Software Project Management
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Lecture - 26
Project Scheduling

Welcome to this lecture. In this lecture, we will start to discuss about Project Scheduling. Project scheduling is not only confined to software projects, but to all types of projects. And, naturally this is a very old technique, but then there has been lot of developments recently. This technique, the project scheduling techniques date back to nearly a century. Over last one century, many techniques have been proposed and we will see that there are several charts that get developed, but a recent phenomenon is to use a computers in the scheduling process.

The charts are automatically updated, different parameters are computed so, what used to be once computed manually and very painstakingly now can be done at the press of a switch. But, still the main ideas of scheduling are very important. The project manager even though has a tool at disposal, but has to know the nitty-gritty of project scheduling to be able to effectively schedule a project.

Let us look at the main concepts in project scheduling.

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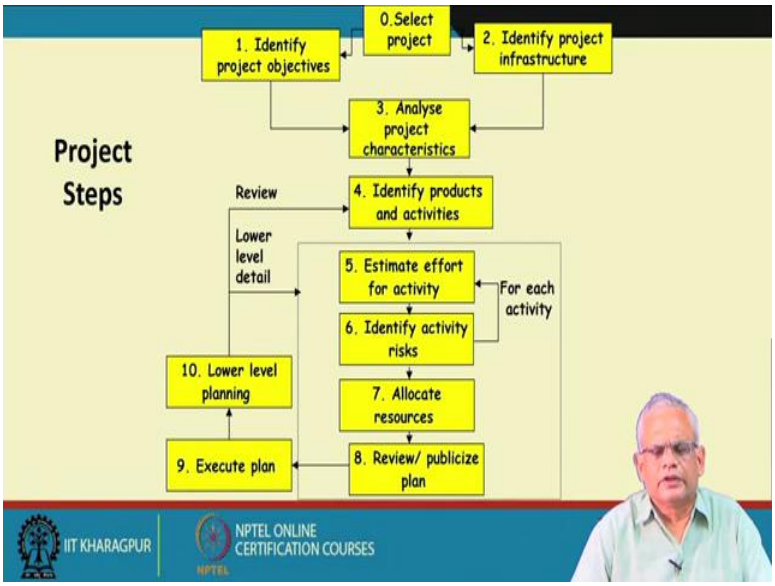

Before we look at project scheduling let us look examine the overall project steps. Once the project has been selected we need to identify the project objectives and the infrastructures. These are two main things that what the project needs to do and also what infrastructure it needs to use, what will be the team, team organisation, hardware and so on. And, once that is done we need to analyse the project characteristics – what are the risks involved, what is the resources that are required, what will be the life cycle model that will be followed based on these factors and so on.

And, once that has been done we come to estimation and scheduling. For that we need to first identify all the activities, the different deliverables which we refer to as products, the different deliverables to the customer and what are the activities to be undertaken to produce those deliverables. And, we need to do a finer level risk analysis based on every activity.

And once we do the risk analysis the activities may change. Their effort, duration etcetera may change and once we complete this process we allocate resources and we review and publicize the plan. And, this forms the planning process and then comes the execution. In execution the activities do change we notice very finer level activities and therefore, we do a lower level planning. We find that there are many new sub activities and so on and then we do a detailed lower level planning so, again the same steps.

Let us look at how we do identify the activities and then we identify the precedence and schedule. So, that is goes by the name project scheduling.

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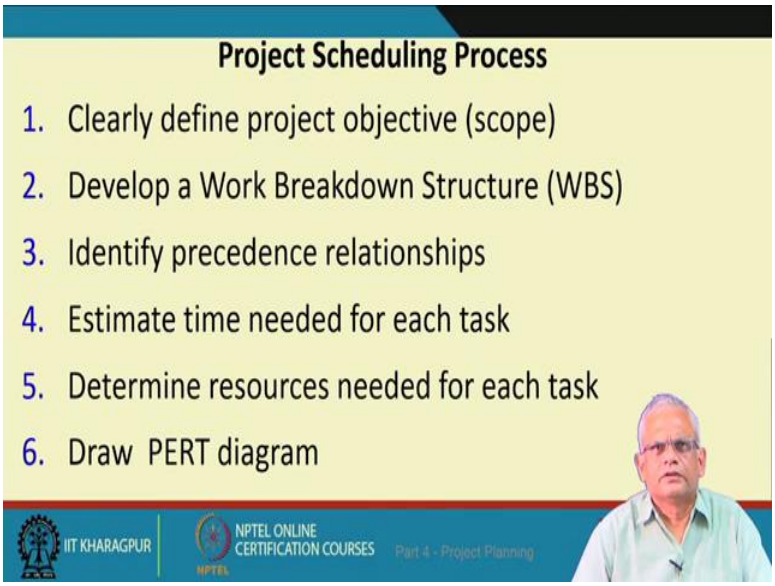

In the project scheduling process, we should have defined the objectives or the scope. And, the first step here once having developed the project objective is to identify the finer level activities. From the objective we get more detailed activities or finer level activities which we represent in the form of a work breakdown structure.

And once we identify the activities we identify the precedence relationships between these activities, which activity would complete then the other activity can be taken up. And, once we identify the activities, the precedence relationship we need to estimate the time duration for each of these activities. We need to determine the resource needed for each of these activities and then we need to draw a PERT diagram which will is a focus of this lecture.

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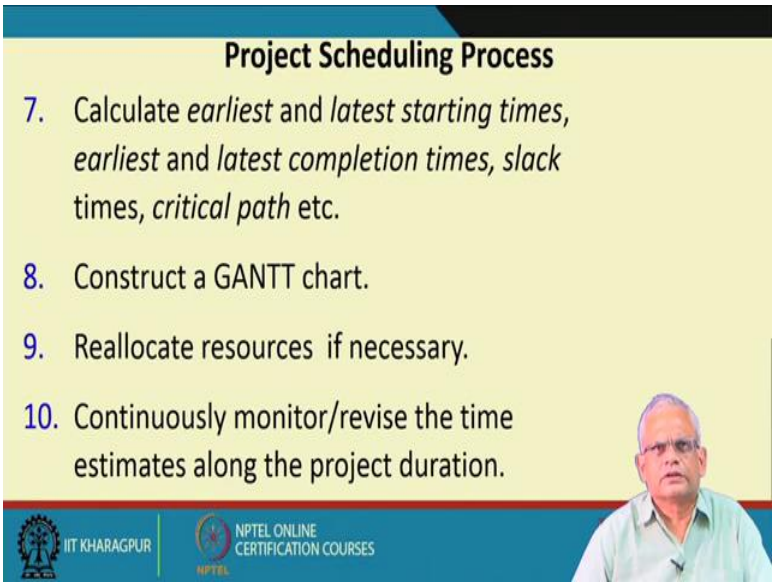

And, once we draw the PERT diagram, we should be able to compute the earliest – latest starting times, earliest – latest completion times, slack times, critical path and so on. And, then once these are complete the project is ready for entering the execution phase. In the execution phase, as we mentioned we are interested in monitoring and control. In monitoring and control we are interested if let us say a developer becomes unavailable what will be the impact on the schedule; if a new developer joins how will the schedule change and so on. And, that becomes easier to do if we have a GANTT chart.

The project manager initially constructs a PERT chart, where the overall schedule is drawn and various aspects of the project such as the earliest start and completion time of the tasks, the slack times, the critical paths etcetera are identified. We will see what the specific terms mean as we proceed in this lecture.

Once having done this overall planning process, the project enters the execution phase. In the execution phase, we need to do monitoring and control. We need to identify what if a developer becomes unavailable or additional developers become available and so on, and that becomes easier to do with the help of a GANTT chart, we will look at the GANTT chart.

If necessary using a GANTT chart we can change the developers or hardware. We may put more developers to one task to make it complete if the task is getting delayed and we can identify what is the impact of that on the schedule using a GANTT chart. And, as we

do this we need to continuously monitor revise the estimate for the entire project duration.

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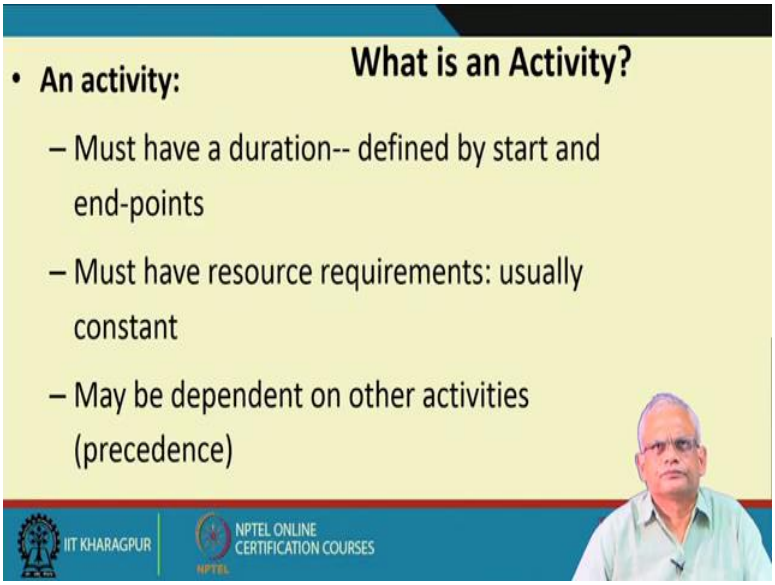

The basic to project scheduling is an activity because we schedule an activity and its sub activities. Let us be clear about what is an activity. An activity is something by which the team achieves or does some work, and naturally each activity has a duration. Over the duration a team member will be doing something and not only duration it will also be defined by a start and end point. It will start at certain time and end by certain time and in between it will have a duration. Of course, the start and end time difference must be larger than the duration.

To do an activity we must have a resource requirement. The resource typically is a developer; we refer to the developer as a resource. There may be one or more developers assigned to an activity, but then for an atomic level activity that is represented on the diagram, we normally keep the resources constant; otherwise it will become extremely complicated. Even if we have the lowest level activity some developers work for some time and then some developers leave, more developers join and so on, it becomes very difficult to represent in a diagram. And, therefore, we assume that for an activity duration the resource is constant. An activity may depend on other activities.

So, these are the characteristics of the activity. An activity is something using which a team member or a few members gets some important work done. These are associated

with a duration and identified with a start and end point. Some resources must be assigned to an activity, will carry out this activity. An activity may be dependent on other activities and this we call as the precedence relation. If an activity A can start only after some activity B has completed, then we say that B proceeds A or there is a precedence relationship between B and A.

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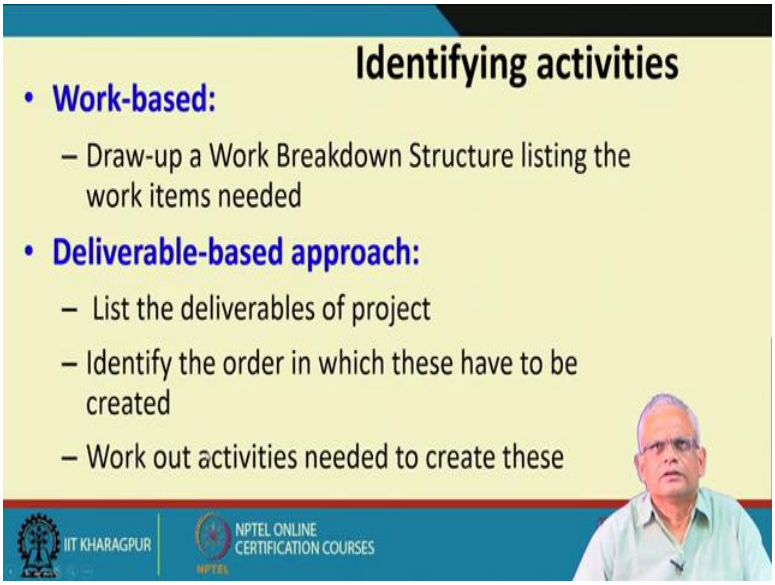

One of the most fundamental things that the project manager does is once the objectives have been identified how to identify the activities from the objectives. There are two main approaches that the project manager uses; one is known as the work-based. In the work-based approach, the project manager identifies that to meet the objectives what are the work that main work needs to be done and from the main work identify what are the sub-work that need to be done.

So, basically identify the activities, break the activities into sub activities and so on, and this is represented in the form of a work breakdown structure. That is, what are the main work which are broken down into sub work and sub work is broken down into sub-sub work etcetera until an atomic level. And, typically an atomic level activity is one where a single developer can do it in let us say a week or something.

It is not a good idea to use a work breakdown structure to break the activities into level of hours or minutes, that is because it will become too much of an overhead for the project manager to develop the schedule minute wise, hour wise or day wise. Typically,

the schedule is done in terms of weeks 1 or 2 weeks. The developer is assigned work for 1 or 2 weeks and then the project manager monitors whether the work is completing on time or is delayed.

And, we can also argue that work granularity of several months is also not good. Let us say we have a work breakdown structure where the leaf level work is 2 months. The main problem with this is that the project manager loses control of the project. The fact that the project is getting delayed or some activities delayed, the project manager can know only after 2 months and by that time it will be too late to control the project and back put it back into the schedule. And, therefore, the project manager loses control of the project.

To repeat the same thing I will say that in a work breakdown structure. The important works are identified and these are broken down into sub works, until the granularity of a week or 2 those form the atomic level or the leaf level activities in the work breakdown tree. We will look at this in the next slide.

The second approach that the project manager uses to identify the activities is based on a deliverable-based approach or product based approach. In the product based approach, a deliverable-based approach the project manager identifies what are the deliverables or the products to be delivered to the customer. And, for first makes the list of the deliverables and then identifies the order in which these have to be created, and for each of these deliverables the project manager identifies what are the activities that need to be performed to create these deliverables. Let us look at some examples of the work-based and deliverable-based approach.

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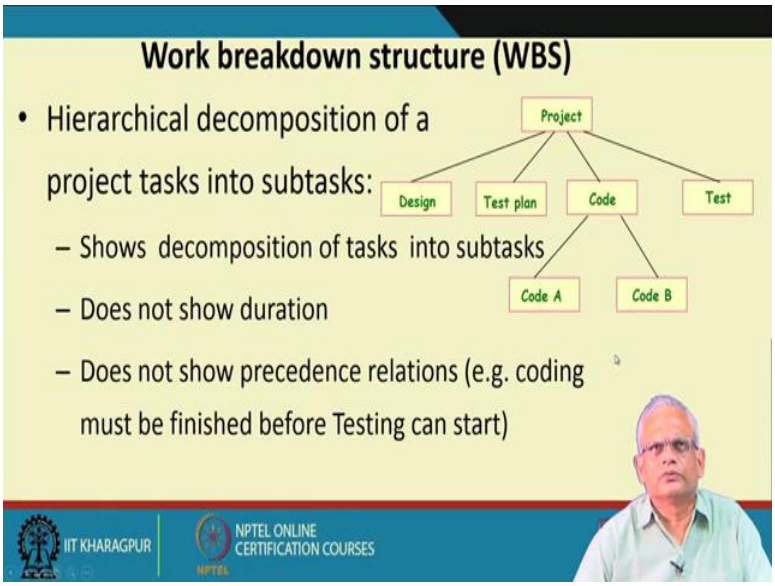

In the work-based approach let us say we need to complete a project. We need to the project manager identifies what are the main activities that need to be performed: requirement specification, design, test plan, code, testing, code two different modules A, B etcetera. So, this is a hierarchical representation of the important activities and the sub activities and at the leaf level they should take about a week or 2 to complete.

At this point just shows the sub activities, the main activities and the sub activities, sub activities and so on, but then the project manager does not accurately determine the duration of these activities that is done later. Neither does it show any precedence relationship. For example, the test plan should be created after the code that is not represented in this diagram or the code must complete before the testing starts that is not implied by this diagram.

The main objective of this diagram is to identify the important activities and then decomposition of these activities into sub activities till the granularity of the leaf level activities is about a week or two.

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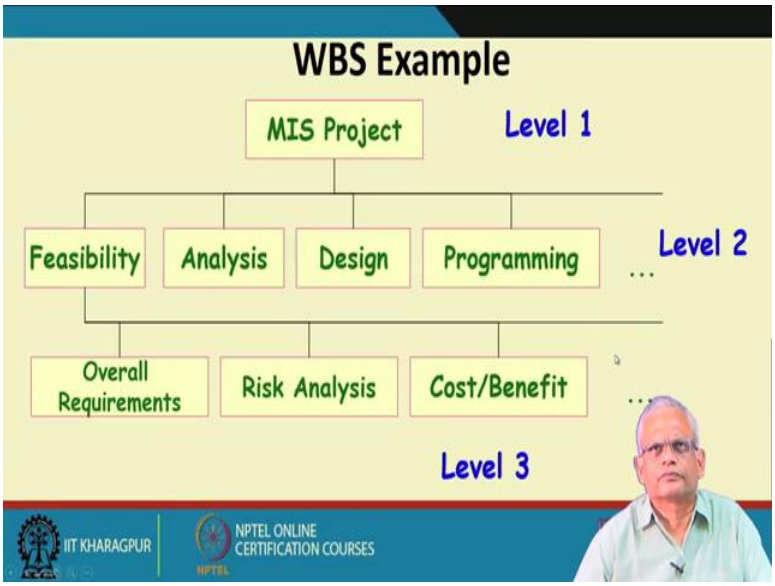

This is another example. This is the hierarchical chart, the MIS project that is represented as a level 1. In the level 2, the important activities the feasibility study, requirements analysis, design, programming, testing etcetera and then for each of these activities the sub-activities for feasibility study get the overall requirements, perform risk analysis, perform cost benefit analysis etcetera. For requirements analysis requirements gathering, analysis of the gathered requirements, documentation in the form of SRS document and so on. These form the level 3 activities and so on.

If this any of these takes more than week or two, then these are decomposed into more finer level.

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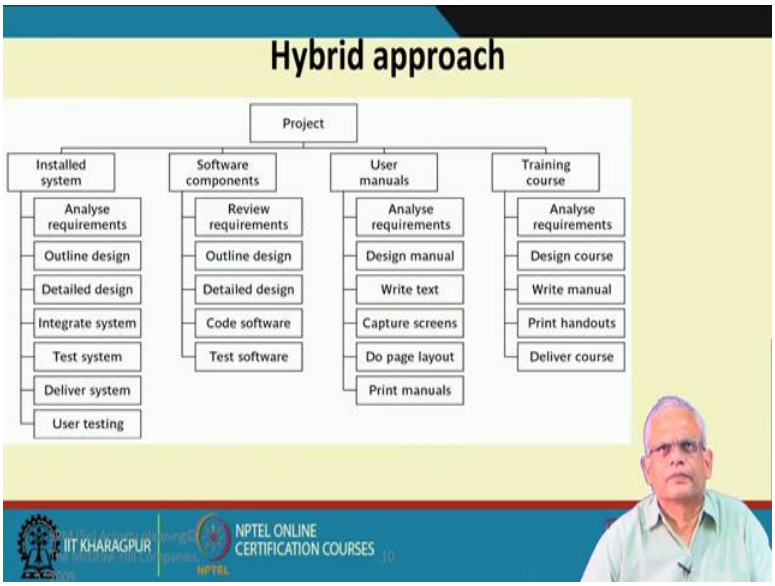

Project managers also use a hybrid approach which has both based on the activities that need to be carried out and also the deliverables that had to be given. Let us look at this example where a project has certain deliverables. These are represented here that the system must be developed and installed; the different software components must be delivered. So, this is the system which is both hardware and software.

The system must be installed at the customer site, the soft and the hardware let say it exists or maybe you can have activity here to develop the hardware. Then, software components have to be developed. The user manual has to be developed and the training programme has to be carried out. For the system installation, we need to identify the requirements, analyse them, outline the design, detailed design, integrate the system, test, deliver and user testing.

For the software components to be developed need to get the requirements design, detail design, code, test. For the user manual analyse the requirements because it write the manual based on the requirements, design the manual, write the text part of the manual, capture screenshots and insert them, do page layout, then print the manual. The training program again analyse the requirements, design the course, write the manual, print handouts and then finally, deliver the course.

So, this is the hybrid approach where which is having both deliverable based. So, some of these internal nodes or rectangles or actually deliverables, and then from there these

are the activities and then we can split these into sub-activities and so on. When you are part of a project or you are the project manager, do not be surprised to see that we have work breakdown structure where each of these are activities and also hybrid approach where there are activities and also deliverables as part of the work breakdown structure.

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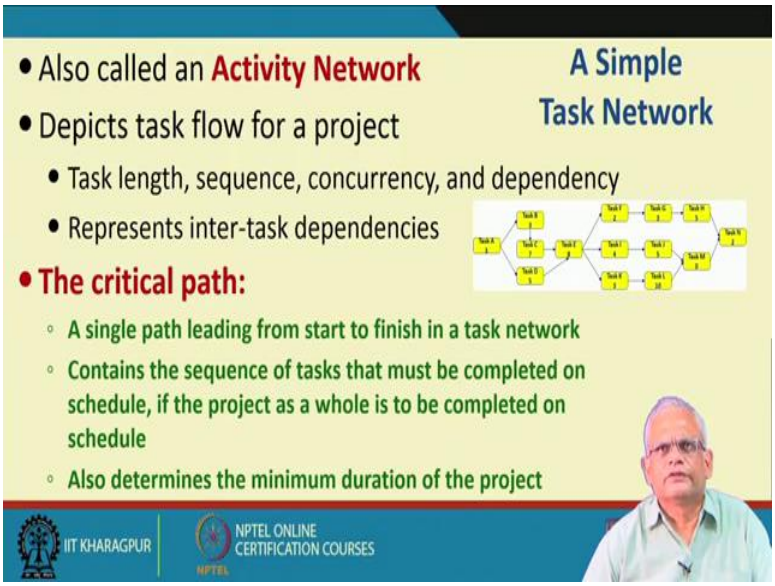

And, once the work breakdown structure has been developed we need to represent these in a task network, they are also called as activity network. These not only represent the important tasks that are present in the work breakdown structure, but also the dependency relations among the different tasks.

And, not only that we need to also identify the task duration; we not only label these nodes on the task network with the name of the task, but also we write the durations here as you can see and we represent the dependencies among the task. And, naturally here we can identify sequence which tasks need to done one after other and which tasks can be done parallelly. For example, the task over here can proceed parallelly with these two tasks, different developers might undertake these three tasks concurrently.

One important characteristic of these task network is the critical path. The critical path you can see that there are many paths here from the start node to the end node there are many paths; a path over here, a path over here and so on. There are many paths, but then the path having the longest duration when we sum up all these durations for various tasks, we get the total time needed for completion of the project for those tasks. And,

because there is a sequence shown by the dependency arrow need to do the one after other and therefore, the total duration among this path is the addition of all these durations.

And, the path having the longest duration from the start to the end is called as a critical path. A path is any a single path is any path from the start node to the end node. The critical path is the one where the duration is the longest and that is the minimum time by which the project can exceed. Along one path it maybe let us says 20, another path maybe 25 another path maybe 23. Then 25 is called as a critical path and 25 is the minimum duration for the project. The project may exceed 25, if some of the path some other tasks here get delayed, but it will not be done any earlier than 25.

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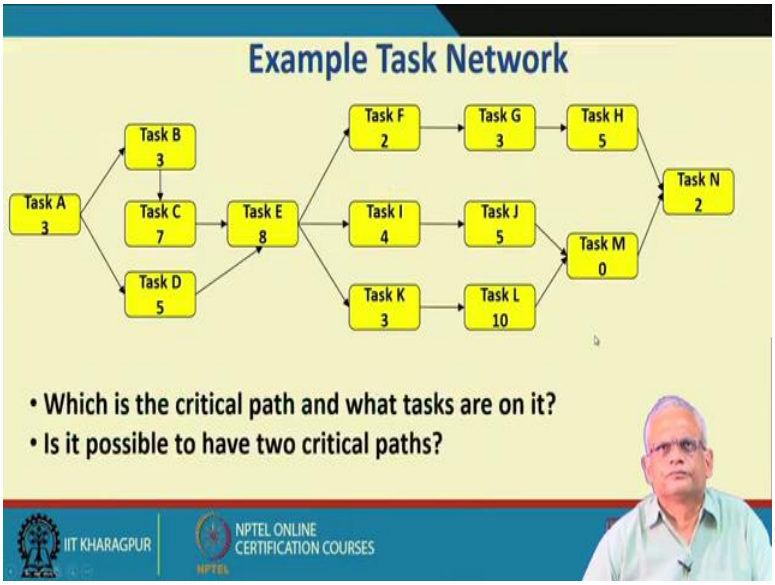

This is an example of a task network. We write the name of the tasks and the durations here. It will be possible to compute the critical path by computing by looking at various paths here adding the total duration and finding the one which has the maximum duration. But, then the main problem with this approach is that there may be many paths we miss out, may do a mistake and so on. And, therefore, systematic techniques have been developed to compute the critical path because that is a very important characteristic of a project.

The critical path is important because project manager knows that is the minimum duration for the project and also the tasks that are there on the critical path if those are

very important tasks, if they get delayed and the project will get delayed. Whereas, the tasks which are not in the critical path they may get delayed, still the project duration may not get affected. But the other question that, is it possible to have two critical paths in a task network? The answer is yes. It can so happen the two of the longest paths each have 25 or something as the duration, or may be three paths have 25 or three paths may have 30. So, then there are three critical paths.

So, it is possible that there are multiple critical paths and it is very important to identify the critical path from the project managers' perspective because he needs to monitor these paths, the tasks on this path very carefully. And for that over the last century systematic techniques have been developed ok.

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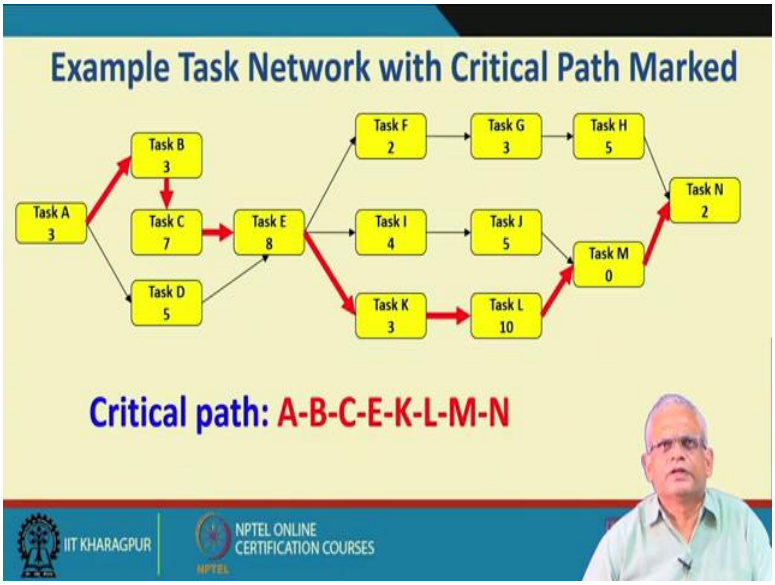

This is an example on this. If we compute various paths this the one shown on the red that is A-B-C-E-K-L-M-N that is the critical path you can compute the duration across this that is 3 plus 3 plus 7 plus 8 and so on. This will be the longest compared to the other paths that are present here.

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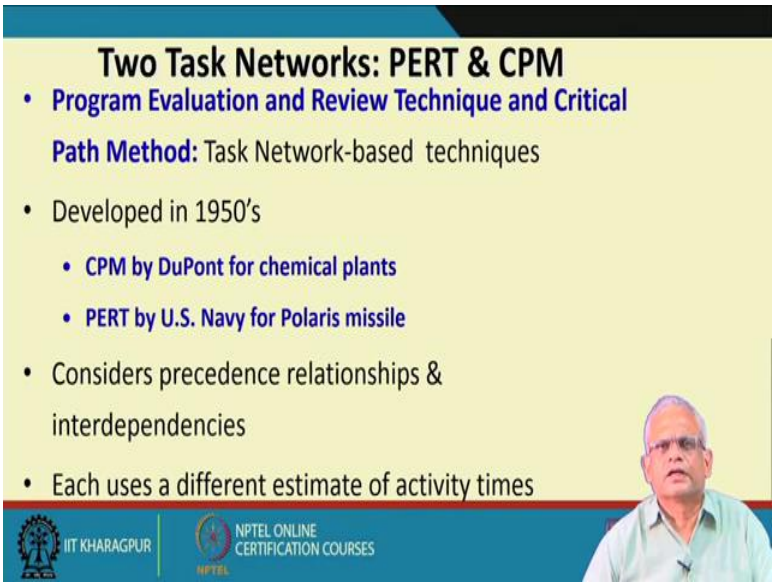

As I was saying that over the century many techniques have got developed. Two important techniques are the PERT chart and the CPM. Both of these are task network based techniques. We will see that at some point of time these were two distinct techniques have in their own uses, but now this to have merged into a single technique called as PERT CPM and these are available in many automated tools. We look at these developments and how these are used to compute various characteristics of the project we will discuss this in the next lecture.

Thank you.