Get Control of Your Screen Making Process: Implementing Standard Operating Procedures

By: Dave Dennings

Offset printers and inkjet printers alike are challenging screen printers for market share. In order to remain competitive in screen printing today, printers are taking their quality control program to the next level.

In the garment printing market, printers are getting more creative. Buyers of printed garments are demanding something new, fresh and exciting. This has spurred the increased popularity of all kinds of specialty printing.

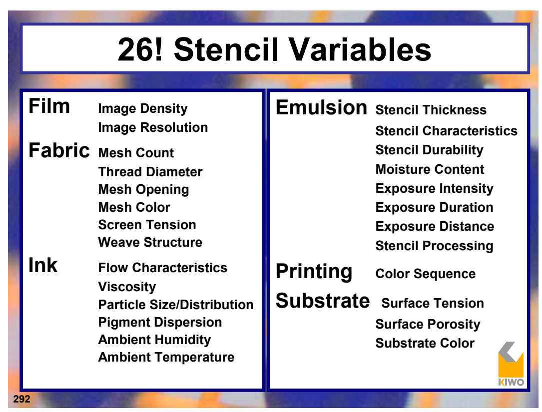
In the flat stock graphics market, customers are demanding higher resolutions and better color control. And, of course, in both the garment and graphics markets, customers are demanding faster turnarounds and better pricing.

In this increasingly competitive environment, screen printers are attempting to run as efficiently as possible, actively managing every step in their process. Standard operating procedures (SOP's) are one way to help gain control over their process. Costs can then be more accurately estimated and controlled with less overruns. Rejects and remakes can be minimized, while profits and fulfilled deadlines are maximized.

This article focuses on explaining variables in screen making that can be controlled by establishing SOP's. A handy reference guide is included at the end of the article, which offers suggested procedures and tools for each step in the screen making process.

Before effective SOP's can be implemented successfully, one must have a working understanding of the many variables in the process. The operating procedures should then reflect the best possible methods to achieve optimum print quality efficiently. This will directly influence the level of success printers will achieve.

Establishing a controlled process begins by analyzing each step in the process and identifying variables that may influence the quality and consistency of the product.



Secondly, one must understand the impact of each of these variables on the process when they are not kept consistent. When employees have a true understanding of how important their work is to the overall process, they feel more inclined to participate in a new quality control program. They also take more pride in their work, which will improve their overall attitude and productivity.

With this in mind let's take a look at some of the variables in the screen making department and how they may influence your print quality. Along the way we will discuss how to monitor and measure these important variables. Using a logbook to document these measurements will help to monitor the consistency of the process. It may also be helpful when troubleshooting problems.

SCREEN STRETCHING

Screen **stretching procedures should be graphically documented and displayed** in the stretching area. There are many methods for stretching screens and each are dependent on several factors such as:

- The type and size of frames
- The type of stretching apparatus
- The type of mesh
- Screen stretchers experience
- The printing application

The most important tool required here is a **tension meter**. Two tension meters should be calibrated and checked for consistency. One is used as a backup in case the other suddenly becomes damaged or isn't reading correctly.

A **logbook** is required to document information such as:

- Screen number
- Mesh count
- Thread diameter and color
- Tension
- Date
- Re-tensioned or not
- Screen makers name

Saving all of the mesh specification tags for reference will help the manufacturer identify a possible flaw in the mesh or bad batch. It also allows you to see if any change in the mesh specification occurs, or if there was an error in ordering.

Another tool is a **mesh counter**. Either a highly accurate sliding microscope like the Bopp Mesh Counter, or a somewhat less accurate film style mesh/film dot counters will work. Although it is rare, mesh manufacturers have accidentally mislabeled bolts of mesh.

Additionally, as the screen printing process becomes more scientific in its approach, specific mesh variables like thread diameter and weave construction will influence whether or not a job runs correctly or not. The day and age of ordering mesh solely by mesh count alone, is becoming a bygone era.

When ordering a bolt of 355 mesh from your local supplier in those days, you never knew what you would get, nor did you necessarily care. You may have received a standard monofilament mesh or, at that time, the newer low elongation monofilament mesh. You may have received a plain weave (woven one thread over, one thread under), or a single twill weave (woven one thread over, two threads under). There is even a double twill weave (woven two threads over, two threads under). And the color could have been white, orange, yellow, ruby, or red.

Not knowing how each of these mesh specification variables influences the final print can cost a company significantly. Proper **instruction and training should be completed** so everyone is aware of the importance and function of each and every variable. Utilizing your vendors and manufacturers representatives to help with the instruction and training is beneficial, but often overlooked. This is a very cost effective way to implement a training program because most vendors and manufacturers offer this type of technical support to their customers free of charge.

Enforcing stretching procedures is necessary. Assume one employee uses a staged stretching technique to get it up to tension, then re-tensions the screen three times, and allows the screen to sit 24 hours before processing the screen further. Then another employee uses a rapid stretching technique with no stabilizing period because a screen is needed immediately. Even though they both may have stretched to the same initial tension, by the time the screens are on press, they will behave differently, have different tensions, and print inconsistently.

The rapidly stretched screen will begin to lose tension right away and throughout the print run. Because polyester mesh is elastic it relaxes after being stretched. Therefore it is recommended to stabilize the mesh prior to coating and imaging it.

By re-tensioning it a few times the mesh becomes more stable removing some of its elastic properties. The mesh will still lose some tension during the first 24 hours. We recommend “quarantining” them overnight before further processing. Using these techniques, will offer the best stability of the printing plate, assuring minimal tension loss during the print run.

If tension drops during the print run, registration is lost and color shifts begin to occur. Poor peel, improper ink release, ink buildup on the print side of the screens, and increased smearing can be associated with tension loss during printing. Printing speeds may also have to be slowed.

The employee who rapidly tensioned the screen may not know that he has contributed to this problem on press, because he stretched it to the same tension, and he doesn’t see the screen once it leaves his department.

The woven mesh consists of a warp and a weft thread. During the weaving process, every other warp thread is separated to allow for the placement of the weft thread. The weft thread is held straighter and tighter than the warp thread being woven over and under the weft thread.

It is useful to understand this because it affects the way the mesh stretches. The warp threads travel the length of the bolt of mesh and often stretch or elongate more than the weft threads that cross the warp threads.

Understanding this, we will want to be consistent in the way we place the mesh onto the frame. The squeegee should travel in the direction of the weft threads because they are more stable and do not elongate as much as the warp threads. Since the weft threads don’t stretch as much as the warp threads, they will not relax or lose tension as rapidly as the warp threads and therefore offer maximum stability on press.

Although this is not as important as it once was, because virtually all mesh used today is a higher quality, lower elongation variety, consistency is still the general rule.

DEGREASING

All screens should be degreased prior to coating with emulsion or film. **Soft**

nylon bristle brushes should be used to brush the degreaser onto the mesh. This adds a mechanical action that aids cleaning. Also brushes are gentler on the mesh than scouring pads and easier to keep clean than rags. Using a **concentrated degreaser** such as KIWO degreaser 1:20 is a cost effective approach to this process.

Care needs to be taken so that chemicals left on the washout booth do not splash back onto the mesh when using a pressure washer to rinse the screens. If fisheyes are a problem, you might consider flooding the screen with a **high volume, low-pressure rinse** to help avoid blowback from the washout booth.

To help reduce contamination problems, **routine daily cleaning of all washout booths** is recommended. A more thorough cleaning should be done every three to six months.

We recommend having **dedicated washout booths**, one booth for degreasing, and another for reclaiming. Thorough rinsing of the entire frame is necessary so that degreaser or other chemical residue left on the frame, or in the frame's channels, does not drip onto the clean mesh during the drying process.

After degreasing, **screens (especially wet ones) should not be placed on a dirty floor in front of a dirty fan**. This will greatly compound the contamination problem.

Instead, use a **water vacuum** to extract 95% of the water from the screen immediately, wipe the perimeter of the frame and store in a clean environment until dry. This method has helped screen printers dry screens faster with less contamination. The screens will dry in approximately five minutes, instead of taking 30 minutes in front of a dirty fan.

INSPECTION

Incoming screens from the reclaim department should be visually inspected for contamination, correct tension, and proper labeling of the mesh count. A properly calibrated **tension meter** and a **mesh counter** are useful tools to assure consistency. Be very careful during this inspection process not to re-contaminate the mesh. Do not touch the mesh with your fingers. The oil from your skin can cause fisheyes in the emulsion coating.

A **light box** with yellow safelight sleeves is a useful tool for screen inspection both prior to coating and after coating.

A simple **chart** in check-off form indicating the condition of the screens may be useful. Dust, lint, hair, and other forms of debris on the screen cause delays in touching up pinholes, as well as rejected screens, and/or premature stencil breakdown.

COATING CONDITIONS

Before coating emulsion, the screens must be completely dry. Otherwise, fisheyes occur in the emulsion coating. After the degreased screens are dry, they should be coated as soon as possible to keep contamination to a minimum.

After coating, **the screens must be kept in a dry environment**. Between **30-40 percent relative humidity** is ideal, but no greater than 50 percent.

Too much moisture in the emulsion coating, even if it feels dry to the touch, will result in improper exposure and incomplete cross-linking (emulsion hardening). If this occurs, it may result in the following problems:

- Pinholes developing while printing
- Premature breakdown
- Difficulty reclaiming
- Increased ghost/haze images after reclaiming

Using a **hygrometer,** which measures relative humidity, where emulsion-coated screens are drying will help monitor the environment. Logging this information helps identify trends when humidity tends to spike and cause problems.

Although a room may be kept dry with the use of dehumidifiers, exhaust vents, heaters, and/or air conditioning; screens should not be used until the emulsion itself is sufficiently dry. A moisture meter can be used as a gauge to help determine when the screens are dry enough to be exposed.

Dry emulsion-coated screens are susceptible to re-hydrating prior to exposure. They are resistant to humidity only after exposure, washout, and drying of the stencil. This applies to diazo-photopolymer (dual-cure) and SBQ-photopolymer (one pot) type emulsions. Straight diazo sensitized emulsions are somewhat susceptible to humidity even after processing the stencil.

If properly dried screens are then stored in a humid environment prior to exposure, the emulsion will reabsorb the moisture and suffer consequences similar to that of an underexposed screen. Be sure to keep screens dry right up until they are exposed.

EMULSION-OVER-MESH (EOM)

Stencil Thickness or emulsion-over-mesh (EOM) is one of the most important variables to control.

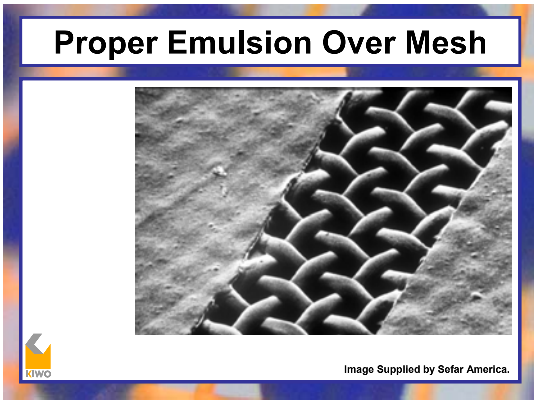
If the stencil is too thin in relation to the mesh thickness, the following printing problems may occur:

- Smearing in the direction of the squeegee
- Dot gain in the shadow areas
- Dot loss in the highlight areas
- Excess ink build-up on the substrate side of the screen
- Moiré
- Saw-tooth in the print
- Fine details closing in resulting from overexposure, if exposure times were set for a thicker stencil

If the stencil is too thick in relation to the mesh thickness, other problems may occur:

- Difficulty drying
- Poor ink release from the stencil, or too much ink deposit in cases where the ink does release from the stencil
- Dot loss, or gain, as a result of the previous problem
- Pinholes and possible premature stencil breakdown resulting from under-exposure, if exposure times were set for a thinner stencil

General printing applications not involving UV inks, fine lines or halftones, benefit from a 20% EOM ratio. This gives the stencil sufficient shoulder to bridge the mesh threads properly and provides a nice gasket with the substrate.



Depending on your printing application and the thickness of the mesh, the actual emulsion build-up above the mesh can be between 12 microns to well over 40 microns. For example, 110/80 mesh with a fabric thickness of 116 microns would print well with approximately 23 microns of emulsion build-up. Whereas a 230/40 mesh with a fabric thickness of 58 microns would print well with approximately 12 microns of emulsion build-up.

With the increased popularity of specialty printing on garments, variations in stencil thickness to yield a special look or effect must be evaluated and documented for repeatability.

High-density printing has sparked some enthusiasm among the print buyers and consumers. The tendency has been to see how thick a stencil can be used and printed with for the most dramatic effect. Keep in mind that with a thicker stencil, the more difficult it is to print with sharp edge definition due to light scatter, and the less likely it will be to print fine details. Some of the best looking high-density designs are achieved with stencil films around 200-microns. Increased depth can be achieved by stacking the colors of the designs on top of each other.

Printing fine lines, halftones, 4-color-process, and UV inks benefit from a 10% EOM ratio. This type of printing is usually performed on finer meshes and doesn't require as thick of a stencil to form a good gasket because the finer meshes have a smoother surface structure than coarser meshes. Additionally, the thinner stencil allows for finer resolution printing.

Depending on the thickness of the mesh, the actual emulsion build-up above the mesh can be between 4 microns to around 15 microns. For example, a 380/34 mesh with a fabric thickness of 48 microns will print well with approximately 5 microns of emulsion build-up. Whereas a 255/40 mesh with a fabric thickness of 58 microns will print better with approximately 6 microns of emulsion build-up.

When printing four-color process with UV inks, a slightly thinner stencil between 2-4 microns will help reduce ink piling and skipping. However, keep in mind thinner stencils have poorer gaskets with the substrate, which can cause their own printing problems as mentioned earlier.

To improve the stencils gasket when using very thin EOM's, I recommend using thinner thread diameters and thin capillary films.

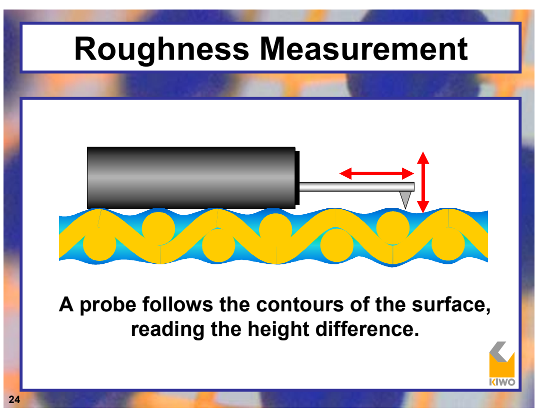
For example, if using 380 mesh, switch from a 34 micron thread to a 31 micron thread, or use a 460 mesh with a 27 micron thread. These meshes are thinner and have smoother surface structures.

And capillary films inherently create better stencil gaskets as they are a solid, flat film as opposed to direct liquid emulsions, which shrink by at least 50% after drying due to their water content.

A **stencil thickness gauge** is essential to monitor, log and control stencil thickness. This tool should be used on regular intervals and the data logged for reference purposes.

Rz VALUE

Rz value refers to the surface roughness of the stencil and is measured in microns by an instrument called a profilometer or **Rz meter**. A profilometer measures the profile of any given surface. The measurement is an average of five readings indicating the average difference between the highest and the lowest measured spots.



An Rz value of 15 microns means there is a deviation in surface roughness of 15 microns. The knuckles of the mesh where the threads intersect one another represents the highest point. And the open area of the mesh where the emulsion shrinks back into the weave of the mesh represents the lowest point.

As screen printers, we are concerned with the surface of the stencil that comes in contact with the printing surface. The stencil surface should be smooth enough to form a gasket, or seal, on the substrate. If a good gasket is not achieved, ink will flow underneath the rough surface of the stencil causing such things as:

- Dot gain
- Color shifts
- Bleeding
- Ink build-up on the print side of the screen
- Smeared images

When printing directly onto a T-shirt, the Rz value is less important than when printing onto a plastisol underbase. The T-shirt is absorbent and the plastisol underbase is not. If your substrate is non-absorbent like vinyl or polycarbonate, the Rz value becomes more important because the chance of ink smearing and bleeding increases. With an absorbent substrate, the ink is absorbed before it bleeds too much.

Rz values need to be observed more carefully when using liquid direct emulsions, as they are made with 50-70% water and shrink back into the mesh taking on the rough surface structure of the mesh. To make the coating smoother we utilize a secondary coating technique called "face coats".

Face coats are applied to the substrate side with a sharp-edged trough after the initial "base" coating has dried. Using a sharp-edged coating trough helps minimize additional stencil thickness. Acting like a doctor blade, the trough cuts the emulsion off at the knuckles of the mesh filling only the low spots of the stencil surface. Three wet-on-wet face coats add only about one micron to the stencil thickness, but can improve the Rz value (smoothness) by 30%! As face coats are merely a thin veneer coating on top of a previously coated screen, the drying time is very short.

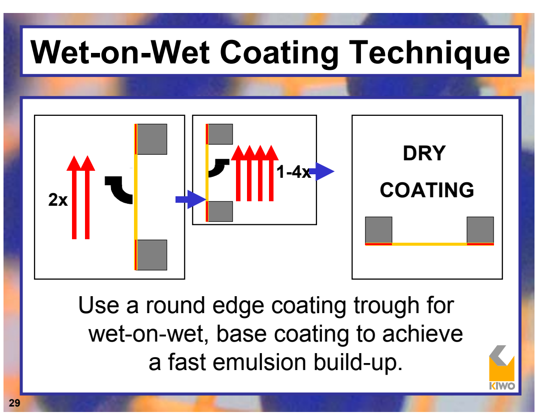
A general rule of thumb is to have the sum of the Rz value of the substrate plus the Rz value of the stencil equal no more than 15 microns. In most cases, the lower the Rz value of the stencil surface, the better the print quality.

COATING TECHNIQUE

Coating techniques vary wildly. A common debate among screen makers is about the best technique to use when coating a screen.

First, lets define base coating and face coating. Base coating is the initial emulsion coating used to get close to our target stencil thickness, typically using a round-edged coating trough. Face coating is an optional wet onto dry coating used to improve emulsion smoothness using a sharp-edged coating trough. So base coat for thickness and face coat for smoothness.

There are several different styles of manual and automatic coating troughs. They vary in their edge radius, angle, and volume of emulsion they hold. Decide which style of trough suites your purpose and stick with that one design. Do not intermix brands of coating troughs.



Always begin coating from the substrate side of the screen until a mirror-like glossy finish is observed from the squeegee side of the screen when viewing at a low angle to the lights. Then complete your base coating from the squeegee side.

If coating by hand or by machine, a round-edged trough is desirable, as it will require fewer passes to reach optimum stencil thickness. Many troughs used on automatic coating machines are too sharp and require many coating passes to reach the desired emulsion thickness. This reduces the machines throughput capabilities.

There are times when sharp-edged troughs should be used. For example, when face coating to improve Rz values. Therefore, a set of sharp-edged troughs is good to have on hand. When hand coating, the Sefar dual-edged (one sharp, one round) coating troughs work well.

The number of coats to use to reach our target thickness is influenced by:

- Mesh count
- Mesh thickness
- Thread diameter
- Coating trough edge radius
- Emulsion's viscosity and solid content
- Coating speed, angle, and pressure
- Fill capacity of the coating trough
- Cleanliness of the screen

To avoid getting air trapped within the coating, coat from the substrate side until a glossy, mirror-like finish appears on the squeegee side. To identify this hold the screen with the squeegee side facing your safelights and view it at a low angle.

If the squeegee side has a dull, matte finish, the emulsion has not pushed all the way through the mesh and you run a risk of trapping air bubbles in the mesh openings.

These air bubbles may not be visible without magnification as the emulsion is encapsulating the air bubbles and pinholes may not be detected. However, when the screen is being printing with, the cycling of the squeegee and flood bar may break open hidden air bubbles in the screen causing a slow progression of pinholes during the press run.

Two coats with a round-edged coating trough will usually achieve a glossy finish on the squeegee side. At this point, no further coats are required from the substrate side. Three coats may be required on some meshes like 380/34.

Sharp-edged coating troughs fill the mesh very slowly if at all, making it very difficult to fully penetrate the mesh.

Once full penetration is reached, begin coating from the squeegee side. The number of coats from the squeegee side is more important in achieving our specified stencil thickness. With each successive coat of emulsion from the squeegee side, the emulsion builds up on the opposite (substrate) side.

Don't be concerned about how thick the emulsion looks after coating a screen using a round-edged coating trough. Most **emulsions are over 50% water**, which evaporates during the drying process. The dry emulsion film will shrink back to less than 50 percent of its wet film thickness.

A **stepped coating procedure test** can be used to find the coating technique that matches our target stencil thickness. For more information on the stepped coating technique please see our Web site at www.KIWO.com. A stepped coating technique is used to apply various coating thicknesses onto one screen. When dry, these coatings are measured to identify the proper technique required to achieve a specified emulsion thickness (EOM) and Rz value.

A stencil thickness gauge and an Rz meter are used to measure and log these two most important stencil variables: thickness (EOM value), and smoothness (Rz value). **For many mesh counts, a 2/2 coating technique works well**. But for others like very coarse meshes or very fine meshes, other coating techniques will often need to be used.

UNDER & OVER EXPOSURE

Exposure calculators and **neutral density step filters** are key process control tools to assure the emulsion is receiving enough UV light to fully react and harden the stencil.

If the emulsion is not hardened all the way through its coating, problems associated with underexposure will ensue. For example:

- Scum in the image area
- Sawtooth - Poor mesh bridging
- Premature stencil breakdown
- Difficulty reclaiming
- More pronounced ghost/haze images

Overexposure is associated with certain problems as well, such as:

- Decreased resolution
- Loss of highlights
- Poor edge definition
- Possible moiré due to loss of highlight dots
- Grossly overexposed stencils may become brittle

EXPOSURE CALCULATION

Exposure calculators are used to determine where complete exposure takes place. To properly use an **exposure calculator**, each different mesh count and/or color must be coated to its targeted thickness, thoroughly dried, and exposed for twice the assumed proper exposure. Depending on the number of neutral density filters in the calculator, between five to ten steps of different exposures will be represented from under to over exposure.

When the exposed and developed screen is dry, evaluate it in front of a light table. Look at each exposure step of the calculator starting with the shortest exposure (the darkest filtered step on the film's calculator), and determine which step shows no visible outline of the rectangular filter. Multiple the factor/number associated with this step by the time used to expose the calculator. The result is the optimum exposure time to thoroughly harden the emulsion and achieve complete exposure. Ideally, this will be the new, correct exposure time.

The next step is to determine if the copying properties at this exposure step meet or exceed production requirements. Remember to evaluate the stencil's copying properties at the step determined to be appropriate in the previous paragraph.

RESOLUTION, EDGE DEFINITION, & MESH BRIDGING

Copying properties include resolution, edge definition, and mesh bridging. A **50-75-power microscope** is useful when assessing a stencil's copying properties.

Resolution is determined by the fineness of line or dot the emulsion reproduced.

Edge definition is how sharply defined the stencils edge reproduced in comparison to the films artwork.

Mesh bridging is how well the emulsion maintains the size and shape of the films artwork when bridging the gap between the threads.

Evaluate detail similar to the detail your print requirements call for utilizing that particular mesh count and color.

A common mistake is to evaluate the finest detail of the exposure calculator regardless of what mesh count and color it was reproduced on. This can be a problem because oftentimes the detail on the exposure calculator is too fine for the mesh count it is reproduced on.

Many exposure calculators have only fine lines and halftones on them, but are used on coarse meshes to calculate exposures. That's okay but don't expect to hold all the detail represented on the calculator. Coarse mesh counts cannot be used for extremely fine detail printing, so don't expect to resolve 50 micron lines on 110 white mesh.

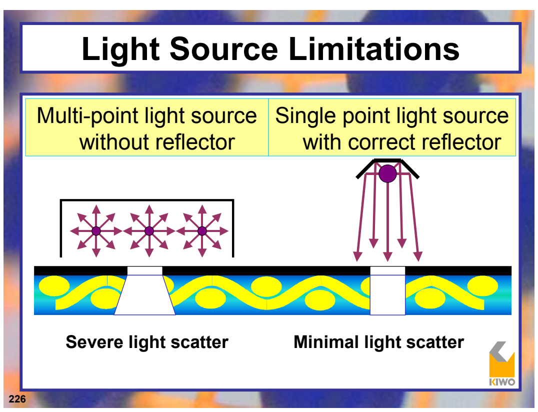
Remember to take into consideration the mesh count and the amount of detail typically used on such screens when evaluating copying properties.

White mesh cannot hold the same resolution as yellow mesh of a given mesh count due to light scatter. Dyed meshes absorb much of the light used to expose the screen and helps prevent light scatter from undercutting the opaque image areas of the screen. Light scatter exposes and hardens emulsion that should be washed out during development. Because dyed meshes absorb more light, they require at least 50-80 percent longer exposure times.

THE ROLL LIGHT SOURCES AND VACUUM FRAMES PLAY IN ACHIEVING RESOLUTION

If a quality point light source is used with a properly functioning vacuum frame, resolution should not be a problem even at complete exposure.

The light source should be able to expose evenly across the surface of the vacuum frame and exhibit collimated light. That is light that travels perpendicular to the vacuum frame without much scatter.



The vacuum frame should have scratch free, optically clear plate glass, and must be capable of achieving Newton rings during vacuum draw down.

Newton rings are impressions seen on the film through the glass that indicate a tight seal is being achieved between the film positive and the emulsion. Newton rings can be identified when looking at the vacuum table glass at a low angle. They will look like dark, wet, ring-like little circles covering the film positive.

Verifying that there is a proper seal between the film and the emulsion is an important step in assuring process control and should be done on a regular basis. **Monitoring or Documenting inches of mercury** from your vacuum frame can be useful in troubleshooting. Loss of highlight information in the print and poor stencil edge definition may often be tracked back to insufficient vacuum.

With insufficient vacuum, light leaks underneath the image areas of the film positive during exposure, thus exposing emulsion in the image area. During washout, fine details may not open up fully, or at all.

EXPOSURE CONTROL FILMS

Neutral density step filters, also called hardness scales, like the Stouffer 21-step consist of small square neutral density filters ranging in density from .05 to 3.07. These small films can be placed right on the vacuum frame just outside the image area or directly on the screen itself. The 21-step control film will assist you in finding variations in your stencil making process. It does not tell you what has changed, but will tell you when a change has occurred.

When developing a stencil, some of the 21 steps will fall off. The number of steps that remain firmly attached to the screen is used as a numerical reference of stencil durability or hardness. Exposing to a solid step nine means nine steps remain firmly on the screen, while 12 steps fall off, or are beginning to fall off. When developing screens, one can easily see if a consistent solid step is being maintained. If it is, you know your stencil is achieving the same hardness. It is important to be very consistent with your developing process.

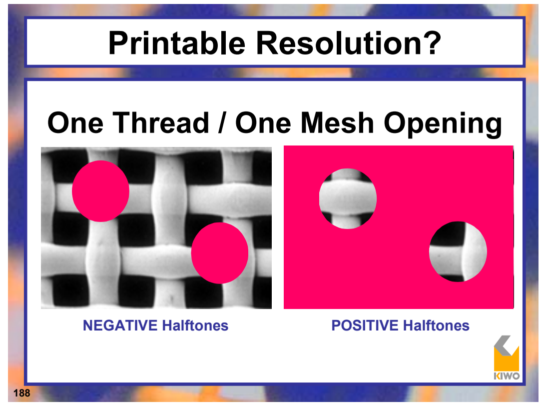
The 21-step control film will help determine such things as:

- Changes in emulsion types
- Variation in lamp distance
- Change in coating thickness
- Deterioration of the lamp not compensated for by an integrator
- Variation in development
- Change in mesh selection

ART-TO-MESH RELATIONSHIP

The relationship between artwork and the mesh is key to capturing all that was intended by the artist. When artwork entails very fine lines, text, or dots, mesh selection becomes more critical. The mesh needs a high enough frequency of threads for the emulsion to anchor or attach to.

There are limits in screen printing to how fine a line or dot can be printed. Since ink has to transfer through the printing plate in this process, it is proportional to the thread diameter and mesh thickness. Even the finest meshes carry/hold more volume of ink than do offset printing plates. Therefore, when ink transfers to the substrate in screen printing, there is naturally a greater flow of ink, which hinders our ability to resolve very fine lines and/or dots.



When the finest mesh counts with the thinnest threads measure 40-50 microns in mesh thickness, it is unreasonable to expect to print detail smaller than 40-50 microns. Although it can be done, so much of the image is blocked by the threads that print distortion must be expected.

Screen makers are asked to do the impossible. Many film positives used today for halftones and four-color process contain dots that are too small to print.

In the case of highlight dots, there is significant dot loss because the dots are nearing the size of the threads. If the dots are positioned right on top of threads, ink will not pass through the stencil. Even if the dot is not positioned directly over the thread, it is unlikely the ink will be able to release from the column formed by the emulsion. This is referred to as the "**tunnel syndrome**." When the diameter of the dot to be printed is less than the height of the tunnel it must pass through, the ink tends to adhere more to the tunnel than to the substrate. Most of the ink will remain in the screen after the mesh "peels" or "snaps-off" instead of releasing onto the substrate.

In the case of shadow areas (negative dots), the area to be kept open, free of ink, is too small to compensate for ink flowing after the screen "peels" from the substrate. This is referred to as dot gain.

When artwork is so fine and pushes the limits of printability, it becomes a problem in several areas:

- Screen makers are asked to resolve information on the film that is impractical to print.
- In an attempt to open up highlight dots, the screen maker under-exposes the screen, which leads to increased pinholes.
- Shadows are printing 100% solid because the negative dots are too small to realistically keep open.
- Slow degradation of detail in the shadow areas occurs as a result of premature stencil breakdown. Dots fall off the screen due to poor anchoring to the mesh caused by under exposure and their small size.
- Stencils become more difficult to remove because a chemical reaction occurs between the ink, solvents used in wash-up, and the un-reacted emulsion left in the screen from under-exposure.
- Ghost haze is increased because of the chemical reaction mentioned above, which "locks in" stains.

Production parameters must be set and monitored for optimum printing. Settings such as off contact, squeegee angle, speed, and pressure needs to be tested for different applications to establish optimum printing parameters.

Once these are in place, each press should be fingerprinted or mapped to see what the resolution capabilities are for that press with each mesh count imaged according to specification or standard operating procedure (SOP).

This involves printing **4-color process test films** with various halftone screen rulings output from 0-100% with known percentages for highlight, midtone, and shadow areas. The art department can utilize this information to see how compressed the tones become, and then make adjustments to the output file to compensate the film positives accordingly. Adjusting the tonal levels of the output file should be done so that the printed job matches the proof.

Additionally, they will see just what a "gettable" dot is in print. Knowing what the smallest dot you're capable of printing is will help when creating the artwork and discussing jobs with customers.

RECLAIMING

This processing step is often taken for granted. It involves removing the ink, emulsion, and any stains left in the mesh after completing a print job. Obviously this is not the most glamorous job in the shop. Oftentimes it is difficult to find employees willing to do the job at all, let along to do a conscientious job.

We must again remember the screen itself is the printing plate, the hub of the entire process. If anything fowls up during any step involving the screen, production can come screeching to a halt.

Each and every employee must be reminded how important their position is to the success of the company. I've found that when employees feel like they are a part of the team and their work is truly appreciated, they will put forth their best effort and do it with a positive attitude.

With that in mind, let’s take a look at what the overall goal of reclaiming the screen is. Screen reclaiming is the process where we attempt to bring the screen back to its original condition. This involves removing the ink from both the mesh and the frame. The emulsion must also be completely removed, followed by any ghost images and stains.

All too often a substandard job is done in the reclaiming department. For example, ink is sometimes left on the frame, which makes its way to the coating and exposure area, thus contaminating the vacuum blanket, glass, and subsequent screens. This causes costly and unnecessary delays in production.

Additionally, when emulsion is not thoroughly removed along with its residue and stain, ink transfer problems arise on the next job. The problem begins to compound itself with each additional job. The result is rejected screens, remakes, and press downtime. The most costly place to have a rejected screen is on press. The shops efficiency suffers due to lost time and results in cost overruns. Contributing to cost overruns is the need to replace mesh more frequently.

It is important to brush the chemicals in when using ink degradents, stencil removers, and degreasers. In the case of ink degradents and stencil removers, using nylon bristle brushes help to break down the ink and emulsion to a liquid state and more effectively release them from the mesh. This leaves the mesh cleaner with less residue and stain.

Too often printers rely too much on their pressure washers to “hammer” the ink and emulsion out with brute force in an effort to save time. This doesn’t give the reclaiming products enough time to break down the ink or emulsion, and may leave particles and a thin residue behind in the screen. This residue can restrict ink transfer in subsequent jobs and will build up over time. Premature ghost or haze images will become a problem.

Printers are often told they don’t need to degrease their screens because their stencil remover or haze remover contains degreaser. Be careful and thoroughly test the procedure before implementing it. You may encounter problems with fisheyes in the emulsion coating, or you may have difficulty with scum in the image area that impedes ink transfer when you begin to print. This happens more frequently when finishing the reclaiming process with a solvent ink haze remover that allegedly has degreaser in it. The screen may need to be washed with an aggressive solvent prior to printing in order to remove this film from the mesh.

Although saving time by eliminating the degreasing step sounds good on the surface, it may cost you more time and money in the long run. A good concentrated degreaser is so economical the price is insignificant. And the time it takes to properly degrease a screen will be saved in less time spent touching up pinholes, less press downtime, and fewer remakes.

SUMMARY

In order to get ahead or stay ahead in this changing market, screen printers need to take an active roll in implementing current technology that improves quality and workflow efficiencies. Suppliers and manufacturers often conduct seminars and workshops on the latest technologies available, and how to incorporate them into a production flow.

With so many variables influencing the screen printing process, it is valuable to fully understand as many of these as possible. By dedicating time to research the impact these variables have on the quality of your product, you will be able to establish a quality control program with standard operating procedures. Consistency, efficiency, increased productivity, and ultimately increased profitability and competitiveness will be your reward for implementing such a program.

Hopefully this article provided you with a basic understanding of variables involved in the screen making process and their impact on the overall health and well being of your business. Below is a simple reference chart with suggestions and recommended tools to help you get started.

QUICKSTART GUIDE TO CREATING STANDARD OPERATING PROCEDURES

Helpful Tip: Clear, concise, graphically illustrated procedures for each of the 10 steps can be laminated and posted at each station to help reduce confusion while emphasizing the importance of following SOP's. It will also be useful in training new employees more effectively.

SCREEN PROCESSING STEP	SUGESTIONS AND TOOLS FOR SUCCESSFUL IMPLEMENTATION
1) STRETCHING	Log of mesh roll specification tags
	ID and log all frames for tracking screen life and cause of failure
	Mesh alignment on frame (warp/weft) and to minimize wasted mesh
	2 tension meters calibrated and checked for consistency
	Mesh counter: Measuring microscope or Mesh/Film Dot counter (acetate film type)
2) DEGREASING	Clean booth every day
	Use soft nylon bristle brush instead of rags or scouring pads
	Use dedicated, clean, water vacuum to remove water
	Rags to wipe frame
3) DRYING	Keep area clean and dust free
	Drying cabinet or heaters and/or air purifiers instead of dirty fans
	Screens placed in racks and off the floor
4) INSPECTION	Light table
	Calibrated tension meter
	Mesh counter
5) COATING	Clean/damp mop coating area every day to reduce screen contamination
	Round-edged coating trough design for base coating
	Sharp-edged coating trough design for face coating
6) DRYING	Dehumidifiers, heaters, and air purifiers for efficient, controlled drying
	Hygrometer to monitor temperature and humidity 30-40% humidity, 50% max, 90-100° F temperature if possible
	Moisture meter to check emulsion dryness
	Stencil Thickness Gauge to monitor and log EOM
	Profilometer (Rz Meter) to monitor and log Rz value
7) EXPOSURE	Integrated pin registration system for screens, vacuum frame, and press
	Film punch system
	Clean glass and film positive prior to exposure, check alignment
	Clean vacuum blanket periodically
	Log vacuum from gauge (inches of mercury)
	If possible, check for Newton ring formation on film positives while screen is under vacuum
8) DEVELOPMENT	If possible use warm water developing
	Fine spray pattern but ample pressure
	Water vacuum to accelerate drying
	Rags to wipe frame
9) PRESS READY	Light table
	Loupes and/or microscopes
	Touch-up, block-out, and tape
10) RECLAIMING	Dedicated nylon bristle brushes per each chemical
	Brush both sides of screen thoroughly with each chemical
	Back lighted washout booth if reclaiming manually
	Minimum 1000 PSI pressure washer