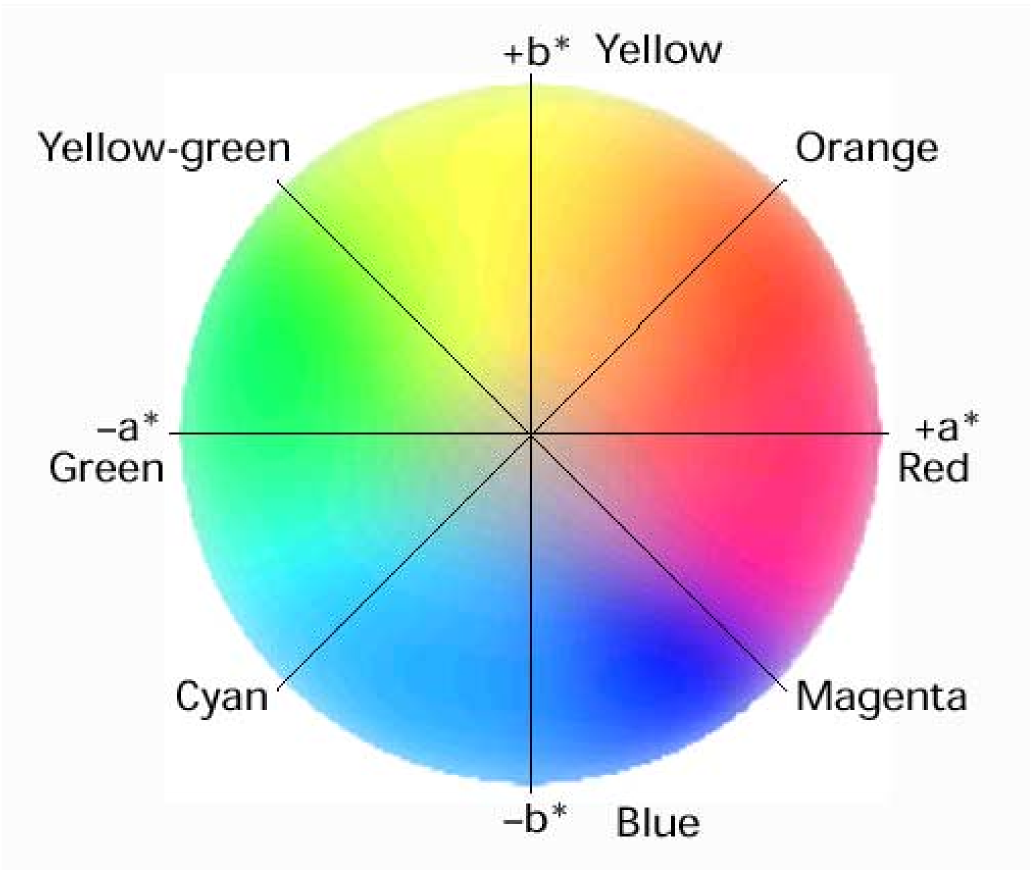
US Ink A Division of Sun Chemical Corporation

What is Color Gamut?



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Color Gamut refers to the range of colors that can be reproduced by any device/system. Unfortunately for printers, the color gamut in nature is much larger than any we can reproduce with paper, inks, dyes and pigments. The best we can do is to choose those conditions over which we have control in a manner that will permit us to get as close to the original scene/photograph as possible.

To better understand this concept, please refer to Figure 1. This portrays the color gamut of several different systems. It is quite obvious the gamut decreases as you move from the visible to CMYK process printing. This decrease in color gamut is due to several factors including:

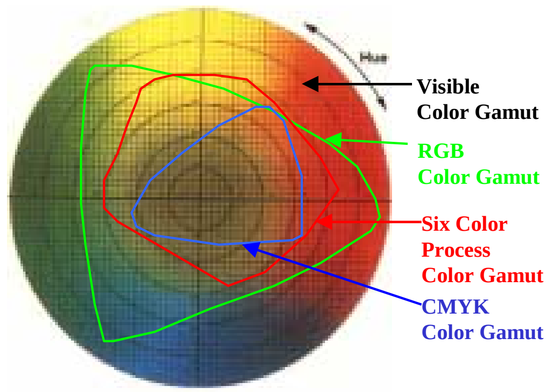


Figure 1- Color Gamut

Additive vs. Subtractive Color

Colorant types and combinations

Paper selection

Solid ink printed density

Trapping

Additive vs. Subtractive Color

These two color theories explain how we create and perceive color. The Additive process uses colored light to create the gamut. A common example would be movie theaters, televisions or computer projectors. The Primary Colors are Red, Green and Blue. The Subtractive process uses chemical colorants that absorb various portions of visible light to produce the colors. The Primary colors are Cyan, Magenta and Yellow. This is how color is produced on a printed sheet.

Colorants

The production of a colorant is a complex chemical process. The creation of a perfectly pure Subtractive Primary colorant is not presently possible. Colorant manufacturers have created products that must be acceptable process colors, capable of large volume production, and reasonably economical.

The colorant's function is to absorb visible light in certain parts of the spectrum and reflect light in other parts. Figure 2 shows a Reflectance curve over the visible spectrum. A "perfect Cyan" would reflect all of the light in the Blue and Green areas of the spectrum and absorb all of the light in the Red region. The Cyan curve, as shown in this figure, is a typical Reflectance curve for ink printed on newsprint. The Cyan does not reflect all of the light in the Blue and Green areas and reflects some light in the Red area of the spectrum. This is a function of the pigment, paper and solid ink density of the print. The deviation of the printed Cyan from the "perfect Cyan" is one of the causes for a reduction in the color gamut. Typical printed process Magenta and Yellow inks are also inferior to their "perfect primaries". Alternate colorants can be used, particularly for the Magenta and, to a lesser extent, the Cyan, to minimize this difference. Unfortunately, these normally carry significant economic premiums.

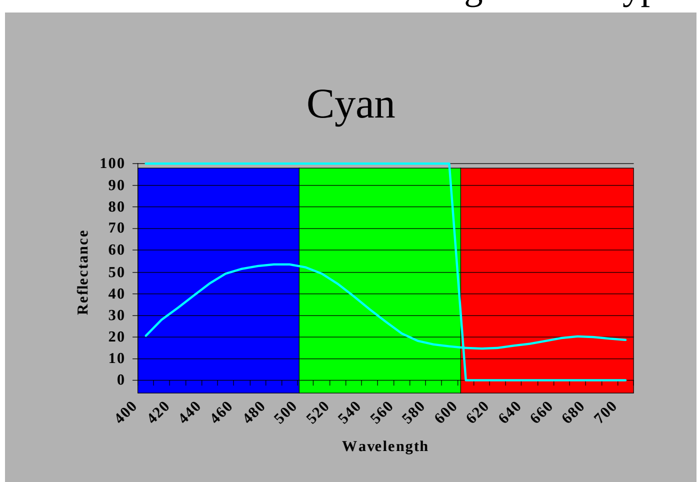


Figure 2- Reflectance Curve

The greater the number of colored inks you can use in a printing process the greater the color gamut one could create. As seen in Figure 1 the Six Color Process color gamut is greater than the CMYK. This is because more than four colors are used to create the printed product.

This is not a practical or economical approach in the publication market. More printing units are needed and the other two inks utilize premium priced colorants. The increased costs preclude this from happening. Unfortunately, the creation of a third color by combining two printed colors produces a color that is not as pure or "clean". This is another reason why the gamut is reduced.

Paper

The type and brightness of the paper that a colorant is printed on will also affect the total color gamut. The ideal substrate would reflect 100% of the complete spectrum of incident light. The printing of pigments on a stock such as newsprint will not be able to overcome the absorptive characteristics of the stock, thus the gamut will be significantly reduced. In comparing the gamuts of a commercial heatset print on coated paper vs. that on newsprint the gamut will be smaller on the newsprint due to the effect of the paper.

Solid ink density

The solid ink density of a print is a measurement of how much light is either absorbed or reflected from the surface of the print. The higher the print density the more the light is absorbed. This greater absorption or higher print density will create a larger color gamut. Figure 3 shows the practical densities of a transparency, commercial heatset and newsprint. The practical density range on newsprint is much lower. The newsprint surface is very rough and absorptive of ink and scatters incident light. The surface roughness does not allow for a uniform ink film and requires more ink to achieve equivalent densities. The commercial heatset paper is a coated paper that has a much more uniform, relatively non-absorptive surface. Because of these differences in the substrates, particularly in light scattering, the maximum achievable density on newsprint is lower. This has a significant limiting effect on the potential color gamut.

All of these factors can limit the gamut that can be reproduced by a particular printing process. Variations in the substrate are extremely significant. In most cases, little can be done, on a practical level, without raising other significant process or cost issues.

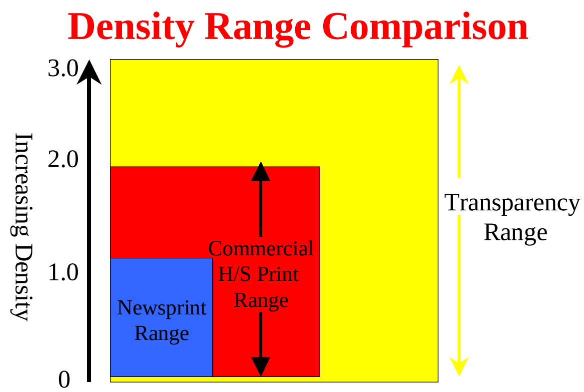
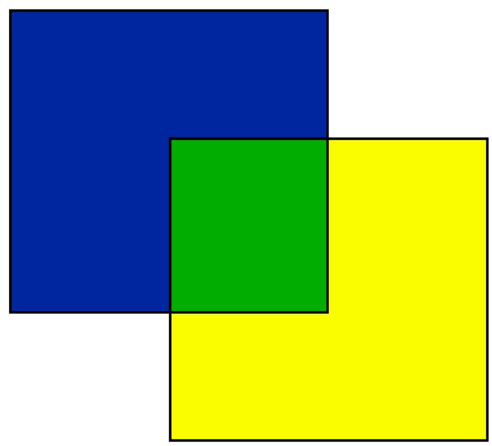


Figure 3- Density Ranges

Trapping

Process color relies on wet-on-wet printing. The first color down must trap the second, the second must trap the third, and so on. Any printed color will invariably transfer more efficiently to the paper than on top of a preceding color. Poor trapping will lead to color casts, but only on color pairs where the problem occurs. Other colors may be normal. The sequence or order in which the colors are printed will affect the color gamut. In order to achieve the largest color gamut the following recommended sequences should be used:



Printing Sequence

SNAP recommended printing sequences:

Offset	Flexography	Letterpress
CMYK or KCMY	YMCK	CMYK

Note: Industry tests indicate that the CMYK laydown sequence yields the widest gamut for letterpress. In newspaper flexography, yellow is laid down first so that it does not hide subsequent colors.

Summary

In order to achieve the maximum color gamut in newspaper offset printing the following steps must be maintained:

- **Print to SNAP specified densities.**
- **Use a clean bright sheet of newsprint.**
- **Ensure that all of the mechanical settings on press are correct so that a uniform ink film and proper trapping can be achieved.**
- **Use the SNAP specified printing sequence to achieve the proper trapping.**