Project Planning & Control

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Lecture – 55

Lesson - 07

Emerging Trends or Tools in Project Planning

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Now, what I would like to do in this session is to actually touch upon some of the emerging trends and tools in Project Planning. So, we have basically covered CPM, CPM based techniques, we touched a little bit about on PERT, but there are many extensions to this. So, I have listed some of the extensions, which kind of or have been active in some of our work at IIT Madras. So, here we have you know I will touch a little bit upon location based management system, I will explain the concept of what it is and how it is becoming relevant today.

I think many of you would have heard a 4D Scheduling with Building Information Models. So, this is also another extension to scheduling and where CPM is getting integrated with CAD or BIM to be able to do very, very innovative things. We will talk about a Design Structure Matrix, which might be new to many of you, but this is something which we've have been exploring for a few years, I will talk a little bit about that.

I mentioned a lot about simulation during the probabilistic scheduling part, I will give a very brief introduction to what simulation is capable of. Similarly, for Critical Chain Project Management or CCPM, the approach is different from a typical CPM and we know many, many companies now go into CCPM as a method to be able to manage projects. I will also briefly touch on Lean Construction, which is based on manufacturing principles.

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So, when we go into location based planning, basically so far when we did CPM we did not take location explicitly into account. We did not talk about what is the construction path is going to be, we just talk activities and started solving activity-based times. We looked at early start early finish, we looked at resources, but actually location and spaces is also an important resource.

So, what location based planning does is, actually try to bring in the space resource explicitly into your plan or schedule and this is not very easy, unless you have appropriate tools to do it and today, tools are becoming available to do what we called LBMS very, very systematically. So, you might have heard of this technique called LSM or Linear Scheduling Method, which is primarily used for linear project such as roads or pipelines or railway lines.

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Now, the LBMS is based on linear scheduling method techniques.

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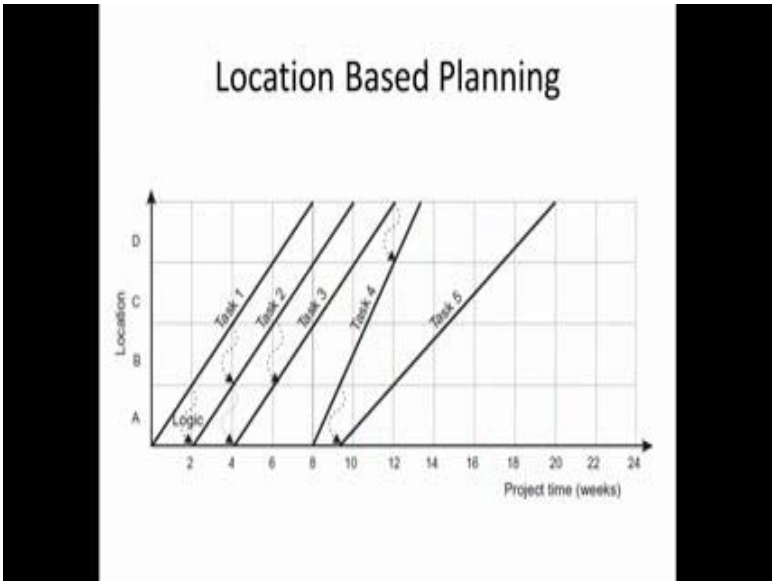

But before, so you can see this is basically what a location based plan looks like. You have location on the y axis here, you have duration on the x axis; that is time basically and each of the tasks have to go through a particular location at a particular time. So, this is what is illustrated by these lines. So, you can see various task 1, task 2, task 3, task 4 and as the task goes through a location at a time, the space relationship between tasks are also specified. So, you can see here, the task 2 has to follow task 1.

So, once task 1 moves out of space A, task 2 starts, so the space relationship is also

bound. Now; obviously, in addition to space relationship I would like to bring in any predecessor relationship, which is the part of these task which can be done using CPM. So, several of the tools today use both the space relationship as well as the logical relationship between activities to be able to do, what you will call LBMS.

Now, without tools like this, ((Refer Time: 04:03)) this is what today you know our site planners or engineers do in terms of actually taking a plan and giving, say week 1, week 2 a particular day and marking in which location, what will happen. So, for example, here your wall reinforcement will happen on these two days and they actually mark where the wall reinforcement is going to go or wall formwork on all of these days and they are going to mark, where they going to go. So, this is a very, very effective way, but it does not give you the help of a software tool or of a very structured approach.

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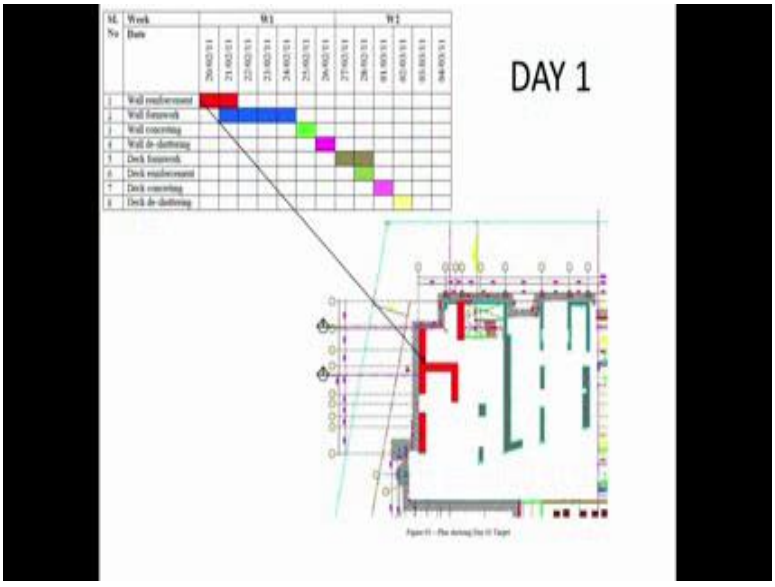

So, if you are a good planner, you might do this, but there are several limitations, specifically that is very difficult for you to keep track of things. So, here we have a much more detailed look at, what is, where the wall reinforcement is being planned and where the wall formwork is being planned and all of these. So this is probably location based planning without the modern tools of today.

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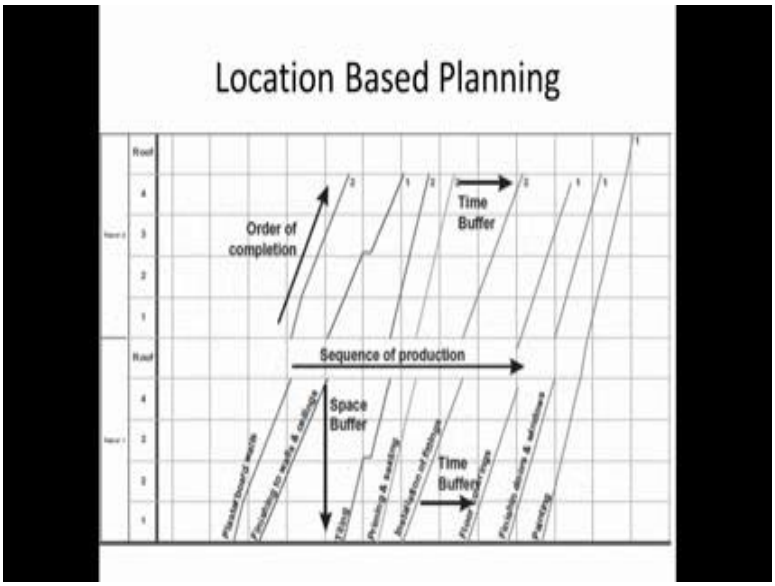

So, the modern tools ((Refer Time: 05:04)), what we explained were represented like this, but you can also have far more detail representations. So, I am not going to get into the details of several of the terminology you see here, but I just wanted to put up this slide to show that location based planning is not just a series of lines, but can be having a lot of planning parameters associated with it. So, here you can see the location now is you have tower 1, tower 2, you have floor 1, floor 2, floor 3, roof. So, what we call, this is a Location Breakdown Structure or LBS.

So, when we do location based planning, you have a location breakdown structure as well as a work breakdown structure, which have to integrate and do. And you might agree with me; that is how actually work gets done, work gets done at a location with a specific activity, so both, integration of both takes place in LBMS.

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So, here is another illustration is to how complex an LBMS can actually look and this cannot be done without the help of appropriate tools.

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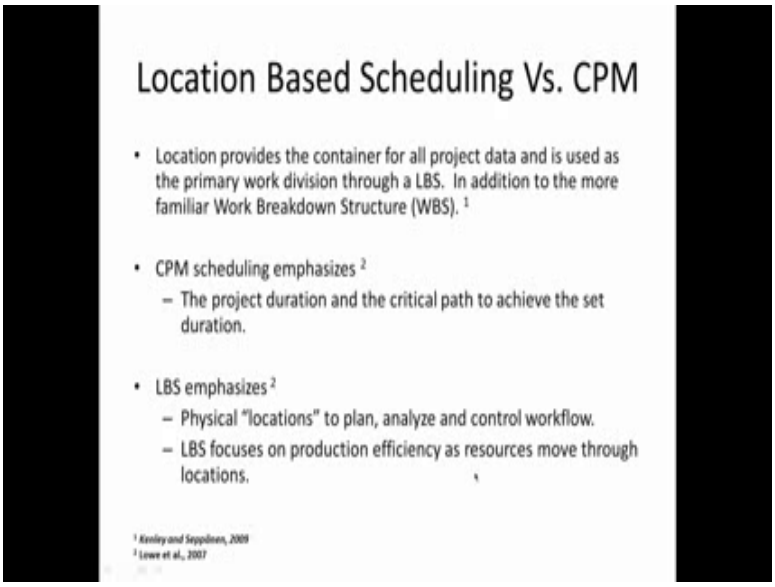

And like I said today, sophisticated tools are available for you to be able to manage this. So, when we compare LB, location based scheduling with verses CPM, the main difference is, it certainly provides a location data which we discussed earlier and we need work division through a location breakdown structure. So, the integration of the location breakdown and work breakdown is a key element of the LBMS, while CPM emphasizes duration, critical path and activity times, LBMS looks at physical locations and it looks at production.

So, LBMS is looking at production at the micro level, at the work phase level, which is what makes this a good tool to compliment CPM. Because, like we discussed earlier CPM looks at the macro level, LBS also brings at the micro level. So, this is the tool worth exploring, you know and you know if it, you know some of you might want to understand this better and explore it further.

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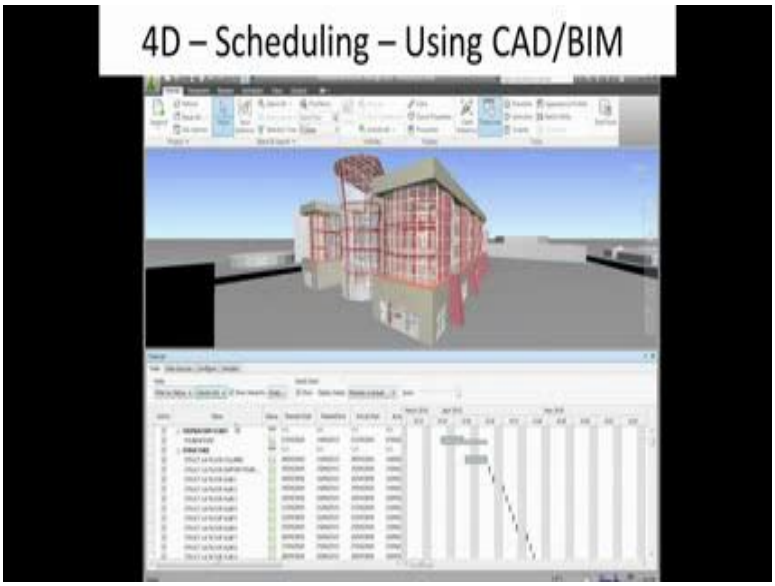

So, this is another tool which is very popular today, it is 4D scheduling, you can use either CAD or BIM and you know, most of the leading industries have shifted to BIM for the use of this and all of you would have used CAD in some form or the other. So, what 4D does is, it integrates the 3D of CAD, our building information models with your regular schedule. You can see here, you have a bar chart here.

So, I would have a schedule of my construction integrated. So, for example if I is going to install this window to a certain time, my activity for window would be here, but my graphic would be here and there would be a link. So, when it comes time to install that window, that link the window the graphic of the window will appear. So, that is why it is called 4D scheduling and it is an integrated model as we, as you would call it.

Now, there is a lot I can talk about building information models, but this is not the course for it, but this is another a big trend in the industry and it is something which, you know information is available to you all, you should probably read up. It is going to be a trend setter and big change in the construction industry is going to be brought about through the usage of BIM. Now, I have a small video here to kind of illustrates what a 4D

scheduling can be ((Refer Time: 08:34)). So, these have different levels of detail. So, for example, here you can show this is actually at a very great level, you are seeing operation level of detail here, the operation level of time is brought about here.

You can see equipment moving, you can see trucks moving, the state of the art in terms of research might be at this certainly in practice, very few industries use it at this operation level of detail. But as we go further, might be here you can see the sequence of operations for a particular schedule, how the structures going up for the cladding.

Here we have back to an operation, where you can see the sequence again; how earthwork is done, and where the excavators are located. So, a lot of times more than actually, that the time base precision, which such 4D schedules offer, it is just the visualization. When a team visualizes what is happening, you find that they are able to coordinate things much better and this is, what is one of the primary benefits of 4D scheduling.

So, here I am going to skim through, there are several examples in this video and I have given a reference to where you can download it, watch the full video. But, this is just an example of integrating time and three dimensional geometry to be able to visualize sequences. Now, it is not just sequences we would want to visualize, it is also the specific durations of sequences. Now, here I have an example of the GFRG building, which we are doing at IIT.

So, here is the sequence in which the GFRG building has been put up. So, in addition to this sequence which you cannot see it here, but we have specific calendar times on which each panel is going to be erected and put, not only calendar time, but also specific time and duration. So, this would give a very detailed 4D schedule for the project. Now, we can do, I do not have an animation to show here, but they can do an animation of this, where you will see day and time at which a particular panel is going to be erected.

So, I am almost making construction like a manufacturing process. I am able to plan to that level of detail in this particular structure, because it is a prefab structure, where I am primarily have to assemble it. This is of course, once the foundation is in place. Now, there is a lot to again cover on 4D scheduling and it is something, if it is of your interest, please refer and read up more on it, so that you can learn further on this interesting area.

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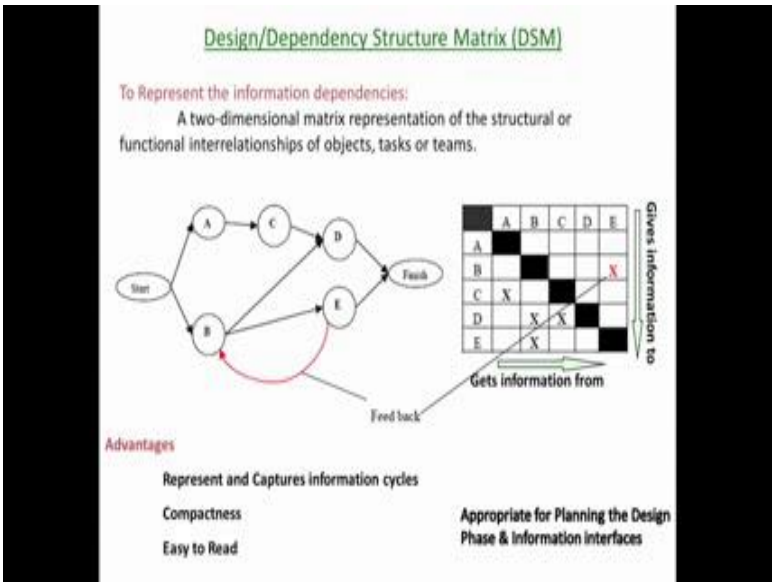

I now move on to an area which is not so much applied in practice, but it is still a very, very interesting area and this is called the dependency structure matrix. Now, you can see that this is the DSM as we call it. You know it is, I have also used the term Design Structure Matrix. Now, primarily the utilization of a DSM is for design management, more than construction management it is used in the design phase for design management and that is a particular reason why, you know when we looked at CPM one of the factors you remember is that the CPM was, it could not take feedback loops.

Remember, here E depends on B, but B cannot depend on E again. If we have a feedback like this, our CPM algorithm does not do any, we cannot apply the CPM technique. So, then what in the design structure matrix, but we know that design is an iterative process, the design is not just a one-time process for each item, we have to iterate and design. So, there will be iteration or information exchanges between B and E and only then, the design should be able to progress properly.

So, what the design structure matrix does is, it takes a network representation like this, it allows you for, you know, for relationships across feedback relationships and this whole network which we are familiar with, now it is represented in the form of a matrix. So, here you can see, the same wherever there is a relationship there is x mark and you can see that, where there is a feedback loop, the x mark is above the diagonal, where all the loops of all the relationships are feed forward, the x mark is below the diagonal.

So, this gives the clue to the design team as to, where there are feedback loops, how the

feedback loops should be managed and things like that. I will give a little bit more this, but certainly when you compare with the network and a matrix, you will find that the matrix representation is much easier to kind of draw and to understand and certainly when we talk about, we all learnt matrix algebra you know, and in the DSM we are able to use matrix like operations to get a lot of information on the dependencies between design teams.

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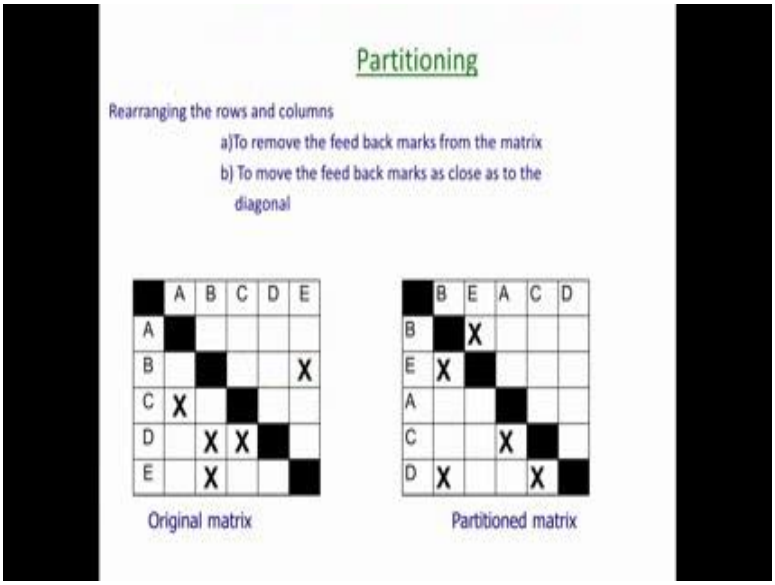

So, as we go in there are several operations we can perform with the DSM, I have just given this for reference, I am not going to get into the detail of this.

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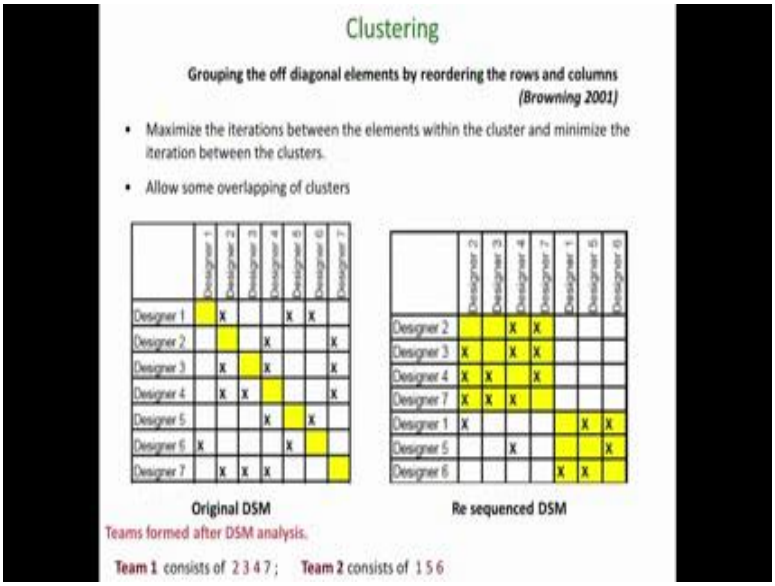

But ultimately what we will do with a DSM is to find design groups that should work together. So, here there is an operation, you know could be calling clustering where the design teams are working. So, we have identified the design clusters that should take place which… So, basically we are saying between the cluster here and the cluster here, within this cluster there is a lot of interdependency and information exchange, similarly within this cluster, which means I should ensure as a design manager that this group works closely together and this group also works closely together and then, they can independently give information as you can see, this group will then give information to this.

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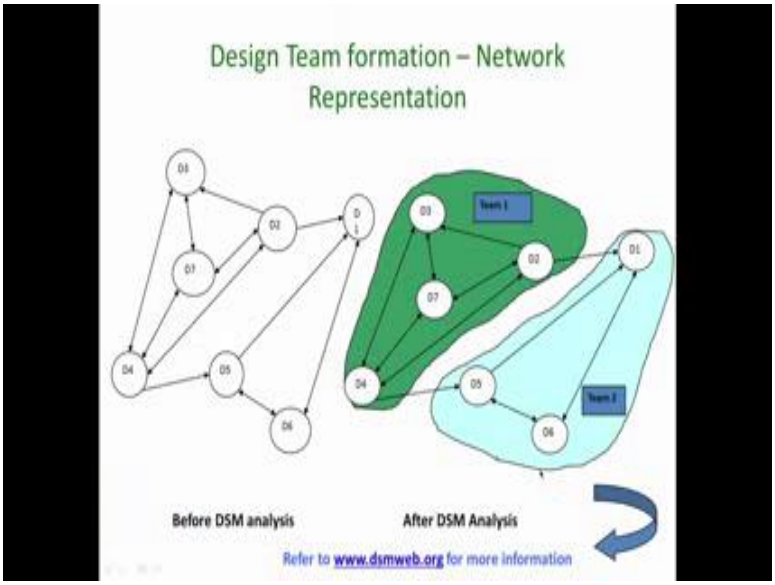

So, design structure matrix basically results in design team formulation and coordination between design, activities and design entities. Now, again I've given you a reference here, which you might want to go to if you are interested in this area.

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We talked about simulation when we talked about probabilistic scheduling. This is not a new area, it is been in, it is been a part of construction management research since 70's. Some of the early years of construction management, the simulation was a very, very hot research topic and it still continues, we have research hot research topic because of the computational capabilities today. So, early years we were focused on you know just getting the computers to do basic simulation and illustrating that the concept is possible.

Today we have moved on to trying to really get decision making and practical results from simulation models. I have again given a reference which gives a lead to a lot of other papers, I think on a simulation which will be of interest. What I have shown here is a basic simulation model and this is the ABCD project which we had. I have just made a simulation model, you can see the model consists of you know activities here.

There are queues and you will have entities, which will flow through the queues, wait, you know the activity gets performed and like we discussed in the last class, the simulation is around several thousand times, it is like simulating the project 1000 times and then data is obtained from the several runs and then, we make decisions based on statistics on how the project is progressing. Again, please go to the references, if this is an area of interest here.

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Now, critical chain project management is again been a very, very current topic. Many large corporations say they have moved from CPM based planning to CCPM based planning because it is more practical and they are able to get better results from it. So, this was initiated by a gentleman called Eliyahu M Goldratt and his book called Critical Chain has been a best seller and he actually writes books, which are very, very easy to read and really gets management concepts in very systematically.

Now, he, in these books he addressed several issues and project situations which are not addressed by CPM. You know his main focus is on resources like on CPM we focus on activities, here he focuses on resources, how to manage resources and how to create different buffers around resources, so that the project, the critical elements of the projects get delivered. Again to implement CCPM you need software tools and they are also available in the market today.

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Finally, I want to touch on this topic of lean project delivery. So, this is something again a group at IIT Madras is working on in terms of advanced techniques and this was something which… If you ask a manufacturing engineer about lean, they will say yes it has a lot to do the Toyota production system and the manufacturing industries embrace lean concepts really well. I mean they have really taken it into many of, to optimise many of their production systems.The challenge has been how do we take a process like a tool and implement it on a project site. So, that's been the challenge we are facing and if you recall in our discussion on project and process management in the early lecture, we said that projects also have processes in that. So, one of the challenges of lean is actually to structure your project more like a process and then start to be able to be more effective in the process and the key element of lean in, once you make it a processes, is to eliminate waste and there are several types of waste, so which need to be eliminated and once you make it more like a process, you are able to identify and eliminate waste.

So, this is the core of lean and as we have kind of given you, shown you here, lean is not just in construction, but you have lean in the project definition phase, in the design phase, the supply phase, the assembly or construction phase and the final operation, use and maintenance phase. So, lean is a holistic concept, it tends to be more of a management philosophy kind of an approach than a technical tool kind of approach, but again very interesting very comprehensive in it is approach and those of you are interested and exploring more management type concepts, you can look at LCI here as a lot of information on lean construction.