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Evaluation and implementation of lean manufacturing in assembly section

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Abstract - Every industry tends to find out the efficient way of mass production system to prove its superiority. This is decided by the ability to produce huge product varieties while the cost of the production remains low. So, as in manufacturing industries, the assembly sections are to be planned in much more flexible way to achieve this. To tackle this problem, conventional manufacturing can be replaced by lean manufacturing. Lean manufacturing is a systematic approach to identify and eliminate wastes (non-value added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection. This project aims to implement the lean manufacturing technique in Sakthi Auto Components Ltd., A few wastages are identified in the assembly section of their main product steering knuckle by doing onsite research. By using value stream maps the company's wastages (non- value added activities) in assembly section such as, assembly line cycle time, motion, waiting time and defects are identified. This affects the company's productivity, product cycle time and cost. The project aims to eliminate these wastages and reduce the cycle time, improve productivity and reduce operation cost by modifying current assembly line layout with the help of value stream maps.

Index words - Lean manufacturing, Steering knuckle, Assembly section

1. INTRODUCTION

A. Introduction to industry

The Sakthi group of companies performs, contributes and touches the lives of many with operation in the field of Sugar, Alcohol,Tea,Soft drinks,Soya Foods,Synthesis,Gems,Textiles,Transport, Retreading,Finance And Foundry. The company has strategically invested in the most modern foundry facility and looks forward to set the pace for the industry in the years to follow.

B. Introduction of lean manufacturing

Lean manufacturing is a manufacturing system and philosophy that was to create revolution in manufacturing sector."It is a systematic approach to analyze and eliminate the wastes (non-value added activities), which are of no use in the production process of the product as the customer wished".

A few study materials dealing with the importance of lean manufacturing and their implementation are studied.

Militia vienazindiene, RamuneCiariene (2013) has made study based on the concept that deals with the importance of lean manufacturing and the end results of implementing lean manufacturing techniques in manufacturing and assembly sector. This paper depends on the concept that all the resources used for any work other than the creation of value for end customer, as wastes.

Sharma Neha, et al.,(2013) had made a study that dealt with various principles of lean manufacturing .This paper helps to evaluate various lean manufacturing techniques and implement them to reduce the cost of production by eliminating non value added activities.

B.Babu et al., (2014))had made a study that dealt with importance of steering knuckle in the vehicle. This paper reveals the impact of steering knuckle defects in the safety of the vehicle. Thus, this paper outlines the stress factor and material behavior of the steering knuckle in various loads.

2. PROBLEM IDENTIFICATION

This section of the report provides a brief background on the topics that are researched in order to identify the problem.Value stream mapping and other related information relevant to the project are considered before the commencement of the project.

A. Value Stream Mapping

Value stream mapping,a lean manufacturing tool, is a technique used to analyze and differentiate the value added activities and non-value added with the help of various information.

The creation of a VSM is divided into five basic steps: 1) Product identification. 2) VSM for current scenario. 3) Evaluate the VSM, identify problem areas. 4) Create a future state VSM. 5) Implement future state VSM.

B. Identification of the product:

The Sakthi auto component's main product steering knuckle used in automotive sector is considered. Sakthi auto components mainly manufactures this component and supplies to various automotive companies such as Maruthi, Honda and Fiat.

The steering knuckle used in automobile, where it connects the steering and stub. However they would like to improve the current production process. The project's goal was to create a VSM which will help the company to reduce the current lead time by some % and although create a more efficient work flow. In addition to reducing lead time, also to develop improvements for their current operations.

C. Assembly line layout:

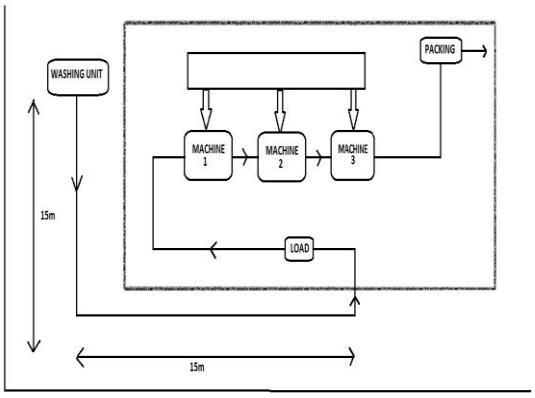
Pressing machines are used to assemble the steering knuckle, bearing and hub respectively. The background research on project helped to understand the conditions prevailing in company. Currently SACL does not use value stream mapping as an operational analysis tool. The WPI/HUST efforts to value stream map part of the SACL operations,the steering knuckle product assembly line, was the first attempt at using this approach.

D. Process and steps involved insteering knuckle assembly section:

Assembly of steering knuckle broken up into 3 process:

1. Bearing assembly,
2. Circlip assembly,
3. Hub assembly.

Current value stream map of assembly line:



E. Collecting relevant data:

An essential part in creating the VSM's for the steering knuckle process was to obtain existing data. There were a few ways in which we gained information. At first, we acquired data directly from the company. The operation managers for the assembly section provided us with production data as well as quality data. The conduct time and production time are recorded and tabulated for further analyzing.

S.NO	DESCRIPTION	DATA
1	NATURE OF PRODUCT	MASS PRODUCTION
2	TRANSFER OF MATERIAL	AUTOMATIC
3	TOTAL MAN POWER	24
4	MATERIAL TRAVEL DISTANCE	10ft
5	NO OF MACHINES INVOLVED	6

F. Time studies:

A time study is a structured process of directly observing and measuring human work in order to establish the time required for completion of that work. We conducted time studies within the section. We recorded the cycle times for individual operations using a stopwatch. These cycle times gave us important information, which we used in our VSM's. The average cycle time told us how well the current operation is doing in relation to the TAKT time. TAKT time is the total available time divided by the no of minutes in demand for that day.The process is automated and it produces output pieces at a very repeatable rate. Generally, we took more time samples on operations whose timeas varied greatly. For example, if the observed cycle times were all four seconds long, then we would only record five observations.

S.NO	NO OF LABOURS	FROM	TO	TOTAL MOVEMENT/PER DAY
1	1/SHIFT =3 (3SHIFT)	WASHING UNIT	OPERATION 1:BEARING ASSEMBLY	11700ft
2	1/SHIFT =3 (3SHIFT)	OPERATION 3:HUB ASSEMBLY	PACKING UNIT	5850ft

However, if the observed cycle time ranged from 10 to 30 seconds, then we would record 15 observations. In order to show the cycle times and other obtained information in a meaningful manner, the data is portrayed in following table.

The observations are analyzed and the average is tabulated below in the table.

Time study: steering knuckle assembly section

TOTAL CYCLE TIME =541 seconds
Motion study: Steering knuckle assembly section

The company provided three shifts per day. Material transfer happens manually by use of trolley. Labor transfers the steering knuckle from washing unit to bearing assembly machine by trolley. After finishing the hub assembly again labor transfers the assembled product from hub assembly machine to packaging unit by trolley. The travel distance from washing unit to bearing assembly machine is approximately 30 feet and the travel distance from hub assembly machine to packing unit is approximately 15 feet. One labor was working per shift and three labors working per day. The total movement of the labor per day is approximately 17550 feet.

G. Problem description

The activity that does not have any values to the product manufacturing process are identified by referring the case studies such as time study motion study and etc.,

Non - value added activities

- Material handling (parts transfer time)
- Motion(labors movement)
- Waiting(parts waiting for operation, machines downtime)
- Material wastes(defects, material damages)

The above activities don't have any value to the product's cycle time. Our team identifies the activities like material handling, motion, waiting and defects are the non- values added activities which don’t add value to the product's manufacturing.

a. Material handling:

The transfer of parts to be assembled takes more time than a part assembling operation. The washing unit is located far from the assembling operation taken place. The distance is approximately about 30 ft., It takes time about 4 to 6 minutes to reach the operation section. The packing unit is also located far from the operation section. The distance is approximately about 15 ft. It takes time about 3 to 5 minutes to reach the packing unit. It takes more time than the time taken for assembling the parts. So, this activity doesn't add value to the product's cycle time.

b. Motion:

The movement of the labors from washing unit to the operation section and operation section to the packing unit doesn't add value to the product's cycle time. The floor space is small area. The motion of the labors to transfer the parts is very difficult in small floor space. The movement of the people is a non-value added activity and at same time it affects people's safety while transferring the parts to the operation section due to the small floor space.

S.NO	ASSEMBLY SETUP	AVG (SEC)
1	STEERING KNUKCLE WASHING	9.2
2	STEERING KNUCKLE CLEANING	7.4
3	STEERING KNUCKLE FLOW FROM WASHING UNIT TO OPERATION 1	190
4	CLEAN THE MACHINE AND SPINDLE UNIT	5.4
5	MOUNT THE PRESSING UNIT AND COMPONENT LOCATOR	7.4
6	ALIGN THE SPINDLE UNIT AND COMPONENT	3.8
7	LVDT SETUP	10.2
8	BEARING ASSEMBLY	18.8
9	CIRCLIP ASSEMBLY	13
10	HUB ASSEMBLY	14.8
11	INSPECTION	21.8
12	ASSEMBLED STEERING KNUCKLE FLOW TO PACKING UNIT	198.8
13	PACKING	40.4

c. Waiting:

The parts from washing unit always waits for long time to the operation to be done. It takes more time

than the time needed for assembling operation. The labor transfers the no of parts in one time movement by trolley. The machine assembles one piece at a time due to the one piece flow. Therefore the remaining parts are waiting for long time until the previous parts are assembled. If the labor transfer 20 parts in one movement from washing unit to the assembling operation section, then the last part to be wait for long time until the previous 19 parts are assembled. The waiting time for the last product is more than the time taken for assembling the parts. If the labor takes more time to transfer the parts from washing unit to the assembling section, then the machines waiting for the parts to be assembled. This leads to undergo the down time. The down time of the machines doesn't add value to the product's cycle time.

d. Defects:

In the inspection section the assembled parts are inspected. If the parts haven't met the customer's requirements,then it will be marked as a defect component. The defect free components are allowed to packing unit. The defects are normally, damages in the products such as parts are missing assembled in the assembly section. The defects are happened during the parts transfer from washing to the assembly section by trolley. While removing the parts from the trolley there will be a chance for damage happening on the parts. The defects also happened due to mis-assembling the parts. The machines used for assemble the parts don't have the sensors and the error proof system. Therefore the mis-assembling of parts occurs regularly. If the component marked as defects, then the time used to make the component is waste.

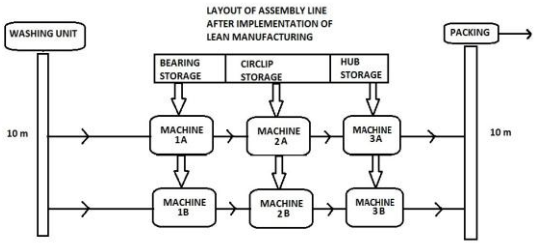
3. RE DESIGNING OF CURRENT ASSEMBLY LAYOUT

A. Re designing of current VSMassembly line layout:

In this section we will discuss the team's recommendations for SACL. They are twofold. First we will discuss ways of improving the lead time in the assembly section. This is mostly accomplished by reducing the material handling time, waiting time. Then some operational improvements are given to reduce the motion and defects. We will also outline modified layout.

The current assembly layout meets the non-value added activities such as,material handling time, motion, waiting and defects. Our team modifies the layout to eliminate the non-value activity identified in previous chapter.

With the objective of the project being to reduce the lead time by at least some percentage, we focused mainly on reducing the larger problem areas, such as material handling time and waiting time. However, we also found that we can reduce the lead time if we also consider the smaller problem areas as well.



MODIFIED VSM FOR ASSEMBLY LINE LAYOUT

MOTION: DATA FROM THE MODIFIED LAYOUT

S.NO	NO OF LABORS	FROM	TO	TRAVEL DISTANCE	TOTAL MOVEMENT
1	0	WASHING UNIT	OPERATION 1	10ft	0
2	0	OPERATION 3	PACKING	8ft	0

TIME: DATA FROM THE MODIFIED LAYOUT

S.NO	ASSEMBLY SETUP	AVERAGE (SEC)
1	STEERING KNUKCLE WASHING	9.2
2	STEERING KNUCKLE CLEANING	7.4
3	STEERING KNUCKLE FLOW FROM WASHING UNIT TO OPERATION 1	9
4	CLEAN THE MACHINE AND SPINDLE UNIT	5.4
5	MOUNT THE PRESSING UNIT AND COMPONENT LOCATOR	7.4
6	ALIGN THE SPINDLE UNIT AND COMPONENT	3.8
7	LVDT SETUP	10.2
8	BEARING ASSEMBLY	18.8
9	CIRCLIP ASSEMBLY	13
10	HUB ASSEMBLY	14.8
11	INSPECTION	4.6
12	ASSEMBLED STEERING KNUCKLE FLOW TO PACKING UNIT	7.6
13	PACKING	40.4

TOTAL CYCLE TIME =151.6 seconds

WAITING: DATA FROM THE MODIFIED LAYOUT

DEFECTS: DATA FROM THE MODIFIED LAYOUT

S.NO	DESCRIPTION	DATA
1	PARTS FLOW	AUTOMATIC
2	MATERIAL DAMAGE	APPROX. 0
3	MACHINES	INSTALLED WITH ERROR PROOF SYSTEM AND SELECTIVE ASSEMBLY
4	MISASSEMBLED PRODUCTS	APPROX. 0

4. RESULT AND DISCUSSION

CALCULATIONS:

MATERIAL HANDLING TIME:
BEFORELEAN MANUFACTURING IMPLEMENTATION

From washing unit to operation 1 (bearing assembly) = 3 minutes and 20 seconds

From operation 3 (hub assembly) to packing unit = 3 minutes and 10 seconds

AFTER LEANMANUFACTURING IMPLEMENTATION

From washing unit to operation 1(bearing assembly) = 10 seconds

From operation 3 (hub assembly) to packing unit = 10 seconds

S.NO	WAITING TYPE	TIME(BEFORE LEAN MANUFACTURING IMPLIMENTATION)	TIME (AFTER LEAN MANUFACTURING IMPLIMENTATION)	TIME REDUCTION
1	2nd PART WAITING FOR OPERATION TO BE DONE	20 seconds	0 seconds	100%
2	MACHINE DOWN TIME	180 seconds	0 seconds	100%

BEFORE LEAN MANUFACTURING IMPLEMENTATION

S.NO	MATERIAL TRANSFER	VALUE ADDED TIME	NON-VALUE ADDED TIME
1	From washing unit to operation 1(bearing assembly)	10 seconds	3 minutes
2	From operation 3(hub assembly)to packing unit	8 seconds	3 minutes and 20 seconds

AFTER LEAN MANUFACTURING IMPLEMENTATION

S.NO	MATERIAL TRANSFER	VALUE ADDED TIME	NON-VALUE ADDED TIME
1	From washing unit to operation 1(bearing assembly)	3 minutes and 10 seconds	0 seconds
2	From operation 3(hub assembly)to packing unit	3 minutes and 18 seconds	8 seconds

REDUCTION IN MATERIAL HANDLING TIME:

S.NO	MATERIAL TRANSFER	TIME REDUCTION
1	From washing unit to operation 1(bearing assembly)	94.73%
2	From operation 3(hub assembly)to packing unit	95.95%

Overall time reduction = 95.34%

WAITING TIME:

BEFORE LEAN MANUFACTURING IMPLEMENTATION

S.NO	DESCRIPTION	DATA
1	NO OF MACHINES INVOLVED	6
2	MACHINES DOWNTIME	0
3	PARTS WAITING TIME	APPROX. 2 SECONDS

Second part waiting for the operation 1 to be done = approximately 20 seconds.
Machine downtime = approximately 180 seconds.

AFTER LEAN MANUFACTURING IMPLEMENTATION

Second part waiting for the operation 1 to be done = approximately 0 seconds.
Machine downtime = approximately 0 seconds.

REDUCTION IN WAITING TIME

OVERALL TIME REDUCTION = 100%

PRODUCTS CYCLE TIME:

BEFORE LEAN MANUFACTURING IMPLETATION

Product cycle time in assembly section = 541 seconds.

AFTER LEAN MANUFACTURING IMPLEMENTATION

Product cycle time in assembly section = 151.6 seconds.

CYCLE TIME REDUCTION

S.NO	TYPE	TIME(BEFORE LEAN MANUFACTURING IMPLIMENTATION)	TIME(BEFORE LEAN MANUFACTURING IMPLIMENTATION)	TIME REDUCTION
1	PRODUCTS CYCLE TIME ASSEMBLY SECTION	541seconds	151.6 seconds	71.98%

OVERALL TIME REDUCTION = 71.98%

5. CONCLUSION

From the research work, it is concluded that,the steering knuckle assembly plan desires to improve the material handling processes by using the lean manufacturing methods. Through the course of this research, several different areas of the steering knuckle assembly operations have been positively affected. It has been illustrated very clearly in this work that a lot of improvements in areas are found with the help of current state map. Current state map and future state map are prepared and analyzed to highlight the benefits of a lean system in a steering knuckle assembly. Further the following conclusions are made(1) by implementing lean tools, the lead time in a steering knuckle assembly is reduced (2) inventory of all forms are reduced (3) as a result of work balancing, cycle time of the bottleneck operations are reduced below the take time (4) value added ratio is increased after lean implementation.
The improper assembly line layout is one of the reasons for generating non-value adding activities.
Using the value stream mapping product movement distance was calculated. Applying the lean technique concept of wastage's reduction using value stream mapping, the assembly line layout was modified and the product movement distance was recalculated.
The modified assembly line layout results in a reduction of 100 feet in the transportation movement distance.
The modified warehouse layout provides the proper ergonomics to the workers in the working area cabin in current assembly layout. The modified warehouse layout is more accessible and economically feasible compared to the present assembly line layout.

COMPARISON BEFORE AND AFTER LEAN IMPLEMENTATION:

The below results shows drastic improvement by the use of lean technique, which has led to the increase in efficiency of the assembly line.

S.NO	PARAMETERS	BEFORE LEAN MANUFACTURING IMPLEMENTATION	AFTER LEAN MANUFACTURING IMLEMENTATION
1	TRANSFER OF PARTS	MANUAL	AUTOMATIC
2	TOTAL MAN POWER	9	6
3	MATERIAL TRAVEL DISTANCE	180 ft.	20 ft.
4	MOVEMENT OF LABOUR	180 ft.	0 ft.
5	NO OF MACHINES INVOLVED	3	6
6	MACHINES DOWN TIME	OCCUR	NOT OCCUR
7	PARTS WAITING TIME	OCCUR	NOTOCCUR
8	PARTS DAMAGE	OCCUR	NOT OCCUR
9	MISS ASSEMBLE PARTS	OCCUR	NOT OCCUR
10	PARTS TRANFERS TIME	208 seconds	20 seconds
11	ASSEMBLY CYCLE TIME	541seconds	152 seconds

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