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**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY****AUTOMATION OF A STORAGE SYSTEM MATERIALS FOR A
MANUFACTURING COMPANY****Cruz Jiménez, B.^{*1}, Avilés Viñas, J.¹, Ordoñez López, E.¹, Contreras Rivero, J.¹ & Montañez
Rufino, M.¹**^{*}Faculty of Engineering, University Autonomous of Yucatan, MexicoDOI: <https://doi.org/10.29121/ijesrt.v10.i12.2021.2>**ABSTRACT**

Nowadays, any company that wants to compete in its sector must focus on offering in its processes and products: quality, reliability, speed and flexibility at the same time that it must worry about being profitable. Therefore, it is important to keep competitive the industries through the improvements and optimization of their processes; this can be achieved through an analysis of their processes and thus determine the best short, medium and long term technological strategy to implement. The company to analyze focuses on the manufacture of packaging for the products of its customers, offering innovative and high-quality packaging, as well as ecological. In addition to this, the company invests in technology to improve its manufacturing operations, currently one of the key processes that requires automation is the transfer and storage between the operations of corrugated and engraved because they are causing downtime and delays in the deliveries to the customer.

Warehousing is the function involving storage and retrieval of raw materials, components, and finished goods as well as shipments of goods. However, auto-store is a new way of thinking when it comes to warehousing where main purpose for the product is to improve the quality of the internal logistics. The automation proposal is an automatic storage and retrieve system that streamlines the process and improves customer response time by analyzing the production strategy, plant distribution and production processes of the company.

KEYWORDS: automation, automatic storage, productivity, manufacturing.**1. INTRODUCTION**

Automation in Mexico has grown significantly in recent years due to the global trend we see today regarding industrial competition, the internet of things and the digital transformation that needs to be implemented in different industries. Some of them, for two or three years, have accelerated the pace in automation such as the automotive industry, in accordance with the cycles and continuous changes of car models that the market requires and demands. In the same way, the food and beverage industry accelerate automation in Mexico, especially in global companies that have a presence in our country and whose focus is to update their existing production lines so that they are more flexible and that they can handle different presentations. or new products.

The manufacturing industry has undergone an unprecedented degree of change; changes in management, process technology, customer expectations, supplier attitudes, competitive behavior, and many other aspects. Along with these changes, the points of view of the companies have changed, regarding the administration and way of doing business. In fact, all the evidence suggests that change is now a permanent feature of the business environment and companies that can adapt to this new environment will gain a significant competitive advantage.

With product life cycles shortening and profit margins shrinking, it has become imperative for manufacturing plants to approach their processes from new perspectives. Flexibility represents one of the most important perspectives to consider improving manufacturing performance. There are factors that industries depend on to accelerate automation. Among them, some linked to the prices in the market of the final products they make.



The growth of automation is based on new technologies that are implemented in production lines and industrial manufacturing processes, such as smart sensors, 3D printers, big data, virtualization, augmented reality, robots, automatic storage systems (AS / RS) and autonomous vehicles (AGV). All of them help to operate under the concept of the connected company, in addition to generating a convergence between the world of operation technologies (OT) and information technologies (IT), with the aim of achieving flexibility of products and manufacturing times more speed, reduction of operating costs, improvements in the use of assets, efficient handling and logistics of the final product, as well as an increase in the safety of its production lines and processes. Automation in warehouse systems improves efficiency in transportation and production, it also coordinates the supply of raw material and product demand and in some cases the warehouse can be part of the production process, which impacts the flexibility of a company to respond in an agile way to changes in the product, the demand and the market.

In this paper, an automation proposal is presented using a warehouse system by analyzing the production and distribution strategy of the manufacturing company plant, in order to reduce damage to the final product and maintain quality, allow a quick localization, which will benefit in a quick response to the client, and reduction in production costs.

2. MATERIALS AND METHODS

2.1 Company context

The company to be analyzed focuses on the manufacture of packaging for its customers' products, offering innovative and high-quality packaging, as well as ecological ones. It is an ISO 9001-2015 certified company, committed to designing and manufacturing high quality packaging, providing a high level of service and seeking customer satisfaction through continuous improvement in its processes. The star product is cardboard boxes made from corrugated paper, manufactured with recycled raw material and with flexographic printing according to the end customer.

Currently the company has automatic and semi-automatic machinery and some manual processes to satisfy the demand that is close to 90 tons per month. The level of automation handled by the company is considered flexible, due to the changes that need to be made to meet customer specifications. The box manufacturing process is by batch, since the dimensions and impressions are unique. Characteristics between orders are not repeated.

2.2 Production process

The cardboard box production process begins with the receipt of the purchase order and ends when the product is stored. The process is described as follows: Once the purchase order is received, a roll of paper is placed in the corrugated machine, where the cardboard is glued, cut and folded to manufacture the batches requested by the customer; later it goes on to engraving to print the logo, brand and other specifications of the client. Finally, the batch goes to die-cutting where it acquires its final shape to be covered with plastic wrap and stored. In Figure 1, you can see the AS-IS diagram of the process.

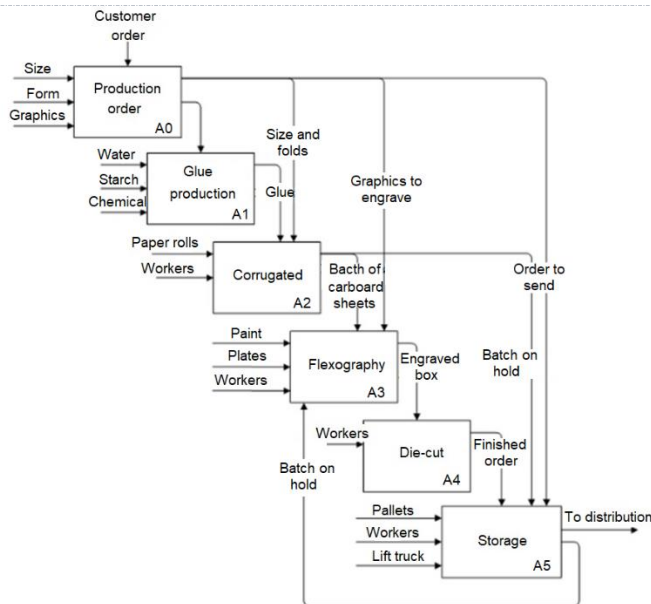


Figure 1. AS-IS diagram of the box manufacturing process.

2.3 Problem identification

A key process to automate in the manufacture of cardboard boxes is the transfer and / or storage of an entire batch between the corrugated and engraving processes, due to the following:

1. Products in a batch are handled using pallets.
2. The pallets are transported by forklifts.
3. Storage requires manual control, as it must be classified according to purchase orders and shipping logistics.
4. There is limited space for storing the finished product, making it difficult for forklifts to access for loading and unloading the product.
5. The preparation time of orders for shipping is very long due to how difficult it is to locate and access them in the warehouse.

In Figure 2. The AS-IS diagram of the “Storage” process identified as A5 in Figure 1 is presented. We can see the manual action of the operators and the different movements between the processes.

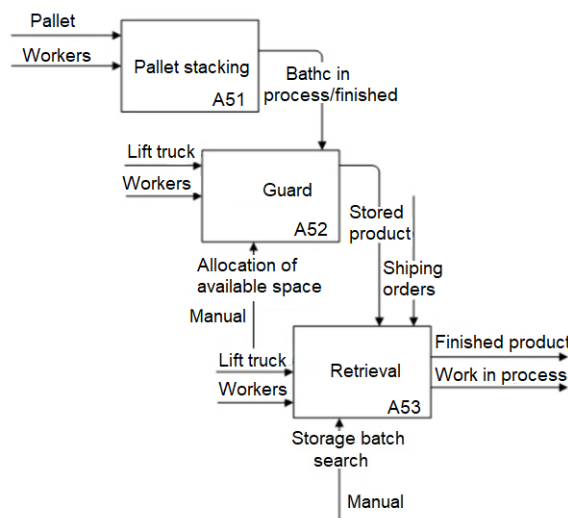


Figure 2. AS-IS diagram of the storage process.

The transport of the product in forklifts, together with the poor distribution and logistics of the products, negatively impact important management indicators such as:

- Productivity indicators.
- Time indicators.
- Quality indicators.

2.4 Automation proposal

The proposal aims to automate the handling of materials. For this, you need:

- Use an automatic storage and retrieval system (AS / RS) to receive, classify and store pallets according to orders and delivery parameters to the customer.
- Modify the current plant layout to allocate a space according to the dimensions of the storage and recovery system.

With the introduction of the AS / RS, the "Storage" process presented in Figure 2 would be modified by the one observed in Figure 3.

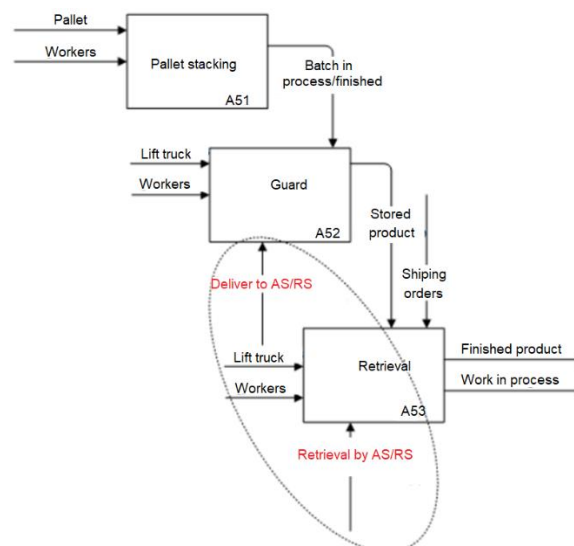


Figure 3. TO-BE diagram of the storage process.

With the above, it will be possible to reduce the time spent storing finished or in-process products, as well as the complexity of handling them when they enter the warehouse. In the same way, it will improve the organization of the warehouse which will allow a quick retrieval of purchase orders and an efficient delivery to the customer. It is important to mention that it would also benefit the quality indicators since they would reduce the damage to the finished product, due to the difficult handling of packages in the warehouse.

3. RESULTS AND DISCUSSION

The following stages are proposed for the implementation of the AS / RS system:

- System design. At this stage, it is necessary to define the capacity of the system, as well as the dimensions so that it perfectly adjusts to the needs of the plant.

The proposed AS / RS system is of unit load, so it is necessary to define the dimensions of the pallets (width, length and depth). The general design of the unit load AS/RS is presented in Figure 4.

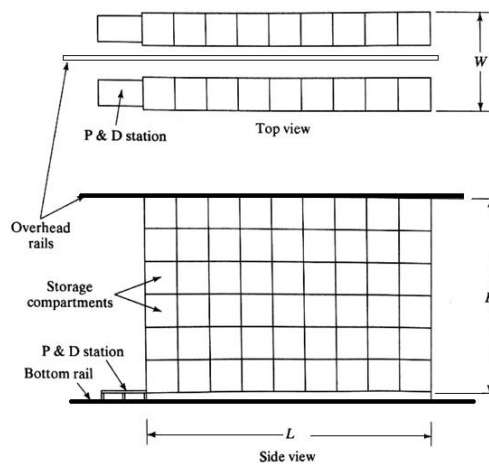


Figure 4 Representation of a unit load AS/RS.

To obtain the specific parameters of the AS / RS the following is necessary:

- Define the maximum system capacity:

$$\text{Maximum capacity} = 2n_y n_z \tag{1}$$

From (1) the variable n_y is the maximum number of pallets that can be placed in an aisle and n_z is the maximum number of pallets that can be stacked upwards.

- Define the dimensions of the system: the dimensions are the variables W (width), L (length) and H (height) of the AS / RS, these can be seen in Figure 4.

$$W = 3(x + a) \tag{2}$$

Where x is the width of the pallet and a is the design tolerance between each compartment of the AS/RS with respect to that dimension, this is followed in in or mm. We calculate the length and the height of the unit as:

$$L = n_y(y + b) \tag{3}$$

$$H = n_y(z + c) \tag{4}$$

Where y is the length and b is the design tolerance between each compartment of the AS / RS with respect to that dimension, this is followed in in or mm and z is the height and c is the design tolerance between each compartment of the AS / RS with respect to that dimension, this is followed in in or mm.

- B. Search and selection of equipment in the market. Knowing the dimensions of the system required in the plant, the technology for its acquisition is quoted in the market and with different suppliers.

The key in selecting suppliers of a product or service lies in the importance of knowing what criteria to use to select them, since it must be taken into account what type of impact the products or services they offer will have and whether this will be a positive impact. with the productivity, quality and competitiveness of the organization itself. For the selection of the supplier, it is suggested to consider the increased characteristics of this, that is, to provide support, maintenance, guarantee, etc.

- C. Acquisition of equipment. Once the supplier has been selected, we proceed to purchase the equipment with the characteristics determined for its implementation.
- D. Redistribution of equipment in the plant (Modification of the layout). For the implementation of the AS/RS system it is necessary to free the space it would occupy. At this stage it is also suggested to reorganize the teams to facilitate transport movements and improve times. This can be very beneficial for the company, even if the modifications are not directly related to the storage system.
- E. Equipment installation. In this stage, the supplier assists the plant to install the equipment according to the specifications given in stage 2. This stage also includes the functional tests, as well as the calibration of the system to avoid accidents, damages or any other imperfect.
- F. Staff training and awareness. Once the equipment is installed and working correctly, it is necessary to train the personnel who will be in charge of the system, as well as the supervisors of the area, it is also necessary for the workers to identify the advantages of using it so that they do not reject the change.
- G. Observation and analysis. During this cover it is necessary to leave the system working for a while in order to collect important information for analysis. Some of the data that are useful and need to be collected are: recovery time, storage time, number of incidents with the finished product, among others. In the same way, this stage is key to verify anything with the provider in case of any failure, error or guarantee.
- H. Evaluation of results. Finally, since there is information and the system has been operating for a considerable time, a comparison can be made between the management indicators, to see the impact that the technology had.

4. CONCLUSION

The automation of the storage system is proposed through the implementation in the plant of an AS / RS system that receives, classifies and stores the pallets according to the orders and delivery parameters to the customer; in the same way, it will allow to recover a batch quickly and easily, which increases the efficiency and productivity of the company.

The proposal presented here is considered viable due to the high market demand, since, being a product of constant consumption, the possibility of reducing and / or eliminating the stored products is very low, which forces to look for an option automation that allows saving space and resources, as well as accessing and locating the product easily and quickly.

The changes proposed for the implementation of the proposal involve structural aspects, such as the redistribution of the plant, but also social aspects such as training and raising awareness of personnel regarding the use of automation technology.

Finally, the implementation of automation will achieve a positive impact on the company's management indicators, as well as increase the satisfaction rate of employees when performing their tasks more efficiently. This will be reflected in the increase in the profits of the company.

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