Optimization of Time by Elimination of Unproductive Activities through 'MOST'

R. M. Belokar, Yashveer Dhull, Surender Nain, Sudhir Nain

Abstract—Productivity is being the most important thing in the manufacturing world. This paper highlights a methodology developed for minimization of non productive activities (NVA) and minimization of fatigue in manufacturing line by using Maynard's Operation Sequence Technique (MOST) revealed the excessive movements of operators. Work study in productivity improvement could be done in two approaches; which are method study and time study. Thus, this research will use process mapping as the method study and Maynard Operation Sequence Technique (MOST) as the time study method. All this initiated by performing work study on the manual operators' activities. This case study was conducted at a LPS Ltd. Rohtak (Haryana) company. From this study, NVA activities, the standard time, utilization and recommendation for man power planning could be established. The necessary changes were suggested in workplace to minimize the stress creating unproductive movements. These results could be used for optimization of time at the company. So, the paper, it is believed, would be great help to those working in the area of efficiency improvement in manufacturing industry.

Index Terms—MOST, Non-Value Added activities (NVA), Fatigue, Total Activity Time.

I. INTRODUCTION

MOST is a work measurement technique that concentrates on the movement of objects. It is used to analyze work and to determine the normal time that it would take to perform a particular process /operation. MOST is a powerful analytical tool to measure every minute spent on a task. It makes the analysis of work a practical, manageable and cost effective task. It was originally developed by H. B. Maynard & Company Inc. and has three versions- Basic MOST (for the activities between 20 s to 2 min.), Mini MOST (for the activities shorter than 20 s) and Maxi MOST (for the activities above 2 min.) [1]. MOST is used primarily in industrial setting to set the standard time in which a worker should perform a task. MOST analysis is a complete study of an operation or sub-operation typically consisting of several method steps and corresponding sequence model. MOST is comprised of Work study, method study, and work measurement. In the organization under study, the excess time in operator's activity and fatigue of worker. Therefor, the real work was to identify the NVA activities and finding the reasons of fatigue in workers and reduce or minimize them. The highly practical, efficient and cost effective time estimation technique [2] - MOST is used for this purpose.

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II. RESEARCH METHODOLOGY

Research methodology is a way to systematically study & solve the research problems. A research problem here was to analyze the NVA activities and reduce or minimize them. MOST can be applied for the activities having well defined work methods. The Basic MOST System is the core of MOST Work Measurement Systems.

The Basic MOST System

The Basic MOST System satisfies the most work measurement situations in the manufacturing arena. Every company very likely has some operations for which Basic MOST is the logical and most practical work measurement tool.

Consequently, only three activity sequences are needed for describing manual work. The BasicMOST work measurement technique [1] therefore comprises the following sequence models:

(A).General Move Sequence—for the spatial movement of an object freely through the air

A B G	A B P	A
Get	**Put**	**Return**

Where A = Action distance

B = Body motion

G = Gain control

P = Placement

These sub-activities are arranged in a sequence model, consisting of a series of parameters organized in a logical sequence. The sequence model defines the event or actions that always take place in a prescribed order when an object is being moved from one location to another.

The common scale of index numbers for all MOST sequence models is 0, 1, 3, 6, 10, 16, 24, 32, 42 and 54. The time value for a sequence model in basic MOST is obtained by simply adding the index numbers for individual sub-activity and multiplying the sum by 10. For instance, a man walks four steps to pick up a small suitcase from a low conveyor belt and, without moving farther, places it on a table within reach.

$$A_6 \quad B_6 \quad G_1 \quad A_1 \quad B_0 \quad P_1 \quad A_0$$

(6+6+1+1+1) x 10 = 150 TMU

(B).Controlled Move Sequence—for the movement of an object when it remains in contact with a surface or is attached to another object during the movement.

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The move sequence model is **A B G M X I A**, in which

A B G – Get, M X I – Move or Actuate, A - Return

Where M – Move Controlled
X – Process Time
I – Alignment

(C).Tool Use Sequence—for the use of common hand tools. However, the Tool Use sequence model does not define a third basic activity --normally it is a combination of General Move and Controlled Move activities. The tool use sequence model is **ABG ABP *ABP A,** in which

ABG – Get Tool, ABP – Put Tool, * - Use Tool, ABP – Aside Tool, A – Return

The MOST has advantages that only one or two observations are needed to measure the work and rating factors is inbuilt. It is more accurate than other techniques and involves less paper work.

MOST application at Production Line:
The present study makes use of Basic MOST for the estimation of NVA activities and worker' fatigue problem and try to reduce them.
The study was carried out in three phases: (i) Time Study [1], (ii) Basic MOST analysis to identify NVA activities and (iii) Finding & Elimination of the NVA activities by suggested the necessary changes in work methods.

(i) Time Study:

The total activity time consists of operator of traveling due to placement of material and other operating devices far from line were note down by timing device i.e. stop watch. Time study is a technique to estimate the time to be allowed to a qualified and well-trained worker working at a normal pace to complete a specified task by using specified method. This technique is based on measuring the work content of the task when performed by the prescribed method, with the allowance for fatigue and for personal and unavoidable delays. This technique is based on measuring the work content of the task when performed by the prescribed method, with the allowance for fatigue and for personal and unavoidable delays. Divide the operation into reasonably small elements, and record these on the Time Study observation sheet multiply it by the rating factor to get normal time.
Normal time = Observed time X rating factor
Determine allowances for fatigue and various delays. Determine standard time of operation by adding allowances in normal time i.e.
Standard time = Normal time + Allowances

Table 1: Total activity time of operator's activities

Process	Time (min)
1. From Raw material – Cold Forging	6
2. From Cold Forging – Knurling	4
3. Knurling – Turning & Facing	4
4. From Turning & Facing – Threading	4
5. From Threading – Heat Treatment	5
6. From Heat Treatment – Centre less Grinding	5
7. From Centre less Grinding - Final Inspection & Packing	4
Total Time	32

(ii) Basic MOST analysis:
The activities of workers at each workstation were broken down into distinctly identifiable and measurable sub activities.

TABLE 2: MOST Estimation Sheet Existing Working Activity

Sub Activity: From Cold Forging to knurling				**Time in minutes**
Sr. No.	**Sub Operations**	**Parameters and Index values**	**Man**	**Time**
1	Move 40-45 step, Bend & arise (50% occurrence), grasp heavy drum with both hand,	A81B3G3A3B3A0 (81+3+3+3+3) X 10 = 930 TMU	1	0.6
2	Walk 4-5 step with drum (bend 50%), Push drum, put drum on lifter, arise	A10B3G3M16X1616 P6A0 (10+3+3+16+16+6+6) X 10= 600 TMU	1	0.36
3	Move 3-4 step, grasp hand lifter handle ,bend & arise (50%), push and pull lifter handle to raise its height	A6B3G3M10X311A0 (6+3+3+10+3+1) X 10 =260 TMU	1	0.15 6
4	Move 40-45 step, push lifter, reach	A81B0G3M16X16I1 A0 (81+3+16+16+1) X 10 = 1170 TMU	1	0.70 2
5	Move 1-2 step, Bend & arise (50%) unlock lifter handle, down height of lifter by push and pull handle	A3B3G3M10X3I1AO (3+3+3+10+3+1) X 10 = 230 TMU	1	0.13 8
6	Move 3-4 steps, bend (50%), grasp heavy drum with both hand, push and pull drum, Put down & arise.	A6B3G3M16X1616A0 (6+3+3+16+16+6) X 10 = 340 TMU	1	0.20 4
7	Move 1-2 steps ,bend(50%),put drum on floor near machine	A3B3G3A0B3P6A0 (3+3+3+3+6) X 10 =180 TMU	1	0.10 8
8	Move 3-4 step, pick up a bin, Return	A6B0G3A0BOP1A6 (6+3+1+6) X 10 = 160 TMU	1	0.09 6

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9	Move 1-2 step, bend & arise(50%) to take bolt from drum into bin, put into machine	A3B3G3A0B3P6A0 [3+3+3+3(6)+6] X 10 = 330 TMU	1	0.2
10	Move 3-4 step, put bin on machine	A6B0G3A0BOP1A6 (6+3+1+6) X 10 = 160 TMU	1	0.096
Total Time				**2.66**

Each sub activity was further broken down into sub-operation and the sub-operation elements. The elements were then sequence modeled using the parameters and index values. Unit sub-activities have common and the same sequenced set of elements and occur frequently in many activities. MOST estimation sheets, one each for an activity, were developed to sequence model the element using the parameters and index value. Table 2 shows a partial MOST estimation sheet for the activity of operators in shoulder bolt process. It explains how operator's sub-activity is broken down into sub-operations and element. The sample calculations, based on parameters and index values, are shown for each element. The operator's activity time (in min.) is calculated by adding the index values and then multiplying the sum by 0.0006 (1 TMU = 0.0006 min.)

1 T.M.U = 1/28 of a second = 0.036 sec
= 0.0006 min
= 0.00001hr

Similar calculations were made for each process and calculated time for each.

So total time calculated by each process
= 5.804+2.66+2.704 + 2.704 + 5.944 + 2.944 + 6.972 = 29.732 min.

Optimize time after applying MOST = 32-29.732
= 2.268 min.

(iii) Finding & Elimination of NVA Activities:

From MOST analysis it's found that some excessive activities are occurring during operator's manual operations which are shown by index parameters in Table 3 (for one process). Index parameters represent the element involving considerable walking, bending, pushing & pulling, grasping, placement, process time etc. Such elements obviously indicate the higher probability of NVA activities. Primary observations revealed the scope for reducing the NVA activities.

TABLE 3: NVA activities in between the process of shoulder bolt

Sr. No.	Process	Sub-operation	Parameters And Index Values	Excessive Activities
1	From Cold Forging to knurling	Move 40-45 step, Bend & arise (50% occurrence), grasp heavy drum with both hand.	A10B3 (10+3) X 10 = 130 TMU	Walking 5-8 steps and bending operation (50%)
		Walk 4-5 step with drum (bend 50%), Push drum, put drum on lifter, arise	A10B3M16X16 (10+3+16+16) X 10 = 450 TMU	Walk 4-5 step, bend (50%), Push drum, put drum on lifter, arise
		Move 3-4 step, grasp hand lifter handle ,bend & arise (50%), push and pull lifter handle to raise its height	A6B3M10X3 (6+3+10+3) X 10 = 190 TMU	Move 3-4 step, , bend (50%), Push and pull lifter handle to raise height, arise
		Move 1-2 step, Bend & arise (50%) unlock lifter handle, down height of lifter by push and pull handle	B3M10X3 (3+10+3) X 10 = 160 TMU	Bend & arise (50%),push & pull
		Move 3-4 steps, bend (50%), grasp heavy drum with both hand, push and pull drum, Put down & arise.	A6B3M16X16 (6+3+16+16) X 10 = 410 TMU	Walk 3-4 steps, bend (50%), push & pull, put down, arise

So NVA activities time for all process = 1590+1740+1590+300+330+300 = 5850 TMU
= 5850 X 0.0006
=3.51 min.

In each case, all activity identified carefully in all operations and it was observed that few small changes in shapes and size of drum, types of lifter, modification in trolleys shape and layout at the individual workstation lead to drastic reduction in the walking distance, bending operation and move controlled. The closely arrangement of material and other operating devices which are far from line further reduced the work contents.

III. RESULT

Time calculated by Time study method = 32 min
Time by MOST analysis = 29.732 min
NVA activities time as calculated by MOST = 3.51 min
MOST time after reduced NVA activities = (29.732 – 3.51)
= 26.22 min

So optimization time = (32.0 – 26.22) min
= 5.78 min

So Reduced 5.78 min or 18.1% min of the total activity time consists of operator of traveling due to placement of material and other operating devices far from line.

IV. CONCLUSION

Since there is lot of improvement in station by which unnecessary movement of the workmen is eliminated. Hence good amount of work content is reduced.

The study revealed that the MOST can be successfully utilized to determine the NVA activities associated with various work elements / parameters.

It helped to establish the standard time of 26.22 min which could save 5.78 min and remove fatigue of workers. The operators' manual activities are discovered. So the standard time for each process could be determined. It would be interesting to utilize MOST to balance the entire work layout by identifying the bottlenecks.

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