CHAPTER 1

The Importance of Beer Packaging, Packaging Line Systems, and Personnel Management

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The usage of beverage packages increases at a global rate of 4% annually. In 2007, beverage packages comprised 15% of the world's use of packages.

Brewery customers are visually oriented drinkers. If the packaging is pleasing, the customer considers purchasing the beer. Getting packaging right is a challenge and an opportunity for a brewery to broadcast excellence. New opportunities lie with the recent complexities of novel multipacks and different bottles, cans, and configurations from the packaging line. The Coca-Cola Company has driven the development of cans and of glass and polyethylene terephthalate (PET) packaging and serves as an example of product driving packaging development.

Beer packaging has six essential functions: containment, protection, apportionment, unitization, convenience, and communication. The different levels of packaging are identified as primary (cans, bottles), secondary (cartons, trays), and tertiary (pallets, stretchwrap, shrinkwrap). Taken together, packaging is the means of safe, efficient delivery of beer to the consumer, followed by the efficient recovery or disposal of material at a minimal cost.

HISTORICAL INTRODUCTION

The Past

The packaging of beer is an idea almost as old as brewing itself. Preserving and holding beer, for later consumption, has been discussed in print for centuries. One 1609 reference addresses earthenware bottles of ale.

> *The True Bottling of Beer*
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> When your Beer is 10 or 12 dayes olde, whereby it is growne reasonable cleare, then bottle it, making your corkes very fit for the bottle, and stoppe them close: but drink not of this beer, till they begin to work againe, and mantle, and then you shall find the same most excellent and spritely drinke: and this is the reason why bottle ale is both so windy and muddy, thundering and smoking upon the opening of the bottle, because it is commonly bottled the same day that it is laid into the cellar; whereby his yeast, being an exceeding windy substance, being also drawn with the Ale not yet fined, doth incorporate with the drinke, and maketh it also very windy.
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> (Sir Hugh Plat, *Delightes for Ladies*, 1609)

Until the twentieth century, most beer was still consumed at local establishments by the glass, from barrels, and on draft. In the latter part of the twentieth century, as packaging technology rapidly improved, there was a major shift in the way consumers preferred to purchase beer and ales. Draft beer from a keg or cask became a shrinking component of overall beer sales in North America. The share of sales of beer in small, shelf-stable containers that could be sold in grocery stores and other retail outlets increased dramatically. As this

trend developed, the cost of packaging beer became, by far, the most significant cost in producing packaged beer products. With the quality of the beer at stake, packaging became an area of focus in the quest to preserve freshness. Since the 1980s, vast improvements have been made in the exclusion of oxygen from packaged beer. Fill-height measurement, improved pasteurization control, and other developments have made beer packaging a repeatable, efficient operation. The need to fill a diverse array of packages has yielded sophisticated changeover systems so that package changeovers take place rapidly. In a large brewery, the most sophisticated labelers can go from the application of paper labels to roll-fed polypropylene pressure-sensitive labels (PSLs) in turnaround times never before imagined through the use of engineered changeover carts with connectors ready for all services. But even with this great technical advantage, there are adjustments made at the line. For example, the rate at which paper labels can be applied probably exceeds the rate at which PSLs can be applied on the same machine. The benchmark of increasing packaging rates, specified in thousands of containers per minute, has been augmented by rapid changeover requirements to accommodate the need for greatest flexibility—and with that flexibility, new challenges need to be overcome.

The word "logistics" comes from Greek *logisticke*, which means applied mathematics. Packaging is part of the brewery puzzle of logistics in that it is the coordinated system of preparing beer for transportation, distribution, storage, retailing, and enjoyment by consumers.

The Present

Today's technical packaging professionals are tasked with supplying beer in packages that maintain the stability and fresh flavor of the product better than ever before while making the smallest possible impact on the environment. At the same time, competition among breweries and financial considerations demand that packaging departments maintain the lowest production costs and offer the least possible number of defective finished packages. Continuously refining the effectiveness of tools and perpetuating a desire for improvement on the work floor enhance packaging line operations.

In the current competitive market, packaging departments go to great lengths to streamline costs and maximize labor productivity. The effect of this is fewer line employees who bear greater levels of responsibility for higher product quality and line efficiency. At the same time, production employees are protected by the strongest labor regulations in history. This means that packaging management must consider many aspects in the design and management of modern packaging lines. Management must design the lines for speed, quality, and efficiency, as well as for safety, maintenance access, and ergonomics. Breweries, as do many companies, pride themselves on excellent safety records.

Quality is emphasized, more now than ever before, as the responsibility of each employee involved in the production and packaging of beer. An attitude of commitment toward zero defects is predominant, driven by the availability of advancing technology in the hands of a skilled packaging professional as well as by the trend of educated consumers demanding the highest quality in all purchases. The use of statistical techniques has greatly improved the quality of sampling plans. With these techniques, sampling plans can be designed to achieve defect rates of 1 in 10,000. Quality checks with these sampling plans are in place to ensure that the packaging process is under control. Since low levels of defects can escape detection, individual package testing must be state of the art.

Artisan-Scale Breweries

Innovative beers are increasingly available and craft brewers have introduced alternative packages, such as the 22-oz. or 750-mL single-serve bottle, possibly sealed with a cork and wire cage, and filled undecorated cans with a plastic-sleeve body label. There are also plastic kegs, small-pack one-use metal minikegs, and growlers from brewpubs and brewery taps.

A manually loaded and manually packed-out line shares many objectives with faster lines. Many examples exist of breweries running up to 100 bottles per minute (bpm) using manual labor to depalletize bottles at the start of the line and manual labor to pack and seal cartons at the end of the line.

The technical overlap of packaged beer from the smallest brewery and from the largest brewery lies in the integrity of the packaged beer. A beer packaged with 0.2 mL of headspace air is going to stay fresher than a beer packaged with 0.75 mL, regardless of the producer, the beer's style, or the specific package it is in. The ease of maintenance, robust operation, and effective use of labor are equally important parameters for packaging lines of any size. The role of automation is clearly recognized in today's breweries, where the fastest packaging lines in a large brewery may be manned by as many personnel as there are at the slowest packaging line in a craft brewery. And the spectrum of skilled personnel to safely and prudently operate a packaging line has no lower limit in production rate.

Breweries have sometimes struggled and have been challenged with maintaining appropriate skilled

professionals for packaging. The only retort to the question Why do we painstakingly and carefully train staff who may leave us? might be this: Is it better to not train carefully and have personnel stay?

Technological Advances

The culmination of the knowledge gained and the technological advances made since the very first efforts to package beer is that beer can now be produced in convenient packages that keep it shelf stable and tasting fresh. Additionally, key performance indicator (KPI) metrics can improve the performance of the packaging operation. There is always room for improvement, and equipment suppliers are continually improving packaging materials and techniques to ship beer further, reduce the effects of age, and make the beer more appealing to customers. An example of these advances is the range of options now available in polymeric packaging with barrier properties that protect beer against the loss of carbon dioxide and the ingress of oxygen. These technologies are developing rapidly and represent the newest challenges facing today's beer packaging management.

The goal of a brewery packaging department is to do the best job possible of minimizing any negative effects that its processes may have on the beer while maximizing productivity of all packaging operations. Knowledge gained from real-time plant floor KPIs yield the forces of change that improve operations.

Engineering, maintenance, quality assurance, and microbiology of packaging play key roles in achieving consistently well-packaged beer. Packaging line management and maintenance, as well as packaging personnel (operators), complete the picture of successful world-class packaging. Accounting tools define and track direct labor (e.g., operators having specific assignments on the line) and indirect labor (e.g., maintenance staff assigned to multiple lines and cleaning and trash removal personnel).

Modern Risk Avoidance Equipment

While not universally accepted as necessary components of bottling lines, electronic bottle inspection (EBI) equipment is an efficient means of performing high-speed evaluations of empty bottles (an EBI typically includes a chipped neck and neck finish inspection, a complete bottle wall inspection, and residual rinse water detection, as well as the essential foreign particle detection and glass fragment intercept) (Fig. 1.1). In North America, every beer bottle produced has already undergone the scrutiny of EBI hardware at the manufacturer's plants. Yet the industry standard of "no more than 1 defect bottle per 10,000" cannot be challenged unless the brewery has its own EBI at the line. Since the advent of the narrow-neck press-and-blow process over the former blow-and-blow process, bottles are being made at lighter weights and featuring thinner walls; superior performance along with lightweighting is now expected. Unfortunately, EBIs can reject some acceptable ware. So if there is a rejection rate greater than 1 per 10,000, false positives from the EBI may be the cause. There are rejection modes, such as small "light streaks" at the base of the bottle (small, localized variations in the color of amber ware), that offer no physical integrity concerns but can nevertheless cause ejection at the EBI soft-push ram.

Small bottling lines face substantial challenges in justifying the cost of investing in an EBI.

Sophisticated full-bottle inspectors at the back end of the packaging operation and ultrasonic crown-integrity tests, as well as full-case inspectors, ensure the highest integrity in the modern bottling line. A best-of-class full-bottle inspector prevents beer bottles containing glass shards from getting to the case.

Beer canning is very different, and the emergence of can line solutions for the artisan brewery offers an attractive and often compelling alternative to bottles and a bottling line. In canning operations, double seaming is a method by which the flange of the can body and the curl of the end are folded over together such that the final joint is

FIGURE 1.1. An electronic bottle inspector on a brewery bottling line performing base and neck finish inspection; the soft-push ram and chute are at the right. (Courtesy Industrial Dynamics Company)

composed of five metal thicknesses. The beer can must withstand in excess of 90 pounds per square inch gauge (psig), and the fastest operations run 3,000 cans per minute on an 18-station seamer.

Can parameters are increasingly measured on-line; for example, curl diameter and depth and countersink depth are measured automatically in high-speed installations. While a standard manual seam inspection can take one operator as long as 1 hour to complete, recent automated stations require less than 1 minute of total labor for a complete inspection. Characterization of each seamer head in a sampling round is now possible in a very short time.

Breweries often deploy full-package at-line instruments, concentrating on measuring fill-height compliance, date coding, label orientation, etc. before the package is sent to the final packaging stages.

PACKAGING LINE PLANNING

The process of specifically designing a packaging line starts with asking questions. What types of packages and sizes are to be filled and what combinations of materials, e.g., regular slotted cartons (RSCs) (prepacked or flat), wrap-around 12 packs, six-pack baskets, and 24-loose multipacks, will be used? Will cartons be manually packed and sealed by tape or hot glue? What label materials will be used and where are their locations on the packages? Will incoming glass be shipped in bulk or in cases? What is the full-pallet configuration (e.g., size of board, case pattern and number of layers, and maximum height)? What speed is appropriate for the line? Will there be a pasteurizer (flash or tunnel)? Is traditional water-based conveyor lubrication anticipated and how will spillout be controlled? Will the line be configured with silicone-based dry lubes? Or will it be lubeless, as found on many lines of 120 bpm or less?

As with anything worthwhile, answers lead to more questions. For example, if a high-speed bulk glass line is desired, what is the footprint and production speed for one or more case erectors and carrier inserter systems to ensure that adequate cartons are supplied at the target output? Is a partition inserter required for loose-pack configuration?

Once the goals are established, it is good to review options and for a packaging system integrator to prepare a scope of works. The hardware can be arranged so that a single operator might watch over more machines with ease. Ready access to all machines reduces maintenance labor hours. Specifications should integrate capability to readily derive those KPIs that can be used to expose and quantify waste—all activities that do not add value for the customer.

The team can then determine objectives, such as executing sterile filling, minimizing packaging labor, maximizing maintenance access for efficiency and safety, integrating automation, establishing critical data logging and management, and incorporating cleaning-in-place (CIP) methods. The optimal location for equipment can be determined early in the planning stage; the best place for depalletizing, palletizing, and shrinkwrap equipment may be at locations in a warehouse where materials are conveyed to and from the packaging hall. There are, of course, factors that affect the flow of materials, such as a new glass inventory and finished goods staging. A kegging line located near a working inventory of empty kegs or serviced by a conveyor and output to a refrigerated room (for unpasteurized kegs) is the norm. Integration of full-keg handling and automated stretchwrapping can be planned. Ease of service of the keg cleaning detergent sets, sterile filters, and the racker itself are figured into the installation geometry and design/layout.

Packaging system suppliers have great expertise and immeasurable experience in laying out a line for their customers. Because packaging line layout is a compromise of many factors, there is almost always something about each layout that is imperfect. For this reason, criticism can probably be found in every layout. In reality there are three key requirements, and a fourth opportunity, which is obvious.

1. Appoint an individual or a group to lead all aspects of the layout project.
2. Plan for the future so that the proposed layout will still be viable in 10 years.
3. Approve the layout.
4. Build morale with the new layout.

With priorities established, the number of operators needed can be determined in consultation with the equipment vendors. This number should be framed around the time interval between operator interventions for each system on the line, e.g., a labeler operator must refill a label magazine at some frequency and a filler operator must pull quality assurance samples at some frequency. It is important that experience and vendor input help determine the maintenance requirements. If a production line goes down, the reaction and response must be immediate.

Packaging Line Theory

The first concept that must be understood before a new beer packaging line can be designed is the function of each machine in relation to the rest of the machines on the

line. The following is a simple illustration of the concept. With the simplest possible packaging line, e.g., a separate machine for each job on the line, all machine speeds must be designed relative to the speed of the slowest machine, the filler. A graphical representation of this concept can be found in Figure 1.2.

Of course, actual beer packaging lines are very complex and differ greatly in type and capacity. The differences between bottling and canning lines are significant, and many variations exist for each of these. A few are explored briefly below.

Examples of Packaging Lines

There are, of course, many variations and alternatives to packaging line configurations. The physical geometry available for a proposed line or for changes to an existing line often constrain the number of suitable options (Fig. 1.3). Overhead views of various bottling and canning lines are illustrated, and the location and number of operators are found in Figures 1.4–1.6.

In designing glass bottling lines, some breweries find that prepacked "shipper" cases can be used effectively, especially for small footprint areas. Figure 1.4 shows the layout of a compact bottling line with one filler and labeler using prepacked cases with bottles. Other breweries find that bulk glass systems can provide production and economic advantages but require

FIGURE 1.3. The location and orientation of packaging machinery is often specified to accommodate constraints in existing building space. (Courtesy Trumer Brauerei-Berkeley)

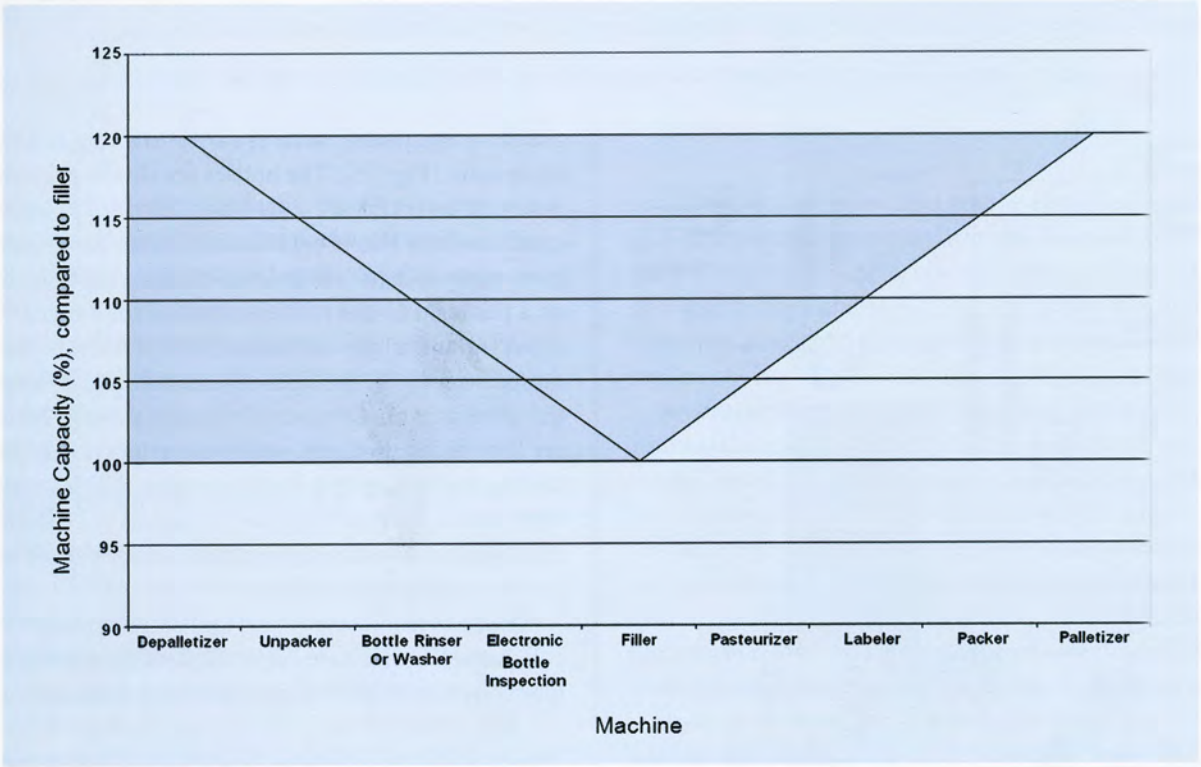


FIGURE 1.2. Line rating, or throughput capacity, for package line design is based on the filler speed specification, set at 100%. The need for higher ratings is to allow for removal of transient accumulations caused by short-term stoppages of parts of the line. This is a starting point for a line design, but if used absolutely, it can result in oversized lines at higher-than-needed costs. (Courtesy J. Jurado)

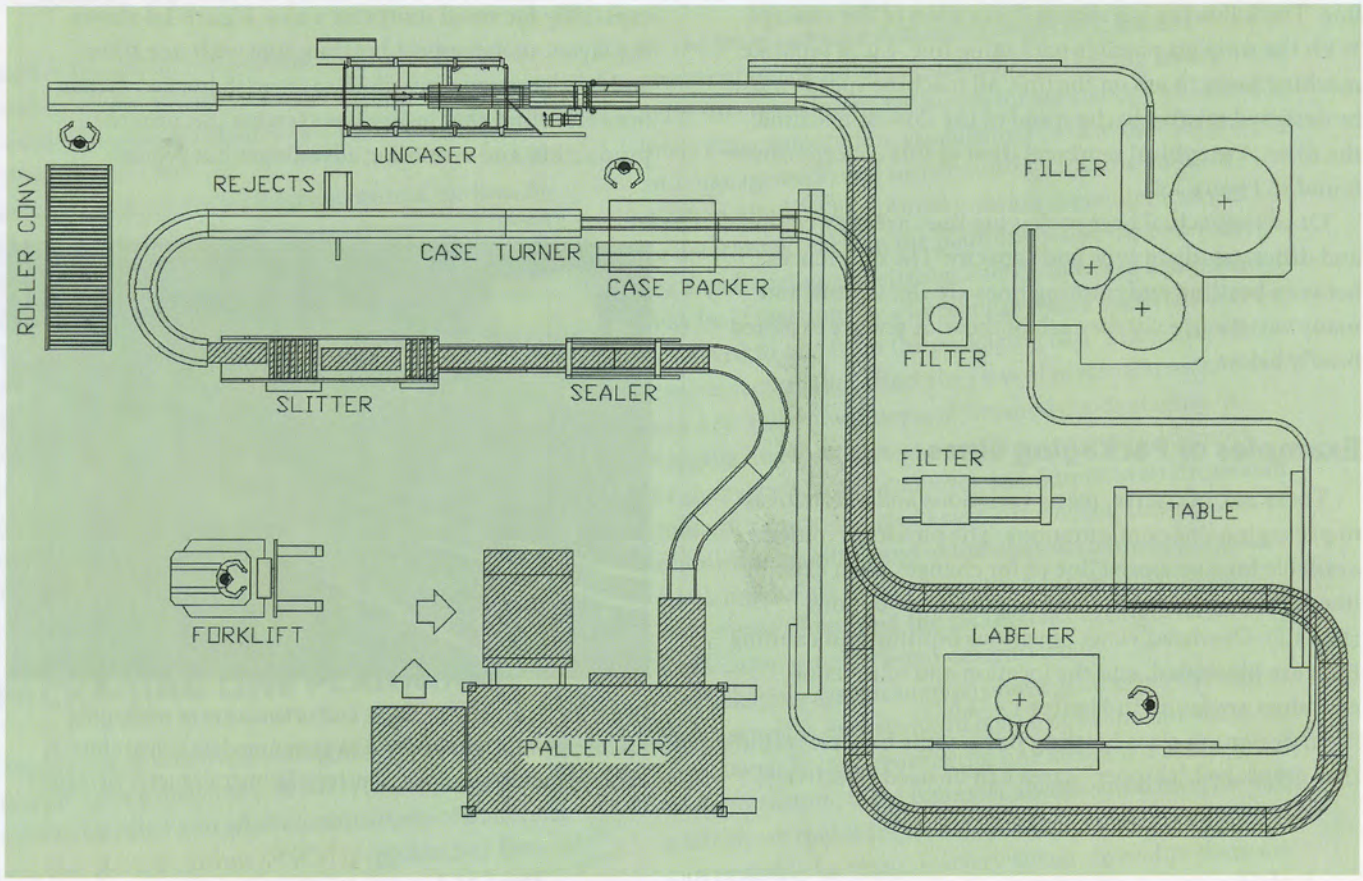
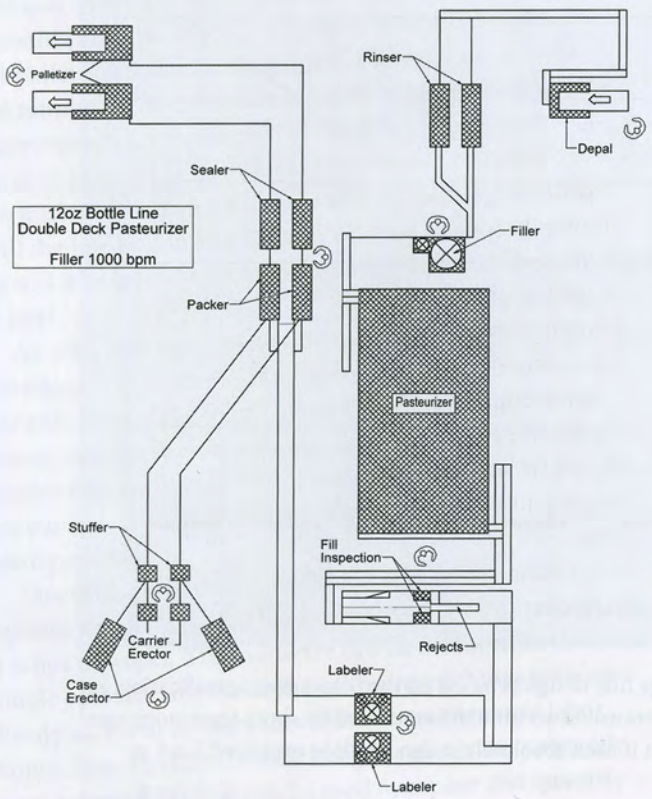


FIGURE 1.4. Bottling line 1: A small line filling 250 bottles per minute with sterile-filtered beer. (Courtesy S. Bates)



ancillary equipment, such as carton erecting and stuffing equipment (Fig. 1.5). The bottles are closely packed on pallets in layers (as are cans when delivered in bulk), with cardboard tier sheets between each layer. Some breweries have sweeper depalletizers, in which the pallet is elevated on a platform to meet the elevation of the outfeed conveyor and a layer of bottles is swept off onto the outfeed conveyor; the layer of ware below is then raised to the same point in advance of the next sweep. There also are lift-off depalletizers, which use grippers that lift ware, elevate, and swing to a discharge table. Alternatively, some breweries find that space concerns or economic considerations make buying glass already packed in cases the best situation for them.

Most can lines have filling and pasteurization equipment similar to those of bottle lines but they have many variations of final packing equipment, such as

FIGURE 1.5. Bottling line 2: A larger bulk glass line filling 1,000 bottles per minute (bpm) with pasteurized beer. (Courtesy S. Bates)

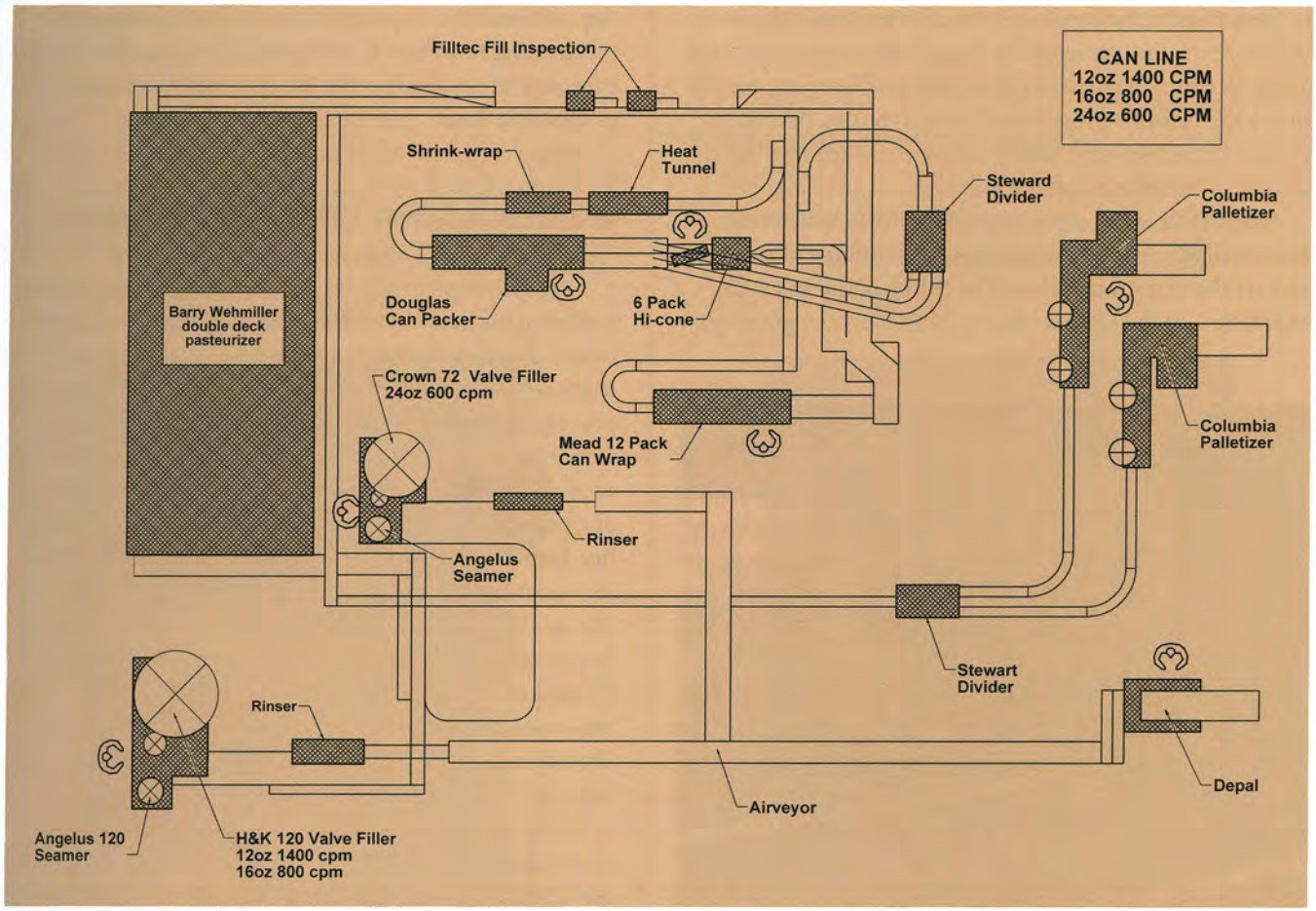


FIGURE 1.6. Canning line: A large line filling different can sizes using two fillers. cpm = Cans per minute. (Courtesy S. Bates)

high-cone machines for six packs coupled with tray-making machines, machines that package cans in wrap-around–style cartons, and machines that are adjustable for running many styles of final packing, e.g., traymakers and shrinkwrappers (Fig. 1.6). Flexibility is a key aspect for many packaging lines with today's demand for variety.

Planning for Keg Operations

Some breweries have their brewing operations production department manage and plan kegging operations, and some make this the responsibility of the packaging department. No matter which department owns this key area, accurate communication is required so that the correct volume of beer is ready in-spec and efficiently kegged.

The predominant keg package is the single-walled keg with U.S. Sankey fittings. This package is used for 15.5-gallon (one-half U.S. brewer's barrel [bbl]) containers, 7.75-gallon (one-quarter U.S. bbl) containers (mostly with containers that are the same height as the 15.5-gallon keg; hence it is slimmer), "sixtels" (one-sixth U.S. bbl containers, also the same height as the 15.5-gallon keg), and 50-L (13.2 U.S. gallons) containers. Common metrics in regards to keg operations are unique: kegs per hour.

A contemporary kegging line features robust automation and the use of robots or forklift clamp trucks, which are used to squeeze and hold kegs. These are increasingly used in breweries to handle empty kegs and palletize full kegs to eliminate manual offloading and palletizing. A keg line requires fewer personnel than does a canning or bottling facility, and suppliers can recommend a realistic manning level for an appropriate crew. A comprehensive chapter in this volume covers this important topic, but a brief summary of the stations follows.

An option not frequently exploited in the United States is flash pasteurization of the beer just prior to kegging.

Small breweries often clean keg exteriors manually with soap, a brush, and a hose. However, the first common