The Influence of Dot Area and Ink Density on the Lithographic Process

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ITGRA 182 – 001 Offset Lithography
April 26, 2007

INTRODUCTION

PROJECT OBJECTIVES:

- To develop an understanding of how and when dot gain/sharpening occurs during the lithographic process, and how it can impact the quality of the finished product.
- To learn why and how the density and dot areas of different materials are measured and compared with each other.

BACKGROUND INFORMATION:

- Dot gain is said to have occurred when the halftone/screen-tinted dots in the image area are enlarged during the transferring process. This results in a subsequent darkening of ink coverage on the final print.
- Similarly, dot sharpening occurs when the area of the dots shrinks to a size smaller than originally intended. This results in a subsequent lightening of ink coverage on the final print.
- At any time during the lithographic process, the dots making up halftone patterns and/or screened-tints are subject change. Each time that an image is transferred from medium to medium, there is the possibility of dot gain or dot sharpening.
- Dot gain/sharpening that occurs during the image's transfer from digital output to film can occur from incorrect exposure time and from incorrect screening of the image. The exposed film being measured was created with a computer-to-film exposure unit, so the negative should be free from any problems relating to human error.
- Dot gain/sharpening that occurs during the image's transfer from film to plate can occur from a variety of things, including incorrect exposure, insufficient vacuum seal which causes the exposure light to spread out over a larger area, and/or processing errors.
- The majority of dot gain/sharpening occurs during the printing of the image. There are many potential causes for the dots' change in size during this stage, such as, the amount of ink applied to the plate, the receptiveness of the paper, the quality of the ink, etc.
- Another factor that must often be accounted for is the number of lines used in the screen. Common numbers of lines in halftoned or screened images typically range from 85-200. Fewer lines usually result in a lower quality print, as the resolution of the image or type has fewer dots to be translated to which results in an image with less detail. Higher line counts can reproduce finer details, because there are more dots overall to represent the image.
- Lower line screens were traditionally used in the newspaper industry, as the lower quality was more accepted in the generally one-time-use product. It is not uncommon, however, to see newspapers printing with higher screens due

to the advancements in lithography and its dominance of the market. Higher screens are used to produce magazines and fine art prints.

- Ink density can vary widely across the press sheet, due to maladjustment of the ink keys and from the depletion of ink available to the plate when there are large image areas close together.

MATERIALS & EQUIPMENT:

- Screen Tint Guide
- Test Pattern Negative
- Exposed Plate
- Finished Press Sheet
- X-Rite 528 Reflection Densitometer
- Gretag D-200 11 Transmission Densitometer

PROCEDURE

MEASUREMENT GATHERING

- Measure and record the dot area (coverage) film with transmission densitometer at the following screens:
  - 80, 100, 110, 133, 150, 200
- Measure and record the same screens on the processed plate with the reflection densitometer.
- Measure and record the same screens on the finished press sheet with the reflection densitometer.
- Measure and record the ink density on the black test area of the press sheet with the reflection densitometer. Take six measurements evenly spaced across the page.

EVALUATION:

- Compare the readings from the negative, plate, and press sheet.
- Address whether the dot size changed from material to material.
- Note how dot gain/sharpening varies and relates according to the luminance of the image area (highlights, midtones, or shadows).
- Determine how different line screens are affected by dot gain/sharpening.
- Examine to what extent density has on dot area of the final product.

REPORT

RECORDED MEASUREMENTS

Dot Area: Film Negative

10	20	30	40	50	60	70	80	90
10	20	30	39	49	59	70	80	90
10	20	30	40	50	60	69	80	89
9	20	30	39	49	60	69	80	89
9	20	29	39	48	59	69	80	90
9	20	28	39	48	60	70	80	87

Dot Gain: Computer to Film

0	0	0	0	0	0	0	0	0
0	0	0	1	1	1	0	0	0
0	0	0	0	0	0	1	0	1
1	0	0	1	1	0	1	0	1
1	0	1	1	2	1	1	0	0
1	0	2	1	2	0	0	0	3

Dot Area: Plate

9	22	33	47	56	67	75	83	90
14	22	32	47	55	66	77	85	91
10	25	38	52	59	68	79	85	92
12	23	32	48	60	67	76	83	92
8	22	36	47	59	68	76	84	93
7	22	35	49	62	68	76	84	89

Dot Gain: Negative to Plate

-1	2	3	7	6	7	5	3	0
4	2	2	8	6	7	7	5	1
0	5	8	12	9	8	10	5	3
3	3	2	9	11	7	7	3	3
-1	2	7	8	11	9	7	4	3
-2	2	7	10	14	8	6	4	2

Dot Area: Press Sheet

30	44	56	68	78	83	83	88	92
31	48	59	69	77	84	83	89	92
30	54	65	73	81	89	84	89	92
31	51	65	76	85	88	86	88	94
28	59	70	78	86	91	88	91	92
35	55	71	81	89	83	90	92	96

Dot Gain: Plate to Print

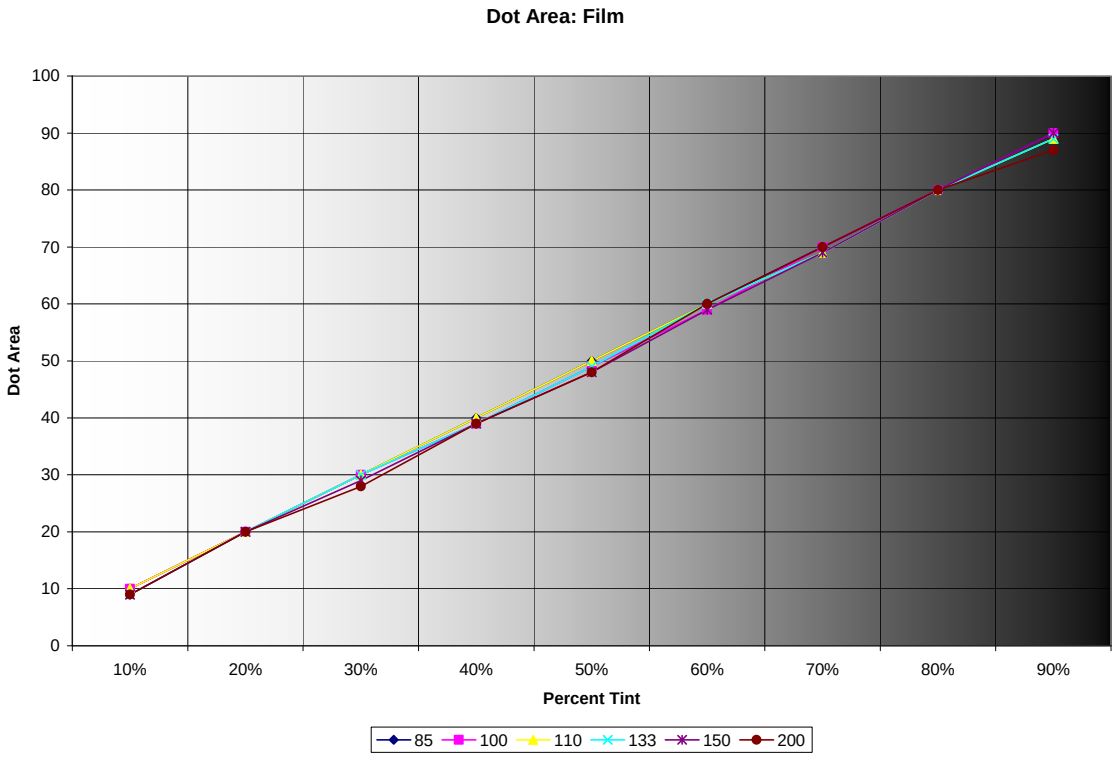
21	22	23	21	22	16	8	5	2
17	26	27	22	22	18	6	4	1
20	29	27	21	22	21	5	4	0
19	28	33	28	25	21	10	5	2
20	37	34	31	27	23	12	7	-1
28	33	36	32	27	15	14	8	7

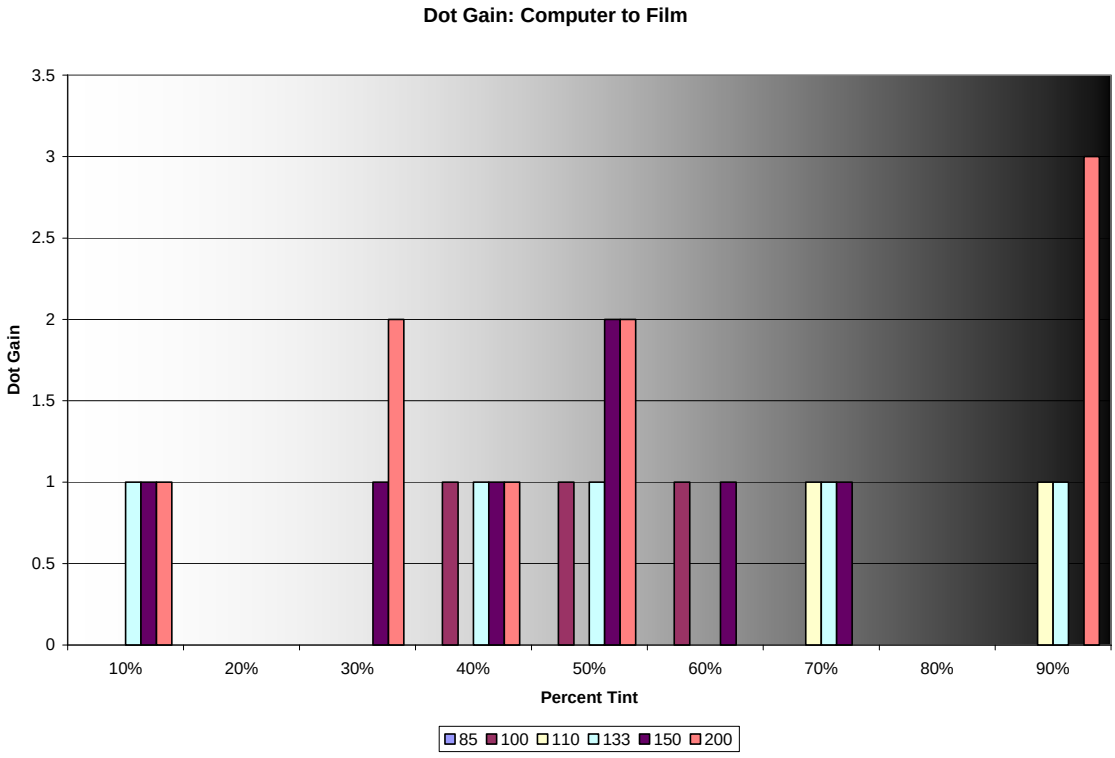
Ink Density: Press Sheet

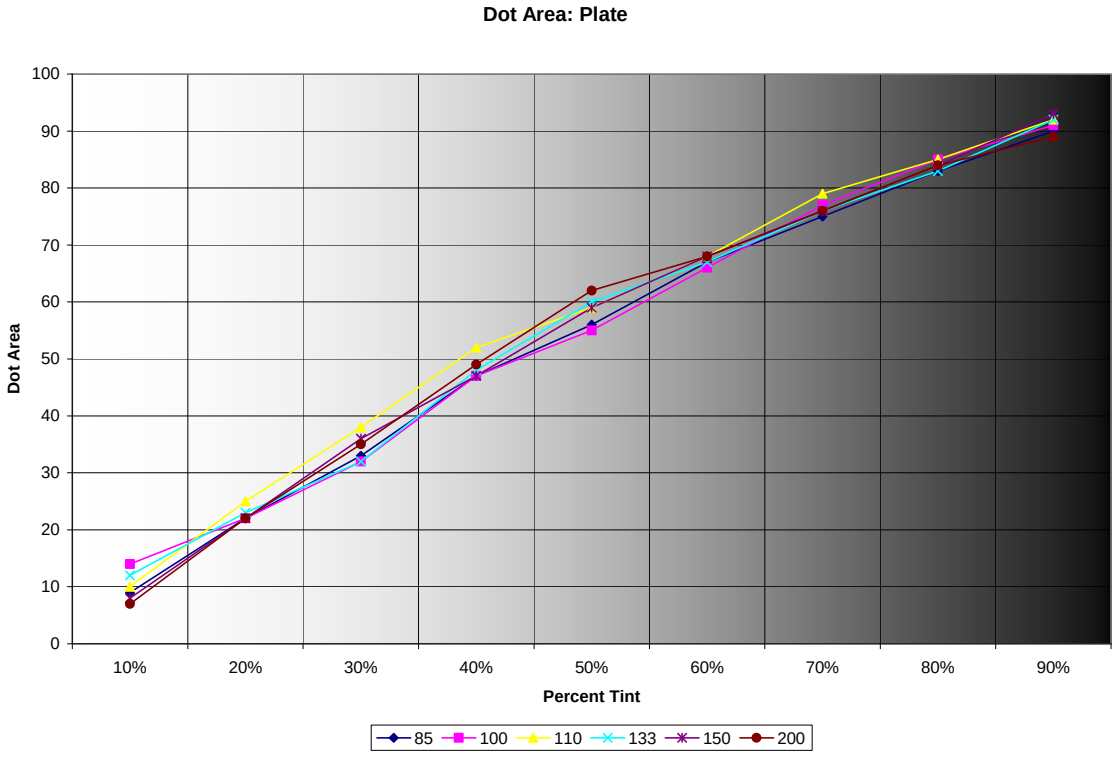
1.33	**1.25**	**1.16**	**1.12**	**.98**	**1.00**

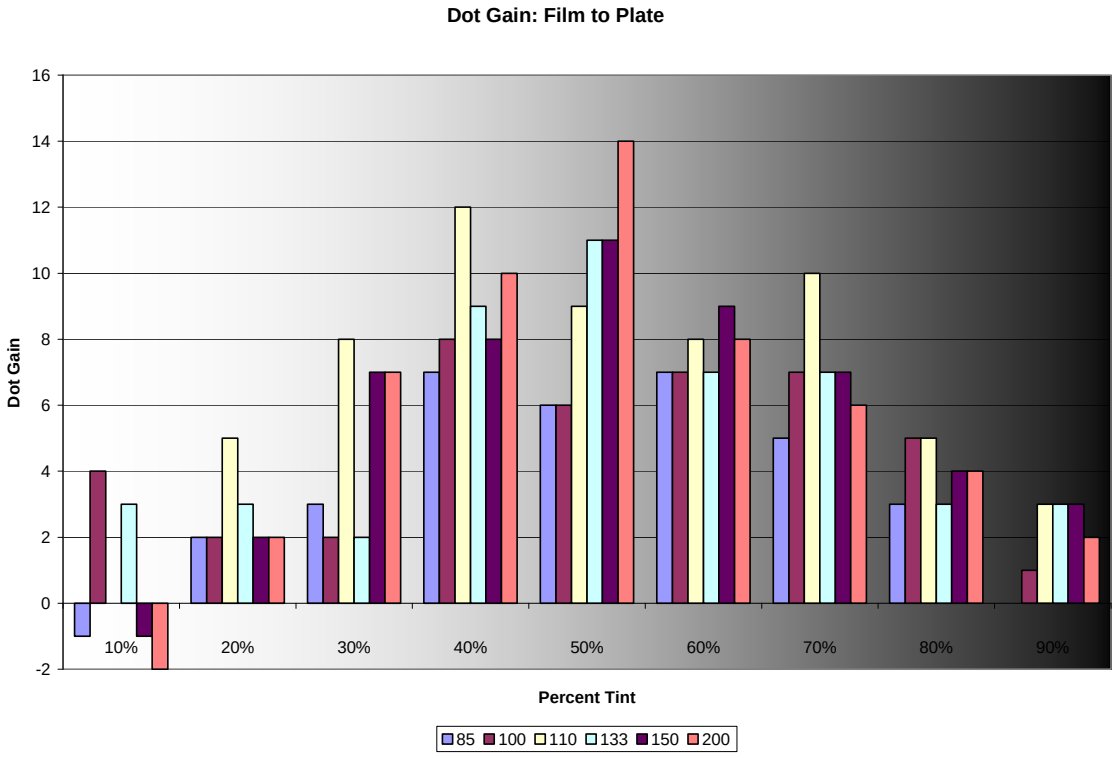
Total Dot Gain: Computer to Print

20	24	26	28	28	23	13	8	2
21	28	29	31	29	26	13	9	2
20	34	35	33	31	29	16	9	4
23	31	35	38	37	28	18	8	6
20	39	42	40	40	33	20	11	2
27	35	45	43	43	23	20	12	12


Dot Area: Film
100
90
80
70
60
50
40
30
20
10
0
Dot Area
10%
20%
30%
40%
50%
60%
70%
80%
90%
Percent Tint
85
100
110
133
150
200


Dot Gain: Computer to Film
3.5
3
2.5
2
1.5
1
0.5
0
Dot Gain
10%
20%
30%
40%
50%
60%
70%
80%
90%
Percent Tint
85
100
110
133
150
200


Dot Area: Plate
Dot Area
Percent Tint
0
10
20
30
40
50
60
70
80
90
100
10%
20%
30%
40%
50%
60%
70%
80%
90%
85
100
110
133
150
200


Dot Gain: Film to Plate
Dot Gain
Percent Tint
-2
0
2
4
6
8
10
12
14
16
10%
20%
30%
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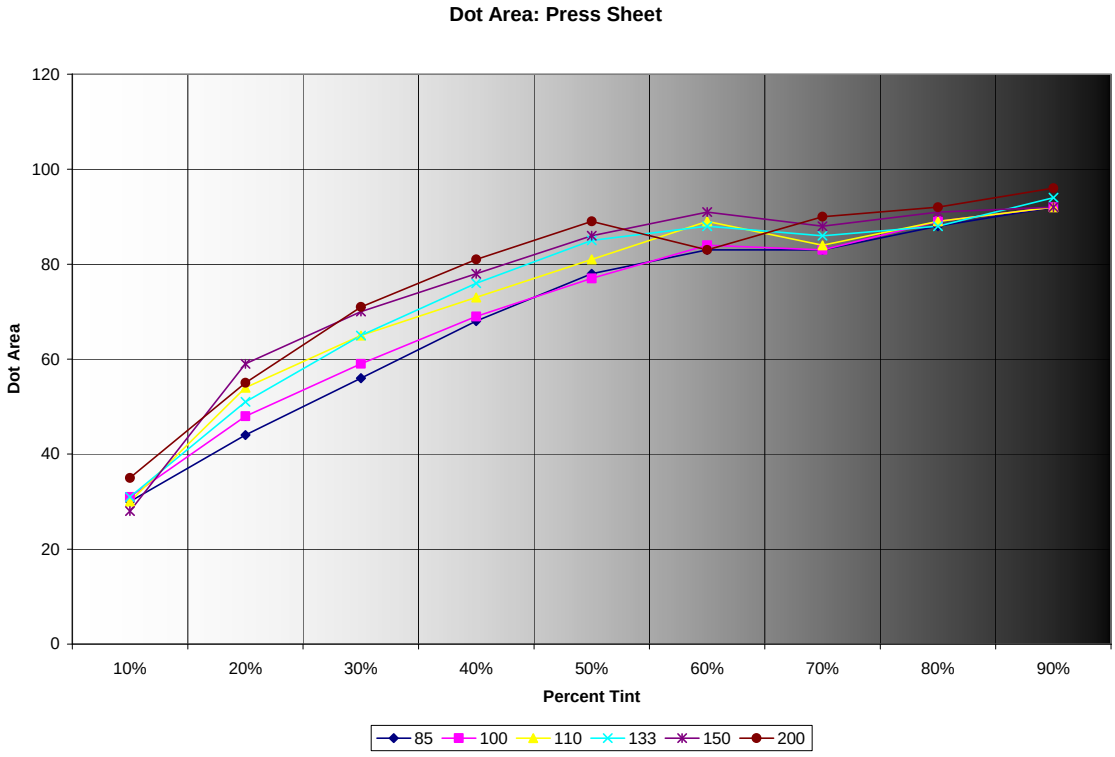
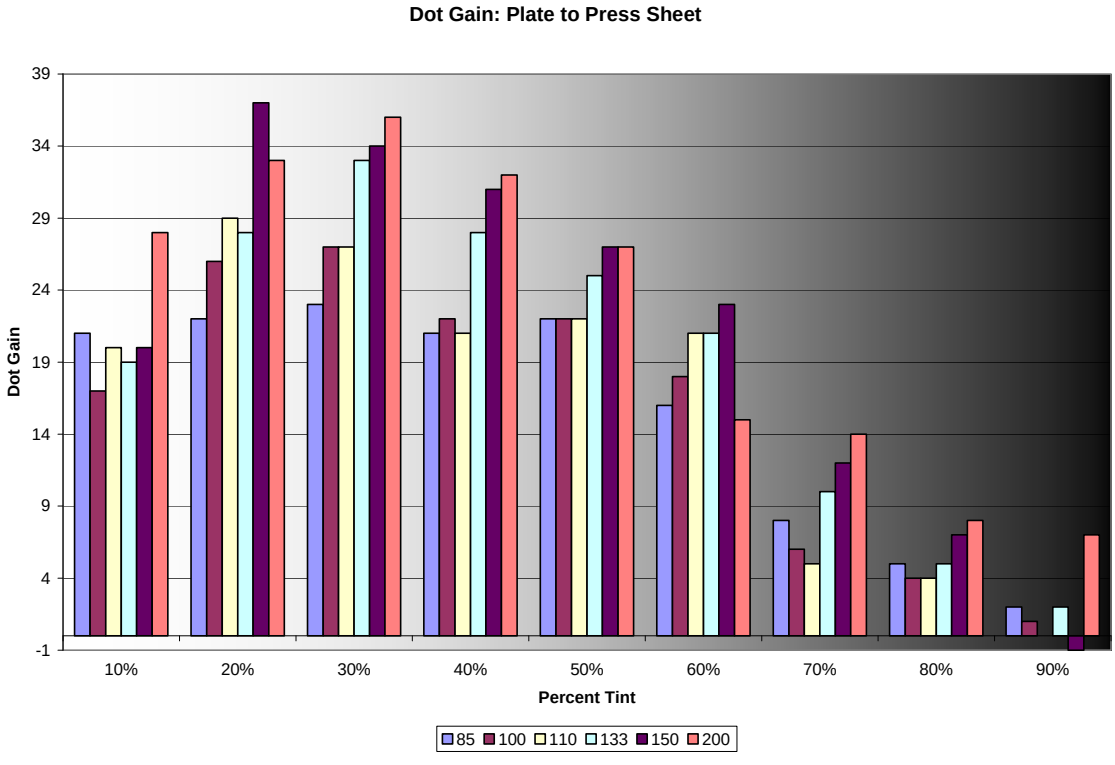
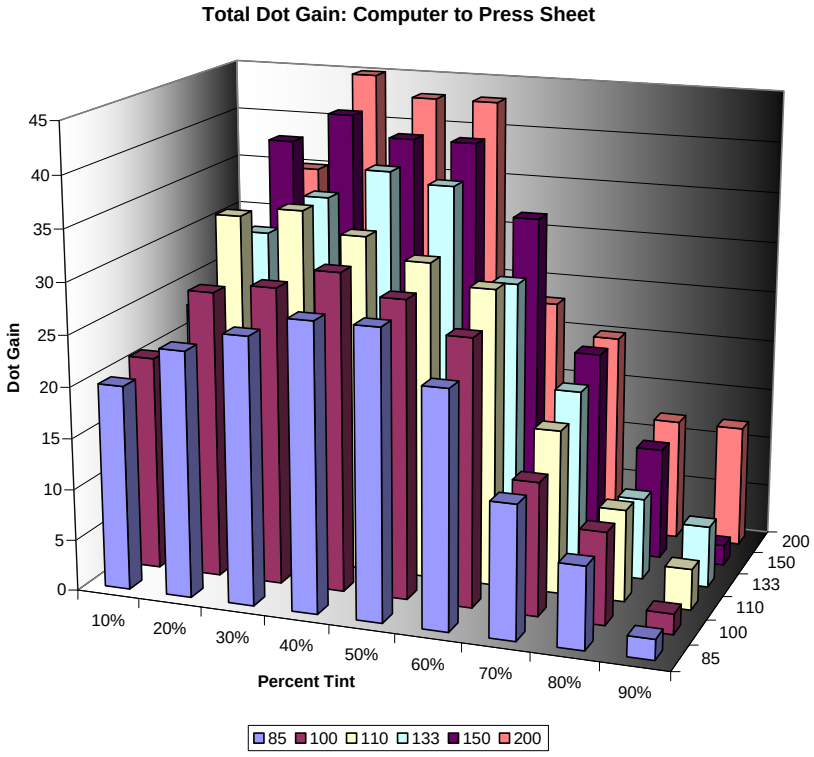
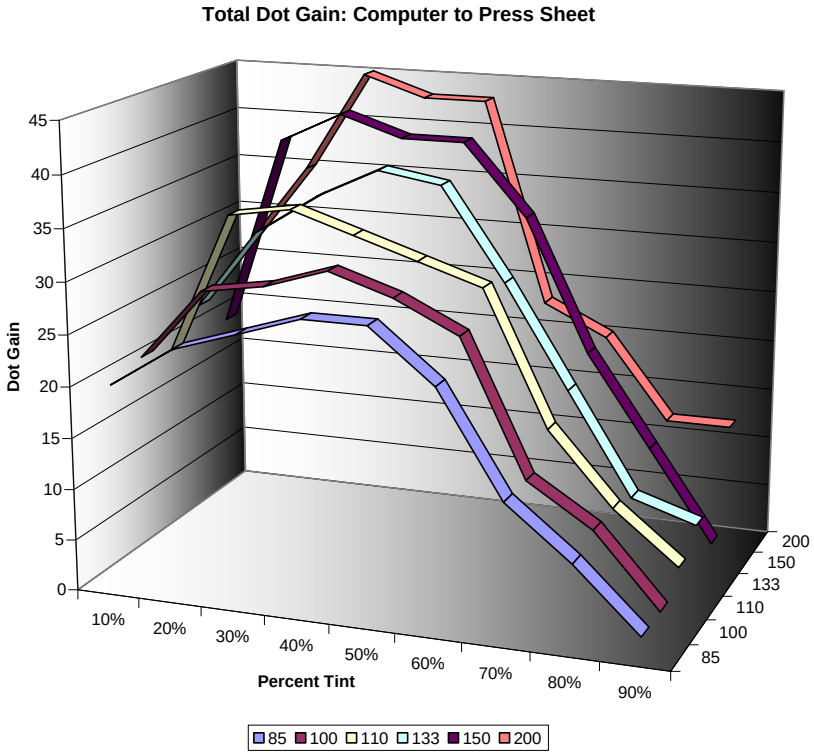
50%
60%
70%
80%
90%
85
100
110
133
150
200


Dot Area: Press Sheet
120
100
80
60
40
20
0
Dot Area
10%
20%
30%
40%
50%
60%
70%
80%
90%
Percent Tint
85
100
110
133
150
200


Dot Gain: Plate to Press Sheet
39
34
29
24
19
14
9
4
-1
Dot Gain
10%
20%
30%
40%
50%
60%
70%
80%
90%
Percent Tint
85
100
110
133
150
200


Total Dot Gain: Computer to Press Sheet
Dot Gain
45
40
35
30
25
20
15
10
5
0
10%
20%
30%
40%
50%
60%
70%
80%
90%
Percent Tint
200
150
133
110
100
85
85 100 110 133 150 200


Total Dot Gain: Computer to Press Sheet
Dot Gain
45
40
35
30
25
20
15
10
5
0
10%
20%
30%
40%
50%
60%
70%
80%
90%
Percent Tint
200
150
133
110
100
85
85 100 110 133 150 200

DISCUSSION

FILM

- The dot area of the film image was consistently the closest to the original computer generated tints of any of the other measured parts of the lithographic process. It can be assumed that due to the use of a computer-to-film imager, there is virtually no dot gain because of the machinated process. This allows for high quality transfers that essentially guarantee that during this stage of the process, the physical image area is as close as possible to what appears on the computer screen.
- Though there is very little variance from the pure tints, the higher-lined screens are already beginning to show that they are more susceptible to dot gain and it can be inferred that they will constantly out-gain the smaller, lower quality screens.

PLATE

- The midtones and shadows have both experienced some dot gain during the transfer from film-to-plate, and remarkably, the highlights have actually undergone dot sharpening, rendering them virtually invisible after accounting for the dot gain from the transfer to film. The highlights will most likely not present any problems during printing, as their low dot area levels will possibly cancel out any visible gain that occurs.
- It is with this data that the trend of increasing susceptibility to dot gain of higher-lined screens first makes itself clear. There is an obvious trend that is producing higher dot areas for the finer-screened lines, and could pose a problem, as some of the midtones have already jumped nearly to the next multiple of ten.
- Causes for the dot gain during this stage could have been a minute lack of vacuum suction that would have held some parts of the flat less tightly to the plate during exposure. This is typical and generally cannot be avoided without the use of a computer-to-plate system.

PRESS SHEET

- As the image is printed on the press and transferred to the press sheet, there was a substantial amount of dot gain; much higher than expected. The highlights gained an average of around twenty and in some cases, the midtones jumped nearly to thirty. The shadows, being unable to gain any more area, generally experienced little or unnoticeable dot gain, especially when regarded in relation to the rest of the tints on the image.
- As a whole, the differences in line screen did not vary as long as their values were taken in proportion to their respective tints. But the data presented here is a clear indication that higher-lined screens do undergo more dot gain than lower ones, and especially in the midtones. The midtones of higher-lined screens can be argued as definitely being the most difficult parts of a job to print.
- Causes for the dot gain during this stage could have come from a variety of things, as the presswork subjects the image to many different processes. The gain could be caused, in part, by the quality of the ink used. If the ink was too tacky and effortlessly stuck to the paper, the paper could have easily picked up extra ink that would amount to dot gain. Another inevitable problem that can cause dot gain is that when the paper is pulled through the rollers, it is squeezed between the blanket and impression cylinders and the ink placed upon it by the blanket could be smashed down, forcing the ink to move outwards.

THE EFFECTS OF DENSITY

- Ink density appears to have affected the final printed image as the denser areas of the test strip were on the left side of the page, in tandem with the extra ink that was spread out over the highlight areas.
- The amount of ink used can also be related to the measured density. Due to the higher amounts of ink needed to print the darker tints on the right side of the page, there is only a limited amount of ink left to cover the test strip at that side. The lower amounts of ink used to print the highlights would naturally

allow for more ink to be available to print the test strip on the left side of the page, which obviously accounted for the higher density numbers that were measured there.

CONCLUSION

DOT GAIN/SHARPENING

- The problems associated with dot gain and dot sharpening are inevitable, and cannot be avoided in the physical world. The properties of chemistry, physics, and mechanics that allow the lithographic printing process to occur allow dot gain and sharpening to happen, and thus, they are very hard to eliminate. Possible solutions to their effects include purchasing new equipment that allows plates to be manufactured directly for the digital image. This is expensive and unrealistic for most print shops, as the machinery is very expensive. Another possibility would be to adjust the image while it remains on the computer by flattening out its tonal range and polarizing the midtones closer to pure black and white. This would eliminate the problems with high midtone gain, but could run the risk of washing out the contrast of the image. Thus, dot gain must be lived with and has little chance of elimination for most commercial printers. However, as long as the printer is aware of the facts behind dot gain and the problems that it can cause, he can make adjustments to minimize its effects.

LINE SCREEN

- Line screen has always been about the quality of the details of the final print. The use of a finer screen can allow the image to be reproduced with more detail, but as evidenced by the data presented above, dot gain can cancel out that detail by making the main portion (of most images), the midtones too dark. This suggests that a higher screen should be used with caution and if the extra detail's presence is not paramount to the finished product, the job should be printed at a lower line screen to allow for finer control and accurate reproduction of the image area, due to the lower possibility for dot gain they present.