International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 04 | Apr 2019 www.irjet.net p-ISSN: 2395-0072

Basic Study of Assembly Line Balancing

Rohan Agarwal[1], Devang Bagul[2], Chinmay Agey[3], Pratik Ayare[4]

[1234]*Final Year Mechanical Students, BVCOE, Navi Mumbai, Maharashtra*

Abstract - *Assembly Line production is one of the best-used production systems. Th e main problem of Assembly Line Balancing that is often faced by the industries is the minimization of the number of workstations & cycle time and maximization of workload smoothness and work-relatedness. It is used to assembling quickly large numbers of a uniform product. In other words, assembly line balancing (ALB) makes efficient flow-line systems available for low volume assembly-to-order production and enables modern production strategies like mass customization. Assembly lines are the most attractive means of large-scale production. After the invention of the assembly line by Henry Ford, many developments have been further taken place in production systems which changed assembly lines from strictly paced and straight single model lines to a more flexible system with includes intermediate buffers. Ford was the first person to build factories based on this concept. In this research paper, a basic study is done on assembly line balancing methods. The design of assembly lines is an important issue in modern days in manufacturing engineering, management, and control. Simple line-balancing problem method mainly consists of assigning tasks, necessary for manufacture a product, to workstations such that the idle time is minimized while the tasks are satisfied.*

Key Words: Assembly, workstations, feasible, precedence, constraints, unpeace, stochastic

1.INTRODUCTION

Modern production systems are characterized by short product life-cycles, high level of automation, the emergence of new manufacturing equipment and technologies, and high investment. Assembly is a key to success to the production activity; thus, it is often necessary to develop assembly lines. Assembly lines are mainly characterized as production systems that include serially located workstations in which operations or tasks are continuously processed. They are employed in many industries like the automobile, electronics, etc. where the objective is to produce a large series of similar products. The design of assembly lines is an important issue in manufacturing engineering and management, Askin and Standridge (1993), Dolgui and Proth (2010). The balancing of workstations is the most interesting performance index for assembly line design. The simple line-balancing problem consists of assigning tasks for assembling a product to work-stations (or the number of stations, cycle time, cost) is minimized and precedence constraints between tasks are satisfied.

Salveson (1955) has suggested a linear program to describe all possible tasks for an assembly line. There is no constraint on task splitting and so it may generate infeasible solutions. Bowman (1960) added a 'non-divisibility' constraint by using a zero-one integer program. An assembly line balancing problem can also be modeled with a tree where each arc represents a station and each path corresponds to a feasible balancing solution, see Jack-son (1956).

In Wee and Magazine (1982), based on the bin packing algorithms are suggested. There are also dedicated heuristics, for example, the ranked positional weight (RPW) algorithm, Helgeson and Birnie (1961): first, assign the tasks which have long chains of succeeding tasks. The length of the chain is measured either by the number of successor operations or by the sum of the operation times.

Kilbridge and Wester (1961) have suggested a method which is based on the graph presentation of precedence constraints. Tasks are further assigned layer by layer because there are no precedence constraints between tasks of the same layer of a graph. In the past, assembly lines were developed for a cost-efficient mass production of similar products.it makes efficient flow-line system available for low volume assembly order production and enables modern production strategies like mass customization. In this manufacturing process, interchangeable parts are added to a product in a most suitable sequential manner to create a finished product. Assembly Line Balancing is defined as assigning the tasks to a minimum number of workstations for a given cycle time.

Assembly line balancing is mainly used to achieve the following objectives:

- minimization of the number of workstations;
- minimization of cycle time;
- maximization of workload smoothness;
- maximization of work relatedness.

Due to assembly line balancing, there is a sudden decrease in the costs of production, lower prices of manufactured goods, better competitiveness of enterprises, and better exploitation of the market's potential.

2. MAIN TYPES OF ASSEMBLY LINES

There are many types of assembly line systems, which commonly include classic, intermittent, automated, and lean manufacturing models. These assembly line

systems are used for making different types of products. Assembly lines have few shared characteristics. Figure 1 illustrates the kinds of assembly systems. The types of assembly lines are as follows:

1. Single Model Assembly Line

Single model assembly line is a type of assembly line in which assembly workers work on same kind of products.

2. Mixed Model Assembly Line.

In mixed-model assembly line, it is the practice of assembling several models of a product on the same assembly line without changeovers and then sequencing those models in a way that smoothest demand for upcoming components. Setup times between models can be reduced enough that intermixed model sequences can be assembled on the same assembly line. In spite of the many efforts to make production systems more versatile, this usually requires homogeneous production processes. The objective of this type of assembly line is to smoothen the demand on work centers, manufacturing cells or suppliers and thereby reduce inventory, eliminate changeovers, improve Kanban operation. It eliminates difficult assembly line changeovers. The Mixed-Model Assembly Line (MMAL) is complex to balance where several types of the products are assembled on the line simultaneously which considers the shape of line.

3. Multi Model Assembly Line

Multi-product production delay with process manufacturers where single or multiple components run through a processing line which delivers end items and finished products. Serial or Lot control for components and end items are available, as is a variety of costing and yielding methods.

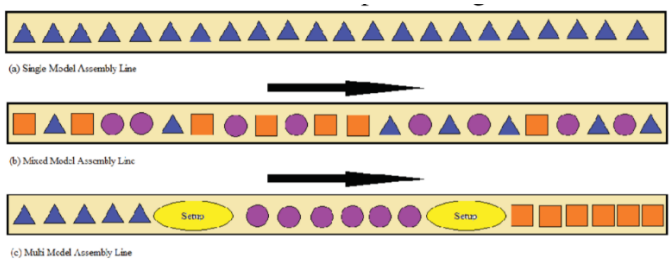

Fig. 1. Assembly lines for single and multiple products. Assembly line balancing relates to a finite set of work elements or tasks, where each have an operation processing time and a set of precedence relations, which specify ordering of the tasks. One of the problems in organizing mass production is how to group work tasks to be performed on workstations so as to achieve the optimized level of performance.

Line balancing helps to allocate equal amounts of work to the various workstations along the line. The fundamental line balancing assigns a set of tasks to an ordered set of workstations, such that precedent relations are satisfied and overall performance is optimized. The aim of assembly line balancing problem is to assign activities to stations in accordance to various precedence relationships while performance is optimized. According to Ghosh and Gagnon [2], two main types of measurements have been used in the ALBPs. The first one is technical measurements such as cycle time, balance delay or total idle time, and minimization of number of workstations. The second one is economic measurements like profit maximization and cost minimization.

4. Peace and Unpeace Assembly Line

In peace assembly system, a fixed time value restricts the work content of stations. Assembly lines with this nature are called paced, as all stations can begin with their operations at the same point in time and pass on work pieces at the same rate. In unpeace line system, work pieces do not need to wait until a predetermined time interval is elapsed, but are rather transferred when the required operations are finished. This type of line control is implemented if stochastic and probability distributive variations influence processing times.

Generally, assembly line balancing problem occur when an assembly line is to be designed or redesigned. The assembly line problem was firstly introduced by Henry Ford in 1915, the father of modern assembly line used in mass production.

3. WHY WE USED LINE BALANCING

Generic algorithm and fuzzy logic are used in places that have traditional assembly line and new assembly lines such as heuristic and U-type. Simulation method is often used to improve parameters like productivity and to obtain high yield.

Completion of this goal is done by considering the previous technique which is used to locate a machine, also assignment of employer to machine is done with the help of this. With the help of line balancing, few companies are successful in the area where 1 employer controls 2 or more than 2 machines. Advantages of line balancing are mainly are, increasing the

rate of production, to cut short man power and idle time near machine. Line balancing is also used for producing more than 2 products at a time. In mass production system, most important component is line balancing. It is very useful of the manufacturers who produce products in high volume, it helps to complete their products fast and reduces the cost as well. Balancing performance is the key factor in determining the productivity level of line balancing. Assigning the tasks to successive workstations considering some constraints and optimizing the performance is the task of assembly line balancing. It minimizes the number of workstations used in a workplace.

4. ASSEMBLY LINE BALANCING TERMINOLOGIES

The terminologies often used in assembly line balancing are told in this section. Workstation. To perform a given assigned task a particular location is there, which is workstation. Usually, a workstation is accustomed by only one operator.

Several operators also work on a workstation, e.g. automobile production line. Minimum rational work element. Minimum work unit in the assembly line after which work cannot be divided. In an aircraft assembly, fixing engines, fuel tank, wings etc., are some of the examples of minimum rational work element. Cycle time. It is the maximum time of individual workstations. Cycle time = (Production time per day/Output per day). For e.g. A firm produces bicycles at the rate of 420 bicycles per day. Time taken to produce one bicycle is 420 minutes.

To get the cycle time in seconds, multiply the production time by 60. Therefore, the calculations are as follows, (420*60)/420 = 60 seconds. Efficiency = (Sum of all task times)/(Actual number of workstations*cycle time).

BENEFITS OF ASSEMBLY LINE BALANCING

Two types of benefits are obtained from assembly line balancing. Technical benefits – Reduction in the number of workstations for a given number of cycles.

Cycle time is also reduced for the given number of workstations -Balance delay is minimized. -Total idle time is reduced. -Overall line length is reduced.

The objective of line balancing is to distribute the task to different workstations and it aims at bringing the workstation together to achieve optimization in the time required, number of workers required etc. Reduction in the delay is another important factor in line balancing. Buffer time is also reduced which helps in better utilization of machines in the workplace. Aims of study are as follows: -

- Improvement in productivity and decrement in production cost.
- Figure out the minimum number of workstations.
- Elimination of bottleneck by locating and identifying them.
- Determination of different machinery required.
- Equal distribution of workload among workers.
- Optimization of production functions both manually and automatically.
- Minimization of idle time and buffer time.

REFERENCES

[1]. M. Fathi, M. J. Alvarez, V. Rodríguez (2011) "A new heuristic approach to solving u-shape assembly line balancing problems type-1" World academy of science, engineering and technology vol: 5 2011-11-25

[2]. 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 Vol 13 Issue 2 Version 1.0

[3]. V. P. Jaganathan (2014) "Line balancing using largest candidate rule algorithm in a garment industry: a case study". International journal of lean thinking, issue 1 December 2014.

[4]. James C. Chen (2014) "Assembly Line Balancing Problem of Sewing Lines in Garment Industry" Proceedings of the 2014 International Conference on Industrial Engineering and Operations Management Bali, Indonesia, January 7 – 9, 2014.

[5]. PATRICK R. MCMULLEN1 and PETER TARASEWICH2 (2003) "Using ant techniques to solve the assembly line Balancing problem" IIE Transactions (2003) 35, 605–617

[6]. Dr. Poornima G. Naik Girish R. Naik (2013) Application of Genetic Algorithm to Mass Production Line for Productivity Improvement International Journal of Latest Trends in Engineering and Technology (IJLTET) Special Issue - IDEAS-2013

[7]. Kuan Eng Chong, Mohamed K. Omar, and Nooh Abu Bakar (2008) "Solving Assembly Line Balancing Problem using Genetic Algorithm with

HeuristicsTreated Initial Population" Proceedings of the World Congress on Engineering 2008 Vol II WCE 2008, July 2 - 4, 2008, London, U.K.

[8]. Matthias amen (2006), "cost-oriented assembly line balancing: model formulations, solution difficulty, upper and lower bounds". European journal of operational research vol. 168, pp.747–770.

[9]. Nils Boysen A, Malte fliedner a, armin school (2007) A classification of assembly line balancing problems. European journal of operational research 183 674–693

[10]. Nils Boysen, Malte Fliedner, Armin Scholl (2008) "Assembly line balancing: Which model to use when?". Int. J. Production Economics Vol.111, pp.509–528