# Understanding The Pad In Pad Printing

*by Peter Kiddell*

Probably the most difficult question to answer about the pad printing process is, "How do I determine what pad to use?" One answer won't apply for every shop or application. Rather than lay down inflexible rules, this article will provide a methodology for determining the optimum pad characteristics and a framework you can work within to get the best performance from your pads time after time.

As prior articles in "Screen Printing" magazine ("Pad Printing: Controlling Ambient Conditions for Better Quality," July '94, page 94 and "Cliché Selection in Pad Printing" Nov. '94, page 122) have stressed the key to good pad printing is to reduce and control the variables. Though the function of the pad seems simple - to just transfer the image from the printing plate onto the substrate - it is subject to the same types of print-quality fluctuations if you don't choose the correct pad type and use it properly.

Five key pad characteristics can affect the quality of the printed image:

- shape
- size
- hardness
- surface finish
- material

Vary any one of these and the print quality will shift. You must take these factors into account when you plan the job and order pads from your suppliers.

**Shape and Size**

Shape is the most important variable in selecting a pad.

**Figure 1:**
It's important to choose a pad shape that will achieve a "rolling" action when the ink is both picked up from the cliché and deposited on the substrate. Without this rolling action, air can be trapped between the pad and either the cliché or the substrate, causing print distortion and pin-holes due to irregular ink pickup or deposition.

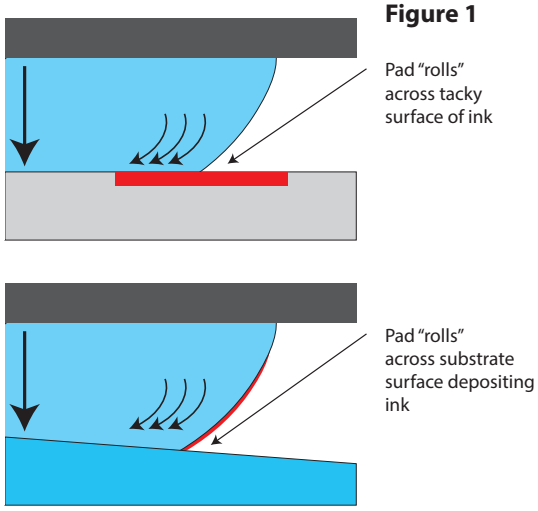


**Figure 1**

In order to achieve a satisfactory print, the pad surface must roll onto the cliché (plate) and the image area of the substrate, as shown in Figure 1.

The shape of the pad largely determines how well the pad will achieve this rolling action. This makes shape the most important variable in selecting a pad. Most pad suppliers have hundreds of pad shapes in their standard inventory. But most are based on these three basic shapes (see Figure 2):

- Round
- Rectangular
- Bar

Although hundreds of pad shapes are available, most are based on these three shapes: round, rectangular, or bar. Regardless of what pad shape you choose for a job, avoid pads with perfectly flat profiles, since these can trap air during ink pickup or deposition. For best printing results, use the largest pad size that is practical for the item to be printed.

Each of these shapes could have either curved or flat printing surfaces, depending on the nature of the part to be printed. But regardless of what shape the pad has, it must roll onto both the cliché and substrate for good printing results. Try to avoid flat-bottomed pads, as they have a tendency to trap air when they come in contact with the cliché, hampering ink pickup. Again, the more rolling action that is achieved, the more ink that will be transferred.

Another important variable to consider is pad size relative to image size. In screen printing, the larger the screen is in relation to the image size, the less distortion that will occur. The same holds true in pad printing. The larger the pad, the less the image is likely to distort. Often, the distance between the cliché and the body of the machine (sometimes called the "throat" of the machine) will determine the maximum pad size you can use.

Generally, most pad-printing shops will have a favorite shape that covers 90% of their applications. But standard shapes are available for all sorts of unusual applications. For example, many suppliers have standard shapes that will print onto oven-control knobs. These special pads have holes in them to accommodate the embossed portion of the knobs and allow the print to be applied to the beveled edge. So before you go to the expense of having a custom pad mould made, check with your suppliers to be certain that no such shape already exists. Nowadays, someone, somewhere should have a pad shape to suit your job. Remember, if you do pay to have a special mould made, your supplier will probably include the item in the next edition of its catalogue.

For unusual imaging needs, a custom pad may be used that combines two different profiles, as the one pictured to the right. Such pads are expensive and must be carefully designed to avoid print distortion. Often, a better alternative is to use two different pads and mount them together on the machine.

These "combination" pads are worth considering, but they can be expensive and they are prone to print distortions unless they are very carefully designed. A preferable solution is to use two separate pads and mount them close together on a single machine. The lower half on Figure 3 shows how the combination pad above could have been designed as two separate pads. Another advantage of using two pads is that if one is damaged, the cost of replacing it is much less. Always use as little pressure as possible to pick up and print the image.

**Use these guidelines when choosing a pad shape for a particular job:**

- First, try your standard pads that you think would do the job for this particular part. Do a test print to verify that the proposed print area is imaged accurately.

- If the pad shape you have chosen provides a satisfactory print over just a part of the area, look for similar pad shapes that extend the profile in a way that will cover the entire image. Distortion at the image edges is almost always caused by undersized pads.

- If the obvious pads fail, try ones that appear to be unsuitable. Maybe the pad has a sharper angle than would seem to be appropriate, or is clearly too large for the image. It still may solve the problem.

- Irregular ink pickup during the test print usually means that air is being trapped between the pad surface and the cliché. Watch carefully as the pad is being imaged to be sure that a rolling action is occurring.

- Whenever possible, ensure that the point or apex of the pad does not come into contact with the image area of the cliché. This tends to thin the ink at that point, causing an inconsistent ink deposit.

- If the pad is "overstressed" (that is, too small for the image) or the image is too close to the edge of the pad, distortion is likely to occur. Always use as little pressure as possible to pick up and print the image. If the machine is running too fast, excessive pad pressure can cause distortion as well as poor ink transfer.

- If your experimentation doesn't reduce the print distortion to an acceptable level, and a custom pad is out of the question, your last resort is to distort the image on the cliché to compensate. This is often done by printing a grid onto the substrate and measuring the distortion of the grid to guide you in the alterations that must be made to the original artwork. This will shorten the time it takes you in test printing, but it won't eliminate the trial-and-error altogether. This method also leads to ongoing problems since positioning of the part and the pad (relative to the image on the cliché) must be absolutely dead on each time the job is set up to avoid distortion. We have heard that computer software packages are available that will do this work, but none are known to us.

**Hardness**

The hardness of the pad is normally determined by the amount of silicon oil used when the pad is molded. The harder the pad, the less silicone oil that was added. Four basic pad hardnesses are standard in the industry and cover most applications. Customs pad hardnesses are available through most pad suppliers. Many pad manufacturers color code the four standard hardnesses by adding pigment to the silicone itself or by coloring the pad base. Not all manufacturers use the same code, but the typical color designations by pad hardness are:

| Color | Hardness |
|---|---|
| Blue | 550 Shore (+2) |
| Pink | 500 Shore (+2) |
| Green | 450 Shore (+2) |
| White | 350 Shore (+2) |
| Yellow | 350 Shore (+2) |

As a general rule, the harder the pad, the better the performance. However, a hard pad may be impractical in some applications, such as when using a low-power machine or printing onto a delicate item. Choosing the proper pad hardness for a job is a matter of experimentation and experience.

Special 550 Shore pads are available for printing onto abrasive substrates and textured finishes. Two such applications include the turn-signal control arms and windshield-wiper control arms of automobiles, which are molded in glass-filled nylon. A heavy white ink is required, and the pad must resist the abrasive nature of the substrate.

A useful tool for all pad printers is a durometer gauge for determining pad hardness. This simple tool (the same one you would use to measure the Shore hardness of a squeegee) is available through silicone-rubber suppliers and many general-service dealers in the screen - and pad-printing industries. You can now purchase pads with a "ready to use" finish.

Maintaining accurate pad hardness can be problematic for some pad manufacturers, making the durometer gauge an ideal quality-control device for incoming pads.

**Use the following guidelines for pad hardness when selecting your pads:**

- Hard pads are most suitable for textured surfaces you can also use them when you need to print an image in a recessed area next to a raised surface and the pad will have to roll over the "step".
- You can also use hard pads in a pad "nest" or matrix, when you must fit a single machine with numerous pads that are spaced with small gaps between them (for example, when printing computer keyboards).
- Use softer pads when printing onto heavily contoured surfaces. Also use them when printing onto fragile items.
- You must use a softer pad is the power of your machine can't compress the pad sufficiently to achieve a satisfactory rolling action.
- Avoid using pads of different hardnesses on the same application, or the thickness of the ink deposit will vary on the substrate. This is particularly true when dealing with a pad matrix.

**Surface finish**

Throughout the pad-printing industry, the custom practice among pad manufacturers is to furnish pads with a high gloss finish. Users have had to "matte" the pad surface - that is, remove excess silicone oil that creates the glossy appearance - to enable the pad to pick up and transfer ink during the printing process. Typically, pad printers will use a strong solvent such as a fast thinner for the initial silicone-oil removal. But, excessive

use of such a strong solvent damages the pad and shortens its life.

You can now purchase pads with a "ready to use" finish that virtually eliminates the need to matte the pad. With these pads, the base rubber material is very close to the desired pad hardness, so the manufacturer adds much less silicone oil, if any.

After you matte the pad (if necessary), the only other step that must be taken prior to production is to gently wipe the pad with an alcohol-based pad-cleaning fluid. This removes any free silicone oil that can sometimes leach out of the pad. Once you have used the pad, however, the best way to remove solid debris, dried ink, and dust is with a quality brown packaging adhesive tape. By following this simple procedure, you will improve your print quality, reduce downtime, and prolong the pad's life.

Some pad suppliers provide a "**rejuvenating oil**". This is basically a silicone spray that can be applied to the pad surface when it becomes dry due to the removal of silicone oil by aggressive thinners. It can help prolong pad life, but spraying silicone spray anywhere near a surface that has to be decorated is a recipe for disaster. Because of the potential problems, using such oils is not recommended.

We have come across two extreme cases of pad abuse: The first company soaks their new pads in a solvent tank for four hours prior to use, while the second company has a press dedicated to "running in" new pads before they are used in production. Pads have a limited print life, they are susceptible to mechanical damage, and they are not cheap. Such extreme measures make very poor use of your investment.

**Material**

This topic refers not only to the material of the pad itself, but also the base onto which the pad is mounted. For example, you may order pads mounted onto aluminum bases rather than wooden ones, the advantage being that the pads can be mounted very accurately on the machine. Pads with wooden bases rarely are supplied with holes drilled into the bases for attaching to the pad holder of the machine. This means that the printer usually screws the pad in himself, making it difficult to get repeatable pad positioning. Also, with wooden bases, you use wood screws. If these screws are taken on and off several times, the base becomes loose. On several occasions, we have seen pads literally fall off the machine during the print cycle because of this problem.

Aluminum bases are better because they come with predrilled holes, so there is only one position to mount the pad on the holder or backing plate. Also, unless you have a very heavy-handed press operator, the threads of the screws are not easily damaged. This means that it is simple and quick for press operators to mount or replace pads. Choosing the proper pad hardness for a job is a matter of experimentation and experience.

Similarly, if a setup requires multiple pads (such as a matrix), aluminum bases are preferable because they will make pad positioning easier and more repeatable. One further advantage of aluminum bases is that they can be recycled with your pad supplier.

If you are using a long-bar pad that does not have an aluminum backing, then back the pad with either aluminum or a thicker piece of wood. This will prevent the base from bending when it comes into contact with either the cliché or the substrate. Such bending can cause print distortion or prevent the pad from picking up the image entirely.

Recently, pads have appeared on the market that are molded onto a nylon-type base material, offering the advantages of aluminum at less expense. These pads are also delivered in a protective clear vacum-formed plastic that you can use to store the pads, while they are not in use.

Regarding the pad itself, virtually all pads today are made of silicone rubber. The first printing pads were made of gelatin, although there is some evidence that inflated pig bladders were used in the UK pottery industry at the beginning of the 20th century. Only a limited range of pad shapes were used at that time due to the mechanical properties of the gelatin. The printing surface was much flatter than modern pads since gelatin lacks the elasticity of modern silicone rubbers. These older shapes have come back into fashion with the very hard pads currently being used in compact-disc decorating.

Certain pads can be recycled (sometimes called "recovered" or "resheathed"). Large pads are very expensive. To reduce the cost of replacing pads, some printers will send their worn or damaged pads back to their supplier. The supplier cuts the surface of the pad away and inserts the remaining rubber into the mould where the replacement pads are created, reducing the amount of new silicone rubber that is needed. The new material cures and bonds onto the old rubber and the finished pad performs like new, with a savings of up to 50% over the cost of a new pad. If your pad has been split or broken down internally, however, it cannot be recycled.

Some pad manufacturers will use recycled material and mix it with new silicone rubber. As long as the pad surface is "virgin" silicone rubber, this practice is perfectly acceptable.

Special pads for large images
In some situations, a large image area must be printed and the machine does not have the power to compress such a heavy pad in a smooth motion. Two solutions to this problem are available.

The first is to use a pad with a hollow interior that provides the same surface hardness. This technique also reduces the cost of silicone rubber for such a large pad. The second option is a dual-hardness pad, where the core of the pad is made of a softer material and the outer layer is the harder rubber. Both methods can help, but the second produces a more stable pad. (A third option, of course, would be to use a different imaging process such as screen printing for larger image areas).

We're aware of another very unusual pad configuration that is a bit reminiscent of the inflated pig bladder concept. This involves very specialized machines that use hollow pads that are inflated with air just prior to ink pick-up. The pad stays inflated until it comes into contact with the substrate, when the air is evacuated. The deflated pad can conform to a wider area of the substrate, allowing 180° of a sphere to be printed (with standard pads, the largest angle that can generally be printed onto a cylinder or sphere is 100°.) One sample application is multicolor beach balls, where cartoon characters are printed directly onto the surface of the inflated ball. This technique is a cheaper alternative to in-mould labels for such specialized work.

**Quality control of pads**
Poor-quality consumables like pads can destroy the performance of the printing machine. When you receive pads from your supplier, it's vitally important before accepting them to check the pads for:

- blemishes on the print surface
- foreign particles in the print surface, such as wood splinters
- "nipples" on the print surface
- firm attachment of the pad to the backing plate (The pad should be secure, with no air bubbles that will cause the rubber to come away from the base.)
- hardness within +20 Shore (using your durometer gauge)

- positioning on the backing plate (It should be concentric, with its vertical center line at a 90° angle to the backing.)

- height (this is particularly important in multiple-pad applications). Report any defects to your pad supplier immediately so that replacement pads can be furnished.

**Pad Life**

Next to "What should I use?", the most difficult question to answer is "**How long should a pad last?**" Pads are like most things in life: The better you treat them, the longer they will last. Mechanical damage, aggressive solvents, and poor storage all take their toll. But the real killer is a careless operator. Some press operators have been known to pull a pad completely off its mounting plate during cleaning. If you make your staff aware of how much pads cost, they may treat them with more care. *Use a softer pad if the power of your machine can't compress the pad sufficiently to achieve a satisfactory rolling action.*

It isn't unusual for pads to last 50,000 prints. Going substantially over 50,000 prints isn't common, though. We know of one claim that a pad lasted 500,000 impressions, but we saw the 500,000th print and it looked pretty dreadful. Conversely, some pads are irreparably damaged before they print a single item. Usually, this results from a poor setup, when the downward motion of the pad during ink pickup or deposition is far too long, resulting in the destruction of the pad.

Although no hard and fast guidelines regarding pad life are available, you can take a number of steps to get the most life from all your pads:

- Use a strong solvent only for initial removal of the silicone oil on the surface.

- Use a mild solvent such as alcohol, or preferably an adhesive tape, if the pad must be cleaned during production.

- Always use an adhesive tape to remove debris and dried ink before starting a production run.

- Don't use too much pad pressure.

- Ensure that the substrate is free of debris, particularly sharp particles, before printing.

- With wooden-backed pads, don't allow the mounting screws to penetrate the rubber.

- When possible, avoid printing near sharp substrate edges.

- Use as large a pad as is reasonable for the job.

- Never store a pad on top of another.

- If pads are supplied in a protective shell, use it when storing the pads in your shop.

- Handle and store the pads very carefully.

One other point about pad life: Certain inks have aggressive solvents that will be absorbed by the pad during printing, much as squeegees will absorb solvents during long print runs. This absorption will cause the image to "grow" on the pad, to the point that it will eventually affect the print quality. At this point, you must stop the machine and replace the pad. This isn't a permanent condition, though: If you allow the original pad to

stand, the solvents that have penetrated into it will evaporate, returning the pad to its normal surface finish. You can accelerate this process by warming the pad.

**Conclusion**

Although the importance of pads is sometimes overlooked in the field, remember that the process derives its name from these silicone-rubber image carriers. Correct selection and care of pads is essential. As with any process, pad printing has its limitations and it's best to understand those before you choose a pad. Common sense and experimentation will guide you. Overall, keep the pad surface in good condition, and it should serve you well.

**About the author**

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