Non Periodic (Stochastic) Screening, Offset Negative and Positive Tone Reproduction Part 2.

Tracking the Dot / Spot Gain in Non Periodic Printing

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Key Words

Periodic, Non Periodic, Screenless, Tone, Tint Gain

Abstract

Three different manufacturers' non periodic screening systems were used in this study. Two would be considered "First Order FM" the other "Second Order FM". User generated linearized negative and positive image film vignettes were used to characterize the output [film, plate, press] tone reproduction and tint gain of these systems. This paper attempts to follow the change of these attributes as the images pass through the repro train.

In non corrected Non Periodic Negative acting printed images, the rate of change in tone values initially increases at a rapid lineal rate up to 40% tint area. At that point the rate of change becomes exponential up to input levels on average of 20%. At levels higher than this the rate becomes asymptotic to 100% tint area. Such a response exhibits, on average, tint levels of near 60% output for an input value of 20%, and 90% for input values of 40%.

In contrast Periodic Negative acting images exhibit a less rapid incline in tint response with 20% input about equal to a 40% output. The Periodic sample also exhibits an extended inflection point. Therefore, an 80% input tint results in a 85% output image. Additionally, the Periodic tone curve does not becomes asymptotic to 100% tint area.

Non Periodic Negative acting Tint Gain Curves are skewed. Reading tint gain at a 50% input tint level may be misleading. A major portion of this gain was found to occur at the platemaking step.

Non Periodic Positive tint gain is considerably less than that of periodic tints. Non periodic Positive images are more susceptible to sharpening than periodic images. Tint sharpening occurs when Positive films are contact printed onto Positive acting plates. Platemaking exposure induced sharpening is an effective additional means of achieving a closer

tint match from Positive non periodic to periodic images. Some Positive non periodic images may not need more than film to plate induced sharpening to match periodic images. Therefore, the tone reproduction scale (hence the tint gain) of Positive non periodic images can be made to be a close match to Positive periodic images.

Introduction

A prior paper (1) disclosed the differences between Periodic [halftone] (P) and Non Periodic (NP) [Stochastic] positive and negative linearized film and ink on paper images. This paper uses the same file and output images. An additional platemaking exposure series and press run have been included.

In that paper, users of 4 different manufacturer's non periodic screening applications were supplied digital files consisting of from 0 to 100% 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 third output ("A") can be classified as "Second Order FM". The smallest features of the applications studied ranged from 20 to 30 microns.

The press, fountain solution, inks, blanket, and paper used in printing the positive and negative plates of (1) are also employed.

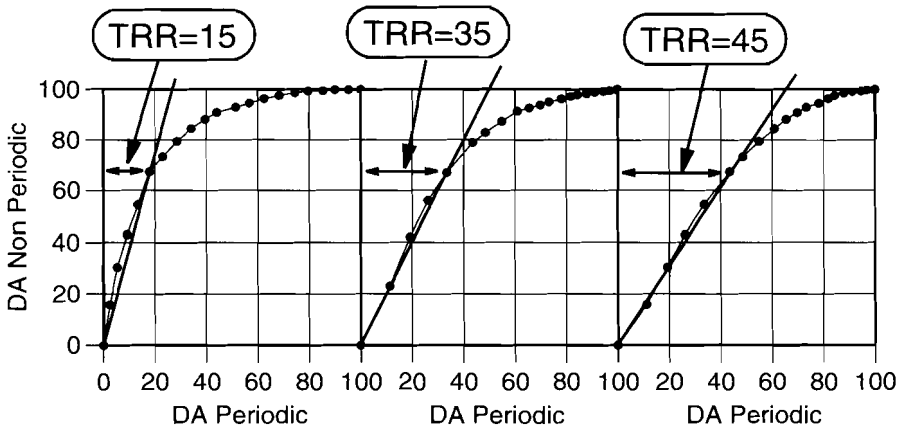
Metrology and Analysis Procedure

Plates: As per Fisch and Cavin (2) using a proprietary 3M Analysis Program.

Reflection Copy: Gretag SPM 100, No Polarization, Status "T" density response, operated according to ANSI CGATS.4 1993 was used to measure the reflection images. A black paper was used behind the sample while readings were made.

Graphic analysis was used to illustrate differences between reproduction steps, applications or screening systems. A numerical indicator of the tone reproduction capabilities of screening applications called Tonal Reproduction Range (TRR) is used in this paper. The TRR value is similar to one called the Basic Density Range (BDR) (2) used in measuring the tone capabilities of contact screens. Figure 1 illustrates how TRR values are obtained.

Figure 1 Obtaining the TRR value



A straight line is drawn connecting only the linear portion for each of the curves. The line for the first curve extends from 0 to 15% input dot / spot areas, the second line from 0 to 35% dot / spot area and the third from 0 to 45% dot / spot area. The first application would be assigned a TRR of 15, the second 35 and the third 45. The second and third exhibit greater tonal range than the first. When films or plates are compared, a tint for tint reproduction may be possible. When repro systems which include a printing ink on paper step are compared, the relationship between the input and output variables will not be 1:1 or 100%. Tint gain during printing or light scattering from the paper surface affects this relationship.

Results

I. Image Reproduction Characterization, Film to Press [ink on paper]

Figure 2 TRR values of the Non Periodic (NP) and Periodic (P) Negative acting [film to press] systems.

Table 1 Negative Acting TRR Values

Screening	Application	TRR Value
Non Periodic	A	15
Non Periodic	B	20
Non Periodic	D	20
Periodic	G	40

Observations: Tone Reproduction Negative Acting Systems [film to press]. The higher the TRR value, the greater the tone reproduction range. The Periodic image produced a TRR value of 40. Non Periodic applications produced TRR values of 15 to 20 depending on the application.

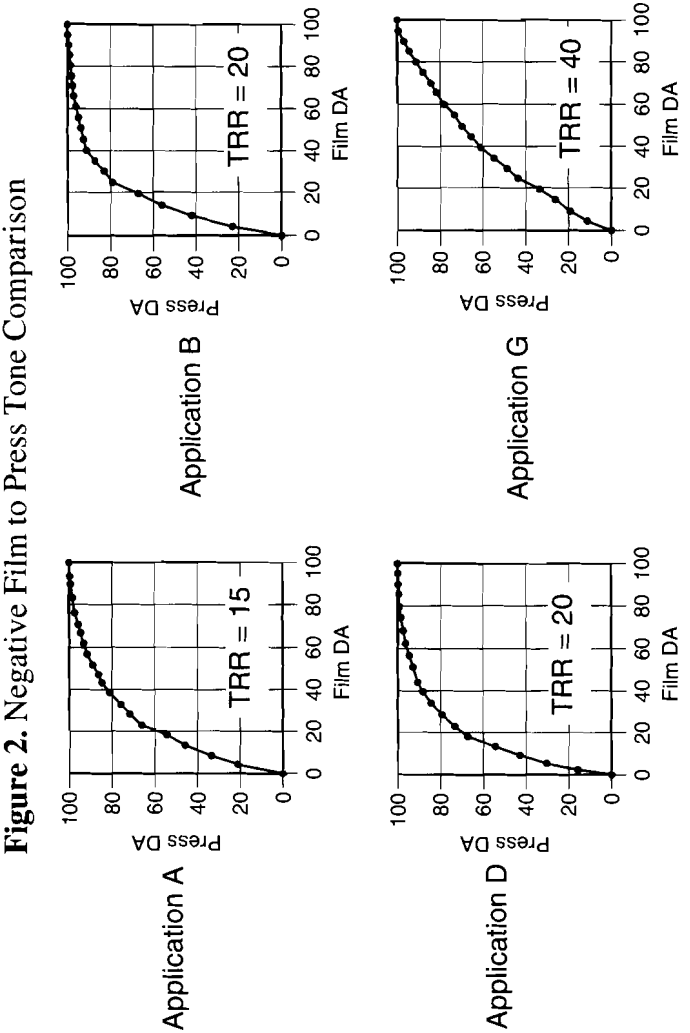


Figure 2. Negative Film to Press Tone Comparison

In non corrected Non Periodic Negative acting printed images, the rate of change in tone values initially increases at a rapid lineal rate up to 40% tint area. At that point the rate of change becomes exponential up to input levels on average of 20%. Input tonal levels higher suffer compression, from shadow densities to Dmax (ink solid densities). Without some sort of tonal compensation the NP Negative acting system is useless.

The "Second Order FM" application "A" appears to exhibit less tonal compression at the input (tint) levels of 40% and above.

Figure 3 TRR values of the Non Periodic (NP) and Periodic (P) Positive acting [film to press] systems.

Table 2 Positive Acting TRR Values from Figure 3

		TRR Value (at resolution:)		
Screening	Application	6 micron	8 micron	10 micron
Non Periodic	A	40	45	60
Non Periodic	B	40	45	60
Non Periodic	D	45	50	60
Periodic	G	40	60	65*

* = Manufacturers recommended resolution

Observations: Tone Reproduction Positive Acting Systems. [film to press]. The TRR values of the Positive NP acting systems are greater (2 times) than the TRR of the Negative acting system. Tint sharpening using increased exposure levels also increases the Positive NP TRR values. NP platemaking exposures that insure 8 to 10 micron resolution produce TRR values near those of the P application. In some cases some little input data file compensation may be needed (less than that for Negative acting systems). The rate of TRR change per exposure level appears different for different NP applications. Care must be given to insure that a particular exposure level or application does not lose it's smallest feature by increased exposure.

Dot/Spot (Tint) Gain

Figure 4 Tint Gain curves of the NP and P Negative acting [film to press] systems.

Note: The Tint Gain Curves are not Gaussian, they are skewed. The tint value giving the most gain may not be 50%.

Table 3A 50% [input] Tint Gain for Negative Acting NP and P Samples

Screening	Application	At 50% Tint Value
Non Periodic	A	37%
Non Periodic	B	43%
Non Periodic	D	41%
Periodic	G	20%

Table 3B Maximum Tint Gain for Negative Acting Systems

Screening	Application	Tint Value of Max gain	Max Gain
Non Periodic	A	33%	43%
Non Periodic	B	30%	53%
Non Periodic	D	29%	51%
Periodic	G	40%	21%

Positive Film to Press Tone Reproduction Analysis

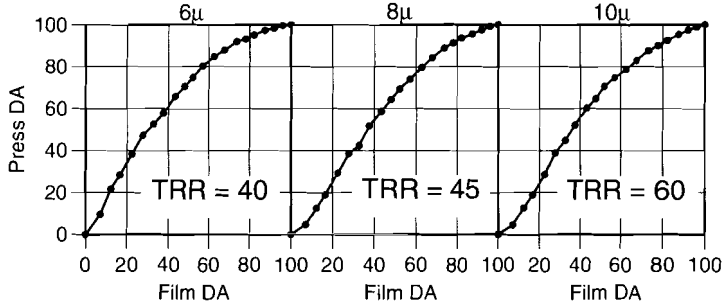


Figure 3A.
Application A

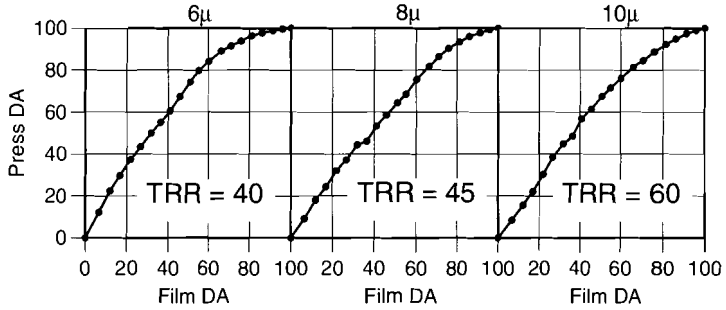


Figure 3B.
Application B

Positive Film to Press Tone Reproduction Analysis

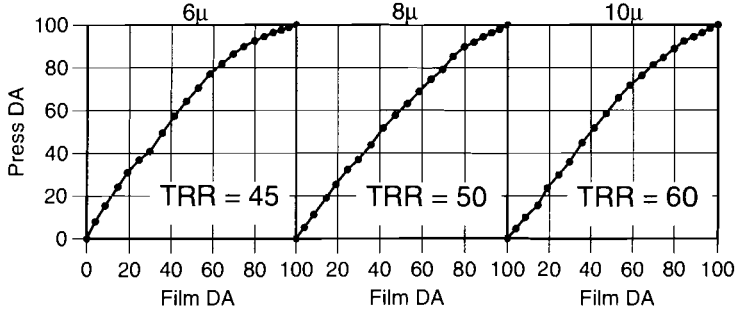


Figure 3D.
Application D

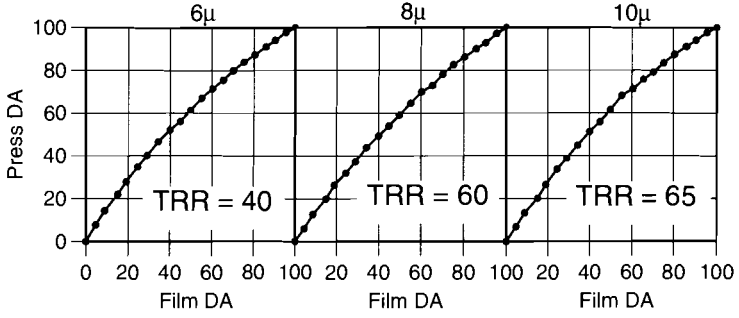


Figure 3G.
Application G

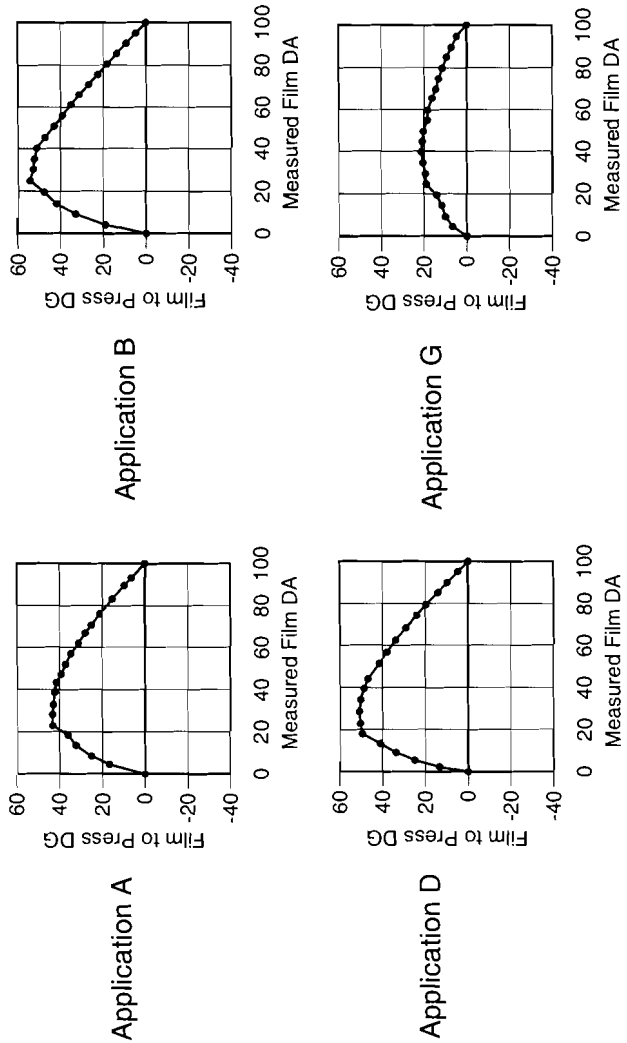


Figure 4. Negative Tint Gain Film to Press

Observations: Tint gain Negative acting systems [film to press]. The Tint Gain curves of Figure 4 do not have the traditional symmetrical bell shape. They are skewed. There is more gain in the highlight and mid tone areas. When monitoring conventional halftone images many only monitor the gain at a 50% input level. In most NP applications however the tone value with highest gain may not be at 50%. Therefore, NP screened measurement at 50% will not convey the true extent of the gain experienced.

Observations (Figure 5, Table 4): Tint Gain Positive Acting Systems [film to press]. As expected Positive systems produce less tint gain than negative systems. Each NP application exhibits a different rate of change per exposure change. This difference may be caused by differences in feature size and shape.

P (conventional) Positive screened dots do not exhibit the same dot sharpening per exposure increment as NP screened spots. This is most likely because the tint features of NP images are smaller than P images. When sharpening by increased platemaking exposure is utilized, little if any file changes need to be made when matching Positive acting NP to P images.

Figure 5 Tint Gain curves of the NP and P Positive acting [film to press] systems.

Table 4 Maximum Tint Gain for the Positive Applications [film to press]

Screening	Application	Resolution (microns)	Tint Value of Max gain	Max Gain
Non Periodic	A	6	57%	23%
Non Periodic	A	8	57%	17%
Non Periodic	A	10	57%	18%
Non Periodic	B	6	55%	24%
Non Periodic	B	8	55%	14%
Non Periodic	B	10	55%	17%
Non Periodic	D	6	59%	19%
Non Periodic	D	8	59%	10%
Non Periodic	D	10	59%	13%
Periodic	G	6	55%	12%
Periodic	G	8	55%	9%
Periodic	G	10	55%	13%

Observations: General [film to press]. The Negative materials rise from their Dmin at a rapid rate. Input values over 20% produce output values of near 70% with tonal values above that level being compressed. The compression limits affect almost 80% of the possible print tone reproduction scale.

The Positive acting NP print tone reproduction curves exhibit higher (35 to 60) TRR values than the those of Negative acting prints (15 to 40). By definition this means they are able to reproduce a greater tone reproduction range. Less input image file compensation, if any, may be required to match Positive acting reproduction NP to P images than that required to match the corresponding images produced by Negative acting reproduction systems. Exposure adjustment during platemaking, is an effective tool to use when matching the Positive NP images to Positive P images.

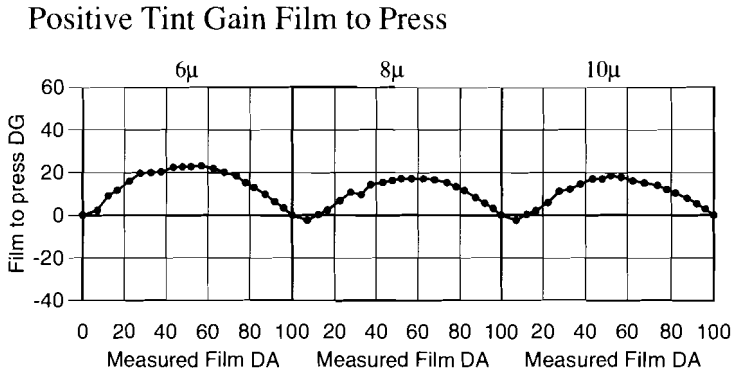


Figure 5A.
Application A

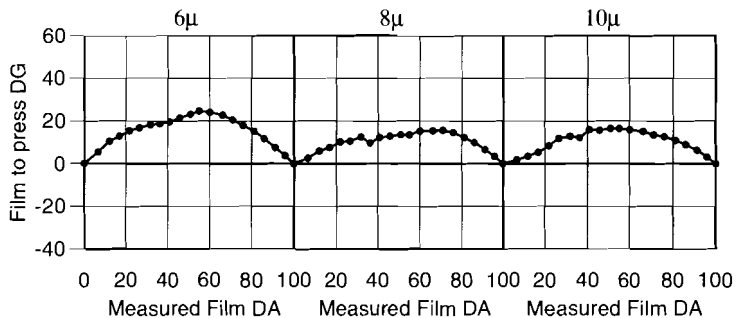


Figure 5B.
Application B

Positive Tint Gain Film to Press

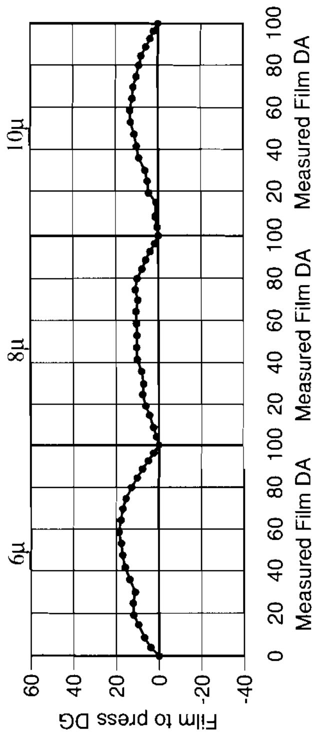


Figure 5D. Application D

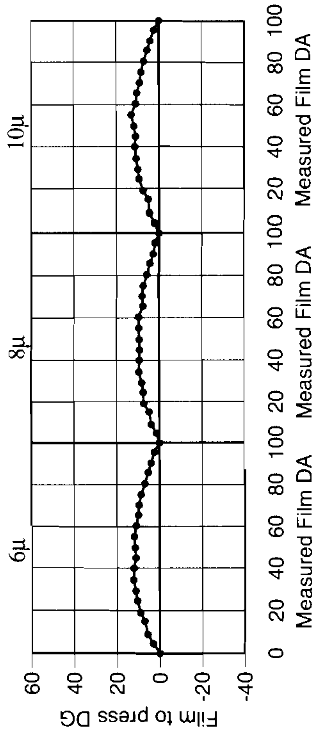


Figure 5G. Application G

Negative acting NP images exhibit excessive tint gain. Such gain ranges (depending on the application) run from 40 to 57%. Comparative conventional (P) Negative acting applications exhibit tint gain of 20%. Positive acting NP tint gain can be adjusted by exposure control to match either Negative or Positive P images.

Exposure induced sharpening is an effective means of achieving a closer tint match from Positive NP to P images. NP Positive tint gains are considerably smaller than those of the P tints. Positive values range from

23% to 13% depending on application and exposure vs. Negative tint gains which range from 43 to 37%. The maximum film to press tint gain of Positive acting NP systems using linearized film appears to be 15 to 22% @ a 50% tint level (depending on the platemaking exposure).

Positive NP images exhibit less tint gain than Negative P images. The tint gain of P images is between 15 and 16% at maximum tint gain levels. An increase in exposure during platemaking can adjust NP tint gain to closely match the gain of the P control.

The following sections attempt to trace the origin of the difference in TRR noted in the previous section.

II. NP to P, Image Reproduction Comparison [Press to Press]

Figure 6 compares the tone reproduction curves of the of the Negative acting system NP press images.

Table 5 Negative Acting TRR Comparison Values from Figure 6

Screening	Application	TRR Values *
Non Periodic	G vs. A	45
Non Periodic	G vs. B	40
Non Periodic	G vs. D	50

*100% = exact tonal match

Observations: Tone reproduction Negative acting systems [press to press]. The comparison of Negative acting ink on paper results between NP and P images indicate that NP images exhibit more tonal compression than P images at input tint values of 40 - 60%. This is not surprising and is predicted by the TRR values of the NP (Negative acting) film to press tone reproduction Table 1 and Figure 2.

Figure 7 Comparison of the tone reproduction curves of the NP plate images of the Positive acting system at 6, 8 and 10 micron resolution.

Figure 7A P application G vs. NP application A
Figure 7B P application G vs. NP application B
Figure 7D P application G vs. NP application D

Table 6 Positive Acting TRR Comparison Values

		TRR Value (at resolution:)		
Screening	Application	6 micron	8 micron	10 micron
Non Periodic	A	60	70	80
Non Periodic	B	75	80	90
Non Periodic	D	80	85	90

Observations: Tone reproduction Positive acting systems [press to press]. The "First Order" NP applications "B" and "D" compare favorably to the P application. The "Second Order" NP application "A" will need input data file compensation to more favorably compare to the P image.

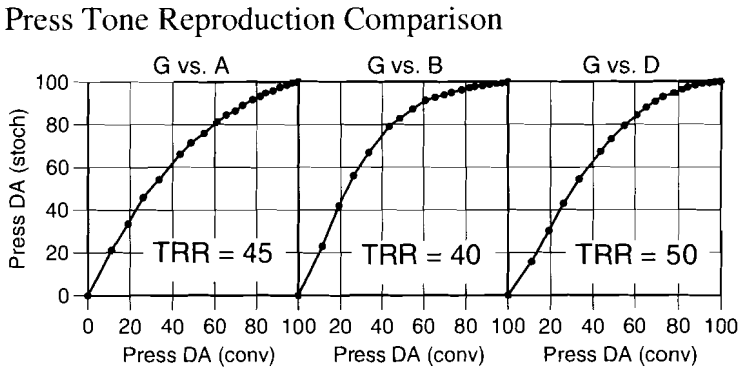


Figure 6.
Negative Press

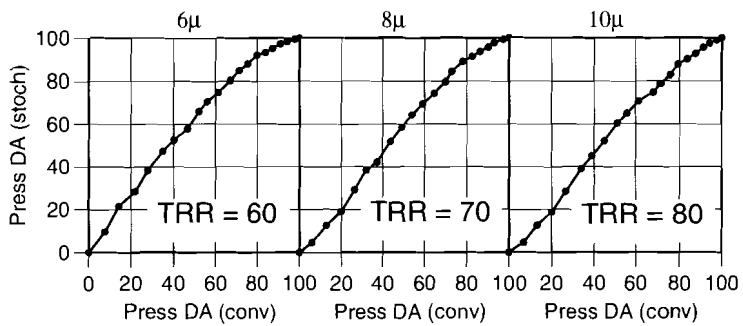


Figure 7A.
Positive Press
G vs. A

Press Tone Reproduction Comparison

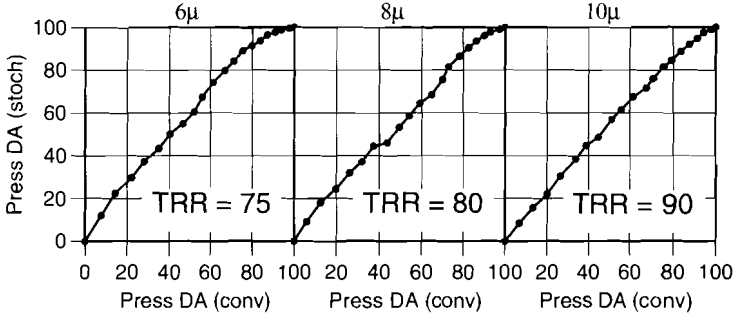


Figure 7B.
Positive Press
G vs. B

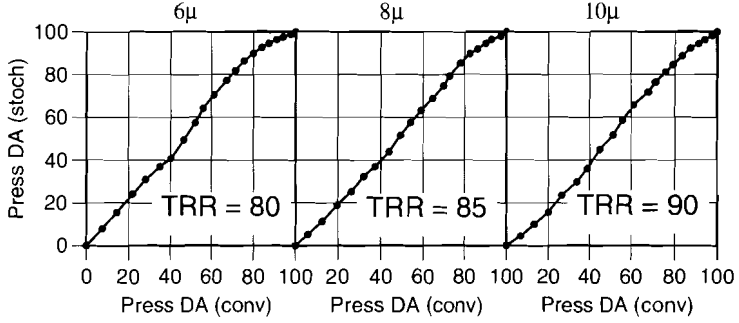


Figure 7D.
Positive Press
G vs. D

The following sections attempt to trace the origin of the tint gain depicted.

III. NP to P, Tone Reproduction Comparison [Film]

A full analysis complete with graphs comparing film to film NP to P both for Negative and Positive Acting films is available in (1). As identified, in that paper application "D" exhibited less than perfect linearization in tint areas from highlight to midtone.

Table 7 Negative Acting Film TRR Comparison Value

Application	TRR Values
G vs. A	100
G vs. B	100
G vs. D	90

Observations: Except for "D" the Tone Reproduction values of the Negative acting film images are identical to one another. "D" differs from the rest in the toe portion of the TRR curve. These values indicate that the tone reproduction and tint gain in the ink on paper images are not caused by the films.

Table 8 Positive Acting Film TRR Comparison Values

Applications	TRR Value
G vs. A	100
G vs. B	100
G vs. D	90

Observations: Tone reproduction Positive acting system comparisons [NP to P films]. The results indicate that the tint gain of NP Positive ink on paper images are (with the exception of "D") very close to those of P Positive images, and little or no tone compensation is needed.

Final Conclusions

The input film was properly linearized (except for "D") and therefore pending mitigating actions should have responded identically throughout the reproduction cycle. The input films do not directly contribute to the TRR and Tint Gain NP effects evidenced in the film to press comparison

IV. Image Reproduction Characterization [Film to Plate]

Figure 8 shows the print tone reproduction of Negative acting NP and P screened images [film to plate].

Figure 8. Negative Film to Plate Tone Comparison

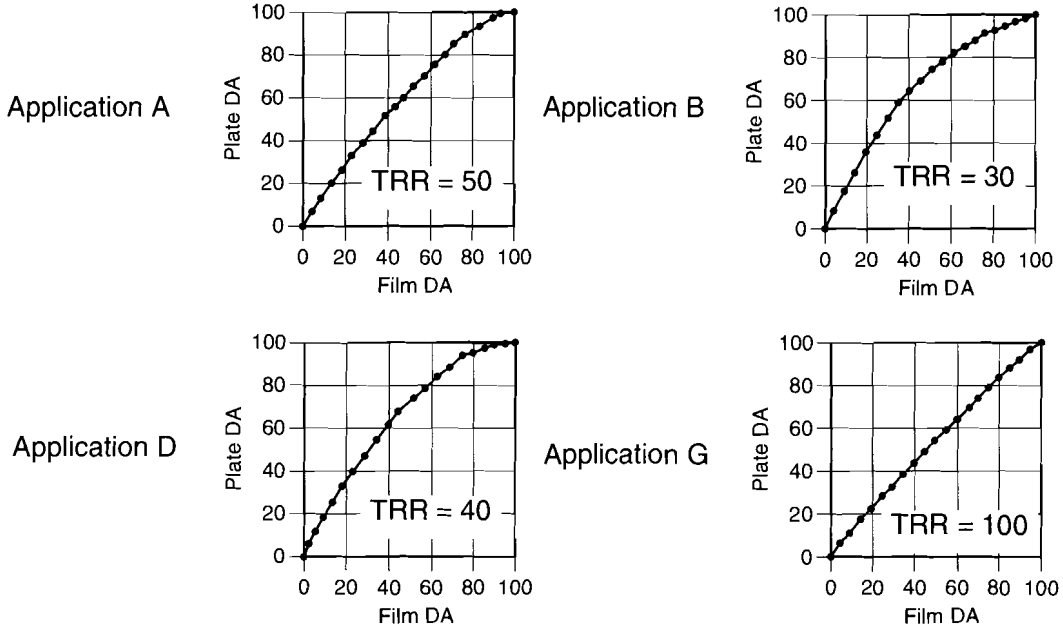


Table 9 Negative Acting TRR Values [film to plate]

Screening	Application	TRR Value
Non Periodic	A	50
Non Periodic	B	30
Non Periodic	D	40
Periodic	G	100

Observations: Tone reproduction Negative acting systems [film to plate]. Both figures and tables indicate that the film to plate (platemaking) step is responsible for a large portion of the gain when one prints non periodic Negative acting films on press.

Figure 9 shows the print tone reproduction of Positive acting NP and P screened images [film to plate].

Table 10 Positive Acting TRR Values from Figure 9

		TRR Value (at resolution:)		
Screening	Application	6 micron	8 micron	10 micron
Non Periodic	A	70	80	90
Non Periodic	B	40	40	50
Non Periodic	D	50	50	55
Periodic	G	100	100	100*

* = Manufacturers recommended resolution

Observations: Tone reproduction Positive acting systems [film to plate]. TRR Values of Positive acting P screened film to plate are also 100. The NP positive TRR values change between applications as well as by sharpening through changes in platemaking exposure. The TRR values vary from 70 to 40 at 6 micron resolution; 80 to 40 at 8 micron resolution; and 90 to 50 at 10 micron resolution. The unusual shape (extended toe of application "B") is the cause of the reduced range. The combination of application and platemaking exposure level can produce both NP and P positive images having a TRR of 100. Image data files, of course, can bring all the values to 100. The film to plate dot gain appears to contribute significantly to the final tint gain of the system. The smaller feature sizes of "B" can also affect TRR and tint gain values. Smaller features being prone to sharpen faster.

Figure 10 Tint Gain Response of Negative Acting Systems [film to plate]

Observations (Figure 10, Table11): Tint gain Negative acting systems [film to plate]. TRR Values of Negative acting P screened images for film to plate are 100. NP TRR values range from 30 to 50. Only about one half the range of conventional P negative images.

Positive Tone Reproduction Analysis Film to Plate

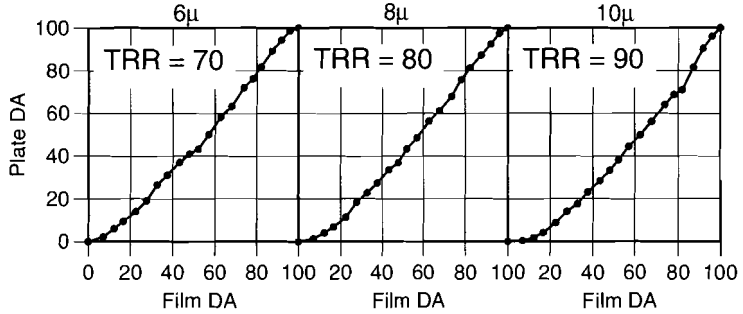


Figure 9A.
Application A

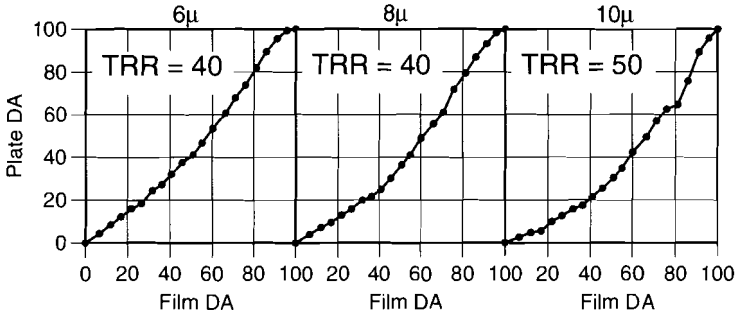


Figure 9B.
Application B

Positive Tone Reproduction Analysis Film to Plate

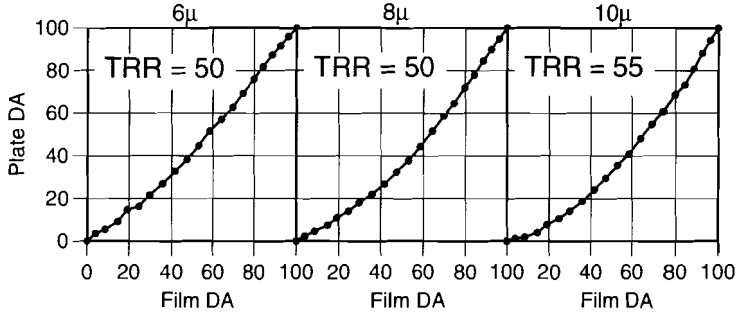


Figure 9D.
Application D

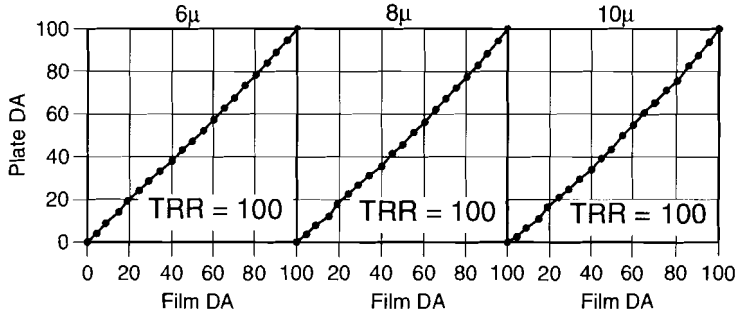
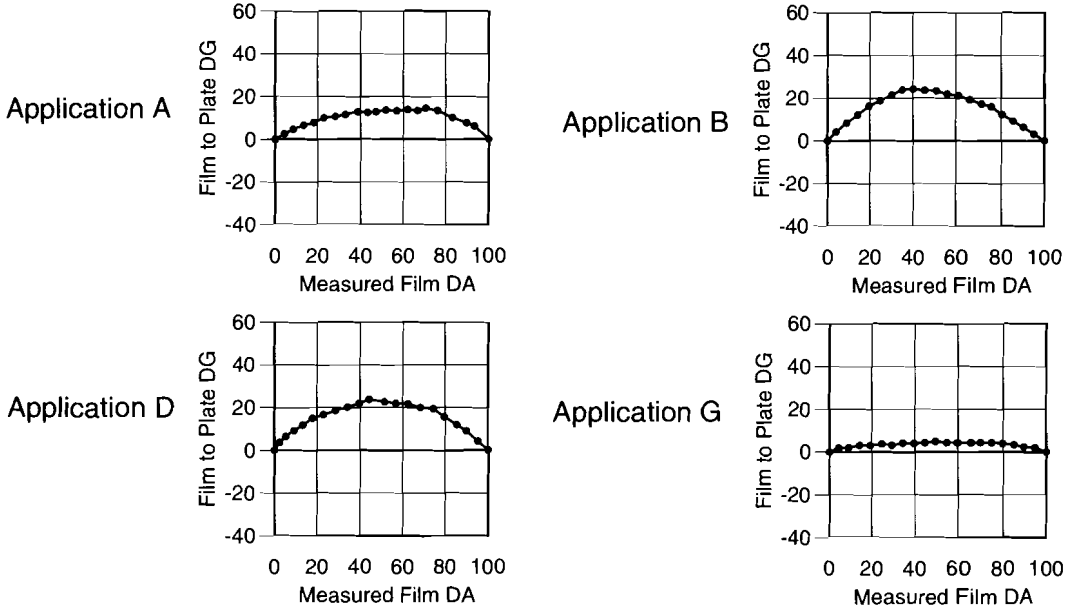


Figure 9G.
Application G

Figure 10. Negative Tint Gain Film to Plate



The maximum tint gain values are at 50% for all the applications both P and NP. Most importantly, the maximum tint gain for Negative acting applications average about 20% where the P acting material exhibits only 3% gain. In the case of Periodic screening, the Negative film to plate tint gain appears to be about 3%. The negative Non Periodic dot gain ranges from 2 to 8% vs. Periodic tint gains of 12 to 20%, depending on application and dot size.

Table 11 Gain at 50% Tint, Negative Systems.

Screening	Application	Tint	Gain*
Non Periodic	A	50%	18%
Non Periodic	B	50%	22%
Non Periodic	D	50%	21%
Periodic	G	50%	3%

* Maximum tint gain value for these curves is 50%

Figure 11 Tint Gain Response of Positive Acting Systems [film to plate]

Table 12 Gain at 50% Tint, Positive Acting Systems.

		50% Gain(at resolution:)		
Screening	Application	6 micron	8 micron	10 micron
Non Periodic	A	-12%	-13%	-18%
Non Periodic	B	-15%	-18%	-21%
Non Periodic	D	-15%	-17%	-20%
Periodic	G	-2%	-4%	-8%

Observations: Tint Gain Positive acting systems [film to plate]. Positive acting NP screened film to plate gain varies from 12 to 15% for 6 micron resolution; 13 to 18% for 8 micron resolution; and 18 to 21% for 10 micron resolution.

Tint sharpening by selected exposure can reduce the spot gain over a range of about 6%. Additional changes per application can be corrected by data file changes.

Conclusion

Negative acting NP images need input data file correction before being useful. The reason for the correction is the rate of press gain which produces tone compressed images. The tone reproduction scale (hence the tint gain) of Positive NP images can be adjusted (sharpened) during platemaking (by exposure) so that their tone reproduction more closely matches that of Positive P images. Not all Non Periodic applications react in a similar manner to sharpening. Some Positive NP images may not need more than film to plate induced sharpening to match a Positive Periodic image.

Figure 11A.
Application A

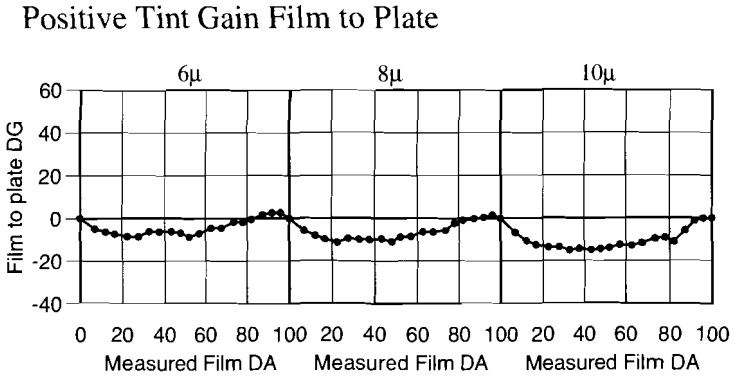
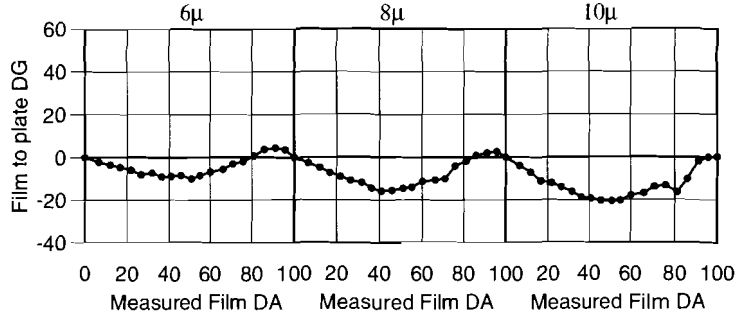


Figure 11B.
Application B



Positive Tint Gain Film to Plate

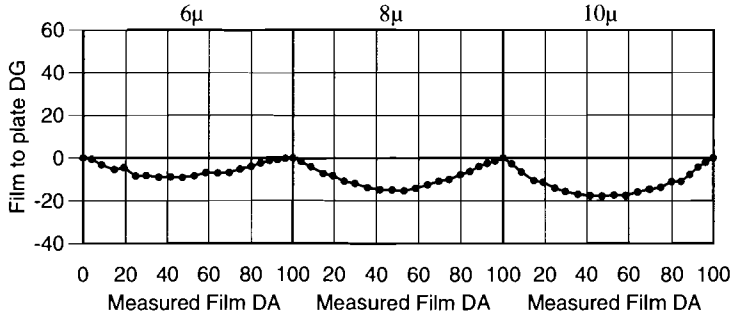


Figure 11D.
Application D

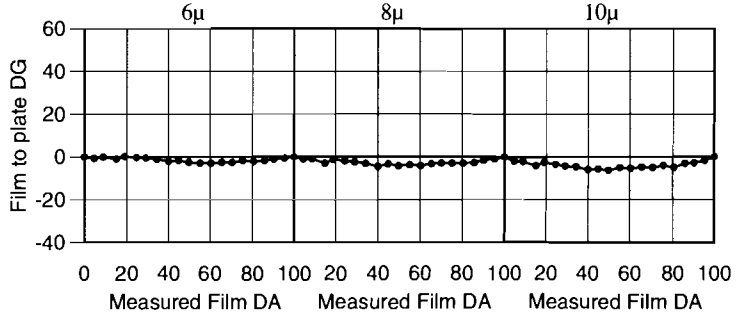


Figure 11G.
Application G

NP Positive images exhibit less tint gain and are more susceptible to sharpening than P images. Tint sharpening occurs when Positive films are contacted onto Positive acting plates. Exposure induced sharpening is an effective additional means of achieving a closer tint match from Positive NP to P images. Some Non Periodic application Positive images will need some input file compensation to match the tone curve of Periodic Positive images.

Non Periodic Negative acting tint gain curves are skewed. The tradition of reading tint gain at a 50% input tint level may be misleading. Tint Gain should be measured at the input value of highest tint gain.

Tone Reproduction (TRR) Analysis, rather than tint gain, is a better tool to determine the print characteristics of NP images. In NP Negative acting systems, the rate of change in tone values initially increases at a rapid lineal rate up to 40% tint area. At that point the rate of change becomes exponential up to input levels on average of 20%. Higher Input levels suffer compression, and produce densities from shadow to Dmax. Input data file changes are needed.

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