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Research Paper

TIME STUDY MODEL OF A COMPACT FLUORESCENT LAMP MANUFACTURER IN INDIA: A CASE STUDY

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This paper focuses on making a time study model for a reputed Compact Fluorescent Lamps (CFL) manufacturing company. Manufacturing companies are finding it difficult to survive with challenges increasing from its competitors day by day. To overcome these challenges they have to improve their productivity, reduce the cycle time and operational cost. The organizations need to manage the production schedule, the work force and labor costs in an effective manner. In order to achieve all these goals Time study is an important tool which needs to be worked out on. The method is applied to the manufacturing processes which have been divided into parts with an objective to establish time standards for carrying out specific operations and setting up a production schedule in the factory. The method of time study was developed by Frederick W Taylor who is considered as the father of Scientific Management. F W Taylor was an industrial engineer and focused on improvement of industrial efficiency. Time study involves various techniques of which Stopwatch technique and Predetermined time standard system (PTSS) are the widely used and the simplest. Although there are various other techniques like flow diagrams, multi- activity charts, operations chart, process flow chart and many more to list. But a using a stopwatch is the simplest way and record the timing on a time study sheet. The results of this time study show that company s output has significantly increased with reduction in cycle time.

Keywords: Manufacturing, Process analysis, Time study, Stop watch technique

INTRODUCTION

Sequence of operations in manufacturing of a compact fluorescent lamp needs to be studied in order to achieve improved efficiency and productivity. Each operation is studied minutely and benchmark time is set up for production scheduling and forecasting.

The first research on work study was carried by F W Taylor in the 1880s with the famous published article "The Principle of Scientific

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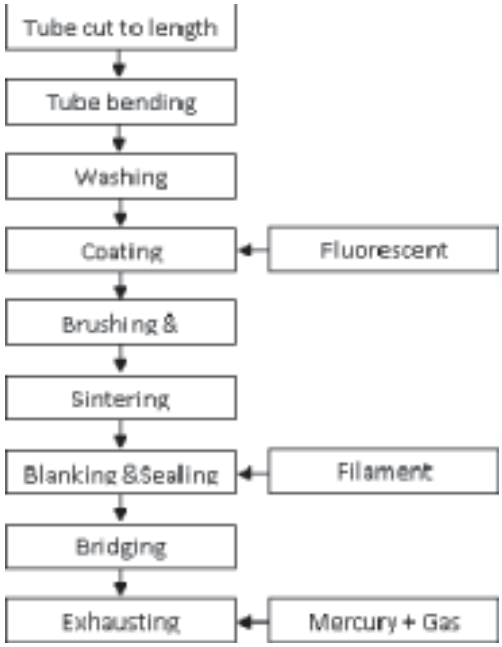
Management" which involved assigning each operation to the best person and training them to do that in the best possible way.

This paper is an attempt to develop a model of time study for the lamp manufacturer company. The company of concern is a top notch in lamp manufacturing having factory at Faridabad city in Haryana state of India. The company manufactures lamps of different varieties viz. Integrated and Non-Integrated lamps, Retrofit and Non-retrofit lamps, in different shapes and sizes and the power of lamp varying from as low as 5 watt to as high up to 85 watts. Every type of lamp moves through two shops before completion viz. Capsule manufacturing shop and the Assembly shop. Here we are taking only Capsule (the Glass part) manufacturing shop into consideration. A capsule is technically a Discharge Tube (DT), so we will be using the same nomenclature hereafter. There are a total of 9 processes and 2 side processes involved in making a complete DT. The sequence of operations has been shown in Figure 1.

In this paper, the matter of concern is the time taken by a number of individual workers in performing the same operation. After collecting values and analyzing them standard times for each process and a complete standard cycle time for the whole process can be established.

Here, an attempt is made with the help of time study to find out the work done by a trained and qualified worker in a fixed period of time. The worker is supposed to perform under some specified conditions, at a specified place and via a pre-standardized method at a certain pace. Allowances are given for certain delays due to various factors (L C Pigage and J L Tucker, 1954). The time taken is known as "time standard" (Aft L S, 2000).

Figure 1: Process Flow Chart of DT Manufacturing Process



The major aim of a time study is to bring the cycle time to an optimum value and control manufacturing costs. Time study provides solutions to various manufacturing related problems like:

1. Determining the number of machines to be deployed.
2. Determining the number of people to be employed.
3. Determining manufacturing costs.
4. Assembly line balancing, work allocation and work cell balancing.
5. Individual worker's performance evaluation.
6. Identifying operations that can create

bottlenecks and look for remedial measures.

7. Identifying the areas of cost reduction.

Advantages of conducting a time study are reduced wastage level and increased productivity. The eight wastes of a manufacturing system are:

1. Transportation, excessive movement
2. Inventory, overstock.
3. Extra movement of body to do the work.
4. Waiting time, people remain idle.
5. Overproduction, sometime leading to rejection.
6. Over Processing, number of unnecessary operations.
7. Time taken in rework and rectifying defects.
8. Time lost in placing and finding things not at right place.

The phases of a time study technique as it has been applied in the current scenario are:

1. Identify the Operation and the Employee to be studied.

This is the first phase of time study series. The person conducting the study has to select the best course of action from those available after gathering ideas from different people. The employee being studied should be made comfortable with the study and should have an idea about it. Also employee's ideas must always be welcomed. It is always ensured that the employee under study is a trained operator and the method of work under study is a standard one.

Gather Information about the Content of the Operation

A record is kept about the method of doing the operation exactly as it was being done when carrying out a time study. This is done so that the work can be reproduced at any time in the future. Details to be recorded include the general information about the operation, description of the workplace, workplace environment, the method being used.

The obtained record is important as it is critical in determining the frequency of operation changes, developing standard time for the operation, training of other operators according to the standard method enabling them to meet standard times. If the information is not recorded properly, the standard time would not be accurate. Two things need to be assured about the information gathered before considering it to be complete: Whether the operation can be reproduced from the described method and whether the operation includes every detail about the activities of the worker. This is illustrated for operation performed on glass tube cutting machine in a DT manufacturing process in Annex A.

Breaking up the Operation into Elements

In this step operation is broken into pieces and time for each part is to be specified. For breaking a operation into elements some guidelines may be developed to maintain uniformity in the recorded times.

Some of these can be: Homogeneity should be made between content of each element, Man time and machine time should be considered as different elements, each element should either have a constant or a relative value of time. However due to variation in the size of the operation there may be variations in time value of same element. Each element should be allocated a fixed start and end point as far as possible so the stopwatch can be read at correct time every time the element occurs. Table in Annex B illustrates a operation on tube cutting machine broken into elements.

Recording Time for each Operation

After the operation elements have been identified and broken up into adequate number of elements time values are recorded for each element using a stopwatch. Before conducting the study it should be made clear whether which method of stopwatch reading to be used and what is the adequate number of time values required to reach at a conclusion.

There are two methods of stopwatch reading: Continuous reading and Snapback or repetitive reading. The two methods are described in further portion with proper illustrations.

a) Continuous Reading

Stopwatch starts as the operation begins with the first operation and continues till the end of the operation. Time value is recorded on a study sheet at the end of each element. After each element the recorded value is written down in the 'R' column of the time study sheet and the watch continues to run till the end of the operation. The values in the R column are subtracted from subsequent values and the subtracted time value is placed in the T column, this is the actual recorded time for each element. This has been illustrated in Annex C1.

b) Snapback Reading

With the beginning of the operation stopwatch is started and set to zero after time value for first element has been recorded. The same process is repeated and the watch is set to zero every time a value for an element is recorded. Thus the time values obtained every time are for a single element. These time values are directly placed in the T column of the time study sheet, unlike in the continuous reading method. This has been illustrated with a time study table as in Annex C2.

The second thing to be assured is that what should be the number of time values to be recorded to reach at a conclusion.

Either it can be done that time is recorded for each and every part produced. But in organizations who are involved in mass production, as the one taken into consideration, it is impossible to record time values for thousands of operations each and every time.

So a reasonable sample of time values is taken when the person is assured that it is sufficient to get a standard time value with the help of statistical calculations. This second method (Snapback reading) is widely used and also being employed in this case too.

Calculate the Average Time for a Operation by a Certain Operator

The time values obtained during the study show

some variation among them. Some of them are too high and some are too low then the expected values, such values are called 'abnormal' time values. All time values have to be taken into consideration in determining the average time of an operation by a particular operator. The average time has been calculated in Annex D.

Calculate the Base Time by Rating or Leveling

Although the average time has been calculated and standard time is fixed for the job, yet it is not sure that two or more operators working separately would be able to complete the operation at the same pace and within the specified time limit. During time study it is assumed that an operator that has been trained for the particular task would be able to do in the specified standard time at a certain pace, under certain conditions and through a certain method.

The method of comparing the pace of working of different operators performing same operation with the expected pace of an operator for that particular job is called Rating or Leveling. Rating of employees is an approach to relate the observed performance and what is expected from a certain operator who has been assigned for a particular operation. The base times for the calculated values of average time for each operation is shown in Annex D.

Applying Allowances to the Base Time

There are always interruptions in work due to some unavoidable causes. These interruptions cause delays which may be minor or for a long time. The long time delays and their causes can easily be identified and recorded but problem arises in the case of very short term delays i.e. minor delays which are difficult to be recorded. Delays that are natural or due to the nature of the work cannot be enforced on the operator. Hence allowances are provided for each type of such delays. Rules should be made in the time study regarding which type of allowances should be considered for allowances. Total work time in a shift consists of net production time and the delays, and the delay time is related to the total work time for every element and for every production system. The allowances for delays can be determined by a rigorous time study conducted on the element. There are also certain standard tables from which values for allowances can directly be taken but these values are not equally applicable in each and every case. Already having calculated the base time for each element of an operation we can determine the percentage allowances for each element according to the formula:

$$\text{Percentage allowance} = \frac{\text{delay time}}{\text{net production time}} \times 100$$

Then we have the standard time allowed as per the formula:

Standard time = base time

x (1+ percentage allowance)

The application of these two formulae has been depicted in Annex D.

Applying the Standard Time Values

This is the most important step of a time study.

Whatever has been explored in the previous steps has to be finally drafted and implemented in this step. The standardization of time values is a matter of great importance as it should not affect the working environment of the organization and should not cultivate a feeling of negation among the operators. They should not have a sense of feeling that restrictions are being imposed on them or they are being bound. Such conditions arise because the operators do not have the knowledge of whatever is going on.

So they should be made familiar about the results of the time study and should be ensured that they understand the value of these results for the improvement of the process.

A policy is formed which defines what standard time is, defines the responsibilities of person applying these standard times, the procedure of study how these standard time values have been calculated should be mentioned in the policy. The method for implementing the standard methods of working and standard time values need to be mentioned in the policy and under what circumstances these time values and standard method can be changed or modified should also be given due consideration.

Annex E shows a complete time study sheet after applying standard time values.

The standard allowed time values for different processes are shown in the following Table 1.

And the total transportation and waiting time between different stations is given in the following Table 2.

Table 1: Process Time

Process	Allowed Time (s)
Cutting	51
Bending	21
Coating	617
Brushing and Wiping	120
Sintering	840
Blanking and Sealing	250
Bridging	18
Exhausting	25
Total	1942

Table 2: Idle Cycle Time

Transportation and Storage	Allowed Time (s)
Cutting to Bending	90
Bending to Coating	436
Coating to brushing	75
Wiping to Sintering	280
Sintering to Blanking	125
Sealing to Bridging	110
Bridging to Exhaust	145
Filament section to Sealing	330
Total	1591

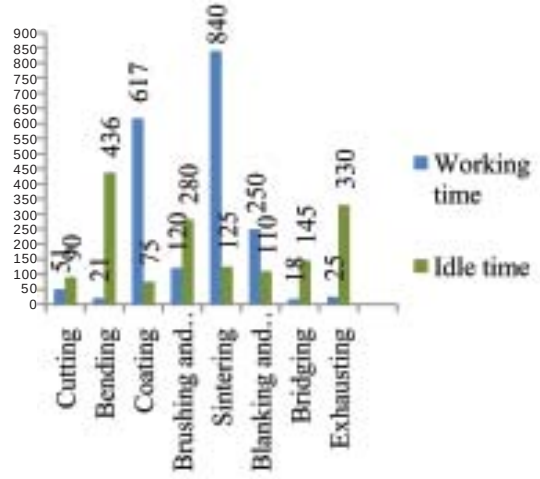
It is clear from the above tables that total working time in the process is 1942 second while the total transportation time of 1592 second nearly equals to the working time. The transportation time between stations is almost forty five percent of the total process time which may sometime lead to overstock of material at one station, while the other stations are running idle. This works as bottleneck in the

process resulting in a deterred production level.

Total working time versus idle time as percentage of cycle time;

Figure 2: Station Wise Working Time Versus Idle Time

Figure 3: Idle Cycle Time Versus Process Time



CONCLUSION

Time study in the above mentioned case has revealed the status of cycle time and is an attempt to show how cycle time can affect the overall productivity of the organization. Various methods employed in a time study have been represented in the paper. It can be concluded that the process cycle time can be improved by removing certain unacceptable and needless processes and movements. These time values may be due to unwanted handling and storage or during transportation of material between different stations. These studies prove to be useful at the time of appraisal or for awarding incentives or bonuses to the employees. However at times employees who are not aware of the benefits of the study refrain it.

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ANNEXURE A

Time Study Sheet - Operation Description

Operation	**Tube Bending**	**Department**	**DT Production**
Operation no.	1		
Operator	_____		
Machine	Tube bending machine		
Studied by	_____	Date and time	_____
Approved by	_____	Date and time	_____

Drawing	**Notice**
	

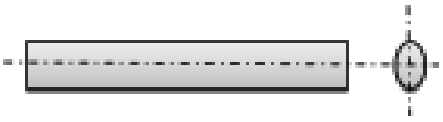
Element no.	**Operation Description**		**Allowed Time**
	Left hand	**Right hand**	
	Pick up glass tubes	Hold the tubes horizontal.	
	Place the tubes in the hopper	Hold the tubes.	
	Turn the machine on	Idle	
	Lift the stopper	Release tubes	
	Pick uncut tubes from machine bed	Pick uncut tubes from machine bed	
	Unload tubes	Unload tubes	

ANNEXURE B

Time Study Sheet - Elements of Operation

Operation	**Tube Bending**	**Department**	**DT Production**
Operation no.	1		
Operator	_____		
Machine	Tube bending machine		
Studied by	_____	Date and time	_____
Approved by	_____	Date and time	_____

ANNEXURE B (CONT.)

Drawing	Notice
	Notes Allowed time values are in seconds for simplicity.

Element no.	Operation Description		Allowed Time
	Left hand	**Right hand**	
1	Pick up glass tubes	Hold the tubes horizontal.	
2	Place the tubes in the hopper	Hold the tubes.	
3	Turn the machine on	Idle	
4	Lift the stopper	Release tubes	
5	Pick uncut tubes from machine bed	Pick uncut tubes from machine bed	
6	Unload tubes	Unload tubes	

APPENDIX C1

Time Study Sheet - Continuous Stopwatch Reading

Page	1 of 2	Endpoint of elements
Start study	_____	
End study	_____	

Notes		**1**		**2**		**3**		**4**		**5**		**6**	
		T	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**
1. Time values have been converted to seconds for easy understanding.	1	11	11	7	18	3	21	2	23	18	41	9	50
	2	11	61	8	69	3	72	3	75	18	93	8	101
2. Few values have been shown for illustration.	3	13	114	8	122	3	125	2	127	17	144	9	153
	4	12	165	7	172	2	174	2	176	18	194	9	203

Summary

Total of "T"					
No. of observatons					
Average "T"					
Rating					
Base time					
Percentage allowance					
Allowed Time					

APPENDIX C2

Time Study Sheet- Snapback Stopwatch Reading													
Page Start study End study	1 of 2 _____ _____	Endpoint of elements											
Notes		**1**		**2**		**3**		**4**		**5**		**6**	
		T	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**
1. Time values have been converted to seconds for easy understanding. 2. Few values have been shown for illustration.	1	11		7		3		2		18		9	
	2	11		8		3		3		18		8	
	3	13		8		3		2		17		9	
	4	12		7		2		2		18		9	

Summary						
Total of "T"						
No. of observatons						
Average "T"						
Rating						
Base time						
Percentage allowance						
Allowed Time						

APPENDIX D

Time Study Sheet													
Page Start study End study	1 of 2 _____ _____	Endpoint of elements											
Notes		**1**		**2**		**3**		**4**		**5**		**6**	
		T	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**
1. Time values have been converted to seconds for easy understanding. 2. Few values have been shown for illustration.s	1	11		7		3		2		18		9	
	2	11		8		3		3		18		8	
	3	13		8		3		2		17		9	
	4	12		7		2		2		18		9	

APPENDIX D (CONT.)

Summary						
Total of "T"	47	30	11	9	72	35
No. of observatons	4	4	4	4	4	4
Average "T"	11.75	7.5	2.75	2.25	18	8.75
Rating	98	88	137.5	112.5	100	97
Base time	12	8	2	2	18	9
Percentage allowance	4	4	2	2	4	2
Allowed Time	12.48	8.32	2.04	2.04	18.72	9.18

ANNEXURE E

Time Study Sheet - Elements of Operation

Operation	**Tube Bending**	**Department**	**DT Production**
Operation no.	1		
Operator	_____		
Machine	Tube bending machine		
Studied by	_____	Date and time	_____
Approved by	_____	Date and time	_____

Drawing	Notice
	

Element no.	Operation Description		Allowed Time
	Left hand	**Right hand**	
1	Pick up glass tubes	Hold the tubes horizontal.	12.48
2	Place the tubes in the hopper	Hold the tubes.	8.32
3	Turn the machine on	Idle	2.04
4	Lift the stopper	Release tubes	2.04
5	Pick uncut tubes from machine bed	Pick uncut tubes from machine bed	18.72
6	Unload tubes	Unload tubes	9.18