Color Consistency of Continuous Ink Jet and Analog Proofs

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Abstract

Experiments are described which compare the color repeatability of IRIS continuous ink jet proofs to 3M analog Matchprints. CIE L*a*b* and density measurements were taken from several IRIS and Matchprint proofs, which contained a standard test image. The test image consisted of a color patches with different colorant amounts. 95% confidence intervals for density, L*, a*, and b* were computed for each color patch and for each proofing system to assess densitometric and colorimetric color variations. Results indicated that the IRIS ink jet proofs were comparable to Matchprint proofs in terms of color consistency.

Introduction

In order to simulate the color output achieved on press, the graphics arts industry utilizes three different proofing methods. These methods include press sheets, analog proofs, and direct digital color proofs. Of the these methods, analog and direct digital color proofs are the most commonly used today.

Analog Proofing Systems

Analog proofing systems, such as 3M Matchprint and DuPont Cromalin, produce proofs directly from color sep-aration films. With the advent of analog proofs, the graphic arts industry could produce proofs without having to make printing plates and press sheets. Analog proofs also exhibited better color consistency relative to press sheets, which made it easier for printers to predict the final result on achievable on press.

While analog proofs provided significant advantages over press sheets, producing analog proofs pose certain drawbacks compared to direct digital color proofing. Analog proofs, for example, require new sets of separations films to be produced every time changes are done to an image. The time and labor required to produce films and analog proofs can also be significantly higher than generating proofs with direct digital color proofing technologies.

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Direct Digital Color Proofing

Direct digital color proofing, or DDCP, is the latest proofing technology utilized by the graphic arts industry. DDCP devices make proofs directly from a pre-press workstation without having to produce separation films or plates. As stated earlier, by not having to generate films or plates, direct digital color proofs can be created faster than analog proofs and press sheets. However, industry concerns over color consistency has limited the proliferation of DDCP devices.

Continuous Ink Jet Technology

Continuous ink jet printing is one image technology utilized for direct digital color proofing. Continuous ink jet produces a continuous stream of droplets using a capillary stimulated with a piezo crystal. Droplets are selectively charged using a charge tunnel assembly, and pass through a deflection structure. A charge applied in the deflection structure directs charged droplets to a knife-edge/gutter system and allows uncharged droplets to be printed.

Color Repeatability

Over the past few years, IRIS Graphics has worked to improve the color repeatability of their proofing systems, which utilize continuous ink jet technology. These improvements had resulted in enhancements in hardware, software, and image processing and color tolerancing.

Previous papers described experiments to evaluate the color repeatability of a four color continuous ink jet proofs.[1,2] Results from one of these studies indicated that the colorimetric repeatability of continuous ink jet proofs were comparable to analog proofing devices. However, these experiments were based on a small number of sample proofs and were conducted in a controlled laboratory setting. This purpose of this paper was to assess the densitometric and colorimetric repeatability of a large number of analog Matchprint and IRIS continuous ink jet proofs produced by a large U.S. printing facility in a production environment.

Experimental

Test Pattern Design

A test image was developed to evaluate colors produced by each proofing system. The image consisted of color patches at 25, 50, 75 and 100 percent dot values

for the four primaries (cyan, magenta, yellow and black) and the two color overprints (red, green and blue).

Sample Collection and Measurement

Using the test pattern image, the printing facility produced one hundred sets of Matchprint and IRIS proofs over a two month time period. The sample size and time frame allowed the printing facility to assess lot-to-lot material variations in proofing system. The printing facility also generated the Matchprint proofs using one set of separation films.

After making a proof, densitometric and colorimetric measurements were made for each color patch on the proof. The densitometric measurements were obtained with an X-Rite 408 densitometer. Colorimetric measurements were made using an X-Rite 918 colorimeter. Colorimetric values were in terms of CIE L*a*b* (D50, 1931, 10 degree observer).

Densitometric/Colorimetric Analysis

After obtaining density and CIE L*a*b* data from all of the proofs, 95% confidence intervals for density, L*, a*, and b* were computed. The density confidence intervals were only calculated for the primary color patches, while L*, a*, and b* confidence were computed for the primary and two color overprint patches. After determining the confidence intervals, ΔE*ab values were then computed for each color patch using the confidence intervals for L*, a*, and b*.

Results

As seen in Tables 1 and 2, the average density and ΔE* color variations obtained for the IRIS proofs were comparable to the analog Matchprint proofs. In terms of average density variations, the IRIS and Matchprint proofs reproduced primary colors within +/- 0.03 density units. The average colorimetric consistency for both proofing systems was less than 3.0 ΔE* units for primary and two color overprint colors.

Conclusion

Matchprint and IRIS proofs were found to be equivalent in terms of densitometric and colorimetric consistency. It is important to note that the Matchprint findings excluded separation film processing variations. This means that the color variations observed with Matchprints using different separation films could be higher than reported in this paper. This fact further supports the argument that continuous ink jet proofs can achieve a level of color consistency similar to analog Matchprint proofs.

Table 1. Average 95% Confidence Intervals with Respect to Density

Color	IRIS	Matchprint
Cyan	+/– 0.028	+/– 0.030
Magenta	+/– 0.026	+/– 0.018
Yellow	+/– 0.020	+/– 0.019
Black	+/– 0.025	+/– 0.026

Table 2. Average ΔE* Values Based on 95% Confidence Intervals for L*, a*, and b*

Color	IRIS	Matchprint
Cyan	1.5	1.7
Magenta	1.8	1.7
Yellow	2.6	1.6
Black	1.3	1.6
Red	2.7	2.2
Green	2.7	2.1
Blue	2.7	2.9

References

1. J. Ingraham, "Colorimetric Repeatability of Continuous Ink Jet Images for Prepress Proofing," *Advance Printing of Paper Summaries, IS&T 46th Annual Conference,* Boston, May 1993, pp. 190-192. ***(see page 305)***
2. P. Engeldrum, J. Ingraham, J. Laskin, "Evaluating Colorimetric Repeatability of Continuous Ink Jet Images," *Color Hard Copy and Graphic Arts,* Jan Bares, Ed., Proc. SPIE Vol. 1670, pp. 217-223 (1992).