**Network Analysis for Mines and Mineral Engineering**
Prof. Kaushik Dey
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Lecture – 01
Introduction to Network Analysis

First let me welcome you to the course NPTEL online certification course Network Analysis for Mines and Mineral Engineering. In fact, in this course we would like to give you idea about the basic idea about the mines and network analysis and we will give some particular reference at the end of your basic idea receiving the basic idea about the particular reference to mining and mineral engineering how these are being applied.

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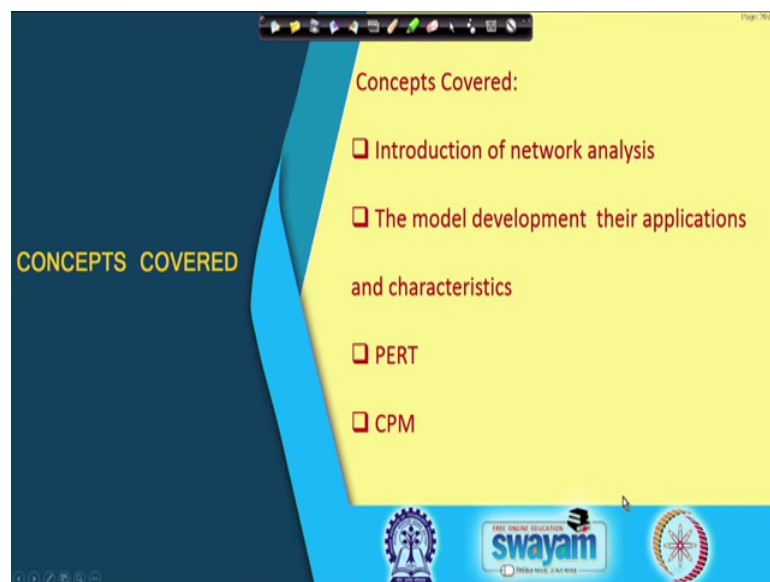
So, this is the very first lecture where we will introduce you to the network analysis and the concept will cover is the introduction of network analysis, model development their application characteristics and PERT CPM, P E R T and C P M.

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So, but first letters explain, what is optimization what is network. So, for that let us assume that a person is willing to travel from Ghaziabad to Kharagpur ok. So, if you would like to travel from Ghaziabad to Kharagpur his he is having different options, say first one he can avail weekly train or he can directly come to Delhi and from Delhi he can come to Kharagpur by using more number of trains, which have more number of trains are available for that. So, he can have better option there, he can come using a direct train from Delhi to Kharagpur instead of that he can come from Delhi to Howrah and from Howrah to Kharagpur by another train.
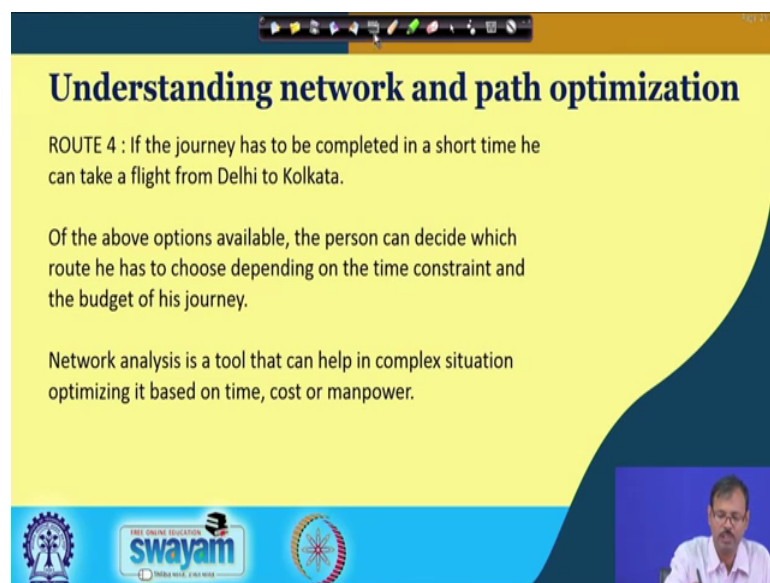
And he is also having another option that he fly from Delhi to Kharagpur, Delhi to Kolkata by flight then from Kolkata to Kharagpur by road or by rail. So, like that a person may have different options and it is essentially required for the person to decide, which is the better option for him, better in terms of what?

Sometimes this better means she needs to have a less time address this or he has to reach Kharagpur in a less time or maybe he would like to opt for a cheaper one which may take longer duration also, but no problem. But most of the time people come out with the solution which is neither costly nor very time consuming; that means, which one is suitable for him if that person must use that one, but that is optimization. When it is coming the network, let us understand it little bit different way.

Suppose his idea is to go to Ghaziabad to Delhi, there he is having different options say he is coming by bus, he is coming by car, he is coming by train. So, these different options are available, but suppose he is being accompanied by one of his close relative who is coming from not Ghaziabad, say he is coming from Kanpur. But they would like to come together from Delhi to Howrah or Delhi to Kharagpur together and that is why they have to start one person from Kanpur another person from Ghaziabad. And they have to meet in the Delhi to board on the same train or same flight. So, for that their routes are different and they have to go for different options, the Kanpur person may take train Kanpur person may take bus, Kanpur person may take car.

Same options are available similar options are available for the Ghaziabad persons, but their route lengths are different, but the essential constant is that they have to meet together in the Delhi then only they can board on the train from Delhi to Kolkata because they need the similar option similar purpose to be solved, when they are coming together. So, basically there are n number of constants which are basically creating a problem.

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Now, if you just forget this one and go in a deeper way that how if we are trying to construct something or we are trying to make something, how the different at different things are coming to form that one. Suppose if you are considering your, you would like to manufacture one television.

Then what are the different compositions television is having? Having different components say a television is having one display board.

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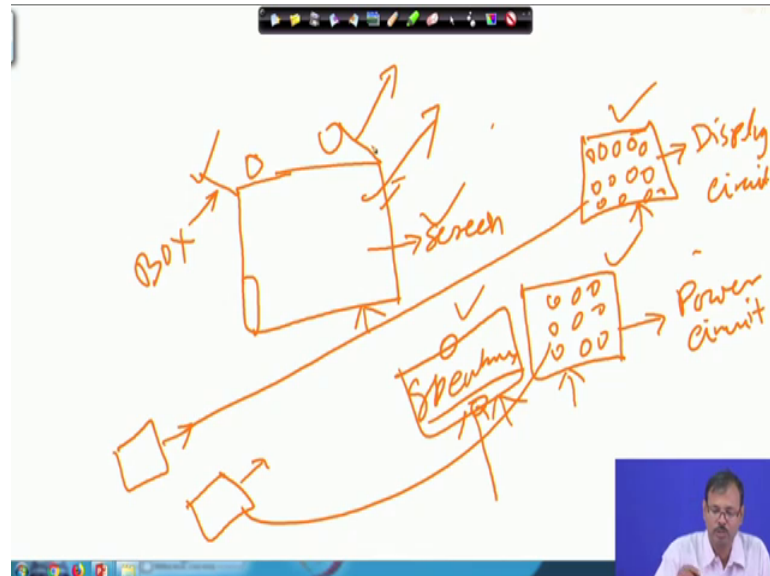
It may be LED, it may be LCD, it may be CRT screen. So, this is the screen and the screen is attached to a box so; that means, there is a box, then what are the other components it is having? It is having some electrical component. So, this is the display circuit, then the power has to be managed for the display circuit and sound circuit, then it is a power circuit is there.

And apart from that he is having speakers, sound speakers for providing the sound and there are n number of components attached to these things, may be diode, triode, semiconductors, ICs or resistance connected etcetera etcetera are also attached to all these components. But finally, when a TV is formed, television is formed you that must have the all this individual parts assembled in a right manner; that means, when the final position, this everything are being assembled prior to that these all this individual components must be finished appropriately.

So, that is why this is basically the branches, branches of a tree which has to be completing the complete tree; that means, this has to be fixed in some part, this has to be fixed in some part of the box and then the screen is fitted. Finally, it is giving the television; that means, we are having the option individually we manufacture this one that is one activity, individually you are manufacturing this one that is another activity,

we are manufacturing this one that is another activity. Manufacturing of this one is another activity manufacturing of this one is another activity.

So, all these different unit operations are carried out first then they are meeting together to complete the whole process. So; that means, basically network is being created of the different activities so that the complete working process can be carried out. So, network analysis is basically a tool which gives us that how to address the complete process; that means, it is a pictorial assessment of the complete process. And if we present it in pictorial manner, then only it is easier for us to optimize it based on time, cost and manpower.

Basically it is man, manpower, material and the cost and time is being considered in this case. So, this is the essential requirement and that is why for any type of engineering, any type of manufacturing even if our in our day to day life for a decision making also this network analysis is an essential tool.

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So, let us observe one video at this moment so that which is taken from the YouTube so that we can understand, this is a road construction process, you can see first the vegetation is removed, then the first soil cover is rolled, then the metallic cover is given on that, then the coarse aggregates are placed on that. Then finally, the rolling of the coarse agreements are given that is the GSB layer granular sub base layers of after

completion of the sub base, then the bituminous concretes are placed there, then the final wearing surfaces place to finish the final road.

So; that means, the different activities are carried out one by one at this place, but if you look into this in different way you will find out that when the on the exact position vegetations are being removed. That time digging for the soil which is given as the embankment in this position is already carried out in some place.

So that means, simultaneous activities that is the manufacturing or procurement activities for the file is being carried out, simultaneously when the vegetation for being removed from that place. Similarly the manufacturing or crossing of the borders for the granular aggregates are made simultaneously when the soil layers are being placed in the or in the rolled in the proper place.

So, like that way different activities are carried out, there are sub activities also those are also carried out. Simultaneously and the optimization of the whole process is essentially required.

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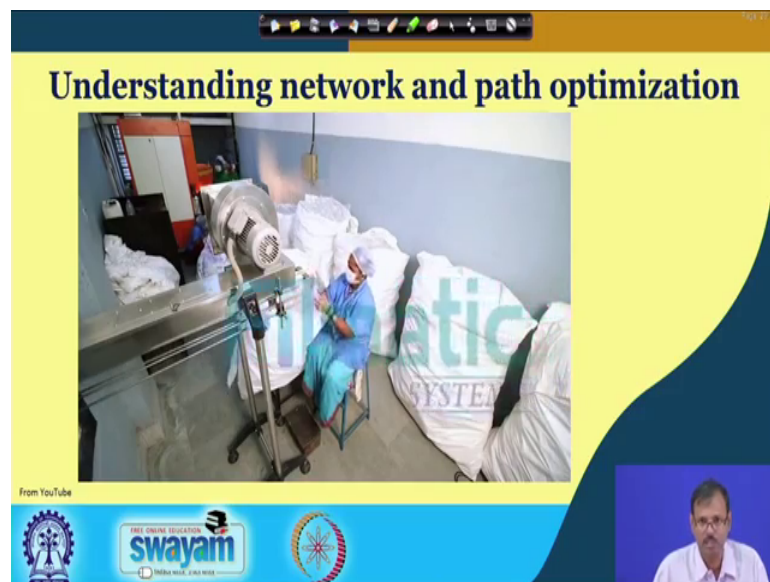
So, basically we want a network or we want to develop the network which is basically define the complete process in a special manner so that it is easier for the user to understand, it is easier for the user to solve the network for the possible optimization and the cost reduction.

So, let us observe another video here, this is basically video of a bottling plant where the water is being bottled, mineral waters is being bottled in the plant. So, you can see once in one place the bottles are manufactured, the simultaneously bottles are manufactured and being transferred into the bottling place.
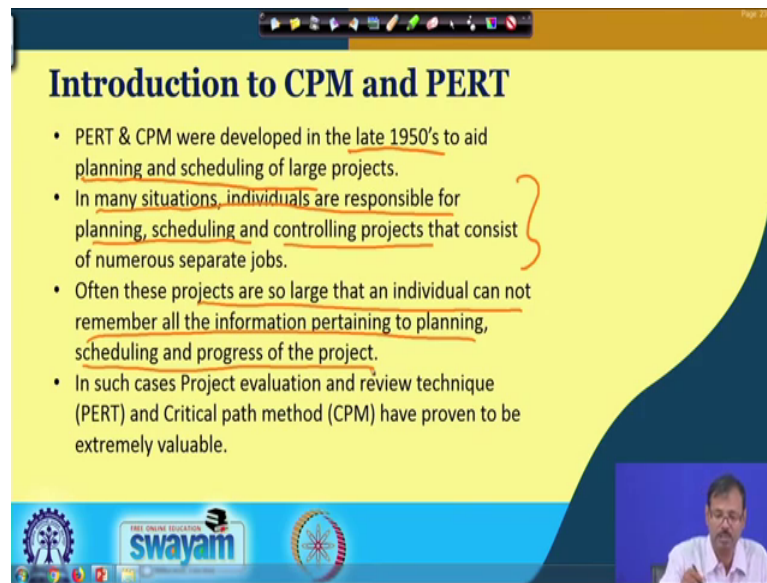
Those manufactured bottles are placed in a row so that that can come and automatically that will be washed. So, there are activities which are coming one by one unless and until one is being complete another cannot be possible so; that means, you can see here bottles are manufactured first then the bottles are coming and washing of the bottle is going on.

So, only after washing of the bottle then only the water can be filled in this bottle. So, these are the essential requirement and that is why this washing requirement must be carried out before the bottling of the water in inside the bottle. So, these activities are placed or these unit operations are carried out such a way that one must be there which is carried out before and another must be there which is carried out after that.

So, when the bottling is complete it is now then placed for the placing of the cap before it. So, before that what is the requirement? Before that the requirement is that cap must be manufactured, cap must be traded properly then they are arranged in a manner so that they can be shown to the machine which will kept the bottle.

So, this is now placed in this machine this machine is placing the cap on the bottle so; that means, different unit operations are there they must be properly arranged and then only a network may be formed for the possible optimization of the same.

So, now let us see how these are carried out, let us observe the network analysis theory and for this let us go back to little bit how it was developed. So, both basically network analysis is carried out in two way one is the deterministic manner another is the probabilistic manner.

So, that probabilistic manner is called PERT Program Evaluation and Review Technique and deterministic manner is called critical path method CPM where the consideration for the cost, duration, man material requirement etcetera are considered as fixed and that is why it is deterministic analysis. Both these probabilistic and deterministic analysis were developed in the late fifties in mostly in US and this were this were that time aid to the planning and scheduling of the large projects.

We will discuss the little bit history of that and in many situation it has been found individuals are responsible for planning and scheduling and controlling of the projects and that leads to the brightness of the thinking. Say, suppose if you as you are the person related to the mining industry let me discuss about the mining, suppose there is a deposit and if you ask some individual to plan that one there that person may have personal affection on the say dragline operation.

Say, whether the dragline may not be that much financially acceptable then also because of his personal affection he may wish to give introduce the dragline in that mine which is not may be a good economic decision. But if the network analysis is carried out cost
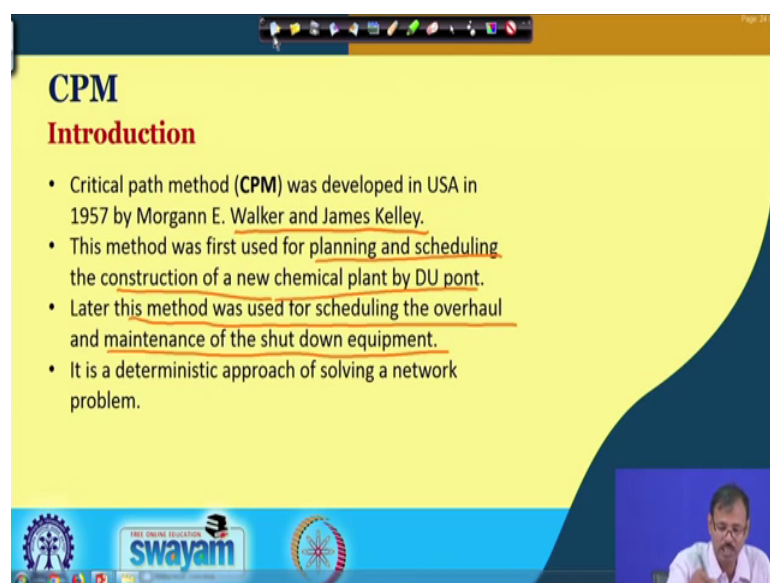
optimization is carried out, then it would have been found that the dragline may not be a suitable deployment of the message in that particular mining.

So, that is why network analysis may remove those type of problems which if it is carried out by some individual without the analysis that those errors may be in carded in the decision making process. So, these projects are large in those cases individual cannot remember all the information part pertaining to the planning scheduling and progressing. So, suppose if you are considering sending a satellite to the say, sending a satellite to the moon or sending a satellite to the mars.

In those cases the problem is that there are n number of activities involved and those in n number of activities those n number of problems cannot be solved by one individual person. Because specialization in the fuel, specialization in the material science of the rocket, specialization in the gravitational movements, specialization in n number of other things are essentially required in those complex projects.

And for that everyone carry out their individual networking path that has to be placed in a computer system and computer must, computer must analyze that system in a systematic matter manner for the optimization of the same. So, that is why it is essentially required that a computerized program must be developed for those large projects.

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So, that individual should not be biased individual should not be carry on those hectic process.

So, now let us look into the history first, critical path method was developed in USA first in 1957 by Walker and Willy, this method was first used for planning and scheduling of construction of a new chemical plant by DU pont ok. So, by DU Pont the chemical plant which was constructed that was planned and scheduled using critical path method. But later this method was used for scheduling of overhauling maintenance, shutdown of the equipments. And nowadays critical path method is used all for almost all the manufacturing units for their maintenance, for their construction this is very very common method. We will learn these methods later on.

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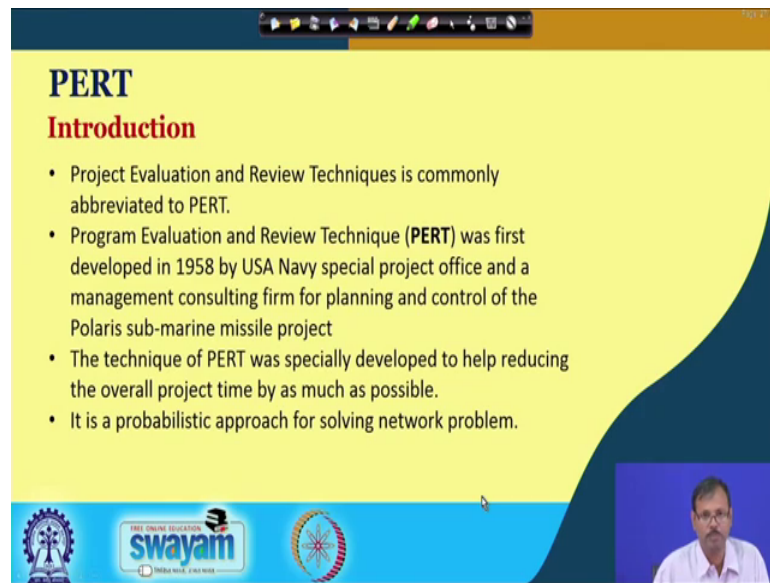
Let us look into the details of the critical path method. Critical path method is a deterministic approach for solving network; that means, the each unit operations here are considered of fixed duration and fixed cost consideration of manpower requirement material requirement, these are fixed and the exact values of these things are available with the plant. So, this is the essential requirement where this methods are being introduced, but and that is why this method is emphasizing the relationship between the man machines and resources with the particular reference to the time duration that is basic part of this critical path method.

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However the probabilistic approach is called P E R T or PERT it is aggregated from project evaluation or programmed evaluation and review technique and this is considered where the exact values are not known to us. This was first introduced in 1958 by US navy when they were trying to or eyeing want to develop a Polaris missile which is basically a atomic power supported missile. Atomic bomb career missile and proposed to be launched for the submarine launched from the submarine, below the see proposed to be launched on the submarine to attacked to a missiles in the sea bed or any land or any port.

So, for that they were aiming to develop such a missile project. So, the matter was that it was the case of development, no one knows exactly how much time it will take to develop a particular system that is what will be the launching system, what will be the power propagation system. What will how the velocity will be controlled, how the target will be fixed, how the laser guided target and that is position of if the change target position is changed, how that will be further followed?

All those has to be considered and the technology was supposed to be developed for all those things because there has no previous development. And that is why no one knows how much time it would require to invent that particular system.

So, that is why there was there was some probabilities that say suppose for a particular system say may a velocity control system that may take 30 days time, that that may take

45 days time. So, there are some pessimistic assumptions, there are some optimistic assumptions and there maybe some mean values between the pessimistic and optimistic assumptions.

So, like that way the exact value, but pertaining to that system is not known to the user and that is why program evaluation and review technique was developed where the probabilistic approaches are made. And based on that it was decided how the particular time by which the Polaris missile will be, ballistic missile will be developed and will be introduced with the US army.

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So, that is why this is the probabilistic approach and the target was fixed considering the probability of different component. So, there is a likely chances that the probability target finishing target date may deviate with a certain range that is the mean or deviation within that it may deviate.

So, that is why PERT is the method of analyzing the task involved in completing a given project, especially the time needed to complete each task and identifying the minimum time needed to complete the total project. Where the each task time is not essential known to the, or it is not fixed and essential not known to the user. So, this type of probablitics probabilistic task are being addressed with the PERT system.

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So, basically basic difference between the CPM and PERT is the collection the both in both the cases first requirement is the collection of the unit operations which is also called activities in this case, each activity is the start and ending time. It may be probablistic also and their exact sequence of operation this is the basic requirement for both PERT and CPM.

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And their applicabilities are known, almost for all the cases even if in our personal life also you have to decide by the logical thinking basically our brain is also try to analyze the system like this way.

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And the basic difference between the PERT and CPM is given in this slide, the basic is basically one is probabilistic approach and another one is deterministic approach.

So, PERT is basically deals with the uncertainty and CPM is not basically uncertainty, CPM is basically guide that if the target date is fixed, how the target that may be achieved using some additional resources or maybe some accessing manpowers like that or excessive costings.

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So, this is more or less end of our first lecture. So, these are the different text books, all this text books are commonly available in the market and this is one of the book I particularly most of the time follow this book and you will find the number of examples in this lectures are available in this books. Apart from that I in general use a number of videos which are available in the you tubes, a number of problems may be given in different books.

A number of a problems available in the different web sources may be used for your better understanding. Generally I used that anyone who is having any book all are basically similar maybe problems are different maybe explanations are in a different text, but basic theory is same. So, whichever book is possible a student may follow that book the basic principles of this network analysis is same for all the books.

So, any books you people can follow and it is better you can observe different websites of this different manufacturing units also so that you can understand how this different television boards are made in different places then assemble. Then that will give you some idea about how the networks may be formed. So, this is the end of the first lecture.

Thank you.