Improving Bergstrom Zone 12 Layout Efficiency and Part Accessibility

Shae Alhusayni[1], Jacob Benedetto[2]
Industrial and Systems Engineering
Northern Illinois University
DeKalb, IL USA
[1]Z1724538@students.niu.edu, [2]Z1795757@students.niu.edu

***Abstract*—Bergstrom Inc. is a company located in Rockford, IL that specializes in making heating, ventilation, and air conditioning units for vehicles ranging from mining equipment to school busses and semis. Our focus in this project is Zone 12, which specializes in assembling small water valves and controls that are shipped to customers or used throughout the plant. Due to product variation and poor zone orientation the zone has been experiencing low productivity, lack of consistency and excess motion. The goal of the project is to improve the zone's efficiency and part accessibility. In this project, we use various Industrial and System Engineering tools to investigate the current state of the process and identify the root of the problems by collecting and analyzing data to propose solutions. Automation solutions were proposed to reduce non-value-added and essential non-value-added activities. Also, a comparably better layout was designed to addresses the inefficiencies and excess motion., reducing the average travel distance by 52.71%.**

Keywords-component; layout design, spaghetti diagrams, capacity analysis, automation

I. Introduction

Bergstrom, Inc. is a company located in Rockford, IL that specializes in making HVAC units for vehicles. The company is over 65 years old and has become a world leader in the business. They have devoted themselves to lean manufacturing methods and continuous improvement solutions. This mindset is one of the main reasons the company was willing to take on a senior design project through NIU. The goal of the project is to redesign and optimizing Bergstrom's Zone 12. Originally, Zone 12 was in a small room in the front of the factory but, as demand grew, it relocated to the center of the plant floor due to the units being used throughout the factory. Since it has moved locations about 12 years ago, the layout has not been updated or improved to fit their current needs. Zone 12 is divided in half to build control and water valve units because they are both high volume and physically small. Zone 12 needs a redesign because the current layout does not reflect the zone's throughput, and the zone never became implemented into the plant wide Kanban material replenishment system. Due to a lack of resources, Zone 12 has been forgotten and our project hopes to change that.

II. Problem Description

Due to product variation and poor zone orientation, the product assembly process lacks efficiency and consistency leading to low productivity and unnecessary motion that can be improved through new layout implementation.

Currently, Zone 12 has 12 stations utilized to make both water valves and controls (6 for each). Stations make different products with different sets of tools. However, similarities exist across the stations. There are 5 operators in Zone 12: 3 for controls and 2 for water valves. Therefore, the operator to station ratio is 5:12, making 7 stations unutilized while operators are working.

In addition, the parts in Zone 12 are not on the facility's replenishment system, causing the operators to spend non-value-added time on filling up part order requests. The parts in Zone 12 are stored in a central area further away from the stations. Thus, operators have to move constantly to retrieve parts. If operators reject any product, they do not record it. Instead it is reworked immediately. However, external rejects (rejected by the customer) are recorded, but the scope of our project will not cover it, and it will not cover the shipping process either. The scope of our project includes layout improvement through redesigning, adjacent zones that might be affected (Zone 18 is the only adjacent zone), automation opportunities and ergonomic improvements.

III. Objective

The overall goal of our project is to redesign and optimize Zone 12 to increase efficiency and reduce waste. We also hope to upgrade the parts presentation to display the parts in an easy and accessible manner to the operators. In the current layout, the parts are not located near the operators, and there is excess travel within and outside of the zone to retrieve parts and materials. In our improved layout, we will optimize material flow and reduce excess motion and activities. To further improve delivery of parts, we will analyze how to prepare Zone 12 to be on the plant-wide material replenishment system, so the operators do not have to spend time ordering their own parts.

IV. Data Collection

Before beginning the analysis process, data had to be collected to make data-driven decisions. The data collected include: time studies, motion studies, and demand data; using stopwatch or a Microsoft Excel sheet, laser measurer, and historical data, respectively.

A. *Time Studies*

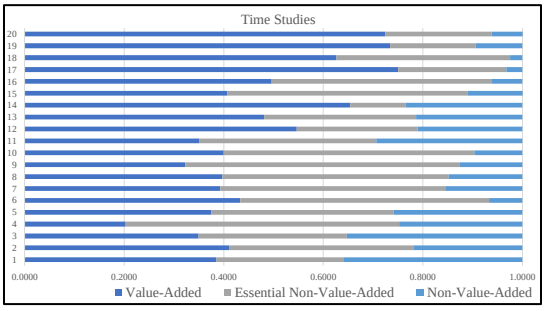

FIGURE 1 - TIME STUDIES SUMMARY

To fully grasp the current assembly process, time studies on operators building different products were conducted. The time studies are summarized in the chart shown in Figure 1. The time studies revealed that a significantly large amount of time is spent on non-value-added and essential non-value-added activities. As a result, on average only 47.21% of the time is value-added. This data helps us identify areas of inefficiencies to investigate potential solutions. Operators spend time manually filling out redundant forms. Also, operators spend a large amount of time retrieving parts, transporting products, or transporting tools. This issue can be solved through an improved layout and improved station definitions that are designed to serve the current assembly process flow.

B. *Motion Studies*

Spaghetti Diagrams were created simultaneously while conducting time studies. Figure 2 shows an overlap of all the motion studies, each color represent a different motion study.

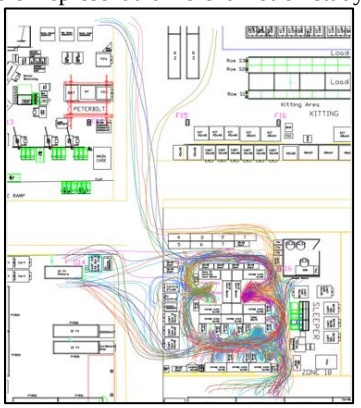

FIGURE 2 - CURRENT STATE SPAGHETTI DIAGRAM OVERLAP

The spaghetti diagrams illustrate the excess amount of motion in the zone, and the large distances traveled outside of the zone. Consequently, the average travel distance per order is 552 feet. Therefore, it is essential to create space in Zone 12 to include all the needed materials and eliminate motion outside of the zone.

C. *Demand Data*

Understanding the demand that Zone 12 has to fulfill is essential in the analysis process to prevent missing deadlines or working overtime. 2019 demand data was collected from Bergstrom. We found no seasonality in the historical data.

D. *Capacity Analysis*

Using the time studies data and the demand data, the capacity analysis was conducted to find the ideal number of operators for Zone 12. For this analysis we assumed operators have 80% productivity, each operator works 38.5 hours per week (excluding breaks and meetings), and there are 4 weeks per month. The calculations showed that Zone 12 needs 4 operators: 2 for water valves and 2 for controls. Since the current number of operators in the zone is 5, one operator can be reallocated to another zone, where demand is higher.

E. *In-Station Tools*

To analyze similarities and potentially merging stations, the tools in each station were recorded. Clustering was applied to find similarities in the stations. The results show that Zone 12 does not need 12 stations. We recommend reducing the number of stations from 12 to 8. As a result, the new operator to station ratio is 4:8.

V. PROPOSED LAYOUT

Five different layouts were designed, using the new operator to station ratio. All five proposed layouts created space for areas outside of Zone 12 to be included in the zone. The two extreme motion studies (four total - longest distance and shortest distance for water valves and controls) were used to compare how the new layouts change the distance traveled. Table 1 summarizes the motion savings for each layout. Layout 1, shown in Figure 3, has the highest reduction.

TABLE 1 - LAYOUT COMPARISON

Layouts	Average Travel Distance (feet)	Percent reduction
Current Layout	719	-
Layout 1	295.08	52.71%
Layout 2	315.875	27.97%
Layout 3	339	38.86%
Layout 4	249.35	41.61%
Layout 5	249.35	41.61%

FIGURE 3 - PROPOSED LAYOUT 1

VI. RESULTS

Our analysis shows that with our improved layouts, excess motion is reduced by 52.71% and the new operator to station ratio is 4:8 compared to it previously being 5:12. Also, the company asked that we explore different areas of automation within the zone and we found that any potential areas that could be automated would be very costly to implement and would take many years to profit. In the future, the company should choose one of our proposed layouts, and execute as many of our solutions as possible in order to maximize efficiency and reduce waste.

VII. CONCLUSION

Zone 12 has many issues that have accumulated throughout the years, but our project addresses many of these problems and we were successfully able to deliver five improved layouts, as well as many other solutions ranging from low-cost easily implemented solutions to more expensive options for the longer term.

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