

Cycle Time Improvement in Structure Section of an Automobile Industry: A Case Study

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Abstract. — Cycle time is a very crucial factor in manufacturing processes and its minimization is a tough task. This paper presents the prospective solutions for the reduction of cycle time in the structure section of an automobile industry by the removal of non value added activities. In the structure section there were 5 stations having total initial cycle time as 404 minutes. The Non Value Added activities range from 6 to 26 minutes, thus forming a total Non value added time as 79 minutes for all 5 stations. In this way the actual cycle time after removing the Non Value Added activities were found as 325 minutes. Thus there is saving of approximately 20% of the cycle time.

Keywords: Cycle Time, Non Value Added activities.

1. Introduction

The structure section forms the beginning of all the processes in the bus manufacturing industry. There are a large number of operations and subsequently activities to be performed in this section. It comprise of five stations. The starting of process is marked with the opening of the chassis. It includes activities: checking of gas in cylinders, dismantling battery connection and its removal etc. After this the chassis gets passed onto for the shell dropping of the frame. Later at the subsequent stages the vehicle frame and the body is added on with the lateral dashboards, mud flap and wheel covers on the station#2. The vehicle is then passed onto the station#3, where it is welded and the front seat adjacent to the driver, front body cover is added. At the station#4 the body is loaded with the luggage box, footstep. At this station the welded joints are checked in case they require some rework. The grinding of entire body is carried out at this time. Finally the vehicle is passed to the paint primer shop marked as the station#5. The vehicle is cleaned, sealed, masked and painted with the paint and thinner mixture.

The processes involve a large number of activities such as cutting, transportation of materials, welding, grinding etc . Many of these which take a considerable amount of time and are actually of no use as far as increased productivity is concerned. In this paper these are termed as non value added activities (NVAs). The cycle time of the process will increase if NVA's are not rectified properly at the stations. Some of the NVA's which observed are general and occur almost at all the stations. It was also observed that these NVAs arise simply out of loopholes in planning and maintenance of the workplace. The second types of NVA's are process specific and these are removed by modifying the process/ method. In a manufacturing process the removal of NVA's yield the following benefits: reduced cycle time, lesser load on the workers/operators rules out the scope of fatigue to a great extent, increased efficiency, increased production and capital benefits.

Cycle time is the total elapsed time to move and process a work piece from beginning to the end of physical process. It includes process time during which a work piece is actually processed / machined to bring it closer to final shape/ size, and delay time, during which the work is spent waiting to take the next action. The reduction of cycle time is directly related to the increased productivity¹. Literature survey reveals that the factors that cause increase in the cycle time are: improper workplace design, lack of supervision and co-ordination at the stations, bottlenecks, workforce issues, possibility of redo of work, inventory storage problems, at the moment issues such as tool preparation etc. The methods that could be adopted to keep a track of the amount of time dedicated in the process at par with the amount of time it actually requires includes maintaining a check sheet at the station so as to note down the timings for the activities and the

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operations involved, analysis of these check sheets will help to analyze that what are areas and activities actually demanding our concern to reduce cycle time. The maximum cycle time obtained after the analysis of these sheets should be set as reference cycle time.

The literature survey also shows that implementing the lean manufacturing techniques has always been a major thrust area for the increasing the productivity of the operation. Cycle time reduction is one of the the challenges to be addressed by the lean manufacturing techniques. Removing the NVA's has an upper edge among all other techniques used for the cycle time reduction because it requires comparatively very low capital investment, lesser changes in the sequence and scheduling, less alterations in the machinery set ups. Of all the research conducted in the field of cycle time reduction factors such as Just In time inventory control, Cellular manufacturing approach, and Value Stream mapping have been investigated thoroughly by various researchers 2-7. But the aspect of cycle time reduction by removal of non value added activities seems to be a left out. Hence in view of the above facts an attempt has been made to reduce the cycle time by the removal of non value added activities and to access its benefits and ease of accomplishment as compared to other mentioned methods. In this research this aspect has been investigated and results have been brought out after conducting the time based trials on all the action plans suggested against the existing NVA's.

2. Research Methodology

The study was conducted in an automobile industry situated in Lucknow region of Uttar Pradesh, India. The research started with the understanding the layout of the plant. From the different sections existing in the plant, the structure section was chosen as the target area of study and all of its stations were identified in terms of operation performed in them. The different processes and the activities occurring at the station were identified and observed in a time bound frame. The starting and completion time of each activity was recorded. They were later categorized as the value added or the non value added activities. Suitable action plan for NVA's has been identified and implemented in the time bound trials. If the suggested action plans gave satisfactory results they were adopted. Following section of the paper gives a detailed description of observations and corrections made at each and every station. All the times were measured by stop watch.

3. Results and Discussion

3.1 Station#1

The operation performed at station#1 is the chassis preparation having 5 operators. The chassis is opened up before the frame is attached to it. Various processes happening are: air sprinkling to dry the wet chassis, checking the gas cylinders for them being empty, dismantling battery connection, removing them and placing them in adjacent rack, driver's seat, steering wheel, nycil cover, combination switch, cluster, acceleration pedal, handbrakes, service indicator, piano switch removal, opening up main harness tying it up and placing it in rack, covering of radiator, leather covering and clamp addition for welding of frame. The total cycle time at this station comes out to be 68 minutes including NVA of 14 minutes.

NVA#1: Rigorous tying of main harness that takes about 5 minutes

Action Plan: Instead of giving multiple folds and rigorous tying we can use the plastic bags to keep the main harness safe in store. The plastic bags would have the model number of vehicle printed in front, thus making it easier to get back from store at later stage.

NVA#2: Radiator covering with board and tape takes about 9 to 11 minutes. Also due to the complicated location of the radiator it becomes quite difficult for the operator to reach to the exact site. The other activities are hampered too because the operator is holding his position for a considerably large time.

Action plan: Since the size of radiator is fixed, thus we use a pre fabricated part made of asbestos sheet with a glue stick line on it. The operator will have to just peel off the sticker and fix the entire part over the radiator of the vehicle. This reduces the same process completion time from 9 minutes to 4 minutes. The CAD image (Fig. 1 a & b) and the actual image (Fig 1 c) of the new radiator covering part is provided to get an idea of how the exact thing is supposed to work. Results are summarized in Table 1.

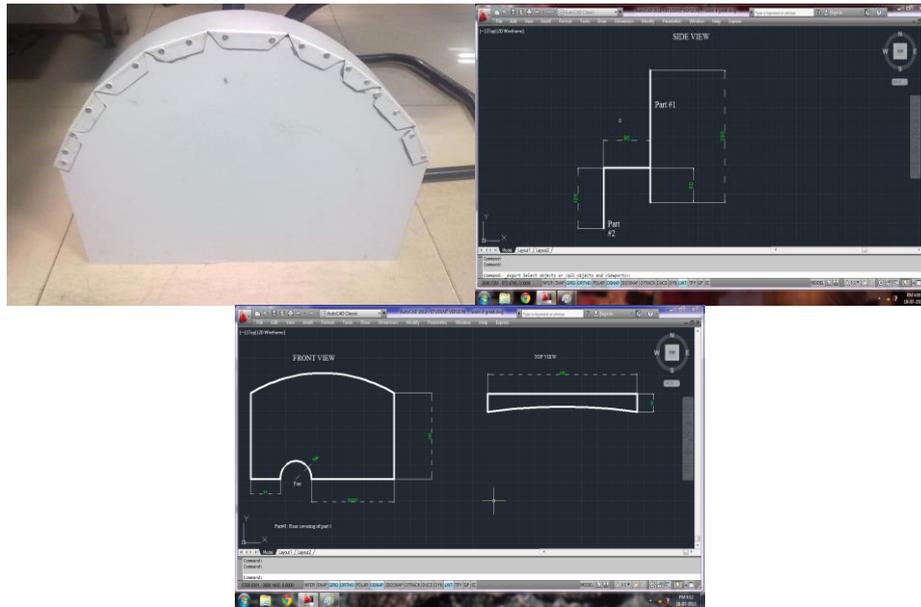


Fig. 1 CAD image of radiator cover.

Thus employing these techniques the cycle time at station#1 was reduced by 8 minutes.

Table 1 Initial and improved cycle times of various activities along with NVAs.

Station No.	Activity	Initial Cycle Time (including NVAs), min	NVA, min	Improved Time, min
1	Chassis opening	68	14	60
2	Lateral Dashboard, Mud flap welding	80	10	73
3	Welding	87	26	61
4	Footstep, Luggage Box, Grinding, Reworks	125	23	102
5	Paint Primer Shop	44	6	38
	TOTAL	404	79	325

3.2 Station#2

The operation performed at station#2 includes the addition of lateral dashboard to the bus body, welding tacking, mud flap welding and the wheel cover addition. The manpower deputed at this station was 4. In the process of lateral dashboard addition, the activities involved are: measurement of the sides on the bus body, then cutting the sheets to the desired side lengths and finally placing, adjusting and welding them to the site. As far as mud flap welding is concerned, the flaps are already placed and adjusted at the time of shell dropping, thus just the welding is carried over it. For the wheel cover addition, the wheel cover placed in the adjacent bin is picked up and brought to the vehicle, this is placed and adjusted to the site using the “C” clamp. The total cycle time recorded at this station was 80 minutes including 10 minutes of NVAs.

NVA#1: When the Vehicle enters the station, then the operator performs the measurement, moves to cutting shop, gets the sheet cut and brings it back to the site for placement. This is a repetitive process and a one-time act takes 10 minutes at an average.

Action plan: To rule out this mathematical model of deviation is adopted and the sheets are pre-cut on the higher side of dimension of a given model. In such a case just minute alterations would be required and that could be done at the station itself.

Observation: Vehicle Model: LCV 912

Vehicle 1: Left Side: 1600 mm, 1150 mm, 1100 mm

Right Side: 380 mm, 1950 mm, 1020 mm, 320 mm

Vehicle 2: Left Side: 1600 mm, 1130 mm, 1120 mm

Right Side: 390 mm, 1960 mm, 1020 mm, 310 mm

Considering the values on the higher side, the pre cut sheets of following dimensions was suggested

Left Side: 1600 mm, 1150 mm, 1120 mm

Right Side: 390 mm, 1960 mm ,1020mm , 310 mm

This requires just 2 to 3 minutes and thus reduces the cycle time by 7 minutes. Results are summarized in Table 1.

3.3 Station#3

The operations performed at this station are: permanent welding of joints, adding front seat adjacent to driver, door aperture fixing and welding, front body covering. The manpower deputed at this station is 8. The total cycle time at this station is 87 minutes including 26 minutes of NVA's.

NVA#1: Movement of labour for cutting and bringing the front cover sheet takes about 10 minutes

Action plan: As per the model numbers of buses, the sheets could be cut into predefined sizes and kept at the same station. When the vehicle comes, then as per the model measurement the required alterations may be done. This reduces the present cycle time consumption from 10 minutes to almost 4 minutes.

NVA#2: Immediate changing of welding tip nozzle takes about 2 minutes.

Action Plan: Proper and timely maintenance of the tools helps in saving out this time. Although this time of 2 minutes is considerably small, but keeping in mind the number of workers working at one time this accounts for a larger wastage in cycle time.

NVA#3: Intermediate brakes account for 15 minutes.

Action Plan: The work flow was well defined in the beginning of the shift itself. The sequence of the work was so planned that certain operations get finished before the intermediate tea/ refreshment brakes. This helps in maintaining the continuity of the ongoing process. In case a brake comes between the processes executing, the workers performance is affected at least 5 minutes pre and post brake period.

NVA#4: Labour adjustment and random change in position takes about 3 minutes

Action Plan: On the arrival of the vehicle, the position and site of working for each labour was well decided and defined. This helped in removing the interference and also in allocating the proper manpower to the different tasks. The distribution adopted was in a way that out of 8 the 5 people were allocated for the welding work. Out of the remaining 3, 1 will assist the person working on the door aperture and the remaining 2 will perform the addition of front body cover.

These action plans when implemented yielded a new cycle time of 61 minutes, saving the 26 minutes from the initial. Results are summarized in Table 1.

3.4 Station#4

The operations performed at this station are: addition of footsteps, addition of luggage box, welding joints, welding at door joints, grinding of the surface. The total cycle time at this station is 125 minutes and NVA's are of 23 minutes.

NVA#1: The movement of operator to pick and bring the footstep from a distance to the bus site takes about 3 minutes.

Action Plan: A rack placed adjacent to the station#4, with footsteps arranged orderly in it. It saves 3 minutes of the cycle time.

NVA#2: Welding at this station that consumes 20 minutes.

Action Plan: The welding tacking is done at station#2 and the proper welding is done at #3. If the quality check is employed just after the completion of these operations at the end of station#3, then the need of redo at #4 is removed. This would save 20 minutes. Results are summarized in Table 1.

3.5 Station#5

This is the paint primer shop. The operations performed at this station include cleaning, sealing, masking and painting. The manpower employed at this station is 5. The cleaning of the vehicle is done using a cloth and thinner solution which takes about 5 minutes. Sealing is the closing of all the openings on the surface to prevent the leakage of any type using caulker compound. It takes 27 minutes. Masking is the covering of the areas which are not to be painted, with the paper sheets. It has a cycle time of 6 minutes. Painting is done by the mixture of primer 1k and thinner. The cycle time of painting operation is 33 minutes. The total cycle time of this station is 44 minutes and NVA's account for 6 minutes.

NVA#1: Preparation of mixture when the vehicle enters the station.

Action Plan: In the start of shift, an assessment of number of vehicles going to enter the station should be made and as per it the mixture should be prepared then itself. This would save an average of 3 minutes time on each vehicle and reduce cycle time by 20 minutes for one working shift

NVA#2: Painter's preparation

Action Plan: Under the proper supervision the painters should take just 2 minutes to get ready into their complete costume to carry out the work.

Thus the cycle time of the station#5 is reduced by 6 minutes with an improved time of 38 minutes. Results are summarized in Table 1.

4. Conclusion

These action plans help in increasing the number of manufactured units on the shift/ day basis. They tend to relieve the operator from the unnecessary load and fatigue that occurs due to performing of Non Value Added activities. The time bound trials and result proves that the improvements suggested above help in attaining the desired task of reducing cycle time without any investment of capital and also without bring out much change in the fixed components on the machine plant layout. These are easy to be implemented in any workstation and the time bases trials are sufficient to showcase the results and benefits born by it.

- At station#1 the initial total cycle time was 68 minutes. NVAs were spotted to be 14 minutes, it was removed and the improved total time obtained is 60 minutes
- At station #2 the initial total cycle time was 80 minutes. NVAs were spotted to be of 10 minutes and the improved total cycle time is 73 minutes.
- At station#3, the initial cycle time was 87 minutes. NVAs were spotted to be of 26 minutes and the improved time is 61 minutes.
- At station#4, the initial total cycle time was 125 minutes, NVAs were spotted to be 23 minutes and the total improved time is 102 minutes.
- At station#5, the total initial cycle time was 44 minutes, NVAs were spotted to be 6 minutes and the new improved cycle time is 38 minutes.

Implementing the action plan suggested in this paper, the initial total cycle time of 404 minutes was reduced to 325 minutes, thus saving 79 minutes of time.

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