ANALYTICAL REVIEW FOR DIFFERENT ASPECTS OF DOT GAIN

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ABSTRACT

This document gives information about Dot reproduction, Dot gain, factors affecting dot gain, calculation of dot gain measurement and control over dot gain in different controlling parameters. Dot generation in print reproduction and different aspects which causes dot gain during image generation with photochemical process, during printing with mechanical process and during visual inspection of print dot gain is occurred. This document gives information about all causes of dot gain and controlling of causes at different levels. For the visual impact of printed image it is necessary that it have sharp and accurate colour reproduction. For accurate image generation and colour combination controlling of dot reproduction is key for result.

KEYWORDS — *Dot gain, optical dot gain, mechanical dot gain, Yule-Nielsen factor*

I. INTRODUCTION

Reproducing an image on a printing press is combined product of an artistic creativity and a scientific engineered execution. To achieve the illusion of a tone or shades of grey, artist have used effects like crosshatching or aquatints to fool the eye into thinking there is tone. Where continuous tone imagery (film photography, for example) contains an infinite range of colours or grey, the halftone process reduces visual reproductions to a binary image that is printed with only one colour of ink. This binary reproduction relies on a basic optical illusion—that these tiny halftone dots are blended into smooth tones by the human eye.

Take a spot on a photograph .Break it down into its various colour components; e.g. C-40%, M-40%, Y-40%, K-20%

To reproduce this original photograph, half tons are created. In this method, the dots are made so small our eyes cannot notice what it is actually, so we see it as continuous tone.

Review of dot gain starts with the construction of Dot, its area and density of dot under effect of ink deposition. Amount of ink affects the dot area and visual sensation of dot structure. Then actual Dot gain come in existence at the time of image generation process, the steps involve image generation added the error in dot reproduction by mechanical factors and by affecting visual appearance for optical factors. According to the factors causes dot gain in process they are measured and calculated. The calculated correcting factor is then incorporated in image generation process. While calculating consideration for Yule-Nielsen factor are need to done. It explained in Y-N factor determination of ‘n’ factor, and significance of Y-N factor while determining Dot gain on Proof and Actual Print. Result and Discussion session explain the outcome of practice and why the controlling of Dot gain is necessary. Then the future scope for development of dot gain controlling parameters and improving print quality with Conclusion of dot gain causes and controlling in print process.

II. DOT AREA(1)

Halftone dot percent (sometimes called halftone dot area) is a method for describing the relative size of the halftone dots in a screened tint or image. E.g. halftone dots which cover 25% of the area in a tint or image are referred to as 25% halftone dots. It is the ratio of amount of light reflected back or transmitted through a given halftone versus the amount of light reflected or transmitted through the solid of the same colour.

$$D_a = (1\text{-}10^{-Dt/}1\text{-}10^{-Ds})*100 \quad \textit{(Equation 1)}$$

Ds- Density of tint, Dt- Density of solid (The value of tint and solid is compared.)

III. DOT GAIN(2,3,4)

It is the increase in the size (diameter) of halftone dots. Every stage of printing contributes to dot gain. It is not bad. It will be always be there in conventional printing process. Dot gain is the growth in size of a halftone dot. E.g. 50% dot has to be printed, but after printing 67% dot printed. Then dot gain=67-50=17%

Mechanical Dot Gain

It signifies physical growth of dot. Physical dot gain is the difference in the physical size of the halftone dot from the film to the printed sheet. This is solely a result of increases (or decreases) in the size of the halftone dot during the plate making and printing process (backlash in gear) and Over exposure. The difference in speed causes the dot to elongate in the printing direction.

Types of mechanical dot gain-

a) Directional dot gain

It is due to doubling or slurring. Slur is the deformation of dots due to surface speed difference f two cylinders. Dots may elongate in printing direction. Its contribution in dot gain is only 1-2%. Dot gain is more affected by doubling. It mostly happens in multi color press. If the impression of the 1st unit doesn't exactly match the 2nd unit, then doubling occurs. This occurs due to paper stretch and gear play.

b) Non directional dot gain

It is obtained through other press related problems such as fill or improper exposure due to plate making.

Optical Dot Gain

After the dot is printed, the half tone dots printed appears larger than actually printed to human eye or densitometer, when viewed under normal viewing conditions. It is due to interactions between paper and ink. Paper being porous doesn't reflect all the 100% light that falls on it. Light gets scattered within the paper. Some of light gets trapped below the halftone dots. Hence light is absorbed by ink. The larger lateral light scattering within paper is, the larger optical dot gain amount becomes. Apparent dot area takes into account the visual effect that the substrate has on the halftone dot. Light from a reflection densitometer bounces off the substrate.

Depending on the substrate that the light reflects off, some of that light may be lost. Light may be absorbed by the paper, and some may reflect under printed areas and be lost. In some case, some of the light never makes it back. This result in a dot percent appears larger than the actual size of the measured halftone dots. It is an apparent phenomenon derived from the light which passes through halftone dots, then scatters laterally under the dots within paper, and subsequently emerges back from non-image part at periphery of the dots.

IV. MEASUREMENT OF DOT GAIN (3,4,5)

Mostly the difference between apparent dot area and physical dot area is not concerned. And in fact, if you are measuring halftone dot percent on film there is no need to worry about it at all. On film (i.e., transmission densitometer measurements), the two equations end up giving the same result. The

problem arises when you try to measure halftone dot percent on a reflective substrate. Once that happens, there are significant differences between the results that the equations give.
The dot gain calculated by densitometer is optical/visual dot gain. MURRAY DAVIES is used to calculate it.

$$D_g = (1\text{-}10^{-Dt}/1\text{-}10^{-Ds})*100 \qquad \textit{(Equation 2)}$$

Ds- Density of tint, Dt- Density of solid
It gives you more information about what the dot actually looks like on the target substrate. In addition, But if densitometer calculates dot gain by YULE-NILSON rule, the value of mechanical dot gain is obtained.

$$D_g = (1\text{-}10^{-Dt/n}/1\text{-}10^{-Ds/n})*100 \qquad \textit{(Equation 3)}$$

Where
n= empirical calculated factor
For real geometric dots are, n>1
n = a light scattering constant 30%Theoretical Physical Apparent

V. YULE – NIELSEN FACTOR (5,6,7)

Y-N factor is mathematical value which gives the correcting factor for ink reflectance readings. The reflectance of ink depends on the ink layer thickness, ink printed in superimposition with one colour or two colour, ink printed in sub-imposition with other ink, no. of ink layer printed. The physical property of ink as transparency, pigment size and dispersion also affects the ink reflectance. The ink coverage area on observed area affects the light permitted to reach at substrate. The substrate light reflectance and scattering of reflecting light affects reading of ink densitometer values. The light absorbed by substrate get transmitted and refracted by the physical construction of substrate. The transmitted light gives values for reducing intensity of reflecting recorded light and retracted light gives the added values for ink area coverage that results in error for dot gain values and density values. For the correcting factor for physical structure it is depends on microstructure of surface i.e. the smoothness of paper affects the ink coverage and density of ink film as it observed on rough surface (e.g. ink coverage, dot gain and density difference for Coated paper and Uncoated paper) Depending on surface reflectance by structure the dot gain reading have different correcting factor for image carrier (plate as it have grains – hills and valleys, gives effect on light reflectance as more light scattering and no light transmission) and substrate (paper as it have fibrous structure gives effect on light reflectance as absorbed light scattering and transmission) To compensate this correcting factor in light readings the Yule-Nielsen factor is calculated for surface reflectance. It is an apparent phenomenon derived from the light which passes through halftone dots, then scatters laterally under the dots within paper, and subsequently emerges back from non-image part at periphery of the dots.
Determining 'n' factor [5,7]
A new n factor should be determined for each type of substrate. It is just a correction factor by using n factor comparison of coated and uncoated substrate can be done. It is experimentally determined by adjusting the n factor until densitometer reads the desired value at a known dot percentage. Dot gain in the middle tone it is maximum. If densitometers used the Yule-Nielsen formula, then users would have to factor in an 'n' value for each of their substrates. This would make it much easier for errors in calculation to occur, and also make it much harder to compare measurements from a variety of substrates.

$$Dp_{apparent} = Dp_{visual} + Dp_{geometric} \qquad \textit{(Equation 4)}$$

Where,
Dp_{visual} = optical/visual dot gain
$Dp_{geometric}$ = mechanical dot gain

In general, dot gain experts recommend that you avoid using the Yule Nielsen formula unless you have very specific requirements (as in the case of calibrating on image setter paper). In terms of measuring dot gain on press, there is no such problem with transmission densitometers. Although some light may not make it through the film, this is easily compensated for. The same was true if they converted density measurements using some of the commonly used density to dot percent conversion tables, which were based on the Murray-Davies equation. 'Dot gain values refer only to an additive increase to the 50% halftone dot.' Dot gain is usually highest around the 50% halftone dot because it occurs around the perimeter of the halftone dot. Larger dot sizes (up to 50%) have a larger perimeter, and therefore are more likely to grow in size. And while a 5% halftone dot may double in size, which contributes only to a 5% increase. Beyond 50%, halftone dots have merged on at least two sides with their neighbours, so the perimeter available for dot gain begins to decrease.

Significance for Proof and Print

There is a need to measure dot gain under normal printing condition. For prints, apparent dot gain is important. In printing plates, the geometric dot spread has to be found out. Approximate average of dot gain throughout the press room is important to prepress department, it can correct dot gain problem. It is also important when press sheets are compared. Proof and printed sheets use different inks. Dot application method on proof and printed sheets is different. Pressure and adhesion technique is used in press. There is no mechanical dot gain in proofs.

VI. RESULT AND DISCUSSION

Dot gain in a print is combine result for the mechanical operations, visual effects having consent of illumination, observer and environmental condition for the controlling of dot gain on mechanical ground the generating process need to the stream line with reference to process standard. Stream lined standardized work flow précised output. The optical dot gain have major significance of individual perception of observer under all the effecting aspects related to illumination, visual capability of observer, colour perception of observer with psychological effect and environmental condition. It is necessary to have control on dot rip production parameter at each and every process stage the visual impact of printed image and so called impact factor of end product depends on the final appearance of print. The print image quality having significance of accurate dot reproduction, colour combination and end physical constrain of printed product.

VII. FUTURE SCOPE

It is impossible on a practical ground to remove all the cause of dot gain. The physical process involve in image generation, the human factor execution the process and handling the operations and working constant of equipment causes the dot gain then the process under a standard workflow.

The future scope involves:

a) Determining précised out with minimum variation with minimum limit of dot gain.
b) Defining a standard workflow and control parameters for minimum dot gain in every process cycle.
c) Reducing the economical lose in print production.

VIII. CONCLUSION

- Printing process has always under effect of dot gain having maximum effect on middle tone.
- Dot is generated due to mechanical process and optical perception of observer, and these parameters are uncontrolled due to individual mechanical and personal aspects.
- Mechanical dot gain can be controlled by Standardizing mechanical process and workflow to have Précised output.
- Optical Dot Gain is occurred because of dot area, ink density and visual constrains in Inspection.
- Light reflecting property of surface gives significant effect on dot measurement and calculation; to compensate the reflecting error Y-N factor is considered in calculations.

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