INTRODUCTION

Screen-printing is simply a process used for making multiple prints of the same design. Screen-printing uses a stencil with open areas through which the ink or paint passes and solid areas which act as a mask preventing the passage of ink. When a fabric-covered frame is used the process is often call "silk screening" because silk was originally used as the fabric of choice.

The procedures described in this handout can be used for printing on either paper or fabric. There are several methods that can be used to produce the stencil and the screen and a variety of inks and paints that can be used. In some cases, alternative methods are described. In general, the methods described have worked well in producing designs and screens suitable for printing on light colored t-shirts and other cloth items. The user is encouraged to experiment with a variety of procedures, adapting those they find work best for them.

This silk screening method is inexpensive and allows girls to be involved in the actual printing process. However, it is important to remind them that even though they are using a stencil, they are creating an original work of art. The amount of ink, the pressure applied, and the care taken with the screen will affect their finished design. Minor "flaws" are common. If you are looking for perfect, identical shirts, you should use a different method or purchase shirts.

MATERIALS

The following materials will be necessary or useful throughout the process. The resource list at the end of this handout lists some sources for most of the materials listed. Many of these supplies can be borrowed from GSCNC..

Silk screen frame & fabric
Photo emulsion kit
Screen Filler
Photo emulsion remover or Clorox
soft nylon brush (old toothbrush)
dish washer detergent
masking tape (wide)
small paint brush
small blocks of wood
craft sticks (for stirring)
piece of black paper
smooth cardboard
large flat box (for "dark room")
glass or Plexiglas
paper towels
squeegee
ink or paint
small spray bottle

GETTING READY

THE SCREEN: A silk screen frame is simply any frame over which a fine mesh fabric can be stretched and secured. Pre-made frames complete with stretched fabric are the easiest for beginners, but can be costly if several frames are needed. Frames can also be assembled from precut pieces available at art supply stores or from 1x2" lumber, but this can be challenging. Most people will use the prepared frames. However, fabric choice, preparation and mounting will be described briefly since it is often necessary to eventually replace fabric in a screen.

If using a new frame, it is advisable to paint or varnish the frame before or after fabric is attached. Fabric designed for frame use is usually nylon or polyester and can be purchased at art supply stores. Fabric designed specifically for silk screening is generally identified by coarseness with a number followed by xx's. The coarser the fabric, the more ink it will allow to pass. For general purposes a 8-12 xx fabric works well. Once you are familiar with the process, different fabrics can be used for different effects or with different inks.

The fabric is attached to the frame and stretched tightly and uniformly. Fabric should be cut at least 1" larger than the frame on all sides. If using a frame with a channel, fabric is centered over the channel side of the frame and loosely thumbtacked or taped to the corners. A spline or cord is gently tapped into the grove and the thumbtacks removed. The cord is then set in the grove by using a spline or cording tool or tapping it into place with a hammer and wedge such as a wide screwdriver. This method allow for easy removal of the fabric when required. Fabric can also be stapled to the frame using a twill tape, but this is more permanent and can more easily cause tears in the fabric. In either case masking tape is applied over the edges of the fabric, the channel and along both top and bottom of frame covering at least 1/2 inch of fabric within the frame. Shellac or urethane varnish can be applied to all surfaces of the frame, covering the tape and extending slightly onto the fabric to make clean up easier and prolong the life of the screen.

In all cases, the fabric must be clean and factory sizing removed to allow photosensitive chemicals to adhere to the screen. Do this by scrubbing the fabric with a soft nylon brush and a solution of dish washer powder mixed with water. Thoroughly rinse and allow screen to dry.

PRINTING BOARD: A printing board is essential for professional quality prints, especially where more than one color is used or where uniformity of the prints is essential. The board provides a smooth flat surface for printing and carries the "registration" tabs necessary for aligning multi-color prints. Most shirts girls produce will not be this elaborate, but a simple printing board can be improvised using a smooth board and masking tape.

THE PHOTO EMULSION MATERIALS: Creation of a photographic stencil utilizes light sensitive materials, which harden when exposed to light. A thick syrupy liquid emulsion is used to coat both sides of the fabric. Once dry the design is placed on the screen and exposed to light. The light hardens the emulsion in areas of the screen not blocked out by the "positive" created from your design. Areas blocked out are not hardened. After exposure, the screen is washed and the unhardened areas wash out, creating open areas of the screen where ink will pass and be deposited on the item being printed.

There are two types of chemicals which can be used and are generally readily available: bichromate or diazo. Each uses an emulsion that is not light sensitive and makes up the bulk of the material. A small amount of sensitizer, either diazo or bichromate, is added. The bichromate emulsion is designed for quick exposure and can be used with most kinds of ink. It dries quickly and is easily applied to all fabrics. However, it begins to lose its effectiveness within 4-6 hours once the chemicals have been mixed and coated screens must be exposed within 24 hours.

Diazo sensitized emulsions last longer and can be stored up to 3 months at room temperature and up to 6 months if refrigerated. Screens coated with a diazo mixture can be stored up to 8 weeks if not exposed to light. Screens coated with a diazo mixture generally give a sharper print. These screens require a longer exposure time however, and the emulsions are more difficult to remove. The diazo has less toxicity and no known environmental problems associated with it.

The *SQUEEGEE* is used to apply the ink. Squeegees can be made with a plastic, wooden or aluminum handle. All use a rubber blade that is either removable (by sliding it out one side) for easier cleaning or permanently attached to the handle. Squeegees come in different lengths. You generally want to use a squeegee that will cover the area is one pass.

The type of *INK* or paint used will depend on what is being printed, how it will be used and any special effects desired. When printing on fabric, it is important to use textile ink. Water-soluble ink is recommended because it is easier to clean up. It is important, however, to be aware of the permanency of the ink you are using, especially if the item is to be washed. Most textile inks require heat setting once the ink has dried completely. Do this by ironing both sides of the fabric at least 3 minutes with a medium-hot iron (using a pressing cloth) after the design is dry, or following directions on ink container.

SCREEN FILLER can be painted on the screen to fill in areas that you do not want to print. It is very useful in covering pinholes or other flaws that appear in the fabric after exposing it to the light. **DESIGN**

DESIGN

Almost any design can be used in screen-printing but beginners will have more success with a simple, one color design. In planning the design, think in terms of color/no color rather than trying to get "halftone" or shades of gray. The part of your design that is black (or colored) on your drawing will be the part that accepts the colored ink. Areas that are white in your drawing with remain the color of the fabric or other background material. As you become more experienced, it is possible to add color to even a simple design. If your design contains large areas of color, more ink will be used in the screen process. However, designs with extremely fine lines may cause the screen to clog more rapidly so the lines begin to fade as more items are produced..

Your ultimate goal is to create a stencil using your design. Tthere are several methods to create a stencil but the method described here will be for creating a photographic stencil. The actual design can be one you draw, or can come from a variety of sources. You must use your judgment in copying designs from books and other sources, as copyright laws protect many designs. There are many designs available from art supply stores and Dover Publications that are copyright-free. If your design will include a Girl Scout logo or associated words, you must read the chapter on Trademarks in Green Pages to understand the appropriate use and approval required for these designs.

Once you have a black and white design, you are ready to copy it onto clear acetate, also known as transparency film or overhead film. Your design can be transferred to the acetate by drawing using special pens (most markers will not adhere), using stick on letters, shapes cut from opaque paper, etc. or by photo copying your original design. This method produces the most exact copy of the design and allows even the most complicated design to be turned into a screen stencil. Most full size copiers will allow you to hand feed clear acetate, and most copy outlets carry this in stock. Be sure to check that the copier is producing clean copies. Stray lines and specks on your acetate will become part of your design. You will need 3-4 copies to assure light does not show through darkened areas. Carefully line up and tape together copies. (This can be done by taping one copy to a window then aligning additional copies one at a time and attaching with double sided clear tape.) Your resulting sheet is called a "positive."

PREPARING THE SCREEN

Since the emulsions react to ultra violet light but less readily to incandescent light, it is possible to prepare the mixtures and the screen using normal room light, although it is best to work with as little direct bright light as necessary. Cover work surface with newspapers. Mix photo emulsion solution according to directions. Place the screen on the work surface with the flat fabric side up. (This is referred to as the BOTTOM.) Pour a small amount of emulsion along one short edge. Using a squeegee or piece of stiff cardboard, spread the emulsion evenly across the screen. Squeegee back in the opposite direction. Add more emulsion if necessary to completely coat the screen with a THIN even coat.

Turn screen over, ***SETTING IT DOWN WITH BLOCKS OF WOOD supporting its corners or edges. (IT IS ESSENTIAL THE COATED FABRIC IN THE PRINT AREA OF THE SCREEN DOES NOT TOUCH THE BLOCKS OR TABLE SURFACE.)*** Repeat the coating procedure on the inside (TOP) of the frame. Be sure to smooth out or scrape away excess emulsion that seeps through screen so coating is thin and even. Dry screen in a horizontal position - fabric side down - supported by wood blocks or push pins placed in the corners. Screen should be dried in a dark room, such as a closet, or covered with a large opaque box. Screen will generally dry in one to two hours. A fan will speed the drying process. When dry, apply a second coal on the bottom if more than 200 prints will be made. Dry again.

PLACING POSITIVE

When screen is completely dry, you are ready to position your positive. You should consider where and how you are going to expose your screen at this point. If you are going to expose the screen outside, you will need to set it up so it can be carried outside when ready. A shallow box with a lid works well. If you are going to expose it inside, you can set it up in position using dim room light and position the lamp the correct distance. (See "Exposing the Screen.")

Many books insist the positive should be placed on the bottom of the screen but placing it on the top also works, so different placement methods are described below to allow you to select one that you prefer.

Method 1: You will need a foam pad 2" thick and 1-2" smaller than the inside dimensions of the frame. Place the foam pad on a flat surface and center the frame on top of it with the bottom of the frame facing up. Only the fabric should touch the foam to ensure that direct contact is made between the positive and the emulsion. The positive is placed on the fabric **SO THAT IT APPEARS BACKWARDS** and a piece of glass or Plexiglas is placed on top of the positive to further ensure direct contact between the positive and the emulsion.

Method 2: Instead of using a foam pad to ensure direct contact, spray the bottom of the screen with a light coat of contact cement or photograph mounting adhesive. Allow the cement to dry for 3-4 minutes then place the positive in position. **Remember, it must be backwards.** Remove air bubbles by gently rubbing them out and place a piece of glass or plexiglass on top. After the screen is exposed, the positive is gently peeled away. After exposing, washing and drying the screen, wipe the bottom of the screen with mineral spirits to remove any residue from the adhesive.

Method 3: Place the screen bottom side down on a piece of black paper. Place the stencil on the *top* of the screen (inside the frame) and place a piece of glass, cut to fit the inside dimension of the frame, on top of the positive. In this method the stencil is in the readable position.

EXPOSING THE SCREEN

The screen can be exposed to either sunlight or artificial light, but direct sunlight, if available, is preferable, since exposure time is considerably shorter. Exposure time will depend on intensity of light source and the type of emulsion used. Indoor exposure is also affected by screen size, which determines the distance from light source.

For outdoor exposure, place screen in box or cover with opaque material to prevent exposure until ready. Carry prepared screen to a sunny location. Carefully check position of positive just before uncovering. Repositioning positive once exposure has begun will result in fuzzy lines and "shadows.") Uncover, making sure there are no shadows on the screen and begin timing. Length of exposure time will depend on intensity of sunlight and the type of emulsion used. On a bright sunny day about 30-45 SECONDS will work for bichromatic sensitizers, about 1-1 ½ MINUTES for Diazo emulsion. If sun is extremely intense, shorten time slightly. On a cloudy or overcast day lengthen exposure time by 30 seconds to one minute. Do NOT do this if it is raining or sprinkling since this will begin to wash away chemicals before they are hardened.

For indoor exposure a 150-watt household bulb or number 1 photoflood light (250 watt) bulb can be used. Bulb should be set up with a reflector shield (which can be made using aluminum pie plate.) A clamp-type socket works well because you can adjust its position. The distance between the lamp and the screen will vary by screen size. As a rule of thumb, measure the diagonal of the frame and place the light at this distance. For an 8 x 10 light is placed 12-13 inches from screen. For a 10 x 14 inch screen light is about 17 inches away. Exposure time is approximately 45 MINUTES for 150 watt household bulb and 10 minutes for 250 watt photoflood light for *bichromate* emulsions and twice that time for Diazo emulsions.

To guarantee the proper exposure, a multi-timed test can be set up using an extra screen prepared along with the primary screen. Mount the positive and place opaque cover on all but 2" of the screen. Expose screen for less than suggested minimum time and move cover to expose more of the screen in graduated increments, keeping track of time for each increment. Wash screen as described below, test with ink and determine which time gives the best prints.

At the end of exposure time, immediately cover, remove the positive and glass if used and the wash screen with a forceful spray of tepid water (NOT HOT), concentrating spray on design images. Design area should appear lighter than exposed area. Continue spraying all emulsion in design area has washed out. These areas should appear clear. Allow screen to dry flat. When dry, hold to light and check for pinholes and other areas where unwanted light shines through. Even the tiniest pinhole will allow ink to seep through where it is not wanted. Use masking tape or screen filler to cover these holes. If screen filer is used, allow it to dry.

MAKING PRINTS

Printing can be done on a variety of paper or textiles, although cotton or 50/50 poly/cotton works best. Ink generally will not adhere to high gloss or plastic coated papers, or nylon or vinyl fabrics. Some finishes on fabrics also make ink adherence difficult as well. In some cases, it is recommended that fabrics be washed and dried before silk screening to remove the "sizing" which might prevent ink from adhering or interfere with permanency of the ink.

When printing on T-shirts, place a piece of smooth (not corrugated) cardboard inside the shirt so ink does not seep through to the back of the t-shirt. Make sure fabric is smooth and free of wrinkles. It is difficult to screen across seams because screen will not lie flat across the entire area and ink will clump on the seam. Different fabrics accept ink differently, so a test print should be made.

Place screen, bottom side down, directly on top of item. Many printers prefer the "off-contact" technique in which the frame is raised slightly off the item by taping a thin spacer, such as a penny or piece of piece of cardboard, at each corner of the screen. In this method, the stenciled fabric touches the screen only when forced down by the squeegee so that ink left on the screen from the previous prints will not create a double image on the item.

To begin printing, pour or spoon a small amount of ink along one edge of screen. Make sure screen in held tightly in place either with one hand or with another person helping. Using a squeegee, slowly draw ink to the opposite side of the screen *without pressing down.* This first stroke is the "flood stroke" and it fills the screen with ink. Add more ink if there is not enough. Follow this with the "printing stroke" pressing down to force the ink through the stencil. In both strokes the squeegee is only slightly angled.

Experiment to see if these two strokes are enough and how much pressure is necessary to produce a clear image without allowing too much ink to come through the screen. If children are doing this inking process, they have a tendency to not push hard enough and therefore want to go back and forth several times. This often will produce shadows as the frame slips or too much ink is deposited. When inking in done, rest squeegee along one edge of the screen and carefully lift screen off shirt. Rest it at a slight angle on a block of wood. Remove cardboard and hang or lay item flat to dry. Screen should be used immediately for the next item. Continue in this manner until all items are done or screen needs to be cleaned. Add more ink as necessary.

DO NOT ALLOW SCREEN TO SIT FOR MORE THAN A MINUTE OR TWO, ESPECIALLY OUTSIDE IN HOT WEATHER. THIS WILL CAUSE INK TO DRY ON SCREEN, ESPECIALLY IN THE OPEN AREAS AND THE SCREEN WILL BECOME UNUSEABLE.

If unwanted spots begin to appear on screened items, check for ink on the bottom of the screen or ink on someone's hands. If that is not the case, some of the hardened emulsion has begun to wear away. If the images become lighter, this generally means the screen has begun to clog. In either case the screen must be cleaned. First carefully wipe the bottom of screen with dry paper towel and test on a piece of paper. If ink spots still show, hold to light to check for pinholes. A temporary fix for pinholes is to cover on the bottom of the screen with a bit of masking tape.

Weather and humidity may affect ink causing it to dry quickly or clump, especially is screening is being done outside. In some cases it may be necessary to *lightly* spray the screen periodically. Spray top of screen, then wipe *bottom* with dry towel. *Be sure bottom of screen does not have stray ink or water on I before you begin to print again.* If in doubt, gently set it on a sheet of paper and check for unwanted ink.

Ink can dry on the screen within minutes, especially in dry weather. If the screen is to sit unused 5-10 minutes, place a damp (not wet) paper towel on top of screen or scrape off all ink and rub bottom dry with paper towel. Where considerable time will elapse between "runs" wash screen and allow it to dry. Be sure screen and frame are dry before reusing. (A fan or hair dryer can be used to speed up the drying.). Screens may begin to deteriorate after repeated use and washings.

For jobs making multiple prints (hundreds) or over an extended time, it is advisable to make 2 or more screens. That way one screen can be washed and allowed to dry while a 2nd screen is used. If a screen begins to wash out, there is a back up available.

CLEAN UP

When all prints have been made, scrape excess ink from screen (return to jar if colors are not mixed) and thoroughly wash all ink off screen using warm water and mild soap. If this design will not be needed again, wash remaining photo emulsion off so screen using photo emulsion remover of Clorox so the screen can be used for a different design. It may be necessary to gently scrub the screen with a nylon brush to remove all emulsion. Some ink STAIN may remain and will not affect screen as long as no ink remains in the mesh holes. Hold screen up to the light to be sure all ink and emulsion have been removed. Allow the screen to dry so it will be ready for use again. Photo emulsion allowed to remain on a screen for an extended period of time may become permanent and the fabric will have to be replaced. Remember to thoroughly clean squeegees. If the squeegee has a removable rubber blade, remove it and clean in the grove. If some of the masking tape comes off, replace it when the screen is dry.

ADDING COLOR TO YOUR PROJECT

A single color design need not be dull if the color of the shirt and the ink color are chosen carefully. (Keep in mind that the darker the shirt, the more difficult it is for ink color to show up. Test various ink colors on a sample shirt before beginning.) There are several simple ways to add additional colors to a design.

The simplest method is to create a black and white "coloring book" design and have girls then fill in the shapes with fabric markers to create unique shirts. Another simple method is to use several compatible ink colors in a "rainbow" fashion. Using a single screen, pour small amounts of two or three colors onto the edge of the screen next to one another. As the squeegee pulls the ink across the design, the colors blend where they touch. Depending on the desired effect, it may be necessary to do a couple test runs to get the type of blending desired. As multiple items are screened, the inks will become more mixed and it may be necessary to add more ink to get distinctive colors again.

PRINTING MORE THAN ONE COLOR

If a multi colored print is desired, it can be done either using a single screen and blocking off different sections, or by making a separate screen for each color. If a single screen is used, cover areas you don't want using masking tape or a sheet of acetate taped along the edges. When ready to switch colors, uncover the area, wash and dry the screen, and reposition the mask. This method is best where only a few items are being screened since the adhesive from the tape may be difficult to remove after a time, or its removal may damage the screen. Try to position tape so it will not damage the design area.

If separate screens are needed, a separate positive will be needed for each screen. Different colored areas must line up in the correct positions on the screens so the colors will align properly on the finished item. Beginners are advised to use simple designs where precise alignment of colors is not required. It is nearly impossible to align a screen once it had ink on it. To assist with alignment, registration tabs or markers can be used with a printing board. Two tabs are placed along one side and one tab is placed at the bottom. Each item is positioned in exactly the same spot in relation to the screen, which is attached to the board.

This method generally will not work with T-shirts unless special equipment is used to ensure the various colors are aligned, although you can experiment to see what will work. One caution: **do not move shirt between colors** - the stretchiness of T-shirt fabric will make it impossible to put it back in exactly the same position once moved.

SUPPLIES are available at Michaels and many local art stores The following are also good sources for supplies:

Nasco Arts & Crafts Catalog (1-800-558-9595) (www.enasco.com)
Dick Blick Art Materials (1-800-447-8192) (www.dickblick.com)
S & S Worldwide (1-800-288-9941) (www.ssww.com)
Atlantic Coast Cotton for tshirts (703-631-7311) (www.atlanticcoastcotton.com)

TROUBLE SHOOTING: Problems and possible solutions

Photo emulsion will not adhere to screen.

- Screen may be dirty or have "sizing"-- try re-washing with dish washer detergent solution

Photo emulsion will not wash out to create a stencil.

- Too much light or heat or too much time elapsed before screen exposed
- Art work positive not opaque enough on not in direct contact with screen
- Over exposure.

Too much photo emulsion washes out of screen after exposure.

- Improper mixture of emulsion.
- Insufficient exposure time.
- Acetate not transparent enough.

Small details do not wash out completely

- Over exposure.
- Art work not in direct contact with emulsion.
- Art work not sufficiently opaque.

Too much ink on prints or prints not sharp

- Squeegee not used properly. Hold squeegee in more vertical position.
- Ink too thin.

Prints too light

- Squeegee not used properly. Hold a more of an angle.
- Inks drying on screen. Wash screen. If extremely hot and dry weather, add a drop of glycerin (available at drug store) to ink. Do not screen outside in hot weather.
- Not enough ink used. Add ink. Use flood then print stroke.

Textile ink not opaque enough

- Screen mesh too fine.
- Improper squeegee use. Use rounded blade. Make multiple passes.