Introduction to Color

Color as a design element impacts the viewer. There are both positive and negative effects from color, and individuals actually have measurable physical effects from color. Additionally, there are document color preferences for gender and age.

As stated, people have physical responses to color. For example, red acts as a short-term stimulant, while blue calms and slows responses.

There is a strong connection between age and color preferences: Infants prefer luminous colors like yellow, white, pink, and red; children shift to red and blue; young adults prefer blue-green colors. Throughout the world, the dominant order of color preference is blue, then red, green, violet, orange and yellow. Generally speaking, men prefer darker colors; affluent people lean towards pastels and neutrals, and children favor primaries.

Although color is a very complex topic, this will give you a basic understanding. The more you know about color, the more you can help your customers see the value and impact of color in their documents.

What is Color?

Light causes color. Things obtain color by the properties they possess that either absorb or subtract certain wavelengths of light while reflecting other wavelengths back to the viewer. The absence of light is black. Color is a visual sensation that involves three elements – a light source, an object, and some type of viewer, which can be either the human eye, film in a camera, or a light-sensing instrument.

Light + Object + Perception (Viewer) = Color

Light waves are extremely small and travel like the ripples produced by dropping a pebble into a pond. Light waves are not colored, but produce the sensation of color for the viewer.

Light is a form of energy. All wavelengths of light are part of the electromagnetic energy spectrum. Visible light is only a very small portion of this spectrum. At the end of the visible spectrum are the short wavelengths of light we perceive as blue. At the other end of the spectrum are the longer wavelengths of light we perceive as red. All other colors that we can see can be found somewhere in between. By dividing the visible spectrum into thirds, the predominant colors are red, green and blue, the primary colors of light. In between the primaries are the secondary colors, cyan, magenta and yellow.

These colors make up the additive and subtractive color systems, and are the only way that color can be reproduced, regardless of the media, whether it is printing, film, or monitors.

The Additive Color System

The additive color system is more popularly known as RGB. Additive color involves the use of colored lights. It starts with darkness and mixes red, green and blue light together to produce other colors. When combined in equal amounts, the additive primaries produce the appearance of white. By combining one of the additives with another, a secondary color is produced.

Examples of systems that use the RGB additives are television screens and computer monitors. A monitor or screen is made up of thousands of red, green and blue phosphor dots, which emit light. When activated, these dots use a combination of different intensities to make up all of the colors that we see. Because they are so small, they cannot be seen individually, but rather, as colors formed by a mixture of light.

The Subtractive Color System

The subtractive color system, what we are most concerned with, is also called CMY. Subtractive color involves colorants and reflected light. It uses cyan, magenta and yellow material (toner, ink, dye, etc.) to subtract portions of white light illuminating an object to produce other colors. When combined in equal amounts, pure CMY produces the appearance of black. This is also known as processed black.

Printing uses colored toner or ink that act as filters, subtracting portions of the white light on paper, to produce other colors. Printing toner or ink is transparent, which allows light to pass through and reflect off of the print surface. It is the surface that reflects any un-absorbed light back to the viewer. Rather than processing black by combining the three colors, black toner or ink is added to the mix, giving us the CMYK process.

To reproduce an original color image, such as a photo, on a press or printer, the image is first converted into a pattern of small dots for each of the four colors. When printed on paper, the dots trick the eye and give the visual appearance of the original image.

Color Reproduction's Limitations

It is impossible for any color system to reproduce all of the colors we see in nature. Every type of color reproduction system has its own range of colors, or gamut.
The number of colors that can be reproduced on a monitor is greater than what can be reproduced on film, which is greater than what can be reproduced in printing.

Just how many colors are there?

To the human eye – billions
To a computer screen – 16 million
To photo film – 10 to 15 thousand
To a printing press – 5 to 6 thousand

Additive Color vs. Subtractive Color

Video monitors and computer screens use the additive color system, and as you can see by the numbers above, display a much larger gamut than can be produced by most color print devices, which use the subtractive color system. With each device using a different system, the end user can run into difficulty. The colors you see on the monitor will probably not be what you get when the job is printed, unless a lot of image adjustment at the printing end.

Part of the problem with the CMYK process is due to the image screening process and part of the problem is the paper used to print the image.

The screen process converts an original continuous tone image (contone), like a color photograph, into a pattern of small dots for each process color so the image can be printed with a pigment (toner, wax, ink) or dye on paper. A continuous tone image shows a continuous density range between light and darker areas. An ink printable image is made up of small dots, which creates the illusion of lighter and darker tones – a halftone image. A screen image can be produced using a fixed grid pattern of different sized dots, or by varying the number of randomly placed, same size dots – or a combination of the two.

The original color image is separated into four halftone images – one for each of the processed colors (cyan, magenta, yellow) and one for black.

To reproduce the image, each area of the original image is converted to a dot size that gives the same visual appearance as the original. Areas with larger dots appear darker than areas with smaller dots when printed. The size of each halftone dot is measured in terms of dot area percentage, from 1% to 100%. In a conventional halftone image, the dot size changes proportionately to the tonal value of the original image.

The fineness or coarseness of the grid, or screen ruling, determines the distance from the center of one dot to another. There are some new digital screening methods, including stochastic screening, that produce very small, similar sized dots that are placed randomly instead of on a fixed grid.

However, even with new screening methods, the number of density levels in a continuous tone image is still far greater than a screened or halftone image. This means the tonal range of an original must be compressed during the image reproduction process. The result is tone compression, which requires that certain parts of the tonal range must be emphasized at the expense of others.

Paper is the other issue in the subtractive CMYK process. It is the paper that reflects the unabsorbed light back to the viewer. Paper stocks vary in color, gloss, brightness, texture and absorbency. A printing device that prints on coated paper produces a wider range of colors than a printer that prints on uncoated paper. Rough paper scatters the light and reduces the amount of light reflected back to the viewer. Smooth, glossy white paper returns more light to the viewer. The effect of the paper on the printed image is so important that the paper can almost be considered a fifth color.

Why and How Color is Measured

Our eyes cannot measure color because our eyes only sense the color. We also cannot measure how our brains interpret color. (Variances in lighting conditions also influence how we see color. When comparing output, make sure the lighting conditions are the same.) However, there are three characteristics of color perception that everyone uses – hue, saturation and brightness.

Hue is a term that refers to the actual name of a color and identifies its position on the color wheel. In three dimensional color spaces all the hues are oriented around the center axis. The center axis represents brightness, with white at the top and black at the bottom. The farther from the center, the more saturated the color, or greater the saturation. Value is another term used for lightness/darkness. Most hues have the greatest possible saturation at the midpoint of the brightness axis.

Creating Full Color Documents

In order to create the most effective presentations, documents, and charts and graphs, it is best to have a good understanding of color.

Color Printing Basics

All colors for printing and copying are derived from a color model that uses CMYK as the primary colors. RGB are considered secondary colors in this model. As you may remember from mixing paints in school, cyan and magenta equals blue, yellow and cyan equals green, and magenta and yellow equals red. Tertiary colors are the six colors that are created by mixing equal parts of one primary color and one secondary color: blue and magenta equals purple, red and magenta equals red-magenta, yellow and red equals orange, yellow and green equals yellow-green, green and cyan equals green-cyan, and blue and cyan equals blue-cyan.

Color Wheel Relationships

Color experts use a color wheel and define a variety of terms from the color wheel. Many may be familiar with you.

- **Complementary**: pairs of colors opposite each other on the wheel.
- **Near Complementary**: pairs of colors one-step from complementary.
- **Adjacent**: a series of colors next to each other on the wheel.
- **Cool**: a series of colors in the blue/green range.
- **Warm**: a series of colors in the red/yellow range.
- **Contrasting**: pairs of colors with three colors between them on the wheel.
- **Analogous**: harmonious colors close to each other on the wheel.

Important Color Terms

The following are important color terms.

- **Hue:** general appearance of a color as identified by its name. Red is a hue.
- **Saturation:** intensity of a color's hue; its vibrancy; its level of purity undiluted by white or black. Also called chroma.
- **Brightness:** lightness or darkness of a hue. Also called value.
- **Tint:** result of adding white to a color.
- **Shade:** result of adding black to a color.
- **Tone:** result of adding a complement to a color.
- **Monochromatic:** series of colors of the same hue, but with different saturation.
- **Achromatic:** black, white and shades of gray.
- **Achromatic Plus:** black, white, gray and one hue added.

Symbolism of Color Groups

The combination of light or dark and saturated or unsaturated colors have moods attached to them. By using these. A designer can replicate the mood the combinations carry.

Light saturated colors: These vivid colors convey lively, energetic, festive moods. While possessing the ability to lighten the mundane, light saturated colors are best used as accents.

Dark saturated colors: These colors carry a sense of dignity, richness and elegance.

Light unsaturated colors: Adding white to saturated colors creates these colors. Light unsaturated colors are also known as tints. When mixed with large amounts of white, saturated colors become pastels, known for their soft, cheery or dreamy quality. Saturated colors mixed with small amounts of white may appear washed out or dull, therefore weaker in symbolism than their saturated parent color.

Dark unsaturated colors: Adding black to saturated colors creates these colors. Black added to dark saturated colors tends to strengthen them, reinforcing themes of richness and elegance. The addition of black makes colors heavier and more serious, even to the point of becoming stern or melancholy.

Dull or muddy colors: Created by adding both white and black to saturated colors. When both white and black are added to a saturated color, the color loses its vibrancy and becomes neutral or even drab. Dull colors can rarely carry themes on their own; they need support from vibrant colors, or should be used as backgrounds. Dull colors by themselves tend to become depressing.

Choosing Colors

Here are some general guidelines for choosing colors.

- Make your design work in b&w first; then add color.
- Use fewer colors for greater impact.

- Select object color after choosing a background.
- Select hues after deciding on overall lightness levels.
- When in doubt, go achromatic.
- Be careful using trendy, clichéd or overused colors.
- If you want the latest up to date color combos – look at fashion or design magazines.
- Colors look bolder in large areas, tone down, if necessary.
- Warm colors work best in small areas.
- Use black in combination with two other colors for a rich striking combo.
- Avoid reds and greens with low saturation levels because of people with red-green color deficiency. (10% males, 1% females)
- Use color consistently.

Test the use of colors with the audience (customer or client)! Reactions to colors can change. If your audience on Tuesday was teenagers, your presentation for adults on Friday should take into account the different reactions to color by age. Color style also changes. Does anyone remember when avocado and harvest gold dominated kitchens? How about the color themes from 80's TV shows like Miami Vice?

Consider the fact that 83% of what we learn is through our eyes. In addition color:

- Accelerates learning, renditions and recall by as much as 55%.
- Improves and increases comprehension by more than 70%.
- Increases willingness to read up to 80%.
- Increases recognition by more than 75%.
- Increases motivation and participation up to 80%.
- Reduces error count from 55 to 35%.
- Sells more products by 50 to 85%.

And if all this were not enough to justify the use of color, here are just a few more reasons to use color:

- Color graphics bring better clarity, understanding and interpretation of your message.
- Color enables you to condense information, while making it more "telegraphic".
- Color catches attention, retains interest, and makes comparisons easier.
- Color easily highlights important information.
- Color makes a presentation or document appear to be more important, timely, sophisticated and thought out.

In Conclusion

At first, it may seem a little challenging, however if you know color theory you will gain a better understanding of KMA color products. In turn, if you understand the product and value to the customer, you will uncover more color opportunities and increase your sales.