US Ink® A Division of Sun Chemical Corporation

Understanding The Importance of GRAY BALANCE

Volume VI

Conceptually, color is first created in the "Mind.@ The creative mind is a fertile area and hampered with few rules and regulations. In the Graphic Arts, the only real constraints to creativity are the limitations of the reproduction processes themselves. Sometimes these limits are pushed knowingly or otherwise. This is where problems arise and where the need to measure and quantify color comes in. Measurements and standards can serve to more realistically achieve consistent results. This can be illustrated by the following of the factors we live with in the printing world:

! Viewing an image on a computer screen in the 16.7 million shades of color mode; when the printed process is only capable of approximately 5,000 shades.

! Viewing a desktop color proof, at the incorrect line screen (DPI) on a stock that does not represent the one you will be printing on.

Gray balance is the first important step undertaken by the color separator, in determining the color content and contrast that the final printed piece will have. Gray balancing is a scanner calibration procedure, in which the operator programs specific dot percent ratios of YELLOW, MAGENTA and CYAN into the scanner output. When film is output to these percentages and is proofed or printed, it should reproduce a "neutral gray" color. Once the scanner is Gray Balanced all of the color contained in the separations is a default of these settings.

A midtone three-color gray can be comprised of 50% Yellow; 50% Magenta and 60% Cyan. This will render a neutral gray tone. All other midtone process color values will be dependent upon this setting. If the "gray balance" settings are altered, then the color balance will also be altered. Because of the limitations of the pigments in the process inks, when equal amounts of cyan, magenta, and yellow are printed on white paper, they do not reflect equal amounts of red, green and blue to produce gray (See Figure 1). Each of the process inks absorbs or reflects an unequal amount of its share of the red, green, and blue of the spectrum. As such, if equal amounts of cyan, magenta, and yellow are printed, they would make a brownish color rather than a neutral gray.

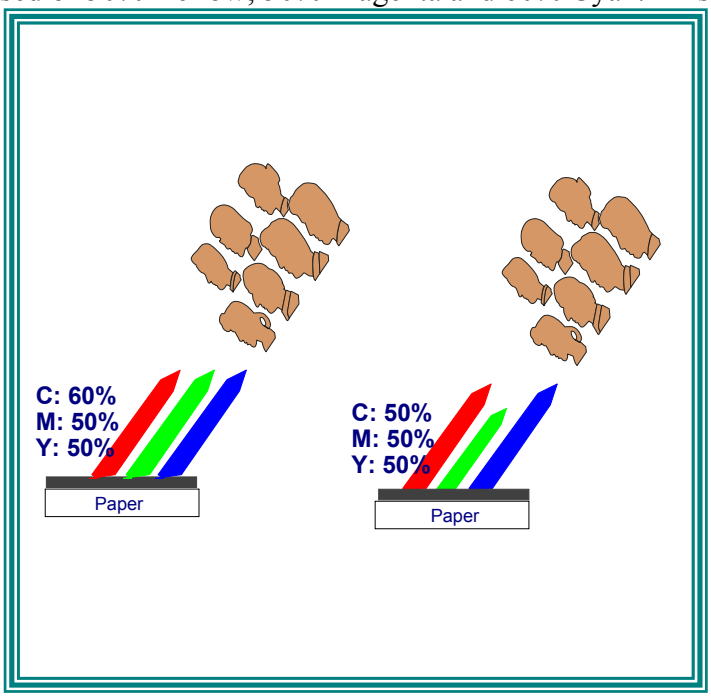

Figure 1

The second most important control the scanner operator has at his disposal is the choice of gradation. The choice of gradation dictates how "full" a job prints. In other words the scanner determines or influences the amount of dot gain a job will have.

The third most important control the scanner has is the % UCR setting. This setting dictates how much Yellow, Magenta and Cyan are printed in order to make up a three color shadow neutral (Grays and Browns). This will affect how well inks will trap or overprint and what shadow colors can be reproduced.

With scanning having this much influence and control over color, it is imperative that the prepress and press operations attempt to reproduce the scanner "gray balance" set up. Otherwise we are only guessing at correct color during a make ready on press.

Gray Balance agreement occurs when the proper proportions of yellow, magenta, and cyan that were blended together at the scanner, are reproduced at the press. Gray Balance is a significant factor in determining what the overall color gamut will be.

Proper color reproduction at press can only occur when the press has achieved the same "gray balance proportions" as were present in the color separations. Proper assessment of a printing ink's performance can be made only after the press has been "Gray Balanced@.

"Proper Gray Balance" is achieved when the values put in at the scanner are reproduced on the prepress proof and the printing press with little to no color difference between the two.

One area that complicates the gray balance process and sometimes requires some interpretation, is the prepress proof. Some proofs are manufactured with a color bias or cast. This will force the scanner operator to "alter his gray balance setup" in order to get a better proof for his sales staff or the print buyer. In this case, the final films having been prejudiced will not yield proper color on a balanced printing process. Furthermore, if the press is pushed to an imbalanced condition, the inks will be compromised and not allowed to perform to peak ability.

We need to measure for Gray Balance because each person's individual perception of color is different. Each person has subconscious preferences that influence their color judgement. The human eye can detect any shift in neutrality when neutral areas are compared side by side. Comparing just by looking at the neutrality of two gray scales is much easier than comparing the purity of the reproduced process inks with a color in the original. The eyes can quickly detect if there is any color cast in the neutral area. In this respect, the eyes become the most sensitive instrument for checking gray balance. We are all influenced by variables in our environment that we are usually not aware exist. To illustrate this, compare the two greens in Figure 2.

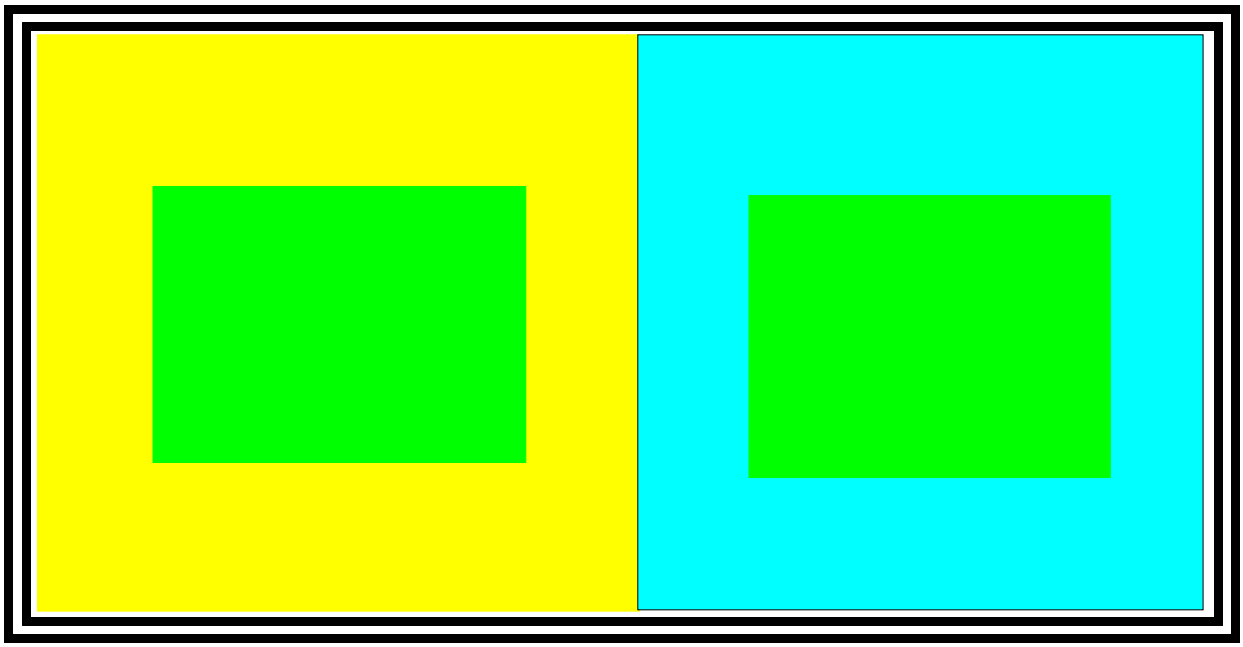

Figure 2

Although the two Greens in the squares in Figure 2 are the same, they appear to be different. This is caused by the different "surround color" in the two frames. Our eyes "take in" the surrounding tones and incorporate them into the initial color data for our brain to process. We are incapable of eliminating this information unless we mask out the offending areas. Often we are unaware that there is an offending or influencing other color. Without measurement, the judgement of color becomes an arbitrary exercise and is always open to argument. This is but one of many examples of how we are influenced in our perception of color.

The color we view on the CRT (computer) monitor is made up of RED, BLUE, and GREEN spots that are generated by the monitor's electronic systems. The resulting combinations of these colors can amount to as high as 16.7 million shades; of which we can see approximately 8 million.

The printing process on the other hand uses mixtures of YELLOW, MAGENTA, CYAN and BLACK. These colors filter out various portions of the electromagnetic spectrum in an attempt to "simulate" the RED, BLUE and GREEN monitor colors. This is an imperfect process right from the start due to limitations of the inks and stocks. This process can reproduce approximately 5000 shades of color. In essence we have severe tone and color compression. This is why we must be more critical of color at the prepress proofing stage. If we are not happy at this stage (proofing) it will not get better at press. (See Figure 3)

A gray scale is used as a common device for checking both tone reproduction and gray balance. To check for the accuracy in tone reproduction, the reproduced tone values of the gray scale are compared with the original tone values. For gray balance, only the neutrality of the reproduced gray

scale is compared with the original gray scale. Although it seems that there is no relationship between the two, inconsistency in one will affect the accuracy in the other. During the adjustment of gradation in a scanner, the tone values of gray are independently set for each color. If these settings do not compensate for individual characteristics of each ink and do not take into account the press and paper variables, there will be an uneven gray balance. The tone values for one or all three of the colors may have to be readjusted to properly reproduce the gray scale.

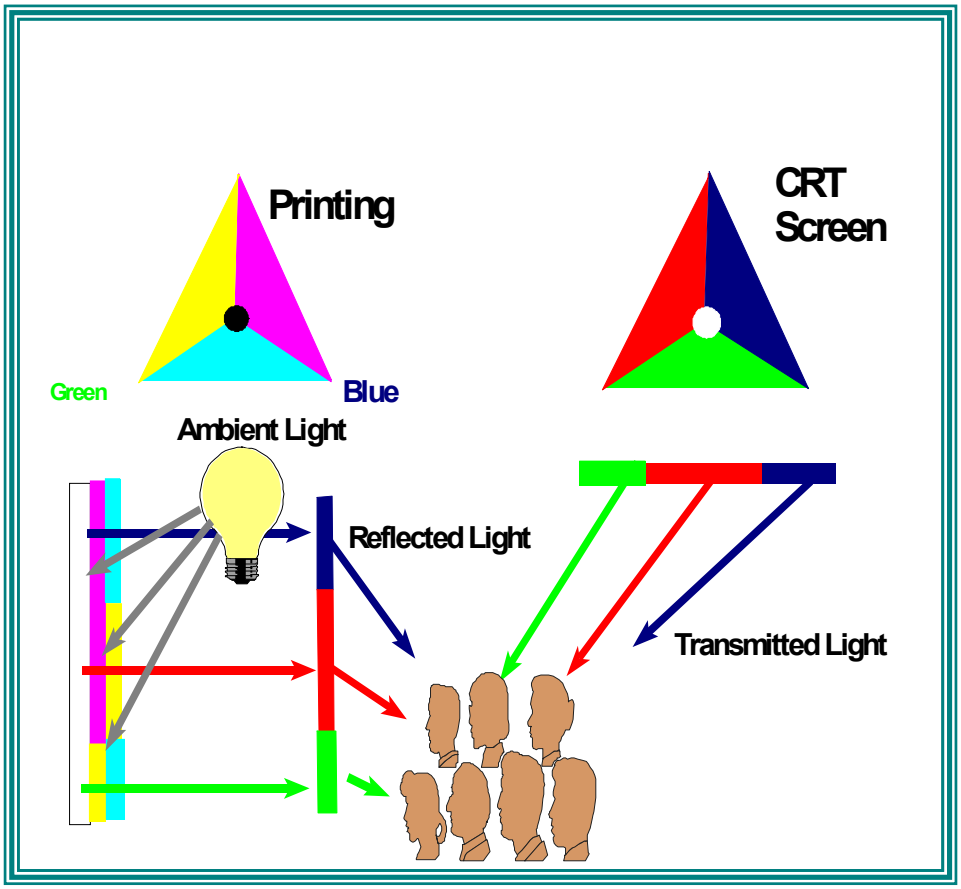

Figure 3 Differences between Reflected and Transmitted Light

To illustrate the differences that slight shifts in the reflected light can make in the appearance of a neutral gray, see Figure 4. As one can see in this figure, all three boxes are gray in appearance however, by equally adjusting the amounts of red, blue, and green reflected light, a true gray can be achieved.

Figure 4

Some of the factors that influence Gray Balance and color at press:

- Dot Gain

! The balance of dot sizes between the various colors
  - Choice of scanner gradation
  - Dot shape
  - Screen ruling
  - Incorrect contacting of film and/or plates
  - Plate and blanket choice
  - Ink formulations
  - Paper choice

! The trapping efficiencies with regard to over printing of the inks
  - Ink formulation
  - Press blanket packing
  - Choice of stock
  - Choice of printing plates

! The density of the 100% solid prints
  - Ink formulations
  - Target solids= density values.

! The Hue Error and Grayness[1] of the process colors
    Ink formulations
    Coloration of the printing stock
    In line ink contamination at press

! The Press
    Any number of mechanical conditions and settings

! People

[1] "Hue error," is an expression that indicates how far a process color is from its theoretical ideal. Grayness is an indication of how "clean" a process color is, again compared to its theoretical ideal.