Work System Design
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Lecture – 49
Introduction to Synthetic Data and PMTS

Hello friends, welcome to session 49 of our course on work system design. We are currently trying to find out the standard time for performing the task and prior to this we have had discussion for 4 weeks on method study and if you remember in method study we have found one best method for performing that task. We have found out one best sequence of operations to perform the task.

So, already the way method, the technique by which the work has to be done is already known to us. Now we are trying to find out that how much time it will take for a skilled experienced worker to do that task using the standard approach. And in that we are discussing the various tools and techniques of work measurement. and in work measurement if you remember we have already seen the stop watch time study.

We have seen the time sampling approach now our focus primarily is to understand that why do we need to do the study again and again why cannot the things would be a reference, why cannot there be a standard synthetic data through which we can do the calculations and to find out how much time it will take to perform the task. For example, this is an example which I normally use in the class.

That a hole has to be made in 1 centimeter or 10-millimeter-thick mild steel plate. So, the problem is we have to make a hole in a plate which is made up of all material which is already known to us no we have to make a hole if we divide this overall operation of hole making or drilling in a steel plate we can be divide it into the individual work elements maybe fixing up of the job.

Switching on of the machine bringing the tool sorry the machine down performing the actual drilling operation then moving the drill up, then removing the job from the work holding fixture,

cleaning the machine. So, these are the various work elements that will be used now suppose we are doing a time study using the stopwatch and for each of the work element for 3 or 5 different workers we note down the ratings using the stopwatch.

Then maybe for each work elements and for each work we try to take 5 to 10 for 5 different workers we take these readings. We average out and then we multiply it by the rating multiply these with the rating factor finally adding the allowances we are able to find out a standard time for hole making in a steel plate of 10 milli meter thick only the diameter I have not specified for example it is a 10 millimeter diameter hole.

The diameter is 10 milli meter the thickness is 10 milli meter of the plate. Now suppose maybe after 6 months or after one year I have to again find out the time required for making 20mm hole or for that matter 5mm hole, the diameter is 5mm and the thickness is again in the same sheet it is 10 mm. Why do I need to do the time study all over again when already I have divided the overall operation into the individual elements.

And for each element I have taken may be 25 or 30 different readings and for each work element I have averaged out the reading that I have multiplied with the rating factor and the same workers are going to perform the task. Why do I need to do the time study again cannot I document the data which I have done for 10 milli meter diameter 10mm and use the work elements which are common in my time study or stopwatch time studied data.

So, whatever elements are common I can directly take the information from there and whatever is uncommon which is special I can do the study only for that and then I can combine the 2 and set the time standard a very very practical approach for setting the time standard for operations or work elements for which the data is already available. So, if we have already available data we can make use of that data and that is the basic concept on which we are going to discuss today.

The importance of the synthetic data and the PMTS we have the title of the course today we are going to discuss is introduction to synthetic data and PMTS predetermined motion time systems So, both these terms I have used numerous times in our discussion on work measurement, today

we are going to start this discussion and maybe in the session number 50 our target will be to discuss the motion time measurement MTM system which is one form of the PMTS system.

Today is the introductory part and I think I have laid a good foundation for the discussion for today that it is not always desirable to do the time study or work sampling again and again. So, if we have the standard data available with us for the various work elements which are common with the different types of jobs we can use the standard data and synthesize the data add that data for the basic motions to find out the overall time standard for the particular job or the task.

Or the group of task so let us start our discussion with this background now let us see what is synthetic data.

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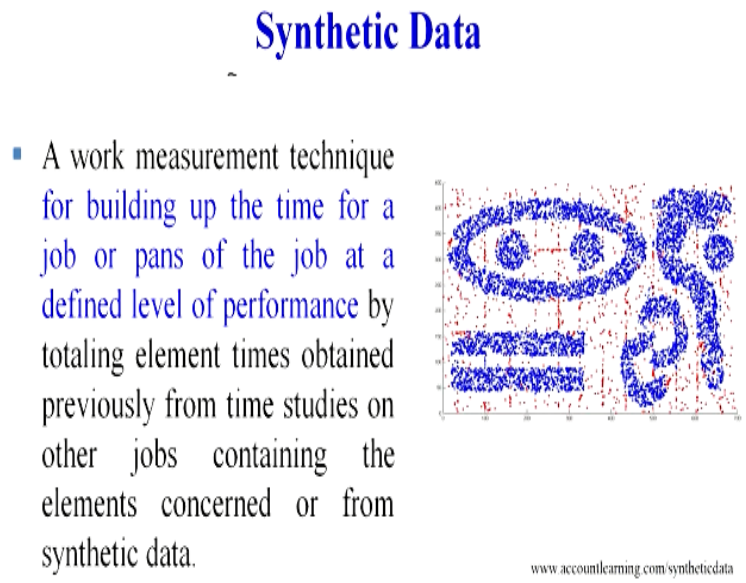

Very very important here we can see adding up all of the dots has led to the depiction of a figure here also adding up of the dot. So, so here also the basic work motions or work elements we are going to identify in the job in which we are for which we are going to set up the time standard and then we are going to add up the elemental times for each and every element to synthesize it into a time standard.

So, what do we mean by synthetic data so it is a work measurement which is our broader topic so synthetic data is a work measurement technique for building up when we make a building we

make it brick by brick by brick by brick. So, similarly building up here means elemental time + elemental time + elemental time maybe for all the work elements we add the time and we get the total time for performing the task.

So, it is a work measurement technique for building up the time for a job or pans of job at a defined level of performance. How so this is a technique for finding out or calculating or synthesizing the time required for performing the job at a defined level of performance. How by totaling element times obtained the totaling element time? So, we have to divide the overall work into their individual element and for each work element we have to look in the synthetic data.

The time that is already recorded for some other job which was time studied earlier and the time elemental times are well documented. So, from there we will take the time for the common elements. So, once we are able to get to the times for that various elements we will obtain previously from the time studies. So, whatever time we get what we will do we will total them so totaling the elemental times.

Obtained previously from the time studies on other jobs containing the elements concerned or from the synthetic data. So, basically what we are going to do we are going to divide the overall work into the individual elements and for each element we are going to look for the synthetic data available in the form of time estimates and one in these individual time estimates we will add up and try to set up the standard time for the job in question.

Now what are the steps involved in synthetic data.

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Steps Involved in Synthetic Data

- Collect ***all the details about the job*** (dimensions, tools, method).
- Analyze jobs into constituent elements.
- Select **appropriate basic times** from synthetic data covering contingent factors.
- Synthesize and apply synthetic data covering contingent factors.
- ***Verify details of elemental analysis*** for job method and condition.
- **Total** the basic times, rating and allowances to compute standard time for the jobs.

Collect all the details about the job dimensions, tools, method as I have given an example of the drilling operation. Analyze the job into constituent elements.so whatever is the job suppose this is the job we have to divide it into the constituent elements for example the total job is divided into 4 elements 4 basic work elements. Select the appropriate basic times from the synthetic data covering the contingent factors.

So, for all these 4 elements we have to find the basic times. Synthesize and apply synthetic data covering contingent factors. SO, for now this we have to first select the time for the individual element then we have to add up these times to synthesize these trying to get the total time. Verify the details of elemental analysis for job method and condition. So, we have to check that whatever total job has been divided into the element different work elements.

Whether it is actually depicting the complete job profile or not or something we are missing or something we are adding additionally which is not required in the job actually or practically is not required in the job. Total the basic times which already has been said rating and allowances to compute the standard time for the job. So, the only thing here is that we are not going to actually or physically going to record the time.

Or the worker to observe the worker and then note down the time. We are also not going to do the work sampling where a time study analyst is going periodically or randomly to the shop floor

to see whether the person is working or idle. Here we are going to use our previous data of elemental times to add up the elemental times for the job in question only those elemental times we will add for which we have the previous data available.

And then we will try to synthesize the standard time for performing the task. Now what can be the advantages you can very easily now infer the advantages.

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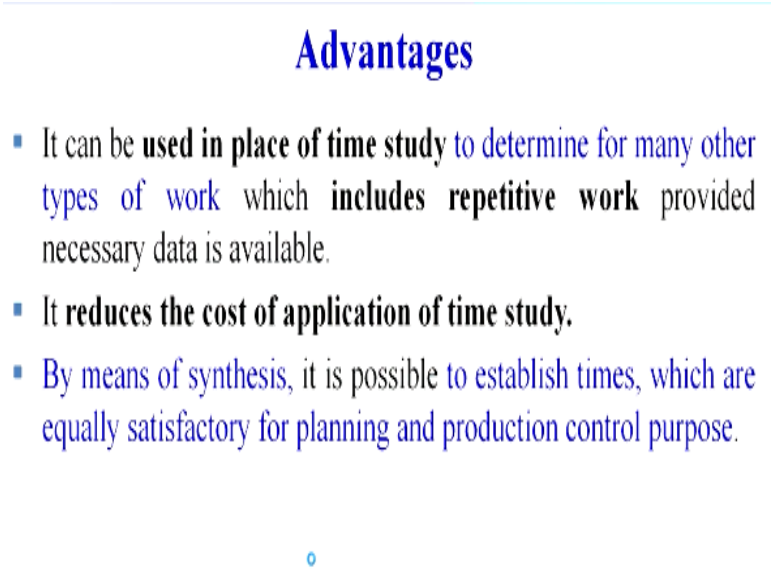

It can be used in place of time study to determine for many other types of work which includes repetitive work provided the necessity data is available. So, repetitive work is there in that case you can use the synthetic data. It reduces the cost of application of time study so we need not have persons going on doing the recording for or recording of time for the various worker. SO, it is just maybe summation of the already available data to find out the standard time.

By means of synthesis it is possible to establish times which are equally satisfactory for planning and production control purpose. So, why do we want to find the standard time for performing the task in order for planning and for production control per person. So, whatever information we can derive from synthetic data can be equally useful as if we have done it manually or physically timing the worker or the work sampling approach.

So, even if we do a stopwatch type of time study or do we do a work sampling study or work

sampling procedure to set the standard time this synthetic data approach is equally profitable is equally applicable for the planning and the production control purposes.

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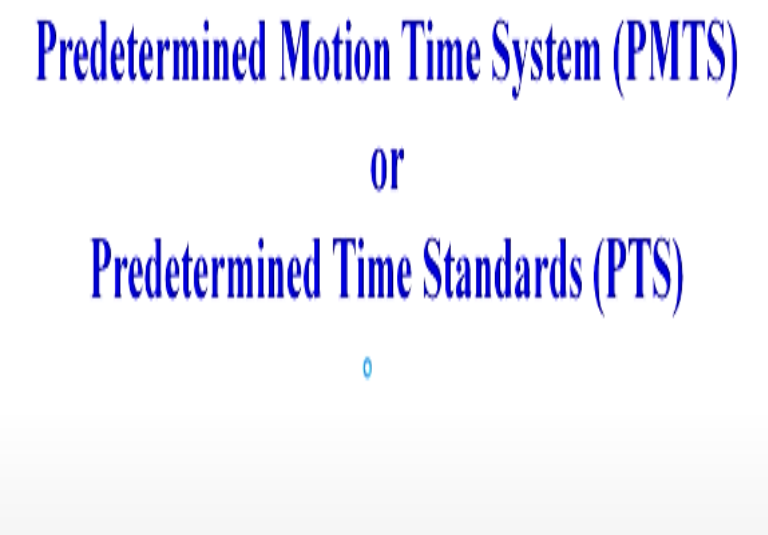

Now the second approach is the predetermined motion time systems or the predetermined time standards this we will try to understand. So, there are different types of PMTS we will try to just have a historical review of all these types of systems and then finally we will see that what is the basic behind predetermined motion time systems. So, what do we mean by predetermined motion time system synthetic data I think is clear to all of you.

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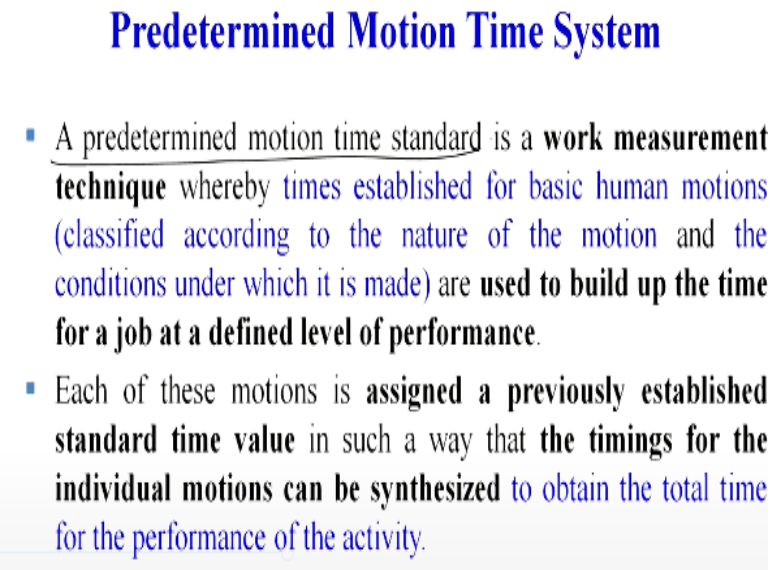

Now a predetermined time standard or a predetermined motion time standard is a work

measurement technique it is also work measurement whereby times established for basic human motions times established for basic human motions classified according to the nature of the motion and the conditions under which it is made. So, the basic human motions or the times established for basic human motion are used to again build up the time for a job at a defined level of performance.

So, the important point is that already there is time established for basic human motions. So, there are maybe standard tables or values which are already available with us. So, these values are the times established for basic human motions are used to synthesize or build up the standard time for performing a task or for performing a job at a defined level of performance. Each of these motions is assigned up previously established a standard time value.

Previously established in case of stopwatch times work sampling we set the standard time. We find out we calculate we use statistics to calculate the standard time. But here we are using that time standards already established for the previous jobs and from there we are trying to do do so as much information as possible. But one thing we have to keep in mind that our new job or the job.

For which we are trying to find all the standard time element must have same work elements for which the time standards are already available. So, that is an important prerequisite because we have to first divide the job at hand into it different work elements or per this definition into the basic human motions. So, for these basic human motions the data is already available so and that data is based on according to the nature of the motion and the conditions under which it is made.

So, we will see different types of examples for PMTS and try to understand that what do we mean by the nature of motion and what do we mean by the conditions under which it is made. So, each of these basic human motions or basic human motions is assigned a previously established time standard value in such a way that the timings for the individual motions can be synthesized to obtain the total time for the performance of the activities.

So, we will build up we will add up we will synthesize all this basic work element into the total

time required for performing the job at the defined level of performance.

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Commonly Used PMT Systems

- Method Time Analysis (MTA) - **1924**
- Work Factor System (WFS)- **1938**
- Methods Time Measurement (MTM)- **1948**
- Basic Motion Time (BMT) -**1950**

Now these are commonly used predetermined motion time systems very quickly one slide 2 slide each we will try to cover these method time analyses. Work factor system, methods time measurement, basic motion time. So, let us see one by one this MTM we are going to study in detail maybe we may cover this in the next session.

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Method Time Analysis (MTA)

- **A. B. Segur** of Oak Park Illinois was one of the first to establish the relationship between the time element and the motion itself.
- Segur stated that ***the method must be well defined*** before an attempt is made to estimate the time standard for the motions involved in the task.

1886- 1975

So, a method time analysis the historical perspective A B Segur of Oak Park Illinois was one of the first to establish the relationship between the time element and the motion itself. So, there are 2 things one is the basic motion and another one is the time. So, we have to divide the work into

the basic motion and for those motions we have to establish a time that this is the time or the time element required to perform this basic motion.

So, Segur stated that the method most be well defined before an attempt is made to estimate the time standard for the motions involved in the work. So, this is what I have been emphasizing in the beginning of almost all of my sessions. We have been saying this again and again that we have already discussed the best techniques or the techniques which can be used to find out the best method for performing the task.

Some of the graphical tools that we have already studied are the outline process chart, flow process chart, multi activity chart, 2 handed process charts, SIMO chart principles of motion economy also we have studied, therbligs we have studied. So, we now know what can be the techniques which can help us to find out the best method for performing the task. What is the best method all of you know?

Now once the method is established then we have to focus our attention on finding the time required for performing the task.

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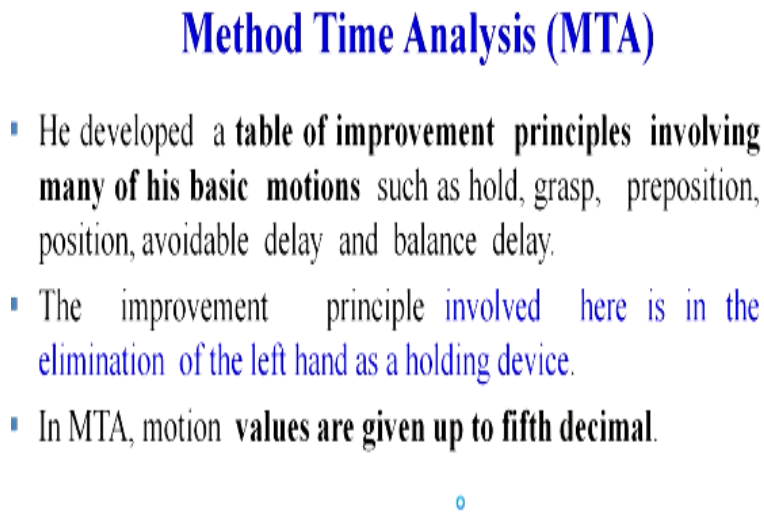

He developed a table of improvement principles involving many of his basic motions such as hold, grasp, preposition, position, avoidable delay and balance delay. So, these are the basic

motions so these basic motions were involved in dividing the total work into the individual motion and for each motion then there can be a time estimate which can be added up depending upon the types of motions coming into picture for the specific job.

It may not happen that all the principles or all the basic motions are being used for a particular job whatever it is used to be selected time will be noted down and it will be synthesized or to build up. So, table of improvement principles involving many basic motions were developed by him the improvement principle involved here is in the elimination of the left hand as a holding device.

So, this is the improvement principle which is very very specific to method time analysis. In MTA motion of values are given up up to fifth decimal place. This is the historical perspective of MTA.

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Work Factor System

- This is a **system of PMTS** in which it is possible to determine the work factor time for manual tasks **by the use of pre-determined data**.
- A detailed analysis of each of the task is made based upon the identification of major variables of work and the use of work factor as a unit of measure.
- Then the **standard time from the table of motion value is applied to each motion.**

This is a system of PMTS in which it is possible to determine the work factor time for manual tasks again the manual task the work has to divided into manual task by the use of predetermined data. So, the basic principle remains the same that we have some historical or some previous data pre-established data available with us and we have to correlate to the job for which we are performing the work measurement.

And we have to divide the job into the individual elements and then look for the data available and then find out the data and synthesize it into the standard data. So, detailed analyses of each of the task is made based upon the identification of major variables of work and the use of work effect as a unit of measure. Then the standard time from the table standard time from the table of motion value is applied to each motion.

So, the basic language may change but the theory behind the principle remains same.

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Work Factor System

Four major variables of work factor system are:

- Body member
- Distance
- Manual control
- Weight or resistance
- **This system is applicable to highly repetitive work.**

Now work factor system 4 major variables of work factor system are body member, distance travelled, manual control, weight or resistance maybe suppose I am moving and holding a weight for maybe 2 meters' distance. So, the weight is also coming into picture as a factor the distance of 2 meters is also coming into the picture. So, that will be accounted for when we look for the standards.

And accordingly we will add up these standards to find out the standard time for performing the task. This system is applicable to high repetitive work so the important factors need to be understood the body member, the distance, the manual control and the weight or resistance.

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Basic Motion Time study

- Basic motion time was developed by **J. P. Woods** and **Gordon Limited, Toronto (Canada)**.
- According to **Woods and Gordon**, it is defined as "Any motion which starts from rest, moves through space, and ends at rest."
- **Type 1- Reach**
- **Type 2- Move**
- **Type 3- Turn**
- The body motion and symbols are very similar to the body motion employed by MTM and the only difference lies in the step, where the distance measured is the distance the foot travels.

Now basic motion time study third type of PMTS system. Basic motion time was developed by J P Woods and Gordon Limited in Toronto Canada. According to Woods and Gordon it is defined any motion which starts from rest so the initial state is rest state moves through the space that is the motion and ends at rest. So, that is they have defined the motion as now different types are type 1 reach.

For example, this pointer is kept here I am standing here I am in a state of rest so first can be I reached to this place I go and pick it up. The second type 2 is move. I have moved and type 3 can be in the body motion and symbols are very similar to the body motions employed by MTM and the only difference lies in the step where the distance measured is a distance the foot travels. So, maybe the MTM classification.

Or the motions are more or less similar to the basic motion time study. So, we are going to study MTM in much more detail. We will have a complete session on MTM. But this is the historical perspective of the PMTS system or various types of PMTS system. So, the overall summary of the PMTS is that yes there is a standard data available or there is the time estimates available for the various basic motions.

And we can divide the work into the various basic motion to find out the standard time for the job.

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Components of Basic PMTS

Motion	Description
Reach	Move hand to destination
Grasp	Secure control of object with fingers
Move	Move object
Position	Line up and engage object
Release	Let the object go
Body Motion	Leg, trunk movements

Now let us see the predetermined motion time systems basic what are the basics so the components of basic PMTS system are given here the motions, reach the description is given to move hand to the destination, grasp, secure control of object with fingers. Move - move the object, position line up and engage object, release let the object to go, body motion and leg trunk movement.

So, these are the various basic motions and this is their description given for them now what we need to keep in mind we need to keep in mind that whatever the work we want to find out the time estimate for the for the work for which we want to find out the time estimate of standard time. We have to divide the work into the individual motions and for these motions we have to take into account other factors also.

The distance moved the steps moved suppose somebody has to bring the material or a job from the first floor so the person will move for a particular distance then he will climb up the stairs then well go to the shop maybe he will move certain steps in that movement also then he will locate where the job is lying then he will pick up the job. The job may be heavier it maybe 10 kg 15 kg of weight.

He has to bring down the job from the steps and come back to the place from the where he

started. So, the same one of the principles we have seen in the state of rest then he moves then he again he comes back to the state of rest. So, all this total of work is divided into the individual elements or the motions and for each motion then we will have to look for the time estimates and based on the times we will calculate the total time required for performing this task.

And these are some of the motions given on your screen.

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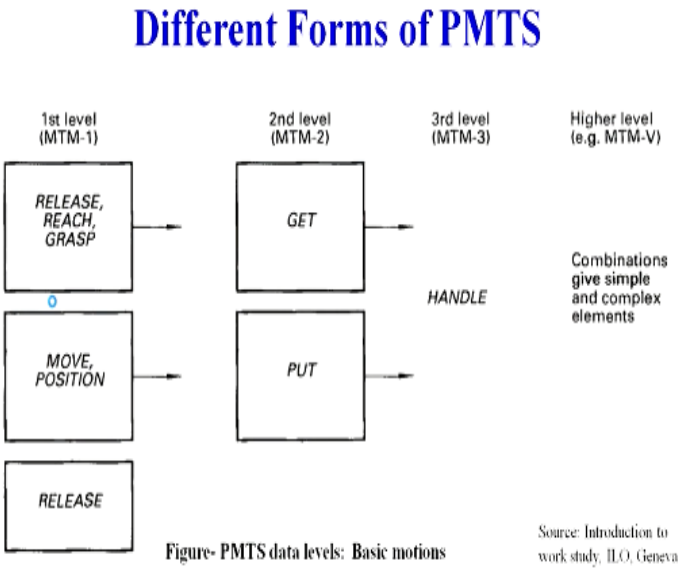

Now there are different forms of PMTS systems this is the first level MTM-1 so here we use basic motions like release, reach, grasp, move, position, release. In the second level of MTM we use GET which can be a combination of release, reach, grasp and then PUT which is going to be a combination of move and position. So, in PUT we can see put this thing here another things is move first and then position it at this place.

So, move+position in MTM2 we can say PUT and the third level we can say HANDLE, HANDLE means GET and PUT. So, I am getting it and then positioning it so it is handling I am handling this particular pen. So, may be different levels of MTM so the basic body motion of the basic motions is divided into different levels or different levels of micro analysis or different levels of micro motion.

And if you remember we have already seen in method study the principle of therbligs. So, we at

one point of time focusing on the basic motions of the human body. And the other and or the higher level of analysis we are developing outline a process chart where we are focused on the overall industry in totality or as a whole. So, we have different levels of analysis we can have analysis at the system level.

We can analyze at the man machine interaction level or we can have the analysis the man or the basic hand movements or basic foot movement of the basic eyeball movement of a worker who is performing the task. So, the level of analysis keeps on changing and this MTM-2 also MTM-2 also MTM for also higher level MTM-5 is given. So, maybe different levels are there so it is for us to decide that.

At what level of basic motions we want to go and find the time required for performing the task.

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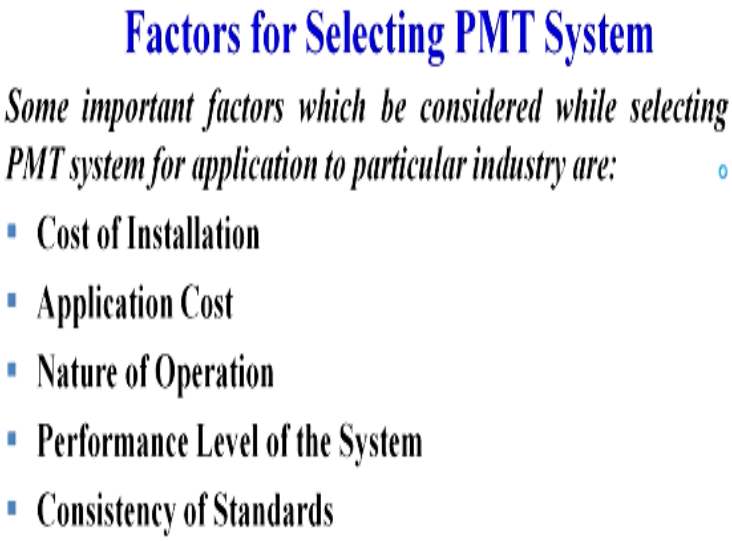

Now factors for selecting the predetermined motion time system so these some of the important factors which we will consider while selecting the PMTS system for application to particular industry. So, we have seen there are MTM-1 2 may be depending upon the level of analysis we can have different systems. So, how to decide which one to use one I have already told you that depending upon the level of our analysis.

We can decide which one is suiting to our requirement. But there are other factors also cost of

installation application cost application cost means when we are trying to find out the standard we may need to hire the expertise of a consultant so that it can be one of the cost involved in the whole process. Nature of operation as I have already highlighted that depending upon the nature of work being done in our organization or the industry on the shop floor.

We have to take a call that at what level we want to do the calculation. Performance level of the system that we have to a little take into account because the performance level at which the system that we are using or the already existing data has been recorded or has been documented whether our system is able to match up to that performance level or not has to be taken into account.

Then consistency of standards is another parameter which must be taken into account that whatever standards are followed in the industry where the system was developed or where in our industry only. Whether we are able to consistently follow those standards for which the previous data or the data which we are using for building up over time was developed over that consistency of standards also has to be kept in mind.

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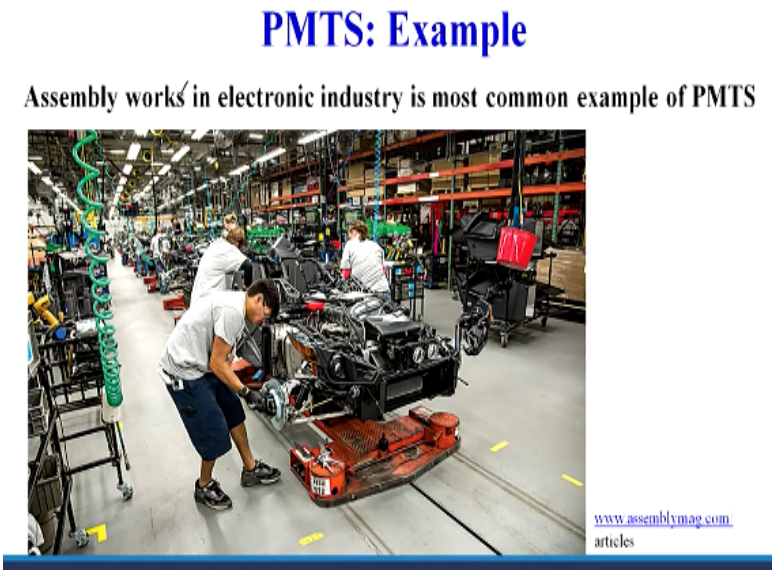

Now this is an example assembly works in the electronic industry most common example of PMTS system. Because you see the same type of repetitive work is being done. So, even if there is a small change in the operation we did not do the time study again. We can look for the basic

motions and then try to find out what are the additional motions being done try to look for the time estimates.

And add up the time estimates to get the new time standard, what are the applications of PMTS

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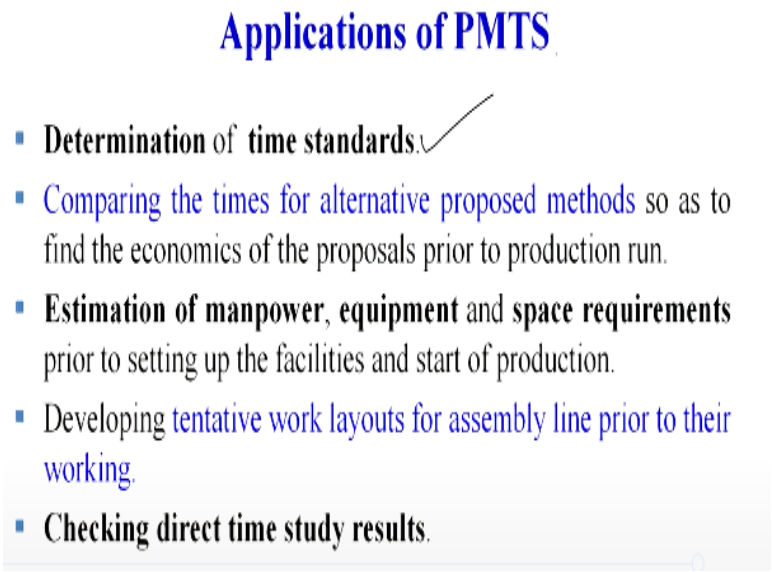

It helps us the determination of time standards I have been highlighting this all through today. Comparing the times for the alternative proposed method so as to find the economics of the proposals prior to production run. So, we may have 3 or 4 different proposed method so we want to find that method which will be accomplishing the work in the minimum possible time. So, time standard

Or PMTS system can help us select the best proposal out of the alternative proposal method. This is a very common advantage or application of work measurement technique that we can build estimation of man power, estimation of equipment, space requirement prior to setting up the facilities and start of production. So, once we know how much time will be required by able bodied person to perform a specific task using a standard method.

We can very easily do the calculation for the man power requirement, equipment requirement, space requirement as well as other decisions related to managerial activities. Developing tentative work layout for assembly line prior to their working So, that can be also be seen if we

have to for example make assembly line where the movement of the job on the assembly line can easily be controlled.

If we are able to find out at how much time a worker will take in performing a specific task and then checking the direct time study result. So, we can also find out what improvements have been noticed after the finding out of the standard time.

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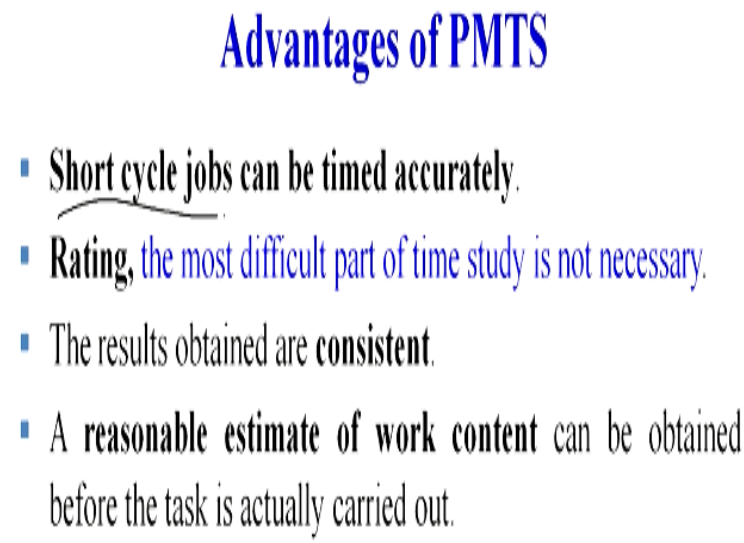

Now what are the advantages of PMTS system short cycle jobs can be timed accurately, rating the most difficult part of the time start is not necessary here we have to find order times for the various basic motions and then add them to calculate the standard time. So, there is no need to multiply the observed time with the performance rating factor or in work sampling also we use the rating which is not required in PMTS system.

The results obtained are consistent. A reasonable estimate of the work content can be obtained before the task is actually carried out. So, here we can synthesize based on the already available information what we can synthesize the time data whereas in case of stop watch time study and work sampling the work might be in or the work has to be in performance. the work has to be done or the work has to be in action.

Because we have to record our data based on the actions of the work but here the action is

missing that action is not required. We have the data we have the information based on that information based on our common sense of the work being done dividing the work with individual constituents we can synthesize the time standard before the work actually being done on the shop floor.

So, that is another advantage of PMTS system so that is all regarding the PMTS system, as well as the use of synthetic data in the next session our target will be to understand the MTM system which is one of the important types of PMTS systems. Thank you.