Improving the Performance of InkJet and Laser Printing through Paper Modification

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Abstract

Digital Printing, including inkjet and dry electrophotography (laser), is rapidly increasing while most analogue processes are flat or declining. This growth is driven by the increase in speed and quality of digital prints enabling new uses for consumer and business users.

However, both inkjet and laser printing suffer from issues that could be easily addressed by paper improvements. Hewlett Packard, working with International Paper, incorporated some of these improvements into the HP Everyday papers. Everyday paper performance was improved giving:

- *Faster drying time*
- *Darker blacks*
- *Vivid colors*

We achieved these improvements through the addition of color locking technology.

These improvements and other improvements that improve inkjet and laser performance are available to the paper industry. Hewlett Packard, and other printer manufacturers, would like to see the paper industry incorporate these improvements and allow further growth in digital printing.

Background

Digital printing, led by color printing is growing at a substantial rate. This increase is driven by continuous improvements in inkjet and dry electrophotography. For example, for Hewlett Packard inkjet, the number of drops fired per printhead has doubled every 18 months for the last 20 years. Increasing the number of drops allows Hewlett Packard to increase the speed (more drops/second) and quality (smaller drops). As ink jet technology advances with the numbers of nozzles and firing frequency increasing at an enormous rate, inkjet is expanding into a plethora of different applications. These applications demand high quality printed pages.

However, more drops fired do not result in darker black, more vivid colors, or faster drying. Improvement in features such as dry time, image quality, color saturation, and text sharpness are required. With ink jet technologies and everyday paper, the paper allows the ink to and colorant to penetrate the porous structure, resulting in a loss in color strength, and ragged text edges. This can be improved by two methods, either improvement in the ink formula or improvement in the paper.

Ink scientists have a large formulation space to improve the performance of the inks, but must also contend with balancing performance with image quality, high jetting reliability, safety, and materials compatibility. HP has a variety of patents describing how to control the penetration of inks[1]—and interaction between inks[2]—for sharp, crisp text, and vivid graphics. Inks must also be formulated to print on a large variety of substrates.

There is a great demand for paper of high enough quality to be suitable for printing of a digital image of high print quality and durability on an inkjet printer. Thus, there is a strong demand for papers that meet high quality standards with respect to brightness, opacity, and dry and wet strength, and that, upon printing with any of a wide range of colorants, provide a water-resistant and vivid printed image. Paper scientists also must contend with limited formulation space and the cost limits associated with manufacturing everyday paper.

However, there are cost effective methods to improve image quality, color saturation, dry time, and text sharpness of everyday paper. One of these methods, when applied to the manufacture of everyday papers, provides noticeable improvements in ink jet ink performance:

- Faster dry time with many inks -- customers can handle the printed output sooner with less transfer.
- Print Quality – darker, richer blacks, and more uniform, vivid colors – for improved text and color graphics.
- Improved contrast in mixed color graphics due to improved color to color bleed.

Improving Paper

As digital printing increases, there exists a growing opportunity for papers to differentiate in terms of performance. Quality needs to be improved as customers use digital prints for new applications. Hewlett Packard, working with International Paper, has introduced color locking technology into the HP Everyday Papers to improve quality of both inkjet and electrophotographic prints. HP Everyday Papers with color locking technology show darker blacks, faster drying, and more vivid colors with inkjet printing.

Black Optical Density and Drytime

Most inks employ a pigment for printing black. The pigments used in inkjet inks are stabilized primarily by electrostatic stabilization through the use of polymer dispersants or surface treatments on the black pigment. Black optical density can be increased by adding larger amounts of pigment and by designing the vehicle to minimally penetrate into the paper.

Drytime is primarily influenced by the vehicle design. Designing the vehicle with large amounts of surfactant can result in a fast drytime. However, achieving good optical density and a fast drytime is a challenge.

Effect on Black Text and Optical Density

Typical inkjet ink on everyday paper is shown in Figure 1. The ink is designed to absorb into the paper and both the vehicle

[1] US6786957, US6630017, US6585364

[2] US6786955, US6572690, US6500880

and the colorant penetrate deeply into the paper itself. A balance between drytime and optical density in attained.

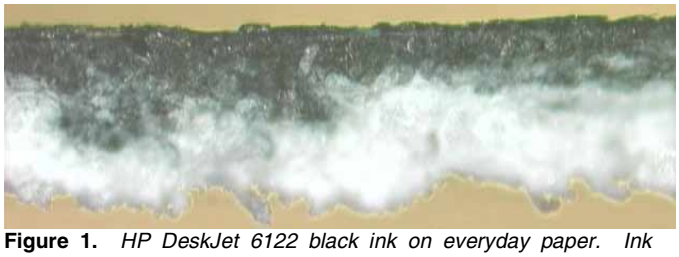

Figure 1. *HP DeskJet 6122 black ink on everyday paper. Ink penetrates deeply into the paper.*

Treating the same paper with color locking technology results in significant improvement in black text quality and optical density. Color locking technology destabilizes and flocculates the pigments on contact and retain pigments in inks near the surface of the paper. This is clearly shown in Figure 2.

Figure 2. *HP DeskJet 6122 black ink on everyday paper treated with color locking technology. Ink is retained on paper surface.*

The effect of retaining the pigment near the surface of the paper markedly improves the black optical density. As shown in Figure 4, HP Multipurpose paper treated with color locking technology has significantly darker blacks as measure by optical density, than all other papers tested. The darkness advantage is 120 mOD units on average compared to the other 10 papers tested.

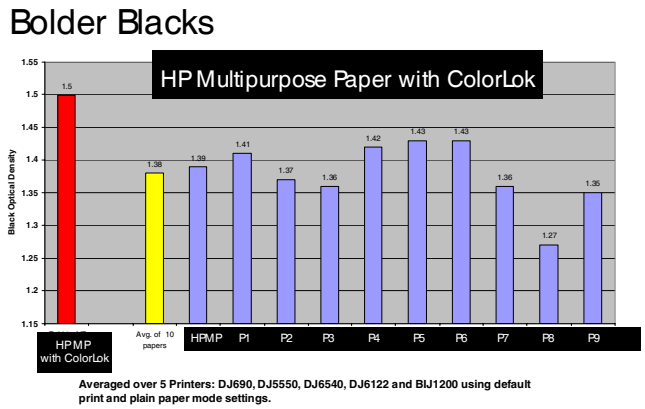

Figure 3. *Black Optical Density advantage of HP Multipurpose Paper treated with color locking technology, versus 10 other multipurpose papers (*Averaged over 5 printers: HP DeskJet 690, 1200, 5550, 6122, and 6540 series printers, using default plain paper print mode settings). Measured using a X-Rite 500 series spectrodensitometer.*

Effect on Ink Transfer

When color locking technology is incorporated, the ink vehicle penetrates into the paper, without taking the colorants down into the paper interior allowing very rapid printing of pigmented inkjet inks that dry rapidly. This will reduce ink transfer from the printed area to the back of the next sheet. The addition of color locking technology significantly improves this ink transfer as shown in Figure 4.

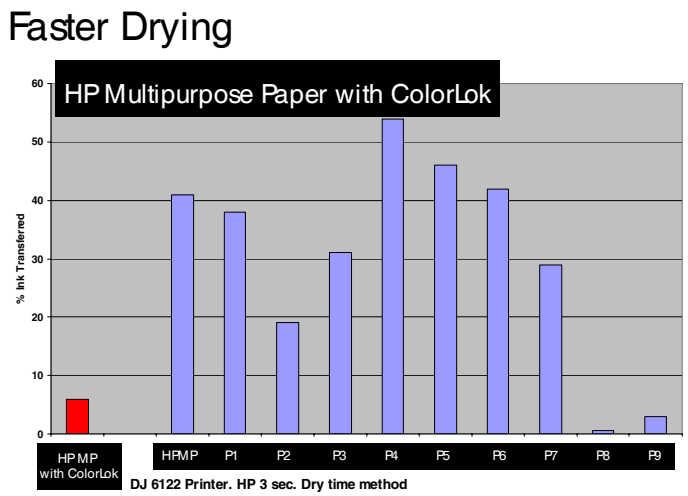

Figure 4. *HP DeskJet 6122 black ink on HP Multipurpose with ColorLokTM. 6122 series printer using default plain paper print mode settings. Pressed with a 2Kg weight three seconds after printing. Ink transfer is measured using an X-Rite 500 series spectrodensitometer.*

Papers on the market today can be faster drying or high optical density. Color locking technology improves both drytime and optical density.

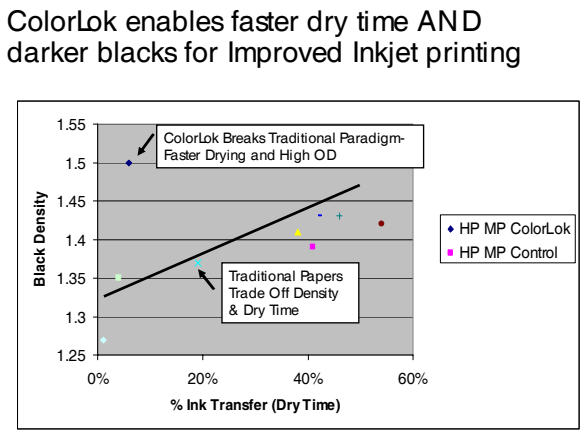

Figure 5. *Black Optical Density versus Drytime. HP Multipurpose with ColorLokTM transcends the traditional tradeoffs.*

Effect on Color Saturation and Color Gamut

Inkjet prints have a lower color gamut or vividness compared to laser prints. However, adding color locking technology not only affects black pigments, it also affects colored pigments. The effect of retaining the colored pigments near the surface of the paper markedly improves the color gamut. Color gamut also is improved in laser printers.

Improvement in Laser Printing

In addition to improving inkjet printing, there is an improvement to dry electrophotographic (laser) printing. Sheet feed reliability at 15C/10%RH (Low/Low conditions) is significantly improved. Below is a chart showing the sheet feed reliability of two typical plain papers compared with Colorlok papers over a wide range of dry electrophotographic devices.

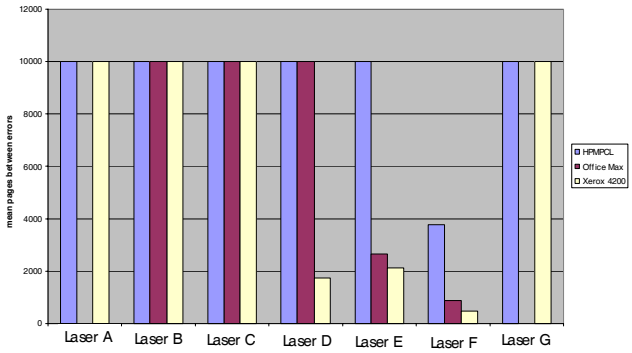

Figure 6. *Sheetfeed reliability testing of maximum 10,000 sheets. Depending on the type of laser printers, HP Multipurpose with Colorlok technology (designated as HPMPCL) performs better than other plain papers.*

Summary

Customers need better paper for better printing. We have shown that the addition of color locking technology into the paper manufacturing process allows the paper manufacturer to deliver unparalleled benefits to customers while adding little additional cost to paper manufacturing. As inkjet printing becomes more prevalent in the home, home office, and business, paper with color locking technology will enable the ability to produce documents with bolder, sharper images, and faster dry times at no additional cost.

Path Forward

There are additional methods to further improve inkjet and electrophotographic printing. One area of interest is to improve the expected life of laser printers by reducing the abrasiveness of the papers. This is a particular concern with papers from emerging markets where many papers contain a high percentage of large particle filler materials in excess of 15 microns in size. Figure 7 shows the increase in wear of a typical laser printer as the percentage of large particle fillers increases.

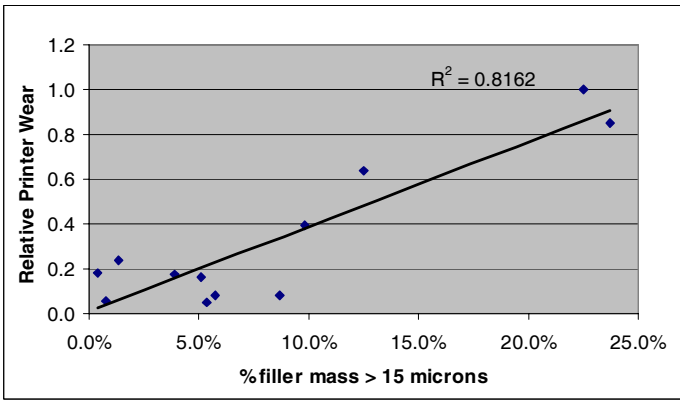

Figure 7. *Printer wear versus % of filler >15 microns.*