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Case Study on Manufacturing Systems in Diamond Packaging

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Executive Summary

The case study was done at Diamond Packaging located at Rochester, NY. The plant was visited on 22nd November, 2013. The case study deals with the manufacturing systems used in the company. This study suggests improvements that can be done in the company to improve its productivity. This study deals with the implementation of JIT manufacturing system in the company Diamond Packaging Corporation.

1. Definition

Just-in-Time, as the name suggests, is a system which meets customer's demand with minimal lead time. The customer can either be an end-customer or a manufacturer who is a customer for a particular supplier. Just in time is a pull system of production, so actual orders provide a signal for when a product should be manufactured. Demand-pull enables an organization to produce only what is required, in the correct quantity and at the correct time.

2. Problem Statement

Diamond Packaging was founded in 1911; it is now a global industry leader specializing in developing innovative and sustainable packaging solutions. Diamond packaging designs and manufactures paperboard and plastic folding cartons, counter-top displays, blister cards, and sample packaging, and provides comprehensive contract packaging services. Diamond Packaging uses manual gantt charts for production scheduling, which is managed by a scheduling supervisor using hand written tickets to denote each job that should be performed on an hourly basis. Human intervention can cause many problems in the schedule this may lead to errors in scheduling which will result in increasing the lead time. The cutting blades on the dieboard are fixed by craftsmen in Diamond Packaging. These craftsmen are highly skilled and are growing old; Diamond packaging has no other skilled craftsmen other than the ones working at present. Due to the installation of the new Heigelberg Speedmaster XL 105 UV press printing machine, the gluing stations had to be relocated to accommodate for the printing press. The relocation of the gluing stations has increased the material handling time. The process layout of Diamond packaging was disturbed due to the space constraint.

3. Problem Solution

The solutions to the above recognized problems during the case study are as follows:

- It is recommended that Diamond Packaging uses a computerized system that provides real-time production information and scheduling. Diamond Packaging, a job shop, can find commercially available software that will meet their requirements. This will help the company overcome any problems due to human intervention and increase the efficiency in scheduling the production.
- Highly skilled craftsmen are designated to fix the cutting blades onto the dieboard. As of now the craftsmen are growing old and will need a replacement soon. It is highly recommended that Diamond Packaging train new craftsmen by having them work under the present craftsmen. The company can also install a computerized machine that can fix the blade automatically; reducing human effort and increasing reliability.
- The process layout of the company was disturbed with the installation of the Speedmaster XL 105 printers. With demand increasing on a day to day basis, the business is expanding, and Diamond Packaging should realize the need to expand the shop floor to keep the process layout intact. This eliminates waste due to material flow and improves the flexibility of the system.

4. Historical Background of Diamond Packaging

Diamond Paper Box Company was founded in 1911 by George and Harriet Snow as a supplier of folding cartons primarily for the garment and bakery industries. Boxboard was purchased from the Lawless Bros. Paper Mills in East Rochester, NY and transported to the company site on Water Street in downtown Rochester. The Genesee River was the primary source of energy for the original plant [5]. In 1935 Wayne Baumer, the general manager took over the business. Later in 1939, Wayne Baumer moved the operations from the four-story Water Street location to a 10,000 square feet one-story building on Somerton Street, off of Park Avenue, in the city of Rochester. An advertisement to sell the company was published in a local newspaper [5]. Ted Woodward, a local Certfified Public Accountant (CPA), and George Steininger, Quality Control and Motion and Time Manager for Rochester Folding Box, answered the advertisement and took up the ownership in 1948. Harry Voss a specialist in the paper and printing industry, who worked for the Oxford Paper Company in New York City, took over the company in the year 1963. The company flourished under Voss which by 1973 had reached $750,000 in sales and employed 13 new people [5].

Five years later Diamond Packaging moved its box operations to its current facility on Commerce Drive in Rochester with 23 employees. Within its first year in the new building, Diamond Packaging exceeded $1.8 million in sales [5]. In the year 1996 Diamond Packaging was awarded the ISO 9002 certification making its contract packaging division the first in North America to achieve that distinction. In about less than a year Diamond Packaging partnered with a German folding carton supplier, to form the North Atlantic Packaging Alliance (NAPA), in order to better service customers in the northern hemisphere [5]. The alliance soon expanded into the Global Packaging Alliance (GPA), with the goal of supporting international clients in launching new brands or products, while significantly reducing time-to-market.

Today, Diamond Packaging is a recognized global industry leader specializing in developing innovative and sustainable packaging solutions. Utilizing state-of-the-art technologies, Diamond designs and manufactures paperboard and plastic folding cartons, and provides comprehensive contract packaging services for Fortune 500 companies, including Bausch & Lomb, Beiersdorf, Coty, Elizabeth Arden, Estée Lauder, Godiva Chocolatier, Johnson & Johnson, L'Oreal, and Procter & Gamble [5].

5. Prototype Development

Diamond packaging uses Offset printing also known as offset lithography. In this method of mass-production, images printed on the metal plates are transferred (offset) to rubber blankets or rollers in the printer and then to the print media. The print media, usually paper, does not come into direct contact with the metal plates [1]. This prolongs the life of the plates. In addition, the flexible rubber conforms readily to the print media surface, allowing the process to be used effectively on rough-surfaced media such as canvas. The main advantage of this method is its high and consistent image quality. The process can be used for high-volume jobs. The plates needed for printing are prepared by diamond packaging using AGFA Elantrix 125 SX machine. The raw aluminum plates with emulsion are fed into the machine in which the required color profile and design is generated [1].

Before the advent of computer systems and modern automated machines, it is a known fact that humans were the primary resource in any manufacturing industry. Similarly, the mechanical artwork at Diamond Packaging was created by a group of skilled graphic artists. The graphic images were created by hand. These elements were then "pasted" to a piece of illustration board over a hand drawn die line. This artwork was then photographed on a black and white graphics arts camera [1]. From the original film negative produced by the camera, skilled prepress people separated the different color elements into separate film negatives for each color [1]. This process was carried out in a dark room; upon completion of this process they would have 1 film negative for each color that was to be printed. Each of these films was then step and repeated to match the multiple up cutting die on a printing plate.

6. Machinery used in the production process

The two major machines that are used in Diamond Packaging are:

- Heidelberg Speedmaster XL 105 UV Press
- Bobst ExpertCut 106 PER die cutter
- Gerber Profile Series Diemaker

6.1 Heidelberg Speedmaster XL 105 UV Press

- The Preset Plus Feeder reduces the makeready time since the entire feeder is adjusted automatically by a computerized system. A central suction tape with air pressure settings sucks the sheets at a high speed and a speed-compensated rotary valve for sheet separation 1ensures reliable sheet transport [3]. The multi-stage sheet monitoring system provides greater reliability. The pneumatic pull lay gently aligns the sheet for transfer to the printing unit.
- The Prinect Inpress Control inline system in the printing unit automatically measures and controls color in the press and at all speeds for faster setup, less waste and greater productivity [3]. Programmable cloth washup devices help the environment by minimizing the amount of washup solution and the number of washup cloths used [3]. The Air Transfer system's venturi nozzles help ensure contact-free sheet transport through the press and the volume of air required can be defined at the Prinect Press center based on format and material thickness.
- The machine consists of two coating units. These coating units are for special coatings like gloss, shine and holographic coatings on the sheet.

Figure 1

- The printing press consists of a control station of the printing press. It is highly flexible with a wide range of options with which the operator can choose the printing parameters. Figure 2 provides the display of the control station. This system is integrated with color measurements and control systems for high quality control. The operator has full access to this quality system and can modify the color density based on the requirements

Figure 2

6.1.1 Advantages

This machine satisfies most of the demands in terms of quality and production. Two of these machines were installed in Diamond Packaging in order to improve the productivity of the plant. The following are some of the advantages of the machine which helps the company to achieve its goals and satisfy customer demands on time.

- It provides high production speed and printing precision at the same time reducing the overhead.
- It can communicate electronically with prepress via its patented CIP3 system which helps to make the process more automated.
- The Heidelberg also makes use of new technologies that reduce the amount of paper, water, and chemicals used in the printing process, making it one of the most eco-friendly presses.
- Speedmaster XL 105 has faster setup which reduces the downtime of the machine and helps to achieve JIT.
- The coating unit produces results which meet the quality standard of the company and satisfy the demands of the customer.

6.2 Bobst ExpertCut 106 PER die cutter

- The cam driven platen of the die cutter delivers superb quality and high net outputs. The BOBST system increases the time available for each sheet to pass so that it can be transported smoothly through the die-cutter while at the same time reducing wear on cutting tools.
- The center line unit of the die cutter guarantees fast and precise tool positioning. It delivers quick machine set-ups, increased up-time, and superb finished product quality [2].

Figure 3

- The Bernoulli tablets in the die cutter controls the flatness of each sheet as it stops for cutting, stripping and blanking; maintaining the quality of the outgoing sheet. The unit has an automatic self-cleaning system for reduced maintenance and increased reliability of the machine.
- The automatic in-line waste stripping station on the die-cutter is designed to remove even the smallest pieces of waste at full running speed [2]. Using dedicated or universal tooling, the station is up and running in no time, delivering outstanding performance and quality immaterial of the job.
- The die cutter comes with an automatic in-press blank separation that delivers perfect balance of force and finesse needed to blank sheets separation.

6.2.1 Advantages

The quality of the product is very important as it will reduce the necessity to rework on the defective products. Since, Diamond Packaging is a job shop; the use of modern machines is a must. The various features of this machine used in Diamond Packaging helps the company in reducing the lead time and achieving JIT. The advantages of this machine are as follows.

- The various units mentioned in the above section boosts productivity, improve quality, optimize ergonomics and improve the availability of the machine.

- Automatic Pile Transfer (APT) reduces manual intervention and ensures a continuous supply of material. APT can also be integrated into your in-house logistics, piloting work from print to die-cutting, and on to downstream processes. This reduces the possible human errors as it is automated.
- The die cutter involves with sheet handling automation. It calculates the optimum sheet feeding interruption based on the thickness of the carton. Considering the number of tie-sheets that need to be inserted, this new system delivers substantial time, output, and financial gains to users.
- The machine makes job changeovers simpler and faster than ever before. Dedicated tools can be fitted straight into the die-cutter with the assurance that they will all be perfectly aligned and ready to run. A single stop button brings your machine to a halt in the perfect position to carry out a job changeover. This reduces the human effort and increases the productivity of the machine.

6.3 Gerber Profile Series Diemaker

Gerber Profile is a diemaker that uses Computer Aided Manufacturing (CAM) system to profile the die. The software used is called diemaker [4]. It is a digital rotary machining process; it has a carbide conical cutting tool that cuts a dieboard into two layers. Each layer formed is a mirror image of the other. The two layers are joined with a high-performance adhesive and with the help of a profile press, the layers are laminated together to form an exceptionally strong and durable dieboard. Further the cutting blades are cut and precisely fixed on the dieboard by highly skilled craftsmen manually, only the fixing of cutting blades to the dieboard is the manual operation involved in die making. Figure 4 shows the Gerber profile diemaker used in Diamond Packaging.

Figure 4

7. Production Process

The type of process used in Diamond Packaging is a high-volume batch production. The raw materials required for production are: white paper rolls, ink and raw aluminum printing plates.

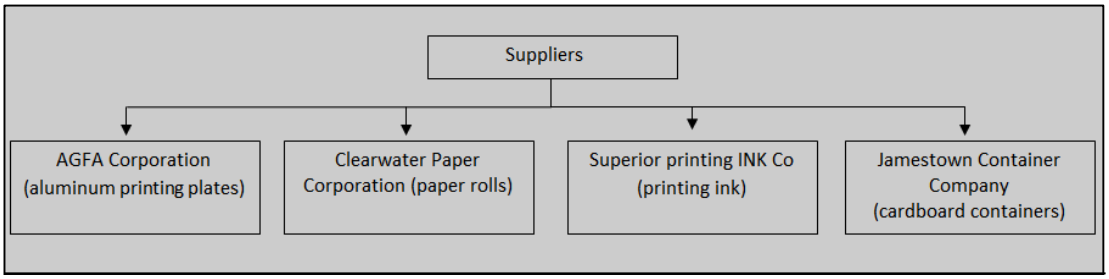

Figure 5

The raw materials are supplied by trusted suppliers based on the need as per the production schedule. The white paper rolls are stored in the warehouse that is located close to the production plant. The materials are transported to the production plant and an in-house inventory is maintained to meet the production capacity of the plant and avoid interruptions in the production. Diamond Packaging has a dedicated cell for ink mixing and blending within the production plant that is supervised and managed by Superior Printing Ink Co [1]. Superior Printing Ink Co employees at Diamond Packaging have access to the production schedule and the ink required is provided on time reducing the lead time for production. Jamestown Container Company supplies cardboard carton boxes for packing and shipping of finished goods. AGFA Corporation supplies the raw printing plates for Diamond Packaging

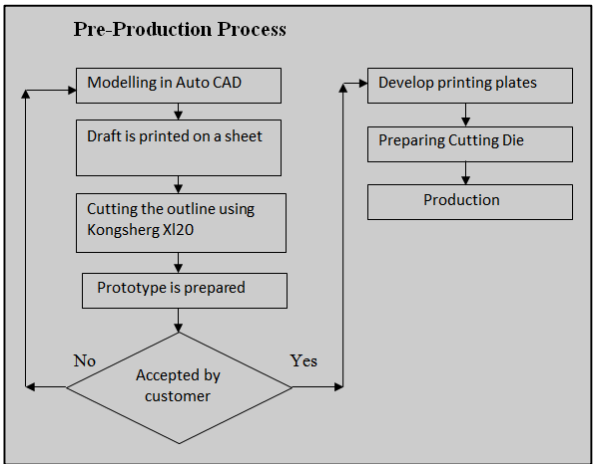

Figure 6

Figure 6 describes the pre-production process that takes place in Diamond packaging once the work order is received. The design is often given by the customer with the appropriate requirements specified. The design team is takes up the design from the customer and responsible for the designing of the prototype. The 2D drawing of the design is designed using AutoCAD by Diamond Packaging. The design is then printed using printers and is exported to the cutting machine Kongsberg X120. The cutting machine records the co-ordinates using a laser and the outline of the design is cut out precisely using a cutting tool. The co-ordinates of the design are manually taught by the operator. The prototype is now ready; a customer representative is called in for checking the specifications and finalizing the design. Once the prototype is accepted and finalized by the customer, the printing plates and cutting dies are developed and prepared respectively making the design ready for production.

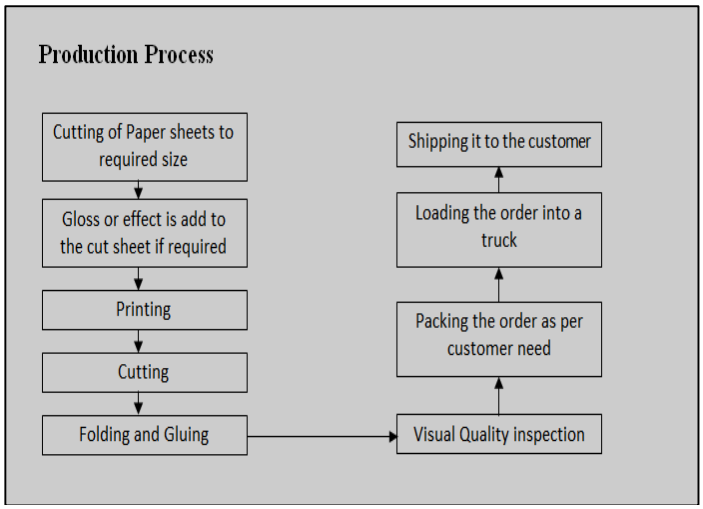

Figure 7

It is a costly process and is done only when emphasized by the customer. The printing is done using two Custom-Configured 8-coloured Heidelberg Speedmaster XL 105 UV Presses. The Speedmaster XL press is a special double coating configuration with initial flexo dispersion coater, four modular deliveries, and full interdeck UV capability. The entire printing setup is completely automated and is thoroughly monitored by a supervisor. The supervisor inspects one in every 500 sheets and is responsible for checking and maintaining the quality of print. The printed sheets are unloaded and transported to the die cutting machine with the help of a fork lift.

Diamond Packaging uses a Bobst ExpertCut 106 PER die cutter machine to cut out the required printed area of the sheet leaving behind skeleton of sheets that are sent for recycling. The cut out pieces are stacked one on top of the other and sent to a folding and gluing station. The folding and gluing station uses a conveyor system; an Electronic Article Surveillance (EAS) tag is pasted on the final product as per the customer's requirement. The finished goods are visually inspected for defects and are packed into several carton boxes that are loaded into the trucks and sent out for delivery. The good that are finished before the delivery time are stored in the warehouse and the goods that are to be shipped at the earliest is given a higher priority and shipped to the customer. The transportation of finished goods to the warehouse and to the customer is carried by a local truck company.

8. Quality Management System

Diamond Packaging uses World Class Manufacturing (WCM) methodologies and Total Quality Management (TQM) techniques. Figure 8 depicts the techniques used by Diamond Packaging in its quality system. The four quality management methods used are: Total Industrial Engineering (TIE), Total Quality Control (TQC), Total Productive Maintenance (TPM) and Just in Time (JIT) [5]. TIE narrows down all the possible wastes hence improving the productivity of the system. Total industrial engineering is a system of methods where the performance of labor is maximized by reducing Muri (overloading the system), Mura (irregular operation) and Muda (non-value added operation). TQC deals with maintaining the quality of the product being produced in every station hence achieving a high quality final product with minimal defects [5]. The aim of TQC is to achieve products with zero defects. Diamond Packaging being a JIT is prone to have a cramped production schedule; therefore, Diamond packaging implements TPM and conducts preventive maintenance at regular intervals

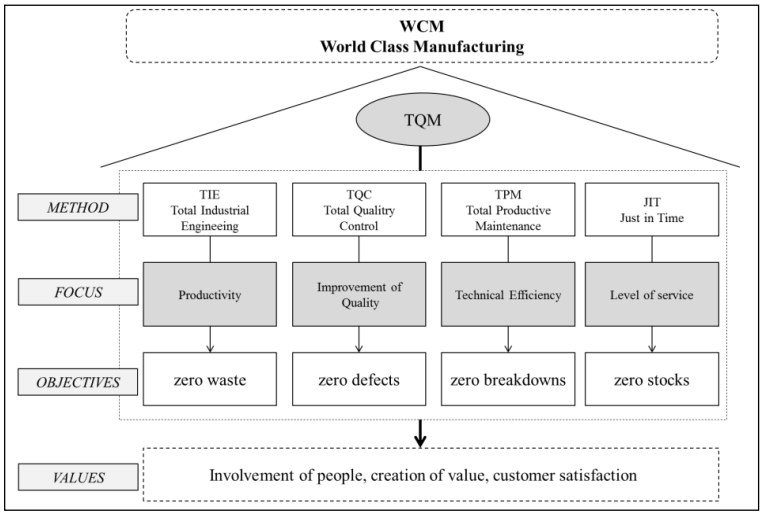

Figure 8

Diamond packaging implements JIT and maintains less on hand inventory to eliminate defects and improve the quality of the system. There are quality control meetings every day in the plant where they discuss about quality issues the plant is facing and come up with solutions to overcome the problem. The quality team takes care of all the issues related to quality. Futhermore, NSF International Startegic Registrations has certified that the Quality Management System of Diamond Packaging conforms to the ISO 9001:2008 standards [5].

8.1 Spectrophotometer

A spectrophotometer is employed to measure the amount of light that a sample absorbs. The instrument operates by passing a beam of light through a sample and measuring the intensity of light reaching a detector Quality control systems are installed in all departments that are used to monitor quality. The Heidelberg Speedmaster XL 105 UV Press has a built in spectrophotometer. The spectrophotometer is the device that scans printed sheets periodically and makes adjustments to the ink density to maintain proper color and quality of the ink being printed on the sheets [1].

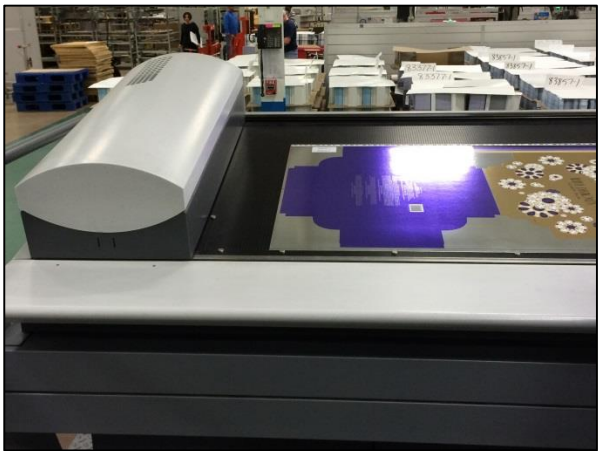

Figure 9

The Figure 9 shows a printed sheet that is kept on the spectrophotometer that is yet to be scanned. The sheet is then scanned and the supervisor checks for the quality specifications. Typically a scan is done for every 300-500 sheets depending on the quantity being produced.

9. Forecasting

Diamond packaging does not use any forecasting methods because the customers demand cannot be predicted in advance. Since the product design and specifications are different for every customer, it is impossible to forecast the needs and demands of each and every customer [1].

10. Inventory management

The primary inventory that Diamond Packaging has to maintain is the paper rolls supplied by Clearwater Paper Corporation. The paper rolls are ordered based on the order quantity of the incoming work order; this reduces the need to have large inventories stacked up in the ware house.

Figure 10

The ink required for printing is supplied Superior Printing INK Co. The in-house inventory for ink in Diamond Packaging is managed by Superior Printing INK Co to meet the daily demand at Diamond Packaging. Figure 10 illustrates the in-house inventory of paper rolls in the job shop production floor [1].

11. Preventive Maintenance

Preventive maintenance is very important and critical for Diamond Packaging as it implements a JIT. It is mandatory a JIT system cannot afford for loss in production due to downtime. Downtime disrupts the entire system and leads to increase in lead time, bottleneck formation and long waiting lines. Diamond Packaging has a full maintenance department round the clock, twenty four hours a day [1]. The monthly and weekly preventive maintenance of machines are scheduled based on the manufacturer's recommendation and is reflected in the production scheduling chart. The maintenance department employees are well trained in all the equipment used by Diamond Packaging.

12. Production Scheduling

An entire room at Diamond Packaging is dedicated for production scheduling [1]. The technique used is similar to that of a Gantt chart used for production scheduling. The room consists of a lucid visual chart shown in Figure 11. The rows in the chart represent a machining operation (printing, die cutting, foil stamping and gluing). Every job is represented by a separate ticket and is placed on the timeline of the chart in advance so as to meet the customer's demand on time.

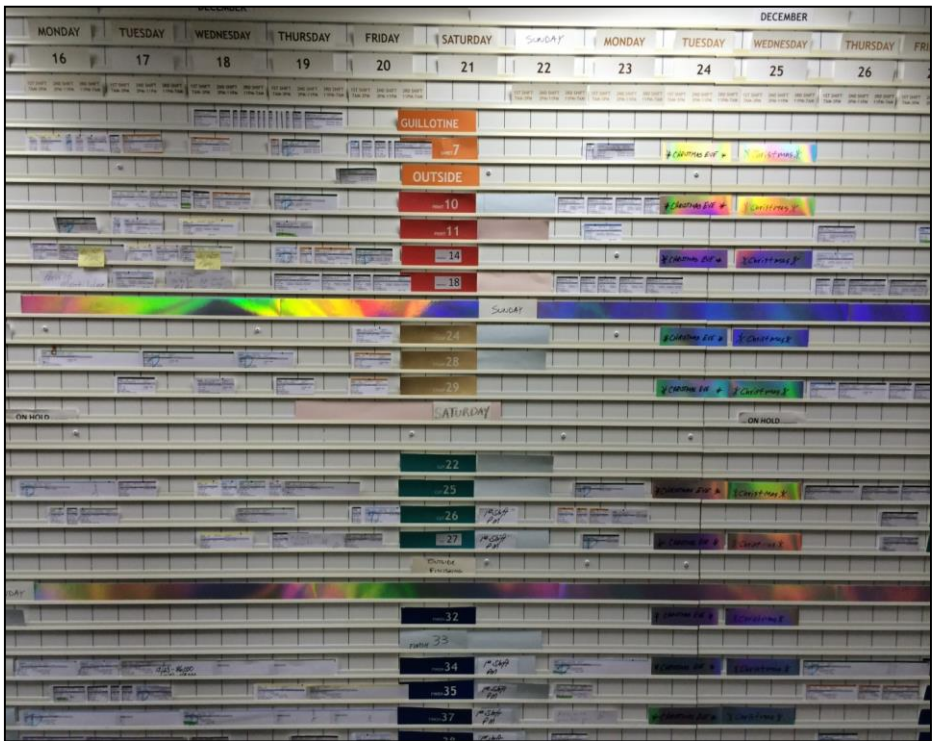

Figure 11

The production process is also managed by the same chart. The chart's timeline is divided right the months to hours of operation; a day consists of three shifts. The tickets are arranged according to the operations involved in a work. As soon as the order is received from the customer, the production supervisor generates a ticket and places it in the timeline of the chart; this decides the start and end of each production. The ticket is taken off the chart once a particular work is completed.

13. Conclusion

The case study was done on the manufacturing system at Diamond Packaging. During the visit, the job floor activities were observed and analyzed. This case study gives a detailed explanation of all the activities involved in production right from modelling the design to the final produced product that is ready to be shipped. The study also recognizes the opportunities for improvement that can be implemented in the company with appropriate suggestions.

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