A Tone Reproduction Study of Desktop Publishing Images When Printed by Direct Laser Exposure and Conventional Contact Means

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Abstract

The impact of electronics has changed the face of communication. Nowhere has this become more apparent than in the field of digital communications. The decade of the 80's was the decade of the computer and the laser. The limited computer power available to the people has been increased beyond the hopes of the first PC makers. Any new exposure source is, of course, of interest to those involved in imaging. A coherent source like the laser is of vital interest to the graphic arts.

Initially, the devices that implemented these two innovations were incorporated into large devices available only to a select few. Today with the scale-down in size and dollars made available from material research and production quantities, personal computers and laser diode exposing sources are available to most all of us.

Questions have arisen concerning the comparative image quality of some of the steps employed by desk top publishing compared to the traditional steps in the reproduction chain. This paper explores the tone reproduction cycle of some aspects of desktop as compared to conventional printing. Specifically detailed is the differences between electronic image file fidelity and direct-to-plate imaging. The major study tool will be the study of tone reproduction in offset positive printing as represented by the 'GRATR' analysis technique.

Introduction

Considerable literature exists concerning the tone reproduction ability of conventional print processes such as offset lithography and gravure. Newer devices and techniques based on the use of personal computers and lasers are now being implemented. Input images no longer need to be hard copy transparencies or art. Films no longer are necessary to make printing plates. No literature exists on the tone reproduction cycle when these new steps or short cuts are employed.

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Lately reproduction analysis tools have been employed to enable this study to be more effective and less time consuming. Last year such a technique termed 'GRATR', Graphic Regression Analysis Tone Reproduction, was presented at the TAGA annual meeting. It is the object of this paper to apply that technique to aspects of the desktop publishing reproduction chain--specifically, the study and comparison of the tone reproduction of the offset printing technique when electronic images are output by imagesetter and then printed by means of contact exposure to metal plates.

Experimental

Materials

The following hardware items were used:
1. Apple MacIntosh IICX computer
2. Linotype Postscript RIP 3
3. Linotronic 300 imagesetter

The computer software employed consisted of:
1. *MacScan* by New Image Technology, Inc.
2. *Freehand* by Aldus
3. *Linotype Calibration Utility for Linotype Imagesetters*

Photosensitive software included:
1. 3M Brand HeNe imagesetting film
2. 3M Brand Onyx HeNe imagesetting plate (polyester base)
3. 3M Brand Onyx camera speed plate (polyester base)
4. 3M Brand Viking SE Printing Plate (metal)

Image Generation and Manipulation

An electronic image was constructed in Aldus Freehand that includes both a computer generated target image and practical photograph. The practical was scanned using MacScan from a continuous tone original. It was linked to the Freehand page and output as three separate images. These were designated to be output at 100, 133, and 150 lpi. The computer generated image consists of 100 tint patches in 1% dot increments. Aldus Freehand was used to assign dot percentages to these patches at 150 lpi. The test target part of the image consists of 100 patches covering a range of 0-100% dots in 1% increments at a screen frequency of 150 lpi.

The L300 imagesetter (operated at the medium resolution setting of 1270 lpi) was loaded with 3M imagesetting film and calibration test images were exposed using a Linotype Calibration Utilities program and processed in rapid access developer.

From this exposure series, an L300 density setting was determined by selecting the exposure test patch that exhibited specific attributes. The targeted attributes included the following: a Dmax density of 3.00 or above in a solid imaged area, loss of scan lines, and ability to hold small dots at both ends of the dot range.

Having set that exposure into the L300, a grey scale was exposed and developed. A Gretag D200 transmission densitometer was used to read this grey scale and percent dot areas were determined for each step. These dot areas were then entered into the Linotype Calibration software which calculates a transfer curve from this data. This curve was then downloaded to the RIP(raster image processor). This transfer curve serves to linearize the device/film output to achieve linearity and dot size predictability. As is evident, this transfer curve is specific to the device, photosensitive material, developing conditions, output resolution and output phase(negative or positive). For best results such linearizations should be done daily as in a conventional scanner system.

Final Electronic File Output

Once the imagesetter was calibrated for correct exposure and linearized for the output conditions, the final electronic image file was downloaded from the computer to the imagesetter and exposed onto 3M Brand HeNe imagesetting film and then developed. The calibration and linearization procedure was repeated for both positive and negative output.

A 3M Brand Onyx imagestter printing plate was also set into the L300 and the above described procedure was also carried out for the plate material in a negative imaging mode. This produces an image on Onyx such that the ink receptive area is the D-Min portion.

(In all cases, the output was not modified from linearization by any user curve. In addition the transfer curve option within Freehand was set to 'default').

Conventional Image Output

The negative film image was used to expose a 3M Brand Viking metal printing plate and the positive film image to contact expose an Onyx polyester printing plate.

Final Electronic File and Conventional Image Hard Copy Evaluation

A Gretag D200 transmission densitometer was used to measure percent dot areas of the negative and positive films on the test target grid. An X-Rite 309 reflection densitometer was used to measure the Onyx images. Measurements were recorded for zero to 100% dot levels in five percent increments. The metal plate was measured with a Bausch and Lomb Omnicon image analysis system.

Final Press Printing and Analysis

The three plates (Onyx direct imagesetter exposed, contact exposed Onyx, and metal plate) were used to print a black single color ink-on-paper image. All three plates were run on a Multi 1360 Offset Duplicating Press onto 60 pound paper. All three were printed to an ink solid density of 1.35. The percent dot area ink-on-paper images were analyzed using reflection densitometry.

Results

A tone reproduction diagram of the type described by Fisch [1] in last years proceedings based on Graphic Regression Analysis Tone Reproduction or 'GRATR' (Figure 1) will be used for the analysis of the tone reproduction cycle for the electronically generated images under study. When using the 'GRATR' diagram, please note that some tiles graphically depict specific steps in the tone reproduction chain and some of the tiles depict the interaction to move from one step to the next. Those tiles that have a background tint are the interaction steps and may be mathematically expressed as regression equations. In a reproduction step which has no change, the interaction tile would have a straight line at a 45 degree angle indicating dot-for-dot reproduction.

In the above traditional tone reproduction 'GRATR' diagram, the original is a continuous tone grey scale on Ektachrome film. Note that most all interactions have a curve and not a straight line.

Contact Imaged Onyx Image

The contact imaged polyester plate 'GRATR' tone reproduction is shown in Figure 2. This tone reproduction exhibits nearly no change in the first imagesetting step *when the process is linearized.* The dot sizes on the film positive are virtually the same as the original. In the 'Film-Plate' interaction there is a small change due to contacting. The largest change is due to press gain.

Metal Plate Image

The contact imaged metal plate condition is shown in Figure 3. In this case the imagesetter output was film negative. Again, when linearized, the imagesetter interaction(electronic original dot size versus film dot size) falls on a 45 degree line. In this particular case the film to plate interaction step also exhibits minimal change from a dot-for-dot reproduction. All the changes occur in the press step.

Direct Imaged Onyx

This 'GRATR' reproduction depiction (Figure 4) has only two interactions. The imagesetter interaction tile represents neglible change. The press dot gain of course changes the image.

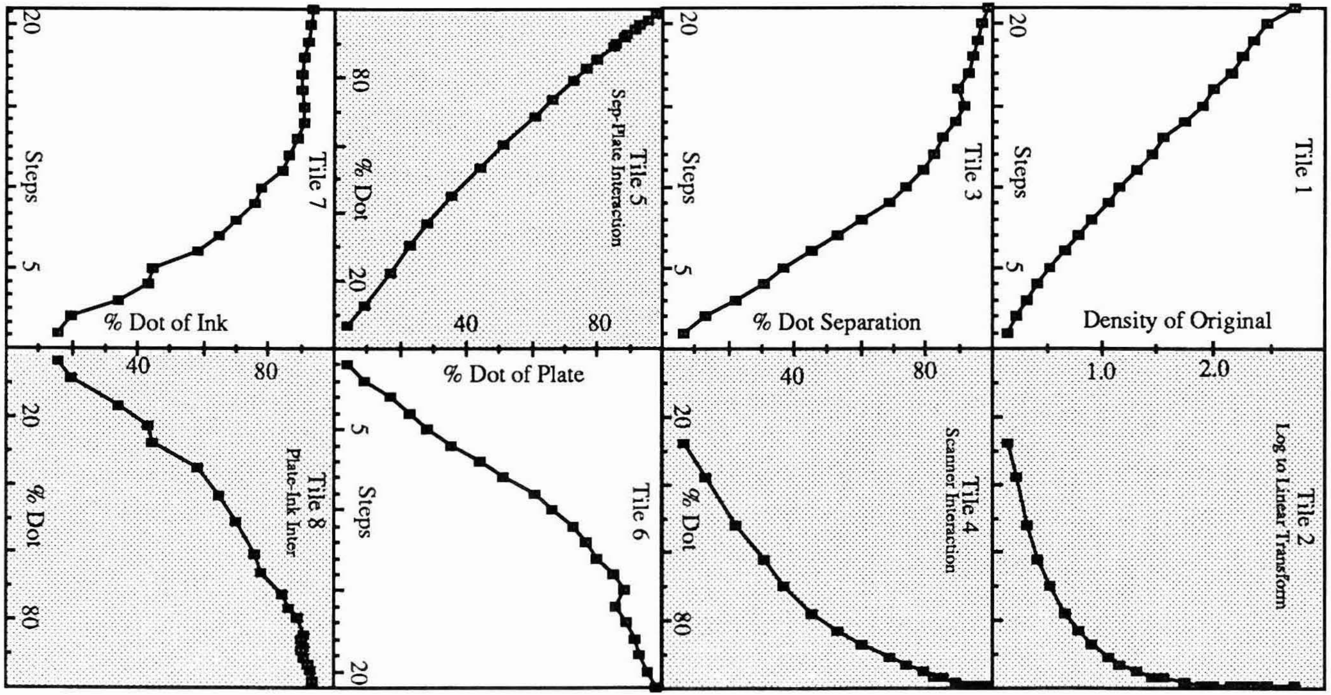


Figure 1

A 'GRATR' Model Representation of the Conventional Web Offset Printing Process

Red Separation, Cyan Image

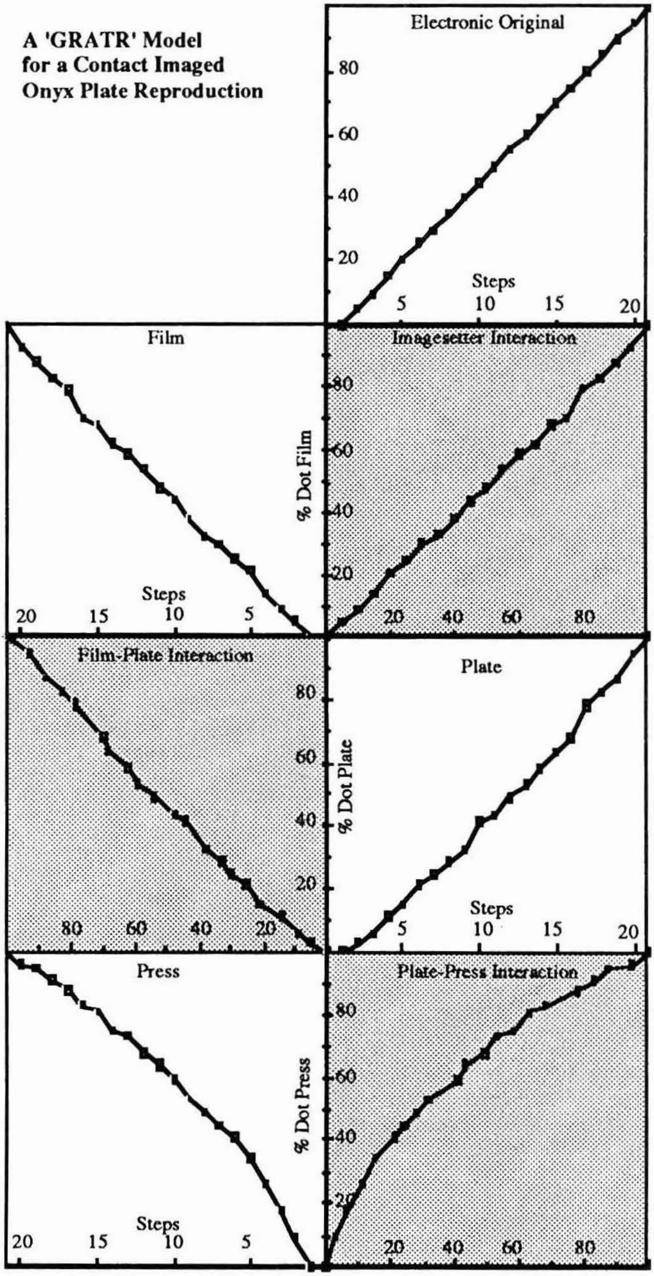

A 'GRATR' Model
for a Contact Imaged
Onyx Plate Reproduction
Electronic Original
80
60
40
20
Steps
5 10 15 20
Film
Imagesetter Interaction
% Dot Film
80
60
40
20
Steps
20 15 10 5
20 40 60 80
Film-Plate Interaction
Plate
80
60
40
20
% Dot Plate
80 60 40 20
Steps
5 10 15 20
Press
Plate-Press Interaction
% Dot Press
80
60
40
20
Steps
20 15 10 5
20 40 60 80

Figure 2.

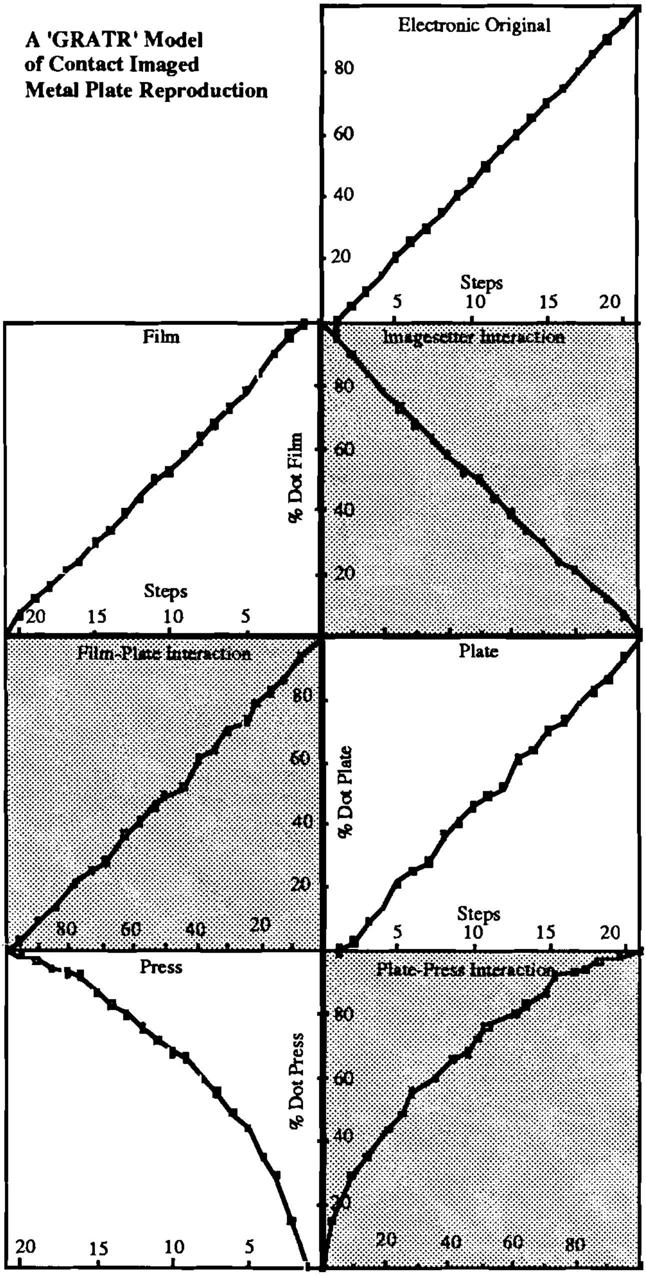

A 'GRATR' Model
of Contact Imaged
Metal Plate Reproduction
Electronic Original
80
60
40
20
Steps
5
10
15
20
Film
Imagesetter Interaction
% Dot Film
Film-Plate Interaction
Plate
% Dot Plate
Press
Plate-Press Interaction
% Dot Press
20
40
60
80

Figure 3.

A 'GRATR' Model of Direct Onyx Imaged Plate Tone Reproduction

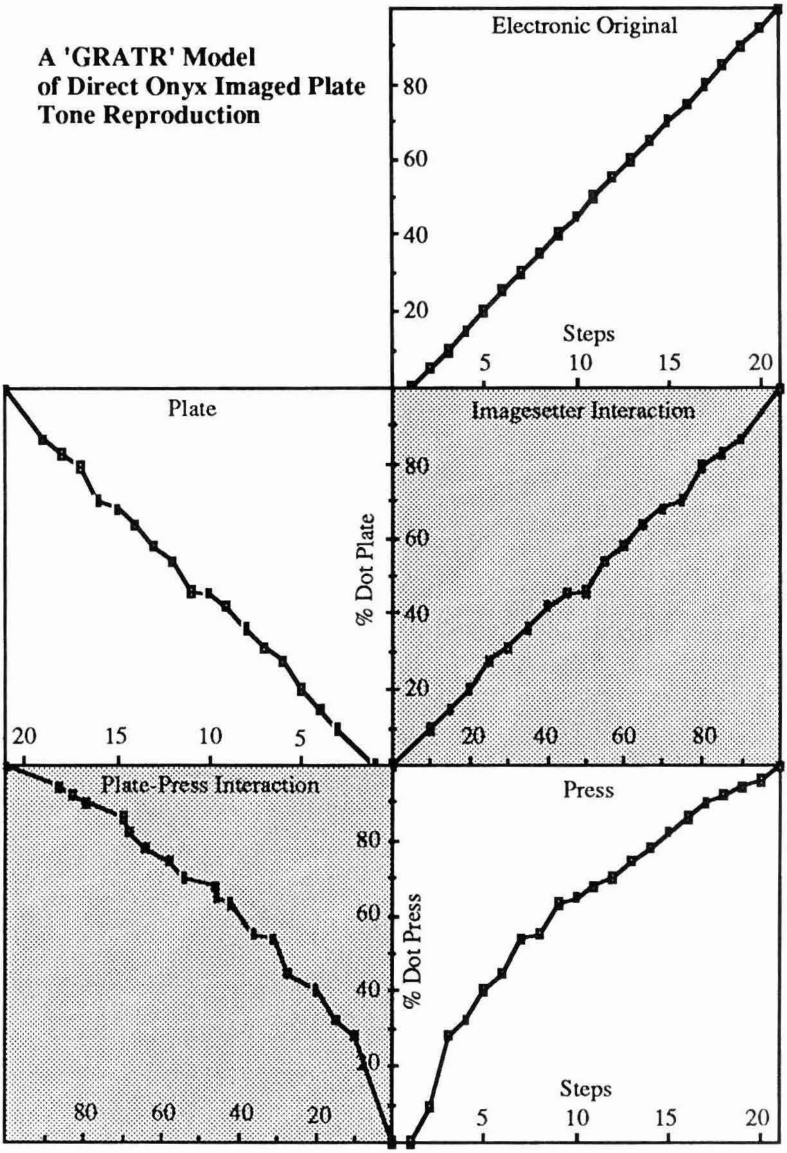


Figure 4.

Interactions

The interaction steps for the three imaging conditions are compared in figures 5 to 7. It is obvious that in a linearized system, file fidelity is maintained through the first electronic-photosensitive material interaction step. In the contacting-plate step, minimal change is evident. The only change is one imposed by the press fingerprint. Therefore, by following a 30% original dot through the reproduction chain, the change from dot-for-dot reproduction.response is dot gain.

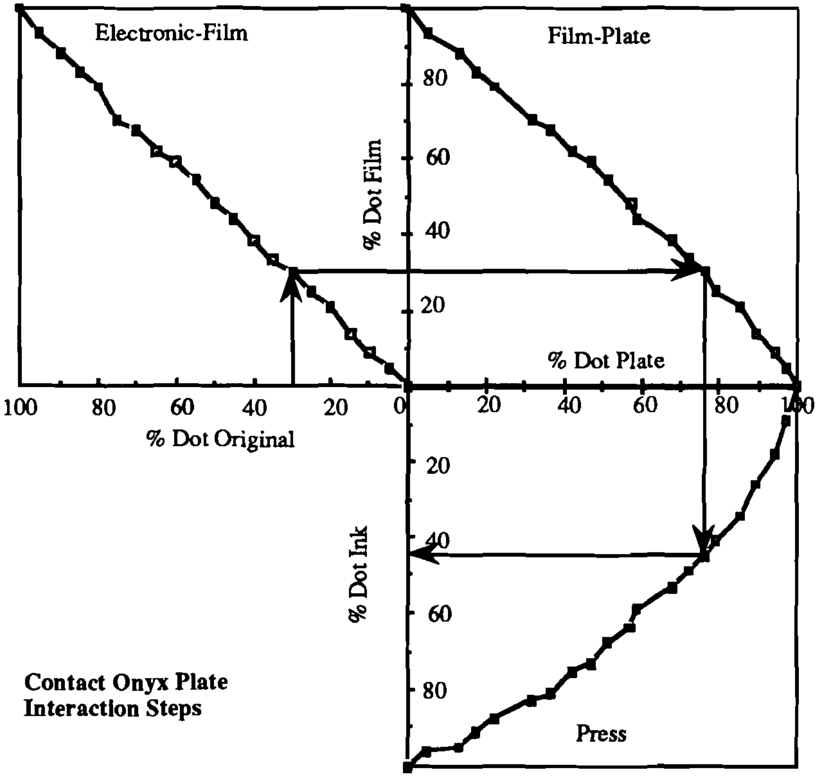


Figure 5.

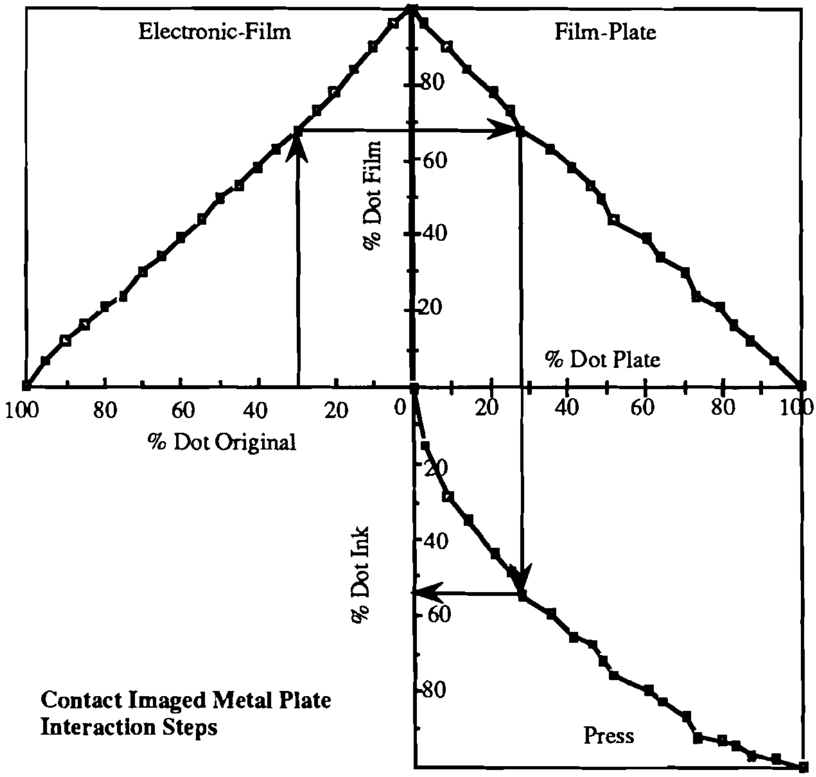
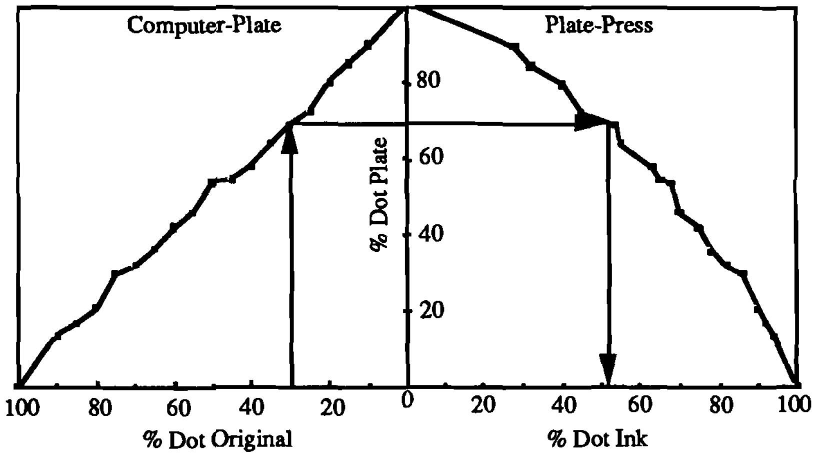

Electronic-Film
Film-Plate
% Dot Film
80
60
40
20
% Dot Plate
100
80
60
40
20
0
20
40
60
80
100
% Dot Original
20
40
60
80
% Dot Ink
Contact Imaged Metal Plate
Interaction Steps
Press

Figure 6.



Direct Imaged Onyx - Interaction Steps

Figure 7.

Figure 8 plots the dot gains for all three printing conditions. These dot gains exhibit dot gain for the total process(ink-on-paper dot size minus original). Although the plates were all printed on the same press, by the same operator, to the same density, each condition exhibited a different dot gain curve.

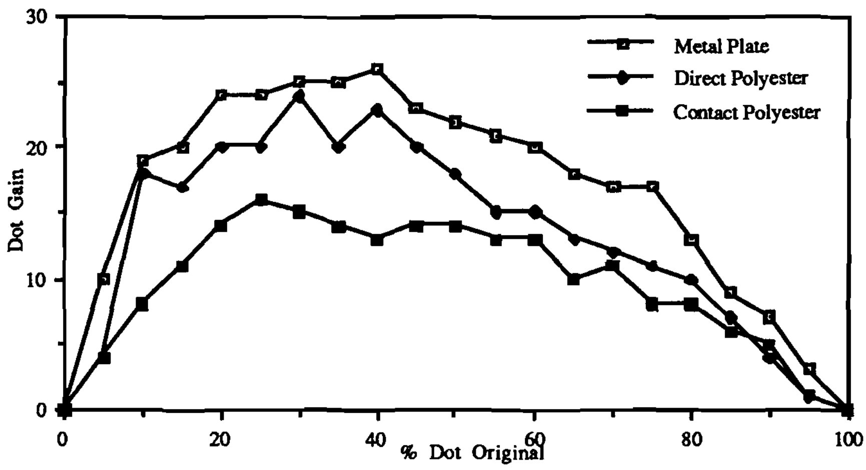


Figure 8. Dot Gain (Final ink-on-paper minus original)

The regression equations for the above interactions are presented mathematically in Table 1.

Table 1

Contact Onyx Plate Reproduction				R-sq
Electronic-Film	y= -0.260	+0.979 x		99.9
Film-Plate	y= 104.63	-1.032 x		99.5
Plate-Press	y= 97.05	-0.155 x	$-.007x^2$	99.3
Contact Metal Plate Reproduction				
Electronic-Film	y= 98.537	-0.980 x		99.9
Film-Plate	y= 99.11	-1.007 x		99.8
Plate-Press	y= 9.4651	+1.708 x	$-.008x^2$	98.9
Direct Plate Reproduction				
Electronic-Plate	y= 99.136	-0.967 x		99.6
Plate-Press	y= 97.872	-0.229 x	$-.007x^2$	98.9

To assume that all imagesetters are set-up to give file fidelity will cause unpredictable or unwanted results. For example, the test image used for this test was sent out to be printed. No specific instructions were given except to be printed at their normal set-up. The result from one such place (Site X) is presented here to show how final image can be affected. The output was on 3M imagesetting film as a positive and at medium resolution. These are the same conditions used for the contact exposed Onyx plate condition followed in this paper. The dot gain on film is depicted in Figure 9.

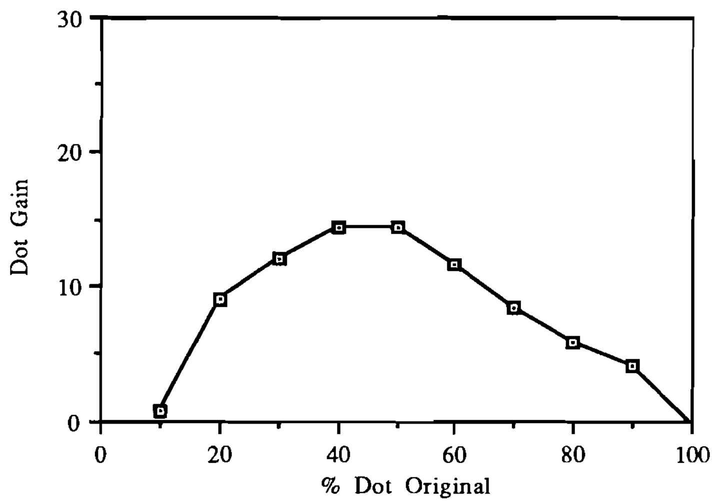


Figure 9. Site X Dot Gain on Film Positive

If this Imagesetter interaction for Site X is replaced in the tone reproduction chain of Figure 5, the following graph(Figure 10) could be expected assuming that the plate and press interactions would be the same. By following the arrows from an original 30% dot through the interactions, the resultant ink-on-paper dot size would be 58 compared to 44 in a linearized system.

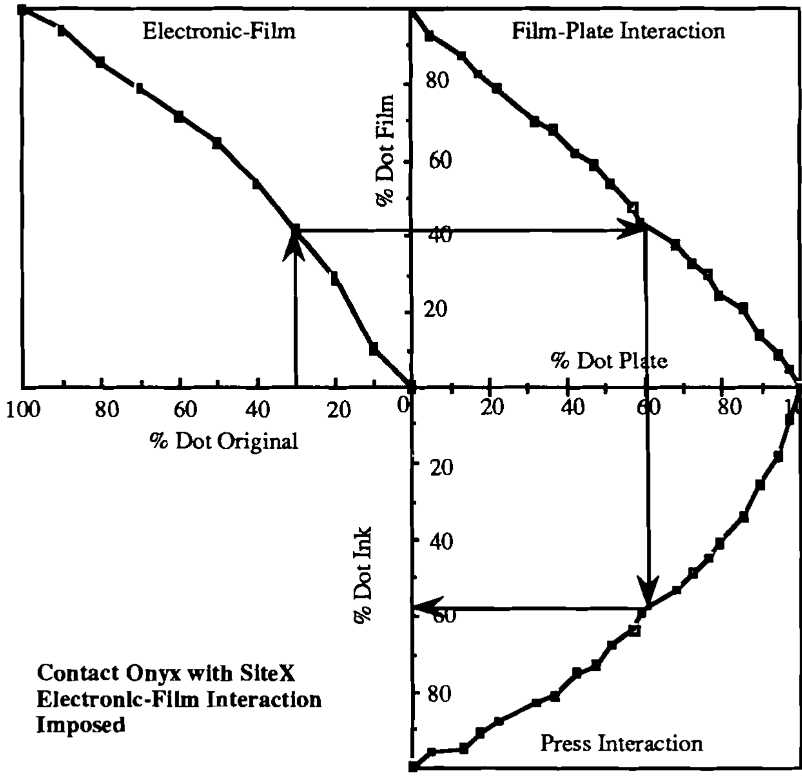


Figure 10.

Conclusions

When the reproduction cycle of imagesetter images is followed, two distinct originals must be considered albeit separately: the traditional image (transparency or flat art) and a computer generated file image. The traditional image may indeed be inserted into the existing computer generated file image. The original image involves consideration of many variables including original art contrast and paper, exposure range, image color, etc. The computer generated images has its own set of interactive considerations. These include input equipment and considerations, software considerations, and output capabilities.

The characteristics of an original image can easily be characterized by density units(a logarithmic scale). The electronic file is a more nebulous undefined grey scale level consisting of a series of bits. Software and other program considerations enable us to define these electronic images in a relative way and assign percent dot values to them. However these dot percentages are not as rigidly defined as the physical dot on film.

This paper has demonstrated a procedure developed by one imagesetter manufacturer (Linotype) to define that dot size on film when dealing with electronically created images. Linearization is the means to predictability in the desktop environment. The tone reproduction cycle was illustrated using the 'GRATR' technique for linearized systems as well as one example of a non-linearized system This is the basic building block of the total integrated desktop publishing system.

Literature Cited

1. Fisch, R.S.
1989. "'GRATR', A Tone Reproduction Model; Illustrating the Conventional and GCR Offset Lithographic Web Printing Process," Annual Proceedings TAGA, pp. 387-415.