Visualization/Aesthetics/Semantics

Viewing Cues

Sheelagh Carpendale
University of Calgary

Visual Complexity

- increasing information complexity
  -> increasing visual representation complexity
- unknown information spaces
  -> space probes, satellites, electron microscopes
- visual representation of abstract information & concepts
- all lead to increasingly complex visualizations

Galaxies
Pacific Northwest National Laboratory,
Information Visualization

Cosmic Tumbleweed
Pacific Northwest National Laboratory,
Information Visualization

The Tardis
SEED Project,
Carpendale, Cowperthwaite, Fall
Mis-interpretation is common

Churchwarden’s accounts of St. Dunstan in the West (1628-45)
Guildhall Library Ms 2968/3
Guildhall Library, Corporation of London
Mis-interpretation is common

Churchwarden’s accounts of St. Dunstan in the West (1628-45)
Guildhall Library Ms 2968/3
Guildhall Library, Corporation of London

Drawing a parallel: viewing & reading
In collaboration with Thomas Strothotte

• viewing operations (text - reading)
  – a query to be answered by inspecting the visualization
  – possibly more complex than reading - not all visualizations support all viewing operations
  – data may have been omitted/misrepresented/obscured/distorted
Drawing a parallel: viewing & reading

In collaboration with Thomas Strothotte

• **viewing operations** (*text - reading*)
  – a query to be answered by inspecting the visualization
  – possibly more complex than reading - not all visualizations support all viewing operations (data may have been omitted/misrepresented/obscured/distorted)

• **viewing methods** (*text - whole language reading vs. phonetic reading*)
  – the procedure used by the viewer to carry out the viewing operation
  – since visualizations can be interactive viewing methods can be static or dynamic

• **viewing cues** (*text - spaces/punctuation//page numbers/chapter headings/etc.*)
  – any aspect of the presentation that has been added solely for the purposes of guiding users in discovering and carrying out viewing operations
  – in text we take the presence of these cues for granted, in visualizations we still need to work these out
Spatial or Dominance Axis

- **Integrated** viewing cues
  - incorporated directly into the visualization
  - in text: using *italics* is an integrated viewing cue
- **Augmented** viewing cues
  - are located within the space of the primary visualization but a distinct
  - in text: **underlining** is an augmented viewing cue
- **Accompanying** viewing cues
  - the cue is placed adjacently
  - in text: a mark in the margin or a footnote\(^1\) are accompanying viewing cues

\(^1\) A footnote can add some extra explanation

Cultural Axis

- **Pre-attentive** viewing cues
  - uses pre-attentive perceptual abilities - no conscious processing
  - not culturally tied
- **Acquired** viewing cues (*text - gaps between words*)
  - a perceptual skill that has been "internalized" - included here are perceptual skills that may be discovered to be pre-attentive on further testing
- **Formalized** viewing cues (*text - alphabet*)
  - a visual formalism is a visual representation that has agreed upon meaning for for a given community
- **Constructed** viewing cues
  - is designed specifically for the visualization it is used with
  - a re-used construction becomes a visual formalism, for example thought balloons is comics.
## A Space of Viewing Cues

<table>
<thead>
<tr>
<th>Cultural Axis</th>
<th>Integrated</th>
<th>Augmented</th>
<th>Accompanying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-attentive</td>
<td>Shape from shading</td>
<td>Occlusion, shadows</td>
<td>Surrounding flash</td>
</tr>
<tr>
<td>Acquired</td>
<td>Perspective</td>
<td>Including object of known size</td>
<td>Rear-view</td>
</tr>
<tr>
<td>Formalized</td>
<td>Cartographic grids</td>
<td>Backdrops</td>
<td>Orthographic projections</td>
</tr>
<tr>
<td>Constructed</td>
<td>Transparency to indicate scale</td>
<td>Frame to establish spatial alphabet</td>
<td>Difference bitmap images</td>
</tr>
</tbody>
</table>

### Pre-attentive processing

```
2358945739756860796752453512346534624356245762457245
613452352352352352352352351345324716498762987460329587
2358276533637872138764298769876364098721696532962413
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2649872165971523972356987129721653978216409871246478
346721898763945089764398217346946496439276430987263
4287469864987597152397123976490871469876498724369812
7346987461435895321456865437
```

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C. Ware

*Information Visualization: Perception for design*
Pre-attentive processing

These show typical results

<table>
<thead>
<tr>
<th>Number of distracters</th>
<th>Response time (milliseconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>250</td>
<td>750</td>
</tr>
<tr>
<td>500</td>
<td>91  263</td>
</tr>
</tbody>
</table>

C. Ware
Information Visualization: Perception for design

Integrated Pre-attentive Viewing Cue

- **Example: Shape from shading**
  - A pre-attentive ability is a perceptual skill that does not require conscious processing
Sparse representations

Unfamiliar Representations
Shape from shading

Augmented Pre-attentive Viewing Cue

- **Example: occlusion**
  - Occlusion provides information about 3D shape

Cowperthwaite and Carpendale,
Accompanying Pre-attentive

- Example: surrounding flash

Notice This
Integrated Acquired Viewing Cues

- An acquired skill is one that has been learned so well that it is processed almost as fast a pre-attentive ability
- **Example: perspective**
Integrated Acquired Viewing Cues

- An acquired skill is one that has been learned so well that it is processed almost as fast as a pre-attentive ability
- **Example: perspective**

![Perspective example](image)

Perspective can be very convincing

Augmented Acquired Viewing Cues

- **Example:** including object of known size

Interior of St Bavo's Church
P. J. Saenredam
courtesy of: National Gallery of Scotland, Edinburgh

Accompanying Acquired Viewing Cues

- **Example:** sideview mirror
Integrated formalized viewing cues

- **Example: the cartographic grid**

J. Bertin, *Semiology of Graphics*
Augmented formalized viewing cues

- **Example: backdrops**

Images: Andreas Raab and Thomas Strothotte,

accompanying formalized viewing cues

- **Example: orthographic projections**
Accompanying formalized viewing cues

- **Example:** orthographic projections

Integrated constructed viewing cues

- **Example:** transparency to indicate scale

Image: Andreas Raab and Thomas Strothotte,
Augmented constructed viewing cues

• Example: using ‘halos’ to reveal flow lines (V. Interrante)

Images: Victoria Interrante

Augmented constructed viewing cues

• Example: using ‘halos’ to reveal flow lines

Image: Victoria Interrante
Augmented constructed viewing cues

- **Example: using ‘halos’ to reveal flow lines**

![Image: Victoria Interrante](image1.jpg)

Accompanying constructed viewing cues

- **Example: difference bitmap images**

![Images: Thomas Strothotte, University of Magdeburg](image2.jpg)