Scheduling Techniques in Projects
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Lecture - 02
Inputs to Scheduling

This is week 1 lecture 2 on basics in scheduling. Last lecture we have seen primarily the inputs or the introduction to project management and then we started little on inputs to scheduling, WBS we started. We will continue and we will see more details in today's class. So, today's class primarily what am I going to cover? So, we will see activities, definitions, list primarily the list of activities how to arrive at. So, the WBS example we will again continue for today's class. Then, how to estimate the activity duration and the different types of estimations available in theory, practice we will see everything and the relationships between activities also we will see.

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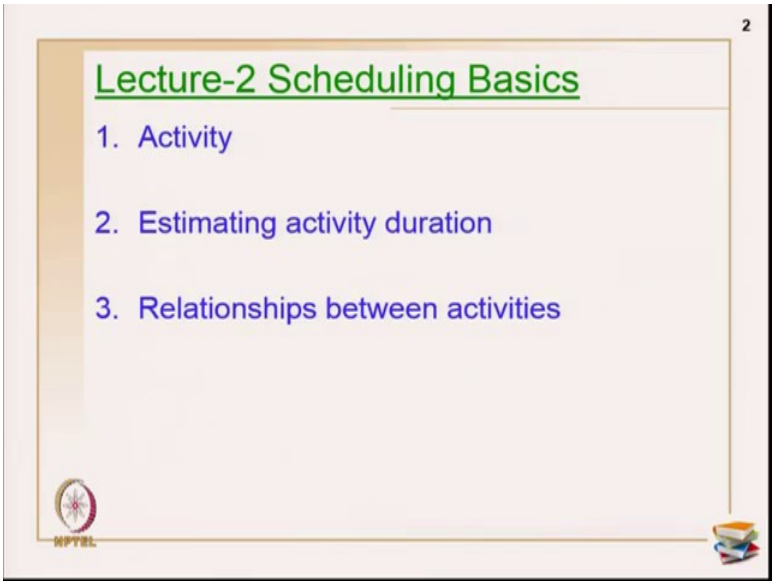

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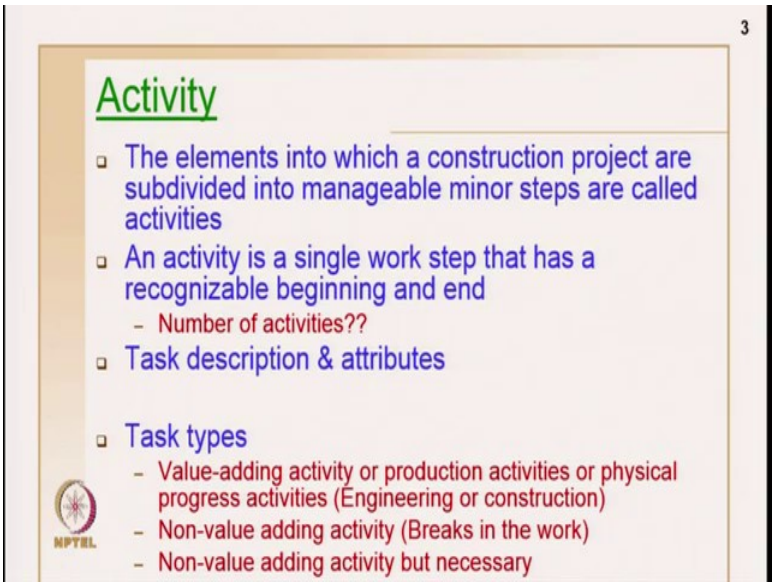

So, activity; what do you mean by an activity? The elements into which a construction project is subdivided into manageable minor steps are called activities. While explaining WBS also I told a project at that level it is very difficult to handle or by a project manager to foresee all assumptions and other issues. So, the project at that level it is very difficult so, we have to break down into sub elements in order to manage the entire project. Manage in a sense; plan, schedule, control, whatever. So, that break down the last level of the hierarchical breakdown is primarily called the activities and then we arrive at the list of activities. An activity has a same objective as that of a project in terms of specified goals, in terms of definite beginning and the end, in terms of consuming resources, in terms of objectives specifications; everything it has a similar meaning. That is what is this. An activity is a single work step, that has a recognizable beginning and an end.

Now, what about the number of activities? Is there any guideline? Should I have 100 activities? Should I have 5000 activities and so on. There is no limit, there is no hard and fast rule. If I am able to manage my activities at 300 numbers then you can go with that, otherwise you can go with 1000 also when you are comfortable in foreseeing the project at that level. So, there is no hard and fast rule in any project. But for every activity it is advisable that you give a description to the activities, primarily the scope of the whole activity should come in the description along with attributes which can be measurable and subjective attributes.

Now, coming to activity types, every time you say there are list of activities and activities. And for example, I am taking an excavation as an example. In excavation, there are series of steps I would say. And in the series of steps there may be a value adding portion, there may be a non-value adding portion and so on. Let us see what are those categories. So, task types; so value adding activity, non-value adding activity, but there is another if also non value adding, but necessary portions of those non-value additions.

Value adding activities the direct physical progressing activities maybe it can be a design activity or an engineering activity in the design phase or it can be just a construction execution in the construction phase. So, other segments for example, shifting the equipments, setting up the whole site, setting up your place and getting ready for that task, then safety audits, safety meets they are not part of the value adding portion. So, the value addition is set as direct meaning whatever is a physical progress of your design or construction is primarily called the value adding activity.

What is a non-value adding activity? Breaks in the work, nobody can work for 8 hours per day and so on. So, they may become fatigue. So, there are breaks, those breaks can be a very good example for demonstrating a non-value addition. Those activities even if they are not in the system still there is no harm or there is no loss of the work going on work progress then they are called the non-value adding activities. Then the non-value adding activity, but necessary category, what are those? They can be procurement related activities, administrative activities etc. For example, checking for the stock list in the godowns, and inspecting with the local markets and then procurement placing an order for procurement or it can be an audit inspections, quality inspections, safety meetings; these can be some sort of an procurement or admin activities which are necessary in the whole goal. Now, with this I will just show a small example on unloading of rebar in the site. So, we are very curious to know how much non-value adding portions were there and how much value adding portions were there in the activity.

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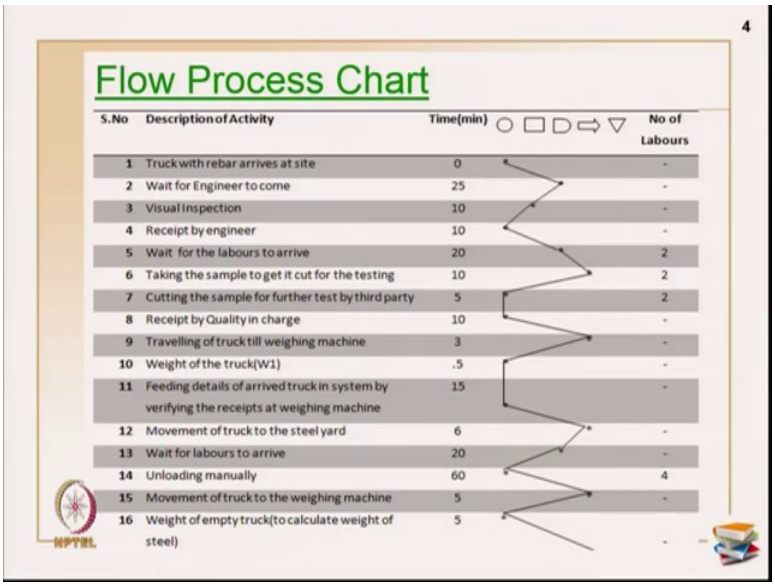

So, we used a simple diagram called flow process chart to measure all those. So, flow process chart. This is the flow process chart. These are all planning techniques as part of your work study which I will cover up at the end of the lecture on other scheduling techniques. I will give a small introduction to this. But I will just explain how to read this table first.

So, the description of activity primarily these are the 1 till 16 and it is only a snapshot, I have several more down in the line. So, this is only a snapshot on the steps for completing an unloading of rebar in the site. Primarily I have cropped only till unloading of rebar in the site and this is a time taken in minutes for each of these steps and these symbols are primarily to show the weights and then the last column is primarily the number of labors workers required to do all these operations.

So, now I am just going to read out few of the statements or steps here so that you will understand when we are really executing the work you will not note down all these unnecessary steps. But you will see what are all the unnecessary steps and you will always you should try to improve on the value adding portion to enhance or promote your constructions projects. Truck with the rebar arrives at site. It is just arriving thus we are starting from there that takes 0 minutes. So, we are not counting previously before entering the site, only from the site we are starting our time calculations.

Waiting for the engineer to arrive; so, 25 minutes there was a delay on that particular day for the engineer to come then the visual inspection on the steel was taken down, it took another 10 minutes, then receipt was given by the engineer another 10 minutes then wait for the labours or workers to arrive, it took another 20 minutes after the receipt was given then the phone call was done to those labours and the labors arrived in another 20 minutes time span.

Then your sample was cut and it was sent for testing it was another 10 minutes, then cutting the sample for further tests by the third party agencies who is doing the laboratory test. Then receipt by the quality in-charge that the steel is actually in the good condition or not as per the specifications that took another 10 minutes. Then traveling of truck till the weighing machine in order to determine the weight of the steel that took 3 minutes, then wait of the truck was noted down it took 0.5 minutes, then feeding details of the arrived truck in the system for verifying the receipts at weighing machine. How much was a load which has entered the site, the receipt has to be entered in the register that took 15 minutes.

Unloading manually; so, when the truck arrives unloading happened with the small test with the steel test. So, primarily value adding portions are very less here and there. Unloading it took 60 minutes, then the truck again empty truck has to go back to the weighing machine to really determine the self-weight of the steel which has entered the site. So, if you see the number of small-small steps, you will understand where is non-value adding and then value adding portion. Effort has to be made in order to improve or promote the value adding portions and try to minimize or avoiding non value adding portions in the whole operations in construction.

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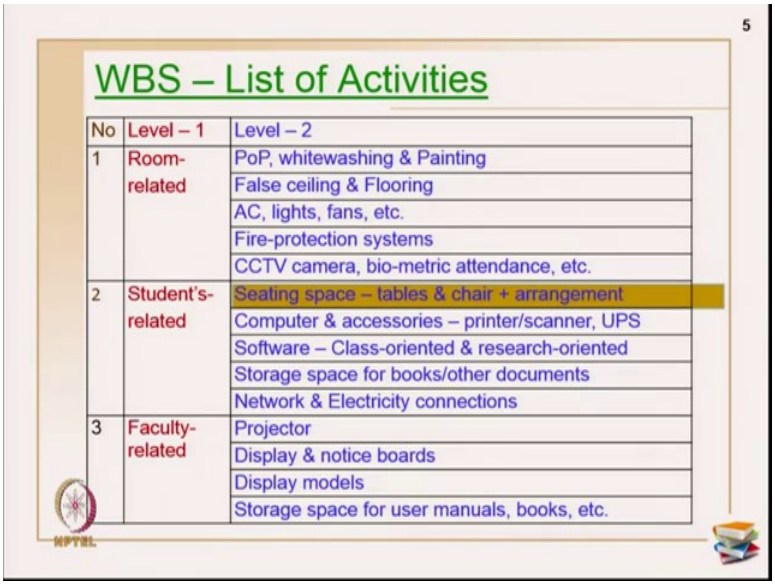

Now, let us move on to the earlier example which we were seeing in the last class. So, primarily to derive at list of activities, how do we go level 1, level 2 level 3. What is a breakdown we can go ahead in order to generate the list of activities? So, we just may continue with the same example and I am just continuing with the same highlighted task which we have seen for layout, arrangements decision making and all what happened last class we have discussed.

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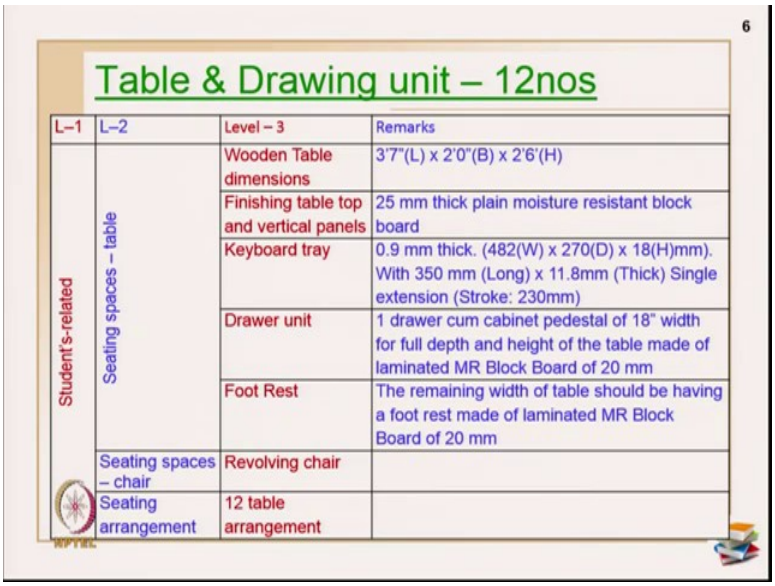

So, level 1. So, here if you see level 1, level 2 we have. I have shown you in the last class. Now level 1, level 2 I am still keeping with the same. Only on table alone we are going to go a little more in depth. Dimensions of the table; so, arriving at that is one

activity. Finishing the table top and what is a make for the table top, vertical panels that is another activity. Keyboard tray, drawer unit foot rest, so, these are all the different I would say parts or segments of the table and wherein if you are making to if you are planning to customize a table inside, then you may have to procure material ask for carpenter to make it. So, separate specifications also follows along with each of these activities; wooden table dimensions is 3 foot 7 inch, length breadth was 2 foot and 2 foot and the height was 2 foot and 6 inch. The finishing on the top and vertical panels was 25 mm thick plain moisture resistant block board and the keyboard tray was planned as 0.9 mm thick and the width dimensions and all are given with a single extension stroke only one extension was possible in the keyboard tray. The drawer unit, one drawer cum pedestal cabinet pedestal of 18 inch width was planned for full height of the table was planned. And, it should be made of laminated MR block board of 20 mm that was planned for. In the foot rest, the remaining width of the table you are supposed to have a foot rest in order to give strong support to the whole table also. That was what planned. Other things we are not we are ignoring right now. Now, moving on to detailed specs; so, when you are going on into the detailed levels again you have to work out more on the scheduling in order to really have a clear idea on the whole project. Detail specs I am not going to read out, but you can understand this is how everybody starts looking at the projects.

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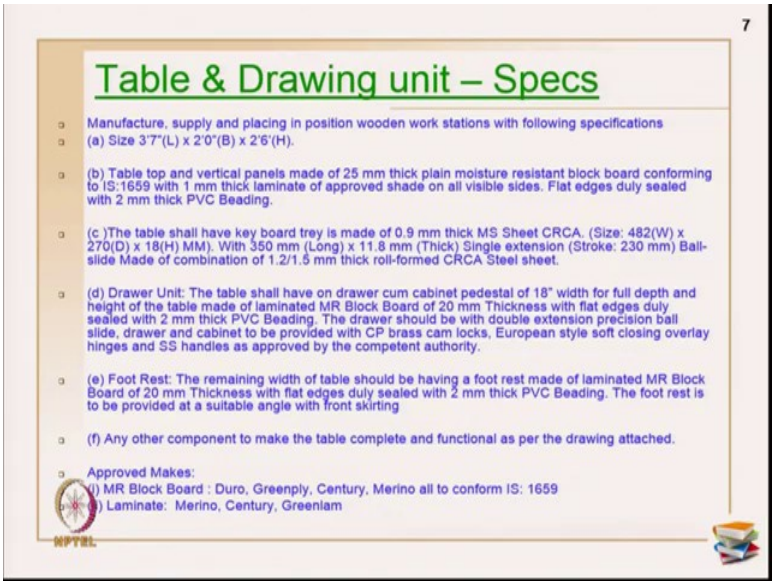

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Now, what are the options available for me? Either I go for customized options; like bringing in a carpenter, negotiating with the carpenter and then making him do it in the same site or like here I can order. Or here like this I can order from a website and then make them delivered to my place. So, these two are the customized options and these were from a photograph I have taken here and these two by the options. Only thing is that the specs may not match exactly with these two options. But the specs may exactly match with these two options, because with these options because it was taken from the students who are going to be the users and from their specs were derived and this will be exactly implemented in the site.

Now what is the duration based on the availability of 12 numbers table, on decision on whether to choose this or this, you will get the table accordingly. The duration of the table depends on what? The decision that you are going to make. Whether I want to use this, this may take 2 weeks at least to manufacture all these tables or should I go with this the availability is there within 3-4 days you will get the table in site. Otherwise it may take 1 month or so if you are planning to order then get it from the stock and then you are going to have it.

So, accordingly the schedule durations now vary. Which is what I have written. What about the duration? Duration is now its not known you have to really explore what can be the duration based on decision making. So now what I am trying to say is each time it

is not that automatically something is happening, there is a system on decision making when you go down every level and duration is coming out as a result of that, based on the comforts, conveniences, constraints which are coming into the projects along with the requirements of the whole project.

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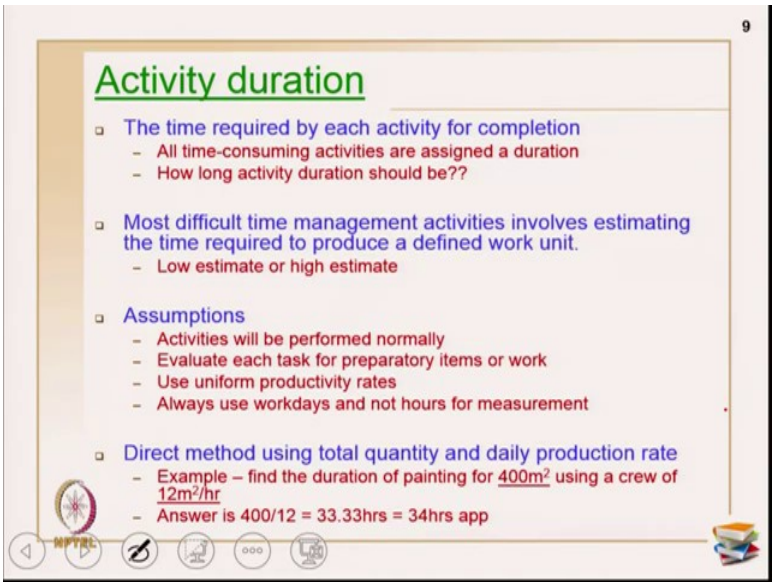

Now, what is activity duration? Now we are stopping at still duration so, what is it that I want, I really wanted to know what is the duration of my individual activities to really want to know what is the duration of my whole project. So, what is activity duration? The time required for each activity for its completion is primarily call activity duration. So, all time-consuming activities are generally assigned a duration. Now how long this duration of an activity can be? So, for example, if I have an activity which says like 3 months, 5 months and so on. Should you really keep it as same or should you break down the activity into sub activities, so that you are able to have a smaller duration. Again, just like how I told in the activities case, there is no hard fast rule here, there is no thumb rule on how much the duration should be. If you are able to manage at whatever level you want you can still go ahead, but generally it is advisable to keep it in work days or working months rather than in working hours. That is the only suggestion you will see in many textbooks. Now what is a most difficult a time managing activities: estimating the correct time which will take for completing a project. Define work unit, for example, it can be setting up a lab or it can be setting excavation work, it can be a reinforcement concreting activity. If you do a low estimate what happens is: schedule may look like

that we may be finishing earlier, you may be committing saying that I will be finishing my entire project in 1 year, but as such on-site it may take beyond. If you are doing really a high estimate you may show that it may be taking so much days and months, but actually you could have wrapped it up and finished it up fast and you may end up in paying more overhead cost, lethargic, slow progress of work. So, there are many problems which will happen.

So, the difficult challenges how you are estimating an activated duration, which is really challenging. So, what assumptions people use when they are deriving a duration of an activity? Activities will be performed normally. Suppose when you want to measure the distance from your hostels to your classrooms, you should not walk in a very fast speed or you should not walk very slow. So, the both are not considered good when you are measuring the calculations. You should be walking in a normal pace and then measuring up what is the time it will take to travel from your hostel to the classrooms.

So which implies any activity should be performed in a normal speed, in a normal environment and normal situations by a normal worker also. And evaluate each task for preparatory items are work. So, how much time is a preparatory item requires and how much is the real value adding portion in the whole activity and use uniform productivity rates. This I will I will explain you after one or two slides and as I told you this earlier you always use work days and not hours for measurement.

I am just bringing a small example to showcase how to find the duration, which we call as a direct method. There are several methods available we are going to see many of the methods in today's class. Direct method using total quantity, crew size, and daily production rate. In this example, I have said there is a crew and the productivity alone. I have not told what is a crew composition in this particular example.

For example, find the duration of painting activity of 400 meters square, that is the work content or work unit quantity using a crew of productivity 12 meters square per hour. Painting activity we generally take measurements in terms of area only. It is not in volume anyways. So, its primarily meter square and the crew capacity is 12 meter square per hour. So, what will be the answer, which is 400 by 12. So, approximately 34 hours is the duration you are going to take for the painting activity if you are using this particular crew.

Now the next question which comes to your mind is how am I going to get the 400 meter square and who gives me the value of 12 meter square per hour. 400 meter square obviously comes from your estimation exercises. I have a drawing. Generally in construction what happens is I am given all GFC drawings which is good for construction drawings. From there you have to really do the estimation in getting out all your quantities. You have to do working out all the quantities and people use generally central line method or long wall short wall method there are methods available which you have known earlier. From there these quantities come there and the crew composition comes from your resource availability and the productivity of the crew it can come from the productivity constants also.

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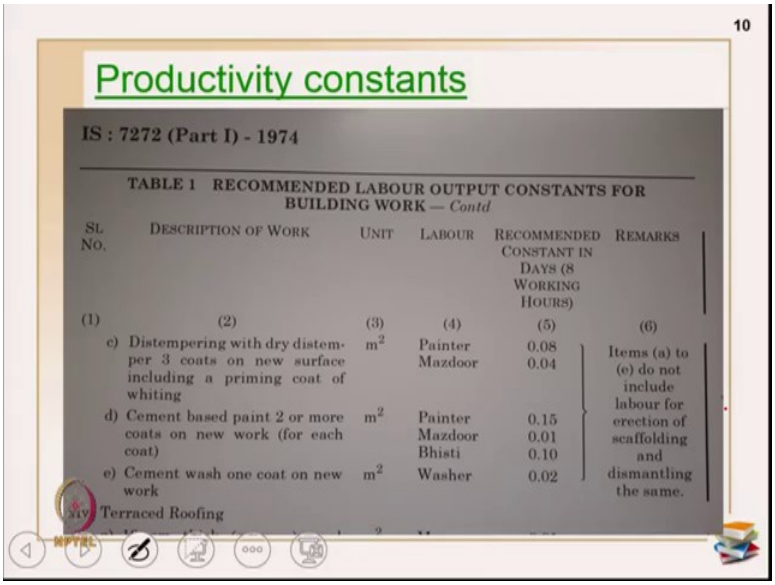

Sometimes we can also use experience, suppose if you are not comfortable in or you are just first time a beginner in going ahead with the project, then you can always choose productivity constants from the IS code. There is also an IS code available IS 7272 and I just showed a sample of a snapshot of that, but the only one problem is it reliable and how many assumptions have gone in here.

Now is it reliable? This data has been taken in 74 and there are plans to revise this IS code. That is another issue. Now how far can I just use the data for working out a project in 2019. It is very difficult and you do not know how many assumptions have gone in for making all these works. For example, say x on level, on same ground level and on maybe

on twelfth floor or fifteenth floor, same work, can you measure the same duration? Can you think the duration of these two activities will be the same? Activity is the same, but the place at which you are going to work is; obviously, varying. So, do you think you will get the same duration for both the activities? Obviously, no, which is what I said under what situations what circumstances, what is the hazardous nature of the whole activity, if it is not known or it is not clear at all then you cannot use this standards. But instead of saying I am not clear on how to go ahead with and you have to build it up and start using your own measurements from the construction sites. That is what is advisable.

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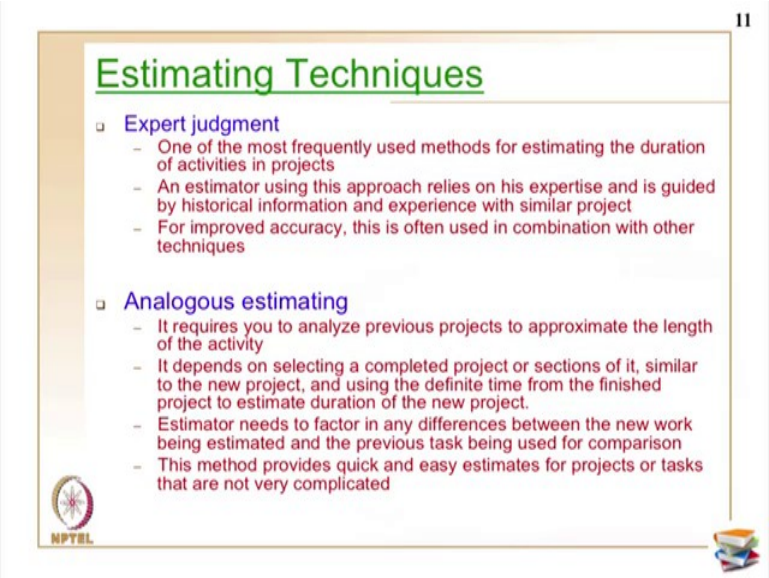

Now, what are the estimating techniques people use or people have as a choice when they are planning for estimating the activity durations. Number 1; expert judgment; there is no particular order. So, I am just using my own order. Number one is expert judgment. It is one of the most frequently used methods for estimating the duration of activities in projects. So, in this method what happens is that the estimator, he realize on his own expertise and he consider by some historical information and experience with the previous projects and then he just says excavation activity: this will take 2 months, this will take 3 months. So, he just uses that expert knowledge and he starts filling up the duration of the activities. But what happens is: for improved accuracy it is recommended that if this can be combined with other techniques which has a little scientific issues behind, so that it can be done with ease and at a faster pace you can finish up the whole estimation exercise.

Then the next is analogous estimating. So, it requires you to analyze the previous projects to approximate the length of the current activity. I would have done 2 or 3 sewer line projects and this is my fourth sewer line project. So, I may have some different sort of experience in the previous projects in estimating the durations, I can use some portion. Maybe I can take a completed project or I can take a section of those project and I can compare that work with my work how much is a deviations and then accordingly I may use this method for estimating their duration. In this method what happens you can have a very quick easy estimates for projects or tasks that are not very complicated. In sewer lines maybe the ground conditions your design maybe a little varying, but construction more or less it may not vary. So, you can still go ahead because you may have repetitive types of a construction work.

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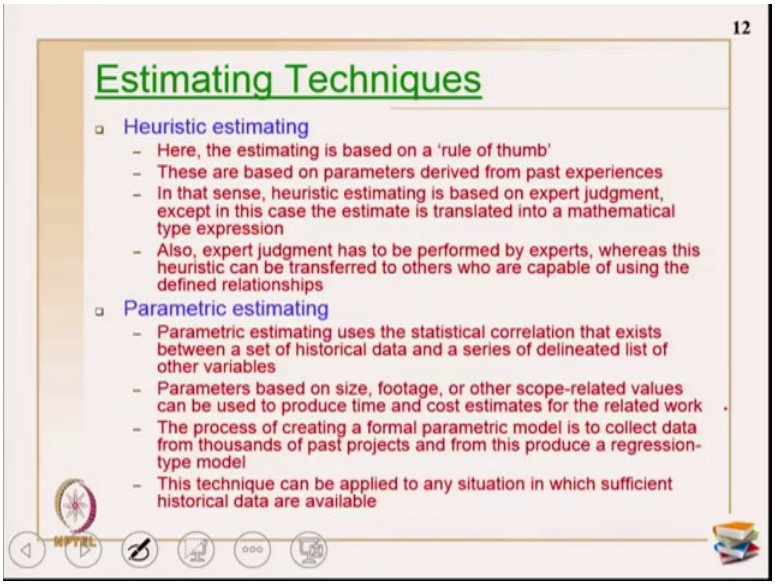

The next is heuristic estimation. So, heuristic estimation this is based on parameters derived from past experiences. In here, what happens is it is actually close to your expert judgment, but in expert judgment they really go with experts opinion and primarily it is dominated by experts. And, in this heuristic estimation people use a mathematical type of expression in order to arrive at a formula and they use that expression and that expression can be also handled by non-experts in this type of a heuristic estimate when the expression is made available. That is the underline statement here.

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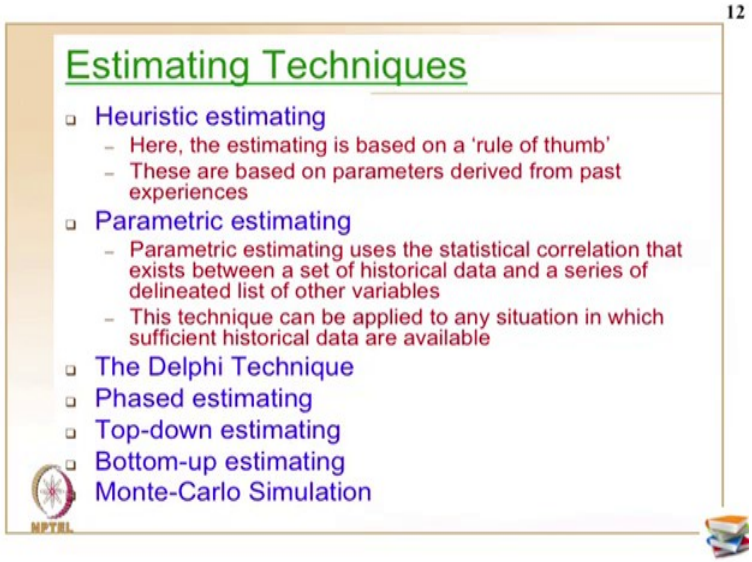

The next method is parametric estimating. As a name implies its primarily talks about parameter which is nothing, but a small last element and then whole WBS structure. For example, an activity can be design of a beam or a slab and the parameters can be thickness of the slab, cover to the reinforcement and spacing of the reinforcement. It can be so many issues. Same way in this parametric estimating, I have two similar projects, I have done some one project very earlier and the project which I am going to estimate is right now here in front of me. Just do parametric estimation. Is it only the windows alone have changed, there I have used wooden windows and here I am going to use an aluminum windows and another estimation may fall in place for me. So, that type of a model you can still see in and you can still capture from there and you can compare and then you can do. So parametric estimating uses the statistical correlation that exists between a set of historical data and a series of delineator list of other variables, parameters based on size, footage or other scope related values can be used to produce time and cost estimates for the related work. The process of creating a formal parametric model is to collect data from thousands of past projects and from this produce a regression type of a model. And this technique can be applied to any situation in which sufficient historical data are not available which is what I have told you earlier.

The next is Delphi technique and Delphi is a common term which construction management researchers generally use. Delphi is like I take opinion from few people then once that iteration is over I start brainstorming on the results that I have got in front

of me. The results are coinciding then you can conclude, the results are not coinciding and, but they are close to converging again you have to do one round of getting expert opinions. Then the results asking that person x had given an y value, can you please change or what do you think about it. So, getting concurrences on others values and then you start getting at an converged convergence. And the problem here is you may also land up in several iterations in order to arrive at a converged value. Sometimes the first round itself you have got totally diverged value. Some people has told 2 days, and somebody has told 2 months. Then it is like too diverged. And then arriving at a consensus may never happen at all. That is a real drawback in Delphi technique. Enquire a from several independent experts to estimate the duration of an activity in your project and then evaluate the results to provide an objective estimate. This method is based on the assumption that the independent experts are unknown to each other and does their individual biases will cancel out resulting in an accurate estimate. I am not worried about what the other what my other expert has told. So, I am worried about what all I think got the assumptions, constraints and etc and I am giving my value at all and once the first iteration is complete the panel meets to discuss the results then estimators review their estimations in the delta column and this process will continue until a consensus is reached. Normally Delphi technique is used for more highly complex situations for which there is little historical background. However, the concept works in situations where a non-biased estimate is needed, because this technique seeks estimates from multiple participants, It tends to remove the bias and politics that may happen. Rather than going with only one expert judgment. I am just having assigning a person for giving his data and so, he will give only his value which may be more close to the actual or which may be too deviating from the actual. This can eliminate all those errors because I am taking opinion from several parties. One of the drawback is as I told you is the amount of time it can take for the panel of experts to reach a consensus.

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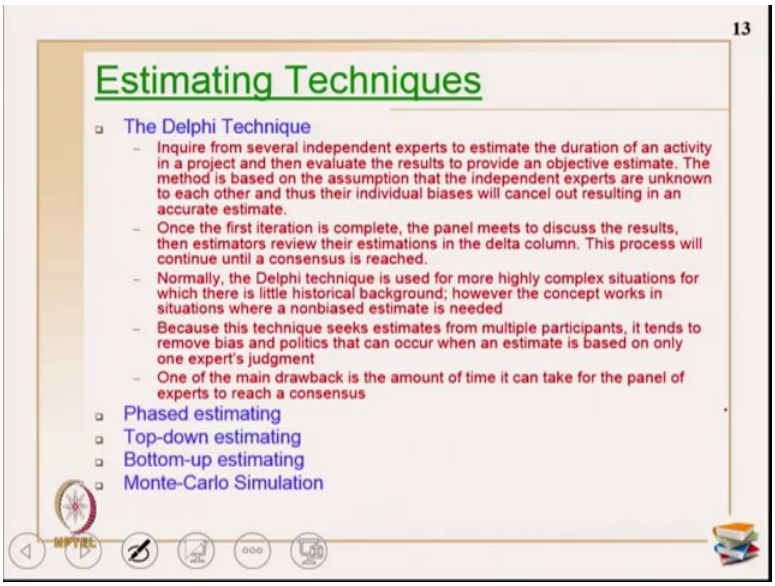

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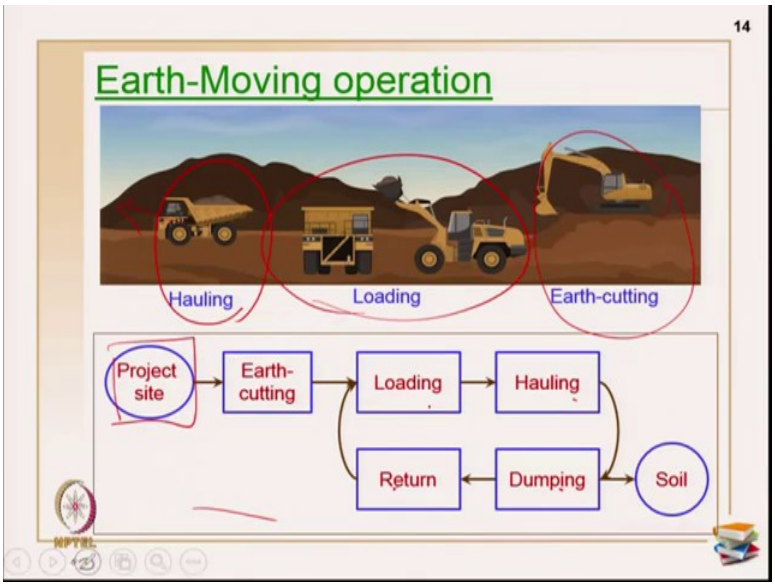

There are other methods also on estimating. So, these techniques which I would say starting from expert judgment, analogous estimation, heuristic estimation, parametric estimation, Delphi technique and so on; I will show you the problems with practical examples.

Let us take now one practical example, a very simple earth moving operation. This is a very classical example and researchers in construction management group use this example very widely for explaining a simulation exercise. There is a simulation cyclic

operation here and for that they use this example very widely. So, what does this earth moving operation example; let me explain this figure first. I am having an excavator, so excavator is here, so if which does the earth cutting operation. Then the next step once the earth is cut so, primarily I am just doing my earth excavation work and cutting the soil, the first layers and then depositing the soil in somewhere else.

The next is loading operation. So, I need a loader and a dump truck for loading all the excavated earth onto the truck. So, it does only the loading operation. So, after one truck is fully loaded up, the next truck comes on the loader keeps on loading up onto the next truck. And the next is hauling operation hauling is nothing but moving on road with the truck. So, this is primarily the hauling operation, the dump truck is actually leaving the site it is going to dump the soil somewhere. This entire process I have I have shown it on a diagram right now. So, I have a project site. So, if the project site is the essential resource for me in order to do the earth moving operation. So, I am having first activity called earth cutting, then I have loading, hauling, dumping, return and then the trucks return back, empty trucks return back to the loading site wait in the queue in order to have the next loading operation to go on and the soil is dumped in a place in an marked destination b.

Here what happens the movement of earth. Let me erase all this. What happens to the movement of the earth? The earth movement is starting from here, it is moving on, cutting, loading, hauling and then dumping. So, this is actually the earth movement which you stopping till here. Excavator there is no moment here, but what happens to the loader? The loaders moment is only till here (Refer Time: 29:22) only till here only till the hauling operation and the truck it actually moves in a cycle. So, this actually shows that truck cycle also. Loader loading operation, hauling with the moment of the truck with the soil or the earth and then it dumps, then the empty truck comes only the empty truck with no earth it just comes back and then stays here. So, there are now so many activities which you have to match now. And three equipments are there in this exercise.

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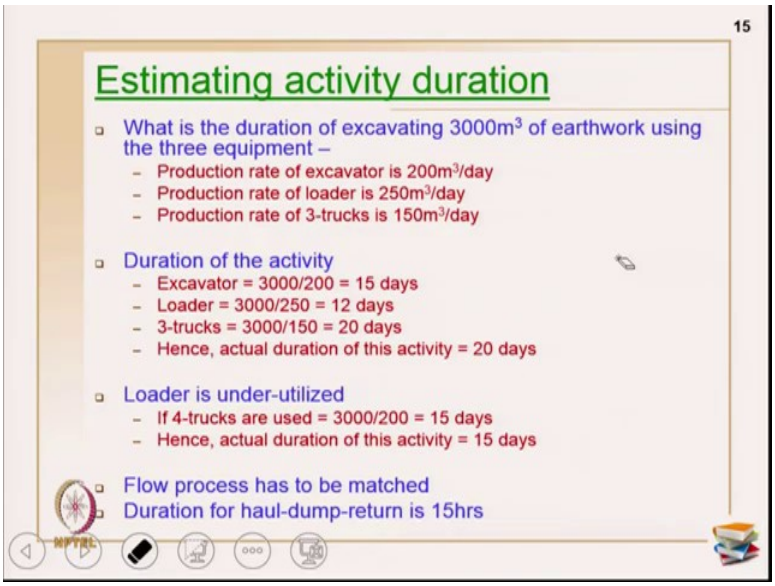

Now, let us start the example now. Now what is the duration? I am just starting up with the simple example. What is the duration of excavating 3000 meter cube of earth work using the following three equipments? I have now excavator, loader and I am using a 3 truck a combination to match up the loader also. This is the first cut decision we are made and the quantity of excavation to be done is 3000 meter cube. Now what are the production rates? Production rates can be obtained from the manufacturers also. Production rates of excavator is 200 meter cube per day, of loader is 250 meter cube per day, of the 3 truck combination is 150 meter cube per day. Now what will be my answer? So, duration of the activity now, for the excavator alone if this is the production cycle then it will take 15 days to finish the 3000 meter cube. Loader 12 days it will take to finish the 3000 meter cube, 3 trucks combination it will take 20 days to finish my 3000 meter cube. And hence, what about the actual duration of this whole activity? So, it needs 20 days, because a truck cycle also has to be matched up. So, I need 20 days to finish up my entire exercise on this 3000 meter cube of excavation. Now what do you see here, one just excavator is used for 15 days. My trucks are completely used in the 20 days duration, my excavator is used only for 50 days and 5 days its idle and what about my loader? And the loader I am using only for the 12 days and the 8 days I am going to pay for the idle equipment which is going to rest in my site.

Now let us rethink the combination. So, loader is underutilized which is what to has been identified. If 4 trucks are planned to be used what will happen to the productivity? The

productivity just use interpolation. So, you will get at least 200 meter cubes per day and the duration of this truck 4 trucks combination will be 15 days. So, what will be the actual duration of the whole activity now? 15, 12 and this 3 trucks will be changed to 4 trucks and I will have 15 here. So, the duration of this entire activity will be now 15 days. So, loader is not utilized only for 3 days which is not too bad a option compare to the earlier case.

Now what happens is there is a flow process here which is what I wanted to see here and when I was explaining this example also, I showed all the flows. Why? Because when you are matching, when you are deriving the duration of excavator, loader trucks and so on, you cannot view everything as independent activity. You have to match with the flow. So, that is where I showed the cycles I explained the flow process also. In the earlier case also why I brought in scheduling estimating techniques is you cannot look at one activity and see only that and then go ahead, you have to match the whole process. So, for example, the flow process has to be matched.

Now I am giving you one critical situation right now. Let us assume the duration for the haul dump return cycle it. Let us assume it takes 15 hours. Now what happens here, I am having my excavator with just cuts earth and the loading is operation is going on. So, 12 days it takes to finish up the process and how many trucks I am going to use; four trucks. So, when the first truck is gone, second truck comes and it goes on then what happens by the time the fourth truck is supposed to be over, the first truck which has gone on for dumping the soil has to come back and wait in the queue. Suppose if the duration for the haul dump return; we are not very clear on what is the duration it takes. In peak hours it may take 25 hours, in no peak hours it may take 15 hours, some situations like this arise. What will happen now? You may have to make the loader wait and the excavator also to wait and you may have to pay for other equipments. So, under those situations you may have to think off increasing the loader and the truck combination or you may also have to think of an option wherein the loading can also do the hauling exercise.

So, there are several options available. Accordingly, resource has to be changed, modified and then you have to match up with the flow process. So, which is what I would like to tell here right now. Now in the same way, Is the flow process, matching up the flow process is it the only one way it works in all projects? No not necessarily, the

previous example it works and what happens in this case this was setting up a laboratory example which I explained in the recently.

In the same example do you think the flow process will be matched up when you are putting in more crews and more workers. It will not work out in every time. So, now, what are the other options available now?

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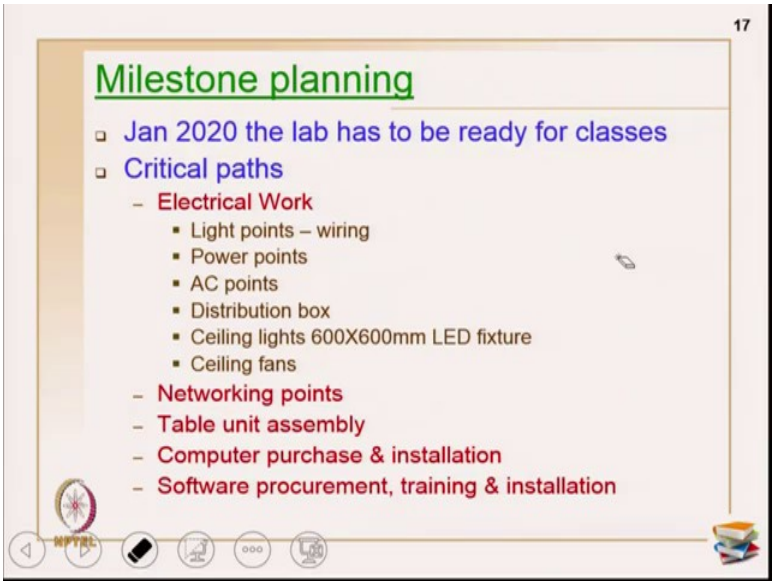

Let us again I am just giving a critical situation here and what we say is a milestone planning. The resources all has to be based on the milestone which you are planned and assigned in the project and accordingly you plan or you schedule the entire exercise. Let us assume in the same developing a construction management laboratory exercise, January 2020 the lab has to be ready for the classes and today we are in July. So, hardly 5 5 months or 6 months we have in setting up the laboratory.

Now what are all the critical paths one has to look out? We have to look from the backward, from the finishing phase we have to see. So, first software procurement, training, installation has to be done before the class has to start. To do the software procurement, training and installation computer hardware purchase installation has to be done and to set up the computer you need the table unit and assemblies, because you cannot dump the computer on the floor. So you need the table unit has to be come in place and before you put the table unit and then do the installations and so on networking points that trickle points has to be fixed.

So, now, let us look at all the tasks. So, every task will have a list of sub tasks. For example, electrical work I may have to do light points, wiring for the light points I may have to do power points I may have to look at AC points, again earth work, wiring for earth everything you have to do. Distribution box I have to set up. Ceiling lights I have to fix. Ceiling fans I have to fix. Otherwise you cannot put the computer and then do the installation also. Now if I assume approximately some n is a duration for each and every item if by putting in more crew you will not be able to do because most of them are like sequential activities and some only you can do it in parallel.

Electrical work can go parallel when you are doing the table unit assembly, because table will not recover any electrical fixtures. So, some works can go parallel and some works can go sequential, but the duration of these activities are like fixed and you cannot alter and there are series of steps in each and every item like this. So, in this how do you do the scheduling and how do you go with the whole exercises? We may have to fix the milestones and accordingly work backwards on your schedules and then go ahead with the schedules. That is how it has to be done.

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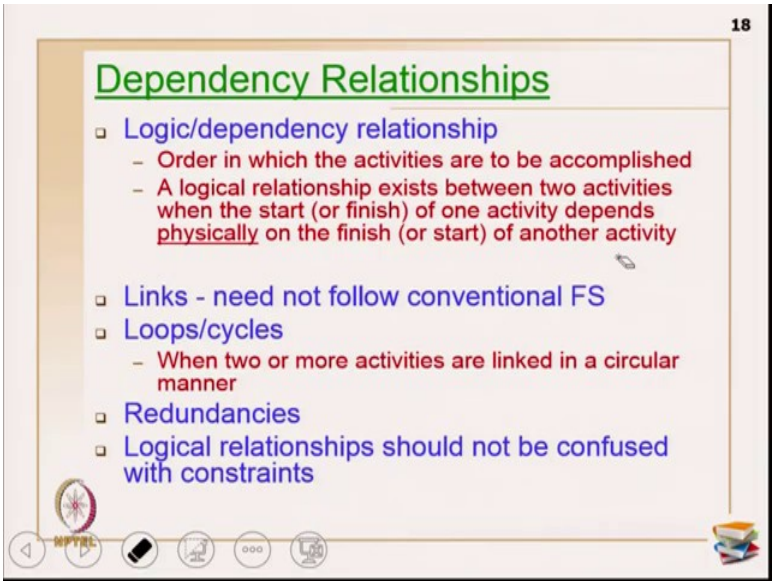

Now we will see more on now relationships. In the flow process or in milestone planning whatever it is now, we have learned little on durations. So, we will see now what is the relationship that governs because your durations alone is not essential in order to fix your schedule of the whole project. Now relationships, what are the different relationships

available? So, there are sequential and parallel which is a common relationship which we use in construction phase alone. There are other types of relationships are also there that we will see later and in resource relationships are also there which also we will see little later.

Generally, when you see a dependency relationship by default it is call logic relationship. So, what do you mean by logic? It is an order in which the activities are to be accomplished. It is an order in which A has to be done first. After A, B has to be done or A and B can be done in parallel. So, it determines the order in which the activities has to be executed. And what is it exactly defined as a logical relationship which exists between two activities. When the start, it can be also finish of one activity depends physically on the finish or start of another activity.

Why am I underlining here physical, is this supplies only when you are using a logical relationship. For other relationships this physical will not play a role the other resources will play a role for resource relationship, information will play a role for information driven relationships and so on.

Now there are different terminology which I would like to say. Number one links, links is the word which we use when we are not following in the conventional finish - start. For example, in the previous place I said finish of one activity it is connected with the start of another activity; there is a finish there is a start. But in links what happens is I can actually start another activity after some pace of the activity has been progressed. So, it can start somewhere in the middle, it can also finish somewhere in the middle. They are primarily called as a links.

Then the next loops are cycles when two or more activities are actually connected in a circular manner, then they are called as loops or cycles which we will see more elaborate as we move on into the week 2 week 4.

The next is redundancies; redundancies are unnecessary relationships in a project. I will show you with an example also on this and the logical relationships should not be confused with constraints. We will we will explain now what is a constraint.

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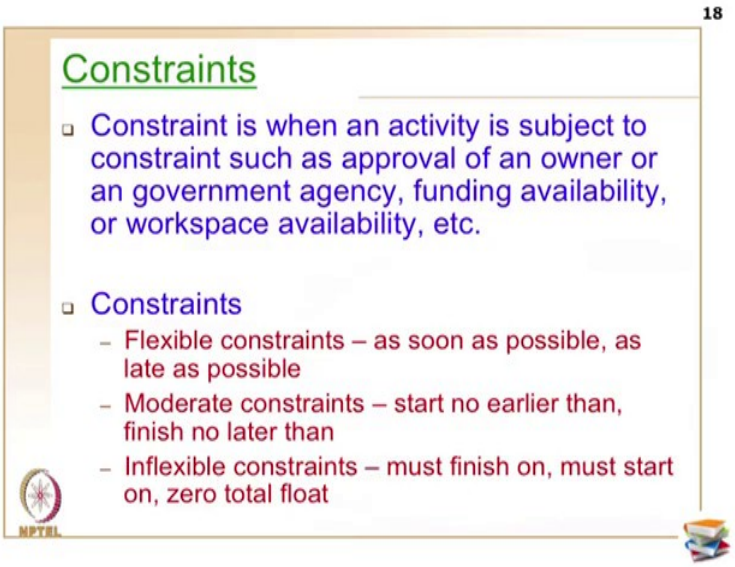

Constraint is when an activity is subject to constraint such as approval of an owner or a government agency etc. The constraints when you work on softwares like MS project or Primavera you will come across some sort of constraints which we classify as flexible constraints, moderate constraints and an inflexible constraints.

What does a flexible constraint? It is very flexible as soon as possible, the excavation work should start as soon as possible there is no deadline. There is no demand. I can start today if possible, I can start next week if possible there is no harm; so, if because it is a flexible constraint.

Moderate constraints start no earlier then so which implies I can start the activity, but there is a deadline only for the start, I can start even very ahead of whatever I can. Next inflexible there is a date given and you have to go only with the same date, must start on must finish on are all called inflexible constraints.

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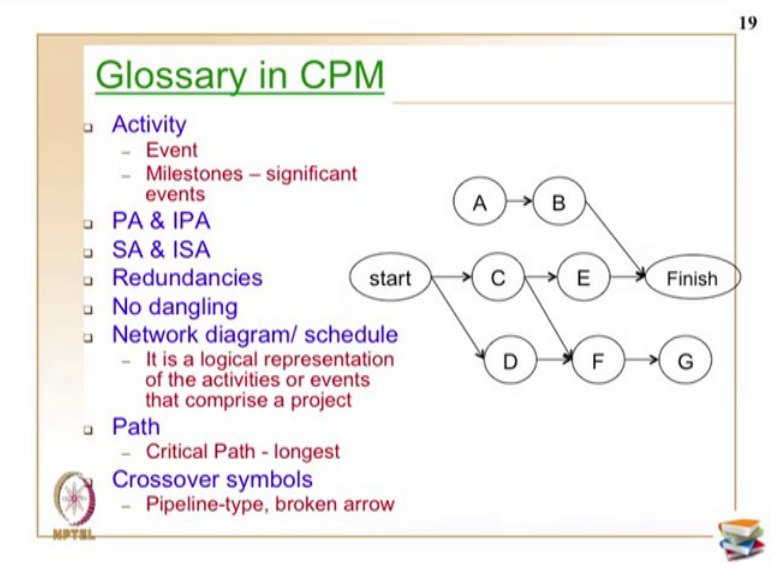

Now, moving on into glossary in CPM, which I will start with the small example. This is a small example which I thought with that I will explain. Now, this is a simple example and I have written ABCDEF, how to draw this network, how to represent (Refer Time: 41:41) this we will see in the next class, but this is a simple network diagram. We are actually moving into network schedules on critical path method and before going into the network schedules and critical path method some terminologies in critical path method, then we will go with the proper introduction on that.

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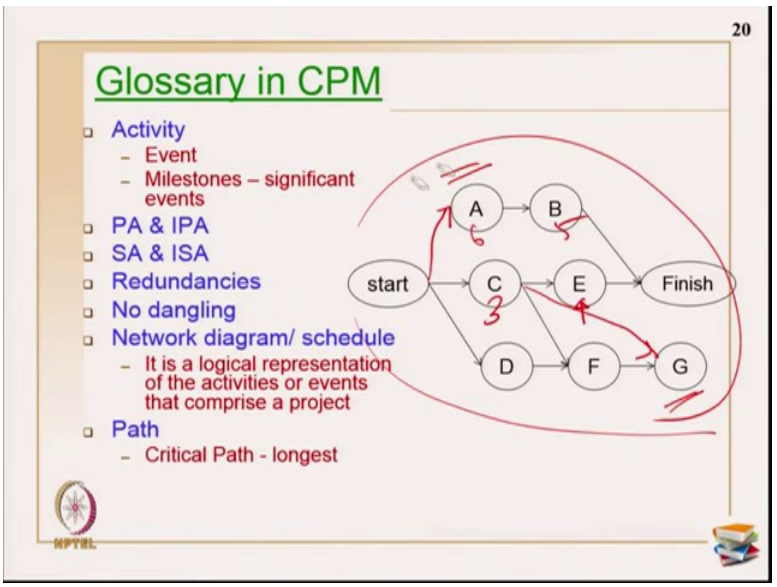

So, there are two terms in any network schedules; one is called activity and you know what is an activity. Any activity is something which has a definite start definite end. So, there is a time duration for this and there is a duration for all these activities then it is called as an activity. An event is just a single step in the whole exercise. It can be start of the activity or it can be end of the activity. That is primarily called as an event. And the milestones are nothing but significant events. So, event will not consume any resource and event will not take any duration. The same case with milestones also, they will not consume any resource or they will not take any duration as such.

The next predecessor activity and immediately predecessor activity; I am having an activity called G; I am just taking this example as G. So, for G,F,C,D all are predecessor activities, but F is an immediately predecessor activity. The activity which just proceeds the current activity, we call as IPA and all others are primarily call the PA's.

Now, same case successor activities; I am just choosing an activity called D, F, G. Both are successor activities to D, but F is the immediately succeeding activity to D.

Next redundancies for which I have to erase. Redundancies. how do you explain redundancies? Redundancies are nothing, but unnecessary relationships. For example, if I am marking from C to G, is it really necessary because already after C is completed, you are starting and F activity. So, it is really not necessary if you are having a relationship from C to G, unless it is a different type of a relationship. In logical relationship the C to G is not necessary and this we call it as an redundant relationship.

The next is dangling; dangling is nothing, but the free lose activities which are in the project. I just showed this example purposely. So, as such what should happen is all activities should be connected. So, in the terminology A is supposed to be called as start dangling and G is supposed to be called as finished dangling which you will learn more when we are doing the PDM the precedence diagramming method.

The next, so what is a network diagram or a schedule? So, network diagram or a schedule so, we are just coming into network diagrams. It is a logical representation of the activities or events that comprise a project. So, primarily the way with which I have drawn this complete exercise, this is primarily called network diagram or we can also call network schedules when you are planning to write a duration here, 6, 5, 3, 4 something when you write then it becomes a network schedule also.

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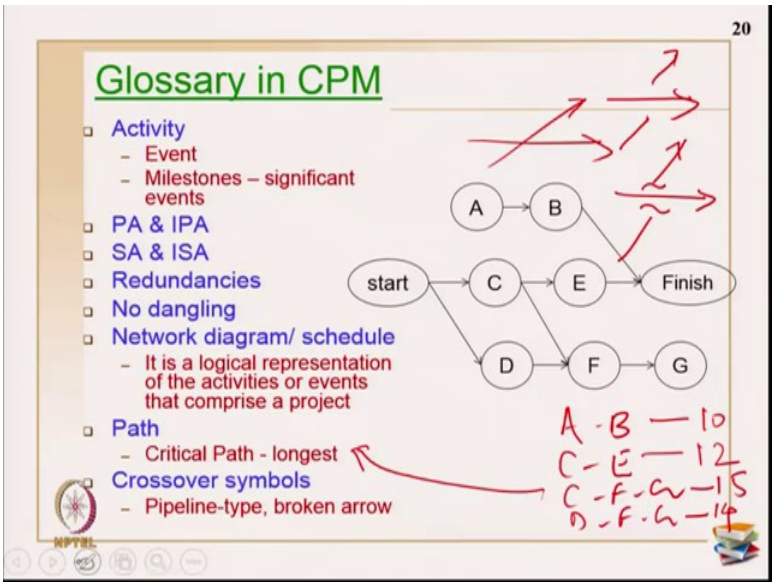

And what do you mean by path? Again, I will erase. Path is nothing, but the connection between all activities. For example, here how many paths I have? I have A-B is one path, CE is one path, C- F - G is one path, then D - F - G is another path. So, these are all called the paths. Suppose AB takes 10 days to finish, CE takes 12 days to finish, this takes 15 and this takes 14, then the CFG is called as a critical path, because it takes a longer time to finish. That is called the critical path.

In all network diagrams you may draw the diagram and then when you are assigning the duration to all these activities and then doing analysis, primarily the forward pass and backward pass, then you primarily land up in arriving at or finding out which is a critical path. So, that becomes a longest path in the whole project. Then crossover symbols, suppose I am crossing over two relationships like this then there are symbols available for the crossing over.

One is pipeline types and the other one is broken arrow which implies just like this. So, these are the two forms of crossover symbols we have for crossing over. You can still cross over two arrow marks. Otherwise if you want to use symbols the two symbols which are available or pipeline types and the broken arrow types.

So, now so far what happened is in this particular lecture we have described all the inputs in scheduling, starting from arriving at what is an activity, list of activities, relationships, duration, duration little more we have seen in estimating techniques in a project as well

and we have started up introducing on critical path method, the glossary in critical path method and the network schedules. The next class we will see more on critical path method in detail and how to do analysis scheduling, how to draw a network and so on.

Thank you.