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A Review of Balancing Assembly Line Using Pso Algorithm

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Abstract- **Assembly lines are special flow-line production systems which are of great importance in the industrial production of high quantity standardized commodities. Recently, assembly lines even gained importance in low volume production of customized products (mass-customization). Due to high capital requirements when installing or redesigning a line, its configuration planning is of great relevance for practitioners. Accordingly, this attracted attention of plenty researchers, who tried to sup-port real-world configuration planning by suited optimization models (assembly line balancing problems). In spite of the enormous academic effort in assembly line balancing, there remains a consider-able gap between requirements of real configuration problems and the status of research. To ease communication between researchers and practitioners, we provide a classification scheme of assembly line balancing. This is a valuable step in identifying remaining research challenges which might contribute to closing the gap.**

Keywords-**Configuration of assembly lines; Assembly line balancing; Classification, Balance Delay, PSO**

I. INTRODUCTION

Assembly line balancing consists of a series of work stations that comprises of work elements. A set of work element having tasks which have a defined cycle time or operating time with a set of interrelated activities in a certain order. Each work element possesses a task time which is a standard time to complete the elemental task. The collective time of all the workstations is the total work content that determines the total time for the assembly. Assembly line balancing is mainly done for the effective utilization of machine and to achieve less congestion within the production system. The three suitable techniques of assembly line balancing i.e. largest candidate rule, kilbridge and wester column method and rank positional weighted method are applied here to determine the best results pertaining to the assembly line which will eventually decrease the idle time and material handling.

II. A DEFINITION OF ASSEMBLY LINE BALANCING (ALB)

In the following, we define the scope of the classification. First we characterize the SALB problem as the core decision problem in configuration planning in its very basic version. A forward, the basic assumptions of SALB are examined of how they have to be adopted for setting the more general assumptions of ALB. That way, a definition of ALB, the field to be classified, can be derived. Among the family of ALB problems, the most well-known and well-studied is certainly the SALB problem. Although it might be far too constrained to reflect the complexity of real-world line balancing, it nevertheless captures its main aspects and is rightfully regarded as the core problem of ALB. In fact, vast varieties of more general problems are direct SALB ex-tensions or at least require the solution of SALB instances in some form. In any case, it is well suited to explain the basic principles of ALB and introduce its relevant terms. Prehensive review of SALB and its solution procedures is provided by Scholl and Becker (2006).

III. OBJECTIVES OF THE PRESENT STUDY

Through analysis of operations at the pre-assembly line and processes at the corresponding workstations,the objectives of this study are,

- To investigate the balance losses in the current pre-assembly line,
- To achieve a lean assembly line by eliminating wastes in current production system and performing necessary revisions with the current station setup,
- To close one of the parallel pre-assembly lines and switch to single line production,
- To balance the new pre-assembly line for the most complex models of each of City, Intercity and Coach bus types.
- To evaluate different layout possibilities for the new station setup,
- To perform these tasks with minimum costs.

IV. LITERATURE REVIEW

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Assembly line (AL) concept was first presented by Henry Ford in early 1900's. It is a cost efficient, highly productive way used by manufacturing organizations It reduces the waiting time of manpower and machines by assigning equal work load to each station along the line. Assembly line balancing (ALB) sets to reduce the possibility of disruption of production line. It makes the flow efficient, cost effective and increases production rate of assembly line. Assembly planning and line balancing was integrated [1] to incorporate decisions on process planning. the system methodology was first explained along with the drawing of the product.

The precedence diagram is drawn that gives us visual explanation of the assembly line. A heuristic procedure for assigning the tasks in the assembly line was performed using kilbridge and wester column method. The aim was to minimize the balance delay and providing smooth postural load in-between the workstations [2]. A detailed study [3] was presented regarding the balancing in a production system. The problems of assembly lines are classified as simple and general model assembly line balancing problems. Mathematical model, heuristic procedure and stochastic algorithm are proposed for optimizing the balancing problems. Largest candidate rule and kilbridge and wester column method were explained in detail using flow chart. In order to not violate the cycle time and precedence constraints, largest candidate rule is determined to assign tasks to the workstation and maintain smooth and continuous flow [4].

A comparison was done between LCR and KWC to a better line efficiency amongst the two on a refrigeration plant. These methods showed huge improvements when compared with the existing line that helped distribute the task evenly so that the idle time of both the machines and men are decreased [5]. A manual assembly line balancing was done by all the three methods of LCR, KWC and RPW and was found that RPW provided the best results with a very high line efficiency as well as labour efficiency [6]. Another researcher also computed the assembly line balancing using all the three methods and tabulated the results pertaining to idle time, line efficiency and smoothness index [7].

Coming to the practical scenario, when applying these methods, they show drastic improvement. Researchers [8] have applied Largest candidate rule in the garment industry and the assembly line efficiency have increased up to 26%. And also, the productivity increased. Thus, this paves way for its application in a real time huge manufacturing set ups. LCR can also be studied on computational experiments that will help to make the software more user friendly and interactive [9]. Different balancing methods were evaluated with the help of operation time. Remaining time is computed at each workstation and then analyzed using rank positional weight method (RPW) [11]. Researchers also found that RPW is a method that minimizes the workstations thereby minimizing the balance delay and ultimately improving the line efficiency. slack time is reduced task is completed in a shorter time [12]. A multi-product assembly line balancing problem [13] was investigated using the method of RPW. The methodology provides a clear scenario of the work done and an expert system is proposed. The bottlenecks of an engine assembly were decreased by RPW method thereby increasing the production by25% [14]. Other researches [15] have used other methods such as genetic algorithm to solve the assembly line balancing problems.

Assembly lines also have been categorized based on the variety and numbers of products get assembled. Three main types of assembly line are:

- Single model assembly line
- Mixed model assembly line
- Multi model assembly line

In single model assembly line, only one type of product can be assembled. In mixed model assembly line, different models of a products can be assembled. In multi model assembly line, the products are assembled in batches and set up can be changed with time [12].

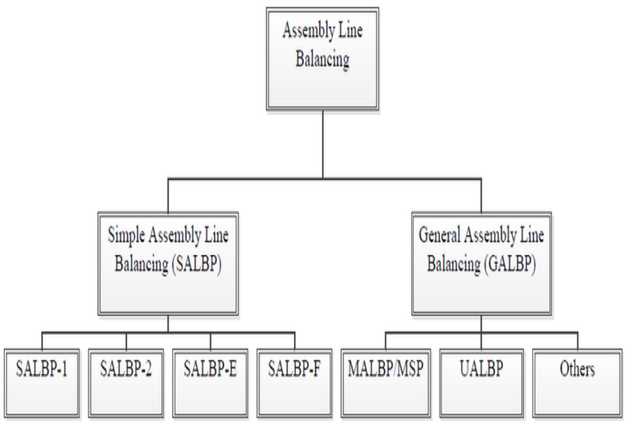

Fig. 1 Classification of assembly line.

In the literature of productivity improvement various methods have been introduced and discussed for balancing production and assembly lines. The most commonly methods are largest Candidate Rule (LCR) method, Kilbridge and Wester Method (KWM), and Ranked Position Weight (RPW). These are heuristic methods based on logic and understandings rather than mathematical proofs and formulas.

These methods are used to develop solutions, which are not optimal but good solutions which approach the true optimum. These heuristic methods commonly used to arrange and distribute the tasks and workload amongst workstations [13].It is important to find the suitable

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technique for balancing the line. In LCR method, work elements arrange in descending order and assign to workstations based on the duration of standard time (Te), sequence of elements and required jigs and tools [14]. In RPW method, the elements assign to workstation based on the size of RPW and their position in precedence diagram [15]. Kilbridge and Wester Method (KWM) method which is also called Colum method, elements assign to workstation according to their position in precedence diagram [13].

V. ASSEMBLY LINE BALANCING PROBLEM

Applying Lean thinking, the first step in increasing the assembly line productivity is to analyze the production tasks and its integral motions. The next step is to record each motion, the physical effort it takes, and the time it takes, also known as time and motion study. Then motions that are not needed can be eliminated also known as non-value added activities and any process improvement opportunity exists must be identified. Then, all the standardized tasks required to finish the product must be established in a logical sequence and the tools must be redesigned.

If required, multiple stations can be designed and the line must be balanced accordingly. The distribution of work on each of these stations must be uniform. The productivity can be improved by incorporating a dedicated material handling system. This allows assembly operators to concentrate on the essential tasks. Some of the most critical components of an assembly line are given as follows: The members of the list are mainly application dependent and can be altered according to the assembly requirements.

- Process design or standardization
- Line balance
- Material handling
- Parts procurement and feeding
- Work-in-process management
- Man power
- Line size
- Line configuration

All these factors are closely related with one another and have a considerable impact on the assembly line performance as well as production cost. Various line configurations would demand different material handling strategies and multiple levels of line re-balancing so that the desired performance level can be achieved. Assembly line design involves step-by-step approach by varying and analyzing each of these factors and arriving at a best feasible design, McMullen et al.

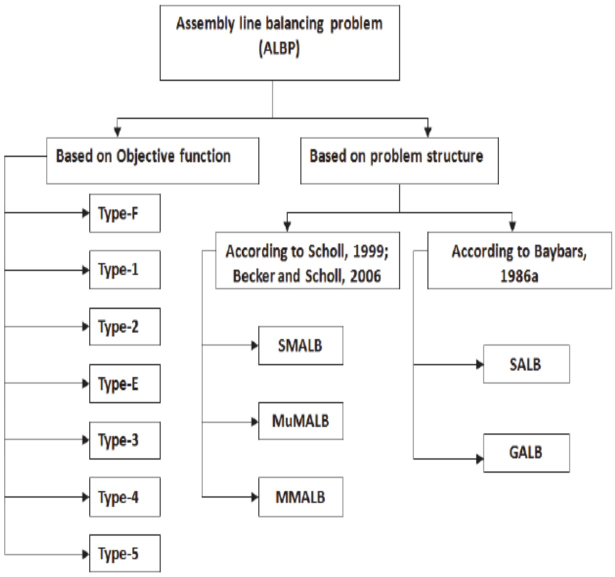

Fig. 2 Classification of Balancing Assembly line Problem.

VI. METHOLOGY

PSO is a subset of evolutionary algorithms (EAs) that model biological processes to optimize highly complex cost functions. PSO is inspired from the mechanics of natural selection and natural genetics such as inheritance, mutation and recombination (also known as crossover). It is used in computing to find the optimal solutions to optimization and search problems. PSO was developed by John Holland in 1975.Through the work of John Holland in development of genetics. This chapter concludes the work, application results and findings of the appropriate process. In addition, the chapter summarizes the comparative analyses of various evolved models and gives a summary of the deliverables of the project, possibilities to improve the obtained results and to better the features of the developed models are also highlighted,Suer et al.

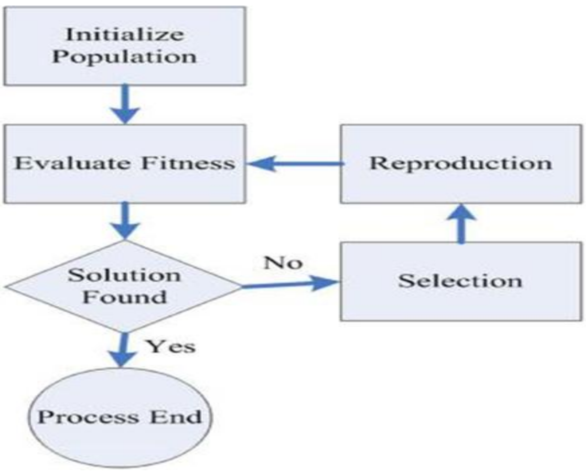

Fig.3 PSO flow chart

VII.CONCLUSION

The improved assembly line efficiency gives an output of 500 boxes/operator/hour, which is about a 92% increase in operator productivity efficiency. From the original method, when a situation for maximum 10 count and storage time 0.2 for each product, transportation time 0.7. Also, with this Single Stage Parallel Line with the help of PSO, the floor space usage is reduced by half compared to original method. This method also determines the material handling requirements as well as the input and output buffer sizes with this new assembly line. When having an assembly line with multiple stations, the impact of having station imbalances on the individual operator performance is also recognized.

The current project addresses the productivity improvement of a manual assembly line by making use of operations analysis in the framework of Lean production. A methodology is proposed that helps to improve the productivity of any production process. The methodology consists of selecting a product or product family to be studied followed by current process study. Once the existing process is documented, all the assembly tasks involved must be timed using time study techniques. Operations analysis enables the reduction of non-productive tasks and results in a set of standardized work elements along with the set of standard procedures for performing the operations.

Assembly line balancing along with the associated operations analysis assists in constructing or re-configuring an assembly system, which is the key step in improving the overall performance of an assembly line. Following this approach, two manual assembly line configurations (single Stage parallel line and five-stage serial line) are constructed for a case study. The results show that by changing over to the single stage assembly line configuration the operator productivity is doubled when compared to the existing assembly method.

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