

# TO STUDY THE PRINCIPLE OF MOTION ECONOMY IN INDUSTRY

Naveen Lohan, Sandeep Nandal, Anshul Bhandari  
MAE Department, HMRITM, New Delhi, India

**Abstract-** In this world of competition every industry wants to excel. To stand better in the market industry should know the proper utilization of resources. The main resources are people/men, material, methods, etc. which must be used in proper manner [2]. Labor productivity is very important factor that affects the overall productivity of an industry. Different labors show different level of productivity and affect the overall time and profit [10]. Principle of motion economy helps to give some rules for the betterment in movement of an operator performing any task. This paper mainly focuses on the movement or motion of the workers and then the principle of motion economy is to be applied to improve the efficiency and to reduce fatigue and weariness in performing manual work. This is very much useful in improving the method of doing work. The objective of this project is to provide efficient movements to the worker so that weariness can be reduced and best output can be achieved by the industry. This can be the helping hand for the industry in improving the overall productivity which may leads to huge profit.

**Index Terms-** Labor productivity, Reduce fatigue, efficient movements, improve productivity

## I. INTRODUCTION

At present, industries are trying to make them stable in the market. This stability can only be achieved if there is will be more will be the output and less will be the production time and leads to result in very low production cost. This makes the industries to earn more profit and to stand hard as concrete in the market.

Paul Dickinson et al. [1] Motion economy refers to minimizing the number and dimensions of human movement, in combination with smooth ballistic motions, with the objective of improving productivity through reduced work cycle times. Principle of motion economy gives some rules and suggestions for the improvement of work done by the worker in

manufacturing and to reduce the weariness and fatigue and to eliminate the unwanted movements done by the worker while performing the various tasks or activities [3]. Gilbreth develop a study method based on the analysis of work motions, consisting in part of filming the details of operator activities while recording the time it took to complete those activities. The films helped to create a visual record of how work was completed, and emphasized areas for improvement [6]. If an operator or the worker is performing some manual work, they will make use of their body parts.

For each movement of body part, it will consume some time. Lillian Gilbreth chose the right way by studying the existing methods in detail and determine the motion used. There are some motions which are inefficient or waste [5]. In the same way movements performed by the workers are thoroughly studied. After the analysis of a worker performing the operation, there is collection and recording of necessary information. The information includes:-

- Activities performed by the worker
- Time consumed for performing those activities

After the complete study, principle of motion economy is applied to each and every movement of the worker so that better movements can be achieved by the worker and unwanted movements can be eliminated while performing those activities which will be helpful for the worker( from safety point of view) and also for the industry. Lillian Gilbreth explains the simple rearrangement of a workplace could save workers many motions and much fatigue. [4]

Principle of motion economy can be achieved in three groups: - [3]



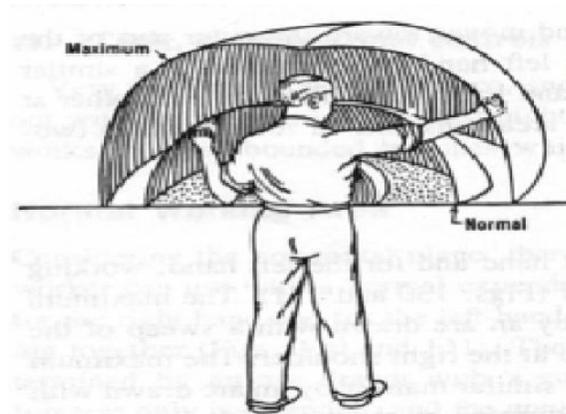


Fig.1 Symmetrical movement of hands

Human beings use their preferred hand for maximum work and leave the minor work for the other hand. As the preferred hand is fast and more powerful it will be more in use. But principle of motion economy gave its first rule that the two hands should be commensurable or simply we can say that two hands should be symmetric. So the two hands should work together proportionally.

### Motion of eyes

Movement of eyes is also concerned with the study of motion economy. The flexible motion of eyes causes wastage of time.

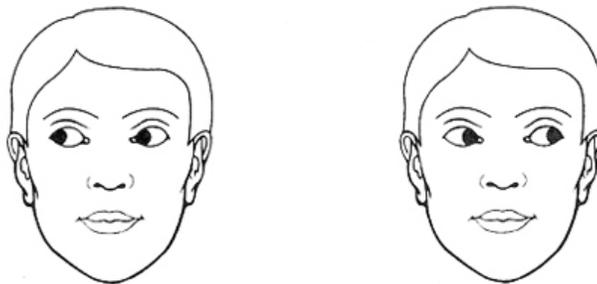


Fig.2 Horizontal movement of eyes

The horizontal movement of eyes is more preferable than the vertical movement. Frequent change in the focus creates problem for the operator. This problem leads to wastage of time. For example, if the pneumatic guns are hanging at the head level, the operator has to move the eyes and his head in vertical direction to pull the gun down. This will cause wastage of time.

### Obstacle

Motion should be free and open to avoid any hurdle or resistance in the motion which causes weariness or fatigue. If the worker is picking the parts from the bin and if there is some hurdle in picking of parts. It will come under obstacle. So more time will be consumed in picking the part from the bin and this will leads to wastage of time or increase in production time.

### Body movements

It includes various points such as

- Shoulder movement
- Upper arm movement
- Forearm movement
- Hand movement

It is one of the important rules which come under principle of motion economy. Under this it is preferred to use forearm or hand rather than upper arm or shoulder. As the use of hands and forearm is safer than the shoulder and upper arm. If an operator is making use of its shoulder or upper arm it can be unsafe for the operator as there will be heavy workload on the shoulder or upper arm. This heavy workload on the shoulder and upper arm can be risky for the worker and will cause fatigue. It will be beneficial for both the worker and the industry if the

worker is using his hands and forearm for light work rather than shoulder and upper arm.

### Arm movement

With the attrition of the movement, less energy is required. Less energy results in less tiredness. So the movement should be minimized to get efficient output.

It includes various points such as:-

- ❖ Upper arm movement
- ❖ Forearm movement
- ❖ Wrist movement
- ❖ Fingers movement

Ranking is given from 1 to 4, which will define the different movements and which movement is considered as the best movement in terms of producing the better output. The figure below shows the ranking

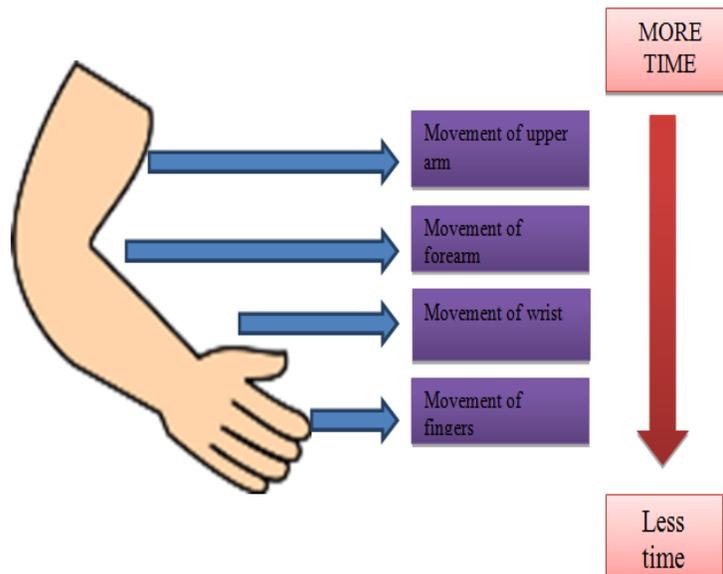


Fig3. Preferred arm movement

From the above figure it is clear that movement of upper arm is less preferable whereas movement of fingers is considered as best movement. When the worker is performing the operations on the floor it is better to use the fingers and wrist as it consumes less

time as compared to upper arm and forearm. So to achieve the better output (in terms of time consumption) rule for arm movement should be followed.

IV. OBSERVATION

MOTION ECONOMY					DEPARTMENT: ABC				AREA: XYZ				STATION NO: 000			
ACTIVITY NO.	ACTIVITY	HAND ACTION	MOVEMENT OF EYES	OBSTACLE ACTION	BODY MOVEMENT				ARM ACTION							
					SHOULDER	UPPER ARM	FOREARM	HAND	MOVEMENT OF UPPER	MOVEMENT OF FOREARM	MOVEMENT OF WRIST	MOVEMENT OF FINGERS				
1	walk to take assy. Trolley	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA			
2	pick cylinder liner from part kit	✗	NA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
3	assy. Of cylinder liner	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
4	pick inside arm from the kit	✗	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓			
5	assemble inside arm	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
6	apply loctite and assembly screw	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
7	picking of gun	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
8	tightening of screw	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
9	setting of tie rod	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
10	assy of tie rod	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
11	apply grease on inside seal & assembly in	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
12	walk to RHS to trolley	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
13	assy of RH tie rod	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
14	pick circlip and fix it in plier	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
15	tighten bolt of tie rod with gun	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
16	pick LOM lever and o ring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
17	assy of o ring in LOM lever	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
18	assy of LOM lever and valve control link	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
19	pick stake and hammer and fix roll pin	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
20	place hammer and stake	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
21	pick height limiter bracket	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓			
22	assy of height limiter bracket	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
23	pick cylinder liner rings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
24	assemble rings of cylinder liner	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
25	place lift body cover on assy trolley	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
26	pick activator from rack	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓			

27	apply activator on lift body cover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
28	apply loctite of lift body cover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
29	pick hydraulic lift body front plate bolts	✓	NA	NA	✓	✓	✓	✓	✓	✓	✓	✓
30	assemble lift body cover	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31	picking of grab screw	✓	x	✓	✓	✓	✓	✓	✓	✓	✓	✓
32	pick guiding screw	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
33	fitting the guiding screws	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
34	picking of gun	x	x	✓	✓	✓	✓	✓	✓	✓	✓	✓
35	tighten the bolts of lift body cover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
36	unscrewing the guided screws	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
37	wiping extra loctite from lift body cover	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
38	assy of load control link	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
39	fix retaining ring in tool	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
40	assy of retaining ring	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
41	assy of end of stroke	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Summary											
	Number of ✓	36	23	28	26	27	28	28	28	28	28	28
	Number of x	4	3	0	2	1	0	0	0	0	0	0
	Number of NA	1	15	13	13	13	13	13	13	13	13	13
							✓					
							x					
							NA					
							✓ --- ok					
							x --- Not ok					
							NA --- Not applicable					

✓	→	CORRECT
x	→	NOT CORRECT
NA	→	NOT APPLICABLE

Table above shows the various activities which are performed by an operator on the floor of a particular station. All these activities are analyzed with keeping in mind the rules of motion economy. Here the red boxes show the faulty movements which are to be

rectified. These faulty movements are the reason for more time consumption in performing the activities and sometimes they become risky for the worker working on a particular station as these motions can cause injury to the worker. So they need

improvement or they should be eliminated for better work output and for the safety of the workers.

V. OPTIMIZED BODY PARTS MOVEMENT:-

Activity no.	FAULT	Activity performed	EXPLANATION
2	<b>Hand motion</b>	Pick cylinder liner from part kit	<b>Unsymmetrical motion</b> (Worker is not using his both Hands while working as his One arm is idle)
4	<b>Hand motion and Shoulder</b>	Pick inside arm from the kit	<b>Unsymmetrical motion and work load on shoulder</b> (Worker is not using his both Hands while working as his one arm is idle and due to this there is workload on Shoulder)
7	<b>Hand motion And Movement of eyes</b>	Picking of gun (as the gun is hanging at some height)	<b>Unsymmetrical motion and vertical movement of eyes</b> (Worker is not using his both Hands while working as his One arm is idle and vertical Movement of eyes)
21	<b>Upper arm</b>	Pick height limiter bracket	<b>Work load on upper arm</b> (As height limiter in not heavy But there is some load on Upper arm)
26	<b>Shoulder</b>	Pick activator from rack	<b>work load on shoulder</b>
31	<b>Movement of eyes</b>	picking of grab screw	<b>Vertical movement of eyes</b> (Box where grab screw is kept Is at such position that eyes Moves vertically)
34	<b>Hand motion And Movement of eyes</b>	Picking of gun (as the gun is hanging at some height)	<b>Unsymmetrical motion and Vertical movement of eyes</b> (Worker is not using his both Hands while working as his one arm is idle and vertical Movement of eyes)

VI. CONCLUSION

We presented the movements of the workers performing different activities on the floor. With the help of certain rules of motion economy, there is

advancement in the working of the worker. This advancement includes the reduction of weariness and fatigue and also to enhance the safety of the workers. It was rightly said by Voltaire that “our labor preserves us from three great evils – weariness, vice

and want” [8]. So to get efficient output from the labor, motion study is to be done which according to us is the best way to taking out the productive labor from the normal labor.

#### REFERENCES

[1] Paul Dickinson, Adelaide Ergonomics Pty Ltd, South Australia, paul@adelaide-ergonomics.com.au, PRINCIPLES OF MOTION ECONOMY: SOME CONCERNS, AND OPPORTUNITIES TO RETAIN MOVEMENT IN WORK.

[2] S.K Sharma, Industrial engineering and organization management: “Industrial engineering and development of factory system”, pp1-19, Edition 2012

[3][https://en.wikipedia.org/wiki/Principles\\_of\\_motion\\_economy](https://en.wikipedia.org/wiki/Principles_of_motion_economy) ----- (principle of motion economy)

[4] Frank and Lillian Gilbreth: critical evaluation in business and management: “Lillian Gilbreth: other involvements”, page 274, Edition 2003

[5] Frank and Lillian Gilbreth: critical evaluation in business and management: “continuing research in Gilbreth methods”- Harold B. MAYNARD, page 313

[6]<https://www.boundless.com/management/textbooks/boundless-management-textbook/organizational-theory-3/classical-perspectives-29/scientific-management-taylor-and-the-gilbreths-165-4019/>

[7] O.P KHANNA, Industrial engineering and management: “work study”, pp 9-12, Edition 2015

[8] VOLTIRE, candide - quotes –“labor preserves us from three great evils – weariness, vice and wants”

[9] A review of industrial engineering and technique: An application and future scope of work, Ankur D. Mehta and Darshak A Desai, International journal of Management Information Technology and engineering, volume 2, Issue 3, pp 29-36

[10] Miss.Rajshri Shrishirmal, and prof. R.R Salgude, “time and motion study of residential site” International journal of innovative and emerging research in engineering volume 2, Issue 6, pp 5-10

[11] Katsundo Hitomi, Manufacturing systems engineering: “Process planning and design”, edition 1996

**Author bibliography**

	<p><b>Naveen Lohan</b> Assistant professor in HMRITM,Hamidpur ,Delhi</p>
	<p><b>Sandeep Nandal</b> Assistant professor in HMRITM,Hamidpur ,Delhi</p>
	<p><b>Anshul Bhandari</b> <i>Doing B.TECH (Mechanical and Automation) from HMR Institute of Technology and Management, GGSIP University, Delhi</i></p>