Exploiting the Power of the Human Visual System

Maureen Stone, StoneSoup Consulting
Jock Mackinlay, Tableau Software

Components of the visual system

Eye
- Cornea
- Iris
- Retina
- Choroid
- Nerve fiber layer
- Ganglion cell layer
- Temporal
- Nasal

Brain

Eye

Brain

Information processing system

This is not a camera

Experiment from Daniel Simons and the VisCog Lab at the University of Illinois

Illustration from Colin Ware Visual Thinking for Design

From the Texas School for the Blind and Visually Impaired

Workmen (also actors) arrive with door. The two must step apart to let out of the way. Original actor with map creeps away.
Can only see what you attend to

"Change blindness" demos

From Ron Rensink, University of British Columbia (Quicktime Demos)

You have to look to see

Eyes move continuously, directed by task and attention (saccades)

Pattern of eye motions when asked to identify the age of the people in the painting "An Unexpected Visitor," by I. E. Repin. From Yarbus, 1967

Image from the University of Wisconsin Eye Research Institute

Visual processing is bi-directional

Bottom-up: build patterns
Top-down: directs and reinforces

From Colin Ware Visual Thinking for Design
Accountants use pop-out

Exploit more than pop-out

Depends on your task

Designed to work with the visual system
Light focuses on the retina

Light

Inside the eye: Mayo Clinic

Retinal cells respond to light

From Medscape.com

Two visual systems: Where and What

<table>
<thead>
<tr>
<th>Where System</th>
<th>What System</th>
</tr>
</thead>
<tbody>
<tr>
<td>motion perception</td>
<td>object recognition</td>
</tr>
<tr>
<td>depth perception</td>
<td>face recognition</td>
</tr>
<tr>
<td>spatial organization</td>
<td>color perception</td>
</tr>
<tr>
<td>figure/ground segregation</td>
<td></td>
</tr>
<tr>
<td>colorblind</td>
<td>color selective</td>
</tr>
<tr>
<td>fast</td>
<td>slow</td>
</tr>
<tr>
<td>low acuity</td>
<td>high acuity</td>
</tr>
<tr>
<td>high contrast sensitivity</td>
<td>low contrast sensitivity</td>
</tr>
</tbody>
</table>

From Vision and the Art of Seeing by Margaret Livingstone

Color and luminance

Hue & chroma

Luminance

How do we fix this?

Get it right in black & white

Maps courtesy of the National Park Service (www.nps.gov)
Contrast hierarchy creates layers

Wrong

Urgent
Context
Normal
Context
Normal

Right

Urgent
Context
Normal
Context
Normal

From Larry Arend: colorusage.arc.nasa.gov

Rules for managing attention

silent
whisper
indoor voice
shout

An ongoing process

Monitor Data in Analytical Dashboards

Potential Problems by Product

Volume and Uptake by City
Map for symbols vs. map for navigation

Tableau data maps

Control size and transparency
If you can’t use color wisely, it is best to avoid it entirely. Above all, do no harm.

“Color is the most relative medium in art.”
—Josef Albers, Interaction of Color

Visual perception is not just camera work.

Square A is darker than B, right? From Stephen Few
Exploiting the Power of the Human Visual System

**Visual perception is not just camera work**

From Stephen Few

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**Bezold Effect**

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**Spreading: Adjacent colors blend**

From Brian Wandell, *Foundations of Vision*

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**Tufte’s Fundamental Uses**

To label
- Primarily hue variation
- Associated with color names

To measure
- Vary lightness & chroma
- Map to data distribution

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**Fundamental Uses**

To evoke nature
- Metaphor, symbolic
- Illustration: distilled experience

To decorate, beautify
- Emotional design
- Visceral & reflective

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**Color as label: identify**

Created by Tableau - Visual Analysis for Databases™
Define groups

Contrast creates emphasis

Colors are named

Eleven basic names in English:
Red, green, blue, yellow, black, white, gray, orange, purple, brown, pink

Categorical colors

Tell your story
Different colorings tell different stories

Categorical, but different styles

Suggests an ordered relationship

Emphasize

Not everyone has the same color vision

Vision is information processing

Features Patterns Objects
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July 21, 2009

Resources

Colin Ware
- Visual Thinking for Design. Morgan Kaufmann

Margaret Livingstone
- Vision and Art, the Biology of Seeing. HNA Press

Edward Tufte
- Envisioning Information. Graphics Press

Stephen Few
- Now you see it. Analytics Press

Maureen Stone
- A Field Guide to Digital Color. AK Peters

Jock Mackinlay
- Information Visualization: Using Vision to Think. Morgan Kaufmann
  co-authors: Stuart Card, Ben Shneiderman