Scientific and Graphic Design Foundations for C2

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Introduction

• Lots to cover in a little time
  – Graphic Design
  – Psychology
  – Our approach
• Will only hit the major points
• We are expanding the paper into a web-based document for ease of use
Graphic Design

• Layout
  – Literally the aesthetic of the display design

• Typography
  – Serif versus sans serif
  – Font sizes
    • Note display type is an issue
      – Small versus large screen
    • Note viewing angle
  – Also note display medium
    • Paper has great resolution!
• Color

– Associations

<table>
<thead>
<tr>
<th>Color</th>
<th>Associated meanings</th>
<th>Color</th>
<th>Associated meanings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Stop, fire, hot, danger</td>
<td>Blue</td>
<td>Cold, water, calm, sky, neutrality</td>
</tr>
<tr>
<td>Yellow</td>
<td>Caution, slow</td>
<td>White</td>
<td>Neutrality</td>
</tr>
<tr>
<td>Green</td>
<td>Go, OK, clear, vegetation,</td>
<td>Grey</td>
<td>Neutrality</td>
</tr>
<tr>
<td></td>
<td>safe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

– Consistency and redundancy
Graphic Design

- Data graphics
  - Data-ink ratio (Tufte, 1983)

- Small multiples (Baker & Bushell, 1995)

![Data graphics examples](image_url)
### Visual Perception

#### Perceptual organization

<table>
<thead>
<tr>
<th>Gestalt Principle</th>
<th>Example Figure</th>
<th>Verbal Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Law of Simplicity</td>
<td></td>
<td>Every object is perceived in a way that the resulting structure is as simple as possible.</td>
</tr>
<tr>
<td>Law of Closure</td>
<td><img src="example.png" alt="Closure" /></td>
<td>Tendency to close gaps and complete unfinished objects.</td>
</tr>
<tr>
<td>Law of Similarity</td>
<td><img src="example.png" alt="Similarity" /></td>
<td>Elements which look similar (example, size, color, orientation, velocity and shape) are perceptually grouped together as a object.</td>
</tr>
<tr>
<td>Law of Good Continuity</td>
<td><img src="example.png" alt="Continuity" /></td>
<td>Elements that are smooth and continuous are perceptually grouped together than ones that contain abrupt changes in direction.</td>
</tr>
<tr>
<td>Law of Connectedness</td>
<td><img src="example.png" alt="Connectedness" /></td>
<td>Elements that are physically connected are perceptually grouped together as a object.</td>
</tr>
<tr>
<td>Law of Proximity</td>
<td><img src="example.png" alt="Proximity" /></td>
<td>Elements that are close together are perceptually grouped together as a object.</td>
</tr>
<tr>
<td>Law of Common Fate/Common orientation</td>
<td><img src="example.png" alt="Fate/Orientation" /></td>
<td>Elements with the same moving direction or orientation are perceptually grouped together as a object.</td>
</tr>
<tr>
<td>Law of Balance/Symmetry</td>
<td><img src="example.png" alt="Balance/Symmetry" /></td>
<td>Elements in symmetrical alignment are perceptually grouped together as a object.</td>
</tr>
<tr>
<td>Law of Common Region</td>
<td><img src="example.png" alt="Common Region" /></td>
<td>Elements tend to be group if they are located within a common region. The closed contour tends to be perceived as the boundary of the object.</td>
</tr>
</tbody>
</table>
Visual Perception

• Pre-attentive processing
  – Certain information “pops” out
  – Other information cannot be “ignored”

• Two examples
  – Stroop
  – Visual Search
• Stroop task (say the color as quickly as possible)
  – Humans can’t not read the color name

RED   RED
Visual Perception

- Find the vertical bar
**Visual Perception**

- Find the diagonal bar
Visual Perception

• Theories of visual attention
  – Space-based – attention distributed over space irrespective of objects
    • “Spotlight” theories of attention
  – Object-based - attention distributed based on objects (e.g., Gestalt laws)
    • Resource allocation theories of attention
  – Both (see Logan, 1996)
Visual Perception

• Theories of visual attention cues
  – Exogenous – automatic response to visual cue

B
G
C
F
M

P
X
R

B
G
C
F
M

P
X
R

*
Visual Perception

- Theories of visual attention cues
  - Endogenous – under voluntary control
Visual Perception

• 3D and depth perception
  – Monocular versus binocular

• Do we need 3D
  – What is true 3D
  – When is it useful?
• Memory and displays?
  – Sensory memory
    • Sperling experiments
  – Short term memory
    • Miller’s magic number
  – Long term memory
    • Declarative versus procedural
  – Prospective memory
    • Remembering to remember
• How do we evaluate graphical displays we create?
  – What are the types of experiments?
  – What questions can be asked?
    • e.g., Situation awareness, memory question, or questions about the IVS
• Examples of visual information fall under low and high level visual tasks
• Low level visual tasks - Wehrend and Lewis (1990)
  – Locate
  – Identify
  – Distinguish
  – Categorize
  – Cluster
  – Distribution
  – Rank
  – Compare within entities
  – Compare between relations
  – Associate
  – Correlate
• High level visual tasks - Zhou and Feiner’s (1998)

<table>
<thead>
<tr>
<th>Visual Implication</th>
<th>Type</th>
<th>Subtype</th>
<th>Elemental tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization</strong></td>
<td>Visual grouping</td>
<td><em>Proximity</em></td>
<td>Associate, cluster, locate</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Similarity</em></td>
<td>Categorize, cluster, distinguish</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Continuity</em></td>
<td>Associate, locate, reveal</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Closure</em></td>
<td>Cluster, locate, outline</td>
</tr>
<tr>
<td></td>
<td>Visual attention</td>
<td></td>
<td>Cluster, distinguish, emphasize, locate</td>
</tr>
<tr>
<td></td>
<td>Visual sequence</td>
<td></td>
<td>Emphasize, identify, rank</td>
</tr>
<tr>
<td></td>
<td>Visual composition</td>
<td></td>
<td>Associate, correlate, identify, reveal</td>
</tr>
<tr>
<td><strong>Signalling</strong></td>
<td>Structuring</td>
<td></td>
<td>Tabulate, plot, structure, trace, map</td>
</tr>
<tr>
<td></td>
<td>Encoding</td>
<td></td>
<td>Label, symbolize, portray, quantify</td>
</tr>
<tr>
<td><strong>Transformation</strong></td>
<td>Modification</td>
<td></td>
<td>Emphasize, generalize, reveal</td>
</tr>
<tr>
<td></td>
<td>Transition</td>
<td></td>
<td>Switch</td>
</tr>
</tbody>
</table>
How to Apply to C2 Information Displays

• Don’t apply en masse – use as needed

• What if one is building from the ground up?
  – Not done perfectly (we all have biases)
  – Can test by component parts first
  – Interdisciplinary background teams essential

• So how does one test the “final product”
  – Again test components first
  – Test in small settings before large
  – Keep abreast of testing research and theories
It's QUESTION TIME!!

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