Productivity Increase on Manufacturing Line A

Maria Victoria Grant Tejada
Master in Engineering Management
Dr. Hector J. Cruzado
Graduate School
Polytechnic University of Puerto Rico

Abstract *— In company that shall remain anonymous, Manufacturing Line A was underperforming, often falling back in orders. Therefore, the company decided to put in place a project to look at increasing productivity in this high-mix low volume assembly line. After conducting an analysis of historical data, the high runners were selected for the redesign of the assembly line. Time studies were conducted to identify areas of opportunities, and operator interviews took place. Besides increasing productivity, reducing any potential risks was also considered while evaluating the assembly line. Manufacturing Line A was re-designed and post-implementation time studies were conducted to validate the increase in productivity. These time studies demonstrated that the daily production output will be increased by 47% if the proper mix of designs are in the schedule. Also, three risk reduction projects were implemented. For the success of this project in the intended timeline, the collaboration and prioritization from all involved departments was instrumental in addition to including the operators as key members of this project.*

Key Terms *— Design of manufacturing assembly line, Lean manufacturing, resistance to change, time studies.*

INTRODUCTION

The company subject of this project, whose name will remain unshared for confidentiality purposes, is a manufacturing plant that has about 240 employees and counts with 200,000 sq ft area from which 110,000 sq ft are of manufacturing space. This site has 20 stamping machines and counts with a tool room that supports an additional four facilities of the company. This site operates on a high mix/low volume production and counts with a total of 43 manufacturing lines.

The area under study will be referred to as Manufacturing Line A, where various designs of motor manual starters are produced. Every operation is manual and there are no machines involved. This line is constituted by one press and four different riveters. Manufacturing Line A was evaluated because it was a very inefficient line, with no clear labeling of components. When employees were working in batch production, if a mistake was made at one step of the process, multiple units needed to be reworked. This line was often found to be in backorder, and safety concerns were also present. This line needed to be evaluated to be able to increase the daily output, meet demand, and ensure profit.

Project Objectives

The intention of this project was to increase productivity of Manufacturing Line A to fulfill late orders and ensure new orders can be fulfilled on time. In addition to this, risk reduction projects were to be implemented if risks were present in the assembly line.

LITERATURE REVIEW

Many companies look at increasing productivity to reduce manufacturing costs, increase revenues, and ensure customer satisfaction. In multiple industries, there are many key players that sell similar products and companies need to be creative to remain relevant in the field and maintain market share against competitors. To be able to do this, there are multiple tools available that companies can utilize to ensure their production lines are meeting the required standards.

Productivity increase – the lean concept

One concept that is often utilized in different industries is Lean Manufacturing. This concept has as a main purpose the creation of value in the manufacturing process by eliminating those activities that customers are not willing to pay for [1]. When evaluating the manufacturing process, it is important to understand what activities during the processing time add value and don't add value to the product. By classifying activities as value added vs non-value added, improvement opportunities can be clearly identified.

Time studies

Time studies are often performed to determine what the process cycle time is, from these time studies, activities can be classified under value added vs non-value added, as suggested by the lean concept. The pioneer of the use of the time study method was Frederik Winslow Taylor who believed that by calculating the duration of the work associated with human, machine, or a combination of both, under an excellent measurement of the state, the amount of time required for the complete process can be determined [2]. In the case of Manufacturing Line A, only human/manual operations are utilized, which makes the time studies easier to conduct since the focus is only in one variable.

Batch production vs. one-piece flow

A concept that companies often evaluate when looking at increasing productivity is how their manufacturing processes are built. The two major options are batch production vs. one-piece flow. Depending on the duration of each step of the process, and how complex the manufacturing of the product is, companies may benefit from one or the other. One important thing to note is that for one-piece flow to be implemented successfully, a high degree of work balance, low variability in task times at each station, high quality, and high equipment reliability need to be in place [3]. If any of these items are not implemented successfully, the implementation of one-piece flow may cause more issues than benefits in the manufacturing process.

Resistance to change

When going into a productivity increase project, besides the technical and executable aspects of it, it is important to also include the human aspect to the process. People are a big component in the manufacturing process, especially in manual operations, and it has been proven that there is often resistance to change. Typically, employees show resistance to change because they are afraid of the unknown and there might be misunderstanding of why things need to change and what the potential repercussions are. In addition to this, there is often low tolerance towards change because humans are creatures of habits and don't always feel comfortable when change is introduced to the mix [4]. Therefore, it is important to not get carried away when going into these types of projects and ensure shop floor personnel are included in any pertinent conversations during the project, this way they feel involved in the process and motivated towards the change as they have been a part of it.

ANALYSIS

The first step in the analysis phase of this project was to analyze the historical data. This analysis would be the baseline to determine the high runners of Manufacturing Line A since this is a high-mix low volume assembly line. A pareto analysis was done to identify the 80/20 mix of the manufacturing line. Table 1 demonstrates that the high runners for this assembly line are Design 1, Design 2, and Design 3.

Based on the analysis of historical data, time studies were conducted for assembly designs 1, 2, and 3 for which activities were categorized as value added (VA) and non-value added (NVA). The results from these time studies are shown in Table 2. It can be noted that the percentage of time spent on NVA activities is greater than the percentage of time spent on VA activities.

Table 1
Analysis of historical production data

Product Mix	Quantity	Daily	Production %	Cumulative %
Design 1	1991	8	38.95%	38.95%
Design 2	1984	8	38.81%	77.76%
Design 3	431	2	8.43%	86.19%
Design 2A	414	2	8.10%	94.29%
Design 4	292	1	5.71%	100.00%

Table 2
Time studies results (NVA vs VA activities)

Product	Total Time	NVA	%NVA	VA	%VA
Design 1	1425.2	978.3	69%	446.8	31%
Design 2	1673.1	1128.2	67%	544.9	33%
Design 3	1794.3	1180.6	66%	613.7	34%

After conducting the time studies, operator interviews took place to ensure their opinion was considered while redesigning Manufacturing Line A. The operators expressed some concerns in regard to the assembly process, frustration on not having components properly labeled, and issues with replenishment because warehouse personnel did not have a clear visibility on when replenishment was needed.

Based on the baseline design of Manufacturing Line A, where operators performed the process sitting down doing batch production, the amount of time invested in non-value-added activities was greater than the amount of time invested in value-added activities. A new design of Manufacturing Line A was proposed.

The redesign of Manufacturing Line A consisted in the removal of waste and increase of productivity in addition to reducing the material inventory in the assembly line. In addition to this, three risk reduction projects were taken care of. The first was changing bins for bulky items to smaller bins, as they present ergonomic risks for the material handler and the operators as they must pick up the material from the bins sitting on the floor. The second risk reduction project was related to PPE and the operators not wearing gloves for critical tasks. The third risk reduction project was the implementation of a fixture that could fit all the different designs for the products assembled on Manufacturing Line A to eliminate the risk of ergonomic issues and potential injuries.

RESULTS

The new proposed design showcases a cell style assembly line where production will be done utilizing one-piece flow, standing operations, and having part of the process done in each of the stations. The process will flow from station 1 to station 7 and can be executed by one or two operators. For one operator, this person will complete the full manufacturing process. For two operators, the second operator will start processing when the first operator is on station 5 and both operators will complete the full process for each unit. The rationale for this is based on the standard time it would take for the operators to complete the process for each station.

This new design also allows for a reduction of inventory present at the manufacturing line, where only components required will be present in each of the stations, with a 2-bin Kanban system to trigger when the warehouse replenishes without ever having to wait for components. Bins are also placed in the manufacturing line to allow for quick changeover between the different designs, since this line has a mix of designs being produced daily.

After implementing the new design for Manufacturing Line A, a post-implementation time study took place to validate the increase in productivity of Manufacturing Line A. Table 3 shows the results of these time studies. With this new design of the assembly line, for all designs the operators will be spending more time on value-added than non-value-added activities. The output per day is expected to increase to 40 units per day when the line operates with two employees following the suggested mix per day.

Table 3
Post-implementation time studies results

Product	Total Time	NVA	% NVA	VA	% VA	New Daily Output
Design 1	764.9	318.1	42%	446.8	58%	15
Design 2	957.3	412.4	43%	544.9	57%	15
Design 3	1058.8	445.1	42%	613.7	58%	4

CONCLUSION

The redesign of Manufacturing Line A was proposed because this line was often in backorder and often rework was being performed. There was a need to increase productivity in addition to reduce safety risks. With the implementation of this project, productivity of Manufacturing Line A has been increased by 47% and three risk reduction projects have been implemented to avoid ergonomic concerns and potential injuries.

During this project, it was instrumental to include the operators in the process of the redesign of Manufacturing Line A. Including the operators in the process helped with ensuring they were aligned with the new design of the assembly line, and they felt valued. At the end of the day, they are the ones that must perform the operations daily and need to feel comfortable with the process. For this project to be successful, it was required that multiple departments aligned on the timelines and ensured the required support was available, everyone made this a priority and the weekly meetings that were held to share progress and upcoming activities were a good way to ensure project would not get delayed.

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