Project Management
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Module No #4
Lecture No #20
Activity Networks Used in Project Management

Good morning, Good afternoon and hello my friends this is the twentieth lecture of each of being of half hour duration and we are just at the middle of the course of the project management. So today we will consider the concept of PERT CPM this is the just starting and if you remember we consider what are the concept of activity on arc? And activity on known concept and based on that we will now proceed. So if you see the slides which is two hundred and twenty seventh one.

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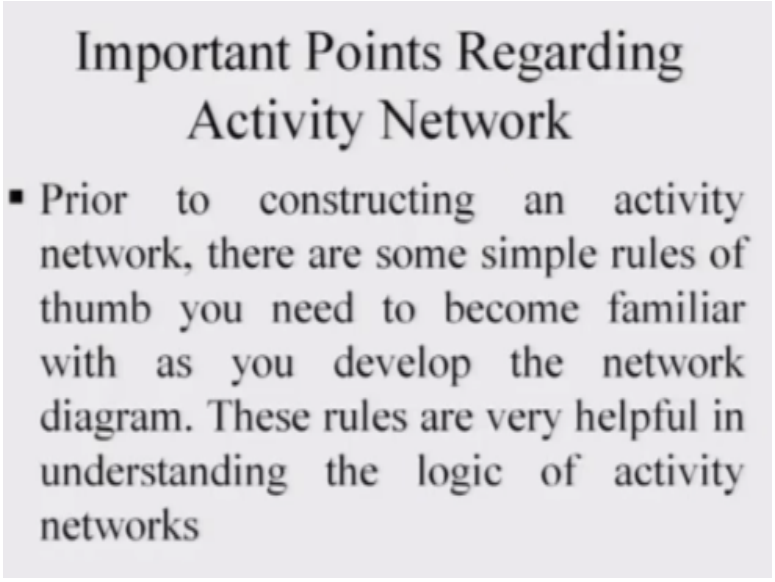

So to prior to constructing an activity network there are some simple rules of thumb you need to become familiar with as you develop the overall set of activities which makes the project. So these rules are very helpful in understanding the logic of the sequence of the activity based on which we will work to basically find pout what is the critical path or what is the time duration taken for project and based on that we will take a decision.

Whether crashing can be done whether that set of activities are optimal or whether they are critical whether resources should be utilised in order to finish the overall work before time

and resources are being utilised. What is the overall consequence on the general cost structure for the project?

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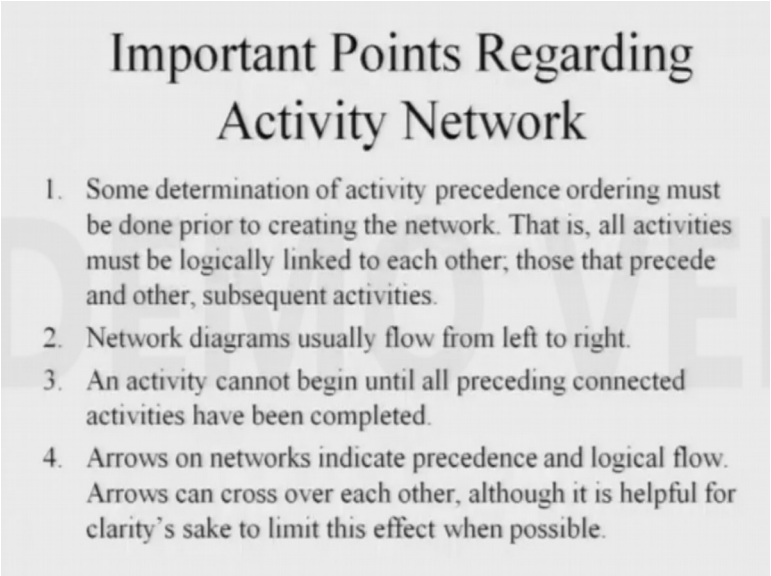

So some important points regarding activity network some determination of activity precedence ordering must be done prior to creating the network. So we need to understand which job comes first? Which job comes second? Whether there is a sequence of jobs which has to be followed or whether they can rank concurrently or whether there should be a delayed two activities and jobs. So these should be well known to the project management team who are basically trying to implement the project.

That is to say all the activities must be logically linked to each other those that preceed and other subsequent activities should be planned accordingly the network diagram using flows from the left to the right. So if you remember the decision tree diagram which was there on the left. We had the start where you are trying to basically start off your total decision process and on the right was the end but even though the whole process basically was from left to right.

I actually had decision whether there was logic depending on the expected value of the decision. Whether you should continue with that particular set of activities not continue with the set of activity which was basically taken from the right. So this would not be technically the case in many of the actual. So called rules based on which we are trying to analyse the PERT and the CPM.

An activity cannot begin until all preceding connected activities have been completed which is very important to know arrows and the network indicate precedence and logical flows. Arrows can cross each other although it is helpful for clarity sake to limit this effect when possible because crisscrossing would basically make it much more confusing.

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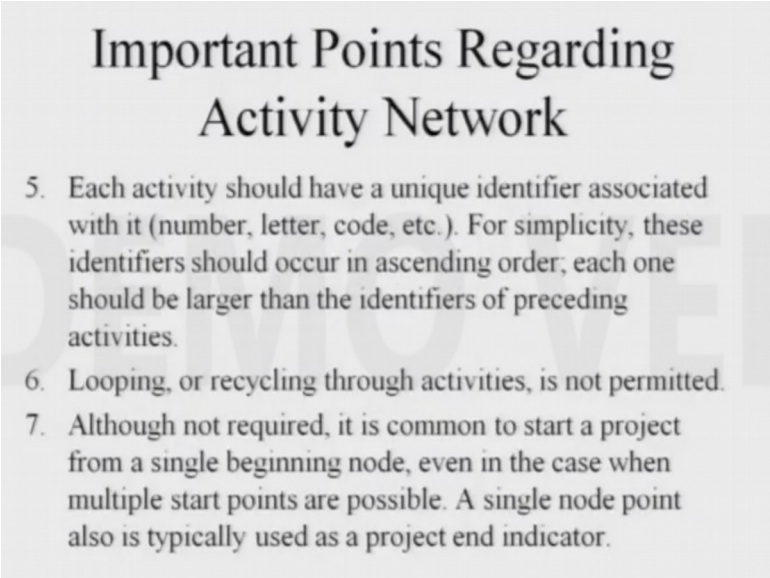

The fifth point of discussion is that for the important points regarding ho the activity network is made and what should we remembered is each activity should be have a each unique identification associated with this numbers or letter code like if the letter code is A, B, C, D there should not be in clash or if the activities are starting at one and two. So other should definitely not be such that as the clash like one and two should be unique.

So other can start at two but there should not be all starting at the same point or ending at the same point considering the numbering for simplicity this identifying identifier should occur in ascending order each one should be larger than the identifiers of the preceding activities. So as we write down the numbers in column format the numbering should be basically the lead should be on the top and they should go down as we go in the logical sense.

Below looping or recycling through activities is not permitted even though looping and cycling is not permitted if you see this six point remember the looping would be a part of consideration when we are going to GERT and Q GERT concept. So that was the one of the

main book based on which we will try to cover the concepts where basically the Pritzker although not required.

This is common to start a project from a single beginning node even in cases in the case when multiple start points are possible or single node point also is typically used in a project end indicator to end signify the project ended.

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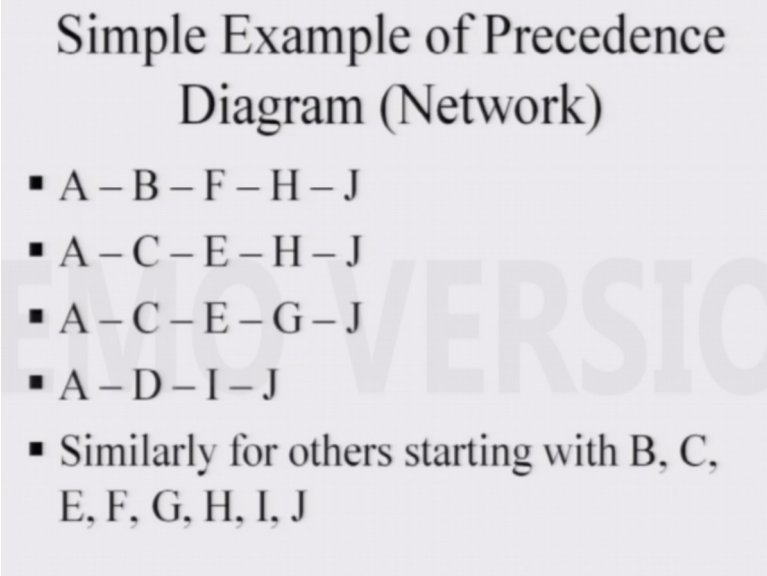

So consider a very simple example is example of precedence diagram in the network concept. So it can be like A, B, F, H then J or else the sequence of the activities can be in the second bullet point A, C, E, H, J. Third being A, C, E, G, J and fourth being A, D, I, J. Similarly for other starting with B C E F G can be mentioned. So if you look at the first, second, third, fourth bullet point it means that A is the first one.

Now if i ask the question what set of other jobs or activities are there after A. So what you will do is the basically you are attention on the set of activities which are after A. So if you see the first bullet point the second third and the fourth. You will see that after A you can have B C and D that means when the start would actually mean that what is the relation between A and B?

What is the relationship between A and C? And what is the relationship between A and D? But it would also mean that E C and D may start at the same time may start at different time. So let me say that in simple words. It may also mean that B can only start after A and C but it

may not be the case of C. C can be such C starts only after A starts. So the starting point of B and C are different and D can be say for example it only starts after say for example half of A is complete.

So how they are denoted in the diagram concept. I will come to that later on. So similarly after B, C and D you have F and I and correspondingly the sequences are given.

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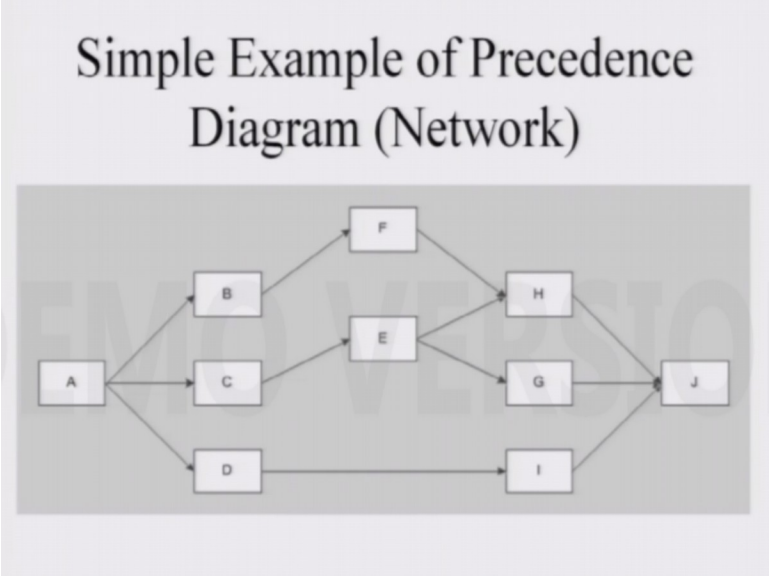

If you see this. This is what i meant then after A you have B, C, D jobs and activities and after B you had after C you had E after D you had I. So the sequence of activities which were shown in the set of slide which was two hundred and thirty. If i just convert it in the though activity and the precedence diagram concept it has basically A been followed by B, C, D in sum of sequences then after B you had F and after C you had E and then as you proceed.

More on to the right F and E would basically to H E would lead to G and D would lead to I so once H G and I are done complete. In some sense it would basically go to the end job which is J it completes the work.

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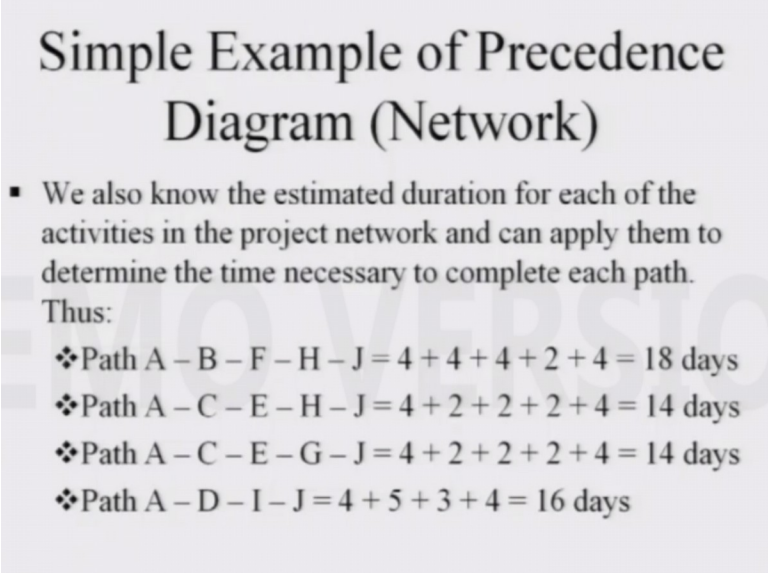

We also know the estimated duration for each of the activities in the project network and apply them and to determine the exact time necessary .So say for example if the duration of the jobs are given as given in this four bullet point star bullet points path A ,B, F, H, J has the durations accordingly as given four is basically the time duration which is taken for completing the job. So if you have A, B, F, H, J which is five in number.

So obviously there are five such durations if A takes four so if you consider the concept of A. A would basically be four both in path one, path two, path three, path four. If i consider B. B has duration of four. If i consider C. C has a duration of two both in path two and path three. Similarly, if you note all the job timings or the durations if you add up they give you the total duration which has been taken for path one. The first one is eighteen days similarly for the second third and forth the duration are fourteen and sixteen days.

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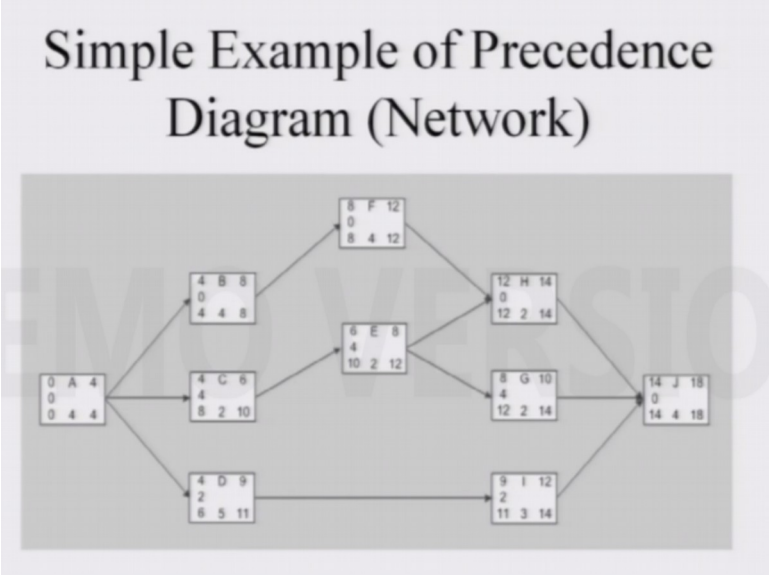

So if you consider the diagram here actually now it is basically giving you the values figures inside the square such that they will give you estimation or the concept that when is the earlier concept based on which the job can start what is the earlier earlier concept based on which the job can stop or finish and all this information is there. So if i consider say for example the job A is zero means basically it has to start on the zero thing that means where my project starts the duration is given as four.

Now if i consider say for example job B. It means that it can start at the end of day four which means once job A is finish four days has been completed then only we can start. So if i consider the duration of job B it is basically four. So the total amount of duration indicate to complete A and B combine together is four plus four. So similarly everything is given accordingly here so all the values how they calculated iam going to come to that very soon.

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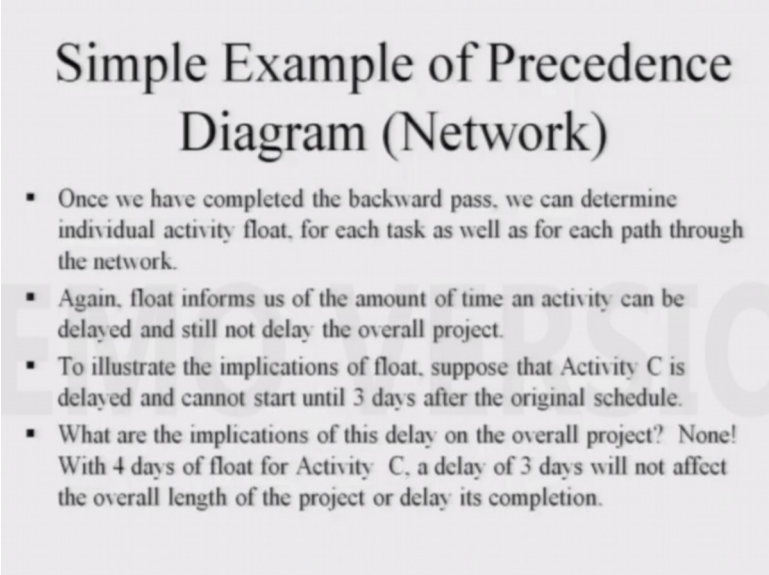

So once you have completed the backward pass that means either going in the concept where you go from the left to the right or you come from the right to the left we can determine. So these is backward pass and what is the concept of forward pass i will come to that so using that you can determine the individual activities there floats for each task as well as for each path through the network.

That is the overall time duration taken and what whether the time duration is critical or not again float informs us the amount of time an activity can be delayed and still not delay the overall project to illustrate the implication of float suppose that activity C is delayed and cannot start until three days after the original schedule. So these concepts how they are done? What the third bullet point basically means?

If you refer back to the last slide which is the two thirty third slide you will understand or it makes sense. So iam just mentioning that in the qualitative aspect we will slowly start solving the problem in detail. So that you will understand that how the concept of forward pass or backward pass are utilised in order to find out the total duration the slacks the critical activities the critical path and so on and so for. We will also try to understand what are the implications of the delays?

And whether the delays have a as a consequence on the total duration of the project? So if we consider this implications the total deviation or the delays of the project in many of the cases can be zero in the sense they would be some slacks for which the delay is advisable. So as that shifting on an activated job can be done with four days of float for activity C a delay of

three days will not affect the overall length of the project if you go back to the last slide which is again iam mentioning two thirty third slide you will understand that is true .

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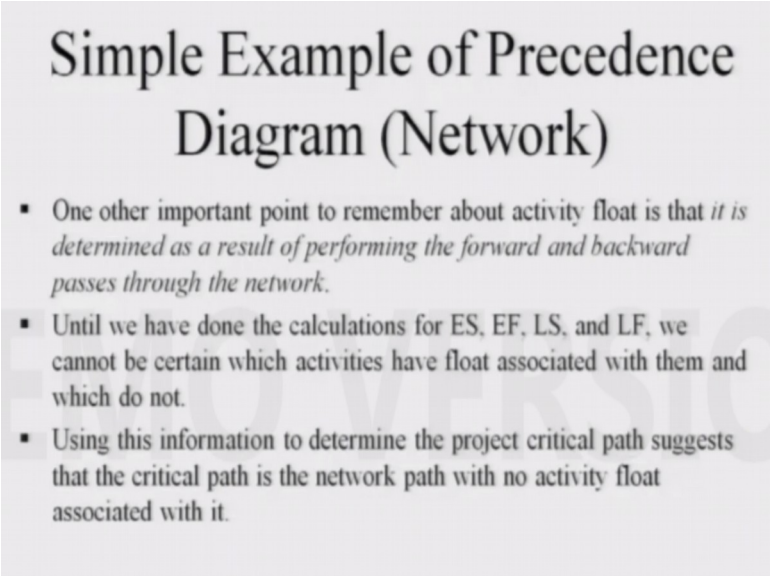

One important point to remember the a activity float is that it is determined as a result of performing the forward and backward passes the concept which will come very soon and what i have been mentioning that. How you calculate the total float? And how you find the slacks accordingly? Until we have done the calculations for this ES EF what are these i will now explain.

So until we have done the calculation for the early start ES EF is early finish LS is late start and LF is late finish we cannot be certain which activities have floats associated with them and which do not have any slacks associated with them using this information to determine the project critical path such as the critical path is the network path with no activity floats as that is critical to understand that any delay in those particular activities would definitely have an negative impact on finishing the time duration of the project.

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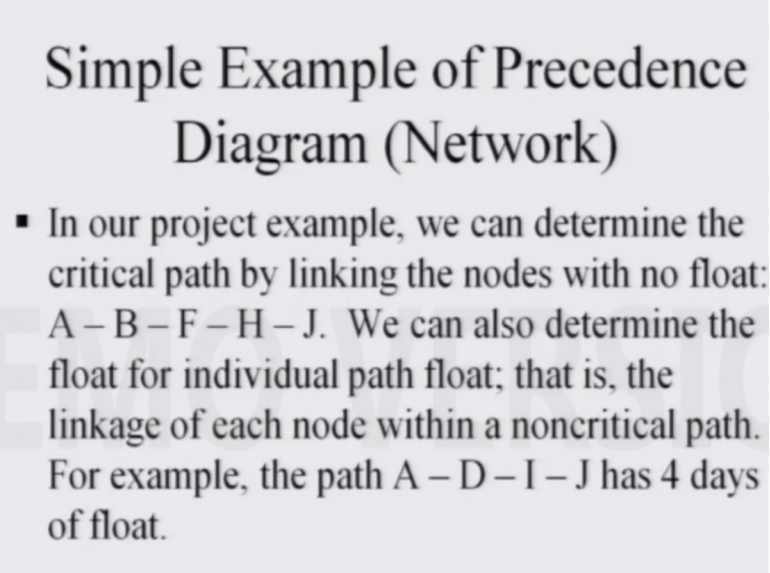

In our project example which we just consider we can determine the critical path by linking the nodes with no floats that means if the floats is zero obviously it means that there is no leave way of changing the duration or the end of those particular activity or jobs. So here with no floats is the set of sequence A, B ,F, H, J we can also determine the floats for individual path float which are there.

So there can be other paths also to reach that total project but which means that if on of them is critical the others would basically have some float. So that means there is some leave way in trying to change some activities in that path where there is a float which is to say let me continue the linkage of each node within a non critical path would be there .For example, If you consider in that diagram.

Which we just discussed the path A, D, I ,J has four days of float that means four days can be utilised for trying to read that in case of emergency or some changes in the activity start and finish as taken place for this for the sets of activities which are there on the non critical path.

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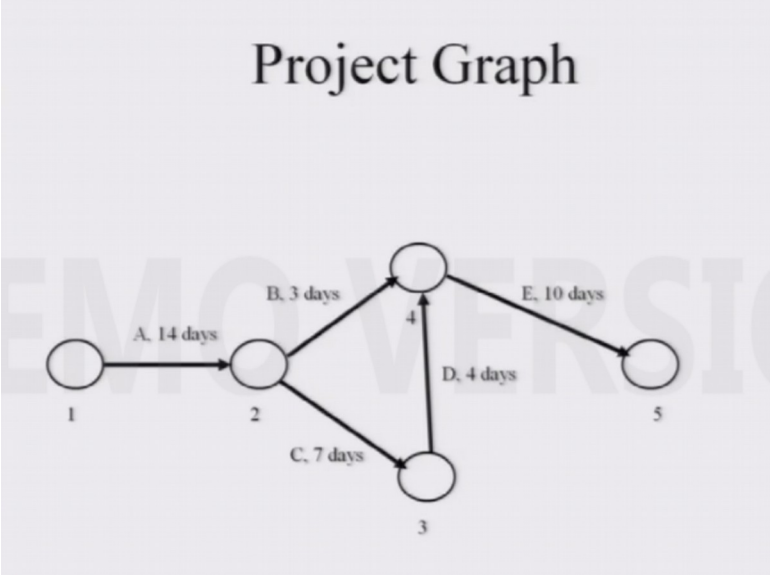

So consider this diagram this is based on the fact that A has fourteen days. B has three days. C has seven days. D has four days. E has ten days. So very generally it means after A ends you basically can start B and C and the corresponding number of days is given after C is done then some work whatever the activities has to be finished that it ends in a certain time and provided D and B is finished then only you can start E. So you start at one finish at five considering the activities are A B C D E in some sequence

Now in this diagram in order to make you understand i have marked the path or the set of paths all the activities which are critical so this is basically A C D E so now the question is why it is critical why not B is critical. So iam just explain it qualitatively. Now if you see after A and fourteen days are all over for the project if D and C start immediately then B would end after the end of seventeen days but in that case C has to complete extra of four days because C has seven days.

So if it has to basically complete the whole work for C the extra such four numbers are required to basically finish C technically it means that B would have been delayed by four days such that if four days had been the delay for B then C would have completed four days of work. So say for example on the eighteenth day C would start some portions of the C has already been finished.

So for eighteenth nineteenth and twentieth day the work would basically continue for C and then considering that eighteen days are already over. So that B would also start. So end of B and end of C would be such then would end on the twenty first day but consider now again

in D has come into the picture which means that if i now till now i have not consider D and if D is also considered into the picture.

So the total number of days be before C and D can be finished considering B is also there it would mean that now iam considering two sets of jobs at one go which is C and D and is B. So fourteen days is over here C and D has eleven days seven plus four. So now if i start B B would basically finish on three days. So if i consider seven plus four is eleven eleven minus three it is basically eight days of total leave way is there where i can adjust these such that they would not be any delay when C and D finishes.

When A or D is also which is at the same point of time it finishes because until and unless B C D finishes it cannot start D. So the whole critical path is the red one at shown in this diagram.

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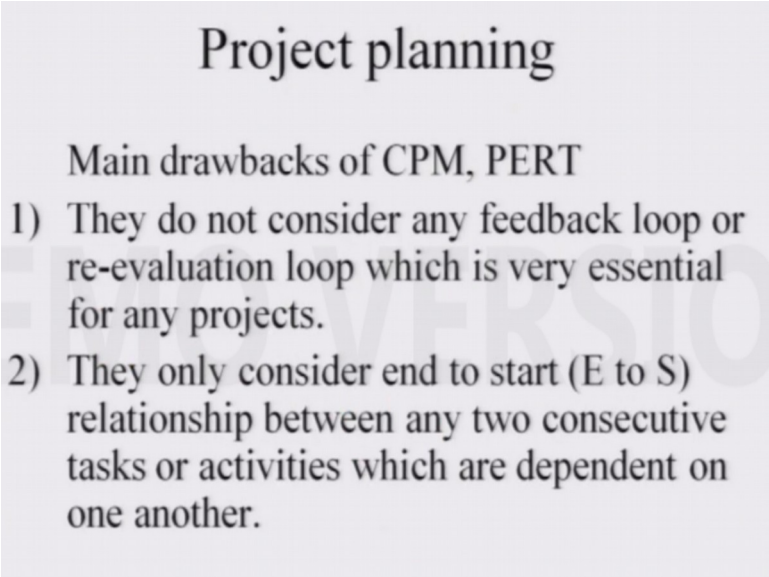

So main drawbacks for the critical path better than the project evaluation review technique is that they do not consider any feedback loops which i mentioned that in the beginning of the course and we consider this concept been taken into the fact for GERT and Q GERT concepts. So hence feedback loops are re-evaluation loops which is very essential for any projects are not there under the CPM and PERT then only consider end to start.

So this concept i will just come within few slides so this PERT and CPM only consider end to start concept not the other one which i just mentioned like end to finish then or finish to start

and finish to finish concept are not considered. So out of this four concepts which i will just explain with a diagram this PERT CPM only consider the end to start relationship between any two consecutive activities or tasks or events.

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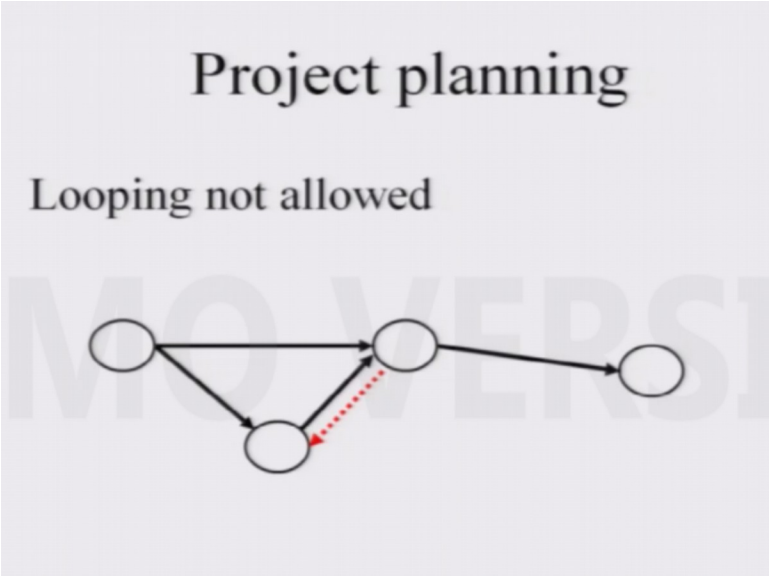

So as looping is not allowed. So this is what i mean. So the red one means basically if you had this one as so this one say for example was A this was B this was C this was D. So any relationship between C and D whether the looping is been done is not allowed in PERT CPM.

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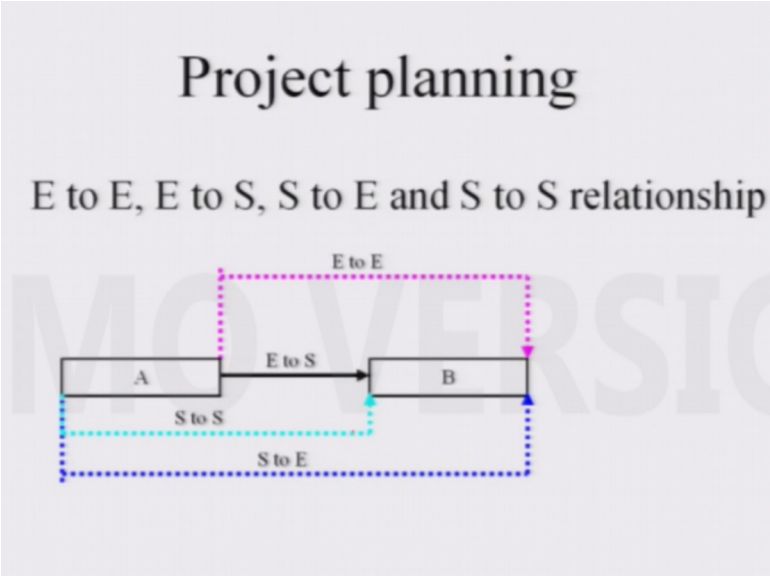

So now if you remember i mentioned about the concept of end to start end to end start to end and start to start so let me explain with a diagram which is very nicely explained in this two forty first slide. So consider the activities are A and B. A and B are shown not to scale in the

sense the number of days been utilised for to finish A or number of days which is required to finish B are not shown in the sizes they are just shown as activities.

And if you consider the relationship between A and B there are four relationship which can exist between A and B. The first one if you see the black bold arrow it means that B can only start after A finishes. So there cannot be anything like B starting somewhere between when A is progressing this is that is not allowed the second one which is the pink one so let me consider the second one which is shown here.

It will be basically the end to end end to end means the number of days stipulated between the end of A and end of B is fixed. So when they start whether B starts before A or whether B starts after A it does not matter it can only basically mean that end to end structure of the number of the days is very fixed and cannot be changed that is the rule based on which we will proceed. The third concept is start to start which is shown in this greenish blue line.

The arrow it means that the starting of A and the starting of B are linked to each other with the number of days it has no mention about the ending of A and the ending of B like in the first one it is the ending of A and ending of B were linked here. It is the start of A and start of B which are linked together and the last concept is basically start to end which means the starting of A and the ending of B are linked together.

So it does not mention that when A would end or when B will start that relationship is not mentioned only thing is start and end concept between A and B are required. So for the CPM which is the critical path method and the PERT method. We will only consider the end to start concept based on which we will find on the slack and the critical path and the floats.

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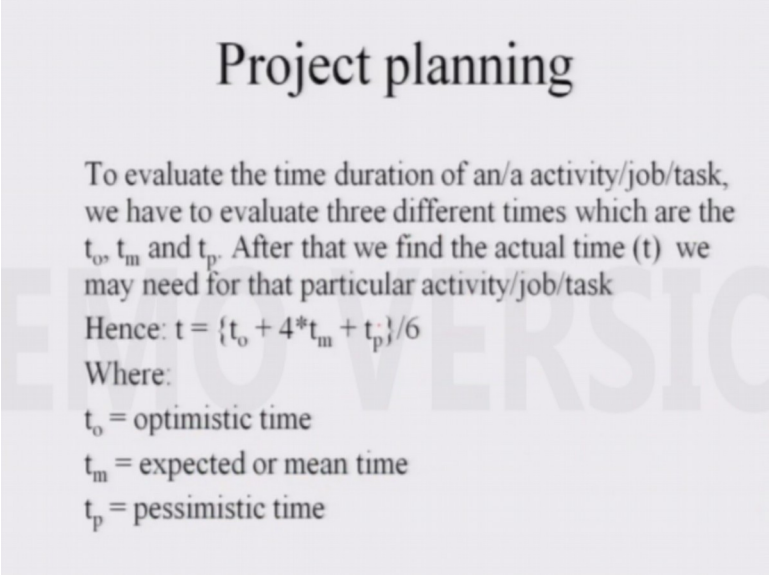

So to evaluate the time duration of an activity a job we have to evaluate three different times which are as given T not T suffix O, T suffix M and T suffix P .So if you remember few classes back i had been mentioning about the optimistic time pessimistic time and the average time. Time and again so these are what i meant by T suffix O, T suffix M and T suffix P so TO means the optimistic time.

Optimist concept considering the all the resources are been optimally utilised Tm is the expected of the mean time and Tp is the pessimistic time. So hence if i need to find out the actual time required to finish the job considering the distribution is beta the average is ground out and given average that means based on which we will do the calculations not the Tm part it is given by T not plus four into Tm plus Tp divided by six.

So overall if you see the probabilities of the weight ages we are trying to give to the time is one sixth to the optimistic time one sixth for the pessimist time and four six for the mean time. So this is the distribution based on which as i mentioned beta and then we proceed to find T which is used for all our calculations and similarly you can find out the variance also if you try.

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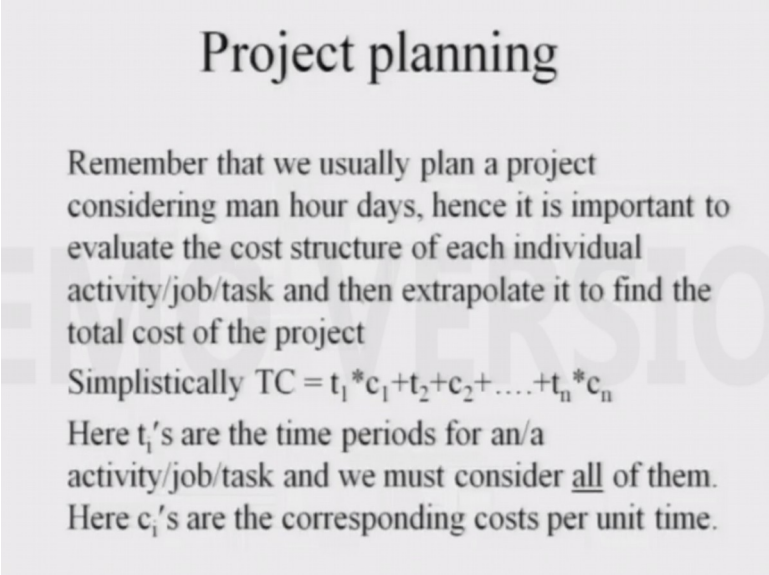

Remember that we usually plan a project considering man hour days. Hence, it is important to evaluate the cost structure for each individual activity job task and then extrapolate to find the total cost of the project. So if i consider very simplistically the total cost of that particular project would be based on the fact that what is the overall cost for each activities added together. So if i want to fin out that what is the cost for the first set of activity i would be T one will be the time taken for activity. One multiplied by the cost which is C one.

Here iam considering C one as the linear cost. It can be quadratic also or some other polynomial we are not going to consider that the second would be the time taken to find out the overall cost for the second set of activities which is T two into C two.

Similarly, for the last one is T one into Ca here T ones are the time period for an a activity job task and you must consider all of them which is the combination of activity one or two or three whatever it is here. Ci are the corresponding costs per unit time so as i mentioned the costs are linear in nature.

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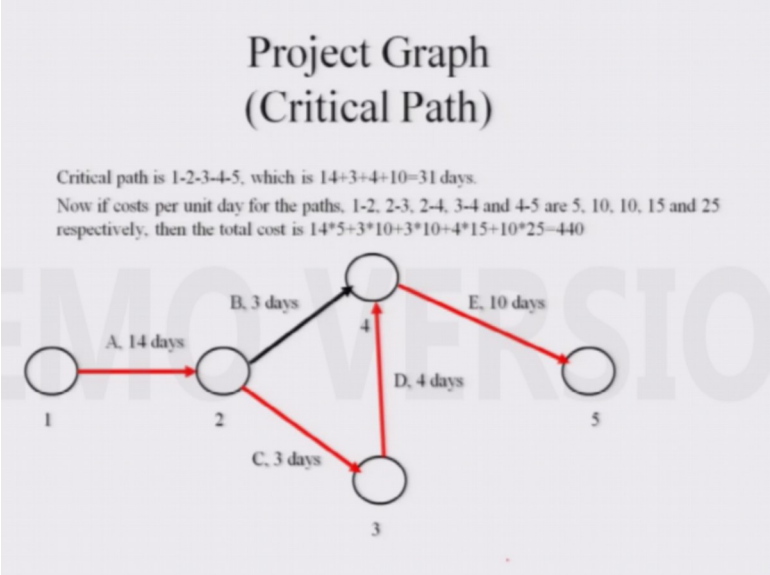

So as i mentioned in the diagram last so the critical path is basically as shown the red one to two, two to three, three to four and four to five. So now if the cost per the unit paths one two, two three, two four, three four, four five are correspondingly given as five, ten, ten, fifteen and twenty five then the total cost would be fourteen multiplied by five for the first set then you have basically three which is the number two four two to three multiplied by ten. Which is the second one then again for the next one basically the total job.

The total time taken obviously that will come into the picture would be four into the fact which is basically now fifteen and then the last but one would be ten into twenty five but obviously even though B is not in the critical path first protocol also come into the factor. So the cause factor would be three into ten. So if i want find pout the overall cost do not concentrate only on the critical path.

Critical path is basically a path which would be considered in order that any delay in any of the activities would effect the overall time duration negatively but if i consider the cause factor it would be fourteen multiplied by the cost component per unit day. For A similarly three multiplied by the cost component for activity B similarly for C. Which is C multiplied the cost component the activity C, D would be four multiplied the cost component for D and the last one will be E which is ten into the cost component for activity E .

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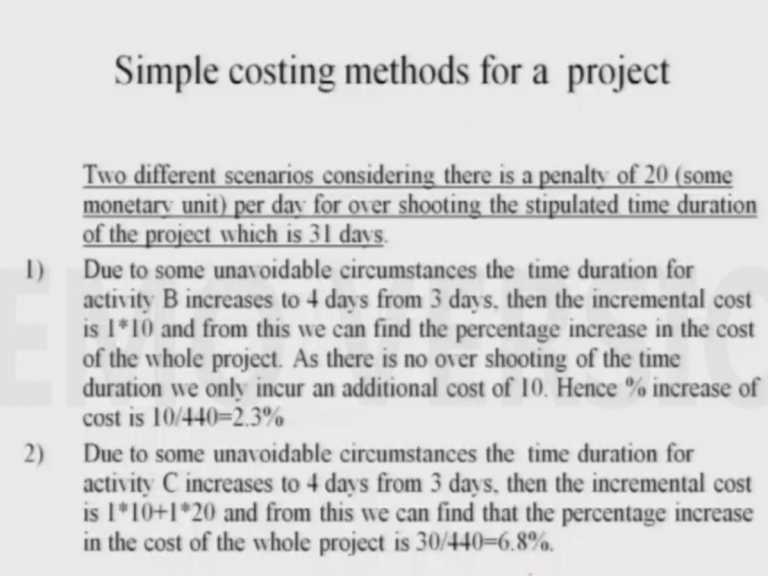

So differ two different sceneries considering there is a penalty of twenty some monetary unit whatever it is required for overshooting the stipulated time the duration of the project which is thirty one days so due to some unavoidable circumstances let us consider the time duration for activity B increases from two four to three days increase to four from the three days then incremental cost would be the number of days is one.

What is the cost per unit is ten? Consider it is not in ten it is a linear constant function if you remember i mentioned and from this you can find out the percentage increase in the cost for the whole project and there is no overshooting of the time duration we only incur the additional cost which is ten hence percentage increase would be consider the over call cost it was four forty. So considering it has the overshooted by two point three percent.

Now if i consider due to some unavoidable circumstances the time duration for activity C has increased to four from three days when the incremental cost would basically come from the fact that C is increasing which is one by ten plus the fact that E which is the last job is also increasing by one day. So it will be one by twenty hence the overall cost now not ten but thirty.

Hence, Critical path being unaffected would have an more devastating effect on the total cost component which is now increased from two point three to six. Six point will do the calculations later on and slowly proceed. How we find out the use the forward pass and the backward pass method to solve the critical path method? So with this i will end the twentieth

lecture and iam hope the students understand the concept very clearly for any questions and queries please write to the form have a nice day thank you.