# High Speed Shrink Packaging: Controlling the Process

by Robert Bisbee

## Defining the Issues

Achieving an aesthetically pleasing shrink package at high speeds requires controlling the entire process; from purchasing the right equipment; to controlling the products/film on the shrink wrap equipment; to final product output of the shrink tunnel. Total process/machine/product control is vital for successful high speed shrink packaging. Any installation is only as good as the least effective part of the overall system.

Thus, even before shrink wrap equipment or film is purchased, a team should be formed to define final product/equipment needs and resolve potential issues up-front. Choosing the right team early in the process is also a key to establishing open lines of communication. At a minimum, this team should involve the film supplier, machinery manufacturer(s), machinery purchaser, and integrator(s). Bringing the suppliers together will help insure that things proceed smoothly. Once the team has been formed and needs are defined, the process of purchasing equipment/films can start.

## Background

Before addressing the machine segments in detail, a little background about the development of High Speed Shrink Packaging can set the groundwork for discussion. Decades ago, the first manually fed L-bar sealers (with corresponding shrink tunnels) were introduced to wrap products in shrink wrap film. Then, the semi-automatic L-bar sealer for shrink wrap was introduced to increase through-put, but still required an operator to handle products entering into the shrink wrapper. The next step was the introduction of the automatic L-bar shrink wrapper. Now, no operators were required to handle products entering or exiting the wrapper, lowering the operating costs and increasing product yield. Gradually horizontal form fill and seal (HFFS) shrink wrap machines began to evolve, allowing manufacturers to again increase production and decrease operating costs.

Today L-bar sealers and HFFS wrappers are still the workhorse of the shrink wrapping industry. However there is a growing demand to push the shrink wrapper industry to new heights for speed and efficiency. Some manufacturers have found that shrink wrapping 30 or 60 products per minute (PPM) is no longer adequate. To compete with growing competition and/or meet customer needs for lower cost products, manufacturing processes must be faster and more efficient. This is where high speed HFFS shrink packaging machines come in.

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For the purposes of this paper, we'll consider high speed shrink wrapping to start at a minimum of 100 products per minute (PPM) (or, with a 10 inch bag, 1000 linear feet per minute) and increase from there. Why? At 100 PPM interesting things start to happen to the shrink film delivery systems, product flow, and product appearance. Film that was running smoothly below 100 PPM may have trouble running. Products that were flowing smoothly below 100 PPM may not run (or seal) as smoothly. Package appearance (after the shrink tunnel) above 100 PPM may not be satisfactory. Let's take a closer look at each of these pieces of the high speed HFFS shrink wrapper and shrink tunnel to see what is needed to successfully shrink wrap products at high speeds.

## The Shrink Film

Shrink film comes in many different thicknesses, sizes, shapes, and materials. For high speed shrink application, it is recommended that a flat film be utilized over folded film, for several reasons. Flat shrink film rolls can hold more than twice the amount of film per roll than folded film, making film roll change-over less frequent. Most high speed shrink wrappers can be purchased with an optional film splicing station, allowing the splicing of an almost empty roll of film to a new (pre-staged) roll of film on the fly, without stopping the wrapper. With flat film (as opposed to folded film) there is little or no scrap film produced, allowing for longer machine run times and less human intervention. While center folders (a device that will fold flat film in half) can be purchased to fold flat films, threading can sometimes be difficult and a side sealer will have to be used to close the film, producing scrap. And scrap means that actual film costs per part produced, human intervention, and down time all increase.

In general, thicker shrink films will take longer to seal than thinner shrink films. (No rocket science here.) To get a good seal three things are needed: time, temperature, and pressure (TTP). The thicker the film, the more TTP it will take to seal it. Pressure can be changed on some wrappers and temperature can always be increased (to a point), but in general sealing time will have to increase with thicker films, decreasing the PPM. Keeping films thin will not only decrease the seal time (increasing the PPM), but also will decrease the cost per package and increase the amount of film on a roll (less changeovers).

Wise choice of film is fundamental to the process, affecting every aspect of the system functionality. Selecting film should take into account not only the package style and look needed, but also the production requirements and equipment capability to accomplish the task effectively. For example, four wrappers intended to run at 150 products per minute to wrap product coming from the freezer at 600 per minute will not necessarily do the job with a thick barrier film. Final output of the equipment might be reduced to 100 PPM, or 400 PPM total, falling 200 PPM short of the goal. Again, a coordinated team effort from the beginning can identify problems at the design stage. Then, changes to the film can be made to more reasonably fit the requirements. Avoiding the problem up front means your whole system runs at full capacity and peak efficiency.

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**Shrink Film Control**

Controlling the shrink film in the wrapper is another key to successful high speed shrink wrapping. The film unwind, whether core or surface mounted and with or without dancer bars, must be able to control the tension on the roll of film through wrapper accelerations, decelerations, and at constant high speed running. For many applications surface mounted film roll without dancers provides the best control with the additional advantage of easy, fast roll change. Since the roll diameter can start at around 16 inches but decreases as film is consumed, the film unwind tension control system must dynamically change to keep the tension in reasonable range. This accurate control over the tension is needed to keep the film tracking well on the forming box (or forming plow). Without the proper film tension being maintained, film will not track well across the forming box opening, leading to many problems in efficiency, package integrity, and aesthetics.

When a wrapper is being utilized to run only one size product at high speeds, a fixed forming box size will work best and will require the least amount of set up time. It eliminates the fiddling. With no tools quick change options of today's wrapper technology this process is made painless. If multiple size products are to be run on the same machine, try first to find a forming box that might fit all product sizes (within reason). Otherwise, lean toward purchasing multiple sizes of fixed forming boxes. Review the forming box changeover process as this will add or detract from the system up time. Some manufacturers offer adjustable forming boxes. Some work great at high speeds, others do not. The best adjustable formers will be sturdy and provide a ridged foundation to run the film through for all sizes. In general, if doesn't look strong, it won't last long, and won't track film at all.

After the film passes over the forming box, it passes through a lap (longitudinal) sealer to seal the bottom edges of the film together, forming a tube of shrink film. In general, there are two main types of lap sealers, static and thermo. (Others examples would be a band sealer and/or a hot air sealer, both are not recommended for high speed shrink film applications.) A static seal uses high voltage pulses to form a static charge between the two overlapped edges of the film, effectively creating a strong bond between them. A thermo lap sealer uses a heated bar that the two edges of film ride over to seal the film. The film supplier can help determine which type of lap sealer will work best, but with higher speeds, a thermo lap sealer will probably be the best option.

Sealing the ends of the bags (or packages) is usually accomplished either by a transversal seal or rotary knife seal system. The transversal end seal is made with a set of sealing surfaces that come together and follow the film for a set time, allowing the seal to have some dwell time. However, high speeds are difficult or impossible to achieve using this style of end seal. The rotary knife end seal system uses sealing surfaces that are attached to a shaft (one above the film and one below the film). By rotating the shaft the seal heads come together to form a seal. The advantage is very high sealing speeds (up over 400 PPM on some wrappers and in some applications). The disadvantage is short dwell times (remember TTP?) and limited product heights (typically 4 inches and under).

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Look at these features closely on each wrapper being considered. They will be the foundation for producing products that have the same film bag length, height, and width. Therefore. making shrinking the film easier, more consistent, and more effective.

## The Product

Product positioning is vital to the process. Today's technology is comprised of multiple servo positioning sections, each with independent servo motors and drive systems with controls to coordinate to the wrapper system. These require that the product be oriented and organized into a lane or lanes to match the required wrapping configuration. An infeed system to control the stream of product often consists of a multi-belt placement system to provide precise control. Most of these controls have a level of buffering, allowing random product to product gaps to become equal gaps (spaced) products.

Other servo belt sections provide precise movement of the product. Limiting the amount of correction in each stage keeps the speed within the acceptable range to control the product. Smooth product handling by progressive step adjustments of the gap is necessary for the product to be in position for delivery to the film or flighted conveyor. The best of today's technology does the positioning with precise servo control. Be aware of systems that substitute servo control for other forms of product movement.

To run products successfully at high speeds, the wrapper must have full control of the product at all times. From the infeed, through the forming box, and on through the end seal area, products must not move out of position. Depending on the product, an over-head hold down conveyor might be required.

All transition points in the wrapper should be smooth. Little gaps between conveyors will cause problems at high speeds. Any bumping or slight movement of the moving product through the end seal area could mean trouble at high speeds. Remember, a product in motion, tends to stay in motion unless acted upon. This can be minimized with proper tooling for your particular product(s) to make sure the transfer is trouble free.

Wrappers should also have detection systems that verify product positions accurately through the wrapper. If a product is detected out of position, the wrapper should appropriately deal with that situation without causing other problems. Some upper level systems are equipped with a No Gap / No Seal option that will keep the wrapper running and skip sealing out-of-place products.

## The Tunnel

How do you get that aesthetically pleasing package? Getting the right bag around the product with the wrapper and adjusting the number of (and location of) pin perforation hole are the first few (and crucial) steps, but the real control over the package appearance depends on choosing the right shrink tunnel for the application. The more control options the tunnel has for directing air flow and adjusting air velocity, angle, and belt speed, the better the resulting appearance.

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There are many different styles of shrink tunnels on the market today. Some models are newer and some have not changed their designs in decades. Some use baffled chambers to restrict and/or redirect air flow to the top, sides, or bottom of the package and others do not. Most have different conveyor belt options (good for different film types), viewing window options, and different types of control system. So choosing the right tunnel can be difficult, but some thought to the particular application can help.

Shrink films have changed significantly over the years. Shrinking today's films is easier than ever, but it still can be difficult to make that perfect package. In general, with high speed shrink, a longer tunnel chamber will be needed. The length depends on the shrink film being used and the conveyor speeds needed. Checking with the film supplier and asking for information on the shrink properties of a particular film can be a great starting point. With high speed shrink films a five foot heated chamber should be a minimum starting point. For package rates from 150 to 300 PPM an eight or nine foot long heated chamber may be needed (depending on the shrink tunnel air flow).

Air flow in the shrink tunnel is critical to achieving a superior looking package, and even more so for high speed shrink applications. Shrink tunnels used for this purpose should have the ability to not only re-direct air flow to different areas on the package, but be able to control the volume of air flow as well. Some tunnels offer the ability to intentionally direct air nozzles onto the product which helps shrink those tough applications at higher speeds. Again, the more control over the air flow velocity, direction, and location, the more control over the shrink, the better looking packages will be.

**The Electronics**

Now that the physical parameters have been arranged to fit your application it is time to take control. Today's Open Ethernet network provides complete communication between machines in the system both up and downstream and to sister machines in a multi-machine installation. Each wrapper can "talk" to up-stream processes, know the amount of product coming, and adjusts speed to match the anticipated product arrival. Each wrapper can also "talk" to the sister wrappers and speed can be adjusted automatically if one of the other wrappers stops for any reason. The wrappers ramp up and speed is adjusted as needed to package accumulated product and keep up with the production requirements. Speed can sometimes be adjusted subordinate to temperature readings based on film parameter settings in the recipe so that as speed ramps up or down the seal integrity is maintained. (Remember TTP?) (Not available on all wrappers.)

For downstream (and other) communications the open Ethernet may provide signals necessary from a simple "the wrapper is ON or OFF" signal, up to a more sophisticated message sending system. Remote system monitoring connection can also be established to tie into a company's Intranet for access from any PC around the world. Sometimes, password protected, limited remote access logon is available for Internet troubleshooting from the OEM's (Original Equipment Manufacturer's) plant. In multi-machine installations integrated supervision allows any wrapper to be utilized as the monitor for the entire system.

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## In Conclusion

This is what you do . . .

- Set up a project team (equipment, film, and integration suppliers, and you)
- Then, involve the entire project team in the design effort from the beginning
- Determine the package appearance to be achieved
- Determine the controls needed on the equipment during the design stage
- Pick the right machinery
- Pick the right film for the total requirements
- Set up the necessary controls to meet the requirements
- Ensure product orientation and positioning
- Control the product through the packaging process
- Establish on-going process control procedures
- Measure the control process
- Reap the benefits

This is what you get . . .

- Problems are avoided
- Equipment/film fit the application
- Aesthetically pleasing package
- Substantially increase up time
- Substantially increase throughput
- Low scrap rate
- Materials cost savings
- Better integration
- Less labor intensive
- Real time communication and production monitoring
- Fast return on investment

## About the Author

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Robert A. Bisbee is an officer of the George Gordon Associates, Inc. holding the position of Vice President of Operations, and is on the board of directors. He has over 12 years in the packaging business and has been involved in every aspect of packaging operations, including field service, engineering, manufacturing, and trouble shooting. He has held positions as Electrical Project Engineer and Electrical Engineering Manager for a major shrink film packaging company. Mr. Bisbee has a Bachelor of Science in Industrial Technology, with the Electrical Engineering option, from Keene State College, Keene, NH. He also has a Minor in Management, Concentration in Computer Science and has many credits toward his Masters of Computer Science from Rivier College, Nashua, NH. Comments: robb@ggapack.com