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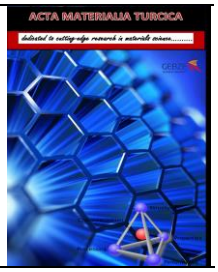

Production Productivity by Automation Application in Manufacturing Industry

A. S. VANLI[a]*, A. AKDOGAN[a], S. FIRAT[b], M. KOCAMAN[b]

[a]*Yildiz Technical University, Department of Mechanical Engineering, 34349, Besiktas, İstanbul, Turkey*

[b]*Mesan Furniture Equipment, 34590, Silivri, İstanbul, Turkey*

Abstract:

One of the fundamental quality philosophies of ISO 9001 Quality Management System Standard certification is "improvement" approach. All organizations, aiming at quality products and quality systems, can expand their customer networks and ensure customer loyalty only as long as they constantly improve themselves. Improvement of quality leads to increases in productivity, it decreases in production costs and sales prices, thus increasing competitiveness in local and global markets could be reached. In this study, an increase in productivity with an automation cell installation is shown in a plastic and metal injection factory which produces accessories in furniture sector. This fully automatic programmable logic controller (PLC) controlled assembly cell provides high quality assemble of shelf supports and fixing parts. The fully automated PLC controlled assemble system is for installation of shelf carrier and fixing parts with centering pin with nail. The production is realized with station-based pneumatic automation system. In addition to labor and energy savings, it has contributed to the increase in productivity with shorter injection times achieved by reducing raw material quantities through part design modifications realized within this study.

Keywords: Mass production; Quality Assurance; Productivity; Automation; Assemble.

DOI:

1. INTRODUCTION

ISO 9000 quality management system standard family helps to direct and control an organization with regard to quality generally includes establishment of quality policy, quality objectives, quality planning, quality control, quality assurance, and quality improvement. This standard applies a process approach that includes Plan – Do – Check – Act (PDCA) cycle and risk-based thinking aiming to take advantage of opportunities and prevent unwanted results. Identifying risks and opportunities provides a basis for increasing the effectiveness of the quality management system, accessing improved results and preventing adverse impacts [1].

As explained in the "Deming's Chain Reaction" in Figure 1, organizations tried to improve their systems to reach improved quality processes. This improvement helps doing processes right for the first time, without reworking, time-wasting and scrap. Improvements in the organization's performance help to improve productivity inevitably. Better productivity implies lower production cost. Cost reduction allows companies to decrease prices as an advantage in competitiveness. After that, increased sales, gaining market share, new customers and customer loyalty would be supplied [2].

Today, in manufacturing environments most industrial processes are automated with the goal of reducing the cost of labor and improving production

*Corresponding Author E-mail: aliserdarvanli@hotmail.com

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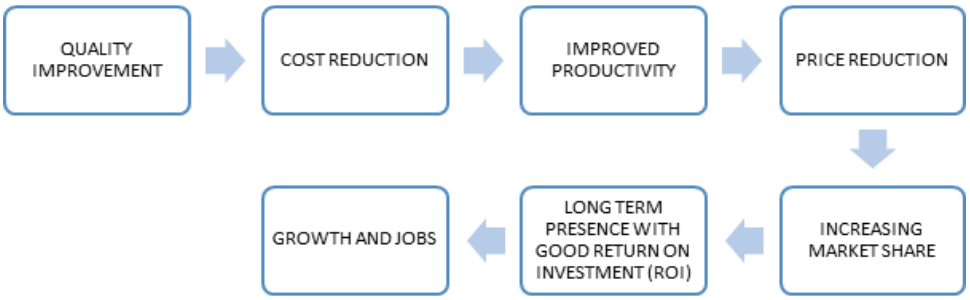

Figure 1. Deming chain reaction.

productivity. Certainly, industrial automation has great advantages in activities that were previously carried out manually. Programmable automation is a form of automation for producing hundreds of thousands of workpieces in mass production environments. In order to move parts between the stations, we use automated production lines consisting of a series of workstations connected by a transfer system. Each station is designed to process a specific operation. Modern automated lines are controlled by programmable logic controllers. Moreover, assembly operations are traditionally performed manually in single assembly workstations or in multi-station assembly lines. Due to the high labor work and cost, more attention has been given to the use of automation for assembly work in the last recent decades. If quantities are large, the product is small, and the design is simple, assembly operations can be automated using production line principles. For products that do not meet these requirements, manual assembly is often required [3]. There are works detailing on manufacturing automation using at least considering one of the computer aided systems [4-6]. Some papers subjected to present the effects of gathering and analyzing data across machines in Industry 4.0, enabling faster, more flexible, and more efficient processes [7, 8].

In this study, an increase in productivity with an automation cell installation is shown in a plastic and metal injection factory which produces accessories in furniture sector. This fully automatic PLC controlled assembly cell provides high quality assemble of shelf supports and fixing parts. In addition to labor and energy savings, it has contributed to the increase in productivity with shorter injection times achieved by reducing raw material quantities through part design modifications realized within this study.

2. FULLY AUTOMATIC PLC CONTROLLED ASSEMBLE CELL

Experimental works of this paper have done in Mesan Plastic Company which manufactures accessories in furniture sector by injection of plastics and metals like Zamak, Aluminum and Zinc alloys. Since its establishment, Mesan has always been a customer focused company that prioritizes its satisfaction by quality works and certificated by ISO 9001 Quality System Standard in 2002. With this work, the design and manufacturing of a fully automated PLC controlled assemble system for installation of shelf carrier and fixing parts with centering pin with nail is successfully done for the use in the furniture industry.

Due to its design and assembly structure, there were some problems in product and usage of shelf carriers and fixing parts in furniture assembly phase. Particularly due to the fact that the Zinc alloy body is separated from the plastic body and/or is not in the correct direction, no refund or new orders were possible. After a large benchmarking work of us we recognized the following conclusions in design stage of the project. Firstly, our competing companies made the nail by melting the plastic body with heat treatment after assembly to prevent the Zamak body from coming out of the plastic body. Secondly, the product thickness is optimized to remove collapses from the plastic body. Finally, a barrier is set to prevent the deviation of Zamak body from the right direction in the plastic body after installation. On the other hand, due to the importation of products of foreign origin, domestic user companies need to work in stock. This leads to an increase in inventory costs and an extra financial burden. The products (left) and the assemble types (right) are shown in Figure 2.

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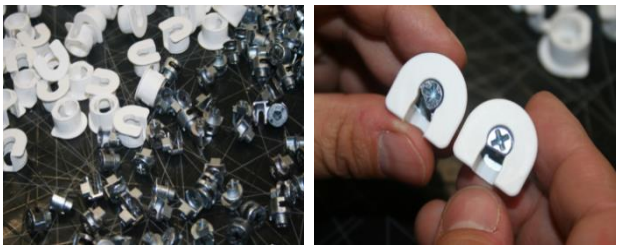

Figure 2. The products (left) and the assemble types (right).

Designing new products to solve existing problems, developing the assembly platform that can make error-free product assembly, making revisions on the assembly platform and the product to minimize the quality problems, increasing sales quantities and finding new customers are the main aims of the project.

At the design stage of the assemble cell, we examined our manufacturing experience and cost in the past, we decided to produce with plastic and Zinc alloy injection according to our prediction. Moreover, considering the quality, quantity and cost, it is envisaged that the production will be realized with station-based pneumatic automation system. In addition, suitable wedges for vibration noises, missing or defective products detect and control systems were chosen. Design and material criteria of machine body and vibration channels were done. Die designs were made. Pneumatic system designs were completed. PLC control system is chosen. The designed and manufactured fully automated PLC controlled assemble system is shown in Figure 3.

3. RESULTS and DISCUSSION

With this work, the design and manufacturing of a fully automated PLC controlled assemble system for installation of shelf carrier and fixing parts with centering pin with nail is successfully done. With this automated assemble project, to ensure the accumulation of knowledge for the company and its employees, to reach a competitive position by minimizing labor and raw material costs were succeeded. The processed assemble product gains are listed in the Table 1.

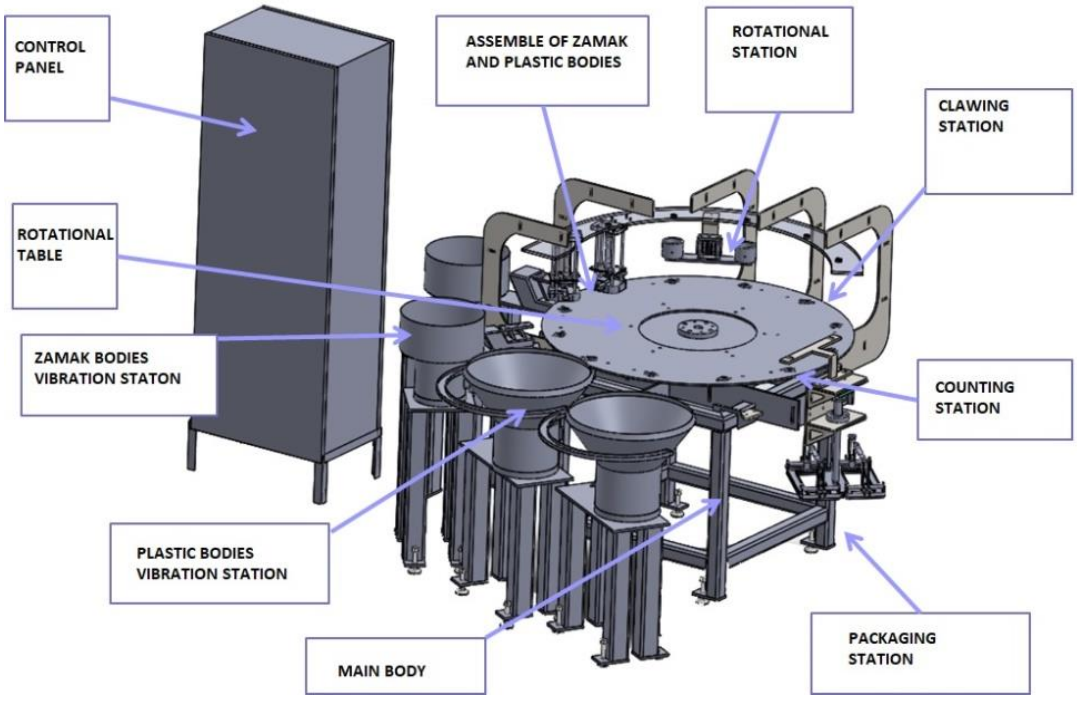

Figure 3. Fully automated PLC controlled assemble system components.

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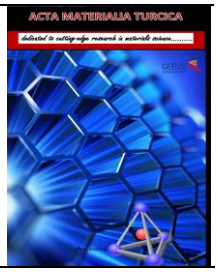

Table 1. The processed assemble product gains.

Manually Assembled Part (The Ex)	Automated Assembled Part (The New)
The flexible nails cannot fix the Zinc body and leaves it easily.	Fixed nails by treatment can fix the Zinc body.
Due to the large thickness of structure causes collapses.	Optimized thicknesses prevent collapses.
Sometimes plastic body and pin cannot be directed in the correct assemble direction.	The right assembling direction can be performed at each time.

As an example for the gains with detail we can explain the saved time and labor. Time and employee savings in assemble are the most important gains of this automated assembling system. In the conventional assembling style; a worker could only assemble 13 parts per minute. 15 workers were doing 195 parts per minute. The designed automated assembling system makes 40 assemble per minute. Totally five automated machines with one worker as a controller of the systems does 200 parts per minute. Additionally, the productivity gains are listed as follows;

1. One worker in new automation line instead of 15 workers in the conventional assemble line,
2. 2400 units/h assembles in new automation line,
3. Max. 0,01% error in assembling,
4. 15 sec / rotation speed (full rotation speed),
5. Max. 5 stations in assemble,
6. Success in part directing,
7. Min. error in packaging,
8. Nail pre-formulation at 80-120°C heat treatment to prevent assemble mistakes,
9. Energy saving by new 24 gravures die design.

4. CONCLUSIONS

In this study the advantages of an automated manufacturing system gains are reached with the goal of reducing the cost of labor and improving production productivity. Certainly, industrial automation has great advantages in activities that were previously carried out manually. Since the automated cells typically perform the manufacturing process with less variability than workers, the fully automatic PLC controlled assembly cell provided high quality assemble of shelf supports and fixing parts. In addition to labor and energy savings, it has contributed to the increase in productivity with shorter injection times achieved by reducing raw material quantities through part design modifications realized within this study. Finally, the conducted automation system has allowed high speed and great repeatability with high quality of the parts which are crucial for the production industries.

5. ACKNOWLEDGMENT

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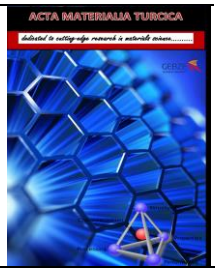
*Corresponding Author E-mail: aliserdarvanli@hotmail.com



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*Corresponding Author E-mail: aliserdarvanli@hotmail.com