Non Periodic (Stochastic) Screening, Offset Negative and Positive Tone Reproduction

Part 1

R.S. Fisch *

Key Words

Stochastic, Periodic, Nonperiodic, Plate, Film, Press, Image, Platemaking

Abstract

It was found that the tone reproduction output of positive and negative non periodic (Stochastic) output differ from one another in the plate exposure and ink on paper printing steps of the offset reproduction train.

It was confirmed that the output of negative acting films exhibit extensive dot (spot) gain. Where the image acceptance criteria "match the period screen image" then file compensation is required. In comparison, positive files need comparatively little compensation. The positive output dot (spot) size can be reduced during plate platemaking (exposure).

More work is needed to isolate platemaking (exposure) gain effects from those produced in press, ink on paper and printing.

Definitions

Since confusion may arise concerning the meaning of some of the terms used, for purposes of this paper the following definitions will apply:

Periodic Screening:

Otherwise known as Amplitude Modulation [AM] Screening.

A technique for reproducing contone images as printed bi level images. This technique uses a single frequency modulated carrier (halftone screen) to carry the contone information. The printed images produced by this

* Printing & Publishing Systems Division, 3M Company
St. Paul, Minnesota 55144

means appear as regular, periodic, cell-centered patterns. The smallest printable feature produced by this means is called a "dot".

Non Periodic Screening:

Otherwise known as Frequency Modulation [FM] or Stochastic Screening.

An alternate technique for reproducing contone images as printed bi level images. This technique, however, does not require a formal carrier as the periodic screen. In non periodic screening, the image itself is the carrier. The non periodic resultant images appear to be to more contone like than periodic screen images, especially when viewed from closer distances.

This definition includes screenless printing where the irregular nature of the grain of a printing plate surface or of the granularity of the silver image in a photographic film acts as both the carrier and the graphic arts bi level image (the signal). The smallest printable feature produced by this means is called a "spot".

Introduction

Much has been written on the pro and con of Negative and Positive Printing and Periodic and Non Periodic Screening (1), (2), (3), (4). Such comparisons are beyond the scope of this paper.

95% of the separations used in Europe are positive images and about the same percentage of separations used in the United States are negative images.

The initial work effort on electronic non periodic printing came from Europe. The available literature from that source did not identify potential differences between the output of positive and negative data files when output using non periodic means (1), (2), (3).

It was therefore assumed that once a satisfactory linearized file image was available it could be printed either as negative or positive with the same results (within reason). This proved not to be the case. Practitioners in the US, found excessive tonal compensation was necessary before a satisfactory image could be obtained, while their European counterparts did not find the need for very much if any compensation. This paper attempts to define the causes of this disparity.

This work compares the film production, platemaking and printing of negative and positive individually linearized vignette images output by non periodic screening. The images studied were output using commercially available non periodic screening programs from three different manufacturers.

Identical positive and negative (both linearized) periodic screened images from the same file data have been included as comparative references.

Experimental

Users of 3 different manufacturers' non periodic screening applications were supplied digital files consisting of from 0 to 100% dot (spot) area vignettes (at 5% increments).

Those users were asked to produce individual linearized negative and positive output films using their (in house) non periodic screening programs. Output resolution equal to a 133 line per inch screen was requested. A linearized 133 line per inch periodic comparison vignette was produced for use as a reference. The films, chemistry, imagesetter, and processing system used were those routinely employed at the user's location.

2 of the 3 non periodic outputs "B" and "D" can be classified as "First Order FM" images, The smallest feature of those range from 20 to 30 microns. The 3rd output, "A", can be classified as "Second Order FM".

After processing, film output was analyzed, by 3M, for dot (spot) area response using a dot area meter of the type available at RIT, UGRA, and other research organizations.

Results and Analysis

FILM OUTPUT COMPARISON

The films received from the various users were compared to verify that the films delivered matched the request for linearized output. Both non periodic and periodic films are included.

Figures 1A & B compare the measurements made from the film output obtained to the requested (linearized) output. The X axis designates the requested linearized value, and the Y axis the "measured" delivered value. A 45 degree line indicates exact coincidence between the films. The measured values obtained from this effort are used throughout this paper. This information is vital since the object of this exercise is to compare positive to negative output.

Figure 1A, Negative Films

The Non periodic screening applications "A", "B", and periodic application "G" appear to be linearized, within the experimental error possible between different

Film Comparison

Figure 1A. Negative Film

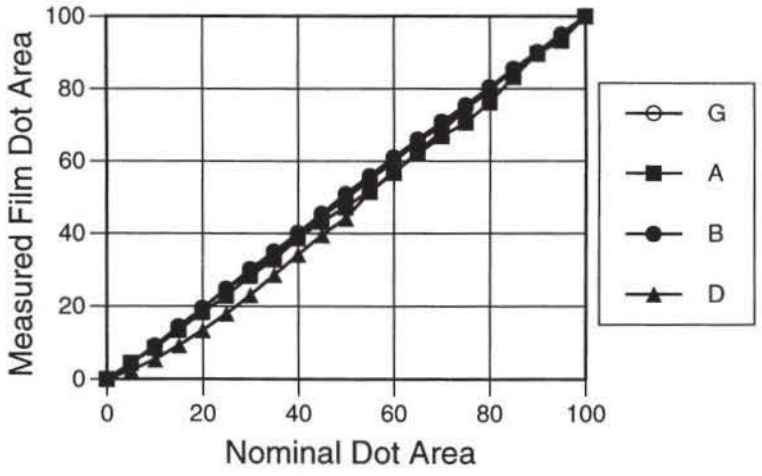
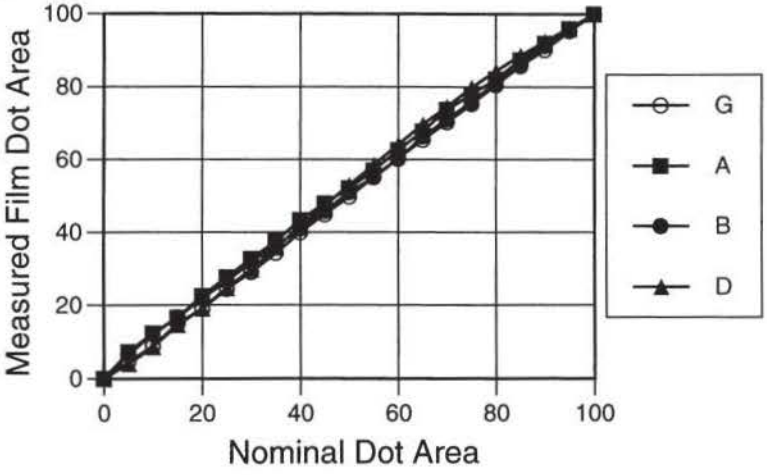


Figure 1B. Positive Film



sites' equipment, materials and application programs. Application "D" appears not to be fully linear especially in the low to mid tone areas.

Figure 1B, Positive Films

The positive output films, both non periodic and periodic application, show fair conformance to one another. All the images appear to exhibit a very slight increase between the 60 and 80% dot (spot) areas. A slight downward deviation of the curves between the 80 to 100% level is most likely experimental error. "A" appears to have linearization difficulty from the 10 to 22% tone region.

Figures 2A & B compare the measured (conventional) periodic film output to the measured values of the non periodic reference. The X axis values are measured tone values of the periodic screened films and the Y axis of the measured values of the non periodic screen film.

Figure 2A, Negative Films

As in Figure 1A, a 45° line connecting the 0% and 100% dot (spot) areas depicts perfect linearization. Differences between the non periodic and the periodic control are now more graphic. Application "D" results are not quite linear. The low to midtone spot areas are below the 45° line. At about the 40% spot level they slightly cross over the line and are out of linearity. "A" is more linear than "D".

Figure 2B Positive Films

The results of this comparison reinforce the results obtained from Figure 1B. Generally, considering the films used were produced using different manufacturers, different materials, exposed and developed on different devices in different shops, their similarity is surprising. Following film analysis, each of the images were stripped onto a flat and used to expose printing plates.

PLATEMAKING

Plate Exposure Level

Negative Plates

The flat containing the negative films was exposed onto 3M Brand Viking GMX Negative Acting Printing Plates using the manufacturers [AM] recommended procedures, and a Stouffer Scale exposed to indicate a full step 6.

Measured Periodic to Measured Non Periodic Comparison

Figure 2A. Negative Film

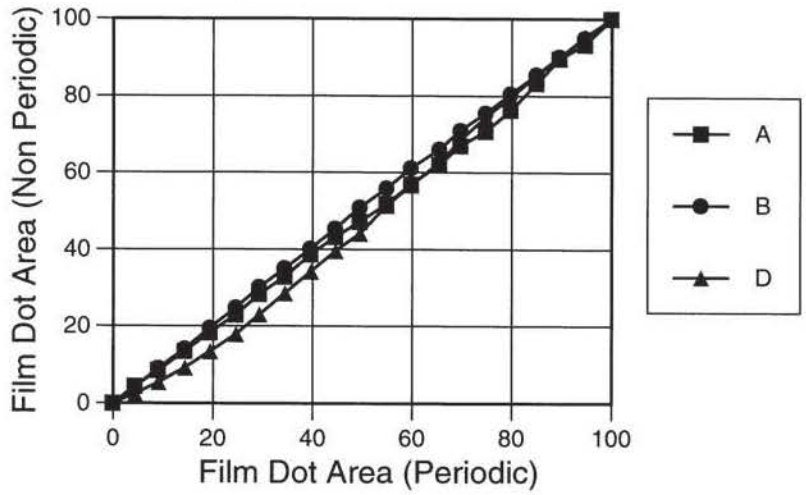
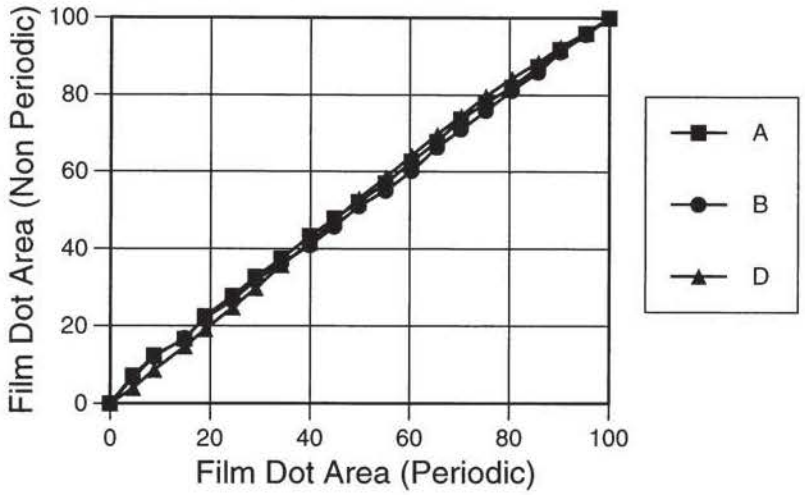


Figure 2B. Positive Film



Positive Plates

The film flat containing the positive films was exposed onto 3M Brand Viking PCX Plate following manufacturer recommendations and an UGRA Plate Control Wedge exposed to obtain 10 micron resolution.

Plate Processing

Both negative and positive exposed plates were processed using manufacturers' solutions at their recommended times and temperatures. The resultant plate images were analyzed using the image analysis device described by Fisch and Cavin (5) using a 3M Company (proprietary) analysis program.

Dot Gain Results: Film to Plate

The dot (spot) gain curves, Figures 3 & 4, represent the resultant film to plate dot (spot) gain curves of both periodic and non periodic images.

Figure 3 Negative Plates , Stouffer Step 6

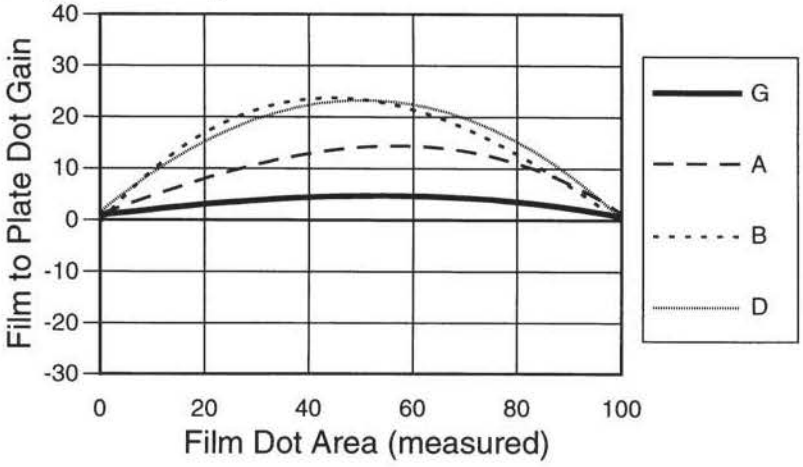
The periodic plate image "G" gained about 3 to 5% at 50% film dot area. All three non periodic images exhibited greater spot gain than "G". The "Second Order FM" output "A" exhibited less gain than both "First Order FM" applications, "B" or "D". At 50% spot area, "A" gain is about 14%. For "B" and "D", both "First Order FM", spot gains were excessive, about 23% (about 20% above that of the non periodic, conventional "film "G").

Figure 4 Positive Plate 10 micron resolution

At the 10 micron resolution level the periodic screen image "G" exhibits about a 3 - 4% sharpening. The non periodic images differ from one another. At a film spot area of 50% "A" plate spot area gain (sharpening) is near 16%, "B" and "D" near 20%. There is the lack of symmetry between the various non periodic images. "B" and "D" are more symmetrical than "A".

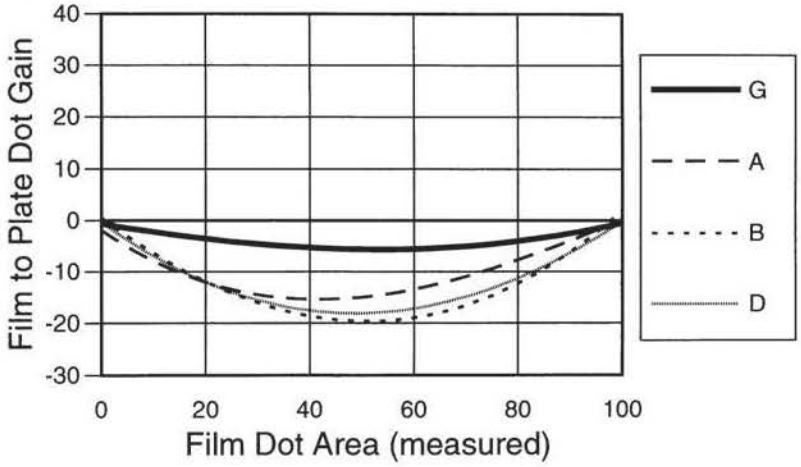
Film Dot Area to Plate Dot Gain

Figure 3. Negative Film



Film Dot Area to Plate Dot Gain

Figure 4. Positive Film 10μ



PRESS

Press Conditions

The following table lists the press, fountain solution, inks, and paper used in printing the negative and the positive plates

Press	Heidelberg GTO
Plates	Negative Acting, 3M Viking GMX
	Positive Acting , 3M Viking PCX
Fountain	Rosso's G7A- V Combination, 15% alcohol
Ink	Kohl Madden Process Black AGU1, Tack 13
	Solid Ink Density 1.55 to 1.61
Blanket	Reeves: Style 2000
Paper	Lithofect Plus 80 lb. Gloss Text
	Cross Web Solid Ink density, 1.55 to 1.61

Dot Gain Results: Film to Press

Figure 5 Negative Output, film to press (ink on paper)

As expected the periodic film image "G" produced a plate dot gain peak of about 21 to 22% near the 40% film dot area. The periodic image is nearly symmetrical. The non periodic curves are less symmetrical (peaking at a 30% film spot size) than those of the periodic plate.

The FM images "B" and "D" are nearly identical in spot gain profile (shape) differing only by experimental error. The peak spot gain (at 30% film spot size) is 52 to 54%. The "Second order FM" image "A" exhibits a spot gain shape similar to the other two with a peak spot gain of 45%.

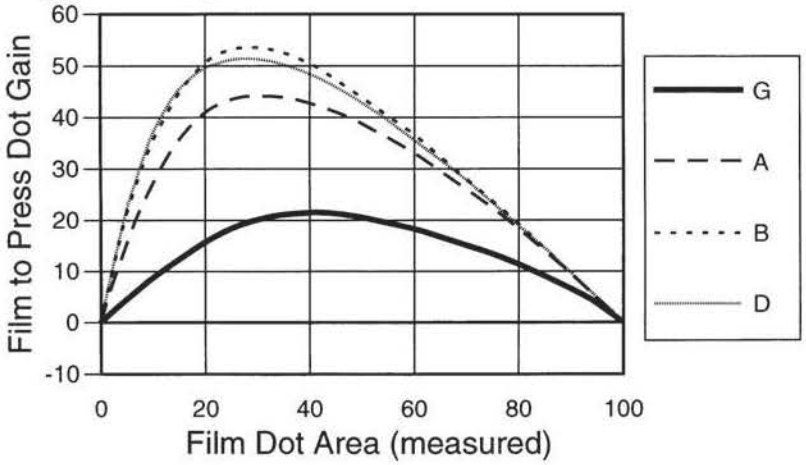
Figures 6 Positive Output; film to press (ink on paper) 10 micron resolution

The plate dot gain for the periodic image "G" (at a 50% film dot area) is about 11%. The dot gain profile is low and symmetrical.

"A" (a Second Order FM image) and "B" (a First Order FM image) are almost identical except for the fact that "A" appears to lose spots below the 5% film spot size. First Order FM application "D" is sharper than the periodic image

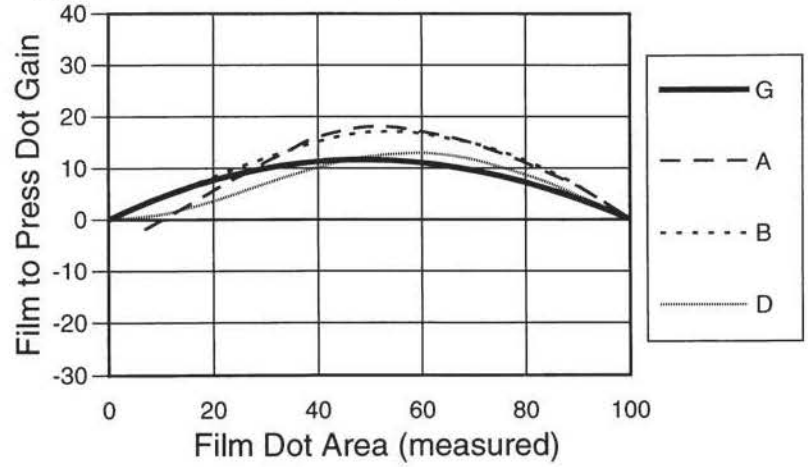
Film Dot Area to Press Dot Gain

Figure 5. Negative Film



Film Dot Area to Press Dot Gain

Figure 6. Positive Film 10μ



"G" at film spot areas lower than 40%. At spot levels greater than 40% "D" and "G" are only a few percent different.

Comparison Non Periodic to Periodic Ink on Paper Images.

Negative Acting Systems

Spot gain is higher for negative acting non periodic systems. Periodic systems exhibit significantly lower dot gain. Excessive data file changes would be needed to match a non periodic output to a periodic output.

Positive Acting Systems

Spot gain is reduced for positive acting systems. Periodic systems exhibit dot gains of almost the same magnitude. Minor data file changes would be needed to match a non periodic output to a periodic output.

Periodic NEG Film to Press Results
vs.
Non-Periodic POS Film to Press Results

Figure 7. Negative Film (G)
Positive Film (A & D 6μ)

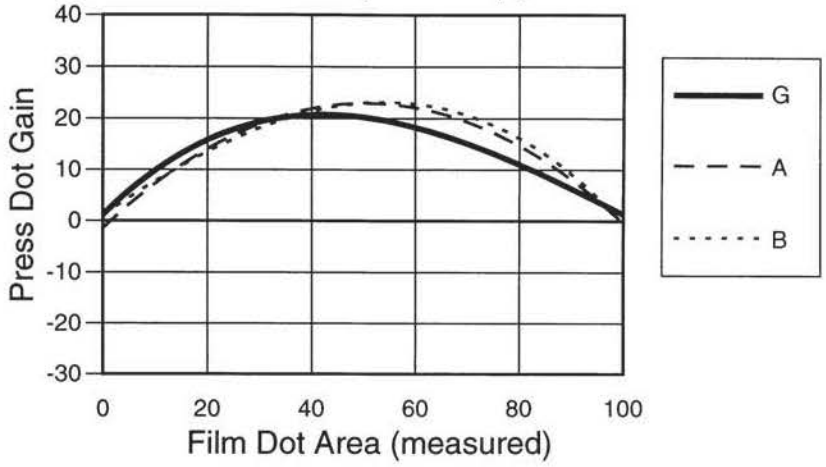


Figure 7 Periodic Negative Film to Press Results vs. Non Periodic Positive Film to Press Results

A direct example of the differences between negative and positive non periodic and periodic dot (spot) gain can be seen by comparing Figures 5 and Figure 7

Figure 5 illustrates the excessive spot gain of negative acting non periodic printed images and a comparative periodic printed image. Figure 7 compares the positive non periodic image to the negative periodic image. Very small file changes are needed to match the periodic negative and non periodic positive output. Excessive change is needed to match the non periodic and periodic output exhibited in Figure 5.

Conclusions

1. Linearized positive and negative film produce printed output differences greater than expected when non periodic screening techniques are employed

2. Positive non periodic printed images need less file spot gain correction to produce satisfactory images closely matching those of periodic images.

3. Dot sharpening is an effective tool to adjust the tone reproduction of positive non periodic images.

4. Dot (spot) gain differences between the observed results is attributable to both the plate making and printing steps.

A striking difference is seen between the output of the non periodic negative and positive imaged films. Although the non periodic ink on paper images were expected to be different than the periodic images (and were), a more significant difference was found between the non periodic negative printed results and the positive printed result. The positive printed results showed significantly less spot gain than the negative printed results.

Such a difference indicates that less correction needs to be applied to a non

periodic positive file to make the tone reproduction curve match that of a periodic file. By contrast, more tonal correction needs to be applied to a negative file.

The results of the early work presented here appear to be confirmed by a similar test being run by the Graphic Communications Association (GCA) , Print Properties Group, Stochastic Study Group soon to be independently published. Further work is planned concerning the cause of the dot (spot) gain differences between periodic and non periodic image output.

Acknowledgements

The author would like to acknowledge the contributions of S. Kopp, R. Cavin, and S. Bartels and the members of the GCA Print Properties Stochastic Imaging Study Group, without whose help this paper would not be presented.

Literature Cited

1. G. Fischer
   1989 "A Screenless Electronic Imaging Process Using Frequency Modulation"
   TAGA Annual Proceedings pg. 195 to 201.

2. E. Widmer, K. Schlaepfer, V. Humbel, S. Persiev
   1992 "The Benefits of Frequency Modulated Screening"
   TAGA Annual Proceedings pg. 18 to 44.

3. A. Stanton, R. Warner
   1994 "Color Reproduction Characteristics of Statistically Screened Images"
   TAGA Annual Proceedings pg. 65 to 92.

4. R. Chung, L. Y. Ma,
   1995 "Press Performance Comparison Between AM and FM Screening"
   TAGA Annual Proceedings pg. 321 to 328.

5. R. Fisch, R. Cavin
   1986 "A Report on the Percent Image Area Measurements Taken from Plates Used in the GCA 1985 Print Properties Test".
   TAGA Annual Proceedings pg. 267 to 278.