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ASSEMBLY LINE BALANCING IN AN ALTERNATOR MANUFACTURING COMPANY USING RPW METHOD

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Abstract- *Improper line balancing causes the accumulation of inventories, poor distribution of workloads and workers along the assembly line. Many companies facing a problem of irregular production rate. So we decided to propose a new assembly time with the objective of redeployment of work force. This is done with analyzing and application of RPW method to the existing assembly line. This aims to minimize workloads and workers on the assembly line while meeting a required output. The production rate is depending on how well the line is running. A new layout will be proposed to make the assembly line achieve its required production rate. The work involves analysis of present production line for identifying the sources of waste in differentiating Value added time and non-value added time. Line balancing was done to minimize the idle time and improve cycle efficiency by reducing the number of work stations.*

Keywords: *Assembly line balancing, RPW method*

1. Introduction

The paper titled "Assembly line balancing in an alternator manufacturing company" is aimed at identifying some of the major problems regarding the present assembly line of an alternator manufacturing company under the government of Kerala, and to develop an efficient assembly line, so as to improve the production performance of the firm. In Industry sectors, it is important to manufacture the products, which have good quality products and meet customers' demand. This action could be conducted under existing resources such as employees, machines and other facilities. However, the goal of balancing assembly line is to average the working hours of workstations, to reduce total idle time, to improve production efficiency. The paper focus on line balancing conducted in an alternator manufacturing company. Improper line balancing causes the accumulation of inventories, poor distribution of workloads and workers along the assembly line. Companyfacing a problem of irregular production rate. It is found that at some stations, inventory pile up more but in some other stations starving is there. So we decided to propose a new assembly time with the objective of redeployment of work force. This is done with analyzing and application of ALB methods to the existing assembly line. Hence the study is mainly make the company more competitive through process improvement

2. Literature Review

Many scholars have made researches on Assembly Line Balancing and plant layout modification for production optimization. Jun Hua Wu sets single line model for ALBP-I, and give heuristic algorithm to solve the model. We-Min Chow gives the conclusion of different kinds of heuristic algorithm. But the direct research on ALBP-II is almost rare. Helgeson and Birnie solve ALBP-II as ALBP-I, Hsackman solve ALBP-II in ALBP-I by giving more constrains. From mid-1970's focus has been built around the performance of computer program, as computer has started to become important tool for computation. Macaskill (1972) explained that effectiveness of algorithm depends on the choice of procedure for selecting the appropriate candidate for assignment. Two major factors to consider in this regard are balance efficiency and speed of computation; these factors are inversely proportional to each other. Macaskill (1972) was the first to consider Multi Model Assembly Line Balancing concerning about allocation of work to operators and effect of model sequence on assembly performance.Naveen Kumar &DalgobindMahto (2013) conducted a research onProductivity Improvement through Process Analysis for Optimizing Assembly Line in Packaging Industries he useSimulation tools such as Fact
Model, to modeling the production line and the works estimated are used to reduce the line unbalancing causes and relocate the workforce associated to idle time, eliminating the bottleneck and improving the productivity. Nguyen Thi Lam et al (2016). Focuses on Lean line balancing for an electronics assembly line. This research shows that there are many wastes which could be eliminated with the simple lean tools. It is not very complicate but it would bring essential benefits. After the line is balanced, standardization of works should be done. The guideline should be developed in detail for training and

assuring the quality of jobs. Other lean tools such as 5S, Kaizen, or TPM should be studied, which could support setting up the lean environment for the company.

3. 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 thenumber of workstations should be reduced. Forexpansion (when demand is increased) type Iproblems also can be used to minimize the number ofextra stations need to install.In type II problems, when the number of workstationsor number of employees is fixed, the objective is tominimize the cycle time. This leads to maximize theproduction rate. Type II balancing problemsgenerally occurs, when the organization wants toproduce the optimum number of items by using afixed number work stations without expansion. Inthis type it is necessary to identify precedence, and constraints. While balancing the main line, it isnecessary to consider subassembly lines.Type I problems are more common than type II. Theexact algorithms available for the same becomeintractable when the problem size increases.

Heuristic Methods of Line Balancing

1. Moodie -Young Method
2. Killbridge and Wester Heuristic
3. Ranked Position Weighted Method (RPW)

The RPW solution represents a more efficient way toassign the work elements to station than any othermethods mentioned above. In RPW method, one canassign cycle time and then calculate the work stationsrequired for production line or vice versa. Thiscannot be done in any other method of line balancing.So in the existing problem RPW method is used.

4. Methodology

4.1 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 Line balancing in machine shop of company line balancing.
The main product of company is brushless alternator. The company manufactures and markets products like general purpose brushless alternators, brushless alternators for lighting and air-conditioning of rail coaches. In the company 4.5 kw alternator is produced in 3 parts and it is assembled. The parts and process are:

1. **Rotor making**
2. **Stator making**
3. **End Shield**
4. **Assembling**

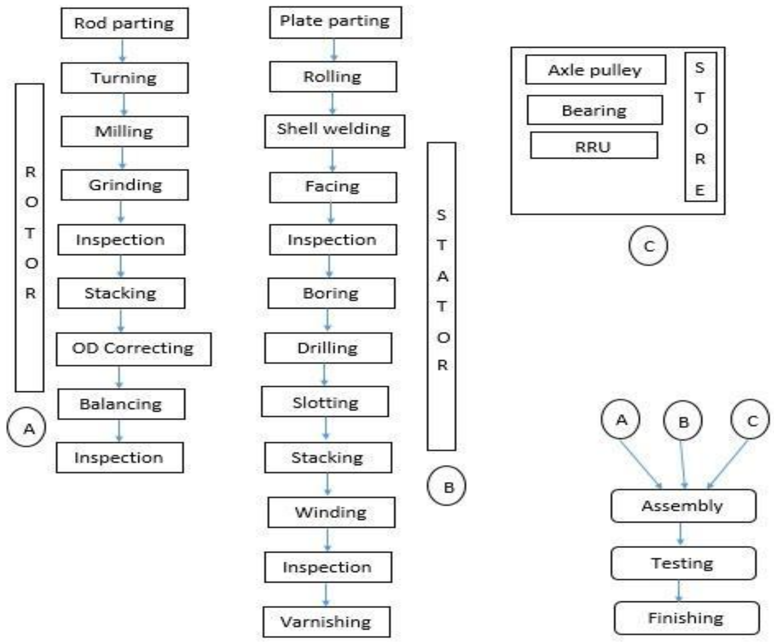

Fig 1. production process

Figure shows all the process involved in the production of 4.5 kw alternator

5. Precedence diagram

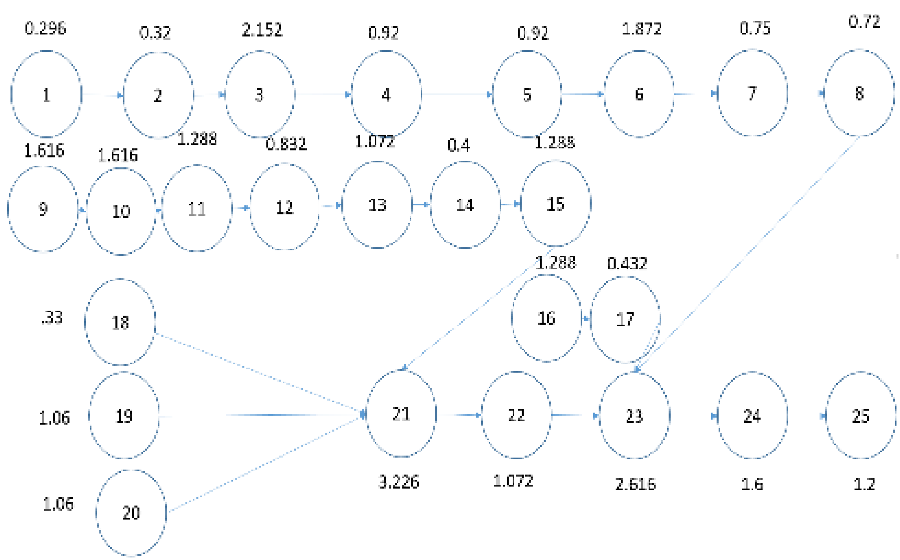

Fig 2 precedence diagram

A Precedence Diagramming Method (PDM), which is sometimes also known as the Activity on Node (AON) Diagramming Method, is a graphical representation technique, which shows the inter-dependencies among various project activities. The Precedence Diagramming Method (PDM), which is sometimes also known as the Activity on Node (AON) Diagramming Method, is a graphical representation technique used to show the inter-dependencies among various project activities.

6. Calculation of current cycle efficiency

- Takt time=net available time per day × customer demand per day
- Net available time per day=24hrs-break time=22 hrs
- Annual customer demand=1440 units
- Customer demand per day=6 units
- Takt time =22/6=3.666 hrs
- Total time for production=29.936 hrs
- Total no of current work station=25
- Maximum cycle time=3.226hrs

$$\text{current line efficiency} = \frac{\text{Total time for production}}{\text{no of work stations} \times \text{max cycle time}} \times 100$$

=29.936/(25*3.226)

=37.118%

- Idle time=n*c-time of production=24*3.226-29.936=50.174hr

7.Balancing using RPW method

Operation	Time (hrs)	Positional weight
1	0.296	13.336
2	0.32	13.04
3	2.152	12.72
4	0.92	10.568
5	0.92	9.648
6	1.872	8.728
7	0.75	6.856
8	0.72	6.106
9	1.612	17.810
10	1.612	16.198
11	1.288	14.594
12	.832	13.306
13	1.072	12.474
14	.4	11.402
15	1.288	11.362
16	1.288	7.136
17	0.432	5.848
18	.33	10.044
19	1.06	10.774
20	1.06	10.774
21	3.226	9.714
22	1.072	6.488
23	2.616	5.416
24	1.6	2.8
25	1.2	1.2

Table 1. Positional weights

The above table shows all the 25 work stations and their positional weight according to the consideration of time and precedence relationship

8. Allocation of work element to stations

The actual result of line balancing here the number of work stations are reduced from 25 to 10. But there is some practical feasibility issues. From the above results the work element 22 (varnishing) is to be included in workstation 8 but in the actual company scenario varnishing is a separate plant so it cannot be included in work station 8. So it should be treated as a separate work station so some changes are made from the actual line balancing results are made for practical convenience without violating the cycle time and precedence relationship. That modified line balancing is shown in the table 2

Stn No	Work element selected	Time	Unassuaged cycle time(hrs)	Ready task
1			3.226	1,9,15,17,18,19
	9	3.224	0.002	1,10,15,17,18,19
2			3.226	1,10,15,17,18,19
	10	1.288	1.938	1,11,15,17,18,19
	1	0.296	1.642	2,11,15,17,18,19
	11	0.832	0.81	2,12,15,17,18,19
	2	0.32	0.49	3,12,15,17,18,19
	17	0.33	0.16	3,12,15,18,19
3			3.226	3,12,15,18,19
	3	2.152	1.074	4,12,15,18,19
	12	1.072	0.002	4,13,15,18,19
4			3.226	4,13,15,18,19
	13	0.4	2.826	4,14,15,18,19
	14	1.288	1.538	4,15,18,19
	15	1.288	0.25	4,16,18,19
5			3.226	4,16,18,19
	18	1.06	2.166	4,16,19
	19	1.06	1.106	4,16
	4	0.92	0.186	5,20,16
6			3.226	5,20,16
	20	3.226	0	5,21,16
7			3.226	5,21,16
	5	0.92	2.306	6,21,16
	6	1.872	0.434	7,21,16
8			3.226	7,21,16
	7	0.75	2.476	8,21,16
	21	1.072	1.404	8,22,16
	8	0.72	0.684	22,16
	16	0.432	0.252	22
9			3.226	22
	22	2.616	0.65	23
10			3.226	23
	23	1.6	1.626	24

Table 2. Balancing using rpw method

9. Calculation of new cycle efficiency

New cycle efficiency= 29.936*100/(11*3.226) =84.36%

New Idle time=n*c-time of production=11*3.226-29.936=5.55 hrs

After applying assembly line balancing the no of stations reduced from 25 to 11 work stations hence cycle efficiency 37.118% increased to 84.36%. That is47.24% increase in cycle efficiency. And idle time is reduced from 50.714 hrs to5.55hrs.

10. Comparison of present assembly line and new assembly line

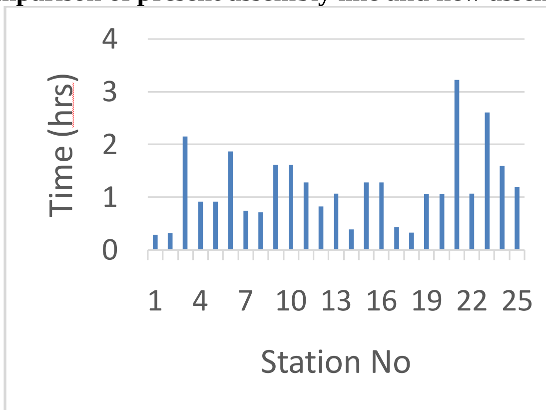

Fig 3.Present assembly line

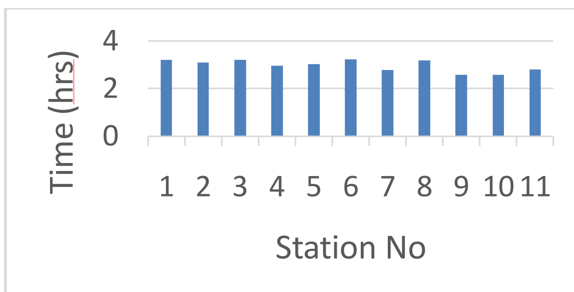

Fig 4.new balanced assembly line

From the first graph we can see that there are 25 work stations. According to the principles of line balancing when the no of workstations increases efficiency of line will decrees. From this study it is clear that from the first assembly line have 25 stations and that line have only 37.118% efficiency. And each station have an uneven time distribution the maximum cycle time is 3.66hrs and the smallest time is 0.32hrs. From this we can see that time of each station is not uniform.

The second graph fig 4 shows the time distribution of balanced assembly line. From this fig we can see that the no of workstations are reduced from 25 to 11 and the efficiency is increased from 37.118%to 84.32 %. From the graph it is clear that the time distribution is also become more uniform than the existing assembly line.As a result of line balancing a new assembly li ne with fewer number of work stations is obtained. As a result the total no of work force in the different stations are reduced from 24 to 15 in a day. It will save a lot of money in the production of 4.5 kw alternator.by considering average manpower cost per day for one worker is about Rs.800. Daily production rate is about 6 units. Cost saved per piece is about Rs.1200 annual requirement is about 1440 units so the total money saved during a year is Rs.1728000.

11. Conclusion

The main purpose of this paper is to represent use of RPW method to develop the assembly line andbalancing that line. With this study it is found thatRPW method is useful when the less data isavailable. Again with the help of RPW method,one can find out the way to synchronize the workstations the work flow and sequencing. So thebottlenecking of the assemblies can be reduced. Inthis case study numbers of workstations have beendecided and proper layout has been proposedbased on RPW method. After applying assembly line balancing the no of stations reduced from 25 to 11 work stations hence cycle efficiency 37.118% increased to 84.36%. That is47.24% increase in cycle efficiency. And idle time is reduced from 50.714 hrs to5.55hrs. The result obtained from the RPW method is checked with flexible line balancing software and obtained the same results.

Reference

[1] Naveen Kumar &DalgobindMahto, Productivity Improvement through Process Analysis for Optimizing Assembly Line in Packaging Industries, Global Journal of Researches in Engineering Industrial Engineering, Volume 13 Issue 3 Version 1.0 (2013)

[2] Nguyen Thi Lam, Le Minh Toi, Vu ThiThanhTuyen, Do Ngoc Hien, Lean line balancing for an electronics assembly line, *Department of Industrial Systems Engineering*,ProcediaCIRP 40 (2016) 437 – 442

[3]Celso Gustavo Stall Sikora, Thiago Cantos Lopes, Leandro Magat˜ao, Traveling worker assembly line (re)balancing problem: model,reduction techniques, and real case studies *European Journal of Operational Research(2015)*

[4]Mahendrasingh, Innovative practices in facility layout, international journal of marketing,vol.1 Issue 12, pp.126-136, (2012)

[5]Ravi Kothari, Insertion based Lin–Kernighan heuristic for single row facility layout, Computers & Operations Research 40 (2013) 129–136

[6] AadarshAdeppa,A Study on Basics of Assembly Line Balancing, *International Journal on Emerging Technologies* (Special Issue on NCRIET-2015) 6(2): 294-297(2015)

[7]Abhishek Jain et al, "Improving Employee & Manpower Productivity by Plant Layout Improvement", Proceedings of 2014 RAECS UIETPanjab University Chandigarh, 06 - 08 March, 2014

