Quality Comparison of HP Indigo to Offset Lithography

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Abstract

HP Indigo press with liquid toners is marketed as a digital press with offset print quality. This study was to compare the print quality of HP Indigo 3500 to Heidelberg Speedmaster CD74. The parameters studied were color gamut, mottle, line resolution, dot quality, and tone reproduction. Printing was done on gloss coated paper with each press. The parameters were used to compare the quality quantitatively. The results showed that HP Indigo 3500 press produced decent print quality. The line and dot resolution of such press were not as competitive as those of conventional CTP offset lithographic printing. Due to the different colorants used in the printing processes, the color gamut produced by HP Indigo 3500 was smaller than the one produced by offset lithographic printing when four process colors were used.

Introduction

Liquid toner technology used on HP Indigo press has some advantages over dry toner system. Liquid toner particles are significantly smaller than dry toner particles, so it is capable of producing high resolution toned images [1]. This capability combined with pure color has made liquid toner system be used in high quality color reproduction. This technology competes traditional offset lithographic printing especially in short-run market.

Traditional offset lithographic printing uses CTP (Computer-to-Plate) technology. The print quality is affected by the RIP, the resolution of the CTP device, the interaction of ink and substrates, the fountain solution, the blanket, and the press settings. Liquid toner system uses electrostatic for imaging. It also has an intermediate drum with blanket to transfer toners. Liquid toner system transfers a mixed color film onto substrates, unlike traditional offset lithography, the wet ink is transferred onto another wet ink film for color mixing.

The resolution and color reproduction of liquid toner printing system was studied at different screen rulings [2]. It was found that when printed at higher screen ruling by the liquid toner system, images appeared better contrast but worse in color reproduction and details than those printed at lower screen ruling. Other print qualities such as line raggedness, dot roundness, image growth, and image sharpness of liquid toner system were studies [3]. Liquid toner system showed higher image growth and better sharpness than inkjet system.

The comparison of color reproduction between liquid toner and offset lithography [3] showed that the process colors used for two systems are different. Use gray control method developed for offset lithographic printing could improve the color reproduction of liquid toner system.

The purpose of this study was to exam the print quality difference between liquid toner system and traditional offset lithography with CTP plates. The qualities studied included tone reproduction, color gamut, fine line reproduction, fine dot reproduction, and solid mottle. The quality of images, color, and RIP were discussed.

Experiment

Two similar test forms were printed on a Heidelberg Speedmaster CD74 press and a HP Indigo 3500 press to compare the print quality.

A GATF test form (Figure 1) was RIPed through Apogee Prepress. The screen angles for process colors were set as yellow at 90°, magenta at 15°, cyan at 75°, and black at 45°. The plates was burned with Cero Trendsetter 3244 and processed with Kodak plate processor. The plates used were Kodak Sword Excel with ultragrain.

***Figure 1**: GATF 19 by 25 inches test form for the Heidelberg Speedmaster CD74 press.*

Certain elements were picked from the GATF test form to create the test form for the HP Indigo 3500 press (Figure 2). The form was RIPed by the Indigo press. Default screen angles were used on the HP Indigo 3500 press (yellow at 90°, magenta at 75°, cyan at 15°, and black at 45°).

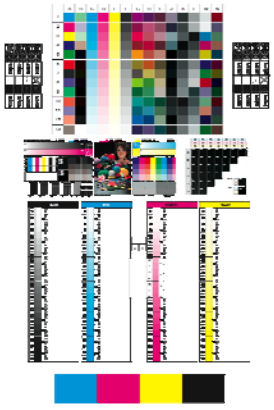

***Figure 2**: Test form created for the HP Indigo 3500 press.*

Paper used for printing on the Heidelberg Speedmaster CD74 and the HP Indigo 3500 was NewPage Sterling Ultra 100lb gloss coated text stock with 10% recycled content. Offset lithographic inks were Kohl & Madden Relay process colors. Four-color Electronic Inks were used on the HP Indigo 3500.

Offset lithographic printed test form was controlled to follow GRACoL specifications. The screen ruling was set as 150lpi. The HP Indigo 3500 press has it own calibration process. There was no density control applied. The screen ruling selected was 144lpi on the Indigo press.

Results and Discussions

Tone reproduction

Tone reproduction was used to learn how many details could be reproduced at certain conditions. Tone reproduction is affected by the capability of the RIP, the press settings, and ink/substrate interaction. It was evaluated by measuring the dot percentage of different steps. The comparison of tone curves was presented in Figure 3.

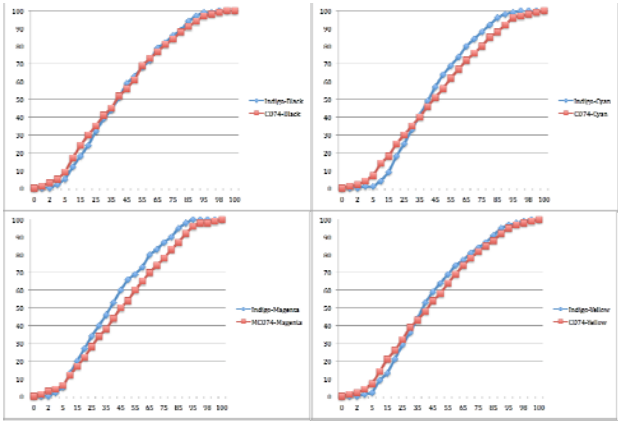

***Figure 3**: Tone curve comparison of the Indigo and the Speedmaster press printed tones. Blue line is for the Indigo press. Red line is for the Speedmaster press. The upper left one is for black. The upper right one is for cyan. The lower left one is for magenta. The lower right one is for yellow.*

The results showed that tone produced by the Speedmaster press was smoother than the one produced by the Indigo press. The smoother tone curve contributes to smoother images and gradients. The curve produced by the Indigo press also showed flatter at highlight and shadow areas. This means that there are fewer details in very light and very dark areas could be reproduced by the Indigo press. These differences are mostly due to the capability of the RIP. The RIP on the Indigo press could not render the dots smaller than 5% correctly. The Indigo press also showed that more dot gain from midtone to shadow areas, and less dot gain from highlight to midtone were produced while comparing to the Speedmaster press.

Solid ink density and color gamut

Both presses used only four process colors to print the test forms. The color differences between the process colors used on the Indigo press and the Speedmaster press were fairly large. The color difference and solid ink density values for process colors were listed in Table 1. Color difference was presented as ΔE_{lab}. The color target was measured with ProfileMaker 5.0 Measure Tool on a SpectraScan. The profile was generated and the color gamut was plotteed by ColorThink Pro 3.0. The color gamut difference was shown in Figure 4. The inks used on the Speedmaster press produced larger gamut than the inks used on the Indigo press. There was no curve adjustment was applied for both presses.

Table 1: Solid ink densities and color differences between the process colors used on the Indigo press and the ones used on the Speedmaster press.

	Black	Cyan	Magenta	Yellow
Solid ink density (Speedmaster)	1.75	1.39	1.45	1.03
Solid ink density (Indigo)	1.09	1.04	1.06	0.81
Color difference ΔE	22.26	8.47	8.07	16.68

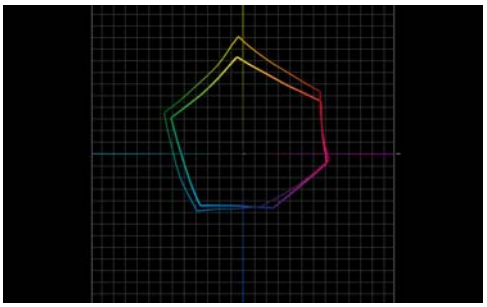

***Figure 4**: Color gamut comparison between the Indigo press and the Speedmaster press. The outsider line represents the color gamut printed by the Speedmaster press.*

Mottle Index

Mottle is the organ-peel appearance on solid area. It is usually affected by ink/substrates interaction. Solid prints were measured by ImageXpert software to reveal the unevenness of printed surface. Mottle index was the parameter for describing the density variation in a certain area of a digitally captured image. The results were listed in Table 2.

Table 2: Mottle index comparison between the Indigo and the Speedmaster printed solids

Mottle Index	Black	Cyan	Magenta	Yellow
CD74	0	29.40	13.30	0
Indigo	356.10	344.10	281.00	169.10

The significant differences were observed. The solids printed by the Speedmaster press had lower mottle index than those printed by the Indigo press, which resulted in smoother solid appearance. This difference may due to the mechanism of ink

setting on paper surface and due to the density difference. The inks used on the Speedmaster press adsorbed more by paper compared to the inks printed by the Indigo press. The higher solid ink density also reduced the appearance of the unevenness.

Line quality and resolution

Line quality was described by the raggedness of both edges of the line. Thin lines were printed to study the resolution of certain press could produce. The thin lines for this test included thin positive lines and thin negative lines ranged from 0.01 points to 1.00 points. The average line width, standard deviation of line width, and mean deviations of two sides of the line were measured. ImageXpert software was used for this measurement. The quality of producing different positive and negative line widths were reported and shown in Figure 5 and Figure 6.

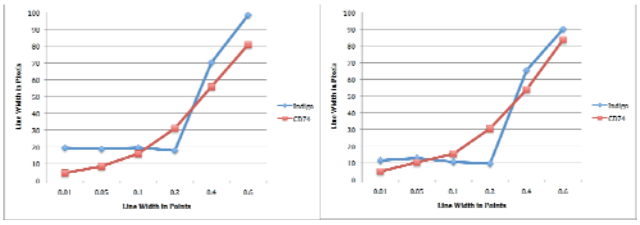

***Figure 5**: Positive fine line reproduction comparison. Left one is for horizontal lines. Right one is for vertical lines.*

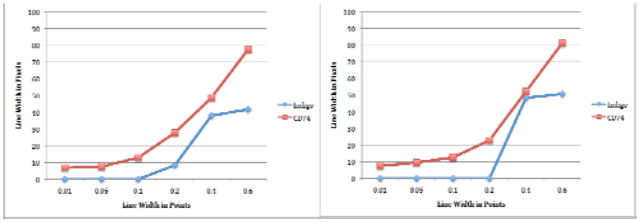

***Figure 6**: Negative fine line reproduction comparison. Left one is for horizontal lines. Right one is for vertical lines.*

The Indigo press could not render fine lines appropriately. There were very little differences from 0.01 points line to 0.20 points line. These lines were rendered as about the same. The Indigo press could not produce negative lines finer than 0.20 points. The Indigo press printed thicker horizontal lines than vertical lines, while the Speedmaster press printed similar horizontal and vertical lines. The positive lines printed by the Indigo press were produced thicker, while the negative lines were produced thinner than those printed by the Speedmaster press. The Speedmaster press used the plates imaged by platesetter, which usually has higher resolution than the RIP for a digital press. As shown in the following figures (Figure 7 and Figure 8), horizontal lines and vertical lines produced by conventional offset lithography are smoother at two sides and more uniform in width.

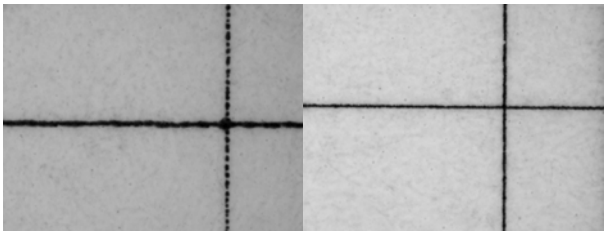

***Figure 7**: Horizontal and vertical line quality comparison (0.05 points). Left image was printed by the Indigo press. Right image was printed by the Speedmaster press.*

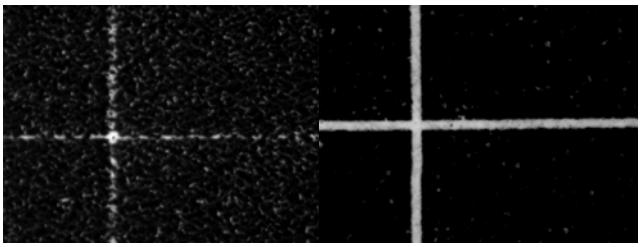

***Figure 8**: Horizontal and vertical line quality comparison (0.20 points). Left image was printed by the Indigo press. Right image was printed by the Speedmaster press.*

Dot quality

The size and shape of the halftone dots determine the detail reproduction and tone smoothness of the print. The maximum and minimum dots that could be reproduced are important for producing high quality images. 5 percent, 50 percent, 75 percent, and 95 percent of dots were evaluated. The parameters were listed in Table 3.

Table 3: 50% and 95% black dot quality (95% dot area was determined on the non-printed areas)

		Number of dot in AOI	Dot area (pixels)	Dot are standard deviation	Average axis ratio
5%	Indigo	160	60.683	60.554	0.778
	CD74	188	136.682	19.612	0.751
50%	Indigo	173	1834.653	519.263	0.862
	CD74	207	1559.010	417.687	0.827
75%	Indigo	184	1175.250	487.016	0.706
	CD74	196	1014.622	195.825	0.840
95%	Indigo	173	270.498	212.066	0.513
	CD74	204	276.392	74.630	0.761

The Indigo press printed dots were generally bigger than those printed by the Speedmaster press except at highlight area. The Indigo press could not reproduce dots with size smaller that 5 percent. At 5 percent tone printed by the Indigo press, some dots were significantly bigger than the others (Figure 9). Dot size was not uniform. Another issue with the Indigo press printed dots was dot connection. This irregular connection made the printed image appear mottled. This phenomenon was clearer with the color inks than black ink. The enlarged 50 percent magenta dots were shown in Figure 10. At shadow area, 75 percent tone printed by the

Indigo press appeared horned. This also contributed to unsmooth tone reproduction. The images were shown in Figure 11. At 95 percent tone, dots printed by the Indigo press were connected to become solid. No detail could be reproduced in the areas that are larger than 95 percent by the Indigo press (Figure 12).

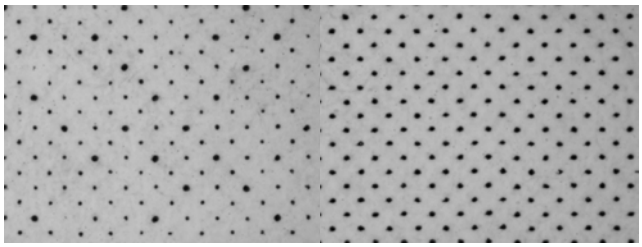

***Figure 9**: 5% black dots comparison. Left on was printed by the Indigo press. Right was printed by the Speedmaster press.*

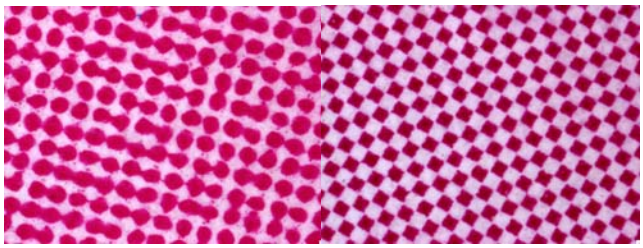

***Figure 10**: 50% magenta dots comparison. Left one was printed by the Indigo press. Right one was printed by the Speedmaster press.*

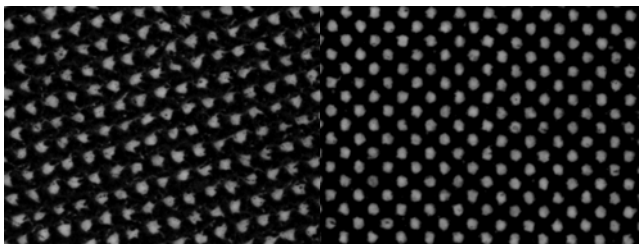

***Figure 11**: 75% black dots comparison. Left one was printed by the Indigo press. Right one was printed by the Speedmaster press.*

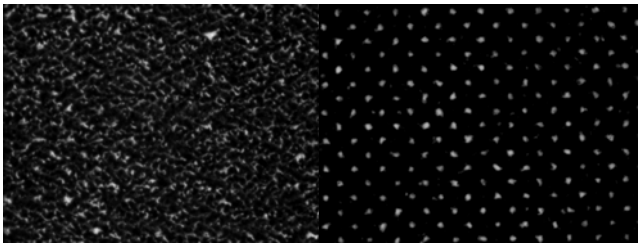

Figure 12: 95% dots comparison. Left one was printed by the Indigo press. Right one was printed by the Speedmaster press.

Conclusions

Test forms were printed by a HP Indigo 3500 press and a Heidelberg Speedmaster CD74 press. Tone reproduction, color gamut, solid mottle, line quality, line resolution, and dot quality were compared. It was demonstrated that HP Indigo 3500 could produce decent color gamut with four process colors. The color gamut was smaller than the one produced by traditional offset lithography. The tone curves were less smooth than those printed by offset lithography, especially at highlight and shadow areas. There were fewer fine dots could be reproduced by the Indigo press, thus less detail could be presented in images. Dots with size smaller than 5 percent could not be reproduced by the Indigo press. At midtone area, dots printed by the Indigo press were randomly connected, which appeared less smooth in tone reproduction. The Indigo press could not produce fine lines well. Line width finer than 0.20 points were not able to reproduced by the Indigo press.

HP Indigo 3500 with liquid toner competes traditional offset lithography in short run market. But the quality, especially in detail reproduction was not competitive with traditional offset lithography with CTP plates.

References

[1] Arthur Diamond, David S. Weiss, Handbook of Imaging Materials (Marcel Dekker, Inc., New York, NY, 2002) pg. 239.

[2] L. Mandic, A. Poljicak, D. Agic, Case Study: Digital Offset Printing – Resolution and Color Reproduction, Proc. IWSSIP, pg. 153. (2008)

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Author Biography

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