

Colorimetric Comparison between Generic and Custom Press Profiles

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Keywords

CMM, Profile, Color gamut, Color matching

Objectives

A generic SWOP profile is suitable if a printing system conforms to SWOP specifications. (SWOP, 2002) In a repeatable printing system, a custom-built profile could be a great benefit in better color matching. However, it is not clear whether or not there is an advantage for using a custom-built press profile over a generic press profile. Therefore, if there is no significant difference in color matching performances between a generic and a custom-built profile, then a custom profile is not worth building.

To determine the value of creating a custom profile, this study focuses on the color gamut difference between a generic SWOP press profile and a custom-built Heidelberg Sunday 2000 press profile. Furthermore, under a repeatable printing system adjusted to SWOP specifications, the accuracy of color-matching comparison between a generic and a custom-built profile were compared on three different a^*b^* slices. Finally, the result is then compared with a similar colorimetric comparison between a generic profile and a custom Heidelberg M-1000B press profile. (Hsu, 2002)

Resources

The following is the list of resources needed in this study.

1. Conventional presses

Heidelberg Sunday 2000 web offset presses.

2. Press profiles

Generic press profile: U.S. Web Coated (SWOP) v2

Custom press profile: Sunday_April_18_03.icc.

3. Test targets

The a^*b^* slice test targets are defined by CIE Lab color space on L30, L50, and L70. The range of the color swatches go from $a^*=-100$ to $a^*=100$, and $b^*=-100$ to $b^*=100$. (Figure. 1)



Figure 1.
 a^*b^* slice test target

4. Profiling software and profiling target

GretagMacbeth CMYK profiling target, TC3.5 CMYK1.tif, was used for press profiling target with profiling software, GretagMacbeth ProfileMaker 4.1.5. (Figures 2 and 3)

5. Application Programming Interface

Adobe Photoshop 7.0.1

6. Data collection and analysis

Gretag SpectroScan and Microsoft Excel template "F_ab_slice(v1.0).xls" (Chung, 2002). CIE $\Delta E76$ was used to calculate the color difference between source $L^*a^*b^*$ and the press output $L^*a^*b^*$.

Procedures

The following shows the procedures in this study.

1. Press profiles

Generic profile: U.S. Web Coated (SWOP) v2 in Adobe Photoshop 7.0.1 was used as a generic press profile.

Custom profile: Using ProfileMaker 4.1.5, a custom profile was built for for the Heidelberg Sunday 2000 web press from the April 18, 2002 press run. The press run was adjusted to conform SWOP specifications.

(More details about process variability and specifications are shown in Box 1.)

2. Color gamut evaluation

The evaluation tool "Gamut View" in ProfileEditor 4.1.5 was used for investigating the difference of color gamut between the generic profile and the custom profiles.

3. Color-matching performance evaluation

Generic and custom profiles were used in Photoshop 7.0.1 to convert the original a^*b^* slice target from Lab files to CMYK files. For maximum color accuracy, the conversion engine was set as Adobe (ACE), rendering intent as absolute colori-

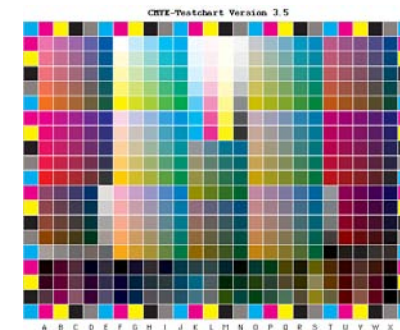


Figure 2.
GretagMacbeth
ProfileMaker CMYK
profiling target

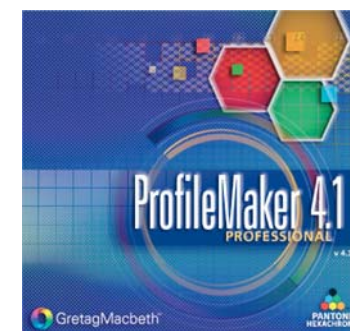


Figure 3.
Profiling software,
GretagMacbeth
ProfileMaker 4.1.5.

metric, black point compensation unchecked and dither unchecked.

These targets were then printed on the Heidelberg Sunday 2000 web offset presses. A Gretag SpectroScan instrument was used to measure $L^*a^*b^*$ values of the printed a^*b^* slice targets under the following settings: D50 illumination, 2-degree observer angle, no filter and black backing measurement.

The Excel template, "F_ab_slice(v1.0).xls," was used to evaluate the color-matching performance. When we analyze the color matching performance, it is important to check the gamut boundary using Photoshop "Gamut Warning." Only those patches inside the gamut boundary should be taken for analysis. To do that, in Photoshop color settings we first set the CMYK working space as the desired output profile. All the conversion options would be the same as the settings when these a^*b^* slice test targets were converted from Lab files to CMYK files. Then open the original Lab files of a^*b^* slice test targets and turn on the "Gamut Warning" feature. Only reproducible patches would show and all the patches outside the gamut boundary would grey out. (Figures 4, 5, and 6)

Discussion

The following are the major findings from this study.

1. Color gamut comparison

The colors defined in the a^*b^* slices cover the whole range of CIE Lab space. However, those colors, lying outside of the press gamut, would be clipped under absolute colorimetric rendering intent when doing color space conversion.

Figure 4. Reproducible patches on L30 a*b* slice target embedded with the custom profile, Heidelberg Sunday 2000_April_18_03

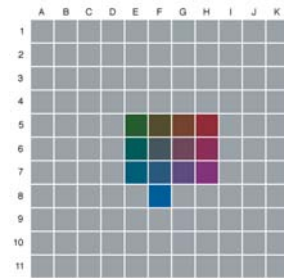


Figure 5. Reproducible patches on L50 a*b* slice target embedded with the custom profile, Heidelberg Sunday 2000_April_18_03

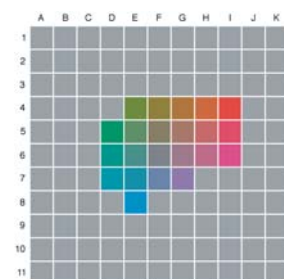
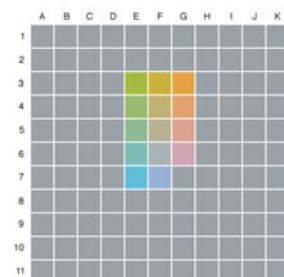


Figure 6. Reproducible patches on L70 a*b* slice target embedded with the custom profile, Heidelberg Sunday 2000_April_18_03



The gamut boundaries of the custom and generic profiles are shown in Figures 7, 8, and 9. On L30 a*b* slice, the Heidelberg Sunday 2000 custom profile describes a significant larger gamut in the magenta and cyan areas. On both L50 and L70 a*b* slices, the custom profile shows slightly larger gamut in yellow and green areas. However, because all of these profiles were calculated for the SWOP condition, their gamut boundaries are pretty much in the same shapes.

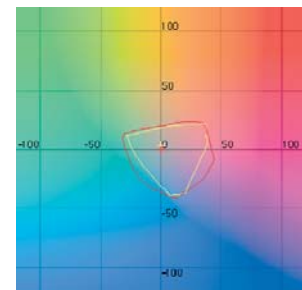


Figure 7. Gamut boundary comparison on L30. (Yellow line -generic profile, red line -custom profile)

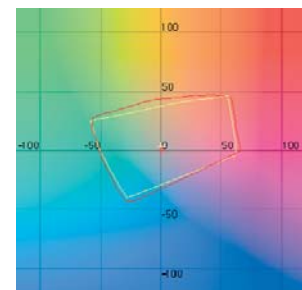


Figure 8. Gamut boundary comparison on L50. (Yellow line -generic profile, red line - custom profile)

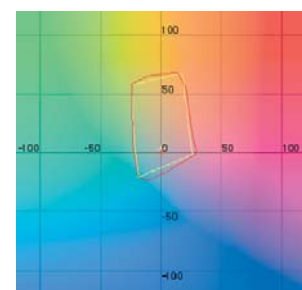


Figure 9. Gamut boundary comparison on L70. (Yellow line -generic profile, red line - custom profile)

2. Color-matching performance comparison

In this study, only reproducible colors were used for color matching evaluation. The color difference observed in Table 1 shows the difference between two printing conditions using generic SWOP profile and Heidelberg M-1000B custom profile. (Hsu, 2002) Table 2 shows the difference between SWOP profile and Heidelberg Sunday 2000 profile. In Table 3 and 4, pairs of neutral color (a*=0 and b*=0) swatches were compared. In Figure 10, a visual comparison of neutral colors shows the custom profile resulted in better gray balance than the generic profile.

	L30		L50		L70	
	Generic	M1000B	Generic	M1000B	Generic	M1000B
Samples	9	13	19	20	10	12
Min.	4.2	3.4	1.5	1.9	2.6	0.8
Max.	7.4	8.8	9.1	5.2	8.4	4.5
Ave.	6.1	5.5	5.5	3.5	5.1	2.6

Table 1. ΔE comparison (Generic SWOP profile vs. custom Heidelberg M-1000B profile.)

Aim point	L*=30	a*=0	b*=0	ΔE
Generic	31.75	5.76	-0.47	6.04
M1000B	32.41	-0.08	-2.43	3.42

Aim point	L*=50	a*=0	b*=0	ΔE
Generic	51.04	4.88	-0.28	5.00
M1000B	51.33	1.27	-2.30	2.94

Aim point	L*=70	a*=0	b*=0	ΔE
Generic	72.44	4.18	-2.00	5.24
M1000B	71.74	1.45	-0.34	2.29

Table 3. ΔE comparison - Neutral colors. (Generic SWOP profile vs. custom Heidelberg M-1000B profile.)

Generally, the generic profile provides less reproducible color samples, higher average ΔEs, and higher maxima ΔE values. By applying the custom profile, ΔE values dramatically decreased. (Table 1, 2, 3, and 4)

In conclusion, a repeatable printing system can achieve better color matching performance via correct custom device profiles.

References

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	L30		L50		L70	
	Generic	Sunday	Generic	Sunday	Generic	Sunday
Samples	10	13	22	22	13	14
Min.	3.5	0.9	2.6	0.9	2.9	0.7
Max.	7.2	5.4	12.4	8.2	15.4	8.3
Ave.	5.7	2.8	7.1	3.5	7.2	4.0

Table 2. ΔE comparison (Generic SWOP profile vs. custom Heidelberg Sunday 2000 profile.)

Aim point	L*=30	a*=0	b*=0	ΔE
Generic	29.74	2.55	4.70	5.35
Sunday	30.22	1.02	0.82	1.33

Aim point	L*=50	a*=0	b*=0	ΔE
Generic	50.12	2.64	4.15	4.92
Sunday	51.51	2.18	2.59	3.71

Aim point	L*=70	a*=0	b*=0	ΔE
Generic	72.41	1.80	-0.63	3.07
Sunday	69.58	-0.81	0.78	1.20

Table 4. ΔE comparison - Neutral colors. (Generic SWOP profile vs. custom Heidelberg Sunday 2000 profile.)

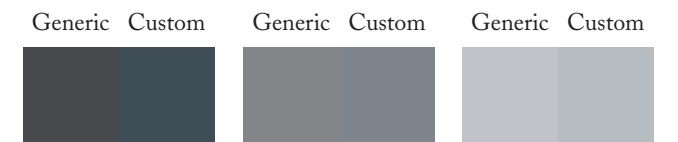
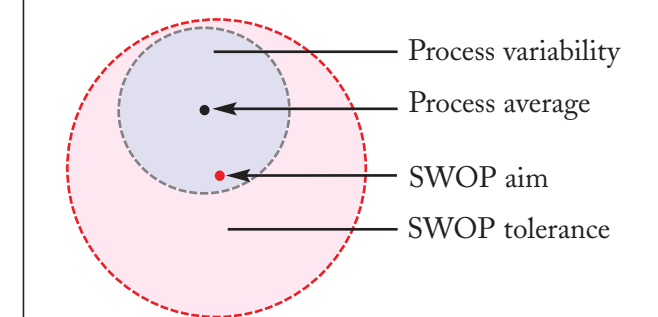


Figure 10. Visual comparison of neutral colors. a*=0, b*=0 on each L30, L50 and L70 slice. (Generic profile vs. custom Sunday 2000 profile)

Box 1. Process variability and specifications.



The graph above shows the concept of process variability and specifications. The SWOP generic profile was calculated for average of several carefully controlled SWOP runs. Custom profile was calculated for our condition and it compensates for the fact that our process was within SWOP tolerance but not exactly at SWOP aim.