10 Things They Should Have Told You About ECDIS

D. Edmonds
PC Maritime Ltd, Plymouth, UK

ABSTRACT: The aim of this paper is to highlight some operational and system issues that are frequently encountered by navigators trying to get to grips with ECDIS. This information should also be beneficial to managers and owners who are making decisions about which system and chart format to buy, and the priority that should be given to formal training ahead of a mandatory requirement.

1 WHAT IS THE SYMBOL THAT LOOKS LIKE A SCREW HEAD?

This is what one Pilot said to me, referring to the Isolated Danger symbol which seems to turn itself on and off with a will of its own. Many of the symbols that appear on an ENC are immediately recognisable to navigators but some are not; one of the most important that an ECDIS operator must know is the Isolated Danger symbol.

Here's why. We had a vessel trialing Navmaster ECDIS with ENC and ARCS charts. They came to anchor off Teesport on the east coast of England. The ARCS chart to the right shows four wrecks in the vicinity of the vessel's position. The ENC to the left shows three wreck symbols; but the wreck to the west of the vessel is depicted by an Isolated Danger symbol because its depth at 30 m is less than or equal to the safety contour value set by the operator.

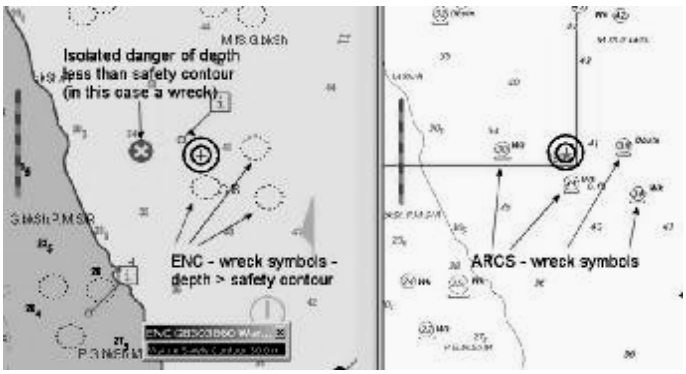

Fig. 1. An example of the use of the Isolated Danger symbol on an ENC

So here is a fundamental difference between ECDIS with ENCs and other chart display systems.

The chart display, and sometimes symbology, changes depending on how you set ECDIS up.

In this case, if the safety contour value were set to 10 m the symbol would change back to a wreck.

2 WHY DOESN'T MY ENC SHOW SOUNDINGS?

ECDIS gives the operator three display levels: Base, Standard and All Other. The chart detail shown at each level is tightly specified in IHO S-52. During type approval an ECDIS is carefully checked against the IHO produced ENC Test Data Set to ensure that the information displayed on the chart conforms to the Test Data Plots for each display level.

The ECDIS performance standard specifies[1] that the Standard display shall be used when a chart is first displayed by ECDIS and that the display can be set to Standard by a single key press.

All well and good, except that the operator may have configured his chart display to his preference with more or less information than that given by the Standard display (eg by the addition of soundings) only to find that when a new ENC is loaded or he selects Standard display, settings revert to the IHO-specified level. I can imagine on occasions that this is quite perplexing. Soundings are not included in

[1] IMO PS for ECDIS Section 2.4, 3.3, 3.4 & Appendix 2

the Standard display and many operators question the rationale for this.

How to get around it? Well, I can only speak for Navmaster ECDIS. The solution there is to create a custom display based on the Base or Standard display with the addition of soundings. This means you can quickly switch back to your preferred display.

3 KNOW YOUR SYMBOLOGY

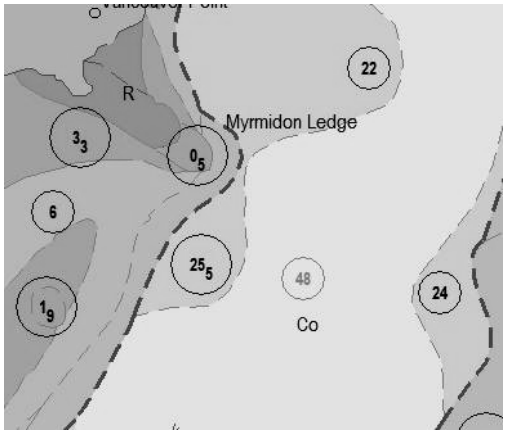

Fig. 2. Unreliable Soundings

The master of a very large bulk carrier asked "How do I get rid of the circles around soundings?" Actually, the circles mean that the data (ie the sounding it-self) is unreliable.

Points 1 – 3 raise several issues:

1 For mariners there is no simple, accessible, reference to ENC symbology. For paper charts there is BA5011 (INT1) Symbols and Abbreviations used on Admiralty Charts. For ENC symbology the best that is available is "ECDIS Chart 1". PC Maritime provides access to ECDIS Chart 1 through the Navmaster help menu. However you have to know what you are looking for and the explanation given for individual symbols is limited to the symbol name.
2 In my opinion it is not the role of ECDIS manufacturers to provide a reference. This should come from an official body such as the IHO.
3 Some ENC symbology is open to misinterpretation or perhaps no interpretation at all, due to unfamiliarity.
4 The importance of ECDIS training, even if the system is not being used as the primary form of navigation. The reality is that with an ECDIS on board, some operators soon pay lip service to paper charts while their focus shifts to the ECDIS display, arguably with good reason (in view of better situational awareness etc). But there are dangers if operators have not had basic training.

4 WHAT IS THE DIFFERENCE BETWEEN S-57 FORMAT AND SENC FORMAT DISTRIBUTION?

ENC data is distributed in S-57 format by organisations such as the Admiralty, Primar and other national hydrographic offices. ENCs in S-57 format have to be translated into the internal data format or SENC (System Electronic Navigational Chart) used by the ECDIS before they can be displayed.

In April 2002, the IHO[2] agreed that the ENC distributor could perform the translation from S-57 to SENC format on shore, subject to the approval of the hydrographic office producing the ENC, and deliver ENCs in ready to run SENC format.

S-57 is a generic format and it is mandatory that all ECDIS must be able to install ENCs in this format. SENC formats are proprietary and therefore specific to manufacturers or groups of manufacturers. The main SENC formats are C-Map's CM-ENC format supported by over 20 ECDIS manufacturers, Transas's SENC service and SevenCs DirectENC service.

Why is this important? Well, when you take delivery of ENCs in S-57 format, they have to be copied, converted, verified and decrypted before they become available for display. Even the IHO acknowledges that this "is not the most efficient means of storing, manipulating or preparing data for display" [1]!.

When you take delivery in SENC format, all the checks and conversions have taken place and the data is ready for display. The most noticeable effect is the difference in installation and updating time. Here are the results of tests that I undertook last year:

Table 1. Comparison between S-57 ENC and SENC installation times (all available cells, Sept 06)

S-57 ENC format	
Disk copying (5 base CDs)	1.5 hours
Decryption, verification and installation	11.2 hours
Total	12.7 hours
Apply Update CD	4.03 hours
CM-ENC SENC format	
Disk copying (1 DVD)	13 mins
Apply licence	5 mins
Total	18 mins
On line update	A few minutes

ECDIS is a real-time system and will often need to be operational during chart installation and updating. Indeed the ECDIS performance standard states that "the (update) implementation procedure should not interfere with the display in use" [2]. I can only

[2] IHO Technical Resolution A3.11

speak for my company's ECDIS which will process chart installation and updating as a background task, leaving the ECDIS fully operational. However there is no doubt that a system that involves less disk copying, no conversion or decryption and takes minutes to install and update rather than hours is intrinsically the safer option. Amongst my reasons for saying this are:

- CD \ DVD drives are generally not type approved. - There is a risk of data being miscopied, particularly under heavy vibration conditions, which could cause ENCs or updates to fail verification checks later in the installation.
- it does not make much sense to carry out verification and quality checks on ENC data at this stage of the operation. If the operator finds that a chart has failed to install, due to a critical error, there is very little he can do about it -apart from call his chart supplier, who will call the chart producer and so on. For less critical errors, the operator should not be faced with numerous warnings about minor infringements to the S-57 product specification, which mean little to him. Far better that all these checks are carried out ashore and the data delivered to the vessel as near as possible "ready to run".
- There will be occasions when ENCs are required urgently, within minutes; lengthy installation procedures could stop a vessel sailing!

5 ALARM MANAGEMENT - SAFETY CONTOURS

ECDIS requires an alarm if “within a specified time set by the mariner, own ship will cross the safety contour” [3].

The Safety Contour is required to default to 30 m on start-up [4] Hence, it is imperative that the operator sets a safety contour and time appropriate for the intended voyage, leg of voyage or sailing area otherwise Safety Contour alarms will be meaningless or so intrusive as to be ignored. It is possible for a vessel to receive no safety contour alarms at all. For example vessels transiting the River Thames would not receive any safety contour alarms with the default 30 m safety contour. Some operators might, at first, be relieved by this but they would be losing significant benefits. A correctly set safety contour provides increased contrast between safe and shallow water and highlighting to the safety contour itself. Examples of appropriate time settings range from very low (say 1 or 2 minutes) on a bendy river like the Thames where a vessel will always be very close to shallow water, or very high (say 1 hour or more) in mid ocean where plenty of warning might be needed of shallow water ahead.

In Navmaster ECDIS we have added an additional parameter so that the operator can define the width of the “searchlight” that looks for safety contours and warning areas. For the river example, this can be set very narrow (down to 1 x beam) and in mid-ocean quite wide (10 x beam at its farthest limit). And the searchlight area can be displayed so the operator can see what, if anything, is triggering an alarm or indication.

Fig. 3. Guard zone set at 1 minute and 5 x beam

6 ALARM MANAGEMENT – PROHIBITED AREAS \ SPECIAL CONDITIONS

ECDIS requires an alarm or indication if “within a specified time set by the mariner, own ship will cross the boundary of a prohibited area or of a geographical area for which special conditions exist” [5].

In most important shipping areas ENCs will be populated with many area related cautions. For example a one-leg route from Dover to Calais generates 49 warnings crossing areas with special conditions. In practical terms, allowing ECDIS during normal position monitoring to generate an alarm every time the vessel is approaching one of these areas is excessively intrusive.

The value of these warnings is at the planning stage, when they provide an essential reference for the navigation officer. In most cases operators will want to turn off alarms generated by areas with special conditions.

7 TRAINING

Today ECDIS training is not mandatory, although STCW part B requires that operators should be familiar with every bit of equipment on the bridge before they use it. Some, eg the International Chamber of Shipping, are quoted as opposing mandatory ECDIS training, their view being that it is "inappro-

priate to force officers to take courses to operate equipment that they either never use or will not come across for several years by which time their training will be out of date or forgotten about" [6].

I have already given some reasons why ECDIS training is important, even when ECDIS is not used as the primary form of navigation as is the case with most installations so far. However, for the moment it seems that national administrations would rather see ECDIS adopted as an aid to navigation, with all the ensuing safety benefits, than place barriers in the way, such as making generic and type training mandatory at a sub-ECDIS level.

To run paperless however, the training and audit requirement is clear. The master and watch-keeping officers must be able to produce appropriate documentation verifying that generic and type-specific ECDIS familiarisation has been undertaken. Generic training is based on the IMO model course on the operational use of ECDIS (IMO course 1.27). Type-specific training is provided by manufacturers [7]. And this could be a barrier to the uptake of "full" ECDIS. The ship owner or manager has to be confident that he has a pool of appropriately trained officers before he takes this step.

Typically generic ECDIS training from approved training institutions runs to 3 days and type-training from manufacturers amounts to another 2 days. There is significant cost involved and the industry would benefit from seeking ways of reducing the cost of training personnel.

One way forward is to develop Computer Based Training (CBT) modules covering appropriate areas of the IMO Model Course. It is arguably too expensive and inefficient to send people to a classroom for days, with all the attendant travel and subsistence costs, simply to be taught aspects of ECDIS that could be equally if not more effectively learnt via CBT (eg Legal Aspects and Requirements, Types of Electronic Chart, Terms and Definitions (S-52, S-57) Reference Systems, etc). Far better to send officers pre-taught about the basics to simulator courses of reduced length but greater focus on the operational issues of working with ECDIS as a primary form of navigation.

A similar approach can be taken by manufacturers by providing good training manuals, preferably in electronic "CBT" form, and ideally recording operators completion of each element.

8 RTFM - READ THE FLIPPIN' MANUAL

I know you wouldn't have thought of this by yourself.

All manufacturers like to think that they produce easy to use and intuitive user interfaces and most do, to a greater or lesser extent. At its simplest, ECDIS will automatically recognise GPS input, load the appropriate chart, and follow the vessel's progress. However ECDIS is much bigger and more complex than suggested by this simple chart plotting function. How many other systems are you aware of that: process continuous streams of data from half a dozen or more instruments; handle complex graphic images; keep extensive records; provide drawing tools, manage large databases; monitor position against chart data and planned route; manage charts and updates, provide reports and so on, all in real time? ECDIS may not have the depth of an application like Micro-soft Word, with features that most people never use, but it makes up for this by making nearly every feature it offers relevant to most operators.

Most manufacturers will have tried to make their operator manuals complete and informative. Reading the manual will alert operators to the tools that are available and the general way in which the system works. It then remains to try each feature in turn, as and when time allows. It should not take more than a few weeks to become fully comfortable with the operation of any ECDIS.

And if RTFM fails, email or call the manufacturer for help. There should be a ready explanation to help you and if there isn't you may be highlighting something that can be done better. Often the manufacturer won't know if you don't tell him that something is either not working or more difficult to do than it should be.

9 KNOW YOUR CHART DRAWING TOOLS

The ECDIS Performance Standard[3] specifies the tools that should be provided for chartwork and position monitoring. This does not specifically include Parallel Indexing tools even though many would consider the use of these one of the most effective position monitoring tools. Indeed, a Royal Navy contact commented recently that they consider their passage plans incomplete if full use of parallel indexing is not specified and this would typically involve half a dozen planned PIX per leg (our product, Navmaster ECDIS offers the navigator the ability to set any number of PIX).

Is parallel indexing an appropriate tool to use in an ECDIS? I raise this question because ECDIS gets its position from GPS and if the GPS is in error any PIX (or any other position related range or bearing) will be in error to the same degree. Some would argue that PIX is more appropriately used as a radar based tool but then some, more expert in this area

[3] Appendix 3

than me, say that AIS (ie GPS) is more accurate than Radar.

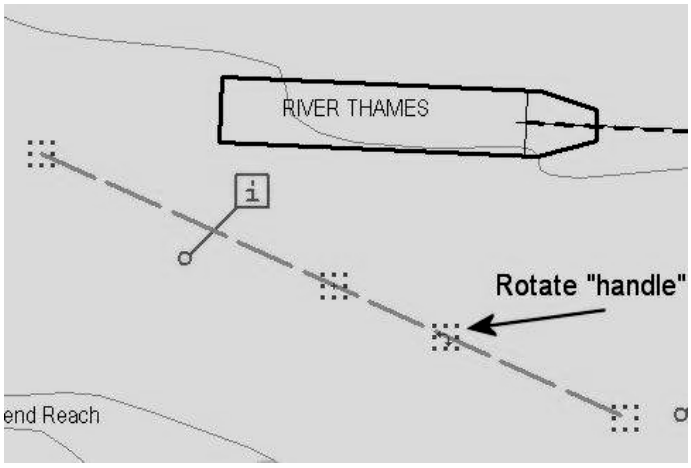

Fig. 4. Parallel Index Line

So doesn't it all come down to using all the sources of information at your disposal and cross-checking one against the other? And to do that you need to know how to use all the tools that your ECDIS provides.

10 UNDERSTAND INTERFACING

With IMO's recent call for the development of an e-Navigation strategy[4] data transfer will become ever more important to keep bridge instruments working correctly and shore side stations correctly informed. Navigation officers need relevant systems knowledge so that they can undertake basic troubleshooting and keep the systems that are being relied on so widely running smoothly - another training need that should not be overlooked.

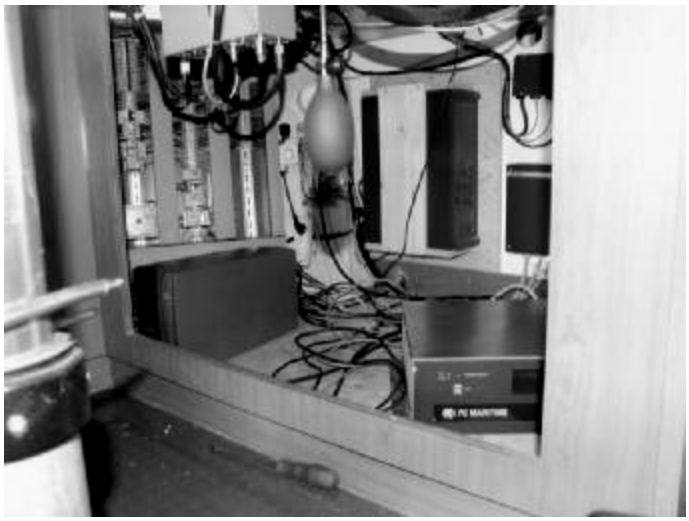

Fig. 5. Boxes and wiring

Fortunately there are no great mysteries about the interfacing between ECDIS and marine instruments. It is well worth becoming familiar with data transfer protocols and troubleshooting strategies as many seemingly fatal problems (eg no position input) can be solved with a bit of know-how, perseverance and remote help from manufacturers.

Marine data is transferred using the NMEA 0183 standard, which is a simple ASCII (ie text) format that defines how data is transferred in a sentence from one instrument to another, eg:

$GPDTM,W84,,00.0000,N,00.0000,E,,W84*41
$HEHDT,340.8,T
$GPGLL,5120.5091,N,00312.7769,E,090813,A*2D

Most sentences begin with a $ followed by a two character talker ID. In the foregoing data, GP is GPS and HE is Gyro. Then follows a three character sentence identifier: DTM is datum; HDT is heading, and GLL is geographic position, latitude and longitude. Even without a knowledge of sentence structure you can extract some meaning from each sentence, eg, the heading above is 340.8°T and latitude 51°20.5091'N.

!AIVDM,1,1,,B,35Vi7f50000AEw<M@ee;wCLB0000,0*3B

The exception is AIS which transmits a sentence beginning with !. The Talker ID and sentence identifier are the same as for other instruments but the remainder of the sentence is encapsulated, meaning that compression techniques are used to send more information than could be achieved by a straight ASCII sentence. Consequently you cannot read an AIS sentence directly.

For troubleshooting, most ECDIS will provide a means of viewing the raw data that is being received on the com ports used to interface with external instruments or you may be able to use the Microsoft Hyperterminal program to view com ports.

It is well worth exploring these facilities because with this basic knowledge there are several strategies you can use for troubleshooting:

1 No data received from a particular instrument? Open the com port viewing window or program and check to see if sentences are present with the appropriate talker ID, eg GP for GPS, HE for Gyro, RA for radar etc. If not the problem is most likely wiring or com port allocation or there could be a simple setup requirement in the instrument itself. Many GPS require NMEA output to be turned on and individual sentences to be activated before they are sent. Much time can be wasted cursing the ECDIS when the fault lies with the source of the data.
2 Data present but unexpected characters present? eg $GPGLL,58 0.5 91,N,0ə312.7769,E,09⁄813,A

[4] "the collection, integration and display of maritime information aboard and ashore by electronic means to enhance berthto-berth navigation and related services, safety and security at sea, and the protection of the marine environment" definition from the International Association of Marine Aids to Navigation Lighthouse Authorities (IALA).

*2D. The data has been corrupted either by faulty wiring or electrical interference. Check the wiring.

3 Data on a port complete nonsense? Quite likely to be caused by the baud rate for the port being set incorrectly. Most NMEA talkers output data at 4800 baud although some may have an option to transmit at 9600 baud. AIS always transmits at 38400 baud. Setting com ports to the correct baud rate usually results in the data becoming readable, which is confirmation of the cause of the problem. Another cause of unreadable data can be incorrect wiring, often as simple as the polarity connection being the wrong way round. Positive connected to negative and vice versa; if the case, wiring reversal gives an immediate result.

REFERENCES

[1] See paragraph 3.3 of S-52 and IHO Technical Resolution A3.11

[2] IMO Resolution A.817 (19) Performance Standards For Electronic Chart Display And Information Systems (ECDIS) Section 4.5

[3] IMO Resolution A.817 (19) Performance Standards For Electronic Chart Display And Information Systems (ECDIS) Section 10.5.3

[4] S-52 Colour & Symbol Specifications For ECDIS Section 3.2

[5] IMO Resolution A.817 (19) Performance Standards For Electronic Chart Display And Information Systems (ECDIS) Section 10.5.4

[6] 'Safety at Sea' magazine, “The future of ECDIS Training” March 2007, page 26.

[7] P18 Facts about charts and carriage requirements Primar Stavanger – IC-ENC Working Group on information (PSIWG) 1st Edition November 2004.