Linotype-Hell

Technical Information

PostScript and Flexography

Today, most of the films output using Linotronic* imagesetters are printed by offset lithography. But a growing number of films, particularly in packaging, labels, newspaper, and specialty applications (like printing on foil and plastic), are printed using flexography.

Flexography was first introduced in the early 1900s. At the time it was called aniline printing because of the dyes that were used in the inks. Later it was renamed flexography because of the flexible printing plates that it used. Flexography's success is based upon several factors:

- Flexographic presses can use both solvent-based and water-based inks. The use of water-based inks makes it popular for environmental reasons.
- Flexographic presses can print on a wide range of substrates. (A substrate is the material that is printed on, i.e., paper, foil, plastic, cardboard, etc.)
- Jobs can be set up relatively quickly on flexographic presses and are very consistent over long press runs.

To understand how the PostScript** page description language is capable of meeting the requirements of the flexographic printing process, we'll have to look at the way that flexographic plates are created.

Flexographic plates

Unlike offset lithography, plates used for flexography employ a raised surface to transfer ink to the substrate. In this sense, flexography is similar to letterpress printing. Flexographic plates, however, are either made out of rubber or a flexible photopolymer. The plate is then wrapped around a cylinder, and inked to print an image. The flexible nature of the plate, and the raised surface result in one of flexography's primary characteristics: distortion. And because flexographic printing cylinders may be as small as a couple of inches in diameter, the distortion can be significant. This distortion must be accounted for if the printed image is to print correctly.

Distortion

The distortion of a flexographic plate depends upon two important factors: the thickness of the plate material and the diameter of the cylinder that it is wrapped around.

When you wrap a flexible material around a cylinder, the upper surface of the material will stretch some to cover the extra distance (see Figure 1). It is a little bit like the difference between racing on a straight track and racing on a circular one. If you manage to get the inside lane on a circular track, you ultimately have to cover less distance than someone in an outside lane.

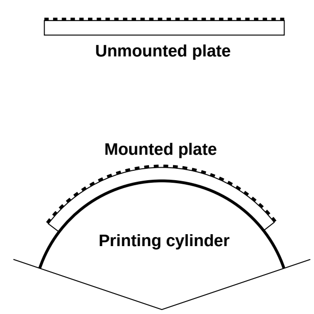

Figure 1 - Flexographic plate before (top) and after (bottom) mounting on the printing cylinder.

For plate materials made out of photopolymers, the distortion occurs in the direction that the material is wrapped around the cylinder. Where the material runs parallel to the shaft of the cylinder, there will be lit-

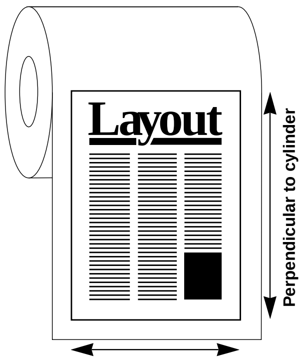

Figure 2 - The distortion of a photopolymer flexographic plate occurs perpendicular to the shaft of the printing cylinder.

tle or no distortion. (See Figure 2.) For plate materials made out of rubber, the distortion may occur in both directions. This is because in addition to the distortion caused by wrapping the plate around the cylinder, rubber plates tend to shrink in both directions after exposure and processing. This complicates the calculations needed to predict the distortion of a rubber plate.

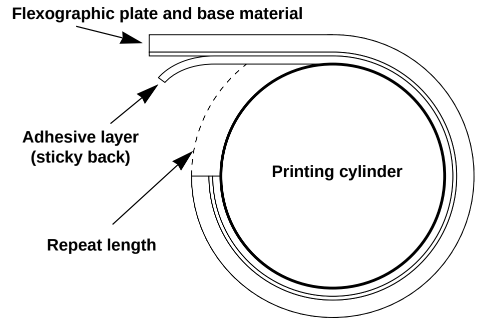

Figure 3 - Cross section of a flexographic printing cylinder showing the variables involved in distortion.

The amount of distortion is determined by several factors: plate thickness, base thickness, and repeat length. Repeat length is the circumference of the printing cylinder when it has had the plate and adhesive layer attached to it. (See Figure 3.) The adhesive layer used to attach the plate to the printing cylinder is often called “sticky back”.

Because of plate distortion (and other factors that will be covered later), it is very important to work closely with your printer. It does you no good to supply films that your printer cannot use. While it is relatively easy to supply films for offset lithography, supplying films for flexography is more difficult.

Distorting with PostScript

Historically, adjustments for plate distortion have been done photographically, but this process requires an expensive lens and is time-consuming. Distortions can be made on the electronic page descriptions in PostScript files, but the software program you are using must allow you to size the page disproportionately.[1] (Both Adobe Illustrator** and Aldus FreeHand** allow scaling to be handled independently in the x and y directions.)

[1]Refer to Appendix A for an example of the calculations used to determine distortion.

Some flexographic applications, labels for example, can be adequately handled using the text and illustration tools in Illustrator or FreeHand. However, for applications that require sophisticated page layouts the problem is more complex because most page layout programs don’t allow independent scaling. There are workarounds for this, but they are by no means simple. One possible solution is to have the distortion done in the RIP (Raster Image Processor). It is possible to download PostScript code that will cause a distortion to be applied to each page as it is RIPed. Linotype-Hell has developed some code that allows this type of distortion. For more information on this code, contact the author at the address at the end of this document.

Flexographic negatives

There is no intermediate blanket cylinder in most flexographic presses. This means that the ink on plate is transferred directly to the substrate. Therefore, unlike offset lithography, flexographic plates are usually made using wrong-reading, emulsion-down, negatives[2]. This is because the image is mirrored when it is transferred. (Offset lithography uses right-reading, emulsion-down, negatives. For a further explanation of this see the technical information piece entitled Analyzing Film Output, part number 3062.)

[2]Wrong-reading, emulsion-down is equivalent to right-reading, emulsion-up. Note: In cases where an image is being printed on a transparent material, if the image is to be printed on the surface, wrong-reading films are required. If the image is to be printed on the back (and viewed through the front), right-reading films are required.

There is some evidence to suggest that an imagesetter film with a matte emulsion forms a better seal with the surface of a plate material during exposure. (A pebbled or matte emulsion allows the air between the film and the plate material to evacuate more easily.) Du Pont recommends a film called Cronatype** for use with Cyrel**, their popular flexographic plate material. Cronatype is designed for imagesetters with a helium neon laser. To find out if other plate materials require matte film, check with the plate manufacturer.

Halftone dot shape

The shape of the halftone dot can play an important role in flexography. The characteristic checkerboard shape of a 50% halftone dot can cause a significant ‘midtone jump’ on a flexographic plate. Therefore many flexographers prefer a round halftone dot shape (that means one that starts out round, and continues to grow round rather than square off at 50%.) Offset lithographers usually stay away from a round halftone dot shape because it tends to plug up and print dark in the shadow areas.

PostScript has a lot of flexibility in the creation of halftone dot shapes, but not all software applications take advantage of this. Some may allow you to assign specific halftone dot shapes to scanned images but not tints. Others may use shapes that are not ideal, or, which may have names which do not truly indicate the actual shape. To see what a halftone dot shape will look like it is best to run some tests that allow you to get a look at the dot as it appears at 10%, 30%, 50%, 70%, and 90%. (For a further explanation, see the Linotype-Hell technical information piece entitled Digital Halftone Dots, part number 3060.) Where the application does not give you the halftone dot that you want, you may still be able to get it through the use of a printer description file (i.e., APDs, PPDs, or PDXs). These files control many aspects of the printed page, one of which is halftone dot shape.

The default PostScript halftone dot shape is round at the low percentages, becomes a checkerboard at 50% and is an open circle in the high percentages. In earlier versions of PostScript, the default shape was actually round throughout (see Figure 4), but this was changed to meet the needs of offset lithography. The code for this early PostScript halftone dot is extremely simple and can be patched into a printer description file (also known as an APD, PPD or PDX file) if you have some familiarity with PostScript code.[3]

[3]Refer to Appendix B for an explanation of this technique.

Figure 4 - A blend using the round halftone dot shape shown at a very low screen ruling so that the individual halftone dots are visible.

Screen ruling

Depending on the type of press and the substrate, the screen rulings used in flexography may range all the way from 45 to 200 lines per inch. However most commonly the rulings will be around 100 lines per inch. Historically, the inability of flexography to hold high screen rulings has been a barrier to its introduction into premium quality markets, yet recent award-winning entries in a flexographic printing contest were done at 200 lines per inch.

Trapping

Spread and choke values for flexography are usually higher than those used in offset lithography. (See the Linotype-Hell technical information piece on Trapping, part number 3057.) While a common offset trap might be 1/4 of a point (about 1/32 of an inch) a flexographic trap might go as high as 1/64" or higher. Check with your printer if you intend to include traps in your films.

Note: The term *trapping* may also be used to describe the ability of an ink to stick to a substrate that already has ink on it. You may prefer to use the terms *spread* and *choke* when talking with a printer to avoid confusion in this area.

Dot gain

Flexography has relatively high dot gain values. For example, one source claims that a 50% halftone dot may grow to 70% during printing. This amount of dot gain needs to be adjusted for to get good-looking printed output. A separate piece could easily be written about dot gain, however briefly, there are several ways adjustments for dot gain can be made. You can:

- Work with a calibration program like the one included in the Linotype Utility*, and underadjust the values keeping in mind the ultimate amount of gain. For example, if you know your amount of dot gain, you can predict that a 50% halftone dot may grow to 70%. If you were to draw a graph of this, you would be able to see what value really gives you a 50% dot. (See Figure 5.) It might be that a 36% dot grows to 50% on press. You could then calibrate so that when you asked for a 50% halftone dot from the imagesetter, it would actually give you 36%.[4]

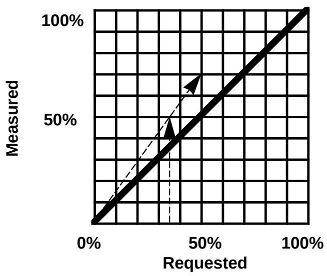

Figure 5 - When a requested 50% halftone dot becomes 70% because of dot gain, a 36% requested dot actually results in a 50% measured halftone dot.

[4]Adjusting a calibration curve in this manner results in lost gray levels, which may become visible in blends or scanned images. See the Linotype-Hell technical information piece entitled Calibration (part # 3075) for more information.

- Use the calibration facilities in software programs like QuarkXPress and underadjust in the manner described above.
- Make (under) adjustments to the transfer curve in a printer description file.
- In the case of tints or synthetic artwork (like Adobe Illustrator or Aldus FreeHand illustrations) you can consciously select tint values that are underadjusted, knowing that they will increase on press. Calibration can then be handled normally.
- In the case of scanned artwork, you may adjust your scan (by lightening it) to anticipate dot gain. Some image manipulation programs even include a special dot gain facility.
- Adjust dot gain through a menu item in a pre-press frontend system.

The important thing to be sure of is that any adjustments that you make will affect all halftoned elements in the page: tints, synthetic art, and scanned art.

Color separation

Given the difficulties involved in creating flexographic plates, it is best to start with single color text, line work, tints or halftones. Process color tints or halftones increase the complexity because of screen angle and ruling issues.

The angles used for color separation for flexography may appear peculiar compared to the angles used for offset lithography, however each value is only 7.5 degrees away from a commonly used offset lithography set.

Flexo:	Magenta - 7.5°	Black - 37.5°	Cyan - 67.5°	Yellow - 82.5°
Offset:	Magenta - 15°	Black - 45°	Cyan - 75°	Yellow - 90°

Another set, listed below, is the so-called ‘normal’ or ‘European’ set:

Flexo:	Yellow - 7.5°	Magenta - 37.5°	Cyan - 67.5°	Black - 82.5°

The reason for this 7.5 degree shift has to do with the inking system used in flexography. An engraved anilox roll with many tiny ink-holding cells is used to transfer ink to the plate. Because these cells are arranged in rows and columns (often at a 30 or 45 degree angle), there is a chance that this pattern might conflict to cause a moiré pattern with the screen angle and ruling of one of the separations. The 7.5 degree shift helps to avoid this problem.

HQS Screening*, the new halftoning algorithm from Linotype-Hell, allows screen angle and ruling to be specified much more accurately than with the earlier version of halftoning in PostScript (so-called RT Screening*). (For more information on RT Screening and HQS Screening see the Linotype-Hell technical information piece entitled Moiré, part number 3063.) Linotype-Hell’s existing recommendations do not cover common flexographic angles. However there is no technical barrier to doing this, it simply will require testing at specific resolutions and screen rulings.

The white plate

For flexographic applications that print on clear plastic, often a layer (or two) of white ink is printed first to overcome the transparency of the substrate. The creation of this white plate can be difficult with software applications that are not accustomed to supplying a paper white. Often a separate spot color must be created to serve as white. In addition, flexographic presses frequently print in a color sequence from light to dark colors. This must be anticipated during the pre-press process because of the effect order of printing has when opaque inks are used. (See the Linotype-Hell technical information piece entitled Trapping, part number 3058.)

Narrow web, wide web

The range of flexography applications is incredible, from packages of varying sizes to newspapers to labels. Some flexography presses are no wider than a few inches! Obviously, for this range of applications, no single pre-press solution can fit everyone's needs. For the current state of the PostScript page description language, one of the most promising areas is in the creation of films for so-called narrow web flexography[4]. Narrow web flexography is particularly appropriate for mass production of labels, envelopes, and forms.

[4]The web is the roll of paper that is run through the press without ever being cut. Presses that use cut paper instead of rolls are called sheet -fed presses.

Rotary letter press

Flexography is not the only printing process that uses plates with a raised surface on a rotary press. Rotary letter press (or RLP) is similar to flexography in terms of distortion, dot gain, and trapping, however it differs in the plate materials and printing press type. Therefore, many of the concepts that apply to flexography, also apply to rotary letter press.

PostScript pre-press systems

Making flexographic films using off-the-shelf PostScript software may be attractive for its economy, but it demands a high level of familiarity with both flexography and the PostScript page description language. Since very few people have this kind of knowledge, it can be extremely helpful to either get instruction from a company that specializes in it, or, to look into a specially-designed PostScript flexographic pre-press system. Linotype-Hell has compiled a list of suppliers of training and systems. Please contact the author at the address at the end of this document for more information.

Conclusion

All of the complexities of flexography cannot be suitably covered in so short a document. The issues of die cuts, bar codes, and step-and-repeat procedures have not even been touched upon. For more information concerning some of the non-PostScript aspects of flexography, a good text to refer to is :

- Flexography, Principles and Practices, Fourth Edition, Foundation of Flexographic Technical Association. This book is expensive ($65 for FFTA members, $95 for non-members), however it contains a wealth of information on flexography. The FFTA may be reached at 516-737-6026.

Appendix A: Distortion

The distortion of a photopolymer flexographic plate is pretty easy to calculate if you know some specifics about the plate material and the press to be used. (Refer to Figure 3 on the second page and the description below.) To calculate % reduction (i.e. distortion):

$$(2\pi \times (\text{Plate thickness - Polyester thickness})/\text{Repeat length}) \times 100\%$$

For example if the plate thickness is .112", the polyester base thickness is .005", and the repeat length = 15”, then the % reduction is 4.48%:

$$(2 \times 3.14159 \times (.112 - .005)/15) \times 100\% = 4.48\%$$

Note: The thickness of the polyester base is subtracted out of the calculation because it is unlikely to distort to the extent that the flexible upper portion of the plate will.

Your printer will know the plate and polyester thickness. They will also supply you with the repeat length. Repeat length is the circumference of the printing cylinder when it has had the plate and sticky back attached to it.) If you are interested in calculating repeat length, use the following formula:

2π x (printing cylinder radius + sticky back thickness + plate thickness)

For example, if the cylinder radius is 2.250", the sticky back thickness is .015", and the plate thickness is .112, then the repeat length is 14.937”:

(2 x 3.14159 x (2.250 + .015 + .112) = 14.935"

To use this information in a program that allows independent scaling in the x and y directions, use the technique in the following example. If your calculations predict a 4.48% distortion, the length of any object in the distortion direction will be increased by 104.48% (therefore a 10" line will be stretched out to 10.448"). To make the objects end up the correct size, you must reduce them by 95.71% (the inverse or 1/104.48%) in the distortion direction. In this case, you would change the appropriate dimension (either horizontal or vertical) in the scale menu from 100% to 95.71%.

Appendix B: Halftone dot shape

To access a round halftone dot shape via a printer description file, it is necessary to remove the existing code and replace it with the code for a round halftone dot. The easiest way to edit a printer description file is with a program called Lasertalk** although it is possible to use other text editing programs. The existing code, sometime referred to as the Euclidean spot function, is in a section in the printer description file called “ScreenProc” or “ScreenProc Dot” and will look like this:

```
{ abs exch abs 2 copy add 1 gt
{ 1 sub dup mul exch 1 sub dup mul add 1 sub }
{ dup mul exch dup mul add 1 exch sub } ifelse }
```

Replace it with this:

```
{ dup mul exch dup mul add 1 exch sub }
```

You should then rename the printer description file and use it as you would any other printer description file. If you run tests at a coarse screen ruling (perhaps 30 lines per inch) you can see if your edit has taken effect.

Comments

Please direct any questions or comments to:

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In addition, I would like to thank: Brian Lawler of Tintype Graphics, Ernie Menkes of Pres-Tige Label, and Bernadette Murray of FlexOgrafx.

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Company list

Here is a list of companies that are familiar with PostScript and flexography:

- **Graphic Service Seminars** (in San Luis Obispo, California) teaches a seminar for flexographic printers who want to start using PostScript to produce films. They can be reached at 805-489-9020. (Brian Lawler of Tintype Graphic Arts is a good resource and part of this organization. He may be reached at 805-544-9789.)
- **FlexOgrafx** (in Portland, Oregon) has developed a system called PrePress Manager which is a front-end system designed specifically for flexography. They can be reached at 503-227-5659.
- **Professional Computer Center** (in Langhorne, Pennsylvania) have a front-end system called the Professional PrePress System for packaging applications that is particularly useful for flexography. They can be reached at 215-860-5200. (But what guarantee do I have that they will sell this guy a L-H backend?)
- **Symbolics?** (in ????) have a front-end system called xxxxxx for packaging and corrugated cardboard flexography applications. They can be reached at xxx-xxx-xxxx.
- **Impostrip?** (in ????) do they have some distortion capability?