Commercial Quality Text: What Does it Take?

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Abstract

The ability to print excellent quality black text has always been the cornerstone of a printing technology's ability to play in the commercial printing-publishing space. Up until recently only certain printing technologies such as electrophotographic (EP) and offset were able to produce adequate levels of quality at an appropriate throughput. In this paper we identify and describe quantitatively the important attributes in producing commercial quality text. We also demonstrate that drop-on-demand inkjet is now capable of delivering text quality and throughput on par with traditional EP workhorses.

Introduction

Background

By the term *Commercial Quality Text*, we refer to a range of quality levels acceptable for applications such as flyers, books, catalogs and brochures. Analyzing an even broader range of black text quality printed on EP, offset, and inkjet technologies, we identified four main text attributes that exhibited variation: black optical density, gloss level, text edge raggedness, and font stroke weight. We conjectured that performance in one or more of these attributes would explain the variation in overall text quality between each corresponding technology. Our objective was to understand this link.

Experimental Overview

We designed an experiment with the following three objectives: 1) Assess the relative importance of the four attributes in the customer's perception of overall text quality, 2) Map the customer acceptability of text quality to levels of each attribute individually, and 3) Compare the text quality of a prototype HP drop-on-demand inkjet system to a range of leading EP technologies. The experiment consisted of a series of comparative rank-order and absolute acceptability assessments of text-only documents. In all cases, the samples shown to observers consisted of two black fonts: 10-point and 4-point Times printed on Hammermill Color Copy paper. The ranges of the four attributes were obtained through a combination of printing on various EP and offset devices whose print engines afforded natural variation, and by simulating the attributes, modifying the text bitmap in the printed file.

In all, there were 32 observers who evaluated the samples. 24 were considered *hardcopy users (end-users)* while 8 were considered *hardcopy producers (producers)*. End-users were the final recipients or users of printed output. Producers were those who play some part in the printing and/or distribution of the hardcopy. Each respondent was asked to judge acceptability in the context on his/her own usage for the hardcopy. Optical loupes were not allowed.

Results

Relative Importance of Each Attribute

We found that the attribute most important to the user's ranking of quality was one that we had not intentionally varied – the readability of 4-point text. The four attributes that we purposely varied were significant only if they affected the readability of this small text. It seems that since all the technologies tested exhibited similar quality in the 10-point font, the observers focused mainly on the 4-point font for making distinctions. In small text, differences in detail rendition and visibility of serifs and other features influenced readability. We found that important contributors to detail rendition and feature visibility were edge raggedness (sharper is better) and extreme levels of stroke weight and gloss (lower is better). Optical density was not a significant factor in the included range of 1.3 to 1.6.

Black Optical Density and Stroke Weight

In analyzing acceptability results of individual attributes, we combined black optical density and stroke weight because they both influence the same user parameter: perceived text darkness. Over the ranges evaluated in this experiment, optical density had very little impact on user acceptability, while stroke weight had a much more significant effect. Figure 1 illustrates graphically the sensitivity of acceptability to relative stroke weight. The response is similar between end-users and producers, however it seems that among these respondents, producers preferred text slightly darker than nominal, while end-users preferred text closer to nominal. The overall preference was slightly higher stroke weight than nominal.

Edge Raggedness

The sensitivity of acceptability versus edge raggedness is shown in Figure 2. The response is rather steep and there is not much difference evidenced between respondent groups. Most EP and offset products scored below four with respect to this metric, yielding acceptability above 80%. This confirms hypotheses that edge raggedness is primarily a concern for low-end inkjet and other technologies where edge-rendering difficulties are especially intrinsic to the technology.

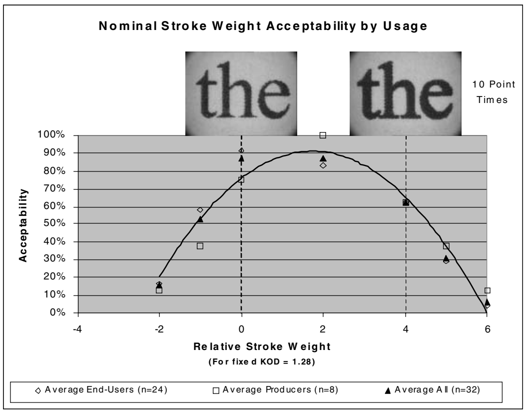

Figure 1. Narrow range of acceptability for stroke weight.

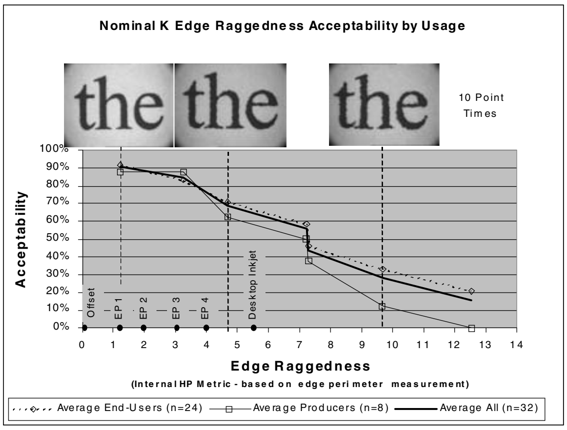

Figure 2. Customer acceptability versus edge raggedness.

Gloss Level

Gloss level is an attribute exhibiting a large de-facto variation between technologies, ranging from very matte to very glossy. Figure 3 illustrates the respondent preference as a function of 60-degree gloss for a series of samples. While end-users appear to have no clear preference for gloss level, print producers clearly prefer glossier text. As some print producers may be more likely to use products that have glossier output, it is not clear if this preference is a cause or an effect of the observation. More in-depth analysis would be required to verify if these producers would truly be averse to less glossy text.

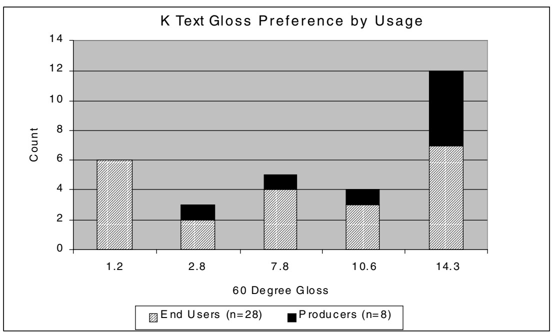

Figure 3. Hardcopy producers prefer glossy text.

Ink-jet Text Performance

With the goal of benchmarking inkjet text quality from a system with better edge-raggedness than prior desktop inkjet systems, a side-by-side comparison was made between a prototype HP inkjet and several EP technologies. Respondents judged the inkjet system to exhibit a level of overall text quality comparable to the other devices. Figure 4 illustrates the relative quality scores and representative micrographs of the samples.

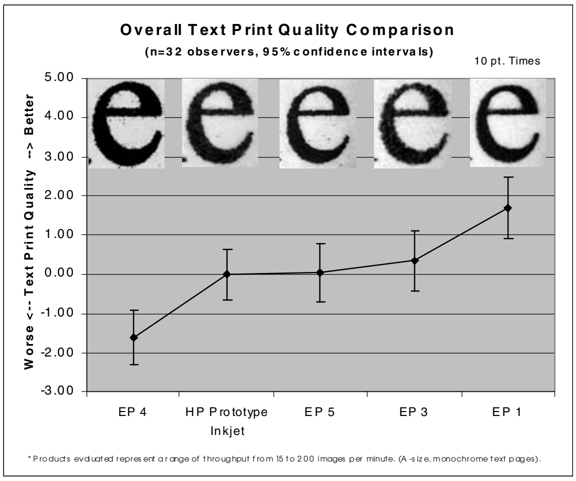

Figure 4. Prototype inkjet compares favorably to EP.

Conclusions

Future technologies targeted at print producers and hardcopy end-users alike should have excellent small as well as large text and should exhibit optical density, stroke weight, edge raggedness, and gloss level within the ranges shown here for sufficient customer acceptability. As the gap between inkjet text quality and EP text quality narrows, a variety of technologies will be capable of fulfilling these needs. It seems only a matter of time before inkjet, once considered a “low-end” technology, becomes a viable alternative in more and more commercial printing applications.

Biography

Jim McCullough received a B.S. and a M.S. in Mechanical Engineering from the University of California, San Diego in 1993 and 1995 respectively. He joined HP in 1995 as a Writing System Engineer in the Inkjet Technology Platforms in San Diego, California. He moved to the Inkjet Commercial Division in Barcelona in 1999 as a Lead Writing System Engineer and System Architect. His primary professional focus is on understanding Image Quality and its component attributes.