Scheduling Techniques in Projects
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Lecture - 01
Introduction to Project

Welcome to all of you. So, this is the 1st week 1st lecture on the course Scheduling Techniques in Projects. So, the 1st course is primarily introduction to what is Scheduling.

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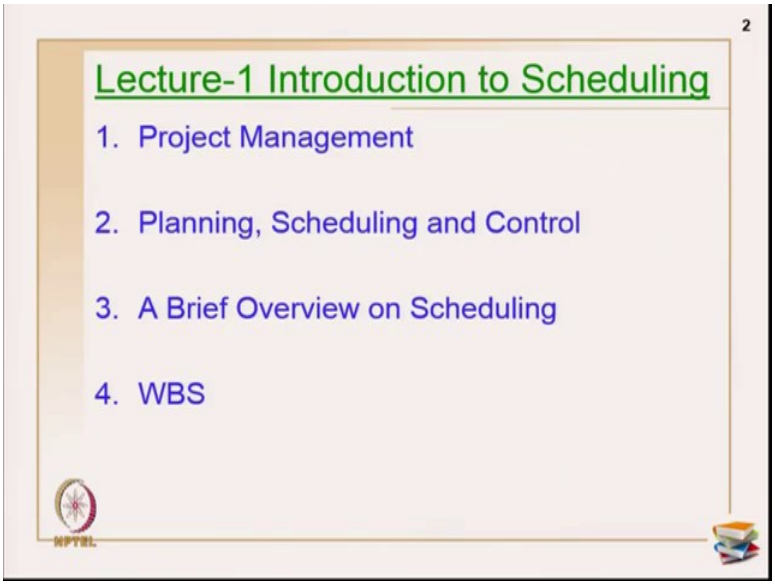

So, as we will see in this particular class there are four topics which I will be covering here. First is what is project, what is construction projects, project management and what are the three main themes in the project management which is very critical for any project for success of any project I would say; planning, scheduling and control. In there we are going to only focus on a very small topic which is only on scheduling and how to apply the different available scheduling techniques, under what situations we have to apply.

So, that is what we are going to learn in this entire course. Since the scope is focused on scheduling, so, we will also be seeing on an overview on what is scheduling, what are the different types of scheduling availability and so on and then, work breakdown structure. So, with that we will finish for today's class.

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So, now what is a Project? Some of these things may be little boring for you because this is like a basic backbone of any construction management student, but still I thought I will just freshen it up and then, so that you will have a little idea on and you will come to a same common platform. So, what is a Project? So, a project there are so many definitions all over the place and if you look at the famous PMBoK definition on project, it has a collective several stages. One unique words which I would like to underline here or every project is unique. For example, manufacturing a stapler. So 1000 staplers if you are manufacturing that is not called as a project, but the initial arrangement in which you are trying to figure out and then do primarily in how to get out a stapler, we can call it as a project.

So, every project is primarily unique. In that it requires doing something different from what was done previously. A project must have a specified objective to be completed with certain specifications. So, what is it I wanted to do? Maybe I want to build a house,. That is a specific objective I have there and certain specifications also I want I want a very lavish bungalow set up or I want a very simple home and with minimum cost into it. So, there is some specifications on guidelines into how I want to achieve my objective and there should be a specific start and a specific end date for the whole project. Maybe I want to start the house construction maybe in the next one month or so and I would like to finish it in 6 months. There may be a specific plan in everyone's mind when you want to perceive any project and you should also consume resources. Resources can be in

multiple forms; manpower materials, machinery, money also can sometimes be a major resource component when you are working on a project.

Now, if you look at the projects, so what can all can be called as a project? Projects can have a varied range. It can range from simple repair works or a medium type of works taken up by most public-private sector parties or the complex construction projects like your roadways, railways, airways you can take. So, all these can be called as a project. So, whatever is you want to classify it should have the above defined objectives, then they are all called as projects. We may also have urgent projects, secret mission projects.

So, the way we operate all these projects will vary from one to another, but everything can be called as a project.

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Now, what is a construction specific? Let us go little into construction. So far I gave a very broad definition. Now we will see what is construction. There are some typical characteristic features of any construction industry. For example, it is a largest industry in the world that nobody can deny. We are the largest employers in manpower compared to any other sector next to agriculture.

Most projects exhibit time delays, cost overruns or conflicts among stakeholders, every time no difference of opinion or maybe they have understood the project in a different way. So, there are some conflicts at each and any stage of the project with primarily with

the stakeholders and most of the projects are always boiled with uncertainty, complexity because many of the reasons can be narrowed down to lack of clear understanding in what the client requirements are, apart from the real complex nature of the project itself. So, these are the characteristic features of any construction industry you can talk about. Apart from there are other issues like environment situations, then unskilled labors in the in the industry, all these enhance the complexity and the problems which we face in construction industry.

Now how does a construction project start? So, the construction project generally starts with a project owners desired to do or perform something it can be create and for example, if it is a government project, it can be even created something like an Airport project or something for if it is a private party it can be set up in apartment projects. So, it can vary from people to people, but there is primarily a desire to do something. And success of the project lies in how best the typical two parties apart from the client or your designer and the contractor and how they have understood or perceived completely the owners' desire and they have implemented in their own design or in construction. There lies the complete success.

So, if you look at project management in construction industry or what we call it as a construction project management, it is primarily a professional practice of planning, scheduling and controlling a finite number of resources to achieve a set of goals. So, very simple definition we have, but when you start working on your project you will understand this is really complex in a construction environment.

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So, with this background now we will see where we are, right. Now, let us just give a glimpse on why is it so complex right now, ok. So, project management in the past 50-60 years and the project management done recently in the last 10 years maybe if you want to look at. So, I just wanted to just list out what all the projects have happened, construction projects has happened. If you look at the traditional project I have given a name called Traditional and Modern. It does not mean the management techniques were traditional and modern, it only I wanted to say the timeline with which these projects have happened.

So, if you look at few examples maybe India Gate, Qutub Minar I am just taking examples in and around Delhi only. India Gate, Qutub Minar, Red Fort, Lotus Temple, Rashtrapati Bhavan, so you can see so many examples which had happened in the last 50 years back, ok. The current projects if you look at Akshardham temple, Delhi Indira Gandhi International Airport, Delhi Metro, Yamuna Expressway very successful projects way I can list out on the other extreme also. So, how was the project management differ in those days compared to now? In those days there was a rigid environment. They took so many years for completion maybe they did not even have a proper mechanism to look at time overruns, cost overruns impact of all these on to the projects. There was one deciding authority and the entire team had gone ahead in the same way.

Now, we have many challenging environment. If you want to even the owner starts asking how much, why are you delaying the project, I want the project in one year. So, now the knowledge is like spread across a whole community and so the environment is very challenging and everybody wants to build something unique compared to others and they wanted to be in the name fame. So, all these have created the challenge in the environment. So, there is a changing trend set now and owners also want more and more in these days. In the earlier days people always have worked in silos so which implies somebody has told me what I have to do. So, I am only very focused with that alone. I am not worried about what x y or z in my team are doing at all in the project.

But right now people are very curious in knowing what others are doing, so that they can also share ideas, share their tasks or they can get some you know inputs from them, they can also share their outputs to others. So, there is an integrated project delivery sort of an environment which is still existing in these days I would say. So, the one advantage I would call in the traditional project management methods are the entire team was sitting in one place close to the project site or in and around in the project site till the project was completely done which is primarily we call as colocation, but right now the entire team is most of the projects you will see this is a common scenario. They are spread across the entire globe and they primarily work, try to operate using clouds, share their models using clouds or they send through emails whatever mechanism.

So, primarily the face to face communication, the real constraints which are faced by the people are not really understood by the team and there is a lot of issues there, but that is how the today's environment has to go because with the technology fast in pace people do not have the time to travel to one place to another, sit there and do nothing other than focus on the particular project because they want to do multiple projects at a one time. So, and the list goes on and, but just comparing on what happened 50 years they were also successful projects in those days and why still project management is really getting into very challenging mode. I just thought I will just put down all these points.

So, primarily this is what is a current scenario right now. The owners want more and more. The scheduling technique was available 50-60 years back were not enough at all right now. So, we wanted more techniques, more solutions, more challenges, more innovations. Obviously we have to keep the project management to the latest trend as with the market.

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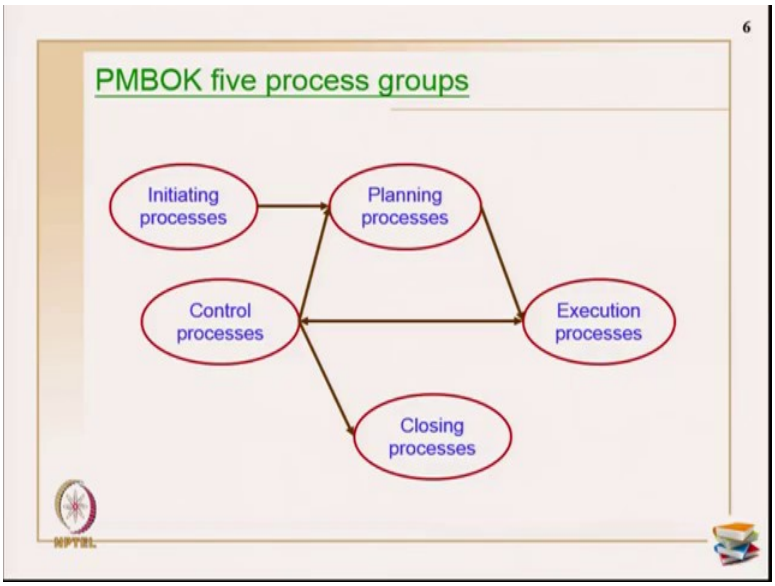

So let us start looking. As I told you the scope of this entire course is towards scheduling. So, let us move more on into the scheduling part. With the last few slides you would have understood the planning, scheduling, and controller are the three triangle of any construction projects. So, this is a PMBoK Five process groups. It is a very simple diagram. I thought I will just showcase this to continue with my team. First you have an initiating process and then there is a planning process, then execution and control. If you see here planning, execution, control itself is a cyclic process and the execution, control is also a cyclic process. You would see that there is a double arrow mark for the same and then there is a closing process.

So, this primarily emerged from the PDCA cycle on cyclic improvements and innovation. So, that is the main idea behind this. So, planning process it is like it is dominant all through even until control phases. Planning is like a first step and it is a continuous step which runs all along the construction till execution and stops. Then next comes execution. Execution primarily involves all facets of your construction management starting from time management, cost management then you have contract management, safety management, quality management, human resource management, communication management. It has so many issues to coordinate in the execution process and the control processes are primarily in terms of how best you can manage your time or cost and bring it back to control suppose if it has slipped beyond your control or something. So, that is primarily your control aspect.

So, as I have explained here, so scheduling is one aspect of the execution process which we will see little more in detail. So, now moving on into little idea on what is planning, scheduling and control. Obviously all three has to go together, but we are only going to focus on scheduling, but little idea on what is planning and scheduling it is essential for us to move ahead. So, what is planning I have drawn a small cartoon over the top.

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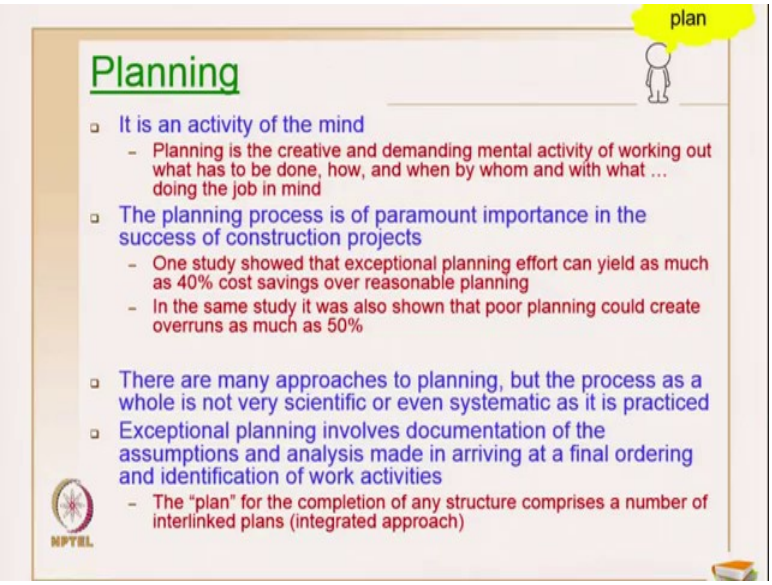

So, primarily it is a mental map with which a person has in his mind. So, which is like if I have to do this say everybody even if you want to go out for a party you think about what to do what dress to wear the when should I start at what time should I go there what is the mode of transport for me. So, there is sort of a mental map everybody has in their mind and if you will see this in day to day activities in your in your life.

So, planning is generally an activity of the mind and planning, there is a definition given. It is a creative and demanding mental activity of working out, what has to be done, how, when, by whom and with what resources. So, primarily it is doing the job in mind. You do so many iterations in some literature people also say it is a mental iteration which is not shared, laid down or drafted out, but the iteration goes on. Is this feasible or that is not possible because I have to reach in time, I cannot use this.

So, that mental mapping is always worked on in somebody's mind that is primarily a planning process. I have brought it out for you the planning process is of paramount importance in success of construction projects and there is statistics that was quoted in

the book. One study has showed exceptional planning effort can yield as much as 40 percent cost savings over a reasonable planning. In the same study, it was also shown poor planning can create as much as 50 percent of overruns.

So, if you have a proper planning obviously you are going to see much benefits in the downtime of your execution part and if you have not done a proper planning, obviously you are going to end up in time cost overruns, whatever, then you are going to have a failed project in a way. There are many approaches to planning and each person can follow their own convenient level, but the process as a whole is not very scientific or it is not even systematic and as it is practiced in these days and exceptional planning also involves lot of documentation, or assumptions, analysis made etc in order to finally arrive at the identification or list of work activities.

And the plan also comprises of a number of interlinked plans. For example, quality plan, safety plan, human resources plan. You may have so many plans and sometimes it is better to have interlinked plans to for an integrated approach.

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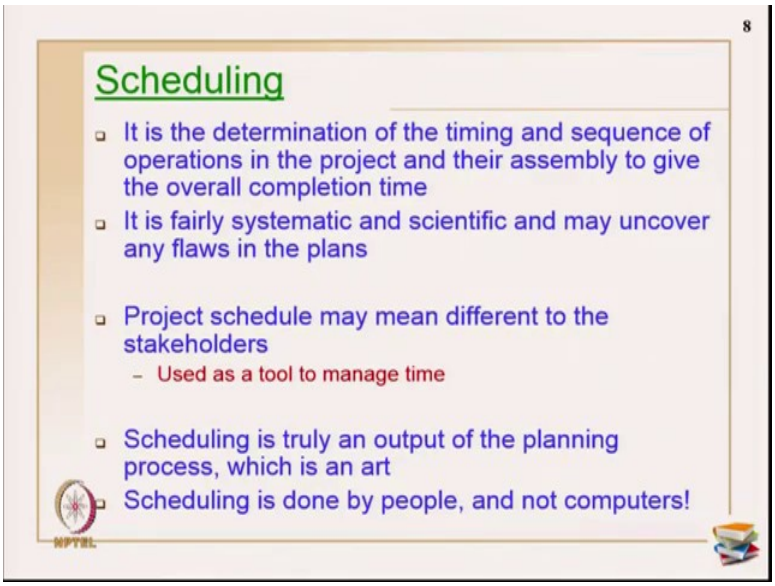

So, next so first we have seen planning, the next is scheduling. It is determination of the timing and sequence of operations in the project and their assembly to give an overall completion time. So, some people they also use like a formula. They say scheduling equal to planning plus time, but I do not want to put it exactly in a formula mode. So, it

is primarily adding duration in order to uncover all your flaws in the plans in order to have a systematic fare through of your planning process is primarily called Scheduling.

So, scheduling is fairly systematic and scientific and can also uncover any flaws in your plans and the project schedule may mean different to different stakeholders, but generally it is used as a tool to manage your time aspects. So, whenever you talk about scheduling, it is only the time management I am going to talk about in this. So, scheduling is truly an output of the planning process which is generally an art and it is never done by computers and it is only done by people. Do not think I have a list of activities, relationships and durations. I am just putting it onto the computers and the computer gives me an output scheduling is done. It is never done by computers and human intervention is always required and you need to know what is the flow, how is it have I done a mistake somewhere. So, scheduling is obviously done by a good scheduler.

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Next Project Control. So, the minute control happens I am only going to talk about planning your project schedules, scheduling process and you are controlling the project schedules. I am only going to talk about time management in the planning scheduling and control. So, when I am talking about time controls, so construction projects rarely go as per the plan. Either it goes ahead or generally it goes as per the plan and sometimes it also goes beyond the time durations .

So, the project control it is a continuous process which has several steps and the few steps are measuring the work progress. So, primarily you have to show if I am working on an activity which is taking like 10 days of duration. On the 5th day you want to know how much of the work has been done progressed and how much is supposed to be executed, how much has been really executed on ground, what was a reason, what is a root cause for the delay accelerated work etc. So, that measurement has to be done first and then it has to be compared with the baseline schedule or budget if you want both and then find any deviations.

If there is no deviations, then fine you can go ahead with your processes. Suppose if the project has taken too much of a delay or it has not even started on the on maybe on 5th day or 6th day and you are just waiting for something, some approval or some materials to come and you are just waiting, then you have to analyze what is a reason for the delay, how to uncover those delays or what is the corrective action you wanted to do and if you are starting on after 5th day, then how much you can finish in the remaining 5 days, do you want to have more resources and how do you want to finish it in the 10 days plan. So, all these are primarily a controlled process.

So, control process is nothing, but it is not just measuring what has happened and what is to be plan, it also talks about corrective actions measuring and so on. So, it is a very broad theme. I would say on the control. So, project control generally refers to time and cost control only. Other controls are also available like quality, safety, etc. which has to be dealt in a very different manner. Only time cost control is really easy to monitor and execute in the sites and next is Schedule Compression.

So, whenever if your schedule has slipped, then you may have to use some techniques which is called Schedule Compression. Compress your schedule or you do fast tracking, time cost tradeoff, another issues fall in place there.

So, now let us move on into Scheduling again. I am just bringing the five process groups which I have shown you earlier. So, I have planning, in the execution part I am going to talk only about the scheduling part and next is a control processes. So, since I told I am only focusing on scheduling, so we are going to see on how to do the little partial plans on building up a schedule and then we will stop with the scheduling techniques available.

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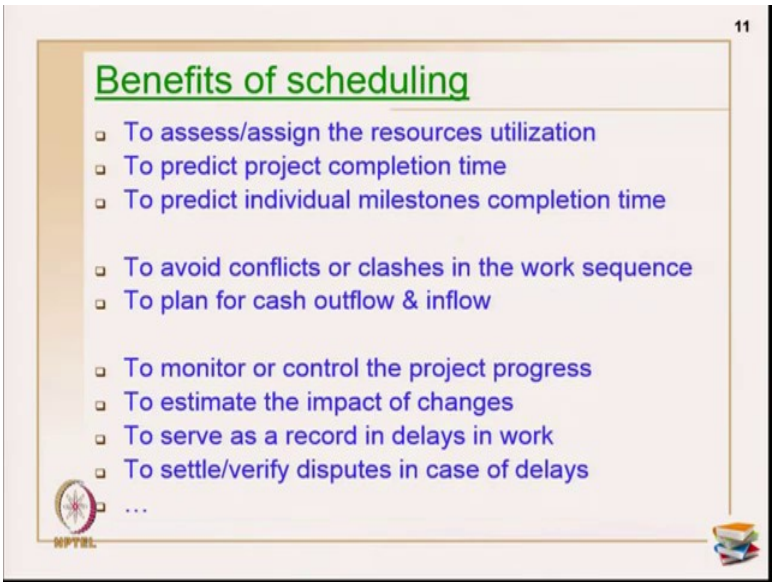

So, now what are the benefits of scheduling? Why should I do scheduling? There are so many benefits available and the list like goes on, on and on. Let me talk about from a planning point of view. So, there are several views I have highlighted in different forms. I should know how much of resource has to be assigned in the project, how many resources has to be consumed for activity A,B,C etc. So, only when I know this, I can always build my schedule. So, primarily this helps you to assess or assign the resource utilization. Anyway while we are discussing on how to derive at activity durations, we will also see little on the resource combinations how it is really playing a major role in arriving at your durations. Next is to predict project completion time. Only when you are putting individual activity time durations and then you are having a very large network diagram, then you will really come to know what is the time completion for my project. Is it one year, six months and so on that curiosity everybody will have on the project management side. The next not only on the total project completion time and somebody really wants to also know what is the individual milestones completion time.

Suppose if I want to build a very big lecture hall complex or something. When will the classrooms be ready, when will the auditoriums be ready, when will the labs be ready, so there are several milestones in the whole project and somebody wants to know when are these milestones can be achieved. So, individual milestones also you will come to know when will they be achieved. The next is to avoid conflicts or clashes in the work sequence as we have seen the in the scheduling itself. When we are assigning your plans

with the time duration, you also try to uncover all the flaws or the mistakes you do in your planning process itself.

Some unachievable plans whatever you have methodologies, you have all get uncovered when you are putting it on in your schedules. So, it can also avoid conflicts clashes later on. If you do not have a proper scheduling, it may it may later on pop up when the excavation when the execution is going on. So, it can also help you to avoid conflicts or clashes.

The next important thing is I can also know what is my cash outflow and what is my cash inflow, when all my cash is spent on various activities and when will I get the payment, how much work I can I can complete till that date, so that I can get the payment back. So, I can easily plan or calculate or anticipate my cash outflows and inflows. So, this scheduling document is used for multiple purposes. The next as we have seen in the control slides. So, to monitor and control the project progress obviously how much has happened and how much has to be happen and there is the gap between the as planned and the as execution. Primarily it helps you to monitor to estimate the impact of changes. Suppose a owner in the midway of an execution says certainly that he does not want X or Y part in the whole project and he wants to be changed something, then you should also you can also easily come up or arrive at what is the change because of a small segment modified or a new segment added up in. So, easily you can estimate the impact on changes on a projects. It also serves as a record in terms of delays in the work. So, sometimes when the delays are there, is it an owner related delays or contractor related delays and is it like shared, is it on the critical path, is it on non-critical path. It also helps you to record.

To settle or verify disputes in case of delays which is what I said. So, suppose if the owner and contractor both have a mutual misunderstanding saying that this is not from their part the delay has happened or the other party has to take care of all the penalty, then this document on scheduling, the initial scheduling helps in a way to settle all the disputes and verify the case properly and the list goes on to the benefits of scheduling.

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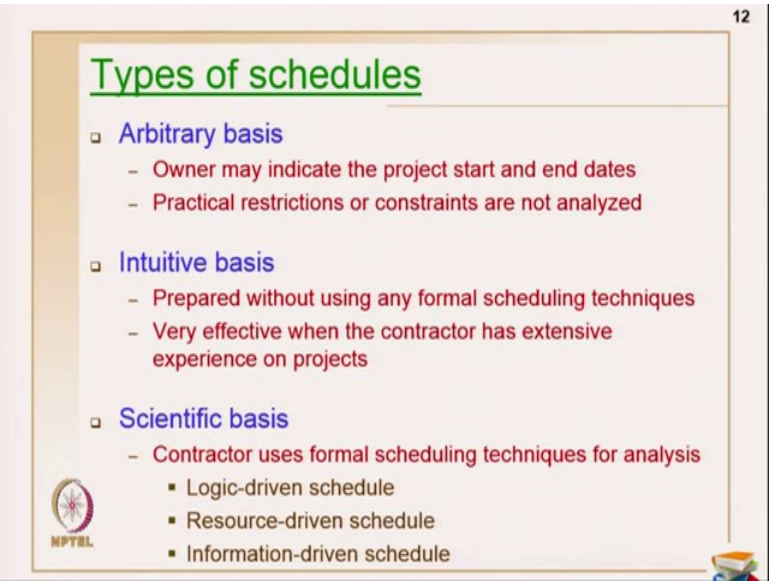

Next Types of Schedules. There are so many types of schedules. Anyway when we see the duration estimation, we will also have little idea on how that individual activity duration have emerged and also how these names have come in. We will see little more at that time.

So, types of schedules. there are broadly three types in the arbitrary basis. What happens is the owner just indicates a project start and end dates. He says the project feasibility time of start will be next after one month and the end date will be after 6 months. So, he just arbitrary indicates. So, the real practical constraints are not at all analyzed in these arbitrary basis because it comes as an urgent mission or it comes as a compulsion or pressure on the person. So, these type of schedules we call as a schedules are drained out of a pressure from the clients.

The next is intuitive basis. So, these are all prepared without using any formal scheduling techniques and very effective when the contractor has extensive experience on projects. Suppose if the contractor has worked on a project and he is supposed to work on a similar project in another 5 or 6 years. With his experience vast experience he had in the previous project he can always use his intuitive basis to in order to fill up the entire schedule. So, those type of schedules we call it as an intuitive basis.

The next scientific basis. Here, formal scheduling techniques are used for analysis and for schedules and the contractor uses methods for scheduling and he executes it. So,

fairly a scientific basis which is what we are going to see right now and here there are three types of schedules which researchers have identified. There are again many more types, but we are only going to see three. One is logic driven schedule; the other one is resource driven schedule and the third one is information driven schedule.

So, what is a logic driven schedule? As the name implies the logic of the construction derives the schedule. For example, after foundation then only you can do your columns or beams and slabs. So, that logic primarily derives your schedule and that is primarily called a logic driven.

The next is resource driven. Suppose I am having two or more crews for doing a particular work. So, based on the resource crews I can always do the work in parallel and are based on less number of our scarce resources that I have. I may have to sequentially execute the project. For example, there are three activities which requires the same resource. So, all these three activities will be done one after the other if there is only one crew with me, but if I have more crews, maybe two crews, then two activities can be done simultaneously or if I have three crews, then all the three activities can be done together. So, those are primarily the resource driven schedules and the last is information driven schedule. We have to define many more terminology to arrive at the word called Information.

So, information is nothing, but height of the structure or width of the beam reinforcement spacing cover to the reinforcement. These are all called information in a project. So, this is these information drive the schedules. So, primarily this is part of your design phase of the execution. I would say we have several design phase examples to cover on information driven schedule, but never assume that it cannot be applied in construction as well.

If you have information driven data in construction, it can be still applied in construction phase. So, in that way the first two logic driven resource driven I may be planning to share more examples from construction sector and information driven primarily from design phase of the projects. That's how I am planning to go ahead and these three schedules we will be seeing in elaborate.

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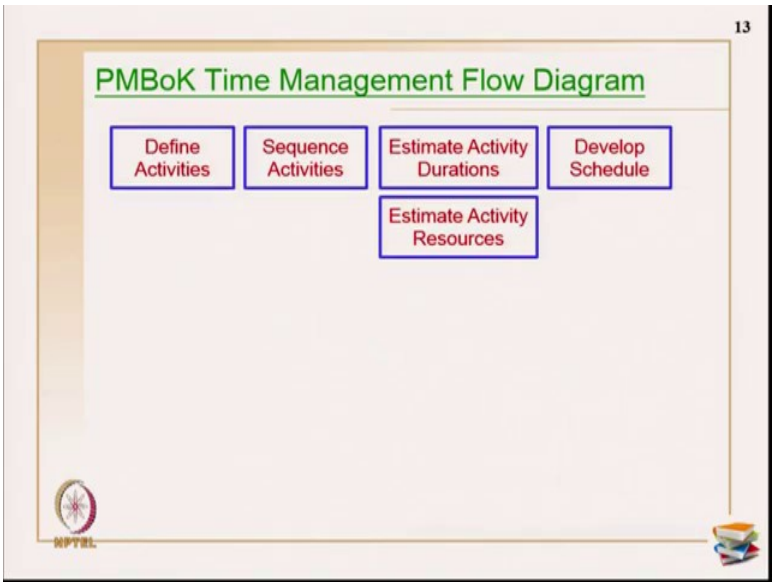

Now, let us come to the PMBoK time management flow diagram. So, now actually we have moved on in to what is scheduling. So, as I have been telling you scheduling is nothing, but planning plus time. So, planning there is lot of homework to be done as to what is the scope of the work, what all has to be done, what is the critical milestones in the entire project, everything is decided in the planning stage itself and then you add duration sequence to the project sequencing with the help of relationship between the different activities and then you move ahead. So, if you look at the time management flow diagram, there are few steps given in the PMBoK. One is define activities. Why do we need activities and what is an activity definition of activity and etc. we will see in the next lecture, but since the name has come right now I will just give a small example.

An activity also has a similar setup as a project. In a very simpler layman language if you want I can tell. So, project and activity both have similar terminologies in the sense both are having a definite start, definite end, both have a specific objective, both the case they consume resources, then why project suppose if you want to think about an auditorium project it is very difficult for you to monitor and six month project in one go.

So, these activities are nothing, but the breakdown of the project into smaller groups, so that you are able to perceive the project and you are also able to control, you are also able to imagine all the assumptions and then monitor the whole project. In that way we

call it as activities and hence we have excavation, foundation, column footings, shuttering, de-shuttering, we have so many activities from that point of view.

Then the next is sequence. The relationship between each activities, once you determine that, then you can easily get the sequence whether I am having all independent activities or dependent activities, what is the sequence between those activities can be really seen. Then the next is Estimation. So, primarily I need to have as I told we are seeing on scheduling. So, it is time aspects.

So, time aspects can come from two forms either you fix the duration and decide your resources or you decide your resources and then fix your durations. So, both has to go in parallel. That is where I have written it like this. So, one is called duration driven schedules or it is resource driven schedules whatever. If I have 5 crores, my duration of the activity will be different. If I have to finish my activity in 10 days, then what is the crew size I have to go ahead? So, that is primarily the two differences we have and then you develop your schedule mechanism.

So, this is a broad flow or diagram which we have for Time management.

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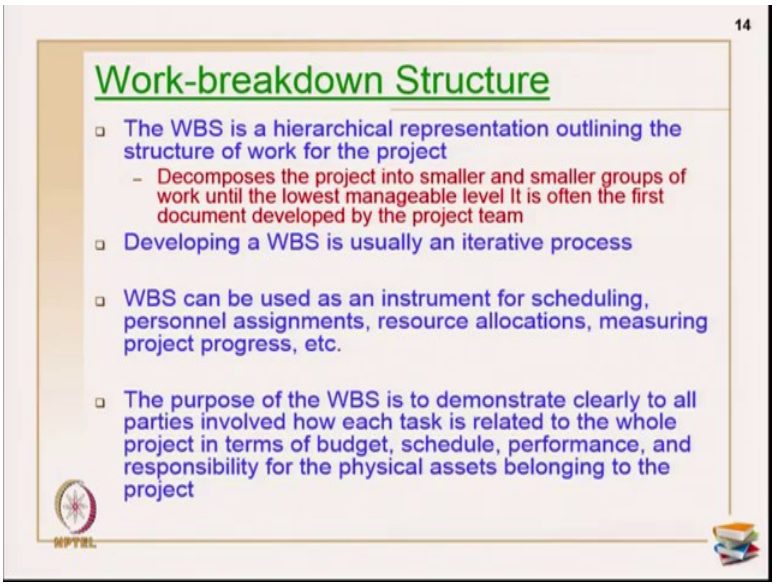

So, now first task define activities in order to arrive at a list of activities, there are some techniques available. The very famous technique in construction is your work breakdown structure. Some people say this part of a planning tip process, also some people say it is a

part of a scheduling process to arrive at a list of activities. So, I thought I will cover this for today and then in the next lecture we will see the definitions of activities, relationships, durations for each activity and so on in detail. So, Work Breakdown Structure the famous short form is WBS. So, what is this WBS? It is a hierarchical representation outlining the structure of work for a project.

So, the smaller and smaller groups of work until the lowest manageable level often it is called activities. That is primarily called as a work breakdown structure. In general, it is an iterative process. Why? Because as and when you start developing a WBS and the scope of the work is also determine along with the along with the WBS generation, so at 10 percent start of the project you have very little information on the project, then after 20 percent start of the project you have some more information coming in, some more players coming in, some more scope of the work gets clarified, then you may have more data coming in. So, then you may have to try, modify, do this and this. So, this keeps on evolving and hence it is generally termed as iterative in nature. And WBS can be used as an instrument for scheduling, personal assignments, which implies human resource assignments, resource allocations and measuring the project progress etc. So, it is also used in a way for doing that. And the purpose of WBS is to demonstrate clearly to all parties involved in the project, how the each task is related to the whole project in terms of budget, schedule, performance, responsibility of who is going to execute the work or the physical assets of the whole project.

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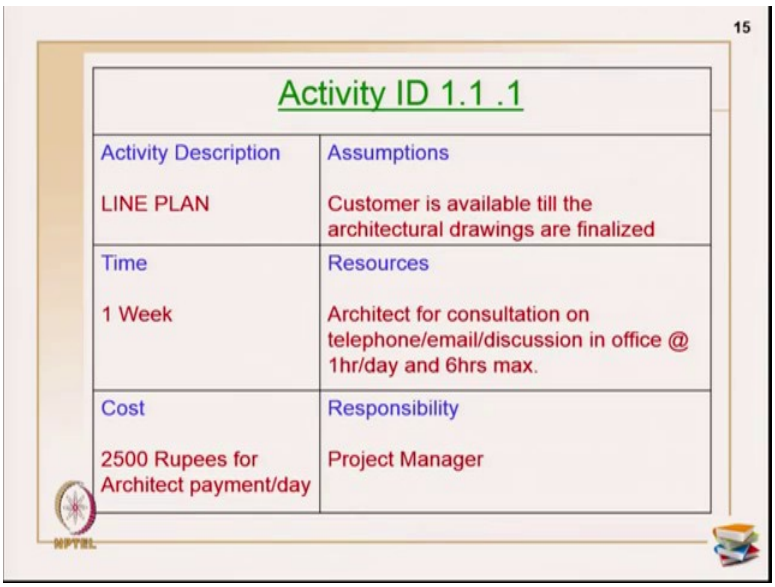

For example I have given an example. This is one activity example. So, at the end of a WBS somebody has to build up a chart like this, not necessarily in the same form, but these are the information which goes in into that activity. Activity ID, this is primarily a housing project and the first activity in the housing project is called Line plan. So, what does it Line plan all about? So, description is line plan. Assumptions made. What is the assumption? The customer is supposed to be available till the architecture drawings are finalized. That is an assumption made for the line plan execution. Time required approximately one week. Resources how many people you want? One architect is enough for consultation and even that person need not be available permanently, maybe one hour per day is enough, maximum of 6 hours is more than sufficient for the whole work and the discussions can happen through telephone, email, discussions and what not. So, what is the cost consumed for this activity? 2500 rupees we have to pay for the architects per day. That is the whole cost part. And who is responsible to execute this line plan? It is a Project Manager. So, who is in-charge for executing this work? It is a Project manager.

So, like this we have to derive for each and every activity that naturally comes with all the assumptions you are putting in and you are actually deriving and decomposing your project into various levels.

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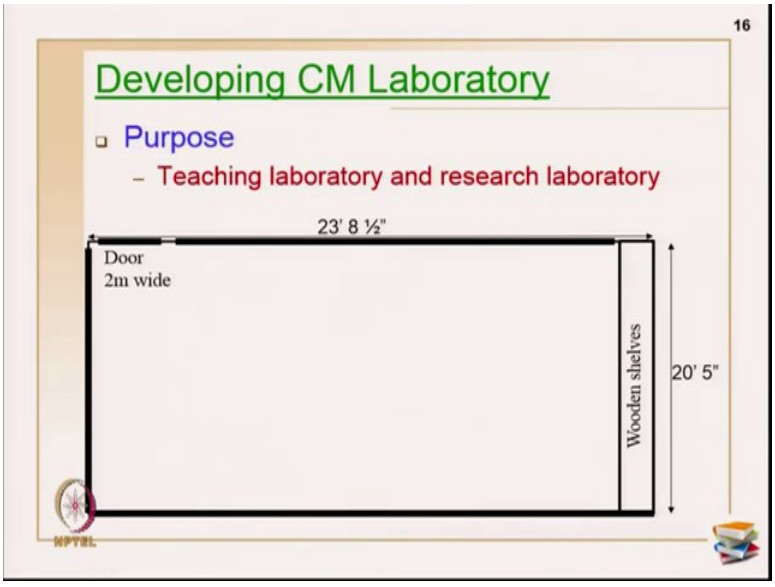

Now let us see an example also. This is a simple example of developing a construction management laboratory. Actually this was a live example which happened in our premises, but I have modified the example just to showcase the problem as such. So, this is a room. So, the room was not functional for few years and this was supposed to be taken up by the construction management group in setting up their laboratory. So, actually, what is the initial scope of the whole work? This has to be developed for a teaching laboratory under research laboratory. So, teaching means teaching for computational software for students, PG students and also as a research laboratory for the PhD students and MTech students. That was a whole scope of the work, and the dimensions of the project are given. So, there is a door that cannot be replaced or shifted. The doors places is fixed, dimensions of the room are given. So, with this the project started.

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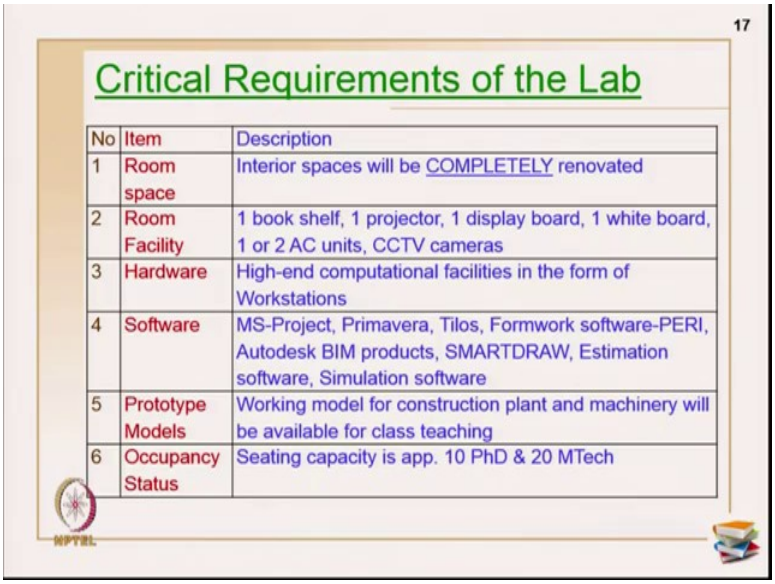

So now what happened? So, the critical requirements of the lab are listed down. So, somebody started noting down what are all required to be done with the given scope. So, it has to be functional. The functional features of the space of the rectangle space is supposed to be served as a computational lab function. So, that has to be set up. So, the room space, room interiors, room facilities, hardware, software, prototype models. So, it is an outline and two or three meetings happened and some lists came from the from the user groups. User groups were the student groups and the faculty groups and some list came emerge together which I have just written down.

Room space, interior space will be completely renovated because it was very old and did not have the ambience for students to sit and work and for a class to be conducted. Room facility - One bookshelf was necessary and people thought there should be a bookshelf or somebody to refer books and then know work on their projects and research. Projector for teaching purposes, display boards for a putting notices and so on. One whiteboard, 1 or 2 AC units for so many people and computer sitting in the room they wanted 1 or maybe even 2 AC units and CCTV cameras for security purposes. Hardware - So, high end computational facilities maybe in the form of workstations were planned and proposed. Software for example what these construction management group generally use. So, MS project, Primavera, Tilos, formwork software, so all these were. So, the list went on and as and how many where they wanted to implement that many software for installations.

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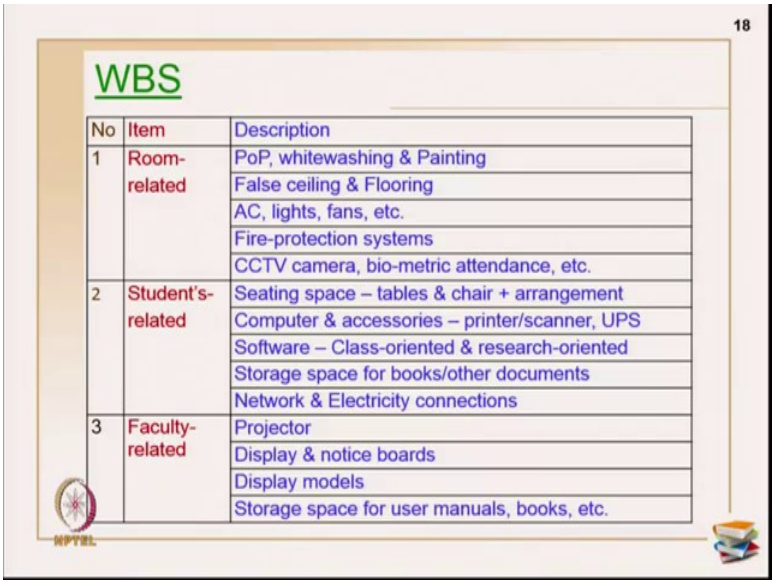

Then prototype models also because it was supposed to be a construction laboratory. They also wanted working models, may be a small backhoe or a crane set up showcase to the students and teach in the class as well. So, the ambience was also planning for a display models and next is Occupancy Status. So, seating capacity approximately with the current situation we plan for 10 PhD students and 20 MTech students who work in the projects should be able to sit very spaciously and without less disturbances they have to sit and work in their labs.

So, after the purpose was drafted out, room was given after two or three meetings had happened. The first cut idea on what is a requirement for the lab emerged, then what happened was so this I am highlighting it because I am going to explain this in detail. So, seating capacity was 10 PhD and 20 Mtechs. Then, the WBS structure started evolving which should define the scope of the whole work.

Keeping these client the requirements of the students and the users. So, WBS I thought I will just put it for you. So, I arranged in under three categories; room related, students related, faculty related. Now, WBS as I told it is a hierarchical tree form and how many ever levels you wanted to go, you can still go and finish. There is no harm and there is no constraints as hard and fast rule as to how many levels you have to go. Is it three levels or four levels or what is the lowest level of the base of WBS? There is no hard and fast rule on anything and how much you are comfortable in building up or in the hierarchical breakdown, you can still go ahead with that.

So, I have purposely brought a non construction example in order to showcase WBS can be done in any form. It is not necessarily that project, then system, component, sub components, you need not go in some hierarchy. You can go in anyway, but the work the next level or your lower level of WBS should always be when you are adding up, you should always supplement your upper level of the WBS that you should keep in mind. For example, under the item number one whatever I have highlighted it should all completely describe the item called room related, so that you should ensure that it is happening and you can go in any order or level you wanted. So, from that angle, so what do you want in the room related. So, room related tasks were all envisioned. So, primarily it is Plaster of Paris or POP. So, the room interior was very bad. So, there should be POP, whitewashing, painting was essential. False ceiling was required in order to avoid too much of current electricity issues. So, false ceiling was proposed. Flooring was also proposed to be modified, then AC was planned. So, AC units and all those lights, fans etc., fire protection systems, CCTV camera, biometric attendance, all these for security purposes in the whole room because so many of inventory were coming into the room space. So, all these were proposed in the particular room. Students related items. So, seating space. First is they need a seating space, a table and a chair to sit and work. Arrangement of tables and chairs was also an essential criteria there. Then computer, computer accessories, printer scanner that is optional and UPS was there.

Software- there are two categories in software. One is a class oriented software or the basic software I would say and the research oriented software which only few students will be using in the particular lab that was also planned for, then storage space for books or other documents for the students to come and work refer something, then they need not carry it all the way for their lunch and then come back. They can leave it in the same lab and then go. So, they needed a small storage space for storing their daily routine items and documents which they were working on. Network connections, electricity connections, all these were primarily students related activities.

Then, faculty related, because it is supposed to be a teaching environment. So, the other user who will be coming into the lab is a faculty. What are their items? So, primarily projector because teaching has to be done. Display boards, notice boards for announcing announcements and instructions. Display models also for teaching in the class to aid in teaching in the class. Storage space for user manuals, books, records thesis only for faculty to use and so on. So, these are the various criteria and with this I would like to say the scope of the work has really you know been identified. This is a stage 2 or level 2 of the items which were drafted. This is how the WBS starts to evolved.

Now, as I highlighted in the previous place on the seatings space, tables and chairs. Now, I will also highlight to show little more details. So, earlier I highlighted on 10 students PhD students and 20 Mtech students will be sitting in the lab or using the lab. In the seating space, primarily the arrangement matters as to how should the table size, chair positions, so that you can give accommodation to all these people.

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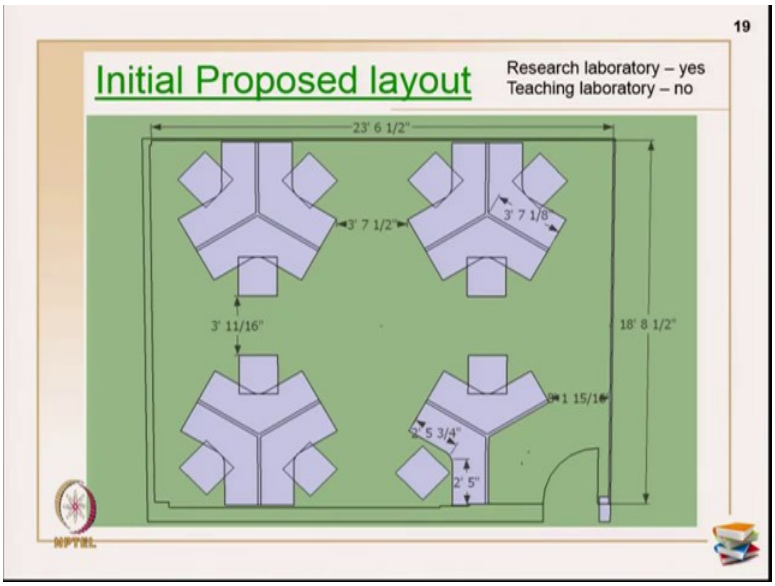

So, the initial proposed layout came out like this. Because research scholars wanted privacy from others in the sense whatever they wanted to work, they wanted a separate place for computer and they wanted a separate place for working and on their notebooks and documents and so on. So, we formed it little like a y-shaped and structure or it is like a three cubicle structure. So, on one part you can work on your computer and the other part you can sit and work on your documents. So, that was planned and hardly 11 people were allowed and positioned with lot of space and movement in and around these scholars. So what happened, it did function as a research laboratory. For a teaching laboratory, we were not able to accommodate more.

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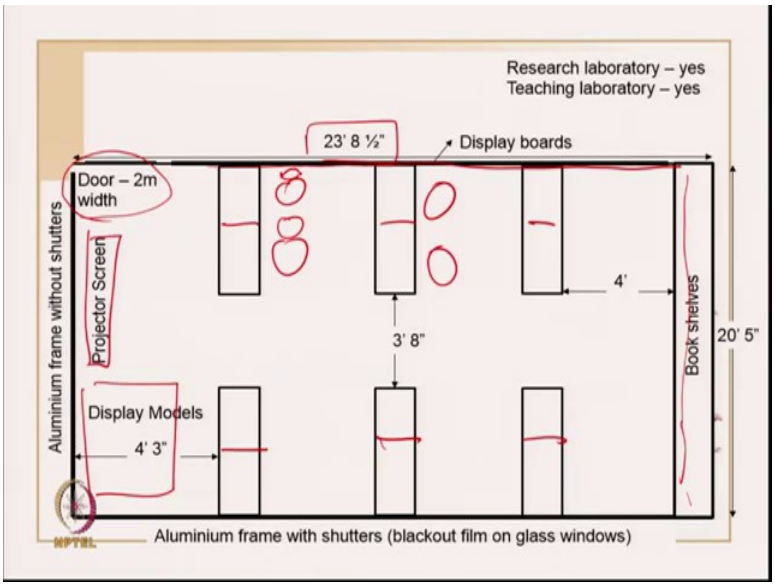

So, the next level of arrangement was planned. So, we planned like regular pattern of a classroom structure. So, there were like 6 tables because more tables could not be accommodated in. So, we proposed 6 tables and there were shutters. So, this was the general layout arrangement. Bookshelves were on the last side of the of the structure. So, this door cannot be modified and the room dimensions are given here. The display boards we thought we will just hang it up all along the whole walls. Display boards were planned and there were bookshelves on the backside of the whole lab. In the front side there was a projector screen plan. The display models were kept on one side of the whole setup. So, all provisions that we thought of keeping in the lab were all had come in. And this was planned as a two-seater or maximum a four seater when the class is going on.

So, in that way research scholars were planned as two. So, this was ideally like 12 people were sitting, 6 tables-12 people were sitting for the research purpose and when the teaching was going on this was planned to be accommodated with two seats per computer and hence, it was also functioning as a teaching laboratory. So, this is the next level of detail plans working out and then the schedule starts coming in as to how should the table size be, how should the chairs be, should we buy stools or chairs. So, all those details will go on when once you start executing the project in the next levels and so on. I thought i will just show you on this now more pictures on this.

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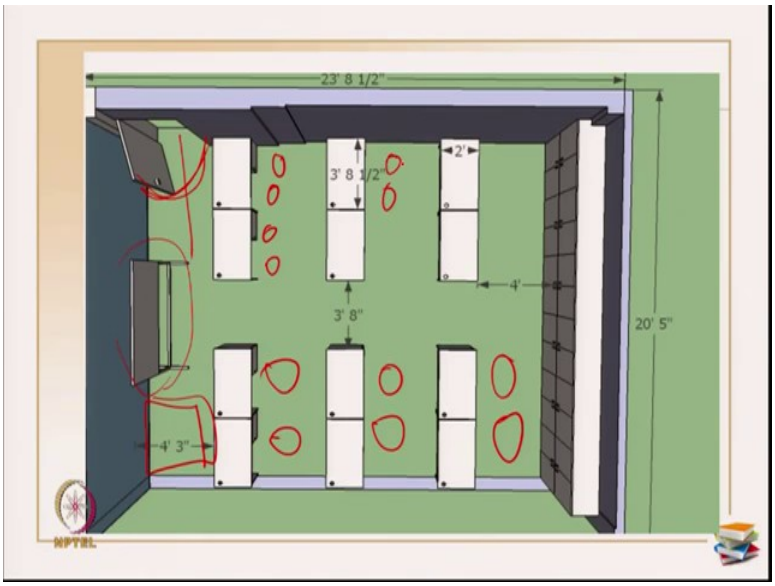

So, this was a rough cut draft. So, primarily my projector screen is lying here, display models were planned to be here and the door is supposed to open on this side for the people to enter and go and so on.

So actually, one seat for the research people to sit and when the classes were going on two people were supposed to sit in all these places, per table and one computer they will share, so that more than 20 people could be seated and had a seating arrangements. And the problem with the earlier setup was this. In this setup, even if he had a projector on one side, all students will not be able to be facing the course instructor and they will not be able to work simultaneously but as in this model they could do. So, in this even the layout and arrangement were all fine. So, these iterations also happen sometimes maybe the example is not that explicitly explaining to you what I wanted to say, but still I would like to say starting from purpose to serve as teaching and research laboratory with the funds, time constraints and all those. So, primarily the idea has to evolve. So, this was the earlier meeting, then this was the next meeting and then just for one item seating arrangements, 2-3 iterations also happened.

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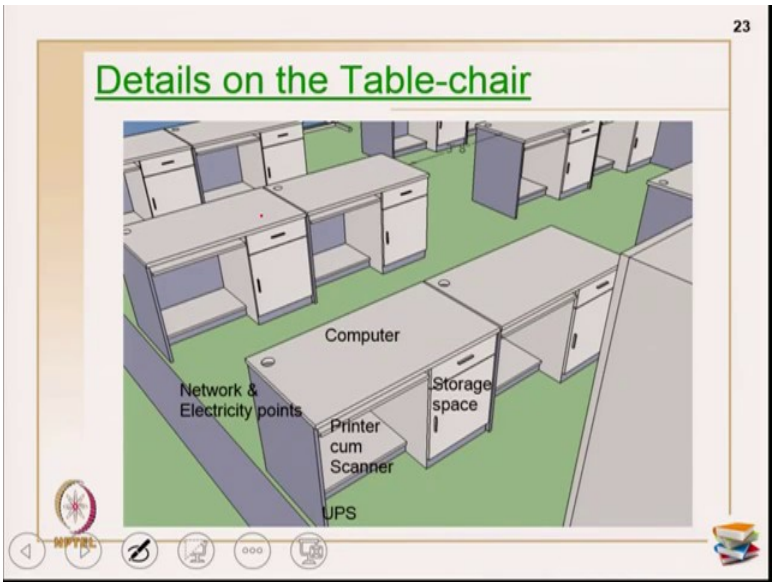

So, this is how the entire WBS process goes on. I just wanted to showcase with this example. This is another view of the same build structure.

Now, coming back to the table chair arrangement alone. So, the computer was planned on the table. Network and electricity points were plan through the walls and to the seats and it used to come below this and then for this table also printers cum scanner was planned to be here, UPS was a small provision for putting in the UPS, storage space. So, all student selected activities has been accustomed here. This I would say the WBS was able to capture the complete scope of the project, some cases it does not do because of the budget, other constraints some cases you may have to modify also and, but in this case it was able to capture the complete requirements of the students related.

So, just wrapping up for todays lecture we started on introducing what is the project, project management, definitions on the project and management etc and then we moved on into planning scheduling and control, we have seen all the three in little detail. Scheduling, as we have seen much more in depth and as to the benefits of scheduling, then types of schedules and what are the various ways of doing the scheduling. For example logic driven, resource driven and the information driven scheduling.

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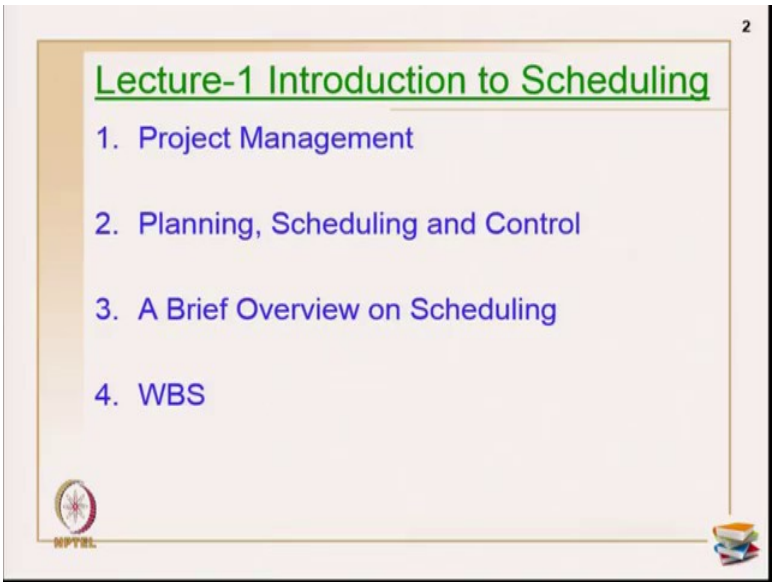

And then what is the sequence of doing a scheduling activity as such. So, first is defining activities. So, WBS is a very famous step with which you can define the list of activities without omitting or without missing any information. You can derive the complete list by using WBS and also WBS serves as a document for scope definition. It also tells you what is the scope of your entire work, that I showed with iterations. How the WBS can be evolved with the same example on developing a computational laboratory.

The same example I will use in the next lecture also to show I would say hierarchical breakdown has moved on into list of activities relationships duration among the activities scope modifications, how it got incorporated and constraints that face in the projects. So, let us see little more in the next class along with defining the activities relationships and so on. So, the next lecture is also supposed to be an introductory lecture on inputs to Scheduling only before we start the Real Networking diagram.

Thank you.