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Separation Basics and Transfer Curves

This chapter covers some basic elements of the color separation process.

In this discussion, the assumption is that the printing surface is white and that the ink used for printing isn't completely opaque, which means that laying inks over each other results in intermingling colors.

Three- and four-color printing is based on the subtractive color model, in which blending colors together yields a darker color. A tone created by combinations of the three basic process colors (cyan, magenta, and yellow) is called a tertiary color. Blending these three colors at 100% intensity produces a nearly black color. But because the combination of cyan, magenta, and yellow cannot create a true black, a black ink is added, in a process called four-color printing.

During printing, ink is always laid down as a solid color. To create variations in tone, the color is screened, broken down into an array of dots whose color blends with the white background of the paper. Varying the size of the dots varies the lightness of the perceived color. This process is also called halftoning, because it creates midtones between the color of the ink and the white of the paper.

In four-color printing, black takes the place of those areas in which cyan, magenta, and yellow all appear simultaneously. This saves ink by using black ink to create black tones rather than approximating them with the other three colors. If the proportions of C:M:Y in a printed area is 100:50:30, the overall gray effect of those colors is

30%. This resulting color can theoretically be reproduced by adding 30% black to the image and reducing the three other components accordingly. In other words, the tertiary color made up by C:M:Y = 100:50:30 in three-color printing can be reproduced by C:M:Y:K = 70:20:0:30 in four-color printing

This introduces an important concept: achromatic colors. In achromatic colors, the share of the least-used secondary color is completely replaced by black. Tertiary colors don't use black at all, but in achromatic colors one of the secondary colors is not used.

However, black doesn't always meet all of these theoretical needs. Four-color black is often supplemented with a black created by printing the other three colors together, in order to obtain a fuller and deeper black. For replacing process colors with black, two principal methods are used:

BG;¬**Black Generation (BG)**
Black generation defines the maximum percentage of a component of a tertiary color that can be replaced by black. In a Black Generation curve, the x-axis represents the initial value, the y-axis determines the share that is replaced. A diagonal line from the bottom left to top right results in achromatic colors, completely removing at least one of the process colors (cyan, magenta, or yellow). A horizontal line at 0 represents pure CMY colors, with no black used.

UCR;¬**Undercolor Removal (UCR):**
This reduces the proportions of the process colors (cyan, magenta, and yellow) in accordance with the amount of black that has been added by the Black Generation.

Transfer Curves
When printing a plate, various grays are output in halftone cells with different dot sizes. These halftone cells and dots have precisely

defined areas of coverage. Varying physical conditions while printing or copying often leads to a loss of such precision; for example, ink may bleed on wet paper. This enlargement of dots is called dot gain.

Dot gain is especially noticeable in the midtone and dark areas of an image. If this effect isn't compensated for before screening, the print will usually appear too dark. Simply increasing the brightness for the complete image would cause a loss of depth in the image, by also affecting lighter areas that are not disturbed by the dot gain.

Dot gain must be analyzed by examining samples, such as a gray balance chart that can be checked with a densitometer. Because not all areas are affected to the same degree, measuring in different areas is essential. The result of this examination is usually displayed in a special characteristic curve called transfer curve.

A diagonal transfer curve from the bottom left to the top right specifies a direct linear relationship between the original data and that sent to the output device. For example, a value of 50 on the abscissa corresponds to a value of 50 on the ordinate. Shifting the curve upward (e.g., x = 50, y = 70) increases the intensity of the print.

Hint: Transfer curves can also be used for special effects. For example, a diagonal from the top left to the bottom right inverts the print. A stairlike curve reduces the number gray levels, which results in a posterizing effect.

Screening

During printing, each of the process colors are printed separately, each from its own printing plate. However, an imagesetter doesn't print colors; it only creates dots that will eventually be printed using a color. The number of dots (or machine spots) an imagesetter can set per inch defines the resolution of the device, measured in dots per inch (dpi).

For creating impressions of varying color or brightness, machine spots are combined to larger dots of various sizes and shapes, called halftone dots. The smaller the machine spot (that is, the higher the resolution of the output device), the more variations are possible in the size of the halftone dot. The number of halftone dots per inch or centimeter is called the line screen ruling or line screen frequency and is measured in lines per inch (lpi) or lines per centimeter (l/cm). The more dots that can be set per unit, the higher the resolution. A line screen of 60 lpi means that there are 60 printed halftone dots per inch.

The number of machine spots that are used to image each of these dots depends on the output device's resolution. If, for example, a 60 lpi screen is created on a device with a resolution of 3,000 dpi, each halftone dot consists of a cell 50 machine spots wide by 50 machine spots tall. The size of the halftone dot depends on how many of these machine spots are imaged and how many are left blank.

Spotfunktion;¬Spot Function
Though the cell of a halftone dot is usually rectangular, the halftone dot need not be. In each cell, a halftone dot can be created in any size and shape. Usually, elliptical or circular shapes are used. The exact form is described by a threshold matrix called ªspot functionº.

Screen Angle
When printing multiple colors, the halftone dots cannot be arranged the same way for each plate, because this causes MoirÝ patterns. Instead, the pattern of halftone dots on each plate is rotated at a different angle. The angle of this rotation is called the ªscreen angleº.

Frequency Modulated Screening
Recent developments are replacing traditional screening methods

with a technique called frequency modulated screening. This methods doesn't produce MoirÝ patterns, so no different screen angles are necessary for the different plates.