

RGB, CMYK, and PMS: the Alphabet of Color

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 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 or food or people's skin tones – a good color match is essential.

So why is color matching such a problem? 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 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 produce thou-



sands 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 television screens 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

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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 colors (C, M, Y) produce the appearance of black. Note, however, that the black actually 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 inks 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.

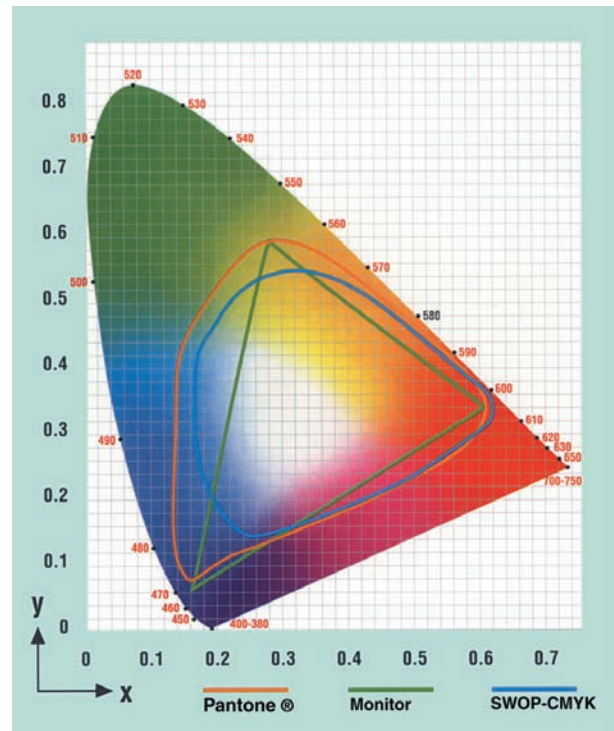
Why RGB colors don't always reproduce as CMYK or PMS

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 colors. 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 the color gamut incompatibilities, 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. Call us at 909.981.5715 and we'll help clear up the mystery.