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Research Article

Multifarious Approach to Improve Productivity of Drain Valve Assembly Line

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Abstract

This paper adopts a multifarious approach combining lean manufacturing, line balancing and layout modification to effective improvements in the productivity on the drain valve assembly line of manufacturing company for automobile industry. A comprehensive methodology is adopted to systematically analyse and effect productivity improvements. A pilot study of the assembly line is done to estimate line imbalance. This is followed by waste (MUDA) identification and elimination and de-bottlenecking to balance the line and optimize utilization of resources. Modification in layout is effected to switch over from batch and queue system to single piece flow. The results of implementation are summarized in the conclusion part of the paper.

Keywords: *Multifarious Approach, Drain Valve Assembly Line etc.*

1. Introduction

The company is engaged in the manufacturing of moulds, tools, electrical, electronics, plastic moulding and fabrications supplied to the original equipment manufacturers (OEM's) in automobile industry. A majority of these products happen to be of high volume – low variety type and fall in the ATO (Assembled to Order) category. The company has solely manufactures and supplies drain valves to all OEM companies.

The company was facing problems due to increased demand, excessive back tracking of material, imbalanced assembly line, huge in-process inventories underutilization of human resources and delays in deliveries. The main source of these wastes was batch and queue process.

2. Methodology

Methodology used for the improvement is given below

- Pilot study of drain valve assembly line
- Bottleneck identification & elimination through layout modification
- Line balancing & resource optimization

2.1 Pilot Study of Drain Valve Assembly

A walk-through on drain valve (manual) assembly line enables to understand the process in terms of work content, sequence of operations, and cycle time on each workstation. A detailed time study accurately estimated production possibility and the extent of line imbalance. Based on the monthly demand, Takt time for present demand and target rate (Takt time for future demand) were calculated. The primary focus was on elimination of non-value added (wastes) activities.

Table 1 gives details about the batch time, output per hour and output per shift considering 100% efficiency (skilled labour) and 80% efficiency (contract labour). The time required per unit is calculated by dividing the batch cycle time by the number units produced. Figure 1 shows the graphical representation of cycle time for all workstations on drain valve assembly line according to the existing method. The present layout of drain valve assembly is shown in figure 2 below.

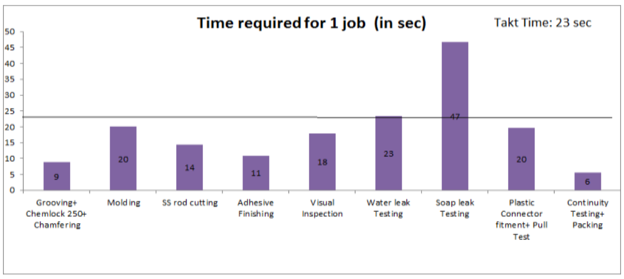

Figure 1: Present Method (Cycle Time & Takt Time Chart)

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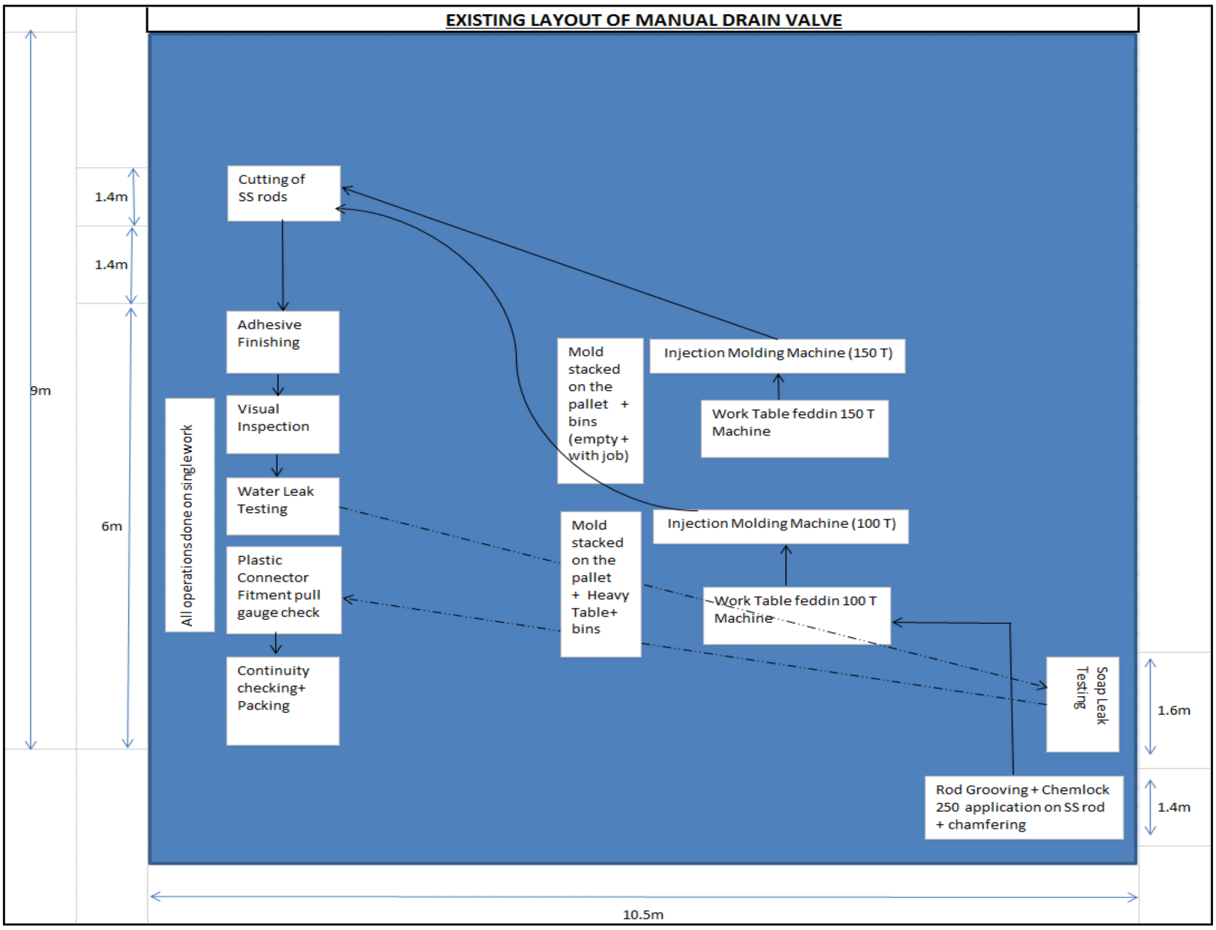

Figure 2: Present Layout (Drain Value Line)

Table 1: Detailed cycle time study for entire assembly line

Sr No.	Station Name		Activity Description	Batch Time (sec)	Time Required for 1 job (sec)
1	Grooving+ Chemlock 250+ Chamfering	1	Checking the wire in gauge Rod Grooving Chemlock 250 application on SS rod+ Waiting time for drying of chemlock 250 chamfering	265	9
2	Molding	5	Wire Binding & fitting rubber band Insert the thread insert in the machine Insert the wire harness Fit the side loaded insert Start the molding machine Remove the job from the machine & seprate the side loaded insert & keep them in water. Remove the thread insert & flashes and write the production date	80	20
3	SS rod cutting	1	Taking the job from bin Fixing it on the fixture & cutting Putting it in the bin	432	14
4	Adhesive Finishing	1	Taking the job from the bin Finishing the SS rod Putting it on the table	326	11

5	Visual Inspection	1	Visual Inspection for flashes & deflashing if any	540	18
			Visual Inspection for wire cut		
			Visual Inspection for wire open		
			Visual Inspection for short mold		
			Visual Inspection for terminal height mismatch		
6	Water leak Testing	1	Taking job from the bin	140	23
			Loading the job on the machine		
			Leak testing & marking on the job if leak found		
			unloading the job & putting it in bin		
7	Soap leak Testing	4	Bringing the bin onto the machine & Taking job from the bin	420	47
			Loading the job onto the fixture		
			Soap dispensing onto the terminals & body		
			Write on the body if leak found		
			Putting it into the bin		
8	Plastic Connector fitment+ Pull Test	1	Picking the job from the bin	592	20
			Air spray on the terminals		
			Putting sprayed job onto the table		
			Picking the sprayed job from the bin		
			Connector fitment on the terminals		
			Putting it onto the table		
			pull check		
9	Continuity Testing+ Packing	1	Picking up the job from the table	170	6
			Picking up the Connector		
			Fitting the drain valve onto the connector		
			Touching it onto the plate		
			yellow marking if ok & Cut the strand if job found Not OK		
			Counting the job + Pasting the cellotape + putting jobs in the corrugated box + pasting the cellotape		
		16	Total Work content		167

2.1 Bottleneck Identification & Elimination by Layout Modification

Workstation 7 (Soap leak testing) is a bottleneck having highest cycle time of 47. Moreover, the rejection rate at this workstation was 19.94%.

The primary reason is on account of excessive movement of the operators due to transportation of the material from water leak testing machine to the soap leak testing machine, non- value added activity. This is due to excess transportation of material and material handling and waiting time. This is also illustrated in present layout in figure 2 above. The layout modifications made are shown in figure 3 below. The non-value added operation of transportation and material handling at work station (soap leak testing) is eliminated by merging the soap leak testing station in the assembly line and converting it in the straight line layout that reduced the work content by 29 seconds.

2.2 Line Balancing & Resource Optimization

The next step is to analyse the cycle time at workstations having higher cycle times and minimize line imbalance by explore possibilities to clubbing, rearranging workstations and operators. The proposed rearrangement of workstations after line balancing is shown in table 2. Graphical representation of the new cycle times at work stations and its comparison with the Takt time is shown in figure 4. Another vital problem at workstation 7 (soap and leak testing) was rejection rate of 17.67% (in-house) due to the terminal mismatch which was eliminated by revising the sharpening frequency of the cutting fixture blade and the checking was provided on the visual inspection to check the terminal height which is shown in the table 3.

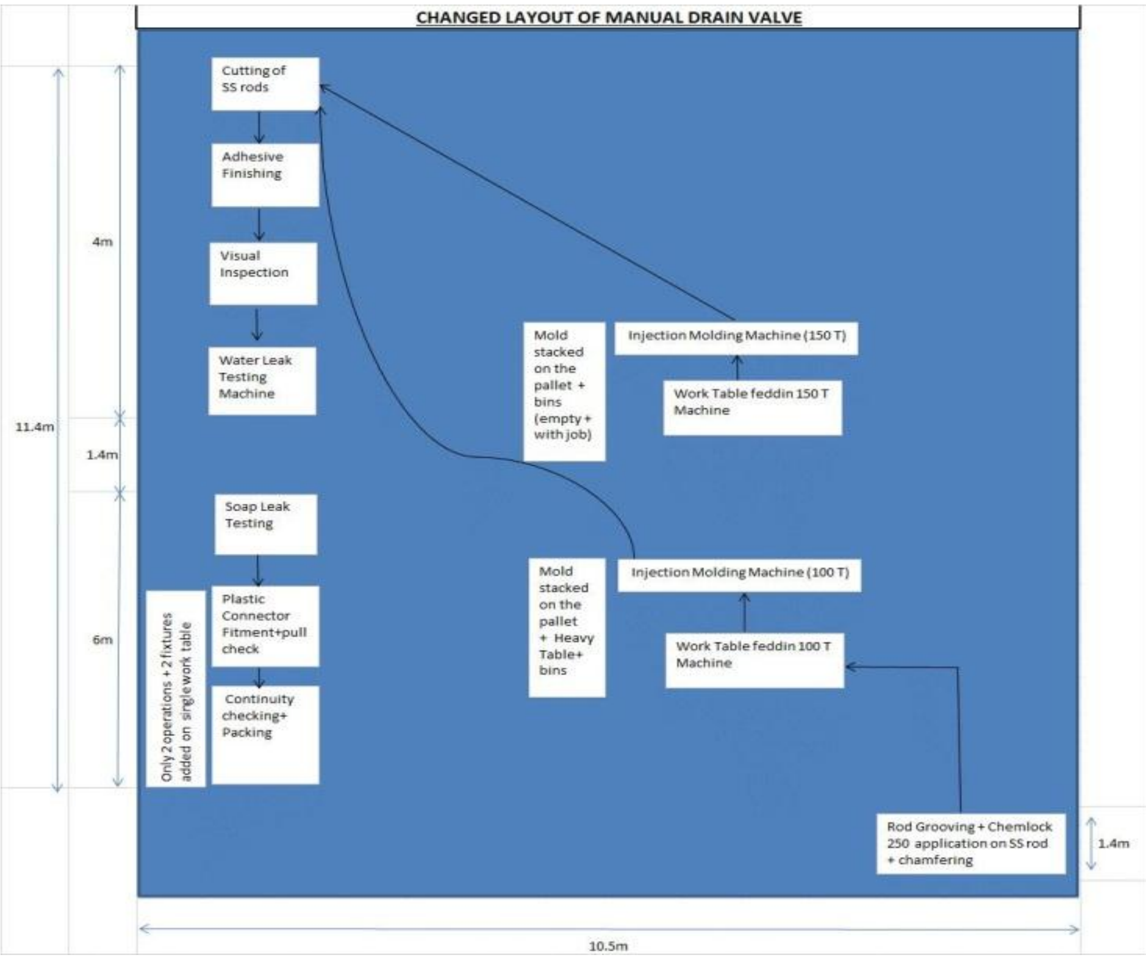

Figure 3: Modified Layout of the Drain Valve Line

Table 2: Proposed Method (After Line balancing)

Sr No.	Station Name		Activity Description	Batch Time (sec)	Time Required for 1 Job (sec)
1	Grooving+ Chemlock 250+ Chamfering	1	Checking the wire in gauge	265	9
			Rod Grooving		
			Chemlock 250 application on SS rod +Waiting time for drying of chemlock 250		
			chamfering		
2	Molding	5	Wire Binding & fitting rubber band	80	20
			Insert the thread insert in the machine		
			Insert the wire harness		
			Fit the side loaded insert		
			Start the molding machine		
			Remove the job from the machine & seprate the side loaded insert & keep them in water.		
			Remove the thread insert & flashes and write the production date		
3	SS rod cutting	1	Taking the job from bin	432	14
			Fixing it on the fixture & cutting		
			Putting it in the bin		
4	Adhesive Finishing	1	Taking the job from the bin	326	11
			Finishing the SS rod		
			Putting it on the table		

5	Visual Inspection	1	Visual Inspection for flashes Visual Inspection for wire cut Visual Inspection for wire open Visual Inspection for short mold Visual Inspection for terminal height mismatch	540	18
6	Water leak Testing	1	Taking job from the bin Loading the job on the machine Leak testing & marking on the job if leak found unloading the job & putting it in bin	140	23
7	Soap leak Testing	4	Taking job from the bin Loading the job onto the fixture Soap dispensing onto the terminals & body Write on the body if leak found Putting it into the bin	360	18
8	Plastic Connector fitment+ Pull Test	1	Picking the job from the bin Air spray on the terminals Putting sprayed job onto the table Picking the sprayed job from the bin Connector fitment on the terminals Putting it onto the table pull check + white marking	592	20
9	Continuity Testing+ Packing	1	Picking up the job from the table Picking up the Connector Fitting the drain valve onto the connector Touching it onto the plate yellow marking if ok & Cut the strand if job found Not OK Counting the job + Pasting the cellotape +putting jobs in the corrugated box+ pasting the cellotape	190	6
		16	Total Work content		139

Table 3: Measures Taken to Reduce Rejection Rate

Actions implemented to reduce the cost of Rejection:-		
Problem caused:-	Due to improper fitment of the job on fixture during cutting	
Corrective Action taken @ SOURCE:-	Marking done on fixture upto which the job should be inserted on fixture during cutting.	
Corrective Action taken @VISUAL INSPECTION:-	Point added in visual inspection marking given on worktable done on higher tolerance.	
PREVENTIVE Action taken @ SOURCE:-	Gauge to measure the specification of the desired cutting limit 5.5mm -6.5mm Blade Resharpening frequency- after every 8000 jobs	

Table 4

	Present Method	Proposed Method	Benefits
Production/Shift	600	1200	↑600 units
Manpower	16	16	-
Space (Sq. M)	119.7	94.5	↓25.2 sq.m.
Line Imbalance	60%	34%	↓26%
Rejection (%)	19.94%	9%	↓10.94%

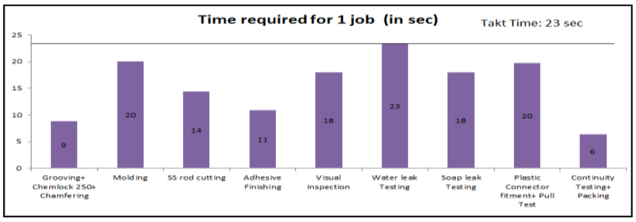

Figure 4: Proposed Method (Cycle Time & Takt Time Chart)

Conclusions & Findings

It is evident from the improvements effected that practical line balancing problems often needs in-depth investigation of work content on the entire line in order to find practical solutions that are often found by rearranging the work content across workstations, merging / splitting the workstations (as the case may be). The basic principles of lean such as waste (MUDA) identification/elimination, cellular approach and layout modifications further supplement the productivity improvements. The benefits derived as a result of all improvements are summarized in table no.4 above. Annual savings on account of reduction in rejection rate are Rs. 346,320 / year.

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