DWQG7-05A

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Improvements to the Display of Chart Quality on Electronic Navigational Charts

1.0 INTRODUCTION

This report will focus on the test-bed component of the DQWG's improvement to the display of chart quality on Electronic Navigational Charts.

Having been invited by the DQWG to draft an S-101 ENC display based on ideas put forth by the group, USM has managed to follow through with two main objectives based on its involvement in this project. The first is to produce a display in keeping with the criterion of the DQWG, the second is to garner feedback based on the developed model.

Stage 1 Testing

The technical parameters for the first model were adopted from a series of meetings with DQWG committee members. The most emphasized of these parameters were the use of green-yellow-red-gray indications for chart quality attributes like *positionalUncertainty*, *verticalUncertainty*, *techniqueOfVerticalMeasurement*, and *categoryOfTemporalVariation*, and possible combinations of the aforementioned.

Electronic Navigational Chart(ENC) US5AN01M.000 was the prototype for this initiative, for the sake of this report would be considered the 'original' ENC. The model was displayed at the USHYDRO Conference during the 26th to 28th March 2013. As a follow up to the model presentation emails were sent out to mariners interested in contributing to enhancing the present and/or proposed model. Feedback garnered from the display are included in the report.

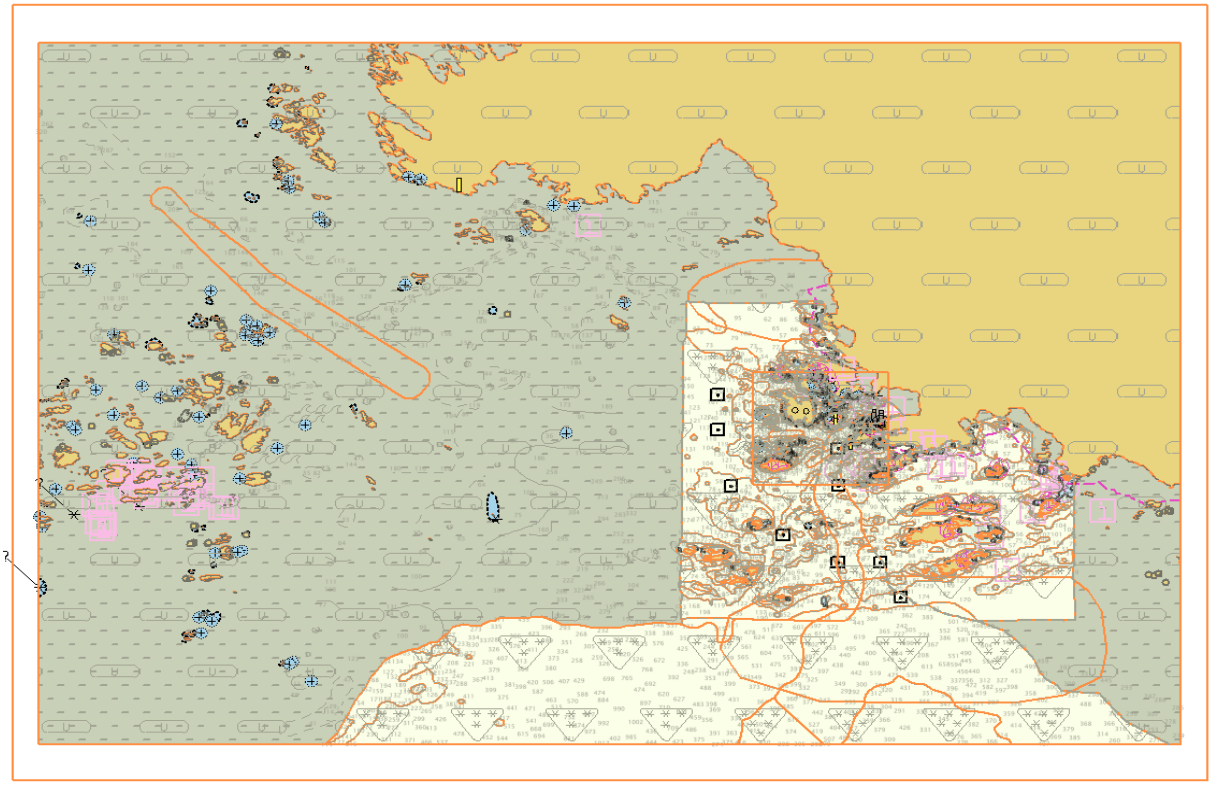

Figure 1.0 : Original ENC US5AN01M.000

2.0 MODEL METHODOLOGY

The intended display product was developed by adjusting/altering the Extensible Markup Language (XML) of the 'System' folder of the CARIS S57 composer software.

2.1 - In an effort to promote intuition when using ENCs the first approach to improving the chart interface was to replace the inverted triangle symbol in the representation of different Zone of Confidence Categories (CATZOC) with color indicators texture by way of diagonal lines was added to the colour scheme to demonstrate versatility in the proposal (Figure 1).

I. GREEN representing CATZOC A1 & A2
II. YELLOW representing CATZOC B & C
III. RED representing CATZOC D
IV. GREY representing CATZOC U

2.2- The second model manipulation featured an increase in feature acronyms for CATZOC as well as attributes which would be used as alternatives to CATZOC. For example inclusion of PositionalUncertainty, SurveyTechnique and CategoryofCoverage attribute elements to Depth Area (DEPARE).To add more detail to feature attributes, feature acronyms were added to the feature table.

3.0 RESULTS

Manipulation 1

Trial 1 proves to be successful with regards to the red, yellow, green indicator scheme.

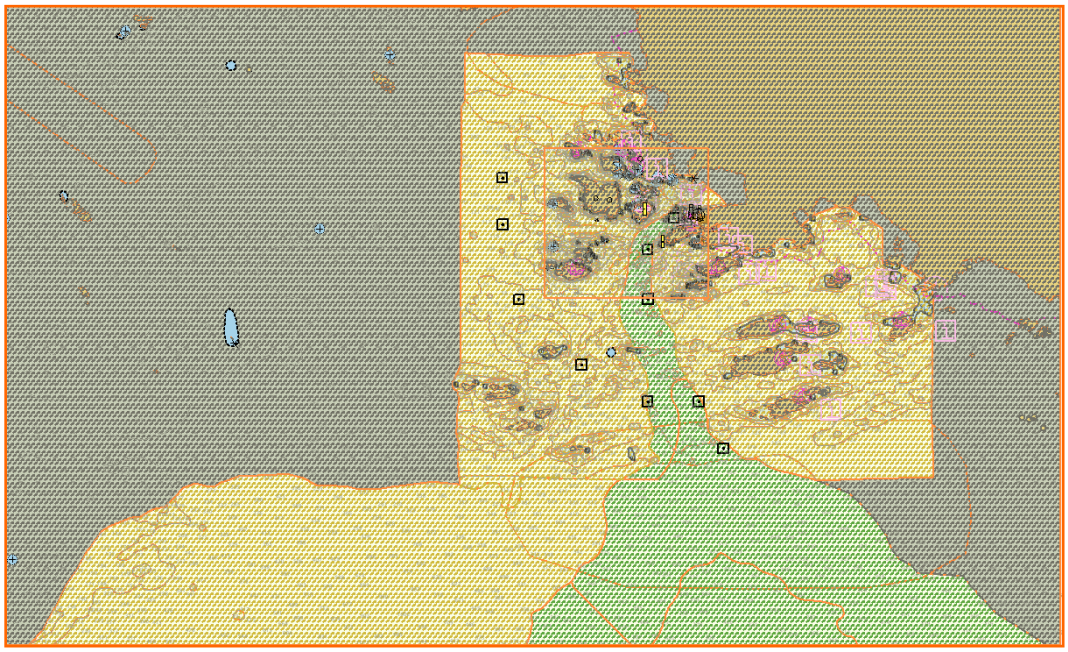

Figure 2.0: Removal of inverted triangles replaced by color indicators applied to the original ENC

In the colour scheme version of the ENC one would observe small regions of blue representing obstructions which did not acquire a colour code since obstructions themselves are not given a ZOC category. Contours can still be recognized as well as obstructions and aids to navigation like platforms and beacons.

*The green areas represent solely CATZOC A1 and the yellow areas represent CATZOC B. US5AN01M.000 bears no red CATZOC areas reflecting no survey areas with 'D' zones.

Manipulation 2

The following figures represent the changes made to meta-objects such as Depth Area (DEPARE) by the addition of attributes.

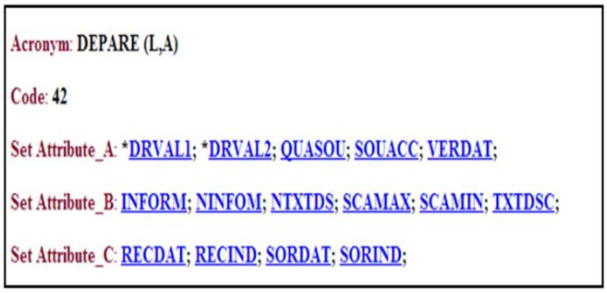

Figure 3:Original Object Class and Attributes

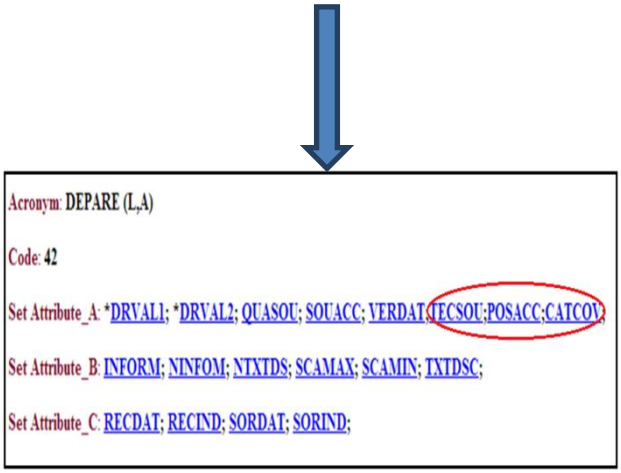

Figure 4: Option 2 - Inclusion of positional uncertainty, survey technique and category of coverage attribute elements to depth Area (DEPARE)

USHYDRO Conference

USM managed to garner feedback from two interested mariners who preferred to be anonymous for the sake of this report but can be reached via email if required. In an effort to be as comprehensibleas possible in relating the intents of this project, I attached a copy of the Sam Harper's paper '*The Development of New Data Quality Visualisation Methods in Electronic Chart Information Systems and Investigation into Associated User Response*' to the mariners via email asking to merge what was demonstrated and what is expected to be developed in the following responses were made:

3.1 - FEEDBACK #1

“Kandice,

I read over the paper. In general I agree with most of the statements and conclusions. It has been my experience that most non-hydrographers pay little or no attention to the source diagrams, and not all nations even bother to put one on the chart.

I, personally, have always disliked the CATZOC. As the paper points out, it is opaque to the user (me) and relies on the judgment of the compiler, not the mariner or even the hydrographer who collected the data in the field. Most of these people have never driven a ship at all, let alone the specific vessel, so that's clearly an inappropriate person to be making those decisions.

On the color scheme and representation, I need to be able to access the actual values. If the POSACC is 5m, I want to be able to quickly see (5m). I think there is value in using more than just 3 colors in the overlay. If they are present all of the time, then the additional colors can add confusion, but as a toggle primarily used for voyage planning or turned on briefly for emergency on-the-fly voyage plan changes, the additional data in a 5 color scheme (Cyan-Green-Yellow-Orange-Red + Grey for unknown) can be useful for categorizing different combinations of data. For example, high horizontal and vertical accuracy could be Cyan, while Moderate accuracy in one dimension and high in the other would be Green. Both Moderate would be yellow. If even one was Poor it would be Orange, both poor would be Red. Definitions of Good/Moderate/Poor should be user-definable with a button for IHO recommended defaults. We use a similar color scheme when we plot freshly surveyed data on our screens for driving into uncharted areas, with Red as places we would run aground, Yellow places we should be safe but cautious, etc up to Cyan where you can safely steam at full speed.

One alternative representation scheme is to skip the overlays and modify the representation of the soundings. For instance, you could put a small symbol next to each sounding, perhaps on the scale of a subscripted "Q," and color code that. Or put a small horizontal bar below and a small vertical bar after the sounding, and either scale them with uncertainty (a long bar is highly uncertain, a point is very certain) or color code them. This would immediately graphically represent in a way that would soon become unconsciously perceived and ever-present the reliability of the soundings and positions.

Another concern is that all overlays and representation color schemes need to take into account the possibility of color blind users, the need for alternative night-vision preservation display modes (black backgrounds, avoidance of the blue end of the spectrum), and the tendency of many crews to place red gels (filters) over monitors at night to preserve night vision. It is due to the red lights that no red pens are allowed on the bridge and nothing on paper charts is printed in red. A very common user complaint of ECDIS and ENC systems is that it is simply not possible to get them dim enough. User ad-hoc dimming setups (ie taped on filters over the screen) can and will interfere with visualization. While you can't prepare for all the possible ways a mariner will try to dim the screen past the lowest setting, you should try and keep that need in mind.

A common mariner complaint with ECDIS systems is the over-reliance on menus. Lots of options may be useful for voyage planning, but once underway, a person cannot spend 5+ minutes navigating the computer to get to what they want. This is part of why I suggest the alternate display method above

that is passive and unobtrusive. Or, if using the overlays, the toggle needs to be readily available. A person walking up to an ECDIS should be able to find and switch the toggle in under 15 seconds without requiring daily-usage level familiarity to do so. If it is primarily used in voyage planning, and not daily, but then needed again in an emergency, it needs to be accessed intuitively and quickly enough that it can actually be used in an emergency without contributing to the escalation of the crisis.

That's all I can think of for now."

3.2 - FEEDBACK #2

"Hey Kandice,

Finally got around to this! So, here's my problems, points etc.

1) S57 CATZOC values are already encoded as separate attributes and have a visual representation in most ENC capable systems. This representation is sufficient for most purposes when it comes to the mariner knowing what ZOC he's in. The quality of the area is shown by a grey overlay of triangles with rounded corners containing asterisks. There number of asterisks dictates CATZOC:

U = unassessed

1 star = ZOC D

2 star = ZOC C

3 star = ZOC B

4 star = ZOC A2

5 star = ZOC A1

As shown below (from: http://www.theartofdredging.com/ecdisupdate2012.htm)

2) Adding additional overlays for POSACC, TECSOU etc. is pointless. All the information the mariner needs is in CATZOC. If there is temporal variation of quality, then the CATZOC value should be the value that changes over time. This would be the least confusing and most display friendly approach to presenting such information to the mariner.

3) Dynamic tides, under keel allowance, vessel specific parameters are already included in most ECDIS. At the very least, the latter two with a static tide allowance is available, represented in the form of safety contours. However, the implementation of this I think needs to be changed.

Safety contours, at the moment, are calculated using the vessel's specific draught, a tide allowance and a safety margin. The thick line surrounding the blue area in the chart picture above is the safety contour. I think that the safety contour display should consider the uncertainty of underlying data. For example, if

the safety contour is calculated to 10m, then rather than just creating a thick line that follows the 10m contour and shading the enclosed area, the contour should be intelligent enough to consider the sounding accuracy. If the vertical accuracy of the sounding is 1m + 2% of depth (i.e. ZOC A1), then the contour should follow 11.2m depths instead. For the same ZOC, horizontal uncertainty of 20m should also result in the contour being buffered by that horizontal margin. To my knowledge this does not occur in any system at the moment but it is how, as a mariner, I would like to see CATZOC used.

4) Separately to the discussion about how to use CATZOC, the UML diagram in the HYDRO2012 paper is awful. There appears to be quite a bit of duplication and then there's the categoryOfTemporalVariation enumeration which appears to be an orphan object. Surely it should be attached to something? Probably the QualityOfTemporalVariation object where it seems to be referenced. There's also too little useful information in the temporal variation - it should specify a likely rate of vertical and horizontal degredation otherwise it is useless."

4.0 -DISCUSSION

4.1 - Because of its role as a representation of optimal achievable survey criteria,CATZOC remains the most reliable quality object on an ENC although mariners may not 'like' using it. Through the development of USM's first ENC model it has been observed that the use of colour indicators for **CATZOC is a preferred alternative to the current inverted triangle method** primarily due to difficulty associated with determining areas of low/moderate/high reliability by way of referring to the old symbol.

4.1.1 - A possible defect of the proposed method though is the possibility of navigating through a survey area which bears multiple zones within the same colour scheme making it difficult to discriminate

between areas e.g. CATZOC B and C. Referring to the schematic guide of section 3.1 both CATZOC B and C appears yellow to themariner. In an extreme case where a mariner faces an either/or situation within a colour scheme, for an area being described as 'yellow' how is one to discern between the two?

One may propose to apply different shades of yellow for those zones or possibly apply different textures but even that may not prove to be distinguishable enough. The proposal by Mariner 1 (Section 3.1) to use several colour schemesis an unlikely solution to this problem as more colours introduce more confusion to the user. **USM suggests the use of the red-yellow-green indicator along with the inverted triangles**. This assures support for the colour scheme suggested by DQWG while maintaining the integrity of the CATZOC Value.

4.1.2 - An extension to the implementation of the colour indicator scheme is the eventual need to change the colour of points, lines and symbols within the Chart. The new application would could potentially hide the visibility of features specifically depth contours(DEPCNT) and soundings (SOUNDG).

4.2- Taking example from paper charts, a system similar to the source diagram is encouraged where temporal mapping of surveys compiled for an ENC can be observed pre-route or enroutesince SUREND and SURSTA are not readily discoverable. This idea is echoed by mariner #1 who puts forth a good argument/suggestion to enable source diagrams within the construct of ENCs. Implementation of a pop up source diagram as the mariner navigates is a promising idea but as mariner #1 mentioned ECDIS is already crowded with a slew of menus as it is the implementation of a floating or pop up feature would only add to aesthetic confusion.

4.2.1 - From the experiences expressed by Marc Van de Velde(http://www.theartofdredging.com/accuracynauticalcharts.htm) the source diagram is no more the problem than lag time between survey completion and notice to mariners or chart updates being too wide for this source diagram idea to be fully effective.

4.3 – Mariner #2 mentions some of the intentions put forth by the DQWG can be realized via ECDIS systems. Supporting his statement TSMAD in its proposal states "It is understood that some sophisticated ECDIS' allow the mariner to prepare a proposed route and then run it through a test routine that checks for various dangers to that particular vessel (underkeel clearance, air draught, vessel width, etc) and presumably warn of a CATZOC which would concern the mariner for a particular area."An extension to the inference that most elements proposed can be achieved using some ECDIS systems is Mariner #1's feedback contribution where he

4.4–'As a minimum the constituent elements of S-57 CATZOC (positional uncertainty, sounding uncertainty, features detected and seafloor coverage) must be encoded in S-101 ENCs for depth areas, as separate attributes' (Harper, 2012). This proposal was interpreted two ways the first is POSACC, SOUACCetc. should be encoded within the depth area (DEPARE) element. The proposal of encoding these attributes toDEPARE is commendable but seemingly unnecessary as the attributes would then be similar to that of CATZOC thereby duplicating the function.

The second way was interpreted as POSACC, SOUACCetc. would be considered individually and represented independently which would **prove extremely fruitful if used in combination with CATZOC.** One would expectquality representation to be easily identifiable for the user for two reasons it ensures the user's preference of reliability is selected as well as it would maintain the quality standard recognized by hydrographic organizations.

4.5 - Though indirectly related to the group's intent USM in attempting to createthe desired model, categories defined as A1, A2, B,C,D or U assigned respective colours (Section 2.1), made an observation worthy of mention to the DQWG. The observation made was the assignment of land as U, representing unassessed. The issue with this is for datasets whose coastlines have been delimited the assignment of its land parcel as U is not coincident to the idea that the defined coastline can be relied upon. Supporting documents for the assignment of 'U' for land is the entire chart is initially given that zone assignment, as data is verified and added that assigned zone category is replaced. **USM suggests replacing the description once the coastline is verified and delimited for that island.**

5.0 LIMITATIONS

A significant amount of time was consumed attempting to familiarize and customize CARIS S-57 composer in hopes of realizing the DQWG's intentions to no avail. For the development of this model USM was incapable of producing the intended Marine Information Overlay (MIO), mainly due to restrictions enforced by CARIS program developers.

Alterations of a few aspects of S-57's interface are enforceable, e.g. creating a display called S-101 with red-yellow-green indicators, while most others at this level requires software authority intervention in order to be realized. If one is to combine attributes to possibly create a new object category or change how the attributes are displayed e.g. six letter caps lock letters to camel Case (POSACC ->positionalUncertainty) the software developer is the only authority to change these variables since the regular user is limited to encoding for simple changes of the interface. This includes and is not limited to the addition of tables and pop-up diagrams resulting in this report not being a visual contributor to the DQWG's intentions but a descriptive one.

Additionally there is a misconception that CARIS S-57 composer allows its users to automatically switch to MIO or even Additional Military Layer products for all versions of CARIS; this is not the case since in the case of the version used by USM those options do not exist.USM opted for a relatively simpler alternative to the creation of the MIO by way of altering the XML of the software. USM has contacted and have been interacting with SevenC's ENC tool to help realize the DQWG's intentions similar difficulties are being faced as customization is severely restricted.

CONCLUSION

The first stage of testing:Garner feedback from possible display model has proven to be successful. The red-yellow-green indicator is the most promising feature change to ENC's. Adding attributes to constituent elements although it increases the reliability of that element possible ways of effectively portraying those additions will need to be revised. To move forward with any further developments as it relates to customization constant collaboration with a CARIS programmer is encouraged since otherwise anyone given the task of customization would be severely restricted.