

Optimizing Work Efficiency Using Lean Manufacturing Tool

B. Bhavsingh¹, Dr. R. Sudarshan², P. Sudheer Rao³

¹Assistant Professor, Department of Mechanical Engineering, Geethanjali College of Engineering and Technology, Hyderabad, T.S, India.

^{2,3} Associate Professor, Department of Mechanical Engineering, Geethanjali College of Engineering and Technology, Hyderabad, T.S, India.

Abstract

Aerospace Limited, a joint venture between Tata Advanced Systems, we began our major project on Industrial Engineering & Management systems. Over the period of this project, we immersed our-self in this exceptional opportunity to gain hands-on experience in the production of Aero plane B737 Vertical Fin. During our time with the, we delved into a variety of unfamiliar topics and encountered numerous new terminologies. We had the chance to work both on the shop floor and in the management systems, where we utilized our skills to optimize manpower data and implement more efficient processes. In this project we are optimizing the man hours that takes to produce a product by using (ECSR) method, It is one of the Lean-Manufacturing Tool, that helps to improve the both productivity and Industrial management systems by providing a better solution and methods which brings a good standards in the production race.

Keywords: Vertical Fin, Eliminate Combine Rearrange simplify automate, Time Study.

1. Introduction

Aerospace Limited facility represents the future of India as a global exporter of aerospace. Spread over 14,000 square meters, the state-of-the-art manufacturing facility has been producing aero-structures for Boeing's AH-64 Apache helicopter, including fuselages, secondary structures and vertical spar boxes for customers worldwide. [1] TBAL is an example of Boeing's commitment towards AtmaNirbhar Bharat and the co-development of integrated systems in aerospace and defense not just for India, but for the world. [2] TBAL, Boeing's first equity joint venture in India, is the result of a 2015 partnership agreement with TATA Advanced Systems Limited. The Boeing AH-64 Apache is an American twin-turboshaft attack helicopter with a tailwheel-type landing gear arrangement and a tandem cockpit for a crew of two. [3] With more than 1,200 aircraft in operation, the AH-64 Apache represents the backbone of the U.S. Army attack helicopter fleet and a growing number of international defense forces. Recently, [4] TBAL also manufactured and shipped its first vertical fin structure for the 737 airplanes.

2. Methodology

ECSRA is one of the motion study techniques used to analyses processes in a production line. ECSR analyses processes. [7] Eliminating unnecessary work Combining operations Rearranging sequence of operations Simplifying the necessary operations. categories in focus of lean manufacturing: [8] productivity, quality and waste elimination, this paper is interested

in the latter and how this could also be applied to administrative processes, not just assembly. Even before the introduction of the term lean manufacturing, Edwards Deming gave lectures and held trainings regarding key quality principles, convincing top managers in manufacturing companies but also many service organizations to adopt a new approach to performance and personally take it to each location on the initially 8-point long checklist.[9] Although the time estimations for this process varied from student to students during the focus group, [10]all agreed that they needed to free-up half a day in order to complete the checklist in all locations

3. Terminology

E = Eliminate

C = Combine operations

R = Rearrange

S = Simplify

A=Automate

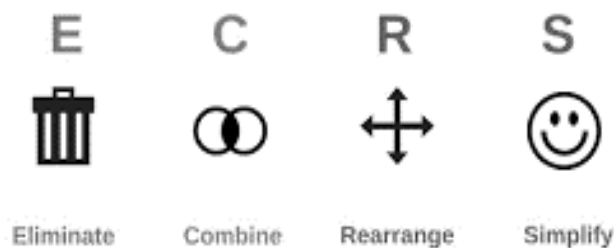


Fig: 1 ECRS principle

Fadlil and Rosyidi (2020) conducted research on how to meet production targets through process and method improvements, including identifying wasteful work elements that do not add value to the product using VA/NVA analysis; eliminating, combining, reducing, and simplifying work processes using the ECRS method; and minimizing production cycle time through line balancing. Their findings indicate that by combining VA/NVA analysis, ECRS, and branch and bound algorithms to optimize line balancing, it is able to enhance the functionality of each station, raise balance efficiency, lowered balance delay, and reduce maximum cycle time or service time, all of which contribute to meeting production targets.(4)Waghodekar (2021) demonstrated that assembly line productivity may be significantly increased by utilizing simple methods such as task simplification. His paper discusses an engine assembly line that operates both offline and online and optimization like taguchi also done (Kumar, P. G et al. 2023 & PVR, G. K et al. 2024) The data collection for the current assembly lines was conducted using Time and Motion principles, with five observations made for each activity at each work station. The data is subsequently submitted to work simplification with the goal of reducing cycle time by considering such essential

tasks as feasibility of deletion, combination, rearrangement, and simplification.(5). In the study of (Nisa et al. 2021) at a data storage manufacturer, they discovered an imbalance in the manufacturing lines after observing these. According to them, the work method is one component of a working system that can be enhanced. In their study, they applied the concepts of Eliminate, Combine, Re-arrange, and Simplify to work technique improvements (ECRS). The benefit of their research was that the company was able to improve the work system on its production line because of the proposed work techniques, hence increasing the company's productivity, following the process improvement, they were able to increase their line's efficiency from 65.62% to 74.43%.(6).ECRS is a motion study technique used to analyze processes in a production line (Suhardi et al., 2019). ECRS is one method used to consider and provide optimal results (powerful) for any procedure that causes non-value-added working conditions identified with human work (Burawat, 2019 ECRS is an essential practice tool to improve manufacturing efficiency to improve production lines by eliminating detailed inspections and analyzing production lines (Kasemset et al., 2014). The ECRS method (eliminate, combine, rearrange, simplify) is simple in its application and use; thus, this method is suitable for its improvement process. The ECRS concept can increase line efficiency by increasing production targets because the ECRS concept can eliminate, combine, rearrange, and simplify ineffective and inefficient work elements (Pertiwi and Astuti, 2020). According to him, the implementation of ECRS can reduce the total work content time, improve balance efficiency, reduce balance delays so that companies can achieve production targets due to a decrease in overall cycle time or maximum station time and an increase in production output. (7)

4. Experimentation

Case:1 To perform time study at POS-4 in main assembly line of V-fin of the B737 (observing the data of each operator in the cell and the work they perform on the job to be noted through time basis: VA/NVA)

This activity should be done until all the operations / MIS completion -that takes 12 days on a single #ss.no of the job in a cell that to in daily shift hours of 7.5 hrs.

Case: 2 All the work sheets data is evaluated by the IE Dept. and the total working hours on the job by each operator are calculated and compared with the MOST hours -time required to complete an operation on the job.

As above, each operation has most hours and the working hours are compared with most hours, if the delta is high then we should work on that extra hours in a particular MIS, and optimize the work efficiency using Lean manufacturing tools by identify the root cause and correcting it through taking an action plan in basis of time ratio can get better and approximate results compared to most hours.

Case: 3 Finding the Root-cause and actingplan from the data of TIMWOODS. We have found the root cause of above activities and also suggested the action plan to avoid delay of

work in a particular MIS or the operator over process time in a operation than an actual time to perform an activity.

Balancing the assembly line is crucial for measuring the efficiency of the production process. A higher assembly production balance rate leads to increased efficiency in the production line.

Line balancing efficiency (η):

$$\eta = [1 \text{ count time} * \text{no. of product/no. of days} * \text{no. of man available}] * 100$$

where,

1 count time = most hours

no. of products produced

no. of days to complete a product

no. of man power available in the cell.

At position in the main assembly line as per data,

1 count time = most hours = (161.3hrs)

no. of products produced = (2 products as per a month)

no. of days to complete a product = (12 days approx. in 7.5 hrs shift)

no. of man power available in the cell. = (6 members at pos-4)

$$\eta = [1 \text{ count time} * \text{no. of product/no. of days} * \text{no. of man available}] * 100$$

$$= [161.3 * 2 / 12 * 7.5 * 6] * 100\%$$

$$= 59\%$$

Table: 1 Optimized hours

S.No	Most hrs	Total hrs	Delta (total-most)	Optimized hrs (ECRS)
1.	5.2	8.6	3.4	1.5
2.	5.3	13.7	8.4	4.5
3.	5.8	11.0	5.2	2.3
4.	12.7	22.0	9.3	4.8
5.	10.9	16.1	5.2	2.1

Total optimized hours = 1.5 + 4.5 + 2.3 + 4.8 + 2.1 = 15.2hrs

assuming 15hrs i.e. 2 shifts (2 * 7.5hrs = 15hrs) = 2 days optimization

where

1 count time = most hours = (161.3hrs)

no. of products produced = (2 products as per a month)

no. of days to complete a product = (12 days approx. in 7.5 hrs shift)

*after line balancing (12 days - 2 days = 10days)

no. of man power available in the cell. = (6 members at pos-4)

Line balancing efficiency (η):

$$\begin{aligned}\eta &= [1 \text{ count time} * \text{no. of product} / \text{no. of days} * \text{no. of man available}] * 100 \\ &= [161.3 * 2 / 10 * 7.5 * 6] * 100\% \\ &= 71\%\end{aligned}$$

Hence, we optimized the 59% of work to 71% by using ECRS method and line balancing efficiency.

5. Conclusion

After enhancing the comparison, it is easy to see that the program's improvements have boosted the assembly line's balance rate to 71% and reduced the delay rate to 12%. While the ideal target of achieving a balance delay ratio of 10% or less hasn't been met, the impact of balancing the assembly line has still been significant. The system's smoothness has also improved before and after the enhancements, signaling a marked improvement in assembly line balancing. Additionally, the production efficiency of the assembly line has increased, leading to improvements in the enterprise's production and management levels.

In industrial engineering, improving work efficiency requires a blend of engineering principles, technology, human factors, and management strategies. This multidisciplinary approach aims to enhance operational performance and gain a competitive edge in industrial environments.

6. References

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- [4] Fadlil and Rosyidi (2020): production targets through process and method improvements, including identifying wasteful work elements that do not add value to the product using VA/NVA analysis.

- [5] Waghodekar (2021): assembly line productivity may be significantly increased by utilizing simple methods such as task simplification.
- [6] of (Nisa et al. 2021) at a data storage manufacturer, they discovered an imbalance in the manufacturing lines after observing the process improvement, they were able to increase their line's efficiency from 65.62% to 74.43%.
- [7] ECRS is a motion study technique used to analyze processes in a production line (Suhardi et al., 2019). ECRS is one method used to consider and provide optimal results (powerful) for any procedure that causes non-value-added working conditions identified with human work (Burawat, 2019). ECRS is an essential practice tool to improve manufacturing efficiency to improve production lines by eliminating detailed inspections and analyzing production lines (Kasemset et al., 2014) ineffective and inefficient work elements (Pertiwi and Astuti, 2020).
- [8] TeoriyaResheniyaIzobreatatelskikhZadatch (TRIZ) TRIZ is an acronym for the Russian word TeoriyaResheniyaIzobreatatelskikhZadatch or Theory of Inventive Problem Solving. TRIZ is an effective tool for repairing defects to increase company productivity (Rafsanjani and Singgih, 2018).
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- [10] PVR, G. K. (2024). Optimizing mechanical properties of virgin and recycled PLA components using Anova and neural networks. *Mathematical Models in Engineering*, 10(1), 1-10.
- [11] Swann (2014), public relations is “the management function that entails planning, research, publicity, promotion, and collaborative decision making to help an organization’s ability to listen to, appreciate, and respond appropriately to persons and groups whose mutual beneficial relationships the organization needs to foster as it strives to achieve its mission and vision” . In a rather concise manner, Grunig and Hunt (1984), also defined public relations as “the management of communication between an organization and its publics”.
- [12] 2021 Description of the state of the art of the HF/E aspects related to the Industry 4.0 paradigm focusing on organizational and management aspects.