# IT'S ONLY A SCREEN

Over the years we have worked with hundreds of companies improving the performance of the screen printing process. I cannot recall a single occasion when all those working directly with the process had looked closely at the mesh. When given the opportunity to view it through a 50x magnification mesh counter the reaction ranged from "Cor it's like the strings on a tennis racket" to "Does the ink have to get through those holes?"

Mesh meters ink or printing medium onto the substrate in the screen printing process, it carries the emulsions or films that create the outline of the image in the stencil. Mesh is the main factor in determining the ink film thickness in all but the finest of lines and tones, when the EOM (Emulsion Over Mesh) has an effect. The energy held in it in the form of mesh tension is the hidden energy of the screen printing process that overcomes the tack (stickiness) of the ink and maintains stability of the stencil.

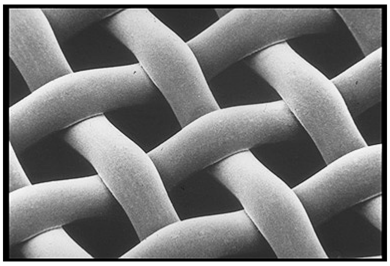
A question that stumps most people is: How many mesh openings are there in one square centimetre of 120 Threads per Centimetre mesh? Believe it or not he most common response is 120! Now that is scary, particularly when the correct answer is 14,161.

In one square metre of mesh the number of mesh openings are: ((120 x 100) - 1) x ((120 x 100) –1) = 1439976001.

Yes! **One thousand four hundred and thirty nine million, nine hundred and seventy six thousand, and one!** That is one heck of a lot of holes. Understanding this enables us to see the mesh from a different perspective. The aim is to enable the ink to flow consistently through every one of the holes that are left open in the image area.

Mesh is a finely engineered product that requires very sophisticated weaving machines a great deal of skill and technology to produce the consistent quality that the mature screen printing industry requires. Quite simply if is cheap its likely to be more use for catching flies than printing.

**Highly magnified image of mesh**



Many attempts have been made to replace woven mesh as the basis of the screen printing process, only in the electronics industry where stainless steel masks are used for depositing solder paste has this proved successful even here the mesh has not been replaced it has been removed altogether.

Other efforts have been based on piercing polyester film to create the image have proved to be less successful than the stainless masks. We are left with a finely engineered woven membrane that is used to meter the amount of ink or printing medium onto the substrate, simply mesh.

Understanding the mesh and its characteristic is the core of screen printing.

You are just about to hear the sound of Grandma sucking eggs, but here goes.

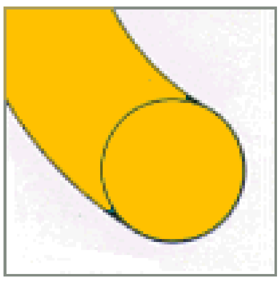
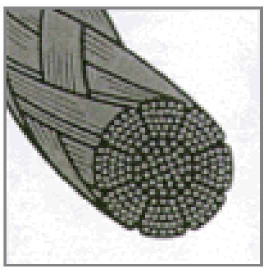
## MATERIALS

Nowadays there are three thread materials used in the weaving of screen printing mesh. Polyester, nylon and stainless steel. In graphics printing Polyester is the preferred fabric. For uneven surfaces such as plastic bottles the elasticity of nylon is very useful it also highly abrasion resistant. Because of its elasticity nylon (polyamide) not ideal for close tolerance work. Stainless steel is completely different, low elongation allows very close tolerance work and finely controlled print film thickness. Polyester meshes are improving and have become more stable with lower elongation and the ability to hold higher tensions. Where the materials approach each other in print characteristics is when polyester mesh is given a nickel coating by electro-deposition. This coating helps reduce elongation and improves stability. As it conducts electricity it can be used for heating thermoplastic inks, which is the also case with stainless mesh. I have never used nickel coated mesh always going to stainless mesh when I require these characteristics. I would be interested to hear the reasons for using the coated mesh in preference to stainless steel. Please get in touch.

Having made the first decision as to the mesh material the second is the mesh count and the thread diameter. This will largely determine the amount of ink that will flow through the mesh and the fineness of the image that can be printed. Then there is the type of weave that is used.

## POLYESTER THREAD

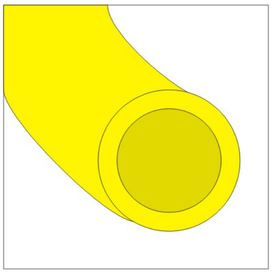
The thread material is extruded polyester. This is monofilament, which means it is a single thread rather than multifilament.

| Monofilament | Multifilament |
|---|---|
|  |  |

With very few exceptions screen printing mesh is made from monofilament, multifilament tends to be used as filtration mesh, which is closely allied to screen mesh.

There are also co-extruded threads where the core material differs from the sheath the intention is to produce a thread that makes use of the beneficial properties of both materials.

**Co-Extruded Monofilament**



### LOW ELONGATION/HIGH MODULUS

Virtually all modern polyester meshes are Low Elongation polyester that means for a given force applied the amount they will stretch is less than conventional polyester mesh. Also when tension is applied to warp and weft (Screen fabric comes on a roll the warp threads are along the length of the roll and the weft threads are across the roll) the difference in elongation is minimal between the two. This consistency is achieved by the sophistication of the weaving process and the material used. In conventional textile weaving the warp threads tend to be stronger.

The Modulus of Elasticity is determined using a tensile testing machine, this will stretch the thread to destruction and measure the loadings applied. Polyester thread has three states:

1) At rest under no load.
2) Under load (tension) in its Elongation (Elastic) Phase. Whilst within this phase it will return to its original length when the load is removed.
3) Under load in its Plastic Phase. If the load is removed the thread will recover but not all the way to its original length. Continued application of load will cause it to break.

Screen printing uses the energy stored in the mesh during its elastic phase to pull the mesh out of the ink film. It is the hidden energy of the process. If it is varied the quality of ink laid down will change as will the size of the image.

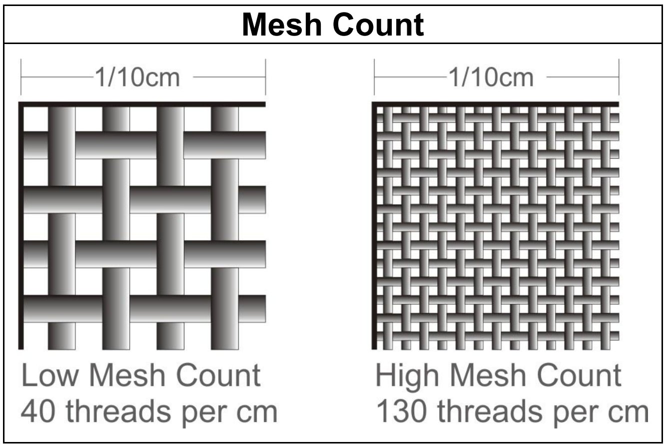
There are some extraordinary claims made by practitioners who believe in using very high mesh tensions on self tensioning frames. They will claim that mesh "work hardens" if it is tensioned several times over and because of this it is possible to work at these elevated tensions. When you speak to the polymer chemists the politely say that there is factual elasticity in these statements. What is happening is the mesh is taken into the

Plastic Phase and is inherently unstable, retensioning simply takes it closer to failure. The mesh will perform at its best within its Elastic Phase. You will achieve extended life and the image size will be consistent

## MESH GEOMETRY

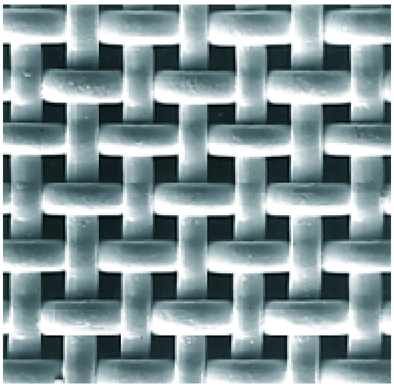
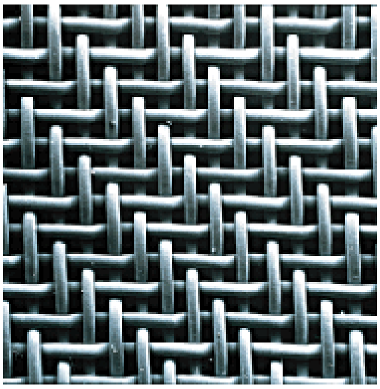
- Mesh geometry will affect:
- Printability of half-tone and fine line images
- Edge definition of the print
- How the ink releases from the mesh
- The maximum printing speed
- Thickness of the ink film
- Ink consumption
- Ink drying

Mesh is a precisely woven material that can be provided in a range of sizes. How one varies from another is in terms of mesh count, thread diameter, weave, colour, thread type and surface finish of thread. The most common way to differentiate between meshes is by mesh count. Simply mesh count is the number of threads per linear centimetre. In the US it is still often given in threads per inch. For example: 120 Threads per Centimetre t.p.cm is equivalent to 305 Threads per Inch t.p.i.




For a given mesh count there can be more than one thread diameter. For example a 90 t.p.cm mesh can have thread diameters of 40, 49 and 50 microns. This in turn will affect mesh openings and thickness of the mesh.

Generally meshes are plain weave; that is one over one under.

| Plain Weave Mesh | Twill Weave Mesh |
|---|---|
|  |  |

Twill weave meshes are available in some mesh types and normally for mesh counts above 120 t.p.cm. If you do use them their performance will be different to a plain weave of the same mesh count. The twill weave has a tendency to put more ink down but the contact between the knuckles of the mesh and the substrate can interfere with the spread of ink in the image area, particularly on fine lines. You must be aware of the characteristics and always specify precisely what you want.

So how do you decide on the mesh, well often the ink manufacturer will advise you but really you should look at the mesh specifications provided by the mesh supplier. These are in the form of tables.

A simple rule is the smallest dot you can reliably print is the diameter of thread plus mesh opening.

Then you use the figure for Theoretical Ink Volume (TIV) as a guide to the wet printed film thickness. Normally the wet film thickness is greater that the TIV

Taking the 120 t.p.cm as a typical mesh the different thread diameters will give the following:

| **Extract from Data SHEETS FOR 120 t.p.cm Mesh** | | | | |
|---|---|---|---|---|
| Thread Diameter | Mesh Opening | Theoretical Ink Volume | Film Thickness | Tension Values |
| 31 microns | 49 microns | 17.2 cm3/m2 | 17.2 microns | 21 N/cm |
| 34 microns | 45 microns | 16.3 cm3/m2 | 16.3 microns | 28 N/cm |
| 40 microns | 47 microns | 13.0 cm3/m2 | 13.0 microns | 38 N/cm |

The finer the thread and hence larger the mesh opening the finer resolution can be printed. However the ink film thickness will in this instance be greater. As the thread gets thicker the working tension can increase.

When using low mesh counts say 32 t.p.cm, with a thread diameter of 80 microns the tension can be as high as 50 N/cm.

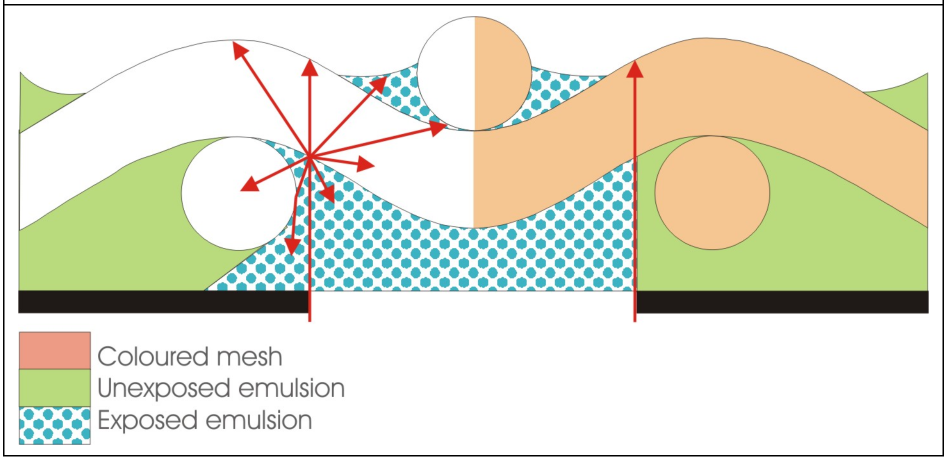
The tensions stated are based on a high quality square frame with 1 metre long sides. As the frame gets bigger for 2 metres less 20%, 3 metres less 25%. Remember printing with a mesh increases its tension with the action of the squeegee and you must be careful not to take it into the Plastic Phase

### SURFACE FINISH

Reducing the surface energy of the mesh by pretreating it in various ways has been a real bonus to the stencil maker. Reduced process times due to the fact that the mesh doesn't need degreasing. Better wetting with the emulsion or film. Improved ink flow and easier screen reclamation makes these meshes a must have to the stencil maker and printer.

### MESH COLOUR

Effect of Coloured Mesh

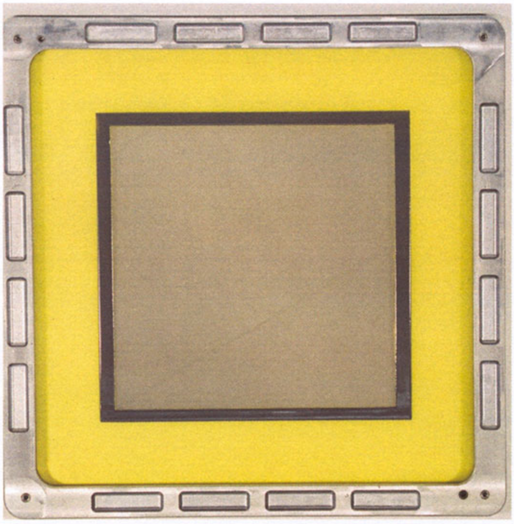



Mesh colour is the final issue. Yellow and Orange are preferable to white if fine detail is important. The colouring reduces light scatter through the threads. White is really only recommended when exposing with direct projection where the lower level of Ultra Violet dose could be unacceptably reduced by yellow or orange coloured mesh.

### STEEL MESH

Used extensively in the electronics industry the stability and very low elongation is ideal for extremely close tolerance printing. Wire (thread) diameters as low as 16 microns mean mesh interference is kept to a minimum. The downside to steel mesh is that it is prone to damage if handled roughly. Life of the screen can be extended by the combination of Polyester and Steel in what is known a trampoline screens. This technique recently refined provides the flexibility of polyester with the stability of steel.

**Trampoline Screens**



Courtesy of G Bopp

As the screen printing process comes under greater pressure from digital printing expect to see more innovative developments in mesh technology. Space in the journal doesn't allow me to go into every aspect of mesh technology and use but the manufacturers have a vast reservoir of expertise available to the user. If all you did was to read the Technical Data Sheets and articles they are happy to supply you will get much better use out of the foundation of the screen printing process. Go on take the risk educate yourself.