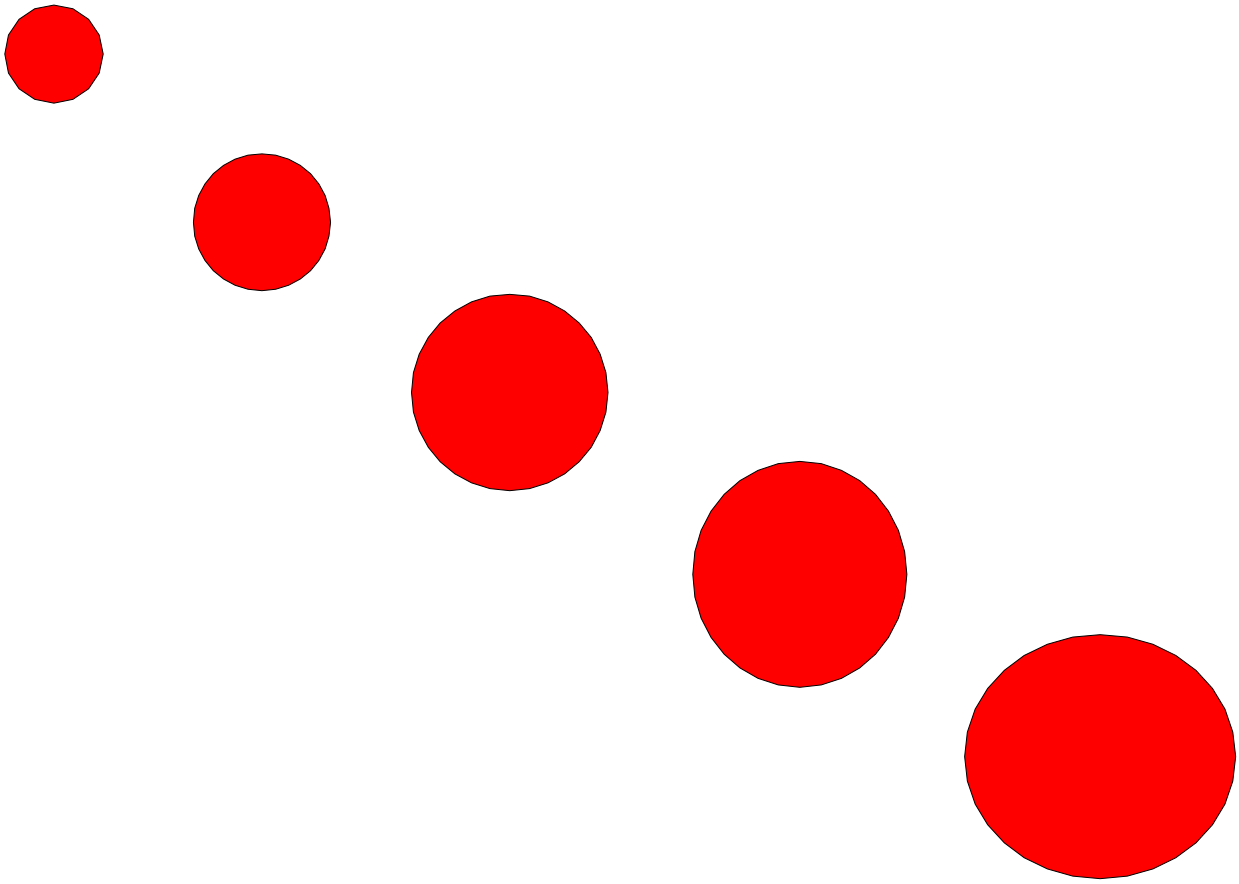
US Ink A Division of Sun Chemical Corporation

What is Dot Gain?



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As a first principle it has to be accepted that dot gain in the context of printing is a FACT OF LIFE. Dot gain will always be present, what causes the problems we see is excessive, variable, or unpredictable dot gain.

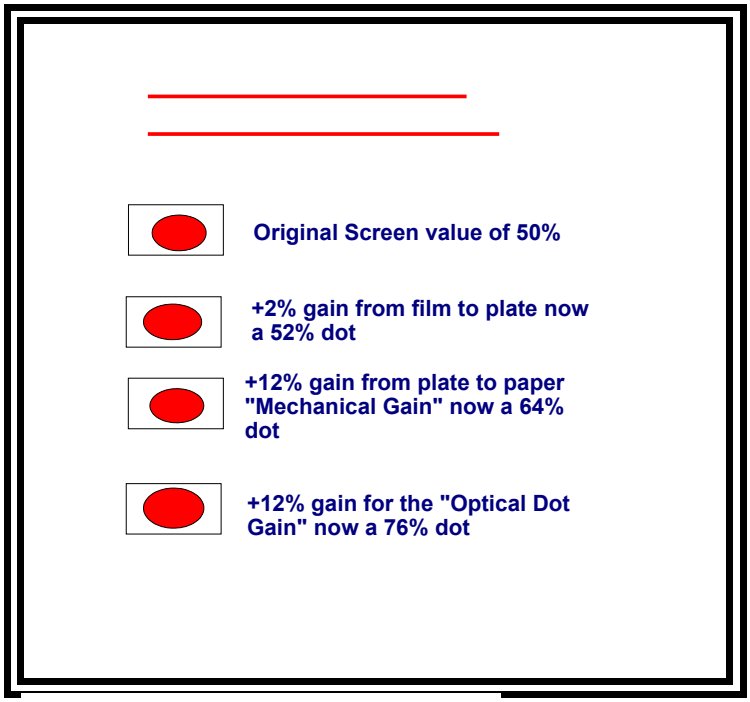

Figure 1

Dot gain is an increase in diameter of the halftone dot. A dot pattern which (on the film) covers 30% of the image area, but which when printed covers, 50% is said to show a total dot gain of 20%. Total dot gain therefore is the numerical difference between the negatives and corresponding dot size on the paper.

Every stage of the process from film, through plate making, to the several stages of printing the final image contribute to dot gain. (See Figure 1)

Not all dots grow to the same degree. The highest area of dot gain is in the midtones (40% 50% 60%). Above this range, as the dots progressively touch each other, the length of clear perimeter available for growth on each dot diminishes, which explains the tapering off. (See Figure 2)

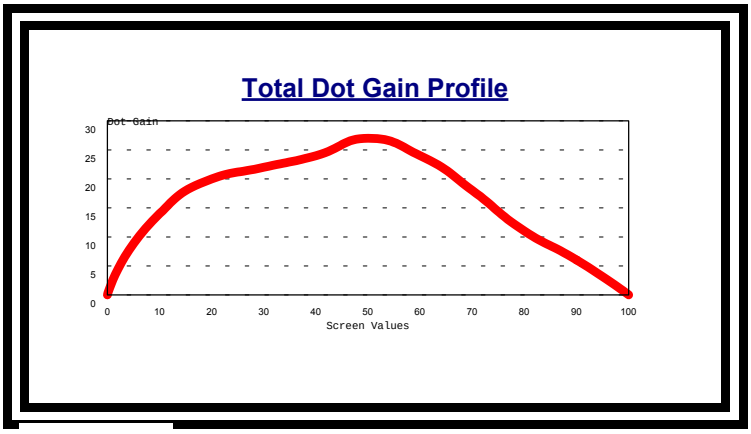

Figure 2

Dot gain becomes more pronounced as the screen ruling becomes finer, this is often one of the factors which limits the choice of screen ruling. As shown in the example in Figure 3 the dot gain will increase under the same conditions as the screen ruling becomes finer.

Screen Ruling Vs. Dot Gain

300 Lines/Inch	30%
150 Lines/Inch	15%
75 Lines/Inch	7.5%

This Example is valid only with screens of the same dot shape

Figure 3

Dot gain in pre-press can occur in the making of the negatives and then in the development of the plate. Exposure times and contact between the negative and plate should be carefully monitored throughout the plateroom. The dot gain in this area should be controlled to less than 2 percent.

Dot gain on press is a summation of several effects. Each time the ink is split (plate to blanket, and blanket to paper) there is a degree of squash, which increases the physical diameter of the printed dot. When the dot is transferred to the paper, setting is achieved by absorption. This takes place in the vertical plane (into the paper), and also occurs sideways, contributing to an increased dot diameter.

There is also an optical effect that occurs in the printing process. After the dot is printed (mechanical dot), the eye perceives this printed dot as larger than actually printed. This effect is called Optical Dot Gain and is illustrated in Figure 4. The light is scattered within the paper and some of the light is trapped below the halftone dots and absorbed by the ink. The reflected light, striking the dot, throws a shadow onto the paper. This shadow can be perceived by the eye and by a reflection densitometer, and has the same effect as printing a larger dot. Optical dot gain can be larger if the shadow is more pronounced and depends on the opacity and the surface of the printed substrate.

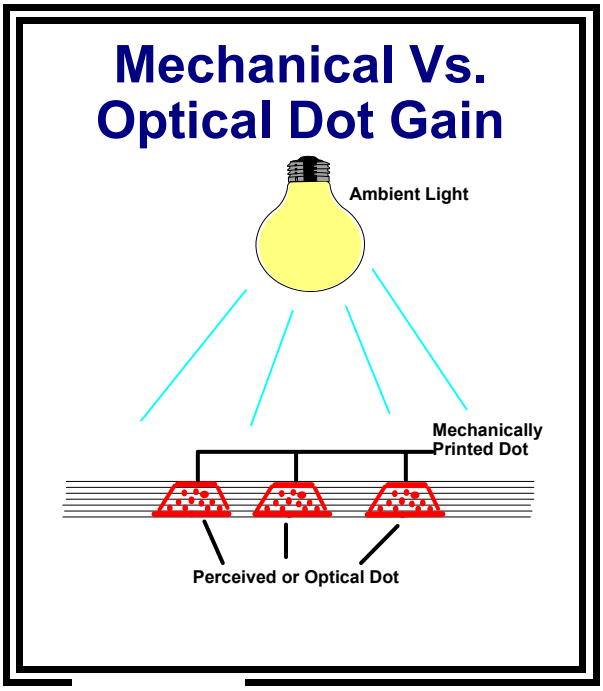

Figure 4

With the press and its settings under control, dot gain should be consistent. For that reason it is possible to compensate for predictable dot gain at the scanning stage.

It is necessary, therefore, to measure the dot gain for a press (benchmark), under your normal printing conditions. For each color, prepare a plate with a dot gain target from a measured set of negatives, (this is a series of tone squares usually ranging from 5% dot to 95% dot). Measure the plates to determine the gain produced in the plate making operation. After a run, when the press is warm and set up for correct ink and water balance, mount the plates and run at normal operating speed.

Using a densitometer, measure the dot gain or dot area on the paper for each tone target. The dot gain is the measured dot area minus the dot area (of the corresponding area) on the negative.

The densitometer will probably use the Murray-Davies equation, which relates integrated density of the tone square to dot size. Various equations are utilized by different manufacturers of densitometers. These different equations will give different results, so knowing which equation the densitometer is using is important. The Murray-Davies equation is listed below:

$$\text{Apparent Dot area} = \frac{1-10^{-(Dt)}}{1-10^{-(Ds)}}$$

Where Dt is density of tone and Ds is density of solid.

Listed below are typical total dot gain ranges for printing on newsprint.

	Black	Cyan	Magenta	Yellow
GATF	25-35%	25-35%	25-35%	25-35%
SNAP	28-34%	28-34%	28-34%	28-34%
X-Rite Corp.	34%	33%	30%	28%

Note- All reported values are calculated from the midtone (50%) area.

After bench marking a press, one may consider that dot gain is excessive for that press and may want to improve the process. By going through the above process one may be able to isolate a particular area where the gain is excessive and thus concentrate on this area. The following variables have been found to affect dot gain:

VARIABLES AFFECTING DOT GAIN

Ink

- Tack and Viscosity
- Ink / Water Balance
- Pigment Strength
- Temperature
- Ink Film Thickness (Print Density)

Paper

- Brightness, Whiteness, and Opacity
- Porosity / Holdout
- Smoothness
- Web Tension

Fountain Solution

- pH/Conductivity
- Hardness of Incoming Water
- Type of Dampening System
-Formulation

Blanket

- Compressibility
- Age
- Tension
- Surface Characteristics

Plate

- Exposure Time and Vacuum
- Processing
- Reactions (Age, Light, Chemicals)
- Tension

Rollers

- Durometer
- Settings
- Glazing

Speed

- Low / High

Packing

- Over / Under

Coverage

- Light / Heavy

It is important to note that the solid ink density (ink film thickness) will have a dramatic effect on dot gain. Therefore it is critical to monitor and control ink density during a run so that the dot gain is consistent throughout the run.

As one can see there are many variables that can affect dot gain. The benchmarking process should be rechecked after any variable is changed in the printing process. If this is left for too long before testing and several variables have changed, bringing the process back into control may be difficult.