Production and Operation Management
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Lecture 59
Work Method Analysis, Work Measurement and Learning Curve

Welcome friends. As we are coming to close of this course and in this particular session, we are going to discuss some of the topics which normally we discuss in the industrial engineering course. But these are also very important topics for an operation manager. In our last session, we discussed some concepts which are going to be the future of operation managers. Like we discussed about it just in time, we discussed about lean manufacturing. But these concepts, interestingly, which we are going to discuss today, are the basics of operation management and industrial engineering.

These concepts came into existence, when industrial revolution and particularly, scientific management came into picture. F.W. Taylor, who is considered to be the father of scientific management and his contemporaries, particularly Gilberts, those give the concept of time and motion study. They are some of the pioneers in the development of various motion analysis of workers in the plant. At that time in the scientific management era, the basic idea was how to improve the productivity of the plants, how to continuously run your plant, so that you can take maximum output from the plants.

And at that time, in most of the European companies, slaves from Asia, slaves from Africa use to work. And therefore, they were considered like machines. So, we expected that all human being is working as machine. And therefore, the concepts like Work Method Analysis, Work Measurement, etc. came into picture. But over a period of time, the development of management philosophies took place. And then after some time of scientific management, a very important development took place and that was a kind of revolutionary development in the field of management, which came in the form of human relation management.

Where the examples of hawthorne experiment became a turning point, that physical conditions are important for the performance, but psychological conditions are equally important for your productivity. If you do not focus on psychological conditions of the employees, you cannot

achieve high productivity. And at that time, people like Abraham Maslow, came up with their philosophies of need hierarchy.

And nowadays, in our organizations we have a combination of you can say, scientific management and human relation management. We are thinking that by giving training we can improve the productivity of our employees and at the same time, we also need to think their psychological well-being. So, we are trying to do a kind of balancing act in the current period, with respect to scientific managements development and the psychological developments.

Now in this particular session, we are going to discuss some of the issues which are important with respect to analysis of performance of an employee. And therefore, the title of the session is, Work Method Analysis, Work Measurement and Learning Curve. Let us see, what are the important terminologies with respect to these things.

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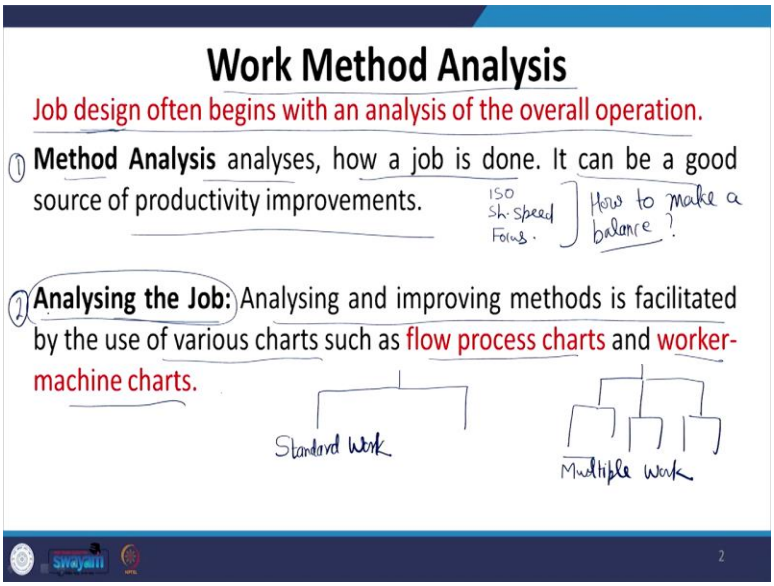

The first is, work method analysis. Now when we are talking of work method analysis, there are important things, that is the job design often begins with an analysis of the overall operation. We have discussed a very important issue, when we were discussing the two different types of layouts; product and process layouts. In the product layout, employees were involved all the time in very standard work, they were doing the same kind of work repetitively. And therefore, they

become highly skilful in their particular job. In case of process layout, they do multiple type of works and each time work requirement may be a different one.

So, today you are doing a different type of job, tomorrow you are doing a different type of job. And therefore, your ability to do multiple type of jobs are required. Now, it is a matter of individual choice. That sometime there are people who want to do a very good job in a very particular area, they want to remain all the time highly focused. And there are people who may feel bored, who may feel monotonous, they may feel fatigue, because they are continuously doing the repetitive type of job. So, there is a continuous debate that high standardization is good or bad.

There are people who say that, standardization improves the skill and there are people who say that, more standardization reduces morale of employees. Because there will not be any job enrichment, there will not be any kind of variety. So, if variety is not there, excitement will also not be there. And if excitement is not there, you will have a problem of morale. Then, there are people who support this kind of multiple work. And they say that, people are doing, workers are doing different type of work, so they are continuously challenged with respect to their creativity, with respect to their skills. So, they enjoy their work because of the challenge.

But all of us do not like challenges. Some of us want very easy going life, that life should like a very smooth flow of water. There should not be any kind of bumpy rides and some of us like bumpy lights. So, depending upon that both these types of models are available in the organizations.

So, the first important thing is about the analysis of the overall operation that is known as job design. Here, two things are important; one is method and the second is analysis, analysing the job. In the method analysis, how a job is done, what are the different you can say, steps involved in doing a particular job. For an example, you are taking a pictures in a camera and when you are taking pictures in a camera, what are the various steps involved in clicking a picture?

So, if you are using a SLR camera, in that SLR camera, you know that you have to set shutter speed, you have to set the aperture, you have to set the focus point. You need to have a proper combination of these three things, then only you can have a good quality photograph. So, these

are the various steps which are required for clicking a photo, that these three parameters are properly set, then only your photo will be appropriate.

So, it can be a good source of productivity improvement. That when you know that, whether your ISO is appropriate, whether the shutter speed is appropriate, whether the focus is appropriate, all these things are appropriate then only you can have a good photograph. So slowly and slowly, you understand that how to make, how to make a balance in these various parameters and that will help you in improving the job. So, some photographers are very good, some photographers are not so good because of their ability to make a balance, appropriate balance with respect to these things.

Then analysing the job, analysing and improving methods is facilitated by the use of various charts such as flow process charts, worker machine charts, etc. Now in doing the job, we have two very important components; one component is worker and the second component is tool. This is machine, this is worker. Now when the worker and machine is appropriately interacting, when worker has to perform, when machine has to perform.

And based on that, we have different types of chart that what is the sequence, how both these things are simultaneously working. We have different types of chars and these charts are helpful in analysing the job. And with the help of this analysis of the job which you are doing, then you are able to see that what are the value adding activities you are doing and what are the non-value activities you are doing. And that is something related to our previous lecture also, where we discussed JIT and lean. All those non-value adding activities which you are doing in your job, these need to be eliminated and then your system will become a lean system.

So, this analysis the job, analysing the job that is also important from the lean manufacturing's point of view, because when the flow process diagram is available, you can identify non-value adding activities.

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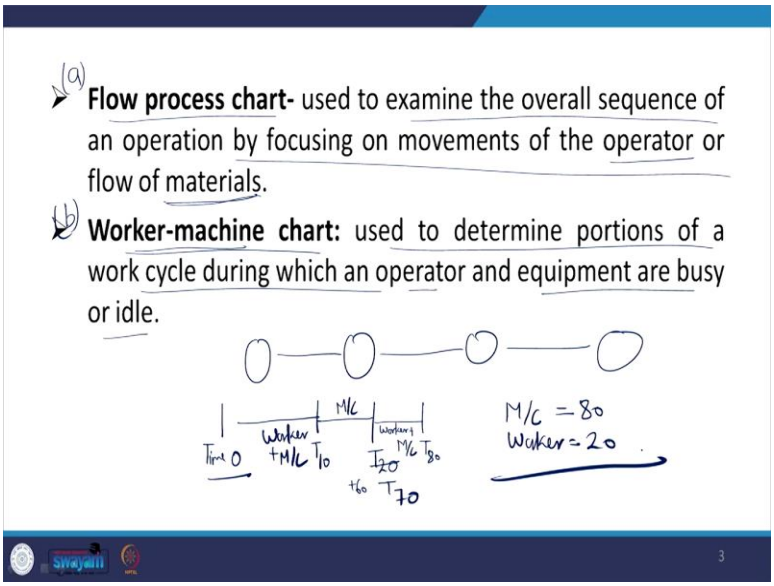

Now these flow process chart and worker machine chart, these are the part of analysing the job and these are used to examine the overall sequence of an operation by focusing on movements of the operator or flow of material, that how material is flowing from one state to another state. Or in case, worker is moving, so how the worker is moving from one place to another place. So, like in a restaurant, in a service organization we have this flow process chart a very useful information about the movement of your employees because to provide service, employees need to move from one place to another place.

So, how employees are moving from one place to another place, this will help you by flow process chart. Similarly, in a manufacturing organization, the flow of material is taking place from input stage to various intermediate stages, and then to the finished the stage. So, that flow of material can also be tracked with the help of this flow process chart. Then in flow process chart, either it will be the movement of operator or the material. The worker machine chart is a combination of both these things, that you have a chart to determine portions of a work cycle during which an operator and equipment are busy or idle.

That the process is a starting at time T0 and then up to t10 worker is busy, then worker has set the machine during this time. Now from T10 to T20, machine is busy. Here worker plus machine both are busy, here only machine is busy. Now the machine is operating you have set the machine. For an example, you must have seen a washing machine in your homes, now in the

washing machine in your home when you are starting the washing machine initially, so you are setting the washing machine at a particular cycle depending upon the clothes you are going to wash.

And during that period, you are also busy, machine is also busy because you are doing that operation on the machine. After that, you switched on the machine and let us say, it is a cycle of 60 minutes. So, from T10 to 60 minutes, that is up to T70 only machine is busy. Now you are free, the worker is free, worker is idle because machine is operating on its own you have to do nothing.

Then after 70 minutes, buzzer beeps up and for another 10 minutes you need to take clothes out from the machine. So again, worker plus machine both are busy. So in this case, machine is busy for about 80 minutes and worker is busy for only 20 minutes. So, that type of information you will understand from worker machine chart, that how much time machine is busy, and how much time worker is busy. When we are doing this kind of recording of work, so during this time camera is also busy and worker that is me, I am also busy.

But when the recording is not happening, only worker is busy in preparing the charts, in preparing these materials, at that time camera is free. So, if how much duration you want to capture, depending upon that worker machine chart will give you idea that how much time worker is busy, and how much time machine is busy, how much time worker is idle, how much time machine is idle. So, that is also a very useful chart in analysing the jobs.

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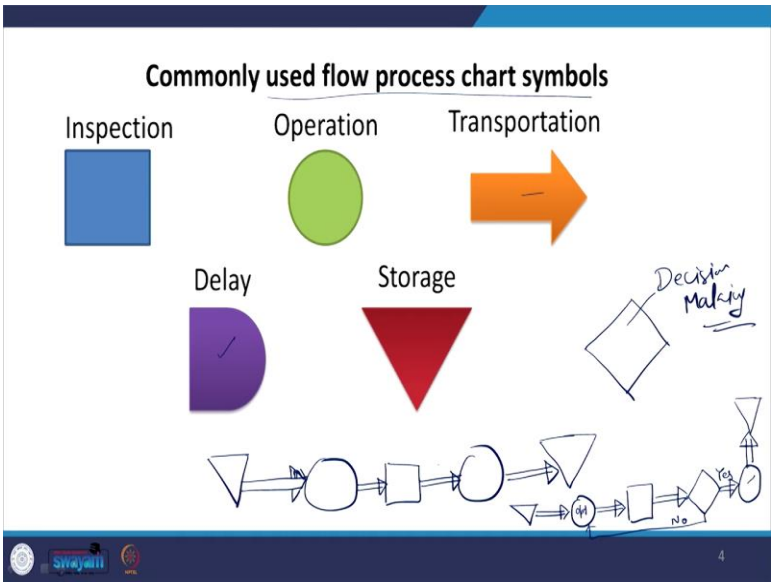

Then for preparing these flow diagrams, these charts the commonly used symbols in the process charts, these are some commonly used symbols. This indicates the inspection, this is operation, this is transportation, this D, the reverse D for representing the delay, and this is for storage. One more symbol like a star type, that is for some kind of decision making.

So, these are the commonly use symbols for various activities in your flow process charts. And based on that, for an example, I can show you that we have the storage of raw material. From here, the raw material is moving, that is the transportation, this is a show like this way. Then some operation is taking place, after operation, again some transportation, and then inspection is taking place, after inspection, again some operation is taking place, and then you are storing them in a finished goods store.

So, this is a type of a flow process chart where two operations are taking place and in-between of two operations you are taking a kind of inspection. Now in inspection, you can also have you, this is one type of diagram. Let me make one more diagram, so that you understand the variations in the diagram. Now in the second diagram, I have inserted one decision making step also, after the inspection it is going to decision making. And if the inspections says that yes, it is okay, then it is going for the next operation, if it is not okay, then it is going back to previous operation, operation one, and it will be reprocessed and again it will be through inspection stage.

So like, you are having first year, after first year you are going through examination, that examination is a kind of inspection. Then the result preparation takes place, in the result preparation if you are pass, then you go to next semester, next year. And if you are not passed, if you are failed, then you go back to the previous class. So, that is a kind of system which is possible and that is how we can use these symbols for preparing our flow process diagrams.

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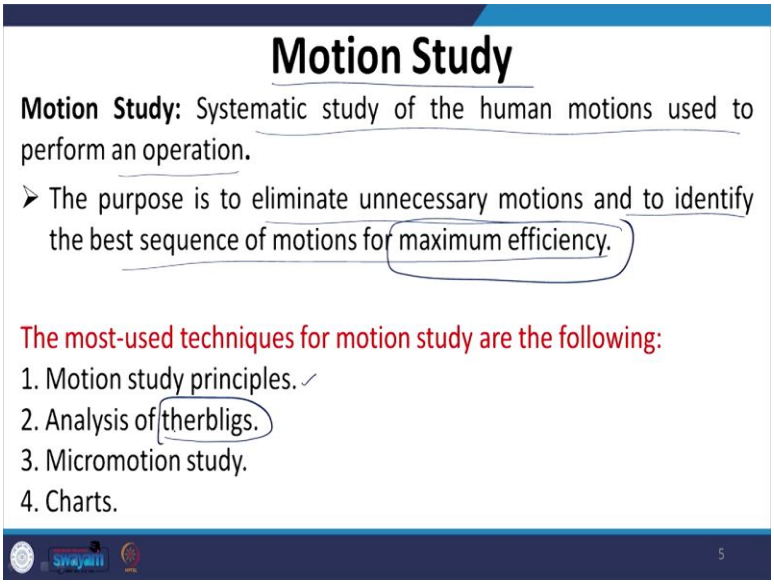

Then another important thing in this work study is motion study. When we are performing a job, we need to have some kind of motions, motions means movements. In our last session of JIT and lean, we discussed about extra movements, that is a waste. If you are moving too much that is a waste. So, we need to do our movements very, very carefully, so that you can work for longer duration without fatigue. And for that purpose, this motion study is being performed, so that you can have a very optimum level of productivity. So, systematic study of the human motions used to perform an operation.

When you are driving, the staring which you are holding that is a very important result of motion study. What should be the angle of your back? That is again an example of motion study. When you are driving scooter, when you are driving bicycle, when you are driving cycle rickshaw, so what should be the optimum angle of holding those handles, that is again an example of motion study. So, that you can work for longer duration without any damage to your body. So, the

purpose is to eliminate unnecessary motions and to identify the best sequence of motions for maximum efficiency.

So, the idea is to get the maximum efficiency and eliminate all unnecessary motions. Now, in the case of this motion study, we have important things like motion study principles, therbligs, which are very important and very old also. Now we are in around 2020, and the concepts are around 100 years old. And in this 100 year we have seen that, how much development have taken place with respect to IT, and nowadays various other aspects of computing. But still, the concepts of therbligs are important for motion study.

How to minimize your unnecessary movements for that, if still we want to go for any kind of study, the concepts are based on the therbligs. Then the micro motion study, where we use a camera which is able to shoot the performing jobs at a very slow rate and later on by using our videos, by using our computers we try to analyse the movement of our employees. And then obviously, the charts, etc. are also important.

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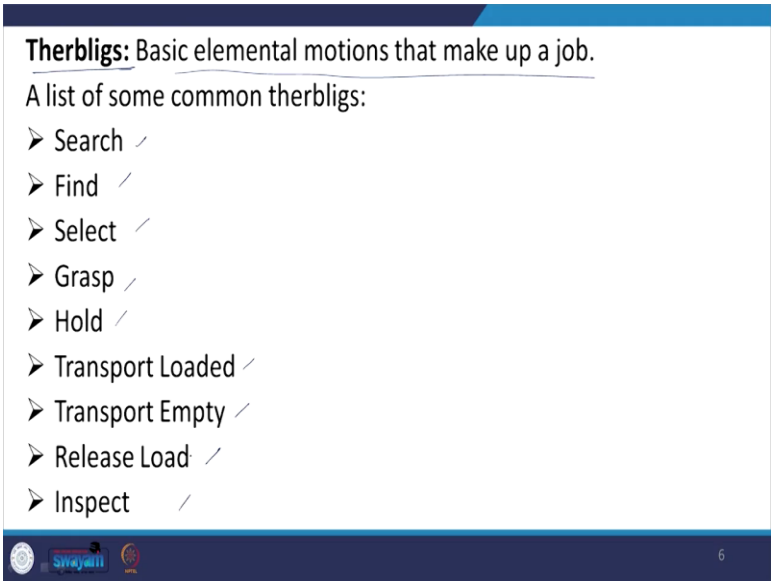

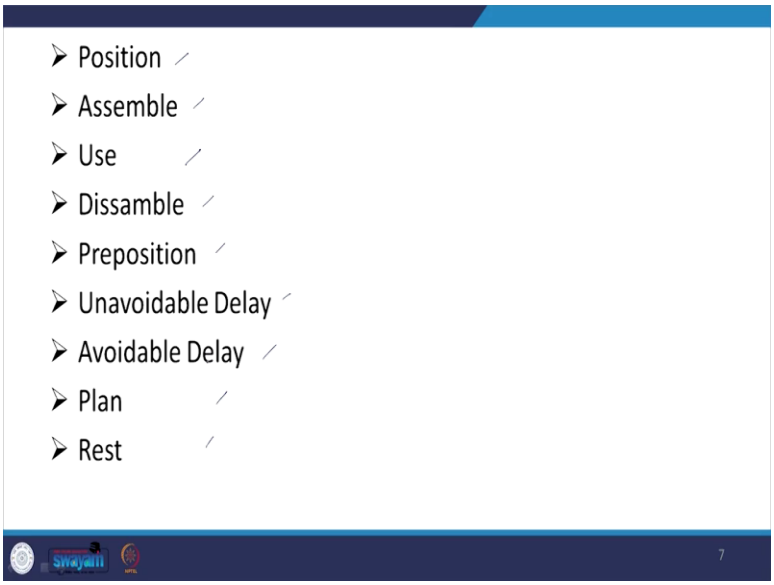

When we are talking of therbligs, therbligs have classified the human motions into some basic elemental motions. And these are the basic elemental motions and various other kind of motions are also combination of these basic therbligs only. And these basic therbligs are search, find, select, grasp, hold, transport loaded, transport empty, release load, inspect, position, assemble, use, dissemble, preposition, unavoidable delay, avoidable delay, plan, rest, all these are the basic type of therbligs. So, we are not going into the details of these therbligs but these are the basic type of motions and all other motions are actually the combination of these basic therbligs, etc.

So, these therbligs help us in analysing the human motions with respect to any particular job. If your motions, if your motions cannot be classified under any of these therbligs or a combination of these therbligs, that to some extent I can say, is a waste full motion, that motion can be avoided. Only these basic emotions cannot be avoided, because these are considered to be important, these are considered to be necessary for completing the job. But other motions are not so important, and other motions of which are not possible to fall under this category can be avoidable.

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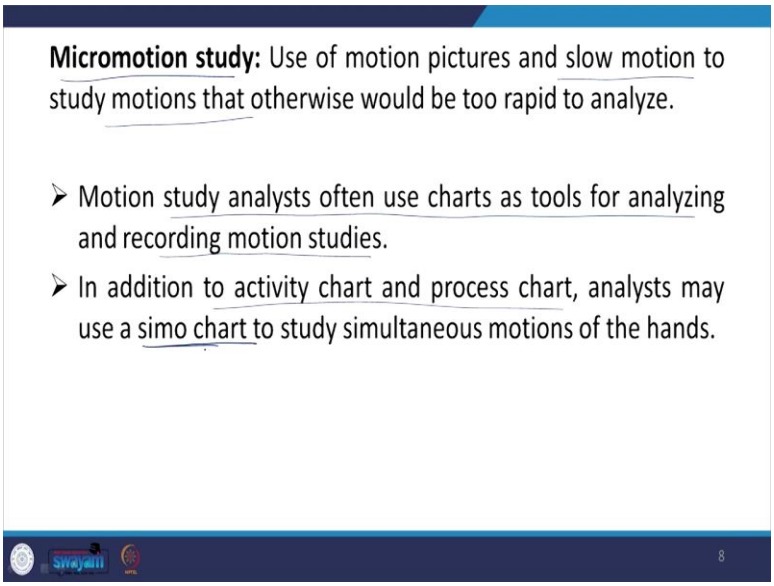

Then another important thing, in the case of motion study is micro motion study. Micro motion study is a very, very useful tool and it gives you a lot of suggestion. Nowadays, particularly in the field of sports you find tremendous use of micro motion study because of good technologies available. In cricket, we see the use of DRS, the third umpire. And that is a type of example of micro motion study, that how the ball is moving at a very slow speed that you are able to track. And on the basis of that, you make your final decisions, whether a player is out or not out, whether it is a 6 or not a 6.

So, all these type of decisions, in football also we make sometime decisions based on micro motion study. Another very important example, in particularly all those 100 meter, 200 meter, 400 meter races, we see that many a time, it is a photo finish. When two players, two athletes are very close at the finishing line and by naked eye you are not able to see the difference between first and second, or second and third, then you use micro motion films to decide which player was by fraction of seconds ahead of other players.

So, maybe up to 1 upon two thousandth, one upon two thousandth fraction of minute, we are able to shoot under the micro motion study. And this is going to be of extremely useful in analysing the job. And in motion study analysts often use charts as tools for analysing and recording motion studies, so different types of motion study charts are also there. And in addition to these

activity charts and process charts, analyst may also use simo chart, which are simultaneous motion charts.

So, like when my left hand is doing something what my right hand is doing at that time, when my both hands are doing something, what my legs are doing at that time. So, the simultaneous movement of my various body parts is being study in simo analysis. So in many cases, you find that people are ambidextrous and when people are ambidextrous their two hands can do two different things simultaneously. But many of us do not have that type of quality.

And if my one hand is involved in writing, other hand is stationary. So, can be develop, can be develop by training some kind of skill, when my one hand is doing some work the other hand is also be productive. Like, an example of that is your sewing machine. So, in that sewing machine we are using both our hands and legs simultaneously for doing the job. So, most of the body parts and eyes are also continuously watching the performance.

So, almost all the body parts are simultaneously involved in the job. But in many jobs, you will see that only either one hand or one leg or only eyes are involved other body parts are not involved. That means you are not able to take complete advantage of your entire body (())(28:30).

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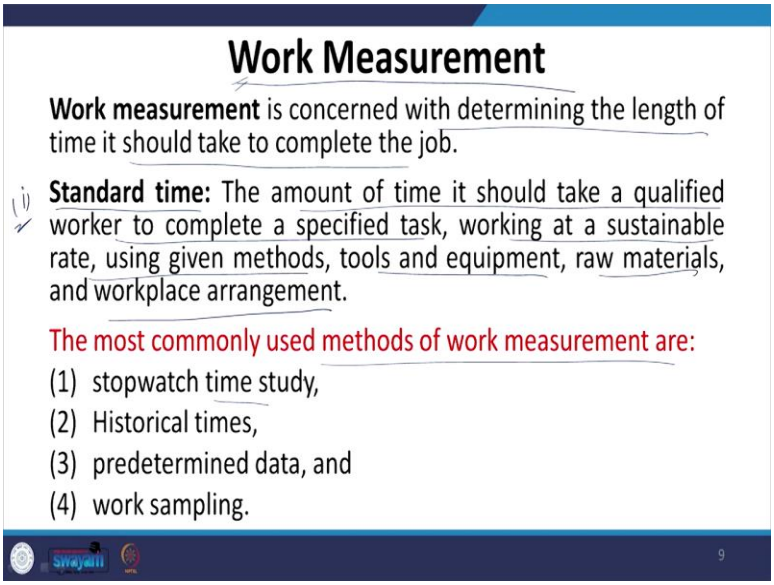

Then another important thing is work measurement. The work measurement is concerned with determining the length of time a job should take to complete it. And that is very interesting. With the help of micro motion studies, with the help of other kind of work analysis, we calculate this time to complete a particular activity. You know that across the globe, the lunch hours are normally for 1 hour. Now how did we decide that lunch hour should be of 1 hour? So, this is a scientific study, that a person can finish lunch in 15 minutes, then how much time he needs to rest before he can go again for work.

And therefore, this is a very good example, a common example across the sectors about the lunch hours. You will find that most of the cases lunch hours is of 1 hour exactly, and that is a result of work measurement studies. Now, in the work measurement study there are different type of time estimates, these are not that time estimates which we discussed in our PERT class. The first time estimate is standard time, in the standard time the amount of time it should take a qualified worker to complete a specified task, working at a sustainable rate, using given methods, tools and equipment, raw material, and workplace arrangement.

Now a properly trained worker without any kind of extra rest or without any kind of extra pace, no rest, no extra pace, so at a normal speed, the worker is working for long duration. So, how much time in that particular situation the worker is taking to complete the job, that is the standard time. And for that purpose, most commonly used methods are stopwatch time study, whenever you are doing a particular task, we prepare the log books using the stopwatch time study. There is a particular engineer, who keeps watching you that how you are performing and how much time you are taking every time.

And that data is being recorded in a logbook. The historical times, how much time you used to took in previous week or previous month, previous year, so that is the historical data. Then pre-determine data, that can you complete the job in this much time. And then we take some sampling, some random sampling we do without telling the workers we will some time, because when workers are being watched and they know that somebody is watching them, they become cautious. And therefore, they will always like to perform at their best speed. So sometime we do the sampling also, random sampling, so that when they are working on a regular basis what is their performance.

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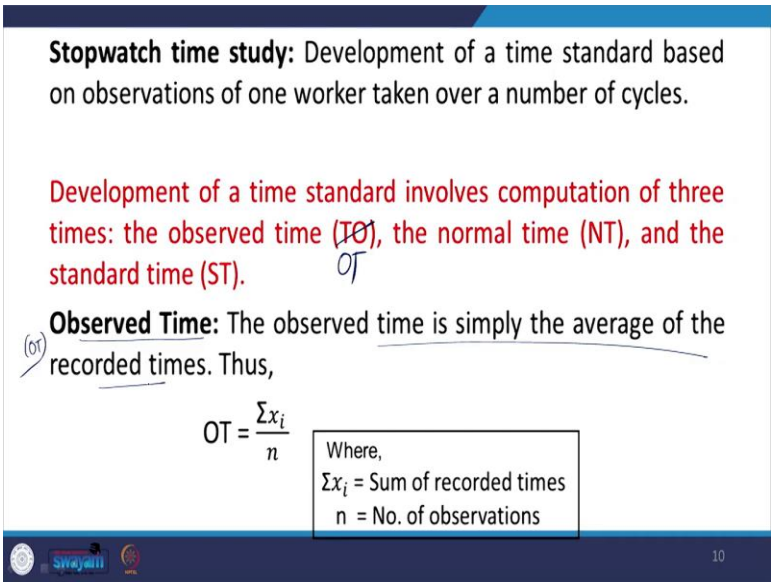

Then in this particular case, the first type of time is the Observed Time, OT. And in this observed time, the observed time is simply the average of recorded time. So, you have recorded the time for 5 continuous activities for a particular worker. So, these sigma xi divided by n, that is the observed time.

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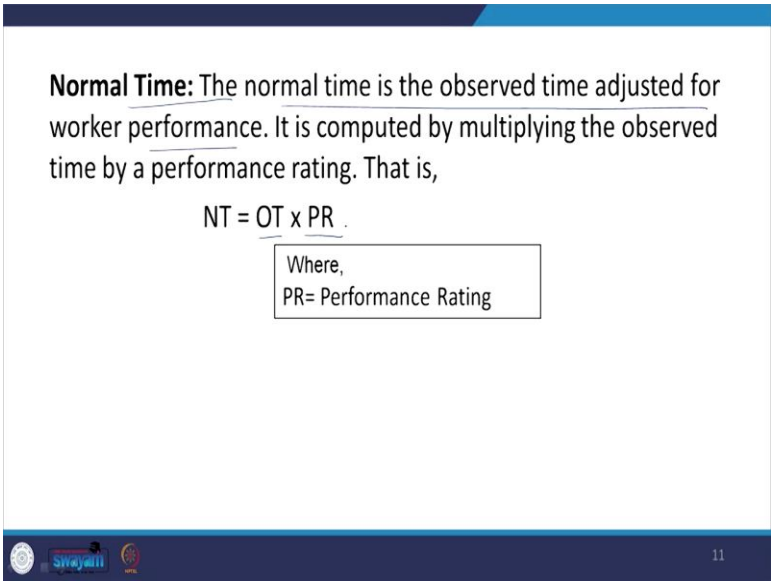

Then the second is normal time, the normal time is the observed time adjusted for workers performance. Now some worker is a good worker, some worker is not so good worker. So, you

give the performance rating to each of your worker, so the observed time is multiplied with the performance rating. So, if some worker is not a good worker, so you will give a lower performance rating and then you will find that this worker, this time is not the normal time. And on the basis of the performance rating, when you multiply it with the observed time, you get the normal time.

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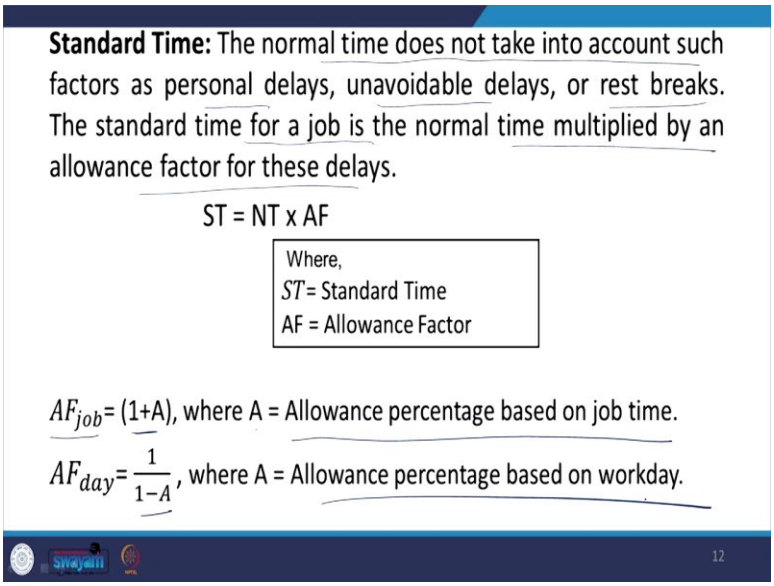

And then we have standard time, which comes after the normal time. The standard time is, normal time does not take into account factors like, personal delays, unavoidable delays, or rest breaks. So the rest, standard time for a job is the normal time multiplied by an allowance factor for these delays, that you can give an allowance of 5 percent, 10 percent, 20 percent.

And when you are multiplying, that allowance factor into your normal time you get the standard time. So, you have two types of systems. One is allowance factor for job, that is 1 plus A, where A is allowance percentage based on job time. And then, another system is allowance factor for the day, that is 1 upon 1 minus A, where allowance A is now the allowance percentage based on work day.

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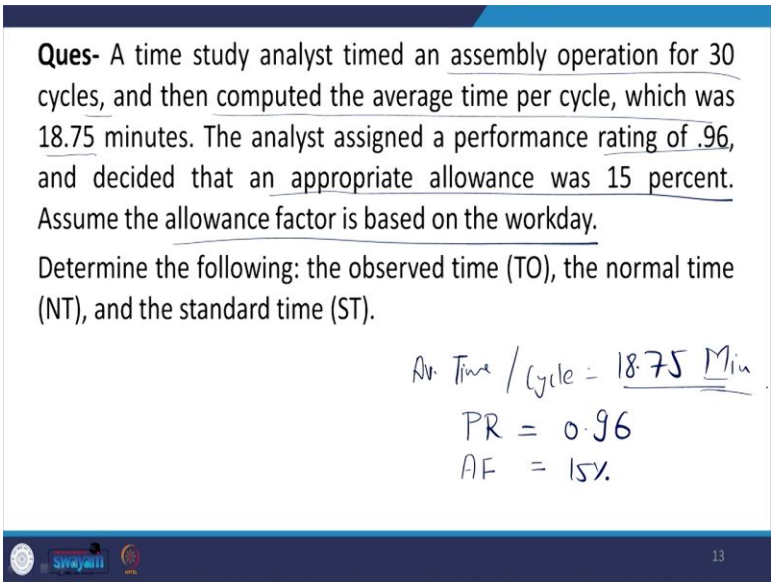

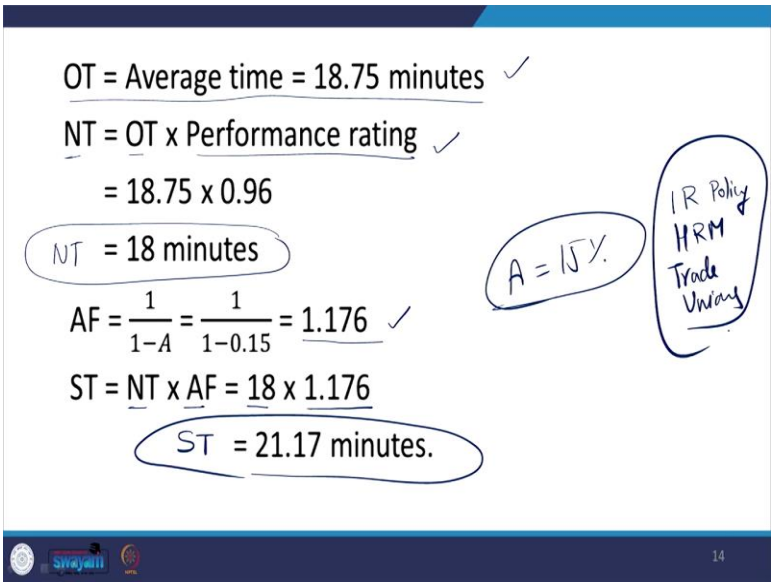

Now let us see, one example with the help of which we will understand the calculation of observed time, normal time, and the standard time. So in this case, an assembly operation for 30 cycles, and then computed the average time per cycle, which is 18.75, so average time per cycle is 18.75 minutes. The analysts assigned a performance rating of 0.96, performance rating of 96 percent and decided that an appropriate allowance of 15 percent. And this allowance factor is based on the entire workday. So, you have to determine the observed time, normal time, and the standard time.

So, let us see the calculation. The observed time is the average time, that is already given to you, that is 18.75. Then comes the normal time, that is observed time into the performance rating. Since the worker is not a good performing worker, its rating is not 100 percent. So, you will see that it becomes obvious to understand that the, this worker has taken more than the normal time.

So, 80.75 multiplied by the performance rating of 96, you get the normal time of 18 minutes. The work should have been completed in 18 minutes, but the worker took 18.75. Now, you have to add, you have to add means you have to include the allowance factor also. And allowance factor is calculated on workday basis. And therefore, AF becomes 1 upon 1 minus A and that is 15 percent is the allowance factor, so this value comes 1.176.

So, NT into AF 18 into 1.176, that is 21.17, this is the standard time. So you expect, that in 21.17 minutes a normal worker should complete the job, a normal worker should complete the job in 21.17 minutes. So, we get the calculation for overtime, we get the calculation for NT, we get the calculation for allowance factor. Here it is important to know, that the value of A was 15 percent. And here, the, how to have this value of 15 percent, the role of your IR policies, your HRM, trade unions, all these are very important component in deciding the allowance factor.

Because as organization, I want to give as minimum allowance factor as possible, as trade unions they want as high allowance factor as possible. So, there has to be a proper negotiation, proper balance about the allowance factor. And that is how A is decided, and on the basis of A, AF is decided. So, this is about the calculations of various type standards which we use for our studies, in this case of work measurement and work analysis. With this, we come to end of this session. Thank you very much.