CARTOGRAPHIC RULES AND DIFFERENCES IN NAUTICAL DATA VISUALIZATION ON PAPER AND ELECTRONIC NAUTICAL CHARTS

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ABSTRACT

This paper aims to present cartographic rules for the production of paper and electronic navigational charts and main differences in compilation, visualization and representation of nautical information. Major differences between paper nautical charts and ENC are visualization of nautical data: colour mixing, resolution of represented nautical objects, human control of display representation and fonts and signatures and chart content are described. It is concluded that electronic navigational charts have many adventages and few shortcomings to paper navigatinal charts.

Key words: paper charts, ENC, nautical chart visualization,

1. INTRODUCTION

The term of modern nautical chart emerged in the early years of the 13th century, when compass was brought from China to Europe ("Carta Pisana"). Nautical cartography can be divided in the following three epochs: portulan charts, hydrographic survey and Electronic Navigational Chart (ENC).

The epoch of ENC began in the early eighties when rapid development of geospatial technologies, especially Global Positioning System (GPS), occurred. New technologies and methods for navigating the seas provide a completely new epoch of the safety of

marine navigation. Navigation practices have changed from "relative navigation" or traditional navigation based on visual observation, radar measurements and positioning on paper charts to "absolute navigation" or satellite positioning methods like GPS, GLONASS and GNSS (Tuurnala and Laitakari, 1999).

It should be emphasized that in spite of all advantages of ENC tehnology, ENC charts have a relatively small market, becouse great investment in the ship equipment are needed for their use.

This paper aims to make the users familiar with a new way of presenting the nautical information necessary for a safe navigation. It endeavours to show all similarities and differences in the visualization of data on the new medium, and highlight advantages and defects against traditional presentation on the paper nautical chart.

2.   CARTOGRAPHIC RULES

As they provide a new way of using nautical data, electronic charts have many advantages over the paper charts, such as: the use of chart in real time (positioning by GPS), the option of drawing a radar panorama using electronic chart or view other participants in maritime traffic, as well as the use of additional nautical information available on the screen display. On the chart display, mariner can control the navigation of other participants in maritime traffic. Deficiencies of these charts are insufficient layout and limited presentation.

Acquiring new technologies and methods of navigation, cartographic rules for visualization of objects have been changed recently. Symbols on nautical charts have become simpler and bigger, while the quantity of objects not used for navigational safety has been reduced, as well as representation of objects on land.

Cartographic rules for production of paper charts and ENC are identical, as both are produced for the same purpose of navigational safety, and from the same nautical information system (IHO). According to the Specifications of the International Maritime Organization (IMO) and International Hydrographic Organization (IHO) nautical charts are adapted to their users. Paper chart has therefore started to use advantages of new technologies and resemble electronic navigational chart.

3.   DIFFERENCES IN NAUTICAL DATA VISUALIZATION

Mariners should become used to different possibilities and ways of using nautical chart. When using charts they first give a passing look at the whole, and then examine in detail

the area of their interest. The use of chart in real time offers mariners a possibility of making decision on the maneuver in a split second, as all information are available on the screen display.

Differences between paper nautical charts and ENC are due to the use of different media for visualization of the same nautical data. Major differences are the following: colour mixing, resolution of represented nautical objects, human control of display representation, new simplified presentation of fonts and signature and reduced chart content.

3.1. Colour mixing

To paper navigational charts CMYK or subtractive system of colour mixing is applied. On the screen display phosphoric granules of cathode-ray tube emit electron beams whose wavelengths correspond to red, green, and blue colours, and RGB or additive colour system (Walraven, 1990).

Range of colours (gamut) achieved in printing is smaller than the one on screen display, which is in its turn smaller than the range visible with the eye (Fig 1).
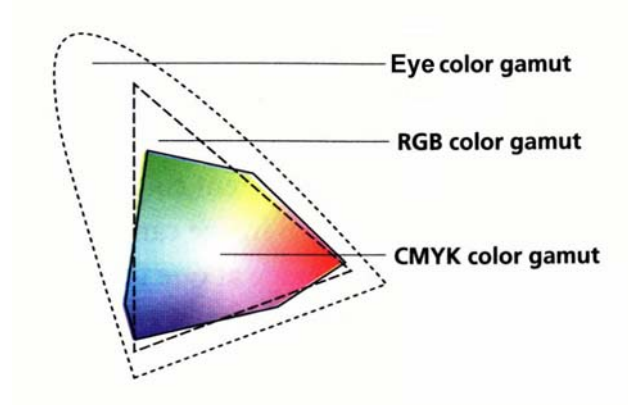

Figure 1. - Different colour range

3.2. Resolution of nautical objects

On the largest screens (19"- 21"), at a high resolution of 1024x768 to 1600x1200 dpi, screen resolution of 60 to 100 dpi is achieved (Stembel and Yelin, 1998; Malic, 1998). At such resolutions the size of a pixel on the display is between 0.22 and 0.28 mm, so that below these dimensions it is not possible to achieve the line breadth, or three times

greater minimum dimensions of the 0.84x0.84 surface (Franges, 1998). Each representation should be enlarged 2.5 to 3 times against the corresponding representation on paper, so as to be clear on the screen display.

Resolution of the printing original is greater than 2000 dpi. Visualization on the display offers several advantages, such as asking questions regarding representation elements, enlargement or selection of a part of representation, selection of contents to be represented by omitting or adding layers, change of colours of the representation elements or entire layers, etc.

3.3. Human control of display representation

Representation on paper chart is well laid out and simple, as it is designed for different users, from fishermen to mariners on supertankers. On electronic navigational chart, user can select the amount of information from the database, to be shown on the screen display at a particular moment. User has therefore a total control over the selection of information, as they are stored in layers. Excess of information may distract attention, and therefore it is important to balance carefully the amount of represented information.

Brightness and contrast of representation is controlled depending on the amount of light and weather conditions on the bridge (too much or insufficient light). Likewise, light or dark background can be selected, as well as daily or nightly viewing (Fig 2) of electronic navigational chart (Heidenreich, 1990).
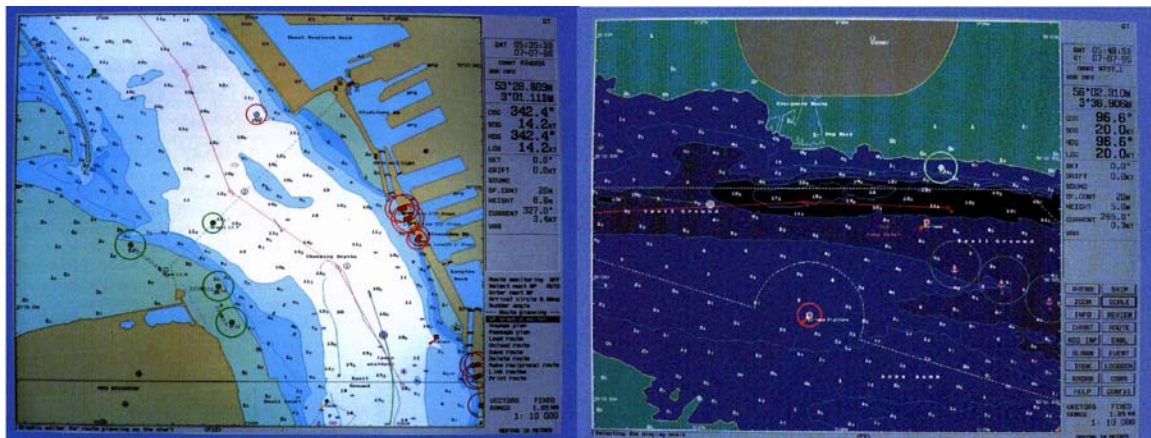

Figure 2. - Daily or nightly viewing of ENC

3.4. Fonts and signatures

The fonts applied on electronic charts must be adapted to the resolving power of the display. Signatures are large and simplified, according to limited capacities of the screen display, being adjusted to a viewing distance of 70 cm. Therefore the size of 12 pixels is sufficient for a good representation of most signatures on the screen display (Table 1) (Eaton, 1993).

Electronic navigational chart offers a possibility of optional selection of signatures as on paper charts or by simplified signature (IHO, 1997).

Table 1. - Signatures on paper chart and ENC (Duplancic Leder, 2000)

	PAPER CHART	ENC		PAPER CHART	ENC
Church			Monument		
Tower			Flare stack		
Chimney			Mine		
Fishing harbour			Hospital		
Light, lighthouse			Colours of lights		
Mooring buoys			Fog Signal		
Cardinal Marks			Lateral Marks		
submarine cable			Sounding		

3.5. Chart content

Representation of electronic navigational chart against that of paper navigational chart has been simplified. Electronic charts are less encumbered with topographic and additional contents which serve for a continuity of representation (settlements are shown by means of raster featuring orientation objects). Some realistic and complex signatures (rocky, reefy and stony coasts) have been simplified on the charts.

Depths and hues show topography of the sea bed. There is a possibility of the use of tidal data in real time (Eaton, 1993). Representation of the land topography has been simplified and reduced to a minimum. The text including warnings, prohibitions and notices is shown on the chart by exclamation mark in a circle or triangle. Clicking on this signature you can reach the text of warnings, prohibitions or notices in the database (IHO, 1997).

4. CONCLUSIONS

Cartographic rules for production of both paper and electronic charts are identical. There are great differences in visualization and the way of using charts. Representation on paper charts has been simplified recently, ENC have many advantages and few shortcomings in comparison with paper charts.

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