The Variables of Color Management of Screen Ink Versus Digital Ink Systems

Screen ink and digital ink systems are very different from each other, but there are some common color management goals that can be achieved:

1. A color gamut that will cover the intended target and a dynamic range of shadows to highlight
2. Accurate Red, Green and Blue overprints
3. Balanced grays

If you achieve these goals color managing for screen or digital ink, you will be producing highly accurate prints at production speed.

Color Management Variability of Screen inks

Legacy 4-color process inks are CMYK (Cyan, Magenta, Yellow and Black). These are used for all analog printing including screen. Most analog process colors used in photographic printing are based on this. The industry has dabbled in adding Light Cyan, Magenta and Black with positive results, but no results have been positive enough to cover the increased cost of additional screens and six or seven colors that need to be kept in inventory. We can easily print CMYK plus Orange and Green or Orange and Violet (Hi-Fi color), but not for the same price. So, CMYK prevails. In digital, it is not so difficult or expensive.

Color management with screen print inks has some basic concepts we need to understand.

To be fair in comparing color management of screen print inks to digital inks we will assume that the inks are being printed on ISO 12647-2-compliant, premium coated paper measured on a white backing, L*95, a*1, b*-4. This premium quality white is bright white at L*95 with almost no red-green cast on the a* axis with a +1, and the b*axis shows slightly cool with a b*-4. This is the new international standard for the white values of a number 1 coated premium sheet.

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The Three Common Goals of Color Managing Screen Print Ink Sets

1. Color Gamut:

Color gamut is the outer edge of the color space you can achieve, along with the darkness and lightness normally based on the substrate **(Figure 1)**. If we know these outer limits of CMYK, the RGB, the white point and the black point, we know the gamut. The volume of the gamut is dependent on the black inks and the paper's ability to get close to "0" — pure black — and the white paper's ability to get to "100" — pure white.

2. Overprints:

The accuracy of the overprints is dependent on the pigments used, the color sequence and the density of the inks **(Figure 2)**. Overprints are the result of solid color, transparency, color sequence and ink pigment hue. A "balanced" ink set does not rely on "density adjustments" to do this. Density is a process control tool "after" you have achieved the correct color and the correct overprint. A poorly balanced ink set can be color managed to work through profiling, but it's always better to start with a balanced ink. The aim points of the overprints will be found in the aim points of the data set you are attempting to match. If using Photoshop for your original images, know what the L*a*b* Red, Blue and Green are. Make sure, when you do your CMY calibration, the result of the magenta over yellow is the right red; and the cyan over yellow is the right Green; and the magenta over the cyan is the right blue. Most screen print ink sets are 9 to 13 delta E out on the blue, and 7 to 9 delta E out on the green. This is a problem, and is the cause of a lot of confusion in the industry on why digital and screen inks are difficult to align in color output. If you find you have this problem, talk to your ink vendor, and ask if they can adjust the overprint result. It will solve some of your color difference problems.

3. Gray Balance:

The gray balance (critical to raster image accuracy) starts with the solid ink balance, and then is balanced in the dominant image area (quartertone, midtone and three-quartertone) using curves or color management profiles. The easiest and most accurate way to do this is to apply G7 Methodology **(Figure 3)**. The starting point is the three color overprint — C,M,Y. Printing 100 percent of each color is referred to as 100x3. It should be neutral. The a* should be close to "0". That means it does not have a red or green cast. The b* should be close to "0". That means it does not have a yellow or blue cast. If you start with a balanced 100x3, managing all the tonal areas created will be easy.

The Five Ifs:

1. If you use inks that have a large gamut through clean, pure pigments produced at a high density on a good, white substrate, you can achieve most colors on an offset proof in screen printing.
2. If you have balanced inks close to the 100x3, and adjust them all the way to neutral at the solid tonal area, you can get good gray balance.
3. If you use inks that have an overprint Red, Green and Blue result close to ISO Standards, you can get accurate Red, Green and Blue overprints.

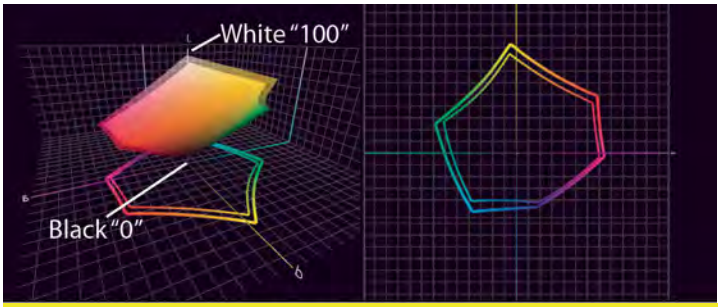

Figure 1: What is color gamut?
Color gamut is the outer edge of the color space you can achieve along with the darkness and lightness normally based on the substrate. If we know these outer limits of CMYK, the RGB, and also the white and black point, we know the gamut. The volume of the gamut is dependent upon the black ink and paper's ability to get close to '0', and the white paper's ability to be as bright as '100'.

4. If you then use G7 Curves to balance the grays from the solids to the white paper, it will look very good, and match very closely to the ISO 12647-2 digital proof.
5. If you don't qualify on any of these first four ifs, you can just print ICC color patches and create a profile that will correct minor color differences. A profile will not fix a shortfall on the color gamut or low densities. What it will do is mix the colors available to get closer to the correct target solids, overprints and gray balance.

(Figure 4).

So, know your target; get as close as you can with what you have, and then profile to make it better.

Color Management Variability of Digital Ink Systems

Color management is very different in digital inkjet inks compared to inks used in analog printing, but the color target should not change. You might be thinking, "if the inks are very different, then the target has to change." Not really. I may not be able to get to the values of the outer limits of the color target due to limitations of the ink's color gamut or dynamic range, but if I have the gamut and the range, I can still get very close to the proof. If I don't match it exactly, I know that I am as close as I can get. It will look good, but not as accurate. With the gamut and range needed, the result will be even better **(Figure 5)**.

Color management with digital inkjet inks has some basic concepts that need to be understood.

Color Gamut:

Just like in screen printing, color gamut is the outer edge of the color space you can achieve, along with the darkness and lightness normally based on the substrate. If we know the outer limits of CMYK and others available with digital — Orange, Green or Violet — we know the gamut. The light versions of cyan and magenta just make it smoother. It does not help the gamut. The volume of the gamut is dependent on the black ink and paper's ability to get close to "0", and the white paper's ability to get to "100". No amount of profiling can make it bigger, but a bad profile could potentially make it smaller.

The Overprints:

The accuracy of the overprints is dependent on color management that may mix three to eight colors, to correct the hue. Color

Figure 2: What are overprints?
Overprints are three of the seven primary colors used in four-color process printing: Red, Green and Blue (RGB). These colors are more important to get right than the solid CMYK. If CMYK colors work together when printed 'over' each other, then color management becomes workable.

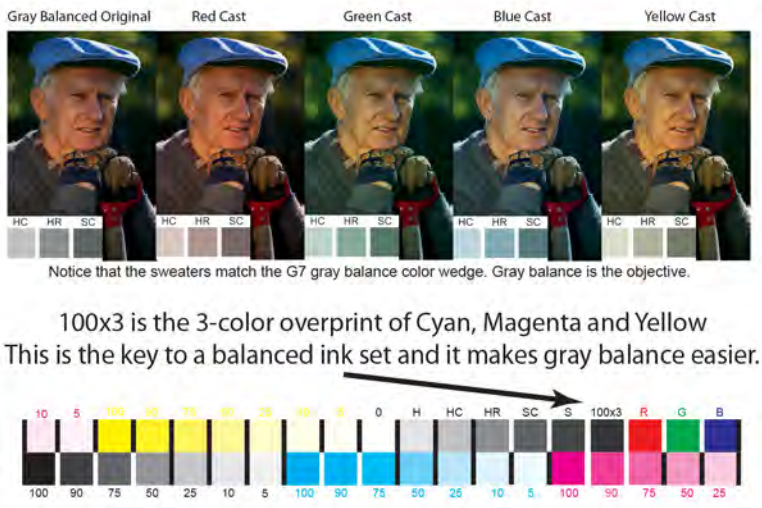

Figure 3: What is gray balance?
Gray balance is critical in managing ink set variations. G7 is the easiest way to manage this important process. The 100x3 (three-color overprint) needs to be balanced before calibration to neutral gray because it becomes more difficult if your out-of-balance ink set throws a cast in all overprints. It can be done, but a properly calibrated, gray-balanced ink set will make it easier.

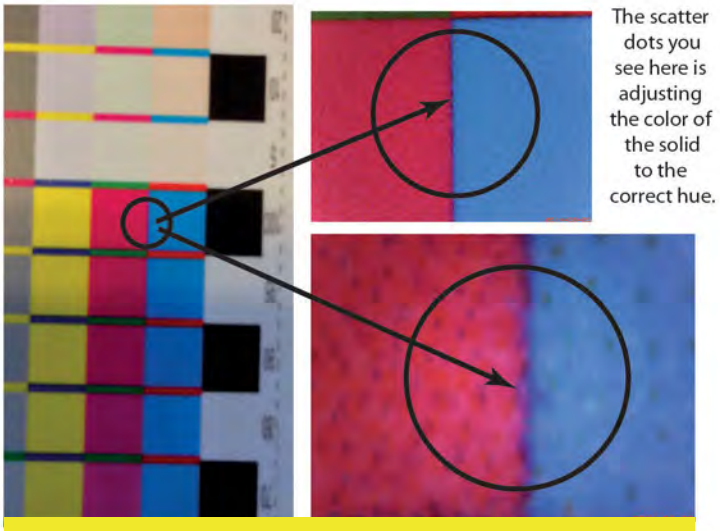

Figure 4: Profile Mixing Colors to Achieve Accuracy
A profile will not fix a shortfall on the color gamut, or low densities, but it will mix the color available to get closer to the needed target solids, overprints and gray balance. Realize the scatter dot you see in profiled solids may have other colors mixed in.

Figure 5: Different Gamuts, But Still a Common Appearance
These two substrates have very different gamuts, but a common visual appearance can still be achieved if gray is balanced based on the substrate's color and its ability to maintain a dynamic range through a whiter white and a blacker black.

management can't expand the gamut. The overprint rules are the same. If your ink is closer, the color management software doesn't have to work so hard.

The Gray Balance:

Gray balance (critical to raster image accuracy) starts with the solid ink balance, but is again corrected by the color management software as it attempts to match the input profile of the RIP. The dominant image area (quartertone, midtone and three-quartertone) using color management profiles is easy using G7 gray balance methodology. Now we have available seven international standard data sets and profiles we can use for aim targets; these data sets take substrates into consideration. The tremendous value of these data sets is that they all are gray-balanced using G7 methodology. The ANSI (American Standard Institue) has CGATS 21-1 and CGATS 21-2 available for all process printers to use **(Figure 6)**.

The seven new data sets are bringing screen and digital closer together by just having common aim points that are gray balanced. In digital, because we use profiling, RGB that is not accurate will be corrected, except where the color gamut falls short of the target. It will match as closely as possible depending on the gamut and rendering intent you choose.

The Three Ifs:

1. If you use digital inks that have a large gamut though clean, pure pigments produced at a high density, you can achieve most colors on an offset proof or any of the CGATS 21 data sets.
2. If you use digital inks that have high density, and add orange and green, or orange and violet, you can go way beyond the standard offset proofs, and use the CGATS 7 color gamut.
3. If you have balanced inks through color management and use G7 methodology, you can actually create a beautiful midtone image that matches offset.

In Conclusion

Some well-meaning print producers say things like, "Digital looks so much better than screen printing." I challenge you to get all the values I have documented correct, and get the viewing distances equalized, and I bet you will find that this thinking is old school. These thoughts come from poor calibration and wrong print methodology.

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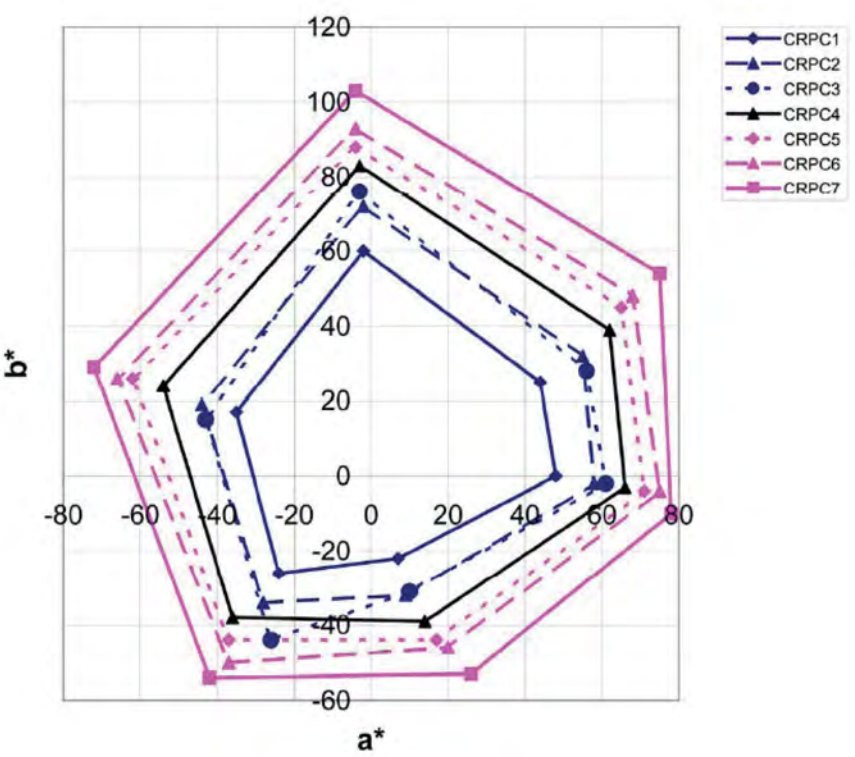

CRPC	Name	Typical Use
1	Universal ColdsetNews	Small gamut printing (newsprint)
2	Universal HeatsetNews	Moderate gamut printing on improved newsprint type paper
3	Universal PremUncoated	Utility printing on a matt uncoated type paper
4	Universal SuperCal	General printing on super-calendared paper
5	Universal PubCoated	Typical publication printing
6	Universal PremCoated	Large gamut (typically commercial) printing
7	Universal Extra Large	Extra Large gamut printing processes

Figure 6: Digital Gamut Choices With a Common Appearance