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Flexographic Plate Technology: Conventional Solvent Plates versus Digital Solvent Plates

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Abstract

Digital, direct-to-plate technology has not been as widely accepted by flexographic printers as it has by the lithographic printing industry. This is due, in large part, to very little savings in time and cost in digital plate making for flexography. Manufacturers of digital flexographic equipment claim the real savings comes from enhanced quality of print. The objectives of this research were to test the print quality of both conventional and digital flexography and to analyze and statistically compare the two processes. The results of this study should be of interest and benefit to those who seek an unbiased comparison before investing in expensive flexographic digital plating technology. This study utilized the quasi-experimental research design and an independent samples T-test. An alpha value of .05 was used throughout the study. There were three research questions and three hypotheses that guided the study: (1) Do digitally imaged photopolymer flexographic plates produce lower dot gain compared to conventional plates exposed from film? (2) Do digitally imaged photopolymer flexographic plates produce higher print contrast values compared to conventional plates exposed from film? (3) Do digitally imaged photopolymer flexographic plates print a longer range of halftone dots from a test target with dot patterns ranging from 1% to 100% when compared to conventionally imaged plates?

The results showed there was no significant difference in dot gain between the two plating systems. There was, however, significant improvement in print contrast values and tonal range with the digital system.

Introduction

The objectives of this research were to test the print quality of both conventional and digital flexography and to analyze and statistically compare the two processes. Test images were created and identical images were plated by each of the two processes. Four different flexographic printing plants and a local university graphics program were solicited to print the test images. The study utilized the quasi-experimental research design and data were subjected to an independent samples T-test statistic. The results of this study should be of interest and benefit to those who seek an unbiased comparison before investing in expensive, flexographic digital plating technology. While recent advances in digital flexography do provide some improvement in workflow over the conventional system of digitally manufacturing film and then producing plates from the film, it does not offer the giant advantages of a streamlined workflow and blazing speed that digital lithography has enjoyed. Early computer-to-plate (CTP) systems could take 80 to 90 minutes to expose a complex job while conventional film and plate exposure was only a fraction of that (Dalton, 2006). Therefore, the major advantages of a digital flexographic system have been enhanced quality and better image control. This study will concentrate on the quality comparison of these two plating technologies.

Literature Review

Conventional photo-polymer flexographic plates require the production of a high-contrast film negative that is positioned over the photo-polymer plate material for the exposure process. The two materials are then placed under vacuum to ensure the film image is in intimate contact with the plate material during exposure. Ultra-violet (UV) light is then flooded over the negative which allows only plate exposure in the open image areas of the film negative. A second exposure (back exposure) is completed to set the floor height of the plate – this is the non-printing area of the plate (see Figure 1). The plate is then chemically processed to remove polymer in non-image areas. The resulting plate has a raised image area and a recessed "floor" for the non-printing areas (Crouch, 2003).

Unlike conventional plating, the direct-to-plate (digital) imaging process is accomplished without the use of a film negative. Plate manufacturers have accomplished this by adding an integral black carbon masking material to the photopolymer plate material. During the digital plate imaging process, a powerful laser removes (ablates) the carbon masking material from the plate in image areas (Foundation of Flexographic Technical Association [FFTA], 1999). After the mask has been imaged by the laser, the exposure and finishing processes are very similar to analog processing (Kenny, 2007). The plate can then be exposed to ultra-violet (UV) light without being placed in a vacuum frame that removes all air. Since the mask is integral to the plate, there is no need for vacuum to hold them together. Once the digital plate has received the same two exposures as the conventional plate, it can be processed in chemistry to remove polymer in non-image areas. This creates the raised image area that is characteristic of flexographic printing plates (Utschig, 1999).

Although this digital plating process has been available for flexographic printing for several years, it did not enjoy the immediate acceptance that lithographic digital plating received. As of 2005, only 20 percent of flexographic printers worldwide printed with digital plating systems (Vanover, 2005).

As the above outlined procedures point out, there is not significant savings in plate processing time in digital flexography.

Also, digital plate material and equipment are significantly more expensive than conventional photo-polymer material. While a 30" x 40" lithographic plate may cost $10 a digital flexographic plate of the same size could cost as much as $264 (Hersey, April, 2006). These two factors, minimal speed advantage and exorbitant equipment and material costs, caused the flexographic industry to question the logic

Figure 1. Properly Exposed Plate

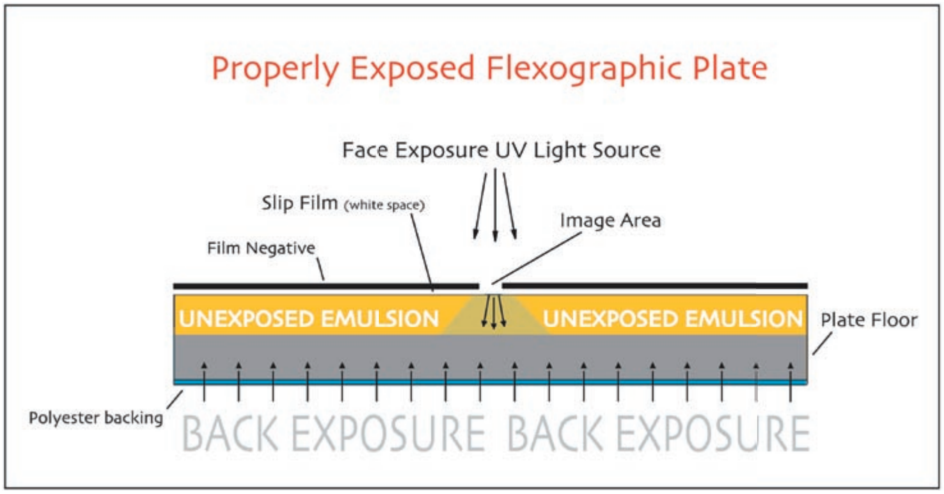
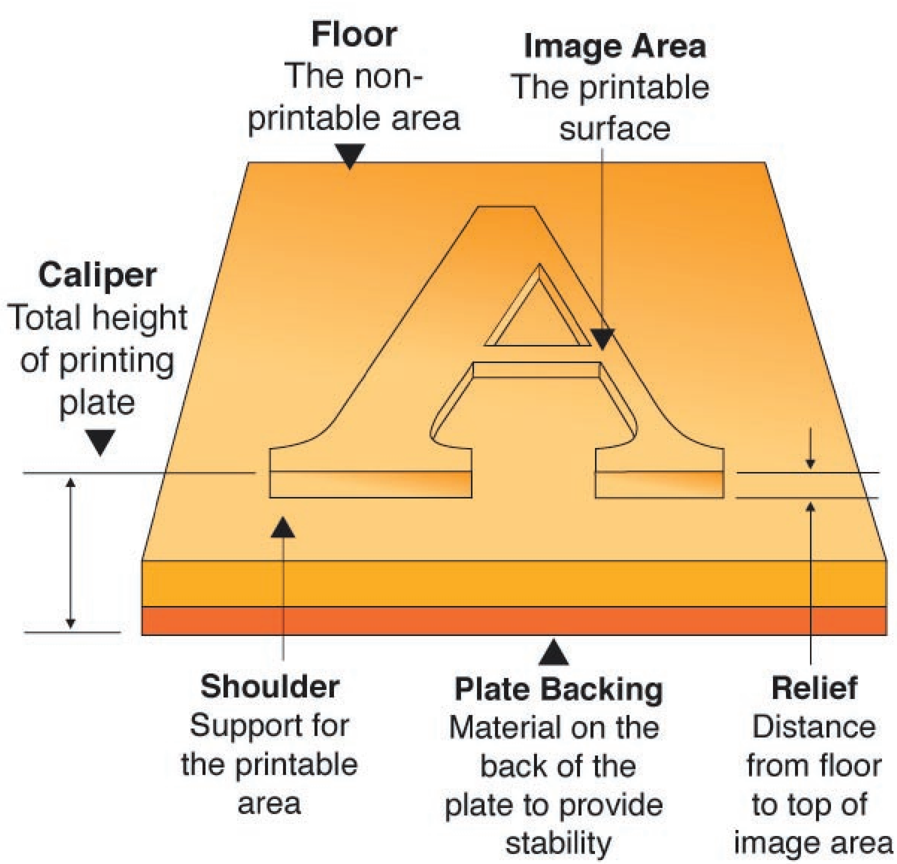


Figure 2. Components of a flexographic plate (courtesy of FFTA)



in purchasing a technology that would not increase production throughput nor decrease production cost (Hamilton, 2005).

James Kadlec, President of Advanced Prepress Graphics summed it up in an quote for Packageprinting:

> *Cost, awkward processing, and imaging restrictions handcuff digital flexo platemaking. Only a few organizations with deep pockets can afford digital flexo platemaking's substantial expenses of material, sheet layout of usable work, (not to mention) press proofing of the incorrectly imaged plates (Hershey, April 2006).*

However, as technology improves and grows acceptance, the cost of equipment and materials will decrease. Ray Bodwell (2006), DuPont Imaging Technologies explained, "In the not too distant future, this situation (higher costs) will reverse itself, and the cost associated with analog workflow will actually be higher than digital" (p. 26). While digital costs decrease, film manufactures will begin to reduce capacity causing the price of film to significantly increase.

While industry experts argued the workflow and cost advantages of digital flexography, most agreed there must be some evidence of improved quality to entice industry executives to invest in the technology. Digital plating equipment manufacturers presented the industry with an explanation that the digital plating technology would offer such an improvement in print quality that it would justify the expense of converting to digital plating. They explained the quality improvement came in reduced tonal value increase (dot gain) and improved ability to print smaller highlight dots (Karstedt, 2002). The equipment vendors also claimed the conventional plating process required the application of a thin film material (slip-film) on top of the photo-polymer plates to prevent the film negative from sticking to the polymer plate during the exposure process. During exposure, this slip-film created a shoulder on the raised images (dots) which proves to be damaging to production quality due to the fact that it contributes to image spread during plate exposure. Digital plates did not have the slip-film, and therefore, produced sharper images and higher quality print (FFTA, 1999). Figure 3 shows a comparison of the wider shoulders of the conventionally imaged plates.

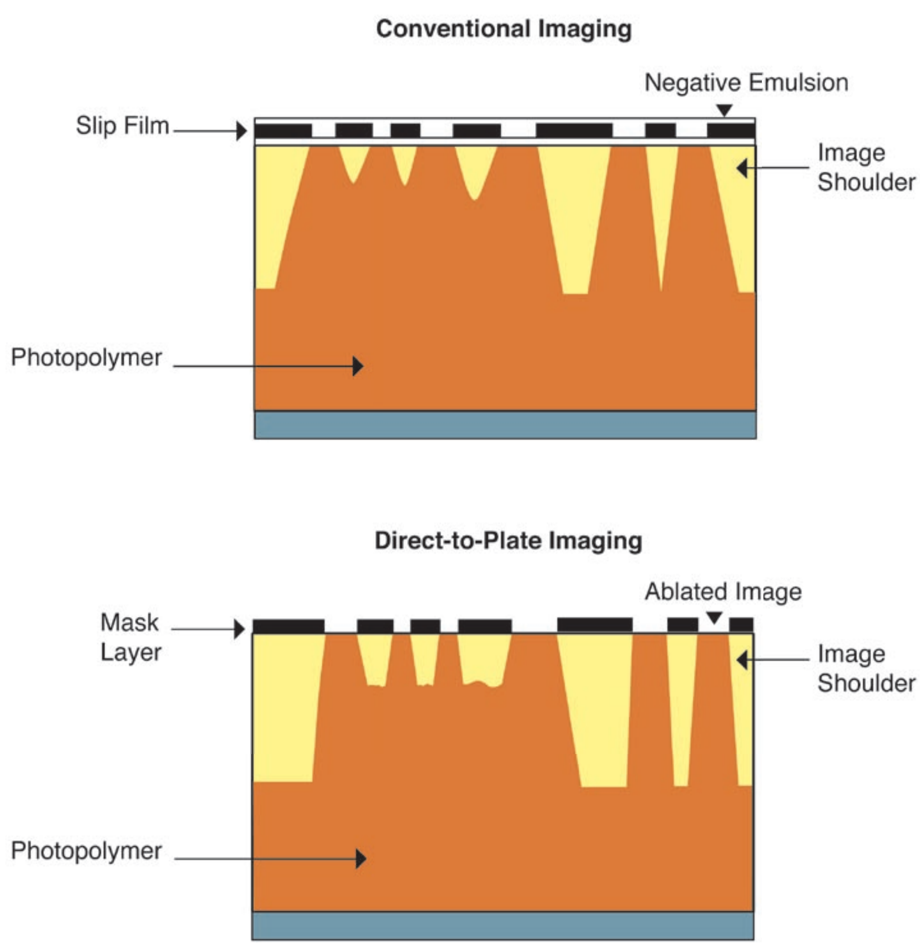
In addition, a conventionally imaged plate is exposed in a contact frame where atmospheric gases such as oxygen, are vacuumed away from the areas surrounding the plate. This contributes to the development of sharp transition from the printing surface to the shoulder of the image. When the plate is impressed to the substrate during the printing process, the shoulder on the images causes the print element to grow in size, thus creating an undesirable outline or "halo" around the image. When reproducing continuous-tone images, this equates to excessive tonal value increase (FFTA, 1999). Figure 4 (see page 5) demonstrates the difference in the dot structure between conventionally exposed and digitally imaged plates.

Methodology

To test the notion that digital plates are capable of producing superior flexographic print quality over conventionally produced film-based plates, a study was designed to create statistical data that could be used for comparison. Specifically, a test image was created that would allow comparison in the three critical areas of print quality that digital equipment manufacturers claimed enhanced quality: tonal value increase (TVI), print contrast, and tonal range.

Tonal value increase is the apparent increase in dot area as the image is transferred from one medium to

Figure 3. Cross-section of plates (courtesy of FFTA)



another, such as from plate to substrate. The test image included a mid-tone, 50% dot area and a solid 100% area which is necessary for TVI calculation. Using a reflection densitometer programmed with a Murray/Davies Dot Gain formula, specific TVI data can be collected and analyzed. Lower TVI numbers indicate superior printing (x-rite, 2003).

Print contrast is a density comparison of the solid (100%) area and a three-quarter tone (75%) screened area. Print contrast indicates the ability of printed work to maintain detail in the shadow areas of continuous-tone reproductions. The test image includes both 75% tint blocks and solid 100% areas. Modern reflection densitometers can provide print contrast data which can be statistically compared. A higher print contrast reading indicates superior print quality (x-rite, 2003).

Tonal range, as defined in this study, is the ability of a printing method to print a wide range of screened tones from a 1% (highlight) dot up to a 99% (shadow) dot without losing each distinct dot. This test image was constructed by creating small blocks with screened dot sizes from 1% up to 99% in 1% increments. Evaluation of tonal range is accomplished by visually evaluating the printed page with a 12X magnifier. If a printed image was able to hold a minimum of a 5% dot without losing any of the individual dots and was also able to reproduce a maximum of a 95% dot without appearing to be solid (100%), the resulting tonal range would be 91. Further explained, out of 99 different dot sizes, it could maintain dot integrity on 91 of the blocks. When evaluating tonal range, a larger range is an indicator of superior quality.

Once the test image was created, a partnership was established with an international service bureau that specializes in the production of high-quality, flexographic printing plates for color reproduction. The service bureau has full capability to produce conventional and digital flexographic plates. The researchers requested they provide five identical sets of test plates, both conventionally and digitally produced. The researchers also asked that all plates be produced at 133 lines per inch. Plates should be .067 inches in thickness and of identical durometer and relief to minimize extraneous variables.

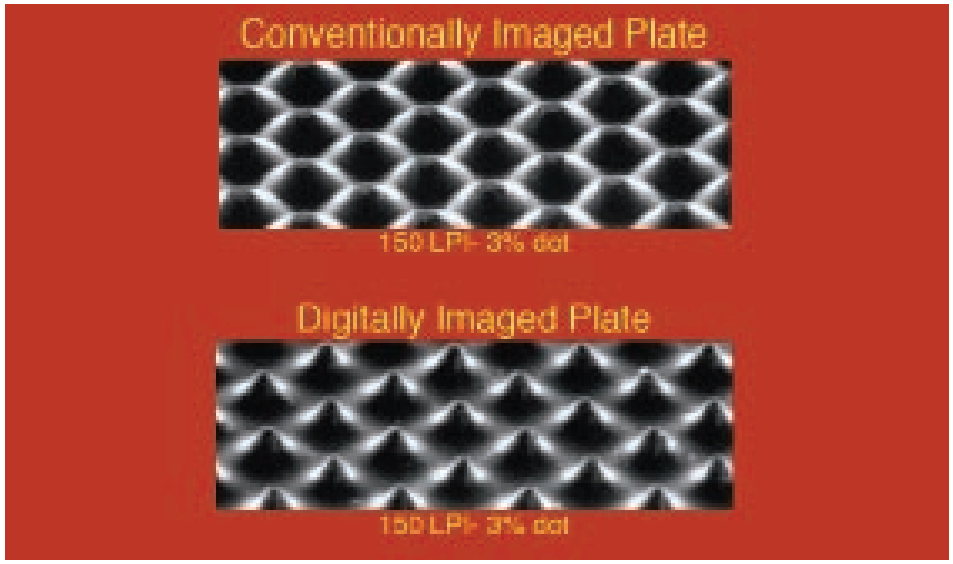


Figure 4. Dot Structure Comparison

Plates were retrieved and delivered to four different experienced flexographic printers in the southeastern United States. Along with the plates, a set of specific directions were given that detailed the conditions for printing the test images. A form was provided for printers to record the ink, substrate, anilox rolls, and presses used to reproduce the test images. The form also stated that both sets of plates should be printed with the same inks, substrate, anilox rolls, press, and print unit. The participating companies agreed to supply samples from three different operators at the highest possible quality from each of the supplied plates. Sets of plates were also printed at a local university by three different operators. Each set of samples were printed from new plates to ensure consistence of quality. Since this was non-funded research and a set of plates cost near $200 it was cost prohibitive to print more than the 14 supplied samples.

Printed samples were collected from each printer and randomly selected for data collection. A Tobias IQ-200 reflection densitometer was used to collect data for the tonal value increase and print contrast readings. The tonal range data was collected by visually analyzing the printed image and recording the range held by each sample. One of the companies was only able to supply samples from two press operators. There were fourteen collected samples.

Research Design

This study utilized the quasi-experimental research design and an independent samples T-test. An alpha value of .05 was used throughout the study. There were three research questions and three hypotheses that guided the study: (1) Do digitally imaged photopolymer flexographic plates produce lower dot gain compared to conventional plates exposed from film? (2) Do digitally imaged photopolymer flexographic plates produce higher print contrast values compared to conventional plates exposed from film? (3) Do digitally imaged photopolymer flexographic plates print a longer range of halftone dots from a test target with dot patterns ranging from 1% to 100% when compared to conventionally imaged plates?

Testing of the Hypotheses

Research Hypothesis 1: *Digitally imaged plates will produce lower tonal* *value increase than conventional plates exposed from film.*

Hypothesis 1 sought to provide evidence that carbon mask plates, that were digitally ablated by laser and exposed to UV light without the use of a vacuum frame, were capable of lower tonal value increase than plates that receive images from UV exposure through high-contrast, photographic film while under vacuum in a contact frame. Data from 14 samples were taken and subjected to an independent samples T-test ($p > .05$). The researcher failed to reject the null hypothesis. There was no significant difference in tonal value increase between digital and conventional plates. Figure 5 shows the means of tonal value increase from both digital and conventional plating systems.

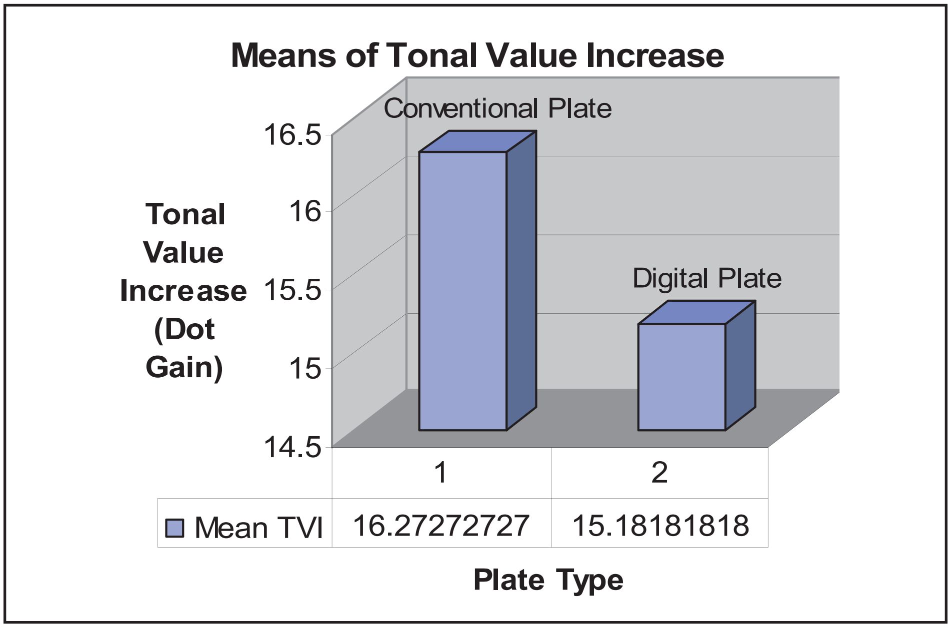


Figure 5. The Means of Tonal Value Increase

Research Hypothesis 2: *Digitally imaged plates will produce higher print contrast values than conventional plates exposed from film.*

Hypothesis 2 sought to establish that digitally imaged plates were capable of printing with a higher print contrast value than conventionally exposed and processed plates. The mean print contrast value for digital plates is 48.8191, where as, conventional plates mean is 42.6609. The independent samples T-test ($p < .05$) allowed the rejection of the null hypothesis and acceptance of the research hypothesis – revealing significant difference in the print contrast values between digital and conventional plates. Figure 6 shows the means for print contrast for both digital and conventional plates.

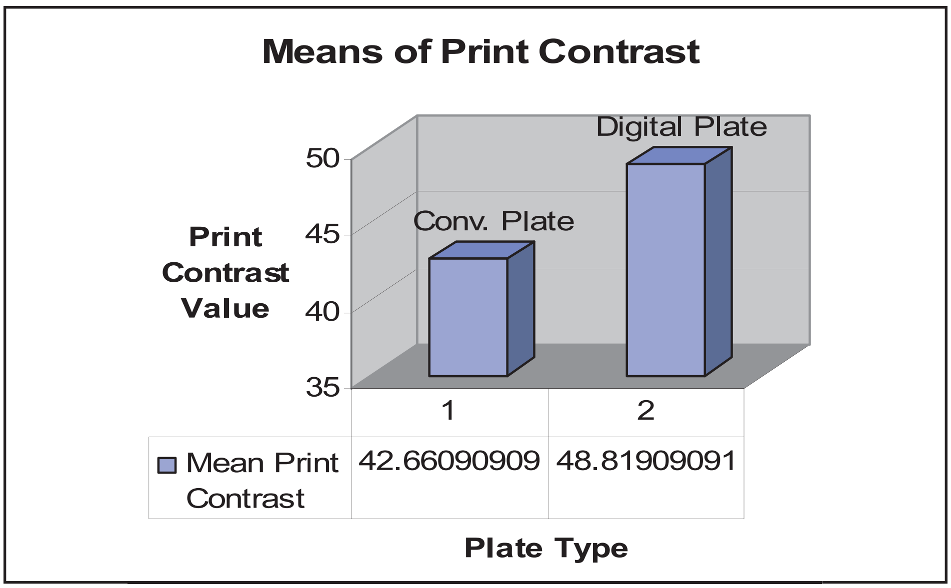


Figure 6. The means of the print contrast values.

Research Hypothesis 3: *Digitally imaged plates will print a longer range of halftone dots from a test target with dot patterns of 1% - 100% compared to conventional plates exposed from film.*

The objective of hypothesis 3 was to establish that digitally produced flexographic plates were capable of printing a longer range of halftone dot sizes than conventionally produced flexographic plates. The mean of the tonal range values for digital plates is 95.7273 and the mean for conventional plates is 91.4545. When subjected to an independent samples T-test ($p < .05$) which allowed rejection of the null hypothesis and acceptance of the research hypothesis – a significant difference was found in tonal range between digital plates and conventional flexographic plates. Figure 7 shows the means for tonal range for both digital and conventional plates.

Results, Conclusions and Limitations of the Study

Digitally processed flexographic printing plates had slightly less tonal value increase than conventional plates (See Figure 5). Statistically, however, there was not a significant difference. This lack of significance could possibly be explained by the fact that digital plate samples supplied by two of the participating companies showed “banding” or “gear marking” when the conventional plates did not. Banding is caused when the surface of the plate and substrate slip during the printing process. This slip would cause an elevated tonal value increase reading.

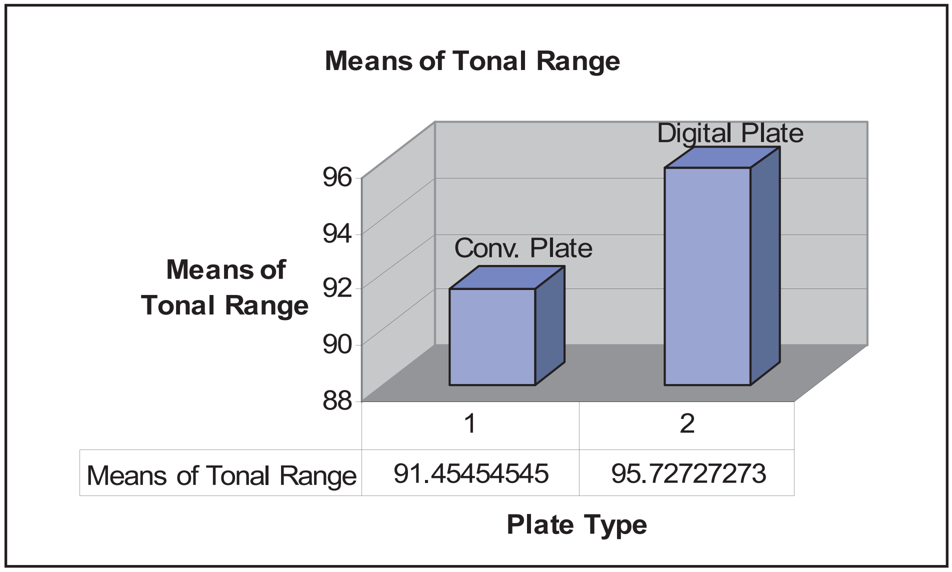


Figure 7. Means of Tonal Range

The plate supplier assured the researchers the plate durometers and other plate characteristics were identical and there was no reason the digital plates should have a banding problem. This may be one of the most interesting discoveries of the study.

The study also showed digital plates produced printed work with significantly higher print contrast values than conventional plates. This indicates work printed with digital plates would have better detail in the shadow areas. Maintaining shadow detail has always been a difficult problem with flexographic printing, and a technology which demonstrates improvement in this area should be attractive to printers considering digital plating technology.

The third hypothesis showed a significant increase in the tonal range values for digitally imaged and processed plates as compared to conventionally processed, film-dependent plates. The increase in tonal range will allow printers to reproduce continuous-tone images with much greater contrast, which would lead to enhanced print quality.

This study shows evidence of enhanced print quality from digitally processed flexographic plates, but printers will have to decide for themselves if the print quality improvement of digital will outweigh the cost of updating with the new technology in their individual plants.

Due to the expense of the research materials and apparatus involved, the study was limited to a smaller sample size and the results should not be generalized. However, the researchers believe this is a valuable applied study that could serve as a springboard for a larger research initiative on the topic

Future Research Needed

Although this study indicates significant quality improvements in two of the three hypotheses, the researchers found it interesting the digital plates showed "banding" in several of the samples collected from various printers. The banding could very well have caused the elevated tonal value increase in the digital plates. The researchers believe this presents an excellent opportunity for further research in the banding tendencies of digitally processed plates. Was this just a coincidence or is there a tendency for digital plates to band?

In recent years, advancements in laser engraved rubber plate technology have resulted in enhanced print quality. The researchers believe there is opportunity to research the quality difference of laser engraved rubber plates to laser ablated mask, photopolymer plates. Has the quality of this newly developed technology reached a level that it is competitive with ablated mask, photopolymer? And finally, the researchers would like to see a funded research project that could produce multiple sets of plates to be distributed to printers throughout the United States which would provide a much larger sampling.

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