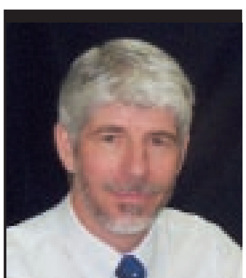
Pumping Polyester for Better Results

Experimenting with new tensioning techniques can seem a little scary at first. However, for the people who lead the charge, the rewards are often worth the risk. Unfortunately most printers take the attitude of "Never be the first to go or the last to change". A more typical example for today might be "Let's don't change at all, it's just too risky."



by Dennis Hunt,
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Imagine a genetically engineered "silk thread" five times as strong as high tensile steel ... moisture and chemical resistant ... and "tuned" to the perfect Modulus of Elasticity for screen printing.

Once upon a time there was an ingenious little worm in China that made an amazing discovery. He found that if he thought about it real hard, that his body could do a very remarkable thing. It seems that the Creator saw fit to design a miniature chemical processing plant in his posterior, complete with a computer link to his brain. That chemical plant was preprogrammed. And it would produce a material so unusual that to this day it has not been successfully duplicated. The mystery material, to which I'm referring, is as you have probably guessed, silk. With its unusually high tensile strength and enviable structural properties, is it any wonder that it eventually found its way into the printing business? And this happened centuries before any of our modern day miracle fabrics surfaced in Europe.

Over in the "Colonies," the silk with which we are most familiar is the common spider web. Occurring almost everywhere and produced in only a few hours it is an amazing example of a "woven fabric." If we could only duplicate by intellect what the spider does by instinct we would be light years ahead in our quest for the perfect medium of transfer for our present printing systems. Imagine a genetically engineered "silk thread" five times as strong as high tensile steel, moisture and chemical resistant, and "tuned" to the perfect Modulus of Elasticity for screen printing. Would our screens finally become five hundred N/cm parallel printing surfaces without compromise? … a VIRTUAL STEEL PLATE with built-in porosity to facilitate shear thinning of the ink with only a baby's breath touch from the squeegee … and at more "ordinary" tensions of say one hundred N/cm or less, thread diameters could conceivably be reduced in size to almost any practical level without danger of breaking.

Although it is still somewhat futuristic to take present day R&D on synthetic silk fibers to these outcomes, it is not at all unlikely that fabrics of these descriptions could become reality within the next decade. While screen printing as an industry still struggles to overcome some of the mistakes of the past, others are busy laying a foundation for its future — which brings me to a rather interesting example of this that occurred recently at SPTF.

For several years researchers at the Screen Printing Technical Foundation have conducted in-depth investigations into the inner workings of the various screen printing meshes. Focusing mostly on the newer "high modulus" polyester fabric, these studies have been widely read and have been both sources of information and controversy (depending on whether you were the consumer or the producer). Others conducted their own (sometimes very impressive) investigations into the subject in an attempt to either prove or disprove what SPTF was saying. No matter which side of the issue you were on at the time, at the very least I believe we can safely say that there is now more information available to the average printer than we could have imagined before these studies began. In the interim many have for the first time become interested in finding out what's really going on with the many materials and variables used in the process. For a new vision of just how extensive that process may be, see "SPTF's New Picture of the Screen-Printing Process: A Tool of the Trade" by Dawn M. Hohl (SGIA Journal, 1999, Volume Three, Fourth Quarter).

In an additional attempt to obtain even better information, stimulate curiosity and perhaps even to foster secondary investigations from its industry supporters, SPTF is again providing an opportunity for discussion with it's "Pulsed Tensioning Project."

THREE OPERATIONAL THEORIES

Sometimes it becomes necessary to try the unusual in order to go beyond the ordinary! Our investigation was really an intelligently guided, albeit limited probe into "Mesh Pre-loading," "Vibratory Theory" and "Shock Molecular Alignment." These three approaches can be an addition to or part of the practice of staged tensioning, rapid tensioning or re-tensioning and are certainly not limited to what is represented here.

Let's begin by considering the practice of mesh pre-loading as a method of improving mesh stability. The presupposition is that if a sufficient amount of weight can be uniformly applied to the surface of the mesh as tension is applied that a certain amount of additional stretching will "pre-occur" during the tensioning procedure. This "pre-stretching" of the fabric, it is reasoned, will help to reduce tension loss after the fabric is secured to the frame and additionally after printing.

For our testing purposes we used a bowling ball to pre-load the mesh while applying force through a pneumatic four-way tensioning system. Each fabric was tensioned to approximately 30 N/cm before securing it to the frame. Tension losses were then recorded at five locations on the screen every 15 minutes for the first eight hours, with subsequent checks

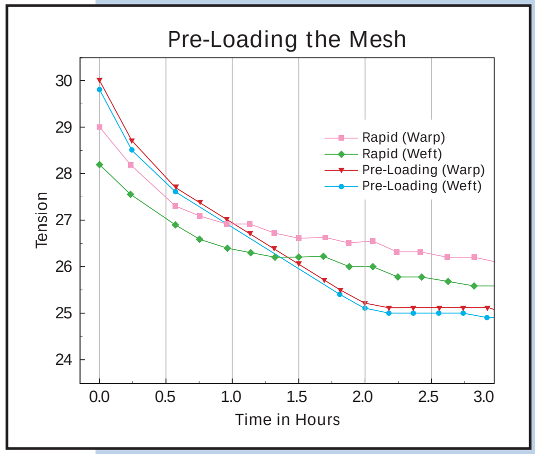

Figure 1
The result of pre-loading the screen while tensioning is very evident. There is no real advantage and some actual detrimental tension losses occur. We definitely don't want to go this direction!

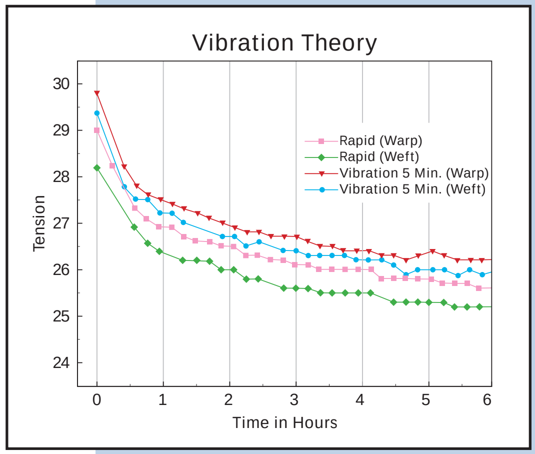

Figure 2
Vibrating the mesh for five minutes is only slightly better than normal staged or rapid tensioning. Extending that vibration time to ten minutes will offer some measurable improvements in the overall effect.

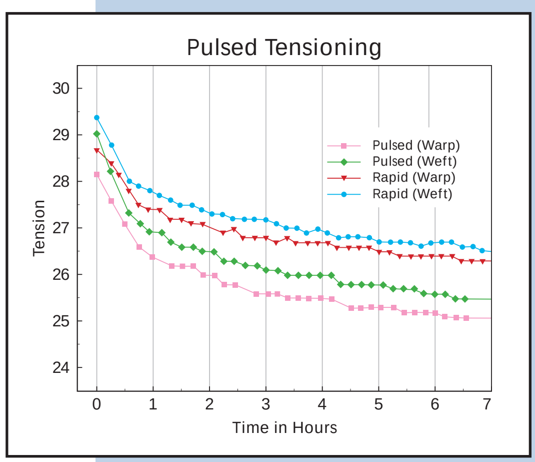

Figure 3
Quickly tensioning and then releasing the fabric produces the most improvement and a good possibility for additional fundamental study.

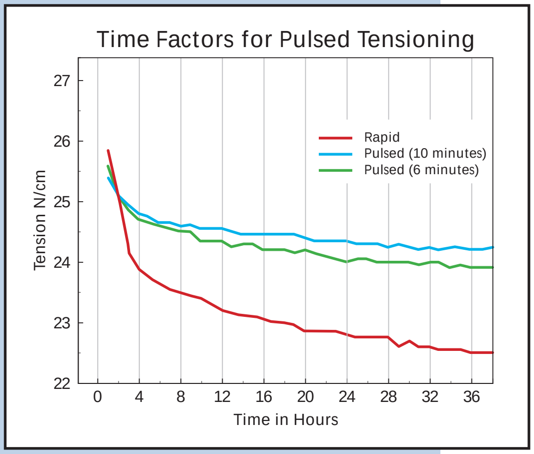

Figure 4
When additional time was expended to pulse longer, results did get better — though only marginally.

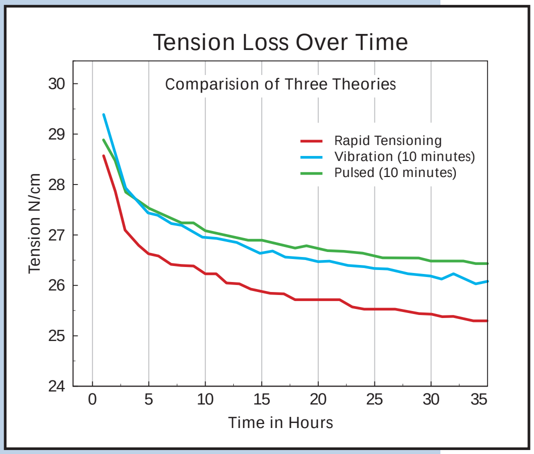

Figure 5
Improvements can be made through both pulsed tensioning and vibration tensioning. These effects can be extended by adding additional time to each procedure and the additional time may be cost effective if the gains are realized by longer print runs without significant tension losses.

being made at regular intervals on the second and third days. Due to the brevity of time allotted for this investigation, testing the effect of longer production print runs was not possible. That may come later.

The second area of investigation was the vibratory theory. This methodology proposes to increase molecular alignment of the polyester threads after the mesh is tensioned but before it is secured to the frame through the application of vibration. The vibrations were accomplished using a simple hand sander with a section of polyester screen mesh clamped in place instead of sand paper. Since this approach was thought to be time sensitive we applied the electronic vibration to the mesh surface for both five- and ten-minute intervals. Again the tension losses were recorded as in the first pre-loading test.

The third area of investigation is what is known as pulsed tensioning. In this approach increased beneficial molecular movement is thought to occur by selectively applying and then releasing the force applied to the mesh. The polyester thread will then attempt to survive the impact by re-distributing its molecules along a newly aligned, stronger pathway. Each additional pulse (or retention as the case may be) is thought to produce further benefit by increasing the alignment of the molecules. Using different time intervals SPTF designed the experiment to pulse both above and below (by 5 Ncm) the target tension of 25 Ncm. While shocking the fabric to a tension higher and then releasing to a tension lower we hoped to encourage more stability (in the middle, 25 Ncm) before securing the fabric to the frame. Tension losses were recorded as before.

WHAT ARE THE RESULTS?

It's always interesting to see what works and what doesn't. The result of pre-loading the screen while tensioning is very evident (Figure 1). There is no real advantage and some actual detrimental tension losses occur. We definitely don't want to go this direction!

The second approach, vibrating the mesh for five minutes (Figure 2) is only slightly better than normal staged or rapid tensioning. However, as we will demonstrate shortly, extending that vibration time to ten minutes will offer some measurable improvements in the overall effect.

BIOENGINEERED SPIDER SILK

by Sean Henahan, Access Excellence, AMHERST, Mass. (1/6/96)

"Dragline spider silk is the fiber from which spiders make the scaffolding of their webs. It has been estimated by scientists to be at least five times as strong as steel, twice as elastic as nylon, waterproof and stretchable."

"Dragline spider silk is actually stronger than Kevlar synthetic fiber and Kevlar is several times stronger than steel," says polymer scientist David Tirrell who wrote a review for the journal Science describing the current research of several groups around the country trying to replicate the properties of spider silk. Tirrell is well known for his research in "bioengineered materials," a new area of polymer research involving the creation of synthetic proteins to make materials with advanced properties.

Using the final approach of quickly tensioning and then releasing the fabric (Figure 3) produces the most improvement and a good possibility for additional fundamental study. Also when additional time was expended to pulse longer, results did get better, though only marginally (Figure 4).

SUMMARY

The bottom line seems to be this, improvements can be made through both pulsed tensioning and vibration tensioning (Figure 5). These effects can be extended by adding additional time to each procedure and the additional time may be cost effective if the gains are realized by longer print runs without significant tension losses. More fundamental research remains to be done in both of these areas in conjunction with manufacturers and concerned printers.

As always, the Screen Printing Technical Foundation welcomes your input on this and any other topic that may be of mutual interest to the screen printing industry and SPTF. Remember, "research is 1% inspiration and 99% perspiration" (Thomas Edison). Keep experimenting! ■