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Human perception problems of ECDIS electronic chart displays



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Recently the Dutch Safety Board (Onderzoeksraad voor veiligheid) published an interesting report about a grounding incident of the Dutch cargo vessel Nova Cura. On the 20th of April 2016 the ship hit a reef in the Mytilini Strait in Greece. No casualties were reported, but the ship was total loss.

It appeared that the ECDIS (Electronic Chart Display and Information System) indicated a depth of 112m at the grounding location, whereas the actual vessels draft was 5.8m. The safety board concluded that the chart data was incorrect, both on paper and electronic versions, showing the reef at the wrong location. This is a locally known problem, which the crew probably would have discovered if they had made a proper voyage planning.

However, it is suggested that if the crew had used a paper chart instead of an ECDIS, the accident was less likely to happen. The Safety Board concluded that modern ECDIS systems have some risky issues concerning Human Perception and information processing. In this article I like to point out some of the issues mentioned, and add a few Human Factors remarks as well.

ECDIS

ECDIS is the successor of the paper navigation chart. Chart data is nowadays presented on a computer screen, together with the actual GPS position of the vessel. If available, ECDIS systems use vector charts (ENC), rather than raster charts (RNC). Because all ENC data is vectorized, there will be no image degradation when zooming in and out. Nautical information is conveniently categorized in layers, and by switching certain layers on and off, the navigating officer can select a level of detail that is appropriate for the actual situation.

Remarks by the Dutch Safety Board:

Risks of layering

An important layer is the CATZOC (Category Zones of Confidence). This provides a visual representation of the reliability of the chart data. In case of the Nova Cura accident, the CATZOC layer would have informed the officer that the chart data was unassessed (= reliability unknown, so possibly poor). However, the layer was switched off at the time of the accident.

CATZOC information is represented by visually detailed symbols covering the entire chart. This representation clutters the chart image, reducing its readability. In many regions the chart data is of good quality, so the layer is off by default and normally only switched on for voyage planning.

Ambiguous presentation of sector lights

Sector lights are beacons that use multiple colour light beams to guide ships around dangerous areas, like subsea obstacles. In ECDIS sector lights are on a separate layer and switched off by default. Unlike the paper chart versions, ECDIS sector light symbols provide no link to the specific danger they are marking. The officer has to consult pilot documents to be sure about their meaning.

In the Nova Cura accident, the officer did notice the sector light, but wrongly assumed it to indicate another shallow point on the route. The safety board concluded that sector light indication on the ENC chart is not intuitive, so interpretation errors are plausible.

Complicated User interfaces

There are about 40 different ECDIS systems on the market. Although the format of nautical information is standardized, the User Interfaces are not. Most systems have many advanced functions, settings and personalization options, often hidden in several menu layers. Therefore the systems are substantially more complex to use than a traditional paper chart.

For instance: in the ECDIS system used on the Nova Cura it took several menu layers to retrieve the Chart Date Information, in this case showing the hydrographic information was surveyed 50 years ago. On a paper chart this information is instantly available in the header block.

Wrong impression of chart quality

All vectorized ENC charts look modern and visually detailed. The image quality of ENC maps is not affected by zooming in, and together with the accurate shape, size and GPS representation of the vessel itself, the user easily gets a false impression of overall accuracy. The underlying chart data can still be obsolete or of much lower precision.

Zooming in and out

The possibility to zoom in may help to get a detailed view of the area close around the ship, but the user loses overview of the larger situational context.

For further details I refer to the original report, available in Dutch only, on www.onderzoeksraad.nl. As a professional Human Factors specialist and ships bridge designer I like to add a few remarks and recommendations:

Better no information than wrong information

Every time an officer uses an EDCIS chart of good quality, resulting in a successful voyage, the worldwide trust in this particular information source will increase a little bit. Since the Greek authorities have not enough capacity to provide reliable nautical charts for their entire maritime area, it can be considered to provide no ECDIS charts at all for areas with known reliability issues. If a ship's crew still wants to enter this area, they should be using the traditional paper charts instead. This is a clear sign for the officer to be extra vigilant, and pay attention to additional information sources, like pilot documents.

Visual conspicuity

A navigation officer is confronted with a lot of information, like direct vision, ECDIS, radar, traffic lights, conning screen, instruments, radio, et cetera. All these information sources are constantly competing for the officer's attention. Therefore it is essential that the most important information is always displayed in the most prominent way. This principle is called visual conspicuity.

The passage through the Mytilini Strait seems to be straightforward, except for a few wrongly indicated shallow points. So, in this case a good option is to use a highly visible marker symbol, instead of the usual inconspicuous dotted line, and a place clearly distinguishable warning text at the reef symbol, something like 'chart location of reef is wrong, refer to pilot'.

Size and importance

Subsea rocks are often pointy shaped, which can result in a very small representation on the chart. Without clear visual markers rocks can easily be overlooked, both on ECDIS and paper charts. Interesting in this respect is the investigation of the Rockness accident in 2004. The official report indicated that the distance between a dangerous subsea rock and the safe area corresponded with a distance of just 0.66 mm on the chart. Although the geographical size of this representation is correct, regarded from its relative importance to the ships safety, it appears to be too small.

Viewing distance and workplace design

The human visual perception system allows us to recognize small details from a relatively large distance. This is possible because our memory seamlessly fills in any missing visual information. The other side of this effect is that people tend to be too optimistic about the degree of detail they can actually see.

Let's assume the officer zooms in to a suitable level of detail when standing right in front of the ECDIS unit. This corresponds to a typical viewing distance of 60 cm. However, when the officer is seated in his rail chair, the viewing distance to the ECDIS is usually 120 cm or more. Although the officer can bend forward or stand up to have a closer look, he often looks at the ECDIS from a too large distance to be able to distinguish all relevant details.

Possible solutions for this problem are using considerable larger screens, an improved workplace arrangement, and zoom controls easy accessible from the officer's chair.

Overview

An ECDIS chart can't be zoomed in and zoomed out simultaneously. However, the officer requires both insight in details, and an overview of the larger context together. Presenting two zoom levels at the same time is not ideal, because in that case the screen has to be divided into two parts – each of half the screen size. This also has cognitive drawbacks, because the officer would need to combine both images in his brain to one mental map. A better option is to stimulate the user to often switch between zoom levels.

On many standard ECDIS systems this can be cumbersome: the officer has to press + and – buttons multiple times. Improvements are possible by using a simple rotary dial for zooming or by using touch screen controls. Another solution is to use 4K high resolution displays, and a workplace design that stimulates the user to frequently change position: from a distance to have overview and from nearby to have a closer look on details – just like a paper chart.

Layering

Switching layers on and off seems to be convenient, but evidently it is not possible to visualize which information is not shown. Instead allow complete freedom in switching on and off layers, it can be considered to use just two or three fixed modes by default, like ‘voyage planning’ (all layers on), ‘Sailing low detail’ and ‘Sailing high detail’. In this case the user will learn for each mode which layers are shown and not.

Interested in more do’s and don’t concerning human behaviour or Human Factors of ship’s bridge design ? Please let me know, and I will dedicate another article to your question. Or take a look on www.maritime-ergonomics.com

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