A Method for Determining Halftone Dot Area using a Calibrated Visual Reference

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Abstract: A new method is proposed for determining halftone dot areas on printing plates, which uses only a calibrated visual reference and no instrumentation. This new approach to dot area measurement removes the uncertainty sometimes associated with measuring halftones with a reflection densitometer. The calibrated visual reference consists of an exposure array of highly sensitive checkerboard targets. The key to the calibration lies in the fact that the exposures in the array differ by a factor which is tuned such that the dot area of the 50% dot will change by a known amount on the printed sheet. A visual comparison between the plate in question and the calibrated exposure array is all that is needed to confirm whether the plate is within a shop's specification for dot gain variation.

Introduction

Along with the rising popularity of Computer to Plate (CTP) systems, is the concern over how to measure the plates. As more printers have invested in CTP systems, four primary measurement techniques have emerged:

1. Densitometer
2. Hand held microscope or loupe
3. Visual target
4. Image analyzer

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Each of these techniques is capable of providing fairly reliable results, depending on the skill and the expectations of the user. Others in the field including Bartels, et al (1996), Romano (1996), Stanton, et al (1996) and Sigg (1988), have described the advantages and caveats associated with some of them. With each technique, typically there are trade-offs between cost, convenience and accuracy, with none offering all three. They do all share one thing in common: instrumentation is required. This paper will present a method of determining dot area which requires no instrumentation, while providing the aforementioned and other advantages to the user.

The research for this paper is a continuation of that done for "A Pseudo Continuous Tone Step Wedge for Digital Platemaking," Romano and Alterio (1997). The new Agfa Digital Plate Control Wedge is pictured below in Figure 1. In the previous work, it was shown that there is a direct and predictable correlation between changes in the density of a fine checkerboard pattern and a printed halftone dot area. Once this relationship is established for a platemaking system, all that is needed to determine dot area is a density measurement of the checkerboard pattern.

This can be done with the following steps:

1. Run an exposure array containing checkerboards and halftones.
2. Measure the densities of the checkerboards.
3. Print the exposure array.
4. Measure the printed halftone dot areas.
5. Plot dot area change against checkerboard density and determine the rate of change.

This provides an accurate and repeatable way to measure and monitor the system. One disadvantage is that it must be done for each screen ruling and addressability, because each will have a different amount of exposure latitude. Also, the targets must be measured with a densitometer. It would be convenient to have had this already done.

Figure 1. The new Agfa Digital Plate Control Wedge

The calibrated visual reference

In February 1998, Agfa released Galileo, a fully automated platemaking system. Bundled with Galileo is AgfaSet, a software program that is used to set up the RIP and platesetter's imaging parameters. Exposure calibration and press characterization is done using two AgfaSet programs:

1. *Exposure Calibration Test Page*: Creates exposure array. Correct exposure is found when checkerboards match. Also serves as a calibrated visual reference.
2. *Print Calibration Test Page*: Characterizes press for halftones exposed to matching checkerboards, correlating the printed results with the visual impression of the plate.

The programs' user interfaces are shown in Figures 2 and 3 and their output is shown in Figures 4 and 5.

The Exposure Calibration Test Page is unique in that it is *used not only to set exposure, but also to serve as a calibrated visual reference*, or dot area indicator. Typically, exposure arrays are discarded after the exposure is set. Most of them serve no other purpose. The operator is happy, trusting that everything is set. If a plate is suspected to be bad, one of the previously mentioned methods is typically used to measure the dot area, with varying degrees of success. If more than one operator is doing this, the results can vary to an even greater degree from one work shift to the next. As a result, halftone reproduction may be compromised and a lot of time and money can be wasted chasing down problems. What is needed is a reliable way to determine whether or not a plate should go to press, regardless of who is operating the system.

One important feature of the Exposure Calibration Test Page is that it creates exposure arrays which are calibrated to specific changes in dot area. The correct exposure is always found at the point where the checkerboards are matching. This is the reference exposure. What if the developer weakens and a week later the checkerboards do not match? How closely do they have to match? Let's assume that the plate to plate dot area variability has a tolerance of ±2%. Each step in the exposure array differs in midtone dot area by 1%. So, the operator marks off the 2 steps above and below the correct exposure. As long as the checkerboards on the production plate appear to fall within this range, and no highlights are lost, the plate is acceptable. See Figure 4.

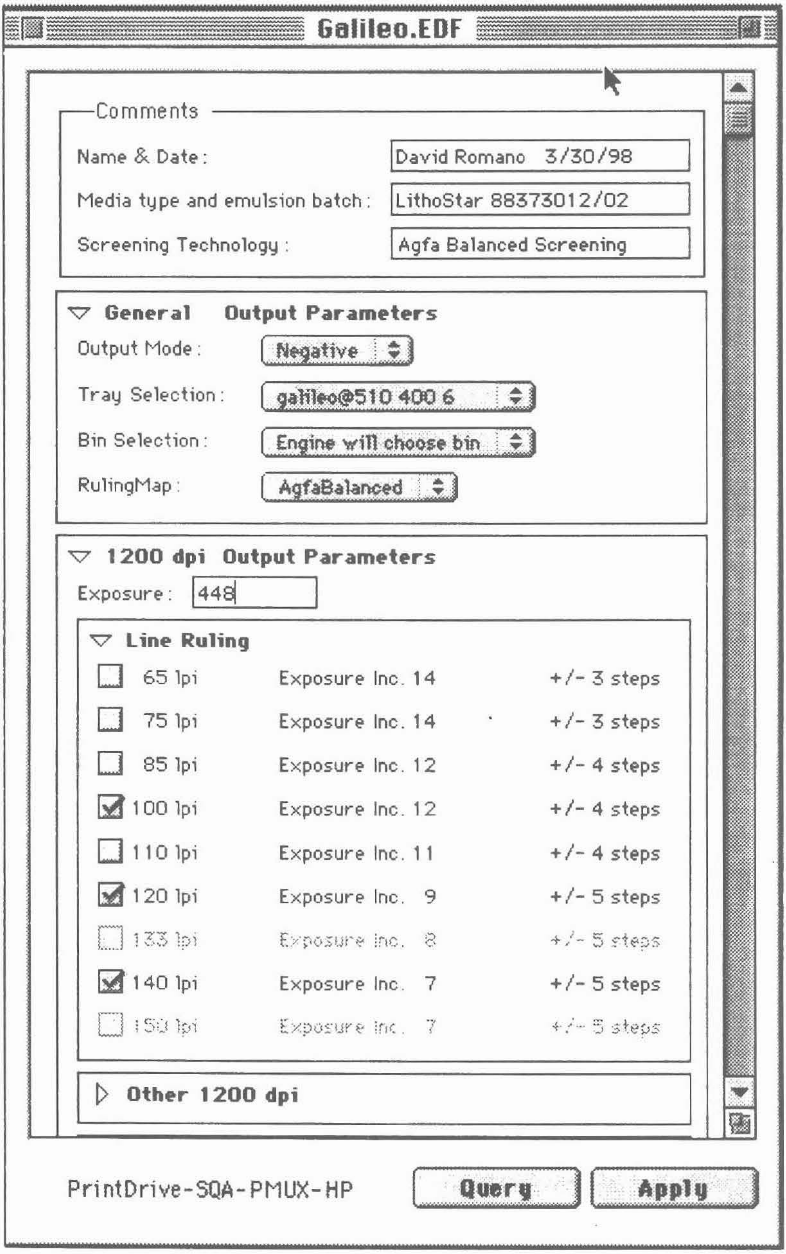


Figure 2. The AgfaSet Exposure Calibration Test Page is used to generate exposure arrays for multiple resolutions and screen rulings on a single plate. Each screen ruling is assigned a different exposure increment.

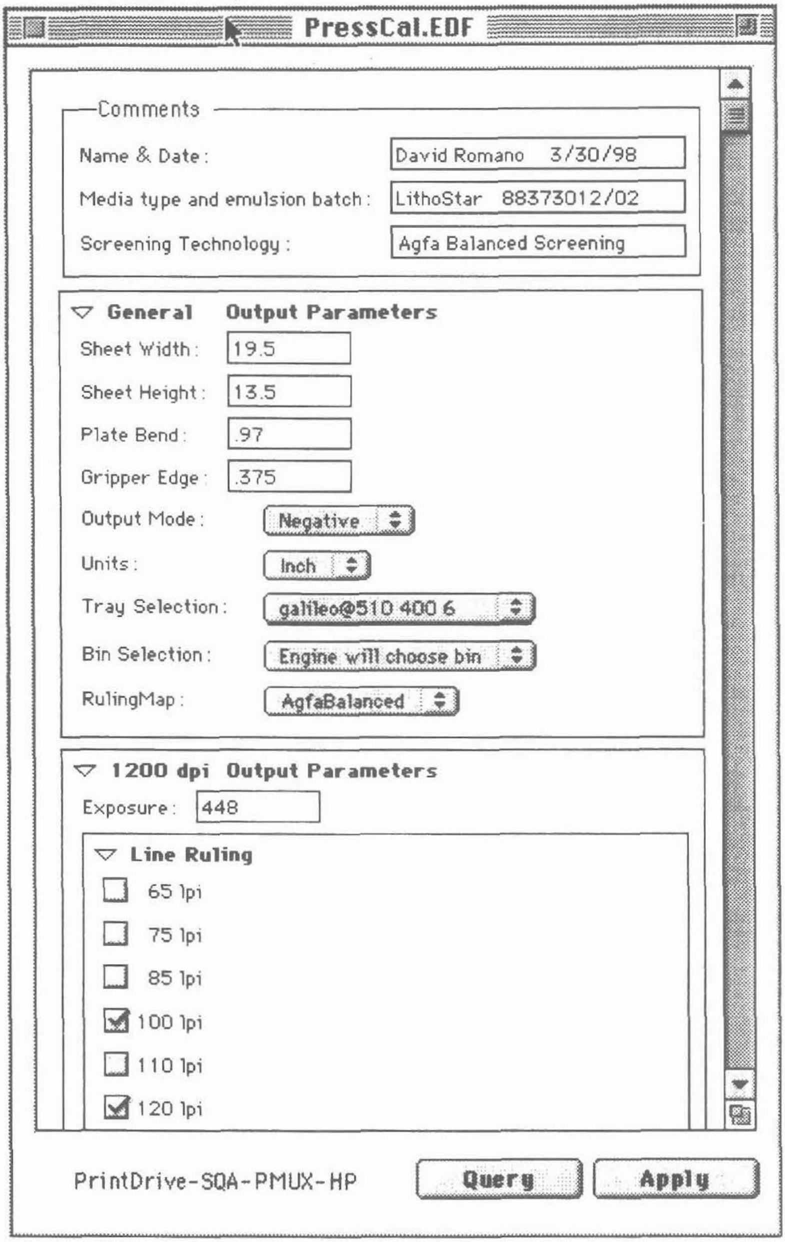


Figure 3. The AgfaSet Print Calibration Test Page produces a set of 4 separations for press characterization. It allows multiple resolutions and screen rulings to be characterized with a single press run.

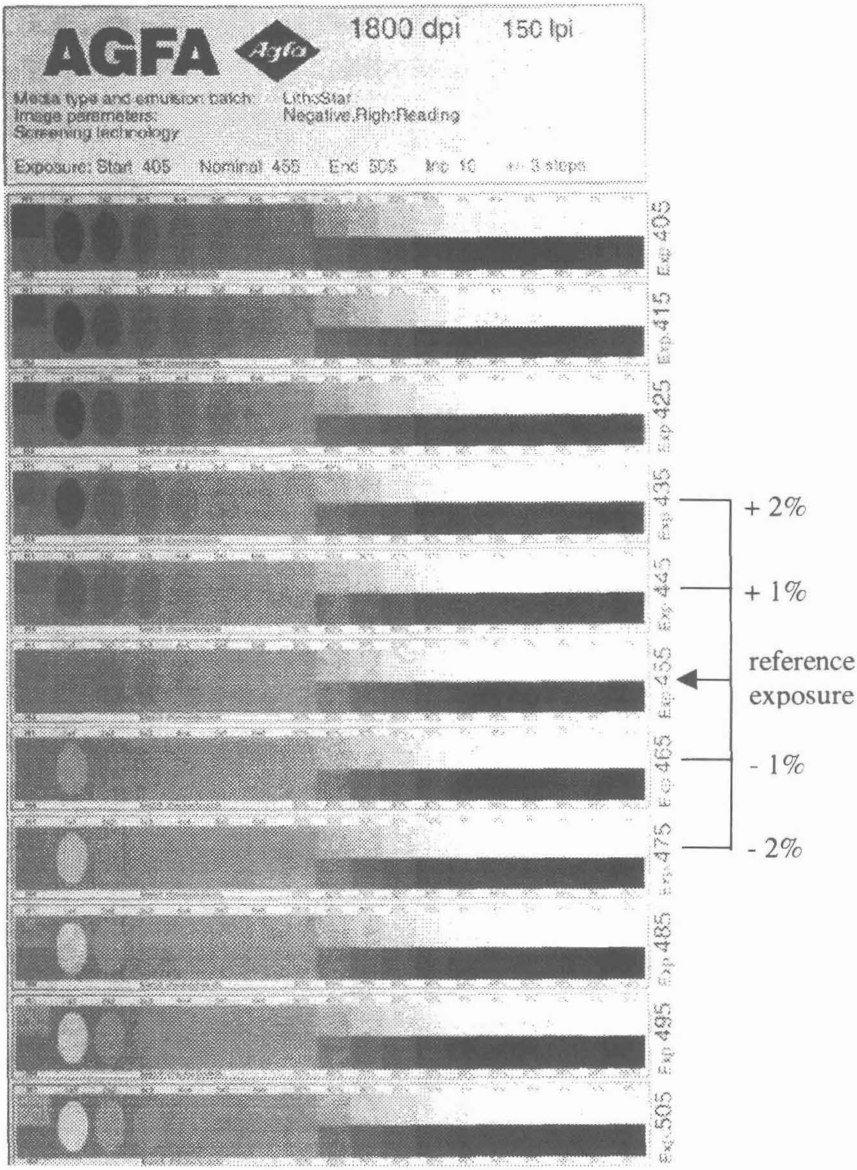


Figure 4. The AgfaSet Exposure Calibration Test Page. The steps are calibrated to provide a 1% change in midtone dot area. The platemaking dot area tolerance can be easily marked off, defining the acceptable range of checkerboard densities. This enables the exposure array to visually indicate dot area, without instrumentation.

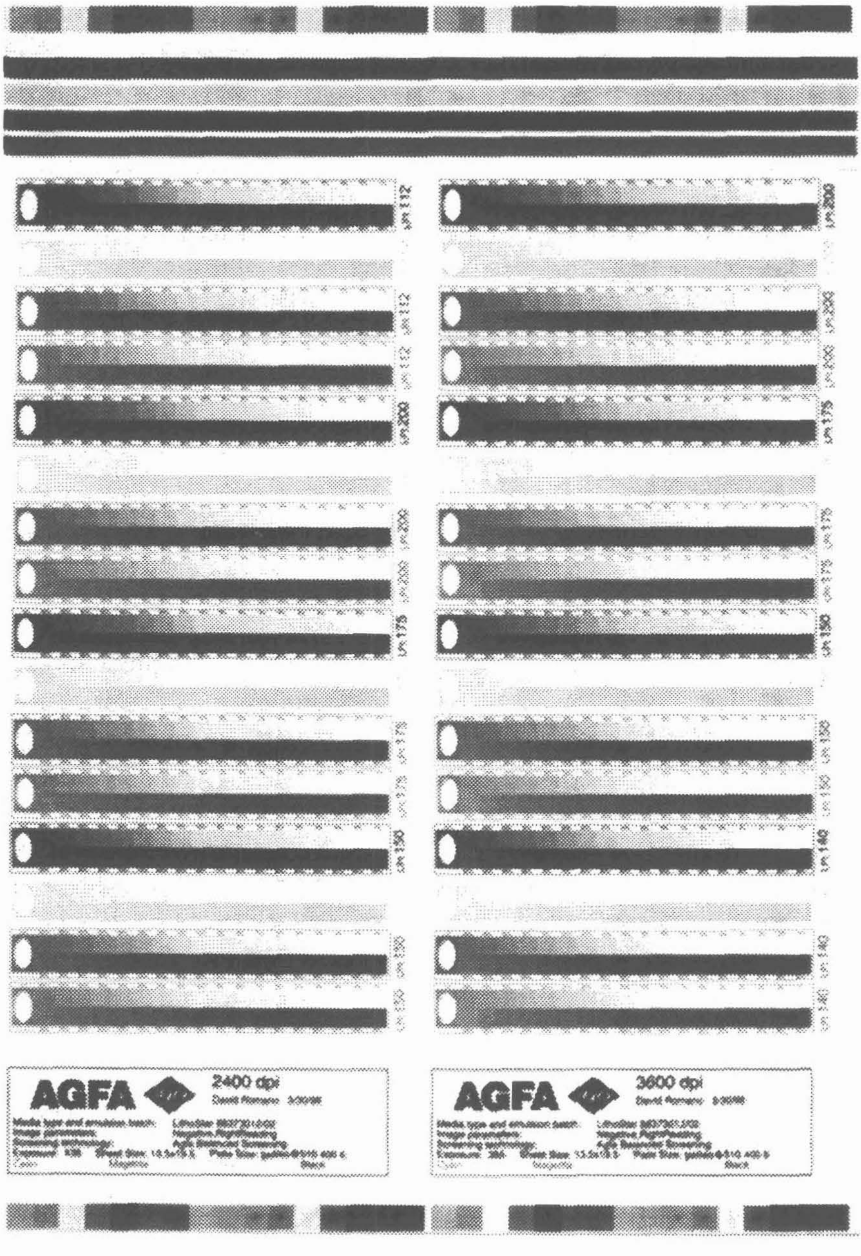
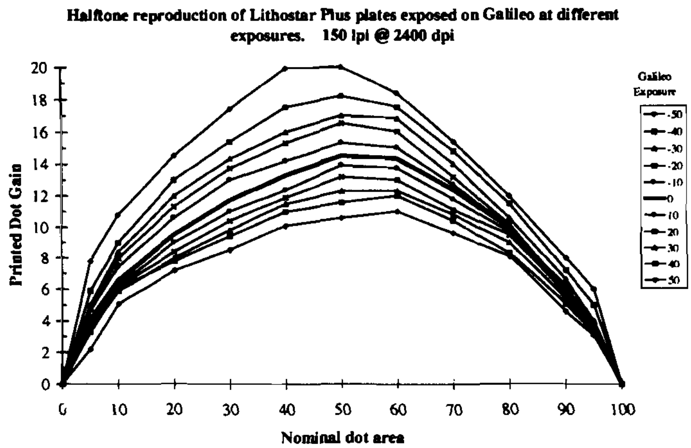
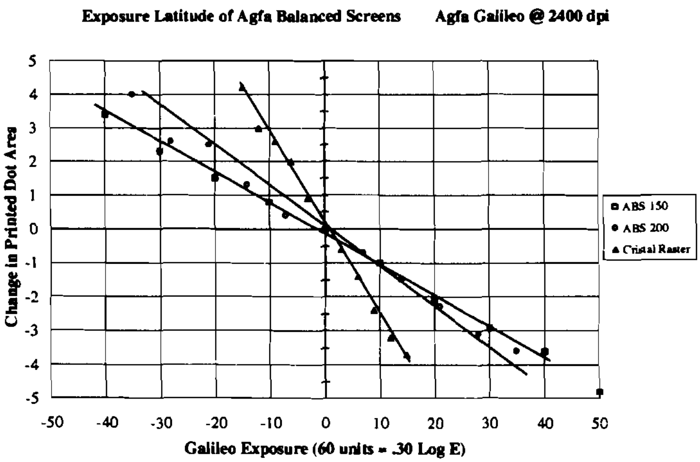


Figure 5. The AgfaSet Exposure Calibration Test Page press sheet. Multiple addressabilities and screen rulings can be characterized with a single press run.

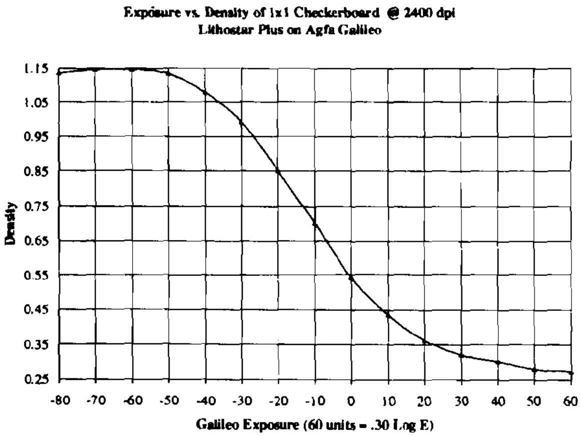
The calibration of the exposure array lies in the increment used in the exposure array. Figure 6 demonstrates how halftone reproduction changes with exposure. Figure 7 illustrates that this relationship is different for different screen frequencies. This means that the exposure array must use a different increment in order to calibrate the exposure array for each screen frequency. To affect a 1% change in dot area at 150 lpi, the exposure must be changed by about 10 units, but the same 10 units would change Cristal Raster by about 2.5%.

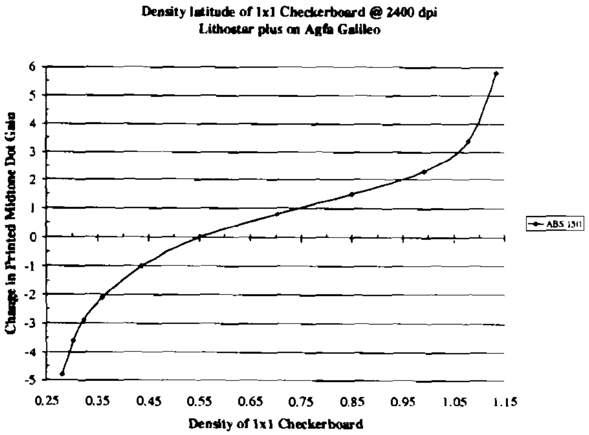




Figures 6 and 7.

As seen in Figure 8, exposure not only changes tone reproduction, it also changes checkerboard density. The 1x1 checkerboard is much more sensitive than a halftone dot and can be evaluated visually. Checkerboard density is a good indicator of exposure, which, in turn, has a direct effect on tone reproduction. All that is needed to monitor the accuracy of the tone reproduction is a checkerboard target. This is done by placing a single exposure target in the bend of each production plate. A visual comparison between the checkerboard densities on this plate with those on the exposure array will indicate whether the plate is acceptable. Figure 9 shows that checkerboard density can vary a great deal and the plate will still be within a spec of ± 2% dot area.





Figures 8 and 9

Implications

The current trend towards CTP systems is forcing both users and manufacturers to rethink quality control. Operating at a cost of several hundred dollars per hour, the press is the wrong tool for detecting problems with tone reproduction. It is the job of the prepress calibration and of color management to send the correct halftone dot information to the platesetter, and of the platesetter to image exactly what is asked of it. The platesetter is the last of several prepress steps involved in halftone reproduction. Without knowing the limitations and variability of each of each step, halftone calibration and color management are not possible.

Before CTP, printers measured their imagesetter films before making a plate. The old tools for measuring film are no longer useful for CTP and the industry is still struggling for a reliable replacement. The real advantage to the calibrated visual reference method that its simplicity and high sensitivity make it more likely to used correctly. A standardized procedure in which an exposure target is imposed on every plate, and is then compared to the exposure array for dot area accuracy, will insure that a bad plate never goes to press.

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