The Impact of the Flexo Folder-Gluer on Packaging Distribution

Alexandra Hartford
Michigan State University
School of Packaging

A322 Bailey Hall
East Lansing, MI 48825
hartfor5@msu.edu
231.884.4840

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Introduction

Corrugated boxes have been successful for over 100 years and statistics show that the corrugated industry is still thriving. Corrugated boxes are one of the most stable packaging forms in today's industry. According to The Marketing Guide to the U.S. Packaging Industry, in 2004 paperboard packaging products made up 40.3% of the shipment packaging industry. Paperboard sales were more than double any other material during both 2004 and 2005. Inside of the paperboard industry, corrugated board made up 64% of all paperboard sales in 2004. According to the same source, corrugated shipping containers alone had $29.5 billion in shipments during the 2005 year. This was more than all plastic packaging material combined which totaled $26.346 billion. Not only do corrugated shipping containers dominate as distribution packages, the industry continues to grow. It is expected that the corrugated container industry will grow by 1.3% from 2005 to 2010 despite the threat from other packaging materials, such as plastics (The Marketing Guide, 2006).

The properties of corrugated boxes make them valuable distribution packages and give the corrugated industry a slight advantage over other competitors. Corrugated boxes are best suited as a shipping container because of their strength to cost ratio (Jonson, 1999). The properties of corrugated boxes are easily modified in order to be compatible to the needs of the product being shipped.

Corrugated boxes have dominated the transportation packaging industry for decades. The distribution of consumer goods is almost exclusively done in corrugated boxes. Of all the goods produced, 90% are shipped in a corrugated container some time within their product life (Fiedler, 1995). Corrugated boxes are economical for shipping because of their low production cost

(Twede). Because transportation is essential to every product, reducing the transportation cost of products is essential to reduce overall costs.

The regular slotted container, RSC, is the most economical box style because it has the least scrap (Twede and Selke, 2005). Minimizing the material for each box produced was a critical factor because consumers wanted the least expensive boxes. Therefore, the need for mass production of the cheapest corrugated boxes became essential to any company who distributed goods.

The Flexo Folder-Gluer

The optimal characteristics of corrugated boxes created a high demand for inexpensive boxes. Eventually, the demand for corrugated boxes created a demand for an efficient, inexpensive way to convert corrugated board into boxes. In 1959, an automated machine that combines printing, slotting, scoring, folding, and gluing was invented. The in-line process greatly reduced the cost of corrugated boxes. This machine, named the flexo folder-gluer, is still the most common machine found in box plants today, 50 years after its invention (Twede and Selke, 2005).

Before the invention of the flexo folder-gluer, the converting process for making corrugated boxes was slow and expensive. The process was done on two machines – the printer-slotter and folder-gluer. These machines worked independently of one another to make boxes. Once a corrugated blank underwent the processes of the printer-slotter, it was manually moved to the folder-gluer to be made into a box (Twede and Selke, 2005). This discontinuous process yielded a significantly lower production rate. The method required many manual laborers which also increased costs. The in-line process of the flexo folder-gluer reduced costs of producing corrugated boxes and also produced better quality corrugated containers.

The flexo folder-gluer utilizes many processes and components in order to complete the box making process. After corrugated board is produced, but before entering the flexo folder-gluer, the blank for each box is scored across the flutes in the machine direction of the liner (Twede and Selke, 2005). Each blank has two scores that allow for the flaps of the corrugated box to be produced. After this, each blank undergoes the operations of the flexo folder-gluer to become a box. First, a feeder takes each blank into the machine to be printed. Next, the blank is creased in the flute direction and slots are cut to form the box flaps. The manufacturer's joint is also cut and trimming takes place if needed. Finally, the blank is folded and glued. At the end of the flexo folder-gluer, the boxes are stacked. This entire conversion process occurs in the seven sections of the flexo folder-gluer – the feed section, printing section, creaser-slotter, in-line die cutter, glue lap unit, folding section, and delivery end. Each component varies based on the model of the flexo folder-gluer. However, the same basic operations are consistent in all different types of flexo folder-gluers (Shulman, 1986).

Feed Section

The beginning of the box conversion process happens in the feed section where blanks enter the machine. This section is responsible for taking each individual blank, already scored across the flutes, into the flexo folder-gluer. As each blank enters the machine, it must be flat and aligned correctly. If the blank is not aligned squarely with the machine, problems arise in the feed section or later in the process. Most times these problems are a result of human operation. However, problems that occur because of machine error, such as one side of the board entering the machine before the other, can also cause lost productivity (Shulman, 1986).

Two different feeding methods exist and each is used for a different reason. Blanks are fed into the machine in one of two ways – from the top of the stack or from the bottom of the

stack. Bottom feeding, also known as top stacking, is the most economical way of feeding. This process takes each blank from the bottom of the stack which allows the operator to easily place blanks on the top of the stack. Although this method is less time consuming and less complicated for the operator, if too many blanks are stacked in a pile, friction on the bottom blank becomes too great and the bottom blank cannot be moved into the machine. Top feeding, also known as understacking, is a more recent innovation that is mostly used for large blanks. Understacking usually requires an operator to manually move the blanks into the machine resulting in increased costs (Shulman, 1986).

Two variations for feeding the blanks into the machine exist, both with different downfalls. Several variants of both pushing and pulling operations exist. This part of the operation must be carefully overseen to ensure efficiency and quality. If pushed or pulled to harshly, the board will be damaged. If the process is too gentle, the blank may not enter the machine squarely and cause problems as the blank continues to move into the printing section and through the rest of the machine (Shulman, 1986).

Printing Section

Next, the blanks are printed with text and graphics in the printing section of the machine. Flexographic printing is used to print the blanks. Corrugated board is printed almost exclusively using flexographic printing. Flexographic printing is a fast-drying process. It utilizes a soft plate in order to make complete contact with uneven surfaces (Bessen, 1990). Most commonly, multiple printing stations exist and each is independent of the rest, like an offset process. Each independent station has an individual ink supply. These printing stations work together and are controlled together to create a process that works correctly. Originally, only one or two printing stations existed in flexo folder-gluer machines. However, in newly made flexo folder-gluers, up

to six stations can exist (Twede and Selke, 2005). When a station in the flexo folder-gluer is not used, it is not removed from the processes. The corrugated board must still travel through the press in order to go to the next station. Physical removal of an entire printing station is possible, but it must be replaced by a station that transfers the corrugated board (Shulman, 1986).

Creaser-Slotter

The creaser-slotter, also known as the scorer-slotter, performs many simple tasks essential to the box making process. It creases and slots the blank, as the name implies. However, it also trims when needed and performs critical tasks for making the manufacturer's joint. In order to complete all of these operations, many different parts make up this section, including two creasing shafts, two slotter shafts, and two pull rollers (Shulman, 1986).

The creasing operation creates creases in the box to allow for folding later in the process. This procedure is performed by a male and female creaser. The male creaser contains the creasing heads and is responsible for making the creases on the corrugated board. It can be either on the top or bottom shaft. The most common creasers have three creasing heads per shaft. The top creaser is adjustable in order to make a harsher or lighter crease depending on the flute of the board running through the machine (Shulman, 1986). For corrugated containers, scoring is always done on the inside of the box. When erecting a shipping container, the walls of the box are folded toward the groove (Twede and Selke, 2005).

Slotting, the next operation in the creaser-slotter, is necessary in order to fold the flaps of the box without them interfering with one another. Another pair of shafts in the creaser-slotter performs the slotting operation. This pair of shafts contains the slotter knives and the glue lap cutter. The slotting heads have two blades attached. Each blade cuts one side of the slot. Slot widths are commonly between ¼ and $^{3}/_{8}$ inch. The end of the slotter knife has a raised blade

which cuts and detaches the third side of the slot. Slotting is always performed in a top down process for easy scrap removal. Scrap may also be accumulated from trimmings and cutting the glue lap. Pneumatical and mechanical scrap removal systems are both common. Blowing air downward at an angle along with gravity removes the scrap quickly. The scrap is generally taken to a recycling pile via a conveyor belt (Shulman, 1986).

Crushing is another essential operation that occurs in the creaser-slotter section. The outside edge of the blank that the manufacturer's joint is adhered or stitched to is crushed. Crushing of the box in this specific area is essential in order to make the box thickness more uniform throughout (Shulman, 1986). If crushing does not take place, the portion of the box where the manufacturer's joint is attached will be twice as thick as the rest of the corrugated box. Although crushing cannot make the thickness completely uniform, it does compensate.

In-Line Die Cutter

Precision and speed are essential factors that are inversely related during the die cutting process in the flexo folder-gluer. The die cutter is usually located after the creaser-slotter; however, there are some instances where the die cutter comes prior to the creaser-slotter section of the machine (Shulman, 1986). These two sections of the machine are always located side-by-side in order to make alignment more precise. Originally, the cutting of the blank in the flexo folder-gluer was created for speed rather than precision. In today's packaging market, both speed and precision are critical. As speed increases in the in-line die cutting process, precision decreases. It is essential for box plant manufacturers to find the correct speed and precision in order to maximize profits.

A rotary cutting process is most common in flexo folder-gluers to increase the speed of the process. A minimum of four cylinders are needed in the die cutting process. Two of the four

are pull rollers which are used to feed and support the corrugated board through the machine. The die and the anvil cylinders are used to complete the actual cutting of the board. As the corrugated board passes between rollers, it is cut by the bladed die which presses against the anvil roller. The order in which the cylinders are placed is not critical. However, the two pull rollers must be together and the die and anvil cylinders must be together as well. All cylinders must rotate at the same surface speed to keep the alignment correct. Die cutting is one of the limiting processes in the box making process (Shulman, 1986). It is slower than the other operations performed by the flexo folder-gluer.

The die cutting process in the flexo folder-gluer offers more options than other parts of the machine. The in-line die cutting process provides a variety of cutting mechanisms in order to accommodate for different preferences. There are three main processes used for die cutting, two of which are common in flexo folder-gluers. Soft cut and steel-to-steel processes are both used in the box making process. They each have different advantages and disadvantages.

The soft cut approach better adapts to the other components of the flexo folder-gluer. Soft die cutting was not invented until 1962, after the invention of the flexo folder-gluer. This process consists of a shear cut that is assisted by the use of an anvil roller. Scrap removal is the driving force of this operation. The blank is what remains after the process is complete (Shulman, 1986).

Steel-to-steel cutting is much more precise but also more costly than the soft cut approach. The steel-to-steel process is able to permit more die rule compared to the soft cut process. Therefore, more complex box shapes that require cutouts are best produced on a steel-to-steel process. From technological advances, this process also allows for easy removal of scrap. Although this process is more precise than soft cut, it requires higher start-up costs. The

cost of the dies is more expensive than the alternative process. However, it continues to increase in popularity because of its precision and repeatability. There are two types of steel-to-steel cutting processes. Most flexo folder-gluer operations have a steel-to-steel process that consists of a male die and an anvil. The other type used is a male and female die that are aligned together. However, in this process the two dies have to match precisely causing the process to be slower and more expensive. Using a male die with an anvil roller allows for independence between the two cylinders making set up easier and causes less error in the process (Shulman, 1986).

Glue Lap Unit

The glue lap unit is used to seal the corrugated box together via the glue lap, also known as the manufacturer's joint. The glue lap unit allows for the manufacturer's joint to be bonded to the fourth panel of the box. The purpose of the joint is to hold a corrugated box together after production. A normal glue lap extends from the length of the box and is as high as the depth with cut angles at each end. Normal glue laps range in width from 1¼ to 1½ inches. Extended glue laps have a longer width and are used for smaller boxes. Short glue laps are rarely used (Shulman, 1986).

Several processes exist for applying the adhesive. The adhesive can be applied to either the lap itself or the panel that it is being adhered to. In some machines and processes, it is possible for the adhesive to be applied to both substrates (Shulman, 1986). There are three primary processes that are used to apply the adhesive to the substrate in the flexo folder-gluer – wheel applicators, extrusion systems, and spray systems. Wheel applicators use a wheel, like one used in printing, to apply the adhesive. Glue is applied only to the tab in this method. Extrusion systems also use a wheel in the process. However, a control system is used in order to

delegate when gluing occurs and when it does not. Spray systems use liquid sprayers to apply the adhesive, also with the assistance of a wheel. Spray systems provide great strength but are also more costly than the other two processes.

Folding Section

The folding section folds the box and adheres the manufacturer's joint. In the folding section, folding occurs along the creases made in the creaser-slotter section. The boxes are not erected, but rather kept knocked down for reduced transportation costs. Of all the sections in the flexo folder-gluer, the folding section has the most jam ups (Shulman, 1986). Most of the time, this is directly related to speed. Some of the most common problems are sheets lifting up from the machine or blanks contacting one another causing misalignment or piling.

The manufacturer's joint is also attached to the other end of the box in the folding section. It is critical that the panel or lap with the glue folds before the panel or lap it is being adhered to. The joining of the manufacturer's joint must be carefully overseen to ensure that the joint is not too tight or too loose (Shulman, 1986). Either one of these scenarios can cause future complications in erecting, filling, and palletizing. The space needed between the two ends of the blank that are brought together is called the gap. Having no gap will cause the box not to erect properly and make it unusable. A gap allows for ease in erecting and filling of the box. After the blank is folded and adhered to itself, it moves on into the last section of the machine.

Delivery End

The final section of the flexo folder-gluer inspects the boxes and prepares them for shipment. This section of the machine is known by many different names but performs similar operations in all machines. The main objective of this section is to prepare the boxes for distributing. First, a counting mechanism counts the boxes and stacks the knocked down boxes

into piles. The boxes are squared and moved out after the correct number of boxes is reached in a pile. Finally, the stacks are tied and put onto pallets.

Inspection and removal of non-qualified boxes creates higher quality boxes to sell to consumers. Inspecting the gap of the box, as discussed earlier, is one of the main functions of the delivery end. Nearly all machines have an electric mechanism for measuring the gap and removing boxes with gaps that do not fall into the specified limits. The delivery section is also able to remove boxes that were identified as defective earlier in the box making process of the flexo folder-gluer. Once the processes of the delivery end are complete, the boxes are finished and the entire process of the flexo folder-gluer is final.

Conclusion

The invention of the flexo folder-gluer has greatly impacted the corrugated industry. It has improved the quality of corrugated boxes and reduced the cost per box. The in-line process makes converting blanks to boxes efficient, requiring little manual operation. The invention of the flexo folder-gluer greatly improved the distribution of goods making it easy and affordable.

The flexo folder-gluer is a complicated machine that requires experts to oversee the operation. Producers of corrugated boxes must weigh the pros and cons of cost versus quality. The speed that the flexo folder-gluer operates at is adjustable. Experts must decide on the optimal speed to run the machine at. As the speed increases, the quality of the boxes decreases. Deciding the best speed to run the machine at can be very difficult. Producing quality corrugated boxes is important; however, the faster the machine runs the more boxes it produces.

Another factor that influences quality of boxes and costs are the different features to choose from in the flexo folder-gluer. There are hundreds of possible variations, all of which affect quality and cost of corrugated containers. For example, it must be decided how many

printing stations are needed. Whether upstacking or downstacking is desired in the delivery end needs to be determined. Dozens of decisions like these must be made. Each one affects the system as a whole and must be carefully thought out. Each different box maker will have different preferences that work best for their needs.

Over the past 50 years, the flexo folder-gluer has undergone many upgrades that have improved the process of making boxes. From 1980 to 2004, the corrugated box industry more than doubled in production and tons of material used, in part because of flexo folder-gluers (The Marketing Guide, 2006). As technology continues to advance, processes will continue to become more efficient and economical.

The distribution of goods in corrugated boxes is still steady, despite threats from other industries. The flexo folder-gluer has continued to produce high quality, low cost boxes for transport containers.

Overall, the flexo folder-gluer has made an enormous impact on the corrugated industry and the packaging industry as a whole. Producing inexpensive, quality corrugated containers is vital considering their extensive uses. As the industry continues to improve, the flexo folder-gluer will aid in producing even higher quality, lower cost containers.

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