Work System Design
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Lecture - 46
Work Sampling: Basic Concept

Namashkar friends. Welcome to session 46 of our course on work system design. So today we are going to start our discussion on an important aspect of work measurement that is work sampling. As you are well aware in the previous week our focus was primarily on setting up of the time standard using the most common type of technique used for work measurement that is time study.

And in time study as you are well aware we have used the direct measurement of the worker or the time for the worker performing the task. Now what task is the worker is performing that was based upon the sequence of activities or the specified protocol or the standard operating procedure which has been developed during the method study. So prior to the work measurement, we have already studied method study in which we have tried to develop one best method of performing the task.

Now using that method from the worker's point of view the worker also has to be a qualified worker, a skilled worker, educated worker and he must be able-bodied worker who can perform the task easily. So the qualified worker when he is performing the task using the specified method, we were trying to find out that how much time he or she will take to perform the task and there are different techniques which can help us.

And these techniques fall under a broader umbrella of work measurement. Now what are these techniques, we can just revise these techniques, it is stop watch type of time study, it can be work sampling, it can be predetermined motion time system, it can be synthetic data, it can be analytical approach, so there can be different approaches which can help us to set a standard time for performing the task.

2 things have always to be kept in mind that the task has to be performed in a specified manner as per the standard operating procedure as well as the person who is performing the task must be skilled, educated to perform the task. He must be mentally and physically alert

to perform the task. So there are few preconditions related to the worker. There are few preconditions related to the work being done or the process being followed to perform the task or the sequence of activities being followed to perform the task.

So when both these constraints are taken into account when the work is being done we can find out the standard time for performing this work. So this is just the revision of what we have already studied till week 9. We have studied different techniques for setting up the standard time that is one of the techniques is stop watch time study. Prior to that we have seen different techniques used to develop one best method of doing the task.

In that case we have studied and understood various graphical tools such as outline process chart, flow process chart, multi-activity chart, 2-handed process chart, flow diagram, string diagram, simo chart, therbligs. So we have seen different techniques which can be used to find out the best method. We are now trying to understand the techniques that are used to set the standard time and which are under work measurement.

So this little bit of revision is always must when we go to the next stage. Now where the work sampling comes into picture, if you see in work measurement our major objective is to set the standard time for performing the task. So one method we have already seen and in the today's session our target will be to understand the basic concept of work sampling which is a different approach for setting up of a standard time or for calculating the standard time.

We will also try to see that how it is different from that stop watch time study or what can be the advantages of doing work sampling as compared to the stop watch time study. So that is the basic thing that we will like to understand today, in our subsequent sessions we will see that how to calculate the standard time using the work sampling approach. So today we may not cover the entire topic we will just try to understand the basic concept of work sampling.

So before going to the basic concept of work sampling there are 2 terms work and sampling. So work all of you know we have seen, we have discussed that work content, what is a basic work content. Then, we have seen the excessive work content, why excessing work content is added in our previous sessions. Sampling is a new word that is being introduced today.

Now what do we mean by sampling. Whenever we are doing any inspection we can do 100% inspection. For example, if we are checking some equipment or part or a component which has to be used in an aircraft industry or has to be used in an aircraft, we will like to go for 100% inspection why because the human life is involved there. The part or the component has to be used in an aircraft or an aeroplane we will go for a 100% inspection.

Why? Because as I have already highlighted human life is involved whereas there can be another set of products for example we are using a pencil which the children use to write on their notebooks. So this pencil may not require 100% inspection, we may not check each and every pencil, we may check a random sample of 100 pencils out of 1000 and see whether the quality that we are producing is up to the mark or not or as per the specifications or not.

So sampling sometimes eases out our work, sometime makes the thing cheaper or the inspection procedures cheaper, saves lot of time. So many times instead of going for a 100% inspection we may go for sampling and there lies the basic concept of work sampling. For example, now we have to find out a standard time for performing a task by a worker who is working on the shop floor.

As per the stop watch time study what will be our approach, how we will find the time. As we have seen in our previous week's discussion, there will get time study analyst who will be standing and observing the worker directly and seeing that how much time he is taking for performing task and the task is further divided into individual elements. So the time study analyst will use a stop watch to check for each work element how much time is being spent by the worker.

So maybe there are suppose 3 work elements, so for each work element the time study analyst will record may be 15 cycles, 20 cycles and note down the time for each work element. Then, the averaging will be done and we will have 3 average time estimates for 3 work elements. So we have observed time for 3 work elements. Then, what we will do, we will also do the rating of the worker who is performing the task.

And as per the standard pace of working, some rating will be given to the worker. This average time will be multiplied with the rating and sometimes the rating may also be given as per the individual element. That for element number 1 this is the rating, for element number 2

this is the rating, for number 3 this is the rating and from this average time for each work element and the performance rating we will get what we will get. We will normal or the basic time.

Then, we have to look for the book and find out the allowances that can be given in performing this type of task and these allowances will then be added to the basic or the normal time to find out the standard time. Just I have revised what we have already covered. In the previous 3 sessions, our focus was primarily on computation of the standard time.

So now we know that this is the standard procedure or step-by-step approach for finding out a standard time for doing any work by using the stop watch time study approach or using the time study approach but in this case if you see the observer of the time study analyst has to observe the worker continuously. So it is kind of a 100% inspection whereas we can do the same thing by sampling also.

Now sampling can be we do not take the complete reading but we only take few samples whether the worker is working or he is not working, how much proportion of the time in a day for example for 480 or 8 hours' duration he was found to be working and at what proportion of the time he was found to be idle, similar things can be done for the machines also.

So basically in sampling it is not the continuous observation of the worker, it is the observation at random intervals of time which can be properly spaced or may be the intervals may be designed in order to do the observation or it can be random intervals also, any given time the time study analyst can go and observe. So we can have fixed intervals or we can have random intervals when the time study analyst will go and observe whether the worker is working or the machine is working or it is idle.

So he can do the reading and based on statistical analysis, we will be able to calculate that what is the standard time required for performing a particular task. Also we will be able to see that for how much proportion of time our machine is idle and for how much proportion of time the worker is idle. So that also will help us to change our management policies regarding the utilization of men and machines.

So work sampling is also an important technique which can be used by management to take proper decisions related to the utilization of different resources at its disposal. So let us quickly now try to understand the basic concept of work sampling and how it is different from the time study approach.

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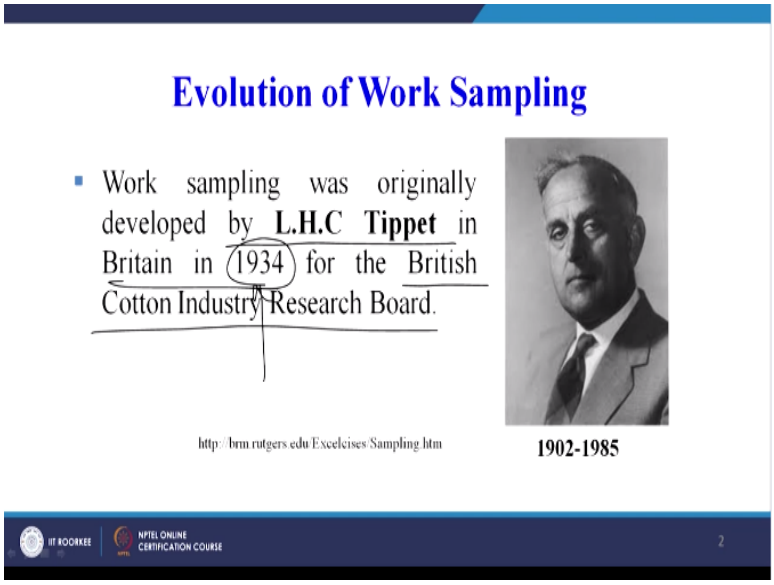

This is the historical perspective of work sampling. You can see work sampling was originally developed by L.H.C. Tippet in Britain in 1934 for the British Cotton Industry Research Board. So this is the historical perspective, it is the old technique developed in 1934 and it was developed for British Cotton Industry Research Board.

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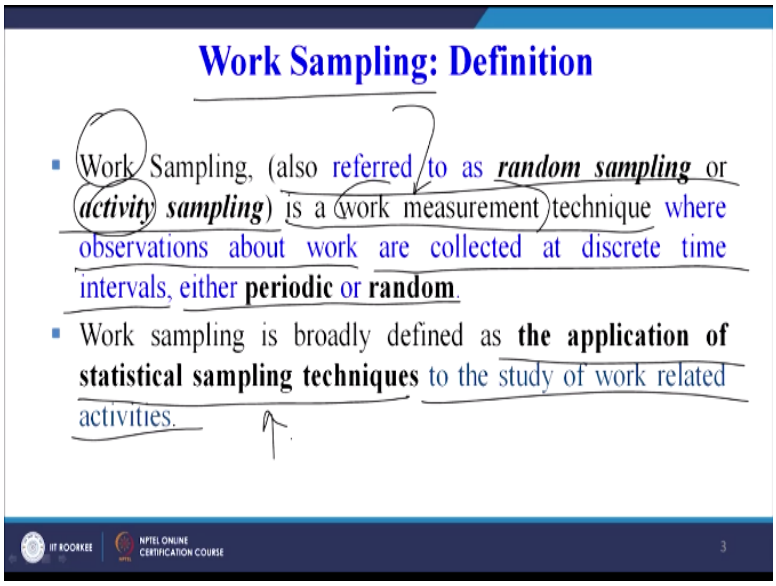

Let us see how the work sampling is defined. Work sampling it is also referred as random sampling or activity sampling. So activity is also may be one form of or synonym of work or

a combination of activities may lead to work. So work sampling is a work measurement technique. What are the other work measurement techniques? if you can just revise in your mind, there are number of techniques, the time study, stop watch time study is one, predetermined motion time system is another, synthetic data.

So there can be number of techniques, so work sampling is one of the work measurement techniques. So work sampling is a work measurement technique where observations about work are collected at discrete time intervals. So the time study analyst will go and check whether the worker is working or he or she is idle. Now these intervals can be either periodic or random which I have already tried to explain.

That either you can go at random interval of time and take a noting that whether the worker is working or you can go at periodic intervals of time. So that depends upon the situation company to company organizational policies. There are number of other factors which will influence this decision that whether the time study analyst must go after periodic intervals of time or he must go or she must go at random intervals of time.

But here the direct observation for the complete work cycle for the worker will not be done, only sampling data will be collected based on the visit of the time study analyst to the shop floor. So work sampling is broadly defined as the application of statistical sampling techniques to the study of work related activity. So we will see that why the word statistical sampling is coming into picture.

Because we will be using the confidence intervals here, the distribution curves, so therefore the statistical sampling technique is coming into picture.

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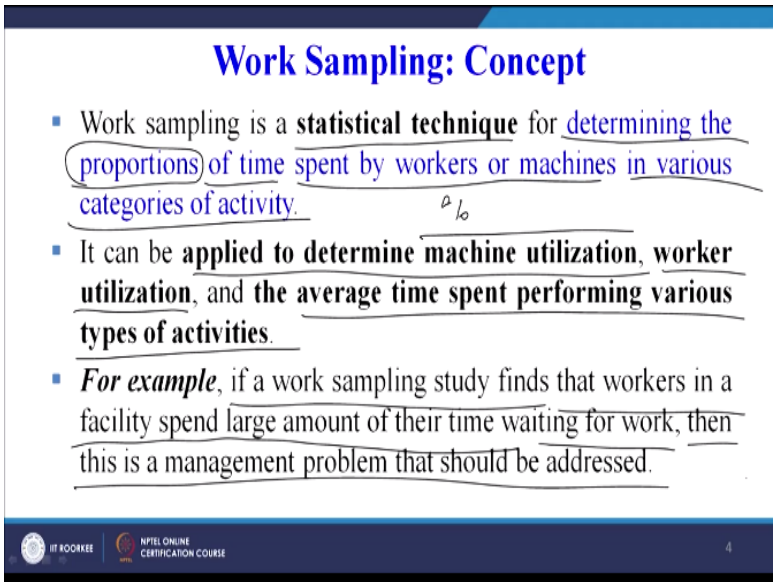

Now work sampling is the statistical technique again the word statistical is coming for determining the proportions that is our target proportions of time spent by workers or machines in various categories of activities. Now we will see that how much time is being spent by the worker as well as the machine on various categories of activity. Now categories of activities have to be classified before we go for a work sampling procedure.

And we will see towards the end of today's session, a work sampling sheet where the activities are clearly earmarked that these are the activities and the time study analyst will go and try to mark that which of the activity the machine or the worker was involved when he visited maybe at 2:10 in the afternoon. Then again he may go at 4:30 in the evening and mark that which particular activity the worker was involved and in which particular activity the machine was involved.

So that is the difference for various categories of activities, so it will give us the relative proportion of time the worker or the machine is involved or they spend on different types of activities. So once again I will read this sentence for you. Work sampling is a statistical technique for determining the proportions of time spent by workers or machines in various categories of activities.

It can be applied to determine machine utilization which I have already told that for how much proportion of time the machine is working or for how much proportion of time the machine is idle. Similarly, for worker utilization and the average time spent performing various types of activities. So very easily we can see that for an 8-hour shift for how much

proportion of the time the machine was working, for how much proportion the worker was working or in which other activities the worker has spent his overall time.

For example, if a work sampling study finds, the work sampling study was conducted and it finds that workers in a facility spend large amount of their time waiting for work. So it has been found the time study analyst maybe he visited 8 times in an 8-hour shift and out of that 4 times if he has found that the workers are waiting for the raw material to arrive or the material to process waiting for the work.

Then, this is a management problem that should be addressed. So it means the workers are available at the workstation, the workstation is also available but they are waiting for the work to arrive or for the waiting the raw material to arrive or for waiting the work in process to arrive. So they are waiting therefore it is a good indicator that the management must look at balancing the line or allocating some other work to the workers while they are waiting for the work to arrive to their workstation.

So this becomes a management issue which can further be resolved.

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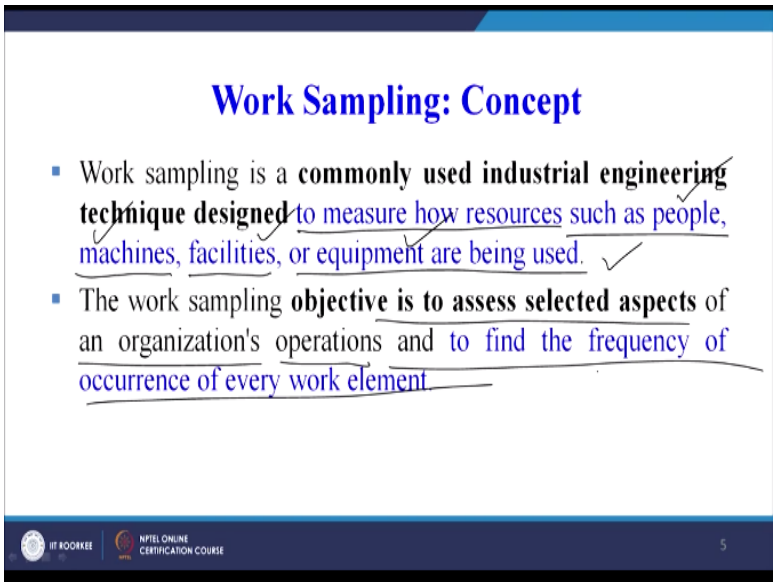

Work sampling is a commonly used industrial engineering technique designed to measure how resources, again the same thing is being repeated, how resource such as people, machines, facilities or equipment are being used. Again the same thing, in the previous slide 2 things were emphasized that was the people and the machines, now the facilities and

equipment are also being added here that we can understand the utilization of these important elements of the manufacturing system that how they are being utilized.

And if they are underutilized, we can certainly try to find out means and mechanisms through which we can improve or increase their utilization rate. So the work sampling objective is to assess selected aspects of an organization's operation and to find the frequency of occurrence of every work element.

So whatever we have seen in the basic concept of work sampling our major summary is that here instead of going for a direct observation we will focus on all the elements of the manufacturing system including the men who are performing the task including the machines on which the task is being performed, the equipment being used to perform the task. So all these maybe elements of the system will be analyzed.

And we will be able to find out the relative proportion of time for which these elements are working and for which they are not working or idle or waiting for the work to arrive. So this will help us in the overall understanding of the way we are performing our work and will help us or guide us or will address the issue of non-utilization of the various resources available at our disposal.

Once we know that these are the resources available are underutilized we can further work hard, we can plan our production in such a way that these resources are also utilized properly.

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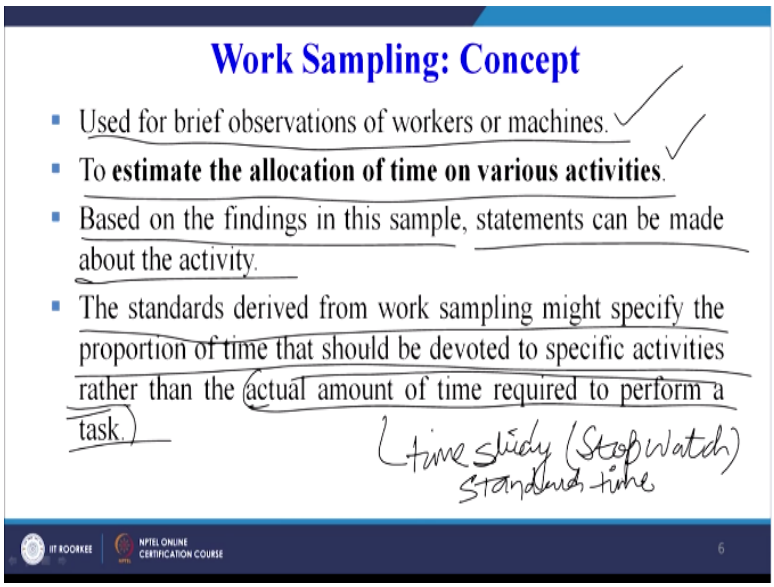

So now maybe slightly to the application side used for brief observations of workers and machine already explained. To estimate the allocation of time on various activities because now we know that for how much proportion of the time the machine is idle, how much proportion of the time the worker is idle, so it will help us to estimate the allocation of time on various activities.

Now we have the data available with us to make our planning in a more informed manner rather than in a theoretical manner. Based on the findings in this sample, statements can be made about the activity. Now about whatever activity is being done, we can make sound statement regarding how the activity must be performed and in how much time it must be performed.

So the standards derived from the work sampling might specify the proportion of time that should be devoted to a specific activity. Now when we are setting the standard from the work sampling approach they will help us to specify the proportion of time that should be devoted to specific activities. Now suppose there are a combination of 8 or 10 activities which is leading to the completion of the task.

Work sampling will help us that how much proportion of time must be allocated to the various categories of activities or the various classes of activities rather than the actual amount of time required to perform a task. So that is one important thing that in actual amount of time required to perform a task, we can very easily find from our time study approach using a stop watch.

So this is possible, actual amount of time required to perform a task which we can call as standard time estimation. So that can be found out but in case of work sampling the top statement or the statement just prior to this statement is correct that it will help us it might specify the proportion of time that should be devoted to specific activities. So here time study analyst is going and checking whether the worker is idle or working.

If he is working which category of activity he is involved in, so the relative proportion of time to be spent on different set of activities can be found out using the work sampling approach.

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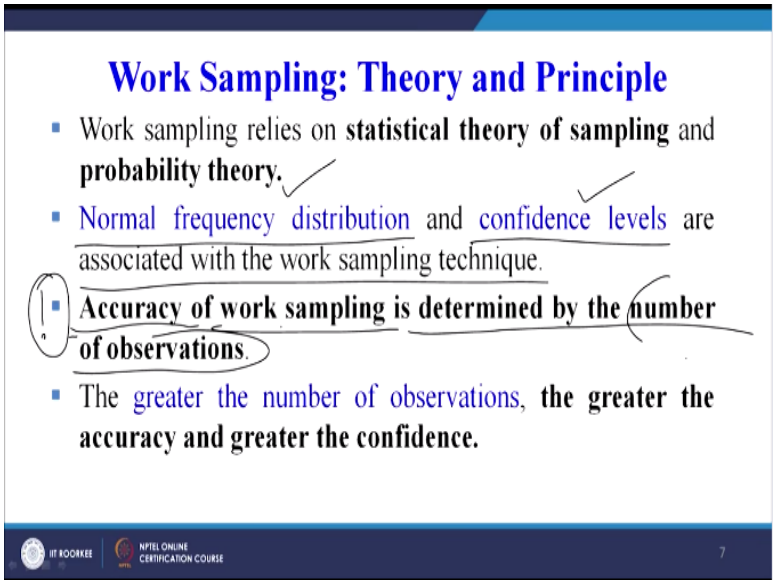

Now work sampling relies on statistical theory of sampling and probability theory. Normal frequency distribution and confidence levels are associated with the work sampling technique. Now what are these confidence levels and normal frequency distribution? We will cover in slightly more detail in our subsequent sessions when we will do the calculations for the time standards.

So normal frequency distribution and confidence levels are associated. Accuracy of work sampling is determined by the number of observation. So this is very, very important point which must be kept in mind. Accuracy of the work sampling is determined by the number of observations. Number of observations means that for example a time study analyst goes to the worker on whom he is doing the work sampling 4 times in a day and in other case he goes may be 14 times in a day.

So now for single given day in one case he has 14 observations, in other case he has only 4 observations. So this point emphasizes that work sampling approach using more number of observations that it may be 14 observations in a day will be much more accurate as compared to only doing 4 observations in a day. So the accuracy of work sampling is determined by the number of observation.

Time study analyst if he goes may be more number of times in a day the accuracy will increase. So maybe the other extreme of this can be that if he is standing there only and doing the recording I think it will become much more accurate. So that will shift from work sampling to the stop watch time study that he is continuously observing the worker. So in

more number of observations that we need to decide that what is the optimal number of observations which will give us fairly accurate results.

Because the other extreme becomes that instead of going and checking he stays there only and spends his whole time just observing the worker. So then it becomes a stop watch type of time study rather than the sampling approach of understanding the work. So accuracy of work sampling is determined by the number of observations. So we should have sufficient number of observations to do the statistical sampling.

The greater the number of observations the greater the accuracy and greater the confidence levels.

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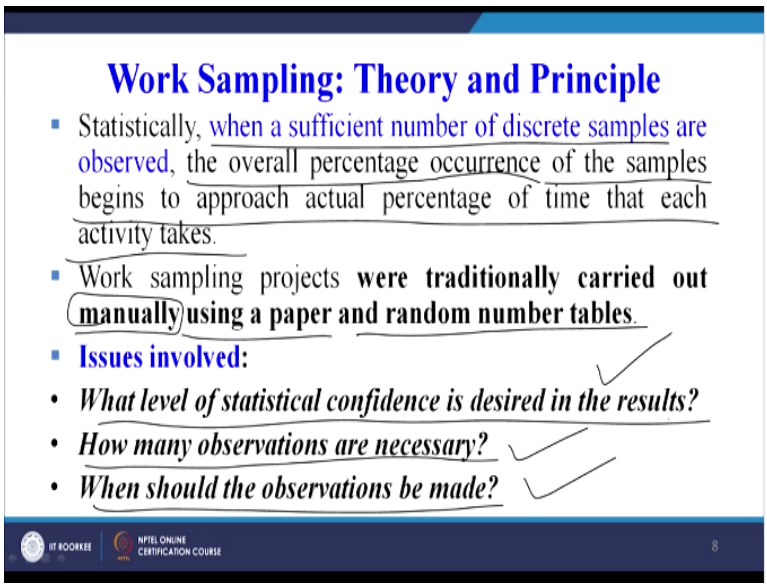

Statistically, when a sufficient number of discrete samples are observed, the overall percentage occurrence of the samples begins to approach actual percentage of time that each activity takes. So this is important so when we have a sufficient number of discrete samples the overall percentage occurrence of the samples begins to approach actual percentage of time that each activity will take.

So maybe this is already I have explained that when the sufficient number of samples are there, our overall percentage occurrence of the samples begins to approach the actual percentage of time that each activity takes. So it slowly moves in the directions of the overall observation of the work may be the extreme can be the complete observation of the work.

Work sampling projects were traditionally carried out manually using a paper and a random number table.

So this is manually they were done using a paper and a random number table. Now what are the important issues? Let us quickly see. I think the basic concept is clear that we have to do the sampling, how many number of samples, there must be sufficient number of samples. If the number of discrete samples taken is sufficiently high, it will be very, very close to the actual time spent by the worker for performing the task.

We will be able to reach to that level begins to approach the actual percentage of time that each activity takes. Now what are the issues involved, if it is so easy we can easily do it, but what are the issues involved. What level of statistical confidence is desired in the results? How many observations are necessary? Very important question. When should the observations be made?

Whether we should go periodically or we must go randomly, so all these questions we need to find the answers and in subsequent sessions we will try to find the answers to all these questions, how many observations to take? When should the observations be take and what level of statistical confidence is desired?

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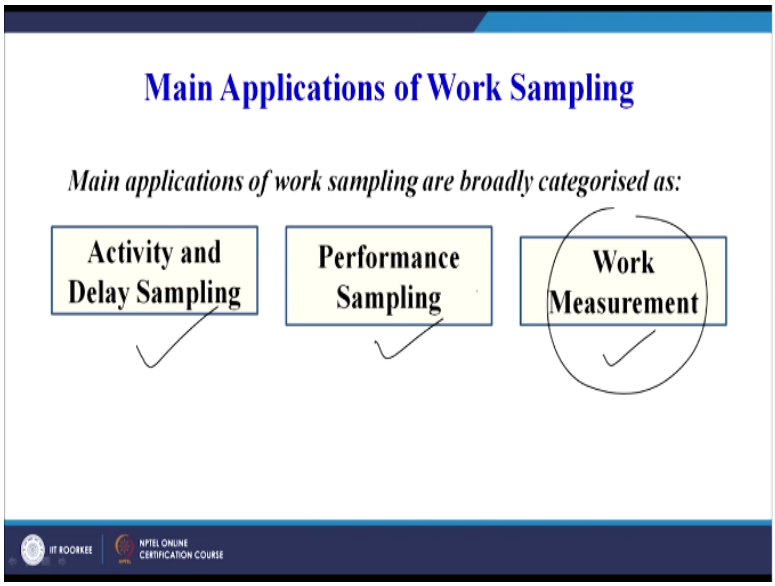

Now main applications of work sampling are activity and delay sampling, performance sampling and work measurement. Work measurement means we will try to find out the standard time based on the work sampling approach.

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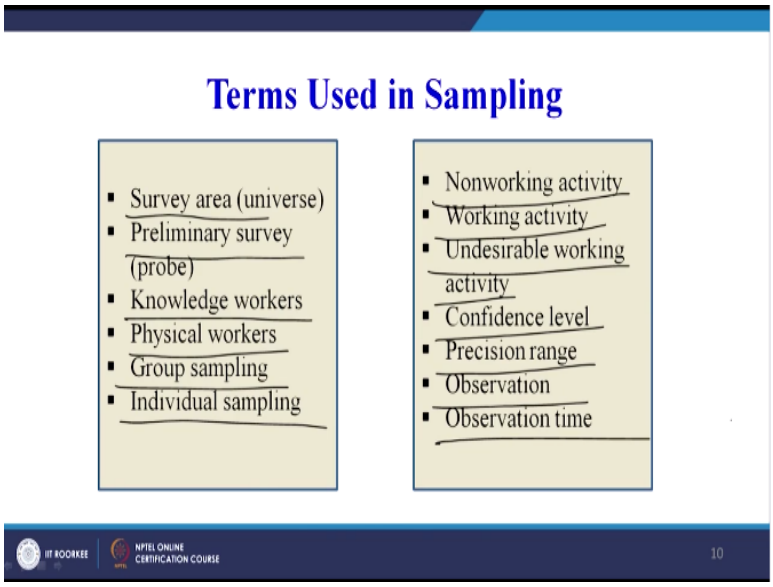

Now various terms that are going to be used in sampling are survey area, preliminary survey, knowledge workers, physical workers, group sampling, individual sampling, nonworking activity, working activity, undesirable working activity, confidence level, precision range, observation, observation time. So we may or may not use all these terms but these terms are important in context of the work sampling approach.

And wherever we will use a specific term during work sampling, I will try to explain the term to the best of my ability.

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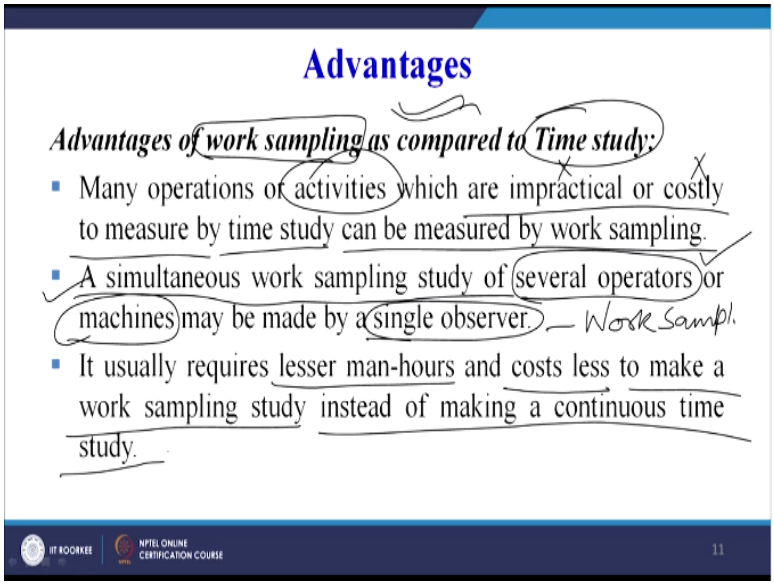

Now this is the last part for today's discussion that what are the advantages of work sampling as compared to time study. It is very, very important from the examination point of view,

from the interview point of view, sometimes you may be asked that how do you differentiate between the stop watch time study and the work sampling. So you must be able to answer all these questions with fair degree of confidence.

So just quickly all the points are self-explanatory and if you have understood the basic concept baring few terms like confidence level or the distribution curve, baring these terms we must be able to differentiate between the 2 and these points highlight the differences in a much, much clearer manner or much, much crystal clear manner. So how our work sampling is different from time study we will try to understand this.

Many operations or activities which are impractical or costly to measure by a time study can be measured by work sampling. So first thing is activities which are impractical or costly to measure using time study can be done using work sampling. A simultaneous work sampling study of several operators or machines may be made by a single observer in case of work sampling.

So a simultaneous work sampling study of several operators or machines can be done in case of work sampling whereas in case of time study for every machine or for every operator you require one-time study analyst. It usually requires lesser man hours, costs less to make a work sampling study instead of making a continuous time study that is a stop watch type of time study.

So it is less involved physically also, less man hours are required, less cost is involved in work sampling as compared to time study.

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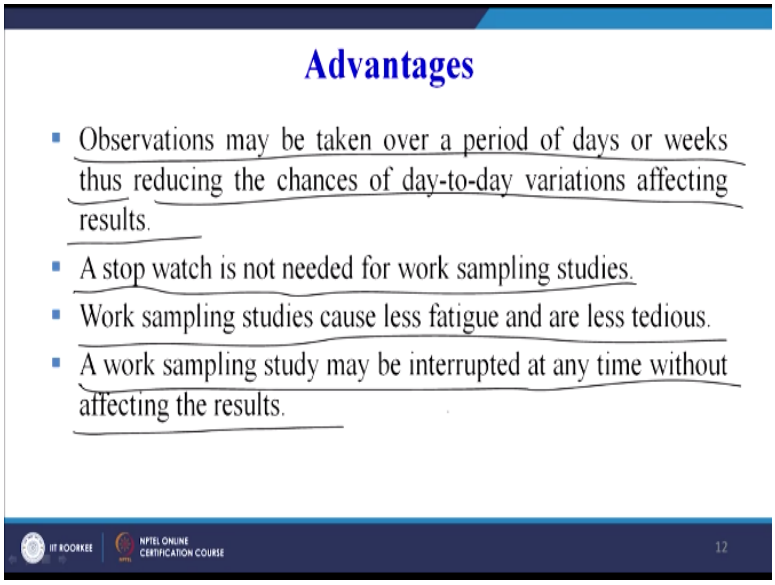

Now observations maybe taken over a period of days or weeks thus reducing the chances of day-to-day variations affecting the results. So sometimes when we are doing the continuous observation of a worker, so day-to-day variations may come into picture whereas work sampling study may be spread over a period of one week or 2 weeks or may be sometimes a month also.

So in that case all these random variations are taken care of which is not taken care of in case of the time study. So observations maybe taken over a period of days or weeks thus reducing the chances of day-to-day variations of acting the time study. A stop watch is not very simple point; a stop watch is not needed for work sampling studies. Work sampling studies cause less fatigue and are less tedious which we have already included in one of the previous points also that it is less time consuming, it is less tiresome for the time study analyst also.

So work sampling studies causes less fatigue and are less tedious, takes less man hours also. A work sampling study may be interrupted at any time without affecting the results. As it is not a continuous observation, so it can be terminated at any given time so the results will not get affected. So with this we come to the end of the very first session of week 10 and we have started our discussion on work sampling.

Although, I understand that there may be few doubts in the minds of learners that what do we mean by the level of confidence, what do we mean by the statistical technique, how do we call it as a statistical technique but all these doubts will be laid to rest in our subsequent sessions when we will try to understand that how calculations are done, how do we decide the

level of confidence, how do we calculate the number of samples to be taken for justifying the statistical relevance of this work measurement technique.

So with time I think all the doubts will be laid to rest, so with this we conclude the today's session and we will continue our discussion on the work sampling approach of work measurement in our subsequent sessions. Thank you.