Comparison of Color Profiles Between Two Digital Presses

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Abstract

It has been over 30 years since the first digital presses were released. Since its start, digital printing has revolutionized the printing industry, offering a host of benefits that cater to a wide range of applications and industries. With continual development and improvement, we now have high quality, cost-effective short run capabilities with quick turnaround times. Further, digital printing provides customers opportunities to incorporate variable data for target marketing and print on demand capabilities. With minimal setup costs, no minimum quantity, and on-demand publishing, digital printing has transformed the way businesses approach their printing needs. Color management on digital presses is a valuable feature that offers numerous benefits that enhance the efficiency, accuracy, and consistency of color reproduction in the printing process. It plays a critical role in ensuring that printed materials meet color specifications, maintain consistency, and meet the expectations of customers.

In this study, a Konica Minolta AccurioPress C2070 and an HP Indigo 7K were used. In both instances, custom color profiles were generated for eight different paper substrates, three uncoated and five coated. The G7® method was used for calibration and then 1,617 patches (CGATS IT8.7/4) were printed and measured offline.

Profiles created were then evaluated and compared in CHROMiX ColorThink Pro. It was found that the differences in gamut volume between the two presses were rather significant, with the Konica Minolta resulting in a larger color range as compared to the HP Indigo. The differences were substantially larger for the uncoated substrates (27.7%-30.5%) as compared to those of the coated (2.9%-11.9%).

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Introduction

It has been over 30 years since the first digital presses were released [1]. Since its start, digital printing has revolutionized the printing industry, offering a host of benefits that cater to a wide range of applications and industries. With continual development and improvement, we now have high quality, cost-effective short run capabilities with quick turnaround times. Further, digital printing provides customers opportunities to incorporate variable data for target marketing and print on demand capabilities. With minimal setup costs, no minimum quantity, and on-demand publishing, digital printing has transformed the way businesses approach their printing needs.

Color management systems within these digital presses have made it easy to automatically register jobs, assess color density and adjust as necessary on the fly, and create unique ICC profiles based on substrates [2]. The initial aim of this study was to explore those inline processes across two digital press brands and compare the color gamuts when printed to meet G7 standards. Time and technological difficulties transitioned this study away from the inline processes to offline methods of color measurement. While this steered away from the many advantages inline color management has, including faster makeready, better process controls, and reduced time and cost [3][4], there is still value in understanding the different capabilities of the two technologies.

Experimental Procedure

In this study, a Konica Minolta AccurioPress C2070 at Ball State University and an HP Indigo 7k at Illinois State University were used to compare the offline profiling process. The Konica Minolta press is an electrophotographic press using dry toners, while the HP Indigo press is an offset press using digital plate and a blanket with liquid inks. Both presses employ advanced technology to ensure precise color reproduction.

For the Konica Minolta press, an offline handheld EFI ES-2000 spectrophotometer was used to measure colors and densities, and to create the ICC profiles. The printing process control software was EFI Fiery Command Station 6.8, while the color management software was EFI Fiery Color Profiler Suite 5.0. For the HP Indigo press, an offline Techkon SpectroDens was used to measure colors and densities. An X-Rite i1Pro 3 was used to measure the targets to create the ICC profiles. The printing process control software is the HP PrintOS Production Pro 8.0.

Brand	*Manufacturer*	*Type*	*Weight (g/m²)*
Cougar Text	Domtar	Uncoated	118
Bold Digital	Xerox	Uncoated	105
Platinum Digital	Navigator	Uncoated	90
Everyday Digital	Mohawk	Coated	270
Tango Digital Cover	WestRock	Coated	195
Flo Gloss Cover	Sappi	Coated	216
Kromekote Gloss Cover	CPI Paper	Coated	170
Sterling Gloss Cover	Verso	Coated	216

Table 1: *Paper Substrates Used*

For each paper substrate, color profiles were created using offline processes using the following steps:

1. CMYK calibration: After 10 warmup pages were printed, a test chart with 51 random patches for each process color was printed and measured. Measurement results were applied to calibrate CMYK curves.
2. G7 gray balance calibration: The P2P51 target was printed and measured. Measurement results were applied to correct both CMY and K neutral print density curves (NPDCs), and iterated if needed.
3. ICC profiling: The CGATS IT8.7/4 target with 1,617 patches was printed and measured. Measurement results were used to create an ICC profile.

Figure 1: *Offline Measurement using i1Pro3*

Results and Discussion

To compare presses, the ICC profiles that were created were brought into CHROMiX ColorThink Pro where they were analyzed. The 2D and 3D graphs of the profiles are compared for each substrate shown in Figures 2-9. In each figure, the profile created from the Konica Minolta press is in red, and the profile created from the HP Indigo press is in green. The profile with the higher gamut volume is depicted

with a wire frame (in each case red), and the profile with the lower gamut volume is depicted with a solid surface (in each case green).

Figure 2 shows the comparison for the Cougar Text substrate. This is an uncoated substrate and has the largest gamut volume difference among the substrates compared between the two presses. There is only one area (in the green to blue region) where the HP Indigo color range exceeded the Konica Minolta one. In addition, the HP Indigo press seems to outperform in the lighter regions (more toward white) across the gamut, whereas the Konica Minolta press produces a wider range of darks. The total volume difference between the two presses on this substrate was 30.54%.

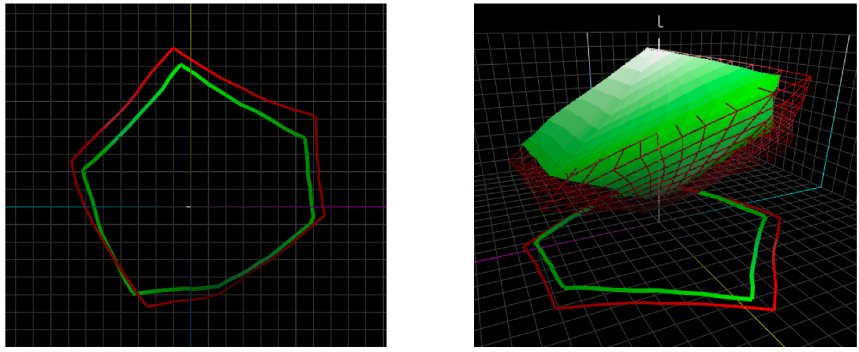

Figure 2: *Comparison between Cougar Text profiles created using the KM Accurio (red) and HP Indigo (green)*

Figure 3 shows the comparison for the Xerox Bold Digital substrate. This is the second uncoated substrate and has the second largest gamut volume difference for the two presses. Similar to the previous comparison, the HP Indigo color range only slightly exceeds the Konica Minolta one in the green to blue region. Again, the HP Indigo press performs better in the lighter regions, but the Konica Minolta press significantly outperforms in the darker regions. The total volume difference between the two presses on this substrate was 27.91%.

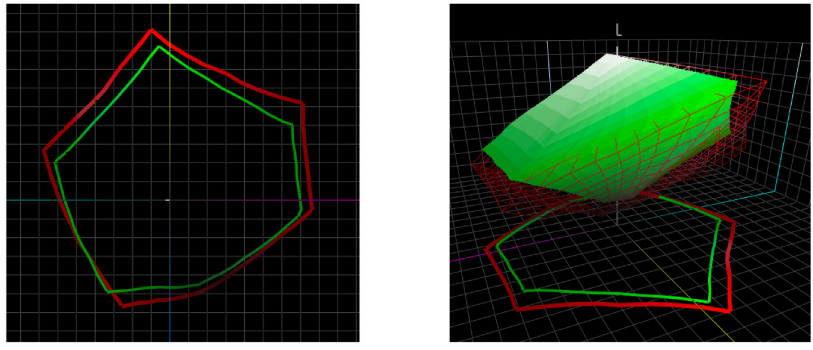

Figure 3: *Comparison between Xerox Bold Digital profiles created using the KM Accurio (red) and HP Indigo (green)*

Figure 4 shows the comparison for the Navigator Platinum Digital substrate, the final of the uncoated substrates. This substrate has the third largest volume difference at 27.68%, with the Konica Minolta press producing a significantly larger gamut. A deviation from prior uncoated substrates is that the HP Indigo press still produces a wider gamut in areas of the blue to green region, but additionally now in the blue to red/magenta region.

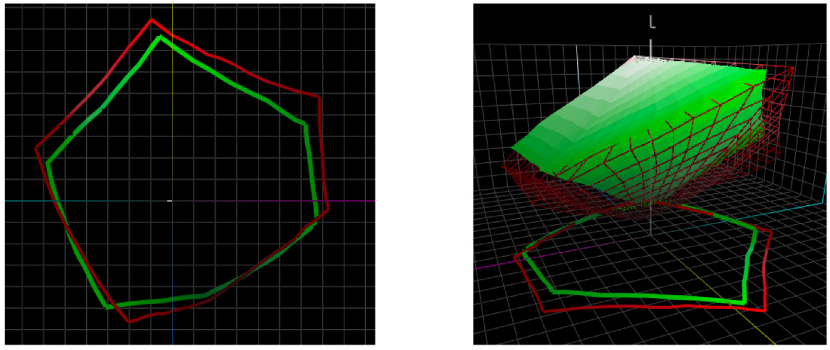

Figure 4: *Comparison between Navigator Platinum Digital profiles created using the KM Accurio (red) and HP Indigo (green)*

Figure 5 shows the comparison for the Mohawk Everyday Digital substrate. This is a coated substrate, and as can be seen, the Konica Minolta press still significantly outperforms the HP Indigo press in terms of gamut volume. The HP gamut is much more contained within the Konica Minolta gamut where there only being a few slight areas where the HP breaks free of the Konica Minolta gamut boundary (lighter colors across the green/blue region). While much closer in gamut range compared to the uncoated substrates, there is still a large volume difference at 11.87%.

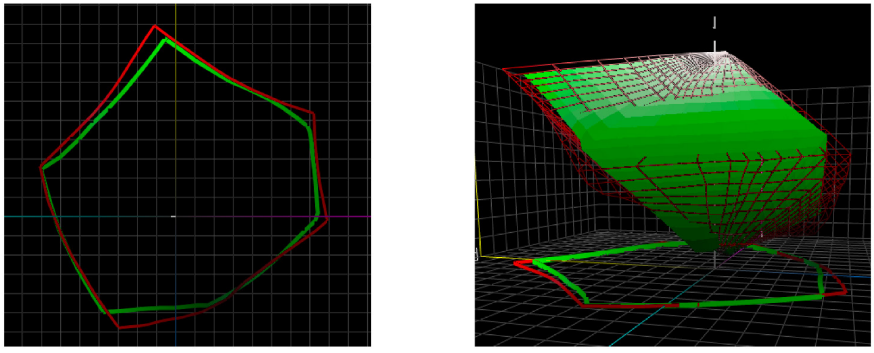

Figure 5: *Comparison between Mohawk Everyday Digital profiles created using the KM Accurio (red) and HP Indigo (green)*

Figure 6 shows the comparison for another coated substrate, the Tango Digital Cover substrate. Like the previous comparison, the gamut volume is much closer but still significantly different with a volume difference of 10.3% with the Konica Minolta press outperforming the HP Indigo press. There is still the area where the Indigo press exceeds range across the blue/green region, as well as some darker colors in the yellow/green region.

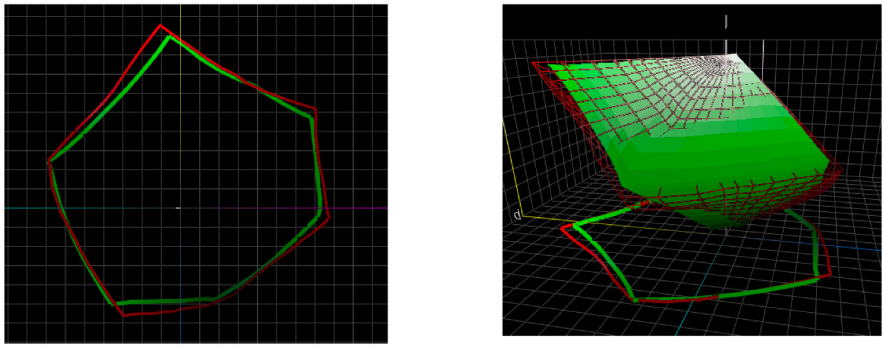

Figure 6: *Comparison between Tango Digital Cover profiles created using the KM Accurio (red) and HP Indigo (green)*

Figure 7 shows the comparison for the Sappi Flow Gloss Cover substrate. This coated substrate has the second lowest volume difference between the two presses, with only a 4.55% volume difference. The Konica Minolta press still outperforms the HP Indigo press; however, we can see that the areas where the HP press differs (yellow to blue regions) are a little bigger than in previous comparisons. In general, the HP Indigo gamut is relatively well contained within the Konica Minolta gamut.

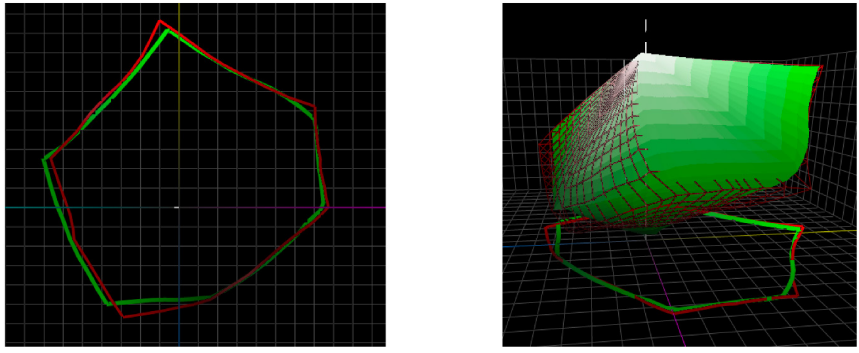

Figure 7: C*omparison between Sappi Flo Gloss Cover profiles created using the KM Accurio (red) and HP Indigo (green)*

Figure 8 shows the comparison for the Kromekote Gloss Cover coated substrate. Like every other comparison, there are areas where the HP Indigo press produces colors the Konica Minolta press cannot (slight areas from yellow through red/magenta), and the Konica Minolta press has the superior volume. The total volume difference for this substrate was 7.67%.

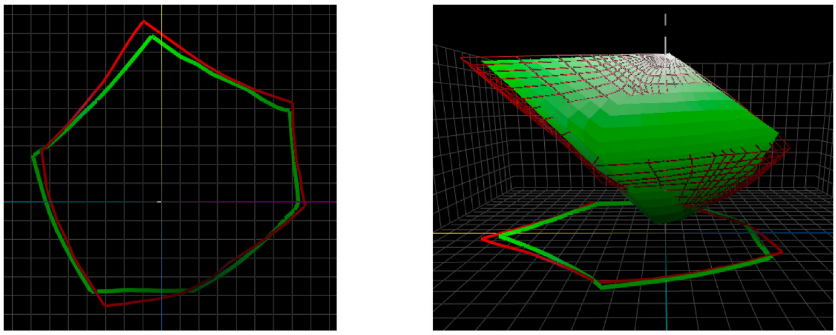

Figure 8: *Comparison between Kromekote Gloss Cover profiles created using the KM Accurio (red) and HP Indigo (green)*

Figure 9 shows the comparison for the coated Sterling Gloss Cover substrate. This substrate had the lowest volume difference between the two presses at 2.88%. As can be observed, the two gamuts are much more closely aligned with areas across each region where one outperforms the other in terms of color reproducibility. The Konica Minolta press still outperforms the HP Indigo press in terms of total gamut volume in this comparison.

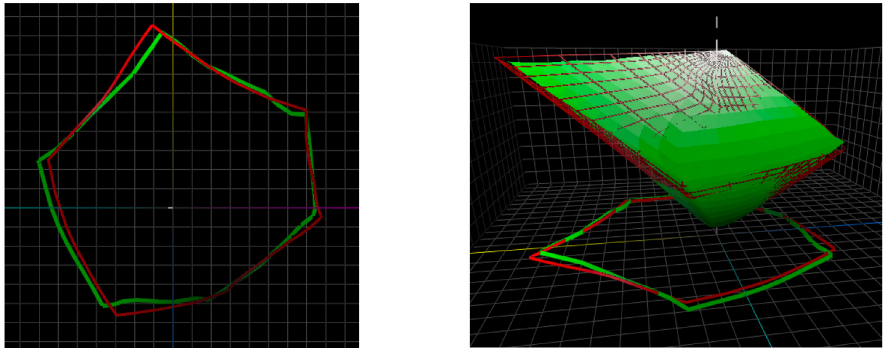

Figure 9: *Comparison between Sterling Gloss Cover profiles created using the KM Accurio (red) and HP Indigo (green)*

The differences between the profiles created for the Konica Minolta Accurio press and the HP Indigo press can be further illustrated quantitatively by the difference in gamut volume as seen in Table 2. The positive values in each comparison represent the larger volume created by the Konica Minolta press in comparison to the HP Indigo press. The percentage values were created by taking the difference value and dividing it by the gamut volume of the Konica Minolta press to reflect the relative difference in gamut volume.

Substrate	*Gamut volume*		*Difference*
	KM Accurio	HP Indigo	
Cougar Text	455,390	316,312	139,078 (30.54%)
Xerox Bold Digital	448,916	323,622	125,294 (27.91%)
Navigator Platinum Digital	382,705	276,761	105,944 (27.68%)
Mohawk Everyday Digital	478,210	421,438	56,772 (11.87%)
Tango Digital Cover	455,282	408,372	46,910 (10.3%)
Sappi Flo Gloss Cover	442,142	422,042	20,100 (4.55%)
Kromekote Gloss Cover	435,746	402,323	33,423 (7.67%)
Sterling Gloss Cover	433,831	421,303	12,528 (2.88%)

Table 2: *Gamut Volume Comparison Between Profiles*

As can be observed, the similarities in gamut volume between the two presses are much closer for the coated substrates as compared to the uncoated. This may be a result of how the liquid inks of the HP Indigo press are absorbed into the substrates as compared to the toners used by the Konica Minolta press. A previous study by Xu and Kellogg [5] to compare toner electrophotography and offset printing also found that wider color gamuts were achieved on Xerox iGen3 than on Heidelberg Speedmaster, especially on uncoated papers, which was similar to our findings.

Beyond press differences, there is the possibility that large differences between coated substrates (2.88-11.87%) could be a result of the finishing processes between manufacturers, with different finishes, brightnesses, and gloss coatings. Given that each substrate is coated, the nearly 9% volume difference across the substrates is interesting.

Conclusions

In this study, a Konica Minolta AccurioPress C2070 and an HP Indigo 7k were used to compare color gamuts and gamut volumes when printed to G7 specifications. Based on initial results, the Konica Minolta press had a much larger ability to reproduce colors as compared to the HP Indigo press. Color gamut differences between the two presses were larger for uncoated substrates than for coated substrates.

Further studies could explore the impacts of substrate finishing and paper properties (e.g., brightness and coating) on the gamut volume. Additionally, further exploration into the HP Indigo press and how it meets G7 compliance is being conducted. There is great debate and disagreement about the performance between liquid inks and toner-based inks and why the gamut volume was so different in this study. There is a possibility that a different approach, utilizing different starting values and an established lookup table, would significantly increase the color gamut volume while ensuring G7 conformance.

Additionally, future research would like to revisit the inline color management system to better compare color management capabilities of the two presses and better assess conformance, time requirements, and color reproduction capabilities.

References

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