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Value Stream Mapping – Strategy for Productivity Improvement

[1]Robin Aby Mathews, [2] Suraj Rane
[1] Student, Department of Mechanical Engineering, Goa College of Engineering, Goa ,403401,India
[2] Professor, Department of Mechanical Engineering, Goa College of Engineering, Goa ,403401,India

Abstract: **-- In manufacturing sectors – Production using available resources in most effective manner is very important. This work is done under a well know automotive manufacturing subsidiaries in India, Goa. In view of highly competitive market, company is in phase change of shifting Conventional machine to man assisted automatic machines from japan. Effective utilization of the machine and man is very important. Workstation minimization and rate of production maximization are important goals. This paper represents the evaluation of machine cycle time reduction using value based mapping. In this work unlike only evaluating each man elements, machine elements in detail with respect to value added to product is analyzed. Also, this study guides the company engineering department in order restore the machine to its required productivity after scheduled Maintenance.**

***Index Terms*—Value mapping, Layout improvement, Work study.**

I. INTRODUCTION

The study undertaken company is an Indian company having 8 units across. For modernization, the conventional man driven machine is converted to a man assisted high productivity machine, imported worth of 200 Lakhs. Machine is assembly line where 6 different components are combined to a single product. Machine is run by a crew of 3 of which 2 are main operators who run the machine in assembling the components and 3rd operator is a service man who brings all components using Material handling equipment's from different area of the plant to machine area. Also 3rd operator acts as a reliever for main operators during tea break, personal requirements and lunch time. Since relieving system followed, machine is meant to run for the full shift (8 hours). The plant is 24 hours running, therefore each crew handover the machine to next shift crew. Main operators assist the machine operation in keeping different components in a sequence manner. Components are fed to machine at predefined timing. Present conventional machine is capability of producing 26 units per shift whereas the new high productivity machine is having a capacity to produce 93 units per shift. This capacity increase is helping the company to reduce the number of conventional machine. Productivity of the machine is taken very seriously in order to meet the market requirement on time. Competitions in market are very high. Indian market is taken as a hub from all over the world. Our Indian products should to capable in all means to compete with other international brands. Today's Customers are very keen in terms of availability, services; cost, Quality, Brand value of the product. Space utilization is important in order to reduce the movement of components by operator.

II.LITERATURE REVIEW

For improving the productivity, the work and time measurement technique is used. Work study [4] involves – Method and Time study. It helps in defining a proper working method [1], [2] and formulates a standard time. The method study – systematic investigation of doing a job helps in understanding, developing and installing an easy, efficient and effective procedure and reduced fatigue job method. The work content of each operator is analyzed and defined clearly with respect to machine elements to ensure maximum effective utilization. Value based mapping [3] of each activity gives us clear oriented picture about factors like Value added time(Actual time required for producing the end product), Non value added time (activities presently essential but time taken

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do not contribute any value to the product). Also once mapping is done it would become easier in defining the method of the operation to be followed by man with respect to the machine. Benefits of work study are better improved and uniform production, higher productivity, accurate delivery of products, better management and workmen relationship, reduced cost of manufacturing, better employee efficiency.

Layouts are associated with factors like minimum movements and material handling, proper cubic space utilization, flexibility to adapt changes in production process. Layout of the plant depends on the type of product. Various types of layouts are Process based (machine arranged based on the process flow), product based (machine are arranged based on the product flow) and Fixed position (Products like ship building, aircraft manufacturing where men, material, machine brought to one position). Layout of the machine with respect to its surrounding in the plant is very important for factors like man movement, Material handling equipment movement, flow of the process – whether forward direction only. Every assembly unit, components are kept nearby the machine - optimized layout is essential in reducing the movement. Parameters like Weight, Size, storing procedure of the components is considered in layout modification to reduce the fatigue.

III. METHODOLOGY

Mapping each elements of the machine process [3] is done to evaluate the Value added and non-value added time. Time study was conducted using stop watch. For evaluating the timings a cross-Functional Team (CFT) was formed. CFT people consisted of Quality control and Quality assurance department (Who decides and validate the machine process value based on experiments and product fields study with known Customers), Plant Engineering departments (re-modify the machine parameters – PLC, sensors, hydraulic operations), Plant Production departments (operators fatigue, relaxation), Industrial Engineering department (Conducts work study, evaluates stages wise man and machine movements) and every production workman. The machine program plays a vital role in deciding the cycle time. Each machine activity which is running based on the PLC program is evaluated depending on the product requirement. CFT Group jointly formed idea session discussion where each component wise building procedure with respect to man and machine is discussed. The necessity of movement of man and machine evaluation in each stage is done. Characterized non valued activity is taken up for discussion. All ideas whether feasible or not is written down. Later on each idea is evaluated and feasibility is discussed. Shortlisted ideas are implemented for machine productivity improvement.

IV. NOTATION

1. C1, C2, C3, C4, C5, C6 – represents Component1 to Components 6 respectively.
2. P – Represents the assembled product.
3. INT – Internal timing(when machine operation occurs, man simultaneously does others jobs thereby helps in reducing machine stoppage)
4. EXT – External timing /Cycle timing
5. F – Final product
6. MO1 & MO2 – Main operator 1 and 2 respectively
7. M/c - Machine

V. CURRENT MACHINE STATE

Current Cycle time

In this case Study, major running production size was taken. Differentiation of man and machine timing was found in holistic view. Man elements were detailed study. The study was done by evaluating 20 different cycles. Timings are in seconds. Total man elements time 79.9 seconds. Total machine elements time 227.8 seconds. Total cycle time 307.7 seconds, 5.13 minutes. Output /shift/machine = 93.6 Units.

Sr No	Stages	Man Timings	M/c Timings
1.	C1	20.6	49.6
2.	C2		76.9
3.	C3		48.3
4.	C4	15.9	
5.	C5	2.8	31.8
6.	C6	15.5	21.2
7.	F	25.1	

Table 1: Current cycle time components wise

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Here relaxation, Contingency allowances is not given since relieving system is provided. Standard rating 85 provided was at the scale of 100. The table 1 indicates the summary of cycle time component wise. There were 24 elements recorded for the components. The study was given importance to man timing and machine timing was just decided based on the manufactures provided timing. Machine was in built with a HMI (human man interface) where the steps of assembling were shown. In HMI mode operator selects the size. Once the machine is started, the machine operates in a sequence of procedure predefined in PLC. The speed/ movement of machine parts are defined in program.

Existing layout

In existing layout storage of components as shown in Fig-1 are kept around the machine. Components are kept in layout based on their Type and structure. Components C1, C2 and C3 are kept on trolleys – each has a storage capacity of 30 Units. Component C4 is brought in rolls. Component C5 and C6 are brought in Trolley of 2.6 meters length and 2 meters width having a capacity of 38 units and 76 units respectively. The machine area is 80 Square meter. Final assemble product is kept on F. F is a trolley designed to keep 6 units. Each P weights around 55 kilos.

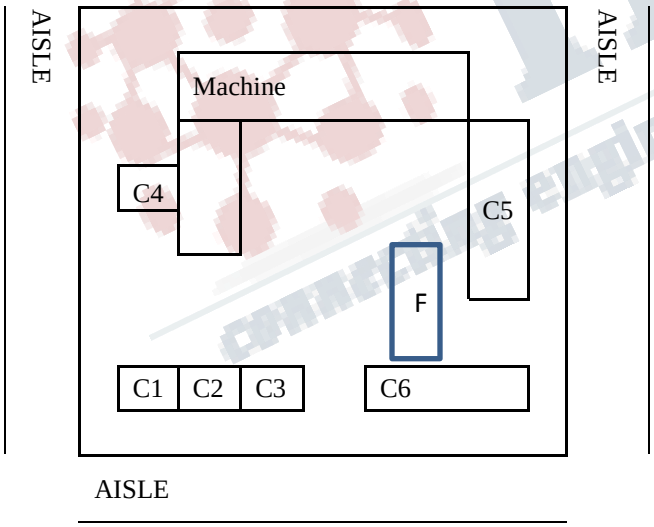

Fig-1: Existing layout

VI. IMPROVEMENTS

Revised Cycle time

Work study was conducted again in more detail – dividing all man and machine elements into external (Timing which is adding to cycle time) and Internal timings (Timing which occurs simultaneously to machine timing) as shown in Table.2. Occupancy of the all three operators was analyzed. In work study all machine elements were divided into finer elements and each finer element were taken up with CFT team for evaluation in terms of its value to the product. Machine elements can also be divided into value adding and non-value adding timing. The existing study elements of 24 were divided into 123 finer elements. Study was conducted by picking the skilled operators. 30 Cycles were taken for averaging out the timings. Man timing rating scale of 90 out of 100 was taken to arrive the expected timing. Each element was discussed in details by CFT team on how it can be reduced. Machine operation included Component fixing operation, Component stitching operation, Stage wise machine activating foot switch, component placing arm for next unit/stage. These operations occur as per the designed program sequence to meet the product requirement. Total man elements time 71.3 seconds. Total machine elements time 217.3 seconds. Total cycle time 288.5 seconds, 4.81 minutes. Output /shift/machine = 99.8 Units.

Sr No	E	MO1		MO2		M/c	
		EXT	INT	EXT	INT	EXT	INT
1.	C1	22.2	10.7		13.8	46.2	17.8
2.	C2		7.0		62.8	70.8	38.2
3.	C3		3.0		18.5	47.4	19.4
4.	C4	15.1					
5.	C5	4.1	5.8		22.4	31.8	50.6
6.	C6	13.4	24.6		35.9	20.9	16.6
7.	F	11.1			8.6	5.5	

Table 2: Revised cycle time components wise summarized

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Machine timing per cycle was reduced by 10.6 seconds. Reasons are the Top and bottom stitches timing got reduced depending on the study requirement on Overlap of the stitch (represents the movement of roller from one point to another), Pneumatic operation movement speed was increased by using dual compressed cylinder storage mechanism and switch was provided instead of foot switch for a specific operation. The Top and bottom stitching operation were done for removing the air traps in the product. The movement of roller stitching the same point was reduced by taking proper trial. Pneumatic operation efficiency was improved by splitting operation into two – half operation controlled by one cylinder and other half controlled by second cylinder. This splitting was done since one cylinder itself is not providing the specified required pressure to the process, minute delay occurs from one operation to another. Converting some operation from foot switch to hand switch closer to operator standing. This need came due to loss in man timing occurring to movement of operator away from the safety sensor zone. As you all know, for any faster moving parts machine safety parameter is very important to avoid minor or fatal accidents. Delay in machine to activate until the operator leaves the unsafe zone after pressing foot switch is reduced by giving him a switch where he stands. The new switch helps him to avoid going to the foot switch to activate the machine. The new switch is equivalent to Foot switch operation.

Revised layout

In revised layout all components storage is realigned in a better way so that all in closer to operator as shown in Fig-2. Man elements timing reduced by 8.6 seconds per cycle. The machine area was reduced by 14 Square meters. Utilization of floor space is very important. The component C5 weights 20kg and C6 weights 6 kg. C5 and C6 were made parallel depending on the type of accessory. C1, C2 and C3 are weighing less than 1 kg. Depending on the weight and aisle the layout was decided. Proposed layout by the CFT team and Union were accepted. Once this machine gets established, more machines will arrive. Reduction in area will give for more space for other application.

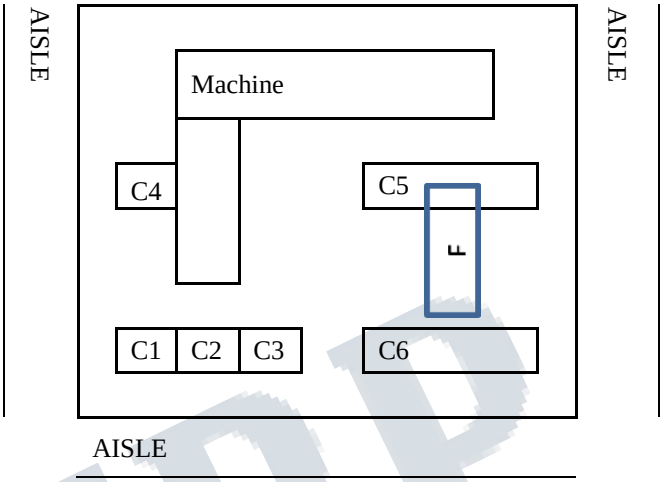

Fig-2: Revised layout

VII.RESULTS

Machine output has increased by 6.2 Units per shift as shown in Fig-3. So we can expect 540 units extra production per month from one machine itself. For this productivity increase only investment of 20,000 rupees is required. Present conventional machines are getting replaced by this new machine. With the improvement requirement of new machines can be planned according. The man power usage remains same. Each unit weights 55 Kilo.

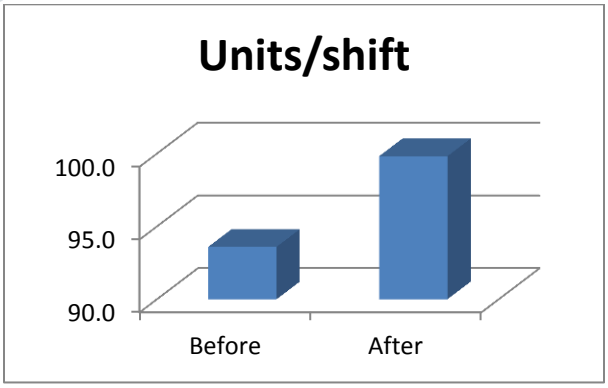

Fig-3 Units/shifts improvement

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Productivity Index is Weight/man-days. Index shifted per shift from 0.588 to 0.0551. Occupancy of the 3rd operator is less compared to main operators. Mechanized material movement will further reduce the occupancy. When more new machines arrive the scope of using 3rd operator common can be studied. Machine requirement for the month will come down depending on the Marketing plan for production. This capacity increases the products to reach market faster.

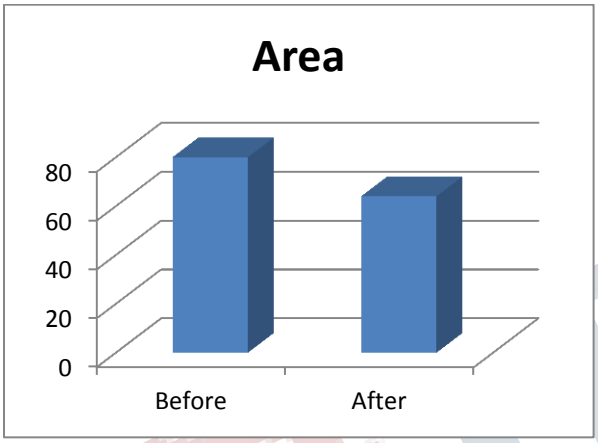

Fig-4 Machine area requireement

Area of the machine along with the components storage is shifted from 80 to 64 Square meters – 14 square meters (17.5 %) saving as shown in Fig-4. The saved area will help in future when new machine arrives. Management as well as the Union has accepted the new layout.

VIII. CONCLUSION

With the detailed study report, benefits are - any method change in future introduced by Quality Control can be easily incorporated for finalizing the output of the machine, Safety has become an important parameter in any industry thereby same studied can be utilized by Safety auditors for evaluating and monitoring the workmen working style, Study can be used by Engineering department as reference in restoring the operation of the machine when deteriorates. Any new operator or supervisor in the department can understand the operations clearly. Study helps the Quality assurance department to monitor the workmen procedures for meeting the product quality. Also when operators violate the procedures for disciplinary actions this acts as a clear guide.

REFERENCES

[1] K.Patil, S.Tonape, Prof. A.Umrani "Assembly Line Optimization Using Lean Principles," International Research Journal of Engineering and Technology (IRJET), vol. 3, pp. 1055-1060, Issue: 07, July 2016.

[2] R.Pulkurte, R.Masilamani, S.Sonpatki, R.Dhake, "Cycle time reduction in assembly line through layout improvement, ergonomics analysis and lean principles," Internal Journal of Applied science and Engineering research, vol. 3, pp.455-463, No2, 2014.

[3] K.Venkataraman, B.V.Ramnath, V.M.Kumar, Elanchezhian, "Application of Value Stream Mapping for Reduction of cycle Time in a Machining Process," 3rd International Conference on Materials Processing and Characterization (ICMPC 2014), pp.1187-1196.

[4] Introduction to Work study, third revised edition, International labour office, Geneva, Indian adaptation, M.N.Pal, A.K. Chatterjee, S.K. Mukherjee.