Work System Design
Dr. Inderdeep Singh
Department of Mechanical and Industrial Engineering
Indian Institute of Technology - Roorkee

Lecture – 50
Introduction to MTM and MOST

Hello friends, welcome to the last session of our discussion for the 10th week of our course on work system design. So, today, I think we are trying to conclude the topics related to work measurement and in the next 2 weeks our focus would be on other topics such as ergonomics which is an important aspect when we design the work system. So, what we have covered till now let us revise as today being the last session for week number 10.

We have covered the basic aspects of productivity we have studied causes of low productivity, productivity improvement techniques, productivity measurement techniques and then we have taken a few examples of calculating the productivity. Also we have seen that how the productivity can be improved, what are the important techniques that can be used. In the techniques we have seen that method study.

And work measurement are 2 important techniques that can help us to improve the productivity of an organization. In method study again we have covered the different topics such as outline process chart the flow process chart flow diagram, SIMO chart, therbligs, principles of motion economy and we have tried to develop a better method of doing the job and we have taken a number of examples.

In which it was shown that if we are able to graphically represent the whole process or the system or the sequence of activities we can very easily identify that how the things can be done in a better manner. Whether there are operations which are redundant whether there are certain operations which we can combine or also we can see that better methods are always possible if we use our common sense.

If we use the graphical tools that are a topic or that are developed under the method study. So, basically we have no understood that how we can analyze the work and how we can combine the

operations eliminate the operations or maybe sometimes improve the operations, improve the sequence of operation and develop a better method of doing the job. Once we know that the better method has been developed.

We have to find out that how much time an experienced worker will take to perform the task using the developed method using the standard protocol using the standard sequence of activities which have been developed as a part or as a as a output of the method study. So, once we have a standard method we will use the standard method able bodied worker a worker who is skillful enough to do the task a worker who has experience enough to do a particular task.

How he will perform the task so that is important so if we did a physical task we have to look for a able bodied person who can perform that physical task. So, worker is also important the work and how the work is to be done that is also important and then we have to find out how much time it will take to perform that task. So, that is the background and when we have to calculate that.

How much time will be taken by a worker will take to perform at a defined level of performance in that case we have to understand certain techniques and in that line only we have already started the most common technique that is the stop watch type of time study. After that we have covered the topic of work sampling after that we came to predetermined motion time system and in the previous session we have covered the basic aspect of synthetic data also.

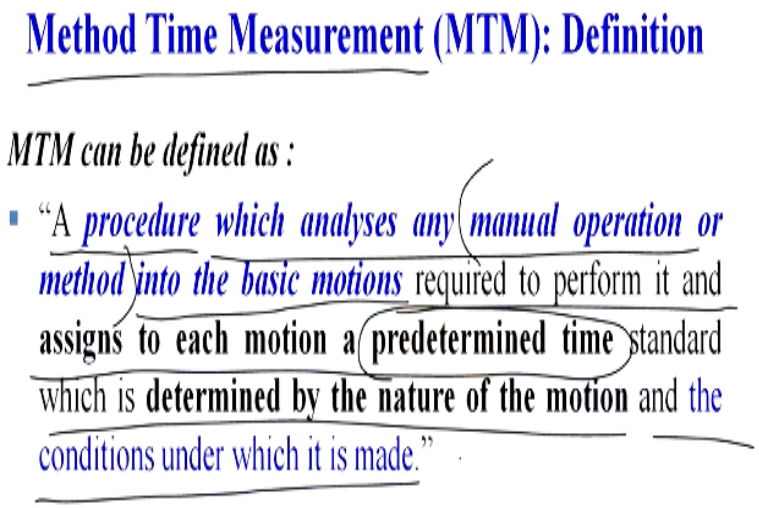
So, depending upon the situation we can very easily decide that which future particular tool or technique or a method we must use to find the standard time for performing the task and we have seen certain examples also and try to find out the number of observations required to work sample the time required for performing that task. So, all this background we have now today is the concluding session for the overall module of work measurement.

If you remember in the very beginning in the introductory video or in the promo video of this course, I have divided the course into 4 important modules. So, the module number 1 was related to productivity measurement then the module 2 was related to method study module 3 is related

to work measurement and the module 4 is related to ergonomic and other important aspects of our system design.

So, module 3 we are going to complete today which is the work measurement and the last part although this requires a very, very exhaustive discussion these topics are very, very important. But seeing the time constraint we will try to maybe introduce the concept of MTM and MOST to all of you so let us see no what is the basic definition of MTM. So, you can just have this definition just read this definition we have already covered this in one of our previous slides now what is MTM.

(Refer Slide Time: 05:43)



A MTM or method time measurement is a procedure which analyzes any manual operation or method so what we are analyzing we are analyzing any manual operation or method into the basic motions for example if I when I started this session today I was not holding anything now once I started to deliver the talk and I am starting to use this console I have picked up the pen and started to make up mark here.

So, these are the basic motions that we analyze we can analyze using MTM technique so are the MTM procedure. So, it is a procedure which analyzes any manual operation or method into its basic motion required to perform it and basic motions required to perform it and assigns to each motion a predetermined time. So, MTM is maybe falls under the predetermined motion time

system PMTS.

So here pre-determined time is very, very important which is determined by the nature of the motion and the conditions under which it is made. So, basically there are 3 things in this definition first thing is the work that work can be a manual operation or method which is divided into the basic motions. So, there is the work being done the second is it is required the work has to be done in order to complete a job.

We need to find out the time required for performing this work and for that we have some data predetermined time standard which is already available with us. So, we will use that data to set the time for the standard time for performing this task which is a manual operation. So, once again I have divided the definition into different sentences so in order to understand it in a better manner let me read this definition for all of you.

What is MTM it is a procedure which analyzes any manual operation or method into the basic motions required to perform it and assigns to each motion a predetermined time which is determined by the nature of the motion and the conditions under which it is made. So, we will see in another subsequent slides that different levels are there that is it is determined the time standard is determined by the nature of the motion.

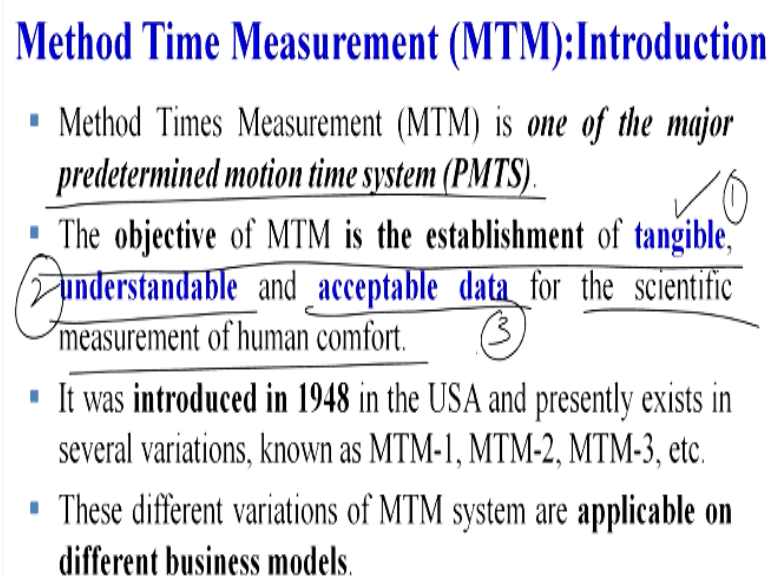
For example, the nature of the motion can be smooth it can be accelerated deaccelerated so depending upon the nature of the motion different levels are different time estimates are there. As well as the conditions under which it is being done if I walk leisurely from this podium to the other end of the studio different time estimate may be there. If I run different time estimate will be there.

So, the conditions are different if I am moving from this place to that place carrying a heavy load of fifty kgs with me the conditions are different. Now depending upon the conditions the time standards are there there is a tabular form of data available. So, based on the nature of the work based based upon on the conditions under which the work is being done. We will accordingly choose the time estimates for the various basic motions.

Which comprise which add up or build up into the complete tasks or the job. Now method time measurement let us see the introduction the basic concept is how I think clear that we are not going to use a stopwatch here time study analyst we are not going to go to the shop floor to observe whether the worker is working or not working whether the machine is working or idle as we do in work sampling.

So, here is what we will do we will divide the overall work into the basic motions and for those motions try to look for the data which is already available or pre-determined data we will try to use to set the time standard. So, that is the basic introduction let us try to understand the other important aspects related to the method of time measurement.

(Refer Slide Time: 09:58)



Method time measurement is one of the major predetermined motion time system. The objective of MTM is the establishment of tangible number 1 understandable number 2 and acceptable data number 3 for the scientific measurement of human comfort or we can also write effort. It was introduced in 1948 in the united states of America and presently exists in several variations such as MTM-1 and MTM-2 and MTM-3 etc.

And if you remember in the previous session already we have seen that MTM-1 these are the various basic body motions MTM-2 these are the basic motion MTM-3 these are the basic

motions. So, you can refer back to the discussion or previous discussion and see that how MTM is buildup. So, we have tried to introduce it there also but these different variations of MTM system are applicable on different business models.

Now depending upon as we have seen that the basic definition of MTM says that we have to take into account the conditions under which the work is being done. So, depending upon the conditions depending upon the nature of work being done we have to take a decision that whether we are going to use MTM-1 or MTM-2 or MTM-3.

(Refer Slide Time: 11:26)

Method Time Measurement (MTM):Introduction

- MTM system ***gives values for the fundamental motions*** of reach (R), move (M), turn (T), grasp (G), position (P), apply pressure (AP), eye travel (ET), disengage (D), and release (RL).
- Normal time values for MTM technique are given in **Time Measure Units** (1 TMU = 0.00001 hr = 0.0006 min = 0.036 sec) which are represented in a tabular form for fundamental motions.

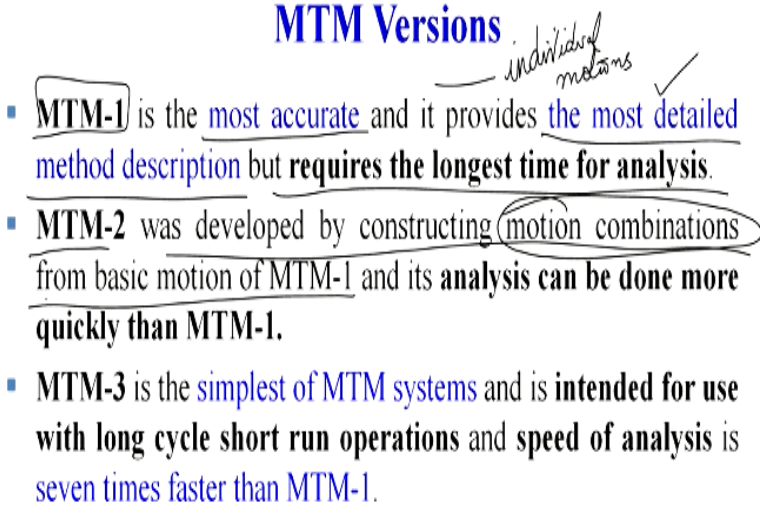
Now MTM system gives values for the fundamental motions now what are these fundamental motions this can be reach which is one move, turn grasp, position, apply pressure eye travel disengage and release. So, there are different types of body motions or fundamental motion so MTM system gives values of the fundamental motions. So, these values we can take from the MTM system and then build up on the standard time required for performing the task.

Which comprises all of these fundamental motion the overall task has to be divided into this fundamental motion time has then to be noted down from the table and then added up to get the overall time required for performing the task. So, the normal time if you can see that this is this requires a different time skill why because suppose there is a you can say fundamental motion called release here.

Now I am holding up a pen when I release it how much time it has taken it has taken a fraction of a second. So, we need to devise a new time unit which we can use for these fundamental motions. So, the normal time values for MTM technique are given in time measured units TMU and 1 TMU=0.00001 hour or 0.0006 minute or 0.036 seconds which are represented in the tabular form for these fundamental motions.

So, we can see that we are going to use a different time unit for doing the MTM measurement or doing the method time measurement. Now there are different MTM versions which we have already covered maybe just an introductory aspect was discussed in the previous session.

(Refer Slide Time: 13:23)



So, MTM-1 is the most accurate and it provides the most detailed method of description but requires the longest time for analysis. So, it is the most accurate require the longest time for analysis also it is the most detailed method of description. So, we will use the very fundamental basic body motions and then try to find that time in the form of the TMUs. MTM-2 was developed by constructing motion combinations.

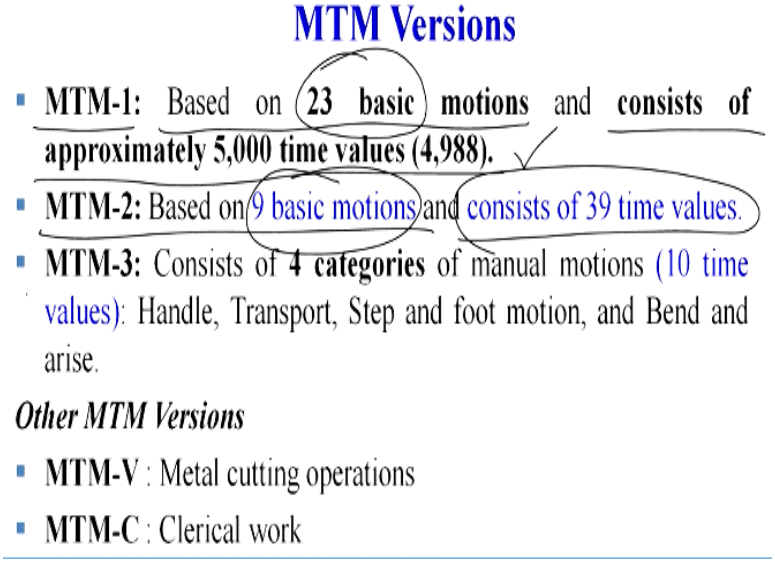
So, here individual motions usually are taken into account the individual motions you have in MTM-1 but here you can see motion combinations as we have seen in the form of a diagram in the previous session also from the basic motions of MTM-1 so motion combinations from the

basic motions of MTM-1. So, MTM-1 we are using the basic motions here we are combining the basic motions and its analysis can be done more quickly than MTM-1.

Because the very fundamental basic motions we have now are combined into maybe a set of 2 or 3 or 4 motions. MTM-3 is the simplest of MTM system as it is and is intended for the use with a long cycle short run operations and speed of analysis 7 times faster 7 times faster than MTM-1. So, here again we go to the next higher level of analysis so in MTM-1 we go to the most fundamental motions.

Then we combine these motions to get a higher level of combinations in MTM-2 and MTM-3 even we go to the highest level and then there are 7 times this method is 7 faster as compared to the MTM-1. So, this is again the representation of what we have covered in the previous slide.

(Refer Slide Time: 15:29)



MTM-1 method time measurement 1 is based on 23 basic motions and it consists of approximately 5000 time values approximately 5000. MTM-2 based on 9 basic motions so here you see there are 23 which have now some have been combined together and only 9 basic motions are there and it consists of 39 time values and MTM-3 consists of 4 categories. So, from 23 to 9 to 4.

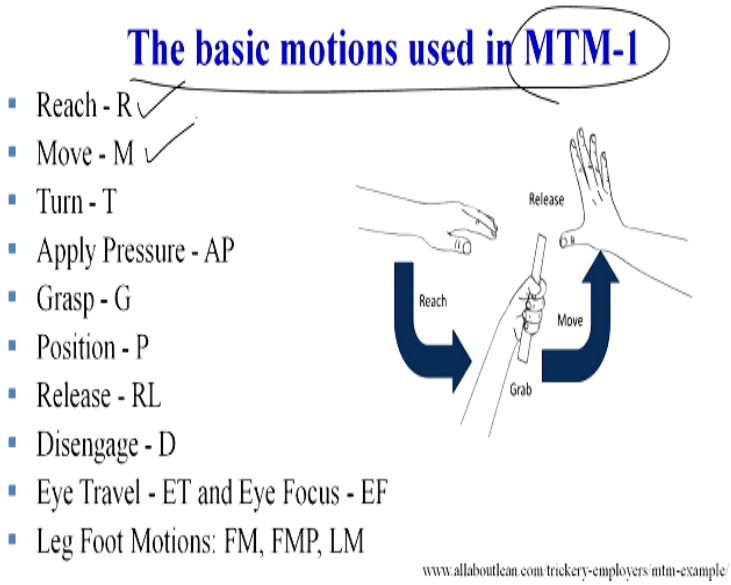
So, 4 categories of manual motions and 10 times a very time times 10 time values only. Now

what that these are 4 we can see handle, transport, step and foot motion and bend and arise. So, these are the 4 categories of basic motions or the body motions of each are taken into account in MTM-3. So, these are the 4 manual motions which are highlighted here then there are other MTM versions also like metal for MTM 5 for metal cutting operation, MTM c for clerical work.

Because basically what is our target our target is to identify the work for which we want to find out the standard time or the time required for performing the task at a desired level of performance using the standard method of course. So, dependent it is not that always the work will be done on the shop floor work is being done at all spheres of our life. So, I am today recording these sessions so this is also work being done.

So, basically we need to find out the time required for performing the task it can be in an office space also. So, these are different MTM versions.

(Refer Slide Time: 17:13)



The basic motions used in MTM-1 explained with the help of examples also one is reach, move turn, apply pressure, grasp, position, release, disengage, eye travel, leg foot motions are also there. So. this is just an example reach, release, open hand, then grab this is shown here then move grab and move and release. So, you can have different basic motions in MTM-1 which can be combined together added up together built up together to do the complete job or the work.

Now we will take one of them only maybe suppose we take reach and try to understand that how reach depends upon that nature of the work as well as the conditions under which the work is being done. Now let us see to simplify recording individual MTM methods.

(Refer Slide Time: 18:12)

MTM-1: Basic Motion Element

To simplify recording individual MTM methods, a system of MTM conventions has been developed. For example :

- **Reach (R)-** Reach is the basic element used when the predominant purpose of the motion is to move the hand or fingers to a definite destination or to a general location

The time for making a reach varies with the following factors:

- Condition (nature of destination).
- Length of motion.
- Type of reach (i.e. whether hands move/ accelerate/ decelerate at the beginning/end of reach or not).

A system of MTM conventions has been developed for example of what is the convention regarding reach reach is the basic element used when the predominant purpose of the motion is to move the hand or fingers to definite destination or to a general location. So, reach is you move your hand or fingers to a definite destination. For example, I am standing here I want to use the pen. So, reach will be my hand moves in this direction to the pen that I want to use.

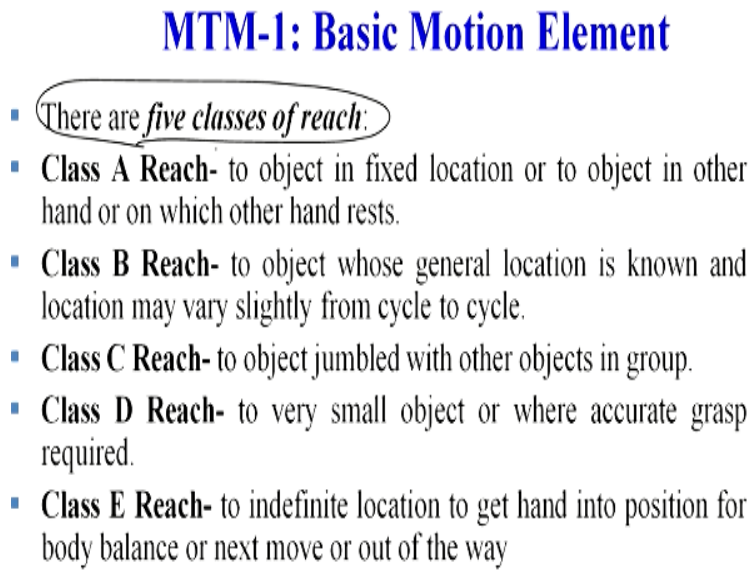
The next can be grasped I have grasped this pen then I have moved this pen. So, we go to that basic motions of our body. The time for making that reach varies with the following factors which I have already told. Nature of condition will depend upon the nature of the destination now suppose this is lying in open space here I have a reached easily suppose it is lying underneath here so the condition has now changed.

In order to reach this pen, I have may have to bend down and then I have to reach to this pen. So, the condition or the nature of destination is important length of the motion is also important type of reach is also important whether the hands move accelerate, deaccelerate at the beginning or the end of reach or not. So, whether it is a smooth motion or smooth reach motion or it is

accelerated or deaccelerated.

So, the conditions may change the type of or the nature of operation or the basic motion may be different depending upon the conditions.

(Refer Slide Time: 19:48)

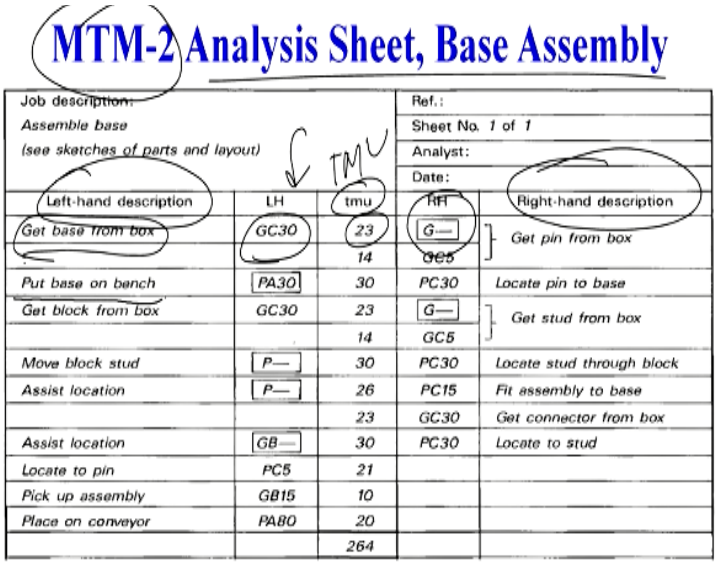


Now there are 5 classes only for reach and if we go back just to look at the various basic motions you can see there is a long list of basic motion. And we are only discussing one that is reach so only for a leech there are 5 combinations possible. So, class A reach this is to an object in fixed location or to an object in the other hand or on which other hand rests. So, maybe this is class A reach.

Class E reach to indefinite location to get hand into position for the body balance or next to move or out of the way. So, even reach also we have so many different variants possible now what is our role as a time study analyst, we have to first analyze the work and divide it into the various basic motions and for each basic motion then we will be able to look for the time in terms of TMU that is time measurement unit.

So, this is only for reach and for others also there are a subclassification so there is a tabular data available and we can look for the classifications. But this is just one example.

(Refer Slide Time: 20:59)



MTM-2 Analysis Sheet, Base Assembly

Job description: Assemble base (see sketches of parts and layout)		TMU	Ref.: Sheet No. 1 of 1 Analyst: Date:	
Left-hand description	LH	tmu	RH	Right-hand description
Get base from box	GC30	23	G—	Get pin from box
		14	GC5	
Put base on bench	PA30	30	PC30	Locate pin to base
Get block from box	GC30	23	G—	Get stud from box
		14	GC5	
Move block stud	P—	30	PC30	Locate stud through block
Assist location	P—	26	PC15	Fit assembly to base
		23	GC30	Get connector from box
Assist location	GB—	30	PC30	Locate to stud
Locate to pin	PC5	21		
Pick up assembly	GB15	10		
Place on conveyor	PA80	20		
		264		

MTM this is giving a MTM-2 analysis sheet similar type of work can be done for MTM-1 so in MTM-1 we have the basic motion elements here which is reach. Similarly, there are other basic motion elements some of them may have a subclassification, some of them may not have a subclassification but then we have to see that what work we are doing and which basic motion element is satisfying or corelating to the kind of work that we are doing.

The conditions of under which the work is being done so we have to first make this complete list that this is the sequence we are following this is the these are the various work element or the basic motion element coming into the picture when we are performing this task. And then we have to find out the time for each and every basic element. Now here you can see this is for MTM-2 this is left hand description this is right hand description.

So, left hand get a base from the box so this is left hand the units are given this is symbol this is the TMU you can see TMU similar right hand get pin from the box G is given here then put base on the bench. So, this is PA symbol is given TMUs are given so then we can calculate the complete do the summation of all these TMUs and we can get that how many TMUs are being spent for performing this task.

(Refer Slide Time: 22:40)

Uses of MTM

- Developing effective methods and plans in advance of beginning production.
- Improving existing method
- Establishing time standard.
- Cost estimating.
- Training supervisors to become method conscious.
- Research in the areas like operating methods, performance rating

Now what are the uses of motion time measurement it helps in developing effective methods and plans in advance of beginning the production. So, if you compare this with the stopwatch time started about exampling in both cases the work has to be in a progress then only we can do the analysis. Then only we can use a stopwatch to find the time but here we can do the calculations before the production actually starts.

And all of our planning may depend upon these time estimates only so it can help us in developing effective methods and plans in advance of beginning the production. It can also help we need to improving the existing the matter so we can compare or 2 or 3 different alternatives of doing the same work and then we can select the best method which is giving us the desired results but with the minimum time.

It helps in establishing the time standard cost estimation because we can very easily know calculate the amount of work being done by the worker. How much work has to be assigned to a worker what is the salary to pay to the worker based on the work he or she is doing? So, the cost estimation can be done. Training supervisors to become method of conscious. Research in the areas like operating methods, performance rating etc.

So, there are certain examples we can discuss each one of these in detail but maybe because of the paucity of time we will shift to the next important topic that we want to cover.

(Refer Slide Time: 24:16)

"MAYNARD OPERATION SEQUENCE TECHNIQUE" (MOST)

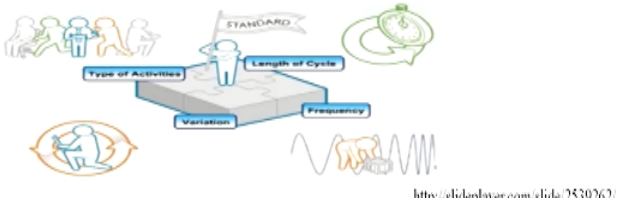
That is the Maynard Operation Sequence Technique which is most commonly known as MOST most commonly known as MOST so the important point here is that there is literature available in books available chapters available and if you understand the basic concept of MTM you can refer to the books and you will be very easily able to understand the concept and very easily able to understand the other basic motions also.

And you can take certain examples which can be asked in the assignment also which can be asked in the examination also you can try to find out the times using the MTM method. Now let us see what is MOST.

(Refer Slide Time: 25:01)

MOST

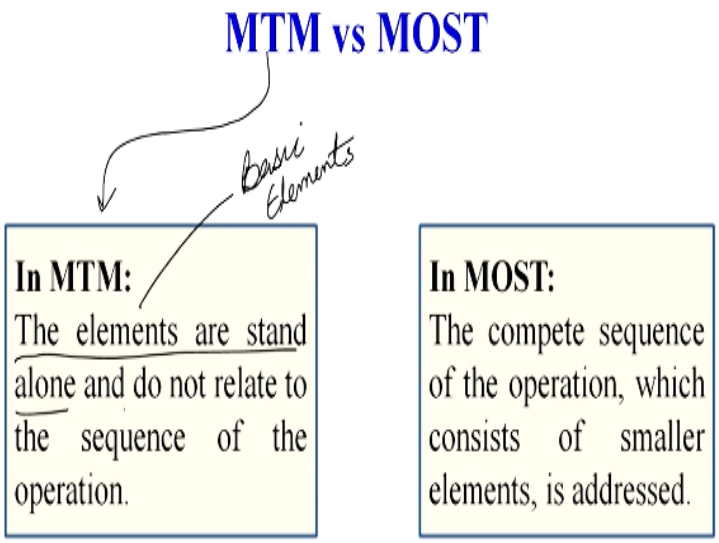
- **H.B. Maynard** and **Company** has introduced MOST system and this new system was brought into practice in the United States in 1975.
- It has gained a wide recognition as a major contribution to the body of Industrial Engineering.



Now H B Maynard and company has introduced MOST system and this new system was brought into practice in the united states in 1975. It has gained a wide recognition as a major contribution to the body of industrial engineering. One of the important topics that is taught in industrial engineering and here the standard in this diagram if you just if you can decipher what is given in the diagram the standard will depend upon the type of activities.

The variation in the conditions the frequency and the length of the cycle. So, these are some of the different parameters which may govern which you may classify the various techniques that fall under most of the various variants that we consider under MOST. Now what can be the difference.

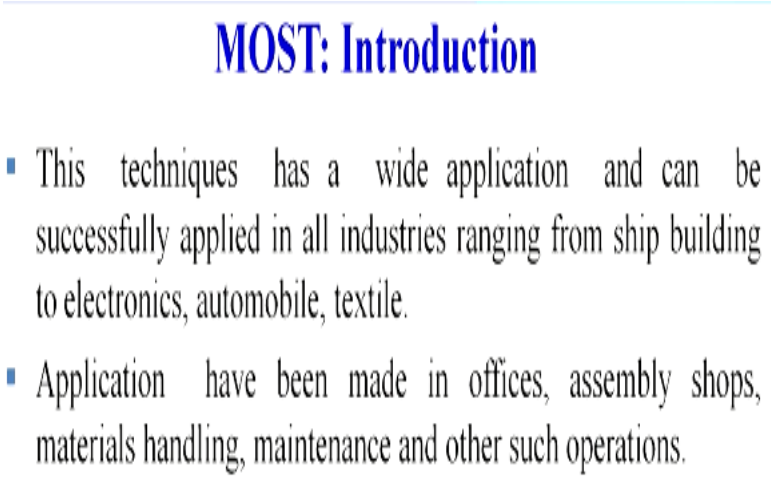
(Refer Slide Time: 25:55)



Now we are discussing MTM now in MTM how it is different from MOST which is explained here. So, that MTM secretly you can be the elements are stand-alone if you see we have taken the basic elements then combine them into the form of MTM-2. So, in MTM the basic elements are stand alone and do not relate to the sequence of the operations. We take the elements we divide the overall work * various elements.

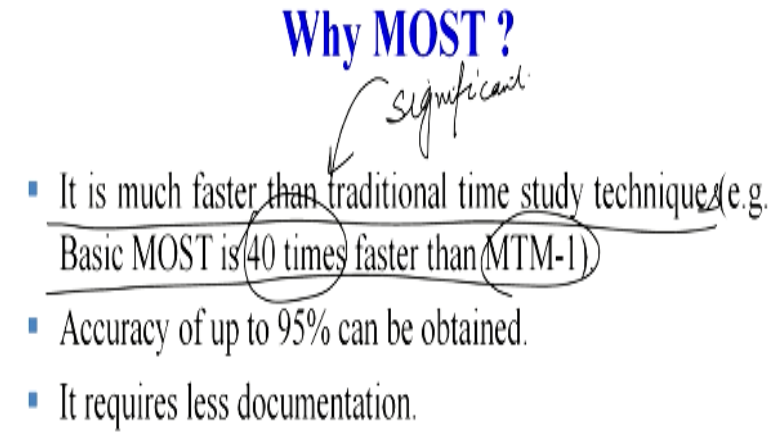
And then for those elements we write down the TMUs. IN most you can see the complete sequence of the operation very, very important this is the MOST complete sequence of the operation which you can see so smaller elements is addressed. So, we focus on a sequence in case of MOST whereas in MTM we focused on the basic or the fundamental elements of the fundamental basic elements. Now let us see what is what do we know about MOST.

(Refer Slide Time: 27:02)



This technique this technique has a wide application and it can be successfully applied in all industries ranging from ship building to electronics to automobile to textile. So, wherever the work is or the manual work is being done the technique of MOST can be easily applied. Application have been made in offices, assembly shops, materials handling, maintenance and other such operations and this the application why MOST.

(Refer Slide Time: 27:32)



It is much faster than the traditional time study techniques. For example, the basic MOST is 40 times faster than MTM-1 significant which is very, very significant 40 times faster than MTM-1. Accuracy of up to 95% can be obtained and it requires less documentation.

(Refer Slide Time: 27:56)

Levels of MOST

We will take one example there are different levels of MOST which I have already highlighted. So, basic MOST for the activity between 20 seconds to 2-minute mini MOST for the activity shorter than 20 seconds. And Maxi MOST for the activities above 2 minutes so we can have variants of MOST also.

(Refer Slide Time: 28:21)

Sequence Models in MOST

ACTIVITY	SEQUENCE MODEL	SUB – ACTIVITIES
General Move	A B G A B P A	A – Action Distance
		B – Body Motion
		G – Gain Control
		P – Placement
Controlled Move	A B G M X I A	M – Move Controlled
		X – Process Time
		I – Alignment
Tool Use	A B G A B P _ A B P A	F – Fasten
		L – Loosen
		C – Cut
		S – Surface Treat
		M – Measure
		R – Record
		T - Think

http://slideplayer.com/slide/2539262/

This is one sequence model which is the followed in the MOST very, very important. So, we can see activity can be a general move it can be a controlled move it can be our use of tool so how what is the general or the standard sequence of model we will follow you can see here A what do you mean by A A means action distance B means body motion G means gain control and then again A is coming B is coming again.

And P is coming P is placement is coming again so this is the standard sequence model that we have to follow that is ABG ABP and then again maybe A. So, we will divide the work being done in to these sequence models and if something may be for a particular sequence of work somewhere if we find that a body motion is not happening so for there we can give the value 0 to the body motion.

Similarly, for a controlled move this is the sequence a model A same B same G same then M move controlled X process time I alignment and then ABG MXI. So, similarly, the sequence will be followed then if we are using a tool this can be the sequence model ABG ABP and then ABP. So, we can see that there is a place here so accordingly we can choose that what we are doing if they are using a tool.

So, we can very easily now be using the sequence or the standard sequence we can identify how the work is being done for example if a person is on the ground floor and he has to move to the first floor and fetch his charger which is located there. Which is being put into the place or charging socket so he has to go from the ground floor climb up the stairs move to the room take out.

Or take control of the charger come down to his room and again put it in the socket and the start the charging. So, this is a maybe we have to see that what are the various sequence may be here you can see the action distance will come into picture body motion will come into picture gain control will come into picture placement will come into picture. So, we will see that which type of the activity.

And which type of sequence model is irrelevant example where a person who goes from first floor sorry from the ground floor to the first floor to bring his charger. And accordingly depending upon the distance he is moving depending upon the steps he is claiming depending upon the way he is gaining that control whether he has to search for the charger or it is already placed in the socket depending upon the conditions of the nature of work.

We will follow a sequence model and try to find out that how much time will be taken using this technique of MOST.

(Refer Slide Time: 31:28)

MOST Study Forms

MOST - Calculation			Code:	
			Date:	
Area:			Sign:	
			Page: /	
Activity:				
Conditions:				
No.	Method	Sequence Model	Fr.	TMU
1	Describe activity 1	Ax Bx Gx Ax Bx Px Ax		
2	Describe activity 2	Ax Bx Gx Ax Bx Px Ax		
3	Describe activity 3	Ax Bx Gx Mx Xx Ix Ax		
		Ax Bx Gx Ax Bx Px _ Ax Bx Px Ax		
TIME =		minutes (min.)		

Now this is you can see describe activity one the standard sequence ABG ABP A similar describe activity 2 we have to give the value of x we have to note down and based on the value of x may be this is the frequency coming into picture then the TMU values may be suppose we get TMU 1 then 2 then 3 then 4 and then we will add up these all TMU values and these TMU values then well help us to find over the time.

Because these are time measurement units so we will be able to find out at the time required for this activity or this work or this task or this job which we have divided into the basic motions and those motions are in a particular sequence. Specially in case of MOST whereas in case of MTM will be taken as individual motions.

(Refer Slide Time: 32:18)

Application of MOST

- This technique finds its application for method improvement.
- It helps to establish the standards and **also for determining the production delays** and **labour performance index**.

So, what are the applications of MOST. This technique finds it application for method improvement we can see that we can compare 2 or 3 different alternatives and choose the best alternative based on the result of MOST. It helps to establish the standards and also for determining the production delays and labour performance index. So, MOST of the outcomes of the work measurement techniques are more or less same.

That we need to decide that what must be the best way of performing the task or if we have 4 5 alternatives at hand which one is going to be helpful for us helpful for the worker, helpful for the organization in terms of consuming less time, less human effort, less energy while delivering the objective or the goals for which the work is being done or the method is being used. So, with this we conclude our session on introduction to MTM and MOST.

In our next session we will start our discussion related to the topic of ergonomics but one thing I would like to suggest that we have not been able to cover the topic in the detail in which I would have liked to. But still I think the introduction part is clear and based on the introduction I would request all of you to have please look at different books and try to solve 1 or 2 problems related to MOST as well as related to MTM. Thank you.