Ink® A Division of Sun Chemical Corporation

UCR and GCR
WHAT ARE THEY?

Volume XV June, 1996

Undercolor removal (UCR) and Gray Component Replacement (GCR) are techniques used in the separation of color for reproduction on a four color printing press. The two processes are different so we will discuss them separately.

UCR

Theoretically, when all the process colors cyan, magenta, and yellow are printed on the same piece of paper, they should absorb all the colors reflected from the surface of the paper and thus create black. However because of the nature of the pigments used, the combination of equal amounts of the three colors is brownish in nature. As a result, the black ink is added to the three colors to compensate for this deficiency. Undercolor removal is the process of reducing yellow, magenta, and cyan dot values wherever black is printed. In other words, areas that are 100% of the four solid colors are reduced to 60% yellow, 60% magenta, 70% cyan, and 70% black. This allows for a total coverage reduction from a 400% ink film to a 260% ink film. This would be described as having 260% UCR. This is an extreme example and is not necessarily real. Most halftone prints would not have this level of coverage. However, the theory would be the same for lower coverage areas with a similar reduction possible. Some advantages of UCR are as follows:

1. **Black brings out better detail and contrast in the photograph than it is possible with the process colors. Black will make the white appear whiter and will add density, resulting in improved contrast in the shadow areas. Higher contrast usually also increases the image sharpness.**

2. **Substantial amounts of the process colors removed from the areas where black is to be printed allows better ink trapping during the run.**

3. **Process colors are more expensive than black. Substituting three process colors with black makes undercolor removal more economical.**

4. **With UCR, the total deposit of ink on paper is reduced, hence the set-off problems are minimized.**

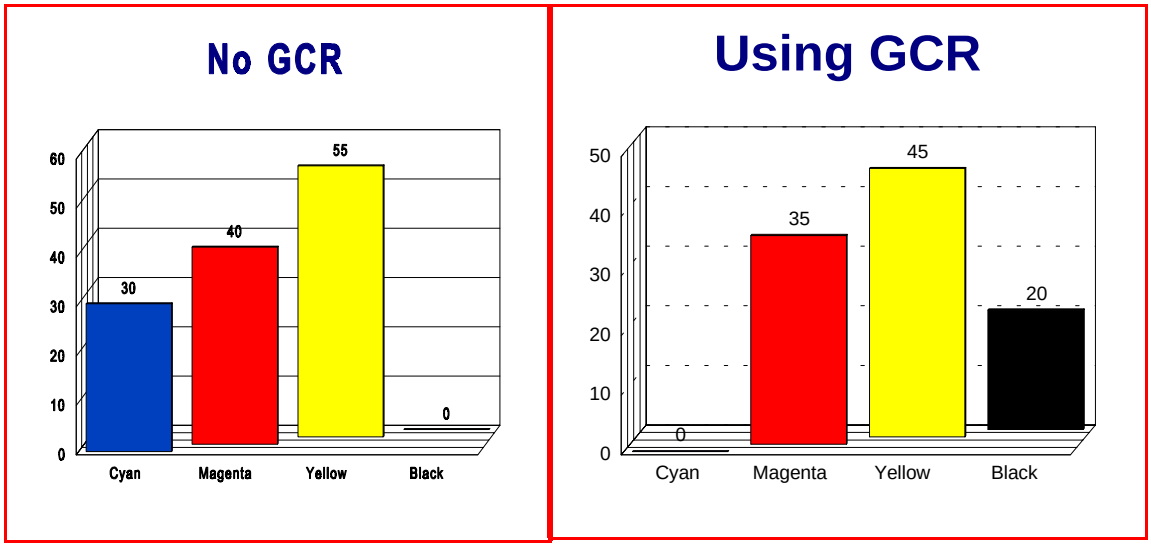
5. **Showthrough or strikethrough and pipe roller buildup are reduced**

because lower-volumes of ink are used. This allows for the use of lighter weight papers.

6. **Because of the use of black, balancing the other three colors is less critical, especially in the shadow areas.**

GCR

The theory behind GCR is that whenever dots of yellow, magenta, and cyan are present in the same color, there is a gray component to that color. That is, if the smallest of the three dot values were to be removed from the color, together with appropriate amounts of the other colors in order to produce a neutral gray tone, then that gray tone could be replaced with a dot of black. For example, to produce a brown a balance of 30% cyan, 40% magenta, and 55% yellow could be used. By using GCR a similar color could be produced by removing the cyan and printing 35% magenta, 45% yellow, and 20% black (See Figure 1). The 3-color separation would require 125% of an ink film while the GCR separation would require only 100%.



125% Ink Flim

With the introduction of GCR, the function of UCR has become less prominent in the separation in a scanner. To better understand why this has taken place, let us discuss some of the differences between the two methods. UCR is mainly concerned with the removal of

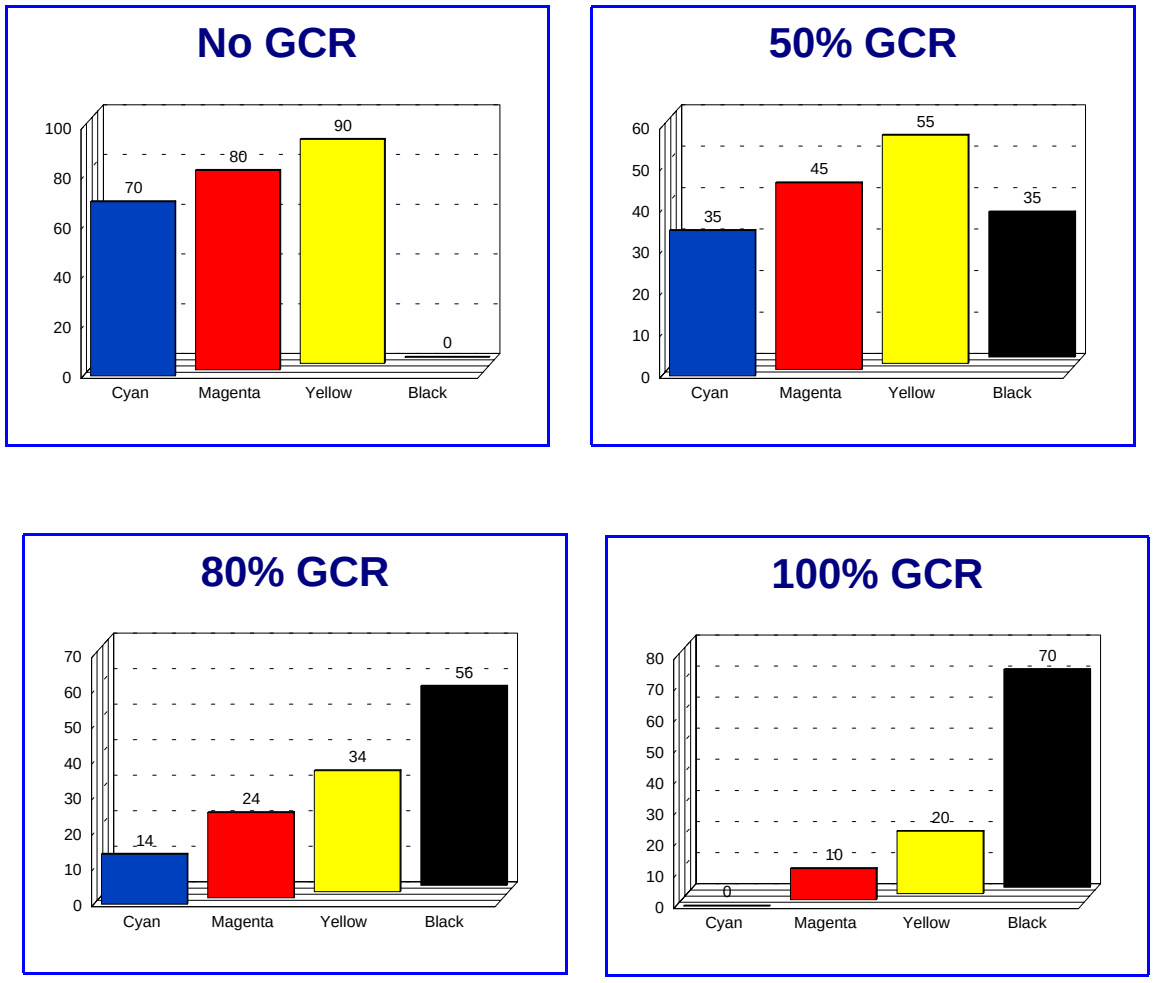


Figure 2

cyan, magenta, and yellow from the neutral areas of the original and replacing the three pigments with black. Originally UCR was referred to as the reduction of the process inks in the dark or near neutral areas of the print. Electronic UCR works satisfactorily with gray, but is deficient in colors close to the gray. With GCR, in addition to the function of removing cyan, magenta, and yellow from the neutral areas of the print, it is also possible to remove the gray component from all colors in the separation, from the highlight through the shadow areas and replace them with black. In other words, GCR consists of those components of the three colors in a reproduced color, which would have produced gray if it had been separated from the reproduction.

The percentage of GCR is related to how much of the tertiary color is removed. For example, if the tertiary color is fully removed, it is said that there is 100% GCR, if 80% of the tertiary color is removed, 80% GCR is said to be used. (See Figure 2).

GCR is given different names by various scanner manufacturers. Some of these are: PIR, Royal Zenith's Programmed Ink Reduction, CCR & PCR, Hell's complementary Color Reduction and Programmed Color Reduction, PCR, Crossfield's Polychromatic Color Removal, and ICR, Dainippon's Screen's Integrated Color Removal.

Advantages of GCR

1. **Color ink consumption is reduced.**

2. **Dot gain fluctuation is generally less critical because most color shades are darkened with black, because only three colors are used to produce these shades as opposed to four.**

3. **The reproducible color space is better. Colors darkened with black show the changes in tonal range better compared to hue shifts caused when a third primary color is used.**

4. **Register problems are reduced because black is dominant and covers most outlines.**

5. **Trapping problems are minimized because the quantity of ink is reduced in all colors.**

The percentage of GCR applied will depend on individual pressroom conditions, such as paper, ink, fountain solution, blankets, plates, etc. Separations with 40 to 60% GCR seem to be optimum at this point. It has been indicated that 100% GCR may create problems such as a white line around an object if the registration on the press is not perfect.

The following are the industry source levels for GCR:

SOURCE	RANGE
GATF 1989	40 - 70 %
SNAP 1994	60 - 80 %

UCR and GCR are techniques that when used correctly can enhance the output of the finished product. However if these techniques are misapplied, they can actually detract from the finished product. In working with these techniques, it is best to work with the supplier of your scanner to achieve the optimum output for your process.

3 Color Conventional

3 Color GCR

4 Color Conventional

4 Color GCR

Black Separation Conventional

Black Separation GCR