Using Time and Method Study to Improve The Manufacturing of Tubular Heaters

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Abstract- *In the modern era of fast and upcoming global competition in each and every industry for getting better and better to serve the customer not just with the high quality products but also at a quicker time so that the next time the customer looks for quick orders it can take the choice easily and this will help also in a strong relationship of the supplier and the customer.*

The project addresses to the manufacturing of a tubular heater which consists of many smaller and larger processes which can have a huge impact of the manufacturing time of the product.

In this project the method and time study techniques are used in the processes of manufacturing of tubular heaters and making improvement in such a way that there can be saving of time for manufacturing and it increases the productivity.

Keywords- Time Study, Method Study, Two handed process chart, Multiple activity chart.

I. INTRODUCTION

In general heater is a device used for heating a device or applied to a device which works on heating applications. Heaters have revolutionized over the years from just being a common heating device now it has wide applications in day to day use electronic devices like AC, Microwaves etc. Hence Heaters are an important product to be manufactured.

With the intention of furnishing the customers with the most efficient and satisfactory heating products, at the lowest possible cost, HEATERS INDIA has striven to manufacture various types of electric tubular heating elements and equipment's, and has aggressively expanded to as the most versatile manufacturer of these products in Bangalore.

Figure 1. Tubular Heaters

II. LITERATURE REVIEW

Patange Vidyut Chandra et al; [2013] [1] "This paper focuses on the crucial area of productivity improvement with the astute use of work study technique mixed with modern soft skills. Management needed to understand its application in not just from angle of production improvement, finance improvement or resource utilization, but also should address critically the soft side of workers psychology to give the best to not only for accepting the productivity solutions, but also be on the forefront during actual implementation to make the study really worth its time and effort. The systematic application of method study, and time study to improve productivity, reduce costs and improve profits."

Prem Singh Chauhanet al; [2019] [2] "This case study was conducted at an Edible refined oil manufacture company. From this study, Value Added activities, performance rating, the standard time, utilization and recommendation for man power planning could be established. The necessary changes and action were suggested in workplace to minimize the stress creating unproductive and ineffective movements. Brainstorming sessions have been conducted to identify all issues that are causing the loss in worker efficiency. These brainstorming sessions are done within different departments and different level of employees to study all issues, these results could be used for optimization of worker efficiency and time at the company. So, the paper, it is believed, would be great help to those working in the area of efficiency and working environment improvement in manufacturing industry."

Kajal Sejpal et al; [2017] [3] "The objective of this research is to improve the productivity by optimizing certain operations of the manualassembly process of a product in a manufacturing industry. By creating a standard process in manual assembly line time is saved as well as energy of the worker is also saved. This leads to increased units of production and lesser fatigue. In this paper, flow process chart of assembly line of a particular product is studied. The two-hand process chart of selective time-consuming operations is carried out. The time saved and improvement to the operations is noted thus improving the assembly process.

The two-hand process chart helped to identify the critical places where optimization could be done. The process was optimized and by applying the changes 31% improvement in time was achieved. The total cycle time was improved to 53.1 seconds.

III. TWO HANDED PROCESS CHART

Two handed process chart is a process chart in which the activities of a workers hands (or limbs) are recorded in their relationship to one another. Using this method we can improve the current method considering principle of motion economy as a factor.

The terminal fitting process is considered for the two handed process chart in a tubular heater manufacturing.

The present method considers the process done currently in the industry that is doing it one at a time which would involve a lot of idle waiting.

Table 1.1: Two Handed process chart (Current Method)

TWO HANDED PROCESS CHART									Sheet No: 1
	Work Place Layout								
Drawing & part:	Bolt bin			Washer bin			Nut bin		Assembled part bin
Operation:									
Operative:									
Location:				Operator area					
Left hand description	○	⇨	D	▽	○	⇨	D	▽	Right hand description
Reach for Washer from washer bin		•				•			Reach for Bolt form Bolt bin
Grasp the Washer	•				•				Grasp the Bolt
Idle				•		•			Move the Bolt to Operator area
Idle				•	•				Position on Bolt to tube
Idle				•	•				Assemble to tube
Move the Washer to Operator area		•						•	Idle
Position the Washer to bolt	•							•	Idle
Assemble to Bolt	•							•	Idle
Idle				•		•			Reach for nut from Nut bin
Idle				•	•				Grasp the Nut
Idle				•		•			Move the nut to the Operator area
Idle				•	•				Position the Nut to the Bolt
Idle				•	•				Assemble to bolt
Idle				•		•			Move assembly to assembled part bin
Idle				•	•				Release assembly

Reach for Washer from washer bin		•				•			Reach for Bolt form Bolt bin
Grasp the Washer	•				•				Grasp the Bolt
Idle				•		•			Move the Bolt to Operator area
Idle				•	•				Position on Bolt to tube
Idle				•	•				Assemble to tube
Move the Washer to Operator area		•						•	Idle
Position the Washer to bolt	•							•	Idle
Assemble to Bolt	•							•	Idle
Idle				•		•			Reach for nut from Nut bin

TWO HANDED PROCESS CHART									Sheet No: 2
Left hand description	○	⇨	D	▽	○	⇨	D	▽	Right hand description
Idle				●	●				Grasp the Nut
Idle				●		●			Move the nut to the Operator area
Idle				●	●				Position the Nut to the Bolt
Idle				●	●				Assemble to bolt
Idle				●		●			Move assembly to assembled part bin
Idle				●	●				Release assembly

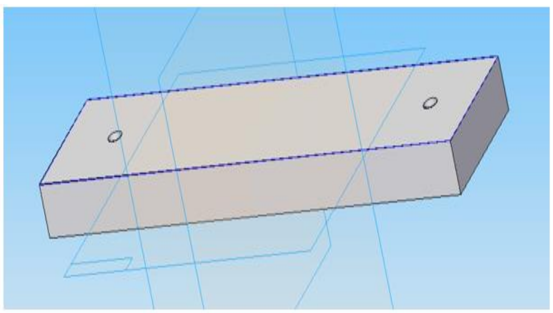

Fig 2 Fixture Design

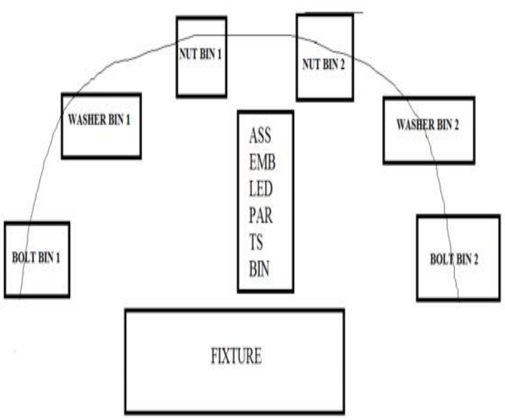

Fig 3: Work Place Layout

Fixture is designed based on the distance required from both the end of the tubes such that there will be smooth movement of both the hands

Table 1.2: Two Handed process chart (Proposed Method)

TWO HANDED PROCESS CHART									Sheet No:
Work Place Layout									
Drawing & part:		Work place layout is given below because it is too big to fit in this space.							
Operation:									
Operative:									
Location:									
Left hand description	○	⇨	D	▽	○	⇨	D	▽	Right hand description
Reach for Bolt in Bolt bin 1		●				●			Reach for Bolt in Bolt bin 2
Grasp the Bolt	●				●				Grasp the Bolt
Move to fixture		●				●			Move to fixture
Position on tube	●				●				Position on tube
Assemble on tube	●				●				Assemble on tube
Reach for Washer in Washer bin 1		●				●			Reach for Washer in Washer bin 2
Grasp Washer	●				●				Grasp Washer
Move to fixture		●				●			Move to fixture
Position on Bolt	●				●				Position on Bolt
Assemble on Bolt	●				●				Assemble on Bolt
Reach for Nut in Nut bin 1		●				●			Reach for Nut in Nut bin 2
Grasp Nut	●				●				Grasp Nut
Move to fixture		●				●			Move to fixture
Position on Bolt	●				●				Position on Bolt
Assemble to Bolt	●				●				Assemble to Bolt
Move the assembly to assembled part		●				●			Move the assembly to assembled part
Release assembly	●				●				Release assembly

Table 1.3: Summary Sheet

Summary					
Method:		Present		Proposed	
		Left Hand	Right Hand	Left Hand	Right Hand
Operations:	○	6	14	10	10
Transportations:	⇨	4	9	7	7
Delays:	D	—	—	—	—
Holds:	▽	19	6	—	—
Total:		29	29	17	17

IV. MULIPLE ACTIVITY CHART

Multiple chart is used to determine the best possible way to improve the present method. Consider 2 cycles, in each cycle the machine can take 6tubes.

We can make a change by expanding the above tray which holds the MgO powder to decrease time for repeatedly climbing and changing the powder and also the two cycles of six tubes can be done at once because the machine can hold 12 tubes but because of amount of MgO powder in the tray only 6 tubes could be used.

Table 1.4 Multiple Activity Chart (Present method)

Present Method				
Chart No	Summary			
Subject charted:		Present	Proposed	Saving
	Cycle Time	(min)		
Process: Filling The Tube with MgO Powder	Worker	5.6		
	Machine	5.6		
	Working			
	Worker	4.8		
	Machine	0.8		
Machine:	Idle			
	Worker	0.8		
	Machine	4.8		
	Utilization			
Operative:	Worker	85.71%		
Date:	Machine	14.29%		

Time(Min)	Worker		Machine
0.25	Operator takes tube from tray	■	□
0.50	Operator places the tube on machine	■	□
1.75	Operator fills the above tray with MgO Powder	■	□
1.85	Operator starts the machine	■	□
2.25	MgO is filled in the tube	□	■
2.55	The tube is taken out	■	□
2.8	Tube is placed in the tray	■	□
3.05	Operator takes tube from tray	■	□
3.3	Operator places the tube on machine	■	□
4.55	Operator fills the above tray with MgO Powder	■	□
4.65	Operator starts the machine	■	□
5.05	MgO is filled in the tube	□	■
5.35	The tube is taken out	■	□
5.6	Tube is placed in the tray	■	□

Table 1.5 Multiple Activity Chart (Proposed method)

Proposed Method				
Chart No	Summary			
Subject charted:		Present	Proposed	Saving
	Cycle Time	(min)		
Process: Filling The Tube with MgO Powder	Worker	5.6	2.3	3.3
	Machine	5.6	2.3	3.3
	Working			
	Worker	4.8	2.0	2.8
	Machine	0.8	0.45	0.35
Machine:	Idle			
	Worker	0.8	0.3	0.5
	Machine	4.8	1.85	2.95
	Utilization			Gain
Operative:	Worker	85.71%	86.96%	1.25%
Date:	Machine	14.29%	19.57%	5.28%

Time(Min)	Worker		Machine
0.25	Operator takes tube from tray	■	□
0.50	Operator places the tube on machine	■	□
1.75	Operator fills the above tray with MgO Powder	■	□
1.85	Operator starts the machine	■	□
2.25	MgO is filled in the tube and Holder is removed one by one	■	■
2.30	Tube is dropped in the tray	■	■

V. TIME STUDY

Time study for the elements are done by taking the elements as the processes in manufacturing the tubular heaters and it is recorded in seconds, by a snapback stopwatch.

Time study was done by using a decimal minute snapback stopwatch, but for interpretation in the below table decimal minute was converted to seconds (For Example: 0.1 minute = 0.1 min × (60 s)/(1 min) = 6.00s).

Consider the performance rating for all elements as 100%, except for bending which is 95%.

Table 1.6: Elements for time study

Element Number	Element Name
1	Taking the tube and cutting it with EG 125 cutter
2	Polishing the tube with a wire to remove dust
3	A coil is wound inside the tube by a winding machine
4	Tube is taken to the filling machine and filled with MgO Powder
5	Rolling of the tube is done
6	Bending the tube to required dimensions
7	Sand Blasting of the tube

Table 1.7 Time study Data

Element Number	Cycles (in Seconds)					Average Observed Time	Basic Time	Allowances		Standard Time
								Fatigue (4%)	Personal (6%)	
1	6	6	5	4	6	5.4	5.4	0.216	0.324	8.316
2	3	2	2	3	3	2.6	2.6	0.104	0.156	3.276
3	2	2	2	2	2	2	2	0.08	0.12	2.4
4	4	4	4	4	4	4	4	0.16	0.24	5.6
5	3	3	3	3	3	3	3	0.12	0.18	3.9
6	16	15	16	15	16	15.6	14.82	0.593	0.889	36.60
7	2	2	3	2	2	2.2	2.2	0.088	0.132	2.44

From the above table it is clear that there is a lot of time consumed in bending the tube into the required dimension and also it reduces the performance of the operator after each bending is done and there is a problem of Shoulder pains for workers after the whole day's work of bending the tube.

Hence due to all these factors, it was decided that a semi-automated bending machine will be designed for solving all the above stated problems and to reduce time in manufacturing the tubular heaters as a whole in a bundle or high number of orders.

The data collected by time study, it was clear that the most time consuming part of the tubular manufacturing is the Bending process. The present equipment for bending the tube not only takes more time but also causes distress to the workers after a certain point of time, which causes is more fatigue and reduction of the speed in which the worker can do the work of bending the machine. Thus the solution to this problem is found in a simple semi-automated bending machine designed for not just reducing time but also will reduce fatigue, the efficiency of the worker will be constant and the quality of the bended product will be constant and good.

VI. DESIGN

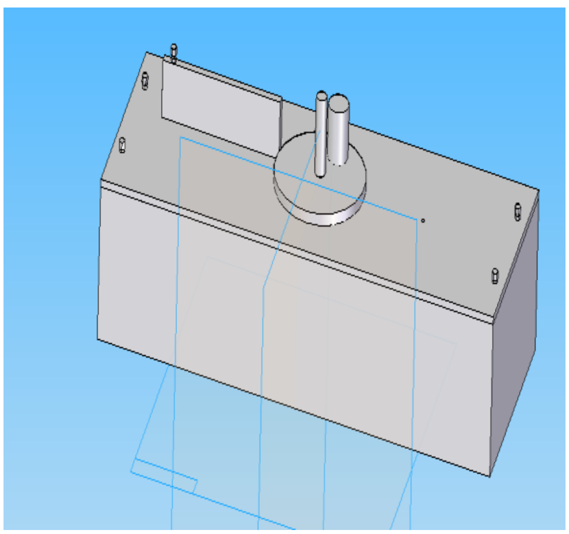

Figure 4. Design of bending machine

The above figure is the depiction of the Complete Assembled Design, it gives the total look of the design after completion of the design and how the part will look in a 3D form of a model.

VII. DESIGN CALCULATION

The design of the semi-automated is as explained in the pages before in detail for the better understanding. Now the major and minor design calculations for the design are as done below.

Considering the largest diameter of tube that can be used for bending in the company as the design parameter of Diameter.

D =11mm

Moment of inertia:

$M = \frac{\Pi}{64} D^4 = \frac{\Pi}{64} (11^4)$

$M = 718.69$ kg/mm^2.

Bending stress:

$\sigma_{max} = \frac{32}{\pi} \frac{M}{D^3} = \frac{32}{\pi} \frac{718.69}{11^3}$

$\sigma_{max} = 5.50$ N/mm^2.

Factor of Safety (FoS):

Consider Factor of Safety as 5 for the design consideration for the material.

Area:

$A = \Pi r^2 = \Pi (5.5^2)$

$A = 95.03$ mm^2.

Force:

F = Stress × Area =5.50 ×95.03

F = 522.665 kgmm/s^2.

Angular Velocity:

$\omega = \frac{\Delta\theta}{t} = \frac{360^0}{2}$

$\omega = 3.14$ rad/sec.

Torque:

$\tau = r \times F = 5.5 \times 522.665$

$\tau = 2{,}874.66$ kg/mm^2.

Power:

$P = \tau \times \omega = 2{,}874.66 \times 3.14$

P = 9,026.42 J/s = 9,026.42 Watts

P = 9.02642 KW.

The motor of specification 9.02 KW is bought from the market and placed into the semi-automated bending machine for rotating the plate.

VIII. RESULTS

1. Two handed process chart helped in making use of both the hand at the same time and thus increasing productivity.
2. Multiple activity chart gave the utilization of man and machine for filling process and making a small change which would affect in decreasing the cycle time of the process.
3. Time study gives the standard time for a person to complete the job which will be useful for future and it also helped in finding a bottleneck in bending process and designing a semi-automated bending machine.

IX. CONCLUSION

Utilizing the time and method studythe productivity can be increased is shown by making some minor and major changes in the jobs or processes which affects in decreasing the time and alsomaking the work easier.

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