

Influences of Ink-Jet Printing Papers on Digital Proofing Performances

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Abstract

There are a wide variety of color ink-jet printing papers in the market. Most of ink-jet printing papers are different in surface coating such as components, particle size, evenness, absorption, so proofing quality change differently. In this article, the influences of seven commonly used ink-jet printing papers were studied.

The aim of our study was to evaluate proofing quality of the seven ink-jet printing papers, respectively from four aspects: tone reproduction, color reproduction, and uniformity of the paper on the proofing sample. In the experiment, the ESPON STYLUS 7600 Color Inkjet Printer was used as printer, and EFI Densitometer and SpectroEye spectrophotometer were used to measuring the solid ink density, dot percentage and ink trapping and dot gain and L^* , a^* , b^* values for the establishment of the basic linearization of proofing quality of the paper, meanwhile, the relative contrast, color difference (ΔE) were calculated and the color gamut was plotted from L^* , a^* , b^* values. The results showed that S1 paper had the maximum K value, the optimum solid ink density and tone reproduction comparing with other six papers; the K values of other six papers were comparable. The variation of proofing quality mainly focus on the tone reproduction and color reproduction of image. The evaluations of color reproduction can be achieved by analyzing and comparing color differences and color gamut of different papers. S2 paper had the minimum color difference, S6 and S5 had the maximum color differences. S1 and S2 had the broadest color gamuts, and the color gamut of S7 was the smallest one.

1 Introduction

Digital proofing is a color prepress proofing method where a job is printed from the digital file using inkjet, color laser, dye sublimation, or thermal wax print technologies to give a good approximation of what the final printed piece will look like. The digital proof is generally less expensive than the traditional photomechanical dot proofing. Digital proofs can often be produced on the actual paper stock of the job adding another element of accuracy. This is true in today's electronic publishing world where Digital Proofing technology holds the promise of faster turnaround and decreased costs versus conventional proofing technology. Recently, a lot of publishers, advertisers and printers are enjoying the advantages of digital proofing. Among of several digital proofing technologies, ink-jet is the most common used and promising one due to the high quality that can be achieved, less complex imaging devices which is capable of reducing downtime for adjustments and calibrations than other digital proofers and cheaper consuming materials. Ink-jet systems are not dependent on light sensitivity, lasers or

LEDs (light emitting diodes). This makes them more predictable from the start and more repeatable when multiple proofs are requested or when several rounds of changes become necessary. With production costs on everyone's mind, the ink-jet process excels. Ink-jet consumables such as proofing paper are much less expensive than other systems (which often require expensive surface treatments before an image can be put on the sheet). Because the Epson's proofing paper is roll-fed, clients can review proofs as either imposed press forms areas cut-to-size page proofs.

Ink-jet printing is a favorable method for digital proofing and can replace of the traditional plate-making proofing. There were several parameters for image qualities controlling, they are solid density, dot gain and contrast ratio, the optimum ink film thickness and ink trapping, whereas it is meaningless to discuss the optimum ink film thickness and ink trapping for digital proofing. Although Customers concern merely on image qualities such as the color consistency rather than the formulations of the coating layers on various papers, but it has significant influence on the image qualities both measured properties and the appearance of the printed result, therefore, the influences of seven commercial papers on image qualities were studied by us via comparing the tone reproductions and color reproductions of the seven papers.

2 Experimental Instruments and Materials

2.1 Color Ink-jet printing papers

Table 1 Specifications of ink-jet papers

Brand Name	GMS(g/m ²)	notations	Resolution (dpi)
EPSON	100	S1	720-1440
CANON	130	S2	2880
KODAK	95	S3	720-2880
HP	100	S4	2880
Prince	95	S5	2880
Feng Cai	130	S6	5760
Smile Cat	120	S7	2880

2.2 Instruments and Image Processing Software

Instruments: ESPON STYLUS 7600 Color Inkjet Printer, DTP41 Densitometer and SpectroEye spectrophotometer.
Software: EFI software, Monaco Profiler and IT8.7-3 CMYK color target.

2.3 Experiment

The linearization of ink-jet paper was performed by using EFI software, and then the optimum amount of ink of ink-jet printer was created by the linerization of ink-jet printer and S1 paper; ICC file of S1 paper was created and used as the reference standard of our studies, S1 was assumed as the paper

with the best print quality and satisfied all the requirements of printing; Six other papers were added on the ICC file of S1, proofing was performed by using EFI software; The solid densities, halftone values and dot gains of the seven proofs corresponding to seven papers were measured by DTP 41 densitometer, and the L, a*,b* values by Measure tool software embedded in Profile Maker Pro5.0.7. Using the ICC file of S1 Paper as reference standard, the L, a*,b* values of S1 paper was subtracted from all the measured L, a*,b* values, then, the ΔL , Δa , Δb values can be obtained, the color differences can be calculated from the color difference equation.

$$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}.$$

3 Results and discussion

3.1 The analysis of tone reproduction

3.1.1 The influences of types of paper on solid ink density

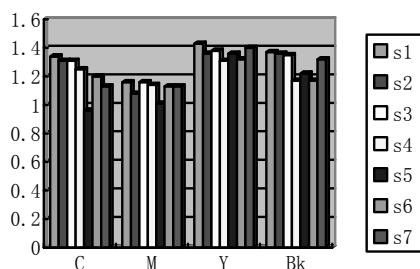


Fig.1 The influence of the paper brands on solid density

It can be concluded from the above Fig.1 that S1 paper as well as S5 paper had the maximum solid ink density via comparing the densities of cyan, magenta, yellow and black ink.

3.1.2 Tone reproduction

Tones convey all of the image information in the picture, including light, shade, color, and detail. The challenge of tone reproduction is to convey the full range of tones accurately, and, at the same time, preserve picture aspects like color and detail. Dot percentage and density were two basic and practical ways to evaluate the tone of an image.

The relationship of dot areas and densities were shown in the following figures.

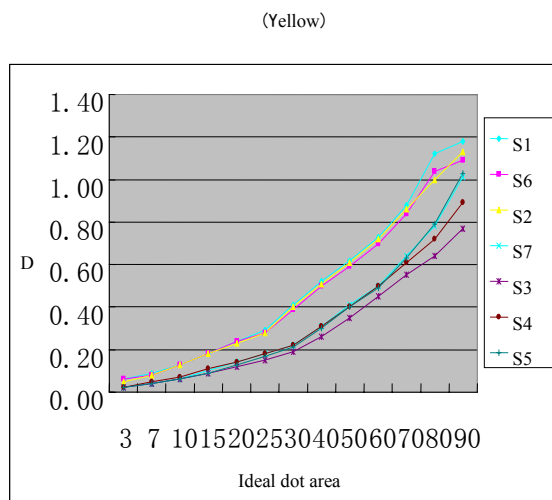
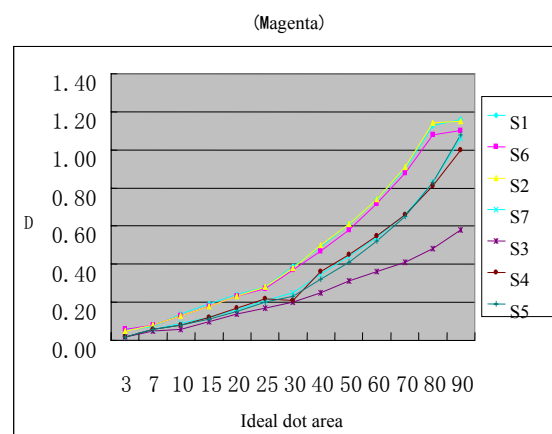
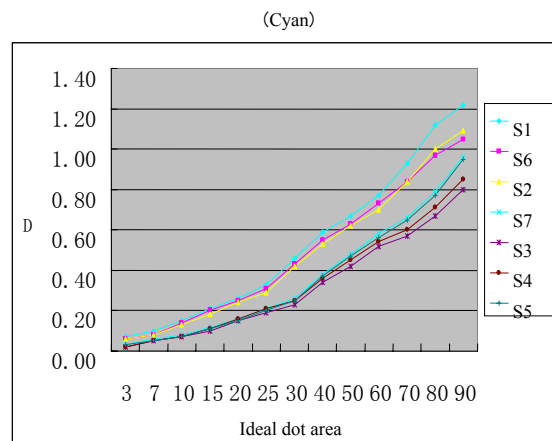
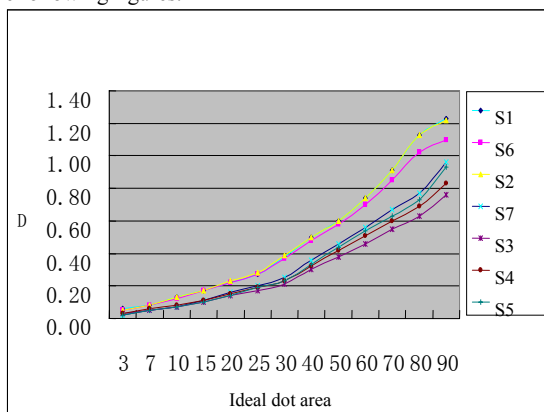
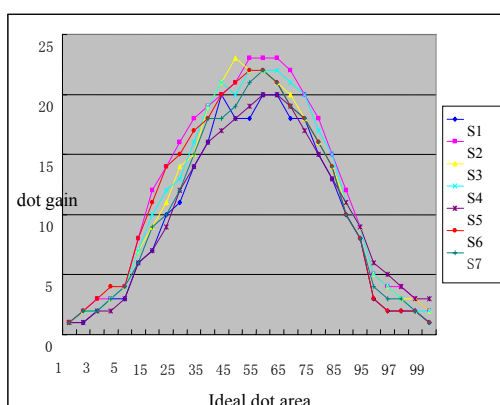


Figure. 2 The relationship of dot areas and densities

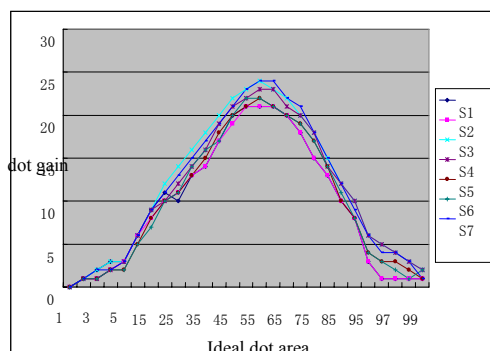
It can be concluded that the tone reproduction of S1 was the best and that of S3 was the worst from the analyses of the densities (see Fig.2) and tone reproduction corresponding to cyan, yellow, magenta and black color, respectively.

3.1.3 Dot Gain

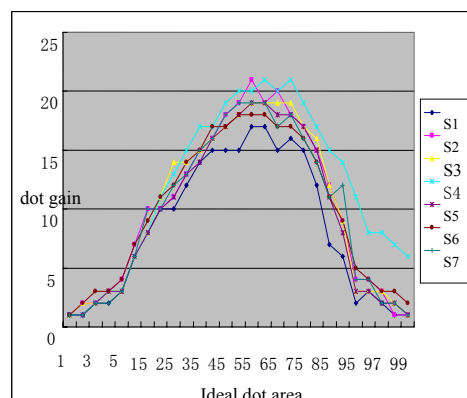
Solid ink density measured by densitometer had a relationship with ink thickness rather than dot size. The dot gain was a normal phenomenon during proofing process. The dot gain must be controlled in a tolerance range, otherwise, the color reproduction and tone reproduction would be affected. The relationships of dot area and dot gain of the seven proofs corresponding to different colors were displayed in the following figures.



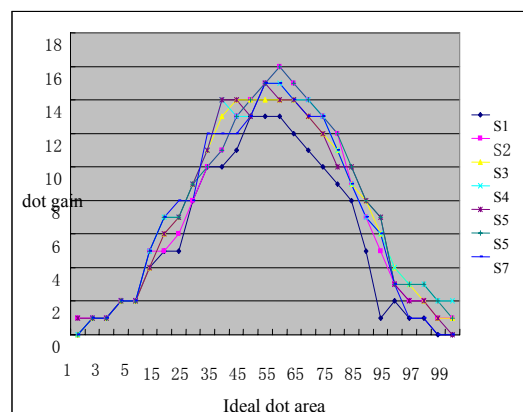
(Cyan)



(Magenta)



(Yellow)



(Black)

Figure. 3 The relationships of dot area and dot gain of the seven proofs corresponding to different colors

In terms of cyan proofs, S1 paper and S5 paper had a relative comparable dot gain; the dot gain of S2 paper was serious in shadow and mid tone area. In terms of magenta proofs, the dot gain curves of S1 and S2 were consistent with each other and the dot gains of them were the smallest; the dot gain of S3 was serious in dark area and that of S7 was serious at light area. In terms of magenta proofs, the dot gain of S1 the smallest; the dot gain of S4 was serious in mid-tone and shadow area. In terms of yellow proofs, the dot gain of S1 the smallest; the dot gain of S4 was serious

3.1.4 Contrast Ratio

Relative contrast was also known as contrast ratio and can be abbreviated as K which is the most important parameter for tone reproduction. K value can be calculated by measuring the solid ink density and the density of 75% dot area. The calculation formula is as follow:

$$K = 1 - D_t / D_s$$

Where D_t is the density of 75% dot area and D_s is the solid ink density.

The range of K value was changed between 0~1. K value was larger, the dot gain was smaller. The optimum solid ink density and tone reproduction can be achieved if K value attained the largest value 1. It was shown that S1 paper had the maximum K value, solid ink density and tone reproduction which were relatively better than other papers. The K values for other papers were comparable.

Table 2 The contrast ratio of different

	K_{BK}	K_Y	K_M	K_C	Ave. value
S1	0.51	0.46	0.36	0.42	0.44
S2	0.47	0.42	0.38	0.33	0.40
S3	0.48	0.41	0.34	0.38	0.40
S4	0.44	0.41	0.38	0.38	0.40
s5	0.45	0.45	0.36	0.33	0.40
s6	0.44	0.42	0.39	0.33	0.39
s7	0.48	0.44	0.35	0.36	0.41

3.2 The analyses of color reproduction (reappearance)

3.2.1 Color gamut

The color gamut can be plotted according to L, a^* , b^* values. It was displayed in the Figure. 4 that paper S6 had the smallest color gamut.

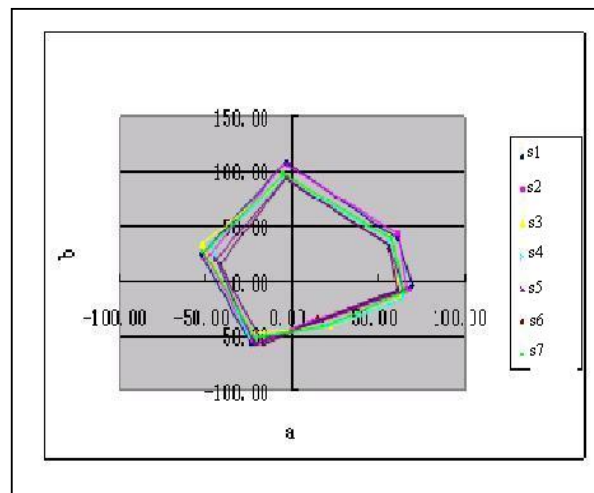


Figure. 4 Color gamut

3.2.2 Color difference

The color differences of S2 were between 0.5 and 6.0, those of other papers were larger than 6.0, especially, most of the color differences of S5 were even greater than 10, so, it can be concluded that paper S5 had the maximum color difference.

Conclusion

The results showed that S1 paper had the maximum K value, the optimum solid ink density and tone reproduction comparing with other six ink-jet printing papers; the K values of other six printing samples were comparable. The evaluations of color reproduction can be achieved by analyzing and comparing color differences and color gamut of different papers. S2 paper had the minimum color difference, S6 and S5 had the maximum color differences. S1 and S2 had larger color gamut, and the color gamut of S7 was the smallest one. It can be concluded that the characteristics of S1 and S2 were comparable and there were always some defect with one aspect of other papers.

The variation of proofing quality mainly focus on the tone reproduction and color reproduction of image. The definition of image on the prints and the uniformity of paper surface coating had been investigated but not discussed in the article.

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