ECDIS Capabilities and Limitations

As a historical comparison the onset of ECDIS could be said to be as significant as putting steam powered engines and propellers on sailing ships. The comfort blanket of the much loved and respected paper chart is fast disappearing and being replaced by a digital equivalent. Some embrace this new technology and others fear it. It is therefore not surprising that the rapid advance of this new technology means there are large numbers of ships navigating with paper charts and ECDIS, or in historical parlance, navigating with sails and engines. This will no doubt continue until adequate training, equipment efficiencies and trust in ECDIS equipment warrants the removal of ‘sails’.

For those that distrust these systems, much of the distrust can be put down to the lack of proper training that would give the operator the ability and confidence to use the equipment efficiently and effectively. The need for training is justified by the large numbers of ECDIS related incidents at sea. We all read about these incidents and with the benefit of hindsight pass judgement, but this could be you joining a ship with ECDIS, without adequate training. Ask yourself whether you would be able to utilise the system safely and effectively? Are you willing to take the risk of not conducting adequate training? One thing is certain, when used by properly trained operators ECDIS provides enormous benefit for the mariner over existing paper charts. Such benefits include:

- **Increase in spatial awareness and efficiency** – This ultimately means the operator has more time to look out of the window.
- **Fusion of navaid information** – Pools information feeds to assist in compiling your picture (e.g. Radar Image Overlay (RIO), AIS and NAVTEX).
- **Increased safety in dangerous conditions** – If you can prove the ECDIS derived position correct you can judge yourself to the nearest point of danger very accurately.
- **Fast, accurate passage planning and re-planning**
- **Automated, fast, accurate chart updates**

It is my opinion that the concept of ECDIS systems can be likened to that of radar sets. Radar sets are subtly different in the way they look and the software they use, but on the whole they all contain much the same functionality. The challenge is to know where to find that functionality on the system you are using. The existence of multiple systems in Fleets makes this challenge greater, although for those that are waiting for the day all ECDIS menus look the same do not get too excited. One only needs to look at radar which has been around for decades to see that it is highly unlikely. It is therefore incumbent on the purchaser to choose their ECDIS system with care so they have the functionality to meet the task (minimum performance standards laid down in IMO A.817(19)). Furthermore, it is essential that adequate training is available so the operator is able to get the most out of...
their ECDIS and understand both capabilities and limitations of the equipment. Playing around with an ECDIS for a couple of hours is not enough to warrant navigating with it. There is no substitute for proper training.

I have listed some advantages of ECDIS over paper charts, but what does ECDIS offer the operator in terms of functionality and time saving during the Route Planning process (Appraisal, Planning, Execution and Monitoring), and what are the shortfalls of using such systems for this purpose?

1. **Appraisal – Gather Information**

   a. **Data**

   Firstly, without data an ECDIS system is useless. It is the quality of data within it that is the basis for navigational safety. It may therefore be prudent for the would-be ECDIS purchaser to choose a quality, reliable data product first before purchasing an ECDIS that can utilise it, rather than the other way round. There are two different types of data product available for use in ECDIS, Raster and Vector charts. Raster charts are high quality scans of paper charts whereas Vector charts are databases that use ‘objects’ in the database to create a customised display. There are official variations of each data type, called Raster Navigational Charts (RNC) and Electronic Navigation Charts (ENC). Both terms sound non-specific but are in fact very specific:

   - **RNCs** by definition are official charts as their official status is based on the premise that they must be constructed in accordance with IHO publication S-61 i.e. standardised and issued by a government authorised Hydrographic Office (HO).

   - **ENCs** by definition are official vector charts as their official status is based on the premise that they must be constructed in accordance with IHO publication S-57 i.e. standardised and issued by a government authorised HO.

   With the existence of Private data produced by companies independent of HOs it is prudent to tread with caution in order to ensure that your data product is official.

   When installed with data, ECDIS systems can utilise a number of different products of both RNC and ENC format to suit the mariner’s needs. The system is also capable of giving visibility of holdings so that you can see which charts are available within your system folio. This can be displayed as a list of available charts or as in the screenshot below, as an overlay similar to that shown in a chart catalogue.
However, the shortfall of the system with regards to data is that ENC coverage of the world is incomplete. Therefore, if your route is not entirely covered by ENCs, then in accordance with IMO Circular 207 the mariner must utilise an appropriate combination of ENCs, RNCs and paper charts to execute the route. Thus, not only does it require careful planning with regard to data use, but also great expense for the mariner. Here are some considerations when using data:

1. What data products can your ECDIS utilise (SENC data such as TADS?)
2. Do you have sufficient coverage of ENCs for your route?
3. If you do not have sufficient coverage of ENCs, do you have sufficient RNCs?
4. If using RNCs you are in RCDS mode and you will require an ‘appropriate’ folio of paper charts in accordance with IMO Circular 207 (www.ecdisregs.com)
5. What is your Flag State definition of ‘appropriate’ folio of paper charts? (www.ecdisregs.com)
6. The operator must ensure the system prioritises the correct chart data type (ENC RNC). Know how your system prioritises data.

b. Cell & Object Interrogation

The obvious advantage when using ENCs is the ability to interrogate it to view information on the cell and objects within the cell (see screenshot). Effectively, it provides access to an encyclopaedia of information that the operator can access. In future this may include the integration of a huge number of information sources such as Admiralty List of Lights & Fog Signals (ALLFS), for example in order that all relevant information is available at the operator’s fingertips. However, before you get excited at the prospect, there is a lot of work required before this vision is achieved. Moreover, access to this information on ECDIS systems is not yet as user friendly as it could be. For example, it is not always possible to get a sufficient explanation of an object, particularly when interrogating ECDIS Chart1 and it can take a long time to find the information required. Many systems do not prioritise the interrogated object at the top of the list of those available in the cell and as such it can take time to cycle through the list before you find what you are looking for. It should be noted that although RNCs are scans of paper charts, when interrogated they also provide limited information about the chart such as Title, Scale, Projection and Updates, but objects within it cannot be interrogated.

c. Tidal & Port Databases

Some systems offer additional databases such as tidal curves (see screenshot below) and prediction data to aid in calculating HW, LW, tidal heights and predicted TS. However, before committing to such databases, it is worth considering where the data is from,
whether it is official data and if or how it can be updated? Not all Flag States approve data provided by ECDIS manufacturers, with some stating that only Admiralty Total Tide (ATT) is acceptable (most systems are able to integrate ATT). The environmental data in some systems may be official, in that it has been purchased from official sources, but it does not necessarily state exactly where it is from, so be careful. Some systems are able to provide their own database of worldwide ports and port information to aid the Mariner whilst others can be integrated with existing publications such as Lloyd’s Fairplay. If utilising databases provided by the manufacturer then consider how the database is updated and whether information can be updated by the user as changes occur.

d. Safety Contour & Safety Depth

The ability of an ECDIS system to highlight a given Safety Contour based on a set Safety Depth is one of the great advantages of the system. ECDIS uses an operator configured safety depth to display a safety contour that differentiates safe water from that which is unsafe. However, the lack of contour data currently available within ENCs means the operator is not yet able to fully harmonise the Safety Contour with the Safety Depth.

2. Planning – Route Creation & Checking

a. Route Planning

Route creation on an ECDIS can be fiddly and frustrating to start with, but when practised makes the process much quicker. For example, if you were constructing a Great Circle route on paper charts it would be fair to say that this would require knowledge, skill and a significant amount of time! However, constructing a Great Circle route on ECDIS takes seconds as waypoints are placed at the click of a button. Moreover, there is no need to rub out your past track and re-plan or transfer waypoints from one scale of chart to another as waypoints are placed on all available charts for its position. Once the Route is complete you are presented with all the information relevant to the route. Enter your ETD and it will calculate your arrival time based on planned speed or enter your ETA and it will calculate when you need to depart. If you enter your ETD and ETA the system can calculate the necessary speed required to meet the ETA i.e. SOA. Some systems can calculate the effect of tide on your route timings and even calculate Under Keel Clearance based upon an entered draught. Once the plan is derived it can be saved and used again and again or even copied to disc and shared amongst a Fleet of ships.

However, the route planning function varies between systems with some being easier to use than others. Furthermore, some systems lack functionality with regard to producing
Great Circle routes. For example, not all are able to split the curved line into individual Rhumb Lines, whereas other systems provide detailed options such as limiting latitudes, number of segments, length of segment etc. It must be noted that not all systems can calculate SOA based upon an entered ETD and ETA.

b. Route Checking

ECDIS systems have the ability to check the planned route for dangers. However, be careful as the check only looks within the Cross Track Distance (XTD) or Corridor of the route, so ensure that it is correctly configured to cover the required area. The wider the XTD the more alarms will be generated, although this is not a reason to reduce it below what is required. The check looks for set parameters which could be system defined as well as operator defined, depending on the system. If your system offers the ability to configure the search beyond set parameters, ensure that what you want the system to search for is selected. Also, when checking the route it is important to ensure that the correct display setting is selected (see screenshots below). In the left hand screenshot the system is in the Standard display and the route check is highlighting a Danger, although it is not shown. In the right hand screenshot the display has been set to Custom and Isolated Dangers have been selected for display. The highlighted symbol is now displayed (non-dangerous wreck). Another frustration when using ECDIS systems to check a route is that it may highlight the same danger on multiple occasions without recourse for the operator to clear the specific danger in one action.

When conducting the check of the route, the system will only check ENCs and not RNCs, unless there are manual alarmable constructs within the XTD. The inability of most systems to highlight gaps in ENC coverage for your route therefore necessitates that a manual check on the best scale charts be conducted for the entire route. Note that this can be time consuming but comes highly recommended! Once the Route has been checked, additional information pertinent to the route can be added. The system can even be configured to alert the operator of such notices. Considerations at this stage are how best to display the information so that it can be clearly seen by the operator. Note that the font size is constrained on many systems and symbology is also limited. Personally, I used to favour a ‘cloud and arrow’ approach on paper charts to draw attention to supplementary information, but this is not necessarily available as a symbol in ECDIS. You must therefore make use of whatever is available and what works for you. Perhaps technology will allow the use of light pens to add such information in future?
Some ECDIS route planning tips:

1. Screen into ‘large’ or ‘planning’ screen format.
2. Orientate the chart to show the beginning and end of the route to get a ‘big handful’ feel for the route.
3. Create a blank canvas by hiding all old routes, constructs etc.
4. Begin with waypoint plotting in the general area of the start and end of the route.
5. Select either Rhumb Line or Great Circle route etc.
6. Zoom in to a more appropriate scale to modify the start and finish waypoints and ‘massage’ waypoints to account for TSS etc.
7. Ensure that you have adequate XTD for the various legs of your route to take into account the nature of the environment and expected possible deviations, lateral separation from the route and collision avoidance.
8. Check Zones of Confidence (ZOC) or Source Data Diagrams and amend the route or highlight as necessary.
10. Conduct a system check of the route at an appropriate XTD to allow for deviations, collision avoidance etc.
11. Once all alarms have been checked and verified, check the route in its entirety on 1:1 scale by manually scrolling along it.
12. Add relevant additional information and manual corrections.
13. Double check Distance / ETD / ETA and Tidal Constraints.
14. Protect the route as necessary and save a back up.
15. If updates are installed prior to sailing or during the execution of the route, ensure that the route is checked again, as updates may affect it.

3. Execution & Monitoring – Interpretation & Cross-check

a. Configuration

It is essential that the system is set up correctly prior to executing the route or important information will not be displayed. This relates to settings for display, data for the vessel itself and the configuration of Alarms on systems that allow it. For display purposes, the amount of information must be configured prior to executing the route and for this purpose 3 types of display must be available for use with ENCs; S52 Base, Standard and All Other. The ‘Base’ display (bottom left screenshot) provides a minimal amount of information and represents data that cannot be removed from the display. As such, the Base display does not provide enough information for safe navigation. The ‘Standard’ display (centre screenshot) incorporates the Base display plus additional features to provide a more appropriate display for safe navigation (of note it does not include Soundings). The ‘All Other’ display (bottom right screenshot) presents all layers of data and I would suggest that this provides too much information for effective navigation. This is because the volume of data shown clutters the display making it difficult to see safety critical information. Therefore, most manufacturers provide an extra display category, normally called ‘Custom’ that allows the operator to configure their display to incorporate information between Base and All Other. Some systems also allow the saving of such displays so that the operator can customise displays for all environments such as Pilotage, Coastal, Open Ocean, Anchoring etc., selecting them as and when required. However, due to the sheer volume of settings and configuration that is possible, it is recommended that check-off cards be produced to cover all environments. Remember, too much information is as dangerous as too little.
b. **SCAMIN**

The system auto-filter means that unless you are navigating on the best scale chart, you will not see all the information available for display. Therefore, when zooming out the system will automatically deselect certain features from display such as Soundings, Lights and Topographical detail. The only way to ensure that your display is not affected by SCAMIN is to always ensure you are navigating on the best scale chart! It is therefore essential that the operator knows how to select the best scale chart on their system.

c. **New Symbology**

ENCs have brought new symbols that must be learnt and understood, like the two featured below.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Wreck Symbol" /></td>
<td>Wreck – Dangerous wreck / Obstruction – Depth unknown / Rock – Underwater, awash rock. Could be depth unknown or value of sounding known - only when interrogated. Separate to depth contour.</td>
</tr>
<tr>
<td><img src="image2" alt="Sounding Symbol" /></td>
<td>Sounding 5.5, reported, unreliable / therefore will not show up with safety contour</td>
</tr>
</tbody>
</table>

d. **Fixing**

The ECDIS system tirelessly fixes and records ship position based upon the primary fixing system (GPS or DGPS), whilst searching the track ahead for risky or even dangerous conditions such as Traffic Separations Schemes, charted wrecks and shoal patches. The system is also capable of loading charts automatically as you execute your passage, based upon ship position. Additionally, ECDIS also offers high levels of confidence by fusing different fixing modes (GPS/Visual/RIO) into one display. Manual fixing functionality is also provided, although some systems provide more functionality in this regard than others.

e. **Precise Navigation**

If the positional information is accurate, the system can be used to give valuable information about a ship’s position when turning in confined conditions. Some
manufacturers have developed precise navigation tools such as the Docking Mode function that allows detailed information on the forces at work on the vessel to be viewed in a separate panel. Furthermore, functions such as the Predictor can also be used to predict the future position of the ship based upon real-time influences on the vessel such as wind, tidal stream, acceleration and deceleration and Hydro-dynamic data (see screenshot below). When used correctly, both are excellent tools to reassure the operator of what is being seen out of the window “this looks a bit tight, we need to put more wheel on – ECDIS concurs...


4. Chart Installation & Updating

The days of updating and correcting charts in the charthouse are numbered, but do not ditch those tracings just yet. In my experience the one component of ECDIS that is guaranteed to ruin your day is the inability to update your system or install charts. Remember, it takes time and system knowledge to complete installation and updating effectively. It is worthwhile timing how long it takes your system to conduct a small and large update so that you are aware of the timescales involved. Remember, after updating the system you will need to check your route again to check for new dangers. Ensure that you are getting your weekly permit updates and that they are updated prior to any charts. Furthermore, be extremely careful when using USB sticks and CDs to transfer information between systems and computers as ECDIS systems lack virus protection. It is recommended therefore that the transfer of information between systems only occurs within the LAN and that any USBs or CDs are virus checked prior to being used. It is also prudent to back-up your system regularly. This undoubtedly needs to be carefully controlled in ship’s procedures.

If you are considering linking your ECDIS to the internet for chart updating purposes, consider the following:

1. Do you need to? Do you have an adequate feed of information from navaiids such as NAVTEX and a system in place to plot it on the ECDIS? If so, do you require such a connection?
2. How effective is the anti-virus firewall? If operating ECDIS and a virus prevents the ship from sailing (or worst case causes an accident) the decision to link to the internet will soon be questioned.
3. Will the system cease safety monitoring for the period it is updating?
4. What is the cost of updating via internet connection?
5. Will the system automatically highlight new updates so the operator can view their relevance relative to the planned route?
Legal Implications

Legally, in order to navigate using ECDIS as the primary means of navigation, that is to say ‘go paperless’, then the following must be achieved (flag state dependent):

1. ENC coverage for the entire route (ENC=official data).
2. Equipment must be in accordance with IMO Resolution A817(19) (Performance Standards). If it is not, then the equipment is an ECS and is not legally compliant.
3. Training must be adequate. At present that means conducting a Flag State approved 5 day IMO 1.27 ECDIS course, and a Type Specific course on the equipment to be used at sea. The use of CBT alone is not sufficient.

Always consult your Flag State for clarification and be aware of Legal anomalies such as flags that do not recognise RCDS mode, or flags that require a risk assessment for example.

Summary

ECDIS systems are designed and built by engineers. This is not a derogatory statement, but it is my opinion that more current mariner knowledge is required in order to provide the mariner with a better, more user friendly product. The systems contain far more functionality than is needed and are not yet as ergonomic and user friendly as they could be. Moreover, inadequate training is responsible for a large number of collisions and groundings as operators are over-reliant on ECDIS and simply do not understand the shortfalls of such systems. However, ECDIS systems are a revolution and do go a long way in making navigation safer and easier, but only if:

- The operator uses the system correctly.
- The operator configures the system correctly.
- The operator understands the capabilities and limitations of the system in use.
- The operator is not over-reliant on GPS or on the ECDIS system.
- The operator utilises spare capacity by looking out the window and assessing the integrity of navigation aids and equipment.
- The operator manages and supervises the system adequately.

Like it or not, ECDIS is coming and for most deck officers it is a case of embrace it or risk becoming irrelevant on the bridge of a ship. For both types of mariner I recommend confronting the problem head on by conducting approved training and learning as much as possible about these systems. It is cringe worthy but true - train hard, navigate easy!

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Screenshots courtesy of Transas and Kelvin Hughes.