction with a better setting of the safety contour he would have, even in the night, noticed the absolutely non-navigable critical depth he was approaching.

AUTOMATIZATION

Subject of maritime navigation according to the International Maritime Organization (IMO) is defined as the process of planning, recording and controlling the movement of the craft from one place to another. This duty is realized by navigator — officer of the watch. We can expect that some tasks and more duties will be substituted by automated equipment and tools. This process — automatization will be extended to all possible areas even those dedicated for intelligent behavior. Knowledge and understanding of automatization limitations among ship crew members (navigators and engineers) is not satisfactory [8] (James S. Wolper..., Understanding mathematics for aircraft navigation, STCW). It is acknowledge by surveys [2] and accidents like shown before. Automatization is extremely useful when operator has to deal/watch with several processes simultaneously or changeable situation. A good example is an ECDIS in areas of high traffic density when is used with ARPA overlay.

That's way it is essential to deliver awareness to the sailors about mechanisms of automatization and its impact on steering process. It is also essential to eliminate routines and dependence to one system when another is available — ability to use alternative resources (MSC 82/15/2 and 82/15/3). It is also worth to notice that many of sailors have been educated before introduction of highly automated navigational systems. The more complex the system is, the more varied the areas, in which misunderstanding could occur. If we count a operator as a part of the system then whole 'system' is even more unstable. Errors can occur in system/hardware/software alone or caused by operator due to improper setting, incorrect usage or a blind faith in the technology. In order to keep safety of navigation on certain minimum level the operator has to understand automated processes, its limitations and outputs values, input values etc. New technologies could be useful in this field. There are number of support systems under development which could assist automated processes giving advices or explanations [1]. As practice shows (number of accidents) assistance would be helpful. For instance although a reliable position is provided by automatic monitoring and self-control of satellite receivers (integrity) it is still not enough for navigation purposes. Many of the bridge equipment and the most important of Electronic Chart Display and Information Systems (ECDIS) skips to estimation mode in case of absents of GPS signal (positions are calculated basing on running fix approach with parameters received from gyro, log). Despite of satellite signal recovery ECDIS could still stay on estimation mode awaiting for manual acknowledge. Such situation is shown on Fig. 6 recorded on Navigator XXI — a training ship being on anchorage on 4 of September 2009.

Fig. 6. Virtual movement of m/v Navigator XXI [own study]

ECDIS DEFICIENCIES

An Electronic Chart and Information System (ECDIS) is an computer based navigation information system which can be used for navigation purposes like paper chart. ECDIS offers a lot of advantages, like: displaying current situation, planning of maneuvers, displaying information from different sensors etc. ECDIS will become one of the main tool for OOW and will be main part of integrated bridge systems. Navigator could benefit from its usage as long as deficiencies and limitations of the ECIDS systems will be clear and understood for them. While designing of new versions of systems and training scenarios experience of those who have been using

ECDIS on bard ships should be taken into account. Authors having contact with courses takers (deck officers with relevant sea experience on different ship's types and positions) found some deficiencies of usage of ECDIS in practice.

1. Users suffer of high complicated handling of equipment. For instance interface with icons, functions differs between different manufacturers.
2. Differences between systems of different producers are too big. Let us just compare two common systems Navi-Sailor 3000 ECDIS and CM-10.

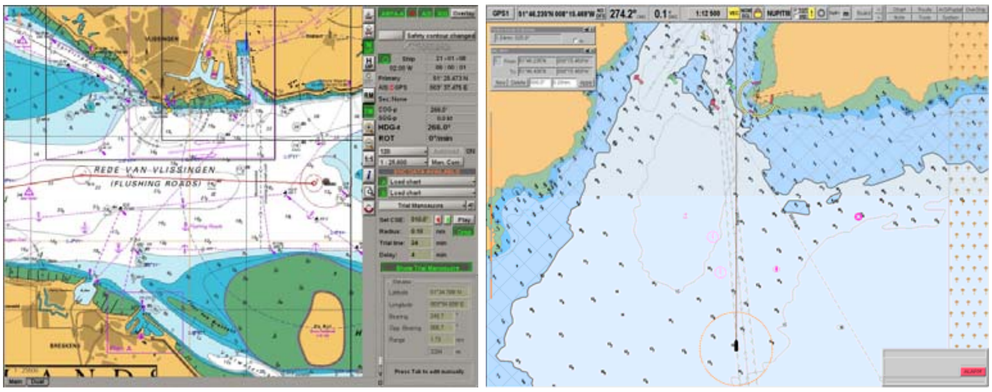

Fig. 7. Displays of Navi-Sailor and CM ECIDIS systems [own study]

Differences are related to:

— window design;
— number and scope of options;
— accessibility of functions.

All systems should have similar appearance. In practice navigator should be signed on with full knowledge and ability to use onboard equipment. Otherwise, if systems will be developed rapidly, every officer will be required to hold certificate of special training for every particular type of ECDIS.

Handling of modern ECDIS systems consumes too much time. Navigators should perform proper lookout, while 'playing' with bridge systems should be limited as much as possible. In practice it commonly happens:

1. Complicated handling of systems leads to fatigue. After few hours of continuous handling users have difficulties with finding proper fields, boxes etc. They seem to be overload with number of functions, required settings, information generated by system, etc.

2. Too much information generated by systems in different display versions and modes could be tricky and in some setting those valuable information can be missed.
3. Number of alarms leads to their ignorance so that most important may be missed. Navi-Sailor 3000 ECDIS-i has got 71 types of alarms. Just with sea area are associated 42. All of them cannot be switch off. Additionally there are alarms related to: AIS, monitoring of planned route, navigational obstructions, sensors, configuration, ARPA etc. Alarms could be generated every few minutes. They needs to be assessed properly. Number of alarm has to be limited. On sea the simplest existence is the best. It could be solved by introducing so called S-mode function (safety or simple). In a areas where experience and knowledge plays main role, that mode could deliver most essential data in one commonly agreed display/format. Those areas are narrow passages, channels, fjords, junction of separation schemes, approaches, anchorages, bunker areas etc.
4. Changeable scale makes navigator not aware of real distance to obstructions. In restricted areas scale has to be changed continuously. First to observe the vicinity and then to check area ahead of the ship. After few changes of scale the real distance basing on ‘ecdis few’ is difficult to assess. Operators have tendency to use to big scale what could be risky in term of safety of navigation. Sale has to be always visible, additionally units should be displayed graphically. Changes would affect units what should be easy to distinguished.

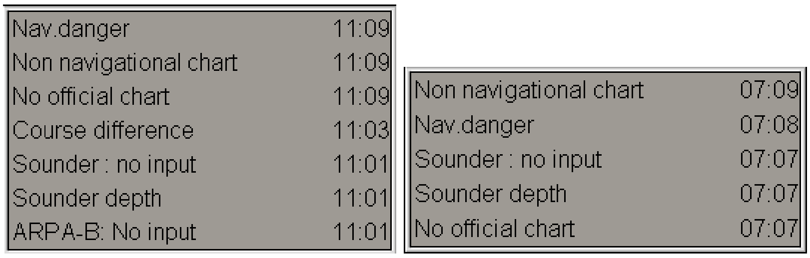

Fig. 8. Alarm log

Remarks

1. Automated processes should be well understood by mariners in order to use them properly on sea. Where possible systems which operate those processes should be as simple and user friendly as possible.
2. Systems like ECDIS or VMS could perform a lot of tasks. Number of alarms associated with those tasks and interference with alarms of another devices on the bridge are too big.
3. Senior nautical officers should be trained in ECIDS systems.

4. With present development soon officers ought to be trained for certain model or version of ECDIS what is simply impassible (some ship owners have such requests). To avoid that development/system has to be standardized.
5. Accidents shows that in case of ECDIS systems more depth contour lines in the areas 10–30 meters would be desirable.
6. Crucial data should be displayed in one format and should be always on if scale permit.
7. Chart scale should always, visible.
8. Additional information regarding awareness should be displayed like: ‘with present scale some shallows are not visible’.
9. ‘S-mode’, ‘panic’ or ‘freeze’ options should be developed. These options would help to skip into well known, simple and friendly display/environment.

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