Packaging Machinery Handbook

The complete guide to automated packaging machinery, including packaging line design

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CHAPTER 6

LABELING

Labeling is defined as affixing printed or graphic material onto the package or product. It does not include direct printing or decorating on the package—that will be covered in Chapter 7 "Coding and Inline Printing."

The primary purpose of most labels is to inform, that is identify, warn, sell or some other reason. But labels serve other purposes as well. They can provide tamper evidency, group multiple products and close packages. Labels may also take the form of multi-page coupon or instruction books. Labeling technology may also be used to apply non-label components, such as hang tags and anti-shoplifting tags.

This chapter will examine the different types of labels in common use and technologies used to apply them to containers and packages.

LABEL TYPES

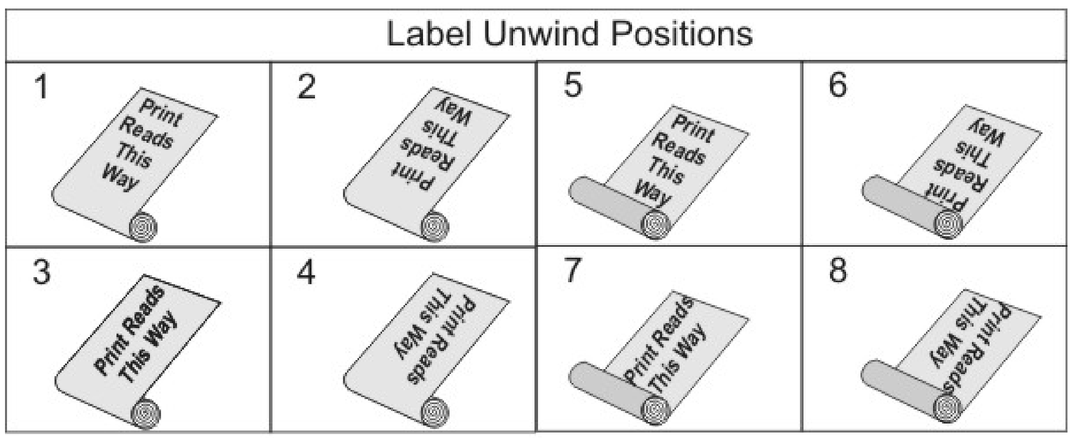
In discussing labels, "front" will refer to the outside, non-glued face. "Back" will refer to the container or glue side of the label. Label "length" will be the dimension of the label in the direction of application. In the case of roll-fed labels, it will be the length along the roll. Label "width" will be the dimension of the label perpendicular to the direction of application.

Labels fall into two major categories: flat and sleeve.

Flat labels are individual pieces of film, foil, plastic, paper or composite materials affixed to the product with an adhesive. Sleeve labels are films formed into a continuous tube and supplied on rolls. Sleeves are cut to length and applied over the package. They are normally held in place by friction and container design but adhesive is sometimes used to help hold it in position. The most common class of sleeve labels use a heat shrinkable film. Once applied, they are shrunk to conform tightly to the package shape.

Flat labels can be supplied as a continuous web (roll-fed) or as individual cut labels (typically referred to as cut-and-stack labels). Flat labels can have square ends (butt cut) or can be die cut into almost any shape.

Roll-fed labels can be oriented in any of eight positions, called "unwind position," and numbered 1 through 8. Although there are eight positions, 5 through 8 are seldom used in packaging. Some unwind charts will show only four positions. This is an industry standard and specifying an unwind position number should be sufficient. Since "should be" is not always the same as "is," one precaution when dealing with label converters, as well as with labeling machine builders, is to always send an unwind chart with the desired position circled.



Label unwind positions

By the author, used courtesy of the Institute of Packaging Professionals

Flat labels are available with a variety of adhesives. The adhesive used will depend on the label material, the substrate or package it's applied to and the label's intended purpose. A label for a frozen food carton will require a different adhesive than a label for a glass bottle at room temperature. This book will not discuss adhesives in depth other than as they relate to the labeling system. Technically "glue" and "adhesive" have different meanings though similar functions. In modern usage the terms are generally interchangeable and this chapter will use both words to mean the same thing.

One method of classifying label applicating systems, other than sleeve labels, is by the type of adhesive they use. The four major classifications are: pressure sensitive; heat activated; cold/wet adhesive; and hot-melt adhesive.

PRESSURE-SENSITIVE LABELING

Pressure-sensitive (P-S) labels are labels with pre-applied adhesive that requires no activation (unlike heat-activated labels which come with pre-applied adhesive which requires heat to activate).

The labels are supplied in roll form on a backing web, called a liner. The coated paper or plastic film liner allows the label adhesive to bind with a relatively high shear but relatively low tack strength. This prevents the label from sliding out of position on the web yet allows it to be easily removed at time of application. The web material is important since it is pulled through the labeler, dispensing the label as it goes. If it does not have sufficiently high tensile strength to withstand the continuous jerking as the label is dispensed, frequent breakages will occur resulting in lost production.

Paper-based webs are also susceptible to nicking. A small nick in the edge of the web will generally cause the web to break. Paper web material is usually satisfactory for most applications, especially at lower speeds with smaller label sizes Plastic backing webs are stronger and much less susceptible to tearing and should be used for higher speeds, narrow labels, complex die cuts or other applications where web breakage might occur.

Labels are generally supplied on rolls although a few applications will use fan-folded labels. Fan-folded labels are folded into layers and supplied in boxes rather than on rolls. Fan folding allows continuous labels to be printed on some types of computer printers. They also allow for non-stop operation as the tail end of the current box of labels can be pulled out and spliced to the leading edge of the next box.

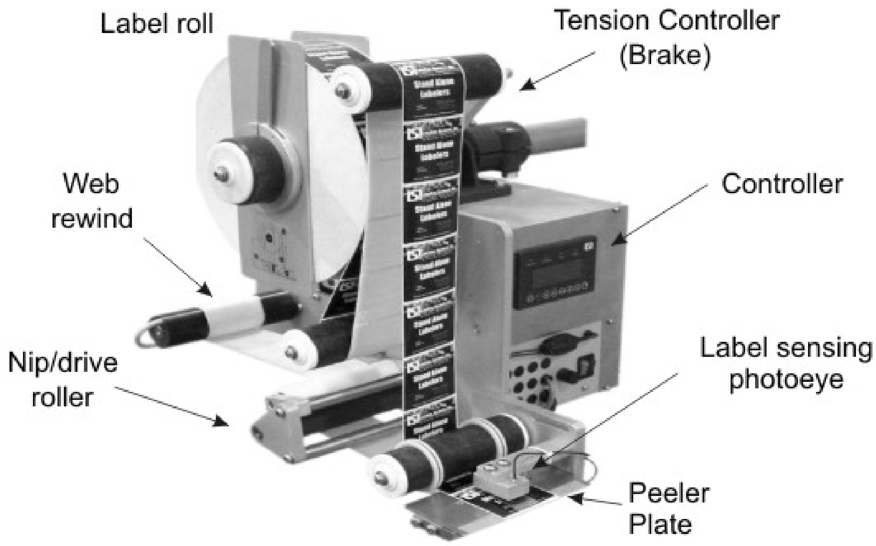
The industry standard for roll labels is normally specifies that the roll will be 12-inch outside diameter with a 3-inch core. For higher speed operations, or where the label is particularly long or thick, larger diameter rolls can maximize the time between roll changes. Sixteen- and 24-inch rolls may be used but bring their own issues: They will be heavier and more difficult to handle. Narrower labels will also be more susceptible to telescoping as the roll diameter increases. Care in handling, combined with specialized handling systems, can minimize these problems. Occasionally other core sizes may be used.

Most pressure-sensitive labels are die cut. They are printed on a continuous film, adhered to the backing web and a die-cutting machine cuts the label shape. The waste material is then removed, leaving the label isolated on the web. The industry standard for the gap between labels is 1/8-inch with the backing web extending 1/16-inch to either side. In some cases wider or narrower gaps may be specified.

Labels are normally in a single row on the web. In some cases, multiple labels may be cut on a single web. An example is a label that must be applied to two thermoformed packages made in a single cycle of the thermoforming machine. By placing two labels side by side on the web, appropriately spaced for the packages, the need for two labelers is avoided.

Occasionally, pressure-sensitive labels will be butt-cut. Instead of using the die to cut away waste material, the die simply cuts in between each label. The label extends all the way to the edge of the web. Most pressure-sensitive labeling applications require a gap between labels for sensing. If butt cut labels are used, a registration mark will be required.

The term “labeling head” refers to the system that dispenses the label. The labeling head is combined with an applicator system and a container handling system to form a complete labeling system.



Pressure-sensitive labeling head
Courtesy: Labeling Systems Inc.

The P-S labeling head consists of five major elements: (1) label unwind system; (2) peeler plate; (3) nip roll; (4) web rewind; and (5) controls.

1. *Label unwind system:* The unwind system consists of the hub or support on which the label roll is placed, as well as the tension-control system. Proper tension control of the unwind is critical to proper label application. If too much or too little tension is applied, the label will not stop in the proper dispensing position. Improperly applied labels or web breakage can also result.

Commonly, the roll will be mounted on a free-wheeling hub and the web simply pulled from the roll. A simple friction brake is used to maintain a constant tension on the roll. The web is led off the roll and around a series of rollers, one of which is on a spring-loaded arm. This arm, at rest, engages the unwind hub with a friction belt or pad to prevent it turning. As the web is pulled, it pulls the arm down, releasing the brake. The balance between the spring tension on the arm and the web pull tension is balanced by the braking friction. This maintains a constant tension on the web.

This system works well at lower speeds and for normal-size label rolls. At higher speeds or with rolls that are heavier (due to larger roll diameter or wider labels) it may be overloaded. In these cases, a powered unwind may be required.

Tension control for powered unwind systems may be of two types: dancer rolls or an air box.

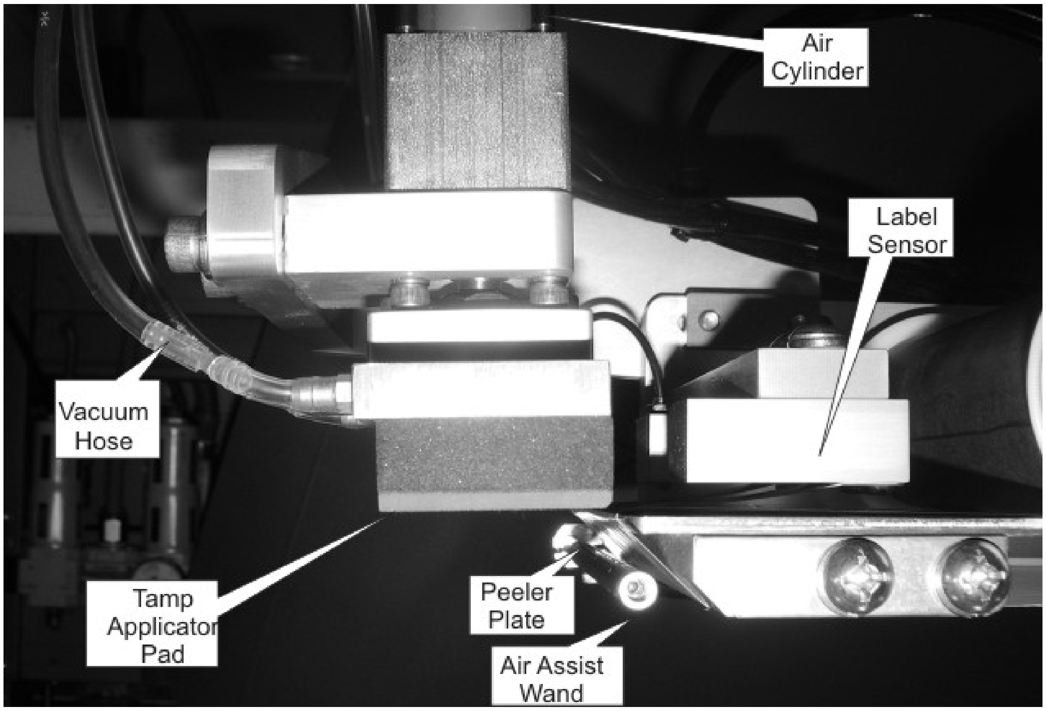
In the dancer roll type, the hub for the label roll is driven by a motor. The label web comes off the roll through several dancer rolls. As labels are dispensed, the web pulls the dancer rolls together, causing a switch to run the unwind motor until the rolls move apart again, stopping the motor.

An alternative to the dancer rolls is an air box. This is an enclosed box into which a loop of the web is fed. As the motor unwinds the web, the loop extends to the bottom of the box where a photoeye or proximity sensor detects it, stopping the unwind motor. As labels are dispensed and the web is pulled through the labeler, the loop moves towards the other end of the box where it is sensed by a second sensor that starts the unwind motor. A small fan may be incorporated into the box to help force the loop to the end.

Some designs, instead of powering the hub, have a motorized nip roll to pull the web from the roll. Tension is controlled by devices similar to above.

Many designs mount the unwind system and roll on the labeler head. Some systems—often where roll sizes are larger or labeler speeds are higher—mount the unwind in a separate unit outside the machine for more convenient access. These systems may have dual rolls and either manual or automated splicing capabilities. See Chapter 3 “Flexible Packaging” for more information on splicing tables and machines.

2. *Peeler plate:* From the unwind system, the label web is led via guide rollers to the peeler plate. Often, in this area, space is provided for code imprinters, barcode readers and/or vision inspection systems (these systems are covered in separate chapters). The peeler plate is a metal plate with a relatively sharp edge, though not sharp enough to damage the web. As the label web passes over the peeler plate, it reverses direction in a 180 degree bend.



Peeler plate detail with tamp applicator

By the author, used courtesy of the Institute of Packaging Professionals

As the web bends around the peeler plate, the label will have a tendency to continue forward, releasing from the liner. As the web is pulled around the peeler plate, an air jet is usually provided to blow against the underside of the label, helping separate it from the liner.

In some systems, such as those applying RFID labels, there will be an inspection system to verify that the label is good (properly encoded) before it is dispensed. One mechanism for rejecting bad labels is a guide at the end of the peeler plate. When a bad label is detected, this guide is activated and forces the label around the end of the peeler plate. It remains on the liner and is rolled up on the takeup roll.

3. *Nip Roll:* From the peeler plate, the now label-less web goes to the nip roll. This is a powered roller that pulls the web through the labeler. A backing roller normally forces the web against the nip roller to prevent slippage. The nip roller operates intermittently, running only as necessary to dispense the label.

More modern or higher speed labelers will use a servo motor to power the nip roll. The motor is turned on and off by the control system to position the label. Servo motors provide the advantage of precise starting and stopping, as well as being able to control speed precisely. This might be important, especially in cases where label dispense speed needs to exactly match the speed of the product. Shaft encoders may be used to communicate the speed of the product to the labeler PLC. The PLC then sends the appropriate speed matching signal to the servo motor.

Other, generally older, labelers use a motor with an electrical clutch-and-brake mechanism to drive the nip roll. The motor often runs continuously but, unless the clutch is engaged, it is not connected to the nip roll. A mechanical brake prevents unintended movement of the nip roll. The clutch and brake are normally linked so that when one is engaged, the other is disengaged. On a signal from the labeler controller, the clutch engages and the brake disengages pulling the web forward via the nip roll. When label dispensing is complete, the clutch disengages and the brake engages, stopping the web in position.

Clutch/brake systems are reliable, especially at lower speeds. At higher speeds, they may not be as precise as required due to lag time in actuation. They are also mechanical devices and will wear. Regular maintenance, adjustment and replacement of the clutch and brake pads are needed for proper operation.

If the labeler is located in a hazardous location, pneumatic motors and controls can be substituted for electronic. Other than the fact that they work with compressed air, the concept of operation will be the same.

4. *Web rewind:* The empty web must be collected. In most cases, this means winding it onto a rewind spindle that is normally located near the nip roll. The spindle either has its own drive motor or is driven by the same motor that drives the nip roll. The speed required to take up the web will vary as web accumulates on the spindle. Due to increasing diameter, each successive revolution of the spindle will take up a greater linear length of web. This can be dealt with by using a slip clutch between the drive motor and the spindle. This may be a spring-loaded clutch or it may be a round belt drive designed to slip.

Occasionally, instead of a rewind spindle, the label liner will discharge into a vacuum system where it can be discarded. This saves the time and effort of removing the used web from the spindle and minimizes downtime. To minimize bulk, the loose liner may be run through a shredded. However, since the web can normally be removed from the spindle with the labeler in operation and since the removed liner is in a compact roll, this is not normally an issue.

The amount of rewind diameter capacity required will be less than the diameter of the full roll, sometimes much less, since the web by itself is thinner than the label/web combination.

5. *Controls:* Tying all of the above subsystems together is the control system. Modern labelers will usually use a PLC to control machine functions. This will have inputs from sensors to determine the position of the label, and detect the product, web breakage and other conditions. It will have outputs to activate the applicator, the air assist, imprinter and the nip roller. The PLC also includes timers to adjust the time at which each activity takes place in relation to the others.

In a simple label dispensing head, the sequence of operations will be as follows:

Photoeye or other sensor detects the presence of the product to be labeled.

This photoeye sends a signal to the PLC which then activates the application delay timer. This timer provides a delay between when the photoeye senses the product and when the label is dispensed. This allows the position of the label on the product to be fine tuned without having to physically move the photoeye.

Once this timer has timed out, the nip roll is activated, dispensing the label.

At about the same time, the solenoid controlling the air assist wand is opened. The air assist is a jet of air blown against the underside of the label to separate it from the liner. This may have its own timer to allow precise control of when and how long it is open.

The label-sensing photoeye located at or near the peeler plate detects the gap between labels. Once it detects the gap, it sends a signal to the label stop-position timer.

The nip roll continues to run until the timer times out then stops. Lengthening the label-stop time will cause the label to stop further past the peeler plate edge. Shortening the time will pull it back.

This timer should be adjusted so that, when the web stops, the edge of the succeeding label is about 1/16-inch from the edge of the peeler plate. The edge of the peeler plate should be centered in the interlabel gap. For butt-cut labels that don't have a gap, the labels should be set to stop with the cut even with the edge of the peeler plate.

If the stop position is too far back, the trailing edge of the label will not be fully dispensed. This can result in the label being pulled from the web by the product. If this happens, it can pull the following label out of position, discontrol the web tension or even break the liner. Or, the portion of label remaining on the liner may be sufficient to pull the label from its ideal position on the product. If the label stop position is too far forward, the adhesive of the next label will be exposed. This can cause it to stick to the product before it is supposed to or can cause the adhesive to dry out.

When the cycle is complete and the labeler is at rest, the PLC will activate the coder, if one is installed.

The above description is fairly typical, though different manufacturers may use slightly different concepts in their designs. It is important to understand precisely the sequence of operation of a particular labeler prior to operating it. If the sequence is not understood, it is unlikely that the timers will be adjusted correctly.

Additionally, the above description does not address the sequence of operation of the applicator. This, too, is controlled by the PLC and must be correctly synchronized with the rest of the labeler.

One of the key components in a P-S labeling head is the label-sensing photoeye. If this does not function correctly, the label will not stop in the correct position. This will cause at least misplaced labels. More likely, it will also cause label jams and web breakage, which will require stopping the machine to clear the fault.

The common configuration is to have the web pass between a photoeye and a light source. Precise guidance of the web is important at this point because an inconsistent label position can lead to inconsistency in sensing and inconsistency in label-stop position. There should normally be a brush or light spring plate holding the web firmly in position between photoeye and lamp. If the position of the web, relative to the position of the photoeye and lamp, varies, it can vary the stop position of the web.

The light shines through the web in the interlabel gap and is detected by the photoeye. As the label moves between the light and the photoeye, it blocks the light, deactivating the eye. Different web and label materials will have different levels of opacity, making it necessary to provide adjustability. This can be provided by a constant intensity light source with an adjustable sensitivity sensor or may be provided by an adjustable intensity source and a fixed sensitivity sensor.

To set the photoeye, the web is positioned so that the interlabel gap is between the light and photoeye. Sensitivity or light intensity is adjusted until the light is just detected through the web. The web is moved so that the leading edge of the label blocks the eye. Sensitivity/intensity is adjusted until the light is just detected through the label and web. The correct setting for the photoeye or light intensity will be halfway between these two levels.

Some newer photoeyes are self-calibrating, which simplifies the setup and improves reliability. They should be used where feasible.

In rare cases, graphics on the label may interfere with this setting. When this happens, it may be necessary to reposition the photoeye to avoid the graphics, use a different sensor or even redesign the graphics,.

In most cases, once the photoeye calibration has been done, it will not change unless the label changes. Occasionally, especially if changing to an “identical” roll from a different supplier, there will be subtle changes that can affect the photoeye calibration. It is always a good practice when changing label rolls to observe the first 10 to 20 labels to be sure all is well with the settings.

When labels are printed on transparent film, the normal photoeye system will not work because it can’t distinguish between the label and the gap. Several solutions exist:

A registration mark, sometimes called an “eyemark” can be added to the label. This is a small square or rectangle in an opaque color located in an inconspicuous area of the label. The label sensing eye is set up to detect this mark rather than the label edge. In some cases, a graphic feature of the label, such as a logo, may serve as a registration mark. If using a label graphic, it must have a straight edge oriented across the label. A round or curved graphic can be detected but even small lateral movements of the web will affect the label stop position. If space or art does not permit the registration mark on the label, it may be printed on the web in the interlabel gap. This is usually a last resort as it involves an additional printing process.

If a registration mark is not feasible, a capacitance sensor may be used. This uses the principle of capacitance to sense the difference between web alone and the web plus label. Calibration of the capacitance sensor is generally similar to calibration of a photoeye system.

Older labelers may still be found that use a mechanical sensor. One design uses a triangular “wheel” that rides on the surface of the label/web. As it passes over the interlabel gap, the edge of the triangle catches on the leading edge of the subsequent label. This causes the triangle to rotate, lifting an arm and triggering a switch or sensor. While these systems work well if properly adjusted, they can be touchy to set up and keep in adjustment. If the label has an embossed graphic or raised print, this can sometimes activate the triangle, resulting in misfed labels. Mechanical sensors should be replaced with more modern, electronic sensors whenever possible.

APPLICATION

Dispensing the label from the head is only the beginning and perhaps the easiest part of the process. Once dispensed, it needs to be applied to the product. Proper application depends on both the label and product being precisely where they are supposed to be. If either one is out of position, a wrinkled, misplaced, loose or otherwise defectively labeled product will result.

As with any mechanical system, labeling machines will have a placement tolerance. The industry standard tolerance is generally +/-1/32-inch, although some machines will have higher or lower levels of precision. These tolerances refer to the vertical and horizontal placement.

Another important factor is skew. Skew refers to the difference in height between the leading and training edges of the label. This is almost always caused by the container and label not being square with each other. With round bottles, especially if the ends of the label meet (meaning a full 360-degree wrap), it can be especially noticeable.

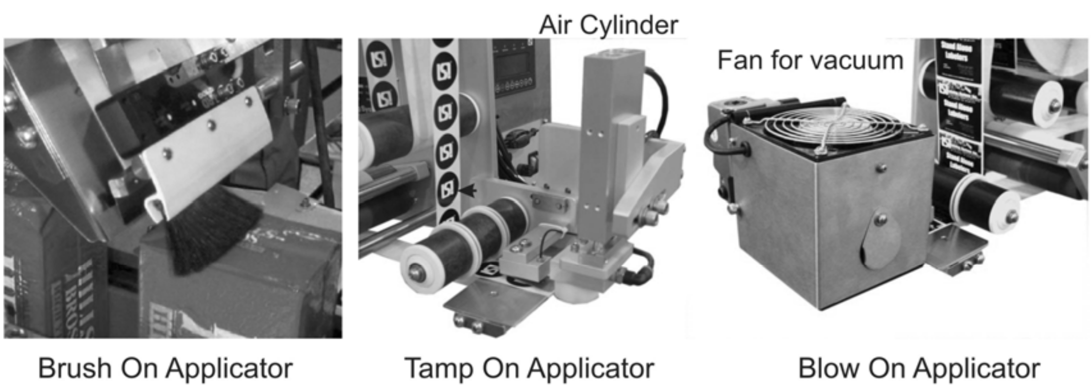
Label placement can be a a source of disagreement between the setup mechanic and the quality inspector if there is not a good specification on the desired label position and how it is to be measured. There are at least three factors that can come into play individually or in combination. These are label dispensing, presentation of the container and variation of the container. These will be discussed later in the chapter. Suffice to say for now that, prior to specifying label tolerances, they must be understood.

Now, this chapter will discuss different label application systems by adhesive type mentioned earlier—pressure sensitive; thermal activated; cold/wet adhesive; and hot-melt adhesive—as well as sleeve and stretch labeling. Then we'll talk about product handling for all labeling technologies.

Pressure sensitive

The simplest way to apply a P-S label is to dispense it directly onto the container as it passes on the conveyor. This will only work satisfactorily only if the speed at which the label is dispensed exactly matches the speed of the container. A container moving faster than the label will pull the label out of the labeler. This can result in web breakage, mis-positioning of the next label or movement of the container. All these result in misapplication of the label. If a container is moving more slowly than the label, the label will attempt to push the container, causing the label to wrinkle.

One way to synchronize the speeds is via a shaft encoder on the conveyor or, where used, the wrap station. The encoder is connected to the labeler drive through the PLC. It will vary the label dispensing speed as necessary to match it with the product and/or conveyor speed.



Pressure-sensitive label applicators

Courtesy: Labeling Systems Inc.

One way to avoid synchronization issues is to decouple label dispensing and application. This is done by pre-dispensing the label onto an applicator. Several styles of applicator do this: blow-on; tamp; vacuum plate roll-on; corner wrap; side panel and wrap; and front-and-back panel.

Blow-on: With a blow-on applicator the label is dispensed adhesive side out onto a grid. Vacuum, usually created by a small fan behind the grid, holds the label in position. Compressed air jets are located behind the grid in a pattern corresponding to the label size and shape. When the container is in position the air jets are activated momentarily to blow the label onto the product.

Blow-on applicators are best used to apply labels to flat or nearly flat surfaces. They can be used with good results on either stationary or moving products. When used on moving products, especially at higher linear speeds, they may lose some precision if the gap between the grid and the product varies, even slightly. The greater the gap, the more linear distance the product will move between the time the air jets blow it and the time it reaches the product. If used in a horizontal application, the label will also fall vertically while being blown across the gap. The problem here is not the gap per se. If the gap is consistent, it can be adjusted for. The problem is that variability in the gap distance will result in variability of label position.

Blow-on applicators are generally not recommended for use where they must blow the label vertically up. They work best in horizontal or vertical down applications. Blow-on applicators do not physically touch the product. This makes them particularly useful with delicate or fragile products.

Blow-on applicators may not always provide good laydown of the label. A brush or roller may be required to force the label into full contact with the product.

Tamp: The tamp applicator is similar in some ways to the blow-on applicator. A rubber pad—in the same size and shape of the label—is located at the peeler plate and mounted on an air cylinder. The label is dispensed, adhesive side out, and held in position by vacuum holes in the pad. When the product sensor signals that the product is in position, the cylinder extends and presses the label onto the product. When the cylinder retracts, the label adheres to the product and the vacuum is broken. There is normally no need to interrupt the vacuum but it can be done when circumstances warrant. One caution is that if the vacuum supply tube to the pad is too short, it may be pinched or kinked as the air cylinder extends. When this happens, the label may slip out of position on the pad, resulting in a mislabeled product.

Tamp applicators must have a flat pad to allow proper dispensing of the label. This makes them best suited for flat products. In some cases, a deep, soft foam or a special articulated pad may be used to allow labeling on round, wraps or other non-flat surfaces.

Tamp applicators are best suited to stationary products. One application is semi-automatic labeling. The labeler is mounted on a support that can be placed on a workbench and has a fixture for the product. An operator places the product into a fixture and activates the labeler. Tamp applicators can also be used to label moving products. They will work well as long as high placement precision is not required and linear speeds are relatively slow and consistent.

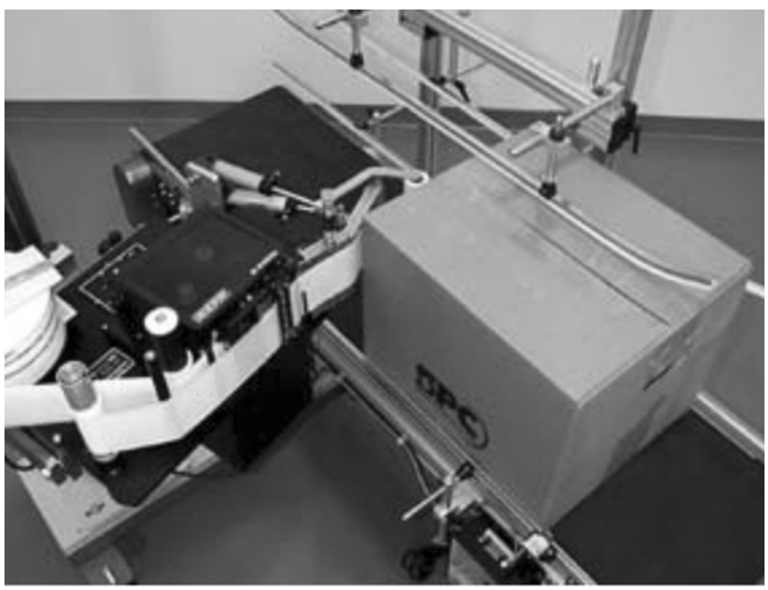
Tamp applicators can be designed to label random size cases by incorporating a photoeye or other sensor in the pad. The air cylinder extends the pad until it makes contact with the container, such as a shipping case. The photoeye senses this contact and immediately retracts the air cylinder, even though it has not reached the mechanical end of its stroke.

Tamp applicators are especially useful when there is a need to place a label into a recess as they can get into places other applicators can't. The applicator can also be mounted to movable arm or even a robot. This allows the label to be applied at a distance from dispensing. Tamp applicators have slower operating speeds than comparable blow-on systems since they need time for the pad to retract prior to being ready to receive the next label.

Vacuum plate roll-on: The vacuum grid roll-on applicator may be either passive or active. In both, the label is dispensed onto a metal plate and held in place with vacuum. The outer end of the plate has a roller or brush which supports the tip of the label. If passive, the plate is angled so that the roller forces the label end into contact with the product as it passes. The product continues pulling the label from the vacuum plate with the roller smoothing it down. The applicator is often spring mounted to allow it to adjust for variations in product position. This works particularly well with round products such as bottles or pails but may not work so well with square or rectangular products.

The active version of this applicator is similar except that it has an air cylinder instead of a spring to push it against the product. In the normal position, the cylinder is retracted holding the plate away from the product. The label is dispensed onto the plate and staged. The product sensor detects the product as it moves into position for labeling. This activates a solenoid causing the air cylinder to push the vacuum plate forward, and the roller forces the tip of the label into contact with the product. Unlike the passive system, which will always apply the label to the leading edge of the container, the active system allows the label to be placed in a specific position. The linear position may be adjusted by physically moving the product-sensing photoeye and/or by a time delay between detection and activation of the air cylinder.

Corner wrap: A popular labeling application is corner-wrap labels on corrugated cases. Corner-wrap labeling extends the label around the corner of the case so the label can be seen and read from two sides. The label is typically applied symmetrically with half on each panel of the case, but asymmetrical application is possible as well. The advantage of a single label is that it eliminates the potential mix ups that can occur whenever two labels are applied to the same product. Corner-wrap applicators will be different depending upon whether the leading or trailing corner is to be labeled.



Corner-wrap labeler with printer

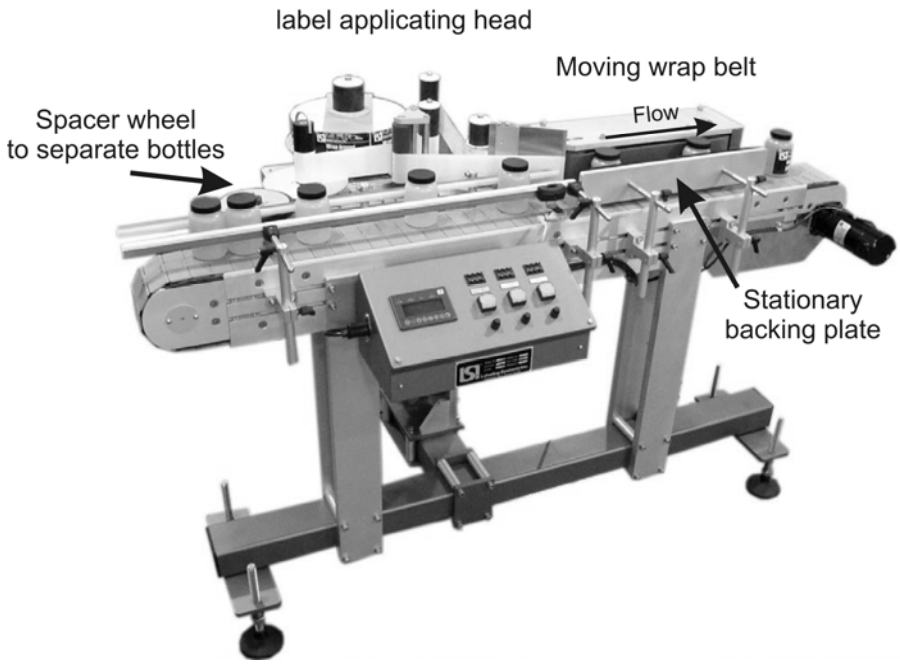
Courtesy: Labeling Systems Inc.

Labeling the leading corner is the simpler of the two. In one design, the label is dispensed onto a cushioned vacuum pad. This pad, along with an independently mounted roller, is swung into the path of the case at a 90 degree angle, parallel to the leading edge of the case. As the case makes contact with the vacuum plate, the label adheres to the leading edge of the case. The plate swings back, via an air cylinder, to receive the next label. The motion of the case forces the roller across the front of the case smoothing the label down. The roller continues around the corner of the case and smoothes the label down the side panel.

If the label is to be applied to the trailing edge of the case, the process is slightly different. The label is first applied to the side of the case with a portion of it extending past the trailing edge. This can be done with a blow-on, tamp-on or vacuum roller applicator. After the label is adhered, a roller on an air cylinder is activated to adhere the label to the rear panel of the case. This can be done with the case in motion—but timing of the rear panel wipe-down can be tricky. Some systems avoid this problem by stopping the case in a fixed position to apply the label.

An objection to the corner-wrap labeling is that the case corner will sometimes not be square. If the corner is damaged, the label may not lie down smoothly or may skew. Some applications use two separate labels applied by the same labeler rather than a wrap. One way to do this is to dispense the label onto a vacuum pad on the end of an arm. In the home position, the pad is parallel to case flow. As the case comes into the labeling station, the arm swings out, perpendicular to the case, and applies the label to the leading panel. The arm retracts and the side label is dispensed. By this time, the side of the case is in front of the arm and it swings out, partially, to apply the label. A similar system can be used in reverse to label the side and trailing panels of the case.

Side panel and wrap (inline): Many bottles require labels on one or more panels. When the bottles are round, the typical method is to apply the tag end of the label to the tangent of the bottle. This tagging typically is at either the three or nine o'clock position (with 12 o'clock the center of the leading edge). The bottle and label then enter a wrap station. The wrap station consists of a powered wrap belt, mounted vertically but running in the same direction as the conveyor and on the same side of the conveyor as the labeling head. In most instances, the belt and/or the backing plate are cushioned to allow them to absorb minor variations in the bottle. Once the label has been tagged on the bottle, it is captured between the belt and backing plate. The movement of the belt causes the bottle to rotate, pressing the label down.



Round bottle wrap labeler
Courtesy: Labeling Systems Inc.

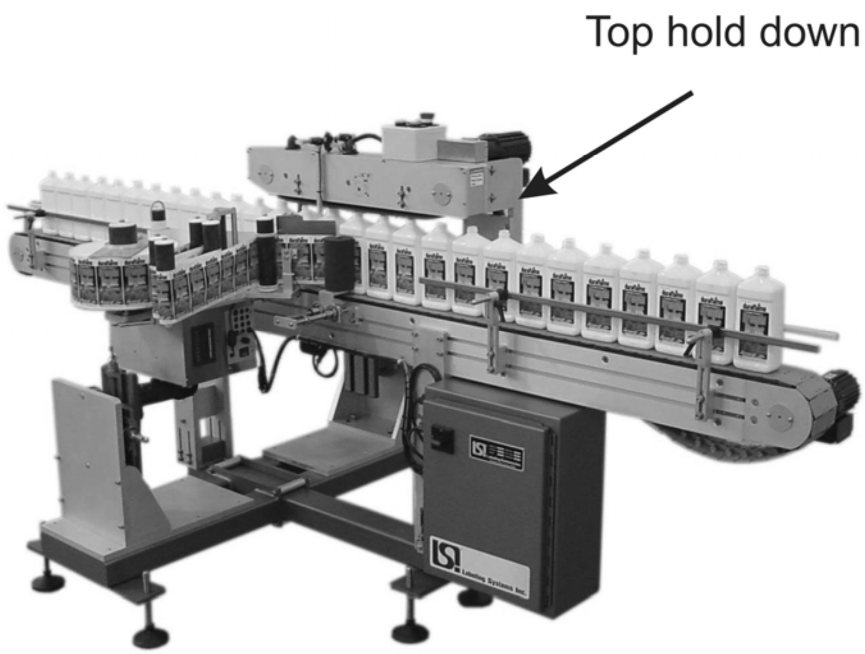
One issue with this application can be that the trailing end of the label may droop. If this happens, the label will wrinkle and skew. This is more likely to be a problem when the label is long, thin and/or narrow.

There are a couple of ways to address this:

One is to set the labeling head so that the peeler plate is right at the infeed to the wrap station. The speed of the wrap station and the label dispensing are synchronized so that the label dispenses smoothly onto the bottle. The label is supported at all times by the peeler plate, the bottle or both.

Another option is to use a vacuum-plate roll-on applicator. This puts the label out into the bottle path and catches the bottle at the 12 o'clock position on the leading edge. As the bottle passes, the roller wipes the label down along approximately 90 degrees of the bottle radius. As the bottle goes into the wrap station, the trailing end of the label may also, depending on length, continue to be supported by the vacuum plate.

Most bottles will be too light on their own for this to technique work. As the roller tags the label on, it will push the bottle out of position. This may be avoided by the use of a top hold-down belt. This is a conveyor belt mounted above and running at the same speed as the labeler conveyor. As the bottle enters, it is captured between the two belts and held firmly in position, top and bottom, through the labeling process. The bottle is released at the entrance to the wrap station.



Front-panel labeler with top hold down
Courtesy: Labeling Systems Inc.

If a bottle is tall relative to its diameter, lightweight or otherwise unstable, it may be difficult to keep it perfectly upright in the wrap station. If it tilts forward or back, even a little bit, the label will skew as it wraps around. This will result in the ends of the label not matching. It may cause wrinkling of the label as well.

One technique to manage this is to replace the wrap belt with trunions mounted on chains. This is a series of vertical rollers, mounted on chains and mounted similarly to the wrap belt. The bottle is captured in the “V” or pocket formed between each pair of rollers. This keeps the bottles perfectly upright. The rollers rotate and, at the same time, move forward. A backing plate forces the bottle into the rollers.

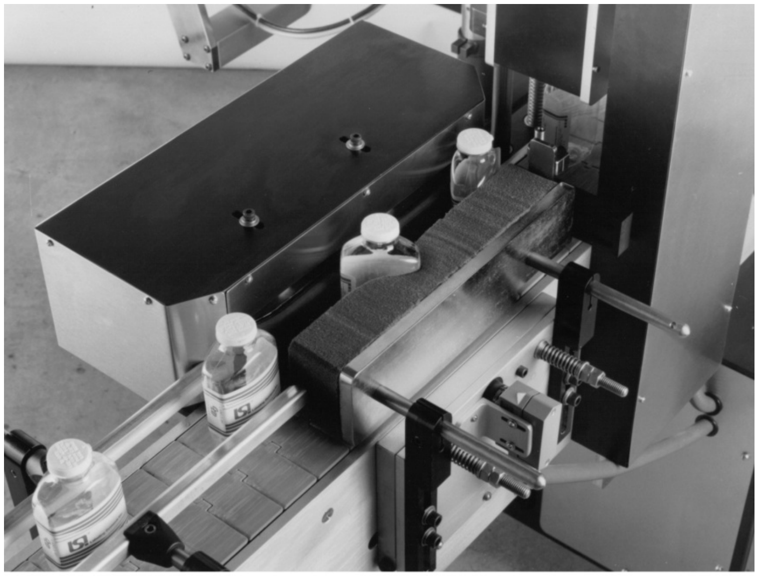
If labeling long, thin products that will not normally stand up on a conveyor, another alternative is a horizontal trunnion system. The trunnions are mounted horizontally and perpendicular to flow. The product is placed on the conveyor in the trunnion V, passes under the labeling head and then under a backing plate that spins the product. An alternate architecture is to use a powered belt on top to spin the bottles instead of a passive backing plate.

Some lower speed labelers will use a three-roller intermittent-motion system. Bottles are positioned in the V formed by a pair of vertical rollers. A third roller is then forced in against the bottle causing it to rotate. As it rotates, the label is applied and pressed down by the rollers. Once it has made a complete rotation, the roller retracts, releasing the bottle.

One application for this architecture is for round bottles where the label must be placed in a specific radial position. For example, the bottle may have silkscreened graphics on one side with the label needing to be placed directly in back of it. A registration mark printed or molded on the bottle is sensed as the bottle rotates. When it is sensed, the label is dispensed. Adjusting the sensor relative to the registration mark allows precise positioning of the label. If possible, it is generally preferable to place the registration mark in the front graphic rather than the bottle itself. This assures that the label is always in the correct position relative to the front graphic even the graphic is a bit out of position.

Still another variation on this is to incorporate the trunnions into either a horizontal or vertical starwheel. This is a standard, two-layer starwheel with two trunnions at the back of each pocket. As the starwheel rotates the bottle past the labeler, the label is applied. If the starwheel is intermittent motion, a powered wheel rotates the bottle and presses the label down as it is dispensed. If the starwheel is continuous motion, the label is flagged on and the bottle is carried past a powered belt that presses the label down.

There may be a need to apply a single label to two, three or even four panels of a square or rectangular product. There are several ways to manage this with an inline labeler. The simplest uses the same design as the round bottle labeler. The bottle is conveyed to the labeler with appropriate spacing and captured with a top hold-down belt. It passes the labeling head and the first portion of the label is applied to one panel (as it were a single side-panel label). It then goes into the wrap station. Instead of the relatively thin, relatively hard cushioning used on the round bottle wrap belt and backing plate, a softer, deeper foam is used. As the square bottle passes through, it rotates—with the foam absorbing the bottle corners. This can also work on rectangular and oval bottles provided that they are not too asymmetrical.



Wrap labeler with non-round bottle
Courtesy: Labeling Systems Inc.

Still another method uses a mechanism to wipe the labels onto the side panels. The bottle enters the labeler and is captured under the top hold-down belt. As it passes the labeler head, the label is applied to the side panel of the bottle.

If a three-panel application, the label is applied with a portion extended to both the front and rear of the bottle. The bottle and label continue to be held in position by the top hold-down belt and move to a wipe-down station that is a series of arms with wiping brushes on them. These arms move in a synchronized orbital pattern on mechanical cams so that they move in, wiping both the front and back side of the label down. As they are moving in, they are also moving forward to track the bottle's linear motion. They then move out and away from the bottle and move back upstream to capture the next bottle. Due to the reciprocating motion, these wipers are only actually wiping a portion of the cycle. To achieve the speed of the labeler, these systems will often contain two or more wiping stations.

An alternate method is to wrap the label around the bottle as if it were round. The wrap belt and backing plate are covered deeply with a soft foam material to accommodate the square bottle as it rotates through.

In cases where a full wrap is required, the bottle is labeled as above but the ends of the label extend past the corners of the bottle after wipe down. These ends are wiped down using a mechanism on the other side of the labeler.

Front-and-back panel: Square or rectangular bottles will normally be labeled on one or more of the flat panels or faces of the bottle. The key to successful labeling here is that the bottles be absolutely square with the direction of flow. If the bottle is twisted slightly on its axis, the label will be applied out of position linearly.

The bottle has to be straightened as it enters the labeler and then has to be maintained in the correct axial orientation through the labeling process. Straightening can be done with aligning chains, timing screw or tightly adjusted guide rails. Maintaining the axial orientation is normally done by confining the bottle between a top hold down belt and the conveyor.

As the bottle is conveyed to the labeler, a photoeye senses it and dispenses a label onto the bottle as it passes. A brush, roller or squeegee presses the label onto the bottle as it is dispensed. As mentioned before, it is critical to proper label application that the label dispense speed match the bottle's linear speed.

Multiple labeling heads can be used on opposite sides of the machine to provide simultaneous front and back labeling.

The mechanical simplicity of pressure-sensitive labelers gives them a big advantage over most other types. The labeling head consists principally of a motor to pull the web over the peeler plate and controls to make it do so in a controlled manner. A variety of applicators can be used with the head to apply labels in almost any situation. Other styles of labeler require a separate adhesive, either hot or cold, which adds complexity as well as clean-up and setup time. At the end of the production day, the P-S labeler is simply turned off. At the beginning of the next day, it is ready to run as soon as the power switch is energized.

P-S labelers can be combined with a variety of coding and printing technologies to provide anything from a simple stamped production code to imprinting a variable code, such as a serial number, to complete label printing at the time of application.

P-S labels can be supplied in virtually any shape and size in a variety of materials, including clear plastics, paper, special folded or leaflet labels, partial tear-away labels and other formats.

P-S labels are price competitive with other adhesive technologies in many applications. This is especially true if the costs of the adhesive, daily maintenance, energy costs and initial machine cost are considered.

The major disadvantage of P-S labels is that they are roll fed with the labels on a web. The thickness of the backing web reduces by about half the number of labels that can be supplied on a roll of any given diameter. Roll-fed labels result in periodic machine stoppages for roll replacement, as well as removal of the used liner. Several techniques can reduce or eliminate these stoppages. One is to use larger rolls. Although 12-inch diameter rolls are standard, labelers capable of handling 16-inch or even 24-inch rolls are available. These provide for significantly longer runs between roll changes. A potential drawback to the larger rolls is that they are heavier and, especially in larger label sizes, raise roll handling issues or may require special handling equipment.

Some high-speed labelers use two supply reels. One reel will mount the label roll in current use with the other reel holding a fresh roll. As the in-use roll begins to run out, a light will alert the operator to be standing by. When the roll finishes, the operator splices the web from the fresh roll to the web of the in-use roll. Splicing tables and even automatic splicing systems are available to minimize or eliminate downtime for roll changes.

Another approach is to build a labeler with redundant labeling heads. One head will be in operation applying labels while the other is in standby mode. When the first head runs out of labels, the machine controller turns that head off. Simultaneously, the second head is activated. While labeling with the second head, the first head is reloaded. When the second head runs out of labels, the first one is automatically restored to service.

HEAT-ACTIVATED LABELING

Heat-activated (HA) labels can be paper, foil or film and may be supplied in rolls or pre-cut. If supplied in roll form, they will be cut at the time of application and will generally need to be square or rectangular in shape. If pre-cut, they can be square or rectangular but can also be die cut into complex shapes. HA labels, like P-S labels have the adhesive pre-applied, but the adhesive is dry (non-sticky) and is activated by exposure to heat.

The HA label dispensing system for roll labels is similar to the P-S system. A roll is mounted on an unwind reel. The continuous label stock is pulled from the roll through tension control rolls by a motor and nip roll. Label dispensing may be controlled by either a servo motor or a clutch/brake system. A photoeye controls the label-stop position by detecting a registration mark on the labels.

The label is extended out and a cutting blade cuts it from the succeeding label. As it is cut free, it is picked up by one of the pads on the turret. Vacuum holds the label, face in/adhesive side out, to the pad. The pad is heated and the adhesive is activated as the turret rotates.

As this is occurring, the product is entering the system and is spaced, positioned and held for labeling.

As the turret rotates, the label comes into contact with the product. At this point, the vacuum is de-energized and the label is released from the turret. If the product is a single flat panel, this completes the labeling process. In the case of a wrap or multi-panel label, the product continues to a wrap or other wipe-down station where the labeling process is completed.

If pre-cut labels are used, the process is slightly different. Rather than using a label roll and cutting the labels at application, the labels are stacked in a magazine, label face to the front. The magazine is open on the end with fingers holding the label edge to prevent them from falling out. A pusher at the back of the label stack keeps the labels pushed up against the fingers. The pusher may be pushed forward by a spring, by a weight or by an air cylinder. The weight is perhaps the simplest and has the advantage of providing a constant pressure regardless of whether the magazine is completely or partially full. This consistent pressure at the front of the magazine is required for consistent dispensing of the labels.

If rectangular or square labels are used, the magazine will consist of a flat plate with two sides high enough to support the label stack. One or both of these sides will be adjustable to accommodate varying label widths. If die-cut labels are used, the magazine may have to be specially designed to accommodate the label shape.

The magazine is mounted on a mechanism that allows it to be moved into and out of contact with the turret. As the turret rotates the application pad into position, the magazine moves to place the label in contact with the pad, holding it there with vacuum. Some systems may use an intermediate transfer mechanism to move the label from the magazine to the pad. Once on the pad, the system is the same as for roll-fed labels.

One advantage of pre-cut labels is that the magazine can be reloaded on the fly. This eliminates either the downtime caused by roll changes or the complication of splicing on the fly. Magazines are usually designed so that a stack of labels can be added in back of the pusher plate. Once the labels are placed in the magazine, the operator maintains a slight forward pressure on the stack. The pusher is rotated up, pulled back and then rotated down to push on the replenished label stack.

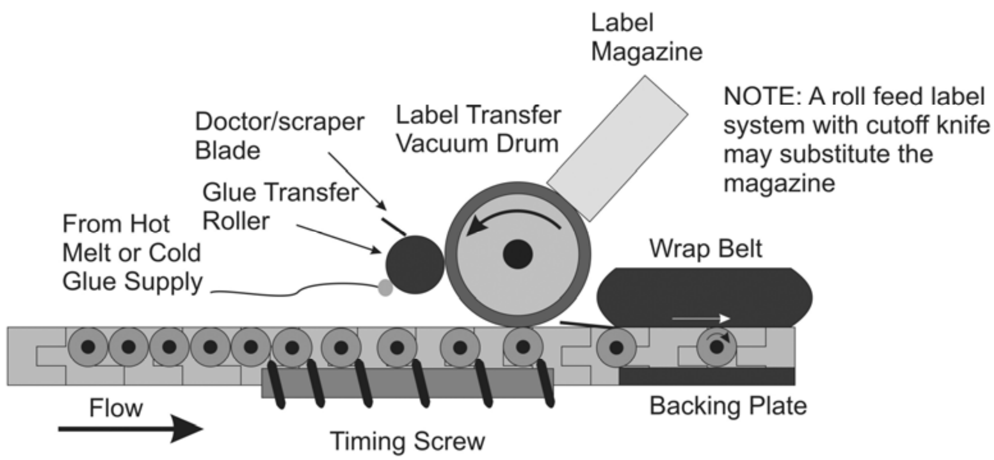
A disadvantage of pre-cut labels is the possibility of mix-ups. If labels of similar size are used for different products, it is possible that two different labels can get mixed in with the same stack. In the pharmaceutical and other regulated industries, pre-cut labels are forbidden for this reason.

If pre-cut labels are used, there must be some means of detecting that the correct label is on each product. This may be via vision inspection, color-coded labels and color sensors on the labeler, barcode readers or other techniques. Human inspection is not recommended. Even the best inspectors can easily miss even a highly obvious mix up. Product inspection is discussed in depth in Chapter 8 “Inspecting.”

HOT-MELT AND COLD GLUE LABELING

Pressure-sensitive and heat-activated labeling supplies the adhesive with the labels. Hot-melt and cold (sometimes called "wet") adhesive labeling systems apply the adhesive to the label or the product at the point of label application.

Hot-melt glue may be applied to either the label or the package prior to labeling. It may be sprayed on using a system as described in Chapter 11 "Packaging Machine Components and Controls" or it may be applied using a transfer roller. Hot-melt glue is not to be confused with heat activated adhesive as described above.



Inline hot-melt or cold-glue labeler

By the author, used courtesy of the Institute of Packaging Professionals

Cold glue is supplied in liquid form and adheres as it dries and/or is absorbed into the product and label.

Cold glue is often used where complete label adhesion is required. Hot melt is more common where the label can be applied with a few beads or strips of adhesive, such as on canned products. If the label is removed, one can see two vertical strips or vertical lines of dots of glue hold the label in place. The first glue strip holds the end of the label to the can. The label ends overlap by about 1/4-inch and a second vertical strip of glue adheres the label overlap. The advantage of using two vertical strips is that glue consumption is greatly reduced. A disadvantage is that the label is only fastened to the product at a single point. If the label tears, it may fall completely off the product.

Some applications, either instead of or in addition to the vertical strips, may use horizontal strips of glue. Depending on the label width these may be at the top and bottom of the label or may be multiple strips of glue. This uses more glue but provides additional adhesion to the product.

Hot-melt and cold glue labelers can be either roll or sheet fed. Labels can be square or rectangular. If sheet fed, they may be die cut into shapes.

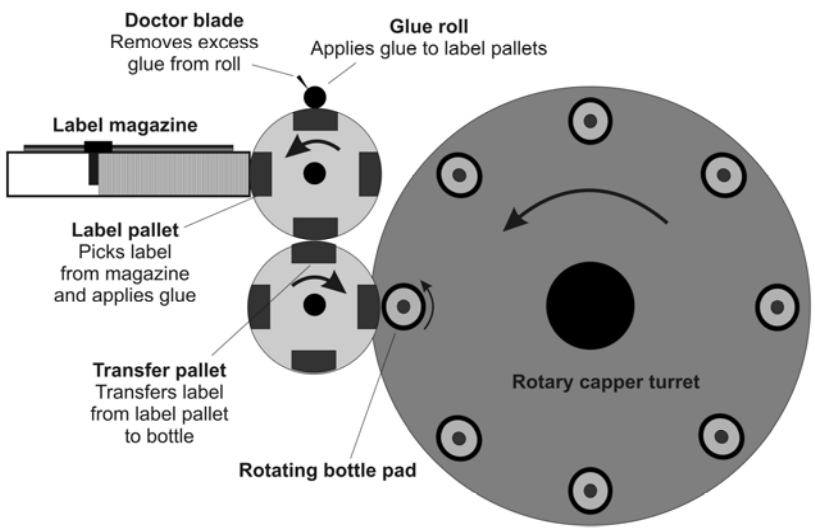
Cold-glue systems begin with a reservoir of glue. This may be a dedicated reservoir but often the glue is used directly from the pail or drum in which it is supplied by the adhesive manufacturer. Glue is pumped from the reservoir and flooded over the glue application roller to assure complete coverage. A doctor blade scrapes off the excess glue, leaving a thin film. Excess glue drains back to the reservoir where it is recirculated.

The glue may then be transferred from the roller to either the product or the label. Depending on the machine design, the transfer may be either directly from the roll to the label/product or may be via intermediate rollers or pads. The exact method will vary depending on manufacturer and product requirements.

In some cases, such as cans, it is only necessary to glue the label ends. A simple, high-speed architecture is the roll-through labeler used for cans and other round containers. The product is fed horizontally (perpendicular to flow) into the labeler where it is captured by top belt and lower machine rails. These serve to carry the product through the labeler as well as rotate it. A glue trough with a powered roller is mounted ahead of the label magazine. The roller rotates into the glue with a doctor blade scraping off the excess. As the can rolls past, a strip of glue is transferred. In some cases, rather than cold glue, hot-melt glue is used. This can be applied by a hot-melt glue nozzle or a system similar to the wheel but using a heated trough.

After the glue is applied, the can rolls over the label magazine where the glue strip pulls the top label off. The can and label continue rotating until they reach the second glue trough and wheel. This is set so that the circumference of the roller touches the can at the leading, or tacked down, end of the label. A strip of glue is applied and, as the can continues rotating through the labeler, the trailing end of the label is tacked down and the can discharged.

Other architectures label the container in an upright position with a similar technique. The glue roller is vertical as is the transfer roll. As the product passes the transfer roll, it makes contact and glue is transferred vertically to the product. This strip adheres the leading edge of the label to the product, which then pulls the label from the magazine. As the container rotates, a second roller applies glue to the outside of the leading edge of the label. The trailing edge is the adhered over the leading edge. In some cases, less than a full wrap is required. The second glue strip can be applied directly to the container and the trailing edge of the label affixed.



Cold glue rotary labeler

By the author, used courtesy of the Institute of Packaging Professionals

Die-cut labels will generally require a full adhesion for good results. In this case, an intermediate pallet may be used to hold the label for glue application. These glue pallets are mounted on a rotating turret and are usually semi-circular. They typically match the shape of the label and need to be changed for different label sizes/styles. They will have a series of shallow grooves or a textured surface that allows them to retain the proper amount of glue.

END OF SAMPLE SECTION

CHAPTER 12

PACKAGING LINE DESIGN

The typical packaging line will consists of a number of machines, often supplied by different machine builders. The key distinction between a packaging line and a collection of packaging machinery is, on the packaging line, the machines work smoothly together to efficiently produce a high-quality product. The key words are smoothly and efficiently. Attention to detail during the design phase can mean the difference between an efficient, profitable line and an inefficient, less profitable one.

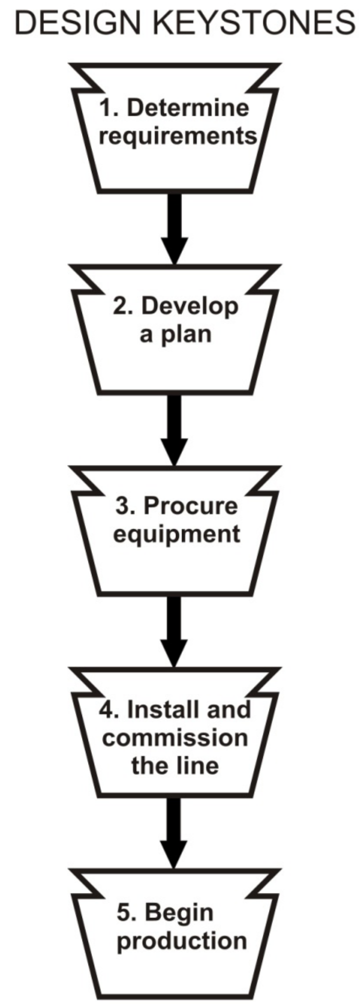
This chapter will use the term designer in a rather generic catchall sense to include various functions. Many of the functions discussed below will be carried out by different people and departments within the company. In some companies, the designer will be responsible for the line design, purchasing will negotiate the purchase, engineering will arrange for installation and operations will perform the startup. Other companies will handle the process differently. This chapter makes no judgment as to the best way.

The designer will sometimes have the luxury of being able to design the facility around the packaging line. In many cases, the designer will need to fit the line into an existing facility, which will require tradeoffs between line and facility designs.

Some packaging equipment will be standard, off the shelf designs. Most will require some modification. Some may be custom designed and built from the ground up. Existing equipment may need to be reused even if it is not what would be selected in designing a line from scratch. In other cases, various constraints may require the purchase of used equipment. All of these factors add to the challenges of designing, purchasing and commissioning a packaging line.

There is no "one size fits all" approach to packaging line design: Every line will be different with different requirements and constraints. This chapter will provide a general framework the designer should find useful as a starting point.

The framework divides the line design process into five sequential steps:



- Determine requirements
- Develop a plan
- Procure equipment;
- Install and commission the line;
- Begin production.

1. DETERMINE REQUIREMENTS

The first step in designing a packaging line must always be to gather information. As the saying goes: "If you don't know where you are going, you are likely to wind up somewhere else." The more information obtained before starting the project, the easier the designer's job will be as the project progresses. More information at the beginning helps guard against (almost always unpleasant) surprises later. More information, widely shared, also helps guard against disappointment due to differing expectations of what the line is to accomplish and how.

Information gathering is an iterative process. At the beginning of the project, information will probably not be complete and is often subject to change. It may sometimes seem as if each answer raises two more questions. No matter. Gather as much information about all aspects of the project as possible. Major areas will include the package and its components, the product, the room where the line will be placed, utilities available, legal and regulatory issues, workforce, transport and more.

Designing a line for even the simplest package can be complex. It is important to get as much information as possible, including samples, as early in the design process as possible. The package designer and the packaging line designer should consult early and often. Simple changes in the initial design stages can avoid problems later on. For example, a package designer may wish to use a carton that is 4-1/8 inches wide. The line designer may find that the maximum width that an existing cartoner can run is 4 inches. It may be that the extra 1/8 inch is not necessary, saving the expense in both time and money of a new cartoner. On the other hand, the 1/8 inch may be necessary and must be accommodated. The decision must be based on information and two-way communication between package and packaging line designers, not on random chance.

The information required can be organized into three main areas: budget, package and block layout.

Budget

It may sound premature to attempt a budget at this point and, in one sense, it is. On the other hand, some people involved in the project may have unrealistic expectations of the costs involved. A project that may make sense if it can be done at little or no additional cost on an existing line may be completely unfeasible if a new machine must be bought for $150,000.

Until the project is well defined, it will be hard to develop anything better than a ballpark budget. This may be off by as much as 50% to 100%. This ballpark budget, sometimes called a “flinch test,” is still useful because it may prevent time and effort being wasted on a project that is prima facie unfeasible. As the project develops, the budget must be continuously refined and updated.

We may borrow a concept from scheduling to describe the two main approaches to budgeting with many variations in between. One, a forward approach to budgeting gives the designer free reign to develop the optimal design with costs calculated based on the design. Two, a backward approach to budgeting gives the designer a budget amount and asks them to design the optimal line within that constraint. In many cases, some middle ground will be used and approval of the funds and line design will be based on negotiation of costs and benefits along with capital availability.

In addition, a ballpark schedule or time budget should be developed as early as possible. This, too, can be forward, with the projected finish date calculated based on design requirements, or backward, with a fixed completion date and the design managed to comply with that date.

Package

To obtain crucial information about the package, designers will need to verify these critical details: component specifications; Bill of Materials; product; facility; utilities; workforce; capacity requirements; external requirements; company policies; and industry practices.

• *Component specifications*—Detailed package specifications and drawings must be supplied to the designer. In addition to specifications and drawings, samples are a good idea to get as early as possible. This is not always possible but with desktop prototyping rapidly developing, it is easier than ever to make prototypes as soon as the package design is complete. Physical samples the designer can see and handle can give insights mere two-dimensional drawings may not be able to.

• *Bill of Materials (BOM)*—A BOM is a complete list of all components and materials required for the final package. This will include primary, secondary and tertiary packaging. The concept of a BOM as used by the designer may be different from that as used by the materials or logistics departments. Some plants do not include common items such as tape or glue in the BOM, treating them as a supply. Designers must include everything in their BOM. If tape is required to close the shipper case, this must be included on the BOM so that the designer can make a provision for applying it. The BOM must also include quantities required of each component for each finished product.

The BOM needs to identify which components will be supplied pre-assembled and which will need to be assembled on the line. A pump dispenser may require a protective overcap. If the pump and overcap are supplied separately, a separate operation, as well as line space, will be required. This additional operation may be done on the capper or it may be a separate machine. If the pump and overcap are to be supplied as an assembly from the manufacturer, this will need to be considered in designing the pump placer and torquer. Inevitably, in the course of packaging, some of the overcaps will separate from the pump. The designer must consider how these separated caps, as well as the uncapped bottles, will be removed from the line without disruption. Some plastic bottles may be labeled at the bottle manufacturer. If so, this eliminates the need for labeling on the packaging line but may raise other concerns that need to be addressed, such as the need to prevent label scuffing in the bottle orienter.

The BOM or a supporting document will need to identify how the components will be supplied to the line. In the case of plastic bottles, there are at least five possibilities. They can be supplied in pallet-sized gaylord or tote containers, jumbled in corrugated shipping cases, multi-layered in corrugated cases, single layered in a reshipper case or layered on slipsheets on pallets. How they are supplied will affect the design of the line and machine feeding systems.

If the package is to be run in an existing plant, bring plant operations people into the process at this point, especially if it is to be run on existing equipment. They are the experts in the existing capabilities and limitations as well as advantages and disadvantages of different makes and models of equipment. Their input at this time can save future headaches. An additional benefit to bringing them in earlier is that early involvement will increase the likelihood of later enthusiasm on their part.

• *Product*—Complete details, including samples, of the product are necessary as early as possible. A description of a product may be completely accurate yet fail to capture its nature. A shampoo may be described by its viscosity but this may not address whether or not it strings at the filling nozzle. If it does, the filler may need some special features to deal with it. Nor will viscosity tell the designer about a thixotropic product that may require special pumps.

Product information must include how the product will be supplied to the line, such as pumped from a remote reservoir, small hand-loaded totes or pails, or large machine-loaded bins.

Some products may have special handling requirements. They may need to be packaged hot or cold. Fragile or delicate products may require gentle handling. Most caps may be handled in a standard rotary sorter with no ill effects. But a cosmetic product, such as a perfume, may have a closure with a highly polished finish that would be damaged with normal handling. The line designer will need to provide a suitable alternative.

Other products such as pharmaceuticals, medical devices or foods may require a “clean” production environment. “Clean” in this case refers to a specific design philosophy requiring special machine design, special air filtration and flow, room design, construction materials and personnel operations. A number of different classifications of cleanrooms exist and the designer, faced with these requirements, may need to seek specialized advice.

Some products may be flammable or explosive, or present chemical or biological hazards, requiring specially configured equipment. A discussion of hazardous product machine requirements is beyond the scope of this book. Suffice to say, in this critical area, the designer must not hesitate to seek expert advice as needed.

• *Facility*—The packaging line designer may not have direct responsibility for facility design issues but must be aware of them as they will affect the success of the line design. The line designer and facility designer must work closely together to determine what is optimal, what is feasible and how to reconcile the two.

Physical space and configuration may be the most obvious criteria but are hardly the only ones. If designers are required to place the line in an existing facility, they must know all details of the available space. The first is room dimensions. Not just size in total square footage but how that space is laid out. A long, narrow area will influence the designer towards a straight line layout. A shorter, wider area, may influence the designer towards a "U"-shaped line layout. A requirement to place a U-shaped line in a relatively long, narrow space will bring additional challenges.

Location of raw materials and finished good storage will influence line layout. If they are on opposite ends of the packaging area, a straight-through line may be preferred. If on the same end, perhaps a U-shaped line will be more appropriate.

END OF SAMPLE SECTION

ABOUT THE AUTHOR

John R. Henry has 35 years of experience working with packaging machinery of all types and in all industries. On leaving the Navy, where he was a marine propulsion and refrigeration specialist, he worked at Alcon Laboratories as Maintenance Manager, eventually rising to the position of Manager, Facility Operations. After eight years with Alcon, he left to purchase Automation Sales, a machinery sales and service company specializing in packaging, assembly and manufacturing machinery. Most of the machinery sold by Automation Sales was either custom or semi-custom made for client needs. During his 22 years at Automation Sales, John had the opportunity to work with a variety of machinery from design to commissioning and ongoing operation.

In 1996, John recognized the need to reduce changeover times in manufacturing. John formed changeover.com to offer his services in this specialty. Since then, John has become known as “The Changeover Wizard.” His book “Achieving Lean Changeover: Putting SMED to work” shares the knowledge he has gained in that field.

A prolific writer, John has published more than 60 articles, columns and essays in various packaging, engineering and manufacturing magazines. Many of these are collected in his book “Machinery Matters: John Henry on Packaging, Machinery, Troubleshooting.” He is a contributing writer at *Packaging Digest* where, under the pseudonym “KC Boxbottom, Packaging Detective” he writes the “Adventures in Packaging” blog.

John is a popular and frequent speaker at conferences—including Pack Expo, Interphex and InterBev—corporate meetings and other venues.

In 2008, John was awarded U.S. Patent #7,377,383 for a two-part mixing bottle.

John teaches the Packaging Technology course at the Polytechnic University of Puerto Rico. Since 1982, John has taught a variety of courses at Southern New Hampshire University's Graduate School of Business. John has an MBA in Industrial Management with a second concentration in Interpersonal Relations. He also has a MS degree in business education.

He may be contacted at johnhenry@changeover.com, where he always enjoys discussing packaging, manufacturing and anything else.