IRJEAS
NURTURING RESEARCH
INTERNATIONAL RESEARCH JOURNAL OF ENGINEERING & APPLIED SCIENCES
ISSN: 2322-0821(O) VOLUME 3 ISSUE 4
ISSN: 2394-9910(P) Oct 2015 - Dec 2015

ASSEMBLY LINE BALANCING: A REVIEW

Syed Afzal Ali[1], Dr. Ravindra Mohan Saxena[2]

[1]M. Tech Student, Department of Mechanical Engineering, SATI (Engineering College), Vidisha, M. P., India
[2]Assistant Professor, Department of Mechanical Engineering, SATI (Engineering College), Vidisha, M. P., India

Abstract - Assembly line balancing is process, how tasks are to be assigned to workstations, so that the goal of production can achieve. Minimization of the number of workstations and maximization of the production rate are the main goals of assembly line. This paper presents the reviews of different works in the area of assembly line balancing and find out latest developments and trends available in industries in order to minimize the total labour cost and time of workstations to improve the overall productivity.

Index Terms— Line Balancing, Workstations, Production Cost, Labor Cost.

I. Introduction

Line Balancing means balancing the production line, or any assembly line. The main objective of line balancing is to distribute the task over the each work station so that idle time of labour of machine can be minimized. Line balancing aims at grouping the resources or labour in an efficient and best pattern in order to obtain an optimum or proper balance of the resources and flows of the production or assembly processes. Assembly Line Balancing (ALB) is the term commonly used to refer to the decision process of assigning tasks to workstations in a sequence way to production system. The task of elemental operations required to build raw material in to finished product.

Line Balancing is a classic Operations Research optimization technique which has significant industrial importance in lean system. The concept of mass production essentially involves the Line Balancing in assembly of identical or interchangeable parts or components into the final product in various stages at different workstations. With 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 productivity.

A. Definitions of Related Terms

1) Line Balancing

Line Balancing is leveling the workload across all processes in a cell or value stream to remove blockage and extra resource. A constraint slows the process down and results if waiting for downstream operations and excess capacity results in waiting and absorption of fixed cost.

Single-Model Assembly Line

In early times assembly lines were used in high level production of a single product. But now the products will attract customers without any difference and allows the profitable utilization of Assembly Lines.

An advanced technology of production which enables the automated setup of operations and it is negotiated time and money. Once the product is assembled in the same line and it won't variant the setup or significant setup and it's time that is used, this assembly system is called as Single Model Line.

a) Mixed Model Assembly Line

In this model the setup time between the models would be decreased sufficiently and enough to be ignored. So this internal mixed model determines the assembled on the same line. And the type of assembly line in which workers work in different models of a product in the same assembly line is called Mixed Assembly Line.

b) Multi Model Assembly Line

In this model the uniformity of the assembled products and the production system is not that much sufficient to accept the enabling of the product and the production levels. To reduce the time and money this assembly is arranged in batches, and this allows the short term lot-sizing issues which made in groups of the models to batches and the result will be on the assembly levels.

2) Non Value Added Costs

a) Cost from Overproduction

Production costs money. There is no need to produce such products which cannot be sold. This is the most deceptive waste in today's time and resources utilization is to be maximized. Overproduction includes making more than what is required and making products earlier than required.

b) Excess Inventory Cost

Higher inventory cost is not beneficial for any company in today's variable demand business climate.

Costs which are associated with the inventory are space, obsolescence, damage, opportunity cost, lagged defect detection and handling. In the case of obsolete inventory,

www.irjeas.org, ISSN(o): 2322-0821, ISSN(p): 2394-9910, Volume 3, Issue 4, October 2015 – December 2015, Page 01-04

all costs invested in the production of a part are wasted. Excessive inventory should be eliminated.

c) Processing Cost

Efforts that add no values to the desired product from a customer's point of view are considered as non value added processing. Non value added operations should be eliminated. Vague picture of customer requirements, communication flaws, inappropriate material or machine selection for the production IS the reasons behind this type of waste.

d) Transportation Cost

Cost associated with material movement is a significant factor in the non-value added cost function.

In a well designed system work and storage areas should be near to its point of use. This consumes huge capital investment in terms of equipment required for material movement, storage devices, and systems for material tracking. Transportation does not add value towards the final product.

Motion

Any motion that does not add value to the product or service comes under non-value added cost.

Motion consumes time and energy and includes man or machine movement. Time spent by the operators looking for a tool, extra product handling and heavy conveyor usage are the typical example of the motion waste.

Waiting

If line is not properly balanced and inappropriate material flow selection are the reasons behind waiting time. The time spent on waiting for raw material, the job from the preceding work station, machine down-time, and the operator engaged in other operations and schedules are the major contributors in the waiting time.

B. Terms in Line Balancing Technique

1) Cycle Time

Cycle time is the Maximum amount of time allowed at each station. This can be found by dividing required units to production time available per day.

$$Cycle\ time = \frac{Production\ \ Time\ per\ day}{Unit\ required\ \ per\ day}$$

2) Lead Time

Summation of production times along the assembly line.

Lead Time = Sum of production time along the

3) Assembly line

Bottleneck

Delay in transmission that slow down the production rate. This can be overcome by balancing the line.

Precedence

It can be represented by nodes or graph. In assembly line the products have to obey this rule. The product can't be move to the next station if it doesn't complete at the previous station. The products flow from one station to the other station.

Idle time is the time specified as period when system is not in use but is fully functional at desired parameters.

4) Productivity

Define as ratio of output over input. Productivity is depends on several factors such as workers skills, jobs method and machine used.

Productivity = Output / Total cost

5) Smoothness Index

This is the index to indicate the relative smoothness of a given assembly line balance. A smoothness indeed is zero indicates perfect balance.

$$SI = \sqrt{\sum_{i=1}^{k} (STmax - STi)^2}$$

STmax - maximum station time (in most cases cycle time),

STi - station time of station i.

Balance Delay

This is the ratio of total station time to the product of cycle time and the number of workstations.

$$BD = \left[\left\{(K) * (CT) - \left(\sum_{I=1}^{K} STi\right)\right\} \Big/ \{(K) * (CT)\} * 100\%\right]$$

C. Aims And Objectives Of The Work

The aim of this is to minimizing workloads and workers on the assembly line while meeting a required output.

The aims and objectives of the present study are as follows:-

- To reduce production cost and improve productivity
- To determine number of feasible workstation.
- To identify the location of bottleneck and eliminate them.
- To determine machinery and equipment according to assembly mechanism.
- To equally distribute the workloads among workmen to the assembly line.
- To optimize the production functions through construction of mix form of automation assembly and manual assembly.
- To minimize the total amount of idle time and equivalently minimizing the number of operators to do a given amount of work at a given assembly line speed.

II. Literature Review

Lean and agile manufacturing is a very vast field and Line Balancing in industries is also very important. Many times in conferences this is main topic of discussion and many students and scholars also publish their work on this topic. Amen (2000) [1] presented work on an exact method for cost-oriented assembly line balancing. Characterization of the cost oriented assembly line balancing problem had been shown by without loading the stations maximally the cost-oriented optimum. According to him criterion two stations- rule had to be used. An exact backtracking method was introduced for generating optimal solutions in which the enumeration process was limited by modified and new bounding rules. Results of an experimental investigation showed that the new method finds optimal solutions for small and medium-sized problem instances in acceptable time. A survey on heuristic methods for cost-oriented assembly line balancing was presented by Amen (2000) [2].

In this work main focus was on cost-oriented assembly line balancing. This problem mainly occurs in the final assembly of automotives, consumer durables or personal computers, where production is still very labor-intensive, and where the wage rates depend on the requirements and qualifications to fulfill the work. In this work a short problem description was presented along with classification of existent and new heuristic methods for solving this problem. A new priority rule called best change of idle cost was proposed. This priority rule differs from the existent priority rules because it was the only one which considers that production cost were the result of both, production time and cost rates. A work on new heuristic method for mixed model assembly line balancing problem was published by Jin and Wu (2002) [3].

A goal chasing method was presented which is a popular algorithm in JIT system for the mixed model assembly line balancing problem. In this work, definition of good parts and good remaining sequence were provided and analyze their relationship with the optimal solutions objective function value. A new heuristic algorithm was also develop called variance algorithm' the numerical experiments showed that the new algorithm can yield better solution with little more computation overhead.

Fleszar and Hindi (2003) [4] presented a work on enumerative heuristic and reduction methods for the assembly line balancing problem. They presented a new heuristic algorithm and new reduction techniques for the type 1 assembly line balancing problem. The new heuristic was based on the Hoffmann heuristic and builds solutions from both sides of the precedence network to choose the best. The reduction techniques aimed at augmenting precedence, conjoining tasks and increasing operation times. A test was carried out on a well-known benchmark set of problem instances; testify to the efficacy of the combined algorithm, in terms of both solution quality and optimality verification, as well as to its computational efficiency. A work on assembly line balancing in a mixed model sequencing environment with synchronous transfers was presented by Karabati and Sayin (2003) [5].
An assembly line balancing problem was considered in a mixed-model line which was operated under a cyclic sequencing approach. Study of the problem was done in an assembly line environment with synchronous transfer of parts between the stations.

They formulated the assembly line balancing problem with the objective of minimizing total cycle time by incorporating the cyclic sequencing information. They showed that the solution of a mathematical model that combines multiple models into a single one by adding up operation times constitutes a lower bound for this formulation. An alternative formulation was proposed that suggested minimizing the maximum sub cycle time.
A work was presented by Simaria and Vilarinho (2004) [6] on genetic algorithm based approach to the mixed-model assembly line balancing problem of type II.
According to them mixed-model assembly lines allow for the simultaneous assembly of a set of similar models of a product. A mathematical programming model was presented in this work and an iterative genetic algorithm based procedure for the mixed-model assembly line balancing problem with parallel workstations, in which the goal was to maximize the production rate of the line for a predetermined number of operators.

A fuzzy logic approach to assembly line balancing work was presented by Fonseca et al. (2005) [7]. This work deals with the use of fuzzy set theory as a viable alternative method for modeling and solving the stochastic assembly line balancing problem. Variability and uncertainty in the assembly line balancing problem had traditionally been modeled through the use of statistical distributions. Fuzzy set theory allowed for the consideration of the ambiguity involved in assigning processing and cycle times and the uncertainty contained within such time variables. COMSOAL and Ran-ked Positional Weighting Technique were modified to solve the balancing problem with a fuzzy representation of the time variables. The work showed that the new fuzzy methods capabilities of producing solutions similar to, and in some cases better than, those reached by the traditional methods. Gokcen (2005) [8] presented a work on shortest route formulation of simple U-type assembly line balancing problem. A shortest route formulation of simple U-type assembly line balancing (SULB) problem was presented. This model was based on the shortest route model developed in for the traditional single model assembly line balancing problem. Agpak and Gokcen (2005) [9] presented their work on assembly line balancing: Two resource constrained cases. A new approach on traditional assembly line balancing problem was presented. The proposed approach was to establish balance of the assembly line with minimum number of station and resources and for this purpose, 0–1 integer-programming models were developed.

A work was presented by Bukchin and Rabinowitch (2006) [10] on branch and bound based solution approach for the mixed-model assembly line balancing problem for minimizing stations and task duplication costs. A common assumption in the literature on mixed model assembly line balancing is that a task that is common to multiple models must be assigned to a single station. In this work a common task to be assigned to different stations for different models.

REFERENCES

[1] Amen (2000)"An exact method for cost oriented assembly line balancing". International Journal of Production Economics, Vol. 64, pp. 187-195.
[2] Matthias Amen Int. (2000) "Heuristic methods for cost-oriented assembly line balancing: A survey". International Journal of Production Economics, Vol. 68, pp. 1-14.
[3] Mingzhou Jina, S. David Wub (2002) "A new heuristic method for mixed model assembly line balancing

problem". Computers & Industrial Engineering, Vol. 44, pp.159–169.

[4] Krzysztof Fleszar, Khalil S. Hindi (2003) "An enumerative heuristic and reduction methods for the assembly line balancing problem". European Journal of Operational Research Vol. 145, pp. 606–620.

[5] Selcuk Karabati, Serpil Sayin (2003) "Assembly line balancing in a mixed-model sequencing environment with synchronous transfers". European Journal of Operational Research, Vol. 149, pp.417–429.

[6] Ana Sofia Simaria, Pedro M. Vilarinho (2004) "A genetic algorithm based approach to the mixed model assembly line balancing problem of type II". Computers & Industrial Engineering, Vol. 47, 391–407.

[7] D.J. Fonseca, C.L. Guest, M. Elam, and C.L. Karr (2005) "A Fuzzy Logic Approach to Assembly Line Balancing". Mathware & Soft Computing, Vol.12, pp. 57-74.

[8] Hadi Gokcen, Kursat Agpak, Cevriye Gencer, Emel Kizilkaya (2005) "A shortest route formulation of simple U-type assembly line balancing problem" Applied Mathematical Modelling Vol.29, pp. 373–380.

[9] Kursad Agpak, Hadi Gokcen (2005) "Assembly line balancing: Two resource constrained cases". Int. J. Production Economics Vol.96, pp.129–140.