Digital Printing Comparison of Inkjet and Toner Technologies Related to Color Gamut and Reproduction Characteristics

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Abstract

Because of the development of computer technology, digital printing machines have been used extensively for small-volume printing for the last ten to fifteen years. Digital printing does not require complicated preparation and makeready that exists in offset printing. As speed and quality increase with digital printing, it is becoming an alternative to offset systems. It is important to understand the reproduction capabilities of digital presses before making an investment. With this study, test prints from both inkjet and toner technologies will be examined in terms of CIELab values, dot gain, and gray balance.

1. Introduction

Printing companies have been investing in digital printing systems increasingly each year. To meet the quality expectations, new reproduction technologies are being developed by various companies.

The purpose of this study is to compare the color gamut and reproduction characteristics between inkjet and toner technologies developed by Eastman Kodak Company.

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A digital test form was designed, and then printed on the Kodak Prosper 5000XL and the Kodak NexPress SE series presses by Eastman Kodak Company. The results are indicated in the study.

2. Methodology

The test form contains CMYK pictorial color images for visual comparison for skin tones, a test target for pastels, a black ramp to measure dot gain, an IT8.7-3 target for device profiling and for quantitative analysis, a special target to find quantization errors in fine-line reproduction in the RIP, a rich-black area for testing Total Area Coverage (TAC), a black checkerboard of 48% dots to check device geometry and gain.

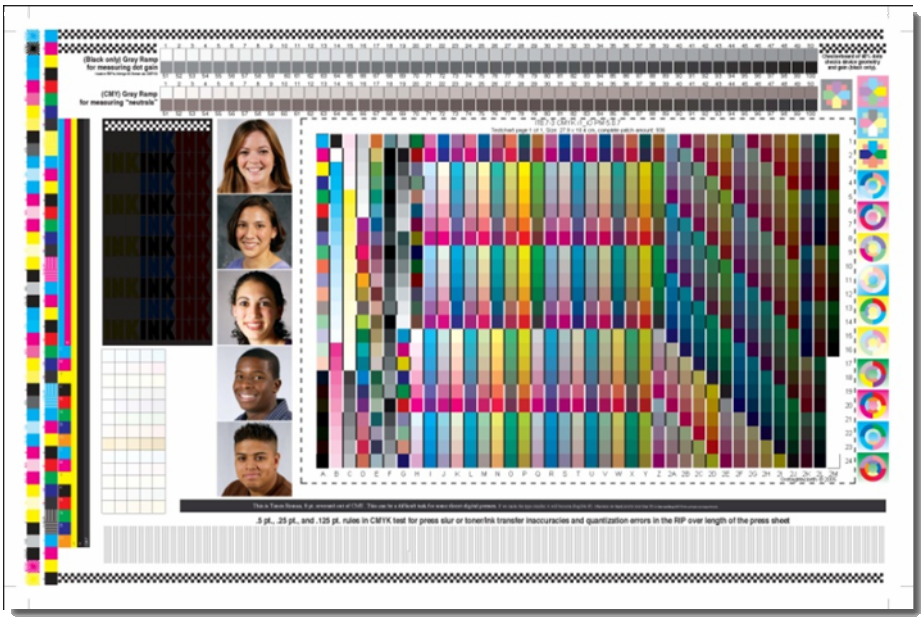


Figure 1. *Test form used.*

Kodak printed two sets of non-color-managed test forms. Color management was not applied to identify the color capabilities of each device without applying any gamut control. One set printed on a Kodak NexPress SE series press using Sterling Ultra Digital Gloss paper and Kodak NexPress dry inks, and the other set printed on a Kodak Prosper 5000XL press using Sterling Ultra Jet paper and Kodak Prosper inkjet inks. Analyses of colorimetric, densitometric, and visual comparisons between the systems were performed and the results are indicated in the study.

3. Results

The data from both the Kodak Prosper 5000XL press and the Kodak NexPress SE series press were measured from the IT8.7-3 target to see color gamut and gamut volume differences. X-Rite Profile Maker Pro 5 was used to build the ICC profiles, and the files were compared in Chromix ColorThink Pro 3.0.

3.1 3D CIE Lab Comparison

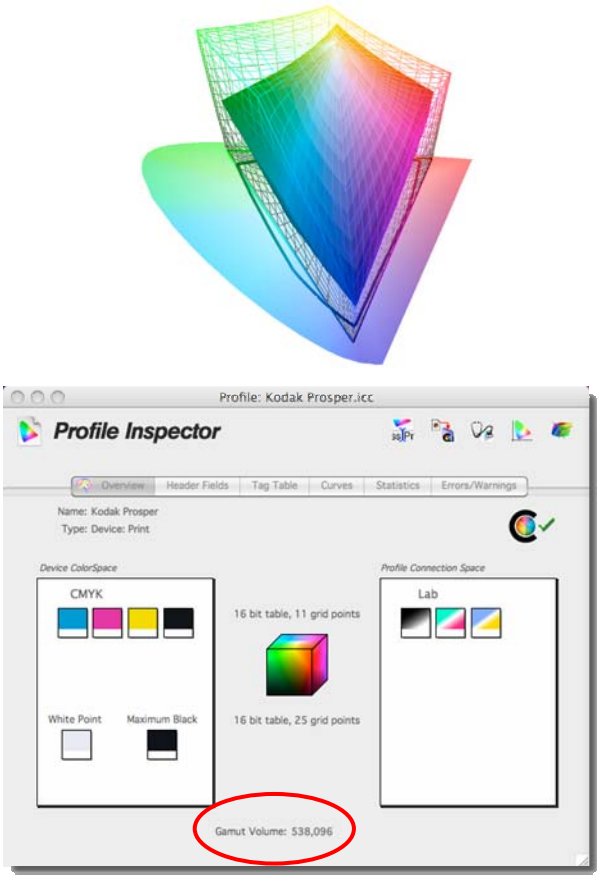


Figure 2. *Adobe RGB 1998 (wireframe) vs. Kodak Prosper press (solid) gamut comparison/Kodak Prosper gamut volume 538,096.*

With the ability to capture images using digital cameras, Adobe RGB 1998 is a very common profile used for digital cameras. So, as shown in the graphic, Kodak Prosper is the gamut as the solid one in the Adobe RGB 1998 wireframe gamut for comparison. Kodak Prosper can reproduce 41 percent of the RGB gamut. The number of gamut volume for Kodak Prosper, 538,096.

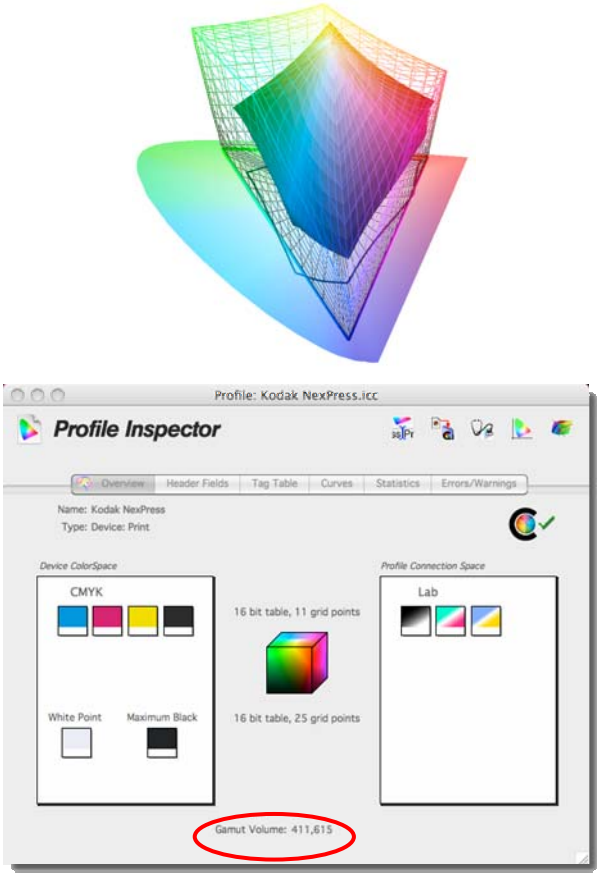


Figure 3. *Adobe RGB 1998 (wireframe) vs. Kodak NexPress (solid) gamut comparison Kodak NexPress gamut volume 411,615.*

Kodak NexPress gamut as the solid one in the Adobe RGB 1998 wireframe gamut. Kodak NexPress can reproduce 31.5 percent of the RGB gamut. The number of gamut volume for Kodak NexPress, 411,615.

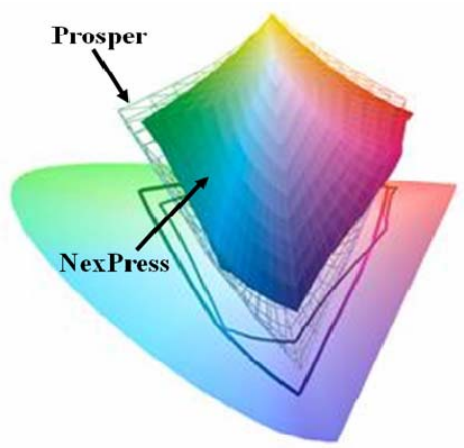


Figure 4. *Kodak Prosper (wireframe) vs. Kodak NexPress (solid) gamut comparison.*

In the Figure 4, the Prosper is represented by the wireframe while the NexPress is represented by the solid one. In comparing these two gamuts, I found that the Prosper gamut is approximately 24 percent larger than the NexPress gamut.

3.2 2D CIE Lab Comparison

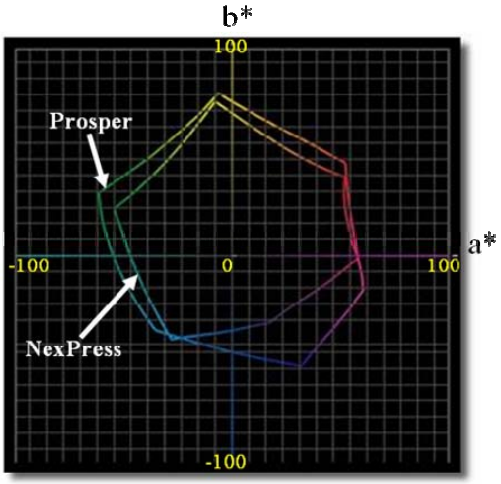


Figure 5. *2-D CIE Lab comparison.*

In Figure 5, the Prosper is larger in all areas, but significantly larger in the blue-magenta hue.

3.3 Dot Gain Comparison

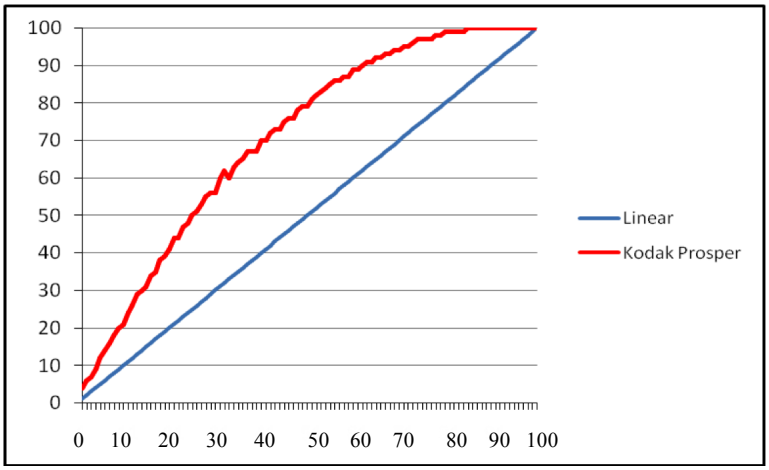


Figure 6. *Kodak Prosper dot gain chart.*

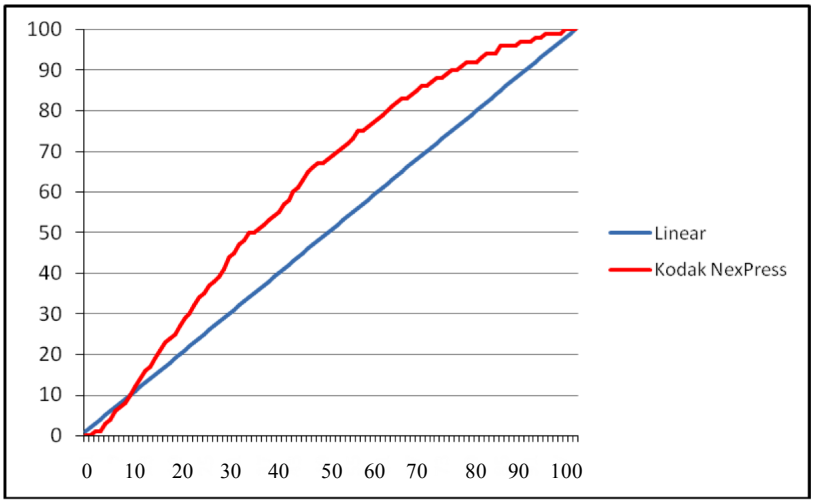


Figure 7. *Kodak NexPress dot-gain chart.*

As shown in the Figures 5 and 6, the dotgain on the Prosper is more than the NexPress. In fact the Prosper shows even more dot gain than is typically seen

with offset printing. However, this should not be a significant problem because dot gain can be controlled by the curves generated in the RIP. The NexPress shows less dot gain and is probably closer to offset.

3.4 25%, 50%, and 75% Dot Reproduction and Dot Structure

Fifty (50) power pictures were taken to see the dot shapes for the 25, 50, and 75 percent dots. The Prosper reproduces completely round and perfectly sharp dots and Kodak NexPress toner dots are smaller than Prosper and more diffuse.

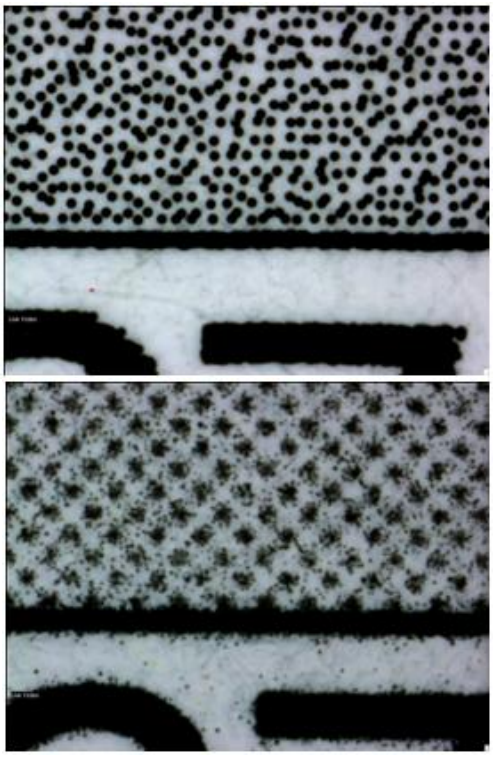


Figure 8. *25% dot structure on Kodak Prosper (left) and Kodak NexPress (right).*

The 25 percent dot reproduced as a 50 percent dot on the Prosper. On the NexPress, the toner dots are more diffused and fuzzy. But there was less dot gain, so the 25 percent dot reproduced as a 35 percent dot.

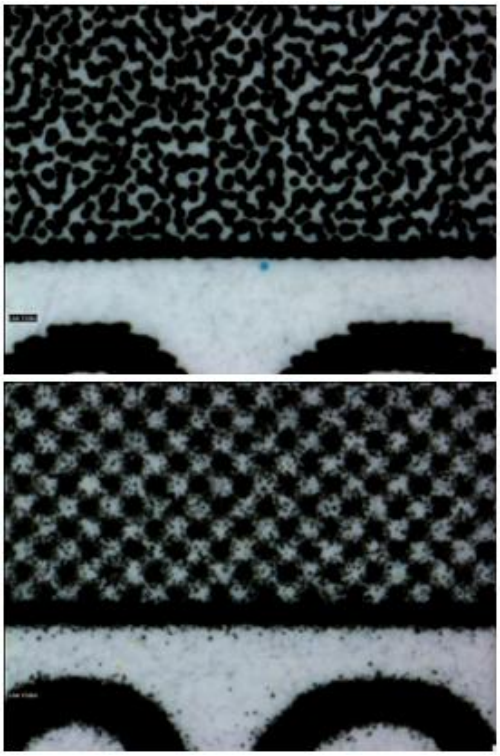


Figure 9. *50% dot structure on Kodak Prosper (left) and Kodak NexPress (right).*

The 50 percent dot on the Prosper reproduced as a 79 percent dot. And on the NexPress, the 50 percent dot reproduced as a 68 percent dot.

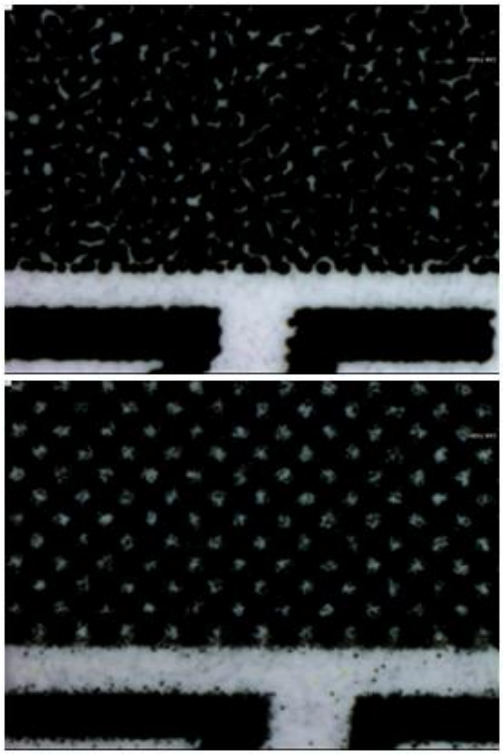


Figure 10. *75% dot structure on Kodak Prosper (left) and Kodak NexPress (right)*

In the last example, the 75 percent dot on the Prosper reproduced as a 97 percent dot. And on the NexPress, the 75 percent dot reproduced as a 90 percent dot. But again this should not be a problem because dot gain can be controlled.

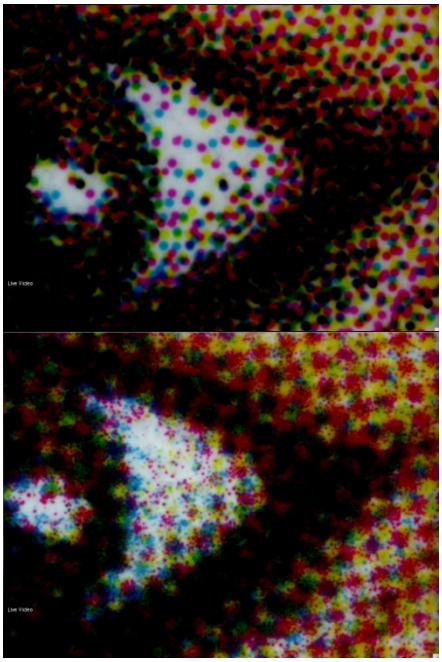


Figure 11. *50x photomicrograph images, Kodak Prosper (left), Kodak NexPress (right).*

At the 50 power view, dots are very sharp on the Prosper and the stochastic patterns are very noticeable. There is a possibility this can create perceptual noise because the dots are so crisp. While the NexPress image has more scattering in the dots and a larger dot pattern that gives a smoother, more continuous-tone look.

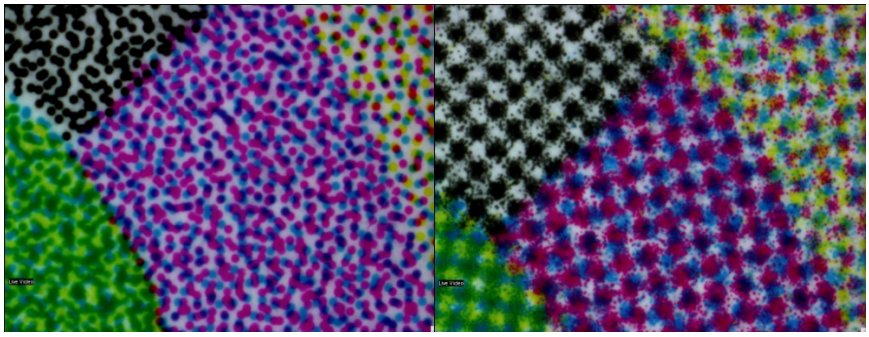


Figure 12. *50x photomicrograph images, Kodak Prosper (left), Kodak NexPress (right).*

It is obvious to see that the Prosper has stochastic patterning, although the NexPress has regular halftone patterning at the rendering of solid color and black color areas.

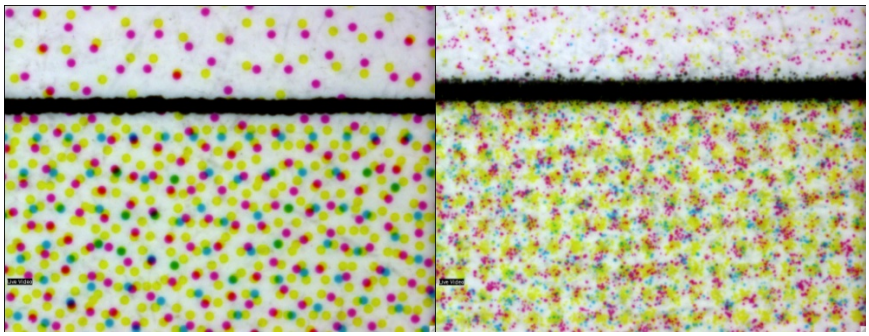


Figure 12. *50x photomicrograph images, Kodak Prosper (left), Kodak NexPress (right).*

Often in offset printing pastel colors are very difficult to reproduce because there is a loss in very small dots from file to plate and plate to printing. The portion of the target shown has various combinations of small dots from 1 up to 15 percent. With both digital presses the pastel colors reproduced very well and there was no loss in dot reproduction. Visually the colors appear slightly more saturated on the Prosper then on the NexPress. An enlarged view of one of the

pastel areas with magenta and yellow combined on the top part and cyan magenta and yellow combined on the bottom. Again, notice the diffused pattern of the Nexpress and sharp dots on the Prosper.

3.5 Fine-Line Reproduction

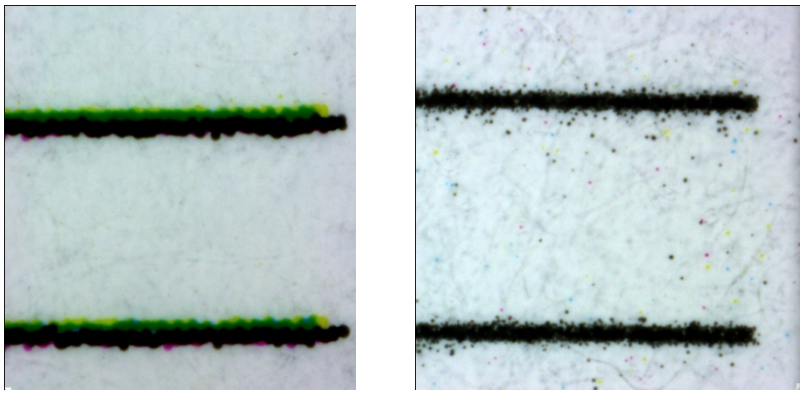


Figure 11. *50x photomicrograph images 0 .125 point micro lines. Prosper is on the left; NexPress is on the right.*

Figure 11 shows a hundred twenty-five thousandth of a point micro line which is equal to 1 point seven thousandth of an inch. They are CMYK lines which allow one to check registration. There is some very slight misregistration on the Prosper reproduction. Given the speed of the Prosper, this slight misregistration is perfectly acceptable and within reasonable tolerance. With the NexPress, there is some scatter because of the electrostatic charge used for imaging. Registration appears to be exceptional on this press.

3.6 Text Reproduction

Figure 12. *50x photomicrograph images, Text on Kodak Prosper.*

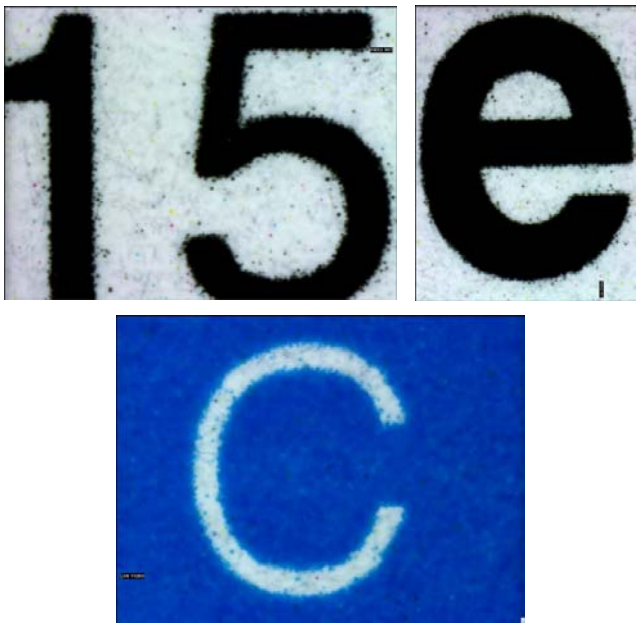


Figure 13. *50x photomicrograph images, Text on Kodak NexPress.*

Figure 12 and 13 shows some detail on how type is reproduced with these two machines. The edges of the type on the Prosper look a little more jagged because of the round stochastic dot while the Nexpress has a much smoother appearance both in the positive and reverse type.

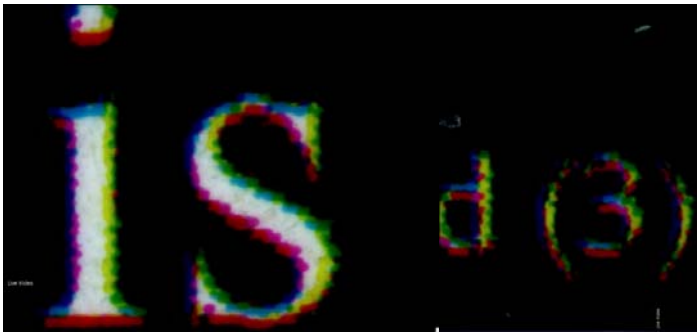


Figure 14. *50x photomicrograph images, Kodak Prosper 8-point and 3-point CMY reverse type.*

Figure 15. *50x photomicrograph images, Kodak NexPress 8-point and 3- point CMY reverse type.*

Figure 14 and 15 shows 50 power view of the CMY reverse type in both 8-pt. and 3-pt. sizes. There is slight misregistration that occurs on the Prosper. The NexPress looks more clean. But still they are readable at both presses.

3.6 48% Checkerboard Reproduction

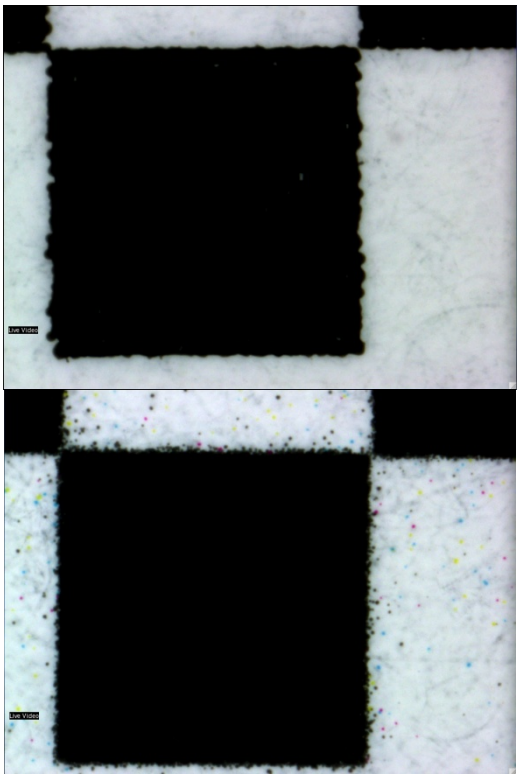


Figure 16. *50x photomicrograph images, 48% checkerboard. Prosper (left); NexPress (right).*

These are 48 percent checkerboards. It is a quick way to see dot gain visually. When the corners touch each other, it shows that there is some dot gain. And the other thing it shows is the device geometry. As Figure 16 shows that the square reproduces very well, indicating the device geometry is very good on both presses.

3.7 Rich Black Reproduction

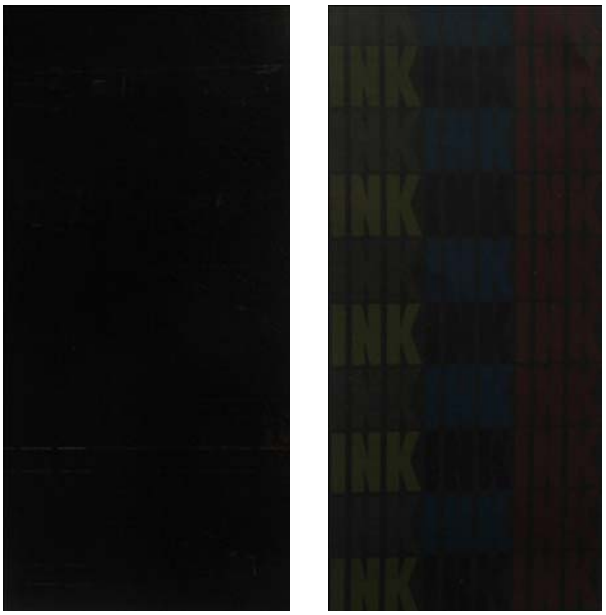
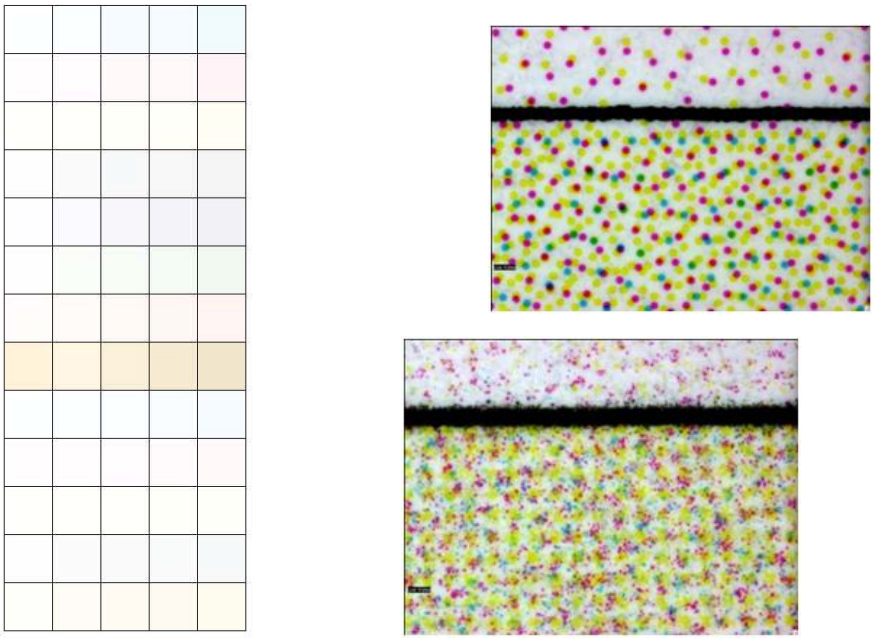


Figure 17. *Rich black areas, Kodak Prosper (left), Kodak NexPress (right)*

Rich black test target is designed to show Total Area Coverage limit. Given that most presses can not reproduce 400 percent of area coverage, this part of the target was built to challenge all presses in this area. For the NexPress the target was run as submitted. The result shows very good reproduction with total area coverage from 100 to 400 percent. For the Prosper, Kodak changed the 400 percent black to 100 percent black in the RIP. Because of the known limitation of the press. The word is viewable on the NexPress sheet while they are not viewable on the Prosper sheet.

3.7 PASTEL REPRODUCTION



Kodak Prosper

Kodak NexPress

Figure 18. *50 defa büyütülmüş pastel test skala detayı.*

Often in offset printing pastel colors are very difficult to reproduce because there is a loss in very small dots from file to plate and plate to printing. The portion of the target shown has various combinations of small dots from 1 up to 15 percent. With both digital presses the pastel colors reproduced very well and there was no loss in dot reproduction. Visually the colors appear slightly more saturated on the Prosper than on the NexPress. Figure 18 shows an enlarged view of one of the pastel areas with magenta and yellow combined on the top part and cyan magenta and yellow combined on the bottom. It is easy to see the diffused pattern of the Nexpress and sharp dots on the Prosper.

3.7 Pictorial Color Image Reproduction

Figure 19. *Pictorial image comparison of skin tones.*

In the pictorial image comparison of skin tones, there is some slight noise in the midtones and shadows on the Prosper compared to the Nexpress. Given that coated paper was used and the dots reproduce so sharply the Nexpress images appeared more smooth while the Prosper appeared more grainy. This effect could go away if printed on uncoated paper on the Prosper.

4. Summary

To summarize, the Prosper has a larger color gamut, especially in the blue-magenta range. Device geometry is good on both presses. The NexPress has smaller dot gain. The Prosper has sharper, perfectly round shape. The NexPress registration appears slightly better. Text reproduction is smoother on the NexPress. Reverse text is slightly better on the NexPress. Rich black reproduction is better on the NexPress. Pastel tones are slightly stronger on the Prosper and Pictorial images are smoother on the NexPress.

5. Conclusion

In conclusion I found both presses reproduced our test target very well. However I was extremely impressed with the Prosper technology. It truly is a revolutionary technology and an extraordinary device. The dot reproduction is sharpest we've seen within the inkjet world, and the printing is tremendously clear. The speed of this device can go as fast as 1000 feet per minute depending on the coverage and resolution. It clearly is a serious competitor in the field of digital printing and compared to other digital devices it is one of the best available today.

6. References

1. Eastman Kodak Company. 2009. *Meet Stream Inkjet Technology.*

2. SpencerLab Digital Color Laboratory. 2008. *Stream Concept Press from Kodak— On the Way to Offset Class Print Quality.*

3. Chung, R. and F. Hsu. 2009. *"Benchmarking Color Image Quality between Inkjet and Offset,"* Test Targets RIT School of Print Media Publications 9.0.