Study And Improvement In Manufacturing Using Time Study And Value Stream Maping Method

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Abstract- *Lean Manufacturing is becoming a vital backbone of production system of manufacturing sector. It has wide variety of tools to treat all kinds of problem faced by an industry, it also helps in making cost effective product and satisfies both customer and manufacturer. Value Stream Mapping (VSM) and Work Standardization are key tools used in lean manufacturing and lean transformation; it makes the process more smooth it helps in reduction of lead time and ultimately increasing productivity. Line balancing on other hand ensures optimum utilization of resources reducing the idle time. This paper displays a case study on how a VSM, standardization and line balancing has to be carried in shop floor consisting of different types of Computer Numerical Controlled (CNC) machines arranged in cells. Work Standardization is carried upon both cycle time and setup time of the process. Video analysis tool is used for time study. Effective man utilization is seen through line balancing. Results and benefits show the capability of lean tools over CNC production lines.*

I. INTRODUCTION

Power transmission is the movement of energy from its place of generation to a location where it is applied to performing useful work.

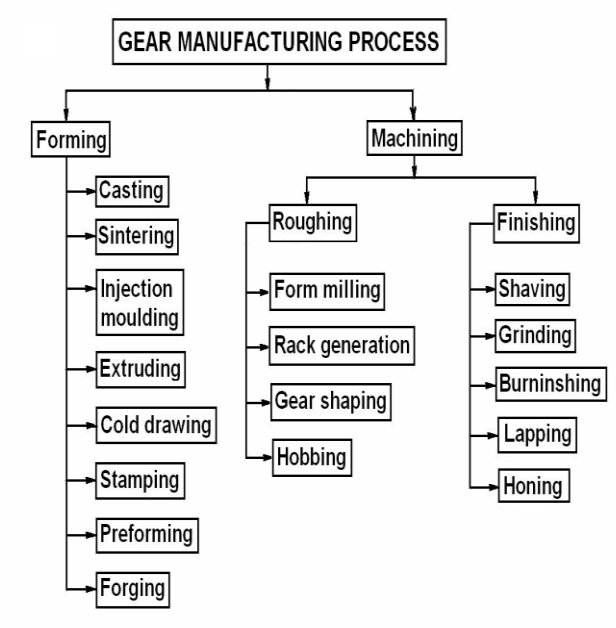
A toothed wheel that works with other to alter the relation between the speed of a driving mechanism such as the engine of a vehicle and the speed of the driven parts of the wheels.

A gear is a component within a transmission device that transmits rotational force to another gear or device.

Types of gear

1. Spur gear
2. Helical gear
3. Bevel gear
4. Worm gear
5. Rack and pinion

Machining process of gear



TIME STUDY AND VALUE STREAM MAPING

Productivity has now becomes an everyday watchword. It is a crucial to welfare industrial firm as well as for the economic progress. High productivity refers to doing work in a shortest possible time with least expenditure on input without sacrificing quality and with minimum wastage of resources. Lean manufacturing is one of the initiatives that automotive companies have been trying to adopt in order to remain competitive in an increasingly global market. The focus of the approach is on cycle time reduction by eliminating non-value added activities.

This paper will show how the cycle time reductions can be made throughout the process by using value stream mapping. It analyses the processes involved in manufacturing and identifies the key areas of wastage and possible solution to overcome them. Value stream mapping was chosen as a tool to gather information on Pump manufacturing because it has

been used successfully by much organization to plan and identify internal improvement.

Value Stream Mapping can be defined as the simple process of directly observing the flow of information and material as they now occur summarizing them visually and then envisioning a future state with much better performance.

The ultimate goal of VSM is to identify all types of waste in the value Stream and to take step to try and eliminate these. Waste can be part of a process that takes time and resources but adds non value to the product.

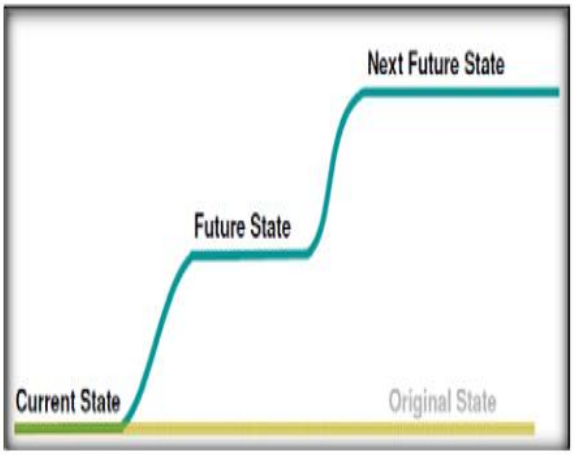
VALUE STREAM MAPING

The use of Value Stream Mapping (VSM) has been attributed to the cause of much of the success that Toyotaof Japan has had since the 1980's1. Developed during the work conducted by TaiichiOhno at Toyota in the 1960's and 70's, at its basic level VSM is a systematic methodology to identify wasted time and actions in a manufacturing process. In more recent times VSM it hasbeen used to re-engineer businesses because it identifies unnecessary effort and resources to permit simplification and streamlining of operations processes.

Waste is one of the seven wastes identified by Toyota. These are:

1. Overproduction: Producing items for which there are no orders.
2. Waiting Time: Employees standing about. Inventory at stand-still.
3. Unnecessary Transport: Moving material unnecessarily or long distances.
4. Over-processing: Using more steps to produce a product than necessary.
5. Excess Inventory: Retaining unnecessary inventory between process steps.
6. Unnecessary Movement: Any wasted motion by man or machine.
7. Defect: Making incorrect product.

Value stream mapping steps



VSM Steps

- Specify value from the standpoint of end customer
- Identify the value stream for each product family
- Make the product flow
- So the customer can pull
- As you manage toward perfection

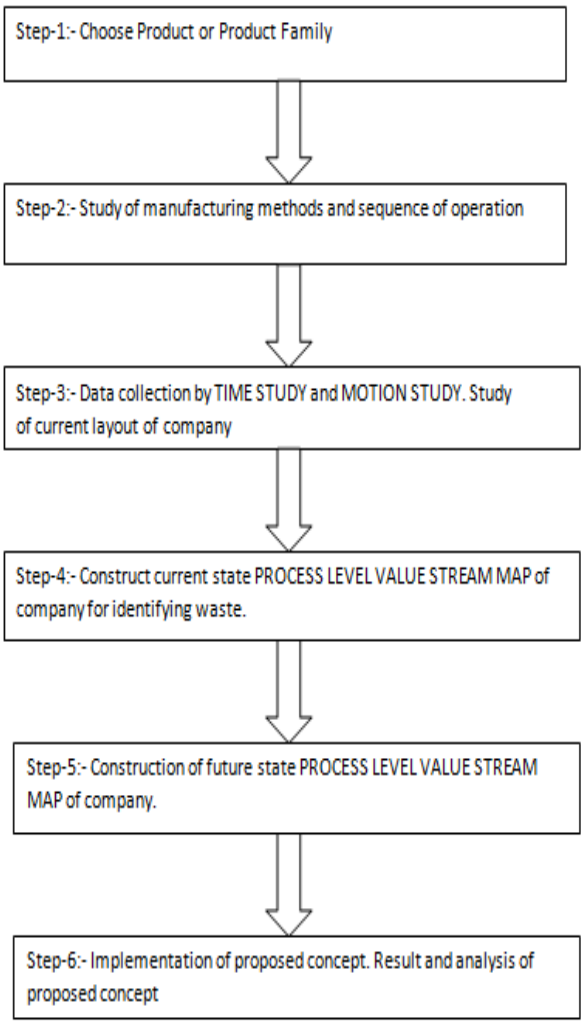
Value stream mapping symbols

	Customer/Supplier Icon: represents the Supplier when in the upper left, customer when in the upper right, the usual end point for material
Process	Dedicated Process flow Icon: a process, operation, machine or department, through which material flows. It represents one department with a continuous, internal fixed flow.
Process	Shared Process Icon: a process, operation, department or workcenter that other value stream families share.
C/T: C/O: Batch: Avail:	Data Box Icon: it goes under other icons that have significant information/data required for analyzing and observing the system.
	Workcell Icon: indicates that multiple processes are integrated in a manufacturing workcell.

Value Stream Mapping Process Symbols

	Inventory Icons: show inventory between two processes
	Shipments Icon: represents movement of raw materials from suppliers to the Receiving dock/s of the factory. Or, the movement of finished goods from the Shipping dock/s of the factory to the customers
	Push Arrow Icon: represents the "pushing" of material from one process to the next process.
	Supermarket Icon: an inventory "supermarket" (kanban stockpoint).
	Material Pull Icon: supermarkets connect to downstream processes with this "Pull" icon that indicates physical removal.

II. METHODOLOGY



Gear Manufacturing Process

Manufacture of gears needs several processing operations in sequential stages depending upon the material and type of the gears and quality desired.

Those stages generally are :

- Preforming the blank without or with teeth
- Annealing of the blank, if required, as in case of forged or cast steels
- Preparation of the gear blank to the required dimensions by machining
- Producing teeth or finishing the preformed teeth by machining
- Full or surface hardening of the machined gear (teeth), if required
- Finishing teeth, if required, by shaving, grinding etc.
- Inspection of the finished gears.

In this section, performing, producing teeth by machining and gear teeth finishing have been discussed in detail.

o **Shaping, planing and slotting**

Fig. 7.2.10 schematically shows how teeth of straight toothed spur gear can be produced in shaping machine, if necessary. Both productivity and product quality are very low in this process which therefore, is used, if at all, for making one or few teeth on one or two pieces of gears as and when required for repair and maintenance purpose. In principle planning and slotting machines work on the same principle. Planing machine is used, if required at all, for making teeth of large gears whereas slotting, generally, for internal gears.

o **Milling**

Gear teeth can be produced by both disc and end mill type form milling cutter as shown in

Production of gear teeth by form milling are characterised by :

• use of HSS form milling cutters
• use of ordinary milling machines
• low production rate for
– need of indexing after machining each tooth gap
– slow speed and feed
• low accuracy and surface finish
• inventory problem – due to need of a set of eight cutters for each

module – pressure angle combination.

• End mill type cutters are used for teeth of large gears and / or module.

Machine Description

Sr. no	Element Description	Machine
1	Bar-cutting	HACKSAW MACHINE
2	Facing & cantering	LATH MACHINE
3	Pre-turning	LATH MACHINE
4	First turning	LATH MACHINE
5	PG hobbling'	HOBBING MACHINE
6	Debarring & Chamfering	LATH MACHINE
7	Carburizing & hardening	INDUCTION FURNACE
8	Tempering	INDUCTION FURNACE
9	Shot-blasting	SHOT BLASTING GUN
10	Straightening	SPM
11	Centre-grinding	GRINDING MACHINE
12	Hard-part turning	LATH MACHINE
13	Keyway milling	MILLING MACHINE
14	Diameter grinding	GRINDING MACHINE
15	Profile grinding	GRINDING MACHINE
16	Super Finishing	GRINDING MACHINE
17	Washing	WASHNG TANK

III. DESIGN AND IMPLEMENTATION

Time Study Top Sheet

Department: Mechanical Production	
Plant/Machine: Amrut gear	
Customer :Textile Industry	
Product/Part :pinion Shaft (Gear)	
DWG No.:350-22-13	
Material:Alloy Steel	

Sr. no	Element Description	W.R			
		L.T	O.T	U.T	T.W.R
1	Bar-cutting	24.55	268.8	23.24	316.59
2	Facing & cantering	23.22	393.6	24.32	201.14
3	Pre-turning	37.02	799.8	23.91	860.73
4	First turning	8.98	240	14.42	263.4
5	PG hobbling'	15.69	333	14.15	362.84
6	Debarring & Chamfering	15.24	180	14.21	209.45
7	Carburizing & hardening	12.14	9	14.67	35.81
8	Tempering	29.13	330	23.53	382.66
9	Shot-blasting	21.94	450	18.76	490.7
10	Straightening	24.27	312	20.22	356.49
11	Centre-grinding	33.26	190.8	26.15	250.21
12	Hard-part turning	27.22	720	23.71	770.93
13	Keyway milling	18.19	300	12.82	331.01
14	Diameter grinding	39.94	27	37.82	104.76
15	Profile grinding	36.89	247.2	32.63	316.72
16	Super Finishing	22.32	262.2	13.26	297.78
17	Washing	14.68	180	16.22	210.9

Note: L.T = Loading Time O.P = Operation time

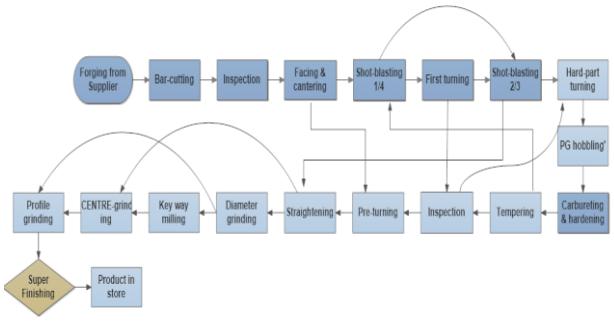
U.T = Unloading time T.W.R = Total watch reading

Flow process chart of Original Plant Layout

Sr. No.	Description	Qty.	Distance in (m)	Time in Min.	●	⇨	D	■	▼
1	Forging from Supplier	1							•
2	Move to machine Shop	1	5	1.54		•			
3	Bar-cutting	1			•				
4	Inspection	1						•	
5	Facing & cantering	1			•				
6	Pre-turning	1			•				
7	First turning	1			•				
8	Inspection	1						•	
9	PG hobbing	1			•				
10	Debarring & Chamfering	1			•				
11	Carburizing & hardening	1			•				
12	Tempering	1			•				
13	Wait for Trolley	1		2.05			•		
14	Move to shot blasting	1	52	7.01		•			
15	Move to 2/3 blasting	1	36	9.59		•			
16	Move to 1/4 blasting	1	18	5.05		•			
17	Shot-blasting	1			•				
18	Straightening	1			•				
19	Move To center grinding	1	9	2.55		•			
20	Centre-grinding	1			•				
21	Wait for trolley	1		2.05			•		

22	Move to F.O.D part turning	1	32	10.01		•			
23	Hard-part turning	1			•				
24	Keyway milling	1			•				
25	Diameter grinding	1						•	
26	Profile grinding	1		2.03			•		
27	Super Finishing	1	37	12		•			
28	Product in store	1							•
Total			169	53.87	13	7	3	3	2

CURRENT FLOW PROCESS LAYOUT



Introduction to Value Stream Mapping

Lean manufacturing programme is being followed by various industries in the recent year which mainly focuses on improving the efficiency of operations by reducing wastes. Value stream mapping is one of the tool of lean manufacturing. By value stream mapping we identify wastes occur in present production line. Industries which are wants to become lean for those types of industries value stream mapping is best way to implement lean manufacturing. Value stream mapping is powerful tool which highlights process inefficienciesas well as improvement guidance. Value stream mapping is combination of all actions value added as well as non-value added. Value stream mapping shows material flow, information flow etc.

Value stream mapping is very helpful to lean implementation. Value stream mapping create road map for improvements in some areas. Value stream mapping is become bridge gap between existing state and future state. At present time every industry want to redesign and redefined production system to face demand and challenges of customer.

The value stream is the whole creation process for a product. The value stream starts at concept and ends at delivery to the customer. Every stage the product goes through should add value to the product, but often this is not the case. Mapping of the value stream aids the identification of value adding and non-value adding (i.e. waste) activities.

A value stream is all the actions (both value added and non-value added) presently required to bring a Product through the main flows necessary to every product: (a)the production flow from raw material into the hands of the customer, and (b) the design flow from concept to launch. Standard terminology, symbols, and improvement methods allows VSM to be used as a communication tool for both internal communication and sharing techniques and results with the larger lean community.

VSM is the process of visually mapping the flow of information and material as they are preparing a future state map with better methods and performance. It helps to visualize the station cycle times, inventory at each stage, manpower and information flow across the supply chain.

Value adding activities:-Machining, Processing, Painting, Assembling

Non value adding activities:-Scrapping, Sorting, Storing, Counting, Moving, Documentation etc.

Value stream mapping visually mapping material flow and information flow of current state. Then prepare future state with improvement and modification. Value stream mapping is help to map station cycle time, inventory, manpower requirement, distance to travelled etc.

Value stream mapping analyze and map the process in order to reduce waste. Purpose of Value stream mapping is used to identify wastes and highlight source of wastes. The aim of value stream mapping is eliminate these wastes and prepare future state value stream map which is more realistic view of company. In value stream mapping many different terminologies are used.

Terminologies used for value stream mapping

Take Time: - Take time is calculated by available working time per day (minutes or seconds) to customer demand per day (in relevant units)

$$\text{Take time} = \frac{\textit{Avilable working time per day}}{\textit{Customer demand per day}}$$

Production Lead Time: - Lead time it means total time requires from raw material arrivals to finish goods deliver to customer.

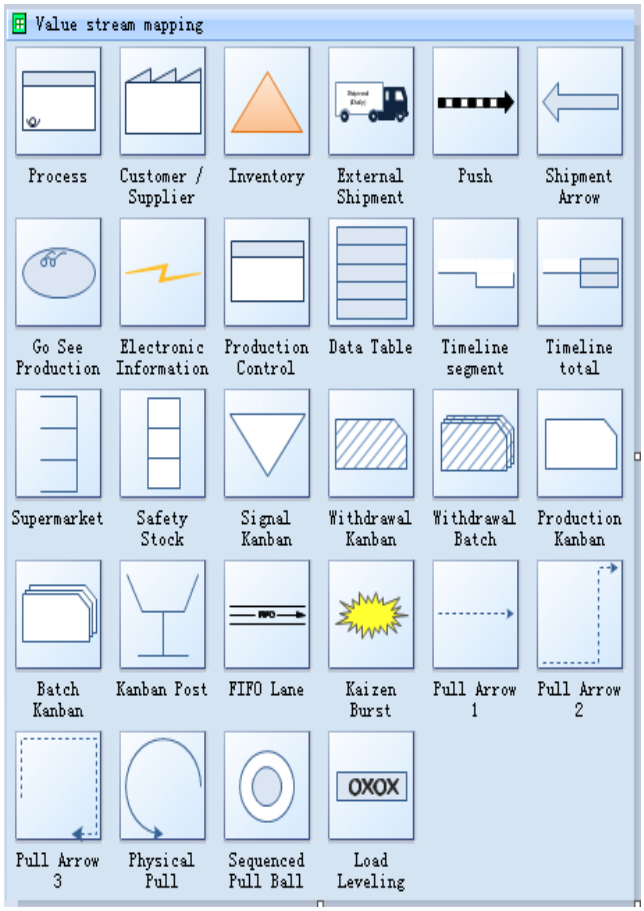
Value Adding Time: - It is a time to require to perform some value adding activity like machining, Processing, assembling, painting.

Current State Mapping: - It shows the current position of production activity.

Future State Mapping: - It shows future position of production activity with improvement and modification.

Kaizen: - Kaizen is tool of lean manufacturing. Kaizen is used for continous improvement in every process and every stage of industry.

Symbols used in value stream mapping



VSM Symbols

Methodology used for Value Stream Mapping

Step1: - Calculate the Take time

Take Time = Available time/ customer demand
= 26*1200*60/3500
=534.85 second
Number of shift per day=2
Number of working days=26
Net working time per day=1200min
Demand for month=3500

Step2: - Under customer demand

In step2 we understand customer demand. Customer demand is 3500 pieces per month. Demand is also in weekly or daily.

Step3: - Map the process flow

This step involves various processes to complete the product. In addition, measure relevant data to put in a value stream mapping box. Moreover, see the WIP between two processes.

Step4: - Map the material flow

The flow of material from raw material to finished goods is given by supplier to customer.

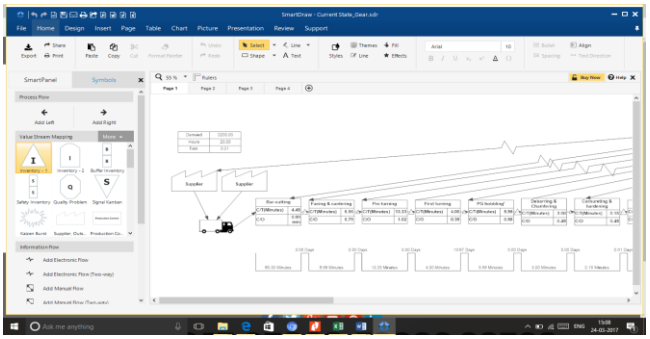
Step5: - Map the information flow

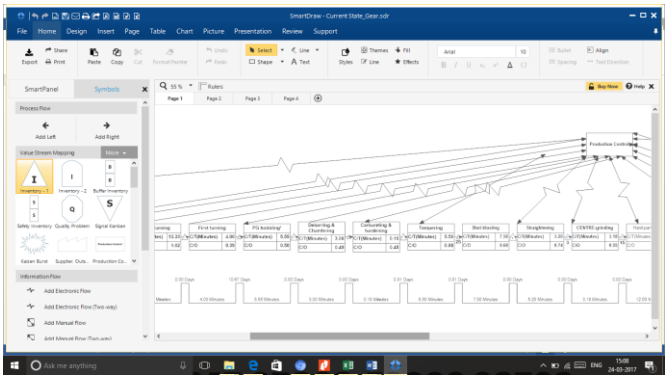
The information flow provided demand information. Information are given by electronic or manually.

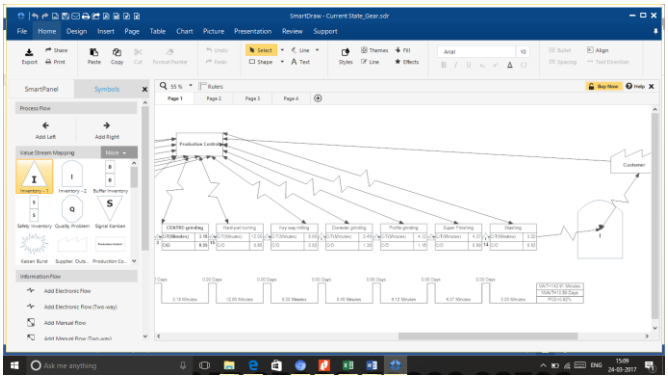
Step6: - Draw the time line

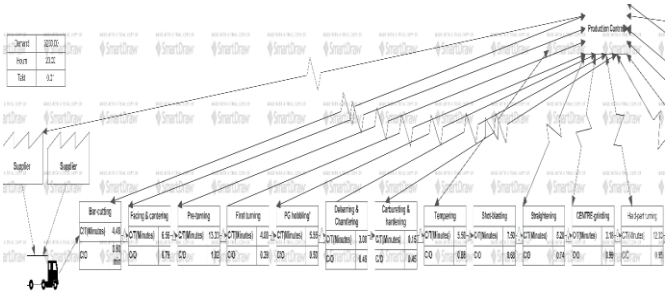
Calculate production lead times for inventory triangles by dividing quantity of inventory by the customer daily requirement.

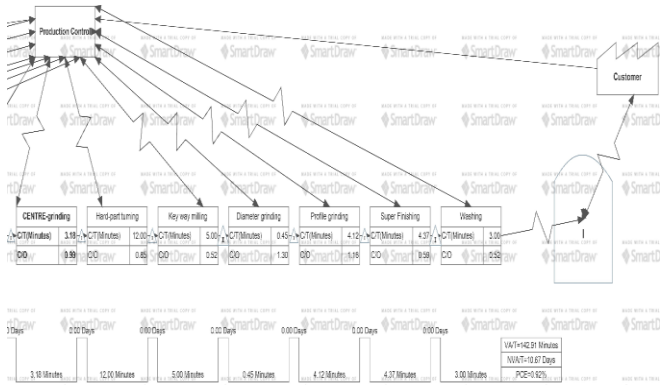
Current state Process Value Stream Map











Identification of wastes

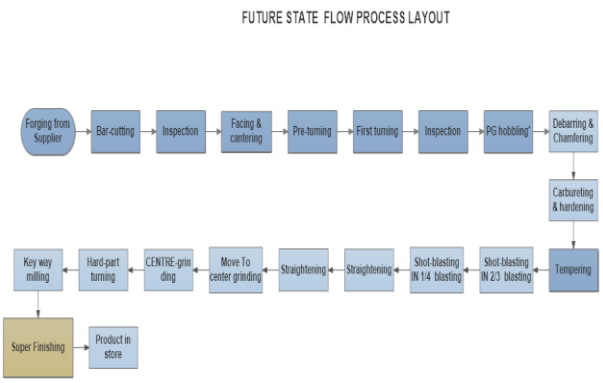
After map the current state of company by process value stream mapping we identifying wastes. In Current state position there are various wastes occur. In present state layout is not proper so non value adding activity like moving is more so transportation waste is occur. By value stream mapping we find that there are high cycle times in some processes. Also we find that rework and rejection is more in some machines.

Waste reduction for future state map

After identifying transportation waste in current layout position we suggest "U" shape layout for the company. For this layout new flow process chart prepare and then after "U" shape layout created. More distance is travelled in original layout; distance travelled in original layout is 169m And transportation time is 48.87min.

Flow process chart FOR Suggested Plant Layout

Sr. No.	Description	Qty.	Distance in (m)	Time in Min.	●	→	D	■	▼
1	Forging from Supplier	1							●
2	Move to machine Shop	1	2	0.52		●			
3	Bar-cutting	1			●				
4	Inspection	1						●	
5	Facing & centering	1			●				
6	Pre-turning	1			●				
7	First turning	1			●				
8	Inspection	1						●	
9	PG hobbing	1			●				
10	Deburring & Chamfering	1			●				
11	Carburizing & hardening	1			●				
12	Tempering	1			●				
13	Wait for Trolley	1		2.05			●		
14	Move to shot blasting	1	5	1.01		●			
15	Shot-blasting IN 2/3 blasting	1			●				
16	Shot-blasting IN 1/4 blasting	1			●				
17	Straightening	1			●				
18	Move To center grinding	1	9	1.55		●			
19	Centre-grinding	1			●				
20	Wait for trolley	1		2.05			●		
21	Hard-part turning	1			●				
24	Keyway milling	1			●				
25	Diameter grinding	1						●	
26	Profile grinding	1		2.05			●		
27	Super finishing	1	57	12		●			
28	Product in store	1							●
Total			44	20.0	15	4	3	3	2



• RESULT TABLE :

Sr. No	Types of Layout	FPC time(min)	Time study time(min)	Total Time (min)
1	Original layout	90	16.49	106.49
2	Modified layout	46	16.49	65.49

Note: Modified layout, Modified layout are based on assumptions.

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