Work System Design
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Lecture – 37
Techniques of Work Measurement

Namaskar friends, welcome to session 37 of our course on work system design and if you remember in the previous session, we have started our discussion on the work measurement and if you remember prior to that we have tried to understand that how the method of doing the work can be improved, we have seen different techniques or different graphical tools or different calculation methods that can help us to develop a better method.

If you remember, sorry; we have seen operation process chart flow, process chart flow diagram, string diagram, multi activity chart, 2 handed process chart, SIMO chart, micro motion study, principles of motion economy which help us to find out one better method of doing the job, once we have decided that this is the better method, then we try to establish the time standards for that job that is how much time must be given to a worker to perform the task as per the defined sequence of step.

As per the defined way or defined method or defined technique of doing the work, so how we have defined it? We have already found one particular better method or one established better technique of doing the work through our output of method study and in method study, we can do analysis at different levels, we can have a broader analysis using operation process chart or we can have a minute test analysis or elemental level analysis of the work being done using the micro motion study or using the therbligs.

So, once we know that this is the method to be followed in our previous session, we have seen that we can do the work measurement, now what are the objectives of work measurement we have covered in the previous session, we have also covered that what are the applications of work measurement and if we are able to find out the standard time, how it is going to be helpful to us.

And we have seen that it is not only one value in terms of time required for performing the task which is the output of work measurement, it can be used for different levels of decision making in an organisation, it can help us in financial planning of our organisation, it can help us in the defining the jobs and incentives of our organisation or the for the various workers working for the organisation, it can help us for better scheduling the various activities being done in the organisation.

So, it is just not a number but it is a kind of an output which is going to influence a number of other key decisions within the organisation therefore, it is very, very important that we know that how much time will be required for an average experienced worker or a skilled worker or a qualified worker to perform a task or perform a specified task at a defined level of performance, so there are 2, 3 things in this definition or the word that I have used.

Defined level of performance, we will try to understand it during the course of our sessions, then we will see standard time or the time required, we will try to find out that time required, how by using different techniques and the title you can see on your screen is the techniques of work measurement. So, today our target is to find out or to learn that what are the various tools and techniques that can help us to establish this standard time.

Now, depending upon the historical data available with us, depending upon the accuracy required, depending upon the application for which we are going to use the time study, there can be number of criteria based on which we can select that which particular technique of work measurement we are going to employ during our calculation or for during our time or work measurement study.

What can be the various techniques? So, let us try to understand, now one thing maybe I will ask you is, suppose you are walking and you decide to walk 4 kilometres per day, how you will time yourself? You will be using your watch or there are equipments available, which can even give you the distance that you have travelled but my question is I am asking that how you will find out the time that you have taken for completing 4 kilometres of walk, you will be using a watch.

So that watch you start from level 0 or you start from the beginning or from your home and then you have to cover 4 kilometres after you come back, you will again see the watch, you will say that I have completed the 4 kilometre walk in this much time, so that is the basic of work measurement that what is the time required for performing a particular task in the most loosely defined manner.

But once we are doing it scientifically, we are doing it logically, we are doing it with the purpose, we are doing it for better management of our organisation, we have to keep in to mind or we have to keep into account a number of other parameters also, now one of the parameters is the level of performance maybe the rate at which I am performing a 4 kilometre walk is different, I may be working, I may be habitual of walking at a slightly faster pace.

There can be other person because of his or her age may not be walking as quickly as I can walk, there can be a person who is younger than me who is much, much, much faster than me, so we need to find out when we have to set a time standard, we need to find out that what is the defined the level of performance for completing a walk of 4 kilometre by averagely experienced person or by a skilled person or by a qualified person.

So, that is basically in the organisation we assume that all workers, who are working or qualified they have the requisite experience and for them only, we will try to perform the or on them only, we will try to perform the time study, so it is not as easy as I have tried to make it that if you start from your home and come back your home after completing a walk of 4 kilometre and the time you see is the time standard, no.

There can be number of other parameters also, now suppose I am taking a walk of 4 kilometres daily, I can average out that for the last 4 years I am going to walk every morning for 4 kilometre, this is the average time that I take, yes, then maybe slightly I am close to the standard time but on any given day if I go I meet somebody I am talking for another 15 minutes there, so that may disturb the value of average.

So, basically we need to do it in a very, very scientific and logical manner and all these kind of delays, all these kinds of allowances have to be taken into account, when we set the standard time for doing a particular task, so there are different techniques; one technique may be indirectly I have exposed all of you to that is using a watch, so basically we use a stopwatch in case of time study.

And try to find out the time required for completing the various elements or the various sub tasks involved in the activity. So, we will see today that what are the various techniques? We will try to understand the basic concept of each technique and then maybe subsequent sessions we will try to take each of these techniques in much more detail with certain examples and case studies.

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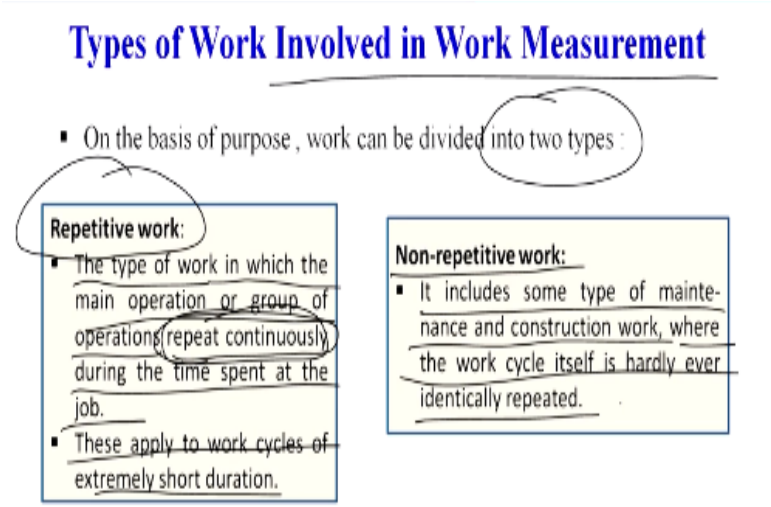

So, let us see now what are the various types of work involved in work measurement that where in which type of work, we can do the work measurement or what is the type of work which we can focus during work measurement, so on the basis of purpose work can be divided into 2 broad types. Now, the first one is the repetitive work, now what do we define as a repetitive work? The type of work in which the main operation or a group of operations repeat continuously very, very important, repeat continuously during that time spent at the job.

So, repetitive work, where the operation or the sequence of operations are being repeated continuously, these apply to work cycle of extremely short duration for example, a person is a

forging or doing a manually he is trying to hit a metallic piece, so maybe it is repetitive in nature, he is hitting it repeatedly, so the work cycle is; we can say repeating continuously. Non-repetitive work opposite to repetitive work, it is a non-repetitive.

Now, what is a non-repetitive? It includes some type of maintenance and construction work, where the work cycle itself is hardly ever identically repeated, so maybe some work may be repeated but it may not be repeated in an identical manner, there may be a few changes here and there, so it is not completely repeating the cycle or the work cycle, so where our focus will be in work measurement, our focus will primarily be on short cycle work cycle of extremely short duration this is a major focus in case of work measurement.

So, wherever repetitive work is done, wherever short cycles are there for short duration in those cases of; in those cases, only we are trying to do the work measurement but there can be few techniques which we are going to see today which can be applicable to the non-repetitive type of work also.

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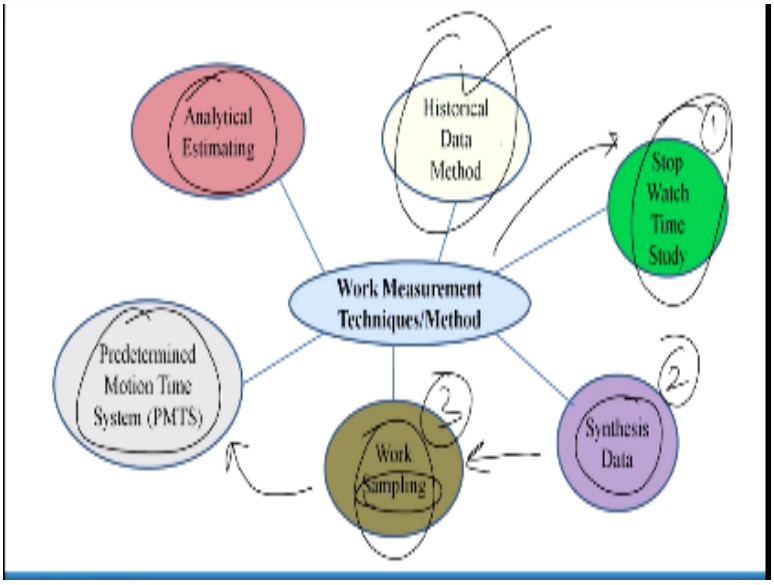

Now, this is on your screen, you can see different types of techniques, which can be used for establishing the time standard of performing the task at a defined level of performance. Now, what are these techniques or the different methods, let us start with this side; first one is the stopwatch time study, very, very important and maybe gives the data in the most simplest manner

and the example that I have already explained you that if you want to time the 4 kilometre morning walk from your home.

And coming back again to home after completing a walk of 4 kilometre early in the morning, you can find out how much time you are taking, so that is one maybe one most simple example of a stopwatch type of time study. Then, the second one can be the synthetic data, so here we are in a process of synthesising the time required, adding up the time for the elemental motions or the elemental activities.

So, what we do? We divide the total work being done into individual smaller sections or smaller work elements and then for those work elements, we try to find out if similar work element is being done in some other activity or operation also and whether the time is available, so if time is available, we directly take the time from there, so that is a synthetic data. Then there is another technique third technique, which is called work sampling.

Where a person goes, from the word you can see sampling, a time study analyst goes and checks whether the worker is working or he is idle or whether the machine is under operation or it is idle and because of the number of such observations at different intervals of time, a day is compiled and that data is used to set the standard time for performing the task, so please do not get confused with the terminology being used here.

Because I can assure you that once we will go out to each and every technique one by one, everything will become crystal clear and we will take certain examples, certain numerical problems also and when we solve those numerical problems ourselves, we will be able to understand the concept in the most clear manner. So, here in today's session I am trying to introduce the various techniques that can be used for finding out the standard time or for calculating the standard time.

The third technique can be work sampling, 4th can be predetermined motion time systems, then in here also, we will see that how we can calculate the standard time analytical estimating technique and the historical data method, so if we have some historical data already available

with us may be for example, we want to make a hole in a 10 mm thick, maybe steel sheet or a 10 mm thick nonferrous sheet or nonferrous plate.

In that case, very easily the data may be available that if the diameter of the whole is 8 mm, the thickness of the plate is 10 mm, the material is maybe steel, how much time it will take so, if that data is available in the; from the historical data, we are directly going to take that data and use it for our further calculations for scheduling for allocation of work to the workers or for deciding the salary of the workers.

So, whatever decisions we need to take based on the standard data, we can make those decisions by taking the data from the historical information or historical data sheet available with us, so broadly there are 2, 3 things coming into picture from this slide, first one can be that we can do the direct measurement of the work being done by a qualified worker using a stopwatch and then we can calculate the time required for performing the task that is one thing that is a stopwatch time study.

Then, whatever there in shop floor if you analyse the work you will very easily understand that there are a number of operations which are common but there are a number of micro emotions that are common, there are number of sequence of operations that are common, so why do we need to calculate for each and every operation, so therefore some data sheet or synthetic data can be available with us.

And from that data, we can take out the relevant information or the relevant time and for that time can be added to the some of the time, which we are not able to locate in the standard data available and then some work can be done experimentally or maybe some time can be found out using experiments, other can be taken directly from the data sheets or the data books available and then this can be combined together to set the standard time.

And the third can be that there is a historical complete set of information available with us specially, for drilling of holes in plates, so if that data is directly available, we can use that data for setting up the time standard. So, we can do the experiment using stopwatch or do we can say

recording of the activity for time using the stopwatch, we can use the previous data also; we can use the historical data directly.

So, depending upon the situation, we will be able to decide, we will be able to select that out of these techniques; 6 set techniques that are mentioned on your screen which one to use or which can be used for which type of work, so that is maybe some of you may be having this question that when we have to find out the time required for doing the operation, why not to call; why not to use a stopwatch and calculate the time for every operation?

So, there are different time saving techniques also wherein we take advantage of the already established times or standard times for the various elements of the work, so we will try to understand each of the techniques in its most simplest form as well as it is in its most exhaustive form also but taking different examples but today, we will try to have an overview of each of these techniques.

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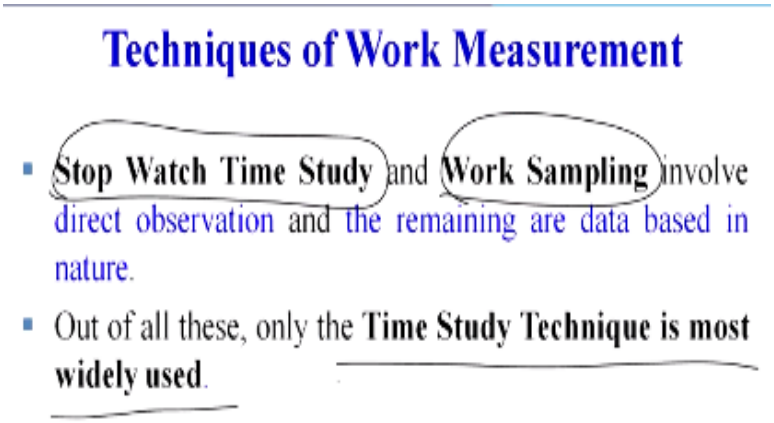

So, the first technique we can see on your screen is the techniques of work measurement; stopwatch time study and work sampling involves direct observation and the remaining are data based in nature. So, if you see the stopwatch time study where we use a stopwatch to record the time for doing the work as well as the work sampling, where a time study analyst go to the shop floor in a random manner after different intervals of time.

And tried to find out that whether the worker is working or he is idle both require the direct observation, so this thing you can keep in mind that the stopwatch time study and the work sampling requires observation of the worker, stopwatch time study further requires the continuous observation of the worker, whereas work sampling, a single time study analyst can analyse a group of workers and machines.

So, we can; because he has to randomly go at different time intervals and see that whether the work is being done or the worker is idle, so these involve direct estimation and as I have already told you the synthetic data technique as well as the other techniques that we have seen for example, a historical data method, analytical techniques, again go to the previous slide, the analytical estimation, synthetic data, then predetermined motion, time system, historical data.

All these are based on the data which is already available in the form of standard data sheets, so out of all these the time study technique is most widely used, so because here, we do the direct observation of the worker who is performing the task, so we will see now all the 6 techniques may be 1 or 2 slides each, the first one is a stopwatch time study. Now, the stop watch is the most commonly used work measurement method.

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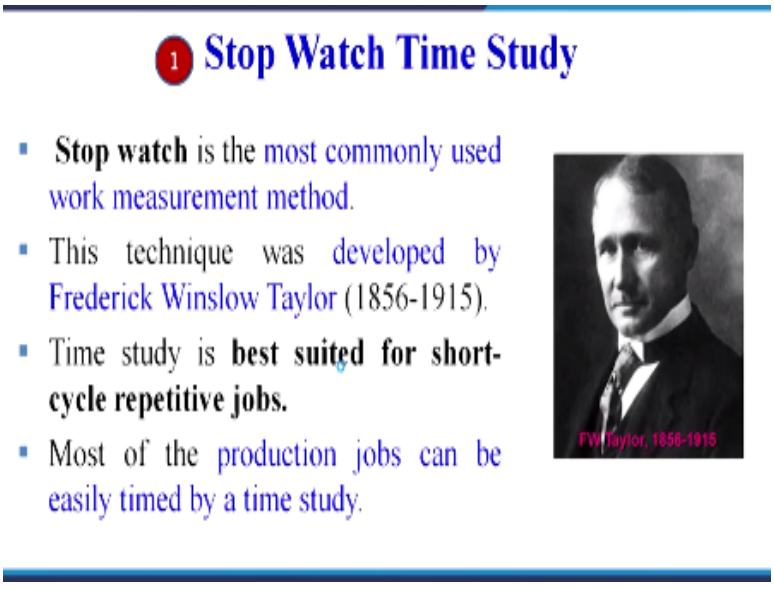

This technique was developed by Frederick Winslow Taylor, time study is best suited for short cycle as we have seen the type of work on which we can do work measurement and we have highlighted there that the various work measurement techniques are most applicable for short cycle repetitive job, so most of the production jobs can be easily timed by using the time study. Stopwatch time study now, what is basically stopwatch time study?

The historical perspective we have seen the wide applicability we have already established in the previous slide that the time stopwatch time study is the most commonly used technique for during time study or for work measurement.

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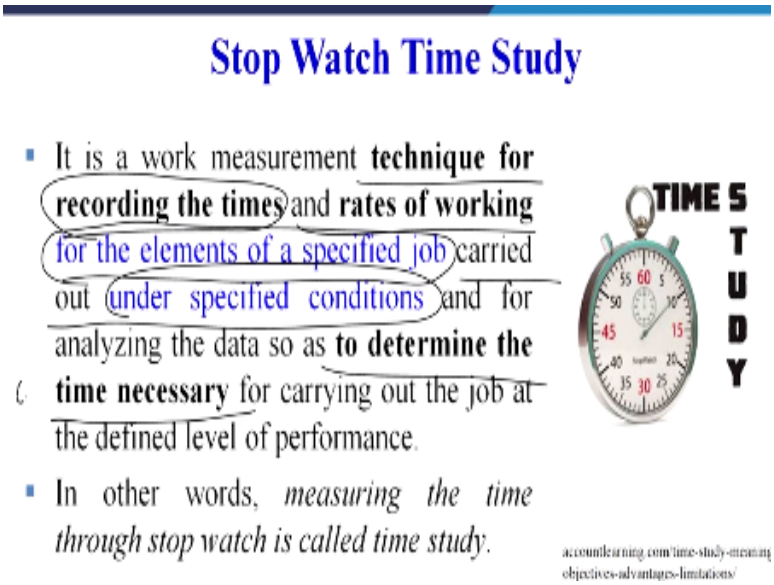

So, it is a work measurement technique for recording the time, so direct recording of the time is done on; we directly record the time taken for completing the work, so it is a work measurement technique for recording the time and rates of working for a elements of a specified job carried out under specified conditions and for analysing the data, so as to determine the time necessary which is the output for this technique for carrying out the job at defined level of performance.

So, basically in time study direct recording of the work is being done using a stopwatch, as soon as the worker starts his work, we start or we switch on the stop clock or the stopwatch and by the time, the operation is over or the activity is over, or a task is over we stop the stopwatch and then

see how much time has been taken for completing the tasks, another thing that we need to take into account is the level of performance.

Because it is very, very important job at the defined level of performance, this sentence is coming again and again and we will be able to understand it, when we understand the rating factor because here also it is again mentioned in detail, rates of working, so the rating factor is an important parameter while calculating the standard time for performing a task and that we will try to understand in our subsequent discussion.

But today, we can just remember that in stopwatch time study, we use a stopwatch, the worker performs the work at a defined level of performance, he is a qualified skilled experienced worker on whom we are performing the time study, in other words measuring the time through the stopwatch is called the time study. The defined level of perform, a specified method we will be may be discussing in our subsequent sessions when we focus on time study.

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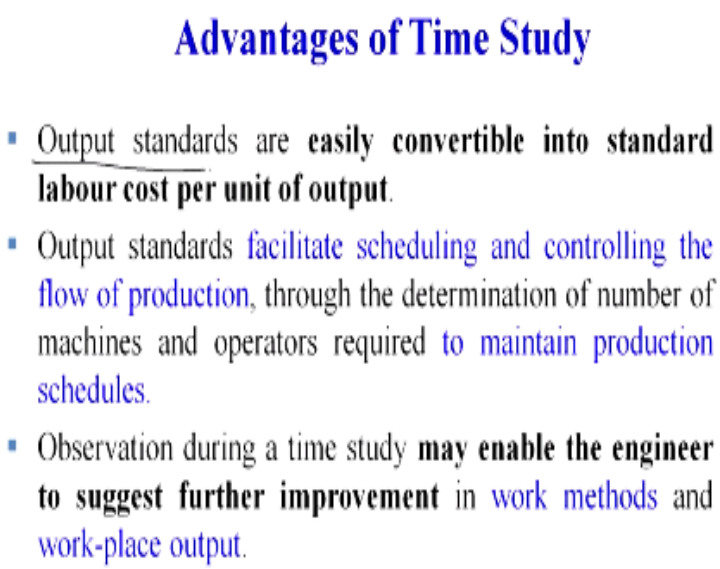

Now, what are the advantages of stopwatch time study? Output standards; now, what is the output; that is the time are easily convertible into standard labour cost per unit of output which can help us even to calculate the manufacturing cost of our product because the time standards are easily convertible into standard labour cost per unit of the outputs. So, once we know the

labour cost per unit of the output very easily, we can calculate the manufacturing cost per unit of output.

Output standards; this we have already covered in the previous session also that what are the various objectives of work measurement or time study and also we have established if you remember that where we can apply these time standards or what are the various decisions that we can take based on the time standards that we established use that; we have established using the work measurement techniques.

So, output standards that is the time facilitate scheduling and controlling the flow of production because for each and every operation in the production line, we know that what is going to be the standard time and if we know that time very easily, we can schedule our flow of production through the determination of a number of now, how we can achieve that we can easily determine the number of machines and operators required to maintain the production schedules.

So, once we know that for performing this task, this much time will be required very easily, we can calculate how many operators are required and how many machines are required in order to balance our production line. Now, observation during a time study may enable the engineer to suggest the further improvement in work methods and workplace output, so even many times our work measurement output in terms of the standard time can help us to improve the current method of doing our job or the work methods that we are currently employing for completing the work.

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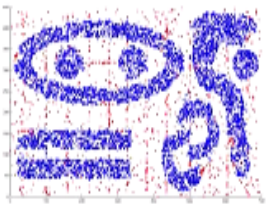
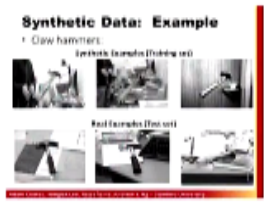
2 Synthetic Data

- A work measurement technique used for building up the time for a job, at a defined level of performance, **by totaling element times obtained previously from time studies** on other jobs containing the elements concerned or from synthetic data.





So, this is just one method, it is not just one method but it is the method which is most commonly used for work measurement, then the second method is the synthetic data, this is a work measurement technique, which is used for building up the time for a job. Now, building up the time for a job, what do we mean that? That we are going to build the time of the job brick by a brick or elemental time by elemental time, so what we do; at a defined level of performance is again coming.

Now, what we do here; we total the element times obtained previously from the time study, so now there is a synthetic data already available with us that for different operations, what is the time of a different tasks or different work elements, what is the time? We try to break down the work into the elemental tasks and for those task we try to look at the data which is already available and then we add the time for the different elements and find out the standard time using the synthetic data approach.

So, again I will read it for you to make it more clear, a work measurement technique used for building up the time for a job at a defined level of performance by totalling element times obtained previously from time studies on other jobs, time studies for other jobs containing the elements concerned. Now, the other jobs may also have the same work elements which are present in the current job for which we want to find out the standard time.

So, there may be elemental times available or similar elemental times available for the same work elements by a time study which was done earlier maybe a year or a 2 year earlier, we have some standard data available with us, so we can take help of that data and use it for totalling the work record; time required for each element and total this time to find out the standard time, so this is very, very important.

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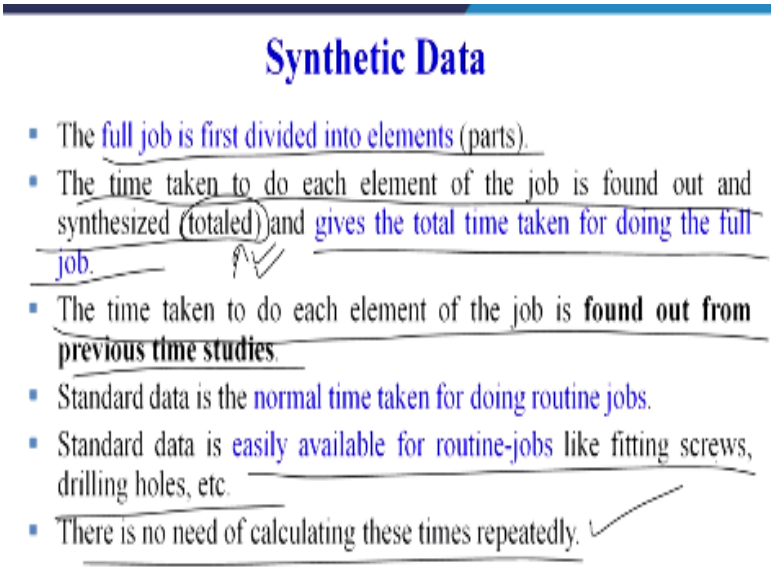

So, we you can do it quickly, I will read it for you, the full job is divided into the elements or parts, the time taken to do each element of the job is found out and synthesised that is totalled very, very important and it gives the total time taken for doing the full job, so whatever is the elemental time we take it from the data already available and at that time to find out the total time required for doing the job.

The time taken to do each element of the job is found out from the previous time studies, standard data is the normal time taken for doing routine job, standard data is easily available for routine jobs like fitting screws, drilling holes, so already for such type of routine jobs, the routine operations, the standard data is already available, so we can take that data add it up in the overall operation time may be in the overall maybe consisting of 4 different work elements.

So, we can find out the time required for all 4 from the data and add these 4 work elements time to find out the total time for performing the job, there is no need of calculating these times repeatedly. So, we need not do the stopwatch time study again and again.

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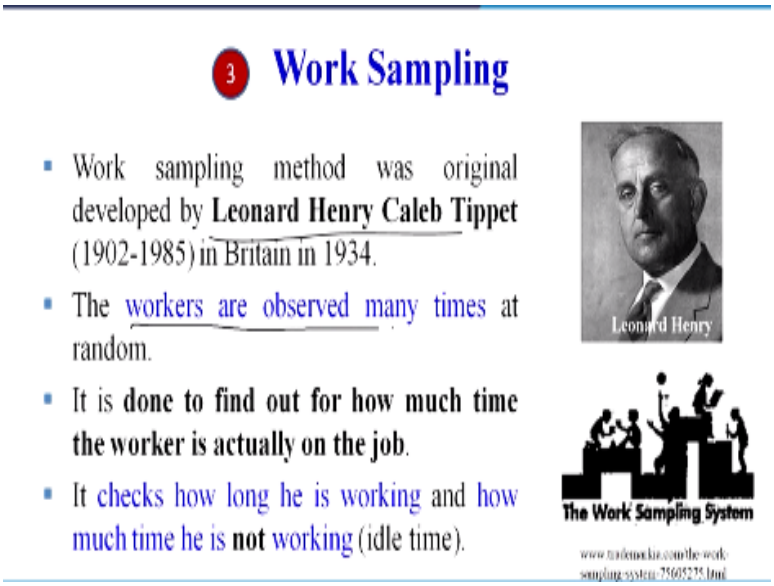

Now, in work sampling, so work assembling method was originally developed by Leonardo Hendry in Britain. The workers are observed many times at a random interval of time, it is done to find out how much time the worker is actually on the job and how much time he is idle, so the time study analyst goes to a job at intervals at different intervals of time randomly and tries to figure out whether the worker is working or the worker is idle.

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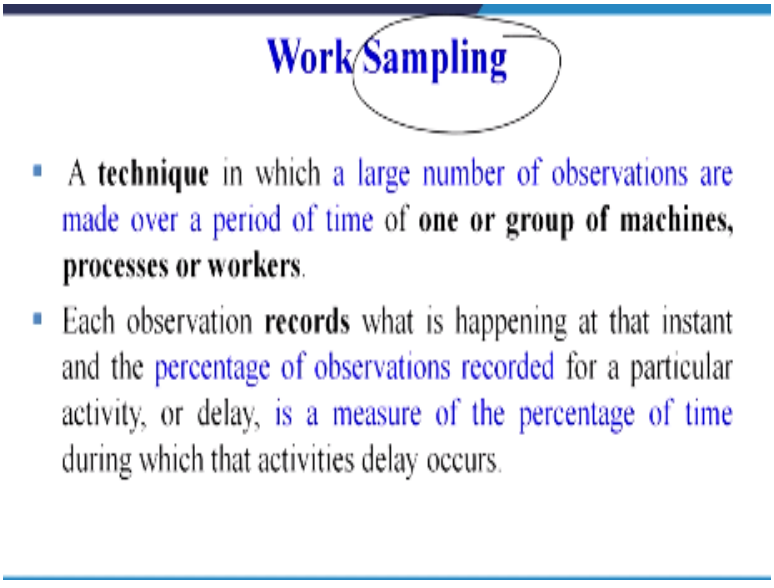

And you take a note of the situation that whether he is working or idle and then based on that it is found out that what is a standard time required for doing the job. A technique in which a large number of observations are made over a period of time of one or a group of machines, processes or workers, so, once time study analyst can time a large number of workers in case of work sampling.

Because here, the word sampling is involved, the time study analyst goes and takes a note that whether the worker is working or he is idle whether the machine is working or idle, each observation records what is happening at that instant and the percentage of observations recorded for a particular activity or delay is a measure of the percentage of time during which that activity or delay activity or delay occurs.

So, this is used to find out the standard time by a standard formulation or a standard formula that we are going to learn when we focus on work sampling but by now, we can just remember that in work sampling, it is not the continuous observation of the worker but it is a random observation of the worker at different intervals of time and one-time study analyst can observe different workers because it is random in nature it is not a continuous observation of the worker.

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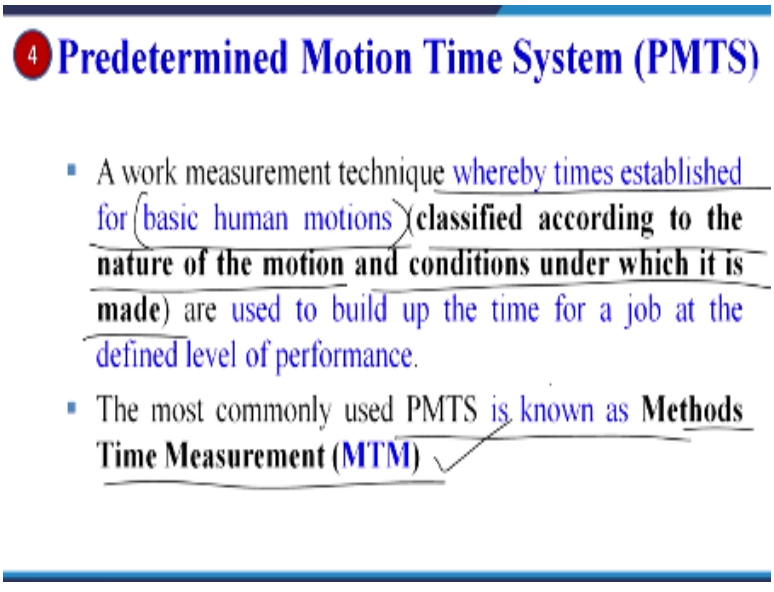

Now, predetermined motion time system; this is a work measurement technique whereby times established for basic human motions classified according to the nature of the motion and

conditions under which it is done, so different basic human motions, these are classified according to the nature of the motion and the conditions under which it is made, so this is for a specific human motions.

It is used to build up the time for a job at the defined level of performance, so maybe this is a technique the times are established for basic human motions and then the times are added up to build up the total time required for performing the task at defined level of performance. The most commonly used predetermined motion time system is a methods time measurement, which we will cover when we discuss this method in detail.

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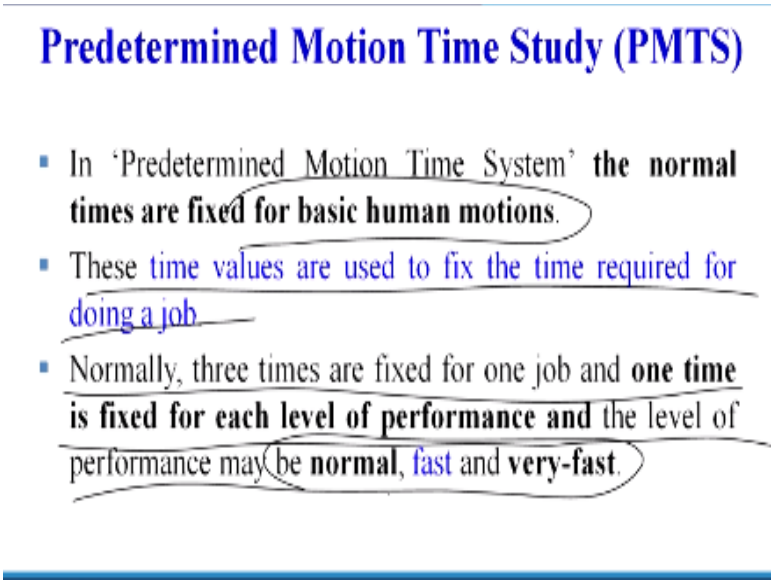

Now, in predetermined motion time system the normal times are fixed for basic human motions, so we try to divide our total task into the individual work elements and for those work elements there are tables available and from those tables, we see the information or the time required for performing these basic motions and then we add the sequence, this times in a sequence and then we try to establish the total time required which will help us to set the standard time for performing the task.

Now, these time values are used to fix the time required for doing the job, I have already explained normally, 3 times are fixed for one job, one time is fixed for each level of performance and a level of performance maybe normal, fast or very fast, so we will see a table that for

different level of performance, may be normal, fast or very fast, different times are there, so we will take the example when we cover the predetermined motion time systems.

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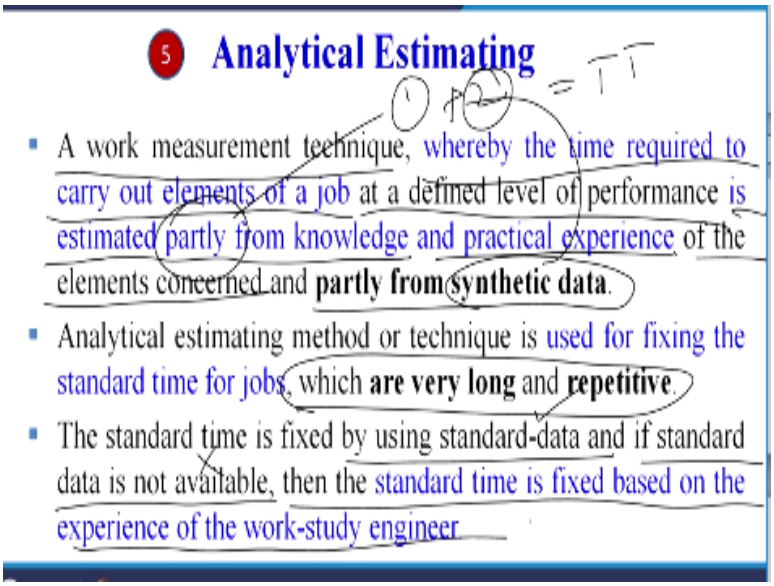

So, then there is analytical estimating, very quickly I will read it for you, a work measurement technique whereby the time required to carry out the elements of a job at a defined level of performance is estimated partly from the knowledge and practical experience of the elements concern and partly from the synthetic data. So, now the total time required is combination of 2 partly, so partly from the knowledge and practical experience.

So, for some work elements, we may not have a standard data available, so we will use our experience and knowledge to set the time for it and the other one will come from the synthetic data, so the time that we are estimating from knowledge and practical experience for different work elements, then for the remaining work elements for which the synthetic data is available, we will take the time directly from there.

And we add these 2 times to calculate the total time, so this is the basic principle of analytical estimating again, I will read it for you, a work measurement technique whereby the time required to carry out elements of a job at a defined level of performance is estimated partly from knowledge and practical experience of the elements concern and partly from the synthetic data,

so analytical estimating method or technique is used for fixing the standard times for a job which are very long and repetitive.

So, it is not a short cycle, it is a long time taking jobs and repetitive in nature, the standard time is fixed by using the standard data and if the standard data is not available, so we will be using the standard data but if the standard data is not available then the standard time is fixed based on the experience of the work study engineer.

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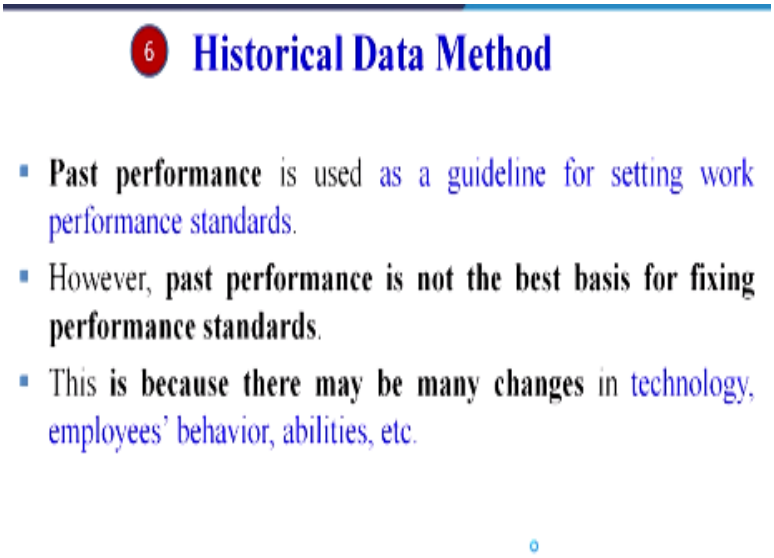

And the last one is the historical data method; past performance is used as a guideline for setting the work performance standards in terms of time, however the past performance is not the best basis for fixing the performance standards, this is because there may be many changes in technology, employees behaviour, abilities and maybe the methods by which they are doing their task.

But for wherever the element of objectivity can be established and not much changes have taken place in that cases, the historical data can be directly used to set the standard time for performing a particular job, so with this I conclude the today's session and in session 2 of our discussion on work measurement in our discussion during week 8, we have tried to understand the various techniques that are used for work measurement.

And some of the techniques involved direct observation of the worker and the machine and others are based on the previous data that is already available as a result of the time studies conducted earlier and in our subsequent sessions, we will focus on each and every technique that we have seen today and try to understand it with the help of examples and case studies. Thank you.