Understanding Gray Component Replacement (GCR)

by Wilfredo C. Ileto

The rapid developments in image manipulation software, such as Adobe Photoshop, have led to the transfer of the color separation process from the color separator to the graphic artist. Because of this development, it is important that the graphic artist be well versed with the concepts of color reproduction.

Color Separation

The process of color separation may take place in the scanning process during which the scanning software converts (or separates) the scanned image into its primary subtractive colors of cyan, magenta and yellow (CMY) with black (K) added to enhance the shadow areas.

A better procedure would be to scan the image to RGB and do the conversion with an image manipulation software such as Adobe Photoshop. This is the logical procedure, since most images are now produced in RGB format from digital cameras. Furthermore, it is always advisable that image manipulation and corrections be done in the RGB mode. Conversion of the image to CMYK should be done as the final step, prior to placing it on the layout.

In Adobe Photoshop, color separation is accomplished by conversion of the image mode from RGB to CMYK using the image > change mode menu.

Although the procedure may be simple, the graphic artist should be aware that the conversion is processed by the software in accordance to certain parameters that affect the final outcome of the color separation. It should be further noted that the parameter settings should be based on the requirements of the print production department or the print shop. Many graphic artists overlook the importance of this matter and merely rely on the default settings of Photoshop, which may not match the requirements of the press room. It is, therefore, imperative that graphic artists learn how to customize the color settings of the program.

In the process of customizing color separations settings, the concept of Gray Component Replacement (GCR) is encountered.

What is GCR?

In order to define GCR, it is necessary to discuss the basic concept of color.

Color has three dimensions or attributes which are interrelated : hue, value and chroma. Hue is the quality whereby one color (as red) differs from other colors (as blue, green, etc.). Value is the strength (lightness or darkness) of the color. Chroma is the purity or saturation of the color. Reducing the chroma value results in a reduction of the purity or saturation of the color and increases its grayness.

Whenever the three process colors (cyan, magenta, yellow) are overprinted, the two predominant ones determine what color it is (its hue). The lesser third color determines its chroma. In effect, the third color converts parts of the color to gray, which has no color, or is achromatic. These amounts of gray (called the gray component) are compost of equal portions of cyan, magenta and yellow; and can be removed from the color and replaced with black ink. This process is called Achromatic Color Reduction (ACR) or Gray Color Replacement (GCR). GCR is basically a process wherein the graying component of color is replaced by black.

Substituting black for the grayness of a color appears to contradict the basic theory of color in color reproduction. This theory states that the color spectrum of primary additive colors (red, green, blue) can be reproduced subtractively by mixing complements of cyan, magenta and yellow (CMY) to block or filter reflected white light. However, due to impurities present in printing inks, a mix of these colors instead yields a low gamut of unsaturated dark colors. To overcome the deficiencies in printing ink, black was introduced as a fourth color (CMYK) to extend the gamut in dark areas and increase shadow detail and density. The black printer is basically a skeleton image with a narrow range of dot values (maximum 50%) in the shadow tone areas.


CMY


K


CMYK

Full GCR removes the third color completely along with equivalent amount of the other two colors. It, thus, extends the range of black printer to the dot values required to reproduce all the details in the image.


CMY


K


CMYK

History of GCR

GCR is actually an old concept, which has its roots in a report by John Yules titled “Four Color Processes and the Black Printer”. It was published in the “Journal of the Optical Society of America” in 1940. Yules proposed substituting black for the graying component in the three primary subtractive colors of cyan, magenta and yellow. For example, a brown color composed of nearly equal amounts of yellow and magenta and a smaller amount of cyan could be reproduced by removing the cyan and equal amounts of yellow and magenta.

While the concept is old, its application required a complex process which could not be implemented with the photo-mechanical color separation used at the time and with analog scanners which came out later. During the 80's, the utilization of digital computers in scanners changed all that, with the various scanner manufacturers coming out their versions of the GCR system. Now, with powerful desktop computers and user-friendly software readily available, the utilization of GCR can be easily done by any graphic artist.

Advantages of GCR

Replacing the gray component of colors with black has many advantages. A major one is reduction in ink cost, especially in long run jobs. The use of expensive color ink is reduced and replaced with cheaper black ink. Some other advantages are:

- sharper image because the details are in black
- better control of color variation
- brighter colors when printing in low grade paper
- reduced drying time due to less ink utilization
- less ink offsetting resulting in higher delivery pile and reduced spray powder
- consistent gray images since only one color (black) is used
- savings due to lower consumption of CMY ink

Full gray component replacement, however, also has some disadvantages. Since the third color in conventional three color combinations has been replaced with black, changes in ink feed will largely affect the value (lightness and darkness) of the image and much less its hue and saturation. This will make it difficult, if not impossible, for last minute color shifts to be undertaken during the press run. This lack of control may be unpopular with some press room managers.

There are other problems with GCR. Black ink by itself may not be sufficient in supporting the gray scale, especially in the darker areas. This may result in weak shadows, lacking in depth and gloss. In full GCR, the image is also sensitive to misregistration in the black print. Any misregistration could produce a white line between light and dark areas.

It is, therefore, important that the graphic artist coordinate with the press room management to determine the degree of GCR to be applied to the color separation process.

Setting GCR parameters in Photoshop

In Photoshop, the parameters may be set in the Color Settings Menu by adjusting the Black Generation and the Black Ink Limit. The gray ramp (figure 1, encircled in red) in the setting box provides a visual guide to the effects of the setting on the CMYK characteristic curves.

The default setting in Photoshop is medium Black Generation and 100% Black Limit (figure 1). This is a safe setting for most jobs with the exception of the Black Limit. A 100% Black Limit will permit the value of black to go up to 100%. Depending on the substrate, it is better to set the Black limit from 80% to 95% (figure 2).

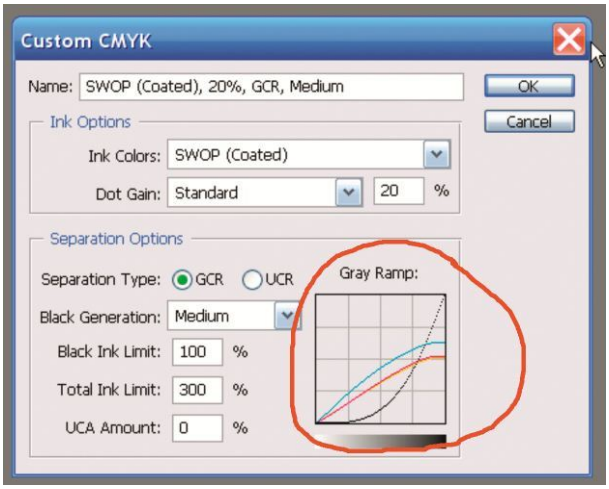

Figure 1

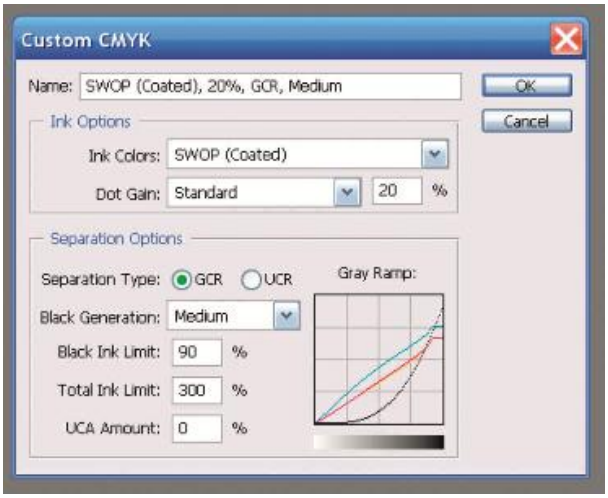

Figure 2

Figure 3 shows the setting which will produce a separation similar to the pre-digital conventional color separation. The light Black Generation results in minimal GCR. Black is used mainly to add density to shadow areas; and, thus, the black screen values are low. Black limit is set at 50%.

A setting with heavy Black Generation shows a dramatic drop in the CMY values as they are replaced by black, which is represented by a rise in the black curve (figure 4).

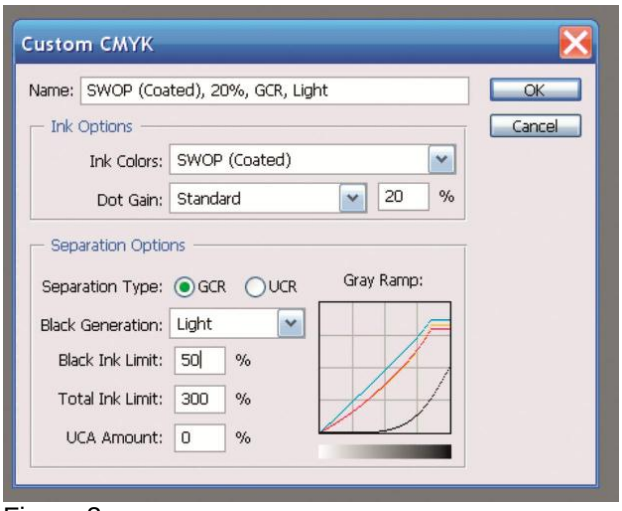

Figure 3

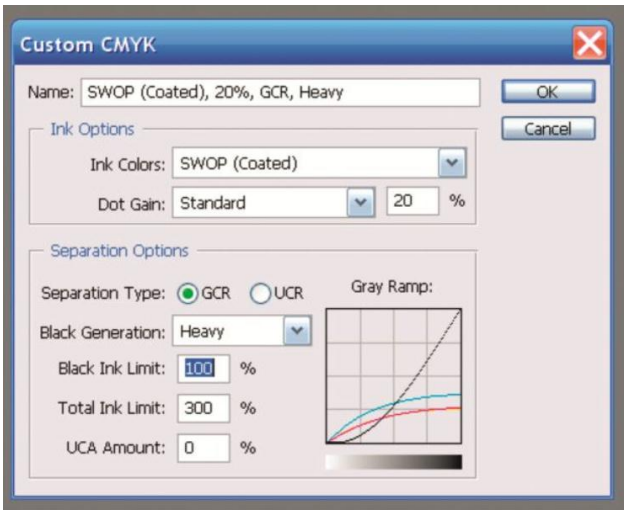

Figure 4

The author has been involved in color separation as early as 1975 when the process was still photomechanical up to the present involving digital CtP technology. He is a past president of the Philippine Printing Technical Foundation and a regular resource speaker for the foundation's seminars. Comments may be emailed to philprinting@gmail.com.

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