Comparison of Ink Jet Media for Drop-on-Demand Piezo Ink Jet Contract Proofing

M. Graindourze and E. Dutoit
Agfa-Gevaert N.V.
Mortsel, Belgium

Abstract

The graphic arts workflows (pre-press) are becoming more and more digital: computer-to-film, computer-to-plate, computer-to-press. It is therefore necessary to generate proofing solutions directly from the electronic files: digital proofing. Proofing is absolutely necessary to control and monitor the pre-press process.

Ink jet-based digital proofing systems are becoming more and more accepted for digital proofing.

Agfa is offering a digital proofing system based upon the Sherpa drop-on-demand piezo ink jet printer, including RIP, screening and color management.

For contract proofing Agfa is offering high quality proofing ink jet media.

This paper focuses on the important role of ink jet media for the contract proofing quality.

Introduction

Contract Proofing Definition

This paper is oriented towards contract proofing for high quality color printing. This high quality contract proofing step is of major importance in the pre-press workflow. The printer and the customer make a contract on the basis of the proof. The proof therefore must predict how the print is going to look like.

Digital Contract Proofing

Contract proofing used to be an analogous process. With the change-over of the pre-press workflow to a more and more digital process, the contract proofing also has to be of a digital type. The digital contract proof is made from the computer files before the films or plates are made.

The main elements of the digital proofing system based upon ink jet technology are the ink jet printer, inks, media and QMS (Quality Management System) + CMS (Color Management System). All components determine the quality of the digital proof. The paper focusses on the influence of the media on the proofing quality.

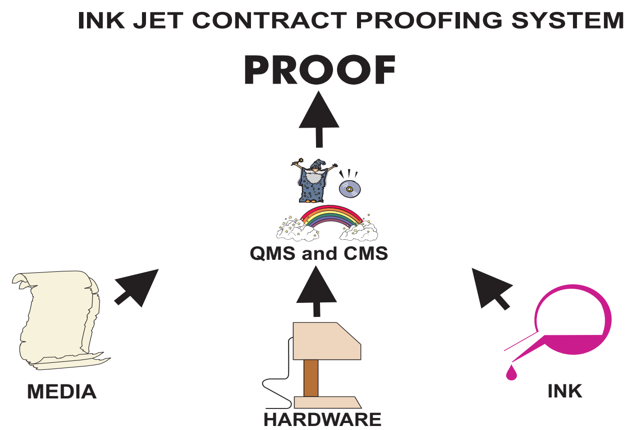

Figure 1.Ink jet digital proofing system elements

Proofing Quality Aspects

Contract Proofing Quality Aspects

The function of the contract proof is to predict the final print quality. The goal is that the contract proof is as close as possible to the print.

The color output of the proof is the first and most important feature of the proof. The so-called color match between the proof and the print is the primary requirement. This is of course highly dependent on the color management and requires a fully optimized system approach of matching the printer, inks and media through the color management. It is necessary that the color space, the so-called color gamut that can be produced by the proofing system, is in accordance with the print color output. Also the capability of reproduction of Pantone spot colors is important; this is only possible with a wide color gamut.

The real lifetime of a contract proof is ranging from several days to a few months. It is also possible that the same print has to be made on different locations and thus the proof needs to be reproducible on all production sites.

Therefore a consistent proofing system is necessary, but also the color output of the proof must be stable.

Of course the proof will also show the accuracy of the text, lines, placement, etc.

Typical considerations for ink jet digital proofs are related to the drying of the inks when printed.

Ink Jet Media Quality Influence

The influence of the ink jet media on these contract proofing quality aspects is manifold.

Concerning the color match the influence is mainly on the color gamut and the color stability; the color management is needed to result in a good color match.

Concerning image quality the media quality can affect seriously the detail rendering and the text quality; defects like bleeding and coalescence are strongly media dependent.

The important aspect of proofing consistency is also affected by the media quality; batch-to-batch consistency of the media manufacturing is therefore needed. Variations in media print quality are disturbing the proofing quality. For instance deviations in print densities from batch-to-batch give variations in the color output and will result in a less good color match from proof-to-proof.

An important aspect of ink jet media is the drying time needed to absorb the ink amounts jetted on the media. When the drying time is too long this can easily result in ink transfer from one proof to another or sticking together of proofs; also simply touching when the media surface is still wet can damage the image.

Last but not least the physical and cosmetic properties of the ink jet media play a role in the digital proofing output. The handling of the media is important; especially the image must resist the normal use without damaging (scratches, cracks,…). Another important aspect of the media is the so-called cockling which can occur during printing; this can be an imagewise deformation of the paper (especially with high ink loads) and/or an overall effect of waving of the paper after printing.

Ink Jet Media Types

Digital contract proofing based upon ink jet is only possible with high quality ink jet media. The high demands of contract proofing impose the use of ink jet media that deliver high densities, large color gamut, high color stability, high image sharpness and so on.

The so-called photograde ink jet media can be used in contract digital proofing based upon ink jet technology.

Two kinds of photograde ink jet papers can be distinguished. The first type is the so- called cast-coated ink jet paper. The second type is based upon a RC-paper support with image-receiving layers coated on top.

Experimental

Sherpa Proofing System

The AgfaJet Sherpa 43 printer is a piezo ink jet drop-on-demand printer with 6 dye-based inks (CMYKLcLm).

The color management Agfa ColorTune Pro 4.0 is compatible with the Agfa Apogee Proofer RIP.

Printing resolution is 720 × 720 dpi.

Ink Jet Media

Paper no. 1 is a typical cast-coated paper. Several different commercial cast-coated papers were tested. The difference in quality between these cast-coated papers for the typical contract proofing quality aspects is limited.

Paper no. 2 and no. 3 are RC-paper-based ink jet media with receiving layers on the print side(s). Paper no. 2 can be printed on both sides because it is symmetric with the same receiving layers coated on both sides. Paper no.3 can be printed on only one side. It has the same receiving layers on the printside and a backlayer on the rear side.

Methodology Quality Aspects

Color Gamut. A simplified way of comparing color gamuts consists of the calculation of the volume of the spatial element which is described by the following 8 (CIEL*a*b*) coordinates: paper white, black, cyan, magenta, yellow, green, red and blue (all printed with maximum possible amount of ink). The larger this calculated volume, the larger the color gamut.

The color stability is measured as the shift in CieL*a*b*-values over 5 days in office light conditions at 20 degrees C and at 50 % R.H. and this for each color on the IT8.7 original. CieL*a*b*-values are measured with a Gretag Spectrolino (illuminant D50, 2° observer angle).

Image and text quality is evaluated on the printouts of the ImageXpert test file. Parts of the prints are captured by a CCD-camera and analysed by ImageProPlus software.

The consistency batch-to-batch concerns the differences in quality of the media inside one production batch and between different productions. In this case optical densities of several rolls were measured with a Gretag densitometer D186 (filterset 47B).

The drying characteristic of the media is related to the fastness of drying of the ink printed on the media. Instant drying is preferred and has the advantage that no smearing of inks and/or smudging of the prints, etcetera is possible. When the drying time becomes too long, transfer may occur from one print to another.

The scratch resistance was measured on a Teledyne Taber 5130 Abraser. Five cycles were run with a weight of 500 grams on the wheels. The effect om gloss was measured at 60 degrees (Dr. Lange gloss measurement).

The cockling of the printed media is very easy to observe. Prints with patches of increasing amounts of inks show from which ink amount level on the waving is visible.

Ink Jet Media Influence

Color Output

The simplified color gamut calculation shows a very significant difference between the cast-coated paper (volume = +/- 380,000) and paper nos. 2 - 3 (volume = +/- 570,000). The color gamut of the RC-based-papers is about

50 % wider. They have the advantage that they can reproduce a large amount of the Pantone spot colors.

The color stability of the media was measured as the shift in the CieL*a*b*-values during 5 days in office light conditions (and 20 degrees C at 50 % R.H.)

The average ΔE for each color patch is 2.34 ($\sigma = 0.99$) for the cast-coated paper, while it is only 1.45 ($\sigma = 1.01$) for the RC-paper-based media. Skin tones show ΔE- values of 3 to 4 for paper no. 1; but only around 1 for nos. 2 & 3.

Image/Text Quality

The ImageXpert prints contain parts that enable to judge bleeding. A Line L of one color is printed between two patches of another color. Using an ImageXpert Motion System, a color image is captured by a CCD-camera at 2.7 × 2.7 micron per pixel spatial resolution. Using ImageProPlus image analysis software, the color mixing zones on both sides of line L are segmented. Then the best fitting line to the 4 edge outlines of the color mixing zones is calculated. The mixing zone widths are obtained from the distance between these best fitting lines.

Table 1 illustrates the difference in bleeding between paper no. 1 and paper no. 3 for a Yellow line between two Cyan patches. The Y/C-bleeding is described by two width parameters: WY equals the width of the line that only contains pure Yellow ink; WYC equals the width of the overlap zones where Y- and C-ink are mixed (sum of widths on both sides of the Y line). The smaller the WY-value and the larger the WYC-value, the more Yellow and Cyan ink are bleeding into each other.

Table 1. Comparison of Y/C-bleeding

Paper type	WY-value	WYC-value
Paper no. 1	243 micron	106 micron
Paper no. 3	257 micron	56 micron

Table 1 shows that bleeding is worse for paper no. 1 (smaller WY- and larger WYC-value).

Also the other color combinations show a more pronounced bleeding for the cast-coated paper compared to the RC-paper-based media.

The most visible (to the naked eye) image/text quality problem of the cast-coated paper is that of thickening of text when printed on top of a colored background.

Consistency

The variation in quality inside one production batch or between several batches can be very disturbing in judging the contract proof. Batch-to-batch variations may be affecting several quality aspects. It was chosen to study it for the effect on the color output simply by measuring the density variations for C, M, Y, K single color patches.

For the paper no. 1 one big production was followed up. The densities were measured for 20 rolls of the same batch. For paper no. 3 a total of 10 rolls out of three different production batches were measured.

The density variation for paper no. 1 is 11 +/- 1 % for each patch (C, M, Y or K); the same variation for paper no. 3 is only 4 +/- 1 %.

Drying Characteristic

The cast-coated paper (paper no. 1) is very fast drying.

The papers nos. 2 & 3 (with the RC-paper base) are drying slower. Important for the practical use of the proof is that the drying is fast enough so that the image is not damaged when judging the proof. The problem with paper no. 2 is that the backside of the proof is also taking up the ink easily, resulting in smudging of the backside of the proof, and even sticking together when several proofs make contact very shortly after printing. Paper no. 3 has a backside that doesn’t accept ink and thus avoids the smudging of the proofs. The ink drying is not instant but fast enough for the normal proofing workflow.

Physical & Cosmetic Properties

The first issue of handling properties is related to damaging the proof when handling the proof. The cast-coated paper shows damaged images under normal usage.

The scratch test on the 5130 Abraser confirms this. The paper no. 1 loses 90 % of its gloss at 60 degrees, the papers no. 2 and 3 only 3 %. The cast-coated paper is damaged much more than the RC- paper-based media.

The second issue of cockling of the media during printing shows an even stronger difference between the cast-coated paper (paper no. 1) and the RC-paper-based media (papers nos. 2 & 3). The cast-coated paper shows two kinds of paper deformation. There is an overall waving of the printed cast-coated paper (visible from 200 – 250 % ink) and there is also an imagewise cockling of the printed paper in those areas where the ink load is high (more than 300 %). These effects are not visible on the RC-paper-based media.

Table 2. Overview of Media Influence

Paper type	COLOR	OUTPUT	IMAGE / TEXT QUALITY	CONSISTENCY Batch-to-batch	DRYING CHARACTERISTIC	PHYSICAL & COSMETIC PROPERTIES	
	Gamut	stability				Handling	cockling
no. 1	0	-	0	-	++	-	--
no. 2	++	0/+	+	++	-	+	++
no. 3	++	0/+	+	++	0/+	+	++

Quality level: ++ = very good + = good
0 = acceptable - = poor -- = very poor

Overview Media Influence

Table 2 shows the overview of all quality aspects discussed in the former paragraphs.

The level for each quality aspect is represented by a scale ranging from very good (++) over acceptable (0) to very poor (--). The level 0 represents the quality level that is just acceptable for high-end contract proofing.

Discussion

It is very clear from Table 2 that there is a very significant difference in quality between the cast-coated paper and the RC-paper-based ink jet media.

The cast-coated paper is not performing well enough for the contract proofing application concerning color output, consistency and physical and cosmetic properties. The drying times are very short: almost instant drying.

The RC-paper-based ink jet media show exactly the opposite quality level; the weak point is the long drying times. Especially high color gamut, high consistency and no cockling are the strong points of these media (level ++ = very good).

The drying characteristic for the double-sided RC-paper-based paper (no. 2) is not acceptable. The risk of ink transfer from one proof to another is too high. This problem is reduced to an acceptable level (level 0) for paper no. 3. The printside is the same as for paper no. 2, but the backside has a special anti-transfer (non-printable) layer that is not absorbing the ink and thereby reduces the risk of ink transfer. This adaptation has resulted in paper no. 3 that delivers at least the acceptable level (level 0) for all quality aspects.

The advantages which RC-paper-based media offer in the context of high quality contract proofing may be explained by the difference in the ink uptake mechanism of both media types.

The cast-coated paper can be considered as an overall porous media type: both the receiving layer(s) on top of the base paper and the base paper itself absorb the ink. This results in deep penetration of the ink dyes into the paper (resulting in lower color gamut and color stability). It leads to the very fast drying of the inks, and is also responsible for the strong imagewise and overall paper deformation during printing (cockling).

The RC-paper-based media with the image-receiving layers on top have a much more controlled way of absorbing the ink.

In the first place the paper itself cannot absorb ink, because it is sealed off by the resin coating which is non-permeable for aqueous solutions. Consequently, only the specific ink jet receiving layers take up the ink. This explains why the drying times are longer for this type of media. The type of support also explains that there is no deformation of the support during printing, meaning that there is no cockling.

The polymer blends-based ink jet receiving layers are designed to control the ink uptake so to minimize the lateral ink spreading (resulting in good image quality) and to minimize deep penetration of the dyes (resulting in high print densities, high color gamut and acceptable color stability). This type of layers can be produced with very highly consistent quality levels.

Conclusion

The importance of ink jet media for high-end contract proofing applications based upon a piezo ink jet printer was studied in this paper.

The comparison of ink jet media for high-end contract proofing (for high quality color printing) results in a clear distinction between the cast-coated ink jet paper and the RC-paper-based ink jet media.

The quality of the cast-coated paper is unacceptable regarding color output (stability), consistency batch-to-batch and physical & cosmetic properties (handling and cockling).

The RC-paper-based media with image-receiving layers deliver an overall good quality. The high color gamut, good image quality and no cockling are the most pronounced advantages of this type of media.

Biography

Marc Graindourze got a Ph. D. at the K.U. Leuven, Belgium (physical chemistry). In 1988 he joined Agfa-Gevaert N.V., Belgium, where he started as a project manager R&D pre-press materials (contact and camera films). Since 1996 he is one of the project managers R&D ink jet media. His focus is on photograde ink jet media for both narrow and wide format ink jet printing, including proofing applications.