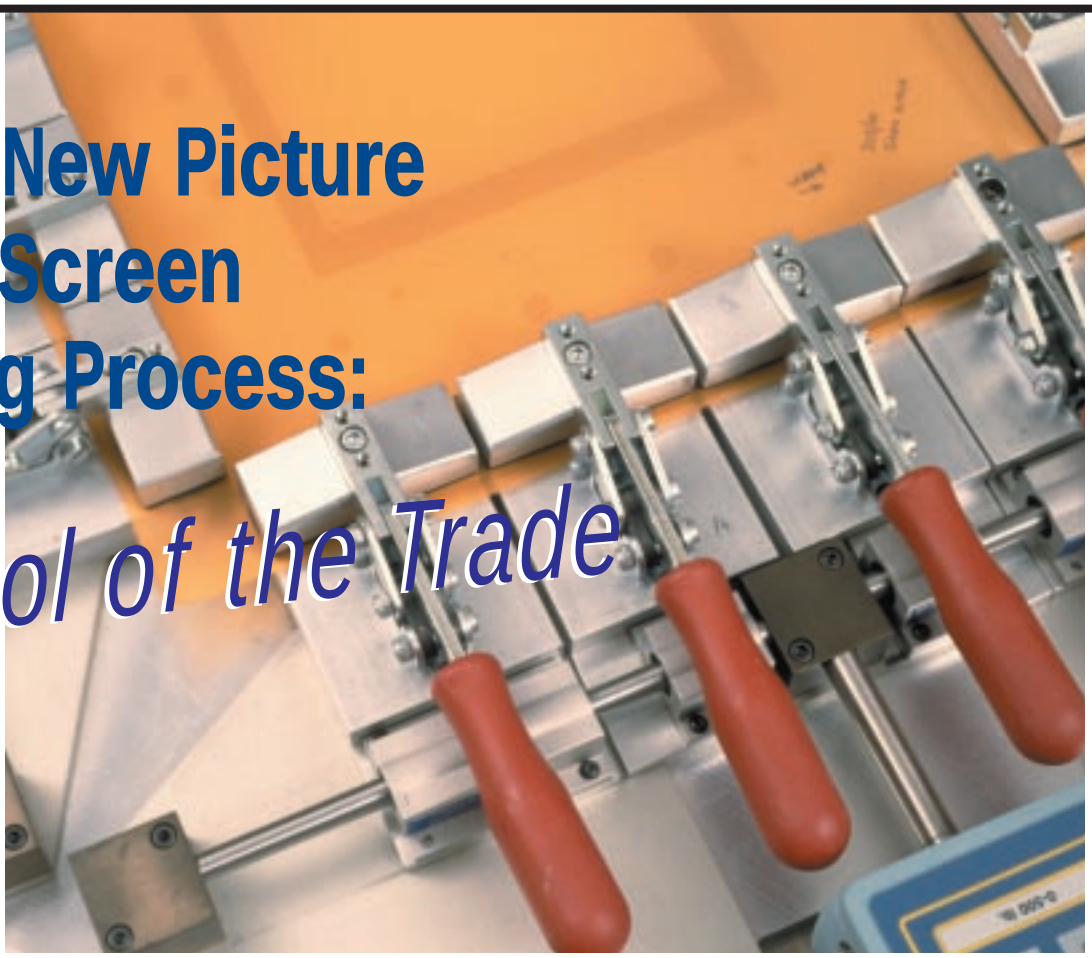
SPTF's New Picture of the Screen Printing Process:

A Tool of the Trade



by Dawn M. Hohl,
R&D Engineer
Screen Printing
Technical Foundation

In this exclusive issue of the SGIA Journal, a folded poster of the Screen Printing Process Model, in chart format, has been included for your use.

There is no question that there are an overwhelming number of variables in screen printing. It is almost unthinkable that each of the 500+ variables (yes, you read it right — over five hundred) has a part to play in how the final print turns out. Some variables have a much larger influence than others do, but they all impact the final print to some degree. Some variables require much more attention than others do, but ignoring any of them will thwart attempts at process control. The bottom line is that each successive step taken in the process cannot improve on the product of the earlier steps. Problems in the beginning stages of the process have a tendency to snowball into larger ones further down the road.

So where do we start? How do we take control? Well, first we have to get the big picture. Create a process model from which to work. In the May/June issue of Screen Graphics magazine, SPTF introduced the first Screen Printing Process Model. The model is presented in a chart format that is broken down into the various sub-processes in screen printing with their respective variables. With over 500 variables represented, a complete chart that was readable could not be reproduced in that magazine article due to its size. In this exclusive issue of the SGIA Journal, a folded poster of the chart has been included for your use.

Now that we have the model, what do we do with it? This article will attempt to answer that question. In that introductory Screen

BELIEVE IT OR NOT:

- *Total number of variables identified in chart is 507*
- *157 of these are manufacturer controlled*
- *350 of these are the printer's responsibility*
- *Total number of printer sub-processes is 37*
- *229 variables are listed under the screen*
  162 of these are assigned to the printers
  67 are the manufacturer's responsibility
- *15 sub-processes are necessary to make a screen*

FACTS *About the Process*

Graphics article, I suggested that the model could serve printers and manufacturers as a tool to further develop screen printing into a controllable, repeatable and predictable process. The content of this article will go a step further and give practical instruction and examples on how to use this model in troubleshooting, training, procedure writing and management activities.

HOW TO USE SPTF'S PROCESS MODEL

TRAINING

Most companies must implement training when new employees are hired, or when moving current employees to new jobs. But training is also useful and necessary when a company wishes to improve quality. Most employees genuinely desire to do quality work, but sometimes lack the skills. Training under these conditions can actually be the key to improved profitability.

There is a difference between just showing someone what to do and teaching them its function and impact on the process. Teaching may take some extra effort, but will promote understanding of the role a task plays in the overall process. Employees with this understanding are much more effective at their jobs.

How to design a Training Program

A good training program will provide specific information that can be retained by the trainees. Three dangers exist in presenting an effective program.

First, avoid generalized statements, which provide little definitive information. The material you present should answer the questions what, how, when, where and who relative to your topic.

A second pitfall is presenting too much information without focus. Stick to a single concept and explore it well, providing specific instruction along the way. Limit training sessions to 30-50 minutes. If a topic is too big to cover in this length of time, break it down into multiple parts.

Finally, take care not to present conflicting information. This oversight fosters misunderstanding and undermines the effectiveness of the training. Don't present two ways of doing something if they conflict with each other without providing clear explanations and distinguishing one as your company's procedure. Be prepared to support your facts with examples.

Numerous question and answer periods should be scheduled during training. Develop ways to get feedback on the trainee's understanding of the subject presented. Encourage active participation. Use an interactive style instead of just lecturing. Ask the participants questions to get them thinking.

Provide written outlines of the presentation and any visuals being used. Make a point of emphasizing key points by writing them on a board and reviewing them several times. Put up key diagrams and pictures in work areas for reminders.

Use visual aids and demonstrations as much as possible. Use pictures, illustration posters, slides, print examples, material samples, measurement equipment — anything that will show the concept being presented. Remember as much as 77 percent of all learning is visual. A picture or visual example is worth a thousand words. Be creative.

Once the training has been completed, acknowledge improvements in the trainee's skills. Assess the effectiveness of the training, and make changes accordingly. Provide further opportunities for employees to learn more. Update them on new technology so they stay current with the latest industry information.

The Process Model Chart is an excellent tool for creating training presentations and programs. Each sub-process can be addressed in a separate training program. Some sub-processes may be too extensive to cover in one 30-50 minute training session, so it may be necessary to divide it into several parts.

Before developing a training presentation identify who you will be training, the level of the course, and the objective of the training. Then use the following outline to develop training workshops for your company. A sample training module based on this method is provided in Example 1.

- Define the sub-process and its overall function in the process. SGIA's upcoming service will provide a narrative for each sub-process that will be useful for this part of the outline.
- Identify the variables in the sub-process. Use the variables listed in the box for that sub-process as a starting point and add to it if necessary.
- Develop a procedure for accomplishing the sub-process in your company. Instruction on writing procedures is included in the next section of this article.
- Define how these variables will be controlled, measured, evaluated, and documented. Show and demonstrate appropriate equipment.
- List safety issues/instructions for this sub-process.
- Identify maintenance/storage instructions.
- Describe how this sub-process effects the process or end product if it is not completed properly.
- Specify common problems and troubleshooting outlines for those problems. It would be a good idea to train employees on troubleshooting methodology in a separate training module. For an example of a troubleshooting outline that could be developed see the Troubleshooting section of this article.
- List reference articles covering the topic. Make these resources available to your employees and encourage them to read them.

PROCEDURES

Consistency is one key to attaining process control. To do something consistently a procedure must be in place that is accepted and followed at all times. A procedure is simply a particular way of accomplishing something that can be written as a series of steps to be followed in a definite order. In a work environment, procedures most often serve as official company guidelines that ensure a process gets done the same way and to the same standards each and every time.

Operating procedures take away the mystique of "tweaking" the process to make it work by providing qualified instructions that someone can be trained to do. Establishing procedures simplifies troubleshooting to evaluating production steps rather than guessing what the problem might be.

For the purposes of this article we will concentrate on writing operating procedures for production. The purpose of operating procedures is to ensure that each part of a process is carried out in a prescribed way that has been determined to produce repeatable quality results.

The next step beyond operating procedures is standard operating procedures (SOP). An SOP is a list of tasks required to perform a process or one part of a process. Its function is to define the correct way to perform work in each department. It can include a listing of the tasks involved, a flow chart of those tasks, employee responsibilities, quality control measures, troubleshooting instructions, safety instructions and maintenance instructions.

How to Design a Procedure

Here are some basic steps to follow when designing a production procedure.

Identify the Variables. Use the process chart to identify the sub-processes that need to have operating procedures (in the author's opinion this includes all of them). Once a sub-process is selected, all the variables that affect that sub-process should be listed. The chart can also help in this task. The procedure should address what and how to handle each of these variables.

Research the Task. The procedure should be based on the skill, knowledge and experi-ence of employees, as well as solid technical information from manufacturers and other industry technical organizations. Question how each variable should be handled and controlled. Thoroughly research the area being written on so the procedure is technically sound.

Write and Test the Procedure. Use the guidelines listed in the next section to develop a working procedure. Changes should be made based on the results of the testing, and the revised document tested again.

Implement the Procedure. Once the procedure is tested, it can be implemented into production. This will involve training and clear communication of expectations.

Check the Effectiveness of the Procedure. Once implemented, the procedure must be initially monitored for effectiveness and problems. Is the procedure producing consistent results? Is everyone performing the task as the procedure describes, or have they fallen back into their old habits? Can everyone understand the new procedure? The answers to these questions may mean the procedure should be revised or that employee issues must be dealt with more effectively.

Revise as Needed. Although the point of a procedure is to ensure a process is done the same each time, it should not be so set in stone that industry advancements and new techniques are not considered for implementation. Operating procedures should in fact be reviewed periodically to determine if changes based on new information could improve things. This approach is part of a continuous quality improvement strategy.

Outline for Writing Operating Procedures

A clear easy to read format should be adopted for operating procedures. Their effectiveness is partly determined by their usability. Generally there are six parts that can be included to create an operating procedure.

Purpose and Scope: The scope and purpose of the procedure must be clearly

stated. Each procedure should be narrow and self sufficient in what it covers.

Reference: Other operating procedures that are directly related or referred to should be listed here.

Terminology: Any technical terms or acronyms used in the procedure should be clearly defined to avoid confusion.

Safety: All safety concerns and precautions related to the scope of the procedure should be listed.

Equipment and Materials: Identify the equipment and materials needed to complete the procedure.

Procedure: Detailed step by step instructions on how to perform the task should be provided.

Additional information such as the department, date, procedure title, revision dates and company name should be included in the title area. Depending on your needs it may be necessary to develop a document coding system. Such a system allows for easier cross-referencing and organization if there are many operating procedures involved. A sample procedure incorporating these sections can be found in Example 2.

Here are some important guidelines to remember when writing procedures.

Procedures should not assume knowledge. This is a relatively easy mistake to make since the procedure writer is often someone who knows the process inside and out. Steps may be left out that the novice does not know to do. Precise details should be included at all times. There are two ways to make sure nothing has been left out. First the procedure writer can follow each step exactly as described in the completed procedure until the task is done. If something is missing it will become clear during this process. Secondly, the completed procedure should be "tested" by giving it to a user to follow while the procedure writer observes. Any questions or problems that arise should be redressed in the procedure.

Procedures should be written with the user's viewpoint and convenience in mind. Procedures should be simply worded and easy to follow. They should be in a format that is appropriate for the nature of the procedure and the target audience.

When writing sequential instructions in a procedure, numbered steps should be used. These numbered steps should always be in chronological order.

Each numbered step should include only one action by the user. Specifying more than one action in a step can cause confusion.

Write steps as commands when possible. For instance, saying "add ink to the screen" is better than "the ink should be added to the screen." Do not use the past tense for procedures as it may be interpreted to mean the step was already completed.

Use the same terminology for each part, piece of equipment, or control throughout the entire procedure to avoid confusion.

Clearly state all specific details with precise language. For instance, saying, "spray with water at 90-110 degrees F" is better than "spray with warm water."

Write in complete sentences, but keep sentences short. Long sentences can be confusing.

Maintain parallel structure in any list. Keep all items as nouns, or actions, etc. All items should fit the same pattern.

Use headings to aid readers in finding specific information.

TROUBLESHOOTING

Troubleshooting is a systematic process of finding and eliminating problems that produce unacceptable print results. In other words, it is a method of asking the right questions in the right order. This is the key in resolving a challenge. The overall goal of troubleshooting is not only to identify and correct an immediate problem, but also to *permanently* fix it to avoid production trouble in the future.

In his book "Troubleshooting the Printed Image," Tamas Frecska gives an excellent account of the basics of troubleshooting *any* problem. The five fundamentals for effective troubleshooting he presents are summarized here for effective treatment of this topic.

1. Use logic and common sense when problem solving. Check the simple and most obvious causes first when faced with any problem. For instance, if a screen rips during tensioning, check first for burrs and sharp edges on surfaces that contact the mesh. Then logically proceed to other causes like insufficient corner softening, and tension level.
2. Collect and create documents and lists that can be referenced when troubleshooting a problem. The Process Model is one such tool. However, while collecting references is useful, documenting and creating your own resource is absolutely invaluable. Recording a detailed account of problems you encounter and the actions taken to resolve them is an important part of effective troubleshooting.
3. Continually educate yourself on the cause and effect relationships in the process. Read articles in trade magazines and journals. Establish contacts with other people in the industry that have a good working knowledge of the process. Think about how the process works and how the variables interact during printing. The depth of your understanding of the process is directly related to your effectiveness at solving problems.
4. Organize possible causes of a problem in terms of their most and least likely effects on the process. This exercise will help you in your logical approach to solving problems.
5. A systematic step-by-step approach to corrective action must be practiced. It is unproductive to correct every suspected cause at the same time. Proceeding one step at a time allows correct evaluation of the effectiveness of the

Example 1

TRAINING OUTLINE 6-99

Mesh Preparation

Who Should Attend: Employees responsible for any aspect of screen making, from screen stretching to stenciling.

Course Level: Basic

Objective: Teach participants the function, effect and procedure for mesh preparation.

I. DEFINITION AND FUNCTION IN PROCESS

Mesh preparation is the process of cleaning and treating the screen to ensure good stencil adhesion and uniform stencil coating, whereby obtaining optimal stencil performance and durability. The mesh preparation process can encompass several different steps, depending on the stencil system and mesh being used.

A. Degreasing

1. Cleans a screen before stencil application.
2. Removes contaminates like oil, solvent residue and dust that would hinder stencil adhesion.
3. Performed on new mesh, reclaimed mesh, and mesh that has been stored for any length of time.
4. Standard step for all screens before a stencil is applied.
5. Improper degreasing can result in fisheyes, pinholes, poor stencil durability, repellent areas and streaks in stencils. These problems can cause press down time.
6. Types of Products: There are special products made for degreasing screen printing mesh. Never use regular soaps or detergents as these products contain other ingredients that get left behind and can hinder stencil adhesion. Degreasing liquids come ready to use or in a concentrate form, which must be diluted with water.

B. Abrading

1. Mechanical or chemical roughening of the surface of mono-filament threads.
2. Roughened threads have increased surface area that the stencil can grab onto, enhancing stencil adhesion.
3. Performed on the print side of the mono-filament polyester or nylon fabrics when using indirect or capillary stencils. Abrasion for capillary films is optional. Stainless steel mesh does not require abrasion.
4. Recommendations for abrasion range from one time for life of fabric to once every 5 stencils.
5. Failure to abrade properly will result in stencil delamination.
6. Over abrading mesh can result in reduced fabric life from the fibers being weakened, and decreased ink transfer efficiency from the ink clinging to the rough mesh during printing. An increase in screen haze is also a disadvantage of abrasion.
7. Types of Products: There are special products made for abrading screen printing mesh. Never use scouring powders as these will severely damage the mesh (show photo of damaged mesh from scouring powder). Both mechanical and chemical products are available. The chemical products either etch the surface of the threads or create a hydrophilic layer on the surface. The mechanical products, the most common, have a very fine grit powder, either silicon carbide or aluminum oxide. Mechanical abrasives come in either a free powder (rottonstone can be used as a free powder) or a paste or gel. The paste or gel is usually a combination degreaser and abrasive in one and offer advantages over the free powders.

C. Wetting Agents

1. Treatment that raises the surface energy of the mesh creating a uniform film of water over the entire screen when using capillary films.
2. An even coat of water enables the stencil to adhere uniformly.
3. Performed just prior to applying a capillary film.
4. May be beneficial for direct emulsions by leaving a microscopic layer that promotes adhesion when the screen is dried after being treated.
5. Some products in this category are not degreasers, so degreasing must precede this step.
6. If mesh is not uniformly wet, air pockets, uneven stencil adhesion and varying stencil thickness can result.
7. Types of Products: There are special wetting agent products made for screen printing mesh. Never use regular soaps or detergents as these products contain other ingredients that get left behind and can hinder stencil adhesion. Wetting agent liquids usually come ready to use. Some products are both degreasers and wetting agents, while some are not.

II. VARIABLES

Degreaser Type	*Abrader Type*
Amount Applied	*Brush Type*
Rubbing Duration	*Rubbing Motion*
One/Both Sides	*Mesh Type*
Stencil Type	*Age of Screen*
Rinsing Time	*Rinsing Pressure*

III. PROCEDURE (DEMONSTRATE)

A. Degreasing

1. Thoroughly wet a new or used screen with water.
2. Apply the liquid degreaser to the surface of both sides of the screen using a spray bottle.
3. Using a medium-stiff, high density, long-bristle nylon or polyester brush, brush the entire surface of the screen on both sides until a light foam develops.
4. Allow the screen to stand a few minutes until the foam subsides.
5. Thoroughly rinse the screen on both sides, including the inside part of the frame with any temperature water until it runs free from foam. Use a low-pressure washout hose.

Perform before applying a stencil on any screen.

B. Abrading

1. Thoroughly wet the screen with water.

2. Apply a small amount of the paste abrader to the surface of the print side of the screen.
3. Using a high density, short-bristle nylon or polyester brush, rub the entire surface of the screen using small circular motions for 10 seconds. Use moderate pressure (excessive force is not necessary and can damage the screen.) Never exceed more than 15 seconds (or you will over abrade the mesh—show photos of various degrees of abrading). Be sure that the screen is uniformly scrubbed over the entire area.
4. Rinse the screen with a strong jet of water from both sides, including the frame edge and corners to completely remove the abrasive from the screen. A pressure washer works well for this application.

Perform once on new screens used with indirect stencil films.

(Note: if product is not a combination abrader and degreaser, the screen must be degreased before a stencil is applied.)

C. Wetting Agents

1. Thoroughly wet a new or used screen that has been degreased with water.
2. Apply the liquid wetting agent to the surface of both sides of the screen using a spray bottle.
3. Using a medium-stiff long-bristle nylon or polyester brush, brush the entire surface of the screen on both sides.
4. Allow the screen to stand one to two minutes.
5. Thoroughly rinse the screen on both sides, including the inside part of the frame with any temperature water. Use a low pressure washout hose.

Perform before applying a capillary film stencil (using the wet or dry method) on any screen.

(Please note that these procedures are based around specific products. Consult manufacturer recommendations when developing procedures for products used in your company, as they may vary from what is presented here.)

IV. HOW ARE THESE VARIABLES CONTROLLED, MEASURED, EVALUATED, AND DOCUMENTED

Everyone should faithfully follow the established procedures for each mesh preparation task. This is the control needed to ensure that screens are prepared correctly each and every time. The main measure of success is in good stencil adhesion, uniformity and durability.

V. SAFETY ISSUES/ INSTRUCTIONS

Degreasers: Degreasers may be irritating after prolonged contact with skin or eyes. Protective gloves and eyewear is recommended.

Abrading Products: Abrading products may be irritating after prolonged contact with skin or eyes. Products that are sprinkled on the screen (as opposed to pastes) may also be irritating if inhaled or gotten in the eyes. These airborne particles are very abrasive and can scratch eyeglasses and contacts. Protective gloves and eyewear is recommended.

Wetting Agents: Wetting agents can contain acid agents that may be irritating if inhaled over a prolonged period of time or if it comes into contact with skin or eyes. Protective gloves and eyewear is recommended.

VI. MAINTENANCE/ STORAGE INSTRUCTIONS

Brushes used for mesh preparation should be thoroughly rinsed out and kept clean of any solvent or ink. They should be replaced on a periodic basis.

VII. HOW DOES THIS SUB-PROCESS EFFECT THE PROCESS OR END PRODUCT IF IT IS NOT COMPLETED PROPERLY?

A. Degreasing

Improper degreasing can result in fisheyes, pinholes, poor stencil durability, repellent areas and streaks in stencils. These problems can cause press down time. (Show a sample screen with half degreased and half not, that has been coated with direct emulsion.)

B. Abrading

Failure to abrade properly will result in stencil delamination.

Over abrading mesh can result in reduced fabric life from the fibers being weakened, and decreased ink transfer efficiency from the ink clinging to the rough mesh during printing. An increase in screen haze is also a disadvantage of abrasion. (Show pictures of over-abraded mesh.)

C. Wetting Agents

If mesh is not uniformly wet, air pockets, uneven stencil adhesion and varying stencil thickness can result.

VIII. COMMON PROBLEMS AND TROUBLESHOOTING GUIDELINES

Few difficulties arise during the actual mesh preparation process. Problems from incorrect mesh preparation, like those just described, show up when applying the stencil, washing out the stencil after exposure, and on press.

IX. REFERENCES

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Products & Technology to Upgrade Your Screen Making, "Tech Tips" page 34, Majestech Corporation, 1995.

"Mesh Pretreatment & Degreasing," Niel Bolding, *SGIA Technical Guidebook*.

"New-Mesh Preparation: Do It or Weep," Tamas Frecska, *Screen Priniting*, Feb 1989.

Screen Printing: A Contemporary Approach, Samuel Hoff, Delmar Publishers, 1997.

Example 2

OPERATING PROCEDURE FOR COMPANY XYZ

O.P. #P5 Title: Measuring Off-Contact Using an Electronic Off-Contact Gauge
Department: Pressroom Date: 7-20-99

Purpose and Scope: This procedure describes the accepted method of using an electronic off-contact gauge to measure off-contact on press. Its scope is limited to setting up the gauge to read off-contact accurately, measuring off-contact at the proper places on the screen, and making measurements while adjusting the press.

References:.

O.P. #P8 Setting Off-Contact during Press Setup
O.P. #P3 Setting Up the Press
O.P. #D10 Documenting Press Variables for a Job

Terminology:

Off-Contact: Off-contact distance, also called snap-off distance, is the small distance between the bottom of the screen and the substrate being printed as the screen is suspended on press in the printing position.

Safety:

1. Check operation of all safety switches on the press.
2. Wear gloves and safety glasses if gauge used in screen with ink in it.

Equipment and Materials:

Electronic Off-Contact Gauge
(Positector 6000 EOC)
Substrate sample
Press variables documentation sheet

Procedure:

1. Clamp the screen in the press according to O.P. #P3 (Setting up the press).
2. Move the probe away from the vacuum table or platen, or any other metal surface.
3. Turn on the gauge by pushing one of the two buttons.
4. Once the gauge powers up, press both the + and - buttons simultaneously. This will put you into the menu. With each menu item, pressing + answers yes to the displayed option, and pushing - answers no.
5. Press the - button until the display reads either METRIC? or MILS?. If METRIC? is displayed the gauge is currently set to read in mils. If MILS? is displayed the gauge is currently set to read in millimeters. If the gauge is set on the correct units continue to press the - button until you exit the menu. If you wish to change the units from the current setting press the + key.
6. Place the substrate to be printed on the aluminum vacuum table of the screen printing press.
7. Enter the menu again by pressing both the + and - buttons simultaneously. Press the - button until the display reads "ZERO?". This is the mode to zero the instrument to the surface of the substrate.
8. Press the + button three times until the display reads "ZERO 3X".
9. Put the probe on top of the substrate, making sure it is fully over the vacuum table/platen. Remove your hand from the probe to allow a reading to be taken which will be indicated by a double beep. If the substrate is rigid in nature, hold the probe in place using slight pressure to ensure good contact of the substrate and vacuum table.
10. After the gauge beeps from the first reading, lift the probe 5 cm (2 inches) or higher away from the surface, and reposition in another location for the second reading. Display will countdown after each reading.
11. Repeat step 10 to take the third reading.
12. After the last reading is taken, the probe should be lifted well away from the aluminum, until a triple beep is heard and the display reads 0 (zero).
13. The gauge is now ready to read off-contact. Lower the screen in the printing position so a measurement can be taken. The substrate can remain on the vacuum table or be removed, it will not effect the measurements. *Be sure that the squeegee and floodbar are not extended where they are applying any pressure to the surface of the screen when taking measurements.*
14. To take a measurement, simply place the probe on the screen, making sure the probe is completely over the vacuum table/platen, and wait for the indicator light to flash and a beep to be emitted. The measured value will appear on the display. Readings will continue to be taken every 2 seconds until the probe is lifted higher than 5 cm (2 inches) above the platen. NOTE:

- *When placing the probe on the screen, do not keep your hand on the probe when taking a reading. Let the weight of the probe stabilize on its own. Pressure from your hand will increase the deflection of the screen and compromise reading accuracy.*
- *Take care not to take a reading with part of the probe hanging over the edge of the vacuum table/platen. The reading will not be accurate.*
- *Clean off any ink that gets on the probe or the cable with solvent. The probe will not be damaged by the majority of solvents. Any ink or dirt on the bottom of the probe may interfere with accurate measurement, so it is especially important to keep it clean.*

15. A minimum of four measurements (the four corners of image area as seen in figure below) should be taken on the screen. If the peel setting on the press is engaged, position the squeegee edge to the front of the image and take measurements right next to the sides of the squeegee. Then move the squeegee to the back of the image and repeat this process.

16. Adjustments to off-contact may be made while the probe sits in the screen. Refer to O.P. #P8 (Setting Off-Contact during Press Setup) for guideline on adjusting off-contact. The gauge will continue to give readouts every 2 seconds to provide feedback on the effectiveness of the adjustment.
17. To move the probe to a new position on the screen, simply slide it to the new area.
18. Once you have the off-contact set on the press, cycle the press and check it again.
19. Record the measured off-contact distance on the press variables documentation sheet according to guidelines given in O.P. #D10 *(Documenting Press Variables for a Job).*
20. To power down the gauge, move the probe away from any aluminum or turn it on its side, and the gauge will automatically turn off after 60 seconds of inactivity. (There is no off button on the gauge).
21. If the readings are in question, and the gauge is suspected, the best course of action is to RESET the gauge (enter the menu mode of the gauge and hit the – button until RESET? appears on the display. Press the + button and wait for display to return to zero). This returns the gauge to the original factory settings. The entire procedure must then be repeated before measuring (RESET deletes the gauges memory.)

corrective action. If the problem grows worse you may have the right variable but changed it the wrong way. If the problem gets better you moved it the right way. And when the problem stays the same you can safely move on to the next possible cause, as the one tested is not responsible for the problem.

I highly recommend Tamas Frecska's book to anyone doing troubleshooting in screen printing. It is a valuable resource for any screen printer.

Troubleshooting Using the Process Model

Here are some steps to troubleshooting production problems using SPTF's Process Model.

Identify the top 10 problems in your shop. Those problems that occur over and over. Clearly describe the problem in detail. Define things like location, direction, size, and frequency of the problem. Ask all the individuals directly involved for their comments and opinions and carefully listen to what they say.

Take one problem and look at each sub-process in the chart and ask if that sub-process affects the problem or desired outcome. If the answer is yes, identify the possible causes of the problem based on that sub-process. Consider all the influencing factors including materials, process, and personnel.

Once you have done this for all 37 printer sub-processes you should have a list of possible causes of the problem. Classify the possible causes in three categories, (1) most likely cause, (2) likely cause and (3) less likely cause, based on your knowledge and experience in screen printing. At this stage it will be beneficial to call a few suppliers and speak with a technical representative. Ask them for their opinion on the most likely causes for the problem you are researching.

After you have the categorized list, begin eliminating the causes from the most likely cause working down to likely causes and finally less likely caues. Using this approach will

increase the likelihood of your success within the first few tries, as opposed to a random approach.

SPTF and SGIA are currently developing a troubleshooting guide for common screen printing problems using the process chart. The troubleshooting checklists will look like the example presented here (see Example 3 for a sample troubleshooting guideline). Part of this guide will include a narrative on each of the sub-processes describing its function and effect on the process. It will also include a list of resources available to SGIA members for each of these sub-processes. These three integrated tools will provide printers with quick help to solving problems on the production floor. Watch for announcements of this new service in future issues of the Tabloid, Journal and on the Association website, www.sgia.org.

MANAGEMENT

The usefulness of a visual model of the process cannot be underestimated with respect to business decisions. Rarely does upper level management have a picture to help analyze their business. The chart can also reduce the chance of forgetting a vital area of the process when management decisions are made.

The process model can serve as a visual tool for management:

- Identifying areas for cost analysis.
- Explaining aspects of the business to financial people and organizations.
- Understanding the workflow in production.
- Pinpointing areas to be redefined and streamlined.
- Developing plant layouts.
- Calculating pricing and cost structures.
- Identifying parts of the process where help is needed.

Other areas where the model can be enormously useful are in various levels of quality management systems. These can include programs for quality con-

Example 3

REGISTRATION TROUBLESHOOTING GUIDELINE

PROBLEM: Image elongated in one direction or both directions

CAUSE	POSSIBLE SOURCE (In order of liklihood)
MOST LIKELY	
Substrate size changing	■ Heat from drying/curing process causing shrinkage ■ Moisture content change (storage temp. /R.H.) ■ Pressure sensitive – adhesive melting from excess heat causes movement on liner ■ Excess heat from drying/curing process (caused from high temp., inadequate cooling/air flow, speed too slow, lamp configuration etc.) ■ Material composition stability (based on material type, thickness, and paper grain direction) ■ Number of colors causing progressive shrinkage
Printing distortion different screen to screen	■ Screen tension inconsistent screen to screen • Tensioning procedure not done the same each time • Tensioning procedure incorrect • Tensiometer not used to monitor tension • Screens at different points in their life • Poor re-tensioning practices • Excessive floodbar pressure decreased tension ■ Off-contact inconsistent screen to screen ■ Peel inconsistent screen to screen ■ Squeegee pressure inconsistent screen to screen ■ Squeegee length to screen different screen to screen ■ Squeegee speed inconsistent screen to screen ■ Inconsistent image placement screen to screen (center/off center) ■ Inconsistent squeegee variables (durometer, angle, bracing, free height)
Tension too low	■ Screen not tensioned high enough ■ Tensioning procedure incorrect ■ Fabric selected cannot be tensioned high enough due to thread size and frame size ■ Re-tensionable frame-mesh slipping out of locking strip ■ Stretch and Glue-adhesive coming loose ■ Stretching system not able to provide sufficient tension ■ Reclaiming chemical damage ■ Water pressure during reclaiming ■ Excessive floodbar pressure decreased tension ■ Frame cannot support tension level
Printing distortion excessive	■ Off-contact too high (primarily caused by low screen tension) ■ Peel to high ■ Squeegee pressure too high
LIKELY	
Poor mesh stability	■ Improper tension ■ Poor fabric selection – polyester, steel, nylon ■ Poor frame stability ■ Fabric beyond useful life
Film out of register	■ Poor film dimensional stability (age, thickness, material) ■ One color remade on camera without the other colors ■ Image expanded or shrunk from unbalanced film processor chemistry ■ Image enlargement not done at same percentage for all colors ■ Low image resolution – heavy serrated edge ■ Distortion from output device ■ Image not properly sized for bleeds and die cutting Computer image out of register
LESS LIKELY	
Press out of alignment	■ Press not parallel ■ Vacuum table not uniformly flat
Stencil dislocated when printing	■ Excessive tape on bottom of screen ■ Irregular substrate ■ Registration guides excessively higher than substrate
Stencil expansion or contraction	■ Stencil expansion or contraction ■ Stencil moisture content at exposure not uniform or too high ■ Excess or insufficient relative humidity ■ Temperature variations ■ Vacuum frame glass bowed and scratched ■ Irregular stencil thickness coating causing variation in exposure. ■ Multiple film layered positive

Terms & Definitions

Quality — *a built-in characteristic, capacity or degree of excellence of a product.*

Quality Assurance — *a final inspection of a product to guarantee defective product is not shipped to a customer.*

Quality Control — *a system of control for the process and product that yields predictable performance and quality over time.*

Process Control — *a part of quality control where the processes involved in making a product are made to be repeatable.*

Process Improvement — *introducing improvements by way of equipment, procedures or materials to reduce the variability of a process.*

Total Quality Management — *the strategy of analyzing all processes and continuously improving them based on their impact on the success of the business.*

trol, quality assurance, process control, process improvement and total quality management (see list of definitions). The process of outside certification such as ISO 900(x) can also be aided by using the model.

In order to make qualified assessments for implementing these various programs, a good grasp of the whole picture is necessary. This awareness then makes it possible to effectively identify workflow, critical areas of the process and critical variables for control. By focusing efforts in the correct places the most benefit will be gained.

Generally, the purpose of any of these programs is to maximize profits, while improving quality. The main way this is accomplished is to reduce waste and reduce variability of process. Variability is found and the cause eliminated so it does not continue to cause problems. In a continuous quality improvement program several objectives should be observed:

- Keep things simple and straightforward.
- Determine quality attributes in the product being made based on customer expectations.
- Use standard operating procedures and SPC to eliminate the cause of defective products.
- Keep the desired outcome in mind. That goal should not be perfection, but rather a repeatable quality product that easily meets or exceeds the requirements of the customer.

Finally, and perhaps most importantly, the chart can serve to bring various departments and levels of management to a common ground by providing a point of focus. Implementing improvements requires that everyone buy into the strategy. To make this happen everyone must have some input into that strategy. Managers must get input from the employees on areas of the process that are problematic, and on their views of where money for improvement would best be spent. Likewise, employees should be aware of things from the business owner's point of view as far as cost/benefit issues are concerned. The expectations of those benefits must be realistic and clearly defined. Ultimately, economic benefits must be clearly understood on all levels before much progress will be made. Good communication is the first and foremost key to effective process improvements.

SPTF'S USE OF THE MODEL IN RESEARCH

Researchers at SPTF originally developed the Process Model as a means of evaluating and planning future projects. Our primary mission is to uncover and define how the process works, a big endeavor to say the least. We needed a picture of how all the pieces fit together, and so the Process Model was born. It has given researchers clearer focus and will be an instrument of communication as we present our research to industry. Printers and manufacturers can also use the chart to gain focus and foster communication.

The response to the Model has been very favorable. Hopefully, the practical suggestions on how to use the model in your company presented in this article have provided useful instruction on using the chart to make lasting change. As with any daunting task, taking one step at a time will eventually lead to a rewarding outcome. If this article has inspired you to undertake a course of action, don't let these plans turn into unrealized intentions. Take that first step today — right now. ■

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