OPEN ACCESS
International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-4, November 2019

A Novel Technology in Lean Manufacturing

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Abstract—In today's emerging world, as the demands and expectations of the people grow higher and higher every day, so is the competition. Thus to face the demand and to be competitive & survive in the market, industries have to produce superior quality components without producing waste. This leads every manufacturer to optimize and standardize the processes of every component being produced. One such concept employed is "Lean Manufacturing". In this paper a novel tool in lean manufacturing is applied. The processes are continuously monitored and collected necessary data to generate VSM and declare the CSM based on the available data. Then the takt time graph and the balanced time – Cycle time – Downtime graph were plotted with the help of which, the scopes for improvements are identified and then the targets are obtained. The FSM is also drawn and a time plan for projects is prepared and monitored continuously. Based on the type of process and the project, different tools are adopted to reduce the cycle time, downtime, waste and thereby increase the productivity. By implementing newer tools, the future demand of the process was successfully proved to be met by the existing line itself and the need of an additional line was defeated, thereby making monetary savings. By implementing this system, the productivity can be constantly increased.

Keywords –Lean, CSM,VSM,FSM, Takt Time, Productivity

I. INTRODUCTION

Lean manufacturing is a production practice that aims in elimination of non-valuable items. Working from the viewpoint of the customer who consumes a product or service, "value" is defined as any action or process that a customer would be ready to give for. Lean defines Eight Deadly Wastes – viz, Defects, Overproduction, Waiting Waste, Non - Value Added Processing, Transportation Waste, Inventory In Excess, Motion Waste, Employee / People Waste. By the concept of LEAN, there are various tools defined, that are used to reduce the wastes incurred in every processes. Some of them are 5S, Bottleneck Analysis, Value Stream Mapping (VSM), Takt Time, Overall Equipment Effectiveness (OEE), Poka-Yoke (Error Proofing).

Manuscript published on January 30, 2020.
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II. EXPERIMENT

A. Value Stream - Current State Map (CSM) and Product Process Matrix

The Product Process matrix was drawn based on the the past data of the volume of all the products, the amount of the orders of the products placed and produced each month and also based on the frequency of the orders placed.Thus the customers are classified into various types, based on the frequency of orders placed to prioritize them, as

Runner – One who place orders very often or almost every time. Repeater – One who place orders with less frequency.

Stranger – One who place orders once in a while.

Once the Product Process Matrix was drawn, the list of VSM parts was identified and the most important part was considered for the case study. Then the VSM - Current State Map (CSM) wasdrawn.The various data needed to draw the CSM were collected and tabulated with the help of the required Parameters and Metrics.

The Metrics required to prepare CSM are as follows in Table 1.

Table 1. Metrics Required to Prepare VSM

Balancing Cycle Time	B.C/T
Cycle Time	C/T
Machine Cycle Time	MC/T
Operator Idle Time	Operator Idle Time
Change Over Time (Product)	C/O
Colour Change Time	C.C/O
Number of Changeover per shift (Product/Tool)	NC/O
Number of Changeover per shift (Colour/Variant)	NC.C/O
Standard Deviation	ST. DEV for setting
First Piece Out Time	FPOT
Number of Operators	OP
Number Of Parts	#PARTS
Number Of Machines Doing The Same Job	#M
Batch Quantity	BQTY
Uptime	U/T
Overall Equipment Effectiveness	OEE
Breakdown	BD
First Time Quality	FTQ
Working Hours	WT
Number Of Shifts	N.S
Available Time	AT
Distance Travelled	D TRV
Floor Space	FS

B. Time Study

For drawing the CSM, the cycle time and all other necessary parameters of all the stations were noted down by doing Time Study, with the help of a Stop Watch.

Parameters such as Cycle Time, Tool Change over time, Colour Change over time, Machine Idle time, Downtime, Uptime, Availability time, Utility Time, Operator Idle timewere noted down to draw the CSM graph. With the help of time study, cycle time of various stations is calculated and mentioned in below Table 2.

Table 2. The Cycle Time Details

S.NO.	STATION	CYCLE TIME (s)
1	Punching	32
2	Manual Assembly 1	46
3	Manual Assembly 2	56
4	Heat Staking	46
5	Manual Assembly 3	45
6	Screwing	47
7	Poka Yoke	45
8	Final Inspection	52
9	Fire Wall	40

C. Overall Equipment Effectiveness (OEE)

The following factors play a vital role in calculation of OEE

Availability

Availability = (Planned Production Time – Downtime) / Planned Production Time

Performance

Performance = Total number of parts produced / (Available time x Production rate)

Quality

Quality = (Total Pieces – Rejected Pieces) / Total Pieces

OEE

OEE = Availability x Performance x Quality

D. Takt Time

The Takt time is the quantity of time that must intervene between two successive unit completions in order to meet up the demand.

$T = T_a / T_d$

Where,

T = Takt time

T_a = Net time available to work

T_d = Time demand (customer demand)

After plotting the Takt time graph, the status of each station, the bottle neck stations and the stations that need improvements were identified. To support this, work study was also done. The following Fig.1 shows calculations of Takt time.

Calculations of Takt Time:

Net time available to work (Td) = 72000 s

Overall Equipment Effectiveness = 0.85

i. Takt time for 240 parts $= \frac{72000*0.85}{240*4} = 63.75$ s

ii. Takt time for 270 parts $= \frac{72000*0.85}{270*4} = 56.70$ s

iii. Takt time for 315 parts $= \frac{72000*0.85}{315*4} = 48.57$ s

iv. Takt time for 420 parts $= \frac{72000*0.85}{420*4} = 36.43$ s

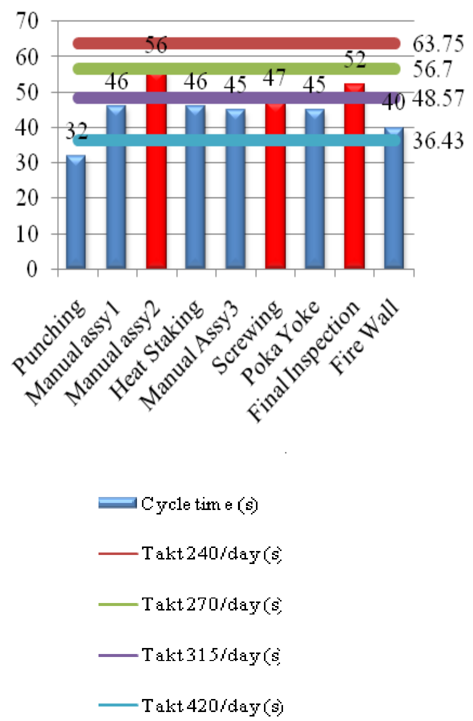

Fig. 1. Calculation of Takt time.

E. Work study

For conducting the Work Study, every station in the line was first shot with the help of a camera.With the help of the videos, the split up of time taken for different activities was noted down.Based on the obtained data, the areas to be improved, the unnecessary work to be avoided and many other details were extracted.Based on these details, various activities, where improvements are required were identified.

III. IDENTIFICATION OF SCOPE

A. Once the scope areas are identified, the various process parameters that influence the process are chosen for optimization and the "Balanced Time – Cycle time - Down Time" (BT – CT - DT) Graph is drawn with the help of following factors.

i. Planned Down Time
ii. Unplanned Down Time
iii. Balanced Cycle Time
iv. Takt Time

Retrieval Number: E3105018520/2020©BEIESP
DOI:10.35940/ijrte.E3105.018520
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering & Sciences Publication

B. From the BT – CT - DT graph, the stations that need to be improved are identified and improvements to be done with the following factors are listed out with which the scope of the CSM is identified.

i. Cycle Time
ii. Up Time
iii. Down Time
iv. Changeover Time
v. Inventory
vi. Floor Layout

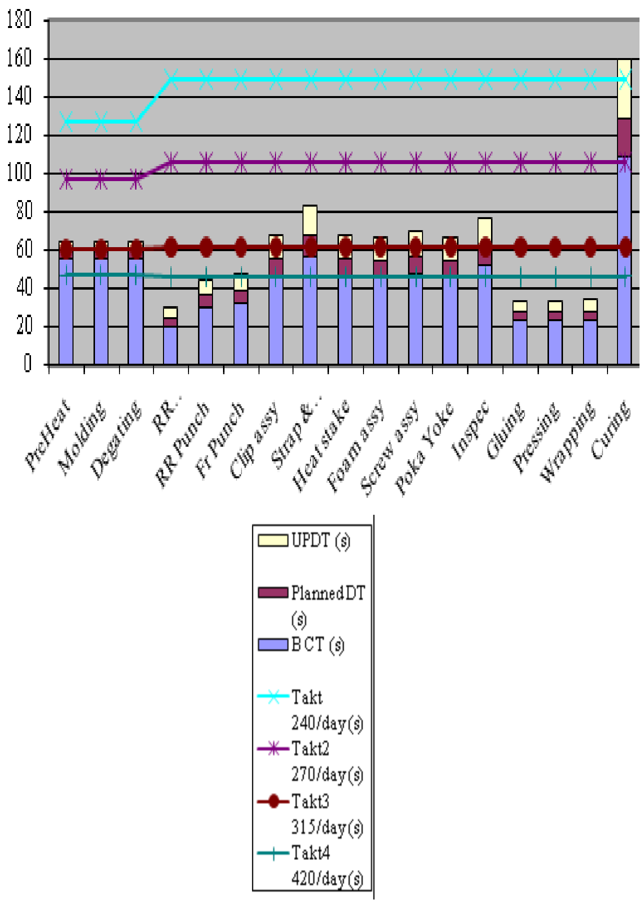

Fig 2. BT – CT – DT Graph

IV. RESULTS AND DISCUSSION

A. Future State Map (FSM)

With the help of the above mentioned processes, the scope and areas of improvements were identified and necessary actions were taken to reduce the cycle time, with the help of various Lean Tools. The FSM was then drawn and future scopes for improvements were listed down. The necessary action plans were suggested and implemented for recording the improvements. The following Table 3 and Table 4 represents cycle time and process efficiency. By implementing the action plans, improvements are seen, the benefits of which are listed below:

Table 3.CYCLE TIME: The cycle time of the following stations have been reduced to the required level, so as to meet the demand.

S. No.	Station	Actual time	Improved time
1	Heat Staking	46	39
2	Foam Assembly	45	39
3	Screw Assembly	47	39
4	Inspection	52	39

Table 4.The Process Efficiency has been increased from 0.048% in CSM to 0.068% in FSM.

Parameter	CSM		FSM	
	Seconds	Days	Seconds	Days
Total lead time	1017846.80	11.780634	683217.26	7.907607 1
Total Inventory time	1017355.80	11.774951	682754.26	7.902248 3
Total value added time	491.00	0.0056829	463.00	0.005358 8
Process efficiency	**0.048%**		**0.068%**	

V. CONCLUSION

Hence by identification of the scope and adopting the action plans the assembly line can be improved further and by applying the concepts and tools, the line can be made lean. The same methodology can be implemented in all other stations also. The CSM has to be plotted in regular interval of six months to one year based on the product/customer demand nature. The improvements scope vs. actions taken has to be reviewed periodically for continuous improvements. Thus by adopting LEAN, the company can be competitive and will be able to meet the demands of the customers. The project thus has projected monetary savings towards the setting up of a separate line, for the same operations and the similar formulated process could be approached for more advantages on lean manufacturing.

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Retrieval Number: E3105018520/2020©BEIESP
DOI:10.35940/ijrte.E3105.018520
Journal Website: www.ijrte.org

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Blue Eyes Intelligence Engineering
& Sciences Publication