

**Paper for Consideration by NCWG**  
**Discussion on the Future of the Paper Nautical Chart from another perspective**

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| <b>Submitted by:</b>      | <b>China MSA</b>  |
| <b>Executive Summary:</b> | Under the background that the traditional paper charts are likely to become the backups for ECDIS or even disappear, this proposal mainly aims at the working draft of the “future of the Paper Nautical Charts” in NCWG4-06. It introduces the upgraded cartographic techniques like multi-dimension integration, remote sensing image, terrain shading, artistic design and one-click mapping, realizing the rapid production of the high-qualified customized thematic chart, which greatly improves the tri-dimensional effect, the scientific beauty and the artistic beauty. With such effort, the paper chart can play a role in the future and the diversified requirements from the non-navigational users, especially administrative users can be better satisfied. We are looking forward to the attention from NCWG and hoping the proposal can be adopted. |
| <b>Related Documents:</b> | <b>NCWG4-06.1A</b>  |
| <b>Related Projects:</b>  | <b>None</b>   |

**Introduction / Background**

After the 1990s, the advancement of computer technology, positioning technology and communication technology greatly influences the development of charting. Digital technology provides various ways for the expressions, the information space provides abundant data resources, so the new products get rid of the restriction of paper medium, realizing the multi-dimensional visual expression and the distortion visualization with digital papers<sup>[1]</sup>.

In this process, paper charts, as one of the traditional form of charting products, have coexisted with digital Electronic Navigational Charts (ENCs) for nearly three decades. However, paper chart becomes increasingly uncompetitive and the annual sales are not optimistic at all (Figure 1). At present, the S-57 ENCs are almost occupy the main market (Figure 2), and the S-100 based products are just arrived or under developing. According to SOLAS convention, Chapter V, Regulation 19, paragraph 2. 10, ECDIS may be accepted as meeting the chart carriage requirements. And the time

deadline for different ships is shown in Figure.3.

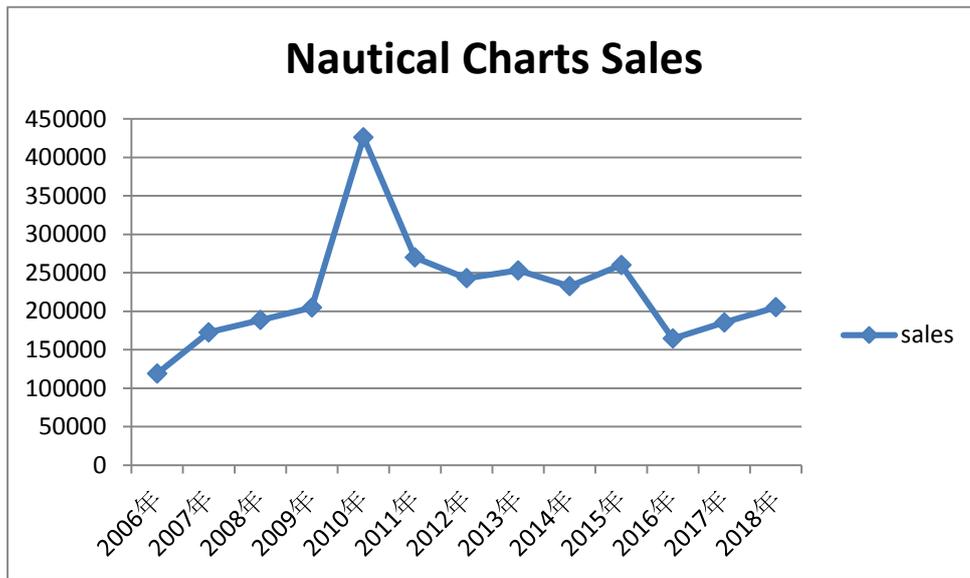


Figure 1a, Nautical Charts Annual Issues of China MSA

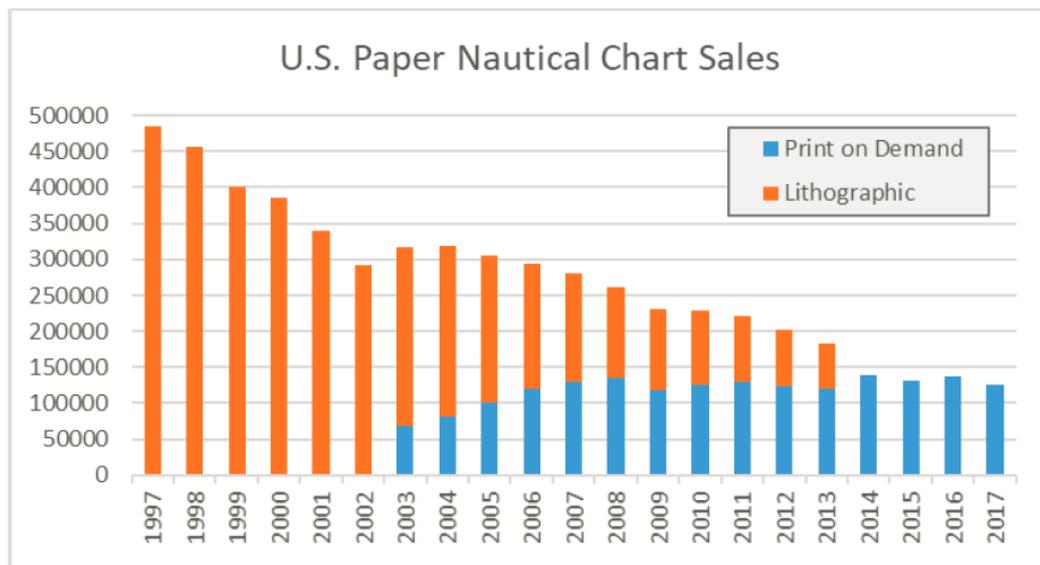


Figure 1b, U.S. Paper Nautical Chart Sales

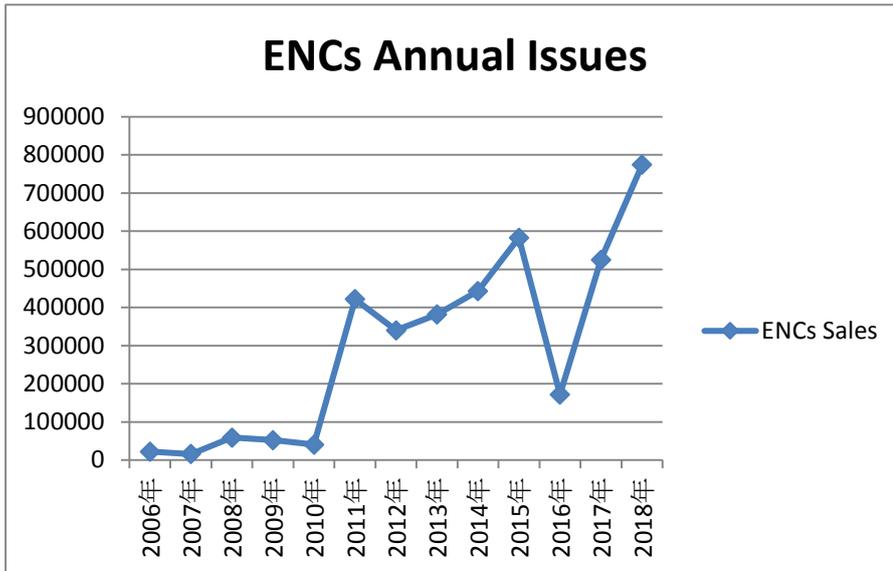


Figure 2, ENCs Annual Issues of China MSA

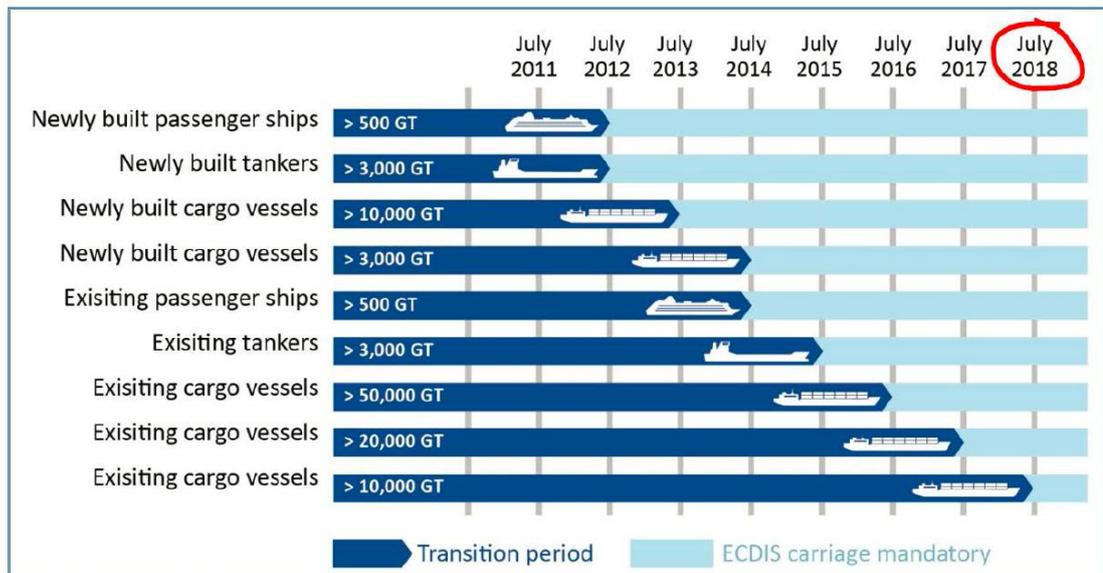


Figure 3, ECDIS Implementation Schedule for Vessels on International Voyages

“Future of the Paper Nautical Chart” has drawn much attention, so IHO NCWG put forward the topic of the Future of Paper Nautical Charts. It is hoped that by exploring and discussing the related issues, the hydrographic offices, mariners and other stakeholders will think about the development of paper nautical charts from different perspective and take appropriate measures to prepare for the future. In the NCWG4's latest conference document (NCWG4-06.1A), the NCWG mainly discussed on the mariners demands for paper charts. It is considered that the potential breakdown of an ECDIS is inevitable, so it is of great necessity to prepare a

paper chart with a reasonable scale for a backup. NCWG also recommend "ENC first" paper chart production workflow where the data of paper charts derived directly from ENC database, and after automatic conversion and automatic symbolization, paper charts can be printed on demand(POD).

According to the personalized requirements from non-navigational users, especially administrative users, this proposal mainly introduces the upgraded cartographic techniques like multi-dimension integration, remote sensing image, terrain shading, artistic design and one-click mapping, realizing the rapid production of the pan nautical chart. This will greatly improves the tri-dimensional effect, the scientific beauty and the artistic beauty, making the traditional paper chart more competitive.

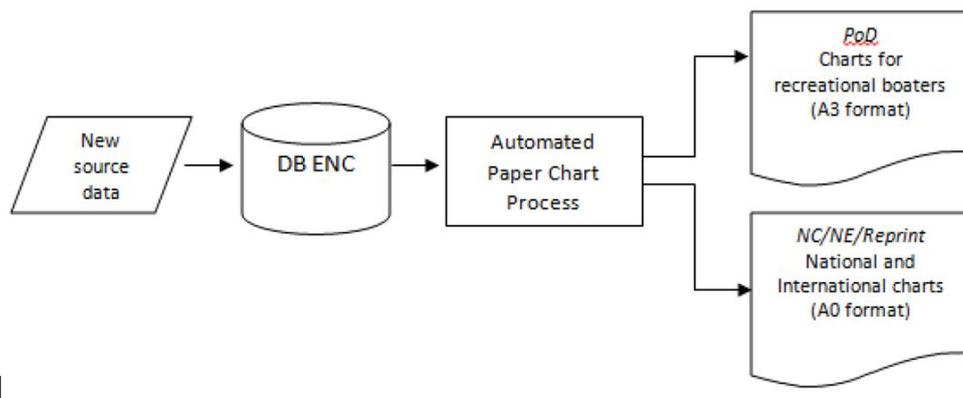


Figure 4, Conference Paper Chart Production Workflow

### **Demands analysis of the sea-related administrative users**

Users of hydrographic products and services can be divided into two categories: mariners and non-navigational users. Non-navigational users mainly include maritime management, port management, waterway management, salvage and rescue, aquaculture, marine planning, marine engineering, oil and gas, marine ecological management, environmental protection, etc. It is obvious that sea-related administrative users account for a considerable proportion. And the characteristics of the requirements on paper chart can be summarized as follows.

- The administrative area is of a small scale.
- Based on the geographic data, focus more on the distribution of department related elements.
- Prefer more statistical charts or diagrams for further data mining and

analysis.

- The expression is more diversified and personalized.
- With higher artistic beauty, the style of the paper chart are designed based on the content.
- The customized paper charts don't need to comply with common standards.
- The public sales is small, and it requires more for printing and decorating.

### Process introduction

In order to ensure the quality of the customized thematic chart, the data of paper chart comes directly from the ENC database (figure 5). More specifically, with the pre-processing and conversion system, the data can be transferred from the ENC database to the vector illustrator software. Then the subsystems was embedded as a plugin into the AI rapid charting system, realizing the charting rules management, symbol management, annotation configuration, relationship processing automatically and so on. After all the steps, the chart can be printed and decorated. This process greatly improves the work efficiency, and ensures the quality of customized thematic charts.

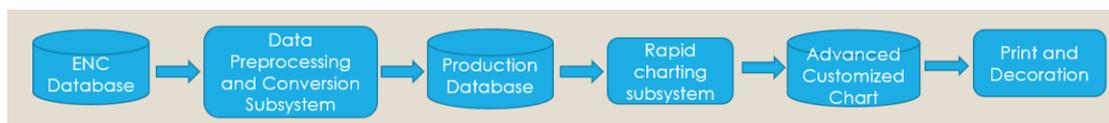


Figure 5 Production process

### Specific methods

In order to meet the requirements of the users, the production of the customized paper chart is based on the integration of multi-source heterogeneous data. By adopting the stereoscopic shading, remote sensing image technology, artistic graphics, symbol design, poster design, printing and decoration, etc. With such effort, the tri-dimensional effect, the scientific beauty and the artistic beauty will be greatly improved, making the traditional paper chart more popular and more competitive.

### Multi-dimension integration

Multi-dimension integration is mainly to enhance the stereoscopic effect of charts. The topography shading, including land and seafloor, is a unique form of three-dimensional expression. The ups and downs of the terrain becomes more visualized by setting the height angle, azimuth, light and dark, and vertical direction of the light source. In addition, the stereoscopic effects can also be enhanced by setting up the ribbon, mountain shadow, water level, transparency, etc. (figure 6a, figure 6b).

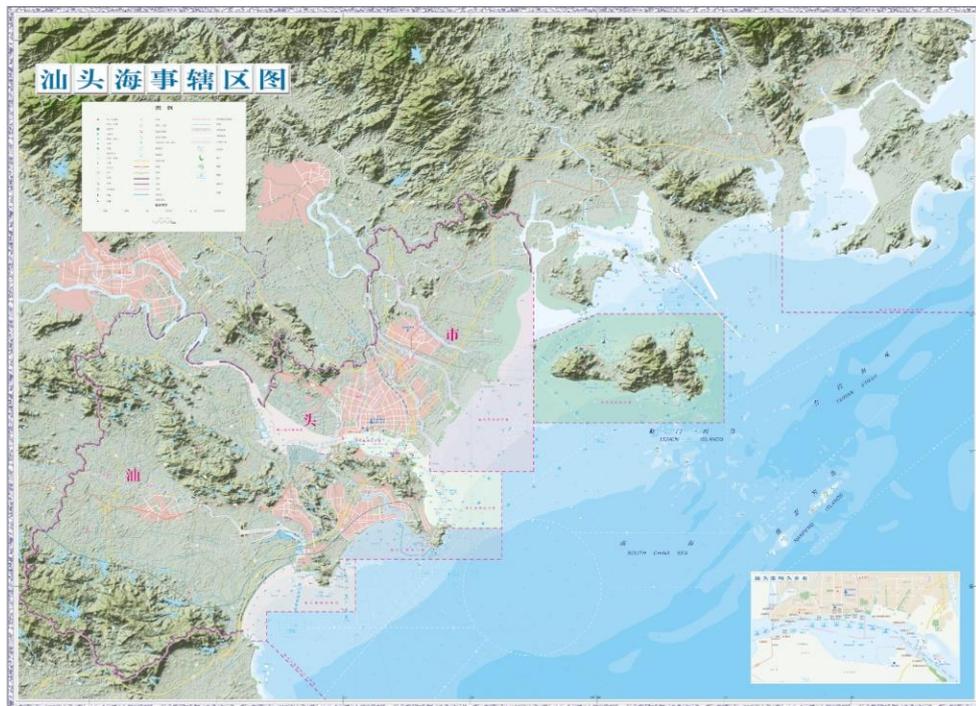


Figure 6a, Terrain shading

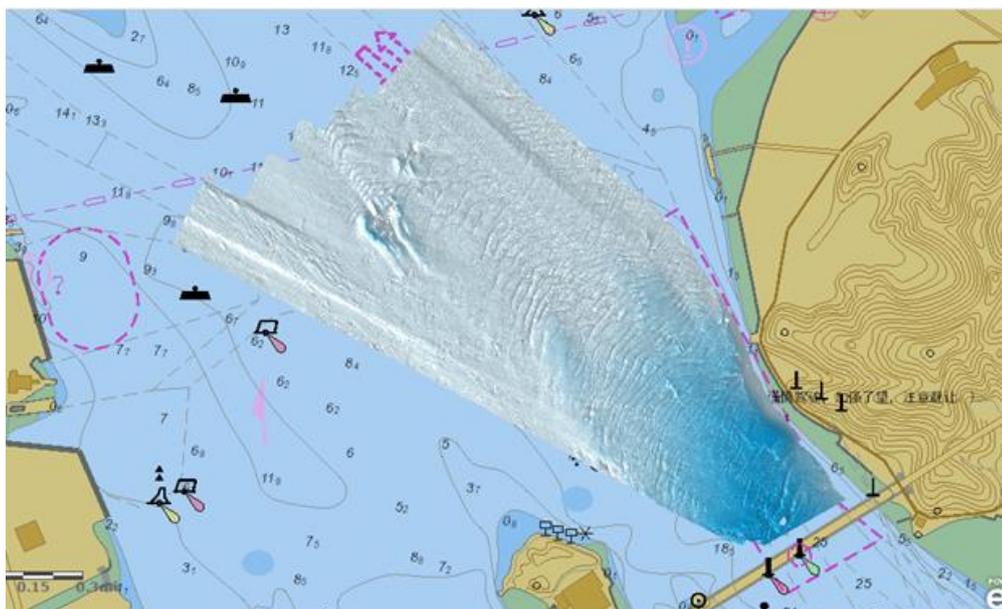


Figure 6b, Submarine Terrain

### Remote sensing technology

By the interpretation of remote sensing images, the vector data of the region can be quickly obtained, and the enhanced remote sensing image can be directly used as the base map (Figure. 7). The main methods of enhancement processing include color enhancement, contrast enhancement, filter enhancement and ratio enhancement. The color management should be harmonized and highlight the important elements of the environment.

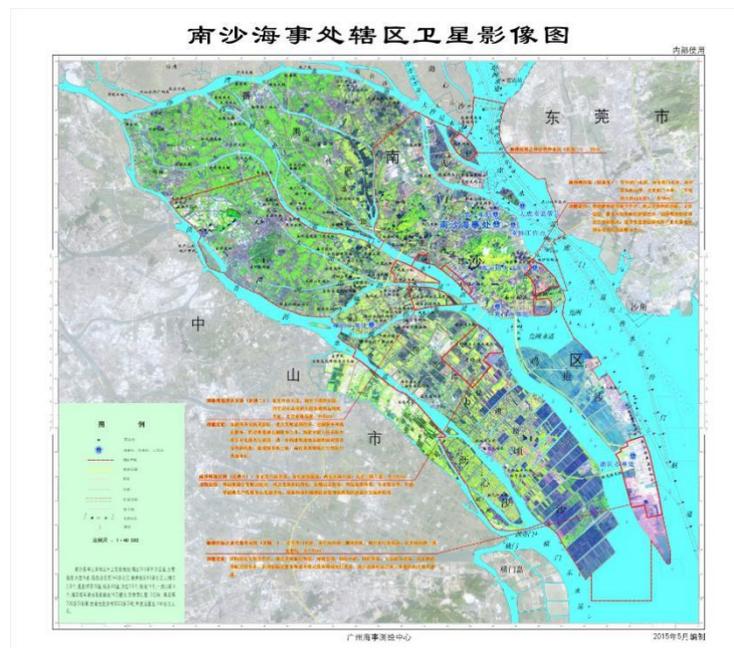


Figure 7.Using Remote Sensing Image

### Symbol design

In order to catch people's attention at the first sight, the symbols on the chart are designed to be more vivid and more artistic. The use of stereoscopic symbol or photo-like symbol is one of an effective method(Figure 9). When it comes to some important elements, we can also adopt hand-painted symbols (Figure 10) to make it more artistic and creative.



Figure 8. Symbol Design



Figure 9. Stereoscopic Symbol

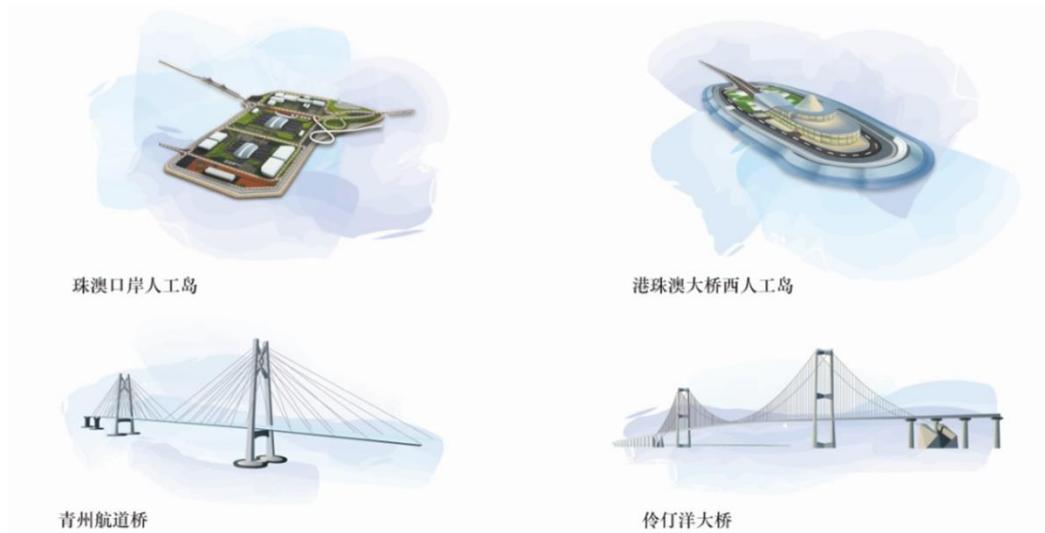


Figure 10. hand-painted Symbol

### Artistic Chart

In the era of big data, the various data can be derived to diversified artist charts (Figure 11). It can promote integration among charts, statistical charts and other elements of interest, realizing the effect of chart plus, which can play an important role on supporting decisions making.

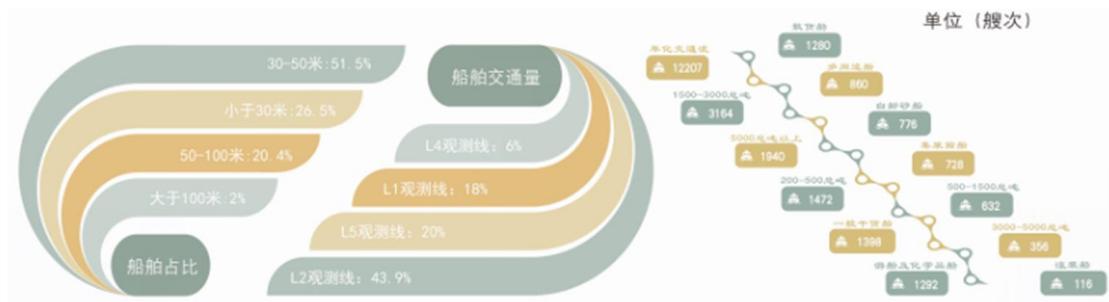


Figure 11. Statistical Chart Example

### Poster design

The poster design and pictorial design are also introduced to the production of the thematic chart. All the elements such as chart, text, color are combined and organized to a product, which can catch people's attention at first sight easily (Figure 12). For example, on the thematic chart for MSA, the ship, the coast, the ATONs are painted as the base, the border of the chart is designed like waves of the sea, which emphasizes the theme of maritime traffic directly (Figure. 13).



worth a thousand words. The production, distribution and application of ENCs are becoming more and more standardized, so the paper charts can be developed to be more artistic and applied to the non-navigational fields.

## Recommendations

The IHO NCWG is invited to follow the paper and if possible include relevant content stated above in the draft “The Future of Paper Charts” document.

## references:

[1] Guo Renzhong, Ying Shen. On the revival of cartography in the ICT era [J]. Journal of Surveying and Mapping, 2017, 46(10):1277.

[2] the International Hydrographic Organization, Nautical Cartography Working Group. the Future of the Paper Nautical Chart. NCWG4-06.1A, 6-9 Nov. 2018: 5, 13.