Water-based Screen Printing and Relevant Stencil Chemistry

Mark Making
Wonderful textures and litho-like washes can be achieved when using Mark Resist 150 microns, which is a finely grained drawing film. It is imperative that you work on the grained side or sensitive washes cannot be accomplished; also this film is thin enough to take rubbings. Remember that this is a positive process which means that any marks that you make will print. Here is a list of useful implements and materials for mark-making:

Soft graphite, chinagraph pencil, soft litho crayon, Faber-Castell TG1 drawing ink, Daler Rowney acrylic black, various brushes, litho sponge, sandpaper (fine, medium and coarse),
methylated spirit, fine dip pen, Faber-Castell Pitt artists pen, scalpel and an old toothbrush.

It is extremely important that the surface of the Mark Resist is degreased before you start work:
use a little methylated spirit and tissue. I find that mixing methylated spirit with the TG1 or Rotring ink gives the best washes, water can be used but when the ink is diluted too much it tends to repel on the surface of the Mark Resist. When taking rubbings the flat edge of a piece of worn graphite seems to be the most sensitive technique, revealing the finest nuances of an image.

By using a mixture of these marks you can build and layer an image ready to transfer to a screen. It is better to to use a heavier mark than too light a mark. Many printmakers like sanding or scratching into an image with a scalpel until the grain or texture required is achieved. It is possible to lay a grain of graphite or chinagraph down first then sand it away and work on top again with a draw image. Do not use Fineliners or Felt-tip pens as these marks will not hold back the light. For fine line work use a dip pen with TG1 ink or ZIG Posterman felt tip (now on sale in the 'Faculty Art shop').

Screen Chemistry
The coating of a screen with a photo-sensitive emulsion is probably the most important stage of the process. If this goes wrong it will effect the exposure time and you will either lose detail or the whole image. From now on I will relate to the 'squeegee side' or the 'back of the screen', which is self explanatory.

With a fine quality coating trough that is not in any way dented or damaged, you coat the back of the screen with a single smooth layer of emulsion. ONE COAT ONLY. If you in any way mess it up, do not try to re-coat a second time! Just wash off with a cold water spray, dry and start again. It is also important that you coat only a dry screen as even a wet coating trough will cause problems. You can coat in daylight but get it into a dark place as quickly as possible. Dry the screen with warm air circulating; a fan heater or hair dryer will do. BE WARNED! if you hold a hair dryer or fan heater too close it will melt the mesh which can be costly and annoying.

When coated and dry you can store the screens in a dark place or a drying cabinet for a day or so. Personally I think that it is preferable to expose the screen within hours. The fresher the better! Remember, when dry the screen is much more sensitive to ultra violet light! (daylight).

TAKE OFF RINGS AND BRACELETS BEFORE USING THE EXPOSURE UNIT !

Place the piece of string over the edge of the screen frame as this helps to speed up the vacuum. Clip the lid down and turn the vacuum pump on. You will see after a few moments that the latex rubber is sucked down and moulds over the screen. This is very important as it gives perfect contact between the screen coating and your image. By pulling the release catch the print-down frame can be swivelled to the vertical position.

We are now ready to expose the image to the ultra violet light source. The light should have been on for at least 15 minutes and positioned on the line on the floor. Set the timer for 65 units (which is the average time for a drawn image on Mark Resist) or ask for advice as all images will vary in exposure times. Press the green button on the remote control outside the exposure room door. **WARNING, ULTRA VIOLET LIGHT CAN DAMAGE YOUR EYES, DO NOT LOOK DIRECTLY AT THE LIGHT AT ANY TIME!** The light source has its own timer and will turn off automatically.

When the light source has turned itself off put the print-down frame back to its original position and turn the vacuum off. Unclip the lid and lift carefully. Remove the screen and wash out the image immediately with a cold water spray. Spray both sides of the image three times making sure that you spray the whole area of emulsion and not just the image area. Then blot both side of the screen with newsprint and place in the drying cabinet for 15 minutes.
Foot-note: Do not use cutting tools on the glass of the exposure unit. Cuts or scratches on the glass will show on half tone work. Also please keep the glass clean.

Some Information on Screen Mesh
Most screen mesh is mono-filament polyester or nylon, the average mesh count for water-based printing being 120T stretched to abut 20 newtons. For fabric printing use a 62T or 90T mesh count. A 120T mesh is 40 microns thick whereas a 90T mesh is 48 microns, a more robust mesh. When fine half tones are needed (65-105 lpi) a 150T is a favourite as there are no problems with interference patterns between the mesh and dot. Screen mesh does not seem to wear out! It usually gets broken in some way.

Degreasing
With a new screen, a dilute coating of paste (Pregan Paste) over the mesh and left for 15 minutes degreases and cleans away silicon used in the manufacture of

the mesh. This is the only time that I degrease a screen. It appears that once you have completely changed to a water-based system there is no grease or oil, the power washer also helps.

Setting Up to Print and Registration Techniques
Remove your dry screen from the drying cabinet, hold it up to a window or above a light box and touch out any specks or parts of the image that you do not want to print using the green touch out filler (Safe guard). Then back into the dryer for a few minutes. Screens must be mesh up in the dryer or damage can occur. Try also to keep wet screens ie: screens that have been washed, to the bottom racks of the dryer as wet screens may drip onto newly coated screens. Take the screen out again and fix it into your screen bed with the four clamps. Do not force the clamps. If they are tight ask for advice. If you leave anything loose you will not achieve register as the screen will move. Most frustrating!
Within your introductory module in your 1st year the different registration techniques will be demonstrated to you (make notes and hang on to them). Fine registration using multiple 'spot' colours can also be produced using the same techniques.

Printing an Image
Actually printing with a squeegee can give many variations to the finished print. Here is some information on how to produce crisp perfect images:
1) The squeegee blade must be clean, undamaged, medium soft Ulon (or Everlast rubber).
2) When setting the screen in position be sure that you have approx. 2-3mm of snap (snap is the gap between screen and paper). Make sure that the screen is secure in the clamps and that there is no movement. This is important as too little snap can make the paper stick to the back of the screen when printing.
3) Make sure that you cover any vacuum holes with newsprint that are showing when the paper is in the stops. This gives you maximum suction under the image area holds the paper down when printing. This is crucial when printing large solid areas.

4) The actual pulling of the squeegee is the most important factor, the problem being that it looks so easy! The squeegee should be 3-4cm wider than the print area and an even pressure should be applied when pulling the print. With the water based process you must always flood the screen with ink before printing. This is called a flood coat, you must squeegee ink over the image area holding the screen off the paper. Only print and flood the image ONCE. Never leave the screen dry without a flood coat between prints or when you have finished printing. This will eliminate any chance of the acrylic ink drying on the screen and reduce staining. Wash the screen off with cold water as soon as printing is completed. The squeegee can be washed later with a sponge.
5) The squeegee angle and the pressure applied when printing can cause many problems eg:
a - Image flooding; too much pressure applied and/or angle too acute. With a small squeegee it is easy, if too much pressure is applied, to bend the blade over and cause flooding.

b - Image sticking to the back of the screen; not enough snap and/or vacuum holes not covered around the image. Incorrect squeegee may also be the culprit.
c - Ink drying on the screen and giving fuzzy images; usually means you have mixed too high a percentage of acrylic. 50/50 is the maximum mix. If you are inexperienced 40/60 pigment to medium is suggested. If you are slow and leave the screen for too long on a hot day drying in will also occur. Spray the screen with cold water, under pressure if need be, to remove drying ink.

ALL HEALTH AND SAFETY PRACTICE MUST BE COMPLIED WITH AS INSTRUCTED BY CENTRE STAFF. THESE NOTES ARE DESIGNED TO ACCOMPANY THE INTRODUCTION WORKSHOP. BECAUSE ALL RELEVANT HEALTH AND SAFETY ISSUES ARE DISCUSSED DURING THE WORKSHOP, THIS AREA CAN ONLY BE USED ONCE THIS HAS BEEN UNDERTAKEN. PLEASE CONTACT THE PRINTCENTRE MANAGER OR TECHNICAL DEMONSTRATOR FOR THE AREA IF YOU HAVE NOT HAD AN INTRODUCTION BUT WISH TO USE THE FACILITIES.

Worksheet compiled by Dave Fortune, Silkscreen Senior Technical Instructor 2012.

Point by Point (include illustration/photography if required)

Screen printing a Colour Separation

The weave of the screen mesh causes an interference pattern (moiré) with the halftone dot on your positives, therefore the most difficult part of colour separation work is positioning stencils onto your screen eliminating the moiré pattern. For the screen process printing you need to select a relevant halftone size. When screen printing, 75 lpi (lines per inch) is a good starter halftone size. The halftone size and production of halftone positives is all prepared in Photoshop and output on a Postscript Laser Printer. An elliptical dot is also advisable to give you a good tonal range. You can print up to 105 lpi but this is not recommended until you are an experienced printmaker. You would also need 'Image Set' positives to achieve this sort of fine half-tone.

When printing with a 75 lpi dot size a 120T mesh can be used, for a 105 lpi dot size a 150T mesh is advisable. The mesh count should be considerably smaller than the dot size.

You will find that when your film positives have been made they should have registration, crop and labels marks on the edge of the film positives. These marks will help you achieve perfect registration, hopefully! When using Folex Matt

Laser Film a strong light is set up behind the screen which makes checking for moiré much easier.

If you have Folex or Image Set clear positives use this technique to position them on the uncoated screen to eliminate moiré patterns.

Hold the screen up with a strong light behind it (approx 70cm away). Place your positive emulsion down (back to front or wrong reading) on to the back of the screen. Remember, back of the screen is the side that your squeegee will not touch, the squeegee side is self explanatory. By slowly twisting the image you will see the patterns appear and disappear through the positive. You will reach a point when twisting the image that the pattern seems to have disappeared, but if you carry on it will appear again. The point of no pattern is moiré free so with a soft, blunt pencil mark the edges of the film on the screen (little corner marks), also mark the top of the image and which colour it relates to. This is repeated for each of the four positives (cyan, yellow, magenta and black). Black seems to be the most difficult. This is a delicate job and much patience is needed to position each positive exactly.

When you have coated the screen (single coat on the back of the screen) and dried it in the drying cabinet take it to the exposure room remembering that they are now much more sensitive to light and will expose in daylight after only a minute or so. The exposure room has fairly subdued light, so quickly with small pieces of magic tape stick each of the positives exactly to the pencil marks on the screen. This is again on the back of the screen, make sure you have the right positive before sticking it on. The images will be back to front as when you marked them. You can then expose the coated screen as per normal.

See Screen Chemistry: Exposing the Screen.

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Water Based Ceramic Transfer

Onglaze enamels come in the form of powder or paste. We use the powders as they are more affordable (students can purchase onglaze enamels from the store). Cookson Matthey or Cerdec produce the onglaze enamels (see suppliers

list). The pre cover coated transfer paper is produced as UWE Transfer Paper or UWET and can only be purchased from John Purcell Papers. Students can purchase this from the Print Centre. The medium is a mixture of Daler Rowney Glaze Medium Gloss and Acrylic Retarder.

It is advisable to mix only enough quantity wise for the transfers you are printing. If you need more than this amount just multiply the measurements given.

Mixing the Enamels

The recipe for the onglaze mix:

1. Start with a heaped teaspoon of Glaze Medium Gloss.
2. Add a flat teaspoon of Acrylic Retarder and mix together. This completes the formula for the medium.
3. Now add 3 heaped teaspoons of the onglaze enamel. Caution: The onglaze enamel is dangerous in the powder form, as soon as it is wet it is much safer. Do this in the open air or use an extraction box and be very careful, **DO NOT BREATHE IN ANY OF THE ENAMEL POWDER.** Mix together thoroughly. You will notice that it is a little more gelatinous than the acrylic inks. When the onglaze is first mixed with the medium mix it seems a little lumpy. As you mix it vigorously with a palette knife you will find it smoothes out to a creamy texture.

The final mix by volume is approximately 70/30, enamel to medium. This ratio can vary depending on the colour enamel you are using. I find that the best way to check the mix is to smear the ink onto paper as you would an ordinary acrylic ink mix. If it looks rather transparent just add more onglaze powder.

Printing and Cleaning

Print as normal, making sure that you flood the screen after every print. As soon as the enamel is touch dry on the transfer paper another colour can be printed on top and so on. It is advisable to print a little faster as the mix tends to dry quicker on the screen. When you have finished printing wash the screen immediately. You might find that the screen looks a bit stained towards the edges of the print area; do not worry as this usually disappears when you wash the stencil off with Pregasol F using the power washer.

If you mix too much and want to use it again, keep it in a container with a top. The mix will eventually stiffen and become more of a gel. Just add a little Daler Rowney Glaze Medium and Acrylic Retarder. Mix it in well and it will become printable again. The larger the quantity mixed the longer it lasts.

Sliding the Transfers

It is advisable to leave the transfers over night before attempting to slide off. Cut the transfers out, leaving about 4mm around the printed image. Use a side or dinner plate and half fill with tepid water. Place the transfers on the water backing paper down. The transfer will curl upwards and then in time will flatten out. Leave for a couple of minutes or until you can move the top surface. Wet the ceramic surface where you want to position the transfer. Take the transfer out of the water and place in position, holding the top surface and sliding the backing

paper out, position your image. Slide until in position and blot with a pad of tissue, carefully push any air bubbles and creases out from the centre of the transfer. As the transfer dries you will find many small creases left should even out (areas of no print will stay a little creased). Leave for an hour or so until dry. The ceramic piece is now ready for firing.

Firing Times for Black Onglaze
1st Ramp: 80∞C per hour to 80∞C.
2nd Ramp: 100∞C per hour to 760∞C, followed by soak at 760∞C for 1 hour.
Orton Cone: 0.16 to 7.30-8.00 o' clock.

Firing Times for Onglaze Reds
1st Ramp: 80∞C per hour for 1 hour.
2nd Ramp: 100∞C per hour until Cone 017 goes (740∞C). Soak for 1 hour 20 mins until cone 015 goes (800∞C).

Suppliers List

Daler Rowney Ltd
Bracknell
Berkshire
Rg12 8ST
Tel: (01344) 424621 Fax: (01344) 486511 (Glaze Medium Gloss)

Johnson Matthey Ceramics
Woodbank Street
Burslem
Stoke-on-Trent
ST6 4HG
Tel: (01782) 524949 Fax: (01782) 524950 E-mail: select@matthey.com (Onglaze Powders)

Cerdec (Sunshine resistant Onglaze Colours)
Scotia Business Park
Scotia Road
Tunstall
Stoke-on-Trent
ST6 4HG
Tel: (01782) 834382 Fax: (01782) 834399

John Purcell Papers
Tel: (020) 77375199 (UWET Transfer Paper)

University of the West of England
Faculty of Art, Media and Design
Kennel Lodge Road
Bristol
BS3 2JT

Tel: (0117) 3444739 (UWET Transfer Paper)

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Problem Solving at a Glance

Screen chemistry: Coating screens/Exposing screens/
Screen washing.

Image area not washing out completely after exposing:
The image can be seen on the screen but when you hold it up to the light it has not washed out sufficiently to print. This problem occurs when the screen has been coated and dried but light has contaminated the screen before it was exposed.

Whole image and screen coating wash away:
Screen has not been exposed at all to ultra violet light (the light source).

Lines in the emulsion when coating the screen:
Blade of the coating trough must be dirty or damaged. Use fine wet and dry sandpaper to clean the edge of blade. Most coating troughs are made of aluminium, which means they are soft and very vulnerable to damage.

Parts of the stencil bubble up and wash away:
Screen not coated evenly, leaving thick areas of emulsion. The thick areas need a much longer exposure time to harden but you will lose detail in the thinner areas. Wash off and start again!

Loss of detail in the printed image:
Vacuum not working on the exposure print-down frame or not enough pressure between image and positive, causing undercutting.
Exposure time too long.
Only one side of the stencil washed off. You must wash both sides of the stencil at least three times after exposing.

Set-up: Registration/Screen cleaning/Ink mixing /Printing

Drying in:
If ink is drying in the screen as you print and affecting the quality of the image take the screen to the sink and spray out with cold water immediately. This is

usually caused by mixing too much acrylic with the print medium. Leaving the screen dry between prints instead of flooding, or just taking too long, will also cause problems.

Excessive staining of mesh after printing:
This is usually because you have mixed too high a proportion of System 3 Acrylic with the print medium. Always flood coat the screen between prints or this will also stain the mesh, as the acrylic dries in much quicker. Do not ever try printing with only the acrylic as it dries within seconds and stains the mesh terribly.

Gritty feel to ink:
This can be a problem when using old pigments that have been allowed to dry around the neck of the container. Old, dry ink can fall into the medium. Make sure you always start with the screen printing medium and add the acrylic pigment. If you start with the acrylic pigment it starts to dry very rapidly causing the same problem. The screen printing medium contains a percentage of retarder that slows the drying time of the acrylic pigment as soon as it is mixed.

Image too thick, or splurging:
Angle of the squeegee too acute; it must be approximately 450.
Too much snap between screen and screen bed; 4 to 5 mm needed.
Image sticking to the back of the screen after printing:
Holes in vacuum bed still showing around print, which need covering with newsprint or more snap needed. If you are printing with no vacuum, peel the print off the back of the screen before you flood back.

Ink drying in the screen:
Always flood the image between prints as dry pulling will cause drying-in problems.
If you mix more than 50/50 System 3 Acrylic pigment to screen printing medium it will start to revert back to an acrylic paint and dry in when printing more quickly. 50/50 is the maximum mix for System 3 Acrylic to the screen printing medium. You can make the mix as transparent as you wish by adding more screen printing medium.

Ink sticking to the blade of the squeegee:
This is usually a problem caused by the angle of the squeegee when printing. It is when the squeegee is at a more acute angle that the ink starts to stick to the blade. The perfect angle is 450.

Key-line:
Final overlay or colour printed on an image. This printer, covers where all previous colours butt together.

Loss of registration or image moving:
Check that the screen is secure in the screen bed and that there is no movement on the hinges.
A very loose stretch on the mesh can also cause inconsistent

registration. For tight registration you need at least a 20 Newtons stretch. Make sure your stops are secure and that you are consistent when placing the paper against them.

Use semi-permanent,
self-adhesive plastic (the old Fablon or similar) three layers thick and cut into small squares.

Marbling effect in the ink:
System 3 Acrylic pigment must be mixed thoroughly with the screen printing medium or marbling will occur. It is also advisable to start with the medium and add the acrylic pigment. Always mix the acrylic pigment thoroughly with the screen printing medium as soon as you take it from the container.

Pin-pricks of ink appearing as the print run progresses:
Screen under exposed. After exposing, washing out and drying the stencil expose the whole screen again for the same length of time. This second exposure to ultra violet light hardens the stencil.

Thick edges on printed image:
Image placed too close to the edge of the screen frame. It is always advisable to give yourself a minimum of 5 cm around the print area. If you miss-print and leave thick areas it takes a long time to dry and paper cockling is likely.

Screen Printing / Historical Background

Screen printing is a process which began in China about AD 221, mainly as a way of transferring designs onto fabrics. The Japanese took up the process using simple stencilling techniques, stencils were cut from parchment or paper of some description. The mesh of the screen was made using woven human hair. Dabbers or stiff brushes were used to force the dye or pigment through this crude mesh.

Silk screens were being used in France in the 17th Century for the printing of fabric, but it is not known who perfected the practice of stretching silk over a frame to support stencils. Brushes were still being used to force ink through the silk until the early part of the 20th century when the squeegee was introduced.

Roy Beck, Charles Peter and Edward Owens from the United States succeeded in producing the first photographic screens. The first photo-sensitive emulsions were produced using glue and gelatin sensitised with potassium, sodium or ammonium dichromate. After coating, drying and exposing the positive transparency to daylight the image would wash out in warm water.

Photo-emulsions, direct or indirect have come a long way since those early experiments. The sensitiser used now is diazo powder rather than the toxic dichromate salts used then. The emulsions are now relatively safe and extremely sensitive. Using short exposure times with less powerful light sources, wonderful

litho-like textures can be achieved. The other great breakthrough is solvent free printing, water-based acrylic inks are now available. This means no costly extraction systems in studios, more time to actually print and incredible detail can now be reproduced on many substrates including water based ceramic transfer printing. Previously, ceramic transfer printing was a very toxic and unhealthy process. Water-based ceramic decal printing is much safer and can be used within education safely.

Linked with computer generated imagery and affordable laser and textured drawing films, the process is now within reach of schools and home printmakers.

Dave Fortune 2012.