As the world of narrow web continues to evolve, more and more press designs have shifted from traditional label presses to multi-substrate platforms. Now that more and more flexible packaging applications are being done on narrow web machines it is critical to have the correct operational and machine features to run them successfully. Today’s presses are designed from the ground up to handle these multi-substrate capabilities. Most of all, the latest models of narrow web machinery are now built with fully automated servo technology. Full automation and the most precise web handling and web transportation options available.

The ability to control and predict the transportation of the web through the machine is critical to the success of the application. Web tension control determines, in large part, the machine’s efficiency and product quality. Improper tension control can severely limit the performance of the machine. Slack web or indifferent tensions, both before and after tension zones are the most obvious consequences of inadequate tension control. These concerns will affect print to print registration, print length issues commonly referred to as ‘snap back’, curling of the web after lamination, core crushing and the worst of all, excessive waste of web material. Adjusting to all of these concerns will lead to reduction in run speeds to accommodate web handling concerns.

Many of these issues are simply accepted as normal and are not usually attributed to web tensions; however anyone who experiences these concerns and recognizes the relationship can improve the process and machines efficiency. By optimizing the tension control systems on press we can improve production efficiency. But first we must understand the tension control options available.

A typical inline machine has more than one tension system and zone. Typical tension affecting devices are the unwind stand, infeed tension control, midfeed pull roller, outfeed pull roller and the rewind stand. These are broken up into four tension zones. Unwind to infeed, infeed to midfeed, midfeed to outfeed and finally, outfeed to rewind. This separation exists because the process in any individual zone may require a different tension level or pattern than in the other zones. Let’s break these down individually to understand the importance and performance of each zone.

UNWIND STAND TO INFEED CONTROL UNIT (ZONE 1)
The unwind module can play a very important part in the operation of the press. The required tension of the unwinding substrate should be roughly 15 to 20 percent less than the proper PLI (pounds per lineal inch) needed for the substrate. We do not want more tension on the unwind than we do in the press so it is critical to keep this ratio. Too much tension on the unwind could cause the roll to tighten on itself or telescope, which could also cause equilibrium issues entering the infeed unit. Too little tension and the infeed will have to work too hard to establish proper press tension.

The ultimate goal of the unwind is to efficiently unwind the substrate during acceleration, run speeds and deceleration. Any significant deviation from the constant tension may be reflected in the next tension zone. One of the unwind’s biggest obstacles is overcoming core shaft inertia and gear friction without taking away the brakes sensitivities and hinder its proper control of the web. It is for this reason there are various options available to support the application to be run. The most common type of unwind brake systems are either pneumatic or electrical braking systems. More effective for film applications are the closed loop tension control systems. The closed loop tension system vastly improves tension control. The actual web tension is measured by transducer rollers and then matched to the desired settings set forth by the operator. Most transducers are either strain gauges, load cells or use a variable inductor to develop a voltage proportional to the tension and are accurate to within 1 percent. The system will then maintain a constant tension from beginning to end of the roll.

INFEED TENSION TO MIDFEED UNIT (ZONE 2)
This zone is from Infeed to Midfeed and its main objective is color to color registration as well as the ability to affect print length. This is where the primary substrate tension setting will be set. Understanding its effect on tension is the key to solving many register issues. Following the proper PLI tension
charts will get you in the neighborhood for optimum settings. Since all presses are designed a little differently, such as web lengths and roller diameters, each will require their own optimum setting. Following the proper PLI settings will also allow you to better control any snap back issues while running film. This issue occurs when the web has too much tension applied. The web is stretched through the transport process and then relaxes after converting. The repeat ends up being shorter than the desired measurement. This could ultimately cause product count concerns as well as the inability to convert in the next process.

There are also various options available for tension control on this module as well. The traditional method for most label presses was to have a mechanically controlled variable infeed roller. This design would allow the operator to either speed up or slow down the pacing roller to increase or decrease the web tension. But it would not hold a constant tension through speed changes or stops and starts. Tension in most inline presses will tend to increase with the increase in speed. Tension is the primary function that will allow you to have good registration, without constant tension through the print zone you will not have constant registration. The second and more desirable choice for web tension control on this module is the closed loop system. Just as with the unwind, this system will monitor and correct for tension deviations that do not correlate with the desired setting by the operator. It will also make tension corrections through press accelerations and decelerations thus improving register performance throughout the speed range.

In order to make the proper tension corrections you must first know what to look for. In snap back related concerns you can usually tell very quickly what adjustments you need to make to the infeed unit. If the image is short due to stretching the material you will need to reduce the tension, if the image is long you can increase the tension. On the newer servo automated presses the print length can automatically be controlled by the variable repeat system control on the plate roller. This is a great feature because you can run an optimized tension with the exact repeat length. In other cases where snap back is not a concern you can always monitor the movement of the color to color registration. This is where the pull of the impression rolls comes into play. The impression rollers are not necessarily a zone in themselves but play a very important part in several aspects of printing. Remember that it is the first impression roller that is pulling on the infeed pacing roller. This is where the initial tension is being determined. It is then up to the progression of the remaining impression rollers and the midfeed to maintain the established tension. Most tension related register concerns are usually seen in long term drifts. By monitoring the first color being printed you can usually identify what type of tension adjustment you need to make. If you are always advancing the first color down than chances are you are pulling it back toward the infeed. In this case I would reduce the tension and let the color drift forward. Register that bounces back and forth within its own color is usually related to a mechanical backlash concern or something related to that particular station. Long term drifts are easily controlled by tension settings as well as the automatic registration systems that most newer presses have. It is the dreaded register bounce that keeps us hopping.

Once the primary tension has been established by the infeed unit and the first impression roller pulling, it is up to the rest of the press to maintain the desired tension. Most narrow web presses are designed with a built in progression into the impression rollers. Although it is minimal with steps much less than a thousandth of an inch per roller, this progression in size is what allows the press to maintain tension, without it the tension would eventually drop off in the center of the press causing registration drifts. The infeed unit can usually maintain the tension for the first two or three stations but after that the press will need a pre determined progression to maintain tension. This is also why the impression rollers most commonly have a 180 degree web wrap. This is what maintains the tension. Picture a small boy playing tug of war with a giant. In a straight line he would certainly loose, but wrap the rope 180 degrees around a tree and the boy will hold him off all day. The webbing and wrapping of the press must be maintained to the press OEM’s recommendations in order to hold the proper tensions. Just as the infeed can hold onto the first couple of print stations the midfeed can pull the last couple.

Midfeed tension to outfeed tension (Zone 3)
This zone is from the midfeed pacing unit through the outfeed pacing unit. Most commonly called the converting section of the press. Its main objective is the last couple of print stations but directly effects print to die registration. Unlike the unwind and infeed tension control systems that have various drive capabilities and options this one tends to be a fixed drive module. It works in conjunction with the established tension that begins at the infeed and natural progression of the press. This fixed speed roller with a pneumatically controlled nip roll maintains its pull by being a couple thousandth’s larger than the last impression roller. The web wrapping of this roller as well as the air pressure regulated on the nip roller will allow considerable adjustments to be made to the tension zone. The
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relationships of this roller in reference to the print to die registration is crucial. If the die strike is continuously advancing away from the print, the nip roller pressure can be increased to minimize the slip and drive more web forward. Just as well, if the die strike is continuously falling behind the print we can reduce the nip roller air pressure to increase the web slip. This will allow the print to retard and pace itself with the die strike.

Another one of the primary objectives of this unit is to serve as an isolation point between the printing zone and the converting zone. The midfeed roller, with the proper nip roller air pressure will isolate most any web disturbance caused from the converting process. This will minimize the possibility of sending shock waves or tension spikes back to the printing zone effecting print to print registration.

The outfeed tension unit is usually set up the same as the midfeed. It is a fixed drive module that also has a step in progress. This is the largest roller in the progression set. It serves to maintain the tension in the converting section and is the final driving roller in the machine. It also has a pneumatically controlled nip roller to maintain and adjust out feed tension. This can also be used to control sheeting registration as well as other delivery functions.

OUTFEED TENSION TO REWIND TENSION (ZONE 4)
The primary objective of this zone is to rewind the product roll with straight edges and uniform density, while preserving the accuracy of registration and repeat length. It must be designed and set up to accurately follow the acceleration and deceleration of the press speed while continually compensating for changes in the rolls diameter. It is also critical that this product rewind have the sensitivity to handle narrow webs that are perforated, stretchable or stiff.

The center rewind system is the only tension system that is used in Narrow Web. The rewinding force is solely derived from the rewind shafts. This system is usually driven by the main press drive or an independent drive source. This design is most common because it is capable of using two tension control systems, constant (closed loop) and taper tension.

The Closed loop constant tension system works just like the unwind and infed. It maintains a pre determined tension setting so the rewinding tension is the same on the first wrap of the roll as on the last wrap of the roll.

The Taper Tension control system works slightly different and is adjustable. This is where the tension on the last wrap of the roll will be slightly lower than on the first wrap of the roll. This is a very common system for the flexible film applications requiring lower tensions.

Typically rewinding films will require less tension than that of label stock or tag. This is due to the film being a non absorbent substrate. Ink build up in high coverage areas as well as ink blocking can occur if the roll is wound too tight. To determine proper rewind tension, use this simple test. Apply pressure to the printed roll with your thumb, you should be able to feel a slight compression of the material. If you can’t, the roll is wound too tight. Optimal rewind tensions are usually the same if not slightly higher than the unwind settings.

OTHER FACTORS
There are obviously many other factors that can effect press tension. Adding individual converting applications like turn bars, rotary screens, embossing units and laminations will all contribute to new challenges. Temperature of the driers and air velocity will also affect the stability of the web tension. But understanding the basic concept of the tension system in your press will allow you to identify the root cause and conquer those challenges more effectively. As we continue to evolve in the flexo inline process with higher plate LPI’s, lenticular imaging and expanded color gamut printing, we will most definitely need to have control of our web tensions for optimum registration results. I hope you will find this information useful in reducing your stress levels created by uncontrolled tension.

ABOUT THE AUTHOR:
Paul Teachout has been in the packaging industry for more than 25 years. Starting out in offset, he moved to flexo press manufacturing with Webtron in 1986. He remained with the company through its evolution to finally become Aquaflex. Teachout has held numerous key positions including printing management, application specialists, sales support, engineering support, marketing and product development manager. As of March 2008, he became southeast technical graphics advisor for Harper Corporation of America. He is also active on industry committees and is a contributor to numerous technical articles.