Overview Lecture 3

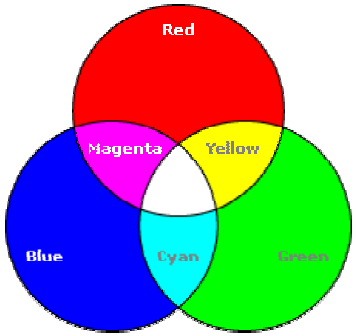
- Color Models
  - RGB
  - CIE
  - CMY(K)
  - HSV
- Colors in Design
  - Visual Communication
  - Color Perception

Primary Colors

- Dominant frequency
- Primary Colors
  - Combine two or more sources with different dominant frequency we can generate additional colors
  - The hues of the sources are callled primary colors.
  - Two primaries that produce white are called complemetary colors
  - No finite set of real primary colors can produce all visible colors
- Given a set of 3 colors a fourth can be produced

RGB Color model

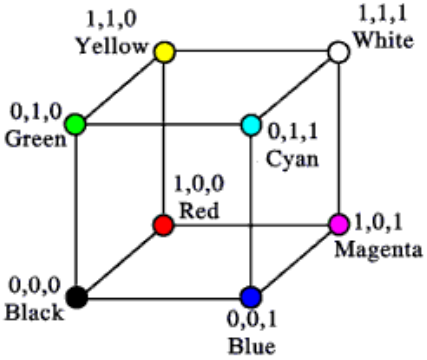
Red, Green and Blue primary colors



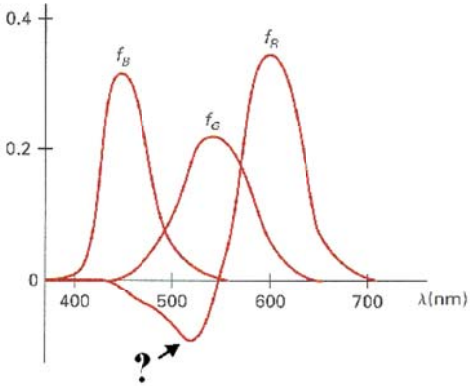
R	G	B	Color
1.0	1.0	1.0	Black
1.0	0.0	0.0	Red
1.0	1.0	0.0	Yellow
0.5	0.5	0.5	Grey
1.0	0.7	0.7	Pink

- Monitors

RGB Color Cube

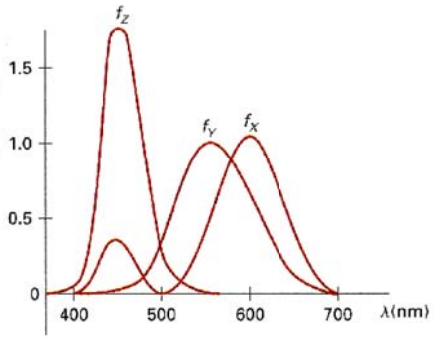


RGB Spectral Colors



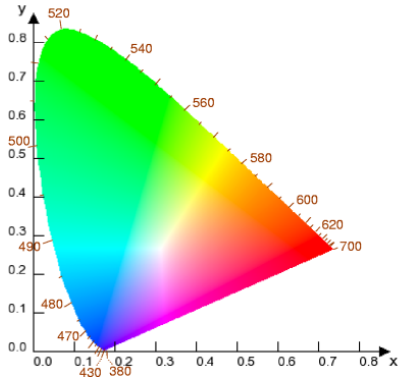
XYZ Color Model

- CIE Primaries
- Imaginmary Colors
- 1931 - Commission Internationale de l'Eclairage



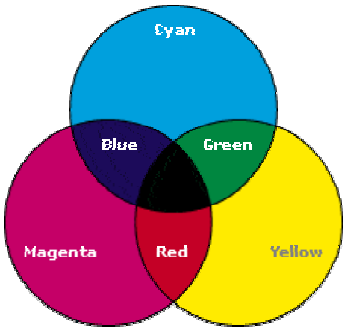
CIE Chromaticity Diagram

Normalized amounts of X and Y for colors in visible spectrum



CMY Color model

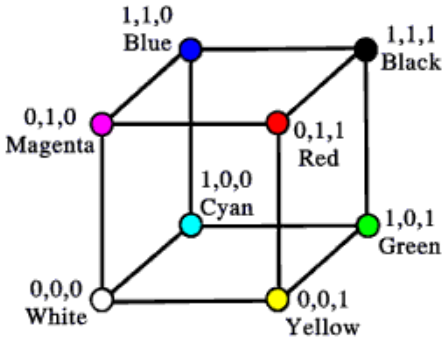
Cyan, Magenta and Yellow are primary colors



C	M	Y	Color
1.0	1.0	1.0	Black
0.0	1.0	1.0	Red
0.0	0.0	1.0	Yellow
0.5	0.5	0.5	Grey
0.0	0.3	0.3	Pink

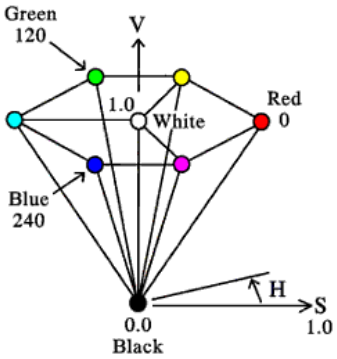
- Printing

CMY Color Cube



HSV Color Model

- Hue, Saturn, Value



H	S	V	Color
0°	0.0	0.0	Black
0°	1.0	1.0	Red
60°	1.0	1.0	Yellow
0°	0.0	0.5	Grey
0°	0.3	1.0	Pink

Design of Interactive Programs

- A smooth display, no flicker or any artifacts of the refresh process.
- A variety of interactive devices on the display.
- A variety of methods for entering and displaying information.
- An easy to use interface that does not require substantial effort to learn.
- Feedback to the user.
- Tolerance for user errors.
- A design incorporating consideration of both the visual and motor properties of the human.

Using Colors Effectively in Computer Graphics

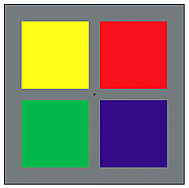
based on Lindsay W. MacDonald's article

- Color is a powerful and attractive aspect of our experience of the world.
- Color shapes our perception, interpretation and memory of everything we see.
- In computer graphics, careful use of colors helps to get the message across.

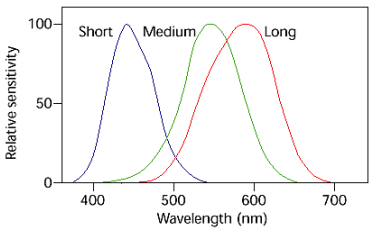
Visual Communication

- Colors used well can enhance the effectiveness of a message.
- Effective use of colors depends on:
  - human factors.
  - which context the audience views the display.
- No strict rules for the use of colors.

Color Vision

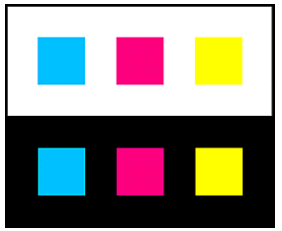


- Avoid using strong red and strong blue adjacent to each other.
- Avoid large areas of bright colors and high contrast in display.
- Never display fine detail using the blue channel alone.
- Don't use hue alone to encode information.

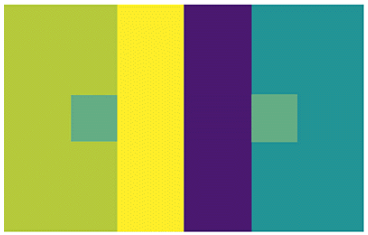


Color	Primaries	Relative luminance (percent)
White	R G B	100
Yellow	R G	90
Cyan	G B	70
Green	G	60
Magenta	R B	40
Red	R	30
Blue	B	10
Black	—	0

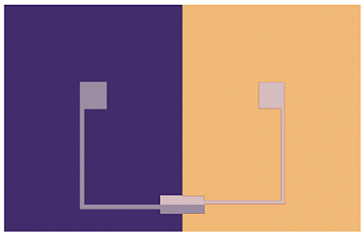
Color Perception



- Colors tend to look:
  - darker and smaller against white
  - lighter and larger against black.
- Surrounding colors can cause a colored region to look tinged.
  - enrich a display in art and design, BUT
  - can cause viewers to see differently than the designer intended.
- Memory.



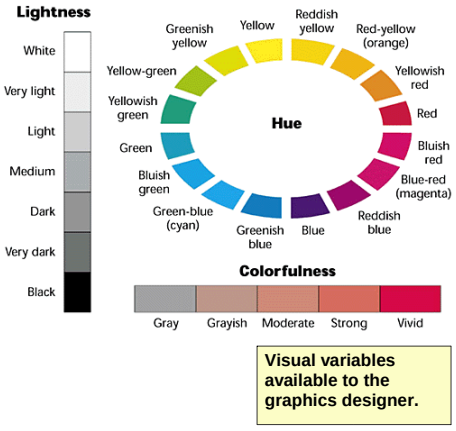
Same colors look different.



Different colors look the same.

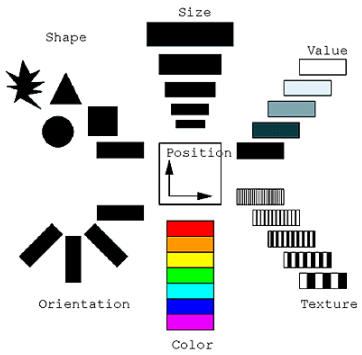
Design Principles

- Get it right in black and white, then add colors sparingly.
- Create harmony:
  - use a group of colors that look pleasing in combination.
    - vary hues in lightness and saturation.
    - the palette should contain contrast.
      - light and dark tones
      - pastel and saturated ones.
- Use a thematic color:
  - a season or geographical region.



Visual variables available to the graphics designer.

Simplified color naming system.



A little color can be more effective than a lot.

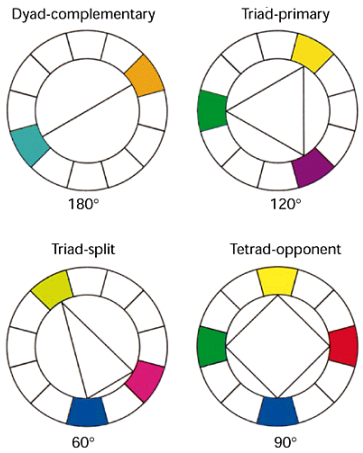
Color can draw attention to an element.

Color similarity can change meaning.

Color is one of the most effective visual attributes for **coding** information in displays and **is** capable, when used correctly, of achieving **powerful** and memorable effects.

Color	Positive Associations	Negative Associations
Red	Passion, strength, energy, heat, love	Blood, war, fire, danger, anger, aggression
Green	Nature, spring, fertility, safety, environment	Inexperience, decay, envy, misfortune
Yellow	Sun, summer, gold, harvest, optimism	Cowardice, treason, hazard, illness, folly
Blue	Sky, sea, stability, peace, unity, depth	Depression, obscenity, conservatism, passivity
White	Snow, purity, peace, cleanliness, innocence	Cold, clinical, surrender, sterility, death, banality
Gray	Intelligence, dignity, restraint, maturity	Shadow, concrete, drabness, boredom
Black	Coal, power, formality, depth, solidity, style	Fear, void, night, secrecy, evil, anonymity

Selection of hue harmonies.



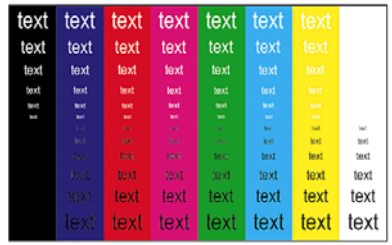
Graphics User Interface

- Create all components of a GUI in mono-chrome and then add color to enhance usability.
- Use strong color in small detail only, such as icons.
- Use a limited palette of colors and offer predefined harmonious combinations.

Text

- Luminance contrast between foreground and background should be a minimum of 3:1 and preferably at least 10:1.
- Highest contrast
  - black or blue on white or yellow and vice versa.
- Red, green and magenta more difficult to read.
- Avoid colored text on colored background where legibility is important.
- Text size 14pt

Effect of text color and size on legibility.



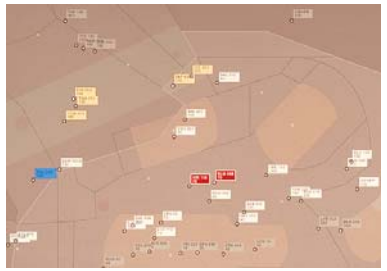
Effect of text and background color on legibility.

Information

- Nominal color coding:
  - unique color codes to different parts
    - not indicating differences in value
    - order or priority
    - limit to seven or fewer colors
- Ordinal color coding
  - graded sequence of colors to represent the value of one or more variables.
- Include a color key or scale.

Color coding creates a layering effect in this experimental air traffic control display.

Nominal color coding.



Visualization

- Don’t use color that doesn’t support or add to the meaning of the information displayed.
- Use colors that enable the user to interpret the meaning of the information displayed.
- In modeling applications, use only enough color to create a realistic effect.

Concluding Remarks

- Using colors effectively is complicated.
  - Many different factors influence how the color will be seen.
    - type of display device.
    - the viewing environment.
    - the visual capability of the user.
    - the task and application requirements.
    - position of other graphical windows and displays.
- There is no easy formula that will work in all circumstances.