

Color Matching between Pantone and Custom ICC Profiles

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Keywords

Color matching, Color difference, Color accuracy, Pantone®, ICC

Introduction

Pantone®, founded in 1963, has a popular system of identifying, matching and communicating colors to solve problems associated with producing accurate color matches in the graphic arts community. Today, Pantone color matching system provides proprietary reference and color matching solutions for spot colors using process inks via Adobe Photoshop API. Since, these values assume “standarized” Pantone press conditions which do not reflect actual press conditions and other process parameters, it would be interesting to evaluate how Pantone compares to a custom-built ICC press profile using various profiling software.

Objective

Evaluate spot color matching performances between Pantone press profile (150 lpi Pantone) and custom ICC press profiles. Color matching accuracy will be determined both by simulation method (DuPont Color Scientist v1.21) and by actual measurement of color difference between Pantone color patches reproduced in print (Heidelberg Sunday 2000 web offset press).

Procedure

The following steps were used in preparation for the simulation method and printed sample method.

1. Fifteen color patches from the Pantone Color Imaging Guide (1996) were selected and their measured CIELAB values specified as aimpoints. The swatches were measured using a calibrated X-Rite 528 spectrodensitometer under D50 illuminant and 2-deg. observer.
2. Two profiling packages, Kodak Colorflow v2.1

and GretagMachbeth ProfileMaker v4.1.1 were used to build the ICC press profile. CMYK options of 280 TAC, 10 % min. Black, 100% max. Black, and medium GCR were used for both. The output profiles were built for the Heidelberg Sunday 2000 perfecting heatset web offset press on which this publication is printed. The profiles were based on test forms printed earlier on the same press keeping all press parameters constant and process variations to a minimum.

3. The two custom ICC press profiles, Sunday_Kodak_vg.icc and Sunday_Gretag_hk.icc were loaded in the Apple ColorSync folder. The Pantone profile for 150 lpi screen (150-lpi Pantone.icc) is already available and comes as a default with most graphic application packages.
4. Out of the 15 Pantone color swatches selected, 6 patches were out-of-gamut while the rest were reproducible in print. This was done to further analyze color accuracy and gamut clipping issues, which however have not been discussed in this article.
5. The measured CIELAB values for the sample color swatches were taken as the reference and converted to their respective CMYK values (B to A conversion, absolute) using the Heidelberg output press profile as the destination space. The CMYK values were converted back to CIELAB (A-to-B conversion, absolute) by two methods.

Simulation Method

1. DuPont Color Scientist v1.21 was used for conversion from CIELAB (ref) to CMYK (using Pantone, Gretag, and Kodak ICC output profiles) and back to CIELAB color space.

2. Color matching accuracy is judged by the average ΔE between the reproducible color samples and their original specifications. Table 1 shows the three different conversion methods used.

Method	B to A (Abs)	A to B (Abs)
Pantone	Pantone 150 lpi	ProfileMaker
Custom 1	ProfileMaker	ProfileMaker
Custom 2	Colorflow	Colorflow

Table 1. The three color matching methods used

3. The color settings used are shown in Figure 1. For maximum color accuracy, Best CMM rendering quality and Absolute Colorimetric rendering intent were selected. Default CMM was selected due to limitations of the software when performing an A-to-B (Abs) conversion.

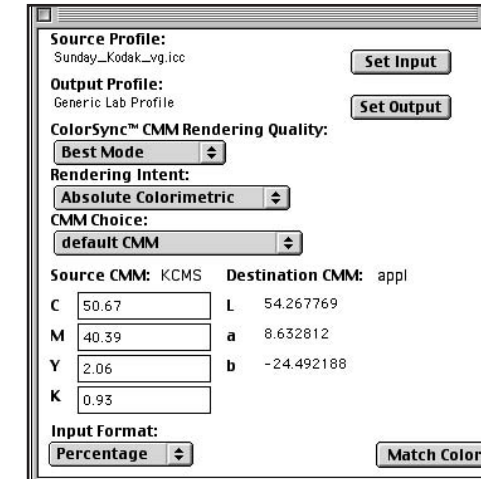


Figure 1: Color settings and sample A to B (Abs) conversion on DuPont Color Scientist v1.21

4. A summary of minimum, maximum, and average L^* , a^* , b^* differences and ΔE between the CIELAB (ref) and CIELAB (DuPont Color Scientist values from B-to-A-to-B (Abs) conversion) for the reproducible patches are shown in

Tables 2a, 2b, and 2c. Table 2c reflects values based on an additional A-to-A (Abs) conversion from the Pantone profile to the output profile using GretagMachbeth ProfileMaker 4.1.1.

n=9	ΔL^*	Δa^*	Δb^*	ΔE
Min.	-0.23	-0.81	-0.90	0.43
Max.	0.78	1.81	1.51	1.21
Ave.	0.25	-0.15	-0.19	0.68

Table 2a. Results for GretagMachbeth ProfileMaker

n=9	ΔL^*	Δa^*	Δb^*	ΔE
Min.	-0.08	-1.86	-0.93	0.14
Max.	0.66	1.82	1.60	1.98
Ave.	0.34	-0.38	-0.07	1.34

Table 2b. Results for Kodak Colorflow.

n=9	ΔL^*	Δa^*	Δb^*	ΔE
Min.	-0.77	-1.86	-2.06	1.00
Max.	1.95	2.10	1.72	2.71
Ave.	1.04	-0.16	0.16	2.08

Table 2c. Results for Pantone 150 lpi.

Printed Samples Method

The following method is used to determine required dot areas for printing.

1. The colors specified were converted to their CMYK values using the Adobe Photoshop API. A sample conversion using the color picker is shown in Figure 2.

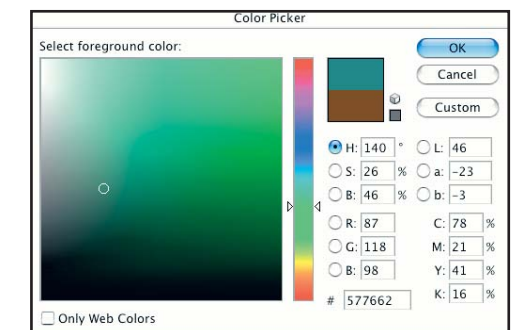


Figure 2. B to A (Abs) conversion using color picker

- The color settings were set to the output working space of the three profiles (Pantone, GretagMacbeth, and Kodak). The rendering intent was set to Absolute colorimetric for maximum color accuracy. Black point compensation (BPC) and the dither options were left unchecked.
- The recorded CMYK values for the three test conditions were converted back to CIELAB (A to B conversion, absolute) by printing these color patches with the CMYK values returned by Adobe Photoshop API and then measuring the press sheets using the X-Rite 528 Spectrodensitometer.
- The colors specified were printed on the same press (Heidelberg Sunday 2000) which was used for printing the profiling targets, keeping all parameters constant and print process variations to a minimum. A summary of results for the reproduced printed colors is given below in Tables 3a, 3b, and 3c.

n=9	ΔL^*	Δa^*	Δb^*	ΔE
Min.	-4.6	-5.1	-4.1	3.1
Max.	1.1	5.2	7.0	8.1
Ave.	-1.9	-1.5	2.1	4.6

Table 3a. Results for GretagMacbeth ProfileMaker

n=9	ΔL^*	Δa^*	Δb^*	ΔE
Min.	-7.9	-6.4	-12.4	1.4
Max.	3.0	5.3	8.7	13.2
Ave.	-1.6	-1.4	0.0	5.4

Table 3b. Results for Kodak Colorflow

n=9	ΔL^*	Δa^*	Δb^*	ΔE
Min.	-11.9	-9.1	-8.2	6.0
Max.	-2.1	4.1	6.3	13.0
Ave.	-5.7	-0.1	3.5	9.2

Table 3c. Results for Pantone 150 lpi

- ΔE values and visual differences perceived between the Pantone and custom ICC output profiles of the color patches are indicative of quantitative as well as qualitative color differences. To enable the reader to visually perceive differences in color, the specified colors reproduced in print on the Heidelberg Sunday 2000 press using the Pantone and custom ICC profiles (GretagMacbeth ProfileMaker v4.1.1 and Kodak Colorflow v2.1) are shown in Figure 3.

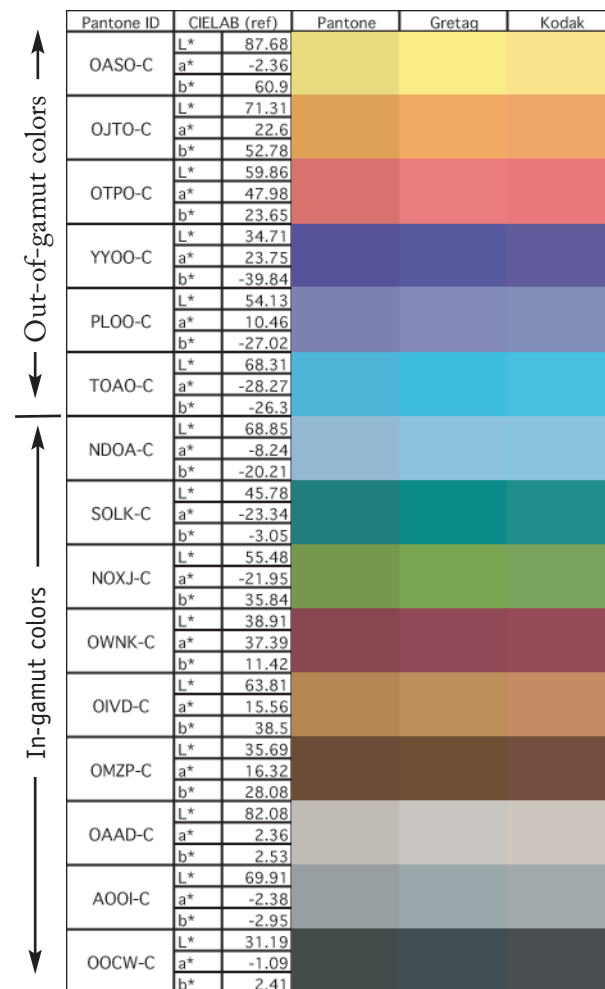


Figure 3. Colors specified and reproduced in print

Discussion

This study was done using two methods of analysis. In the simulation methodology ΔE should theoretically be zero. Since any variations caused by random errors present in the measuring instruments and the printing process itself are eliminated. The residual ΔE differences are due to interpolation and rounding errors of the profiling package, software used for analysis (DuPont Color Scientist v1.21), and CMM used.

Between the two profiling packages used, GretagMacbeth ProfileMaker v4.1.1 provides best color accuracy based on color difference (ΔE) values. A larger sampling of color patches needs to be taken before arriving at a final verdict in favor of GretagMacbeth ProfileMaker.

It is also interesting to note that in the analysis using the simulation method the color differences between the Pantone profile and the custom ICC press profiles was not very large.

In the printed color sample analysis the ΔE differences were more noticeable. As the results in Tables 3a, 3b and 3c show, the custom ICC press profiles had lower average ΔE than the Pantone profile. Using ΔE as a criteria to judge the degree of a color match, we can conclude that the custom ICC profile does indeed provide a closer color match to the specified color than the Pantone profile. This is primarily due to the fact that the Pantone profile has to be generic in nature and does not take into account for the capabilities and limitations of a given output process. We have no knowledge of the print parameters and conditions under which the Pantone profile was built.

This study highlights the fact that for ICC-based color management system to work effectively, graphic arts professionals and printers must be careful in using ICC profiles that reflect their existing process capabilities and print parameters. Having color management is better than no color management. But to use color management effectively, an understanding of how color management works is important and requires effort to build custom ICC press profiles.

As the graphics arts industry moves from a traditional craft based industry to a more exact science, the emphasis is on tighter color tolerances and controlled process variations. Even though traditional skills of a craftsman are replaced by ICC color management, it still requires well trained and skilled operators to implement a color management system or workflow.

The results of the study provides a basis for further analysis on quantitative color matching. For a more comprehensive analysis, a larger sampling of colors can be taken and more profiling packages can be included for color accuracy comparisons.

References

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