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Time and Motion Study Methods for Manufacturing a Pump

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***Abstract*— The purpose of the study was to compare conventional time study method and MOST analysis on oil pump assembly in a manufacturing company. The results showed that the time study resulted in 0.239 minutes and MOST resulted in 0.18 minutes.**

***Index Terms*— Time Study, MOST, Motion Study, Cycle, Operation.**

I. INTRODUCTION

Time and motion study is a business efficiency method that has been generally used to develop and advance a work system [7] [3]. Time study requires a direct and constant observation of a job or task to measure the time engaged to complete a task using a stopwatch. It is employed 1) when there are repetitive work cycles, 2) when a different sub-task is performed [1][2][5];. The analyzed operation in this study was the assembly of an oil pump consisting of a tube, screen sub-assembly, and pump with a performance rating of 110% (task 2). Each cycle was broken down into four different elements and each of these was timed using a continuous timing method and the MOST method. The breakdown of the elements and breakpoints were all determined using visual cues.

II. PROCEDURE

A. Description of Elements

1. Operator retrieves part and inserts it into machine.
2. Picks up second part and inserts it into machine.
3. Operator waits for machine to finish and grasps piece to insert into machine when machine is finished.
4. Retrieves finished piece, inserts bit into machine, and drops finished piece into bin.

B. Description of Breakpoints

Breakpoints were identified for each of the above elements as below:

End/Start Breakpoint→ Operator drops finished piece into bin

Element 1
Breakpoint→ Operator lets go of piece after inserting it into machine

Element 2
Breakpoint→ Operators hand leaves start button

Element 3
Breakpoint→Operators hand leaves stop button

Element 4
End/Start Breakpoint

III. RESULTS

A. Time Study

Data was collected for each four elements for five cycles using a time study sheet. A confidence interval of 90% was set with a mean average error of 15%. After collecting data for 5 cycles, an n-value was calculated for each element using the formula:

$$n = \left[\frac{(t)(s)}{k\bar{x}} \right]^2$$

Where t = t distribution value = 2.132 (for d.o.f = 4; α = 0.10)

S = standard deviation
K = error estimate = 0.15
X = mean average value

Below is a summary of the data that was collected:

Table 1: No Outliers in the data since all values are less than 0.642

Dixon Test (n = 5, Q = 0.642 and n=4, Q = .765)					
	Element 1	Element 2	Element 3	Element 4	Cycle Time
	0.04533	0.04316	0.04433	0.03616	0.17733
	0.04666	0.04316	0.0455	0.0385	0.182
	0.057	0.04666	0.0455	0.03966	0.18883
	0.05933	0.05016	0.04566	0.03966	0.19116
	0.064	0.0525	0.04783	0.041	0.1925
min	0.07142	7.4E-16	0.33333	0.48275	0.30769
max	0.25	0.25	0.61904	0.27586	0.08792

Based on the above observations, we can see that for element 1 we obtained an n-value of 4.5, therefore didn't need to perform any more iterations. Therefore, we were able to calculate the standard time for the operation.

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Table 2: Times for each element in minutes

	Element 1	Element 2	Element 3	Element 4	Cycle Time
Cycle 1	0.045333	0.043167	0.047833	0.041	0.1773333
Cycle 2	0.064	0.043167	0.045667	0.039667	0.1925
Cycle 3	0.059333	0.046667	0.044333	0.0385	0.188833
Cycle 4	0.057	0.0525	0.0455	0.036167	0.191167
Cycle 5	0.046667	0.050167	0.0455	0.039667	0.182
Averages	0.054467	0.047133	0.045767	0.039	0.186367
Std Dev	0.008143	0.004174	0.001273	0.001814	
n	4.515612	1.584306	0.156192	0.437198	

B. Standard Time

Since we know that our data is accurate and in the range of the desired confidence interval, we used this number to determine the standard time for this operation. We knew that we needed to give a 17% allowance to the operators with a 110% performance rating. Therefore, the standard time is: **(0.186 minutes x 1.10) x 1.17 = 0.239 minutes**.

C.MOST Method

The MOST codes were applied on the same elements described above to compare the calculated standard time. The detailed breakdowns of the MOST codes were found to be as:

1. Operator retrieves part and inserts it into machine.
   $\mathbf{A_1B_0G_1}$ $\mathbf{A_1B_0P_3}$ $\mathbf{A_0}$ This MOST code signifies the motion of reaching for the first part and placing it into the machine and reaching for the next task.
   Total TMU's for this element = 60 TMU's
2. Picks up second part and inserts it into machine.
   $\mathbf{A_1B_0G_1}$ $\mathbf{A_1B_0P_3}$ $\mathbf{A_0}$ This MOST code signifies the motion of picking up the second part and placing it into the machine and reaching for the next task.
   Total TMU's for this element = 60 TMU's
3. Operator waits for machine to finish and grasps piece to insert into machine when machine is finished.
   $\mathbf{A_1B_0G_1}$ $\mathbf{M_1X_3I_0}$ $\mathbf{A_0}$ This MOST code signifies the motion of the operator for pressing the start button and a process time of 1.5 seconds of the machine on the part while the operator grasps the piece to be inserted into the machine.
   There wasn't a separate MOST code for piece that the operator grasps for inserting into the machine because this motion occurred simultaneously while the machine was processing the part, hence to avoid double counting only the machine process time (X_3) was used.
   Total TMU's for this element = 60 TMU's
4. Retrieves finished piece, inserts the part into machine, and drops finished piece into bin.
   $\mathbf{A_1B_0G_3}$ $\mathbf{A_0B_0P_1}$ $\mathbf{A_0}$ This MOST code signifies the motion of the operator removing the processed part from the machine and placing it aside in the bin and reaching for the next task.

$\mathbf{A_0B_0G_0}$ $\mathbf{A_1B_0P_6}$ $\mathbf{A_0}$ This MOST code signifies the motion of the operator placing the piece grabbed in element 3 into the machine and returning to rest position. This motion assumes that the piece to be inserted into the machine is already in the hand of the operator hence there wasn't any get motion (that is, it was $\mathbf{A_0B_0G_0}$)
Total TMU's for this element = 120 TMU's

Therefore to find the total time based on the MOST study, each element TMU's were summed which was found to be as 60+60+60+120 = **300 TMU's = 0.18 Minutes.**

IV. Conclusions

There were few to no variables that hindered some of the collected data. The worker performing the task worked at a very efficient pace; there was minimal error during his cycles. The worker worked at a rate were there was minimal idle time between tasks, there was a constant feed of un-milled caps, so whenever un-milled caps were placed in the machine two more filled the place of the previous caps. Instead of a critique for this particular workstation, the manufacturing company should applaud the performance of their worker, and the efficiency of their operations at this point in time.

If one, were to provide suggestions on how to improve these operations, I would suggest the company to take a more ergonomic approach when assigning these type of tasks. Provide mats for the workers to work on to help relieve stress and strain from areas such as the knees and other parts of the legs. Also, if the company would like to alleviate some of the movement of the worker, they could move the machines next to each other. Place the conveyor belts in between each machine, so movement would be strictly from the torso and up. Scheduling breaks and maybe supply a water station nearby to cut down fatigue on the workers body.

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