UNDERSTANDING AND ASSESSING COLOUR CRITERIA IN FOUR-COLOUR PROCESS SCREEN-PRINTING

Mike Ruff explains the four critical principles of print analysis

In a predictable, productive and profitable four-colour process work-flow good print analysis skills are critical. Some screen-print process colour professionals do not even capture the data and only attempt analysis when a print problem occurs. Actually, every job should be analysed good or bad. This is how profitable companies have a benchmark for comparison. By having knowledge of what is good and what is bad, they can avoid print problems but, when they occur, they can quickly and easily trouble-shoot print issues and move on with production.

In this article I will explain the principles of print analysis, what data is important to look at and how to analyse the data. I won't get very deeply into how to correct print issues in this article but if you can develop skills in identifying the problem with a print, you can then quickly and effectively implement corrective action.

BASIC PRINCIPLES

My friend, Bron Wolff, a screen-print production manager and member of the Academy of Screen Print Technology, always informed training classes at SGIA: "Colour is only three things… it is the colour of the substrate, the colour of the ink and the percentage of the dot." This simple principle in print analysis will help you avoid over thinking and confusing yourself in regard to print analysis. I understand there are many variables that can affect colour but, if you think about it, the variables are just affecting one of the three things Bron identifies. By learning the control points of these three things, control becomes more focused on the result rather than the input.

There are four critical principles we must understand in print analysis.

1. The principle of the colour target.
2. The principle of a neutral print.
3. The principle of the colour process ink colour. (More than density.)
4. The principle of the colour of the substrate. (More than white.)

THE PRINCIPLE OF THE COLOUR TARGET

A high quality internal proof must be the final predictor of what is intended on press in a four-colour process workflow. The colour target must be understood to be more than a visual reference. It must be your numeric reference. The data set the proof is representing must be known, such as SWOP, GRACoL or Fogra. By knowing the values of the target, the data recorded from the print becomes relevant. Your internal proof must be accurate and equipped with colour bars that can be scanned. See Figure 1: IDEAlliance 12647-5 Screen Print Control Wedge. All the data you will see in the sample print analysis is scanned from this control wedge.

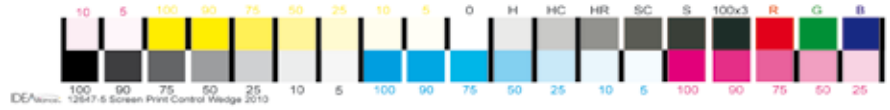


Figure 1: 12647-5 control wedge

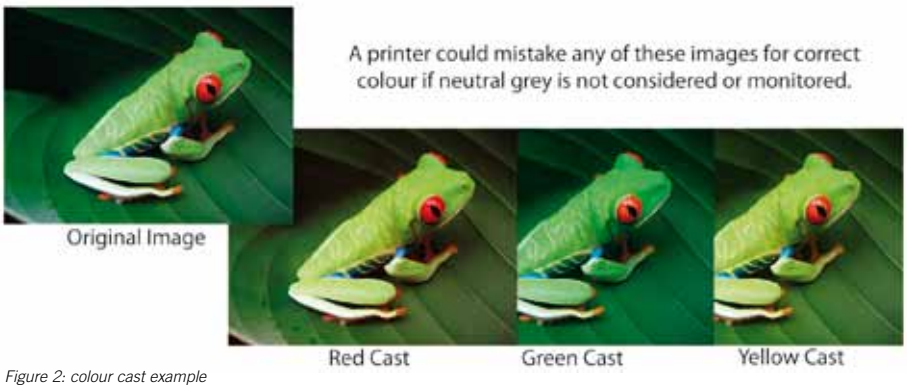


Figure 2: colour cast example

THE PRINCIPLE OF A NEUTRAL PRINT

We must understand that a neutral work-flow guarantees the integrity of the original file. Scanner operators have understood this for years. Printers, for the most part, just chase density and tonal values. But if we understand and print to neutral and to a synchronised tonality we are printing accurately. All analogue print processes can be evaluated by the same rules. If we print to neutral, we are accurately simulating the input with the output. See Figure 2: Neutral Printing.

THE PRINCIPLE OF COLOUR PROCESS INK COLOUR

The density of the solid colour of ink is not the colour. The density is the way we control repeatability. Therefore, the colour of the ink must primarily be evaluated in L*a*b*. Also, the stand-alone values of the solid ink colours are not as important as the three-colour overprint of CMY. The three process colours must be balanced and produce a neutral result. I will explain this on the example analysis in this article.

THE PRINCIPLE OF THE COLOUR OF THE SUBSTRATE

The colour of the substrate is the fifth colour in four-colour process printing. The G7 methodology and the new ISO/TS 10128 Near Neutral Grey Standard documents the principle of adjusting for the substrate. In print analysis the substrate colour must be a noted factor. Substrate can be compensated for through neutral print density curves and in print analysis it must be evaluated.

ANALYSIS EXAMPLE

Now that I have established these four analytic principles, Figure 3: Neutral Grey Proof Data is an accurate ink-jet proof. You can see that it is very close to perfect grey balance. Evaluation of the grey balance graph at the bottom left shows a green line that is the target. The a* axis and the b* axis are very close to the zero line representing neutral.

Figure 4 is a scanned data sheet of a 65 lpi screen-print targeting the accurate proof. We should be able to evaluate the colour without seeing the print using these principles and knowing our intended colour space target. The target this print is compared to is GRACoL 7, the data set most commonly targeted in G7. My mark-up and commentary should point the

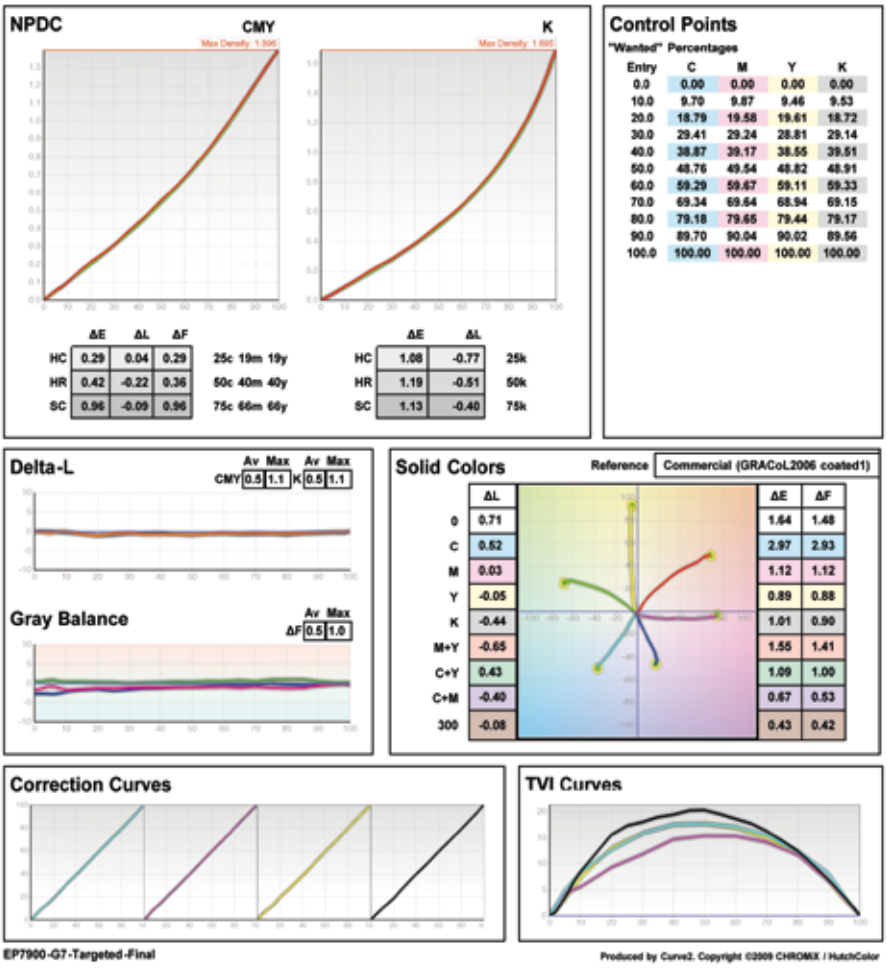


Figure 3: neutral grey proof data

printer to the causes of the mis-match. Note that the data sheet, Figure 4, has two L*a*b* columns. The centre column is the delta E in the CIE2000 Formula. This formula agrees the best with human vision. The L*a*b* column that is designated "target" are the data set values of GRACol 7 (The proof). The column on the right is the print result. This analysis layout is very friendly for easy comparison because results and target are side by side. So let's compare to our 'known' colour data set GRACoL 7, the proof data set.

Continued over

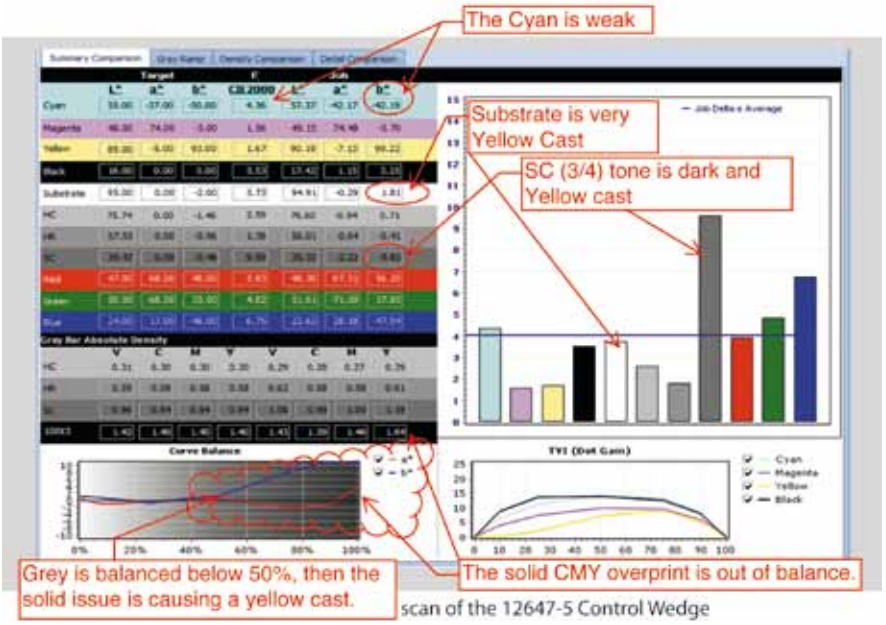


Figure 4: 65 lpi screen print data

COLOUR OF THE INK

The colour of the solid C,M,Y and K seem to be very good except for the cyan. The cyan is close to failure but passes ISO Tolerancs at 4.36 delta E. This was a phenomenon our consulting group struggled with in screen-print grey balance for years until Tim Quinn, a G7 Expert and one of our lead consultants, pointed out and proved with testing and research that the three-colour solid CMY overprint was critical in producing a neutral print.

A quick look at the three-colour CMY overprint in the bottom left of the analysis is indicating a grey balance problem. Both the a*and the b* line should meet close to the '0' on the right side because the '0' point on the right side of the graph is the three-colour black overprint. We desire balanced neutral colour in the three-colour overprint process black. The start of the a* and b* on the left is the paper colour. Ideal paper would start the a* line at 0 and the b* line at -2. (Slightly cool is standard substrate.) As we add colour from highlight to solid we should merge to near neutral CMY black if our ink CMY colour is in balance. It's not in this print.

Notice the ideal 3x overprint absolute density of CMY is 1.40 cyan, 1.40 magenta and 1.40 yellow. The print result of the 65 lpi screen print is 1.29 cyan, 1.46, magenta and 1.64 yellow in the absolute denstity evaluation line. This indicates that, even though the solid densities and L*a*b* colour of the pure CMY are in compliance to our data set target, the overprinting CMY result is not neutral. The primary cause of this it the L*a*b* colour of the ink and using the wrong print sequence, not the density of the ink. This is causing a yellow cast in the print.

TONAL VALUES

The HC, HR and SC are the 25%, 50% and 75% tonal areas. But, unlike conventional densitometry evaluation of each single CMY colour by measuring the TVI (Tonal Value Increase or Dot Gain), a much more accurate evaluation is to look at the tonal values of these areas as grey overprints – in other words with all three colours printing one on top of the other just like a process colour print would print. The values we are targeting are the values of the proof which is the GRACoL 7 data base.

ISO 12647-5 specifies the nominal values of a file that will produce neutral grey is on the chart in Figure 5, Nominal Grey File Values. For example the midtone, CMY is 50% cyan, 40% Magenta and 40, Yellow. This will produce a neutral grey midtone. These are the same numbers Adobe Photoshop will apply if you convert a neutral RGB, 128 Red, 128, Green, 128 Blue to CMYK. If we measure it with a densitometer in absolute density the density values will be about equal if you measure the colours or if you measure the same patch with a spectrophotometer it will be close to a* 0 and b*-2. The numbers are very close to the target except there is a slight yellow cast in the midtone, HR and the three-quarter tone (SC) is dark. This means I have too much dot gain above the three-quarter tone and a slight yellow cast in the grey midtone.

THE COLOUR OF THE SUBSTRATE

Is the colour of the substrate causing a problem? Yes. It is also a big part of the yellow cast problem. Look at line 5, Substrate. It is 3.75 delta E. The a* axis is good with less than 1 dE difference but the target value of the paper on the b* is -2.00. The substrate of the printed piece is a positive +1.81. The substrate is very yellow compared to the ideal white substrate. In my summary I am assuming the substrate can't be changed. However, we can adjust the neutral print density curves to compensate for the yellow cast and the result will be very good.

ANALYSIS SUMMARY

The print is not accurate to the file. It has a strong yellow cast and is should be corrected.

1 The cyan is part of the problem. It is about 8 dE weak in the b*. Higher density would help.
2 The three-colour overprint is very yellow cast. The CMY is not balanced as it overprints and has a yellow cast. Look at the grey ramp in Figure 6: Grey Ramp Comparisons. You can see that the grey ramp is yellow cast. That means anything in the image would have a yellow cast. A blue sweater would be slightly green. A fleshtone would be too warm. A green would be yellow cast.
3 The substrate is also a problem. It is very yellow.

All the problems of the print are correctable except the substrate. But it can be neutralised with a Neutral Print Density using the G7 Methodology or the ISO TS 10128 formula. It will never look exactly like the proof with the substrate so yellow but, if we neutralise the values that we can control such as ink colour, tonal values and overprinting ink colour balance, we should have a very good common appearance with the proof.

CONCLUSION

You can see from this simple print analysis that knowing the target and collecting the data from a print can easily be compared if you understand the numbers and know what the numbers should be. The result of numeric analysis is also much more accurate in determining calibration adjustments than visual assessment. Terms like 'too yellow' or 'too red' or 'too blue' are useless unless you know why something is too yellow, red or blue.

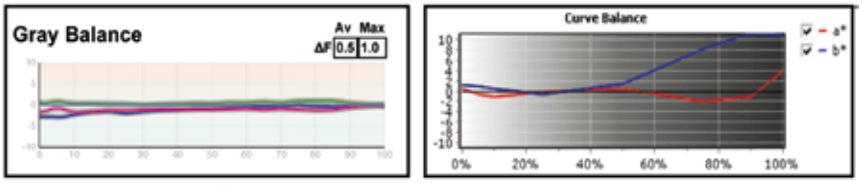
I hope this sparks your interest in becoming a print analysis professional. Remember, know your target, know the data and then just compare the values. Go to colour management classes offered by associations like SGIA, IDEAlliance or Fogra and learn as much as you can about cause and effect in process colour. It may seem difficult at first but you will soon be able to glance at a data sheet and know exactly what is causing mismatches target to print. At that point you move from an artist attempting to be a printer to colour analysis profit producing machine. ■

The values in the chart below are tonal values of linear film or on a file that when printed will produce neutral grey IF the substrate colour is correct and IF the ink color is correct and IF the overprints are neutral. This rarely happens in screen print. Therefore we just target neutral gray and compensate for the variations with Neutral Print Density Curves, Ink Colour and Sequence Control.

Tone Value	Cyan	Magenta	Yellow
25% Tone (HC)	25	15	15
50% Tone (HR)	50	40	40
75% Tone (SC)	75	64	64

Figure 5: nominal grey file values

The left starting point is the colour of the substrate.
The right ending point is the three colour CMY 100% over print. It should be close to "0".



Accurate Proof Grey Ramp — Print Grey Ramp

Figure 6: grey ramp comparison

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