Linotype-Hell

Technical Information

Blends and Shadestepping

One of the most common banding effects, *shadestepping*, occurs when too few steps are used in a blend (also called a graduated tint, a gradation, a fountain, a degradé, or a vignette.) The result is a gradation that does not blend smoothly from one step to the next (see Figure 1). This effect may also be termed *posterization*. Users often mistake this type of banding as a problem with their imagesetter, when in fact, if the gradation is created with certain guidelines in mind, then no shadestepping will appear.

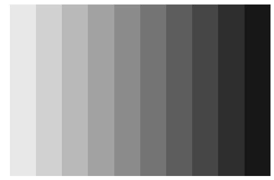

Figure 1 - A blend that shows shadestepping because it was created with too few steps.

Diagnosis

One easy way to determine the cause of a banding effect is to output the job twice: once in portrait mode and once in landscape mode. If the banding is horizontal in portrait mode and vertical in landscape mode, then almost certainly the banding is a result of the way it was created. In this case look to the description below to improve output. If the banding remains horizontal in both portrait and landscape mode, you should refer the problem to the Linotype-Hell Technical Assistance Center.

Length of the blend

Some very helpful formulas for dealing with blends appeared in volume six of Adobe's** Colophon magazine. The formulas help you to calculate the number of grays available, and the number of grays available for a particular blend. However, one additional piece of information is needed to calculate if shadestepping is likely to be present. It is very important to take into account the length of the blend.

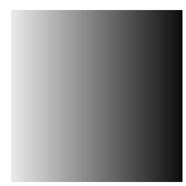

Figure 2 - An inch long blend made up of 50 steps.

For example, in an inch long blend of 50 steps (see Figure 2), each step will be 1/50 of an inch long. If you stretch the same 50 step blend out to nearly 5 inches (see Figure 3), each step will be 1/10 of an inch long, and therefore it is much more likely that each step will appear distinct instead of blending smoothly. A blend resembles an accordion; when it is compressed, you don't see the individual sections, and when it is expanded, each section is clearly visible.

Figure 3 - An extended version of the blend in Figure 2.

The ground rules

There are some things you should consider before you use any formulas:

- The longer the blend, the more likely it will show shadestepping.
- The fewer steps used, the more likely the blend will show shadestepping.
- Using a higher resolution on the imagesetter will reduce shadestepping (as long as the blend is made with sufficient steps).
- 256 levels of gray is the maximum amount of grays that PostScript** can handle, so there is no benefit in using more steps than that.
- Lower screen rulings are less likely to show shadestepping.
- A gradation from 30 to 40% will be much more likely to show shadestepping than one from 0% to 100% (since by limiting the range of the blend you also limit the number of grays available).
- For best results, use the chart on the back page as a guideline.

The formulas

The formulas from Colophon have been included here, along with a new one which takes into account the length of the blend. Together they can be used as a tool to avoid shadestepping. To use these formulas you need to know the following: *resolution of the imagesetter, screen ruling, length of the blend, and the percent change from the beginning of the blend to the end.*

This is the formula to calculate the approximate number of grays available:

$$\textbf{Grays} = \left(\frac{\textbf{Resolution}}{\textbf{Screen ruling}} \right)^2$$

Since PostScript will use no more than 256 levels of gray (even if the particular halftone screen is capable of producing them), do not use any number higher than 256 in subsequent formulas. Next, calculate the number of grays available given the starting and ending percentage of the blend :

$$\textbf{Grays available} = \left(\textbf{Grays x Percent change} \right)$$

Another key factor is the length of the blend. To account for the length of the blend you should use this formula:

$$\textbf{The Blend Factor} = \left(\frac{\textbf{Length}}{\textbf{Grays available}} \right)$$

The blend factor describes the approximate length of each step. Obviously, if this number is large then it is likely that shadestepping will be noticed. For example, a blend factor of .5 means that each step will be .5” long, and will surely be noticeable. Several variables influence the blend factors, but generally values from .03” to .01” (or lower) mean that shadestepping will not be visible (this is in the range of 1/32 to 1/64 of an inch, .75 to .25 of a millimeter, or 2 to 1 points).

An example

A 150 line per inch blend output at 2540 resolution is capable of producing around 287 levels of gray. Since PostScript will only deal with a maximum of 256, that number should be used for the remaining calculations. If the blend is from 0% to 100%, then the number of grays available will be 256 (if the blend was from 20% to 50%, then only 30% or around 77 grays would be available). If the blend is seven inches long, then the blend factor would be .027 inches per step. Here are the calculations:

Grays = (2540/150)2 = 286.7 *(use 256)*

Grays available = 256 x100% = 256

The Blend Factor = 7"/256 grays = .027"/step

A *blend factor* of .027 means that shadestepping will probably not be visible.

Here are the same calculations done for a resolution of 1270:

Grays = (1270/150)2 = 71.68

Grays available = 72 x100% = 72

The Blend Factor = 7"/72 grays = .097"/step

A *blend factor* of .097 (about 3/32" per step) probably will be visible.

Variables

There are a number of variables, however, that may affect the blend factor:

Screen ruling — On high-resolution imagesetters, shadestepping in blends becomes less noticeable as the screen ruling drops. This is because the lower screen rulings have coarser halftone dots that tend to be capable of more grays. Therefore, one solution to shadestepping problems may be to lower the screen ruling while keeping the same resolution.

The range of percent — Very narrow range of percent in a blend means that a significant number of the available grays may not be used for the blend. As a result of this decrease in available grays, shadestepping is more likely.

Output media — Different sensitivities of photographic film or paper, as well as the current state of the film processor, may determine whether shadestepping is noticeable or not. Therefore it is of great importance that your density setting on the imagesetter be appropriately set for different materials, and that your processor be properly maintained.

Resolution — Since resolution is directly related to the number of grays available for a given screen ruling it is, of course, of great importance in shadestepping. Shadestepping problems may be avoided by increasing the resolution while keeping the screen ruling constant.

Logarithmic versus linear — Linear blends spread the grays out evenly over the length of a blend. However, the eye tends to be more sensitive to changes in the very light or very dark portions of a blend. Logarithmic blends attempt to combat this effect by compressing certain portions of the blend, but the effect of this compression may be visible elsewhere in the blend.

Dot shape — Poorly designed halftone dots may accentuate shadestepping. The default PostScript halftone dot is recommended. This halftone dot grows from a small round black dot in the low percentages to a square at 50%, to a small white dot on a black background as it nears 100%. Elliptical halftone dots may be useful for minimizing optical jump around 50%.

Printing Press — Printing presses have their own limitations as well. Plates for certain presses may not be able to hold and print either very large or very small halftone dots. Therefore, halftone dots below 5% or 10% may disappear entirely leaving open white areas, while halftone dots above 90% or 95% may print as a solid black.

Creating blends

Different programs allow different levels of involvement in the creation of blends. There may even be several ways to create blends within a program, not all of which will allow you to set the number of steps. Still, if you assume that the program uses as many steps as it has available to it (to a maximum of 256), then you can still use the formulas to predict shadestepping. Both Aldus and Adobe have preferred methods of creating blends; refer to the appropriate user manuals for more information.

Chart

As a general guideline for blends created with 256 steps, you may use the following chart to see how long your gradation may be depending on the resolution and the screen ruling. Since so many factors affect the appearance of shadestepping, you should experiment some with your imagesetter and processor to determine what will work best for you.

Note: All screen ruling/resolution combinations shown in this chart produce a minimum of 100 levels of gray. The values for this chart were calculated using several established constants: a blend with 256 steps, a blend factor of .03", and a percent change of 100%. If your percent change is less than 100%, you will need to multiply the appropriate number in the chart by your percent change.

Maximum Length of Blend

(Before Shadestepping Is Likely to Be Visible)

		Resolution[2]				
		1270	1693	2032	2540	3386
Screen Ruling[1]	60	7.7"	7.7"	7.7"	7.7"	7.7"
	90	6.0"	7.7"	7.7"	7.7"	7.7"
	120	3.4"	6.0"	7.7"	7.7"	7.7"
	133		4.9"	7.0"	7.7"	7.7"
	150			5.5"	7.7"	7.7"
	200					7.7"

[1]For information on recommended screen ruling values, refer to the Linotronic Screen Frequency and Screen Angle booklet, or contact the author at the address below.

[2]For the Linotronic 630 refer to 1270 for the 1219 resolution, 2540 for the 2438 resolution, and 3386 for the 3251 resolution.

Color blends

Blends where one color turns into another may actually be longer than stated on the chart without noticeable shadestepping in the final printed piece. This is because using two or more overprinted colors may mask some of the shadestepping. However the shadestepping will still be visible on the film.

Spot color conversions

When you convert a spot color to a process color, remember that it may affect your blends. A blend that you create from 0% to 100% using a spot color becomes very different in terms of percentages when converted to a process color. For example, if the spot color is made up of 10% yellow, 70% magenta, 30% cyan and 0% black, you must use the lowest value that is greater than zero to determine the percent change. In this case that means that the yellow plate will determine how long you can make the blend.

Comments

Please direct any questions or comments to:

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