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Color Theory Simplified

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Introduction to Biology or Art refresher:

The human eye sees color by means of light coming into our eyes reflecting from an object.

The light color spectrum is established by the length of the light wave and for many of us is represented by the acronym - ROY G BIV. So where did CYMK and RGB come from? **R**oy **G** **B**iv is the range of hues or colors of light which is created by mixing Red Green Blue light. CYM reflects, no pun intended, more accurately the secondary colors of mixing these lights.

When you mix red light and green light the resulting color is perceived as yellow, the Y in ROY. This is called an additive process and it is how a monitor works. It mixes the light. Inks, on the other hand, actually filter light in a subtractive manner. As a green filter subtracts all light waves but green, so a yellow ink subtracts all light waves except the green and redwave lengths which create it. When you then layer(over print) the yellow ink with magenta (a result of red and blue light) red is the only light wave left bouncing back to your eye.

- Light projected is additive - blue and green light together appear as cyan.
- Light reflected through a filtering element is subtractive - light filtered through a blue and green filter together would appear black because no light would get through. In the color mode of CYMK, K is black.

Devices which project light directly use the colors RGB in an additive process. Devices which use reflected light use their complementary colors CYM in a subtractive process.

Introduction to Physics or the study of light.

The above describes the color hues, but there is more to your perception of color then the color of light. For example while you perceive white, if the full spectrum of light is sent to your eye, not all white lights are the same. We all know about the yellow of tungsten lighting. This difference is expressed as the white point of a light source in Kelvins which denotes temperature.

- Tungsten lighting has a white point of 2800 K
- DaylightÕs is 6500 K
- Computer monitorsÕ are 9300 K.

In addition there is the quantity of light or brightness (Lumen, value or light). The effect of brightness can be easily studied on your computer. If you have Adobe's Photoshop open the colorpicker[selector] by clicking on the color swatch in the vertical tool bar, otherwise use any color selector for custom colors. Brightness may be be referred to as Lumens, as Microsoft does, which is accurate for an image created in an additive process such as on a monitor. Other software may use the term Value, which is

more accurate for ink and printed images.

- First click on the hue [H] button which locks that hue,
- Drag the target with your mouse across the color picker.
- What changes? How great a variety can you get by just changing the brightness and then the saturation?
- Try adjusting the RGB numbers. Make Blue =0. See red and green light do make yellow. Why do they make the best black in oil pigments? Do I hear you all saying because oil is a filter and uses Subtractive process? Tweak the mix slightly to see what happens.

The Science of Color Management

The first thing you might notice are the numbers. This is an attempt to standardize the perceived colors, because as we all know no two monitors project the same color the same way. Some of your color pickers may have other choices than RGB for color modes such as CYMK and L*A*B (or CIE). L*a* b is based on the Commissions International dÕEclairageÕs standard for color measurement and is device independent. It is a good color space to work in for PhotoCDs and for cross platform work. Photoshop uses it to convert from RGB to CMYK. Study how the numbers in the various modes are impacted by the changes which you make. If you can set up two monitors, using exactly the same color formulas evaluate the two representations. Color management is the science of "calibrating" two monitors so that they do present the colors in the same way.

Now that you understand how the colors are actually created, you need to learn how to manage them. Next time we will talk about existing technology which helps you to produce a consistent result even though there you are working in an inconsistent environment.

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