Balancing of an Assembly Line in an Auto Ancillary Company: A Case Study

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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. Many of the parameters like cycle time study, process study are considered while balancing a production line.

Key words: Line Balancing, Cycle Time Study, Process Study

I. INTRODUCTION

Line balancing is an effective tool to improve the throughput of assembly line, which helps in reducing non-value added activities and cycle time. Cycle time reduction has become a key area of opportunity for organizations as reduction in cycle time is directly related to the production cost. In this highly competitive era saving a second for any product saves hours a day in mass production.

Line Balancing is the problem of assigning operation to workstation along an assembly line, in such a way that assignment is optimal in some sense.

II. METHODOLOGY ADOPTED

A. Removing Non Value Added Activities:

1) Value Adding: Any process that changes the nature, shape or characteristics of the product, in line with customer requirements. e.g. machining, assembly.
2) Non-Value adding: Any work carried out that does not increase product value e.g. inspection, part movement, tool changing, and maintenance.
3) Waste: All other meaningless, non-essential activities that do not add value to the product you can eliminate immediately e.g. looking for tools, waiting time.

B. Work Balancing At Each Workstation:

Example:

<table>
<thead>
<tr>
<th>Cycle Time</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>10 min</td>
<td>10 min</td>
<td>10 min</td>
</tr>
</tbody>
</table>

Fig. 2: Work Balancing

III. BALANCING OF PIPE R AND PIPE L SUBASSEMBLY LINE

Phases of Balancing a Line

1) Product Study
2) Process Study
3) Cycle time study

A. Product Study:

Pipe L subassembly: Many parts are welded to pipe L sub assembly as shown in the figure.

Fig. 3: Various Subassemblies of Pipe L

1) Pipe R Sub Assembly:

Parts welded to pipe R subassembly are shown in the figure.
Fig. 4: Various Subassemblies of Pipe R

B. Process Study:

1) Process Flow Diagram For Pipe R Subassembly:

![Pipe R Sub Assembly Diagram]

Fig. 5: Process Flow Diagram

2) Process Flow Diagram Of Pipe L Subassembly:

![Pipe L Sub Assembly Diagram]

Fig. 6: Process Flow Diagram

C. Cycle Time Study:

1) Cycle Time Study of Pipe R And Pipe L Subassembly:

- Step 1: In the first step of pipe L subassembly all the parts are loaded in the fixture.
- Step 2: In the second step tacking of parts is done.
- Step 3: Last step involves the unloading of parts.

Same processes are repeated for pipe R subassembly and after that these two parts (pipe R and pipe L subassemblies) are welded to make pipe R-L subassembly.

Table 1 shows time for each step.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Pipe L Time (Sec)</th>
<th>Pipe R Time (Sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tacking</td>
<td>Welding</td>
</tr>
<tr>
<td>1</td>
<td>31</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>27</td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>32</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Avg.</td>
<td>30</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>53.6</td>
<td>51.8</td>
</tr>
</tbody>
</table>

Table 1: Cycle Time

D. Analysis Of Pipe R And Pipe L Sub Assembly Line:

The process of loading the parts of pipe L in fixture constitutes loading time of 30 sec. This loading time is more than the welding time(16 sec) and unloading time(7.6 sec) as shown in table 1.

Similarly the process of loading the parts of pipe R in fixture constitutes loading time of 29.2 sec. This loading time is more than the welding time(15.6 sec) and unloading time(8.2 sec).

Because of high loading time, the line is unbalanced and hence one piece flow on this line is not possible so batch production is followed. Because of batch production time taken in subassembly of product is very high which can be reduced by balancing the line.

E. Earlier Process Layout:

1) In the earlier process layout batch production is followed for assembling.
2) Pipe L and pipe R are assembled and welded individually in batches and after that welded together to complete the assembly.
3) Figure 8 and figure 9 shows Batch production layout.
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EARLIER PROCESS LAYOUT

Layout of pipe L assembly (line 1)
- Loading: Mp-1
  - Time: 30 s
- Tacking: Mp-2
  - Time: 16 s
- Unloading: Mp-1
  - Time: 7.6 s

Layout of pipe R assembly (line 2)
- Loading: Mp-1
  - Time: 30 s
- Tacking: Mp-2
  - Time: 16 s
- Unloading: Mp-1
  - Time: 7.6 s

Fig. 7: Earlier Process Layout

BALANCED LINE

Pipe L and pipe R
- Loading 1
- Loading 2
- Tacking 1
- Tacking 2
- Unloading 1
- Final welding

W1 15
W2 15

Final piece comes out in 15 sec only...nearly 1/3 saving in time.

Fig. 9: Balanced Line Pipe L and Pipe R

In the flow diagrams (fig 7 & fig 8) it is clear that first pipe L subassembly is manufactured in batch production and after that pipe R subassembly is manufactured in batch production and then both the work pieces are welded to get the final product.

F. Line Balancing:
In pipe R and L subassembly minimum time is in unloading nearly 7.6 seconds and maximum time is in loading nearly 30 seconds. There is nearly 22.5 sec time difference for balancing the line, this time difference is to be normalized.

IV. APPROACH USED FOR BALANCING

A. Splitting the Operation:
Loading is highest time consuming process that need to be split in two steps. For this one extra man power is required and one extra fixture is required.
For both Pipe L and pipe R subassembly same splitting operation can be performed. So 2 extra manpower are required for performing the operation.

B. Merging the Operation:
Unloading for the pipe L and pipe R subassembly can be merged so that the total time becomes nearly equal to 15 seconds. This also saves one man power.

C. Using Two Welders Instead Of One at Final Welding:
Using two welders instead of one welder reduces the time to 15 seconds per piece.
Balanced line is shown in the flow diagram in figure (9)

Fig. 8: Final Welding (On Signal Booth)

Benefits of This Single Piece Flow:
1) Achieved Pull System.
2) Time saving.
3) More Balanced Line.
4) Proper Space for Work on Shop Floor.
5) Avoid Stacking Of Components

Extra Cost Involved:
- One Man for Loading and One Extra Welder.

All this increased cost is nullify by the reduced cycle time and also make the whole process more profitable.

V. CONCLUSION

Nothing is perfect there is always a scope for improvements. Same with manufacturing processes, there is always a scope for improvements.
The concepts like line balancing, cycle time study used here have universal approach, as they have their application not only on one production line but on every production line.

Line balancing concept used here saved nearly 1/3 rd of the production time if this time saving is converted into money, it fetches a lots of saving in terms of money.

REFERENCES