

Color: Use in Design

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Visibility

Color in the interface should help users focus their attention on their work not draw attention to the interface itself.

Icons communicate where languages fail.

The improper use of color can seriously impair the user's ability to interact with the program.

The appearance of a particular color is not absolute. The same area of color generated by a particular set of values in the color look-up table (CLUT) will appear different to users depending on what other colors are adjacent to it in the display.

Allow users to change the colors, and to change default color codings that is used as default. This will maximize the readability of the applications under specific lighting and display conditions. Applications should be designed to utilize the user's preferred color scheme, to prevent problems that might arise when the user's color scheme is different from that of the developer.

Use color to:

- Discriminate between different areas (ex. active window from inactive)
- Show screen elements that are functionally related
- Show relationships among screen elements
- Identify crucial features
- Supplement other highlighting techniques. The information conveyed by color coding should also be presented in font, shapes, locations, patterns, position, highlighting, gray-scale or variations.

Be conservative in color coding.

- Use as few colors as possible (4 per screen, 7 for application)
- Make only gross distinctions between colors

Too much color can have the effect of making something more difficult, rather than easier to use. User studies indicate that users can only effectively follow four colors on a screen at once, and no more than seven over the entire application.

Highlight selected text or object by reversing the background with the bits.

- Black-and-white screens: White turns to black and black to white
- Color screens: Colors are darkened, not reversed.

People cannot easily distinguish colors in small areas. Having to add a label to point to a button is good indication that the button is not visible.

3-D text is more difficult to read.

Aesthetics

Colors look best against a background of neutral gray.

Harmony of color combinations: a person is likely to see balance in colors that are closely related or the opposite.

Avoid using the engineer or hardware model of color. Translate what you know into what your users expect.

Research:

- White or bright backgrounds are more likely to cause complaints from users
- Reading text on a dark background is rated as easier by users
- Flicker is more easily perceived with white backgrounds

Symbolism

Color can:

- Distinguish categories to make information clearer
- Add meaning

Avoid:

- Using color as a means of interpretation
- Ambiguity: don't use the same color to represent success and failure, for example

Use color redundantly code. Never use color as the sole carrier of information.

The meaning of a color is task dependent. The color blue in a figure does not mean the same thing medical application as it does in a map application.

Know the meanings of colors for the domain(s) that your application covers. Recommended colors for certain interface objects and colors to use for certain types of coding:

- Background: Light gray or white
- Text: Black
- Borders: Black
- Controls: Black
- Pointer: Black with white outline

Recommended colors for interface objects

- Red and orange: Stop, error, failure. Attract user's attention
- Blue and green: Go, ready. Tell user of normal operation or process complete and ready for action.
- Light blue: Make something unobtrusive.

Standard Link Colors

Don't change these colors since the ability to understand what links have been followed is one of the few navigational aids standard in most web browsers.

- Not been seen by the user: blue.
- Previously viewed: purple (or red).

Cultural Meaning

Don't force your particular color associations on your users - it may create some incompatibilities with cultural interpretations of color. Subjecting these users to your color associations is an indication of cultural arrogance.

Examples:

- In western society, users may interpret green as indicating the correct response.
- In certain eastern societies, red is considered an affirmative color
- Universal: Death is symbolized by black

See Individual Colors below for more information

Physiological Effects

Color does more than just give us objective information about our world -- it affects how we feel. The presence of color becomes more important in interior environment, since most people spend more time inside than outside.

Each color and color combination has its own vibration. Certain colors and color relationships can be eye irritants, cause headaches, and wreak havoc with human vision.

Other colors and color combinations are soothing. Consequently, the appropriate use of color can maximize productivity, minimize visual fatigue, and relax the whole body.

Over exposure to certain colors may result in negative side effects.

Cool hues such as blue are seen as calming and relaxing
warm hues such as red are seen as exciting and stimulating

Visual Impairment

A significant percentage of the population has some degree of color vision deficiency.

Diminished ability to distinguish between red and green is most prevalent. Attempts to provide unnecessary additional information via these colors will be lost on a significant portion of your users, and may become a source of their resentment.

Partial sight, aging and congenital color deficits all produce changes in perception that reduce the visual effectiveness of certain color combinations. Two colors that contrast sharply to someone with normal vision may be far less distinguishable to someone with a visual disorder.

Hard-coding the color of the text can make it difficult, and in some cases, impossible to read.

Hue, lightness and saturation are the three perceptual attributes of color.

Hue

Hue is the perceptual attribute associated with elementary color names.

Hue enables us to identify basic colors, such as blue, green, yellow, red and purple. People with normal color vision report that hues follow a natural sequence based on their similarity to one another.

With most color deficits, the ability to discriminate between colors on the basis of hue is diminished. Color deficiencies associated with partial sight and congenital deficiencies make it difficult to discriminate between colors of similar hue.

Lightness

Lightness corresponds to how much light appears to be reflected from a surface in relation to nearby surfaces.

Lightness, like hue, is a perceptual attribute that cannot be computed from physical measurements alone. It is the most important attribute in making contrast more effective.

With color deficits, the ability to discriminate colors on the basis of lightness is reduced.

The lightness you perceive may not be the same as the lightness perceived by people with color deficits. You can generally assume that they will see less contrast between colors than you will.

The amount of light that passes through the eye of a sixty year-old is only one-third of that passing through the eye of a twenty year-old.

The only way to ensure that such users will be able to detect symbols is to have sufficient contrast between the symbol and its background.

Exaggerate lightness differences between foreground and background colors, and avoid using colors of similar lightness adjacent to one another, even if they differ in saturation or hue.

Lighten your light colors and darken your dark colors to increase visibility

Saturation

Saturation is the degree of color intensity associated with a color's perceptual difference from a white, black or gray of equal lightness

Congenital and acquired color deficits typically make it difficult to discriminate between colors on the basis of saturation.

With color deficits, ability to discriminate colors on the basis of all three attributes – hue, lightness and saturation – is reduced. Designers can help to compensate for these deficits by making colors differ more dramatically in all three attributes.

Implementation

Determine range of users that your application will be addressing.

Design for black and white first, then colorize that design. Keep black-and-white designs two-dimensional. It's important to maintain the visual consistency of the interface across applications and computer systems. Don't cause unnecessary visual clutter by trying to mimic color effects, such as shadows, in black-and-white designs. Maintain a close visual relationship between a black-and-white design and its colorized version. Users should be able to easily recognize standard interface elements and icons across all monitor types.

People with color-deficient vision won't recognize the use of color to indicate selection.

Don't use color as the only means of communicating important information.

- Some users will not have color monitors
- 8% of the population is color deficient
- Under uncertain lighting, colors will be difficult for the eye to distinguish

Use color redundantly. It shouldn't be the only thing that distinguishes two objects, use other cues, such as text labels, shape, location, pattern, or sound.

The fewer colors you use, the less flashing occurs when the screen's color table is updated during screen redrawing.

- Use bright colors sparingly and only in small areas
- Use light or subtle colors for large areas
- Use true gray instead of a 50 percent gray pattern when a color monitor is present
- Custom elements should follow the color scheme of the operating system
- Colors should be updated when the user changes the color in the Color control panel

Individual Colors

RED: energy, vitality and power. If you stay under the red ray too long or are exposed to red for a considerable time it will make you very agitated or even aggressive. Red on a white surface will fatigue the eyes and cause an after image. Use a soft muted teal as the work surface color to maximize visual efficiency and decrease the After image.

ORANGE: energy. Orange will have a gentle warming effect if used lightly. Orange, like red should not be used for too long. It is not a good color for nervy people or people easily agitated.

YELLOW: used for mental stimulation - it will help you think. It is very stimulating and could cause exhaustion and depression.

- Bright yellow captures the attention.
- Bright lemon yellow is the most fatiguing color. More light is reflected by bright colors, resulting in excessive stimulation of the eyes. Do not use yellow as a background on your computer monitor.
- Yellow is the most cheerful of the spectrum.
- Yellow is a symbol of the deity in many global religions.

Some tips for practical application:

Notice the difference between a yellow of the purest intensity and a softer tint. Also the size of the area that any color occupies determines the color effect. For best results, use softer tints of the hue or small quantities.

GREEN: harmony and balance. It is good for tired nerves. It will balance the emotions and bring about a feeling of calmness. Too much green may create more negative energy if there is some already present.

Symbol:

- Fertility. In Celtic myths the Green man was the God of fertility. Of note is the continued symbolism attached to the color in the latter part of this century. Anyone who chooses a green m & m is sending a somewhat similar message. Green has been reinterpreted by late 20th century American culture to signify a state of heightened sexuality in this specific situation.
- Nature, freshness
- Ecologically beneficial

BLUE: truth, serenity and harmony. Helps soothe the mind. Blue is good for cooling, calming, reconstructing and protecting. Will help with nervous irritations. Too much blue could leave you cold, depressed and sorrowful.

In design:

- Do not use blue for drawing thin lines or entry fields on a dark background, unless you want to hide the field.
- Most difficult to distinguish is light blue, which should be avoided for text, thin lines, and small shapes.
- Adjacent colors that differ only in the amount of blue should also be avoided.
- For things that you want to make unobtrusive, such as grid lines, blue is the perfect color.

INDIGO: Attributes of blue at a higher level. It will clear a congested head to allow a clearer path for the conscious to the spiritual self. It is a good astringent and it is a good purifier. Too much indigo could give you a headache and make you very drowsy.

PURPLE: will also connect you with your spiritual self. Too much purple and you don't tend to live in this world.

LAVENDER: equilibrium, it helps with spiritual healing. It is a color of replenishing and rebuilding. Too much will make you very tired and disoriented.

WHITE: purity. It is the highest charging field to bring peace and comfort at the highest level.

Design:

- White surfaces reflect about 80% of the light, black 5%. We take these two percentages, divide 80 by 5 and we get a 16:1 Light Reflectance ratio. The Illuminating Engineering Society (IES) in the United States recommends a maximum ratio of 3:1 for a visual task and the adjacent surroundings.

Symbol:

- White is the color of mourning in China.
- If a married woman wears unrelieved white in India, she is inviting widowhood and unhappiness.
- Cleanliness

SILVER: peace and persistence.

GOLD: is the strongest color to help cure all illness. It is so strong that many people are not able to tolerate it, so people have to be conditioned to gold over a period of time. Gold strengthens all fields of the body and spirit.

BLACK: will help bring a patient to a state of grace. It will help them reach the silence and the peace of God. Symbol: death.

Color Combinations

The difference between white and black creates excessive muscular activity which fatigues the eyes.

Four different colors is the maximum number that should appear on the display at any one time.

When colors are used in combination, use color complements. The combination of these colors could occur either as

- One color for text and another as field, or
- Both colors as text located near each other on a black or dark grey background.

Good combinations:

- red and cyan
- blue and yellow
- green and magenta

Bad combinations:

- red and blue
- red and green
- blue and cyan
- cyan and green
- green and yellow
- yellow and red
- red and magenta

- magenta and blue

Color combinations should be approximately equal in lightness value.

Green and yellow appear brighter on a CRT than red and blue. If possible, increase the lightness value of blue and red output so that they appear equal in brightness to green and yellow.

Use a low contrast text-background combination to hide information for security or privacy reasons. Examples:

- green text on a cyan field
- red text on a magenta field
- yellow text on a white field

For fields that do not allow input, display the field label in normal text color and the field in blue.

For thick lines or area fill on a dark background, the best colors are listed below

<u>Number of colors to display</u>	<u>Recommended color(s)</u>
1	Yellow, Cyan, Green, Magenta
2	Magenta and Cyan, Magenta and Green
3	Magenta, Cyan and Yellow Magenta, Green and Yellow

Gender Differences

There are differences between gender in preferences for colors.

More pleasing results were obtained from either very small or very large differences in hue rather than medium differences, with this tendency more frequent in women than men.

- yellow had a higher affective value for the men than women
- blue for men stands out far more than for women
- men prefer blue to red and women red to blue
- yellow preferred to orange by women and orange to yellow by men
- men more tolerant toward achromatic colors than women
- women might be more color-conscious and their color tastes more flexible and diverse
- blue green was more favored among women than men
- women prefer tints more than shades
- 56% of men and 76% of women preferred cool colors
- 51% men and 45% women chose bright colors
- men have a tendency to prefer stronger chromas than women

Study: gray room vs. colored rooms. In gray room:

- heart rates were faster
- men were found to have stress reactions more than women.
- men became more bored than did the women

- men could not achieve the same degree of mental relaxation as women.

Women were more likely than men to have a favorite color.

preferences for light versus dark colors - no significant differences between men and women

preference for bright and soft colors:

- women prefer soft colors
- men prefer bright ones.

Combination of red and blue - two extreme color characteristics - creates confusion and distraction, with higher frequency of these reactions in women than men.

Design

People are most sensitive to the chroma used in interior spaces.

Subjects tend to dislike the warm-colored environments that had high chroma and high contrast and medium chroma and medium contrast.

Warm-colored environments

- medium and high chroma - unpleasant and overpowering, but
- medium chroma and low contrast - most preferred interior - appealing and calming
- less attractive and less pleasant than cool-colored environments

Subject's impressions of color affected not just by the coolness or warmth of the color palette, but also by the calibration of value, chroma, and contrast used in the interiors.

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