Wasted Motion – The Basics of Conducting a Motion/Time Assessment at Your Facility

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The most important goal in lean management is the elimination of waste in the production process and any related business activity. But how can you know for sure that your current process is as efficient as possible? The answer is to conduct a motion/time assessment of your work flow.

When attempting to improve the production process, the focus should be on documenting, analyzing and implementing changes to the activities in analysis so that the safety of the workers, the productivity, and the quality of the end-product will increase.

A work study includes two elements: a motion study and a time study. A motion study is conducted with the goal to eliminate or improve unnecessary elements that could be impacting critical productivity, safety and quality metrics. A motion study must be made before the time study, for it would be a waste of resources to determine time standards for poorly designed jobs.

In a motion study, the analyst is challenged to break down the process's activities into tasks and the tasks into steps so all specific movements the worker performs are documented and properly classify as value-added and non-valued-added activities. In most cases the level of analysis goes down to each movement (of every hand) the worker needs to perform to complete a task, and usually these tasks are repetitive. A well-conducted motion study will allow the analyst to develop standard working procedures that can be easily followed by any the worker.

A time study requires the analysis to determine the time that it takes to complete a specific process, activity, task or step. A time study is a critical component in determining throughput, cycle times, cost allocation, lead times, idle times, line balancing, and in general any other performance metric based on time metrics. In conducting a time study some

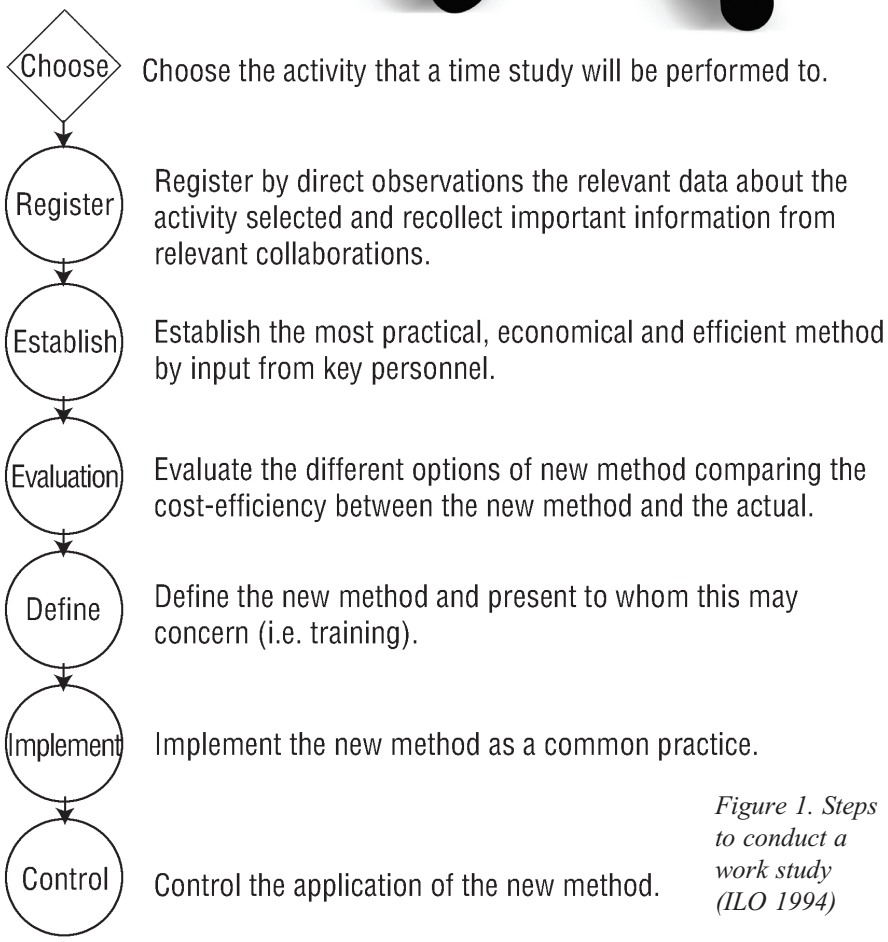

Figure 1. Steps to conduct a work study (ILO 1994)

basic knowledge of statistics is required including the mean, standard deviation, and confidence intervals. In most cases, process times are considered to be normally distributed so the use and interpretation of the normal standard distribution is also required. This knowledge will help the analyst to get a better estimate of the number of samples required to conduct a statistically valid time study.

Figure 1 shows the required steps to perform a work study. Once the motion and time study are performed the next step is to keep the performance of the operation or activity under control. While the motion study facilitates the elimination of wasted motion from the process, the time study will help to keep the cost under control. There are few recommendations that need to be followed in order to perform a successful work study. Figure 1 explains the proper process to conduct a proper study and analysis.

In most cases, workers will be aware of your presence. This could make them nervous and thereby negatively impact the study. Before you start the work study, make sure the workers are aware and explain what you will be doing.

Ask workers to perform their tasks on a normal pace.

Prepare the proper forms required to capture data. In most cases, the analyst will only need a clipboard and a stop watch.

Frequently cameras for pictures and video taking are very good tools for documenting the process for further analysis.

Figure 2 shows a visual form that can be used for a motion study. The symbols and classification of the operations needs to be previously defined by the analyst.

Example of Registering using Bimanual Diagram

1. Define Symbols
2. Graph the activity
3. Do a visual representation

The form in Figure 2 is a recommended for performing a bimanual motion study. In addition, operations can be easily separated into value-added and non-value-added activities (productive and unproductive). By observing the operation and using this form to document every step, the analyst should be able to identify excessive waste and potential areas to improve the operation.

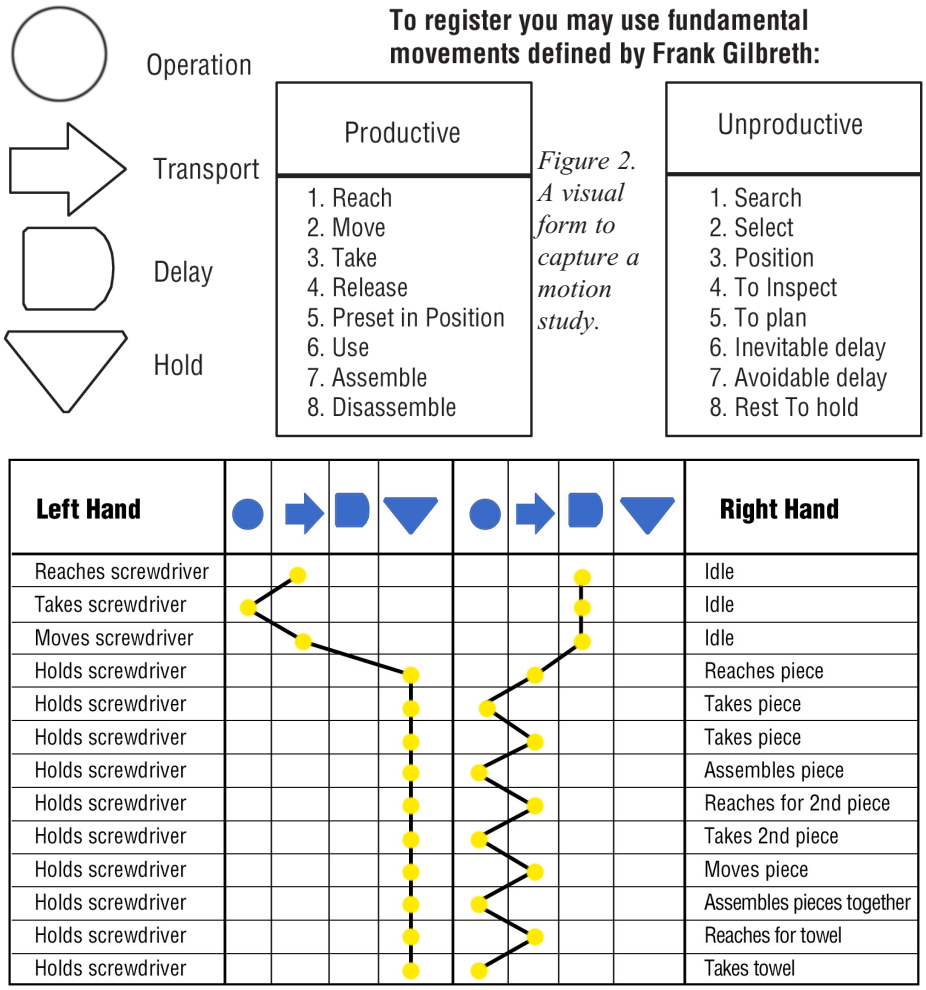

Figure 2. A visual form to capture a motion study.

As mentioned before, a time study covers a series of techniques aimed to determine a standard time for a specific activity or task. In essence, this is the time required to produce a product at a work station with three conditions: 1.) a qualified, well-trained operator, 2.) working at a normal pace and 3.) doing a specific task. A time standard is used to determine certain variables in the manufacturing process:

- Cycle times
- Lead times
- Manufacturing costs (labor and machine cost)
- Number of machines to buy
- Number of operators required
- Scheduling and coordination of machines, operations and people

Figure 3 shows the procedure to conduct a stopwatch time study. The stopwatch method is the most utilized method for time study. The description of each step is as follows (Meyers and Stewart 2002):

1. When selecting an activity or job to conduct a time study consider the following:

- If several people perform the same job, select at least three of them.
- Do not select the fastest or the slowest person, nor anyone with negative attitudes.

2. Get a full description of the job, its purpose and all materials and tools involved. Make sure the method is the standard and right method and verify quality is performing well.

3. When dividing the job, consider the following:

- Elements should be as small as possible, but not less than 0.030 minutes nor larger than 0.200 minutes.
- It´s better to have too much elements than too few.
- Separate machine-controlled elements from operator-controlled elements.
- Beginning and ending points should be easily described.

4. Perform the measurement using a timing device. Decide between continuous or snapback method. In continuous,

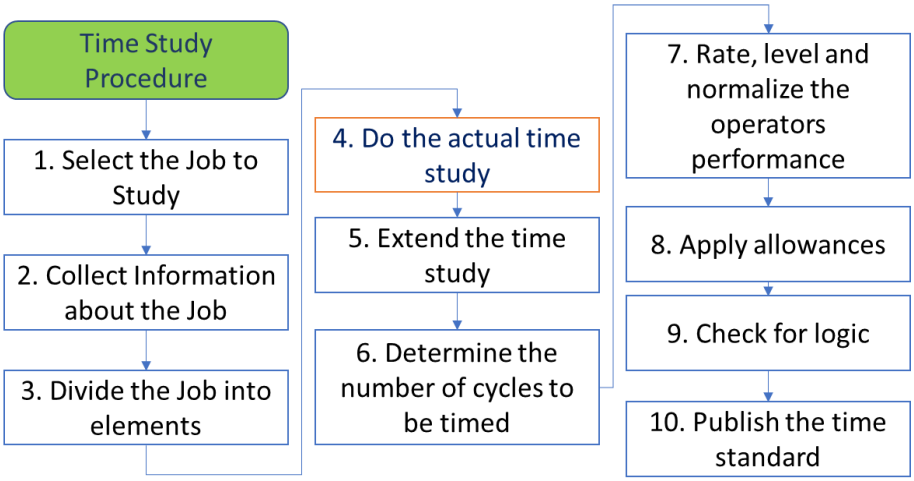

Figure 3. Procedure to conduct a stopwatch time study.

time is cumulative, in snapback, time is reset for each measurement.

5. Compute the normal time, the frequency and unit normal time as follows:

$$Normal\ time = Average\ time \times \frac{\%rating}{100}$$

%Rating is your estimation of how fast the operator was performing, when 100% is normal pace.

Frequency is how often the task is performed. If one out of every 10 parts is inspected, then 1/10 is the frequency.

$$Unit\ Normal\ time = Normal\ time \times Frequency$$

6. Determine the number of cycles to be timed as follows:

$$Number\ of\ cycles = \left(\frac{zs}{e\bar{T}}\right)^2$$

z: the number of standard distributions from the mean reflecting a measure of statistical confidence. For example, if the analyst wants a 95% confidence

s: is the sample standard deviation from the first sample time study

$$s = \sqrt{\frac{\sum(t_i - \bar{T})^2}{n-1}}$$

e: error of the study, determine by the analysis where 0<e<=1

$\bar{T}$: is the average job cycle time from the fist sample time study.

$$\bar{T} = \frac{\sum t_i}{n}$$

n: is number of samples

It is advised that the final Number of Cycles should be computed with a preliminary sample of 10 cycles.

7. Compute the normal time, the frequency and unit normal time as follows:

$$Normal\ time = Average\ time \times \frac{\%rating}{100}$$

%Rating is your estimation of how fast the operator was performing, when 100% is normal pace.

8. Allowances are added to a time study to make the time standard practical:

Total normal time + allowances = Standard Time

9. Look for mistakes and verify that all numbers resulting of the study make sense and publish the results.

Performing a work study has many advantages but the organization must commit resources to the project so the study is conducted and well-aligned with the organization's strategic goals. A successful work study can help the organization increase raw material yields, increase productivity measurements and improve employee motivation. In many cases, work studies can be used to develop a solid incentive system where workers are reward-based on safety, quality, and productivity standards. If the organization wants to embark on a lean journey, a motion and time study must be conducted as a first step along with a basic 5S Lean Analysis, which was covered in detail in the September 2017 issue of *Pallet Enterprise*.