# Reducing Inkjet Ink Consumption with RIP software for POP Display Media

*Yu-Ju Wu*
*Appalachian State University, Boone, NC, USA*

## Abstract

*Most media used for POP display are not paper-based substrates. Finding an appropriate digital print configuration becomes crucial for color reproduction of display media. In most situations, running a digital printer wide-open without ink restriction will not achieve the most accurate, repeatable color. A third-party raster imaging processor (RIP) software interprets raster and vector data files for a specific postscript printer in either RGB or CMYK mode. By controlling CMYK inks directly, RIP software can provide better control for accurate digital color reproduction while reducing ink consumption. The purpose of this project is to reduce ink usage while achieve accurate/repeatable digital color reproduction for display media by establishing a digital print configuration with RIP software for tested display media. Four commercially available display media (DuPont Tyvek, Polypropylene, Satin Cloth, and Vinyl) were used in this study. A third-party RIP software, CGS ORIS Color Tuner, was used to control an Epson Stylus Pro 4800 inkjet printer. The ink usage was determined in terms of amount of ink restriction. Color reproduction quality was evaluated in terms of color gamut volume and inkjet-hooking diagram.*

## Introduction

There is a growing market for outdoor and retail advertising utilizing vinyl, film, or fabric as advertising look for unique ways to communicate brand message. A proper point of purchase (POP) display catches eye with strong wording and colorful branding. Vinyl, film, and fabric service customers with a range of applications at an affordable price, together with benefits of protecting digital output from abrasion, providing greater longevity, and aiding installation[1].

Most substrates used for POP display are not paper but durable substrates and mostly plastics. A variety of plastics are found in the makeup of POP display media, which include polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polycarbonate, polystyrene, polytetraflouroethylene, polyurethane, polymethyl methacrylate, polyimide, and polyester[1, 2].

Today, display media manufacturers avoid using plastics that contain harmful additives to offer “green” materials that still provide durability and flexibility. The plastic itself usually isn’t the problem. Instead, the additives used in the plastic are the problem. Certain plastics contain plasticizers, such as benzoates, phthalates like di-ethylhexyl phthalate, formaldehyde in the adhesive, or heavy metals including cadmium, lead, antimonies, phosphates, and chromium. Those chemicals do not break down properly in landfills and migrate into the ground and water supplies, which in turns to be toxic to human health and the environment[4]. Some plastics are considered more sustainable than others. For example, PE is considered as the most recycled plastic in the world, which contains no phthalate plasticizers, is light in weight, and is 100% recyclable. Dupont’s Tyvek, for instance, is mainly composed of high-density polyethylene (HDPE) polymer. The low additive content allows for its recyclability. Polyester is a clear and dimensionally stable polymer. It also has the benefit of not being a PVC-based film. Textiles are considered as another eco-friendly material, whether it is creating fabric from post-consumer materials or recycling the fabric after use. A finished textile graphic also incurs low shipping and handling costs because of its lightweight. For an eco-conscious customer, eco-friendly substrates become a way to advertise to a targeted market watchful of environmental footprint[2, 3, 4].

The idea of trying to save ink in digital printing is not new, especially when it comes to wide-format inkjet printing. Today, digital printer technology and color management has improved greatly in the past few years. With these improvements, overall ink usage can be controlled and reduced[5, 6, 7]. A third-party RIP software controls CMYK inks directly, which in turns delivers the right amount of ink distributed correctly on the media. Saving ink in a digital print environment can be accomplished by using correct settings of digital print media configuration and ICC Profile generation (black start and GCR)[5]. This study focused on digital print media configuration, which is the first and the most important step in trying to minimize ink usage in digital printing.

## Experimental

This study employed CGS ORIS RIP (COLOR TUNER // WEB 2.0.6) to control an Epson Stylus Pro 4800 inkjet printer. Four commercially available POP display media (eco-friendly and traditional) were tested. Table 1 provides basic properties of substrates used in this study. All tested POP display media contained optical brightener agent (OBA).

**Table 1: Properties of tested display media**

| Substrates | Material | Thickness | Recyclability |
|---|---|---|---|
| DuPont Tyvek | High-density polyethylene | 11 mil | 100% Recyclable |
| Polypropylene | Matte Polypropylene | 8 mil | 100% Recyclable |
| Satin Cloth | Polyester fabric | 6 mil | Non-Recyclable |
| Vinyl | Matte Calendared PVC | 5 mil | Non-Recyclable |

The ink usage was determined in terms of amount of ink restriction. A linearization test target was used to exam the inkjet hooking phenomena, i.e. the ink hue shifting associated with inkjet printers. Due to impurities in the inkjet inks, the color shift usually happens in color and neutral shadow areas of a print. Figure 1 illustrates how a raw linearization target displays color cast. Proper ink restriction (Figure 2) allows all the steps on the linearization test target are printed correctly and evenly distributed. This study experimented with different linearization setting to see how less inkjet hooking can occur. The X-Rite i1iO spectrophotometer was used as a measurement device. CHROMiX ColorThink Pro 3 software was used to determine gamut volumes and provide inkjet-hooking diagram.

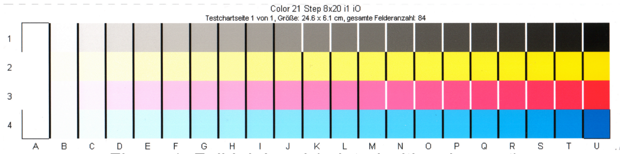


Figure 1. Full Ink Load (printed with color cast).

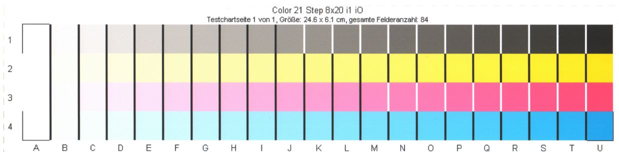


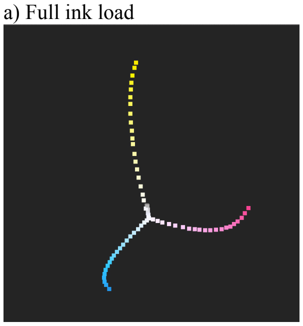
Figure 2. Reduce Ink Load (distributed the tones more correctly and evenly).

## DuPont Tyvek

Figure 3 shows the inkjet–hooking diagram for the Dupont Tyvek display media. A typical inkjet hooking phenomena has been observed when printing with full ink load. It shows the hue angle of cyan color begins to shift from a cyan blue to a contaminated cyan that turns purple because there is more red color in the cyan. The hue angle of magenta color shifts toward yellow. With ink restriction, the inkjet hooking has been reduced. By reducing ink load 16.25%, ink distributed more evenly and correctly on the media.


a) Full ink load


b) Reduce ink load 6.75%


c) Reduce ink load 12%

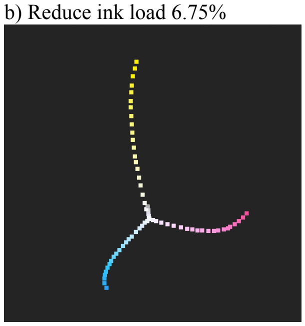

d) Reduce ink load 16.25%

Figure 3. Inkjet-hooking diagram for the Dupont Tyvek media.

As expected, ink restriction reduced the size of the color gamut. Figure 4 shows color gamut as function of ink load for the Dupont Tyvek display media. Reducing ink load by 6.75% cut back the size of color gamut about 2%; 12% ink reduction resulted in 5.3% decrease of color gamut; 16.25% ink reduction cut down the size of color gamut about 9%.

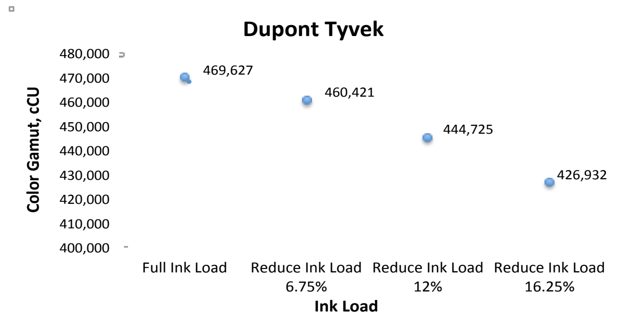


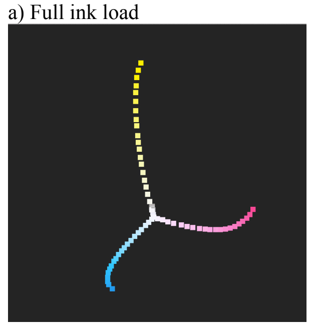
Figure 4. Dupont Tyvek - color gamut as function of ink load.

## Polypropylene

Figure 5 displays the inkjet–hooking diagram for the Polypropylene display media. It shows the color shifts for the cyan and magenta colors. With different ink restriction settings, the inkjet hooking has been reduced gradually. By reducing ink load 14.75%, ink distributed more evenly on the media while keeping chroma. Figure 6 shows color gamut as function of ink load for the Polypropylene display media. Reducing ink load by 6.25% cut back the size of color gamut about 1.3%; 10.5% ink reduction resulted in 5% decrease of color gamut; 14.75% ink reduction cut down the size of color gamut about 7.7%.


a) Full ink load


b) Reduce ink load 6.25%


c) Reduce ink load 10.5%

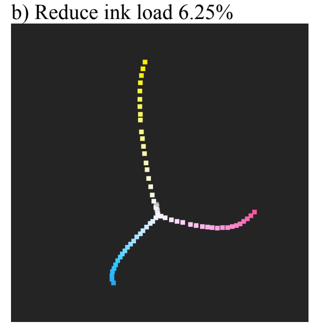

d) Reduce ink load 14.75%

Figure 5. Inkjet-hooking diagram for Polypropylene media.

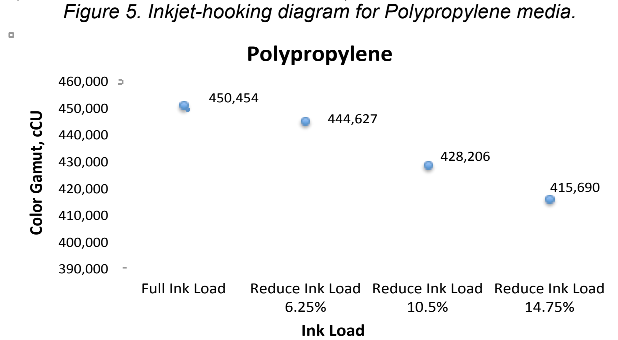


Figure 6. Polypropylene - color gamut as function of ink load.

## Satin Cloth

The inkjet–hooking diagram for the Satin Cloth display media is shown in Figure 7. The typical color shifts for the cyan and magenta colors were observed. With different ink restriction settings, the inkjet hooking has been reduced gradually. By reducing ink load 19.5%, ink distributed more evenly on the media. Reducing ink load by 23.75% might lose some chroma.

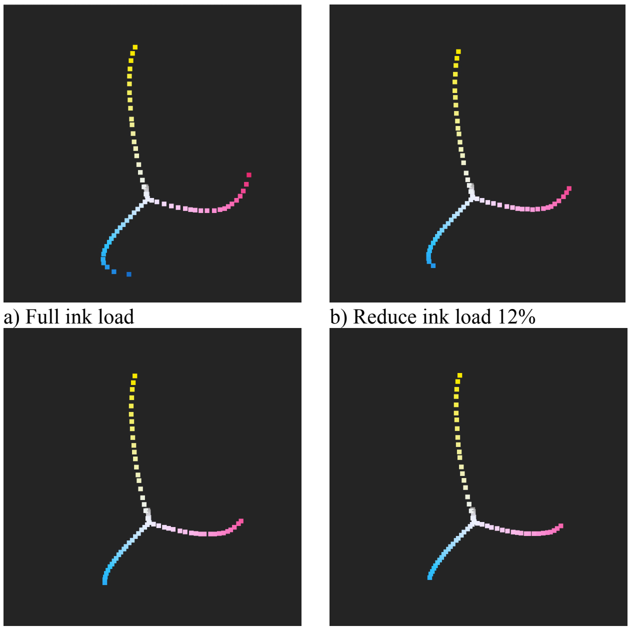

a) Full ink load
b) Reduce ink load 12%
c) Reduce ink load 19.5%
d) Reduce ink load 23.75%

*Figure 7. Inkjet-hooking diagram for Satin Cloth media.*

Figure 8 illustrates color gamut as function of ink load for the Satin Cloth display media. Reducing ink load by 12% cut back the size of color gamut about 6%; 19.5% ink reduction resulted in 15.7% decrease of color gamut; 23.75% ink reduction cut down the size of color gamut about 22.5%.

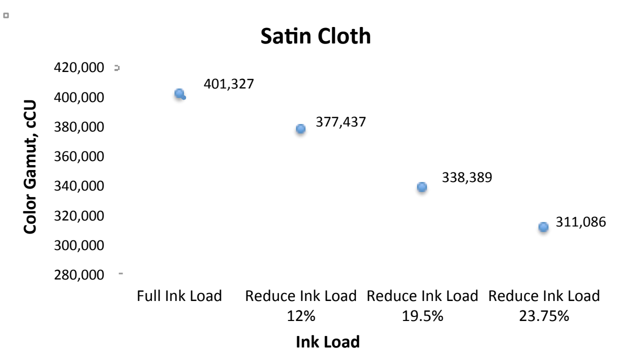



*Figure 8. Satin Cloth - color gamut as function of ink load.*

## Vinyl

Figure 9 displays the inkjet–hooking diagram for the Polypropylene display media. It shows the color shifts for the cyan and magenta colors. With different ink restriction settings, the inkjet hooking has been reduced gradually. By reducing ink load 16.25%, ink distributed more evenly on the media while keeping chroma.

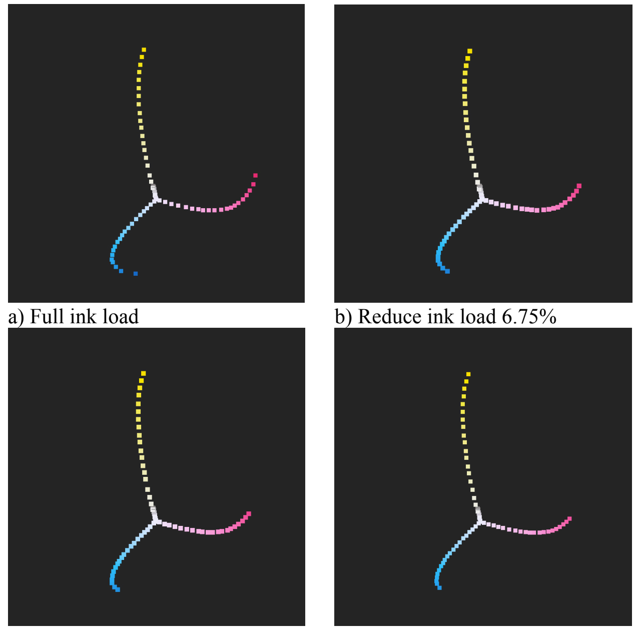

a) Full ink load
b) Reduce ink load 6.75%
c) Reduce ink load 12%
d) Reduce ink load 16.25%

*Figure 9. Inkjet-hooking diagram for Vinyl media.*

Figure 10 shows color gamut as function of ink load for the Polypropylene display media. Reducing ink load by 6.25% cut back the size of color gamut about 1.1%; 10.5% ink reduction resulted in 4.3% decrease of color gamut; 14.75% ink reduction cut down the size of color gamut about 6.7%.

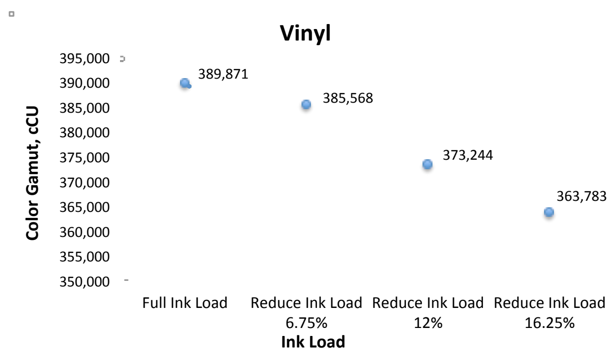



*Figure 10. Satin Cloth - color gamut as function of ink load.*

## Conclusions

The inkjet hooking phenomena was observed especially for the colors cyan and magenta. Each display media behaves differently. It is necessary to experiment with different linearization settings to achieve the right amount of ink distributed on the media. Each individual ink channel should be restricted just right after the color begins to change "hook" from the base primary color, while leaving extra color to extend the gamut for spot colors. It was found that ink reduction for tested POP display media could range from 15 to 20 percent without giving up chroma. Reducing ink load caused color gamut reduction by 6 to 16%. By controlling ink with RIP software, users can reduce overall ink usage, save costs, and support sustainability by producing less post-industrial waste, which must be de-inked before being recycled.

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## References


1. A. E. Watson, "Versatile Vinyl Media Serves a Range of Applications," *Digital Output*, Vol. XIX, No. 3, pp. 47-50, (2013).
2. M. Nonovan, "Paper or Plastic – Sustainable Components and Harmful Elements Define Media," *Digital Output*, Vol. XIX, No. 5, pp. 14-21, (2013).
3. M. Nonovan, "Fabric, Board, Vinyl – Oh My!" *Digital Output*, Vol. XVI, No. 5, pp. 30-34, (2010).
4. G. A. Peck, "Digital Printing leverages Fabulous Fabrics," *Digital Output*, Vol. XIX, No. 11, pp. 12-16, (2013).
5. T. Quinn, "Reducing Inkjet Ink Usage," *The Journal of the Specialty Graphic Imaging Association*, vol. 17, September/October, pp. 23-26, (2013).
6. J. Burton, "The Variables of Calculating Ink Consumption," *The Journal of the Specialty Graphic Imaging Association*, vol. 17, July/August, pp. 5-7, (2013).
7. J. Rich, "The RIP Report-Using and Choosing ICC-Based RIPs that Drive Inkjet Color Printers," Gaithersburg, MD: Rich & Association LLC, (2004).


## Author Biographies


*Dr. Yu-Ju Wu is an Assistant Professor in the Department of Technology and Environmental Design at Appalachian State University. She received her PhD degree in Paper Engineering, Chemical Engineering and Imaging from Western Michigan University. She is a member of the IS&T and TAGA. Her research interests are digital printing and color management, printability analysis, process control, sustainability, and packaging.*