LIGHTING AND THE EVALUATION OF COLOR

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Color matching and evaluation have always been time-consuming and difficult subjects for most printers. This month I want to address some of the lesser known factors that have a major impact on the ability to view, evaluate, and match color. This is not an article about mixing different colors to obtain a new hue. Instead, I would like the focus to be on some underlaying factors that have a large effect on our ability to see and perceive color and color change.

One historical use of color matching has been centered on the Pantone Matching System® (PMS), primarily because this is the color specification system of choice among graphic designers in the United States. It has been particularly difficult for us as screen printers because the system was never designed to be used by our part of the graphic arts industry. For many years we have had to guess at what colors would be necessary to combine to *approximate* the desired PMS shade. Today Pantone has licensed a number of ink companies in our industry with pigment components that tend to work much better than in the past. It is still a difficult proposition at best.

Besides matching the Pantone System, today we must also deal with the far more complex issue of matching and evaluating four-color process images. This is a timely and important subject as more and more printers become involved in desktop color, color separations, and reproduction of process color.

Matching and evaluating four-color process is more difficult than a straight color match for a number of reasons. Chief among these is the fact that all colors in an image are related. If we increase the amount of cyan to intensify a blue, we also change the greys, browns, greens, violets, purples, and some reds. Subtle changes in one component of an image may have little or no effect on some colors, while having a major effect on others. In the example of cyan, a small increase in cyan will have little effect on dark blues and purples, some effect on greens, violets, and browns, and a huge effect on reds, greys, and tans. Understanding how color and light inter-react will help in viewing and evaluating your images.

All printing works on the principles of subtractive color. Ink pigments subtract some of the light that hits the surface. We see the reflected wavelengths as color. For instance, white light illuminates the surface of cyan ink. The color cyan is reflected and red wavelengths are absorbed. Magenta is reflected, and green absorbed. We see yellow while blue is absorbed. It is not that important to understand which colors are absorbed at this point. The relationship of light quality and reflection is.

Many of the colors that we try to evaluate and match are complex mixtures of a number of different pigments. The more pigments are present in a color mix, the more complicated that match will be. If the matched color is composed of multiple pigments, it may absorb light frequencies in different ways. Depending on the quality of viewing light, matched colors may be subject to metamerism. This is a phenomenon where two colors match under one light, but appear different under different lighting. This is a very difficult and frustrating part of color matching that most of us have experienced. Colors like beige, grey, and maroon, as well as many four-color process ink sets, are highly metameric. The quality of the light you use has a large influence on the degree of metamerism present in a color. In this context we will focus on the effect of light on the color match. The subject of metamerism will be examined in a future column where it can be discussed in depth.

White light is made up of all colors that we can see. If all of these colors are in roughly equal proportions, our eye perceives the color of the light as white. The challenge for us comes from the type of light under which we are viewing and the quality of light emitted from these lights. To create some type of approximation of similar viewing conditions the standard of 5000° K was established in 1985 by ANSI as the color temperature under which to view color for evaluation. The lower the Kelvin color temperature, the redder the light appears. Above 5000° F there is a noticeable shift to blue. A color temperature of 5000° F will appear as an almost neutral white.

It is very important to have a standard color temperature for accurate color viewing. If the color temperature is too high, it will affect the yellows. If it is too low, blues will be affected. Color temperature is only part of the equation. The second component is the Color Rendering Index (CRI) of the light source. If all components of the spectrum are present in a light source, it is said to have a CRI of 100. Filament-based incandescent lights fall into this category. As we move into the fluorescent tubes, the spectrum can be made up of continuous portions as well as banded portions. This lowers the CRI to between 54 and 94. Pulsed xenon (used in photostrobes) has a CRI of 93. Our metal halide lamps have a CRI of 62-88.

The CRI is critical in evaluating color. Most of us use fluorescent lights for standard viewing. Typically they are designated “cool white” and have a somewhat bluish appearance. The human visual system is *adaptive*. This means that our brain will tell our eyes that we see white as white under a wide variety of conditions, even if it has a distinct color shift to yellow, red, blue, or green. In reality, what we are seeing is not white at all, but a reflection of a white surface tinted toward the color temperature of the light that we are viewing under. Any of you who have ever taken a picture indoors without a flash will remember the red cast under tungsten light, or the blue-green cast under cool white fluorescent lights. This is because photographic film is *nonadaptive* and records accurately the scene as it is, not how we see it. By using a flash, you add back portions of the spectrum that are missing under current conditions.

If the light source we are using has its output in the form of spectral bands (metal halide, xenon, and florescent tubes), it is possible that there will be gaps in the colors that we see, even if the CRI is very high. Since required wavelengths are missing from the source, you will never see the reflected color of those missing wavelengths. This is common when trying to evaluate very light pastel tones and colors in a watercolor painting. Typical colors affected are pinks, peaches, roses, aqua, tan, and grey.

The level of light at the surface and angle of the light are also important factors. The lower the light level, the more it affects the reds and oranges. Contrast level is also decreased. As the intensity of light level is increased, an image becomes more blue and of higher contrast. When color matching on press, make sure that light level and quality are similar or identical to the area where final color approval will take place, or where the finished product will be displayed.

A simple and effective viewing box can be constructed for less than $100. It consists of a 2' x 4' four tube "drop-in" fluorescent fixture with diffuser panel. In most areas this will cost $35-$60. Install any of the 5000° K fluorescent tubes with a CRI of 90 or higher. These are available from lighting supply companies and cost $7-$10 per bulb. Two popular models are the GE Optima 50 and the Sylvania Spectrum 50. These bulbs are commonly used in autobody paint booths to assure good color matching.

For optimum matching, paint the surroundings in the viewing area a neutral grey slightly darker than 50%. There are specific standards for building a color booth if you wish to be in complete compliance. You can obtain these standards from GATF in Pittsburgh, Pennsylvania.

Viewing and evaluating color are skills you acquire over time. They are very subjective and, for most of our industry, less than critical. Our discussion this month has focused solely on the lighting aspects of viewing and evaluation. We have not addressed the potential of selective color blindness (up to 1% of the U.S. male population), metamerism, or selection and use of pigments used in color matching.

Knowledge in color matching will come in very handy when dealing with clients. It is typical for artists and designers to understand color from an "emotional" perspective, but have little or no understanding of the mechanical aspects of how it is reproduced. A typical response to a printed piece will include comments like: "It looks dead. It needs to 'pop' more" or "The colors need to be brighter." Part of your job is to bridge the gap between this subjective aspect of color evaluation, and the mechanical reality of mixing inks and printing on press.

There are a number of color groups nationally and internationally dedicated to the study and standardization of color measurement and management. If your business is dependent on making quality color decisions, it would benefit you to begin the task of learning about various aspects of color and color reproduction. The more you work with it, the better you will get.