**Principles of Industrial Engineering**
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Lecture - 42
Network Modelling: PERT

Hello, I welcome you all in this presentation related with the subject Principles of Industrial Engineering. And in this presentation, I will be talking about the Network Modelling, more specifically, PERT, one of the network modelling techniques. We know that, in organizations, the different activities need to be planned, they need to be scheduled so that the maximum utilization of the resources can be facilitated in order to provide the services, in order to manufacture the things at a minimum possible cost and realise the increased productivity.

So, the network modelling primarily involves the precedence requirement of the different activities which are to be done for completion of the project and the analysis of the various activities, and these activities are shown using suitable diagram so that suitable analysis for determining the various time values like earliest start, earliest finish, latest start, latest finish, slag time and identification of the critical path and total project duration although those things can be identified after the analysis of the network which we develop.

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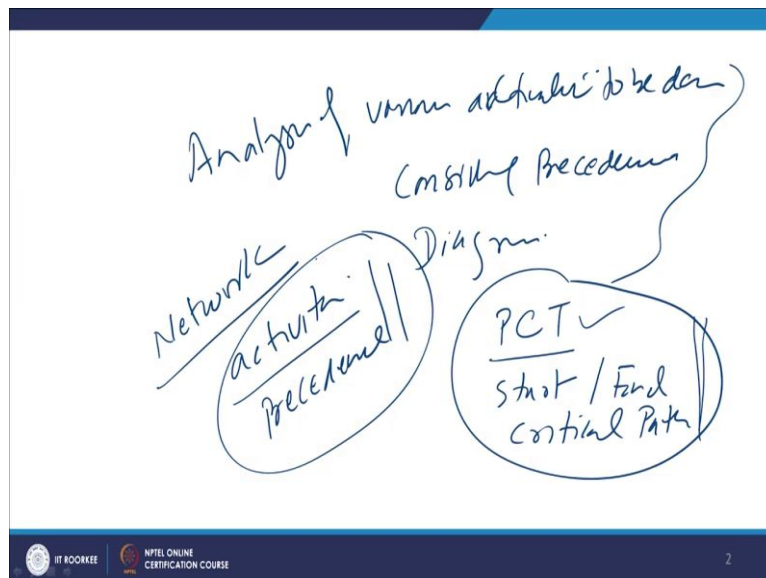
So, network modelling primarily involves the analysis of various activities. Activities to be done for a project, for completion of the project considering the precedence requirement. The activities which are to be done first before the subsequent activities can be taken up. And these activities are shown with the help of suitable diagram.

So, that after the analysis, we are able to identify the project completion time and when a particular activity should start and when it should end, and what are the critical activities which the activities which must be done on time in order to complete the project within the stipulated period. So, identification of the critical path. So, analysis of the various activities in a network will help in identification of these things like project completion time, start and end of the activity, identification of the critical path.

And so, for this, it requires that a suitable network is developed using the activities to be completed for completion of the project and consideration of the precedence requirement. So, the network diagram is developed using these two things. So, graphically we are able to show the network.

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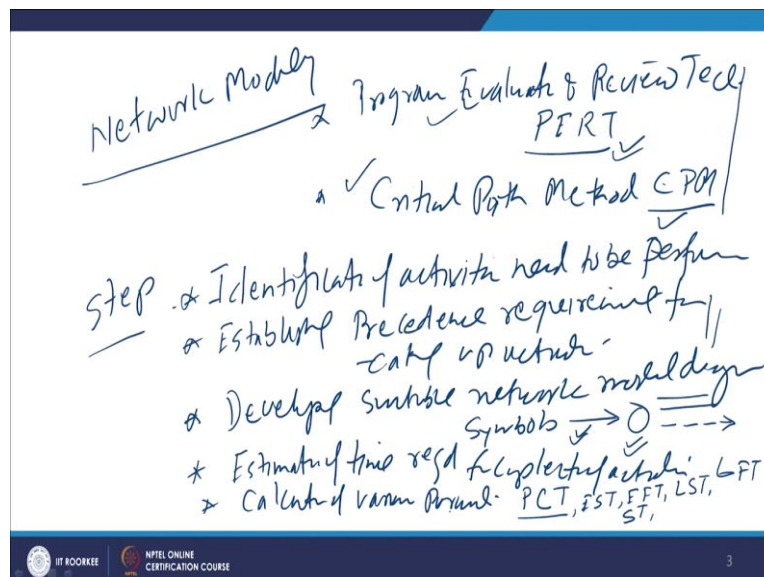
So, there are various techniques which are used in network modelling. The two are of the great importance and which are extensively used. One is called Program Evaluation and Review Technique. In short, it is termed as PERT.

And the second one which is also very commonly used is Critical Path Method. In short, it is called as CPM. So, the PERT and the CPM the another technique of the network modelling which is very commonly used. There are certain things in the network modelling which are extremely important and suitable logical steps are followed in the analysis of the network. The first step here is clear identification of the activities need to be performed, need to be performed.

So, with the great clarity the different things need to be done for completion of a project or completion of the work. Then, if there is any inter relationship between the various activities to be performed that is identified. So, the second thing is like, establishing the precedence relationship like this particular activity is to be completed before the, particular activity can be started or the taken up or the two activities can be done in parallel.

So, those kind of the relationships are established or identified. So, establishing the precedence requirement for taking up the activities for performance. Then, next is, the developing the suitable network. So, considering the activities and the precedence requirement, developing the suitable network model diagram. So, this is basically a simple diagram which is developed using suitable symbols, symbols in form of arrow or the node.

So, these are the two symbols which are common, which are used. In addition to this sometimes the dummy activity in form of dotted arrow is also used. So, these symbols, the arrow indicates an activity and the circular shape symbol shows the node or event which indicates the start or end of the activity and the dotted arrow shows the dummy activity which is primarily used to show the precedence requirement and it does not consume the time and resources.

So, basically, development of the suitable network diagram using symbols and using symbols in form of the arrows and the nodes and this diagram is developed considering the precedence requirement for the various activities need to be performed. The next step is, estimation of the time required for completion of activities.

So, depending up on the kind of approach whether it is CPM or the PERT is being used, the time required for completion of the each of the activity is identified or this the time value becomes deterministic in case of the CPM approach, while it is probably stick in case of the PERT approach.

So, this time required for completion of each of the activity is identified irrespective of the kind of approach for the network modelling is to be used. And thereafter, it involves the calculation of various parameters using the systematic procedure for determining the project completion time. We can say, PCT. Then definite start and end time, earliest start time, earliest finish time, then latest start time and the latest finish time, latest finish time, then slag time.

So, the various performance parameters related with the network modelling are calculated as a fifth step.

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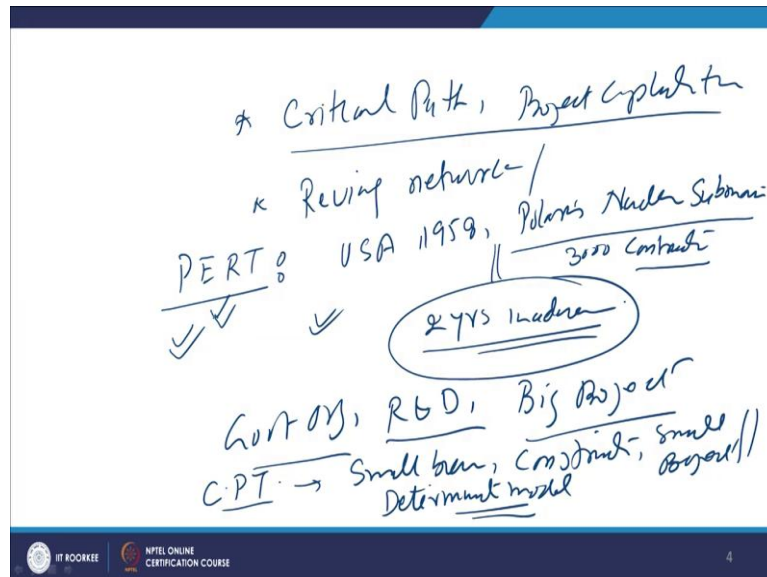
And based on this we will be able to identify the critical path, the activities on a certain route which must be completed on time in order to complete the entire project within the stipulated period and project completion time.

Later on, later on, we will also be revising the network characteristic or the parameters if there is any delay, if there is any new situation comes up then the network is reviewed, it is updated, it is revised so as to complete the project within the stipulated period. This may require crushing of the certain activities on the network. Re-evaluation and revising the network is the next step so as to complete the project in the minimum possible time.

So, these are the general steps which are used in both the PERT and the CPM techniques. As far as the specific features of these techniques are concerned like PERT Program Evaluation and the Review Technique. This technique of the network modelling was developed in USA in 1958 while developing the Polaris Nuclear Submarine.

So, during the development of this submarine, they applied the PERT technique to deal with the various activities that were required to be performed by more than 3000 contractors or manufacturers. So, when this technique was applied, the project could be completed in the 2 years less time than the stipulated period time. So, the project could be completed 2 years in advance than the time at which it was expected to be completed when the Program Evaluation and the Review Technique was applied.

So, if we see another techniques so this was, this is one technique which is primarily used in the government organizations dealing with the long term activities and the projects research and development and the big projects where many activities are too be performed and which are expected to be done by many stake holders and many contributors.

On the other hand, the Critical Path Method, CPM technique is applied in case of the small businesses like construction and small projects. So, in this case, the organizations will be knowing with greater clarity about the time particular activity will be taking for the completion. So, that is why it is termed as Deterministic Model because the time required to become, time required to complete a particular activity during the project that is known with the greater clarity as compared to the case of the PERT technique.

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So, if we see there are few similarities and the dissimilarities in case of the, so, if we talk of the similarities and the dissimilarities in case of the CPM and the PERT. So, as far as the dissimilarity is concerned, so the PERT as I have said and here CPM. The PERT is the technique which is probabilistic in nature and this is deterministic in nature.

This is good for the large project and this is good for small projects. And here this PERT is used for effective planning, scheduling. Here cost is not a major consideration, not a major factor. While CPM also helps in effective planning, scheduling and at the same time it is also effectively used to minimise the cost of project.

So, we, with the greater clarity, we know the time, particular activities will be taking for its completion. It is applied in case of the small scale projects and effectively utilised for

planning, scheduling and the cost minimisation. While we use the estimates in the case of the PERT so this approach is more probabilistic, useful for the large projects and used for effective planning and scheduling.

On the other hand, both CPM and the PERT techniques both will be using the diagrams to show the various activities need to be performed and the precedence relationship. So, the diagrams will be used to show the activities as well as the precedence requirement. Both activities will be able to establish the critical path and will be able to identify the project completion time. So, project completion time as well as the critical path both are identified in case of the PERT and the CPM technique.

Then it can also help in, both will be helping in estimation of the, in both the cases we are able to identify the slag time activities were there is some slag time or identification of the non-critical activities. So, to understand these things in better way, like determination of the critical path, identification of the non critical activities and the activities and the precedence relationship, we need to talk little bit more about the way by which the diagram is developed.

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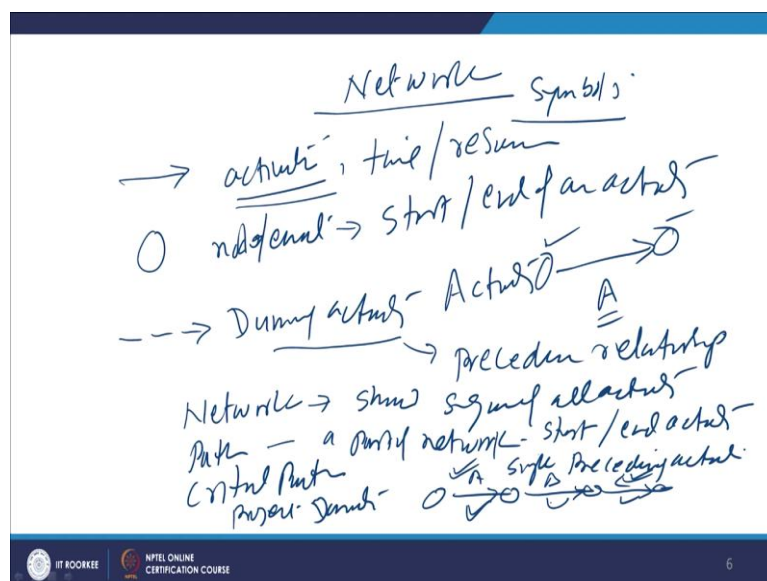
So, for developing any network we use symbols. Symbols are basically in form of the arrow which is showing the activities or which is say, required to be done for completion of the project or you can say many activities will be required to complete the project so these will be shown by the arrow. Then there is a node or event. An activity will always have a kind of nodes at the beginning and at the end.

So, node or event shows the either start or end of an activity. So, depending on the kind of the approach being used or the kind of or the way by which network is being developed like the activity can be on the arrow or the activity can be on the node also. But mostly the people use the activity on the arrow. So, activity arrow is used to show the particular activity say, A to be done. So, here it will be have the nodes will be there at the beginning and at the end of a particular activity.

Now, we will see there are certain, the typical ways by which typical words and the parameters which are used in the network modelling. So, like I have said the activity which is to be done for completion of the project will be taking time and consuming the resources. This is the node is just indicating the start or end of an activity. Then the dotted arrow indicates the dummy activity.

It does not consume the time and the resource but it is primarily used to indicate the precedence relationship with the other activities. Then there are others words like network path and the critical path project duration or completion time. So, as far as network is concerned, a network shows sequence of all activities that need to be performed, (sequen) shows all sequence of all activities that should be performed for completion of the project, the path.

Path shows a part of network, path is a part of network which includes the start and end activity and each activities in between falling on a particular path will have the single preceding activity, means precedence requirement is of the single activity. Just like this here. So, activity A, B, and C like this.

So, activity B can be taken up only after completion of the A. Activity C can be taken up only after completion of the activity B. So, the precedence requirement for C active for start of the activity C is completion of the activity B and precedence requirement for start of the activity B is the completion of the activity A. So, this is like, it will be indicating one path, the activity 1, 2, 3 say in this in a path they are three activities. So, here the start activity and end activity and if it is also showing the kind of the precedence requirement.

Then the critical path. A network may have many paths. In a network there can be many paths but the path which takes the maximum time to complete is termed as Critical Path. I will give the example. Critical Path, one which takes the maximum time for completion of the activities falling on the critical path.

So, a path in a network which takes maximum time for completion is defined as a critical path. And the time required to complete the activities on a critical path indicates the project completion time. So, sum of the activities, sum of the time required for completion of all activities falling on the critical path will be giving the project completion time. I will give, now I will give the one example to understand these things in a better way.

Say, in case of the PERT approach, the time is expressed in different way than in case of the CPM approach. So, in case of the CPM with the great clarity, that the expected time, the time particular activity will take is known with the greater clarity. So, we will write clearly like it will take 3 days or 3 hours.

On the other hand, in case of the PERT, it is not so because it is probabilistic in nature. So, it uses the 3 types of the time values, rather 4 types. One is To, optimistic time. Optimistic time is the minimum time that an activity is expected to take for completion under the most favourable condition. So, it is the minimum time that an activity is expected to take for completion under the most favourable condition.

And the Tp is the pessimistic time, is the maximum time that an activity is expected to take under the most unfavourable condition. So, this is pessimistic time and then, Tm is the most likely time, most likely time, most likely time is the best possible guess of the time value that an activity is expected to take for completion. So, the best possible guess or the estimate regarding the time that an activity can take.

And the Te is the expected time an activity is, expected time for completion of an activity. So, the Te is calculated using the simple equation, T naught optimistic time plus 4 Tm plus Tp divide by 6. This is the kind of equation which is used for calculation of the expected time for completion of an activity in case of the PERT approach. So, now we will take up one example using the where the time values for various activities to be performed is known with the greater clarity.

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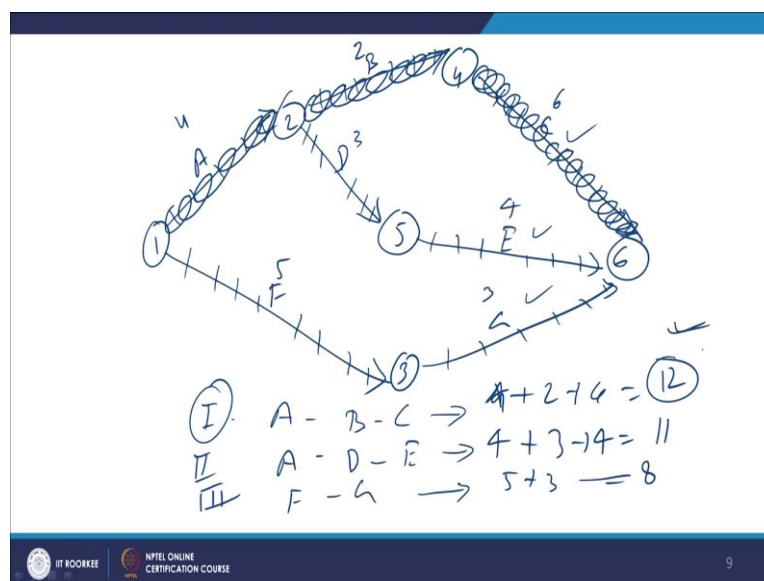
Say, there is a network say, so here we will just do the labelling like 1, 2, 3, 4, 5 and 6. And the activities like A, then B, activity C, then D, then E and F and G. And say the time required for completion of the, like whether we use the CPM or PERT approach say, the expected time in PERT approach is 4, 4 days or hours anything it can be. Then, here it is 2 for activity B. Say, for activity C it is 6, activity D it is 3, for activity E it is 4, activity F it is 5, activity G it is say, 3.

So, now first of all like say, these are the various activities along with the time that these will take. So, activities like say, 1, 2, 3, 4, 5, 6, 7. So, what it shows, the activity B can be taken up only after completion of the activity A. Activity B can be taken up only after completion of the activity A. Now, similarly activity G can be taken up only after completion of the activity F.

And the project will be completed once the activity C, E, and G are completed. So, now if we see, activity A and F can be done in parallel. There is no precedence. So, both can be started at the same time. So, what are the different paths we have? One path is like A, B, and C. So, what it has? Like, start and the end. Then another path, activity F and G.

Then, another path, activity D; A, D and E. so, let us identify the path, the first path is like say, A, B, C. Time required for completion of the activities like 4 plus 2 plus 6 so it is 12 days say. Then another path is activity A, D and E, the time required is say, 4 plus 3 plus 4 so, here it is 11. Now, third path is F and G so, here 5 plus 3 total is 8.

So, if we see the maximum, the path which takes the maximum time to complete is the first path A, B, C and requires the 12 days say or the 12 hours. So, this becomes the critical path. The path which takes the maximum time to complete the activities. The path which takes the maximum time to complete the project. So, this becomes the A, B, C becomes the critical path and project completion time becomes the 12 hours.

So, this is how we can calculate, we can identify. First we can develop the network, then identify the critical path and then project completion time. We will be talking in detail about the determination of the various, other various parameters related with the network analysis. Now, we will summarise this presentation. In this presentation basically I have, I gave the introduction of the network modelling and various terms and the parameters which are used in the network modelling. Thank you for your attention.