SQUEEGEES

Well, there was some fancy stuff at FESPA, high speed, high tech, high priced, high excitement and on some stands as high as a kite. But did you remember your rubber! If not the outcome could be very expensive.

There now you are focussed.

How is it that the one of the key parts of the screen printing process is so misunderstood. Most people say it is made of rubber when in fact it is polyurathane. From fantasy to reality in two sentences.

The squeegee has two functions and only two functions. Bring the stencil into contact with the substrate and cause the ink to flow through the open areas of the mesh. If it does anything else it will have an adverse effect on the process. Split the stencil, stretch the image, smudge the print, create dot gain, abrade the mesh, de-laminate the stencil, damage the substrate, alter ink film thickness and destroy profits etc.etc. All effects that can be achieved by misusing the squeegee. These negative factors can be eliminated and the screen printing process can reach its full potential.

THE TECHNICAL BIT

Squeegees are made of a Polyurethane Elastomer this is an engineering grade synthetic polymer. Polyurethane derives from two main chemicals: diisocyanates and polyols. The diisocyanates used in the mixture are naphthalene diisocyantate (NDI) and diphenylmethane diisocyantate (MDI). It is the NDI and MDI that you need to remember. The rest is to confuse the editor. The physical characteristics that are effected by the choice of material are:

Hardness. The most commonly recognised characteristic. Hardness plays a dominant role in a squeegee bending and wear.

Elastic Modulus. This controls the stiffness and can vary from one manufacturer to another with squeegees of equal hardness.

Abrasion Resistance. High levels ensure longer life.

Tear Strength. Resistance to tearing maintains the printing edge.

Chemical Resistance. The constituents of ink can cause the material to swell and become unstable.

The key issues are that when comparing the performance of MDI against NDI the NDI polyurethane is tougher than MDI. The tear strength of NDI is twice that of MDI. Abrasion resistance of NDI is consistent across all hardness ranges whereas MDI starts of with a lower abrasion resistance and gets worse as it gets harder.

NDI is more expensive than MDI but if you use the squeegee properly NDI is better value for money. Machine downtime is reduced significantly and that will save you far more than a few percentage points on the cost of squeegee material.

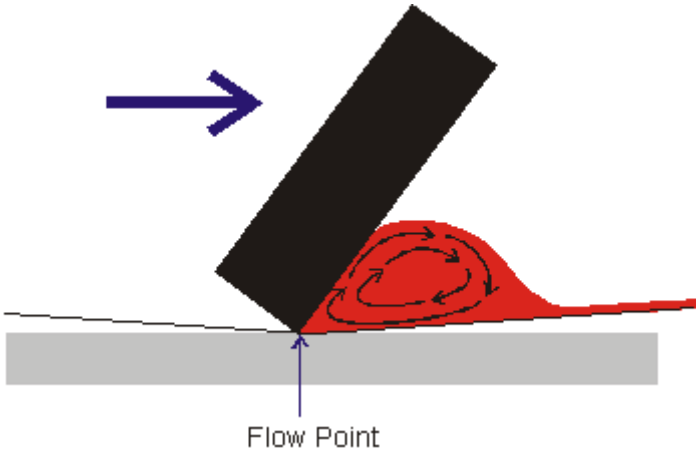
As a printer how do you get the best out of your squeegees? You have to understand what it does and how it fits in to the whole process.

THE ACTION OF THE SQUEEGEE

As the squeegee moves through the ink on the top of the stencil, it creates a wave in the ink. Within this wave, the ink is circulating with the effect of the bulk of ink rolling in front of the squeegee across the stencil.

As the ink rolls the pressure system within the wave keeps the majority of the ink in motion but not flowing through the mesh openings. The ink flows through the mesh openings at the point where the tip of the squeegee is in contact with the open mesh. The amount of ink that flows into the mesh is determined by the angle created by the shape of the tip at this point. The angle is that between the mesh and the tangent to the curvature of the tip

FIGURE 1. EFFECTS OF PRESSURE SYSTEM



As the angle gets smaller the amount of ink increases up to the maximum that the mesh will permit. For the sake of simplicity the point on the squeegee at which the ink is caused to flow through the mesh, openings should be known as the “Flow Point”.

How do I come to this conclusion? By looking carefully at the process and seeing the changes that occur. In addition, data gathered by experimentation.

Printers understand certain “facts”.

1) Increase the pressure on the squeegee and ink deposit increases.
2) A damaged squeegee creates lines in the print.
3) Assuming you maintain the condition of the ink during a print run, the thickness of the ink deposit will increase as the run proceeds.
4) The major angle that you set the squeegee effects inks deposit.
5) A soft squeegee puts down more ink than a hard squeegee.
6) The performance of a moulded squeegee is less effected by changes in the set major angle.
7) A fast squeegee stroke puts down less ink than a slow squeegee stroke.

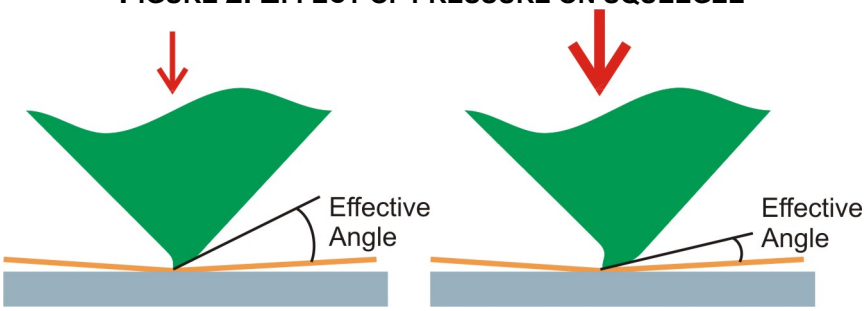
These are all known conditions which skilled printers will have strategies to manage. These strategies will vary from person to person. I want to use them to demonstrate how the process works.

Taking these seven points:

INCREASE THE PRESSURE ON THE SQUEEGEE AND INK DEPOSIT INCREASES

This is where most misconceptions occur in the understanding of the process. “Every printer knows if the squeegee pressure is increased more ink is printed down.” Therefore, the assumption is that squeegee pressure that forces ink through the mesh. No! Increasing squeegee pressure distorts the tip and reduces the effective angle at the Flow Point resulting in a higher flow rate.

FIGURE 2. EFFECT OF PRESSURE ON SQUEEGEE

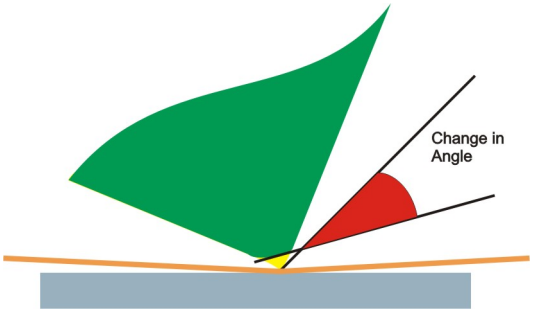


Small increases in squeegee pressure reduces effective angle

A DAMAGED SQUEEGEE CREATES LINES IN THE PRINT

Where there are nicks in the edge of the squeegee the effective angle is reduced at the point of damage resulting in increased ink flow at that point. The effect being to create lines along the print at that point. (This effect can also be seen if there is damage to the flood coater or on a coating trough used for applying emulsion to the mesh.)

FIGURE 3. DAMAGED SQUEEGEE



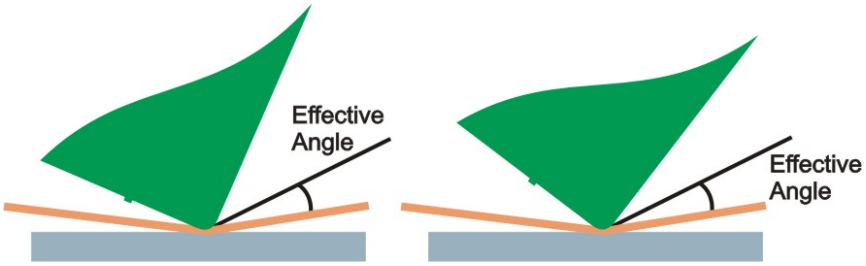
ASSUMING YOU MAINTAIN THE CONDITION OF THE INK DURING A PRINT RUN, THE COLOUR PRINTED WILL INCREASE IN DENSITY AS THE RUN PROCEEDS

Polyurethane is chosen for its resistance to abrasion; even so, the edge will wear during the run. This will result in a more rounded profile that will produce a shallower angle and greater ink flow.

THE MOUNTING ANGLE THAT YOU SET THE SQUEEGEE EFFECTS INK DEPOSIT

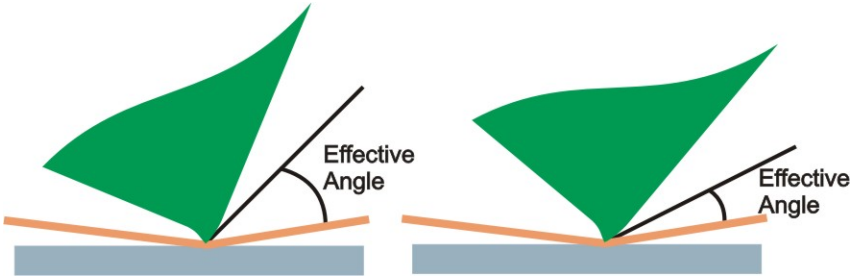
With a newly sharpened squeegee, the major angle will effect the effective angle at the "Flow Point". (See figure 6)

FIGURE 4. THE EFFECT OF MAJOR ANGLE CHANGE



THE PERFORMANCE OF A MOULDED SQUEEGEE IS LESS EFFECTED BY CHANGES IN THE MAJOR ANGLE

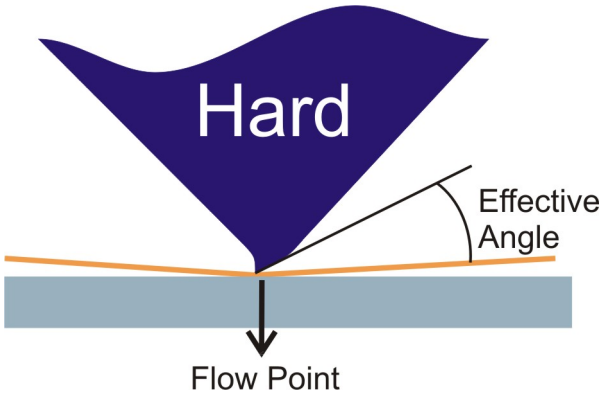
A moulded squeegee has a rounded edge that is produced during the moulding process. This is compared to the sharp right angle produced by the cutting action of the blade used in the production of conventional squeegee. With a moulded squeegee the effective angle is at a tangent to the rounded edge therefore as long as the rotation caused by changing The major angle keeps the Flow Point on the circumference of the rounded edge the effective angle will remain the same.



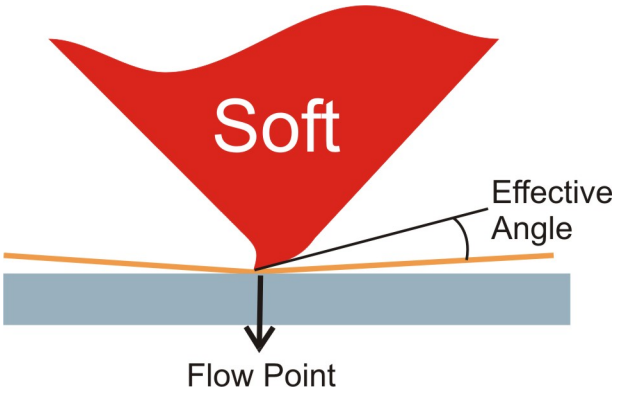
A SOFT SQUEEGEE PUTS DOWN MORE INK THAN A HARD SQUEEGEE

A softer squeegee will distort more at the tip than a hard squeegee and the effective angle will be reduced resulting in greater ink flow.

FIGURE 7. EFFECT OF HARDNESS



Less distortion of tip with a hard squeegee, large effective angle.



More distortion smaller effective angle soft squeegee.

A FAST SQUEEGEE STROKE PUTS DOWN LESS INK THAN A SLOW SQUEEGEE STROKE

Ink requires time to flow through the mesh opening. It will only flow when the “Flow Point” is over a mesh opening. Therefore faster squeegee travel means less flow, slower means more flow.

From these various examples, it can be seen that the effective angle at the “Flow Point” is crucial to ink flow through the mesh. Any condition that alters this angle will effect ink flow. Interestingly experiments have shown that a soft squeegee and a harder squeegee will produce the same ink flow if the squeegee pressure is kept to a minimum such that the effective angle at the “Flow Point” is not effected. Why we see the difference in production is that it is very difficult to control the loading on a squeegee without the use of load cells. Normally the indication is air pressure on the squeegee cylinders, which for the same pressure will distort the tip of a soft squeegee more than a hard.

The extreme condition is where excessive pressure is applied to the squeegee and it deforms to such an extent that the tip is no longer the contact point but the front surface of the squeegee blade is actually being pushed onto the surface of the stencil. This is disastrous as the angle is completely out of control the excessive pressure is stretching the mesh and distorting the image and the squeegee could even aquaplane on the ink.

The conclusion that has to be reached over squeegee performance is to use as little force as is necessary to bring the stencil into contact with the substrate and then move the squeegee. Any additional force will distort the effective angle at the “Flow Point” and create an unstable ink flow. Less force will mean less wear on the squeegee and maintenance of the effective angle for a longer period.

Yes I know there are times when you have to put excessive pressure on the squeegee if the surface to be printed is uneven. There is a lot more to be written about squeegee selection, type and mounting. The basic principle applies, ink flow happens at the “Flow Point” and there is an effect that is the amount of time each individual mesh opening is subjected to the “Flow Point”. It could be argued that a softer squeegee provides a wider point of contact and therefore maintains the flow pressure for a longer period over a mesh opening resulting in more ink passing through the mesh. There is a Doctorate in there for somebody.

Let us not forget that there is another mechanism when the ink comes into contact with the substrate that helps pull the ink out of the mesh. That is the secondary force. Where the intimate contact between the two produces an attraction which extracts the fluid from the opening. There we are back at FESPA.