Balancing Mixed-Model Parallel Two-Sided Assembly Lines: A Case Study

Dr.Virender Narula[1], Rahul Pal[2]
[1, 2]Associate Professor, Dept of Mechanical Engineering
[1, 2] Manav Rachna International Institute Of Research And Studies,Faridabad,India

I. INTRODUCTION

- Assembly lines are flow-oriented production systems where the units of production performing the operations are aligned in a serial manner, referred to as stations. Workers and/or robots perform certain operations on the product at the stations in order to exploit a high specialization of labour and the associated learning effects (Shtub and Dar-El, 1989).
- The smallest individual and indivisible operations are called tasks. The necessary time for a task to be performed is called the task time or the processing time. Every product follows the stations along the assembly line until the raw materials turn into a final product.
- The operations assigned to stations are carried out on the product at each station within a specified time. This time, which is equal to the maximum of sums of processing times of the tasks in all stations, is called the cycle time. Production rate of the assembly line, which is the amount of final goods produced in a period of time, is directly determined by the cycle time.

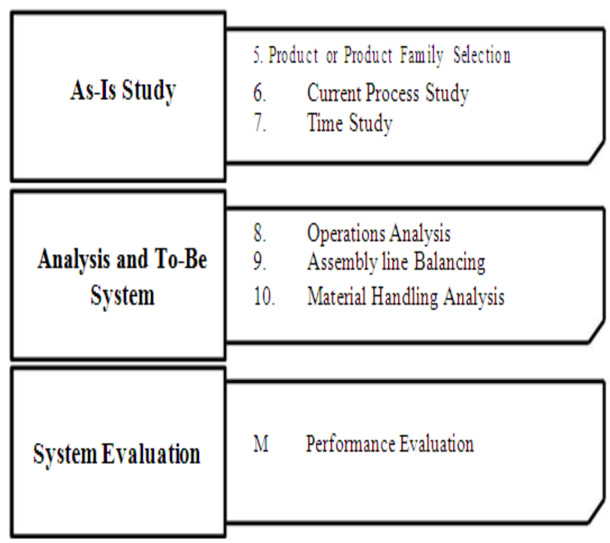
Assembly line balancing (ALB) problem is an assignment problem aiming to assign the tasks to the stations in order to minimize the cycle time, i.e. maximize the production rate, or minimize the line length,

Assembly Line Balancing Problems

1. Mass-production of one homogeneous product is carried out.
2. All tasks are processed in a predetermined mode, i.e. no alternatives for the processes exist.
3. The assembly line is a paced line with a fixed cycle time for all stations.
4. The assembly line is a serial line.
5. The processing sequence of the tasks should not violate the precedence relations.
6. The task times are deterministic.
7. There are no restrictions for the assignment of tasks except for precedence constraints.
8. A task is indivisible. Hence, it needs to be completed in a single station.
9. All stations are identical with respect to workforce, technology, etc.

II. PARALLEL TWO-SIDED ASSEMBLY LINES

The common methodology as listed below in Figure is followed to improve the operational performance of the production system.



Product Selection for Study

Product selection is critical as it provides focus to the project and produce tangible improvements in a timely manner. Trying to solve all problems at the same time creates confusion, inefficient use of resources and delays. Product selection refers to the process of identifying a "product" or "family" of similar products to be the target of an improvement project or study.

- The selection should be based on the following criteria:
- Customer importance and importance of the product to customer.
- Potential to improve overall operations.
- Potential to impact other products.

Different product family classification methods are available, the most dominant in usage being the following methods

A-B-C Classification Method

- The A-B-C classification process is a method that helps to identify products families based on three "importance" ratings namely A-Outstandingly important, B-Moderately important and C-Least important. This classification makes use of "Pareto‟s Principle" which can be generally told as 20% of the products account for 80% of the total dollar usage.
- This method mainly focuses on:
- Classifying product families based on Demand volume and Sales turnover.
- Identifying product families that describe the majority of inventory, which in turn helps with better inventory management.

Time Study

- Time study is a technique used to establish a time standard to perform a given assembly operation. It is based on the measuring the work content of the selected assembly, including any personal allowances and unavoidable delays.
- It is the primary step required to determine the opportunities that improve assembly operations and set production standards. The key objectives of a time study are:
- To increase productivity.
- To balance the work force with available resources.
- To determine the production capacities.
- To determine standard costs of a product.
- Effective production planning and control.
- Efficient plant layout.

Assembly Line Balancing Problem

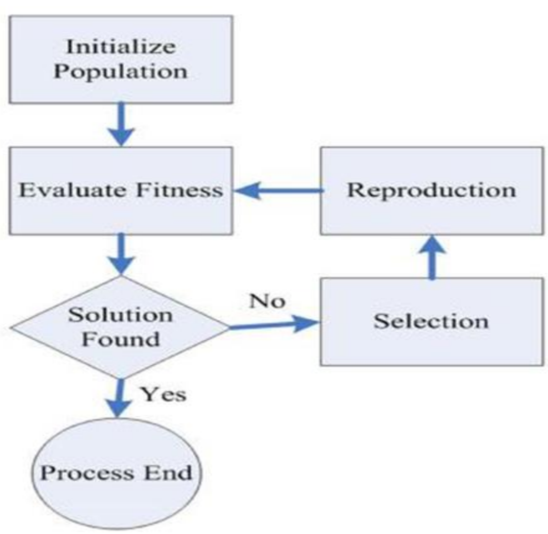
- Applying Lean thinking, the first step in increasing the assembly line productivity is to analyze the production tasks and its integral motions. The next step is to record each motion, the physical effort it takes, and the time it takes, also known as time and motion study. Then motions that are not needed can be eliminated also known as non-value added activities and any process improvement opportunity exists must be identified. Then, all the standardized tasks required to finish the product must be established in a logical sequence and the tools must be redesigned. If required, multiple stations can be designed and the line must be balanced accordingly.
- Some of the most critical components of an assembly line are given as follows Chow (1990). The members of the list are mainly application dependent and can be altered according to the assembly requirements.
- Process design or standardization
- Line balance
- Material handling
- Parts procurement and feeding
- Work-in-process management
- Man power
- Line size
- Line configuration

III. PARTICLE SWARM OPTIMIZATION

PSO is a subset of evolutionary algorithms (EAs) that model biological processes to optimize highly complex cost functions. PSO is inspired from the mechanics of natural selection and natural genetics such as inheritance, mutation and recombination (also known as crossover). It is used in computing to find the optimal solutions to optimization and search problems. PSO was developed by John Holland in 1975 over the course of 1960s and 1970s. Though the work of John Holland in development of genetic.

This chapter now concludes the work, application results and findings of the project. In addition, the chapter summarizes the comparative analyses of various evolved models and gives a summary of the deliverables of the project. Possibilities to improve the obtained results and to better the features of the developed models are also highlighted.

Figure : PSO Flow chart.



Balancing Parallel Assembly Lines Pso Based

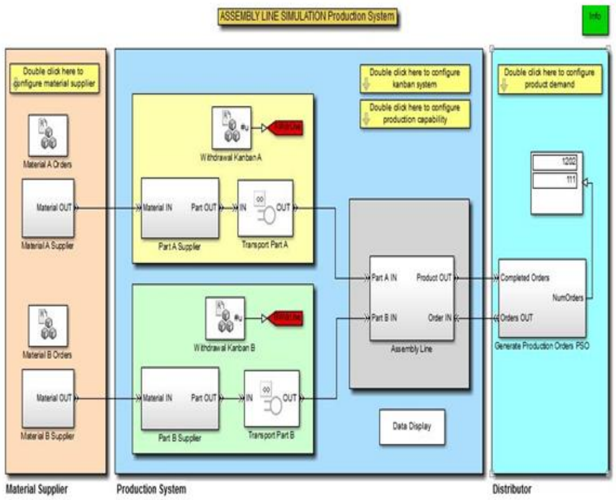


Fig :Two parallel Assembly line controlling PSO.

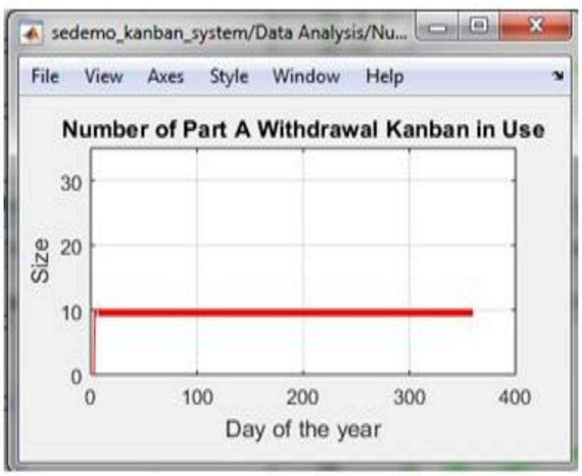


Fig :Two parallel Assembly line controlling PSO Part A.

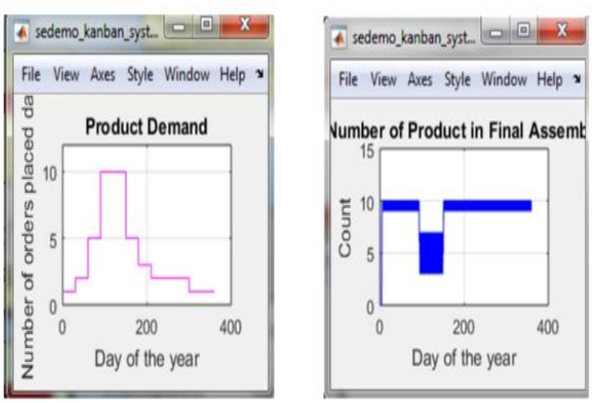


Fig : two parallel Assembly line controlling product demand (b) Final line.

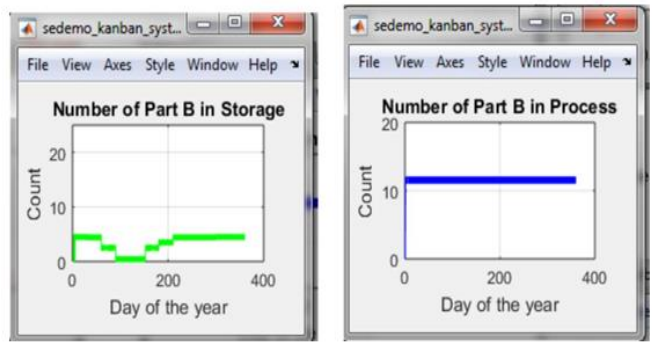


Fig : Two parallel Assembly line controlling product Storage (b) part B storage.

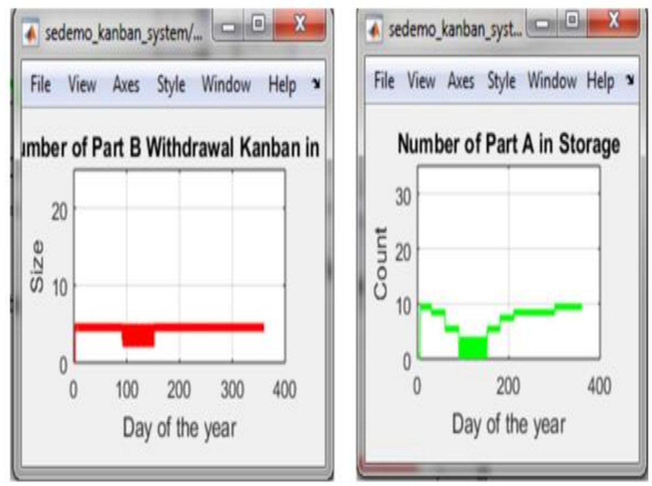


Fig : Two parallel Assembly line controlling Withdrawal product Storage (b) part A storage.

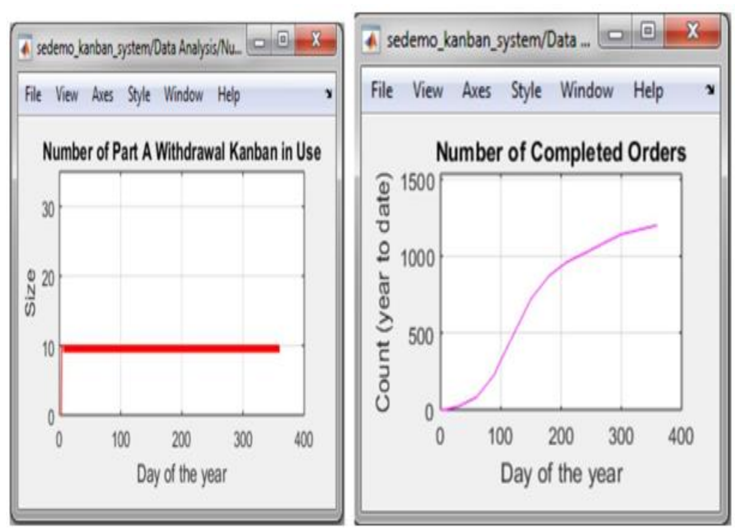


Fig : Two parallel Assembly line controlling Withdrawal product Storage (b) Completed Order.

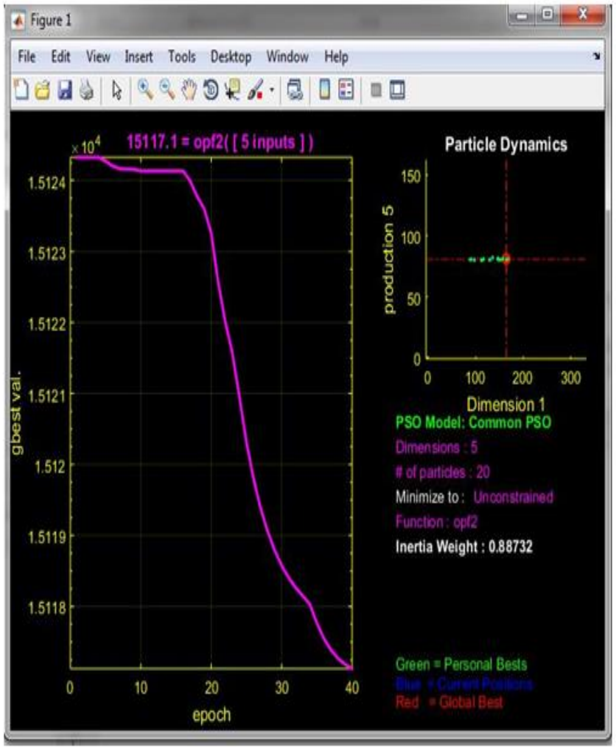


Fig : Two parallel Assembly line controlling PSO code implementation.

CONCLUSION

- The objective of this project was to improve the productivity of the manual assembly line. The three step methodology incorporating Lean principles is applied to a case study problem and two different assembly configurations are developed and compared, namely Single Stage Parallel Line and Five Stage Serial Line. Based on the simulation performance results, the Single Stage Parallel Line is suggested to be implemented. From Figure 23 it can be observed that the proposed system results in doubled productivity. The original assembly line has a target output of 35 boxes/operator/hour, whereas the actual measured output came up to 29.8 boxes/operator/hour.
- The improved assembly line gives an output of 59.8 boxes/operator/hour, which is about a 100% increase in operator productivity from the original method. Also, with this Single Stage Parallel Line, the floor space usage is reduced by half compared to original method. The material handling requirements as well as the input and output buffer sizes are also determined for this new assembly line. When having an assembly line with multiple stations, the impact of having station imbalances on the individual operator performance is also recognized.