

Assembly Line and Balancing Assembly Line

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ABSTRACT

Now in the kind of factory we can find many different types of line and also line balancing problems and for so many of that increase of productivity, rate of production and decrease of cycle time to produce one product and the amount of labour time is very important also in the competition can be change the place of factory we want to this paper concentrates on introduce kind of line balancing the work load among workers on continuous production lines or the assembly line. This paper describes a traditional and new method that is implementing into Line Balancing System. This paper describes the development and testing assembly line and kind of method that used for line balancing.

Keywords: *Line Balancing, Assembly Line, Manufacturing Efficiency.*

1. INTRODUCTION

Assembly line defines that manufacturing technique in which a product is carried by some form of mechanized conveyor among stations at which the various operations necessary to its assembly are performed. It is used to assemble quickly large numbers of a uniform product. Originally, assembly lines were developed for a cost efficient mass production of standardized products, designed to exploit a high specialization of labour and the associated learning effects [1]. In the another hand when we used assembly line balancing (ALB) this makes efficient flow-line systems available for low volume assembly-to-order production [2] and enables modern production strategies like mass customization [3]. This in turn ensures that the thorough planning and implementation of assembly systems will remain of high practical relevance in the foreseeable future and also assembly line balancing problem involves an assignment of various tasks to the workstations, while optimizing one or more objectives without violating restrictions imposed on the line. Various objectives are considered in

ALB problems [4]. In practice, it is often desirable to smooth out the workload assignments, and assign related tasks to the same workstation if possible. Thus, we used line balancing technique to achieve:

1. the minimization of the number of workstations;
2. the minimization of cycle time;
3. the maximization of workload smoothness;
4. The maximization of work relatedness.

An assembly line is a manufacturing process in which interchangeable parts are added to a product in a sequential manner to create a finished product. The assembly line was first used by Henry Ford and his engineers. Ford was also the very first to build factories around that concept.

2. History of assembly line

2.1. Basic problem of ALB:

If we want clearly showed and speak about ALB must be say that an assembly line consists of (work) stations $k = 1, \dots, m$ usually arranged along a conveyor belt or a similar mechanical material handling equipment. The work pieces (jobs) are consecutively launched down the line and are moved from station to station. At each station, certain operations are repeatedly performed regarding the cycle time (maximum or average time available for each work cycle). Manufacturing a product on an assembly line requires partitioning the total amount of work into a set $V = \{1, \dots, n\}$ of elementary operations named tasks. Performing a task j takes a task time t_j and requires certain equipment of machines and/or skills of workers. The total workload necessary for assembling a work piece is measured by the sum of task time's t_{sum} . Due to technological and organizational conditions precedence constraints between the tasks have to be observed. These elements can be summarized and visualized by a precedence graph. It contains a node for each task, node weights for the task times, arcs for the direct and paths for the indirect precedence constraints. Fig. 1 shows a precedence graph with $n = 9$ tasks having task times between 2 and 9 (time units). [5]

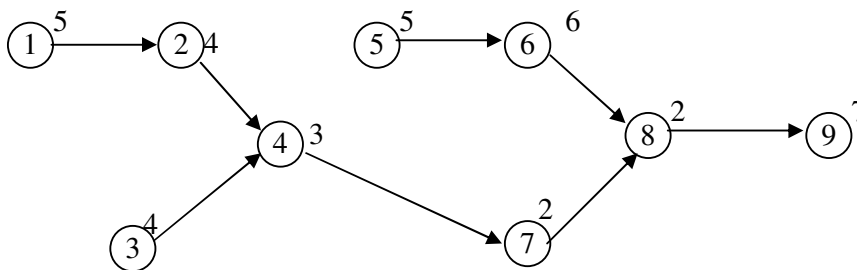


Fig. 1. Precedence graph

Under the term assembly line balancing (ALB) various optimization models have been introduced and discussed in the literature which aim at supporting the decision maker in configuring efficient assembly systems. Since the first mathematical formalization of ALB [6], academic work mainly focused on the core problem of the

configuration, which is the assignment of tasks to stations. Subsequent works however, more and more attempted to extend the problem by integrating practice relevant constraints, like U-shaped lines, parallel stations or processing alternatives [7]. Until the twentieth century, a single craftsman or team of craftsmen would normally create each part of a product individually and assemble them together into a single item, making changes in the parts so that they would fit together and work together; the so-called English System of manufacture. The revolutionary Model T assembly line was introduced to Ford Motor Company by William C. Klann upon his return from visiting a Chicago slaughterhouse and viewing what was referred to the "disassembly line" where animals were butchered as they moved along a conveyor. The efficiency of one person removing the same piece over and over caught his attention. He reported the idea of an assembly line to Peter E. Martin who was doubtful at the time but encouraged him to proceed. Others at Ford have claimed to have put the idea forth to Henry Ford but William "Pa" Klann's slaughterhouse revelation is well documented in the archives at the Henry Ford Museum and elsewhere making him the father of the modern automated assembly line concept. The process was an evolution by trial and error of a team consisting primarily of Peter E. Martin, the factory superintendent; Charles E. Sorensen, Martin's assistant; Harold Wills, draftsman and toolmaker; Clarence W. Avery and Charles Lewis. When the first car was completed using the assembly line, in front of the media, onlookers and even Henry Ford himself, it was Pa Klann who drove it proudly off the line. In the figure 2 we can see the shape of parallel line that used line balancing to achieve high productivity and amount of product and also decrease idle time of each machine and also decrease a flexibility of row martial. [8]

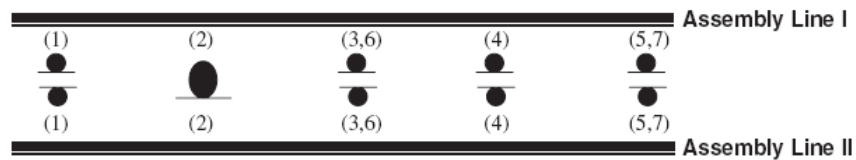


Fig.2. Operator allocations

As a result, Henry Ford's cars came off the assembly line in three minute intervals, a speed much faster than previous methods. Eli is sometimes credited with developing the American System of manufacturing in 1801, using the ideas of division of labor and of engineering tolerance, to create assemblies from parts in a repeatable manner. Ransom Eli Olds patented the first assembly line concept which he put to work in his Olds Motor Vehicle Company factory in 1901, becoming the first company in America to mass-produce automobiles, although the assembly line had already been in use in England for 100 years, having been invented in 1801 by Marc Isambard Brunel (Father of Isambard Kingdom Brunel) for the production of blocks for the Royal Navy. The Block assembly line was so successful that it remained in use until the 1960s, with the workshop still visible at HM Dockyard in Portsmouth, and still containing some of the original machinery.

Henry Ford's engineers perfected the assembly line concept by 1906, and Ford was the first to build entire factories around the concept, which was also referred to as the armory system. The assembly line was an evolution by trial and error and not any single event. It was a team effort consisting primarily of Peter E. Martin, the factory superintendent; Charles E. Sorensen, Martin's assistant; C. Harold Wills, draftsman and toolmaker;

Clarence W. Avery and Charles Lewis, a first line supervisor. They added the conveyor belt, and production by 1916 was over 700,000 model T's --twice the output of all competitors combined. The increased efficiency allowed Ford to cut prices in half and in half again, selling the car for \$850 in 1909 and \$290 by 1924. Ford had made 15 million model T's by 1927. He integrated the assembly line concept with many ideas from the Efficiency Movement, including the famous \$5 day that attracted the best workers. Complex safety procedures - especially assigning each worker to a specific location instead of allowing them to roam about—dramatically reduced the rate of injury. The combination of high wages and high efficiency is called "Fordism,"[9] and was copied by most major industries. The efficiency gains from the assembly line also coincided with the take off of the United States. The assembly line forced workers to work at a certain pace with very repetitive motions which led to more output per worker while other countries were using less productive methods.

The Ford Motor Company at one point considered suing other car companies because they used the assembly line in their production. FMC decided against it because they realized it was essential to creation and expansion of the industry as a whole.

Assembly line balancing problems consist of distributing work required to assemble a product in mass or series production on an assembly line among a set of work stations. Several constraints and different objectives may be considered.

Empirical surveys stemming from the 1970s [10] and 1980s [11] revealed that only a very small percentage of companies were using a mathematical algorithm for configuration planning at that time. The apparent lack of more recent scientific studies on the application of ALB algorithms indicates that this gap still exists or even has widened.

3. Why we used line balancing

All factories that have a line such as traditional assembly line and new assembly line such as heuristic and U-type and also mixed model used a few technique such as genetic algorithms and fuzzy logic and also simulation method to improve a few parameter of line control in other hand manager like has a productivity and high yield in their factory and for this goal get help from previous technique to locate a machine ,employer ,assign employer to machine to select best choose for control and work by machine . In a few company one employer control 2 or more than 2 machines and this result is out put of line balancing. In another word the company used line balancing for grow up the rate of produce and decrease man power, idle time and buffer near machine, also used line balancing for produced more than 2 products. One reason for this deficit might originate from the fact that research papers often regard single or only just a few extensions of ALB in an isolated manner [12]. Real-world assembly systems require a lot of these extensions in many possible combinations. Thus, flexible ALB procedures are required, which can deal with a lot of these extensions in a combined manner. Typically, there is a trade-off between flexibility and efficiency of an optimization procedure. Accordingly, by identifying typical combinations of extensions which often arise jointly in real-world assembly systems, procedures can be developed which exactly fit these requirements, while decreasing the required flexibility to a minimum. Moreover, practitioners might be provided with valuable advices on how to use already existing models and procedures for their special assembly system for that purpose this paper is structured to show a kind of line balancing and also why the factory must be used line balancing in the another word this article want to show

how many model and method is discovered in line balancing and each model when must be used and the benefit of line balancing in the industry.

4. Some of shape of assembly line balancing

4.1. SALBP:

The simple assembly line balancing problem (SALBP) is relevant for straight single product assembly lines where only precedence constraints between tasks are to be considered. Type 1 of this basic problem (SALBP-1) consists of assigning tasks to work stations such that the number of stations is minimized for a given production rate. Type 2 (SALBP-2) is to maximize the production rate, or equivalently, to minimize the sum of idle times for a given number of stations. A more general type (SALBP-G) is obtained by minimizing the sum of idle times subject to varying production rates and numbers of stations.

4.2. UALBP:

The U-line balancing problem (UALBP) considers the case of U-shaped (single product) assembly lines, where stations are arranged within a narrow U. As a consequence, workers are allowed to work on either side of the U, i.e. on early and late tasks in the production process simultaneously. Therefore, modified precedence constraints have to be observed. By analogy with SALBP, different problem types can be distinguished.

4.3. MALBP and MSP:

Mixed model assembly lines produce several models of a basic product in an intermixed sequence. Besides the mixed model assembly balancing problem (MALBP), which has to assign tasks to stations considering the different task times for the different models, the mixed model sequencing problem (MSP) is relevant. MSP has to find a sequence of all model units to be produced such that inefficiencies (work overload, line stoppage, off-line repair etc.) are minimized.

4.4. GALBP:

In the literature, all problem types which generalize or remove some assumptions of SALBP are called generalized assembly line balancing problems (GALBP). This class of problems (including UALBP and MALBP) is very large and contains all problem extensions that might be relevant in practice including equipment selection, processing alternatives, assignment restrictions etc. [13]. Because the research field has grown in an unsystematic manner and, thus, has produced many results which are neither relevant for practice nor for improving the theory. In order to structure the field, to identify practice-relevant research needs and to improve communication between researchers inside the community and with practitioners it seems to be overdue to define a classification scheme. Such a scheme which is based on the logic of the well-known classification scheme for machine scheduling is presented by Boysen [14].

5. ALB in dependency of the number of models

In the briefly we can see all kind of assembly line balancing that related with number of models in the figure 3 and we can see in the continue a summery of each part of this table :

5.1. Single-model assembly lines

In its traditional form, assembly lines were used for high volume production of a single commodity. Nowadays, products without any variation can seldom attract sufficient customers to allow for a profitable utilization of the assembly system. Advanced production technologies enable automated setup operations at negligible setup times and costs. If more than one product is assembled on the same line, but neither setups nor significant variations in operating times occur, the assembly system can be treated as a single model line, as is the case in the production of compact discs [13] or drinking cans for example. Single-model production is the standard assumption of SALB and many generalized ALB problems and have been considered by a vast number of publications. A recent literature overview is provided by Scholl and Becker [14] as well as Becker and Scholl [14].

5.2. Mixed-model assembly lines

In mixed-model production, setup times between models could be reduced sufficiently enough to be ignored, so that intermixed model sequences can be assembled on the same line. In spite of the tremendous efforts to make production systems more versatile, this usually requires very homogeneous production processes. As a consequence, it is typically assumed that all models are variations of the same base product and only differ in specific customizable product attributes, also referred to as options. The installation of varying options typically leads to variations in process times. In automobile production, for instance, the installation of an electrical sun roof requires a different amount of time than that of a manual one. Therefore, station times will depend heavily on the specific model to be assembled. If several work intensive models follow each other at the same station, the cycle time might be exceeded and an overload occurs, which needs to be compensated by some kind of reaction. These overloads can be avoided if a sequence of models is found where those models which cause high station times alternate with less work-intensive ones at each station. This leads to a short term sequencing problem [15]. The balancing and the sequencing problem are heavily interdependent. While the line balance decides on the assignment of tasks to stations and thus determines the work content per station and model, the production sequence of a given model mix is arranged on this basis with regard to minimum overloads. The amount of overload by itself is a measure of efficiency for the achieved line balance. That is why some authors have proposed a simultaneous consideration of both planning problems [6].

5.3. Multi-model assembly lines

In multi-model production, the homogeneity of assembled products and their production processes is not sufficient to allow for facultative production sequences. In order to avoid setup times and/or costs the assembly is organized in batches. This leads to a short term lot-sizing problem which groups models to batches and decides on their assembly sequence [8]. Especially if lot sizes are large, the line balance can in principle be determined separately for each model, as the significance of setup times between batches is comparatively small. However, also in multi-model production a certain degree of similarity in production processes should be inherent. Typically, the different models are manufactured by use of the same resources, e.g. machines or operators. If line balances are determined separately, those resources which are shared by models might need to be moved to other stations whenever the production system is setup for a new batch or have to be installed multiple times. This increases setup times and/or costs. If this interdependency is regarded in the line balance, the setup times might be reduced considerably, which in turn allows for a formation of smaller lots with all associated advantages. [3]

number of models	single model	mixed model	multi model
line control	paced	unpaced asynchronous	unpaced synchronous
frequency	first-time installation		reconfiguration
level of automation	manual lines		automated lines
line of business	automobile production		further examples

Fig.3. Investigated kinds of assembly lines

6. ALB and the level of automation

6.1. Manual lines

In spite of the major advances in the automation of assembly processes, there are still many assembly systems which mainly or completely rely on manual labour. Manual lines are especially common, where work pieces are fragile or if work pieces need to be gripped frequently, as industrial robots might lack the necessary accuracy [9]. In countries where wage costs are low, manual labour can also be a cost efficient alternative to expensive automated machinery.

6.2. Automated lines

Fully automated lines are mainly implemented wherever the work environment is in some form hostile to human beings, as for instance in the body and paint shops of the automobile industry, or where industrial robots are able to perform tasks more economically and with a higher precision (e.g. metal processing tasks). The higher precision of machines typically justifies the assumption of deterministic

task times. If only specialized machinery (each task requires his own machine or tool) is employed, very little other particularities arise merely from the fact that machines carry out tasks.

7. CONCLUSIONS

Thus far, ALB has been an active field of research over more than half a century. This led to a massive body of literature covering plenty aspects of assembly line configuration. With regard to this tremendous academic effort in ALB, it is astounding that only 15 articles could be identified which explicitly deal with line balancing of real world assembly systems. In comparison to the 312 different research papers treated in the latest review articles of Scholl and Becker [7], Becker and Scholl [7] as well as Boysen et al. [6] this is less than 5%. This relation is another indicator for the aforementioned gap between the status of research and the requirements of real-world configuration problems. This article is intended to be a first step towards closing this gap in the future and also by this article I want present the important of line balancing and method that used for this subject. Lastly, if the requirements of practical line balancing are identified, user-friendly computer software is to be developed, which is flexible enough to be successfully applied to these real-world problems. for future I want write article that showed how we can change traditional assembly line balancing to new assembly line balancing such as parallel line and so on this research my be very important because in my country (IRAN) many factory used traditional assembly line and this line had a lot problem that showed in the previous part and if same this factory want to be in the market must change the shape of line and focused in the new figure of assembly line.

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