Research Paper

USE OF RANKED POSITION WEIGHTED METHOD FOR ASSEMBLY LINE BALANCING

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ABSTRACT

Assembly Line production is one of the widely used production systems. The problem of Assembly Line Balancing deals with the distribution of activities among the workstations which lead to the maximum utilization of human resources and facilities without disturbing the work sequence. Assembly lines are traditional and still attractive means of large-scale production. Since the time of Henry Ford, several developments have been taken place in production systems which changed assembly lines from strictly paced and straight single-model lines to more flexible systems as parallel work stations, customer-oriented mixed-model and multi-model lines, U-shaped lines and unpaced lines with intermediate buffers. In this paper a problem of line balancing in cashew nut shelling machine production has been discussed using ranked position weighted method.

KEYWORDS - Assembly line balancing, Ranked position weighted method.

1. INTRODUCTION

The concept of manufacturing assembly line (AL) was first introduced by Henry Ford in the early 1900's. It was designed to be an efficient, highly productive way of manufacturing a particular product. The basic assembly line consists of a set of workstations arranged in a linear fashion, with each station connected by a material handling device. The basic movement of material through an assembly line begins with a part being fed into the first station at a predetermined feed rate. A station is considered any point on the assembly line in which a task is performed on the part. These tasks can be performed by machinery, robots, and or human operators. Once the part enters a station, a task is then performed on the part, and the part is fed to the next operation. The time it takes to complete a task at each operation is known as the process time. The cycle time of an assembly line is predetermined by a desired production rate. This production rate is set so that the desired amount of end product is produced within a certain time period

When designing an assembly line the following restrictions must be imposed on grouping of work elements.

1. Precedence relationship.
2. The number of work elements cannot be greater than the number of workstation. The minimum number of workstation is one.
3. The cycle time is greater than or equal to the maximum of any station time and of the time of any work elements. The station time should not be exceeding the cycle time.

2. Types of Simple Assembly Line Balancing Problem (SALBP)

Simple assembly line balancing problems are classified into two types, type I and type II. In type I problems, the required production rate (i.e. cycle time), assembly tasks, tasks times, and precedence requirements is given. The objective of this is to minimize the number of workstations. A line with fewer stations results in lower labor costs and reduced space requirements. Type I problems generally occurs at the time of designing new assembly lines. To achieve the forecast demand the number of workstations should be reduced. For expansion (when demand is increased) type I problems also can be used to minimize the number of extra stations need to install. [3]

In type II problems, when the number of workstations or number of employees is fixed, the objective is to minimize the cycle time. This leads to maximize the production rate. Type II balancing problems generally occurs, when the organization wants to produce the optimum number of items by using a fixed number work stations without expansion. In this type it is necessary to identify precedence, and constraints. While balancing the main line, it is necessary to consider subassembly lines.

Type I problems are more common than type II. The exact algorithms available for the same become intractable when the problem size increases.

Heuristic Methods of Line Balancing

1. Moodie -Young Method
2. Killbridge and Wester Heuristic
3. Hoffmans or Precedence Matrix
4. Immediate Update First Fit Method
5. Ranked Position Weighted Method (RPW)

The RPW solution represents a more efficient way to assign the work elements to station than any other methods mentioned above. In RPW method, one can assign cycle time and then calculate the work stations required for production line or vice versa. This cannot be done in any other method of line balancing. So in the existing problem of Cashew nut shelling machine RPW method is used.

3. Ranked Positional Weighted Method

Steps involved in RPW method-

Step 1:

Draw the precedence diagram

Step 2:

For each work element, determine the positional weight. It is the total time on the longest path from the beginning of operation to the last operation of the network.

Step 3:

Rank the work elements in descending order of ranked positional weight (R.P.W).

Step 4:

Assign the work element to a station. Choose the highest RPW element. Then, select the next one. Continue till cycle time is not violated. Follow the precedence constraints also.

Step 5:

Repeat step 4 till all operations are allotted to one station.

These steps are followed for solving the problem of cashew nut shelling machine line balancing.

4. Line Balancing of Cashew Nut Shelling Machine using RPW Method

Khedkar Tech India, Kolhapur is manufacturing the Cashew Nut Shelling Machine. Khedkar Tech. India introduced all new 'Cashew Nut Shelling Machine' well engineered, miraculous machine that de-shells overall 90 percent of cashew nuts which fed in the machine for de-shelling.

Initially authors have found out that there is no assembly line for machine manufacturing, because assembly Cashew Nut Shelling Machine is done on single work station, hence time required for the assembly of Cashew Nut Shelling Machine was more. Company has the prospect of mass production. For that purpose, authors decided to develop new assembly line with the help of Ranked Positional weight method (RPW).

After monitoring the different part of the machine which was manufactured at only one work station, it was decided to sub group the assemblies. So based on the observations total machine assembly was divided into the 10 sub assemblies. The study has been carried out for building the whole assembly line and to find out the total cycle time using the RPW method. In this paper the use of RPW method has been discussed for only one sub assembly. The final sub assembly has been presented over here to show the use of RPW method.

For final assembly of Cashew Nut Shelling Machine required 10 sub assemblies which are Hopper, Circuit, Catch up, Pick up, Trolley, Cutter Section, Cutter, Crank Mechanism, Timing Pulley Belt Cover and Bucket. With help of these 10 subassemblies final assembly of Cashew Nut Shelling Machine is complete. For assembly of Cashew Nut Shelling Machine operators are constraints. Total six operators are required for complete assembly i.e., 4 on work stations and 2 for material handling. At first the precedence elements was identified and accordingly the precedence diagram was constructed.

Theoretical Calculation

Bottleneck time = 45 min

Total task time = T = 210 min

Maximum production rate = 420/45= 9.33=9 units per day

Cycle time = C = 420/9= 46.67= 47 min

Theoretical number of work station = N = T/C = 210/45 = 4.67 =5

But number of workers = 4. So the number of workstations should be four.

Take number of workstations as 4.

N= T/C

C = T/N =210/4 = 52.5= 55 min per units.

Production rate = 420/55 = 7.633 = 7 units per day.

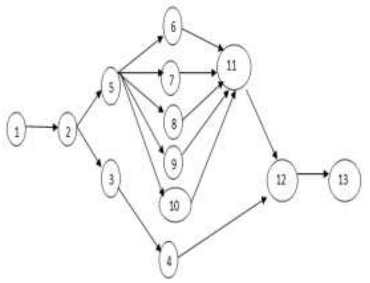

Fig 1- Precedence Diagram for Final Assembly

Table No.1 Final Assembly-Sub Elements Precedence

Element	Time (min.)	Description	Predecessor
1	20	Assembly frame none	----
2	20	Assemble cutter assembly	1
3	45	Assemble motor and G.B.	2
4	10	Assemble crank	3
5	7	Assemble pickup assembly	2
6	5	Assemble belt cover assembly	5
7	8	Assemble tensioned & cup assembly	5
8	20	Assemble bucket and disk assembly with shaft (with pulley)	5
9	15	Assemble feed motor (with pulley) and belt	5
10	5	Assemble circuit assembly	5
11	4	Assemble hopper assembly	6,7,8,9,10
12	45	Connect wires	11,4
13	6	Assemble outer cover	12

Applying RPW method

Step 1: Calculate RPW for each element

Element	RPW	Time(min.)	Predecessor
1	210	20	---
2	190	20	1
3	106	45	2
4	61	10	3
5	115	7	2
6	60	5	5
7	63	8	5
8	75	20	5
9	70	15	5
10	60	5	5
11	55	4	6,7,8,9,10
12	51	45	4,11
13	6	6	12

Step 2: Assign RPW in descending order

Element	RPW	Time(min.)	Predecessor
1	210	20	---
2	190	20	1
5	115	7	2
3	106	45	2
8	75	20	5
9	70	15	5
7	63	8	5
4	61	10	3
6	60	5	5
10	60	5	5
11	55	4	6,7,8,9,10
12	51	45	4,11
13	6	6	12

Step 3: Assign task to workstation

Workstation No.	Element	Time(min.)	Sum of time(min.)
1	1	20	
	2	20	
	5	7	
	7	8	55
2	3	45	
	4	10	55
3	8	20	
	9	15	
	6	5	
	10	5	
	11	4	49
4	12	45	
	13	6	51

As the calculated cycle time C = 55 min per unit so every work station should have cycle time of 55 or less than 55 mins. So on each work station element assembly should be in such a way that summation of time required to process the elements should be equal or less than cycle time 55 minutes.

As shown in above tables after application of RPW method final assembly is done on four work stations hence time required for final assembly is reduced with available manpower.

5. CONCLUSION

The main purpose of this paper is to represent use of RPW method to develop the assembly line and balancing that line. With this study it is found that RPW method is useful when the less data is available. Again with the help of RPW method, one can find out the way to synchronise the work stations for the work flow and sequencing. So the bottlenecking of the assemblies can be reduced. In this case study numbers of workstations have been decided and proper layout has been proposed based on RPW method. Before implementing the RPW method production rate was 26 machines per month. And after implementing the RPW method, production rate was increased by 38% with 36 machines per month.

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