Project Management
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Module No # 08
Lecture No # 36
Graphical Evaluation and Review Technique (GERT) II

Welcome back my dear students, my dear friends and this is the project management course which all of you are doing. I mean if you remember in the thirty fifth class, I started the concept of GERT told about the exclusive or the inclusive or the end operators and gave you the concept. The how three different combinations of the input and two different combinations of the output gives you all the picture of the GERT.

And I also told you, that the two important parameters based on which you will do the calculation was the probability so in the deterministic case the probability would be one and in the probabilistic one the probability would be less than one, so but obviously it means that all additions of all the probabilities of all the paths which were possible would add up to one logically.

And obviously the time to traverse from node one to node two to node three are probabilistic considering that time taken is also not fixed. So let us consider this points and continue our discussion for the GERT. So, what are the steps in the GERT? The logical steps how you take into consideration to basically formulate the GERT are as follows,

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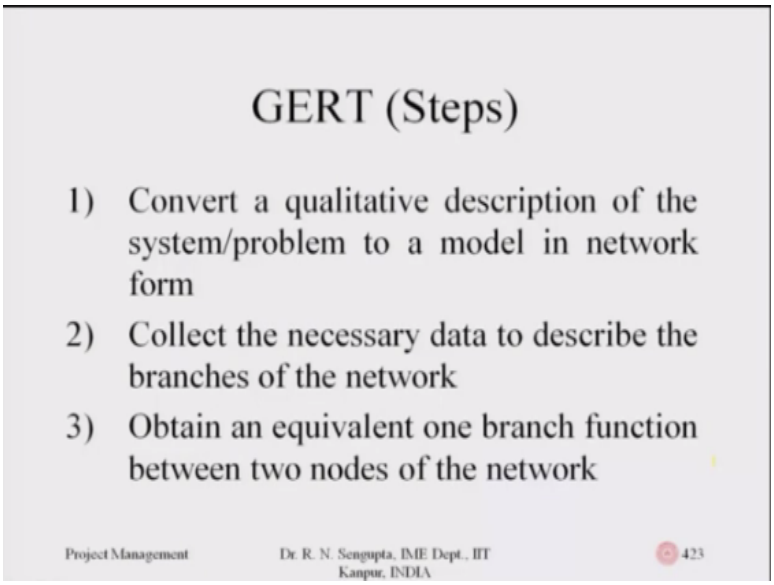

Convert a qualitative description of the system/problem to a model in the network form so basically what you have is that whatever the information which you have based on the information you convert them into a logical set of input. And also a logical set of output, depending on what is your output coming out from the description of the problem so as that you ae able to combine the inputs and the outputs in a very logical fashion to get the sets of inputs.

And outputs in a note form with arcs connecting them and the arcs would be if and only if and exclusive or inclusive or the concept of and would be considered. In order to basically give the most realistic picture and obviously considering the fact that a looping would also be there so the second point I have stated in this slide is that collect the necessary data to describe the branches of the network so you will try to basically collect the information.

To the maximum possible extent as that will give you actual practical picture theoretically as intense picture of as possible of the inputs are that you are able to get the output. In the most best possible manner, the word best possible manner means that logical statement should be taken in account as there is no flaw in the overall flow process of the overall project starting from the source till the sync, source means from where you are starting.

Sync means when I am basically ending the overall project. Third point is obtain an equivalent one branch function between two nodes of the network. So if you say for example there are two

sets of activities and they are being linked like grinding leads to the rate late operation, consider very hypothetically or say for example after finishing on etching operation consider that you will go to the painting booth, we are basically trying to basically manufacture some manufacturing a machine or you are trying to manufacture a machine.

Or say for example you are trying to basically stitch a cloth into a shirt, you stitch it and then the buttons have to put at the right place so these are two, I am considering very simple operations or say for example you have meet and you are trying to basically see how the project can be done very simplistic problem like you are trying to make ice creams at home and then you want to make the ice creams the all the milk and the vanilla and the sweet and the flavor has been added.

The next logical step you put in the fridge, so these are the two logical steps so you have been able to draw this logical steps this practical set of information into nodes as they are connected by edges with their maximum amount of information which has to two sets of information as I mentioned one is the probability and one is the time based on which these two parameters you do all the calculations. The fourth point of the GERTs steps is how you proceed to make the steps in the GERT is to,

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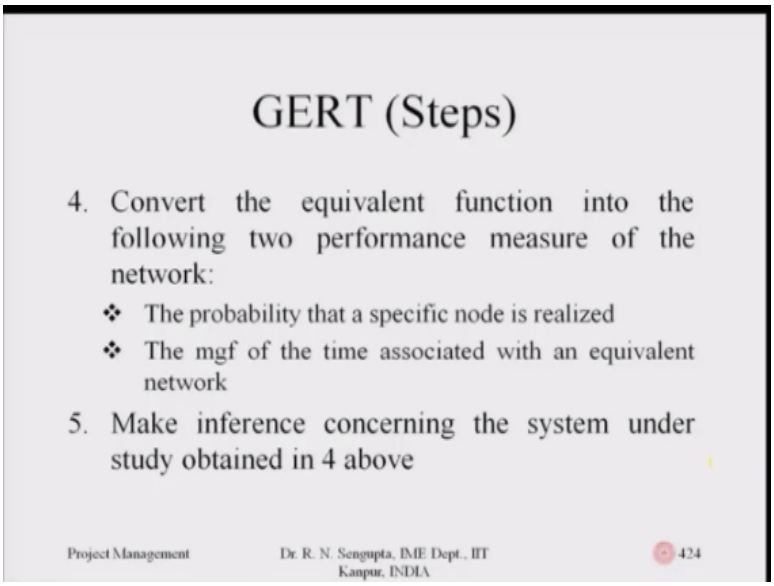

Convert the equivalent function into the following two performance measure of the network so, basically depending upon the two inputs you would want to basically finalize that how you will

try to utilize these two inputs or parameters in order to finalize that how would you rank or how would you find out the overall working of the efficiency of the projects.

One is the probability that has a specific node is realized that would come from a probability function so whether probability is zero point two or zero point two it is something to do with critical index if you remember in the simulation of the PERT network. But it is not directed but I thought I will try to basically mention that such things are much clear. The second point is the moment generating function of time associated with an equivalent network.

So you will try to find out what is the moment generating function of the time as that you can take that time function into consideration in order to find out the overall time of the project. And the last point is that make inference concerning the system under the study obtained in four so that you can take a realistic decision how the overall project is take undertaken considering the probability.

The nodes are realize not realized, looping is there, what is the logical inflow of input what is the logical flow of the output and all these things, now let us consider very simple example in two different flavors,

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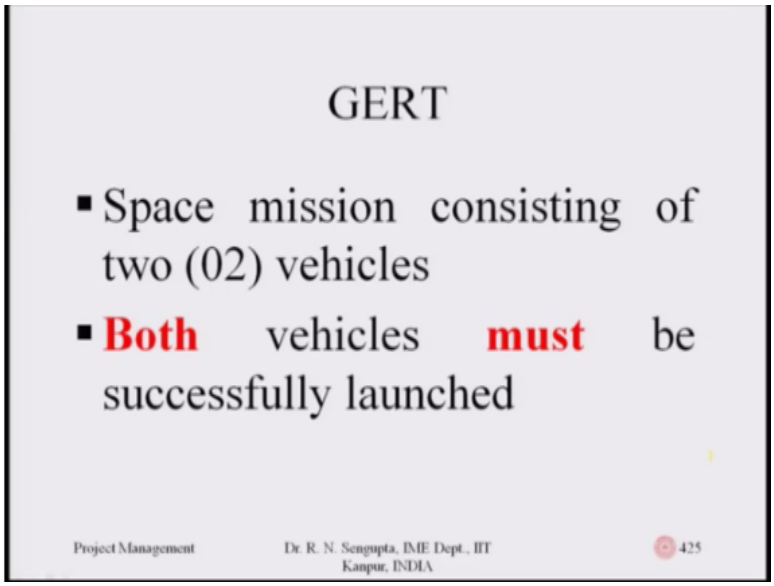

So space mission consisting of two vehicles so before I start off with this all of the problems are taken from the books so all the different references which have taken, so these two examples are taken from the Pritzker JERT book. And if you remember I did mention that when we were discussing the reference list so you can find it in the net also or you can find a hard copy of that in one of the nearest library in the locality where you belong.

So this is a space machine consisting of two vehicles, the second point which is very important to note is that both vehicles must be successfully launch in order to basically have success in the overall project. So based on the statement let me draw the diagram so what you have in front of you

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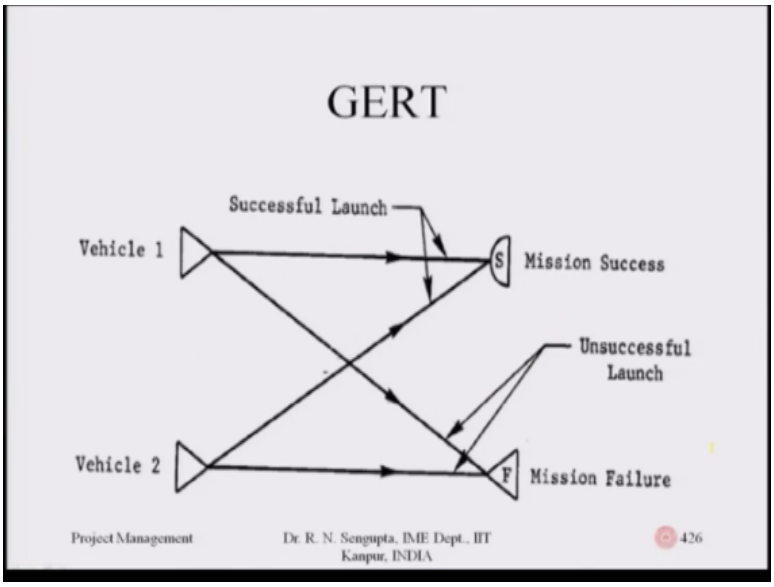

Is the vehicle one and vehicle two so these are triangles, so if you go back to this the points of input and output, which we have done so this was basically the, there was one deterministic one and one was the probabilistic one for the outputs and the inputs and there was an exclusive or inclusive or the and one based on that we proceeded.

So the successful launch which aces these two rows errors which I have, so this the successful launch yeah and this is the successful launch so this I will mark with the red and the unsuccessful launch are this so these are marked in yellow, if you combine them, let me go back to the last

slide to make things much clearer. Both the vehicles must be successfully launched which means that consider there are four combinations.

Yes, for both stage one, stage two that means both are successful yes, no for stage one, stage two which is the vehicle one and vehicle two, case three is no NES for vehicle one and vehicle two and the last one is no, for both the vehicles one and two now, if you consider that the sequence is coming and it is being described in this diagram which is the machine is success which I highlight here and that success basically depends on both of them if you remember the last slide.

Both of them being true so which means that both of them are true then you would basically have a success for this mission while the other three information sets which you have is zero one one one zero if all of them are equally true, means these are the combinations which you have then the machine is a failure as I am now highlighting if this is the case this diagram basically is very simply gives you an idea that out of four combinations for the two vehicles.

Which means for vehicle one yes and yes you have a success, for vehicle one no, and vehicle two is a failure for vehicle one it is yes one and for vehicle two is a failure and obviously the last one mean vehicle one is a no which is zero, and zero no I am basically repeating it with the same essence and vehicle two is also a no which is a failure, it is failure so you have basically a diagram as pointed out.

Now let us consider a different scenario again is the space station consists of two vehicles, now it says in the second bullet point which is important to note as I noted that the both of them should have operate in the last example both of them should have operate successfully for the program to be success. Here it says that at least one of the vehicle should be successfully launched which means now the combinations are exactly the same that means for vehicle one, vehicle two,

Yes, no for vehicle one, vehicle two, no, yes for vehicle one, vehicle two and no for vehicle one and vehicle two. The outputs which you will get for second example will be totally different from what you had in the first example which you have first discussed. So let us see how it is there, if you see

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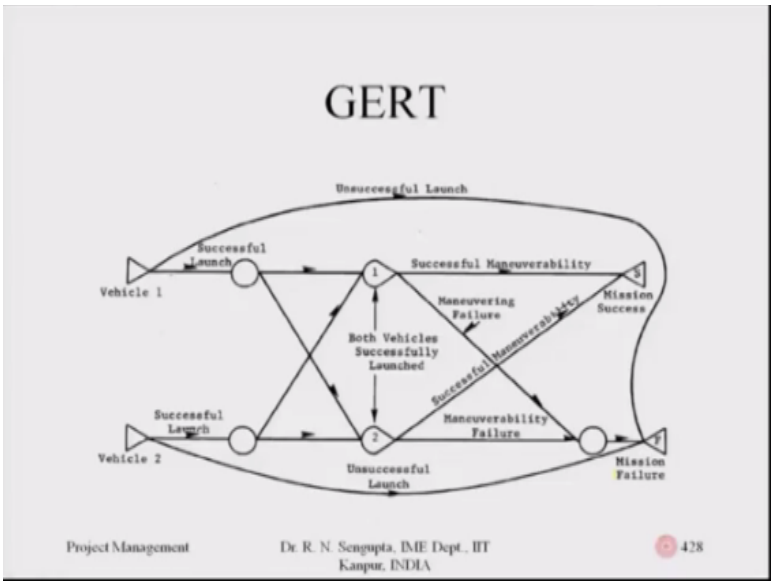

It looks complicated where the overall sequence is very clear so here on the left hand side I will again highlight. So we have vehicle one and vehicle two and on the right hand side you have basically the mission is a success and machine is a failure, the ways they have been depicted this triangle with a line or a hemisphere all these things are based in the fact that what is the input three criteria and output two criteria,

This fixed combination which I did discuss when we started the GERT concept. So the first line which you should concentrate is this one. This is a success for vehicle one and this is the success for vehicle two now the extreme one which was an unsuccessful launch for vehicle one and vehicle two combine together and if you separate them are these points. I am highlighting it using the yellow color this is an unsuccessful launch.

So it comes here so mission is the failure. And this one is also an unsuccessful launch so that mission is the failure which means that both of them being false gives you the answer. As false but any one of them being true as mentioned in the problem statement that one of them being true basically would be successful to that project would lead to the mission means the success which I will try to not highlight in the red color.

So this is the mission being successful, so let me see if I can basically highlight using the color so this is now yellow I applied, so it basically is this is the success and this is the failure. Which I am basically marking with a cross now so they would be one path to failure and three paths to success so let us see them so 1 path of failure is this one which I am again just drawing this line, failure now if you see the successful combined with the unsuccessful one is if you use the red color it would be much easier for us to highlight, yes, so vehicle 1 is the success it goes in this line.

Vehicle two is not successful so many variability is not sufficient is there is basically coming here. Vehicle one being maneuverability being a failure so this is a maneuverability being a failure which will basically come here for vehicle one and vehicle two maneuverability being failure would basically come here, so if both the vehicles are successfully launched then you what you will have is the combination which will leave to the case.

That anyone of them being successful would lead to the end of the project. Which means if you go back to the earlier slide of the and or exclusive or inclusive or concepts they would be brought into the picture so that it gives you a very good idea that how the overall project can be drawn and then I want to race of stress here that whenever you have more than two such logical operators like ABC.

So what you do is that you very simply follow the logical sequence of the operations check whether A and B, I am giving an example see for example AB and C is there and both of them basically have the XR concept in between A and B and this concept of AB combined has the and, so what you will so is that and consider they would be such pileup of such operations coming one after the other.

So the logic followed is exactly the same first you will basically concentrate on A and B, use the concept of XR which is the exclusive or concept and then find out what are the results so obviously there would be four results as we considered so that means A being one, B being one, A being zero, B being one, A being one, B being zero, and last combination being A and B both being zero. Based on that we have done operations.

Now consider A and B has those four outputs and consider this as D, so what you will do is that you combine B and C considering that D has those four outputs as the combination of A and B and then consider that A is B is out of the picture take the four outputs of D combine them with C and then using the concept of AND operations and then proceed accordingly. So if you are basically a set of operations go step by step. So that it makes logical sense how you can combine them automatically.

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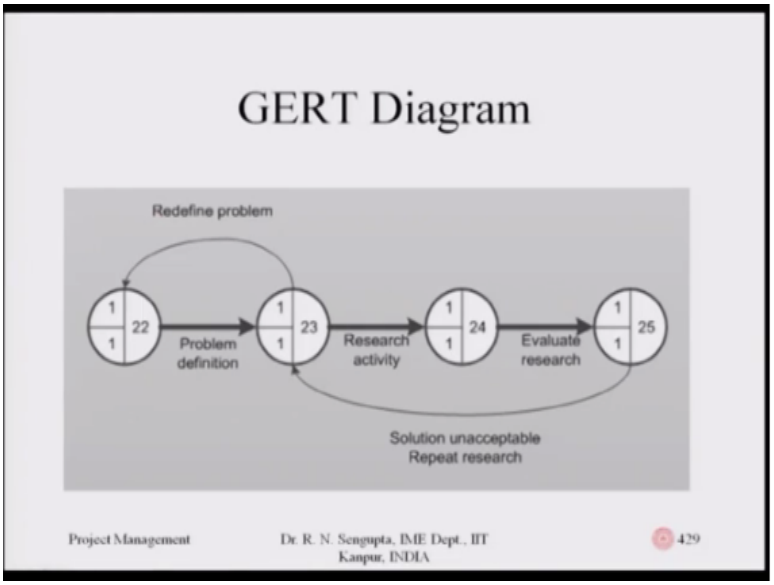

So now consider the looping concept is coming so here consider very simple GERT or GERT diagram which you have in the first node which I am now highlighting basically it gives you the problem demolition definition which is basically from node A to node B the work is being done from node B to node C so this is A, this is B, and this is C and this is D.

Here the research activity consider this basically a simple research project or R and D project which you are going to take and then the combinations of going from C to D is basically you evaluate the research and get an half the project finished if it was a PERT and CPM. So this loops which are now highlighting were not there now the moment you bring in the loops the things become complicated but they give you much better answer.

So the loops are what you see in this diagram is you are going from D to B that means if you draw the precedence concept this precedence concept will also consider the fact that B would technically be followed after A but there would be a feedback loop also coming from D to B such that this solution which is acceptable or unacceptable in the repeat research that feedback which is highlighted here.

Which I am highlighting that feedback would come into the stage B that you can get that feedback from D and utilize that to further enhance the process going from C to D. similarly this feedback which you get if that is a major one from D which means that you have to go to the drawing board and again redo the whole problem. So you have to redefine the problem such that you go from B to A and start of the whole process for again from A to B.

B to C and C to D as that this looping concept which you have gives you a very clear picture that how the work is going on. So when you consider the GERT and the looping concept this looping concept would be considered in such a way that if say for example the success rate is less than point thirty percent so, obviously it means the looping will start which means the probability that the path will be followed or not followed constrained.

And exclusive or on inclusive are and the 3 3+2 which is three into two combinations which you have for the three inputs and the two inputs for logic of operations would make sense such that you can consider this looping concept in a big way, in a logical way.

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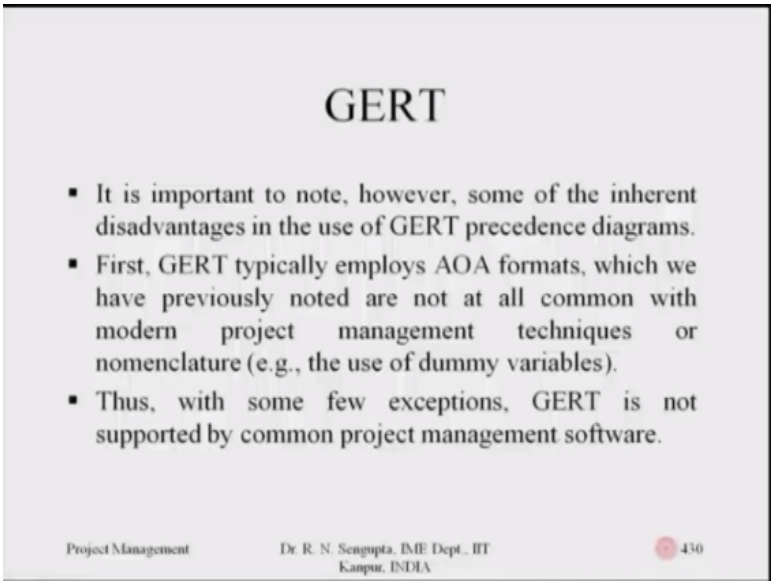

So it is important to note, however, some of the inherent disadvantages in the use of GERT precedence diagrams. I will come into the actual problem later on but let me just go into the concept in very general details. The first GERT typically employs activity on arc formats. So activity on nod and activity on arc maybe one of the reasons that why it will be possible for us to consider the looping concept.

So if the looping concepts are not there, which means then trying to convert the job on to a note or job on to an arc is very simple in the PERT and CPM concept. The moment you have a looping concept means that some feedback some work is being done. Which means that you cannot join or basically put one node on other, so obviously nodes would be the stages where you want to finish.

Or what is the stage where you are staring or whether you stage you should take a stock of the situation of how the project is being completed that should be done. And the feedback to which will come would basically until some work, so here in that case the activity on the arc format would be applicable because those are should basically enter some huge amount of work which is important person of the GERT network.

So let me continue as second part the first GERT typically employs activity on arc formats which we have explained which we are previously noted are not at all common with modern

management techniques so the project management techniques which we did this discuss in some details for the PERT and the CPM we basically consider the arc and activity and nod as the important concept based on which we could proceed.

But that becomes a problem when we come to the god framework, point number two, the dummy concept which we had, the dummy jobs which I did not discuss in the problem but I did mention in somewhere that dummy dots will be connecting two nodes that they give you a logical sequence of the activity which is there. So this dummy jobs or activities is only possible when you have the concept of the activity.

On the arcs on so hence time to be in the dummy jobs using the node concept may not be possible in the GERT framework, thus with some few exceptions GERT is not supported by common project management of two so you have to basically do your own calculations, but it gives you are able to draw the diagram on a piece of paper with all the details that gives you a very clear concept that how the logical operations between job one to job two.

Between job two to job three and so hence forth are taken into consideration as such that point one the logical operations are taken into consideration, point two the probability of a path coming up or a nod coming up is taken into consideration point number three. The time which may be probabilistic can also be considered as an attribute point four the looping is also considered such that we gave a get much more realistic picture of the overall project which we are undertaking.

Further GERT network can become extremely cumbersome and complicated as rightly pointed in the diagram which we did that two vehicles both firing or both being success leads to the completion of the launch or else in the third, second example we considered that one of the vehicle being success who basically lead to the success of the project. So if there are more vehicles or more complicated sequence of jobs obviously the overall project becomes very complicated if somebody is able to draw it to the maximum possible details obviously it becomes easier but generally it is very difficult to do that.

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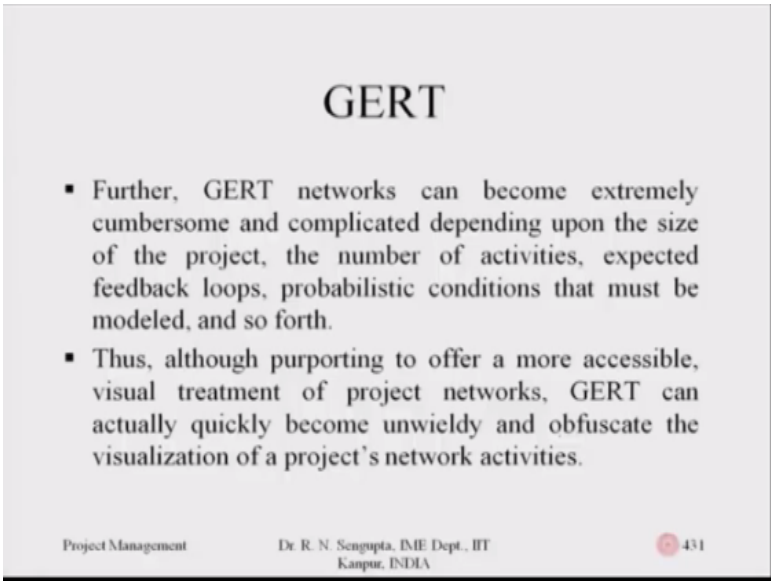

So it says that further GERT network can become extremely cumbersome and complicated depending upon size of the project, the number of activities expected the feedback loops the probabilistic conditions that must be modeled so and so forth. Thus although purporting to offer a more accessible, visual treatment of project networks, GERT actually quickly becomes unwieldy and very difficult to draw and obfuscates the visualization project's network activities as that in the overall scheme of things.

If somebody id considering the overall macro project trying to go into the micro level becomes very complicated many of the time so I will just give a very brief definition of Q-GERT, which is queuing GERT with the notion that will again discuss the simple problem of GERT in the thirty six, thirty seven, thirty eight, thirty nine, and the sorry, this is the thirty sixth one in thirty seven, thirty eight, thirty ninth and fortieth class.

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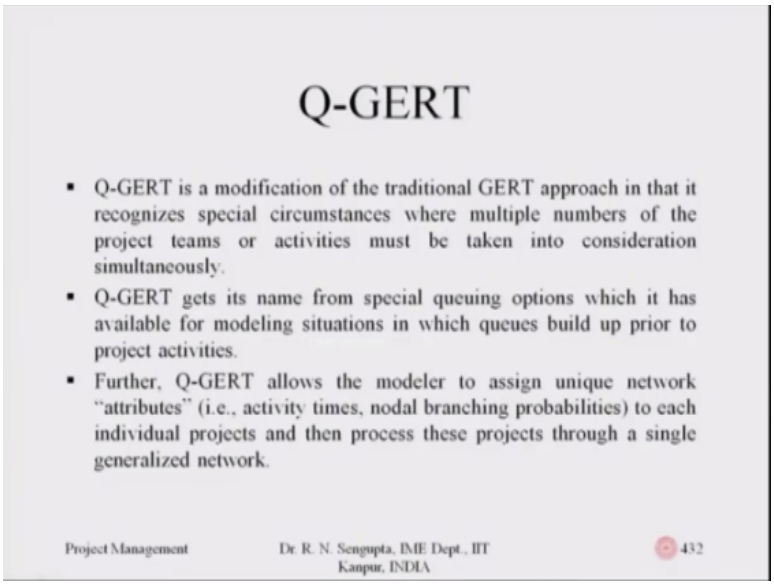

So Q-GERT is a modification of the traditional GERT approach in that it recognizes special circumstances where multiple numbers of the project teams or activities must be taken into consideration when trying to do the work. Q-GERT gets its name from special queuing options which it has available for modeling situations in queues build up prior or project activities.

So what is that I will try to explain here further Q-GERT allows the modeler to assign unique network attributes that is activity times, model branching probabilities what is the probability that branching will happen, branching will not happen, to each individual projects and then process these projects through a single generalized network so let me give you an example in very simple terms.

Consider you have three jobs which are in line so three jobs let me mention A, B and C now consider there is only one machine, so if there is only one machine it may be possible that all three ABC come and they are at the same time, so if they are at the same time consider this the grinding machine all jobs ABC have to be grinded so if I consider the logical sequence so I will basically start with that job which has the minimum time of operation.

Because if I do not take the minimum one what will happen is that if I take the maximum one or some in between like minimum and maximum consider A has the minimum one consider time taken is two minutes, two hours whatever it is, B has three and C as four. So if I take four then and then proceed in any sequence the waiting time which is to be taken by the jobs in totality would be the highest so if I follow the sequence of four, three, two.

The time sequence between CBA and the time taken by the jobs ABC collectively is the highest. Even if I take the sequence of three, four, two then also the time for waiting time is high but not as high as CBA, but if you, so you can calculate it, why because I do the work of four minutes which means job B has to have waited for four minutes, job A has to have waited for two minutes then if I do B which means job A has to have waited for 4+3 minutes so when I go into basically the job A the total time spent for the average waiting for A is 4+3, waiting for three is four.

But if I follow the sequence in this order like ABC then the time rated for B is two, time rated for C is 2 + 3, why does this three comes, because three comes when B is being processed, A is already over and C has to wait. So this sequence of jobs basically depend that what is the processing time. So obviously many of you who are quite experienced would say that what if I have to basically use some jigs and fixes in the shop floor.

So obviously the replacement of the jigs and fixes and all these things would be coming into the picture, so that it gives much more practical flavor but trying to solve the problem would be difficult. Another way can be say for example they are coming in different sequences so if they are coming in different sequences so those sequencing and scheduling has to be considered in such a way that overall either the processing time or the overall average waiting time.

Or whatever the metric that we are trying to utilize has to be minimized in the best possible manner in order to meet the requirement of the overall jobs or the activities or overall project so with this I will close this thirty sixth class and then continue with my thirty seven, thirty eight, thirty nine, fortieth class of this four lectures which are left for half an hour each and consider in a little bit more detail the concept of GERT.

Q-GERT with very simple examples such that they give you a flavor to the candidates and the students that how PERT CPM are fundamentally different from GERT and Q-GERT and how GERT and Q-GERT can be utilized in a practical sense. Even though it may be difficult to implement them in a practical sense to bring the flavor of the practical problem which many of us face when trying to implement the project in the realistic sense. Thank you very much for your attention and I am close today. Thank you.