First attempts to Automatize Generalisation of Electronic Navigational Charts

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GETTING INTO THE TOPIC

How are ENCs different from topographic maps?
What is the project about?
Fun facts about ENCs

• One data model!!!
• Object oriented approach (170/190)
• No presentation concerns (S-52)
  – No labels
• No aesthetics (almost)
• Everyone has to use it (by 2018)
• Straightforward user requirements
• Points, Lines, Areas and Soundings
• Geo, Meta, Collection (and Cartographic)
• ‘Skin of the Earth’ and others
• 3 display levels (Base, Standard, All)
• Developments take place
S-57 Data Model: Points

- Feature Objects may *share* Spatial Objects

Feature Objects

- TOPMAR
- BCNCAR
- LIGHTS

Spatial Objects

- 55.35° N
- 12.41° E

Source: CARIS B.V.
S-57 Data Model: 2. Soundings (cont)

- Soundings with *identical attribute values* can be *grouped* into one Feature Object
  - Result is more efficient storage of sounding data

Source: CARIS B.V.
Example of an object class

Object Class: **Depth area**

Acronym: **DEPARE**  
Code: 42

Set Attribute_A: DRVAL1; DRVAL2; QUASOU; SOUACC; VERDAT;
Set Attribute_B: INFORM; NINFORM; NTXTDS; SCAMAX; SCAMIN; TXTDSC;
Set Attribute_C: RECDAT; RECDND; SORDAT; SORIND;

**Definition:**
A depth area is a water area whose depth is within a defined range of values.

**References:**
- INT 1: not specified;
- M-4: not specified;

**Remarks:**
Intertidal areas are encoded as depth areas. These do not have to include soundings.
The depth range within a depth area is defined by the attributes ‘DRVAL1’ and ‘DRVAL2’.

**Distinction:** depth contour; dredged area; sounding; obstruction; sea area/named water area unsurveyed area; wreck;
## Scales

<table>
<thead>
<tr>
<th>Navigational Purpose</th>
<th>Name</th>
<th>Scale Range</th>
<th>Available Compilation Scales</th>
<th>Matching Scale Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overview</td>
<td>&lt;1:1499999</td>
<td>3000000 and smaller</td>
<td>200 NM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1500000</td>
<td>96 NM</td>
</tr>
<tr>
<td>2</td>
<td>General</td>
<td>1:350000 – 1:1499999</td>
<td>700000</td>
<td>48 NM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>350000</td>
<td>24 NM</td>
</tr>
<tr>
<td>3</td>
<td>Coastal</td>
<td>1:90000 – 1:349999</td>
<td>180000</td>
<td>12 NM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>90000</td>
<td>6 NM</td>
</tr>
<tr>
<td>4</td>
<td>Approach</td>
<td>1:22000 – 1:89999</td>
<td>45000</td>
<td>3 NM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>22000</td>
<td>1.5 NM</td>
</tr>
<tr>
<td>5</td>
<td>Harbour</td>
<td>1:4000 – 1:21999</td>
<td>12000</td>
<td>0.75 NM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8000</td>
<td>0.5 NM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4000</td>
<td>0.25 NM</td>
</tr>
<tr>
<td>6</td>
<td>Berthing</td>
<td>&gt; 1:4000</td>
<td>39999 and larger</td>
<td>&lt; 0.25 NM</td>
</tr>
</tbody>
</table>
Different experience...?
Problem

• No efficient specifications or tools for the automatic generalisation of S-57 data.
• Direct translation of generalisation principles not satisfactory as ENC imperatives are different.
• Safety of navigation condition inexistent among common generalisation methods.
RESULTS
Build-up areas

BUISGL
- Convert into BUAARE

BUAARE
- Another BUAARE within 3mm/cs
- Simplify
  - Aggregate
  - Small
  - SELECT

Simplify
- Do not select
<table>
<thead>
<tr>
<th>Object group</th>
<th>What was done</th>
<th>What went well</th>
<th>What went wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td>AtoNs and Landmarks</td>
<td>Selection, De-clustering</td>
<td>Safe approach, Logical selection</td>
<td>Not all support structures chosen, Manual effort still needed for special cases</td>
</tr>
<tr>
<td>WRECKS</td>
<td>Selection</td>
<td>All selected correctly</td>
<td>Possibly manual deletions involved</td>
</tr>
<tr>
<td>UWTROC</td>
<td>Selection, Removing redundant</td>
<td>Safe approach</td>
<td>Clusters of objects</td>
</tr>
<tr>
<td>LNDARE</td>
<td>Aggregation, Simplification, Collapsing</td>
<td>Time savings, Effective depiction of small islands</td>
<td>Generalisation not on the safe side, Oversimplification</td>
</tr>
<tr>
<td>COALNE</td>
<td>Create feature based on geometry, Buffers, Assignation of attributes</td>
<td>Time savings, Correct attribution</td>
<td>Short edges</td>
</tr>
<tr>
<td>BUAARE</td>
<td>Aggregation, Simplification</td>
<td>Correct shape</td>
<td>No differentiation between close to shore and far from shore, Need to take more objects into account</td>
</tr>
<tr>
<td>OBSTRN</td>
<td>Enlargement</td>
<td>Safe approach, Effective depiction, Consistent with Approach</td>
<td>No OBSTRN points, Clusters of other objects on better scale should be transformed into OBSTRN areas on the target chart</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Selection</td>
<td>Sometimes time savings</td>
<td>Difficult to find patterns</td>
</tr>
</tbody>
</table>
Brazil
France
The Netherlands
General comments

• France
  – “very encouraging to see the results ”
  – “in this area of marine cartography that we lack appropriate tools”
  – “it is necessary to move the objects "seaward"”
  – “generalisation should be holistic (more complex) and not theme by theme”

• New Zealand
  – “land area and coastline not completely desirable”
  – “the routines for de-cluttering of point objects interesting and with a bit of tweaking could be implemented quite quickly”

• The Netherlands
  – “results look promising”
  – “it is a pity that the bathymetry was not generalised, because generalisation of bathymetry is a recurring event”
PROBLEMS & LIMITATIONS
Selected issues

• Data quality
• Standardization
• Long distance cooperation
• What is good?
• Not complex approach (bathymetry)
Open questions

• How to model ‘safety of navigation’ and propagate uncertainty information?
• Holistic approach?
  – Bathymetry determines all
  – Objects interact
  – Meta, Collection objects affected
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