Linotype-Hell

Technical Information

Density and Dot Percent

Many imagesetter users who are trying to output tints or halftones find that the dot percentage that they request (either using the PostScript** language, or a PostScript application) is not the actual percentage that they measure with a densitometer on film. For example, if you request a 50% halftone tint, you may find that the actual percentage is different, by as much as 10 or even 20 percent in extreme cases. Tints may therefore appear darker or lighter than anticipated, and any color separation work will have variations in the resulting printed color. This document will explain why this happens and what can be done to remedy the situation.

Halftone dot gain (or loss)

At every step in the creation of an image, there is a chance for the image to degrade. When a photograph is taken, only a small portion of the information in the scene is recorded. When that photograph is scanned, some information is lost too. A little bit of information is lost in each of the following steps: the creation of the films, the making of the printing plates, and the actual printing of the image. The degradation in these last three steps is referred to as dot gain or loss because the individual halftone dots may increase or decrease in size. Take, for example, the gray scale in Figure 1. Even if the dot percentages were accurate when output to film, by the time that they are actually printed, the dot percentages may have changed due to the printing process. You could attempt to adjust for all of the factors that might cause this dot variation, but for the moment, let's just consider the role of the imagesetter.

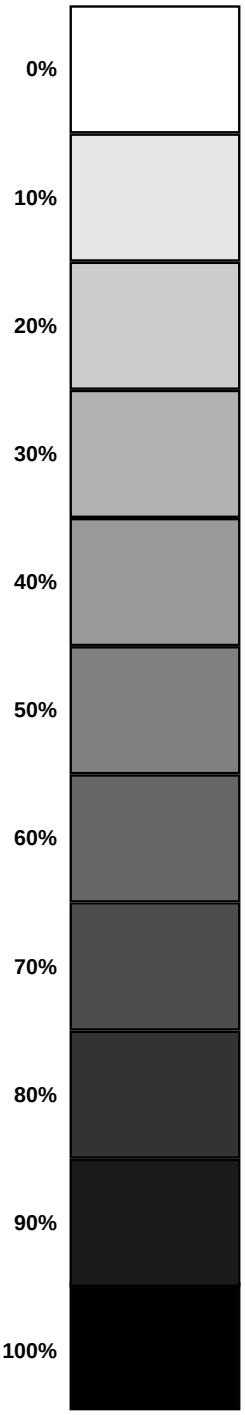


Figure 1 - Gray scale

Halftone dot size variation

It will help to go back to the way that halftone dots are created to understand what is happening here. The laser in an imagesetter exposes the film according to a very regular grid. You could say that it is putting down black marks wherever the laser strikes (and exposes) the film, but strictly speaking, there are no marks until the film is sent through the film processor. At 2540 resolution, that means that there are 2540 of these exposed marks in an inch (or one every 1/2540th of an inch.) Each halftone dot (depending on the dot percentage) may be made up of anywhere from 1 to 500 or more of these marks. Conditions like the type of film you are using, the state of the chemicals in the processor,

and the intensity setting of the laser will all play a role in the final size of the halftone dot. Figure 2 shows how these factors affect halftone dot size.

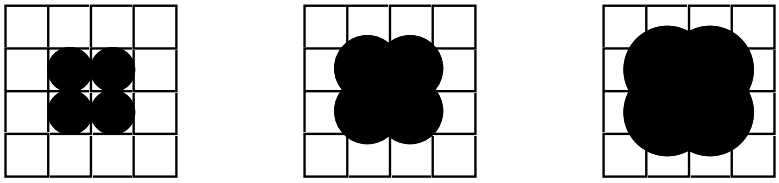


Figure 2 - Factors affecting halftone dot size.

If, for example, the chemicals in your film processor are particularly weak, then the marks may not properly develop. Alternately, on the day you have your processor cleaned and new chemicals put in, the marks may overdevelop. This will alter the size of the halftone dot. But you could get this same effect by changing the intensity of the laser, or even by changing film materials. So how is it possible to know just how the laser, the film and the chemicals are reacting on a certain day? You can do this by measuring the maximum density (the darkest black) on your film with a densitometer.

The tools

A densitometer that measures both density and dot percent is a requirement for tint and halftone work. Accurate halftone work also requires a bath film processor. Bath processors totally immerse the film material in the chemicals, and allow proper development over all areas of the film. In addition, people who are concerned about accurate tints and halftone reproduction will most often be outputting to film. When you output to photographic paper you add an extra step in the platemaking process. (Films must be shot from the paper mechanical.) This can introduce variation.

The only other requirement is a gray step wedge like the one on the first page. If you are familiar with PostScript, you could write this as PostScript code. You might also create it in a page layout or illustration program Or you could use a calibration program like the one that is part of the Linotype Utility.* This document will discuss how you would make adjustments on a Linotronic* 330 imagesetter, although the same considerations would hold for the Linotronic 200, 230, 300, 500, 530 and 630 imagesetters.

Film processing

Keeping the processor running at its best is critical. This means that chemicals should be replaced as they weaken, and the unit should be cleaned regularly. After each cleaning, all settings should be set according to the manufacturer AND NOT CHANGED. This is important because if the temperature and time settings are adjusted by everyone who uses the processor, then it will be impossible to get consistent results. (Control strips, available from the film manufacturer, can be used to test the state of the processor and to determine the proper settings.) For shops where the volume justifies more than one processor, one should be used for film and another for paper.

Imagesetter density settings

Linotronic imagesetters have density settings[1] for each resolution. These settings control the exposure of the laser on film or paper. Depending on the model of the imagesetter, these settings may be adjusted using the key pad, the density control knobs, or the Linotype Utility.

[1]Don’t confuse the density setting with the actual density number that you read from the densitometer. The density settings on the imagesetter control the intensity of the laser, and therefore only indirectly affect the density that you measure on film.

As long as the film processor and film material remain constant, the density settings may be used to control the maximum density (often referred to as dmax) on film. These settings will be different for film and for paper.

Therefore, if you are running both film and paper in a single machine you will have to adjust the density settings when you change film materials.

How to run a test

Density settings will change from machine to machine. You should use the existing settings to start, and change them as needed. It will be useful to keep a chart of the numbers near the machine so that you can track density settings for different resolutions and materials over time. You will need to run a test for each material and resolution that you intend to use. Therefore, if you run at 1270 and 2540 on both paper[2] and film, you will need to run four tests. There may be some variation from lower screen rulings to higher screen rulings, but unless your work demands absolute accuracy, you do not need to run tests for each screen ruling. Select your most common screen ruling for these tests (perhaps 120, 133, or 150 lines per inch.)

[2]For more information on calibrating on paper, refer to the Linotype-Hell technical information piece called Calibrating on Paper, part number 3076.

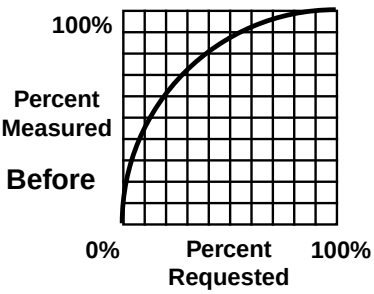
What you are trying to find out is the density setting (i.e., laser intensity) on the imagesetter that will give the desired dmax. Imagine that you are outputting to positive film at 2540 resolution and that you want a dmax of 3.25.

To do this[3]:

- Set the resolution and load the material you intend to use.
- Note the existing density setting (let's say that it is 200.)
- Download the ten step wedge.
- Change the density setting (perhaps to 250)
- Download the ten step wedge again.
- Change the density setting (perhaps to 150)
- Download the ten step wedge again.
- Process the film and measure the dmax.

Let's say your results look like this:

Density setting	150	200	250
Dmax	2.5	2.9	3.7



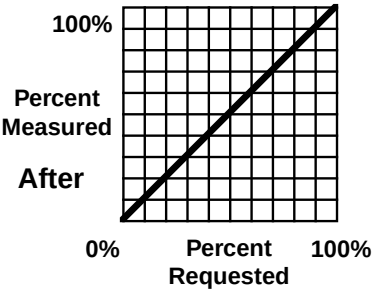


Figure 3 - Halftone dot percent before (top) and after (bottom) imagesetter density is stabilized.

- You would then repeat the procedure using steps between 200 and 250 until you achieved your desired dmax.
- Once you have the density setting set correctly, measure the dot percent at each step. Your results may look like this:

Requested:	0	10	20	30	40	50	60	70	80	90	100
Measured:	0	9	20	31	41	53	63	73	82	92	100

In this example, if you take the difference between the requested value and the measured value, you will find that you were off by by no more than three percentage points at any step. Without specially designed calibration software, this is a reasonable result for a 3.25 dmax at 2540 resolution.

If you were to make graphs of requested versus measured dot percent, in an imagesetter where initially the dmax was too high, it might look like the top graph in Figure 3. The measured values are much higher than the requested values, and so the curves bows upward. When the requested values exactly match the measured values, the result is a straight line (see the bottom graph in Figure 3). A straight line is the ideal result. Using the test results from above, the line would be very nearly straight, but not quite.

[3]You can greatly accelerate this testing process by using the Linotype Utility to download a series of test patterns for different density settings. Once that process is completed, you can use the Linotype Utility's calibration facility.

Calibration programs

If you need either greater accuracy, or a higher dmax, a calibration program is a necessity. Calibration will allow you to make adjustments so that you can get your dot percentages even closer. In the color separation world, this kind of calibration is often referred to as linearization. This is because you are trying to create a straight line in the requested versus measured graph.

Linotype-Hell offers an imagesetter calibration program as part of the Linotype Utility. This will help you run tests to determine the proper density setting for the required dmax as well as giving you a tool to do calibration. (For more information, refer to the Linotype-Hell technical information piece called Calibration, part number 3075.)

But whether you are using calibration or not, it is of the utmost importance to control your dmax on film, because if you do not control the dmax, then a calibration program will be useless.

Conclusion

Here are some of the most important points to consider:

1. Higher resolutions will reproduce halftone dot size more accurately at high densities (say above a 4.5 dmax) than will lower resolutions. For example, if a user needs a high dmax and is having trouble getting accurate dot percentages at 1270 resolution, they should try a higher resolution setting.

2. With resolutions of 1270 or higher, a 3.5 dmax may be achieved without too great a variation in dot percent. The user who requires higher densities will have to settle for greater variation, or investigate calibration programs.[4]

[4]Check with your printer to assure that the dmax on film that you supply is what your printer requires. For more information, see the Linotype-Hell technical information piece on Analyzing Film Output, part number 3062.

3. You will have a much greater chance of success if you follow these rules:

- Maintain your processor well.
- Run dmax tests every day.
- Aim for a consistent dmax, preferably 3.5 or below.
- Calibrate for greater accuracy.

Comments

Please direct any questions or comments to:

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