International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume 4, Issue 4, July2016

Time and Motion Study of Oil Pump Assembly

Sukwon Kim, Ph.D

Abstract—**The purpose of this study was to recommend the improvement methodologies for the productivity of oil pump in a manufacturing company. Any manufacturing company should use its resources in an efficient manner thus improving productivity and minimizing cost. The original time study and the MOST were used to evaluate oil pump assembly. The results showed that MOST resulted in 12.60sec and the time study resulted in 14.30sec.**

Index Terms—**Time study, MOST, Efficiency, Machine cycle, Motion study**

I. INTRODUCTION

Time and motion study is a management efficiency technique that has been widely employed to improve and upgrade work systems (Zandin, 2001; Payne et al., 2006). Time study is a direct and continuous observation of a job or task to record the time taken to accomplish a task using a stopwatch. It is often used 1) when there are repetitive work cycles, 2) when a different sub-task is performed (Groover, 2007; Krenn, 2011; Salvency, 2001).

In this particular operation the worker assembled additional parts to a tube and screen sub-assembly. The worker grabs this piece from his right and places it into a special fixture onto the machine. Following, he obtains a pump from his left and places it onto the fixture with the tub and screen sub-assembly as well. He then presses the palm buttons to activate the machine which assembles the pump and screw to the tube assembly.

As the machine cycles, the operator obtains a screw and waits for the machine to finish running. Upon completion, the operator removes the completed assembly with one hand and positions the screw onto the fixture with the other. The completed assembly is placed into a bin on his right, and then the operator starts the whole process again.

II. ELEMENT DESCRIPTIONS

Element 1: Load tube and screen – The worker reaches to the right and grabs the tube and screen from the counter.

Element 2: Load oil pump – The worker reaches to the left and grabs the oil pump from a box and places it on the fixture.

Element 3: Install oil pump, install screw simultaneously– The worker uses the machine to assemble the oil pump to the tube and screen.

Manuscript received July 15,2016.

Sukwon Kim, Ph.D,,Department of Physical Education,Chonbuk National University, Jeon-ju City, South Korea

,

Element 4: Dispose assembly – The worker places the completed assembly and puts it in the box to the right.

III. ELEMENT BREAKDOWN

Element 1: Start – Hands releasing the assembly in the box
End – Hands release the tube and screen after it is placed on the fixture.

Element 2: Start – Hands release the tube and screen after it is placed on the fixture
End – Hands leaving the oil pump after it is placed on the fixture

Element 3: Start – Hands leaving the oil pump after it is placed on the fixture
End – The sound of the machine ends

Element 4: Start – The sound of the machine ends
End – Hands releasing the assembly in the box

IV. DATA / CALCULATIONS

Collected data was used to create charts using excel. The group took 5 elemental snap back times and used the functions on excel to calculate the observed time and the standard deviation.

Table 1: Recorded time for all elements for an entire 5 cycles

	Time (Seconds)				
		Element 1	Element 2	Element 3	Element 4
Cycles	1	3.4	2.4	2.6	2.5
	2	3.4	1.8	2.5	3.2
	3	3.3	2.6	3.0	2.8
	4	2.9	2.2	2.6	2.8
	5	3.9	2.5	2.7	2.8
	Observed Time	3.4	2.3	2.7	2.8
	Standard Dev	0.238047614	0.341565026	0.221735578	0.287228132

These observed times were used to calculate the required number of cycles needed to meet the desired levels of confidence and accuracy. This was done using the equation shown below. Assumptions were; 95% confidence interval and 15 percent error. $T_{0.05,5}$ = 2.776 and K= .15.

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

Table 2: Calculated additional cycles required

Element	Xbar	Standard Dev	Cycles	n
1	3.4	0.35637	3.763	4
2	2.3	0.316227766	6.4744	7
3	2.7	0.1923538	1.738	2
4	2.8	0.248998	2.7085	3

The table above shows the calculated values. A total of 7 cycles were needed, so an additional 2 cycles had to be recorded.

Table 3: Additional 2 cycles

	Time (Seconds)				
Cycles		Element 1	Element 2	Element 3	Element 4
	1	3.4	2.4	2.6	2.5
	2	3.4	1.8	2.5	3.2
	3	3.3	2.6	3.0	2.8
	4	2.9	2.2	2.6	2.8
	5	3.9	2.5	2.7	2.8
	6	2.9	2.3	3.0	2.7
	7	3.1	2.2	2.8	2.6

Once there were 7 cycle times, the group used the Dixon test to identify and remove the outliers.

Table 4: Dixon test

	Element 1	Element 2	Element 3	Element 4
	2.9	1.8	2.5	2.5
	2.9	2.2	2.6	2.6
	3.1	2.2	2.6	2.7
	3.3	2.3	2.7	2.8
	3.4	2.4	2.8	2.8
	3.4	2.5	3.0	2.8
	3.9	2.6	3.0	3.2
Dixon Max1	0.5	0.1	0.0	0.6
Dixon Min1	0.0	0.5	0.2	0.3
Dixon Max2	0	0.25	0	0
Dixon Min2	0	0	0.2	0.33

Since the N-value was between 3-7, the formulas needed were:

If Largest is Suspect: $\frac{x_n - x_{n-1}}{x_n - x_1}$

If Smallest is Suspect: $\frac{x_2 - x_1}{x_n - x_1}$

Once the outliers were removed, the standard time for the job was calculated.

Table 4: Standard time for the job

	Element 1	Element 2	Element 3	Element 4
1	3.4	2.4	2.6	2.5
2	3.4	1.8	2.5	3.2
3	3.3	2.6	3.0	2.8
4	2.9	2.2	2.6	2.8
5	3.9	2.5	2.7	2.8
6	2.9	2.3	3.0	2.7
7	3.1	2.2	2.8	2.6
Observed Time	3.17	2.37	2.7	2.7
Normal Time	3.483333	2.603333333	3.017142857	2.97
Standard Time	4.0755	3.0459	3.530057143	3.4749

Standard times were added up to calculate the Standard time for the job = 14.13 seconds.

V. MOST ANALYSIS

The Maynard Operation Sequence Technique (MOST) was used to analyze the motions of the worker and compare the results with that of the stopwatch time study. The breakdown for the individual elements that was used for the stopwatch time study was also used for the MOST analysis. Each of the previously noted elements was then broken down to its sequence model, which is shown in the table below:

Table 5: Elements broken down to its sequence model

Element #:	Method:	Sequence Model:	Fr	TMU
1	Load tube and screen	$A_1 B_0 G_3$ $A_1 B_0 P_3 A_o$	8	80
2	Load oil pump	$A_1 B_o G_1$ $A_1 B_o P_3 A_o$	6	60
3	Install oil pump, install screw simultaneously	$A_1 B_o G_1$ $M_1 X_6 Io A_0$ $A_1 B_o G_1$ $A_1 B_o P_3 A_o$	9 6	90 60
4	Dispose assembly	$A_1 B_o G_3$ $A_1 B_o P_1 A_o$	6	60
		Total:	**35**	**350**

The TMU's were calculated as shown, then converted to seconds for easier comparison to the stopwatch time study:

350 TMU x .036 seconds = 12.60 seconds

The stopwatch time study yielded an average cycle time of 14.13 seconds, which is a difference of 1.17 seconds from the MOST technique. Some of this difference can be attributed to the delayed reaction time when using a stopwatch to measure the time required for each element and also to the fact that the worker may not have been experienced enough to be considered an "expert", which is what the MOST analysis is intended to model.

V. CONCLUSION

Both techniques used to analyze the worker's task and its required motions yielded similar results with a difference of just over one second between the two studies. It should be noted that accounting for an allowance factor increased the total cycle time found using the stopwatch time study and was not included in the MOST analysis (Tuan, 2014). This difference could have created some of the time difference between the two methods. The inclusion of the screw installation in the MOST analysis could have also changed the results of the MOST analysis because this particular task was completing during the machine processing time, which was also considered in the MOST analysis, therefore including that segment of time twice. This may or may not have been the best way the model that portion of the overall task.

There are also some improvements that could be made should this process be replicated. The elemental breakdown used for the stopwatch time study may not have been the ideal breakdown to use for MOST analysis (Tuan, 2014), and different breakdowns should be considered (Yadav, 2013; Gupta and Chandrawat, 2012). The stopwatch that was used was simply an application on a touch screen phone and a standard stopwatch equipped with buttons and lap timer would be much more appropriate and would likely produce more accurate results.

ACKNOWLEDGEMENT

This research was supported by "Research Base Construction Fund Support Program" funded by Chonbuk National University in 2016.

REFERENCE

1) Zandin, K. (2001). Maynard's Industrial Engineering Handbook [Hardcover] fifth edition, McGraw-Hill, New York, NY,Section 4, Chapter1, p.2.

2) Payne, S.C., Youngcourt, S.S. &Watrous, K.M. (2006). 'Portrayals of F.W. Taylor Across Textbooks', Journal of Management History, vol. 12, no. 4, pp. 385-407

3) Salvendy, G (Ed.) (2001). Hand of Industrial Engineering: Technology and Operations Management, third edition, John Wiley & Sons, Hoboken, NJ, Section IV.C, Chapter 54.

4) Groover, M.P.(2007). Work Systems: the methods, measurement and management of work, Prentice Hall.

5) Krenn, M.(2011). From Scientific Management to Homemaking: Lillian M. Gilbreth's Contributions to the Development of Management Thought, Management &Organisational History, vol. 6, no. 2, pp. 145-161.

6) Tuan S. T. (2014). Improvement of workflow and productivity through application of MOST, Proceedings of the 2014 International Conference on Industrial engineering and Operations Management, Bali, Indonesia, January7-9, 2014.

7) Yadav T.K. (2013). Measurement Time Method for Engine Assembly Line with Help of Maynard Operating SequencingTechnique (MOST), International Journal Of Innovations In Engineering And Technology (IJIET), vol. 2,no.2.

8) Gupta, M. P. K., and Chandrawat, M. S. S. (2012) To improve work force productivity in a medium size manufacturing enterprise by MOST Technique, IOSR Journal of Engineering (IOSRJEN), Vol. 2, no.10, pp. 08-15.

