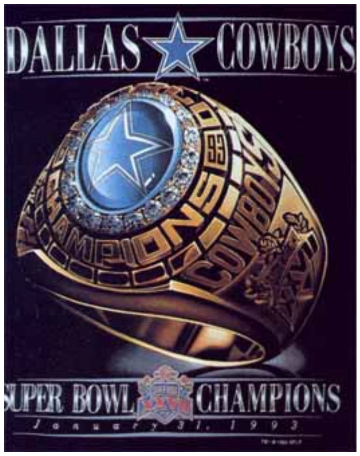
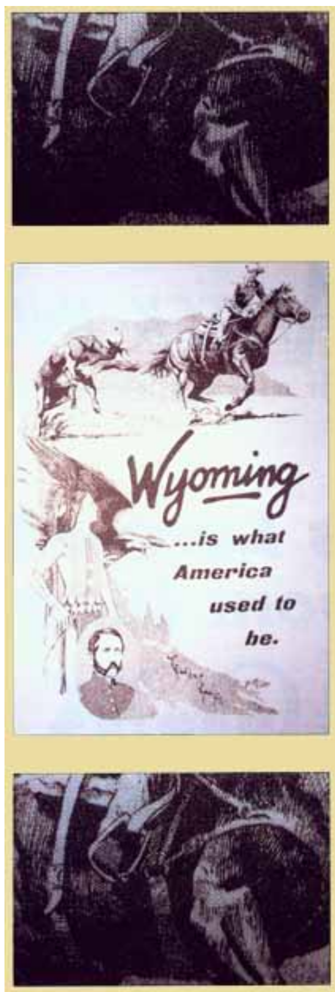
Elevating Production Efficiency, Part 6

Controlling the Stone

TRICK question #1: This image is thirteen automated colors on black. The "Wyoming" image below is a simple, manual black-on-light. So which print's printer will benefit most by using 85-Newton screens? If you picked the "Ring"on the right, you've fallen victim to a common prejudice. The author contends that with both, super-high tension yields equally dramatic results.



By Don Newman



"*... who needs 100 Newtons?*" My answer? Everyone!

With those words, last month, I left you hanging. We had just concluded a before-and-after examination of our "Simpsons" print with my reporting the 57 percent increase in production realized by boosting mesh tension from 7 to 50 Newtons. Additionally, we observed that, with increased squeegee and flood speeds, along with more uniform interface pressures, came an improvement in print quality, due to the drastic increase in mesh tension. Then I went on to make what seemed a *radical* claim that such improvements were only the beginning, and a suggestion that *every* garment printer should consider printing at tensions approaching 100 Newtons.

The facts, however, indicate nothing radical about such a proposal. If our "Simpsons" printer had not stopped at 50 Newtons, but gone ahead and tensioned screens to 85 N/cm (3000 lbs. of total screen force), the production speed would have jumped to approximately 850 pieces per hour (at 50 N/cm, the jump was from 350 to 550 pieces per hour). I say that with confidence, because such numbers are consistently produced at 85N/cm by New Buffalo Shirt Company on its much admired black shirt prints distributed in part by such companies as Salem Sportswear. (Check out, for example, the 13-color gem pictured at left.) Previously, at 35-40 Newtons, New Buffalo only averaged 520 pieces per hour on black shirts.

By the way, improvement on fleece printing went from 250 to 500 pieces per hour in the same tension ranges. (I need to point out, here, that printing at these high speeds and tensions cannot be done without making modifications in other areas of the printing process. Notably, New Buffalo got some help from an ink company that has recently developed a new high-shear ink. We'll deal more with such changes — issues relating to presses, floodbars, squeegees, screen handling and logistics — in a future installment. High tension alone, as we see, is not a cure-all, but a critical starting point.)

No Exceptions

Okay, maybe you're right. But surely what you meant to say was that every big- time automated print shop should be printing at 100 Newtons.

I knew you'd say that. You'll recall however, that I did say everyone. To back that up, I've come up with a simple example from a manual printer. As our "Wyoming" print (right) demonstrates, the manual printer, like the automated printer, also can achieve simultaneous improvement in production speeds *and* quality, in equally dramatic fashion.

A simple one-color, black-on-white, "Wyoming" was successfully printed *manually* at a very respectable 25 Newtons (700 lbs. of screen force on an 18" X 20" I.D. frame). To assure reasonable reproduction of the design's fine details, a 255 mesh was used. But as an experiment, I suggested the printer try the same print at 85 Newtons (2400 lbs. total force), using a mesh specifically designed to handle the extra tension load. The result? Production speed went from an average of 8-10 dozen per hour at 25 Newtons to 20-22 dozen per hour at 85. I have yet to meet a printer, even a manual printer of one-color prints, who considers doubling his production speed a radical idea.

Room for Improvement

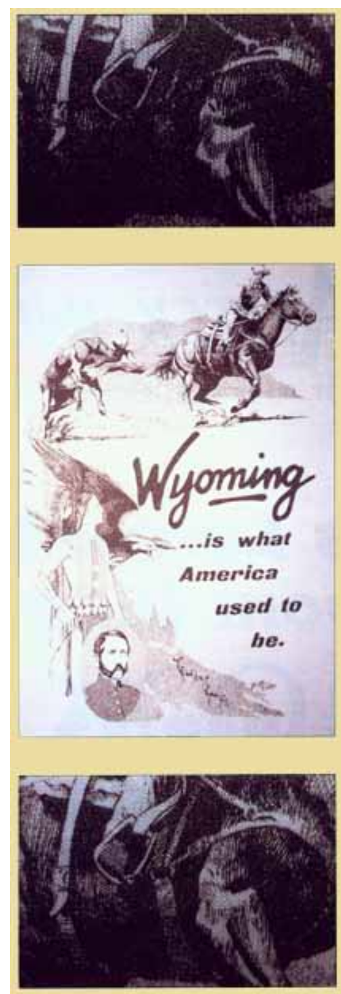
As tension goes up, we're turning the tables on the force relationships within our ink-transfer machine. The higher we go in tension, the more completely we accomplish that reversal. The mesh is increasingly able to counter the crushing power of our "rolling stone" — the squeegee — to control the consistency of interface pressure on the ink (between both squeegee and mesh and floodbar and mesh) and finally, to almost instantaneously release itself from the adhesive grip of the ink while applying only the most minute pressure to the top of the substrate and the ink now residing upon it. Consequently, the ink's influence on peel is increasingly *diminished*. As screen tension goes higher, the squeegee and floodbar speeds can be increased, in nearly direct proportion. From the squeegee's point of view, the snap force of the screen works like a series of compression springs, similar to those in a mattress box spring. The higher the tension, the stronger the spring. The stronger spring simply snaps up much faster and with more force, thus permitting the squeegee and floodbar to travel at much, much greater speeds. As our manual print demonstrates, such benefits continue to accrue far beyond 50 Newtons. It's my contention, therefore, that printers currently experimenting with even higher tensions will find that the point of diminishing returns on speed occurs (as I've previously stated) well in excess of 100 Newtons.

Speaking of diminishing returns, you're no doubt asking how *long* our manual printer maintained this more-than-doubled production speed: *No one can keep that up for eight hours*.

Assuming the "Wyoming" printer was working as fast as conditions allowed at 25N/cm, it does seem unlikely. Yet there's no statistical trickery here. The 20-22 dozen-per-hour figure represents the piece-per-hour range maintained by three printers on three separate machines over three eight-hour shifts.

But as I mentioned last time, a 100+ percent increase in production can't be explained simply in terms of faster squeegees and floodbars. As it happens, high mesh tension also creates conditions, which allow another significant reduction in cycle time, involving the squeegee stroke length.

Before Print



After Print

TRICK question #2: Of the before and after, which print was printed at greater speed through coarser mesh? (Think about it, now.) If you guessed the more detailed one, immediately above, you're catching on.

Shorter Trips

In a low-tension print, the squeegee must pass a good distance beyond the image to allow the mesh to snap cleanly all the way to the end of the screen's image area. If too little of a screen's real estate is allowed between the image edge and the end of the stroke, the mesh will still be laying in the ink, struggling to pull free, as the head lifts. The trailing edge of the print smears, of course, because the ink release isn't complete. Therefore, screen printers have habitually had to begin and end the squeegee stroke *far* beyond the actual image, very near the frame edge. But the squeegee should only need to pass beyond the image edge far enough to allow for snap to be completed. Therefore, when we boosted screen force from 25 N/cm or 700 lbs. to 2400 lbs. at 85 Newtons (a 243 percent increase) on the "Wyoming" print, we achieved a screen snap force in opposition to the adhesion of the printed ink that was previously so overwhelming, snap was (again, for all intents and purposes) instantaneous. The screen now snaps up so quickly behind the squeegee as it passes that there is little or no delay to account for. Consequently, as screen tensions become extremely high, with near-instantaneous snap, total stroke length can be reduced to near image length. The shorter stroke requires less time, and the few seconds shaved per print cycle on a multi-color print job can count up dramatically over a typical month, amounting to several days less press time.

The Fatigue Factor

Naturally, this benefit is most apparent in automated printing, where squeegee-stroke length can be set precisely and is easily repeatable. But far from being left out, the manual printer can not only shave time by shortening his stroke length, but also greatly reduce stress to arms and shoulders.

At low tension, the manual printer must begin his stroke near the back of the screen and pull the squeegee to a point near the frame member closest to him (or vice-versa) to ensure mesh snap, as mentioned above. This requires more arm and shoulder extension than would be necessary if the stroke began and ended near the border of the image area. In addition, at low tension, much of the physical effort that goes into the print stroke is expended to achieve sufficient *downward* pressure to force the mesh down from it's high off-contact position to the substrate surface in order to print.

More effort is required to force the screen down to the mesh at the beginning of the stroke and to keep it down at the stroke's end while the screen peels past the image area. When high-tension conditions allow the stroke to begin and end just beyond the image's edge, several inches closer to the center of the screen, the difference in effort required to print is enormous. Remember, our "non-uniform ink-transfer" chart demonstrates that at the highest tensions, off-contact can be drastically reduced to as low as l/32nd or l/64th of an inch. And, though the resistance of the screen at 85 Newtons has increased by nearly 2000 lbs. of total screen force, the maximum squeegee pressure necessary to print within the typical image area actually drops dramatically, in this case approximately 50 percent. As a result, at 85 Newtons, our manual printer applies less downward pressure within the image area, and (with the shorter stroke necessary to accomplish peel at this tension) no longer struggles to overcome the low-tensioned screen's exaggerated resistance to pressure at the beginning and end of the stroke. The result is drastically reduced friction and drag on the squeegee, making it physically easier, less fatiguing to print, even while printing at much faster rates.

Real World Results

We've observed some ways that high tension's effects on peel makes greater squeegee and flood speed possible, and reduces stroke length. Further, we've demonstrated that ultra-high-tension printing offers these three significant benefits not just to the "big time" printer — of four-color process work or 14 colors on black, armed with sophisticated automated equipment — but to anyone, manual or automated, no matter how simple the print.

Now, however, we need to turn our attention to something that (I hope) has been nagging at you during this entire session. Doesn't this all strike you as ... well, a bit *suspicious?* Most printers might expect to experience print degradation at higher speed or, at best, to possibly *maintain* the same quality. But in both of our examples, image quality shows what can only be described as *significant* improvement.

Your suspicions are likely to turn to disbelief when I tell you that, in fact, the quality improved despite that in each case the printers eliminated or reduced remedial measures commonly employed to *protect* quality. At 50 Newtons, the "Simpsons" printer reduced off-contact to l/32nd inch, re-engineered his art from trap to more-difficult butt registration and further increased machine cycle speed by eliminating flashing. Yet registration was more accurate, smearing was eliminated, better and smoother large-area coverage on the rough (and tough-to-print) canvas substrate was achieved while laying down less ink, and the intervals between screen-wiping sessions grew from 200 to 900 pieces. On the "Wyoming" print, at low tension, a flood stroke and a heavy squeegee stroke were required to force the ink through the small orifices of the 255 mesh. But at 85 Newtons, the print required just one squeegee stroke, and *no* flood and no wiping for eight hours, yet — here's the part that's really difficult to swallow — "Wyoming" exhibited *greater detail* at high tension than its low-speed, low-tension counterpart (see comparison above), *despite* the fact that a mesh more than twice as coarse was used. In addition, both large-area coverage and the finest details were printed from a single screen. To achieve the same quality result without the typical need to stop frequently to wipe screens, the low-tension printer's alternative would be to print the image with two screens — one fine mesh for detailand one coarse mesh for solid coverage— getting a good image, but totally giving *up*on speed. To top it all off, our "Wyoming" printer reported that his screens needed no wiping during the entire three-shift run. (What kind of yield could *you* maintain if you hardly ever had to stop and wipe screens?)

Finer detail with a *coarser* screen? The achievement of good large-area coverage and fine detail from the same screen, without sacrificing one for the other? How do we account for all that? We're not just eliminating ink abuse. Something uniquely positive is happening to a key component of our ink-transfer machine — the ink itself — that we've not yet addressed.

Next time: Newman examines the positive effects of ultra-high mesh tension on a final, and crucial, ink-transfer element.