



The Alphabet of Color... RGB, CMYK, & PMS

The Power of Color

- 92% Believe color presents an image of impressive quality
 - 90% Feel color can assist in attracting new customers
 - 90% Believe customers remember presentations and documents better when color is used
 - 83% Believe color makes them appear more successful
 - 81% Think color gives them a competitive edge
 - 76% Believe that the use of color makes their business appear larger to clients
- Research conducted by Xerox Corporation



One of the more difficult tasks we face when reproducing your printed material is to be certain the color is correct. When we are printing your business stationery, it is critical that the color remains consistent for the first and for each subsequent printing. When printing your company brochure or newsletter, the color on the finished piece must conform to your expectations. And, if we are printing in full color – especially photographs of food or people's skin tones – a good color match may make the document really stand out.

So why is color matching such a problem for us? The answer lies in a combination of how color is created and how the human eye perceives color.

What is Color?

Color is caused by light; without light, color would not exist. In turn, light is a form of energy. Visible light – the part of the electromagnetic energy spectrum whose wavelengths our eyes can detect – is blue at one end and red at the other. All the colors in nature that we perceive fall along the spectrum from blue to red.

Light that appears white, such as light from the sun, is really composed of many colors which become visible if passed through a glass prism. The prism causes the wavelengths to bend, each at a slightly different angle, producing the spectrum of visible light.

When the visible portion of the spectrum is divided into thirds, the predominant colors are blue, green, and red. When arranged in a circle or color wheel, blue, green, and red form a triangle: red at 2 o'clock; blue at 6 o'clock; and green at 10 o'clock. Between the primary colors are the secondary colors – cyan, magenta, and yellow.

RGB: The Colors of Television Screens and Computer Monitors

RGB stands for red, green, and blue – the primary colors of visible light. A television screen or computer monitor that begins as black creates color by generating electrons that bounce against thousands of red, green, and blue phosphor dots within the monitor's screen. If all the phosphors are illuminated simultaneously, the screen turns white. Mix the phosphors in combinations and at different intensities, and you produce all the colors you see

on the screen with more or less saturation. Turn off all the phosphors, and the screen turns black.

Because adding equal amounts of red, green, and blue phosphors creates white light, RGB color is called *additive color*. Additive color starts with darkness (black) and mixes red, green, and blue light to produce all other colors. When combined in equal amounts, red, green, and blue appear white.

CMYK: The Colors of Process Printing

CMYK stands for cyan, magenta, yellow, and black. Three of these – cyan, magenta, and yellow – are the secondary colors of visible light. Black (abbreviated K) is used to darken hues created by the other three colors.

Unlike the phosphors in televisions and computer monitors that combine or add to produce white light, process printing inks use pigments and dyes to absorb white light. Each ink color absorbs or subtracts a different portion of white light. And because printing inks are transparent, the white light passes through the ink (which subtracts a portion of the white light) and is reflected off the paper base. The paper reflecting back unabsorbed light is what creates color to the observer. It also explains why the same ink color looks different depending on the color of the paper base.

Color printing, color photography, and paintings all use the subtractive process to produce color. Cyan ink absorbs red light and reflects green and blue light. Magenta ink absorbs green light and reflects red and blue light. Yellow ink absorbs blue light and reflects red and green light. When combined in equal amounts, pure subtractive primary colors produce the appearance of black. (Note, however, that the black appears more like a muddy brown. For this reason, black is used as a fourth ink in process color printing.)

PMS: The Colors of One-, Two-, and Three-color Printing

PMS stands for Pantone Matching System™, a system used by printers around the world to select, specify, match, and control ink colors. The Pantone Matching System™ formula guide is a book of printing ink formulas and samples on coated, uncoated, and matte coated stock in a fan format. The PMS book is what we use when helping you select color for your project.

Whereas cyan, magenta, and yellow are combined in various percentages to produce a specific color, a PMS or spot color ink is one single hue. In addition, the inks used for spot color are opaque rather than translucent and so do not allow white light to pass through.

Why RGB Colors Don't Always Reproduce as CMYK or Spot Color

Perhaps you have had the disappointment of having the color on your printed piece look somewhat different than it did on your computer monitor. There is a scientific reason for this – the RGB phosphors are capable of producing many more colors than the process printing inks. And the process printing inks, when combined, cannot always match exactly the single hue of a PMS spot color.

To put it more simply – there is not a perfect overlap in the range of colors that are both visible to the human eye, reproducible with RGB additive color, and reproducible with CMYK subtractive color. Whereas the human eye can see billions of colors, RGB can reproduce 16 million and CMYK printing 5-6 thousand. So some colors will convert from RGB to CMYK fairly well (because the color is in the CMYK color gamut) and others will convert poorly (when the RGB is outside the CMYK color gamut).

To illustrate, try this exercise. Using PageMaker, Quark XPress, InDesign, or PhotoShop, convert RGB blue to CMYK. Watch what happens to the color. Does it turn to purple? Now reduce the percentage of magenta by 50% and watch it turn back to blue. This is a dramatic example of how additive and subtractive color spaces are not perfectly overlapped.

Color Us Helpful

If you find all this very confusing, please turn to us for assistance. We will do our best to guide you through the steps needed to make sure the color you select is the right one for the job.

a vocabulary of the graphic arts

worlds

Analogous color: colors that are next to each other on the color wheel, share the same undertones, and harmonize when placed next to each other.

Chroma: attribute of a color that determines its relative strength or saturation. In color space, the distance away from neutral.

Color calibration: setting a device (digital camera, computer monitor, scanner, color printer, copier, or imagesetter) to known color conditions.

Color gamut: the total range of colors that can be formed by all combinations of a given set of light sources or pigments and dyes. A typical CMYK gamut is smaller than a typical RGB gamut.

Color model or space: a scheme for representing color as data; the 3-dimensional coordinate system used to numerically describe colors. Some models include red, green, and blue (RGB); hue, lightness, and saturation (HLS); cyan, magenta, yellow, and black (CMYK); and Lightness, a, b, (L^*a^*b).

Color wheel: representation of both the primary and secondary colors of visible light.

Complementary color: Colors that are opposite each other on the color wheel and that contrast when placed next to each other.

Four-color process printing: The process of reproducing a full-color image by overprinting screened color separations for each of the three process colors (cyan, magenta, yellow) and black using process color inks. Also called full color printing.

Hue: Attribute of a color that describes its dominant wavelength (such as red, yellow, green, blue) and distinguishes it from other colors. In color space, hue is arrayed around the center axis.

Lightness: The luminous intensity of a color. Also called its value.

Spot color: A term used to designate a single hue printing ink. Spot color reproduction is assisted by the Pantone Matching System.

Tone: The lightness/darkness value of an image. The tonal range of an image is the transition from the light areas to the dark areas.

T H E i d e a

Common Ways to Use Color

As a general guideline, we recommend incorporating color into almost any printing project. Use of color improves reader comprehension, calls attention to important information, and improves the overall appearance of your document.

A common way to use PMS color is to combine it with black ink as an accent. The color draws the reader's eye and emphasizes the information printed in color. Or, if used for headlines or subheads in text, the color enhances the document's organizational structure by creating easily discerned text segments.

To create the illusion of more than one color when using a single PMS color, create a tint or screen – a block of small dots – behind a section of text. To the

reader, the screen will appear as a lighter shade of PMS color. For some PMS colors, the tint may appear to be a different color altogether (a 20% screen of burgundy, for example, may appear as pink).

To add color to a newsletter when the budget is limited, combine a PMS color with black ink on the pages that print together on one side of the press sheet. For a four-page newsletter, a typical use would be color on pages one and four. When the newsletter is folded, the color will be on the first and last page, giving the first impression that the newsletter is printed in color. This technique is especially effective when using two colors on the outside and one on the inside, or four colors on the outside and two on the inside.

W O R L D S

Combining Colors in a Document

A color wheel is a useful tool to help determine how to combine colors in a document. The color wheel represents both the primary and secondary colors of visible light. The primary colors (red, blue, and green) appear at 2 o'clock, 6 o'clock and 10 o'clock, while the secondary colors (cyan, magenta, and yellow) appear between the primary colors. Cyan appears in between blue and green at 8 o'clock; yellow in between green and red at 12 o'clock, and magenta in between red and blue at 4 o'clock.

On the color wheel, colors are either analogous or complementary. Analogous colors are those that appear next to each other on a color wheel and share the same

undertones. Red, red-orange, and orange are examples of analogous colors. Complementary colors appear across from each other on a color wheel; red and green are complementary colors.

Analogous colors are used to calm; complementary colors are used to excite. When you want to create high contrast, select complementary colors. Some complementary colors (such as red and green) can even appear to vibrate when placed next to each other. On the other hand, use analogous colors when you want to create unity and harmony.



What is a PMS Color?



PMS is an acronym for Pantone Matching System™, an industry standard for identifying and matching colors. The Pantone Matching System™ was created by Lawrence Herbert in 1963 to solve problems associated with producing accurate color matches in printing and graphic arts.

The Pantone Matching System begins with a base of 14 colors (two yellows, orange, four reds, purple, four blues, green, and black), then creates more than 1000 colors based on combinations of the base in a process similar to the way paint

stores mix paint. Each color is numbered for easy reference, and a color swatch and ink formula are printed in PMS guides – the fan format books we use to help you select colors for your printing projects.

Because the appearance of the ink color is affected by the paper it is printed on, we have several PMS guides for our customer service representatives and press operators to use. In addition, we replace our books approximately once a year to ensure that color swatches have not changed due to fading or exposure to light.

questions and answers