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PRODUCTIVITY IMPROVEMENT IN AN ENGINE ASSEMBLY LINE USING MAYNARD OPERATION SEQUENCE TECHNIQUE- A CASE STUDY

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Abstract

Manufacturing Industries should have high productivity in order to sustain economically and to gain profit margins. Non-value added activities lead to excess work content which in turn increases the time and cost of production. So for higher productivity NVA activities must be reduced. Maynard Operation Sequence Technique aims to identify such NVA activities that are taking more time than required. This is done by ergonomically improving the workplace with better material and tool positioning. This study highlights productivity improvement by applying MOST in Power Roller Bed Engine assembly line of truck manufacturing industry. By proper application of MOST, productivity in an automobile industry was increased by 12.82 %.

Keywords: Non value added activities, Maynard operation sequence technique, Productivity.

1. INTRODUCTION

Maynard operation sequence technique (MOST) is a quick and easy tool of application for work measurement which helps in estimating time, analyzing methods and balancing work flow [1]. Work measurement system is called MOST but in MOST System thought process or thinking time is an exception as it is counted in work where no objects are being displaced. MOST unit is time measurement units (TMU). MOST family is characterized in three groups i.e. MINI MOST, BASIC MOST & MAXI MOST [1]. MINI MOST is used for short repetitive cycle lesser than 2 seconds, BASIC MOST is used for Long cycle (activities between 20seconds to 2 minutes), MAXI MOST is used for Heavy assembly operations (activities above 2 minutes) [1].

MOST comprises of three tools/models shown in table 1. Objects moves from one place to another freely through the air manually is called general move sequence model. For example, getting a stud and placing in the engine. Restricted movement of object in one dimension is called controlled move sequence model. For example sliding a engine block through stacker tool. Common hand tool use is called tool use sequence model. For example activities such as fastening, loosening, etc.

The present study is focused on Basic MOST for reduction in the Work Content in engine assembly line at Volvo Eicher Commercial Vehicles (VECV), which manufactures engines for trucks and buses. The engine assembly line in the study comprises of 3 zones. Zone 1 is Power Roller Bed (PRB). Zone 2 is Automated Guided Vehicle 1 (AGV-1). Zone 3 is Automated Guided Vehicle 2 (AGV-2). Study is being conducted in PRB zone. PRB zone consists of a total of 9 stations, 7 out of which performs major operations, while 1 namely station-3 is robotic and the last one performs quality check.

Table 1- Sequence Models of MOST

1	GENERAL MOVE	ABG ABP A
	SEQUENCE MODEL	GET PUT RETURN
2	CONTROLLED MOVE	ABG MXI A
	SEQUENCE MODEL	GET ACUATE RETURN
3	TOOL USE	AB ABP TU ABP A
	SEQUENCE MODEL	GET PUTTOOL TOOL ACTION PUT TOOL ASIDE RETURN
	WHERE	,A= ACTION DISTANCE , B= BODY MOTION, G= GAIN CONTROL
		P= PLACEMENT, M= MOVE CONTROLLED, X=PROCESS TIME, I=ALIGNMENT, TU=TOOL USE

Nine stations in PRB zone are namely:

- St 1# Assemble set screw, water drain plug & cooling jet on the block
- St 2# Lower bearing shell lubrication & assembly
- St 3# Main bearing cap torque
- St 4# Front cover & fan shaft
- St 5# Timing gear assembly
- St 6# Fly wheel housing & oil seal pressing
- St 7# Damper pulley, auto-tensioner, fan shaft pulley
- St 8# Fly wheel torque
- St 9# Quality check

2. LITERATURE REVIEW

According to research study of Cornejo, (2019) In the research paper of mini rotary shear line process in the ABC Company NVA activities are like downtime due to lack of equipments, long set up time & ineffective material storage. But allocation of workers for reducing NVA activities was not explained which was committed. MOST implementation was not explained in any of the process. [2]

Vinay et al., (2018), in the study of an assembly line using pro time estimation. NVA activities & SVA activities was found 82% of the overall cycle time. NVA activities and SVA activities were detected through MUDA criteria like packing/unpacking, walking for materials & tools, waiting, hoisting, unnecessary quality check etc. [3]

Rahman, (2018) Implementation of MOST to improve Productivity and Workflow in their study by changing the number of operators at bottleneck station, bottleneck was minimized but Minimization of bottleneck was not explained in terms of Basic MOST sequence

Models. [4]

Jadhav and Mungase, (2017) in Productivity improvement through Maynard Operation Sequence Technique, mentioned that productivity was increased due to reduction in manpower in night shift. This leads to save product cost but no explanation of MOST application was applied in the research work. [5]

Meshram and Marre, (2017), in the study of shoulder bolt process did process optimization by eliminating of NVA activities. NVA activities like walking, bending, pushing & pulling etc were found and 18.1% of NVA activities were detected and removed. [6]

Senthil and Haripriya, (2016) in the work Time analysis with MOST technique discussed an issue that MOST study time comes out to be less as compared with time study by stop watch but not mention the NVA activities and how MOST study gets lesser time compared to time study. [7]

Bondhare et al., (2016), in the cable assembly line, productivity was improved. Plant layout was improved with reduced manpower and with increase in production but NVA activities are not explained according to MOST study criteria. Time unit was not in terms of TMUs. [8]

Pandey and Deshpande, (2016), in this research paper improvement in manpower utilization was up to 10% with 25% reduction in excess manpower. [9]

Karad et al., (2016), in this study of assembly of car rear floor, bottleneck was found in 5^{th} station among 5 stations. Study suggested including another station 6 by keeping manpower same resulting in the time saved in total work content. This leads to no need of night shift and saved 18 lakhs investment per year. Gap in this study was found that BasicMOST sequence models are not used in the study. Time unit mention was not in terms of TMUs. [10]

Vekariya and Ashutosh (2015), study was conducted in manufacturing process of diesel engine through MOST. It was found that the Comparative study of MOST technique and stop watch study (time study) was done in assembly department and sub-assembly operation of diesel Engine. And found 18.20% time saved from MOST study. But not mention any NVA activities and justification of MOST time less as compared with time study was not mention. [11]

Saravanan, (2014), in the study 2 bottlenecks were identified amongst 4 stations. Basic MOST was applied in all stations; NVA activities was identified and eliminated on bottleneck stations. [12]

Gupta and Chandrawat, (2012), in a medium size manufacturing enterprise research work emphasis that cycle time was reduced by lean principle which led to higher productivity. Gap in this study was found that BasicMOST sequence models are not used and time unit was not in terms of TMUs. [13]

After study from different research papers from which few are listed above, it was seen that only few papers explained the application of MOST with the NVAA explained in it. But in rest of the papers some of the data are missing such as not use of MOST application like not use of basic MOST sequence models, time unit not in terms of TMUs, NVAA were not mentioned.

From the passage of time working methods in an industry keeps on improving. So there is always a chance of productivity improvement. Therefore MOST technique can be used again and again for eliminating the NVAA for productivity enhancement. As this work is focused in engine line, we can also apply this technique in different area in the industry such as paint shop, LMD Cab trim line, HD cab line, Machine shop line etc.

3. RESEARCH METHODOLOGY

The study was carried out in three phases :(1) Existing TWC calculations using Basic MOST.(2) Analysis to identify NVA activities.(3) Elimination of NVA activities by making the necessary changes in layout/working methods.

1) Existing TWC calculations

A. Write the description of the activity.

B. Write the method to be analyzed by diving it into a number of distinct steps corresponding to the natural breakdown of the activity. Write out each step in chronological order.

C. For each method step select a sequence model.

D. Add all the parameter Index values of activity. Convert the total of Index values into TMU by multiplying it to 10. Next convert the time values to hours, minutes or seconds.

2) Basic MOST Analysis

Higher index value of the parameters lead to higher work contents. Hence, the parameter with higher index value greater than 3 should be critically analyzed. The higher index value parameters represent the element involving considerable walking, bending, extra processing, placement etc. Such elements indicate higher probability of NVA activities.

3) Elimination of NVA activities/Updating MOST analysis

NVA activities are reduced from the original analysis and new theoretical cycle time is generated which leads increase in productivity. The analysis explained for station 1 about NVA activities and the time taken by the activities in terms of MOST i.e. in TMUs, shown in table 2.

Table 2- Most Estimation

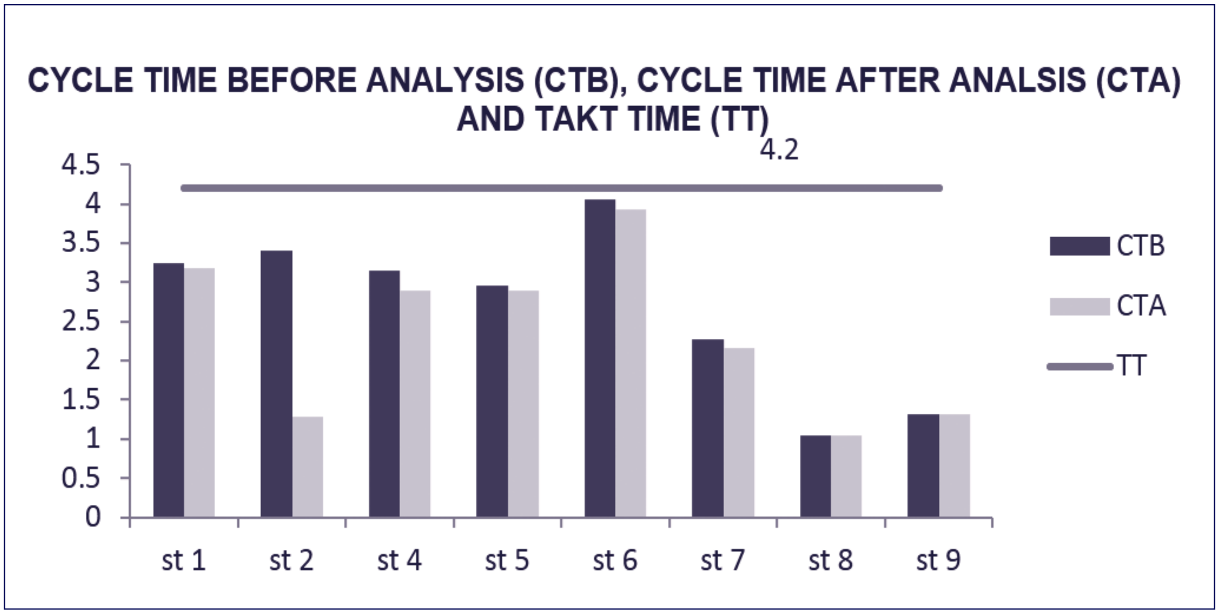
Station 1 # Assemble set screw, water drain plug & cooling jet on the block						
.S.No	Elemental Activities	Sequence Model	PF	FR	NVA	TMU
1	Grasp 6 cooling jet one by one, take 4 steps & come back	A6 B0 (G3) A0 B0 P0 A6			100	150
2	Place 6 cooling jet one by one	A0 B0 G1 A1 B0 P6 A0		6		480
3	Assemble 4 setscrew & 1 water drain plug on the block	A1 B0 G1 A1 B0 (P3) A0	5			180
4	Take air gun & fix nuts of cooling jet	A1 B0 G3 M3 (X24) I0 A0	6			1510
5	Take air gun & fix nuts of water drain plug	A1 B0 G3 M3 X24 I0 A0				310
6	Take air gun & fix setscrew	A1 B0 G3 M3 X24 I0 A0		4		1240
7	Pick MB cap, take 3 steps put MB cap on the table	A1 B0 G1 A6 B0 P1 A0				90
8	Pick spring pin, tool thrust plate & hammer; place spring pin on the MB cap & hammer it	A1 B0 G3 A1 B0 P6 A1 B0 P1 A0		4		520
9	Pick MB caps, 2 spring pin, hammer, thrust plate & come back in 3 steps	A1 B0 G1 A6 B0 P1 A3			20	120
10	Put 2 spring pin on the MB cap of block & fix it with hammer	A1 B0 G1 A1 B0 P6 F10 A1 B0 P1 A0		2		420
11	Put thrust plate on MB cap of block & again hammer it	A1 B0 G1 A1 B0 P6 F6 A1 B0 P1 A0				170
12	Take marker & mark 3 points on MB caps	A1 B0 G1 A1 B0 P3 R10 A1 B0 P1 A0				180
13	Press completion button	A1 B0 G0 A0 B0 P3 A0				40
	TOTAL				120	5410

4. RESULT AND DISCUSSION

By applying MOST technique NVA activities are easily detected. Thus it is possible to reduce work station time by modifying the method of working. As a result there is reduction in the downtime of production. This enables the workers to work for longer hours with less fatigue and high rate of production. Thus by application of MOST, resources can be deployed in the most efficient manner.

Figure 1 below depicts the comparative analysis with and without MOST application in which cycle time before the analysis (CTB) and cycle time after the analysis (CTA). The horizontal line shows the takt time (TT) which is 4.2 minutes.

Figure 1- Comparative analysis with and without MOST



Some other NVA activities were observed from lean manufacturing tools such as standardized work, workplace organization, scrap reduction etc which reduces manufacturing waste [14] are as follows:

a) Gasket are made within reach to the operator to avoid movement

b) Scanner is made within reach.

c) Flywheel housing is shifted near station to avoid movement.

d) Bolts are made within reach.

e) Apron is provided to the operator for keeping marker and small tools in the pocket.

f) Operator is bending to clean the pallet each time thus automated cleaning of received pallet is implemented etc.

Increase in efficiency of PRB engine is calculated below:

Total cycle time of all 8 stations in PRB line=1286.64 seconds / 35740 TMU

Takt time =252 seconds

Total NVA activity time of 8 stations in PRB line=164.88 seconds / 4580TMU

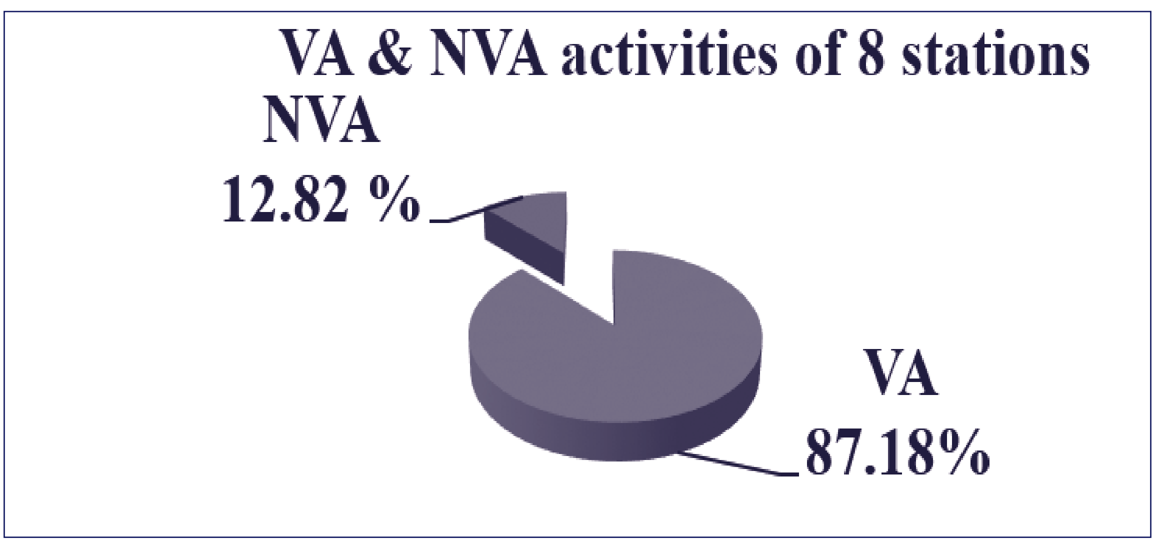
Total cycle time updated by MOST analysis of 8 stations in PRB line =1121.76seconds / 31160

Percentage in reduction of cycle time = (35740-31160) /35740

= 12.82%

By applying Basic MOST analysis to the stations in the PRB Engine assembly line it has been found that the current stations can be optimized as the station cycle time can be synchronized with the takt time by eliminating the NVA activities. Increase in productivity is found to be 12.82 % as shown below in Figure 2.

Figure 2- VA and NVA activities of 8 stations



5. CONCLUSION

The MOST technique that has been applied in the Engine line stations showed significant reduction in cycle time. Through MOST the NVA activities such as action distance, arise and bending can be easily detected by observing the high index value. This can be eliminated by redesigning the working environment ergonomically, so that the unwanted delays can be reduced. The study shows that out of total time 12.82 % of time is NVA activities. So the Non Value Added Activities are identified in PRB engine line stations and were rectified in order to increase the productivity.

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