Influence of Squeegee and Floodbar Lengths: Friend or Foe?

Perhaps an appropriate maxim for press operators ought to be: Always use a squeegee that fits the job — not one that fits the screen!

by Mike Young, Imagetek

Author's note: The length of the squeegee has a much greater impact on the goodwill of printing than most screen printers believe. As the industry moves into challenging times — when each function of a process is being carefully recorded and documented, particularly for statistical and ISO Certification purposes — this writer has yet to see a company that records actual squeegee and floodbar length used for printing (if multiple sizes are used in the operation). Critical issues such as screen tension, ink viscosity, temperature, humidity, time of day, number of rejects and reason why, etc., are some variables that are well documented. However, the length of the squeegee chosen appears to be more at the whim of the press operator, perhaps according to nothing more than "what is left laying around," to complete the job! The length of the squeegee, as well as that of the floodbar, plays a more dynamic role in achieving high-definition printing results today than was imagined at any other time previously.

THE SQUEEGEE

Have you ever wondered why a finished print — which otherwise should have been superbly produced — became distorted, had streaks or lousy ink deposit, showed tone loss or gain, exhibited precarious registration or yielded poor resistance levels with conductive coatings, when everything apparently was set up correctly — especially if the print was trouble-free when it ran previously? The operation may have employed exemplary printing techniques, maintained excellent screen tension, low off-contact, superb on-press controls and a newly sharpened squeegee — yet, for some reason, the result is unacceptable! Perhaps one likely factor creating the deficiencies is none other than the length of the squeegee blade used for printing.

Once all the ideals have been engineered into the process, immediately before printing starts, press operators often begin by choosing, quite innocently, a squeegee that may be too long for the job. Making matters worse, the blade chosen might be twice the image size or more. A simple oversight — perhaps, however, in the final analysis, an obvious weakness in planned process control for high-end printing results!

The interchangeability of squeegee blade sizes or, more importantly, their *excessiveness* in length, probably has more to do with making or breaking a critical job than any other "on-press" component used, once screen making and all the other *variables* become fixed and controlled for printing. Squeegee blade length is usually the last variable in the line of defense that directly relates to controlling ink deposit, correct tone reproduction, image uniformity (not promoting distortion) and, to some degree, registration. As well as to improve imaging characteristics and other proprieties, proper squeegee blade length also serves to yield superior resistance levels with various types of conductive coatings for industrial applications. Length of a squeegee (and of course the floodbar, which is also known as a floodcoater or scraper-blade), unfortunately is a rarely stated re-quirement on most job sheets or quality control checklists.

For many printing operations, the length of the blade is not so much a consideration other than it must be long enough to cover the width or depth of the image to be printed. When demands become stringent — such as for close-tolerance, process work, backlit graphics, monotone blends, graphic overlays, membranes, instrumentation panels and most ink coatings that require controllable deposit thickness — using a squeegee that is clearly too long may yield less than a desirable result. What is frightening about the practice of printing with excessively long blades is that hardly anyone seems to be aware of the damaging repercussion of using such. It is not atypical for squeegees employed on newly installed high-tech printing machines to be nearly twice the length required, simply because they were supplied with the press — hence, equipment often gets a bad rap for doing a lousy job.

Ideally, the squeegee blade should not overlap the image by more than 1/2" – 1" (12-25mm) at either end of its maximum size, which could be smaller than the substrate if printed with a margin. Anything over this amount will always make superior results that much harder to achieve and certainly more difficult to maintain. Interestingly though, it is not the squeegee length that is really the issue here, but rather the clearance between the blade's ends to the inside of frame. In other words, the amount of free fabric between these two points is the concerning factor. This distance, or space, needs to be as large as possible. The greater this distance, the less problematic printing becomes at any level of demand.

Let's suppose for a moment that the image-to-frame ratio is favorable for a particular difficult job — say about 30% maximum. One can still risk obtaining undesirable results when using a longer squeegee because the dynamics of printing will believe the relationship between image to the screen have increased in size, thereby, extending the overall negative effects of distortion in all dimensions. When a blade excessively overlaps the image, several things can typically occur, depending on the amount of overlap or distance between the squeegee to the frame's inside edge (which could be different if the image is offset from the center — thus complicating the situation further). Here are some reasons why a disproportionate distortion and

Fig.1

EFFECT OF PRINTING WITH AN OVERSIZED SQUEEGEE

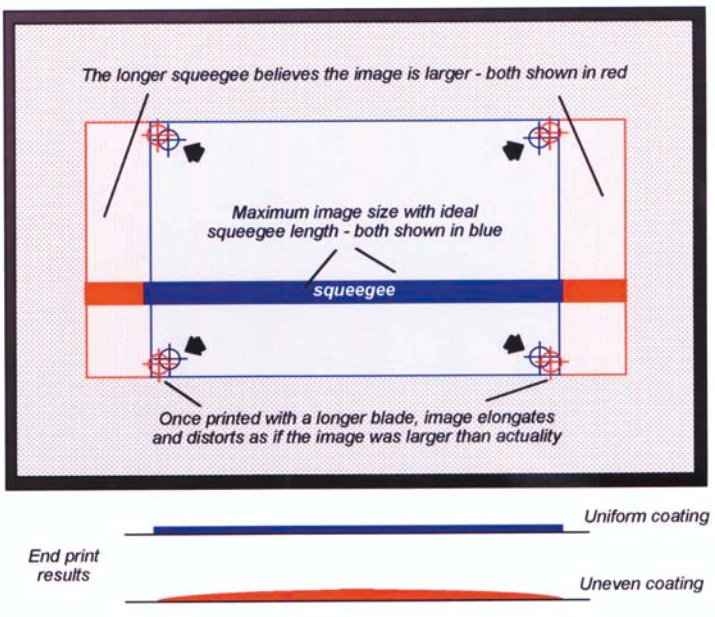
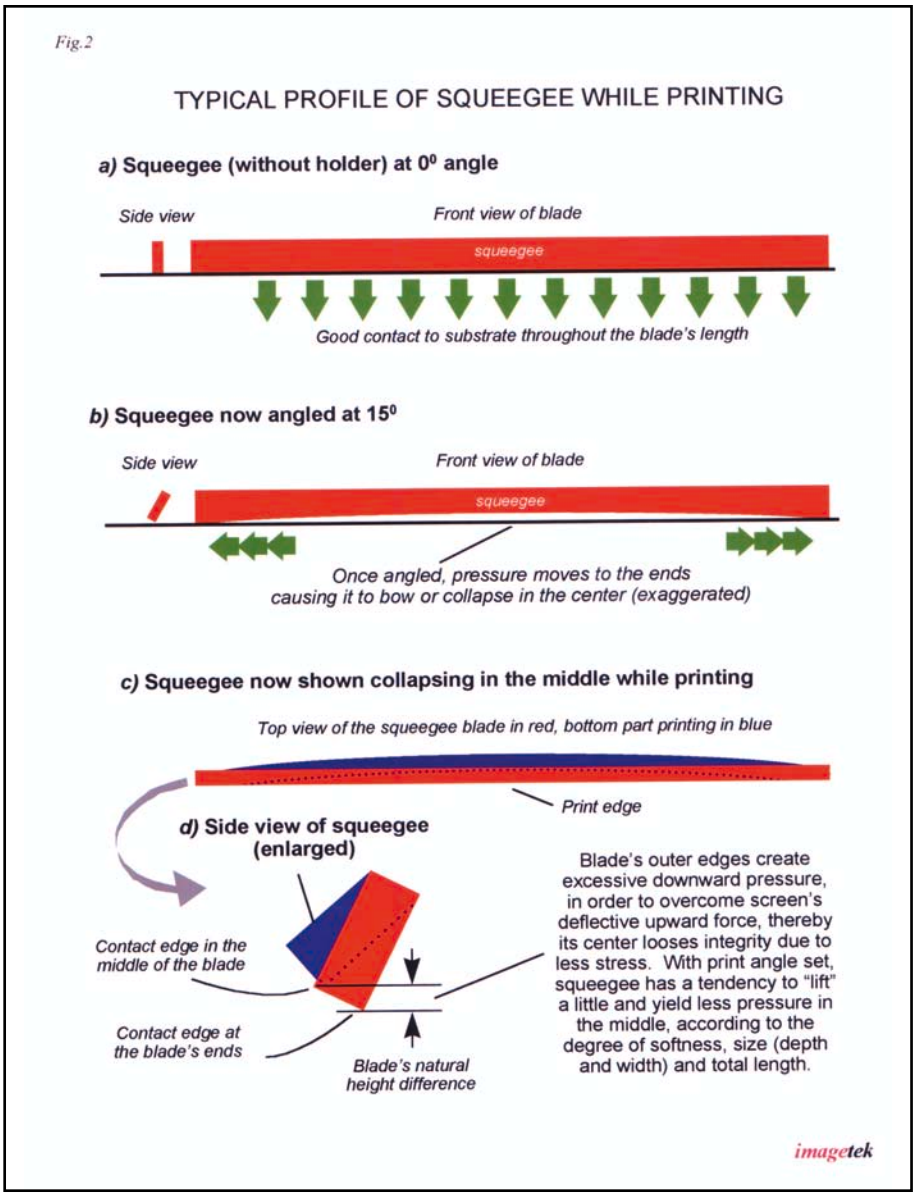


Image integrity is easily jeopardized if a suitable length squeegee (blue) is not used. The influence of the longer blade (red) distorts the fabric way beyond the true image area, thus having a detrimental impact on the end print result.

imagetek



deposit thickness variation with an oversized squeegee blade occur:

- The elasticity of the screen fabric causes the image to elongate or distort — a situation made worse by the squeegee's needless contact with the fabric well beyond the image area (see Figure 1). Even if the image ratio is relatively healthy to that of the frame's overall size, as shown, distortion or additional distortion will occur over and above that from a more suitably sized squeegee length. As the screen fabric behaves normally in a non-prejudiced manner, it automatically assumes the image is larger than it actually is. Therefore, further distortion occurs when printing the smaller image than it should otherwise. It is not hard to visualize that in the reproduction of a very small image, the center of the screen is likely to be distortion-free while increasing its size will progressively distort towards the outer edges, especially towards the corners (diagonally being the longest distance for the error to manifest itself).
- Irrespective of the frame-to-image ratio relationship, the nearer the squeegee ends are to the inside edge of the frame, the greater the amount of image distortion (two-dimensionally) and lack of ink uniformity (three-dimensionally) will be — almost regardless of how much screen tension or low off-contact setting are used. A unique study conducted by the Screen Printing Technical Foundation (SPTF) of Fairfax, Virginia, clearly confirms and illustrates (see Chart 1 on page 32) the behavior of ink coating topography (uniformity in thickness) with varying clearance distances between the squeegee blade to frame. It is easy to say that many specified demands are not so critical for some printing requirements, however, the test spells out the significance of the squeegee distance-to frame without any other factor considered. Furthermore, since this test was conducted with a mediocre 18 Newton screen, it could be reasonably argued that the prevailing negative effects of a longer squeegee would be less influential if a higher tensioned screen were used. While true, one must also realize that due to the greater "upward" force the tighter screen will exert against the squeegee's downward pressure, the state of unevenness along the blade's printing edge will nevertheless occur to some extent, therefore still potentially very detrimental to many high demanding jobs to varying degrees.
- If the squeegee is longer than necessary, the dynamics of printing automatically assume the image is correspondingly larger. The negative effect of an excessive blade length is similar to that of using an undersized frame relative to the image.
- Regardless of the length used, an uneven wet film deposit will always be the net result from excessively long squeegees (see Figure 2). The longer the blade, the greater the degree of difficulty in controlling deposit uniformity without changing, among other things,

durometer hardness and print angle. Simply, the degree of deterioration in ink deposit uniformity is directly related to the surplus length of squeegee used.

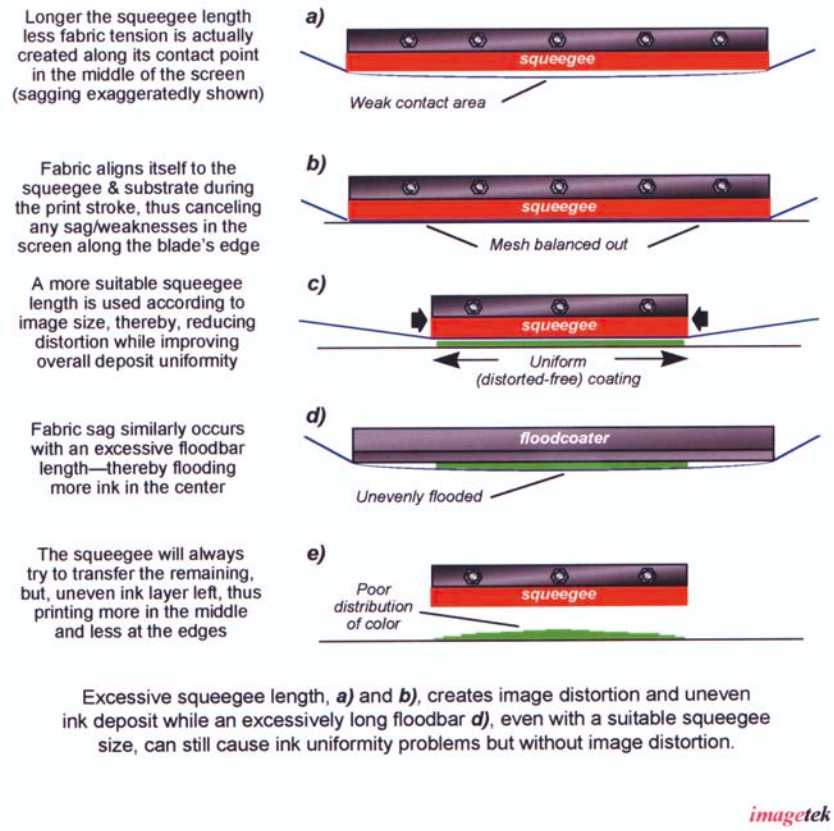
- Correspondingly, if the size of image necessitates a longer blade than normal or desirable according to the frame size for crucial results, then other characteristics become more influential. Techniques, such as blade hardness or need of support backing, angle, pressure, speed, sharpness, screen tension, off-contact or even mesh percentage open area, to suggest a few, may need to be considered, also.

As with most demanding print operations, the squeegee relationship-to-image length can have a detrimental impact on image integrity and deposit thickness printed. When printing an image, the ink layer may have to support several other properties besides *appearance* alone from a two-dimensional viewpoint. Besides the function of area — length and width that yields the two-dimensional aspect of the printed image — many images/coatings need a three-dimensional entity also, thereby requiring a more precise *height* (depth) — an essential commodity for many high-end graphics and high-definition industrial applications.

Oddly enough, the good news about all this is that "image distortion" and "uneven deposit" are intrinsically the same thing, just that their effects are viewed from different perspectives. *Image distortion* is a phenomenon seen two-dimensionally while *ink deposit* (uniformity) is a three-dimensional view of the same. In other words, a distorted image must, by definition, depict deposit thickness similarly distorted to some degree. As such, adopting process techniques to control either one will generally fix the inadequacy of the other. This fact is very important to understand since many operators and supervisors alike consider them as completely separate issues.

Fig.3

EFFECT OF OVERSIZED FLOODCOATER TO SQUEEGEE



Excessive squeegee length, ***a)*** and ***b)***, creates image distortion and uneven ink deposit while an excessively long floodbar ***d)***, even with a suitable squeegee size, can still cause ink uniformity problems but without image distortion.

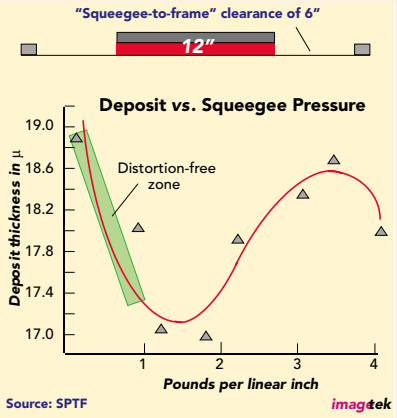
imagetek

It may be observed that an *image* gives "appearance"—while *deposit* gives "functionality" to a product. Although both can be equally important technically from a product standpoint, one may have a greater necessity over the other according to the need. Either way, almost all upmarket printed matter needs to be well produced, within allowable tolerance, and embrace an acceptable ink deposit to fulfill its quoted obligation. The end product could be a simple sign or decal that faces direct sunlight 365 days a year, a circuit board in a military field computer working in subzero Antarctic environment, the defogger of a car's rear window in Alaska or Arizona, a hand-held electronic organizer, an illuminated advertisement at a bus shelter or washing instruction tags for clothing. Each and every application requires different print integrity, which is uniquely important only to the product itself.

Reducing image distortion and obtaining consistent ink deposits will always be important criteria for demanding jobs. When all the mechanical print *variables* become fixed for the press operator — including edge quality of the squeegee — much process integrity could simply be lost through using a blade that is too long for the job. Perhaps an appropriate maxim for press operators ought to be: *always use a squeegee that fits the job — not one that fits the screen!* Therefore, make every inch reduction count as a positive to the final objective.

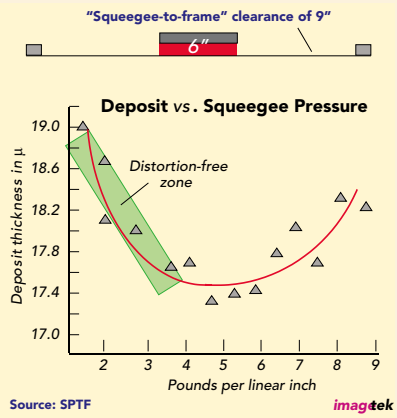
Chart 1

Influence of Squeegee Length & Pressure on Deposit Thickness: 1
I.D. frame of 24" square with 305 polyester fabric @ 18N/cm and 80 durometer squeegee



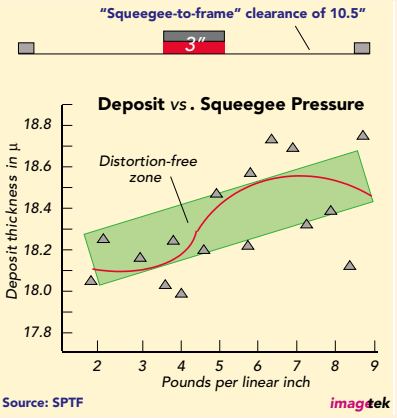
Source: SPTF imagetek

Influence of Squeegee Length & Pressure on Deposit Thickness: 2
I.D. frame of 24" square with 305 polyester fabric @ 18N/cm and 80 durometer squeegee



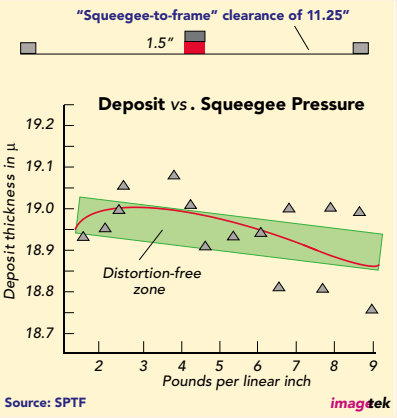
Source: SPTF imagetek

Influence of Squeegee Length & Pressure on Deposit Thickness: 3
I.D. frame of 24" square with 305 polyester fabric @ 18N.cm and 80 durometer squeegee



Source: SPTF imagetek

Influence of Squeegee Length & Pressure on Deposit Thickness: 4
I.D. frame of 24" square with 305 polyester fabric @ 18N.cm and 80 durometer squeegee



Source: SPTF imagetek

THE FLOODBAR

Just when you thought everything was taken care of with the re-sizing of the squeegees, there is another problem to contend with, or at least a potential one according to the nature of the job to be printed — the floodbar. Consider for one moment why it may be difficult to print a uniform ink coating thickness when it ought to be relatively easy to do, especially if the job was recently accomplished successfully. After all, one would reasonably assume the mechanics of the screen have been suitably designed for the process to meet such a demand together with the right length squeegee blade, so, why the trouble? A likely answer could be that press operators, all too often, select their own floodbar size at random, as with the squeegee blade, but without meaningful regards to its size in relationship to the squeegee chosen. As pointed out earlier, when one speaks of using a suitable squeegee length as being crucial to obtaining demanding results, it also means that the floodbar should correspondingly be the same length—a "pair," as it were.

While the appropriate squeegee length will significantly reduce distortion and improve coating uniformity (respectively a two-dimensional and three-dimensional view of the same deposit), a corresponding floodbar length will improve deposit uniformity even further. In many instances, the squeegee itself might not be enough, therefore, one may well be forced to rely on the influence of the floodbar size also to obtain the desired finishing results.

When a squeegee is placed on the screen that is too long, it makes tighter contact with the fabric at its outer ends than in the middle (see Figure 3). This is due to overcoming the natural curvature the screen adopts (upward force of the fabric), as shown in **a**). Ordi-narily, this is not seen as a physical problem because when the screen comes into contact with the substrate during the print stroke, the squeegee pressure effectively forces the fabric fibers out evenly along the blade's length, as shown in **b**) — although contact pressure along its print edge may not necessarily be equal.

Assuming the squeegee length now chosen for the job is correct **c**), if the floodbar is excessively longer, it will have a tendency to leave more ink in the middle and less towards the outer edge **d**). This is due to the weaker screen at the center that naturally occurs along the middle of the floodbar. Unlike the squeegee cycle though, the flooding action takes place without it ever encountering anything to help redistribute its unevenness. What happens when the squeegee tries to print what the longer floodbar has left unevenly flooded on the screen? You guessed it — e)! For all intents and purposes, a longer floodbar leaves behind a similar negative result to that of a long squeegee, that is, a three-dimensional problem with coating thickness although not two-dimensionally (image distortion). As such, the floodbar should ideally be "paired" appropriately in size to gain the fruits of using a shorter squeegee.

The difference in size between floodbar and squeegee may sound innocent enough to press operators and is usually not an issue for many operations or products to be printed. But it can be quite a problem for those seeking exacting and control-lable deposit layers, consistently from end-to-end, corner-to-corner throughout the image area, for con-ductivity and resistance levels, as well as graphically to achieve opaque coatings without streaks, tone loss or gain, blemishes or other unsightly deformities.

When taking the screening process to a higher level than normal — particularly when seeking high definition results — "size" and"quantity" are everything but in reverse. Fundamentally, one is looking for the "least" of everything: smallest image to a given frame size, lowest off-contact distance, minimum peel-off (if any), least amount of vacuum, lightest squeegee pressure, shortest-squeegee/floodbar length and so on. Who said small isn't beautiful? ■