

LABOR UTILIZATION AND MAN TO MACHINE RATIO STUDY AT A SEMICONDUCTOR FACILITY

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ABSTRACT

Productivity is manufacturing industry's main concern. There are many alternatives available for improving productivity. Thus, this study is about improving productivity through identifying current labor utilization before ideal man to machine ratio can be determined using work study methodology. Maynard Operational Sequence Technique (MOST) is the predetermined time standards work measurement tool used to measure operator's activities in a production line at a semiconductor facility. The aim is to observe the sequence of tasks performed by operators, time these activities and analyze the data using a specially designed template to determine the current utilization of the operator, and propose the ideal man to machine ratio for the company. From this study, the value added and non value added activities can also be determined in order to propose to the management on area to focus to further improve the productivity. The improvements when implemented will enable the company to reduce the operational costs and enable it to achieve competitive advantage among other competitors.

KEYWORDS: *productivity, work study, maynard operational sequence technique (MOST).*

1.0 INTRODUCTION

Productivity and labor are 2 main key elements in manufacturing. Productivity is measured based on the number of input and output. To understand the productivity issues we are concern with the changing relationship of these two variables: the output of the system and the input resources utilized. This means that if we want to increase productivity, it is necessary to increase the system's output, if the input remains constant. Similarly, if the system's output is to maintain the status quo, then we need to utilize less input (Mohd Sahar, 2002).

Labor productivity can be measured in terms of either employee number or labor costs (Chapman and Khawaldeh, 2002). The impact of labor productivity in an organization is huge as it contributes to the organization or company's performance. Greater labor productivity enables firms to produce a given amount of goods or services with a smaller number of labor hours (Lardaro, 2001). Most important economic development in the United States in the past decade has been the sustained increase in the rate of growth of labor productivity, or output per hour of work (Sapsford and Varoufakis, 1995, Yellen, 2005).

One of the issues identified at the semiconductor manufacturing facility is that some tasks performed by operators are unnecessary and repetitive. The unnecessary tasks affect the cycle time and daily production rate of the department. Moreover, some operators experienced muscle fatigue due to long-hour standing position. Thus, the purposes of this study are to:

- i. Perform work study on operators' activities
- ii. Determine the current utilization of the operator
- iii. Propose the ideal man to machine ratio

The focus area at the semiconductor facility is at the End of Line (EOL) of Quad Flat No-Lead (QFN) Department. At the QFN Department, there are 5 main processes involved and this study was conducted at the last section; the inspection process.

2.0 MOTION AND TIME STUDY

Motion studies are performed to eliminate waste. The results of motion and time study led to a new work design (Gunasekaran, 2000). The efforts and movements of the human employee are all valuable. Elimination of unnecessary work, the design of methods and procedures which are most effective, which require the least effort, and which are suited for the person who uses the methods and procedures are the objectives of motion and time study (Barnes, 1980). Moreover, it provides methods of measuring work for determining a performance index or productivity index for an individual or for a group of workers, a department, or for an entire plant.

Motion and time study has finally found a home in the modern plant by helping employees to understand the nature and true costs of work, assistant management in reducing unnecessary costs and also balance work cell to make work flow smoothly. Besides, it also contributed the

concept of time standards so that important management decisions can be made intelligently. Motion and time study can reduce and control costs, improve working conditions and environments, and motivate employees (Meyers and Stewart, 2002). Before any improvement in quality or quantity of output, any study of operations time, any scheduling of work or balancing of workload or any calculation of standard time, a study of the current and proposed method is required. Often, studies of overall factory flow or process, called macromotion studies, are made and then additional studies of detail or operations, called micromotion studies, are completed for a project (Aft, 2000).

Motion and time study conducted is composed of three main parts which are:

i. Work Method Design

Method design begins with the consideration of the purpose or goal-to manufacture a specific product. The objective is to design a system, a sequence of operations and procedures that make up the preferred solution.

ii. Operation standardization

After determining the best method for doing the work, the work will be divided into specific jobs or operations. The particular set of motions, the size, shape and quality of material, the particular tools and the equipment should be specified. All these factors as well as the conditions surrounding the worker must be maintained after they have been standardized. A written standard practice giving a detailed record of the operation and specifications for performing the work is the most common way of preserving the standard.

iii. Time standard (work measurement)

Motion and time study may be used to determine the standard number of minutes that a qualified, properly trained, and experienced person should take to perform a specific task or operation when working at a normal pace. This time standard may be used for planning and scheduling work, for cost estimating, or for labor cost control, or it may serve as the basis for a wage incentive plan.

Analyst, which are engineers as well normally perform the motion and time study using the normal method which requires more time and effort. In order to made simplify analyst's work measurement, a new approach known as MOST was introduced.

MOST is a work measurement system which can be easily implemented and practically maintained. It is a system to measure work, and concentrates on the movement of objects. The movement of objects follows certain consistently repeating patterns such as reach, grasp, move and positioning of the object. These sequences can be identified and arranged as a sequence of events manifesting the movement of an object. A model of this sequence is made and acts as standard guide in analyzing the movement of an object. This concept is the basic for MOST sequence model (Crowson, 2006).

3.0 MAYNARD OPERATIONAL SEQUENCE TECHNIQUE (MOST)

Work is defined displacement of an object. All basic work is organized for the purpose of accomplishing some useful result by moving objects. MOST (Maynard Operation Sequence Technique) is a work measurement technique developed by H. B. Maynard and Company, Inc. MOST is a work measurement system which can be easily implemented and practically maintained. It is a system to measure work, and concentrates on the movement of objects. The movement of objects follows certain consistently repeating patterns such as reach, grasp, move and positioning of the object. These sequences can be identified and arranged as a sequence of events manifesting the movement of an object. A model of this sequence is made and acts as standard guide in analyzing the movement of an object.

Analysis of extensive work measurement data indicates that certain sequences of motions repeat consistently. Through research and experimentation, these sequences were verified and organized to form the basics of MOST. The most common activity sequence represents the spatial movement of objects. For BasicMOST, three sequence models have been established; General Move, Controlled Move, and Tool Use (JMAC Consulting, 2007). The time units used in MOST are identical to those used in the basic MTM system and are based on hours and parts of hours called TMU (time measurement units). All time values established by MOST reflect the pace of an average skilled operator working at an average performance rate. This is often referred to as the 100% performance level that in time study is achieved by using leveling factor to adjust time to defined levels of skill and effort.

MOST was designed to be considerably faster than other work measurement technique. The accuracy principles that apply MOST are the same as those used in statistical tolerance control. That is, the

accuracy to which a part is manufactured depends on its role in the final assembly. Likewise, with MOST, time values are based on calculations that guarantee the overall accuracy of the final time standard. Besides that, it is sensitive to the variations in time required by different methods. MOST is also very effective in evaluating alternative methods of performing operations with regard to time and cost.

4.0 METHODOLOGY AND ANALYSIS

Each activity performed by the operator was defined and mapped using the process mapping technique. The data collected includes the cycle time and the daily output rate for the section. The activity time was determined using Maynard Operation Sequence Technique (MOST). Next, each activity was categorized into value added activity or non value added activity. Since there are 2 different operators and 4 different machines involved in this study, there will be 2 different sessions for the data collection. At this company, the operator’s working hour is a 12 hours shift and thus, the data collection should be collected from the beginning of the shift to capture the operator’s variations. For each session, the data will be collected from the beginning of the shift (6.50 am) until the end of the shift (6.50 pm). The area of study will be done at the semi-automated inspection area which at the time of the study contained 17 machines operated by 6 operators. The process mapping template and MOST work study done is illustrated in Figure 1 and the detail explanation of the template columns is shown in Table 1 below.

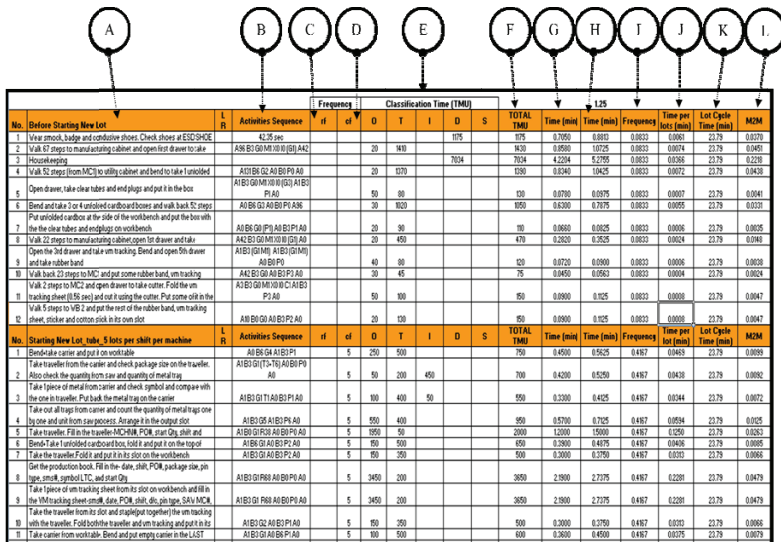
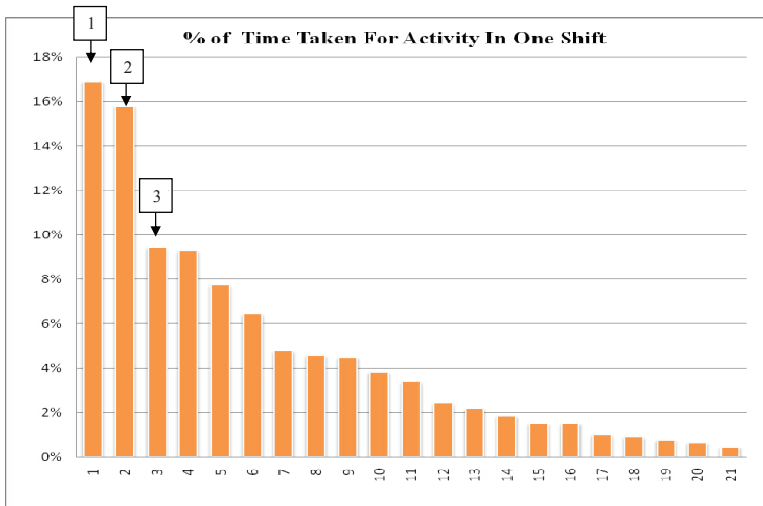


Figure 1 The Process Mapping and MOST Work Study Template

Table 1 The Detail Explanation of Process Mapping Template

NO	INDICATOR	ITEM	DESCRIPTION
1	A	Activity	Description of activities done by operators and determined by observations done in the production line
2	B	Activity sequence	Sequences of activities done based on MOST table calculation
3	C	Repeat frequency, rf	Repetitive frequency of activities done
4	D	Cycle frequency, cf	Cycled frequency of activities done
5	E	Classification time	Classification of activity sequence based on the type of activities being carried out; Operation (O), Transportation (T), Delay (D), Inspection (I), Storage (S)
6	F	Total TMU	Summation of activity sequences which has been converted to classification time
7	G	Time (min)	Time measurement unit (TMU) in conversion of time (min), for operators to complete the activities for each lot
8	H	Time (min) with allowance	Time taken with added allowance to workers (allowance = 1.25)
9	I	Frequency	The frequency of the activities to be carried out per one lot
10	J	Time/lot	The time taken for the activities to be carried out per one lot
11	K	Lot cycle time	The total time taken for one lot to be completed, considering the machine efficiency, lot size and UPH
12	L	MTM	Utilization of operator for 1 machine (assuming 1 lot)

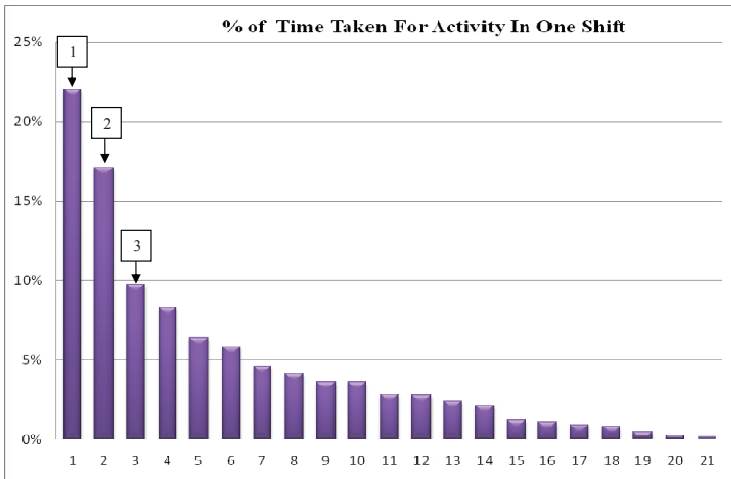
Based on the analysis of the work study done at the inspection area, the activity summary of operators working on cells STI 1 and 2 is shown in Figure 2. The top three contributors to the operators' activity are fix/reset machine (16.90%), preparing clear tubes and end plugs (15.79%) and start new lot tray (9.43%).



Indicator	Overall activity summary	% of time
1	Fix / reset machine	16.90%
2	Preparing clear tubes and end plugs_ 600 tubes/shift	15.79%
3	Start New Lot_ tray(7 lots)	9.43%

Figure 2 STI 1 and 2 cells Overall Activity Summary

Figure 3 shows the analysis on the operators’ activity summary when performing inspection tasks at cells STI 13 and 14. Similarly to operators at cell STI 1 and 2, the top three contributors to the operator’s utilization are the run each lot (22.03%), start new lot tray (17.08%), and preparing clear tubes and end plugs (9.74%).



Indicator	Activity Summary	% of time
1	RUN 2_ each lot	22.03%
2	Start New Lot_ tray(13 lots)	17.08%
3	Preparing clear tubes and end plugs_ 600 tubes/shift	9.74%

Figure 3 STI 13 and 14 Overall Activity Summary

Currently, an operator at the STI 1 and 2 cells is required to operate an average of three machines in a shift. Based on the MOST work study results, the current utilization of the operator is determined at 47.43%. Likewise, an operator working at cell STI 13 and 14 is also handling an average of three machines per shift and the utilization of the operator is at 41.22%.

Based on the work study results, there are differences in the methods of performing similar task between operators at cells ST1 1, 2, 13 and 14. For example, the operator at cell STI 1 and 2 took 2.04 min to enter information in the computer and operator at cell STI 13 and 14 only took 1.56 min for the same task.

5.0 RECOMMENDATION

The results of the work study done at QFN inspection show that operators' utilization at both cells STI 1 and 2 and STI 13 and 14 are very low at 47.43% and 41.22% respectively. The company management is targeting the ideal utilization of the operators to be at 75% in order to achieve optimum operating cost. Therefore, the first recommendation made to the management is to consider increasing the current man to machine ratio from 1 operator to 3 machines to 1 operator to 5 machines to increase the operator's utilization to about 75% at both cells.

The second recommendation made was to eliminate non-value added activities. For example, run 2 activity has the opportunity to be reduced. Run 2 is an additional activity whereby a re-check run is done for lots with high numbers of rejects. In most cases, after completing run 2, the number of rejects decreases because there were machine miss adjustments or some failure to read the data during the first run.

Performing run 2 or re-checking is a non-value added activity since even good units in the lots are checked causing a waste of valuable production time. Focus needs to be put into improving the machine performance will need to be since eliminating run 2 can improve productivity of operators by 22%.

Another activity that has the opportunity to improve the operator's utilization is the preparing end plug. Based on the interview with the operators performing this task, the method of preparing end plugs will need to be further studied due to the complaints of sore finger tips. In addition, the task can be transferred to other operators who are not assigned to handle any machines. The inspection operator's utilization can be further reduced by 10% to 15% if the preparing end plug activity is transferred to another operator.

Although the inspection tasks are the same at cell STI 1, 2, 13 and 14, the work study results showed that the method to perform the tasks vary between operators. Therefore, a Standard Operating Procedure (SOP) to handle the machine and perform the inspection was proposed to the management to be incorporated in the operator's training program.

6.0 CONCLUSION

Significant findings resulting to productivity improvement to a multinational semiconductor manufacturing company have been

generated through this study. The outcomes include:

- i. The activity sequence of STI inspection machine operators has been identified and mapped. From MOST calculation, standard time for each task is obtained. From the standard time, the average daily percentage of operator's utilization were obtained. The results show that operating STI machines are not busy. Thus, there are opportunities to make improvements in order to achieve the ideal man to machine ratio and improved labor productivity aimed by the company's management.
- ii. Through work study, the non value added activities are identified. The run 2 and prepare end plug activities were among the activities that require attention since these activities are among the top three contributor to the operator's utilization.
- iii. The differences in work methods to perform similar tasks were also able to be detected. A Standard Operating Procedure (SOP) is proposed to be trained to the operators.

The improvements on man to machine ratio suggested through work study leads to an improved number of workers in a production line. By reducing workers and optimizing sources, the operation cost can be improved and helps the semiconductor manufacturing company towards achieving competitive advantage over other competitors.

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