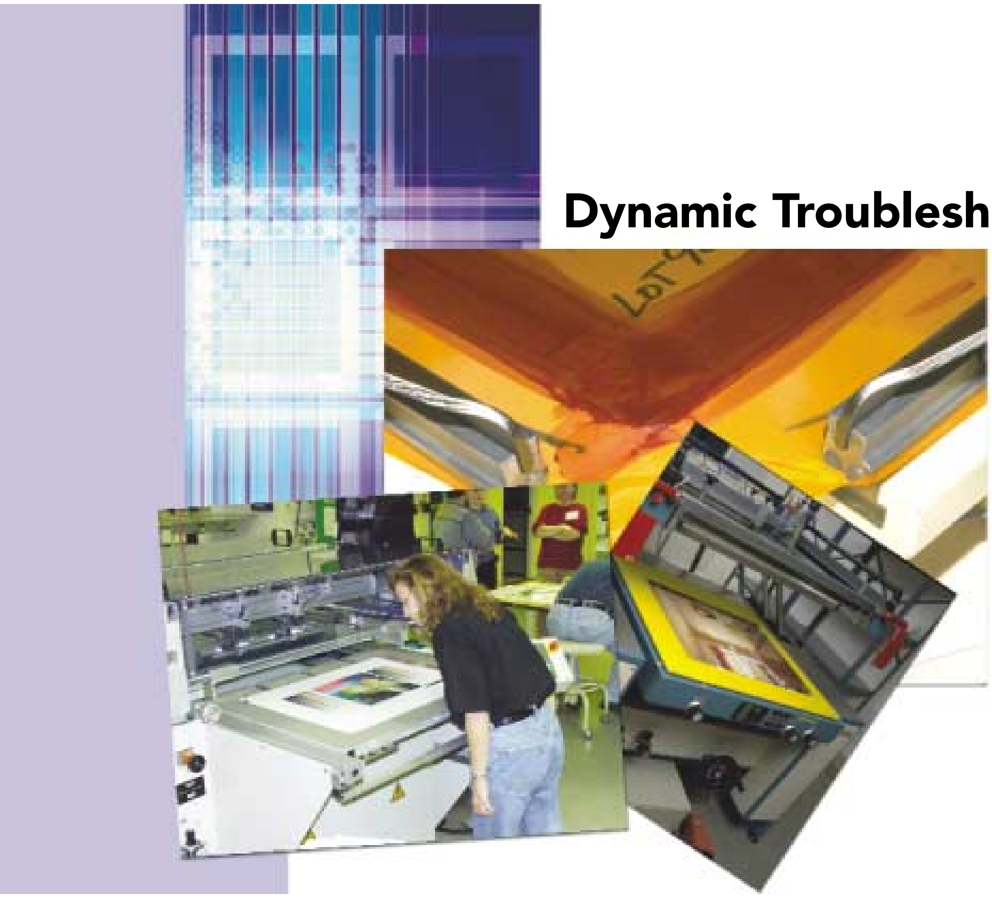

Dynamic Troubleshooting 240 'On-Press' Print Problems for High-Definition Screen Printing: Part I

More than any time previously, companies today are heavily investing in state-of-the-art pre-press technology to dramatically improve overall artwork generation through to screen making. And so they should!

Every printer and print manager knows that badly made screens produce inferior results. Inadequately made screens are usually pulled long before they make it to printing. Nevertheless, even with *perfectly* made screens, by not understanding some of the influential factors that typically control make-ready, on-press adjustments and those governing a printing press overall performance will return less-than-desirable results, too. Without some form of comprehension of these little-understood on-press characteristics that harm performance and quality, seeking solutions to recover integrity are often all but impossible to find due to them being too complex, hidden or not recognized as being directly linked to a particular cause.

For many years, I have advocated that quality-conscious companies that want to take their screen printing operation to another level already have what it takes to reach that level in-house — but it's not *what* they have that matters, it's *how* it is used that counts. And that's the keyword: *how*. With screen printing, "how" that something is put to use is enviably what separates extraordinary results from ordinary and often the difference between success and failure.

More than any time previously, companies today are heavily investing in state-of-the-art pre-press technology to dramatically improve overall artwork generation through to screen making. And so they should! While understanding no one can better the original, many owners and managers alike are striving to at least equal it from an originality standpoint—a good healthy sign industry-wide. With high-quality printing in mind, companies have begun to recognize the direct link to successful profitability is not through productivity (although an essential part of the agenda, nevertheless) but, rather, by focusing on how to perfect the original up-front processing steps and carry those efforts over to production with *blemish-free* screens. And that is the purpose of this article, to develop and enhance those up-front investments made for downstream production. It has been said that spectacular print results are always preceded by *unspectacular* preparation! This adage is not only true, perhaps it has a greater meaning in the world of screen printing than most practitioners realize.

Once a screen has been "perfectly-made," to whatever degree that may represent, production personnel often bemoan screen making because of (seemingly) screen failure; poor edge definition, image distortion or a host of other deficiencies during printing. While pre-press processing may lavishly enjoy rewarding results from its latest investments, an operation must not let that go to waste simply because physical

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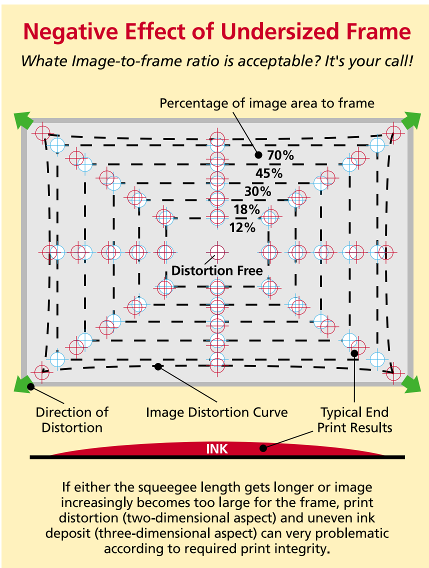

Figure 1

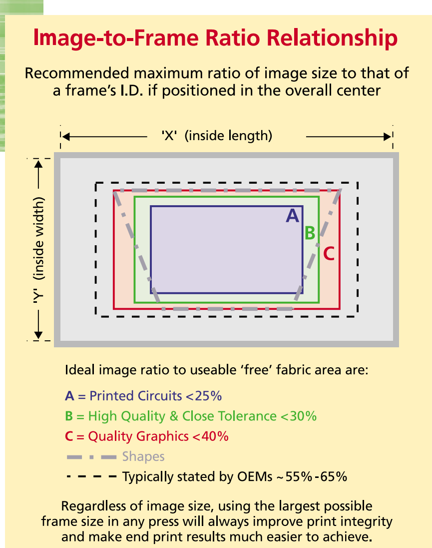

Figure 2 (effects a, b, c, f, g, h, j & k)

production cannot match those transformed up-front efforts engaged earlier.

Production managers typically encounter numerous occasions where prepress has delivered the ultimate in artwork, screen making matched or exceeded their own expectations, modern equipment employed and staffed by experienced personnel, yet prints continuously end up in the dumpster! Why, they keep asking themselves? Good question, but other than possibly the lack of communication (which is a separate but serious issue facing many operations), the answer is not hard to find if we begin to understand the everyday common-type on-press problems that occur in middle-of-the-road situations of those discriminating operations. Usually, it is these undetected on-press problems that prevent operations from reaching the next level in quality performance, almost regardless to the size of earlier up-front investment. Knowing what these problems are and identifying them in their proper perspective and influence on quality, however, will help management to troubleshoot in a way that will determine if a fault is related to production (on-press) or indeed up-stream in screen making or beyond. How many times, for example, have you heard pinholes or some other dirt/foreign matter that developed during production is immediately blamed on lousy screen-making—or somewhere other than in printing?

Image-to-Frame-Size Ratio

If an image has to be created (reproduced) by the way of screen process printing, it essentially means the transfer of information (the complete three-dimensional printed image itself), is made through an elastic-type screen fabric (not the stainless steel non-elastic variety), a material which is not the most stable at the best of times once tensioned. That being so, there must be limits as to what size an image can be successfully screen printed within required tolerance (acceptable distortion and/or registration). Therefore, how does one guess or measure what that amount is? While no one can really assign or characterize something as a definite figure in this respect, a meaningful image-ratio-to-frame size guide can be given as a workable tool for most situations. To arrive at this guide, one must first understand what precisely happens both two- and *three-dimensionally* to the print against the nature of the job's total requirements. Those requirements often concern a wide range to meet product functionality — usually well beyond the normal informative or decorative purposes that "print" largely accommodates.

That said, normally only the operation itself can decide on what is or isn't acceptable image size-wise according to equipment size capability and performance. Figure 1 shows overall image distorting gradually that occurs *two-dimensionally* as image size is increased — while noting that the same distortional effect occurs with ink deposit thickness *three-dimensionally*. Therefore, a print might be within a two-dimensional tolerance but deposit/coating thickness (lack of uniformity) may be unacceptable, or, vise versa. Furthermore, the weaker the screen tension, for example, the worse the distortion factor will be in both dimensions. At this point, it is the product's integrity that determines what is or is not acceptable, not necessarily the process standards itself.

It must be realized that a layer of ink is three-dimensional. This means when one sees an image, say a letter "A," it has a height and a width, which is a two-dimensional view. In many applications, however, particularly for electronic and industrial purposes, the printed image often has a coating thickness requirement, thus rendering a three-dimensional print demand. In other words, if a print job has an ink deposit thickness/uniformity or color/opacity requirement, then a healthy image ratio is minimally required to achieve success together with perhaps other considerations.

Although in essence the ratio given in Figure 2 is a guide based on the amount of anticipated distortion from previous in-house experience, much depends on other factors, particularly to the degree of job crucial requirements. Suffice to say, there will always be a direct link between an image size to that of the frame for high-definition printing. While there are several operations that exceed the ratios with some success — others fail miserably when working under lesser ratio percentages due to other processing/technique conditions not up to the level required for such jobs. Essentially, adopting something like the ratios given or establish a custom protocol internally, according to the degree of print tolerance and quality sought, will go along way to increase the envelope operational-wise. It allows printing a little more latitude if other aspects of the process is not where it ought to be.

On the other hand, if a job does not require such extreme demands, controlled deposit thickness, or uniformity almost regardless of registration, it maybe possible to increase the image-ratio given and still meet successful integrity. As mentioned, although the ratios are presented only as a guide, the writer is still nevertheless amazed by how many high-definition printing operations wonder why they live daily with serious quality headaches while working without any credible kind of image-size to frame-size format ratios.

Image Positioned Offset from the Center

Once accepting the image-ratio (or your own devised format) as a yardstick, from which to work to a distortional standpoint, it is based on the image being centered in the screen. This must be kept in mind for those operations using presses with automatic take-off systems, since they usually call for the substrate to be positioned to one side or at the rear to a fixed position for the take-off mechanism to function, (Figure 3). Once the image has been offset on the screen from the center, even if healthy in size, it effectively increases the image-to-frame ratio as the image now enters the zone of greater expected distortion than from when it was centered.

There is nothing wrong with equipment working in this fashion, where the image is required to be offset for automation purposes, especially as most sophisticated three-quarter and fully automatic presses do so worldwide. Notwithstanding, print distortion is a factor of how far the image is out from the center's "acceptable-distortion" zone area of the screen (Figure 4).

If a job requires greater tolerance than the existing system and processing method applied allows, particularly when using the maximum size frame for the press (ideally the best way to go), consider moving the image to the center. The free fabric area is now evenly balanced at both sides of the image (Figure 5b). While this does not actually reduce distortion, image integrity could be more readily acceptable because the amount printed is centered out rather than occurring from one direction. A further example of this follows.

Reducing So-Called 'Screen Stretch' for Die Cutting

Provided nothing else has changed, when printing multicolor or multi-pass single image jobs, any distortion created (together with its associated effects) is constantly the same so overall registration integrity is usually in tact and acceptable, even if the whole image were slightly distorted (Figure 6a). This is not necessarily true, however, if the same overall printed job were of multiple smaller images, say a 24-up copy, which needs die cutting (Figure 6b). The amount of distortion is still the same but each individual image will gradually move out of register against the die that was made earlier. Once the job is at finishing, die cutters find a column or more of printed images on the far side that may have to be scraped for what they typically call "screen stretch" (Figure 7a).

Regardless of what it is called or where the blame falls, individual images will progressively distort over the whole area. If nothing is done to keep it in check, or to reduce its effects, many otherwise good prints will be destined for the dumpster. If the whole image were positioned to the screen's center for printing (Figure 7b), overall stretch would appear be less by 50% because distortion starts from the center and works outward rather than from one side. Yes, some may call this cheating (professionals refer to this as "tweaking") but no one can deny otherwise that it is a very simple but smart way out of a potentially costly production problem.

With equipment that calls for the substrate to be positioned to one side and/or to the rear (typically with 4-post presses), consider centerlining the image side ways (in the squeegee length direction) by using a temporary edge register guide. In some cases, it is not a bad idea to center the whole image, in both 'X' and 'Y' if crucial and manually remove the printed sheets if the take-off cannot then function. Sometimes, repeatable close-tolerance and image integrity becomes overwhelmingly more important than productivity itself. If distortion is still unacceptable with centerline imaging or 'X' 'Y' centering the whole job, then refer

> Ill-use of the squeegee, in any shape or form, will directly influence the print negatively regardless.

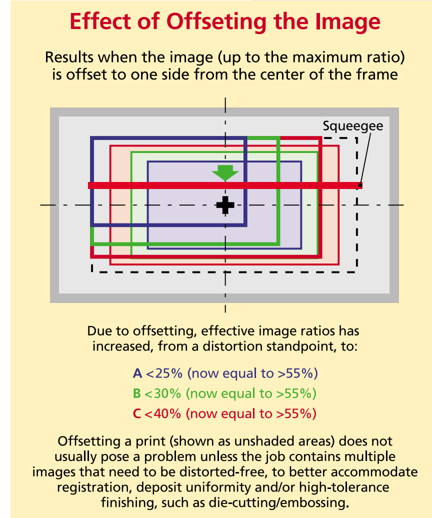

Figure 3 (effects a, b, c, f, j & k)

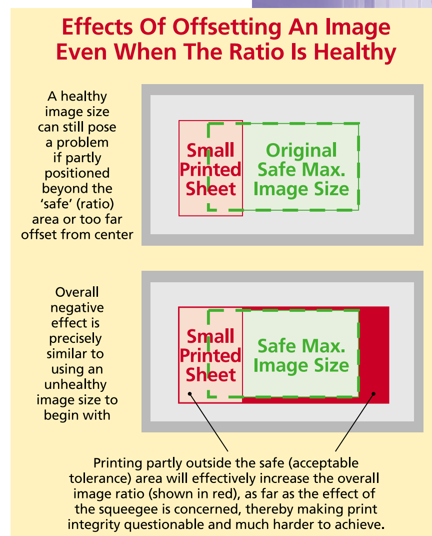

Figure 4 (effects a, b, c, e, f, g, h, k & n)

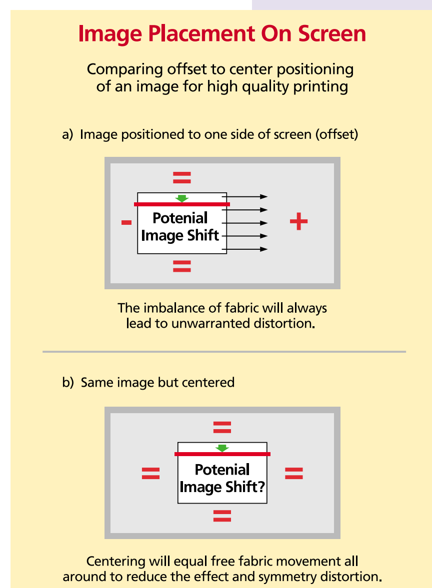

Figure 5 (effects a, b, c, e, f, g, h, k & n)

Screen Printing is a Contradictory Process

Screen printing is indeed a very contradictory process. Apply a lot more of this and you get that. Making the same adjustment in another scenario could yield a completely different result. Applying more squeegee pressure or speed, for example, with one type of ink might provide a heavier deposit while another ink may yield less with the same settings. Results often fly in the face of logic, and to make matters worse, tweaking the process in one fashion all too frequently affects the outcome of other aspects of the print, also — some desirable, some not so. Simply making one adjustment to improve something may well have the adverse effect due to other physical constraints of the process or due to prevailing conditions. Many a time one hears that an adjustment or change made one day does not necessarily work well the next, which leaves the proverbial $64,000 question as to why? Something else must have changed, perhaps several things, unknown to the press operator or support personnel. While adjusting almost anything on-press will affect the outcome of the print to some degree, many faults or errors described in this series of "on-press" troubleshooting are usually caused by a collection of more than one ill-adjusted function or process parameters irrespective of all those variables in screen making and art.

Nevertheless, the aim of this article series is to try to eliminate any perceived mysteries that concern the normal expected performance from any type of flat-sheet graphic screen printing equipment, as well as those related to make-ready and on-press adjustments. This is accomplished by meticulously examining causes and affects to determine the contributing factor for each problem. As such, for brevity and clarity, each accompanying illustration/chart throughout the series will simply carry a range of key letters that either denotes its influence directly creating the problem or contributes significantly towards it.

It is very likely experienced printers could make additional claims that a particular fault can create other deficiencies in the process also according to their specialization. The author, however, has taken the middle-of-the-road approach to give a reasonable account or review of widespread expectations, when something is not right, rather than trying to notch up the numbers of possible errors that could be potentially contributed from it as a result. There are hosts of other parameters that affect the desired outcome, according to specialization, but only those most commonly seen in the everyday workplace are reviewed.

Given that the tip of the squeegee blade brings everything together in printing, it is safe to assume its well-being is utmost paramount and that all manner of quality issues will occur if it is not on par condition-wise to the level of work for which it is to be used. Since many print faults occur due to the poor condition and use of the squeegee, such as a worn/unsharpened edge, wrong pressure, speed, angle, etc., most of these references have been left out to prevent unnecessary repetition. Ill-use of the squeegee, in any form, will directly influence print results negatively regardless of how well other conditions of the process is. Readers are reminded that many drawings are exaggerated to highlight issues being presented.

Key List for On-Press Problems

To follow the effects of various aspects of printing, each illustration/chart contains a row of letters to denote the problem that the scenario is likely to cause. For example, in Figure 2, illustrating the ideal maximum range of image-to-frame size ratios, contains the letters a, b, c, f, j, and k. From the key, it can be seen that working outside these ratios will potentially cause one or more of the following problems; image distortion, uneven ink deposit, image elongation, smearing, loss of edge definition (sharpness) and detail. It is always possible that it will create other problems too, however, those noted here are typically the ones expected to occur on-press in most printing environments under normal everyday conditions. As only on-press issues are our concerns here, other problems will also occur, as with all those throughout this article, due to poor screen making. All those shown without key letters are merely for information purposes only.

Lastly, what does "high-definition" screen printing mean, particularly since it forms part of the article's headline? Although everybody has their own idea as to what level high-definition represents, it usually refers to jobs that require extreme caution for one reason or another. Essentially, high-definition would typically mean operations that specialize at the highest levels of quality graphics/decals/transfers and electronics applications (membranes, overlays, instrumentation, trim, dial/gauges, etc.) as well as many other demanding industrial applications. The crucial nature of work would usually call out for, but not limited to, close-tolerance, repeatable registration, non-trap multicolor, fine lines/characters, tonal bleeds, certain types of 4-color process, precise deposit uniformity, multiple-up images (for die cutting), circuitry, clear/tints, blemish-free requirements, printing on difficult surfaces and/or unstable substrates and otherwise, meeting exacting mechanical specifications beyond those traditionally associated with quality printing.

KEY OF EFFECTS

Listed in no particular order, for each illustration with repetitive cause amounts shown.

Letter Effect	Repeat Qty
a) Causes of image distortion (in all directions)	16
b) Reasons for uneven ink deposit	22
c) Reasons that creates image elongation (in print direction)	15
d) Rationales for causing sporadic mis-registration	3
e) Causes of streaks in squeegee travel direction	15
f) Reasons producing smearing (print beyond desired area)	19
g) Typical causes for tone loss (mono or four-color process)	16
h) Causes for tone gain (not opposing causes of “loss” above)	18
i) Reasons creating ghost images (double-edge appearance)	8
j) Factors creating loss of edge definition (sharpness)	18
k) Reasons for detail loss (parts of image, line, character, etc)	22
l) Banding causes with tonal blends/graduations (vignettes)	7
m) Reasons for streaks/lines, perpendicular to sq travel	7
n) Causes for “image” or “screen-stretch” when die-cutting	6
o) Factors for productivity loss with static	3
p) Causes of pinholes and fish-eyes	7
q) Rational creating moiré	1
r) Reasons for orange-peel	5
s) Typical causes for ink spread	12
t) Reasons for saw-tooth	8
u) Reasons that causes voids	12

to other on-press reasons that can be the likely cause.

Frame’s On-Press Conditions and Positioning

Frames (effectively become screens once fabric has been applied) ought not to be warped or twisted in the corners and lay perfectly flat. Corners should be kept square (90°) when using welded box-type sections (such as stretch and glue-type) or else it will cause a parallelogram orientation that might potentially lead to other problems during printing (Figure 8a). Once the frame is clamped into the press, it must be absolutely parallel to the print table in the squeegee length direction (Figure 8b). Nothing less is acceptable seeking error-free results! Back to front parallelism is somewhat irrelevant at this point because of any peel-off function that may have already taken place. If the peel-off system is disconnected, not activated or does not exist as a feature on the press, then the screen should also be parallel in this axis also (in the squeegee stroke direction). As seen in Figure 8, the seemingly innocent non-parallelism of a screen is directly linked to several major printing problems. However, three-dimensionally speaking is another thing entirely.

Correct Alignment/Position of Image (Burnt to the Screen)

Once the screen has been clamped level correctly to the print table, there may well be concerns about it being aligned three-dimensionally too, according to the printing equipment, frame type, job and degree of print tolerance required. When using a press with an automatic take-off system (usually those requiring mechanical registration edge guides to be used), together with manual locking clamps that suspends the frame from above, substrates have to be pre-positioned squarely against fixed guides so that the take-off functions correctly. If the stencil image has not been burnt in the screen aligned linearly to the substrate, operators are forced to “skew” (rotate) the screen out of square until the image lines up to the correct position against the substrate in order to compensate (Figure 9). Again, this may sound quite innocence at first but as clamps are manually tightened, the screen moves in a parallelogram-type orientation, similarly as those mentioned previously that are not squared. As clamps are tightened, fabric will move

Spectacular **print results** are always preceded by **unspectacular** preparation!

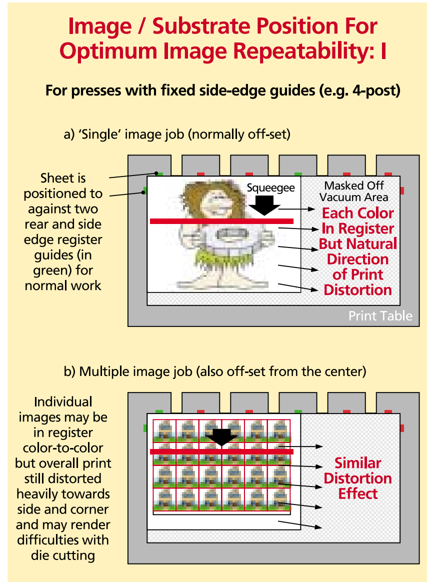

Figure 6 (effects a, b, c, e, f, g, h, k & n)

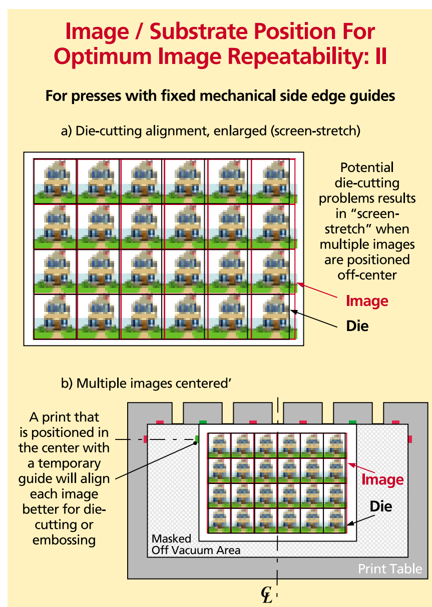

Figure 7 (effects a, b, c, e, f, g, h, k & n)

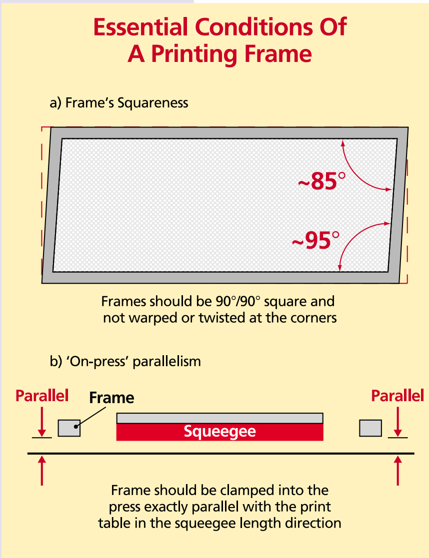

Figure 8 (effects a, b, c, e, f & k)

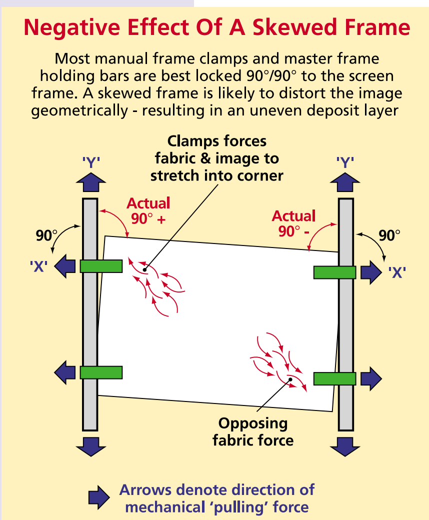

Figure 9 (effects a, b, c, e, f & j)

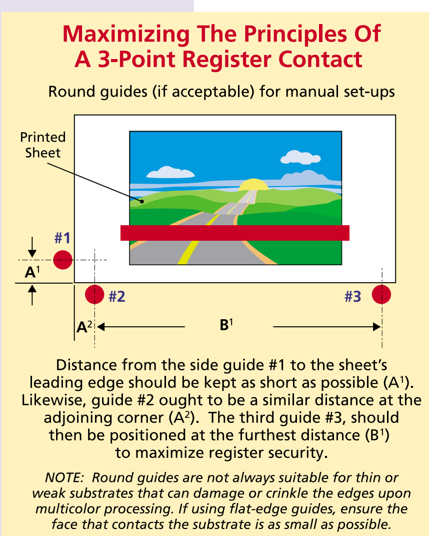

Figure 10 (effects d)

and tension shift to opposing corners, which will elongate and distort the image. Furthermore, it may take on an irregular distorted shape as well as other defects as a direct result.

Registration Guides — Mechanical (Built-in to the Print Table)

When using a printing machine's built-in mechanical registration guides (sometimes called pins, lay stops, tabs, etc.), only three should be used as means to register a sheet. For optimum registration, only the substrate's best cut/square short and adjoining long side for registering should be used. In some operations, the leading edge (and/or side) to register against is indicated by marking the sides all the way down the pile with a magic marker while sitting on the pallet prior to first color. The single left-hand guide is usually used while the right-hand one is reserved for double-sided work (to maintain same register edge). Then the other two guides are employed on the substrate's long side, one at the adjoining first corner and the other at the extreme end according to sheet size (Figure 10). Do not make the mistake of using more than three guides since this will create all manner of problems otherwise.

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Registration Guides — Homemade (Manually Prepared for Each Job)

When using homemade guides for registration (with equipment not having mechanical built-in ones), ensure that their flat edges are small as possible so they come into contact with the substrate fully with ease. The best way to achieve this criteria when printing with substrates having weak edges is by tapering the guides down to something like 1/8"/3 mm. Tapered design, like the top cut off a pyramid, will give the operator greater 'area' to secure the guide with tape or adhesive while yielding optimum (smallest) contact-point registration security. If they are made longer in length against substrate contact edge—two things potentially occur. Guides that are too long will have an adverse effect and are less likely to be made perfectly straight (within themselves) than a short or tapered ones. Longer ones will most definitely be more difficult to align flush against the substrate satisfactorily. When this happens, operators will often bounce the substrate around the guides and miss-register, thereby sporadic misalignment becomes all too frequent.

If substrate edges are rigid enough to allow, consider the possibility of employing round guides, say 3/4" – 1"/19 – 25mm in diameter, rather than using the more problematic flat edge-type. Similarly to the mechanical guides, only three are used but careful consideration must be given to their positions to function properly. As noted in Figure 10, the first two guides are positioned equal distance from the same corner, perhaps 3/4"/ 19mm away, on the substrate's designated side/edge for registering. The third guide is then positioned the same distance from the other corner on the long side. This is the simplest way to ensure register integrity without operators getting a forced sense of security that the sheet is in register when it is not. Never position guides right on the corners. Once a system has been established, it can be *universally* incorporated on all other printing presses that require it as well as for die-cutting.

Coming in the next issue of SGIA Journal – PART II

We have just discussed some of the upfront issues that directly link to the performance of good on-press protocol. Some of those were related to image ratio to frames used, image positioning, frame insertion and the need to adopt a universal 3-point contact registration system for equipment that does not have built-in mechanical ones. In Part II, we shall continue with press alignment concerns and other good practices in make-ready to provide superior on-press control for overall superior printing performance. □