University of New Hampshire

2022AutoCarto

Redlands, Nov. 1-4, 2022





Christos Kastrisios

Colin Ware Subjective & Objective Evaluation of Data Quality Visualization Methods on Navigational Charts

> Christos Kastrisios November 2, 2022

MARITIME TRANSPORT





THE NAUTICAL CHART





BATHYMETRIC DATA SURVEYS





DATA COLLECTION METHODS

Depth Measurement:

- \circ Lead-line
- Single-bean Echosounders
- o Multi-bean Echosounders
- o Airborne Lidar
- o Satellites

D Positioning Method:

- o Distant lines
- Range Azimuth
- o Sextants
- \circ Theodolites
- \circ GPS
- o Differential GPS











DATA QUALITY REPRESENTATION

Sectors:

- Depth accuracy
- Position accuracy
- Data completeness (sea-bed coverage, feature detection)

Evaluation by producers

zoc	Symbol	THU (m)	TVU (m)	Full Seabed Coverage
Aı	***	5	0.5+ 1%	Yes
A2	***	20	1 + 2%	Yes
в	***	50	1 + 2%	No
С	(* * *)	500	2 + 5%	No
D	(* *)	> 500	>2 + 5%	No
U		U	U	U



Electronic Chart Display and Information System **ECDIS**





DATA QUALITY IMPORTANCE





Nova Cura



Pazifik

ZOC category	% area of world's coastal ENC (32 nations)
A1 (6 stars)	2.5%
A2 (5 stars)	3.0%
B (4 stars)	38.5%
C (3 stars)	27.8%
D (2 stars)	12.5%
Unassessed (U)	15.7%



Depth Uncertainty Visualization

Ware

STAR SYMBOLOGY PROBLEMS



- > CLUTTER
- Obscure high-quality more than low-quality data
- Not intuitive
- May not fit in small areas (?)
- Continuous zoom-in/out is required
- Dominate the screen











Requirements

- Minimally interfere with the other charted information.
- Unambiguously relate to the QoBD categories.
- Emphasize the areas of greater uncertainty.
- Be effective in all ECDIS modes.
- Be easy to memorize.

Category of Zones of Confidence



Quality of Bathymetric Data

	QoBD	Symbol	THU (m)	TVU (m)	Full Seabed Coverage
	1	?	5	0.5+1%	Yes
	2	?	20	1 + 2%	Yes
/	3	?	50	1 + 2%	No
	4	?	500	2 + 5%	No
	5	?	> 500	>2 + 5%	No
	U	?	U	U	U
	0	?		-	















QoBD	Lines	Dot Clusters	Color Textures	Opaque Colors	Transparent Color
1		• • • • • • • •			
2		•• •• •• ••			
3					
4		••• ••• ••• ••• ••• ••• ••• ••• •••			
5		** **			
U					



Countable Textures Sequence of textures consisting of countable elements

Benefits:

- ✓ Minimally used in ECDIS
- ✓ Minimally interfere with chart information
- ✓ The combination can be intuitive
- ✓ Good visual hierarchy















> CLUTTER







COMPARISON

Obscure high-quality more than low-quality data







> Not intuitive







> May not fit in small areas





COMPARISON

> Dominate the screen





COMPARISON

Dominate the screen



USER SURVEY

- Consent
- Introduction Section
- Evaluation Section
 - Ratings (Likert o-6 scale for exceptionally bad-great performance)
 - One objective question (identify CATZOC)
 - Rankings (1-5 for worst-best)
- Demographics Section







USER SURVEY

Consent

Introduction Section

Evaluation Section

- □ Ratings (Likert o-6 scale for exceptionally bad-great performar
- □ One objective question (identify CATZOC)
- Rankings (1-5 for worst-best)
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Please rank the 5 alternatives from 1-worst to 5-best for the Day Bright Mode for their overall performance in meeting the requirements of the previous screen.



	1-Worst	2	3	4	5-Best
A - Opaque Colors	0	0	0	0	0
B - Color Transparency	0	0	0	0	0
C - Color Stripes	0	0	0	0	0
D - Dot Clusters	0	0	0	0	0
E - Lines	0	0	0	0	0



USER SURVEY

E - Lines

Consent

- Introduction Section
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IN-LAB EXPERIMENT

Controlled lab experiment

Task: enter number corresponding to QoBD value at marker Two experiments: with (EXPT1) and without (EXPT2) the key displayed Measure: time to respond and errors.



Synthetic Chart Generator







RESULTS

Dot Color Transparent Opaque QoBD Lines Clusters Textures Colors Color 1 2 3 4 5 - U



Color Textures

Transparent Color





DISCUSSION

- Textures the most preferred, but
 - Two big groups: preference to **textures** & **colors**
 - ✓ One Texture & one Color to accommodate both groups
- Results are consistent with previous works that recommend textures for signifying uncertainty for areal objects with coincident visualizations
- Opaque-Colors performed well in emphasizing worse quality areas (coldto-warm?)
- Likewise for Transparent-Color (transparency & Saturation),...but...
- Considerably higher error rates of color schemes in the objective survey question compared to the experiment
- To generalize the countable textures method, standard deviations might be computed over a surface and converted to steps, e.g., the series 0.5, 1.0, 1.5, 2.0, 2.5 would provide five steps.





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Christos Kastrisios Christos.Kastrisios@unh.edu