Methods for Design, Prototyping, and Evaluating User Interaction

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Models

Models

Models describe phenomena, isolating components and allowing a closer look

- Capture Essential Pieces
  - Model should have what it needs, but no more.
  - Avoid underfitting or overfitting
- Allow us to measure
  - Collect data, put in model, compare model terms
- Allow us to predict
  - The better the model, the better the predictions

Creating Models

One approach:

1. Observe
2. Collect data
3. Find patterns
4. Draw analogies
5. Devise model
6. Test fit to data
7. Test predictions
8. Revise

Fundamentally an inductive process

From specific observations to broader generalizations

Models of Human Performance

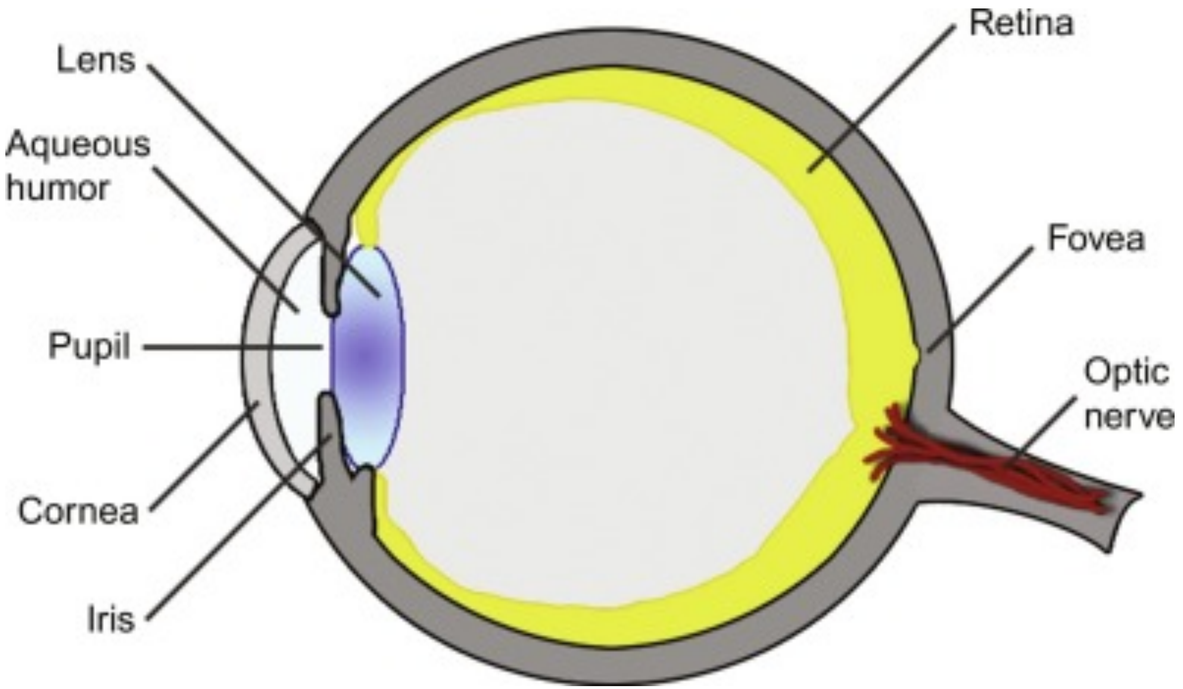
Model of Human Performance	Type of Model
Visual System	Biological Model
Model of Human Processor	Higher-level model
Fitt’s Law	Model by analogy
Gestalt Principles	Prediction interpretation

Visual System

Biological Model

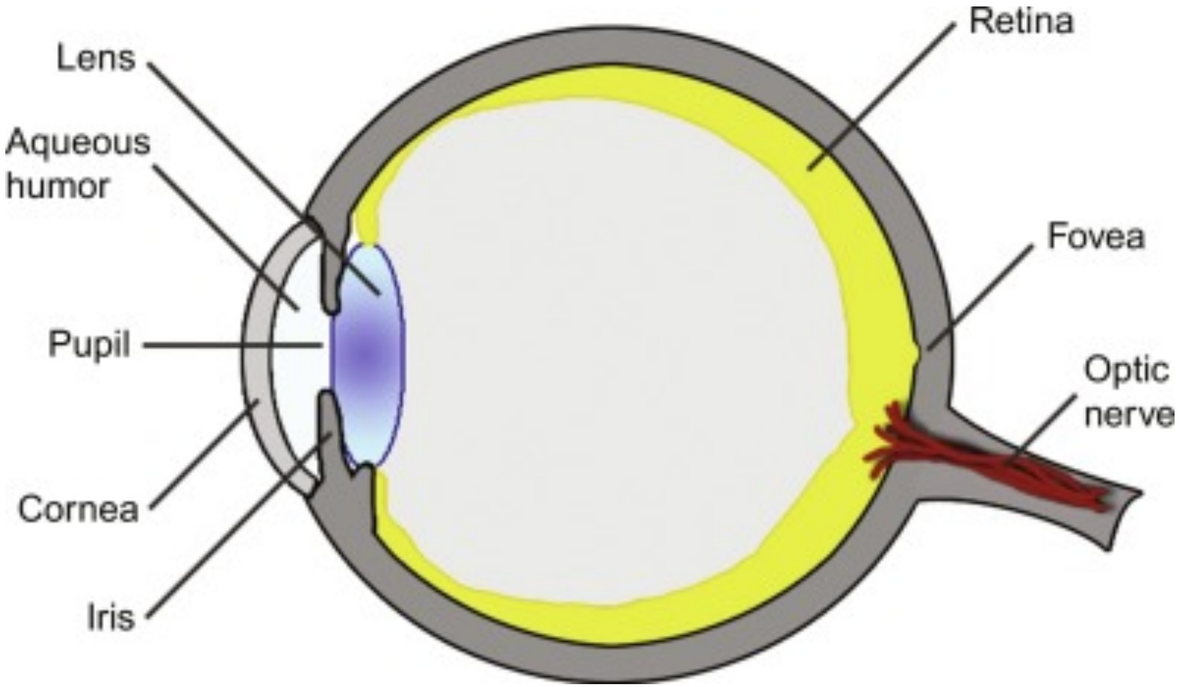
Human Visual System

Light passes through lens, focused on retina, goes to the brain where it gets processed.



Human Visual System

If the light is captured by the retina, and optic nerves have to pass through it, shouldn't we have a blind spot?

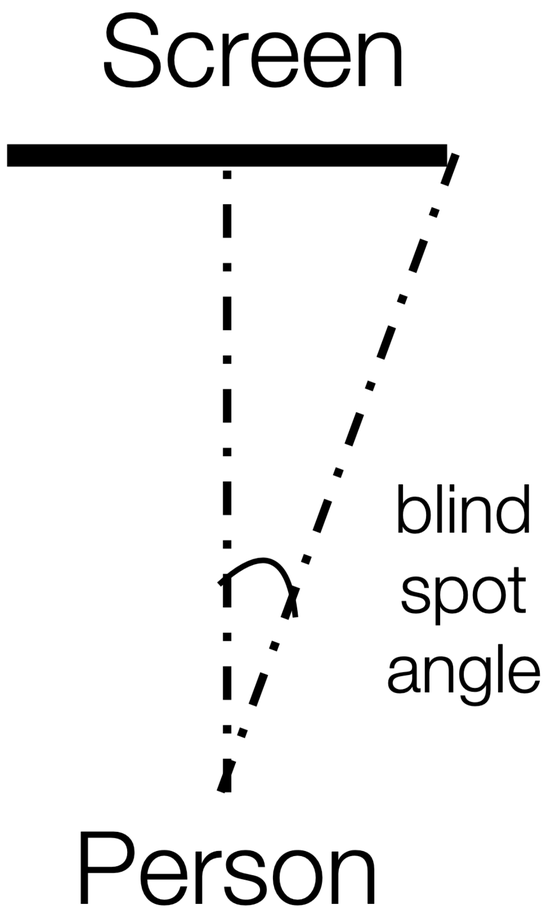


Human Visual System

1. Close your right eye
2. Using your left eye read each number 0 through 9
3. The star on the left should disappear at some point

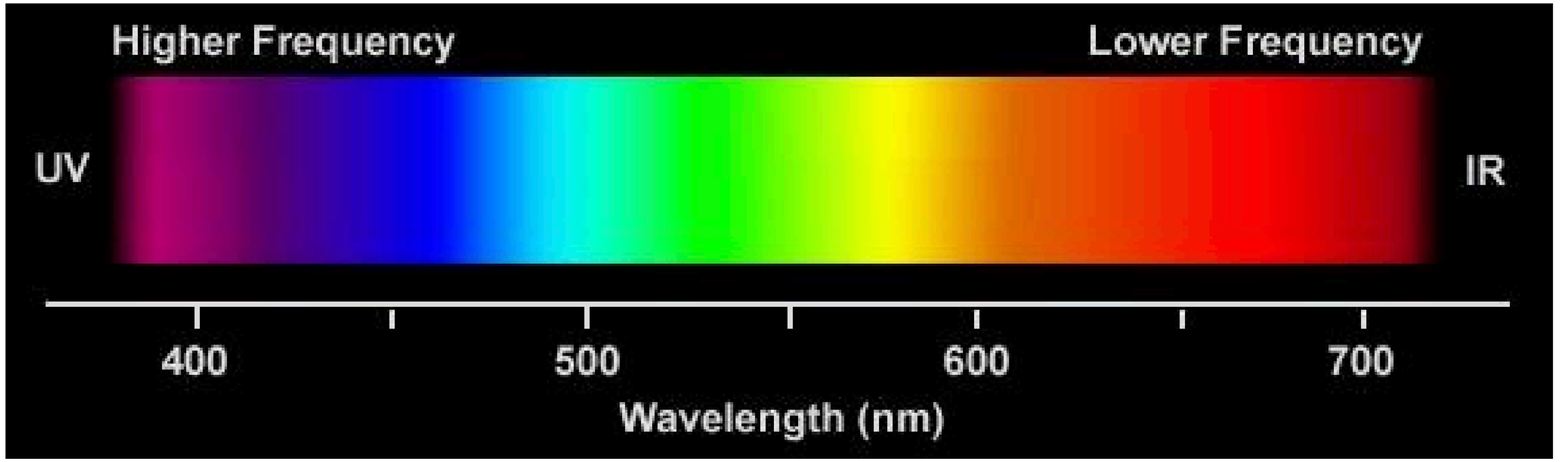
0 1 2 3 4 5 6 7 8 9

Human Visual System



Human Visual System

Visible Spectrum



Human Visual System

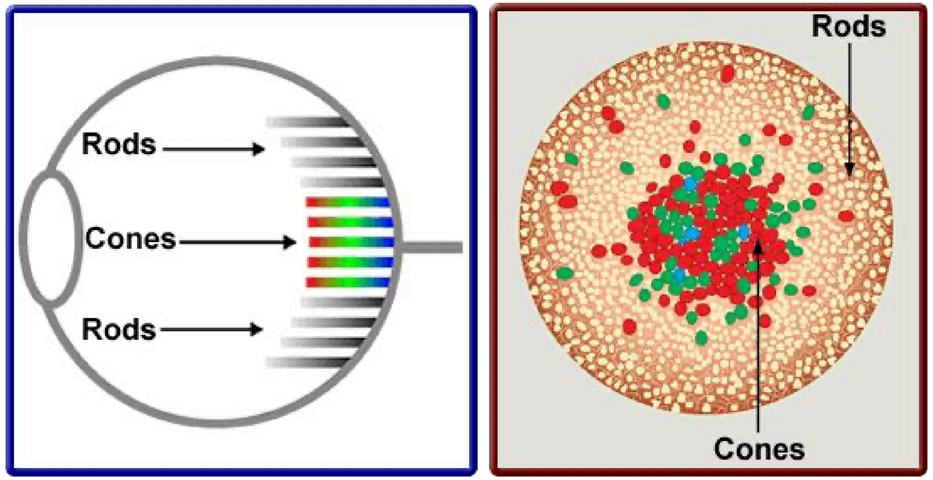
Retina

- Covered with light-sensitive receptors
  - Rods (120 million)
    - Sensitive to broad spectrum of light
    - Sensitive to small amounts of light
    - Cannot discriminate between colors
    - Sense intensity or shades of gray
    - Primarily for night vision & perceiving movement
  - Cones (6 million)
    - Used to sense color

Human Visual System

Retina

- Center of retina has most of the cones
  - Allows for high acuity of objects focused at center
- Edge of retina is dominated by rods
  - Allows detecting motion of threats in periphery



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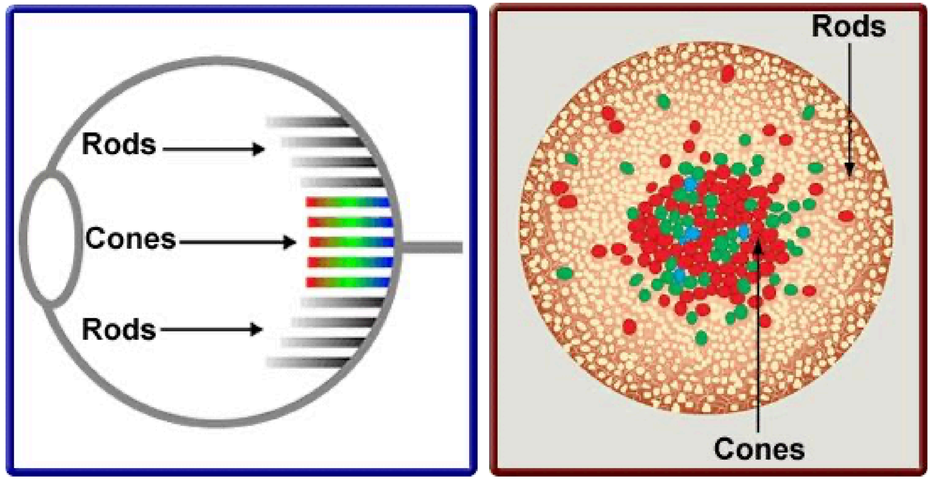
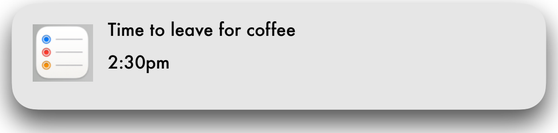


What does that mean for you?

Human Visual System



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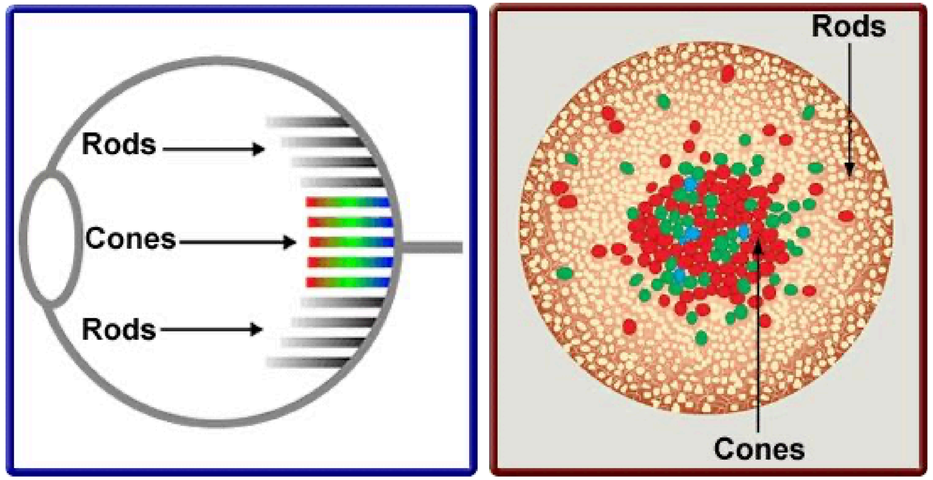

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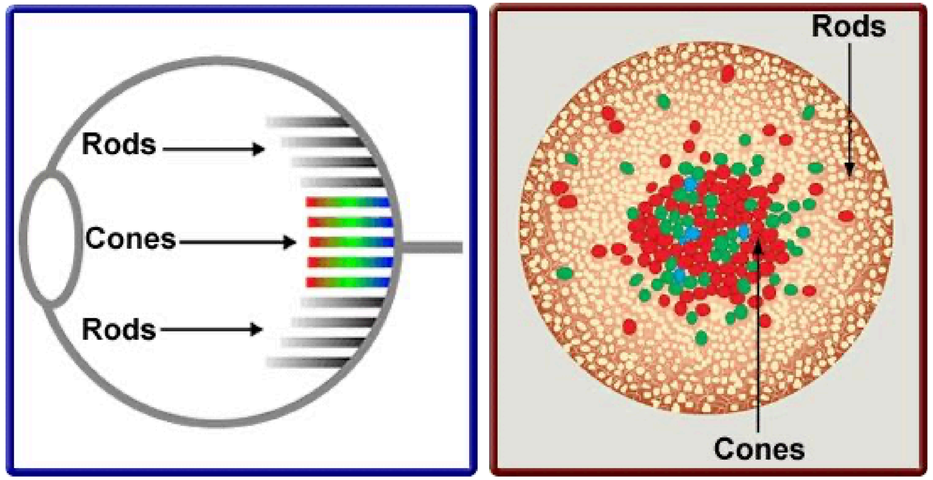


What does that mean for you?

Peripheral movement is easily distracting

Human Visual System

Color Perception via Cones

- Photopigments used to sense color
  - 3 types: blue, green, “red” (actually yellow)
- Each sensitive to different band of spectrum
- Ratio of neural activity stimulation for the three types gives us a continuous perception of color

Human Visual System

Distribution of Photopigments

- Not distributed evenly
  - Mainly reds (64%), Very few blues (4%)
  - Insensitivity to short wavelengths (e.g., blue)
  - Highly sensitive to long wavelengths (e.g., orange and yellow)
- No blue cones in retina center (high acuity)
  - Fixation on small blue object yields “disappearance”
- Lens yellows with age, absorbs short wavelengths
  - Sensitivity to blue is reduced even further
    - (Don’t rely on blue for text and small objects!)

Human Visual System

Color Sensitivity & Image Detection

- Most sensitive to center of spectrum
  - To be perceived as the same, blues and reds must be brighter than greens and yellows
- Brightness determined mainly by red and green
  - Y = 0.3 Red + 0.59 Green + 0.11 Blue (To calculate grayscales and balance colors!)
- Shapes detected by finding edges
  - We use brightness and color difference
- Implication
  - Blue edges and shapes are hard to detect

Human Visual System

Focus

- Different wavelengths of light focused at different distances behind eye's lens
  - Constant refocusing causes fatigue
- Saturated colors (i.e., pure colors) require more focusing than desaturated (i.e., pastels)

This is why it hurts to read this message!

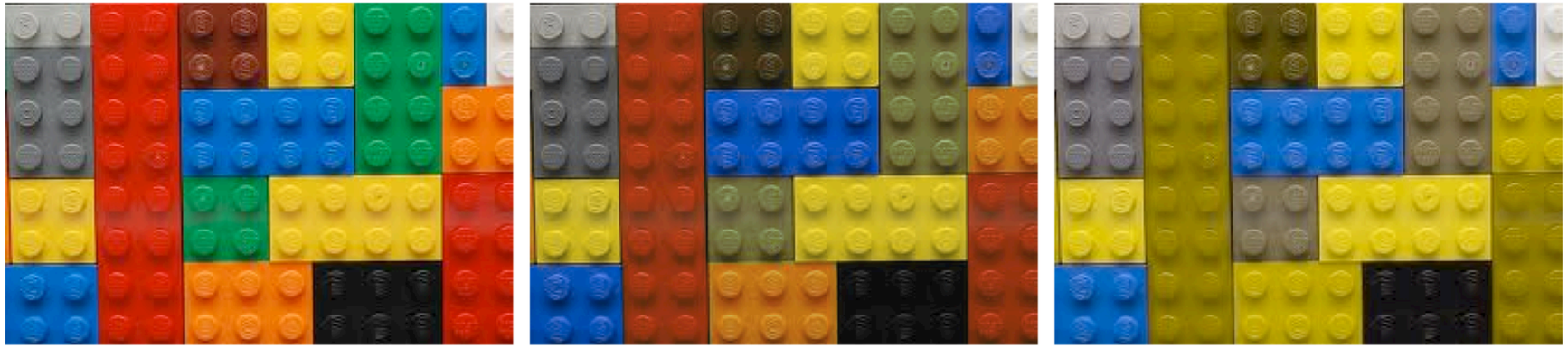
Human Visual System

Color Vision Deficiency

- Trouble discriminating colors
  - Affects about 9% of population
- Two main types
  - Different photopigment response most common
    - Reduces capability to discern small color differences
  - Red-Green deficiency is best known (color blindness)
    - Cannot discriminate colors dependent on red and green

Human Visual System

Living with Color Vision Deficiencies



David R. Flatla and Carl Gutwin. 2012. "So that's what you see": building understanding with personalized simulations of colour vision deficiency. In Proceedings of the 14th international ACM SIGACCESS conference on Computers and accessibility (ASSETS '12). Association for Computing Machinery, New York, NY, USA, 167–174.

Human Visual System

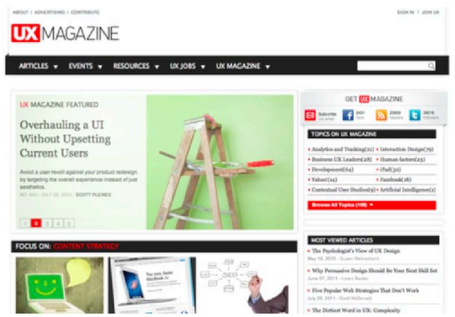
Color Vision Deficiency

- 52% of the population is unable to differentiate 10% of the colors in an average website or infographic.
- 10% of the population is unable to differentiate 60% of the colors in an average website.

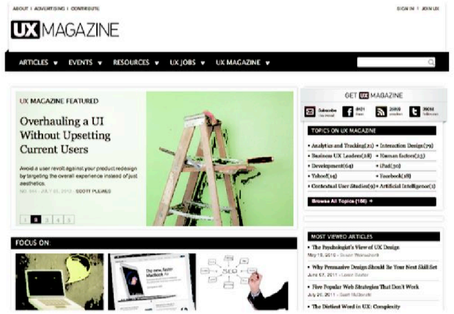
David R. Flatla and Carl Gutwin. 2012. "So that's what you see": building understanding with personalized simulations of colour vision deficiency. In Proceedings of the 14th international ACM SIGACCESS conference on Computers and accessibility (ASSETS '12). Association for Computing Machinery, New York, NY, USA, 167–174.

Human Visual System

So what do they see?



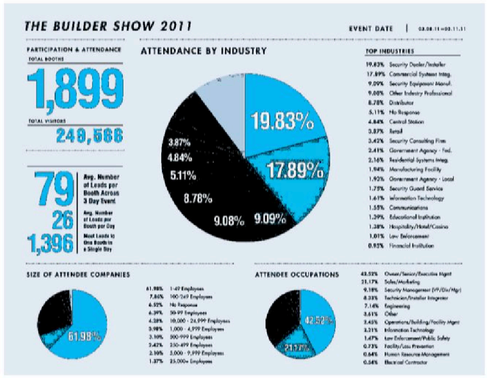
(a) Original website



(b) Colors pairs that are not differentiable by 20% of the population have been set to black.

(c) Colors pairs that are not differentiable by 10% of the population have been set to black.

(d) Original infographic



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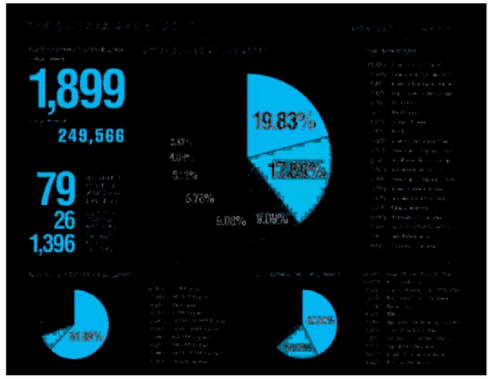
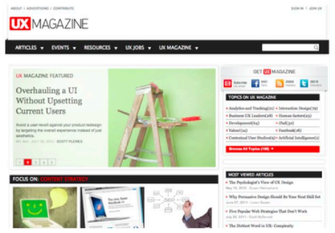


(f) Colors pairs that are not differentiable by 10% of the population have been set to black.

Human Visual System

Color Vision Deficiency

- Usability issues
  - can’t perceive color-coded cues in an interface
- Obstacles in information uptake
  - e.g., if color-coded charts hinders data interpretation
- Reduction of perceived appeal
  - e.g., if an image is perceived with a different color palette than intended



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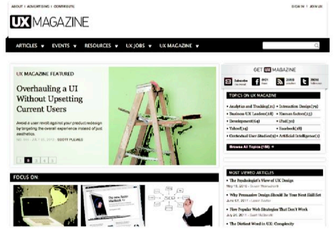

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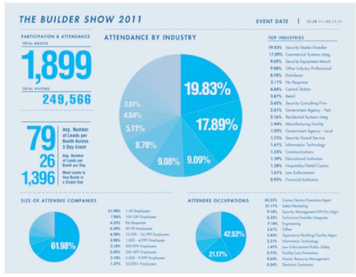

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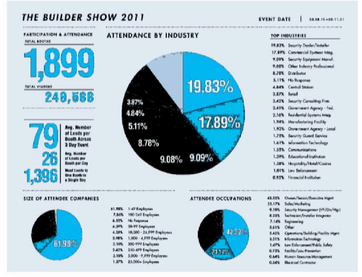

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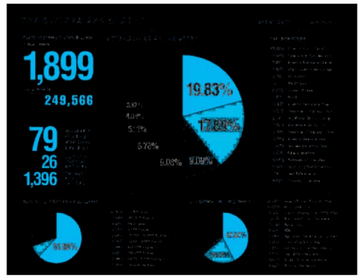

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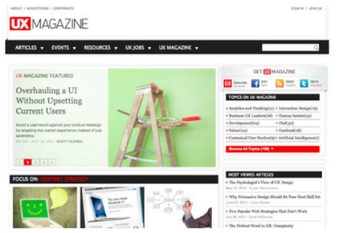
What can we do about it?



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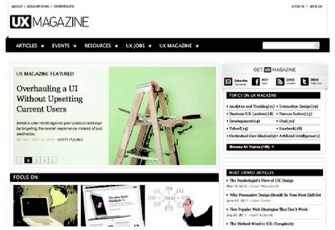

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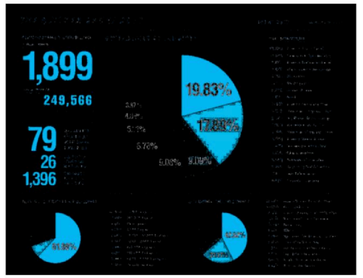

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Human Visual System

Dual / Redundant Encoding

Multiple Sensory Channels:
Information is presented in different formats (e.g., text, audio, haptic feedback) to accommodate users with varying abilities, such as those with visual or hearing impairments.

Human Visual System

Dual / Redundant Encoding

Color-Independent Design:
Important cues are not solely reliant on color (e.g., using symbols, patterns, or text alongside colors) to support users with color blindness.

Human Visual System

Dual / Redundant Encoding

Alternative Text & Captions:
Redundant encoding ensures that images, icons, and audio content have text descriptions, closed captions, or transcripts for screen readers and deaf users.

Human Visual System

Dual / Redundant Encoding

Tactile & Auditory Feedback:
Haptic (vibration) or sound cues reinforce visual elements for users with low vision or those in situations where looking at the screen is difficult.

Human Visual System

Dual / Redundant Encoding

Clear & Consistent Redundancy:
Key information is conveyed in multiple ways without causing cognitive overload (e.g., using both icons and labels for navigation buttons).

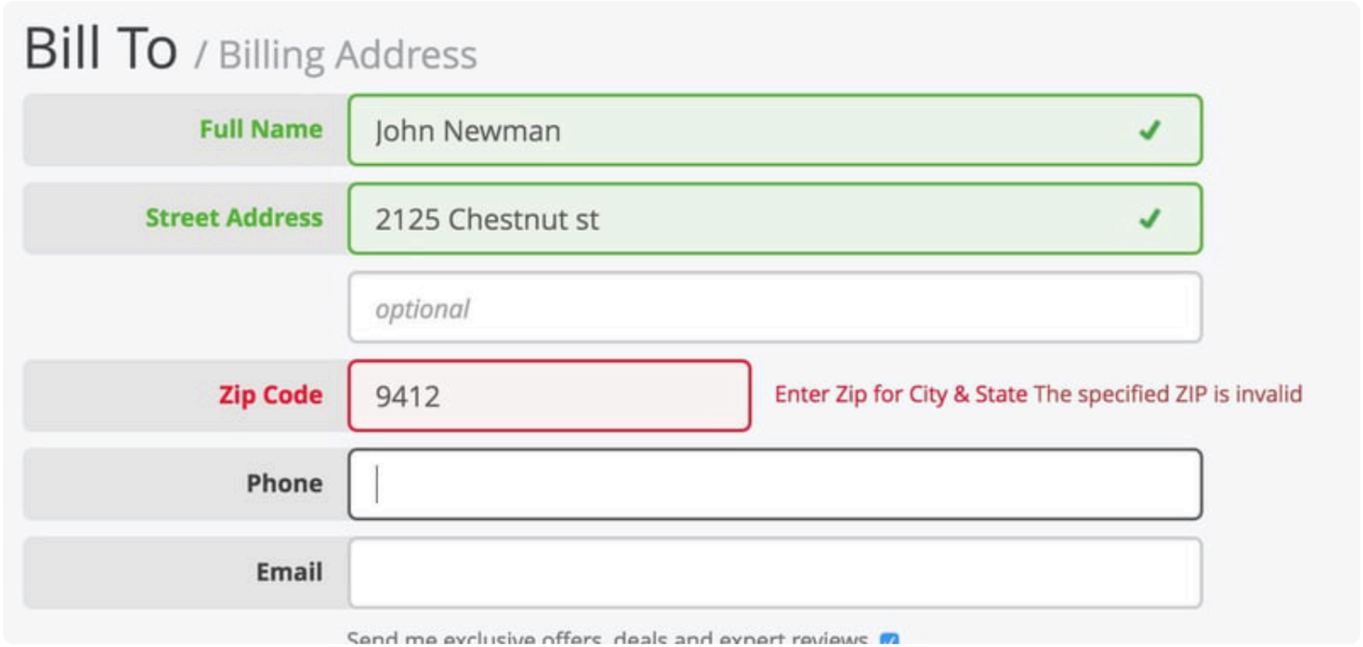
Human Visual System

Dual / Redundant Encoding

Customizable Redundant Inputs:
Users can adjust how information is encoded based on their needs (e.g., enabling spoken feedback, enlarging text, or using high-contrast mode).

Human Visual System

Dual / Redundant Encoding



Human Visual System

Dual / Redundant Encoding

Loracana Deck

Model of Human Processor

Fitt’s Law

Gestalt Principles

Any questions?