Media Selection for Contone Ink Jet Printers—A Survey of Matte Papers

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Abstract

Continuous tone ink jet systems, such as those conceived by Professor Hertz, of the Lund Institute of Technology, and enhanced by Iris Graphics (Bedford, MA), require specially designed media for optimum performance. Most of the digital proofing applications use high quality gel coated, RC base media. However the need for less expensive matte paper with excellent color fidelity is quite prevalent in non Graphics Arts markets. As ink jet printing has grown, paper coating companies have rushed to provide papers with coatings for improved performance. Fourteen papers were obtained from various sources and evaluated for use as contone ink jet media. Visually detectable color parameters (printed color space, ink spread, and paper color consistency) were used to rate the papers for color fidelity. These results were compared to a jury selection process to select the papers having the best overall appearance.

Introduction

Much has been written of the requirements of coated paper stocks for ink jet printing.[1,2,3] Paper coaters are able to use a variety of methods to maintain the ink near the paper surface for good character density. While differences exist, they all seem to be able to produce acceptable black and white images, text printing, or simple color images. However, for high fidelity color printing with contone ink jet printers, subtle paper differences become very significant.

Contone ink jet printing is defined as that being able to create a virtual continuous tone color scale. The Hertz continuous ink jet technology, enhanced by Iris Graphics (Bedford MA), has the capability of modulating the amount of ink per pixel from 0 - 31 microdroplets. By slowly traversing the jet assembly across the paper while the paper is spinning on a drum, all pixels can be addressed. Further, by incorporating jets for cyan, magenta, yellow, and black fluids, a full color contone system can be produced The fluids used in this contone process are water based and designed specifically for the Iris Contone IJP system.

Colorimetric methods (color space in CIE Lab coordinates[5] and short term color shift) have been used to select media (RCbase paper) for high quality contone printing.[4] For this survey, ink spread paper color, and printed color space were selected as parameters which should influence the visual appeal of a color contone IJ print. A visual jury examination was performed in an attempt to correlate these parameters to actual appearance.

Originally published in *Proc. of IS&T's 46th Annual Conference*, May 9-14, 1993, Cambridge, Massachusetts.

Experimental Methods

Fourteen papers were obtained from various sources. Twelve were specifically coated for ink jet printing. The remaining two papers were "standard office" multipurpose paper, and a high quality watercolor art paper.

Paper Color

Each paper's color (in CIE Lab units) was measured using a Gretag Model SPM 100 spectrophotometer, with illuminate D5000, and 2° observer. The difference (DE*) from absolute white (100, 0, 0) was calculated for each paper.

Printed Color Space

Each paper was used to generate a color step wedge on an Iris 3024 ink jet printer, using Iris Graphic Arts inks, at 300 dpi. Multichannel colors are generated simply by adding the individual color channels together. For example, the 20% red block contains 20% pixel color strength of magenta and 20% pixel color strength of yellow. Thus the 100% three colorblack contains three times the ink volume as any 100% primary.

Each step wedge was measured using a Gretag Model SPM 100 spectrophotometer, with illuminate D5000, and 2° observer. Plotting a* vs. b* the maximum chroma coordinates can be determined for each color. These points create a hexagon shape, which represents the three dimensional color space compressed to two dimensions (figure 1). The integrated area provides a color space value in "square a*b* units."

Ink Spread/ Bleed

The step wedge images printed as part of the printed color space procedures, were used to determine the amount of ink spread for each paper. The gap between step blocks were measured using an image analysis system. The gap between the 10% and 20% block of single color black (G1), was compared to the gap between the 90% and 100% three color black (G2). The ink spread was calculated as the percentage decrease in the gap distance moving from Gl to G2.

Jury Test

Each paper was printed on an Iris 3024 ink jet printer, using Graphic Arts inks, at 300 dpi. The image selected was a composite image file containing two images, text, and a gray scale. Individuals were then asked to sort through these prints and provide a rating of 1 to 5 (great to poor) for each print. Prior to each individual the prints were mixed to present a somewhat random process.

Results and Discussion

The data from the parametric measurements are presented in Table 1. For each parameter specific ranges were established to allow the data obtained to be ranked (table 2). The data ranges were set based on what an ideal paper should be, as defined by the Iris IJP user base. In terms of color appeal, the customers expect to see (1) a bright white paper, neutral in color, as light as possible, (2) as large a color space as possible, and (3) no objectionable no ink spread.

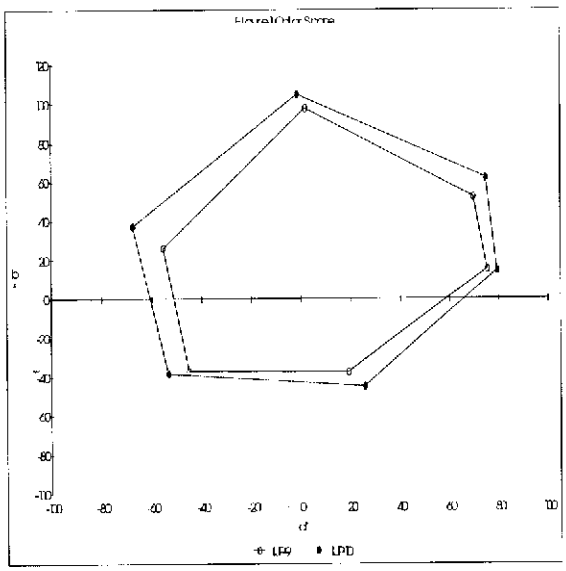

Figure 1. Color Space Max Chroma

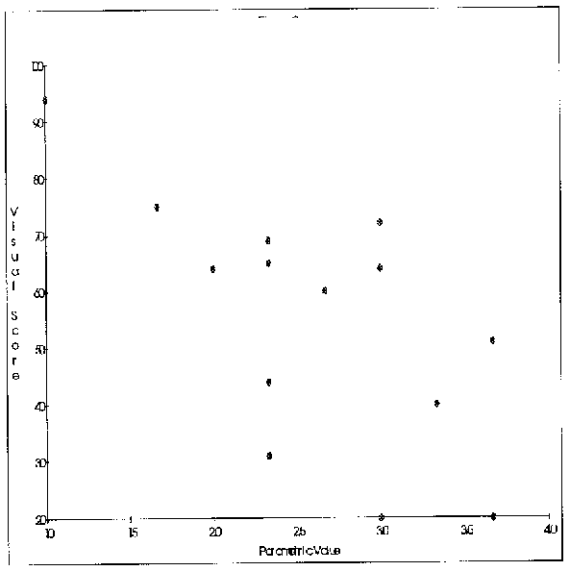

Figure 2. Correlation

Thus each paper could be given a ranking for each category. The average rating was then calculated for each paper. This data is provided in Table 1 . It is quite interesting to see that one paper (IJP-10) received a top ranking in each of the categories. All other papers had at least one "less than top racking." The bulk of the matte papers fell in the 2.5 range.

The data from the jury trial is interesting as well (table 2). The analysis was quite fudimentary. Each rating of 1, earned 5 points; a rating of 2 earned 4 points, etc. The maximum number of points a paper could receive was 100 (20 respondents x 20 ratings of 1). The point total for each paper is also presented in table 4.

Again one paper (IJP-10) stands out as more appealing than the others. The correlation of visual and parametric data is provided in Figure 2.

Table 1. Parametric Measurements

Paper Sample	Paper Color DE*	Color space	Ink spread 0%	Ranking Totals
IJP-1	4.84	15922	100	2.3
IJP-2	5.21	15892	32	1.7
IJP-3	8.5	13395	37	3
IJP-4	5.81	13742	49	2.3
IJP-5	8.37	12112	29	3
IJP-6	4.11	13407	32	2.3
IJP-7	7	12678	100	3.7
IJP-8	6.65	13206	31	2.7
IJP-9	4.24	11887	70	3.3
IJP-10	3.59	15326	26	1
IJP-11	5.29	14033	33	2
IJP-12	4.4	15041	100	2.3
OFFICE1	6.65	11789	28	3
WATER1	8.42	8869	25	3.7

Table 2. Visual Ranking Results

	RATING FREQUENCY					Weighted
Paper	1	2	3	4	5	Totals
IJP-1	0	1	1	6	12	31
IJP-2	7	8		3	2	75
IJP-3	4	8	5	2	1	72
IJP-4	0	8	9	3		65
IJP-5	2	5	8	5		64
IJP-6	3	6	8	3		69
IJP-7		3	6	10	1	51
IJP-8		7	6	7		60
IJP-9	1		3	10	6	40
IJP-10	15	4	1			94
IJP-11	3	5	6	5	1	64
IJP-12	1	2	3	8	6	44
OFFICE1					20	20
WATER1					20	20

Another parameter which may have influenced the visual rating is the apparent smoothness of the surface. A quick comparison between IJP-4 and IJP-10 shows this not to be the case in this study. IJP-4 is a heavily coated paper with a smooth surface appearance, both by eye and by microscope. IJP- 10 is significantly rougher in appearance on a micro scale and some what rougher by eye. The microscopic comparison of the two printed papers shows significant color variation in IJP- 10, due to the contrast between marginally stained fibers, and filled pockets. This contrasts nicely with the smooth color of IJP-4. Yet when visually rated the IJP-10 consistently ranked well above the IJP-4 (94 vs. 65).

Conclusions

Three printed paper color parameters were tested which should predominate an individual's selection of a cellulose paper for high quality IJP. What is shown is that a paper should have significant appeal in contone IJ printing, if (a) it is close to ideal white, (b) has a large color area (>15,000), and (c) is capable of holding large volumes of ink with out significant spreading. If the paper has a less than ideal ranking in any of these categories, the visual appeal of the image will be diminished.

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