STUDY AND MODIFICATION OF LINE ASSEMBLY TECHNIQUE FOR TATRA EQUIPMENT

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ABSTRACT
Initially majority of the sub-assembly operations of TATRA equipment were being carried out in the main line instead of performing some of the sub assembly activities parallel to the main assembly line. This results in increased equipment assembly life cycle time. One more problem associated with the existing layout is that tools required for the entire assembly operation was placed at tool room which was very far from the workstation and the materials spare parts to be assembled was kept at stores which was also very far from the workstation. This makes the works to travel long distance whenever he needs tool or a material, resulting in wastage of time. These problems were tried to overcome in the proposed assembly line by shifting some more assembly activities from main line to the parallel line which resulted in reduced equipment assembly life cycle time. In the proposed assembly line, main line assembly activities are divided into different stages. Tools and assembly materials required for that particular stage activity is arranged near to that stage location or work station there by reducing the unnecessary movement of men and materials.

Key words: Sub-Assembly-Main assembly line-Assembly life cycle time

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1. INTRODUCTION
In order for any company to meet the demands of the customer it should produce a large variety of products and at the same time it should perform the production operations at the minimum possible time in order to get advantage over its competitors. So the reduction in the production time is the major concern for any company. In order to do that well planned plant layout, storage space, material handling and line balancing are crucial.

The existing assembly operations of TATRA 6*6 trucks are carryout in line production. It means operations are carried out in line and also number of several operations are added in a parallel line to the main line depending on the requirement.

Main aim of this research is to reduce the cycle time of the assembly operation of TATRA 6*6 equipment by conducting study of assembly operation of the truck and making some modifications in the assembly line. In the existing assembly line there are total seventeen assembly operations, which incorporates fourteen operations in main line and only three assembly operations in parallel line. So, in order to decrease the assembly cycle time 5 operations are shifted parallel to the main line activities thereby reducing the assembly cycle time.

2. METHODOLOGY
2.1 Plant layout
Plant layout embraces the physical arrangement of industrial facilities, this arrangement either installed or in plan, includes the spaces needed for material movement, storage and all other supporting activities or services, as well as for operating equipment and personnel. The plant layout means the disposition of the various facilities (equipment, material, manpower, etc.) and services of the plant within the area of the selected previously.

Many appear to believe that the layout should be developed first and then material handling system should be developed yet material handling decisions can have a significant impact on the effectiveness of the layout

2.2 Material handling
Starting from the time, the raw materials enters the factory gate and goes out of the factory gate in the form of finished products, at is handled at all stages between, no matter it is in the stores or on the shop floor. It has been estimated that average material handling cost is roughly 20-60% of the total production cost and the ratio between the weight of the handled material to produce an item and weight of the finished item may vary between 40-50. A component may be handled even 50 times or more before it changes to finished product. Material handling involves the movements of materials, manually or mechanically in batches or one item at a time with the plant the movement may be horizontal, vertical or the combination of horizontal and vertical.

2.3 Storage space requirements
Adequate storage space allocation to different materials and supplies is of great importance because otherwise, a small increase in their quantities may give rise to congestion and the whole system may be out of gear. The following items and amount of stock holding determine the storage space requirements.

1. Incoming new materials.
2. Checking and sorting of new material before it is placed at the proper location.

3. Inspection of raw material.

4. Temporarily storing sorting, the new material before it is placed at the proper location.

5. In-process inventory

6. Tools and other supplies

7. Finished products.

2.4 Line assembly

An arrangement of workers, machines and equipment in which the product being assembled passes consecutively from operation to operation until completed. Also called production line. An assembly line is a manufacturing process in which interchangeable parts are added to a product in a sequential manner to create a finished product. Production method requiring workers to perform a repetitive task on a product as it moves along a conveyor belt or track. An assembly line has the advantages of part standardization and rationalization of work.

An assembly line is designed by determining the sequences of operations for manufacture of each component as well as the final product. Each movement of material is made as simple and short as possible, with no cross flow or backtracking. Work assignments, numbers of machines and production rates are programmed so that all operations performed along the line are compatible.

2.5 Assembly line balancing

An assembly line may be thought of as a series of assembly stations through which a product must pass in an orderly, established sequence. A well planned and installed assembly line minimizes the processing time without violating the product requirement. The assembly process can be broken at a given location performing specified tasks. Each of these tasks adds value to the final product. However, the tasks must assign to the various work stations according to the precedence requirements so that the idle time over the whole process is minimum. An ideal situation would involve a line in which all the stations would have equal work content, measured in terms of time, assigned to them. In this ideal case perfect balance would exist, but this seldom happens in practical situation.

Complicated tasks may be subdivided into smaller units of work called elements. Consider the assembly of a unit made up of ten components. One element of this assembly operation would be to pick up one component and place it on another. It is assumed that the time required to perform each element can be reliably estimated by observation, and that time to perform each element is independent of the arrangement of the elements.

Two approaches to the assembly line balancing problems have been used.

1. Fixed production rate to optimize the number of stations

2. Fixed work stations to minimize the cycle time.

3. RESULTS AND DISCUSSION

3.1 Present line assembly technique

The time and men required for each sub-assembly operations in the present line assembly technique is as shown in the Table 1. The existing assembly line of TATRA
6*6 trucks is basically a line production. The time consumed in the main line is not affected by the time consumed by the parallel line. The entire assembly process consists of totally seventeen operations, which incorporates fourteen operations in main line such as Backbone assembly, Axle preparation, Air system assembly, Frame mounting, Frame electrical, Engine mounting, cabin mounting, Airintake and exhaust manifold assembly, Air cleaner assembly, Servo steering circuit and air duct Cabin electrical and chassis electrical, equipment start and wheel mounting, CQA test, Platform mounting and Final testing, and remaining three in parallel line such as Platform furnishing, Frame furnishing, Suspension sub-assembly. Since majority of the sub assembly operations are performed in the main line it results in increased assembly life cycle time, more congested work stations, and increased waiting time of semi-finished product. Finally, all these things lead to reduced productivity.

Table 1 Time and men required for each sub-assembly operation for existing assembly line of TATRA 6*6 equipment is as shown in the above table

<table>
<thead>
<tr>
<th>Main line sub assembly operations</th>
<th>SMH in Hours</th>
<th>Men</th>
<th>Cycle Time in Hours</th>
<th>Parallel line Sub-assembly operations</th>
<th>SMH in Hours</th>
<th>Men</th>
<th>Cycle time in hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backbone assembly</td>
<td>123:00</td>
<td>5</td>
<td>24:36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air system</td>
<td>89:00</td>
<td>4</td>
<td>22:25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame mounting</td>
<td>42:00</td>
<td>2</td>
<td>21:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame electrical</td>
<td>45:00</td>
<td>2</td>
<td>22:30</td>
<td>Frame furnishing</td>
<td>71:00</td>
<td>3</td>
<td>25:39</td>
</tr>
<tr>
<td>Engine mounting, cabin mounting and air intake assembly</td>
<td>91:00</td>
<td>4</td>
<td>22:45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Servo steering circuit, air system and air intake manifold</td>
<td>50:00</td>
<td>2</td>
<td>25:00</td>
<td>Suspension sub-assembly</td>
<td>48:00</td>
<td>2</td>
<td>24:00</td>
</tr>
<tr>
<td>Cabin electrical lamps</td>
<td>50:00</td>
<td>2</td>
<td>25:00</td>
<td>Equipment start and wheel mounting</td>
<td>49:00</td>
<td>2</td>
<td>24:30</td>
</tr>
<tr>
<td>CQA test</td>
<td>53:00</td>
<td>2</td>
<td>26:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platform mounting and final testing</td>
<td>53:00</td>
<td>2</td>
<td>26:30</td>
<td>Platform furnishing</td>
<td>51:00</td>
<td>2</td>
<td>25:30</td>
</tr>
<tr>
<td>Total result</td>
<td>596:00</td>
<td>25</td>
<td>239:26</td>
<td></td>
<td>225:00</td>
<td>34</td>
<td>98:59</td>
</tr>
</tbody>
</table>

The time and men required for the individual assembly operation in mentioned each and every operation. Where SMH is the standard man hour which specifies the
standard time required by one worker to perform that particular assembly operation and cycle time specifies the time required by total number of men in that particular work station. For the entire assembly process the SMH required is 821:00 Hrs. In the existing layout the time consumed in the main line is 239:26 Hrs which is the equipment assembly life cycle time. Equipment assembly life cycle time is obtained by adding up the cycle time of each assembly operation. So the time required for the complete assembly of single equipment is 239:26 Hrs which is equal to 29.9 days (239.26/8hrs per shift). In other words, it takes 29.9 days for a truck to get transformed from back bone stage to a finished product stage. The total waiting time of semi-finished product is 5:50 Hrs.

3.2 Problems identified
From the study of assembly technique of TATRA 6*6 equipment in BEMEL, the problems noticed were,

1. Increased assembly life cycle time.
2. More points of congestions and confusions.
3. Increased waiting time of semi-finished assembled parts.
4. Improper storage of tools and materials.
5. Reduced productivity.
6. Improper way of line balancing.
7. Shortage of raw materials.
8. Little scope for Material handling improvement.

3.3 Proposed assembly technique
The time and men required for each sub-assembly operations in the present line assembly technique is as shown in the Table 2. After noticing the problems associated with the existing assembly line some of the changes have been made in the assembly line to overcome those problems. Changes made in the assembly line are:

1. Three of the sub-assembly operations from the main line such as frame electrical, cabin electrical & lamps and platform furnishing are shifted to the parallel line, which reduces the assembly life cycle time of the main line. This may reduce the congestion and confusion points.

2. Sub-assembly operations in the main line have been divided into five different stages. By making such division, tools and materials required by that particular stage could be placed nearer to that stage by making use of racks, which reduces the movements of the workers.

3. Reallocating the standard man hour required by sub-assembly operations based on the difficulty of the job.

4. Table 2: Time and men required for each sub-assembly operation for proposed assembly line of TATRA 6*6 equipment is as shown in the above table
Table 2 Time and men required for each sub-assembly operation for proposed assembly line of TATRA 6*6 equipment is as shown in the above table

<table>
<thead>
<tr>
<th>Stages</th>
<th>SMH in Hours</th>
<th>Men</th>
<th>Cycle time in Hours</th>
<th>Parallel activity</th>
<th>SMH in Hours</th>
<th>Men</th>
<th>Cycle time in Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backbone Assembly</td>
<td>123</td>
<td>5</td>
<td>24:36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axle preparation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 2</td>
<td>96</td>
<td>4</td>
<td>24:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 3</td>
<td>45</td>
<td>2</td>
<td>22:45</td>
<td>Frame electrical</td>
<td>45</td>
<td>2</td>
<td>22:30</td>
</tr>
<tr>
<td>Frame mounting</td>
<td></td>
<td></td>
<td></td>
<td>Frame furnishing</td>
<td>73</td>
<td>3</td>
<td>24:30</td>
</tr>
<tr>
<td>Stage 4</td>
<td>91</td>
<td>4</td>
<td>22:45</td>
<td>Cabin electrical and lamps</td>
<td>48</td>
<td>2</td>
<td>24:00</td>
</tr>
<tr>
<td>1. Engine mounting, cabin mounting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Air-intake assembly</td>
<td>45</td>
<td>2</td>
<td>22:30</td>
<td>Suspension sub assembly, Tire embroise, frame grase</td>
<td>48</td>
<td>2</td>
<td>24:00</td>
</tr>
<tr>
<td>3. Servo steering circuit, Cabin air system, cabin air intake</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Equipment start and wheel mounting</td>
<td>43</td>
<td>2</td>
<td>21:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 5</td>
<td>46</td>
<td>2</td>
<td>23:00</td>
<td>Platform mounting</td>
<td>70</td>
<td>3</td>
<td>22:30</td>
</tr>
<tr>
<td>1. CQA test</td>
<td>48</td>
<td>2</td>
<td>24:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Platform mounting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>537</td>
<td>23</td>
<td>184:11</td>
<td></td>
<td>284</td>
<td>9</td>
<td>116:5</td>
</tr>
</tbody>
</table>

3.4 Outcomes of the changes made in the assembly line.
Equipment assembly life cycle have been reduced from 239:26 Hrs to 184:11 Hrs. Which implies that the time consumed in the main line have been reduced by 55:15 Hrs (which is equal to 6.8 days).

1. From the division of sub-assembly processes into five different stages the tools and materials required by the particular stage is placed very nearer to it. This reduces the distance moved by worker to get a tool or a material.

2. Material handling gets reduced.

3. Waiting time of semi-finished product have been reduced from 5:30 Hrs to 2:45 Hrs.
4. CONCLUSION

In the existing layout the movements of workers and materials were more, so in the proposed assembly line by the division of sub-assembly process into five different stages the tools and materials required by the particular stage is placed very nearer to it. This reduces the distance moved by worker to get tools or materials.

The materials required for the particular stage have been placed near to the work station using racks in the assembly line. Two of the sub-assembly activities of the mainline have been shifted to the parallel line in the proposed assembly line thereby reducing the assembly life cycle time.

In the existing assembly line the assembly life cycle time required by the mainline was 239:26 Hrs and there was a waiting time of around 5:30 Hrs.

By shifting the zone of the sub-assembly operations from the main line to parallel line we could be able to reduce the time consumed in the main line to 184:11 Hrs which implies that the time consumed in the main line have been reduced by 55:15 Hrs (which is equal to 68 days) and by applying the line balancing technique we could reduce the waiting time of semi-finished product from 5:30 Hrs to 2:45 Hrs.

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