Tuning Up Tension



Music Maestro: What could these shots of our in-house guitar virtuoso in action have to do with production efficiency? Or, for that matter, garment printing in general? Read on…

As most people are aware, I am a manufacturer of retensionable screen frames—not a screen printer. Thus, though it would be fair for readers to question the motives behind my writing on the subject of elevated screen tension, let me state at the outset that I'm not here to sell screen frames. At the same time, I make no bones about being here to sell *something*— that is, the concept of high-tension screen printing.

Certainly, I stand to benefit from such a sale. Yet so, in all likelihood, do other manufacturers who offer means to tension screens to levels once thought impossible. And although at some point we will need to discuss the frame itself as a component of what we'll call our *ink-transfer mechanism*, it is screen mesh that will get the bulk of the attention in this and future articles. In fact, for purposes of this discussion, I don't care how you achieve and hold high mesh tension in your screens, as long as you do so.

There can be no better introduction for this series than last month's interview with its author: Don Newman. Accordingly, if you've not read it, we urge you to do so in order to understand his interest in—and appreciate his concern for—on-press production efficiency. Here, for the first time in print, Newman begins a comprehensive analysis of the subject, stripping away its cloak of scientific jargon and mathematical formulae to reveal a set of simple

By Don Newman

A final word about format: I normally speak to people about this subject face-to-face. When things get too complex, we can backtrack, and I can demonstrate and illustrate my way out of a technical traffic jam. But because, in *this* format, it's not possible for me to stop for questions, that which I cover early on may strike some of you as basic, our progress slow. Bear with me, *though*; I don't intend for us to get bogged down in abstract scientific theories and inscrutable mathematical equations but, instead, to try and cut through to the practical heart of the matter.

My purpose is to pass along the concepts of high-tension screen printing, along with solid evidence that these concepts indeed yield practical benefits which add up to substantially faster print speeds and improved print quality.

The concepts involved in mesh tension, though actually fairly simple, have an astonishingly wide impact on the screen-printing process. Because, in coming segments, we'll examine ways mesh-tension affects the performance of other printing components—films, inks, squeegees, substrates, even the press itself—we are, by necessity, carving up a large subject into more digestible pieces. Yet, in truth, each piece affects the others, and all ultimately work in concert to produce the improvements in printing we'll discuss. Therefore, in order to serialize a subject that is really a unity, I'll be jumping back and forth a bit, while attempting to tie the pieces together.

That said, let's move ahead.

Maintaining Tension

Already we've got to jump back a few paragraphs, because I actually mentioned several of my most important points there. First, I referred to screen mesh as the foundation of screen printing's *ink-transfer mechanism*. We don't commonly speak of the screen that way, but let's do so for a moment, because it will help us see the important position screen mesh occupies in the screen-printing process.

Our's is the last remaining printing discipline that has yet to successfully standardize and stabilize its ink-transfer mechanism. Off-set lithography, rotogravure and flexography, our three sister printing disciplines, have all bitten the bullet by investing in technology sufficient to stabilize and standardize *their* image-transfer mechanisms. Though it is critical for us to do so as well, the screen-printing industry is still "warming up to" that process.

Why are we so late? To answer that, let's first be clear on what I mean by *stability*. Most of .us are quite familiar with the attempt to achieve it. We're engaged in the process of stabilizing our own ink-transfer mechanisms when we attempt every day to "control the *variables*." In order to have a stable system of any kind, its variables—aptly named because they describe things that vary—must cease to vary.

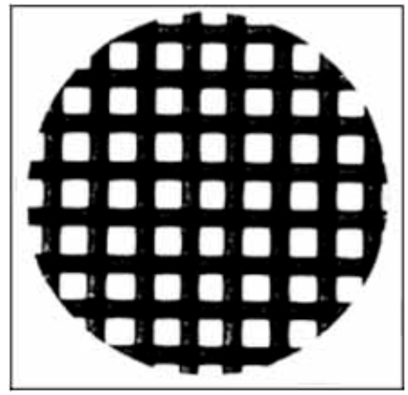
The only way we can stabilize our ink-transfer mechanism, then, is to shift each variable into another aptly named category, the *constant*. As long as variables continue to vary during the printing process, we have no hope of achieving those most important goals of all printing disciplines: repeatability and fast production.

That sets the stage for reintroducing my second point: that we must get and hold high mesh tension. You'll notice that I've indicated by my emphasis that there are really two concepts involved here. In recent years, there has been a generally wide acceptance of the idea that a tight screen beats a loose one. *How* tight they should be is still debated and is a matter I'll address later on. For now, suffice it to say most printers understand and agree that getting high tension is desirable. Fewer understand (and therefore fewer accept) that just as important as achieving a certain tension level is *holding on to it*.

Printers' "*hearing aid*"*:* Once the screen is recognized as your ink-transfer mechanism, it's easier to appreciate the importance of elevated tension. The inset shows the reward of careful tensioning.

Facing the Music

In my travels, I've discovered a unique group of people who have an intuitive grasp of these concepts—not due to education or mechanical-engineering expertise, but because they have in common the fact that they play the guitar. Anyone who plays a guitar with any skill will agree: you can't make good music with brand-new guitar strings. When a new string is pulled between the bridge and neck of the instrument, keeping that string in tune is almost impossible at first. The tuning mechanism itself is simple. You wrap the string around the tuning post and turn the tuning key. What happens then? If you pluck the string while turning the tuning key, the pitch rises because you're tightening—or tensioning—it. If you stop, the pitch immediately begins to fall off. You can tell, by the feel of the string, that it is relaxing, stretching out and losing tension. What do you do? You turn the key again, applying more tension. After several attempts, the string may reach the desired pitch and hold it ... but only briefly. As you strum a few chords, the pleasant sound quickly turns discordant as the string *again* goes out of tune. Undeterred, you continue to retighten the string, perhaps playing for a while, or even leaving the instrument for a time and returning later. You'll repeat the process several times before you can play through even a short melody without having to stop and retune. Eventually, though, the string needs less and less attention—perhaps no more than an occasional adjustment during an entire evening's performance. Now, what has this got to do with screen printing? Quite a bit, as it turns out.



Get DOWN: ... to the filament level. This micrograph reveals how individual warp/weft mesh filaments may be legitimately thought of as analogous to individual guitar strings.

Same Song, Different Tune

To appreciate the connection, we have to look at screen mesh from an unlikely perspective. We're all familiar with the fact that mesh is woven like many other fabrics, built from evenly spaced rows and columns (known as *warp* and *weft*) of fine filaments or strands of material. (In garment screen printing's history, silk, organdy, nylon, and multi-filament polyester have taken their turn in popularity. Today, most printers opt for *mono*filament polyester, which therefore, will be the focus of this and subsequent articles.)

Our mesh-tension story is really told at the individual-filament level, so let's imagine screen mesh as *lots* of guitar strings. Now, guitarists learn by experience that the long, thin piece of virgin material (a brand-new string) is, for some time too unstable to make music. Thus, they make necessary accommodations in the way they tune and use guitar strings. If they're scheduled to perform on Friday, you may be sure they'll begin dealing with new strings on Monday or Tuesday in order to have them ready and avoid, at all costs, playing an hour-long concert on a new string or set of strings.

What is true for guitar strings is also true for screen mesh. In fact, numerous problems encountered in garment printing spring from the fact that many in our industry still attempt to reproduce art with the screen-mesh equivalent of new guitar strings. Worse yet, many have no means to retune those new strings as they relax.

Lending the Industry Ears

Guitar-playing printers are apt students of the "get and *hold*" concepts of mesh tension, because they already apply them in their musical avocation. Yet even they don't readily make the screen-printing connection without some prompting. The reason? Our guitar players, by nature, possess an important guitar-tuning tool – a tone-sensitive ear – for which, until the last few years, there was no mesh-tensioning equivalent. When a musician tunes his guitar, he can hear its pitch. With no similar instrument, screen printers have historically had no way to "hear the pitch" of their screens – no way to gauge tension levels. As a result, mesh tension for many years escaped identification as a culprit in screen instability. (Aggravating the problem is that, though mesh tension is but one of our in-screen variables, it is the *most critical* one, because – as we'll discover – it most directly affects screen stability.)

As a result of this concealment, most of the tension-dependent benefits we'll discuss remained (and for some, still remain) a mystery, while many tension-related problems were (and continue to be) blamed on inks, emulsions, machines and other potentially innocent variables.

So, in order for our musicians (and, by extension, the rest of us) to make the guitar-to-mesh connection complete, let's introduce the tension meter, which we may think of as a sort of screen printer's "hearing aid." (I thought I heard, barely perceptible from my chair here in my office, something that sounded like groans. I'll assume they were in response to my milking the guitar analogy for all it's worth, rather than prompted by my reference to the tension meter, especially because I introduce it here to point out that without it, you read further in vain. It alone can tell us when we've tuned our mesh to the proper pitch, and whether we're holding that pitch. Neither guitar nor screen is able to accurately and efficiently reproduce the works of even a great master, unless properly tuned. In short, the artist is no greater than his or her instrument.)

So where are we? It may seem we've come a short way in a long time, but we've really accomplished a lot. I've piqued your interest (hopefully) by referring to the printing screen as an ink-transfer mechanism, a system of variables in need of constant supervision; we've established that a tight screen isn't enough, but that we've got to find a way to keep it tight; and I shared an anecdote about guitars which introduced three major mesh-tension concepts: elongation, retensioning and workhardening. (Don't go back and reread. I didn't actually name them until now) and it's likely that, though I've answered a few questions, I've raised more. If so, I've succeeded, and you'll be back next month as we drag these cloaked concepts out into the light and – tension meters in hand – unmask them through an investigation into why mesh is unstable and why it's critically important to do something about it.

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The nitty-gritt: Observing the effects tension has on mesh with the aid of an illuminated, 100X loupe enables this tenchnician to assess his results on the *filament level*.