

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, visualisation and representation of nautical information. Major differences between paper nautical charts and ENC are visualisation 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 advantages and few shortcomings to paper navigational charts.*

Key words: *paper charts, ENC, nautical chart visualisation*

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: portolan 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 emphasised that in spite of all advantages of ENC technology, ENC charts have a relatively small market, because 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 visualisation 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

Kartografska pravila i razlike u vizualizaciji nautičkih podataka na papirnoj i elektroničkoj navigacijskoj karti

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SAŽETAK. *Ovim se člankom nastoje prikazati kartografska pravila za izradu papirne i elektroničke pomorske karte i najvažnije razlike u sastavljanju, vizualizaciji i prikazivanju nautičkih podataka. Glavna je razlika između papirne pomorske karte i elektroničke pomorske karte u vizualizaciji nautičkih podataka: miješanje boja, razlučivost prikazanih nautičkih objekata, korisnička kontrola prikaza na zaslonu, fontovi i signature te sadržaj karte.*

Ključne riječi: *papirna karta, ENC, vizualizacija nautičkih podataka*

1. UVOD

Pojam moderne nautičke karte javlja se na početku 13. stoljeća, kada je iz Kine u Europu donesen kompas (Carta Pisana). Pomorska se kartografija može podijeliti u tri razdoblja: razdoblje portulanskih karata, razdoblje hidrografske izmjere i razdoblje elektroničkih pomorskih karata.

Razdoblje ENC-a nastupa početkom osamdesetih godina, kada dolazi do naglog razvoja geoprostornih tehnologija, posebice sustava za globalno pozicioniranje GPS-a.

Usvajanjem novih tehnologija mijenjaju se i metode navigacije na moru i sigurnost plovidbe. Tako se navigacija promijenila od "relativne navigacije", bazirane na vizualnom opažanju, radarskom mjerenju i određivanju položaja na papirnoj karti, prema "apsolutnoj navigaciji" ili određivanju položaja satelitskim metodama kao GPS, GLONASS ili GNSS (Tuurnala i Laitakari, 1999).

Treba naglasiti da je uza sve prednosti tehnologije za izradu ENC-a tržište tih karata još relativno maleno budući da je za njihovu upotrebu potrebna velika investicija u brodsku opremu.

Ovim se radom nastoji približiti korisnicima novi način prikazivanja pomorskih informacija potrebnih za sigurnu plovidbu, prikazati sve sličnosti i različitosti u vizualizaciji podataka na novome mediju te naglasiti prednosti i mane prema klasičnom prikazu podataka na papirnoj pomorskoj karti.

2. KARTOGRAFSKA PRAVILA

Elektroničke karte s novim načinom upotrebe pomorskih podataka imaju dosta prednosti pred papirnatim kartama, i to: upotreba karte u stvarnom vremenu (određivanje položaja GPS-om), opcija iscrtavanja radarske panorame preko elektroničke karte ili praćenje ostalih sudionika u pomorskom prometu te upotreba dodatnih navigacijskih informacija koje su

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 visualisation 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 Organisation (IMO) and International Hydrographic Organisation (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 VISUALISATION

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 visualisation 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).

3.2. Resolution of nautical objects

On the largest screens (19"–21"), at a high resolution of 1024×768 to 1600×1200 dpi, screen resolution of 60 to 100 dpi is achieved (Stembel and Yelin, 1998; Malić, 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 0.84×0.84 surface (Frangeš, 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. Visualisation 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. Users have 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).

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

pomorcu dostupne na zaslonu. Pomorac može na ekranu pratiti plovidbu ostalih sudionika u pomorskom prometu. Te karte imaju i nedostataka, npr. nedovoljnu preglednost i ograničenost prikaza.

U posljednje vrijeme usvajanjem novih tehnologija i promjene metoda navigacije mijenjaju se i kartografska pravila vizualizacije objekata. Tako simboli na pomorskim kartama postaju sve jednostavniji i krupniji, a smanjuje se i količina onih objekata koji nisu bitni za sigurnost plovidbe, posebno je reduciran prikaz objekata na kopnu.

Kartografska su pravila jednaka za izradu papirnatih karata i ENC-a jer su obje vrste karata izrađene radi sigurnosti plovidbe i iz istog nautičkog informacijskog sustava (IHO). Prema tehničkim podacima Međunarodne pomorske organizacije (International Maritime Organization – IMO) i Međunarodne hidrografske organizacije (International Hydrographic Organization – IHO) pomorske se karte prilagođuju korisnicima. Tako je papirnata karta počela koristiti prednosti novih tehnologija i svojim prikazom sličiti elektroničkoj pomorskoj karti.

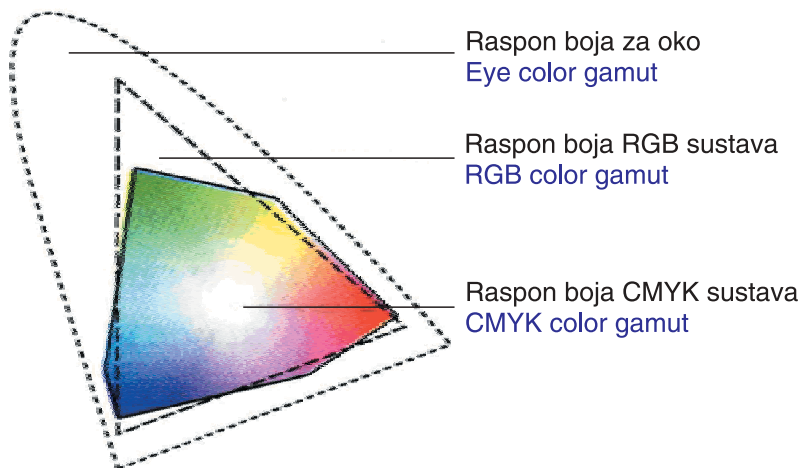
3. RAZLIKE U VIZUALIZACIJI POMORSKIH PODATAKA

Pomorac se dakle treba naviknuti na drukčije mogućnosti i načine upotrebe karte. Pomorac tako najprije letimično pogleda cjelinu, a zatim detaljno pregledava ono područje karte koje ga zanima. Upotreba karte u stvarnom vremenu (*real-time*) pruža pomorcu mogućnost donošenja odluke o manevru u djeliću sekunde i donošenje kvalitetnih i brzih odluka, jer su mu sve informacije dostupne na zaslonu monitora.

Najveće se razlike između klasične, papirnate pomorske navigacijske karte i elektroničke navigacijske karte javljaju u vizualizaciji ili načinima prikaza.

3.1. Miješanje boja

Na papirnatim pomorskim navigacijskim kartama primjenjuje se CMYK ili suptraktivni sustav miješanja boja. Na zaslonu monitora fosforna zrnca katodne cijevi zrače snopove elektrona valnih duljina koje odgovaraju crvenoj, zelenoj i plavoj boji, odnosno RGB ili aditivnom sustavu boja (Walraven, 1990).



Slika 1. Različiti rasponi nijansi

Fig. 1. Different colour ranges

Raspon nijansi (gamut) koji se postiže u tisku manji je od raspona na zaslonu, a on je pak manji od raspona što ga oko može vidjeti (slika 1).

3.2. Razlučivost prikazanih nautičkih objekata

Na najvećim ekranima (19" do 21"), pri velikoj rezoluciji od 1024×768 do 1600×1200 dpi postiže se ekranska rezolucija od 60 do 100 dpi (Stembel i Yelin, 1998; Malić, 1998). Pri takvim rezolucijama veličina točke prikazane na zaslonu iznosi od 0,22 do 0,28 mm, pa je ispod tih dimenzija nemoguće ostvariti širinu linije, odnosno tri puta veću minimalnu dimenziju površine 0,84×0,84 (Frangeš, 1998). Svaki prikaz, dakle, da bi bio čitljiv na zaslonu ekrana, treba povećati 2,5 do 3 puta prema odgovarajućem prikazu na papiru.

Razlučivost tiskovnog izvornika veća je od 2000 dpi. Vizualizacija na zaslonu pruža neke prednosti, npr. upite na element prikaza, povećavanje i odabir dijela prikaza, mogućnost odabira sadržaja koji treba prikazati ispuštanjem i dodavanjem slojeva, mijenjanje boja elemenata prikaza ili cijelih slojeva itd.

3.3. Korisnička kontrola prikaza na zaslonu

Prikaz na papirnatij karti pregledan je i jednostavan jer je takva karta rađena za različite korisnike, od ribara do pomoraca na supert karti korisnik može odabrati količinu informacija iz baze podataka koja će, u određenom trenutku, biti prikazana na zaslonu monitora. Korisnik, dakle, ima punu kontrolu odabira informacija, jer se one nalaze spremljene u slojevima. Višak informacija može odvući pažnju, zato je važno pravilno uravnotežiti količinu informacija koja se prikazuje.

Tablica 1. Signature na papirnatij karti i ENC-u (Duplančić Leder, 2000)
Table 1. Signatures on paper chart and ENC (Duplančić Leder, 2000)

	PAPER CHART <i>PAPIRNATA KARTA</i>	ENC		PAPER CHART <i>PAPIRNATA KARTA</i>	ENC
Church <i>Crkva</i>			Monument <i>Spomenik</i>		
Tower <i>Toranj</i>			Flare stack <i>Plamenik</i>		
Chimney <i>Dimnjak</i>			Mine <i>Rudnik</i>		
Fishing harbour <i>Ribarska luka</i>			Hospital <i>Bolnica</i>		
Light, lighthouse <i>Svjetlo, svjetionik</i>			Colours of lights <i>Boje svjetala</i>		
Mooring buoys <i>Plutača za vez</i>			Fog Signal <i>Signal za maglu</i>		
Cardinal Marks <i>Kardinalna oznaka</i>			Lateral Marks <i>Lateralna oznaka</i>		
Submarine cable <i>Podmorski kabel</i>			Sounding <i>Dubina</i>		

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).

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).

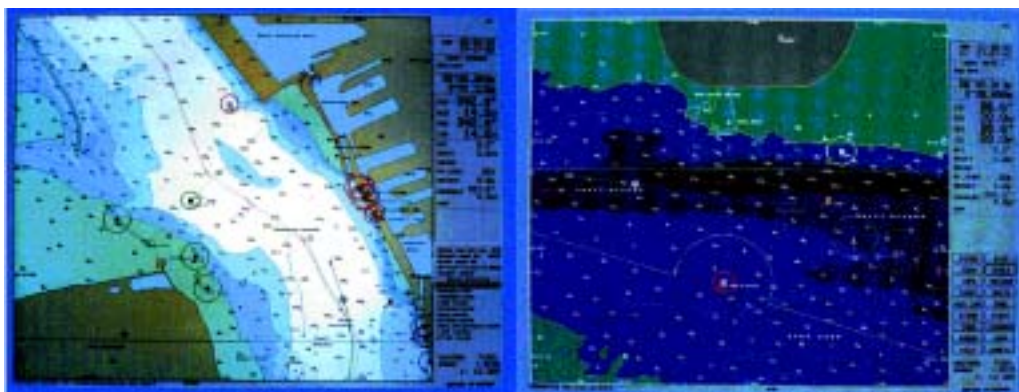
4. CONCLUSIONS

Cartographic rules for production of both paper and electronic charts are identical. There are great differences in visualisation 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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Slika 2. Dnevni i noćni način gledanja elektroničke navigacijske karte
 Fig. 2. Daily and nightly viewing of ENC

3.4. Fontovi i signature

Fontovi upotrijebljeni na elektroničkim kartama moraju biti prilagođeni razlučivosti zaslona. Signature su krupne i pojednostavnjene, sukladno ograničenim mogućnostima prikaza zaslona i prilagođene udaljenost gledanja od 70 cm. Tako je veličina od 12 točaka dovoljna za pregledni prikaz na zaslonu monitora većine signatura (Eaton, 1993) (tablica 1).

U elektroničkoj navigacijskoj karti opcijski se mogu odabrati signature kao i na papirnatim kartama ili pojednostavnjenom signaturom (IHO, 1997).

3.5. Sadržaj karte

Prikaz elektroničke pomorske karte pojednostavnjen je u usporedbi s prikazom papirnatih pomorske navigacijske karte. Karte su manje opterećene topografskim i dodatnim sadržajem koji služi za kontinuitet prikaza (naselja su prikazana rasterom na kojem se ističu objekti za orijentaciju). Neke su realistične i složene signature (klisurasta, grebenasta i kamenita obala) pojednostavnjene na kartama.

Topografija podmorja prikazana dubinama i tonskim vrijednostima. Postoji mogućnost upotrebe u stvarnom vremenu (*real-time*) podataka morskih mijena (Eaton, 1993). Prikaz topografije kopna pojednostavnjen je i reduciran na minimum. Tekst upozorenja, zabrana i obavijesti na karti je prikazan znakom uskličnika u krugu ili trokutu. S pomoću te signature mišem se dolazi do teksta upozorenja, zabrane ili obavijesti iz baze podataka (IHO, 1997).

4. ZAKLJUČAK

Pravila za izradu objiju vrsta karata su ista. Velike su razlike u vizualizaciji i načinu korištenja karata.

Papirne su karte u posljednje vrijeme također pojednostavnile svoj prikaz. ENC-i imaju veliki broj prednosti i manji broj nedostataka u usporedbi s papirnatim kartama.

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