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The Captains' FORUM

THE HUMAN-CENTRED DESIGN FORUM

O hateful Error, Melancholy's child,
Why dost thou show to the apt thoughts of men
The things that are not? O Error, soon conceived,
Thou never com'st unto a happy birth
But kill'st the mother that engendered thee.

(Shakespeare's 'Julius Caesar' 5.3.67-71)

IN 42 BC, confusion led to a misunderstanding, which, in turn, led to the deaths of Cassius and Brutus. Over two thousand years later, we are still faced with the same problem: if we do not clearly understand what is going on, we could so easily make decisions that lead to tragic consequences.

That there is confusion about electronic charts, their use and their legality is absolutely not in doubt. If you visit the website of The International Centre for ENCs – www.ic-enc.org/ – you will find that a "Comprehensive guide to charts and carriage requirements" was made available as recently as 1st December 2004. Download it, and you will see that it acknowledges that there is "a significant uncertainty about status and regulations applying to the products and equipment available in the market today". To be fair, this document does make a positive contribution towards clearing up that uncertainty, and it would be worthwhile keeping a copy on board, but were you aware of its existence?

However, the problem does not end there, because an Electronic Chart Display and Information System (ECDIS), which, by definition, must meet the IMO Performance Standards and be type approved to internationally agreed standards, could still lead bridge teams to make errors, not detect errors or recover too late from errors that may have serious safety consequences. In other words, the standards to which an ECDIS is currently required to be certificated do not include a rigorous human-centred design process aimed at minimising errors that are design or system induced. Some manufacturers may, of course, go further than is required of them and incorporate features in their equipment that are designed to assist with error management. At this stage, we can only look at what is officially required, identify potential areas of concern, suggest remedies and ask you for your opinion.

The IMO Performance Standards for ECDIS get off to a good start by stating at the very beginning that:

"The primary function of the ECDIS is to contribute to safe navigation"; and

"Use of ECDIS shall reduce the navigational workload as compared to use of the paper chart".

As we move into the detail of these Performance Standards, we find that we can identify a great many functional processes which require human interaction. In this context, a functional process could be one that simply involved the user in operating the zoom-in or zoom-out controls to change the scale at which the chart data is displayed. An example of a more complex process could be one in which the user employs software-based tools to construct a route. However, as those of you who have had any involvement in software design will know, what appears to the layman to be a simple requirement can be the complete reverse to the software design engineer.

Taking the zoom function as an example of an apparently simple process can be instructive. Official ENC cells come in six different layers or usage bands: Berthing, Harbour, Approach, Coastal, General and Overview; and all of these can have different compilation scales. The ECDIS software design engineer is therefore faced with the problem of ensuring that the officer of the watch, when viewing an ECDIS chart display, is in absolutely no doubt as to the layer or usage band, area of coverage and compilation scale of the Official ENC cell that he is actively using for the navigation of his vessel. So it is perfectly possible to have several ENC cells displayed on the ECDIS screen at any time, rather like an overlapping patchwork, where each cell has a different compilation scale, and, of course, this means that it is not possible to have them all displayed at the correct scale at once. The method by which the ECDIS manufacturer indicates an over-scale warning for a displayed cell is therefore immensely important from a human factors perspective. If the officer of the watch is misled into believing that he has zoomed to the correct scale, when, in fact, he is using a display scale that is far greater than that

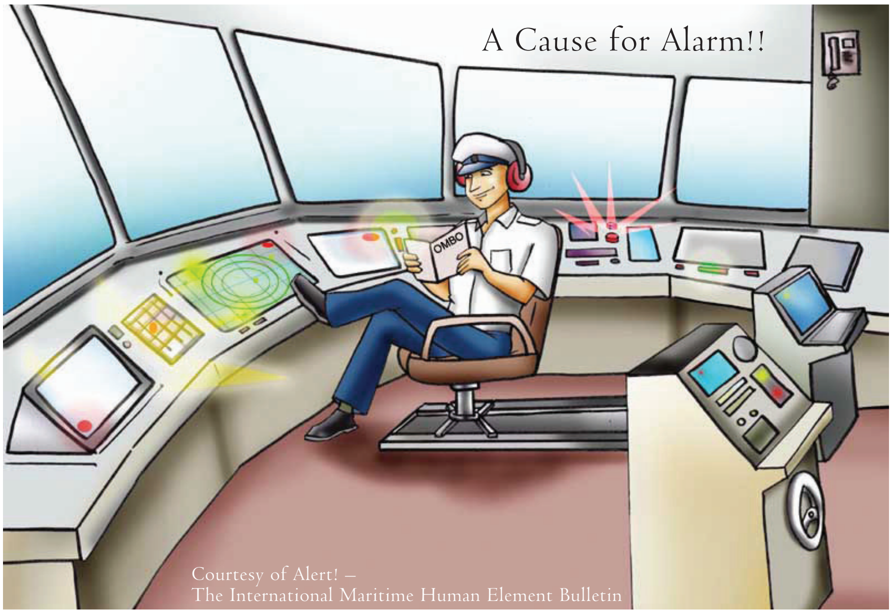
The Captains' Forum is intended to provide those in command of a yacht with a platform to air their views on any issue as a way of enhancing the industry. If you would like to send any thoughts on the above issues for publication in the next forum, or would like to suggest topics for future consideration, please contact: captains@theyachtreport.com for which the in-use cell was compiled, then he could make an unsafe decision based upon a false impression.

Any comments that you may have regarding your experiences with using either “official” or “private” ENC cells in this respect would be gratefully received. In the context of this article, “official” ENCs are those issued by or on the authority of a government-authorised hydrographic office or other relevant government institutions. All the others are “private” and are produced by well-known commercial organisations.

Moving on to route construction, we find that a whole series of human interactive processes are required, and that some of these may have to be performed at the same time. For example, there will inevitably be a need to scroll the chart whilst plotting successive waypoints. Whilst route planning should be performed off-line and prior to departure, there are always going to be times when we need to re-plan whilst the vessel is under way. There may be any number of reasons the original route is no longer appropriate, but an all too common one is a change in the weather. It is especially important at times such as these that the controls available to us for modifying a route plan are very simple to use and completely unambiguous in the way that they feed back the required information.

Again your experiences and views on the methods available to you for performing such tasks as adding, moving and deleting waypoints and then proving the modifications for safe operation would be most welcome.

So far we have concerned ourselves with those human-machine interactive processes within ECDIS that are essentially of a manual nature: plotting, moving, adding, deleting, zooming, scrolling, etc., but now is the time to turn to those parts of the IMO Performance Standards for ECDIS that are concerned with automation and, in particular, those involved with the activation of alarms and indications. These, without a doubt, are the most contentious.



Courtesy of Alert! – The International Maritime Human Element Bulletin

The ability to display own ship’s position in real time on an electronic version of a nautical chart is arguably the best invention since the chronometer. It means that, at a glance, a professionally trained navigator can obtain information about his vessel’s progress, such as: whether or not it has diverged from the intended track, and whether or not it is approaching a hazardous situation. Those who developed the concept of ECDIS, from which today’s legislative requirements spring, determined that there was a need to provide automatic functions to alert the navigator to an approaching hazardous situation. One of their principal arguments was that the limited look-ahead capability afforded by the physical size and resolution of an electronic chart display meant that it was necessary for the system to look ahead for you. So, for example, the ECDIS Performance Standards require that:

“ECDIS shall give an alarm if the ship, within a specified time set by the mariner, is going to cross the safety contour”.

At first sight, this automatic function, often referred to as an anti-grounding alarm, seems to be extremely good value. However, closer inspection reveals that there are a number of opportunities for design-induced human error to create a hazardous situation – quite the reverse from that intended. This automatic function requires two inputs from the navigator: the value of the safety contour, and the value of the time to alarm. If we are to put a high level of reliance on this function, then it is imperative that the safety contour and the time to alarm are correctly set. For any one ship, the value chosen for the safety contour is probably going to be static, but, nevertheless, any opportunity presented by the ECDIS software for inadvertent or mistaken input of the value of the safety contour must be removed. Whilst bridge operational procedures could be in place whereby two members of the bridge team were required independently to verify that the input value was correct, this alone would not prevent an inadvertent change at a later time. The system could be designed to sound an alarm if the value of the safety contour is changed, or values of this sort could be input on installation and password protected. Neither of these measures are required by the ECDIS Performance Standards.

The determination of the “specified time” to alarm is an altogether more complex issue, as it cannot reasonably be given a static value. The time needed to take action to avoid grounding at high speed is more than likely going to be greater than at low speed. When closing the coast and starting to employ regular track changes to take account of: traffic schemes, channels, shoal ground, areas for which special conditions exist, etc., the “specified time” to alarm may need to be adjusted downwards to avoid triggering the alarm at a frequency at which it becomes a positive nuisance.

If, from its inception, ECDIS had been the subject of a rigorous human-centred design process, the initial desire to automate an anti-grounding function may have been discounted on the grounds that it required a disproportionate amount of human interaction to ensure that it could safely be relied upon without causing an unnecessarily high frequency of alarms at a time which could seriously distract the bridge team from its primary function of safe navigation. After all, long before the advent of ECDIS, tried and tested techniques using, for example, the echo sounder, clearing bearings and parallel indexing had been developed for safe navigation in increasingly restricted waters.

ECDIS Performance Standards specify a requirement for:

Six separate conditions requiring alarms:

• Exceeding off-track limits
• Crossing safety contour
• Deviation from route
• Positioning system failure
• Approach to critical point and
• Different geodetic datum.

Three separate conditions requiring an alarm or an indication:

• Largest scale for alarm
• Area with special conditions and
• Malfunction of ECDIS.

Six separate conditions requiring an indication:

• Information overscale
• Larger-scale ENC available
• Different reference system
• Route planning across safety contour
• Route planning across specified area and
• System test failure.

In addition, the Performance Standards require that: “ECDIS should also repeat, but only as an indication, any alarm or indication passed to it from a position-fixing system.” The Performance Standards provide the following definitions with regard to alarm and indicator:

Alarm: An alarm or alarm system which announces by audible means, or audible and visual means, a condition requiring attention.

Indicator: Visual indication giving information about the condition of a system or equipment.

At this point, it is important to take a step back and remember that ECDIS, significant though it may be, is but one part of a modern bridge. Other systems, of which the following is by no means an exhaustive list, will also be present and will also be required to provide alarms and/or indications:

• Bridge watch monitoring system
• Heading information system
• Head/track control system
• Position-fixing systems
• Radar with electronic target plotting functions and
• Relevant machinery alarms.

Inevitably the question arises as to whether or not the architects of ECDIS considered the impact that their requirements for alarms and indications would have on a bridge environment where many other alarms and indications were already required and where more may well be added. Are we approaching, or, worse still, have we already reached, a situation where too many alarms and indications are creating a hazardous situation on the bridge? Any comments that you may have in this regard would be most welcome.

When thinking about this and the other questions posed in this article, you may, if you have not already done so, care to download a “Bridge Watchkeeping Safety Study”, published by the United Kingdom Marine Accident Investigation Branch. This study was commissioned to establish the principal factors that cause nautical accidents, and it reviewed in detail the evidence of 65 collisions, near collisions, groundings and contacts that had been investigated by the MAIB.

One of the study’s findings was that standards of lookout in general are poor, and late detection or failure to detect small vessels is a factor in many collisions. The full text of this study can be found at: www.maib.dft.gov.uk/sites/maib/publications/safety_studies.cfm

Please send your comments and experiences to:

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