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Optimizing Efficiency: Automated Assembly Line Balancing Strategies and Implementation Costs

Abhilash V[1], Anil Kumar [2], Dhilip Kumar D[3],Prabakaran P[4]

[1,2,3,4]Assistant Professor, Department of Mechanical Engineering, PERI Institute of Technology, Chennai

Abstract:

The document explores the concept of line balancing in an automated assembly line, focusing on the optimization of workstations for efficient production. Various solution methodologies and heuristics for assembly line balancing are discussed, with a specific emphasis on the Largest candidate rule. The importance of configuration planning in designing assembly lines is highlighted, along with the benefits of automation in enhancing productivity and accuracy. Different types of assembly line models, such as single-model, mixed-model, and multi-model lines, are also explained. The study presents a case study on engine assembly at M/s TVS Motors, Hosur, to demonstrate the application of line balancing techniques. Overall, the document provides insights into the challenges and strategies involved in achieving optimal assembly line performance in automated manufacturing environments.

Keywords: Assembly line, Cycle time, Automation, Line efficiency.

1. Introduction

An assembly line is a flow-oriented production system where the productive units performing the operations, referred to as stations, are aligned in a serial manner. The workpiece visit stations successively as they are moved along the line usually by some kind of transportation system, e.g., a conveyor belt. Assembly lines are flow-line production systems which are of great importance in the industrial production of high quantity standardized commodities and more recently even gained importance in low volume production of customized products. Due to high capital requirements when installing or redesigning a line, configuration planning is of great relevance for practitioners. Assembly lines are designed for the sequential organization of workers, tools or machines, and parts. The motion of workers is minimized to the extent possible. All parts or assemblies are handled either by conveyors or motorized vehicles such as fork lifts, or gravity, with no manual trucking. Heavy lifting is done by machines such as overhead cranes or fork lift. Each worker typically performs one simple operation.An automated assembly system performs a sequence of automated assembly operations to combine multiple components to a single entity. The components are usually joined out at a time so the assembly is completed progressively.

UgarOzcan and Bilal Toklu(2009), proposed anew mathematical model and a simulated annealing algorithm for the mixed model two-sided assembly line balancing problem. The mathematical model minimizes the number of mated-stations and minimizes the number of stations for a given cycle time. In the proposed simulated annealing algorithm, two performance criteria are considered simultaneously: maximizing the weighted line efficiency and minimizing the weighted smoothness index.

SupapornSuwannarongsri ,DeachaPuangdownreong(2008), proposed a new technique for line balancing using Tabu search(TS) and imposed a new technique called the partial random permutation(PRP). The TS method is used to address the number of tasks assigned for each workstation, while the PRP technique is conducted to assign the sequence of tasks for each workstation according to precedence constraints. The proposed method is tested against three benchmark ALB problems and one real-world ALB problem.

2. Discussion

2.1 Assembly Line Balancing (ALB)

An assembly line is a sequence of workstations connected together by a material handling system. It is used to assemble components into a final product. Assembly line balancing is a process by which all work required to complete an assembly is divided and assigned to progressive stations, such that the work in each station is equal or nearly equal. ALB is the problem of assigning operations to workstations along an assembly line in such a way that the assignment be optimal in some sense. The ALB problem is assigning tasks (work elements) to workstations that minimize the amount of the idle time of the line, while satisfying two specific constraints. The first constraint is that the total processing time assigned to each workstation should be less than or equal to the cycle time. The second one is that the task assignments should follow the sequential processing order of the tasks (precedence constraints). The data for the ALB problem are obtained from the case study done at engine assembly in M/s TVS Motors, Hosur and from the benchmark problem from the journal article (*SupapornSuwannarongsri ,Deacha Puangdownreong*,2008).

2.2 ASSUMPTIONS

1. There are no buffers between stations. Thus, the production sequence is determined prior to the launch such that a reordering or preemption of jobs is impossible.
2. The work pieces have a fixed location on the transportation system, only their orientation may change.

3. SOLUTION METHODOLOGY

There are many solution methodologies and heuristics available for solving the assembly line balancing problem viz,Largest candidate rule, Kilbridge and Wester method, Ranked positional weights method, Branch and bound model, Tabu search, Simulated annealing, etc

From these methods, Largest candidate rule is selected as the solution methodology for solving the problem and the result is compared with the result of the Rational Positional Weight method.

The result for the case study in engine assembly at M/s TVS Motors, Hosur is given below

STATION NO	OPERATION	NO OF ELEMENTS	PROCESSING TIME(Sec)
S1	Oil pump assembly	15	69
S2	Cover oil pump and magneto starter assembly	15	72
S3	Magneto rotor and oil	16	73
S4	Piston and Stud assembly	16	61
S5	Cylinder block and head assembly	16	66
S6	Cylinder head and cam chain assembly	14	61
S7	Cover cylinder head assembly	12	67
S8	Head tightening and ACT assembly	15	62
S9	Tapped setting	7	79
S10	Spark plug and CVT assembly	14	79
S11	Movable drive, belt and fixed drive assembly	12	75
S12	Cover variator assembly	15	75
S13	Engine oil filling scanning	17	69
S14	Stud assembly and engine unloading for testing	7	35

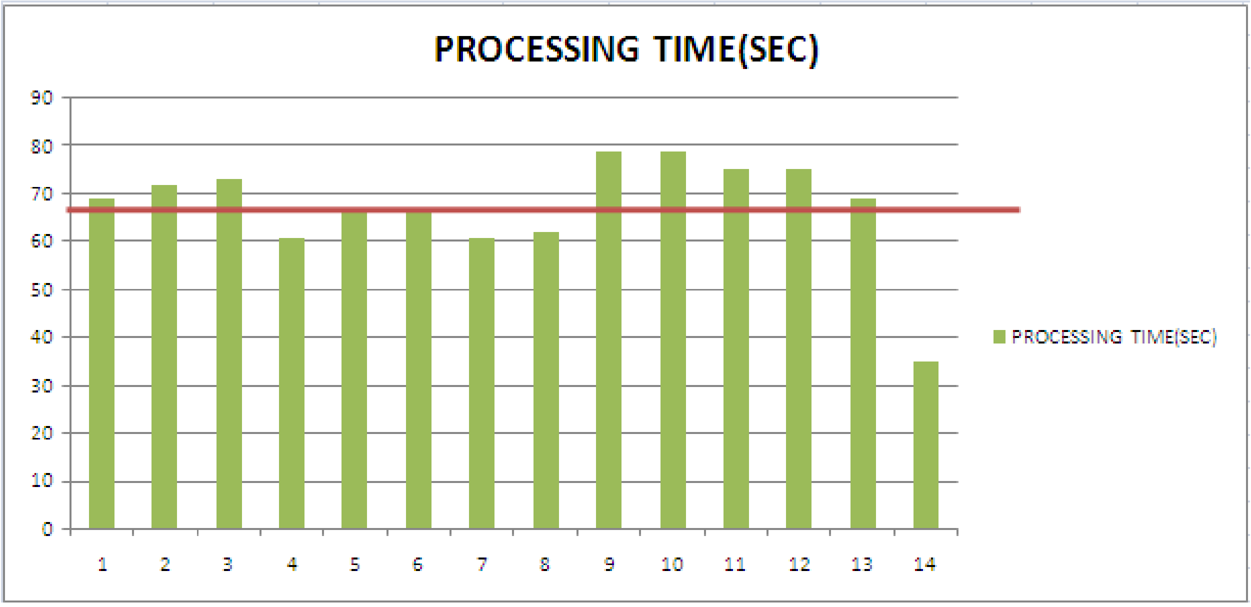
Number of work stations -14

Production rate -37.5 units/hr

Cycle time -1.1225 min/cycle (67.35 sec)

Total work content -15.716min

Line Efficiency -70.15%



After implementing Ranked Positional Weight method(RPW):

Total work content -15.716min

Cycle time -1.1225 min/cycle (67.35 sec)

Line Efficiency -70.15%

After RPW method, it is observed that the position of workstations 6 and 7 are interchanges.

The data from the benchmark problem from the journal article (*SupapornSuwannarongsri* ,*Deacha Puangdownreong*,2008) is given below

STATION NO	OPERATIONS	NO OF ELEMENTS	PROCESSING TIME(Sec)
S1	Front assembly	9	334
S2	Rear assembly	8	329
S3	Engine assembly	7	316
S4	Brake and shock assembly	9	330
S5	Frame assembly	9	343

S6	Chain assembly	7	343
S7	Muffler and cover assembly	7	332
S8	Shroud and cover	4	148

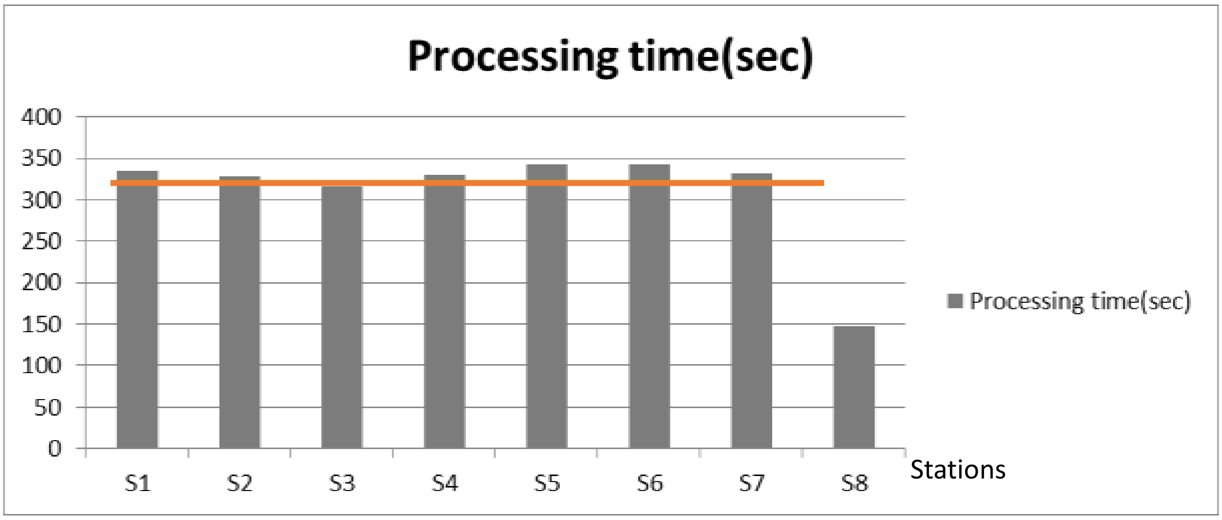
The summary of result for the case study is calculated to be

Number of work stations -8

Cycle time -5.15min/cycle (309.37 sec/cycle)

Total work content -41.25min

Line efficiency - 75%



After implementing Ranked Positional Weight method:

Total work content -41.25min

Cycle time -5.15min/cycle (309.37 sec/cycle)

Line efficiency - 75%

After RPW method, it is observed that the sequence of the work stations has been changed to {5,3,1,2,6,4,7,8}.

CONCLUSION

The line balancing is done by using the largest candidate rule. The data for the assembly line balancing problems are engine assembly at M/s TVS Motors, Hosur and the benchmark problem from the journal article (*SupapornSuwannarongsri, DeachaPuangdownreong*, 2008). After the line balancing is done, the cycle time of each assembly has been reduced when compared to the existing data. The result of this method is compared with the output of the Rational Positional Weight method and it is observed that there is a difference in the placement of workstation between two line balancing methods but the cycle time remains the same.

REFERENCES

1. UgarOzcan, Bilal Toklu“ *Balancing of mixed model two-sided assembly line”,* vol 57, 2009, pages 217-227
2. Nils Boysen, Malte Fliedner, Armin Scholl, **“***Assembly line balancing: Which model to use when***”,** vol 111, 2008, pages 509-528.
3. Joaquin Bautista, Jaime Cano “*Minimizing work overload in mixed model assembly lines”*, vol 112, 2008, pages 177-191.
4. SupapornSuwannarongsri ,DeachaPuangdownreong, **“***Optimalassembly line balancing using tabu search with partial random permutation techniques* **”**,2008.
5. Nils Boysen, Malte Fliedner, Armin Scholl, **“***A classification of assembly line balancing problems***”**, vol 183, 2007, pages 674-693.
6. Christian Becker, Armin Scholl, **“***A survey on problems and methods in generalized assembly line balancing***”**, vol 168, 2006, pages 694-715.
7. Pravin Y. Tambe**“***Balancing mixed model assembly line to reduce work overload in multi level production system***”,** 2006.
8. Charles Fernandes “ *Heuristic method for mixed model assembly line balancing and sequencing”,* 1994.