International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161

Available at http://inpressco.com/category/ijcet

Case Study

Assembly line Balancing: A Case Study in Silencer Manufacturing

ShriramSane[A], VarshaKarandikar[A*], Rahul Pulkurte[A] and SubodhPatil[A]

[A]Industrial and Production Engineering Department, Vishwakarma Institute of Technology, University of Pune, Pune, Maharashtra, India

Accepted 02 May 2014, Available online 01 June2014, **Vol.4, No.3 (June 2014)**

Abstract

An assembly line balancing is to know how tasks are to be assigned to workstations, so that the predetermined goal is achieved. Minimization of the number of workstations and maximization of the production rate are the most common goals. The silencer assembly line is studied in this paper which assembles four products. For line improvement purpose, various Lean Manufacturing tools are employed such as cycle time study, line imbalance calculation, bottleneck identification, Kaizen, space utilization through layout change. Many industries are facing lot of problems like inability to meet production targets, imbalance of work content at work stations, discontinuity in material flow, manpower allotment. In this paper, the design to evaluate the performance, bottleneck identification , reduction in bottleneck cycle time, minimizing line imbalance, workstations organization, reduction in manpower and space saving, increasing manpower utilization of industrial production assembly line are discussed.

Keywords: *Assembly Line Balancing, Cycle Time Reduction, resource utilization*

1. Introduction

Line Balancing means balancing the production line, or any assembly line. The main objective of line balancing is to distribute the task evenly over the work station so that idle time of man of machine can be minimizedby Naveen Kumar and Dalgobind Mahto (2013). Varsha Narayan Karandikar, Shriram Madhukar Sane (2014), discussed waste identification and elimination and de-bottlenecking to balance the line and optimize utilization of resources for improving the productivity. Cycle time reduction is one of the most important elements of successful manufacturing today, Assembly line balancing is the process of distributing work load in an assembly line across successive workstations so that no resource and time are wasted is studied by Meby Mathew, D.Samuelraj(2013). Takt time is the rate at which products or services should be produced to meet the customer demand. Bottleneck Delay in transmission that slow down the production rate this can be overcome by balancing the line. Naveen Kumar & Dalgobind Mahto (2013) in their paper the improvement in knowledge, the refinement in the application of line balancing procedure is also a must. Task allocation of each worker was achieved by assembly line balancing to increase an assembly efficiency and effective use of manpower. Varsha Narayan Karandikar, Shriram Madhukar Sane (2013) described the newly defined Posture – State Variation Report [P-SVR] method of postural analysis to highlight the areas for improvement in work posture for operator comfort and to find out quantitative value of severity of work based upon postural video analysis. Varsha Karandikar, S. M. Sane (2013), investigated the investigated the ergonomics aspect of machine design of work station to kill the root cause of the problem. And also explained the procedure for determining the workstation dimensions and layout has been explained.

1.1 Formulae

$$\text{Efficiency} = \frac{\text{Total cycle time}}{\text{no. of workstation} \times \text{longest operation}} \times 100$$

$$\text{Takt time} = \frac{\text{Available time during shift}}{\text{Production demand}}$$

2. Methodology

2.1 Cycle Time Study

First of all, to know the production capability of each individual station, detailed cycle time study at each workstation is carried out. Cycle time study is done for 5 repetitive cycles. Then, activities are sorted in VA (Value added)/NNVA(Non Value added activity)/PNVA (Partially non value added activity) activities. NNVA activities are focused to eliminate or reduce and NVA activities are focused to eliminate.

2.2 Current State of the Line

In this all the workstation time study is carried out 7 wastes (TIMWOOD) are identified at each workstation. Also, Line imbalance ratio is also calculated. At initial

*Corresponding author **Varsha Karandikar** is working as Assistant Professor; **Shriram Sane** as Professor and **Rahul Pulkurte** and **Subodh Patil** are students

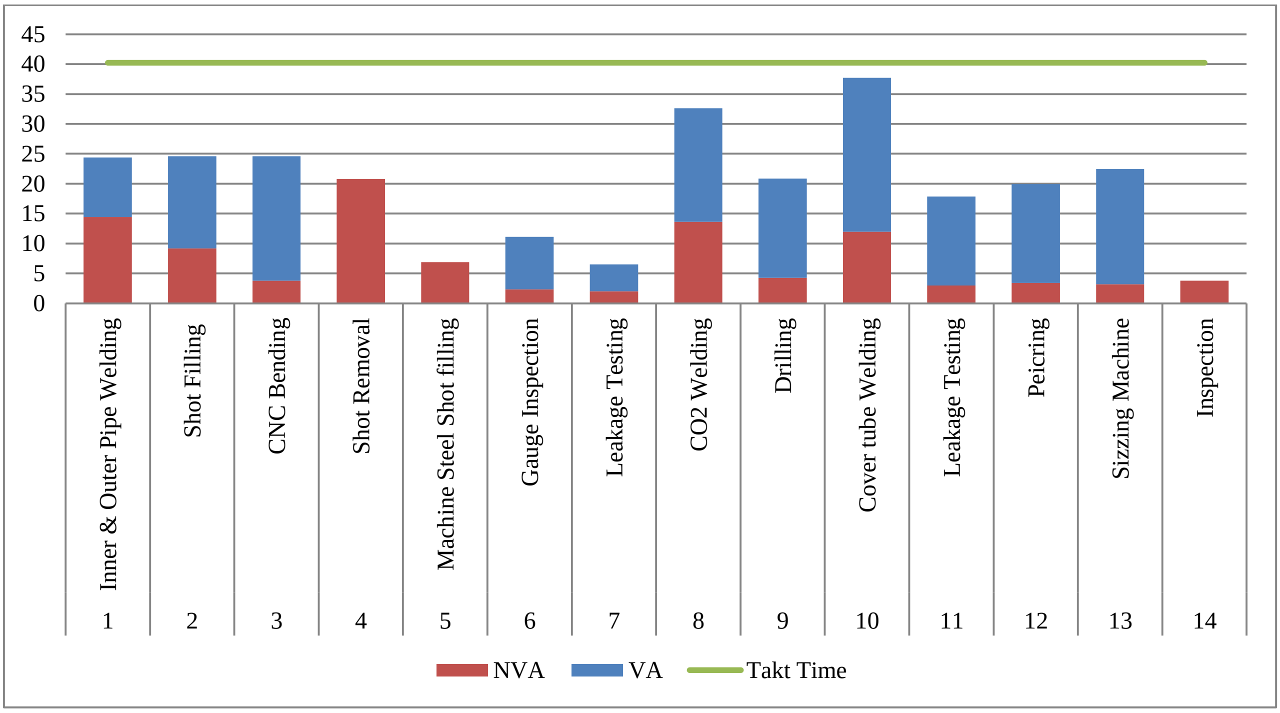

Figure 1: Initial State of line Balancing

level, line imbalance percentage for the line (Pipe B) is 46.04%. Number of operators employed on the line is 14.

2.3 Initial State of the Line

Following figure shows graphical representation of the cycle time of workstation along with TAKT time and Target rate. Workstations having total cycle time more than the target are bottleneck station which should be considered for the improvement on priority.

Table 1: State Of Line before Line Balancing (With 14 Operators)

Maximum Cycle Time in sec.	37.7
Total Cycle Time in sec.	284.8
Theoretical no. of operators	14
Takt Time for present Demand	40.02
Target Rate	34.17
Imbalance Ratio in %	46%

3. Bottleneck identification and elimination

3.1 Machine Steel Shot filling

From figure 1 it is visible that workload at station no. 5, operator 1 requires cycle time of 6.9 sec. and at station no. 2 the cycle time is 24.6 sec. This workload is given to the workstation no.2. This shifting of workload may not affect the Takt time and simultaneously reduction of one operator.

3.2 Gauge inspection and Leakage Testing

The flow of material is not continuous as shown in the Layout figure 5(Before). And Manpower workload is very less as shown in figure 1. The Manpower required for these two stations are two. When these workstations are clubbed the distance is minimized between these two workstations and it helped to deploy single manpower for both workstations. This change doesn't affect the production rate before and after the Improvement as the Takt time for each workstation is 37.7 sec. By clubbing these two workstations cycle time=17.62 sec. which is less than the required takt time.

3.3 Cover Tube Round Welding

In this cover tube welding operation the operator needs to pick up the pipe, cover tube and welding is carried out. At this workstation the cover tubes are placed on the welding machine, not more than 20 pieces are placed. After completing 20 jobs he needs to go storage and bring the cover tube simultaneously. The operator needs to bring material from storage 5 times in hour. To reduce this frequency, the bin is provided at the workstation having storage capacity of 200 pieces of cover tubes.

3.4 Sizing Machine and Inspection

The Inspection Workstation is behind the sizing machine operation. 1.2 sec.,1.3 sec. are the time required for putting the job by sizing machine operator and picking the job by inspection operator respectively. This reduced the savings in 2.5 sec. cycle time. The Sizing machine and the Inspection operations are combined to reduce the manpower and it also saved space required for the assembly line.

Table 2: De-bottlenecking of Workstation

Workstation	Before		After		% Improvement
	Cycle Time	Production/Hour	Cycle Time	Production/Hour	
Cover Tube Welding	37.7	95	33	109	14.66%

Table 3: After Line Balancing State Of Line (With 11 Operators)

Max. Cycle time in sec.	33.00
Total cycle time in sec.	275.96
Theoretical no. of operators	11
TAKT time for present demand	40.2
Target rate	34.17
Line Imbalance in %	16.48

Table 4: Final Results after Implementation

Sr. No.	Improvements	Before	After	Savings	% Improvement
1	Manpower	14	11	3	21
2	Imbalance ratio (%)	46.04	16.48	29.56	64
3	Production Rate(per hour)	95	109	14	15
4	No. of Workstations	14	11	3	21.43
5	Space Saving	966	920	46	4.76
6	Total Cycle Time in sec.	284.8	275.96	8.84	3.10
7	Maximum Cycle Time in sec	37.7	33	4.7	12.47

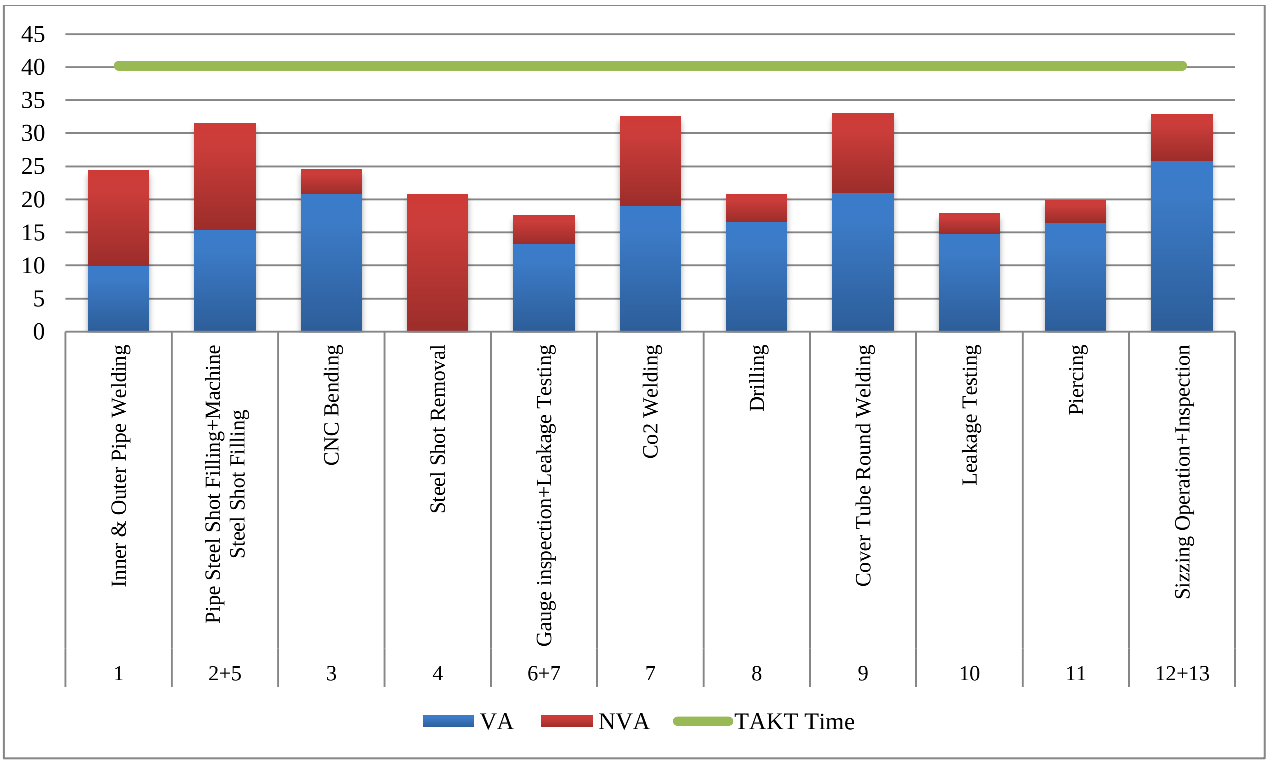

Figure 2: Line balancing results after implementation

4. Line Balancing and Resource Optimization Summarized

After studying and analyzing initial state, line balancing tool is used and it is made sure that line imbalance is reduced and 7 wastes (TIMWOOD) have been taken care and line imbalance ratio has been brought down to 16.48%. Also Manpower optimization is possible and material handling and operator movement is reduced.

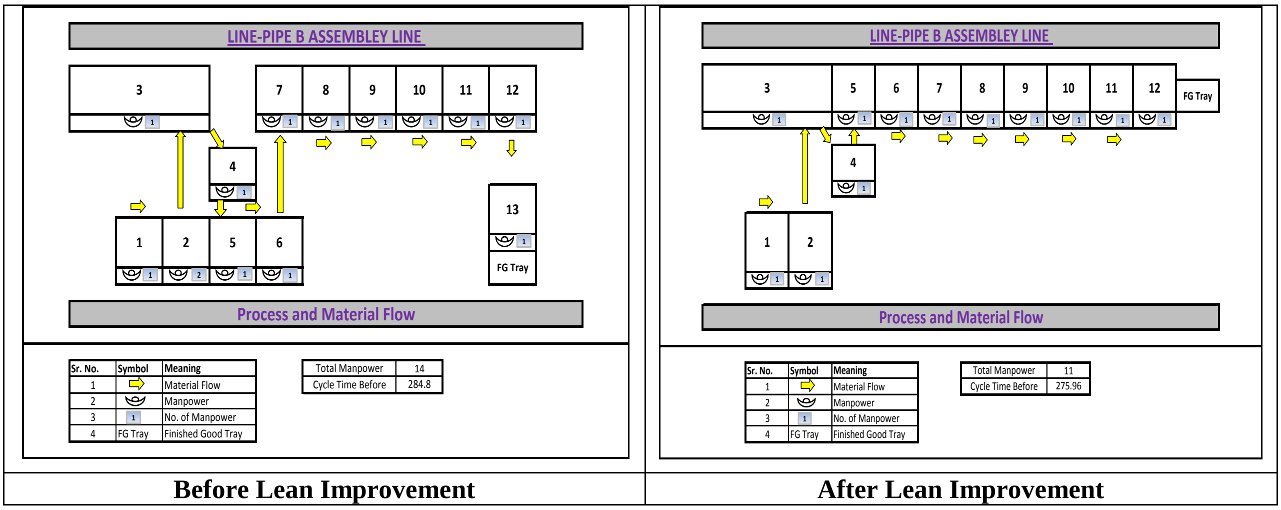

Figure 3: layout improvement (Before and After)

5. Results and Findings

After Lean Implementation on Pipe B Line, along with the results shown in the following table, benefits obtained are as follows

1) Continuous material flow.
2) Reduction in WIP on line.
3) Improved workstation condition.
4) Reduction in Manpower.
5) Achieving Target Production Rate.
6) Minimizing Line imbalance.

Following table shows the results obtained from Lean Implementation on Pipe B Line. Results show that the % improvement is achieved for the line imbalance as it is reduced by 47%.Also manpower reduction is possible.

References

Amardeep, T. M. Rangaswamy, Gautham J. (May 2013) , Line balancing of single model Assembly line, International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 5.

Meby Mathew, D. Samuelraj (April 19, 2013), Reduction of Cycle Time Using Lean Tools in an Automobile Assembly Line, Proceedings of the National Conference on Manufacturing Innovation Strategies & Appealing Advancements MISAA2013, PSG College of Technology, Coimbatore, India.

Naveen Kumar & Dalgobind Mahto (2013), Assembly Line Balancing: A Review of Developments and Trends in Approach to Industrial Application, Global Journal of Researches in Engineering Industrial Engineering Volume 13 Issue 2 Version 1.0

Shriram Madhukar Sane, Varsha N. Karandikar, PrashantUttamBagal2 (April 2014), Line Balancing on Wiring Harness Assembly Line: A Case Study, International Jouranl of Current Engineering, Vol.4, No.2

Varsha Karandikar, Shriram Madhukar Sane(October 2013), Industrial Work Station design: An Ergonomic Approach to Number Punching Machine, International Journal of Current Engineering, Vol.3, No.4

Varsha Narayan Karandikar, Shriram Madhukar Sane (October 2013)/, mapping Postural Severity of various manual tasks using P-SVR [Posture – State Variation Report] method, International Journal of Current Engineering, Vol.3, No.4