Technical Information

Moiré

Linotype-Hell

For those of you who are producing color work, you probably have been faced with the problem of moiré. What is moiré? What causes it? And more importantly, what can you do about it?

Definition of moiré

Halftones and tints are repeating patterns of dots. When two halftones (or tints) are superimposed, a moiré pattern is the result. This moiré may be either extremely disturbing or barely noticeable. At its best, the moiré in four-color work is reduced to a tiny, barely visible, circular pattern of dots called a rosette (see Figure 1). At its worst, the moiré causes shimmery wave-like patterns to appear throughout an image (see Figure 2). It is the frequency of the moiré that is important to us. If the frequency is very high, say that it repeats every 1/64 of an inch, it will be less likely to be perceived by the eye. If the frequency is low, say 1/2 of an inch, it will be obvious and disturbing. Good four-color work is often described as having a tight rosette. This means that the underlying pattern is a high frequency moiré that is not disturbing.

center figure 1 here

Figure 1 - Magnified, black & white depiction of a four-color rosette

replace

replace

replace

Figure 2 - Two coarse tints at the same screen ruling at slightly different angles shown separately (a + b) and superimposed (c)

Occurrence of moiré

Moiré may occur in any job where more than one halftone (or tint) is superimposed. Four-, three-, and two-color work are susceptible to moiré. Even black & white work will sometimes display a moiré pattern if an already screened image is used as an original[1]. When the halftone is rescreened, you are effectively laying down a second halftone on top of the first. You will often see this type of moiré in newspapers, for example in the book review section, where already halftoned book covers are reproduced. In addition, common fabric patterns (like those in a herringbone jacket) may be difficult to reproduce because the pattern and the halftone dots combine to form a moiré.

Moiré patterns often appear in the darker areas of images. This is because in these areas, several process colors are likely to overlap. Remember this if you are creating colors out of process color components. The darker the color, and the more process colors you overlap, the more likely that moiré will be visible. Very often it is the black separation that contributes the most to the occurrence of moiré. Poorly-planned tints or scanned images that rely too heavily on the black separation are susceptible to moiré. UCR (Under Color

Removal) and GCR (Gray Component Replacement) are two techniques that are primarily used to reduce the amount of ink printed on a page, but when properly used they also have the added benefit of reducing moiré in dark areas (not because they reduce the amount of black, but rather because they reduce the amount of cyan, magenta and yellow ink in dark areas so that fewer colors are overprinting.)

[1] If you use an already published image for profit without the consent of the artist or photographer, you may be violating copyright law.

Moiré rules

When people first started printing using four color, it became clear that if they were to avoid moiré patterns they would have to follow certain rules:

- Try to separate each color from the next by 30°.
- Where this is not possible, separate them by at least 15°.
- Make all halftones the same screen ruling.
- Set cyan to 15°, black to 45°, magenta to 75° and yellow to 0°.
- Move black to 75° and magenta to 45° if the image contains important flesh tones. (Avoiding a magenta and yellow conflict.)
- Move black to 15° and cyan to 45° if the image is predominantly light green. (Avoiding a cyan and yellow conflict.)
- In three-color (CMY) work, or in cases where black does not play a dominant role, consider shifting yellow to 45°.

Even using these rules you may end up with some moiré, but generally they work pretty well.

Color shifts

Moiré patterns are not the only reason for these rules. Following the rules also helps to avoid color shifts[2]. Process color inks are meant to act as filters to the light that hits the paper and reflects back to your eye. (For more information on this subject, see the Linotype-Hell technical information piece on Color in Printing, part number 3056.) But because of the imperfect nature of inks, two differently colored halftone dots side by side produce a different sensation of color than do the same two halftone dots overlapped. When the angles are all the same, slight registration problems can cause considerable color shifts because every single halftone dot in a separation may move and cover (or uncover) its neighbor. When the screen angles are rotated, misregistration does not cause such severe color shifts because neighboring halftone dots are not all affected in exactly the same way.

In addition, if all the angles are the same, misregistration can introduce moiré. The moiré pattern created by two superimposed halftones (or tints) of the same screen angle has an extremely low frequency, such that it may not even be visible. However, any rotation of either separation brings the frequency into a range where the moiré may be extremely visible.

[2] A color shift refers to a change in the printed color of an image that occurs during a press run. If the color of an image is not the same on the first sheet off the press and the last sheet, then a color shift has occurred.

Adjusting screen angle

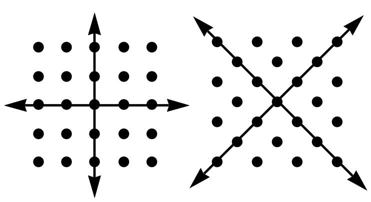

Figure 3 - Enlarged 0° (left) and 45° (right) tints. If you were to rotate these illustrations by 90°, the rotated version would be identical to the original.

The easiest way to avoid moiré is to adjust the screen angle so that the patterns are not as likely to interfere. Two halftones that are separated by only a couple of degrees will exhibit much more moiré than two halftones that are separated by 30°. (See Figures 2 and 4.)

If you could separate every separation from the next by at least 30°, then moiré would rarely be a problem. Unfortunately, halftones are built up on a 90° axis (see Figure 3). This means that a halftone at 90° is essentially the same as a halftone at 0° (likewise, one at 15° is the same as one at 105°). Within 90° it is impossible to separate each of the four separations by 30° (if one is at 0°, another at 30°, and another at 60°, you can't have one at 90°, since that would be repeating 0°.)

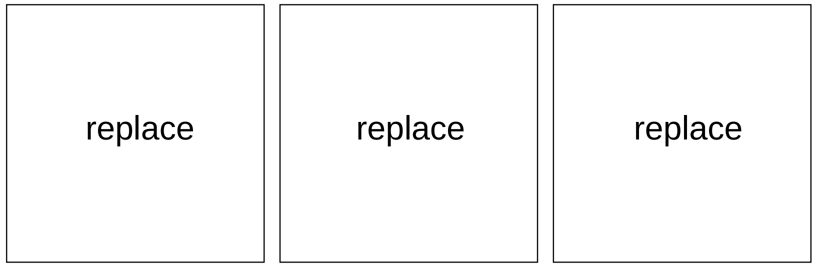

Figure 4 - Moiré pattern formed by two coarse tints separated by 15° (left), 30° (middle) and 45° (right). See Figure 2 for an example of two tints separated by 5°.

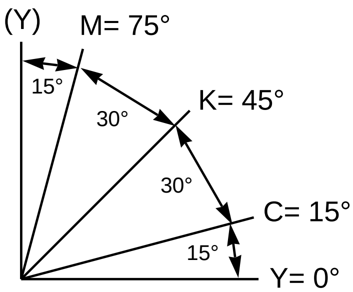

Figure 5 - The commonly used angles for color separation and the distance in degrees between each color.

As a result, printers separate three of the four separations by 30°, and then sandwich the remaining one in between, where it is only 15° away from its neighbors (see Figure 5). The one that gets sandwiched in is usually the yellow separation, since yellow is the lightest of the four process colors and is less likely to contribute to moiré.

As mentioned, you may see magenta at 45°. Please note that because 15° and 75° are complements of each other, it does not matter whether cyan or magenta is at 15°, they may be interchanged without affecting the resulting moiré. (Note: Complementary angles equal 90° when added together.)

Adjusting screen ruling

It turns out that screen angle is not the only determining factor in moiré. Screen ruling plays a role as well. When the four separations are not at the same screen ruling, then there is a possibility that moiré may appear in some areas of the image. However, not all methods of creating halftones electronically are capable of setting four separations at the same screen ruling while maintaining the correct angles. Therefore it is important to understand something about different methods of halftoning.

RT Screening

Up until recently, there was only one type of halftoning in the PostScript** world: RT Screening*. RT Screening is the type of halftoning that has been used since the introduction of the Linotype* RIP 1 in 1985. RT Screening is a patented Linotype-Hell technology that has been licensed to the industry.

One of the characteristics of RT Screening is that 15° and 75° angles are difficult to achieve exactly. In addition, the screen rulings in a set of separations may vary from one color to the next. This is unimportant in black & white work, but for color work it means that even if you do get the angles as close as possible, moiré problems may still crop up. What can you do? The best bet is to follow angle and ruling recommendations for RT Screening that give the best possible results for that method of halftoning.

Recommendations

In March, of 1989 Adobe** Systems Inc. released a list of recommended angles and rulings for color work. These angles and rulings, which were selected with specific imagesetter resolutions in mind, have been chosen to give the best results for color separations created with RT Screening. These recommendations (along with many other things) are enclosed in the PPD (PostScript Printer Description) files that come with Adobe Separator**. Other applications have similar methods for assigning screen angle and ruling. Aldus Freehand** and PageMaker** use APD (Aldus Printer Description) files. Aldus Pre-Print** uses APD and PDX (Printer Description Extension) files. QuarkXPress** has an extension that allows you to check Adobe Screen Values. If your application allows you to save your file as PostScript code, you can also go in and insert these numbers manually. If you would like a list of these recommendations, contact the author at the address on the back of this document.

HQS Screening

If the level of quality of RT Screening is not satisfactory for your application, you now have another option. You can choose the Linotype RIP 30 which uses a more accurate halftoning method: HQS Screening*, a patented technology from Linotype-Hell. HQS Screening allows angles and rulings to be achieved much more precisely. As a result of this accuracy, HQS Screening creates a tighter rosette that is much less susceptible to moiré. Because it is difficult to describe this in writing, a printed sample has been created that illustrates the point. In this case, a picture is worth a thousand words. Contact the author at the address below if you have not received a copy.

Measuring angle and ruling

Because screen angle and ruling are such critical factors in moiré, it is important to be able to measure them. (For more information on this subject refer to the technical information piece called *Measuring Screen Angle and Ruling*, part number, 3055.) A tool for measuring screen angle and ruling may be had by sending a self-addressed, stamped (three first class stamps), 9" x 12" envelope to the address below.

Predicting moiré

A good way to predict moiré is to examine your films carefully. Align your films on a light table so that each film can be lifted and compared with the others. To do this, use the magenta film as a base, and hinge the black, cyan, and yellow films to it. You will have to trim the films so that they will hinge properly:

- Magenta separation - Use as base, do not trim.
- Black separation - Hinge at top, trim 1" (or less) off the right and bottom.
- Cyan separation - Hinge at right, trim 1" (or less) off the top and bottom.
- Yellow separation - Hinge at bottom, trim 1" (or less) off the top and right.

Note: Depending on the orientation of your films, you may have to trim a small amount off of the hinge areas of the black, cyan and yellow separations to allow them to attach to the magenta film.

With your films hinged as described above, you can see potential moiré and where it will occur. The benefit of this method is that it allows you to predict moiré without having to create a proof. Be forewarned that what you will see is the absolute worst-case moiré. The black on the films is much darker than the actual ink colors, and as a result the moiré you see using this method will be worse than in the printed piece. This is particularly true of the yellow separation, since yellow is the lightest process color. To get the most accurate prediction, you should first overlay cyan, magenta, and black. Only use the yellow overlay to determine where conflicts with cyan or magenta may occur.

Conclusion

Moiré is a complex phenomenon with many causes. However, it is possible to predict its occurrence and to seek solutions that reduce it. In addition, a new halftoning technology available from Linotype-Hell produces screen angle and ruling much more accurately. HQS Screening minimizes the appearance of moiré and results in higher quality color work.

Comments

Please direct any questions or comments to:

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