

ROBOTIC PACKAGING SYSTEM IN BEVERAGE INDUSTRY

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ABSTRACT

Packaging is the science, art, and technology of enclosing or protecting products, storage, sale and use. (Wikipedia, 2013) Primary packaging functions are to protect and preserve the product from damage and contamination, serve as storage and handle the product easily. This research discussed the packaging the methods of carbonated soft-drinks. It includes the packaging containment, protection, handling, delivery and preservation of goods. This reseach reveals the robotic packaging system for carbonated drinks. The main process includes palletizing and stretch wrapping. The research also stress more on the process of how packaging is done. The well-packaged carbonated drinks products help to ensure the quality of the products and safe delivery of the refreshment for billions of people around the world.

Keywords

Packaging, Functions, Robotic Packaging System, Palletizing, Stretch Wrapping

1.0 INTRODUCTION

Packaging is defined as “all products made of any materials of any nature to be used for the containment, protection, handling, delivery and preservation of goods from the producer to the user or consumer.” (“Definition of Packaging”, 2013) Besides that, packaging is the last stage prior to warehousing and delivery. Packaging can be classified by layers or functions, that are, primary, secondary and tertiary functions. Primary packaging is the first packaging layer in which the product contained. It is the layer of packaging in immediate contact with the product. secondary packaging is the packaging that used to group various primary packages together. Regarding to these, packaging system used in beverage companies has been investigated. Basically, nowadays the companies will prefer to use fully automated system in the packaging process. Barely any manual operations are involved except during the storage of loaded pallets in a warehouse via forklifts operated by workers due to certain disadvantages. Meeting various marketplace requirements, bottles or cans

enter the packaging machine via conveyors and may be wrapped with cardboard or plastic film to form cases or placed into reusable plastic trays or shells. There are three main objectives for this research about robotic packaging system for the beverages industry. The first objective is to study the importance of packaging system in ensuring the quality of carbonated soft-drinks. The second objective is to study the production of carbonated soft-drinks from input into products along a group of interconnected workstations. Meanwhile, the third objective is to examine the type of manufacturing system implemented by beverage industries.

2.0 LITERATURE REVIEW

Packaging is an vital process to being considered for the production of beverages in industry for several important purposes. Due to nowadays the demand of customers to the products keep increasing, and also mass production has to be implemented, thus robotic packaging system is a good way to package the product before sent out for storage and sales. Before the Civil War, food was either homegrown or sold through central markets and general stores. The second half of the 1800s marked a transition to mass production for everything from food and consumer goods to the machines to make them. Handicraft was replaced by mass production and interchangeable parts (Hounshell, 1984). This paper emphasize on the role and importance of packaging in the transformation. It highlights the practically simultaneous development of mechanical and automated processes to mass-produce paperboard cartons, tinplated cans and glass bottles of beverages. (The birth of modern packaging: Cartons, cans and bottles, 2012) According to Macmillan English Dictionary, automation is a system that uses machines to do work instead of people, or the process of changing to such a system. In other words, machines replace the role of human in the production operation. Fully automated production means that during the whole manufacturing process started from insertion of raw materials until the final product is being produced is done by machines. Bottles, cans, and plastic bottles after being produced using blow moulding, filling of soft-carbonated drinks, filling of drinks, capping,

labelling, palletizing, stretch wrapping all are done by automation. In this case, Coca-cola company is one of the example of the biggest well-known multinational corporation which also implements the robotic packaging system during their production of soft-carbonated drinks. The research method involved reviewing and comparing biographies to contemporaneous and retrospective (“anniversary”) trade publications for the paperboard, canning and glass industries. Multiple sources were compared so as to not bias the biographies in a “promotional” manner. Contemporaneous newspaper articles and advertisements also supplied evidence. It is set in the context of research that documents the history of marketing and production at the dawn of the twentieth century. The findings are Packaging’s industrial revolution played a important key role in the development of modern marketing. Mass production of cartons, cans, and plastic bottles is really necessary to be the building blocks of the mass-markets.

3.0 METHODOLOGY

3.1 The Importance of Packaging System

There are no special requirements for bottling carbonated soft drinks. What’s important is to optimize the manufacturing process of a Carbonated Soft Drink (CSD) bottle to reach physical-mechanical characteristics required by the product. There are some requirements need to be fulfill which are the CO2 level inside the packaging being preserve, reducing bottle expansion due to internal pressure, burst and drop resistance.

We found that in production line, packaging system is the final process for the whole. Usually, it started by using Shrunked-sleeve Labelled Machine, many shapes of bottle are labelled by changing different molds. Next, Ink Jet Printer is being used to print production date on bottle body or cap before we packed the carbonated beverages using Sleeve Shrink Wrapping Machine with shrinking film in 9 to 12 bottles a batch to prevent the products from pollution and breaking. Lastly, to packed bottles of carbonated beverages in cartons, Wrap Around Case Packer is used and its packing speed may reach 15 to 18 cartons each minutes.(Whirlston Machinery, n.d)

3.2 Production Along a Group of Interconnected Workstations

The formation of the bottles is made by injection molding and after that they are moved to the palletizer via bottles conveyor. The bottles are then stack into pallets by pallet robot. Next, the empty bottles is fed on de-palletizer machine to unpacked

them and filled them with the carbonated soft drink. The bottles run down Sentry Conveyors to the filling machine where the filling happens at up to 800 bottles per minute. (Mohan, 2011) As the bottles come off the machines’ filling valves, they depressurized. A lot of caps are used to contain pressures and seal the bottles after they are filled.

In some cases such Coca Cola, a long conveyor is used to create buffers underline should some stations slow down or stop. Some parts of the conveyor system form holding system during backups. Once the backup is resolved, the holding area is released and bottles continue their journey. Then, bottles are gripped by the cap as the machine puts the labels on. Bottles are fed to Hartness 2650 continuous-motion case packer (Mohan, 2011) that places single-serve bottles into reusable plastic shells, or crates. Normally, 24 bottles are arranged in a plastic crate. Then, the plastic crates containing the bottles head for Ryson Spiral Conveyors. (Journey Staff, 2011)

The spiral takes the bottles 18 feet high. The aerial conveyor frees up space on the factory floor. At the end of the line, three crates are orientated into a pallet layer by a robotic palletizing machine. (“Handling of packaged beverages”, n.d.). One layer consists of 6 cartons and once the pallet reaches seven layers, in-line stretch wrappers from WulftecWCRT-200(Mohan, 2011) stretch-wrap finished pallets. After that, the loaded pallets are moved, typically via fork-lift, to a warehouse, where they are stored or distributed directly to customers or vending partners, who then sell the products to the consumers.

Referring to Coca-Cola’s packaging system, they uses fully automated system in its packaging system. In our case, we examined the machines used in a new state-of-the-art plant for Coca-Cola Bottling Company United in Baton Rouge, Los Angeles. The machines used in its packaging system are no doubt conveyor belts, spiral conveyors, case packers, robotic palletizers, and of course, fully automated stretch wrappers.



Figure 1:One of the massive plants that Coca-Cola has to make and package its products.

3.3 Manufacturing System Implemented by Beverage Industries

3.3.1 Flexible Manufacturing System

In making sure that the packaging process run smoothly, most of the company implement Flexible Manufacturing Sytem(FMS) in their factories. Flexible Manufacturing System is a highly automated GT machine cell, consisting of a group of processing stations (usually CNC machine tools), interconnected by an automated material handling and storage system, and controlled by an integrated computer system.

Large company such as Coca Cola Flexible Manufacturing System (FMS) consists of robots, Computer-controlled Machines, Numerical controlled machines (CNC), instrumentation devices, computers, sensors, and other standalone systems such as inspection machines. Each Robotic cell or node will be located along a material handling system such as a conveyor or automatic guided vehicle. The production of each part or work-piece will require a different combination of manufacturing nodes. The movement of parts from one node to another is done through the material handling system. At the end of part processing, the finished parts will be routed to an automatic inspection node, and subsequently unloaded from the Flexible Manufacturing System.

3.3.2 In-Line Layout of Handling System

Besides, in-line layout of handling systems also helps a lot in the manufacturing process. For instance, Coca-Cola manufacturing performs line or flow layout, the arrangement of machines in the part processing order or sequence required. A transfer line is an example of a line layout. Parts progressively move from one machine to another in a line or flow layout by means of an automated roller conveyor. Typically, there are steps of Coca-Cola packaged on a line or flow type of layout, as all bottles of Coca-Cola processed require the same processing sequence of operations. All machining is performed in one department, thereby minimizing interdepartmental material handling.

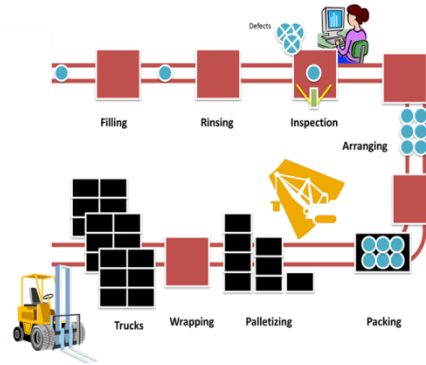


Figure 2: Coca-Cola Company's In-line layout

3.3.3 Loading and Unloading Stations

Loading or unloading stations also important since it is the physical interface between FMS and the rest of the factory. It is the place where raw work parts enter the system and finished parts exit the system. Loading and unloading can be accomplished either manually (the most common method) or by automatic handling systems. The load or unload stations should be ergonomically designed to permit convenient and safe movement of work parts. Mechanized cranes and other handling devices are installed to assist the operator with the parts that are too heavy to lift by hand.

The load or unload station includes a data entry unit and a monitor for communication between the operator and the computer system. Through this system, the operator receives the instructions regarding which part to load on the next pallet in order to adhere to production schedule. When different pallets are required for different parts, the correct pallet must be supplied to the station. When modular fixing is used, the correct fixture must be specified and the required components and tools must be available at the workstation to build it. When the part loading procedure is completed, the handling system must launch the pallet into the system, but not until then; the handling system must be prevented from moving the pallet while the operator is still working. All of these conditions require communication between the computer system and the operator at the load/unload station. (TauseefAized, 2010)

3.3.4 Material Handling System and Storage System

A flexible manufacturing system is a highly automated system consisting of a group of workstations interconnected by an automated material handling and storage system and controlled by a distributed computer system. It is capable of processing a variety of different part styles simultaneously at various workstations and the mix

of part styles and quantities of production can be adjusted in response to changing demand patterns. (TauseefAized, 2010)

3.3.5 Computer Control System

Computer-controlled manufacturing (CIM) is the manufacturing approach of using computers to control the entire production and packaging process of Coca-Cola drinks along the production line. This integration allows individual processes to exchange information with each other and initiate actions. Through the integration of computers, manufacturing can be faster and less error-prone, although the main advantage is the ability to create automated manufacturing processes. Typically CIM relies on closed-loop control processes, based on real-time input from sensors. It is also known as flexible design and manufacturing. The function of computer system consists of workstation control, distribution of control instructions to workstations, production control, traffic control, shuttle control, workpiece monitoring, tool control, performance monitoring and reporting and diagnostics.

3.3.6 Sensing System

Reputable company like Coca-Cola use high quality imported sensing & switches system, including proximity switches, photoelectric switches, electromagnetic switches, etc. That ensures the orderly production process also avoids possible damage for the machine. There are types of sensors such as pressure sensors, thermal sensors, motion sensors and so on. The Coca-Cola Company also looked at opportunities for improved lighting placement and installed a lighting sensor system to ensure optimal energy efficiency. (Coca-Cola Canada, 2009)

3.3.7 Inspection Devices

The production plant starts with syrup, concentrate or beverage base to create finished products which are packaged in PET or glass bottles, cans and cartons. Customers and consumers expect our beverages to be of consistently high quality. Coca-Cola Company aimed to meet and exceed their expectations. This commitment is underpinned by the international standard ISO 9001 and ISO 22000 as well as by their own Quality and Food Safety policy and the global standards of The Coca-Cola Company.

Coca-Cola HBC Ireland and Northern Ireland monitor production processes closely and have sophisticated control equipment and testing

programmers for key stages of the process. Electronic bottle inspection equipment on all refillable bottling lines is installed which can identify even the tiniest irregularity in the product.

The bottles are then visually inspected to ensure that they are clean, not chipped and not cracked. Each bottle is then passed through an electronic inspection, searching for the tiniest speck of dirt – bottles that do not match up to the quality standard are rejected and destroyed.

3.3.8 Programmable Logic Controllers (PLC's)

The automation of many electromechanical processes, such as the movement of machinery on an assembly line, is done through the use of small computers called programmable logic controllers (PLCs). A PLC contains a programmable microprocessor that is programmed using a specialized computer language. Typically, the program for the automated process is written on a computer and then is downloaded onto the programmable logic controller directly through a cable connection. The program is stored in the programmable logic controller in non-volatile memory. Various systems like material handling system, material storage system, load/unloading stations, etc. is programmed through PLC in order to streamline the operations in a flexible manufacturing system. PLCs consist of input modules or points, a central processing unit (CPU), and output modules or points. In many cases, a programmable logic controller allows all of the relays and timers within a factory system to be replaced by a single controller. Modern PLCs deliver a wide range of functionality, including basic relay control, motion control, process control and complex networking. They also can be used in a distributed control system (DCS).

3.3.9 Human Labor

In FMS, most of the work is done by automated machines and robots. There is hardly any need of a manual work or some human intervention. Therefore, in FMS, the labor cost becomes very low. Yet, there are some area still need operators to perform.

4.0 FINDINGS

Packaging ensures the quality of soft drinks produced and enables them to deliver safely to the customers and consumers. It can be carbon intensive in its manufacture and too often ends up in landfill, despite the fact that nearly all their packaging materials can be recycled. They change this and ensure that the packaging that they put on the

marketplace sets the standard for sustainability. They have established Sustainable Packaging and Recycling as an area in which they want to lead their industry. Their goal is to set the standard in low-carbon, sustainable packaging. Packaging accounts for nearly half of the carbon emissions in our value chain. To reduce this carbon footprint we must reassess our packaging from design to disposal and make better use of natural resources by using renewable and reusable materials and ensuring our own packaging is recyclable. (Coca-Cola Enterprises, 2013)

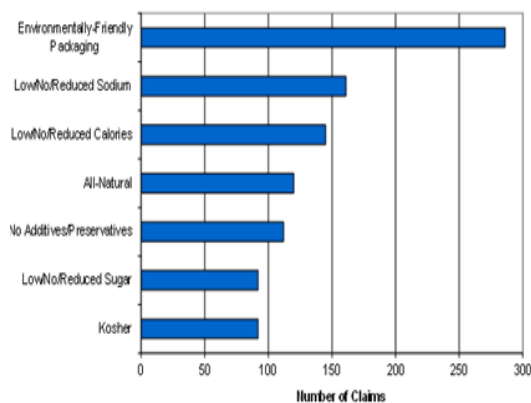


Figure 3: Top Claims of New Carbonated Soft Drinks 2008 - 2011

The use of robotics is widely spread in the 21st century. Robotic packaging system offers numerous advantages in nearly every industry that uses it. Nonetheless, there are also disadvantages of implementing robotic packaging system in the industry. Robotic packaging system ensures the quality of beverages and accuracy of the packaging done. Robotic packaging system has the capability of impressively meliorating the quality of the work and products. By using robotics in the packaging system, mistakes and errors can be reduced greatly as there are less human interventions in the process. Humans are tend to make more mistakes and errors especially when they are emotional and bored with the repetiting tasks. Robotics in packaging system can do very detailed work and follow precise instructions programmed initially by computers and numerical controlled machines (CNC). The quality of the work done is always of the same standard being materials are not wasted due to human error. Robotic systems can be reprogrammed to do different tasks. For example, a robot that was used to make one type of Coke (Coke Diet) could be reprogrammed to work with a new syrup, labeling and packaging. (The Gordon School, n.d.)

Quantity of production increases if robots are used for production and packaging purposes. The throughout speed rises, which directly has an effect on production. They have the capability to work at a

constant speed without the need to take short breaks, sleeps, vacations and some other time-consuming factors. In addition, robotics used in packaging system is able to work 24/7 which has the potential to package considerably more than a human worker. Thus, large amount of products can be packaged using shorter time. For example, automatic palletizing machine can palletized large amount of products at the same time, up to 1000 kg (2,200 lbs). (Robotic Palletizing vs. Conventional Automated Palletizing, 2011)

Besides that, robotic packaging system just require a few workers to supervise and inspect the packaging process. Thus labor cost of robotic palletizing is much lower than the manual packaging system. By using robotic packaging, the personal safety of workers can also be ensured and improved meanwhile the compensation claim for the injuries of workers will be reduced too. This is due to if using manual palletizing method to stack bottles into pallets, the workers may need to face the risk of repetitive injuries and accidents which caused by manual pallet stacking and loading action at workplace. Instead, robotic palletizing will pile the plastic crates on pallet perfectly and without error. The workers are moved to supervisory role which just inspect the machine operation.

One of the weaknesses of using robot packaging in the system is the initial investment of machine for business is quite significant, that is why the decision will makes the company faces the problem, cost of automation exceed the business's financial budget. Another issue is automated packaging machinery needs to train the employees to be expertise in programming. Meanwhile, in terms of return of investment, the automated packaging machinery will not guarantee the high return immediately. This has to depend on the owner has a good strategic business planning during facing any critical problem. Moreover, it is risky to implement robotic packaging system as when there's an electricity shut down, the production line will be stopped completely and this will lead to loss of profit.

5.0 DISCUSSION

Limitations. There are a few restrictions and problems that Coca-Cola company face. Firstly, during the packaging part, the soft drinks have to be delivered to packaging centers in bottles, cans and glass after the complete soft drinks is made up. This is happen when the possibility of the soft drinks must be protected because it may mix with another chemicals when transferring the Coca-Cola to the packaging house.

Next for manufacturing of primary input, the tactical issues that the production of Coca-Cola production

face is the quality inspection of the raw materials and components required.

In term of storage part, the process also may face some problems. Derek O'Donnell (2010) indicated that as Coca-Cola Amatil (CCA) outgrew its on-site warehousing facilities, stock was stored in multiple off-site locations which created numerous problems such as high levels of stock write-offs, site congestion and other health and safety risks.

If the stocks have been stored at different locations, the system throughput rate in which the hourly rate of storage or retrieval transactions will be low.

Suggestions. There are some steps should be taken to make sure that the highest standards in product quality, health and safety and environmental standards of Coca Cola are achievable. By referring to that responsibility, Coca Cola need to make sure that all operations brings their production and distribution of beverages to the same standards by creating an integrated management programme.

Coca Cola need to make a continually consistent checking on this matter especially on the ingredients. Most of the testing part should be focusing on is during the production process. Being their responsibility to check the quality from hygiene to product and packaging quality.

To ensure that each product meets specific requirements, Coca Cola use inpection (Coca Cola, 2011). Inspection is normally referred to as the sampling of a product after production in order to take corrective action to maintain the quality of products.

Referring to its high pallets storage requirements and their limited availability on-site space, the best solution is to maximize vertical height using crane fed automated storage and retrieval system. By doing this, the equivalent millions amount of products can be stored. The racking design was optimised to minimise both building and material handling cost (Coca-Cola Amatil, 2009).

6.0 CONCLUSION

Coca-Cola products packages help ensure the quality of their products and safe delivery of refreshment for billions of people around the world every single day. Packaging is the last stage prior to warehousing and delivery. This process also has become highly automated.

For the selection of product, we choose Coca-Cola. In order to deliver and distribute that large amount of Coca-Cola drinks, the last stage of production line which is packaging very important.

Our focus is on the products in the form of plastic bottles. Flexible Manufacturing System (FMS) are used which implement the used of robots, Computer-controlled Machines, Numerical controlled machines (CNC), instrumentation devices, computers, sensors, and other standalone systems such as inspection machines.

Meanwhile, for the production part, we have further discussed about the production of Coca-cola. Material handling system includes conveyor system, pallet racking system and powered truck and palletizing.

Assembly line in Coca-Cola production which includes blow moulding for plastics bottles, production of plastic screw caps, washing, filling, capping process and labelling process as well.

Finally come to the product storage of Coca-cola, they mainly used rack system and automated system to keep the stocks into store with high accessibility and stock accuracy. To summarize our job, the robotic packaging system of Cola-cola is worth to be studied.

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