Print Quality Comparison Between Kodak Prosper and Offset Lithography

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Abstract

Kodak Prosper Imprinting System with stream inkjet technology targets high volume direct mail market and customized products with print quality close to offset output. This study compared the print quality of a Kodak Prosper press and a Heidelberg Speedmaster CD 74 press. The parameters studied were solid/tone uniformity, tone reproduction, rub resistance, and detail reproduction. The lithography samples included typical screen ruling settings of 133 lpi and 150 lpi for photograph quality comparison. The samples printed were presented to and evaluated by observers with or without graphic arts experience. The visual comparison and quantitative data were presented. The results showed that Kodak Prosper press has decent print quality with good color appearance. The detail reproduction quality is not comparable with lithography quality.

Introduction

The Kodak Prosper 5000XL press prints with resolution of up to 175 lpi at speeds up to 650 fpm (200 mpm). It is marketed for direct mail, versioned catalog, magazines, color books, and inserts. The system offers full color perfecting with a print width of up to 24.5 inches [1].

Kodak Stream Inkjet Technology is used on the Prosper. The technology makes it possible for inkjet printing to achieve offset printing quality, at the same time, to provide lower cost than other digital materials [2].

There was a benchmarking study [3] done by Rochester Institute of Technology to compare the color quality between a Kodak Prosper 5000XL press and a Heidelberg Speedmaster 74 press. The study found that the two devices had the similar visual appearance. Kodak Prosper press provides slightly wider color gamut then the offset lithographic press.

This paper investigated the print quality between a Kodak Prosper press and a Heidelberg Speedmaster CD 74 press. The qualities evaluated were tone curves, fine lines, uniformity of printing at different angles, dot quality, abrasion resistance, and visual appearance. The experimental results were presented.

Experiments

Same test form (Figure 1) was printed on a Kodak Prosper Press and a Heidelberg Speedmaster CD 74 press. The target included an IT8.7-3 target, photo portraits, fine lines, and gray ramps (black only and cyan, magenta, yellow overprinted). The PDF file of the target was sent to Kodak for printing. For making lithographic plates, the PDF file was RIPed through Apogee Prepress. The plates were burned with Cero Trendsetter 3244 and processed with Kodak plate processor. The plates used were Kodak Sword Excel lihto plates with ultragrain. Two sets of offset plate were made with 133 lpi and 150 lpi screen ruling respectively.

***Figure 1**: Test form for this study.*

The paper used for printing on the Kodak Prosper press was 70 lb gloss coated. The paper used for printing on the Heidelberg Speedmaster CD 74 press was 100 lb gloss coated.

The ink set used for the offset printing was Kohl & Madden Relay process color inks. Offset lithographic printed test form was controlled to follow GRACoL specifications.

Results and Discussions

The samples printed by two devices were evaluated with different aspects.

Tone reproduction

Tone reproduction reflects many different features during printing. It is related to the ink and substrates interaction while ink is transferred onto the substrates. While inkjet ink is printed, the tone reproduction is also affected by the drop size, wettability, and drying of the ink drops.

The density and dot percentage of different tones were measured with an x-rite spectrodensitometer. The solid ink density of each process color was listed in the following table (Table 1).

Table 1: Solid ink density comparison.

	Black	Cyan	Magenta	Yellow
Solid ink density (Litho)	1.77	1.35	1.55	1.02
Solid ink density (Inkjet)	2.07	1.60	1.37	1.07

The tone values were plotted (Figure 2).

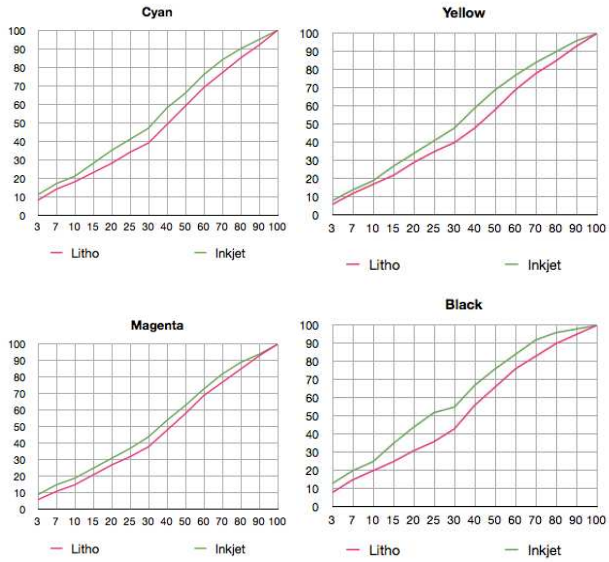

***Figure 2**: Tone reproduction curves of cyan, magenta, yellow, and black produced by Kodak Prosper press (Inkjet-green) and Heidelberg Speedmaster CD 74 press (Litho-red).*

The tone reproduction curves showed that inkjet process produced darker tones than offset overall, especially the black. This is due to the higher density inkjet printed black had. The shape of the curve produced by inkjet press was very close to the one produced by the lithographic press.

Line width and quality

There were lines with different widths included in the test form to study the influence of printing process to the line quality. The quality parameters of a line included line width and smoothness of line edge. The quality of line printed by a litho press is affected by the resolution of plate making process and the properties of the substrate printed on. The quality of line printed by inkjet is affected by the drop size of the jetted ink and the motion of inkjet head movement.

The lines included in the test form were made with the width of 0.5 pt, 0.25 pt, and 0.125 pt. The line width of printed line was examined by ImageXpert system. The results were showed in Table 2.

The measured line width in pixels showed that to print the lines at certain width, the inkjet press produced much wider lines then the lithographic press did. This may affect the resolution of printing.

The images of printed fine line were shown in the following figures (Figure 3, 4, and 5).

The offset printed lines had very little defects at the line edges. The jaggedness of the offset printed line was mainly from the unevenness of the substrate. The jaggedness of inkjet printed lines was from the unevenness of the substrate, but mainly due to the ink drops.

Table 2: Line width of 0.5 pt, 0.25, and 0.125 pt lines produced by inject press and lithographic press. Numbers presented are in pixels.

		Average Width	Width Standard Deviation
Litho	0.125 pt	23.773	2.174
	0.25 pt	38.945	1.886
	0.5 pt	71.627	1.680
Inkjet	0.125 pt	61.824	3.461
	0.25 pt	77.736	5.179
	0.5 pt	108.329	5.021

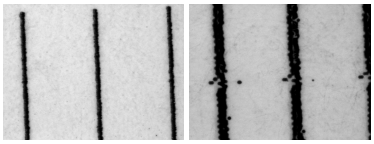

***Figure 3**: 0.125 pt lines printed by two devices. The left one was printed by Heidelberg Speedmaster CD 74 press. The right one was printed by Kodak Prosper press.*

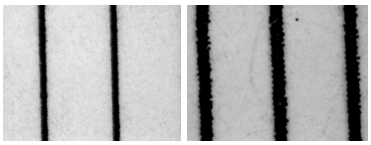

***Figure 4**: 0.25 pt lines printed by two devices. The left one was printed by Heidelberg Speedmaster CD 74 press. The right one was printed by Kodak Prosper Press.*

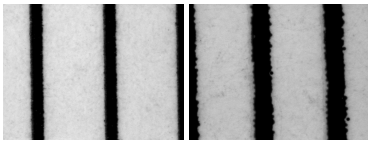

***Figure 5**: 0.5 pt lines printed by two devices. The left one was printed by Heidelberg Speedmaster CD 74 press. The right one was printed by Kodak Prosper Press.*

Dot quality

Dot quality affects the tone production and the visual appearance of the printed product. The 5%, 25%, 50%, and 75% dots were evaluated. The images of the printed dots by two devices were shown in Figure 6 and 7.

AM screen was used for making lithographic plates. The screen appears uniform with a regular pattern. The inkjet press prints ink drops differently. The drops have uniform size but without clear pattern. When the darker image was printed, the dots were close to one another. Some dots were connected even at low dot percentage. This appeared to be somehow less smooth than an AM screened image. At midtone area, the connection of dots was more significant (Figure 7).

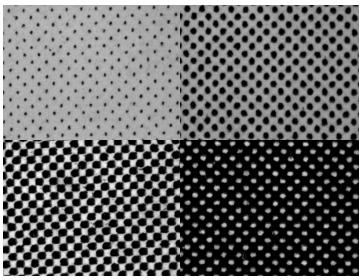

***Figure 6**: Dot shapes of 5% (upper left), 25% (upper right), 50% (lower left), 75% (lower right) printed by Heidelberg Speedmaster CD 74 press.*

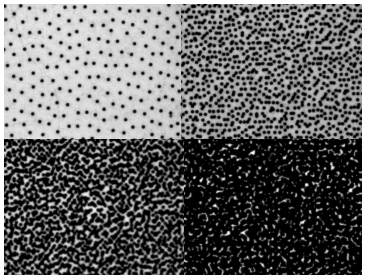

***Figure 7**: Dot shapes of 5% (upper left), 25% (upper right), 50% (lower left), 75% (lower right) printed by Kodak Prosper press.*

The screened images were applied FFT transform to check if there was any significant direction those two types of screening carry. The FFT results of 5% dots were shown in Figure 8. There were two main directions that offset printed dots had. The inkjet printed dots had two major directions along with two other directions that were less significant.

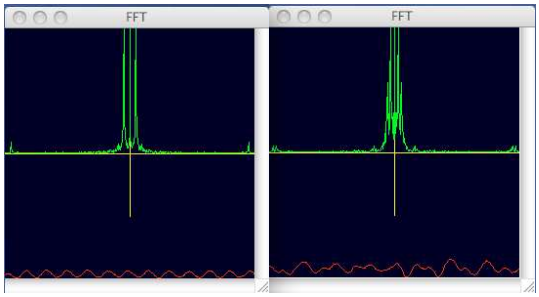

***Figure 8**: The FFT spectrum of 5% black dots printed by Heidelberg Speedmaster CD 74 press (left) and Kodak Prosper press (right).*

Star and slur target

Star and slur target in lithographic printing are used for checking slurring, dot gain, and other printing defects. The targets were printed by two devices.

The star targets were evaluated from the center out. The normalized integrated intensity was presented as radial profile [4]. The printed targets and radial profiles were shown in Figure 9 and 10.

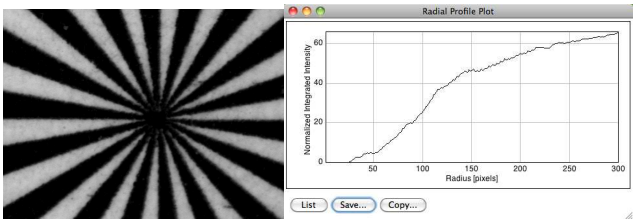

***Figure 9**: Star target printed by Heidelberg Speedmaster CD 74 press and the radial profile.*

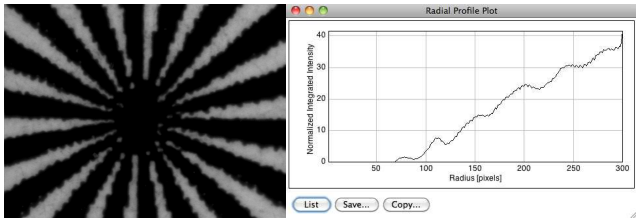

***Figure 10**: Star target printed by Kodak Prosper press and the radial profile.*

The radial profile of the star target printed by lithographic printing appeared to have smoother curve than the one printed by inkjet printing. This reflected the uniformity of the wedges in the star target. Inkjet printed wedges appeared to have rougher edges due to the resolution of inkjet printing and the drop size. The figures also showed that the center of the star target printed by inkjet printing was bigger than the one printed by lithographic printing.

The slur target is structured with horizontal lines and vertical lines at fixed interval. It checks relative moves between cylinders (rollers) on an offset press. Because of the fixed interval between lines, the slur target may not be produced accurately on a digital device due to the drop size and motor movement steps. With the impact of web movement, the lines printed by inkjet printing appeared differently. The horizontal lines, which were perpendicular to the printing direction, showed jaggier than the lines parallel to the printing direction. Some of the lines are closer than the others. The slur targets printed by two devices were shown in Figure 11.

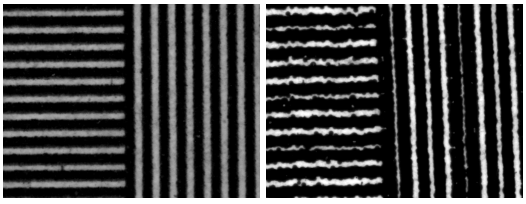

***Figure 11**: Slur targets printed by Heidelberg Speedmaster CD 74 (left) and Kodak Prosper press (right).*

Other observations

Inkjet printing drops small ink droplets on paper at high speed. The absorbency of the substrate, the surface tension of the ink, and the surface energy of the substrate affect the form of the ink film.

It was observed on the inkjet printed sample, that some pinholes were presented in solid area (Figure 11). This may be caused by the wetting of ink on the coated paper surface.

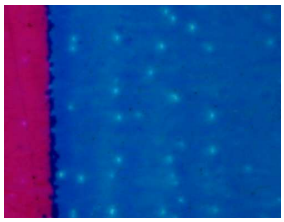

***Figure 11**: Pinholes appeared on solid cyan. Sample was printed by Kodak Prosper press.*

Rub resistance

Rub resistance is important for many applications, for example, brochures, advertisements, direct mails, and more. The rub resistance testing was done on a TMI Rub Tester. The printed sample (solids) was rubbed again a piece of blank paper. The results were shown in the following figure. The samples printed by inkjet printing on coated paper had lower rub resistance.

***Figure 12**: Ink marks scratched off from solids printed by Heidelberg Speedmaster CD 74 press (left) and Kodak Prosper press (right).*

Survey

It is important to understand the perception of printed graphics to the readers. Two groups of observer were selected to conduct the evaluation. One group (Group 1) had observers that understand basic printing and quality terms. The observers in another group (Group 2) had little knowledge about printing. The printed portraits (Figure 13) were given to the observers and evaluated under natural sunlight. There were four questions asked which included the perception of color, resolution, tone smoothness, and overall appearance. The survey results were shown in Figure 14.

The survey results showed that for most of the observer, lithographic printing offers better overall appearance, better resolution, and better smoothness. Inkjet printing offers slightly better color appearance.

Conclusions

High speed inkjet printing offers more business opportunities for the print service providers. The overall print quality of Kodak Prosper press is close to traditional lithographic offset printing. The inkjet printing produces less uniform lines and has problem with producing fine equal-spaced line. The inkjet printed products on coated paper has lower rub resistance than the ones printed with lithographic inks.

***Figure 13**: Printed samples presented for survey. Row A was printed at 133 lpi by Heidelberg Speedmaster CD 74 press. Row B was printed by Kodak Prosper press. Row C was printed at 150 lpi by Heidelberg Speedmaster CD 74 press.*

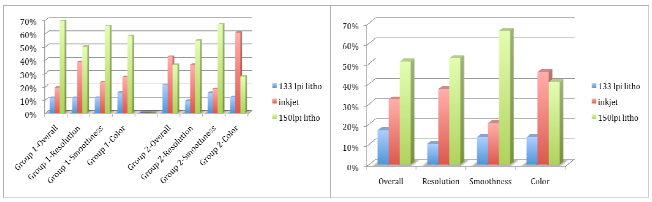

***Figure 14**: Survey results of two groups of observer. The right chart combined the results of two groups.*

References

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[2] Kodak, Meet Stream Inkjet Technology Offset Class Output, pg. 4. (2009)

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