# Effect of Screen Ruling and Screen Shape on Image Quality

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## Abstract

The image quality of a scanned output depends on different parameters like resolution, contrast, screen ruling, screen shapes etc.. The effect of screen ruling and screen shapes on image quality have been studied by the present investigator. In this study, the variation in the image quality has been observed by the histogram representation of the image. Histogram gives a graphic representation of the tonal distribution in an image. It plots the number of pixels at each brightness level. A Macintosh LC475 with U MAX VISTA T630 scanner is used to carry out the experiment. An image, taken as a case study, has been scanned several times by varying screen ruling and screen shapes to obtain the histograms with the help of Adobe Photoshop. The histograms are then compared to observe how the screen ruling and screen shapes affect the image quality. From the study, it has been seen how the image quality can be improved by selecting proper screen ruling and screen shape.

## Introduction

The scanners have initiated a new era in the field of Graphic Arts since 1970. In 1975, digital scanners by Crossfield created the possibility of storing and processing images before output to film. In 1980s, Scitex Response and Hell Chromacom introduced electronic colour correction and retouching of the images for prepress system. In the 1990s, desktop printers created a revolution to bring high-end, low cost, easy-to-use, less personal skill involvement color capability from Apple and Microsoft and publishing programs like Adobe Photoshop.

The image quality of a scanned output depends on different parameters like image resolution, contrast, screen ruling, screen shapes etc.. In this study, an image has been scanned several times varying screen ruling and screen shapes to observe their effect on image quality.

## Theoretical Background

### Screen Ruling

The primary objective of screening is to use area coverage to represent different shades of color, despite the fact that the imagesetter or desktop printer are typically binary devices.

A halftone is a grid of variable size dots of different sizes used to simulate a continuos tone photograph, either in color or in black and white. The size of the dots vary according to the shades of gray they simulate but the center of the dots are equidistant. This distance between the center of the dots is defined as the screen ruling or the screen frequency, measured in lines per inch (lpi).

The total number of shades of a printed image can be determined by the following formula :

$$\text{Total No. of Shades} = (\text{Printer's resolution in dpi} / \text{Screen ruling in lpi})^2 \quad (1)$$

However, using different screen ruling, the shades can be distributed in a manner to give better detail.

As the screen ruling increases, halftone cells will have less number of dots, resulting in fewer shades but the image will be sharper. On the other hand, as the screen ruling decreases, halftone cells will have more number of dots giving more shades of gray, but the coarseness of the screen will be evident.

Hence, it is extremely important to study how the image quality is affected by the screen ruling.

### Screen Shapes

Discernibility of the screen pattern produces an adverse effect on the quality of the printed image since the pattern provides no information about the object itself but acts as a disturbance. The patterns are hard to discern on fine screen images. However, for technological reasons in a number of instances, especially when printing on cheap grades of paper, fine screen images are difficult to produce.

Hence, it is worthwhile to study the variation of image quality with screen dot shape and to develop methods leading to a reduction in discernibility of dot forma-tion patterns on images produced with the help of coarse screens. When periodic patterns of a relatively high frequency are observed, the human visual system perceives mainly the first harmonic of signal. The amplitude of this harmonic and consequently, the discernibility of the pattern is greatest in midtones but fades away gradually with the approach of highlights or shadows. It indicates that discernibility of dot formation patterns should be subdued mainly within the midtones of the images.

The achievement of a satisfactory result lies either in changing the configuration of elementary dot cells or in varying the shape and orientation of dots so that the human visual system would perceive more closely packed contours. The screen shapes are normally designed as diamond, round, cross, line, square, spiral or ellipse.

**Histogram**

It is the most common form of diagrammatic representation of a grouped frequency distribution. The tonal distribution in an image (the brightness and the darkness level) can be graphically represented by a histogram. It plots the number of pixels at each brightness level. The x-axis of the histogram represents the color values from darkest at the far left to brightness at the far right. The y-axis represents the total number of pixels with that value. A histogram for a dark image shows most of the pixels at the left side of the graph. A Histogram for a light image has most of the pixels at the right side of the graph.

The Histogram gives a quick picture of how the pixels of the image are distributed. An image whose detail is concentrated in the shadows is known as a **low-key image**. An image whose detail is concentrated in the highlights is known as **high-key image**. An image whose detail is more or less uniformly distributed from left to right side, is known as **average-key image**.

## Experiment

Adobe Photoshop contains different tools for tonal and color correction which adjusts the brightness of the image to obtain maximum detail throughout the tonal range of the image.

The first step for achieving this is to calibrate the monitor properly so that the printed output matches the monitor image as close as possible.

Printing Inks Setup options are then selected to specify the properties of inks. The screen attributes like screen ruling, screen angles and screen dot shapes have been set in the Page Setup Dialog Box. The image resolution and other parameters have been set accordingly.

The scanning has been done in RGB mode and then the image has been converted to CMYK mode. After scanning the image, the Histograms for each channel, i.e., gray, cyan, magenta, yellow and black are obtained from the Image Menu. The histograms for different screen settings for each channel are then compared to observed how the image quality is affected as the screen ruling and screen shapes are varied.

## Results & Discussions

**Effects of Screen Ruling**

The histograms for a particular image, as a case study, are obtained for 85, 133 and 175 lpi screen ruling. It has been seen that for gray image, the image quality is best for 133 lpi screen ruling as the image has more details for 133 lpi screen. The result is more or less similar for cyan, magenta, yellow and black channels. However, the histograms can be modified for each case to give more detail. It may be noted that the histograms recorded are not corrected or manipulated.

**Effects of Screen Shape**

The image quality in printer for Diamond shape screen loses its detail at extreme highlight zone, i.e., where the brightness level varies from 250 to 255. Hence the diamond screen choice should be discarded for this particular image. The image quality for other screen shapes, i.e., round, cross, ellipse, line and square are more or less identical with a little improvement for line screen. The result is evident from the standard deviation data also.

## Conclusion

From the above study, it may be concluded that for this particular image, 133 lpi screen ruling and parallel line screens give best image quality if other parameters are unchanged.

However, it may be noted that the effect of other parameters on image quality are now being extensively studied. The manipulation requirement will also depend on the image itself (whether low-key, high-key or average-key). Hence different images are now being studied. Further studies are needed using different images on different substrates from Newsprint to Art paper. Only after a detailed and elaborate study, a generalized conclusion can be drawn.

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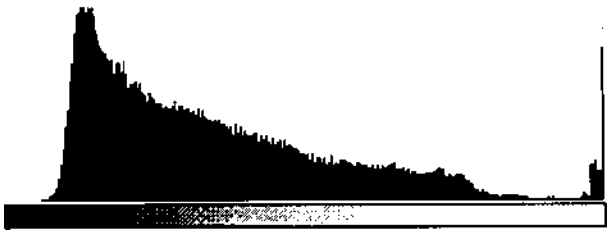

*Figure 1. Histogram of the Gray Channel of the Image at 85 lpi Screen Ruling with Line Screen*

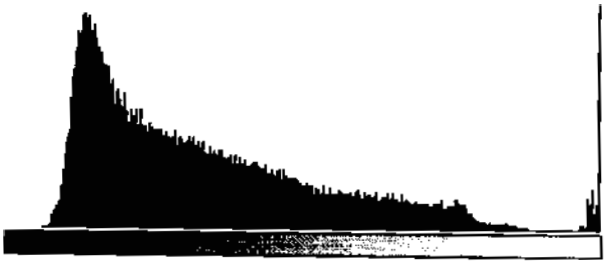

*Figure 2. Histogram of the Gray Channel of the Image at 133 lpi Screen Ruling with Line Screen*

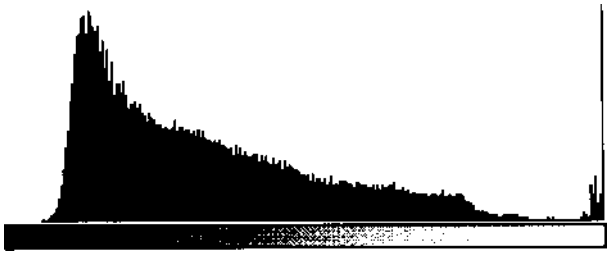

*Figure 3. Histogram of the Gray Channel of the Image at 175 lpi Screen Ruling with Line Screen*

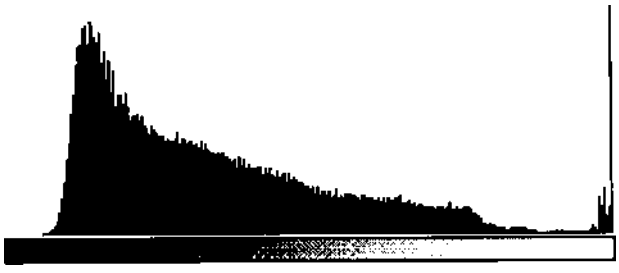

*Figure 4. Histogram of the Gray Channel of the Image at 133 lpi Screen Ruling with Cross Screen*

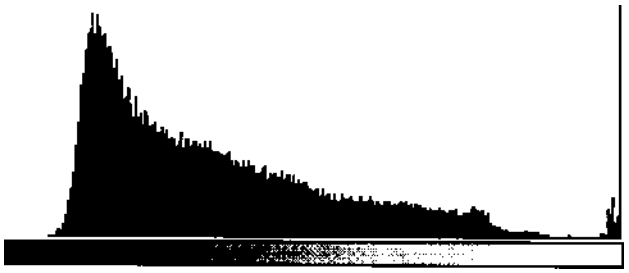

*Figure 5. Histogram of the Gray Channel of the Image at 133 lpi Screen Ruling with Round Screen*

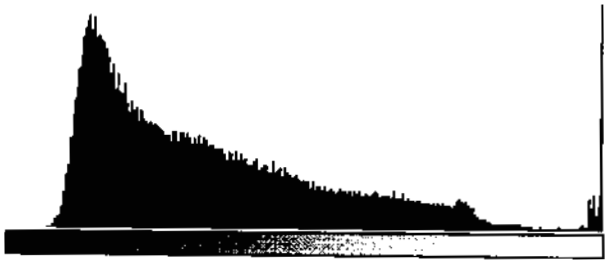

*Figure 6. Histogram of the Gray Channel of the Image at 133 lpi Screen Ruling with Square Screen*

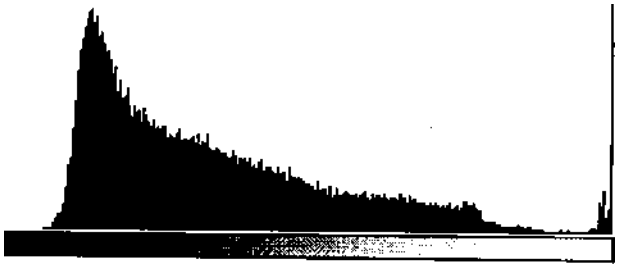

*Figure 7. Histogram of the Gray Channel of the Image at 133 lpi Screen Ruling with Ellipse Screen*

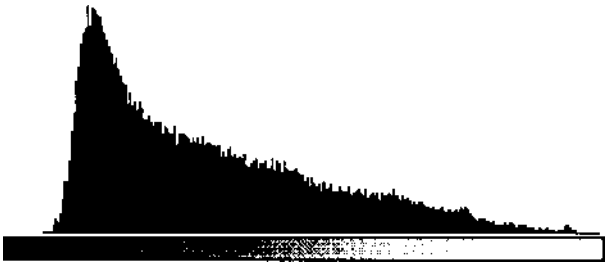

*Figure 8. Histogram of the Gray Channel of the Image at 133 lpi Screen Ruling with Diamond Screen*

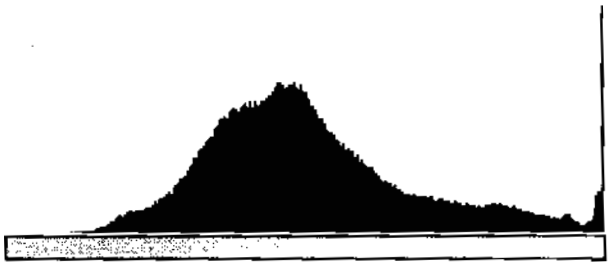

*Figure 9. Histogram of the Cyan Channel of the Image at 133 lpi Screen Ruling with Line Screen*

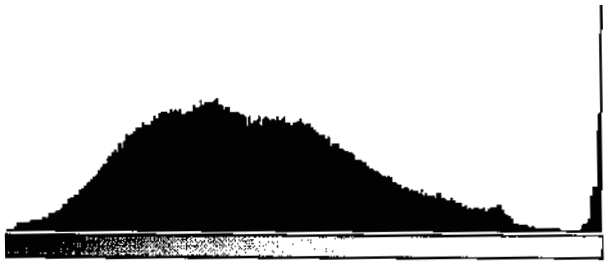

*Figure 10. Histogram of the Magenta Channel of the Image at 133 lpi Screen Ruling with Line Screen*

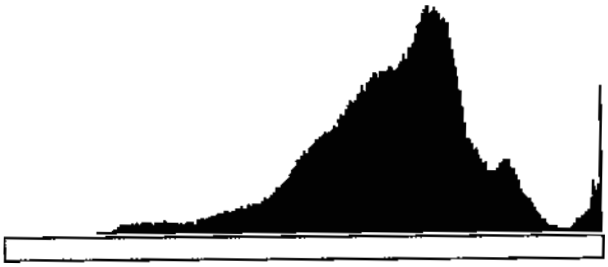

*Figure 11. Histogram of the Yellow Channel of the Image at 133 lpi Screen Ruling with Line Screen*

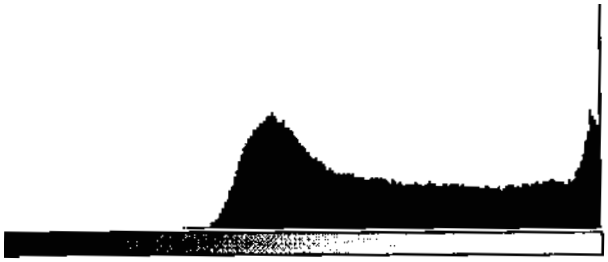

*Figure 12. Histogram of the Black Channel of the Image at 133 lpi Screen Ruling with Line Screen*