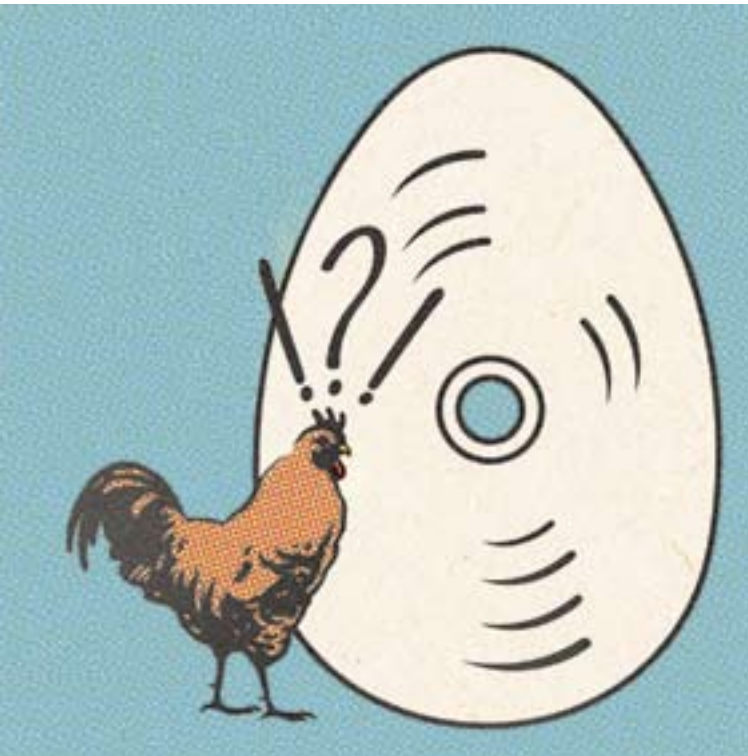


New tension control technology can eliminate common issues experienced by flexographic printers like out-of-round rolls.



The Evolution of Tension Control Speed, Sensitivity Demand, Power & User Friendliness

By Darrell Whiteside

changeovers have all increased the need for more powerful, yet user-friendly controls.

Fortunately, closed loop tension control systems have evolved to meet the demands of printers and customers. Gone are the days when every control loop was the same (whether it was tension control or a temperature control) and you had to have a degree in control theory to program it.

In this article, we'll outline how recent advances in tension control can provide significant benefits to the flexographic press, both for the product and operator.

OUT-OF-ROUND-ROLL COMPENSATION

In the past, there has always been a compromise to make concerning the use of load cell or dancer control. Do I use a dancer system to accumulate the velocity changes of a bad roll? Do I save space and go with a load cell system that also gives me direct tension readout? Do I spend the money for both systems to have the ultimate tension control?

Dancer systems (see **Figure 1**) have been around for many years and provide accurate tension control by providing position feedback. Dancer systems are typically used if there is a concern of the unwind rolls being "out-of-round." In most cases this occurs from improper storage, resulting in flat spots or even egg-shaped rolls. The downside of these systems is the amount of engineering required to correctly design the system and the amount of space needed in the machine.

Load cell-based systems (see **Figure 2**) employ the use of sensors that directly measure tension providing feedback to the control. Although considered the highest level of tension control, they have always been limited by their ability to stabilize out-of-round rolls.

Today's load cell controls can continually monitor the frequency of the flat spot on an unwind and adjust the output as it is about to happen rather than always chasing the velocity change, eliminating the need for expensive, large and difficult-to-design dancer control systems.

Disturbances to the web: every printer's nightmare. Once they occur, they wreak havoc. Jobs are destroyed. Waste scrap begins to pile up. Precious time is lost. Potentially missed deadlines present a danger. It seems like a sorcerer will have to be called in to work his/her black magic to fix things. Panic sometimes fills the air, and it's easy to sense the tension in the pressroom. Transitioning that tension from man to machine improves performance, satisfies customers, but most importantly keeps the presses humming and churning out high quality work.

Accurate tension control is important in any web application, including flexographic printing, where registration, print quality and speed are vital to making the best product as efficiently as possible. In the past, manual systems required the operator to continually decrease the output as the roll got smaller. Advances in tension control, like automatic open loop systems (i.e. follower arms and ultrasonic sensors) have freed the operator, but only made tension corrections proportional to the roll diameter, thereby failing to consider any other disturbances of the web.

For this reason, it is typical to find dancers and load cells or a combination of both on higher-end machines. These systems provide feedback, are the most accurate and provide the highest level of control when correctly applied.

Today's customers and their product demands are pushing the limits of even the higher-end closed-loop controls. Increased speeds, more sensitive material, larger roll builds and faster

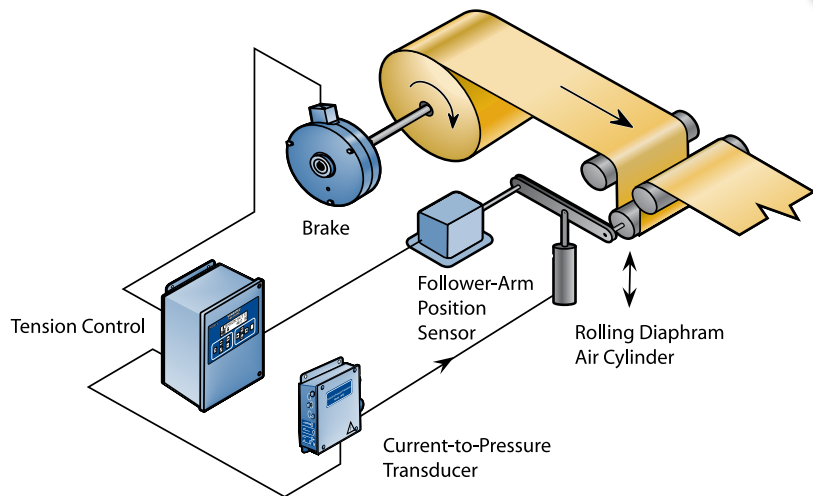


FIGURE 1. Dancer systems.

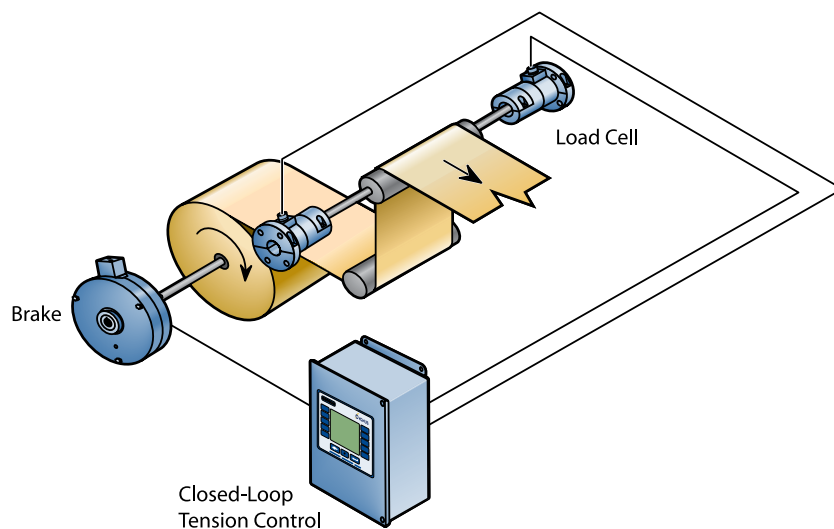


FIGURE 2. Load cell-based systems.

a few simple commands through the keypad. The systems can automatically run to optimum settings based on the dynamics of the machine.

GAIN SCHEDULING

Every machine is designed with certain parameters in mind. It is the job of the end user to push those limits and get everything he/she can from that machine. One of those areas commonly pushed is roll build. In the past, a machine may have been designed to run with 30-in. O.D. (outer diameter) full rolls with a 3-in. O.D. core. One common way to increase efficiency is to reduce the number of roll changes by increasing roll sizes. It is not uncommon today to see the above machine modified to accept 40-in., 48-in. or even 60-in. O.D. rolls. One threat to the increases in efficiency is the limitation of the older control loops (PID).

These older systems employed a single PID loop that was a compromise giving you the best control from full roll to core (because a larger roll requires more gain than a smaller roll). If the system worked at a 10:1 roll build as it was designed (30-in. full roll and 3-in. core), odds are it will not work for the larger 20:1 roll build of the modification (60-in. full roll and 3-in. core).

Even retuning the PID loop will most likely result in very sluggish control at full roll and instability at core. The result will be the inability to run all the way to core before the web becomes unstable. If you are throwing away material because you cannot run all the way to the core, you need to keep reading.

The answer is gain scheduling. Today's closed-loop tension controls offer the ability to have PID parameters at full roll with enough gain to deal with any transients in tension and a completely different set of control parameters at core with enough reduction in gain to keep your system stable. These parameters automatically adjust to give you optimal control all the way through the roll as the diameter changes.

The technology of tension control has changed greatly and will continue to evolve as will the needs of the market. The capabilities of the newest tension controls have made them easier to use and easier for customers to run the best product possible as efficiently as possible. ■

ABOUT THE AUTHOR: Darrell Whiteside is the Tension Control product manager for MAGPOWR. He joined the company to facilitate international sales in 1999 and was quickly promoted to his current position. He travels extensively to gain exposure to varying tension applications in an effort to continuously champion new tension technologies. Whiteside holds a BS in Industrial Science with an emphasis on electronics and robotics from Northeast Missouri State University.

WEIGHTLESS LOAD CELL CALIBRATION

Calibrating load cells has always been a cumbersome job at best. It requires removing the web, threading a rope through the machine and then hanging a known weight from the rope and adjusting the gain accordingly—a fairly straightforward process on a cantilevered machine with load cells of less than 50 lbs. Difficulty increases exponentially as the load cell rating increases and, as a result, more weight is required for calibration.

Newer systems automatically calibrate the load cells without hanging weights. Instead, the task can be completed by software in the control with the entry of wrap angle, load cell type and rating.

AUTO TUNING

The PID (proportional gain, integrator and derivative) loop is still the heart of the closed loop tension control. Simply stated, it measures how much, how often and how fast a control output is given in response to an error in tension.

In the past, the PID loop was the realm of control engineers and theorists who worked their black magic to tune and stabilize the system. Today's controls allow anyone to tune the system with