Pere-Pau Vázquez - UPC

Interacció i Disseny d'Interfícies

Colour

Colour

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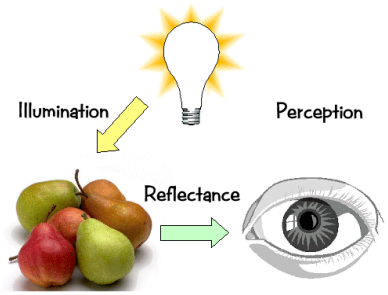
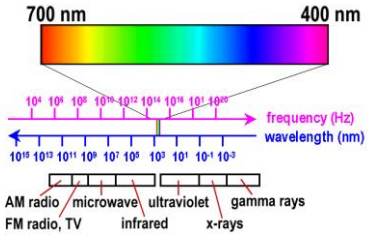
  - Design with Colour

Colour



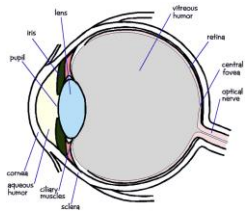
Colour

- Visible light: electromagnetic energy having wavelengths in the range 400-700 nm



Colour

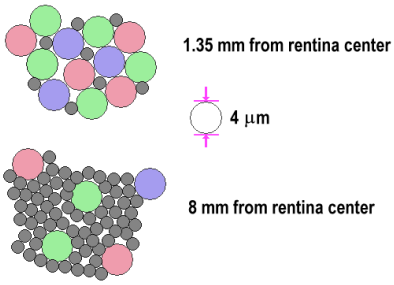
- **The photosensitive part of the eye is called the retina.**
- **Two types of cells:**
  - **Rods and cones**
  - **Cones are responsible for colour perception.**



Colour

- Cones are most densely packed within a region of the eye called the fovea.
- There are three types of cones: S, M, and L.
  - Roughly equivalent to blue, green, and red sensors, respectively.
  - Their peak sensitivities are located at approximately 430nm, 560nm, and 610nm for the "average" observer.

Colour

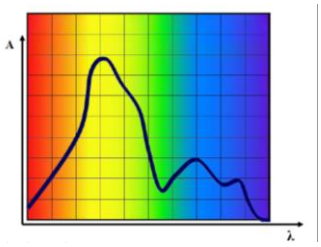


Colour

- **Colour Perception**
  - Different spectra can result in a perceptually identical sensations called metamers
  - Colour perception results from the simultaneous stimulation of 3 cone types (trichromat)
  - Our perception of colour is also affected by surround effects and adaptation

Colour

- A certain colour will be represented by a certain signal

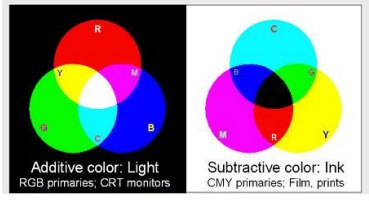


Colour

- Colour representations
  - **Additive colour:** Reproduce the red, green and blue parts of the image by adding together red, green and blue lights, starting with darkness
  - **Subtractive colour:** Filter the red, green and blue components of the image from white light.
    - Use coloured filters that in theory modulate only the red, green and blue components of the spectrum

Colour

- Additive versus subtractive colour representations

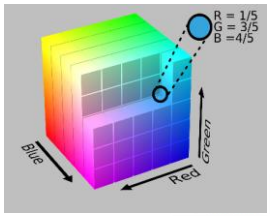


Colour Models

- Colour models
  - RGB
  - CMY(K)
  - HSV
  - CIE
  - Other CIE Lab, HSL, …

Colour Models

- RGB: Colours are represented by varying intensities of red, green, and blue light.
  - Intensity of the components on a scale [0..255]
    - 0 no light emitted
    - 255 maximum intensity



Colour Models

- CMY(K): Subtractive colour model used in colour printing.
  - Known as "four-colour process" or simply "process" colour.
  - All of the colours in the printable portion of the colour spectrum can be achieved by overlapping "tints" of cyan, magenta, yellow and black inks.
  - Combining cyan, magenta and yellow should form black
    - Because of the impurities in ink it produces a muddy brown colour.
    - Black ink is added to this system to compensate for these impurities.

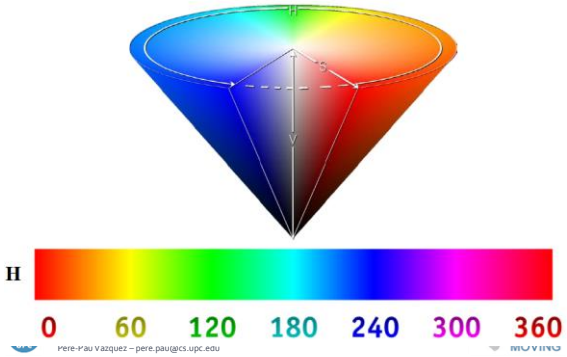
Colour Models

- CMYK:
  - Components quantities usually represented in percentages.

Colour Models

- HSV: encodes a colour using three components: Hue, Saturation, and Intensity (Value):
  - Hue: the actual colour of the object. It is an angle from 0 degrees to 360 degrees.
  - Saturation: measure of purity. Saturation indicates the range of grey in the colour space. It ranges from 0 (grey) to 100% (pure colour).
  - Intensity (value): how light the colour is.
    - The brightness of the colour
    - Varies with colour saturation.

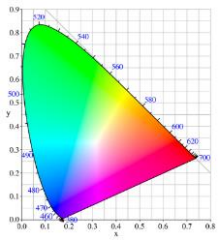
Colour Models

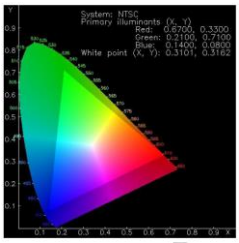


Colour Models

- CIE: Standardized a set of primaries and colour matching functions
  - Based on actual human response
  - The basis for most colour measurement instruments used today
  - Tristimulus values are notated X, Y and Z.
    - Often reduced to two dimensions by projecting them onto the X+Y+Z=1 plane

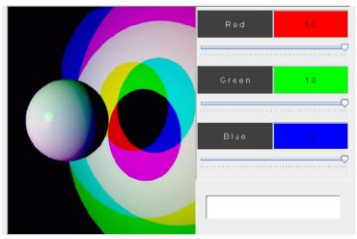
Colour Models





Colour Models

- CD contains applets for you to test



Converting between colour spaces

- RGB to CMY and CMYK
  - RGB to CMY
    C = 1-R;
    M = 1-G;
    Y = 1-B;
  - RGB to CMYK with a percentage *s* of black :
    K = min(1-R, 1-G, 1-B)*s/100;
    C = 1-R-K;
    M = 1-G-K;
    Y = 1-B-K;

Converting between colour spaces

- CMY and CMYK to RGB
  - From CMY to RGB:
    R = 1-C;
    G = 1-M;
    B = 1-Y;
  - CMYK to RGB:
    R := max(1-C-K,0);
    G := max(1-M-K,0);
    B := max(1-Y-K,0);

Design with Colour

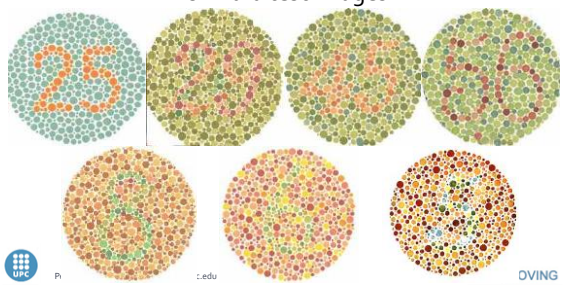
- Size and spatial frequency also important in perception
  - The higher the spatial frequency the lower the saturation
- Chromatic adaptation:
  - Illumination changes affect the colours dramatically
    - Human perception adapts to changes
      - Does not perceive those changes *linearly*

Design with Colour

- Colour blindness:
  - Inability to distinguish the colours the same way than non-colour impaired people
    - 5-10% of men
    - 1-2% of women
  - Relatively easy to detect
    - Ishihara tests

Design with Colour

Ishihara test images

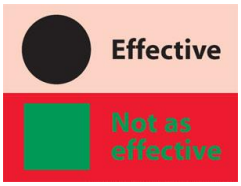


Design with Colour

- Colour friendly design:
  - Exaggerate lightness differences between foreground and background colours
  - Avoid using adjacent colours of similar lightness
  - Contrast dark colours against light colours
  - Content areas should be monochromatic with the font colour and background at the opposite ends of the colour saturation poles
  - Elements of navigation, headers and sub-headers, require some extra visual enhancement

Design with Colour

- Contrast dark colours against light colours

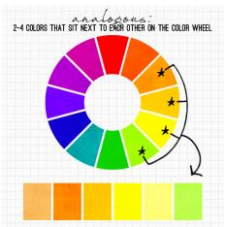


Design with Colour

- Use opposite colours

Design with Colour

- Analogous colours

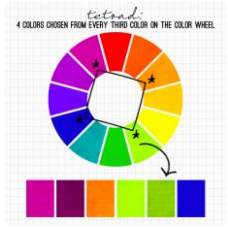


Design with Colour

- Triad relationship

Design with Colour

- Tetrad relationsip



Exercises

- **Un triangle de color verd s'envia a imprimir a una impressora CMY. El paper que hi ha és groc. De quin color es veurà pintat el triangle en el paper? Raona la resposta.**

Exercises

- **Donat el color (1.0, 0.0, 0.5) en CMY, doneu una expressió d'un color RGB de la mateixa tonalitat però menys brillant.**

Exercises

- **Es vol imprimir un dibuix de color RGB = (1,0.5,0.5), en un full blanc usant una impressora que utilitza tintes Cyan, Magenta i Yellow. Contesta i justifica les respostes:**
- **Quines tintes s'han d'usar i en quina quantitat per a obtenir aquest dibuix?**
- **Si la impressora s'ha quedat sense tinta magenta, i imprimeix igualment, de quin color quedarà imprès el dibuix?**

Professors d'IDI - UPC

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