Scheduling Techniques in Projects
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Lecture – 07
Information-driven Scheduling

We will see about Information-driven Scheduling. So, what do you mean by information-driven scheduling? So, first let us discuss on where this generally happens. So, this primarily happens in the design phase.

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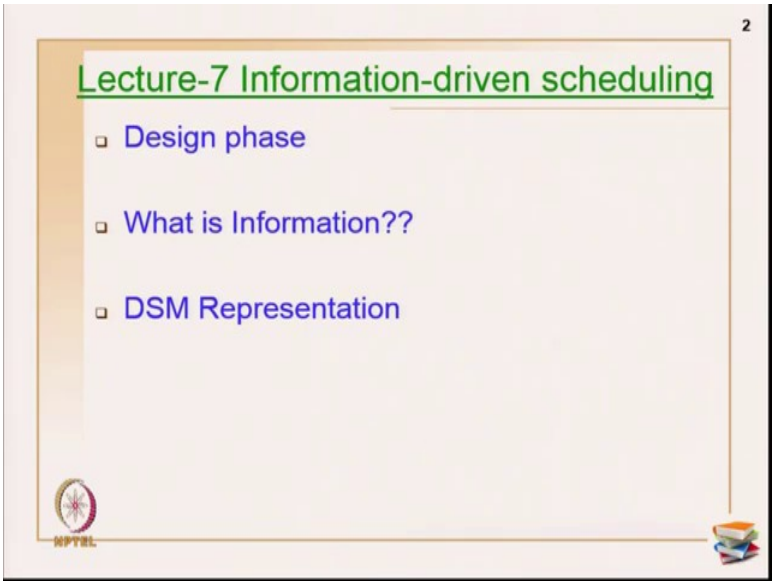

So, we will see a little introduction to the design phase and how far it is a little different from the construction phase and so on. And, then what does this information all about so, that also we will discuss in little detail with some examples. And, then the very famous tool for managing information-driven scheduling is dependency structure matrix. So, we will see how to represent it and one step in the DSM is formation of an activity DSM that also we will see in today's class.

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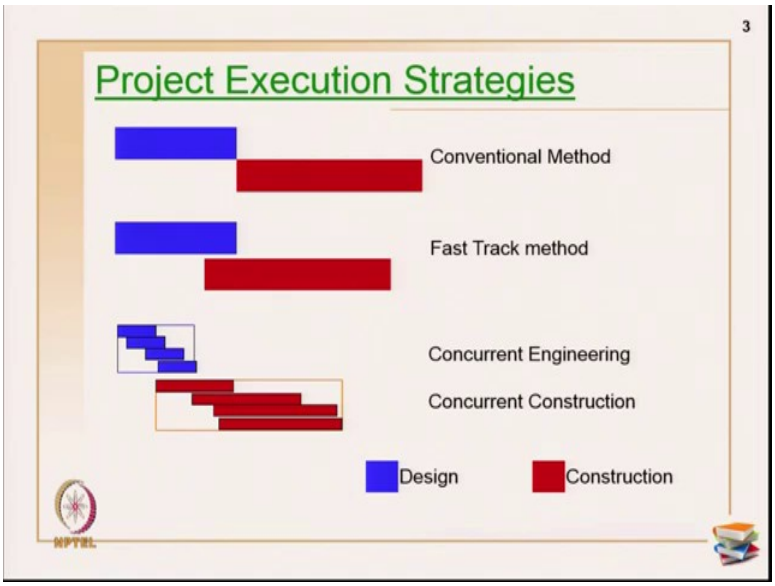

So, now let us start with project execution strategy. So, conventionally if you see what happen is, so, design is generally done and once the design has done, approvals on the design are taken then only the good for construction drawings are generated and then the construction really starts that is what is a traditional method of executing any project ok. What happens as a result of this, you have to wait for a lot of time for approvals and so on. So, it takes so much time for a real project to be completed ok.

When people are really interested in completing the projects faster and so on, so, there came a methodology where in design and construction can overlap. There can be so many ways of overlapping and one way of accelerated (Refer Time: 01:47) construction technique is what we say is a fast track method; it is one method in that group. So, what happens in fast track, we do not really squeeze the design phase or the construction phase? We try to overlap as much as possible wherever we can overlap we try to do it and as a result there is a little time savings in the whole project and that is where the fast track came in came into existence.

And, since even then this was not at all know enough for the owners or the contractor. So, what happened is later on came in came in a way to even still squeeze the total time for completion. So, construction we would not be able to squeeze too much because of the hard logic constraints only after the foundation you can do columns then you only can do beams or slabs. So, that hard logic you cannot violate or you cannot no go away

with that hard logic unless you are thinking of prefab structures or modular units and then assembling it in the site even then the hard logic has to be maintained.

So, construction phase as such you would not be able to squeeze, but what happens in design phase? Design phase is all about information between the people. For example, when I want to release my foundation design, I have a small structure. I have a foundation design to be done. I may have the superstructure design in several forms I have ok.

Suppose, if you want to do foundation design first because you have to give it to the construction site for them to start the construction, what can happen? With your earlier assumptions you can always assume the loads on the structure and what are the live load, dead loads and seismic loads, mean loads whatever you want you can assume you can still release the design for foundation earlier to the sites ok. And, then later on with the real design happening in the substructure and other parts of the whole structure then you can recheck your values and then you can modify here and there small segments, but as such the excavation, foundation can all happen in the meantime ok. That process we generally call it as a concurrent engineering.

Concurrent engineering is the engineering phase or the design phase is generally squeezed by putting all the teams to work in parallel. This is a very common phenomenon right now in many of the projects which are happening today because of the speed with which we have to finish the projects. Concurrent construction is again squeezing within the construction phase through I said alternate techniques are available with which you can squeeze. So, as such the complete construction design to construction phase can be really cut down a lot ok. So, these are all the strategies.

Now, why I brought this picture here is to show you that there is a hard logic really driven in construction phase, but in design phase is primarily the information which is driving through. So, as much as squeezing is possible in design phase compared to the construction phase for that only I brought this picture right now.

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Now, let us move on into what is this design management all about and what is it actually it is to people. I am not talking about the design phase of a construction project I am talking about the generic design management ok, it can be a product design, it can be a process design, it can be an aerospace design. So, I am talking about in general right now.

So, it is a business side of design ok. What does this mean? So, design managers should have to speak the language of business in order to know sell their design they have to do little on the business issues on what will attract the customer, what will attract the stakeholder. So, he has to do that language of business and also he has to do the language of design as well so, which is a very challenging task. You will see later. There are lot of techniques available even for the synthesis portion of designs.

In the last 15 years, 50 years sorry, design was mainly with managing the aesthetic issues on design which you always know. Whenever we talk about design, generally no time frame is really given for a specific design solutions and analysis because it was generally aesthetic appearance and construction was dominating the whole show that is because of the large time it takes for completing it and also for the large cast which goes into the construction phase, that happened in construction also it happens in other domains as well.

So, it has been formalized the design management has been recognized as an individual discipline only since twentieth century or even later than twentieth century and so on. And, what happened after then also there is a slight shift in the focus and now managing design is all about ensuring the ability to innovate how far I can build a new structure, how far my construction will be known everywhere. So, iconic structures or a new way of doing the whole project everybody wants to do something new compared to what others have done. So, now there, your focus again has shifted a large from the last 10 – 15 years or so on ok.

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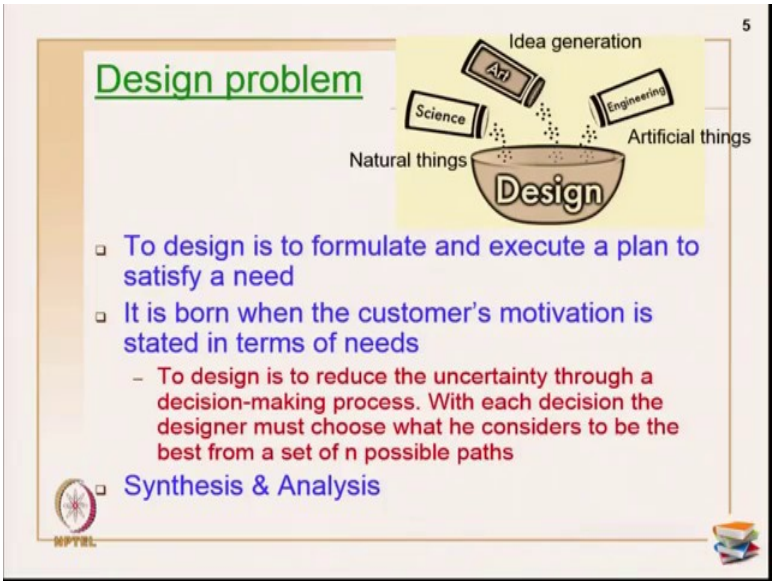

So, now, what is this design problem all about? So, it is not a regular design as such, you have to have several other issues behind. For example, it talks about science many of the ideas comes from natural things it is primarily from the science. From the birds we who can fly from one place to another the idea on aero plane came. So, many of these concepts are really coming from natural sources and from the natural science which we have ok.

Then, next is art. How can you present your artistic view into an idea generation, idea concept, a conceptual issue? So, so from there, art also is part of the whole design phase. The next is engineering. So, if you want to build everything if you want to put in your imaginary world which is your artistic world and your natural world into in, then you need to have little more on artificial things coming in it can be in form of steels, even in

concrete. So, what is the right combination for me to execute or put in together in place, so that it serves a real purpose on what I wanted to achieve ok. For example, the shape of a lotus, you have a lotus temple. So, like this so many things have happened, but you do not get the same feel of a lotus, but there are primarily the artificial things which are put in place and which gave you that feeling of a structure.

So, design primarily you have to have all three characteristic features put together I just brought on small video art view here to show you on this. So, what is a design? Primarily, it is to formulate and execute a plan to satisfy a need ok. So, I should have a proper idea on what to do. So, the artistic view cannot be really an imaginary part, you have to have a little synthesis in your mind and you should also be able to execute a plan and that should be a need which is driving. So, primarily there is motivation or list of needs which is driving me to generate the design ok. I need something new which nobody has done earlier. So, the even the innovation is also drived or driven through the user needs or client needs.

So, this design is generally born when the customers motivation is stated in terms of needs ok. So, it can be in so many forms in so many ways. So, let us see this, to design is to reduce uncertainty through a decision making process as I have shown you in the as I have dealt earlier examples also even in the WBS example on developing a laboratory I have shown you several steps on which so many decision making are taken taking place. Same way even in the design process you are actually reducing so many uncertainties through variety of decision-making process and in design it is like you are actually preceding the entire construction.

So, too many assumptions you have to make in because you are entering a construction world is unknown to you. You do not know who the contractor will be, you do not know what equipments are going to bring in, you do not know what technology they are going to bring in you do not know what form of equipments or methods we are going to use in the whole project, but you have to assume for a variety of people who can execute the whole project. So, there are a lot of uncertainties, but the real challenge is how much ever uncertainty you can reduce at same time there is a decision making at each and every stage.

So, with each decision, the designer must choose what he considers to be the best from a set of n possible paths. For example, if I have to do a foundation. There can be so many types of foundation, starting from isolated foundation, your raft foundation, pile foundation like this I have n number of methods ok. So, which method I have to choose. So, there are several paths for each and every step and you may have to cut down the path or at least try to make it minimal as and when you go on with the information that is pouring into the project. So, that is primarily a challenge you have on a designer ok.

So, next; so, as I told you there are two phases in design. There are so many tools available for these two: one is synthesis. Synthesis we generally used as a solution to arrive at your best or a feasible design solutions and analysis methods are also available for example, for change management, for rework, for iteration or for scheduling techniques. So, there are several methods available, since this course is primarily on scheduling we are going to see the aspect in analysis only and synthesis I am not covering here; analysis also only one method we are going to see in detail ok.

Now, this is also a very famous slide which you will have which you would have come across earlier. So, there are so many domains available in a project especially when you are doing a design ok. When I said set of n possible paths and n ways to do, so, what is this all about?

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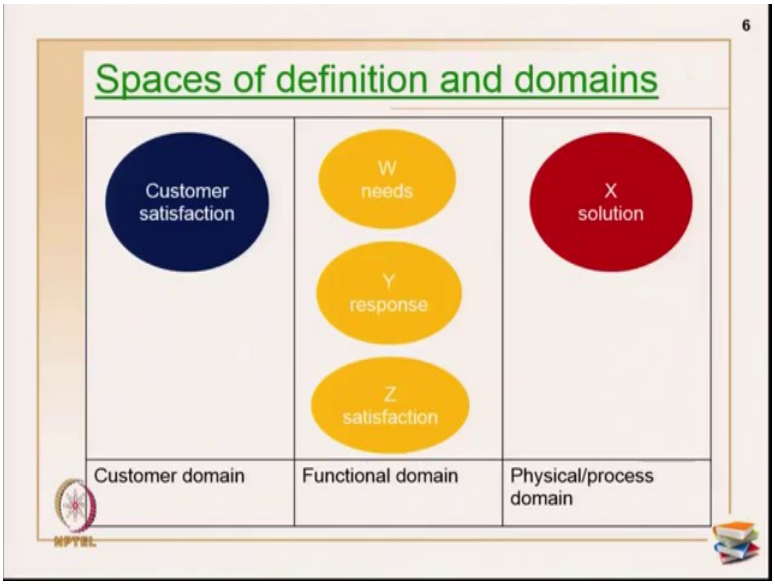

So, I have a customer domain ok. Customer domain or a client domain both are really different. Customer domain can be superseding your client demand. Client demands may be most often the basic demands of a project. For example, I mean auditorium, or I need a house ok. That can be real, basic and mandated requirements can all come from a client domain, that is not what we are talking about. We are talking about the next superseded layer over the client domain which is primarily called customer domain ok. I should have a house which can rotate among on it is axis or something like that. So, they all can be the added features which you wanted to have along with the basic demands of a house the functions of a house.

And, then the next is functional domain. Suppose, if I want to create a structure which will serve as an auditorium then it should have all the acoustic features, lighting issues and so on which really know that I could feel that it I am sitting in auditorium ok. So, there can be W needs on my functions and there can be Y responses. If I want to do all these performances what all I can do? I can have acoustic issues for example, I can have instruments, or I can have a different form of door setup or I can have changed my all wall patterns differently or I can have something which can absorb all the sound and other noises. So, there can be Y responses for all my W needs. So, for each need I may have so many responses.

And, then what will the customer really want if I choose among the Y responses maybe one or two he may be happy then you can only choose those is a responses that is primarily the satisfaction level. Some are basic satisfaction levels and some are like hidden satisfaction. Suppose, if you attack all those responses then the customer will be over happy and over enjoyable.

So, there are now three domains in a functional region itself – the W needs Y responses on Z satisfactions. So, primarily you have to map between them and do a decision making, that is what mentally they do and then arrive at a solution space which need not be a single solution space. It can be a set of solution space as a solution we have driven which we can really execute. We have to also think about how to do the same solution spaces, is it feasible, can I have the resource to do, will I have the budget executes all these you have to evaluate. So, primarily you land up in one or two solution spaces only which is the physical domain, the real execution part of your whole project ok.

So, that is what is the spaces and definitions. So, which primarily you deal with all these in your synthesis solutions ok, but since we are not covering them so, I am just moving ahead.

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So, what is this design specifications and this is a term which you heard you would have read in many of the construction starting classes as to the estimation or so on it starts from design specs ok. So, what is this design specs and what are the related terminology with the design specs because we are really seeing into the design phase.

So, explicit requirements are primarily defined and collected. Explicit requirements are the written stated which are very clearly written that I need a house which should be very secure and so on. So, all these are primarily called explicit requirements. These requirements can be analyzed, they can be refined, they can be extended whatever you want you can still do with them ok. There are certain related terminologies with these explicit requirements which we call demands and wish or wants and needs. There are so many colloquial terms which are available in literature, but I have brought few terminologies here.

Explicit requirements are those requirements given by the client which are really explicitly stated in the in the in the database ok. Implicit requirements are those requirements which you should be able to grasp as an when the client is explaining about the project, ok, these are all he may know wish to keep it in the project. So, you may

have to grasp the series of discussions or interviews with the client. You should be able to rightly capture what are all the hidden I would not say they are the hidden requirements, but they are not explicitly written, but they are part of the whole mandatory requirements ok.

The next is obvious requirements which may also come from user demands ok. So, suppose if I am living in some place where there is so much of rainfall and dampness and so on, then I may have to raise my floor level little high, so that the water or something is not coming into my house or touching my house and always it is damp. So, these are all user demands and which are obvious requirements which may not come explicit, but it has to be attacked by the by the designers.

The next is hidden requirements. Hidden requirements are only for attractiveness ok. If somebody wants to buy your house or you want to sell it to someone so, what is the real attractive feature you want to keep in your house so that it is attracted by an n number of customers that also you may have to study. Now, when I am saying about talking about the customers then there are two types of customers do you want to talk about all anonymous customers then you may get so many responses.

For example, there was one apartment renovation in our campus, and we wanted to know what the real users wanted in the same apartment. So, we did a survey; it was a sample there was one apartment block, 12 houses. We did a survey and we wanted to know what all these occupants wanted when the houses are to be renovated only the interior renovation was planned ok. So, these 12 occupants they gave almost like 96 or 100 responses and which were like two distinct from each other rarely one or two were common requirements from all the occupants otherwise many of the occupant occupants gave a different set of user requirements.

If you wanted to really implement all these then what happens to the budget of the whole renovation it may shoot up really high ok, but these are all specific customers who may stay in the in the same apartment when the houses are renovated. So, these are all specific customers. Now, if you want to take out real other sample survey wherein some other block of people who wanted to have a renovated house so, what can be their requirements? So, these are all anonymous customers who have not stayed in the same block, but who can give a different set of a user requirements.

So, whom do you want to really attack, is it anonymous customers or specific customers? Now, the challenge is now in front. Now, again what we did was we did a priority on all these requirements and we thought of doing at least 10 of these requirements were prioritized and then we went again and roamed around in the entire block and seeing whether the other requirements was also part of the customer. So, some occupants they change their mindset and they said yeah, these are also part of our wish list and they change something, something got modified and then we ranked a 10 requirements to be done and we did a survey on how these and 10 requirements could be accomplished.

So, like this it is really a challenging task when you want to really attract with the hidden requirements. So, most of the designers they generally do not attempt to do, but primarily it is also part of the whole project if you wanted to really have a nice project to be done ok. Then these requirements can also come in two forms – one is quantitative form, other is qualitative form. Quantitative form is really easy to do, but qualitative form is really very difficult to do. I want nice air circulation. The nice can be in any extent you wanted to push or pull so, which is very difficult for anybody to know to handle all these qualitative requirements on the customer.

So, these are the general issues on design specs which I which you should understand when you are working on the design management or information-driven schedules ok.

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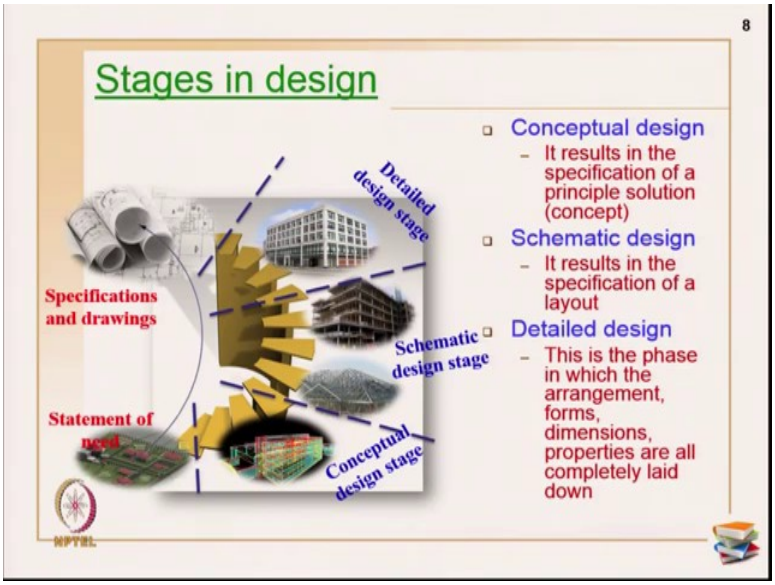

So, the next is stages in design. So, obviously, you need to know what are the different stages and what is this design process all about. Design phase is generally termed as an evolutionary process. You start with the customer requirements or demands and at the end of your whole design phase you are just generating some 500 – 600 drawings and along with a set of specifications. So, what happens in between that many of the people are really not very clear.

So, the primarily there are three stages in design phase: one is a conceptual, next is a schematic and the third one is a detailed design phase. Conceptual design phase – It results in specification of a principal solution or a concept. It is slightly ahead of your feasibility stage of the whole project and as soon as a feasibility is done conceptual design stage starts and de-marketing these three stages are really very difficult. It is like a very hair line mark I will say on the three stages. Generally, if you look at a project primarily it can be a J or a layout diagram or something or a line sketch which we normally say that set off an information should have been finalized when a conceptual design has been completed. So, the principal solution is primarily achieved here in the conceptual design.

The next is schematic design. So, schematic design results in the specifications of the layout; ok, where are the arrangements, where should I put my boxes, where should my apartments come and how should the three layouts look like, what is the orientation, and what is the levels, how many floors are there, how many rooms are here. So, primarily it talks about little more specifications on the layout and little more details have come. Primarily, you would come to know what are all the components and how a structure will look like, partially you can have a visual imagination and idea, then you call it a schematic design ok.

Detailed design is primarily you have to work out on all your design calculations analysis and so on. You work out on loads, you do the design. So, primarily this is a real detailed phase and it takes more time and which arrangement, forms, dimensions, what type of concrete I am going to use, mix designs everything are completely done and then they are all laid down in the form of drawings aspects. Only in this phase you really get dimensions and the properties or layout detailing of the spacing, reinforcement spacing, type of reinforcements all these generally comes in the detailed design phase.

These are three stages in design in ok.

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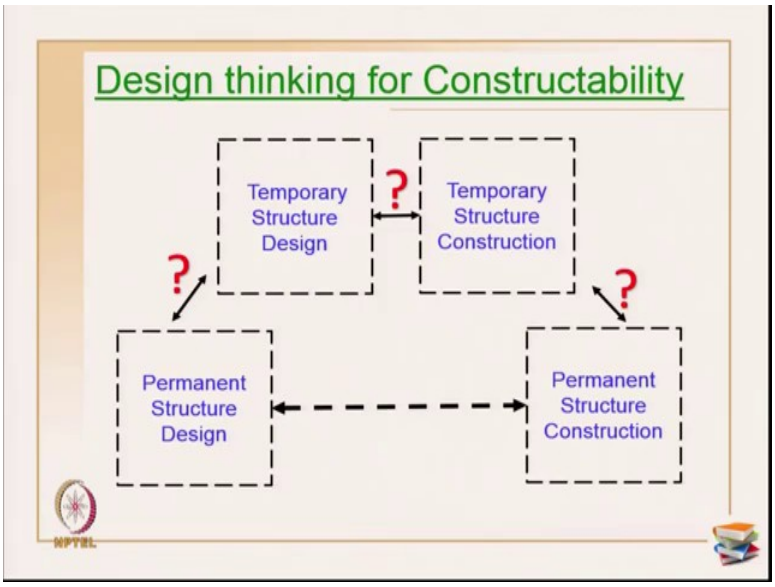

Now, next is the design thinking. Generally, what happens you have something called a permanent structure design and you have something called a permanent structure construction. In permanent structure design what happens is whatever drawing space you do for the real structure that is what we call it as a permanent structure design. In the permanent structure construction, you really think of foundation this that for the real construction, but what happens there is some intermediate steps here which is called the temporary structure design.

All your temporary structures like scaffold, centering, shuttering, false ceilings, sorry not false ceiling you and all your support structures like scaffolds, shuttering, centering and all these are primarily your temporary structure design and those erection installation of those structures are the temporary structure construction. These generally are ignored in some projects, only recently these are all part of the whole construction situations.

Now, what happens is if you want to really do an unique design or design which will not fail through whatever methods and means you are going to adopt in the construction stage, then you may have to think for what can be the temporary structure design, the temporary structure with which they are going to construct it. Is it an aluminum form work or is it an steel form work or is it an plywood or timber form work or so, those all you have to think about and then what about my permanent structure construction and

then you may have to have an idea on that and revisit your design and correct all your designs accordingly. That is primarily a challenge which you have in many of the projects.

And, some projects where some project managers they really do revisit on design thinking for constructability. Otherwise what happens is the minute you start your construction every time you may have to re-do some parts or redesign some parts and you waste a lot of time and cast as a result of the redesign and the works ok. So, what happens in our project and what is this information. So, we are just traveling into the information management as such.

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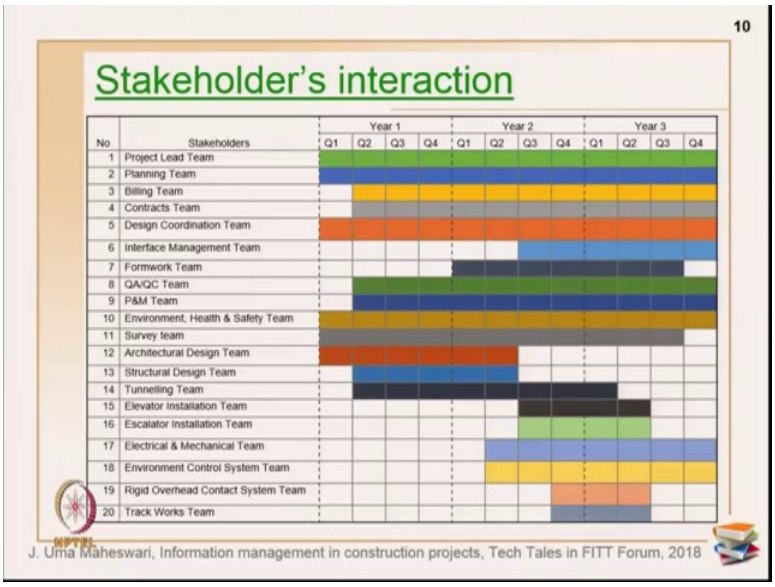

So, let us take a small project. This is an underground metro construction project. If you see here there are like 20 teams, this is even more. This is on a planned schedule on a project which takes 3 years what is planned so, which is given in quarter. So, year 1, year 2, year 3 are the three years timeframe which we worked on the whole project and is given in quarters. If you see the entire 20 teams are almost traveling through the complete all the 3 years of project.

Now, the teams were project lead team, planning team, billing team, contracts team, design coordination team, interface management team, form work team, quality assurance control team, P and M team, environmental health safety team, survey team, architecture design team, structural design team and so on. So, primarily it is a series of

design team, construction team, installation teams, survey team all are traveling together in a metro. In a metro construction you do not do the design first and then you go. You go parallelly with the design and construction.

Now, what am I going to say here? So, even in construction you have so many people you may have to coordinate, and you may have to work together. So, then what is a big deal in the design phase? In design phase what happens is you may have to work more with the information phase which is what is challenging. Let us see that right now.

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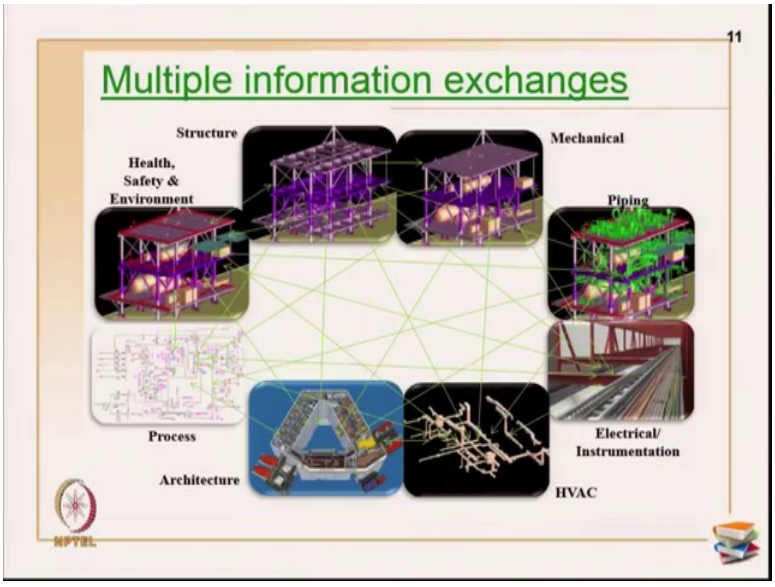

Now, what is a design phase? Again, I am just moving on into an example. This is an offshore facility example. The same project has a different view from different people. There were 8 teams in the project like architecture, HVAC, electrical instrumentation, piping, mechanical, structure, health safety environment process. So, like this there were 8 teams working an offshore facility project and what you would see here is all the 8 people had a different view all together on the whole project. Now, bringing together their views and doing the sequencing on the whole project and getting the information in proper order and working out on the project is always a challenge for any project manager ok.

Now, this is on the team level. The last slide I showed you on all teams almost work together, this is another example again showing that different teams have different views on the entire project and which is like not even know matching with any of them ok.

Now, let us see little more in depth what really is happening. This is a highway design project again ok.

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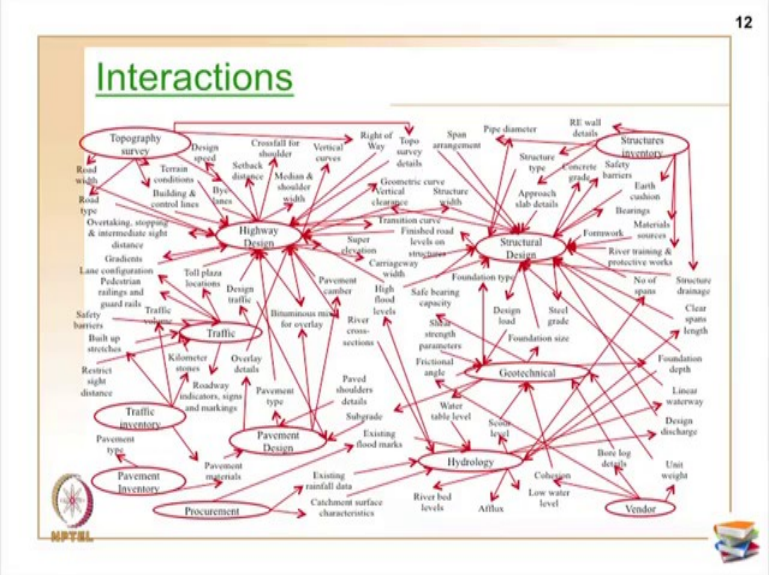

So, here if you see what really happens is each and every day almost like so many information is traveling across different teams and across components and so on ok. So, primarily we call this as a 3C or 3I problems. So, 3C is primarily your communication, collaboration and cooperation. Some people also extend this to complexity, co-location and so on. So, all these are primarily your 3C's ok. We will come to the C's later.

Now, let us talk about the 3I's. The I's are primarily information, interdependency and iteration ok. Now, what is this information? So, see if you see here ok. So, this let us take a good example. From the vendor I have a bore log details which is given to a geotechnical team. So, this is required to geotechnical team between the vendor team and the geotechnical team I have a bore log details as a common as a parameter exchange or a parameter transfer between them ok. So, that is primarily the information I am talking about an information can come in any form. In this case they are the parameters.

What is this parameters I will give you an example also. So, let us take the design of a slab. What are all the parameters I will tell you. At the end of a calculation on design of a slab what all information you get those are all called parameters or they are primarily the information on the whole project. It can be depth of the slab, width, slab dimensions primarily and the reinforcement data, cover to the reinforcements, spacing between the

reinforcement, mix design of concrete. So, all these can be part of your information or parameters ok. So, the small calculations which you go which comes with the value they all primarily called the parameters ok.

Now, what happens the next is interdependency. Interdependency is when these parameters are really interlinked with two or more entities ok. For example, I need some information from another person, other person also need some information from me. Then we have to work together in order to exchange and share you want to do like this I will make an assumption, I will do something then you start giving me information. So, primarily that is set together or working together happens when you have an interdependency ok. In the same example if my assumptions for executing interdependency goes wrong, then I may have to revisit this and rework for a few segment for a few stretch in length that is primarily called as an iteration. In the next one or two slides I will explain what is a 3I's ok.

Now, what happens is I may exchange for example, a person and I am one engineer and there is another engineer who has asked some documents from me. I am sending through email in excel sheet attaching an excel sheet and the same person has reworked on his software part and he did something and he is exchanging the information back to me on the revised values in a pdf form. So, these are the communication media I would talk about.

So, what happens after then seeing this pdf doc you would not know what happened with the earlier your excel file, why where are the changes are happened then what do you do? You send an e-mail and for which he does not have the time to respond then he picks up his phone, he answers your queries on the phone. So, what happens here is there are so many communication medium which has happened ok. Already your information is also traveling between the parties in. I am talking about only two people here and how many rounds? There are several rounds which is happening different information are getting exchanged here and some information are also traveling across several rounds and if these are exchanged in different medium in each time then what happens is it is all like a chaos real chaos happens in the design phase.

So, that is what is the challenge we have in the design phase and we need really solution tools techniques which we with which we have to manage the entire design phase ok.

The available CPM, PDM or whatever you have you use in construction can handle only the workflows or the hard logics they will fail if you want to use your information flows ok.

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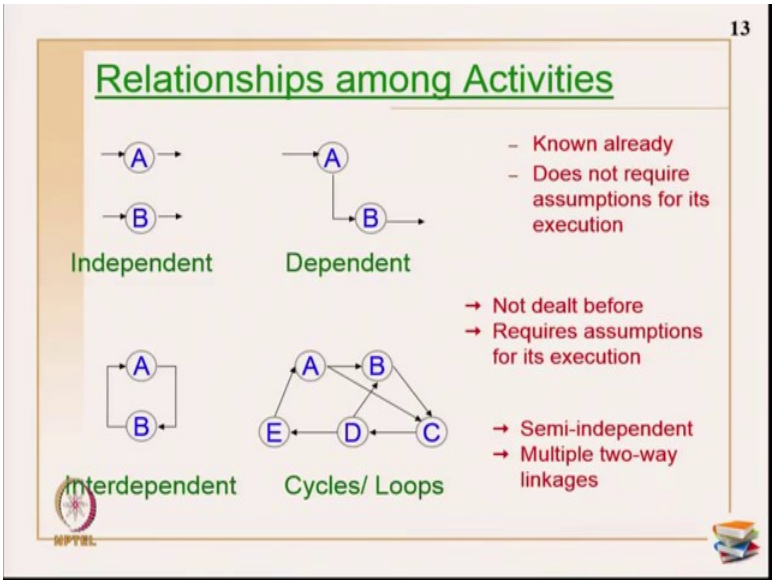

So, now as I explained verbally I thought I will explain you with pictures also. So, the independent and dependent CPM can easily handle this you know this known already. It does not require any assumption for execution. The other one is semi independent which we have used in PDM for explaining the PDM as well. Now, the next is the interdependent and cycles or loops which is what we are going to see right now in information modeling.

So, this interdependent is actually A is dependent on B and B is dependent on A. Cycles are primarily more activities are coming in and there are so many loops inside then we call it as a cycle or loop. This is not dealt before. So, this is a recent concept which comes in only when the design phase has become more and more complex solutions started coming in design phase. And, these require assumptions for executions. For example, if you want to execute this should I start with A or should I start with B or should I start with B, for whatever it is you may have to make an assumption ok.

So, for example, if I want to start A as my first activity, then I need to make an assumption as if E has completed and this information should outcome. So, I am assuming something and then starting it and then obviously, you may have to revisit

whether what you assumed is right or wrong or is it close to what you assumed and so on ok. So, the other issues which I have not explained semi independent we have already seen. There is something called multiple two-way linkages which you will see down the line after the DSM is covered ok. So, I am skipping it for right now.

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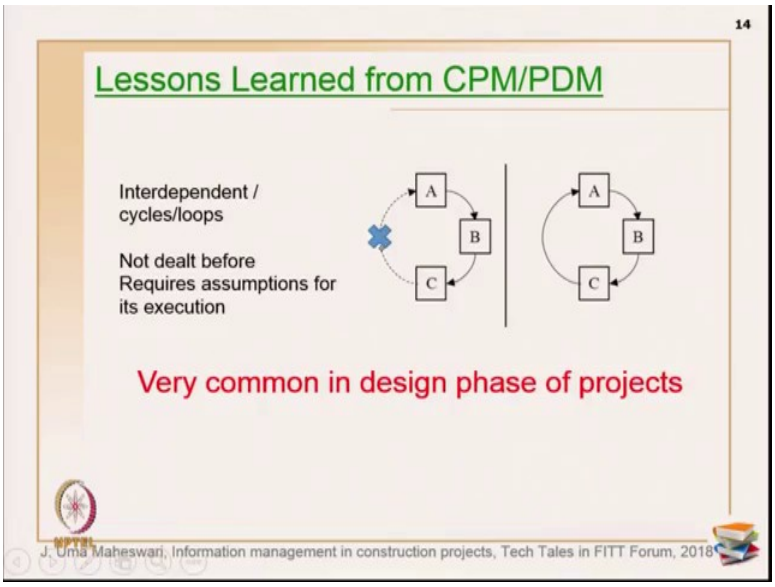

So, lessons learned from CPM or PDM. CPM can handle independent and dependent; PDM can handle the semi independent or the overlaps to some extent. So, the what you cannot handle in CPM or PDM is the interdependency or cycles or loops. Apart from information that is something else which you I am talking about is interdependency. You know what is interdependency; you know what the cycles or loops also. So, now, is this a new aspect altogether and was it not dealt earlier. Same type of projects we have executed 20 – 30 years also.

So, how was it done? Generally, what happens this is what happens. You make an assumption here and then you assume that it has been executed and you avoid this relationship at all and then you use your normal CPM or PDM for execution with. Like this only we have executed the projects earlier. Now, what happens is now we have solutions and techniques which can help you to model the interdependencies and loops, we can also revisit and see how much is the rework which is happening as a result of all these assumptions. So, now, we are able to handle the interdependencies, and which is a very common phenomenon in design phase of a construction project ok.

Now, let us move into tools. So, so far we have I have introduced to you what is design management. So, design management has so many uncertainties it is plagued with too many uncertainties because the starting phase of a project and while construction happens you know what are the teams, who has done the design, layout, structure everything is really clear when starting your construction phase. But, design phase is really with the imagination from the clients you have to really start and execute your whole projects which is really challenging as such ok.

And, we have also seen what is the information all about and the 3I's primarily. At least you know right now what is information and interdependent. Iteration we will see at the end of DSM, you will have a very clear idea on what is iteration. Communication also it is really both information and communication when we are traveling together it really complicates the design phase. I think that much you would have surely understood with the last few slides ok.

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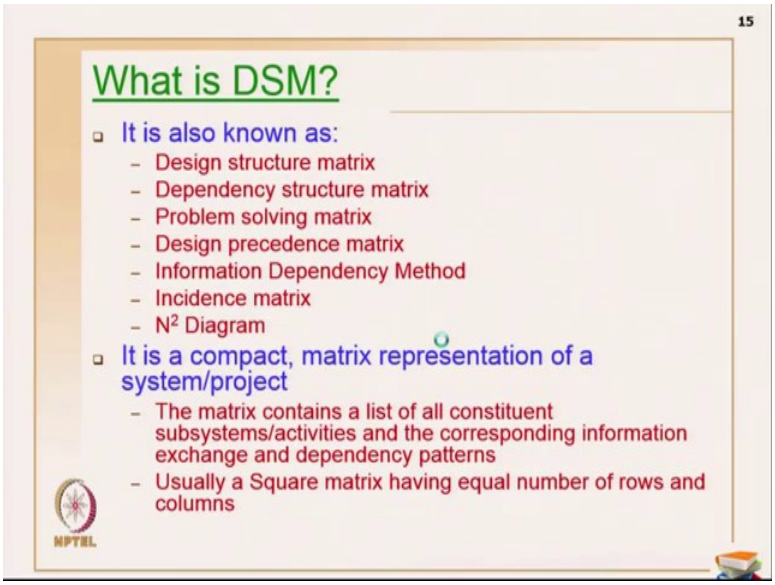

Now, let us move on to the technique, with the DSM how are we going to handle information-driven schedules. What is DSM? DSM is commonly known as design structure matrix because application is predominantly in the design phase. So, earlier when that tool came into existence when the technique came into existence it was named as design structure matrix only. Then, people started working with the construction phase also with for information sharing in construction phase for example; we have also

worked in underground metro construction. So, all these had information passing on between the teams.

So, after some time the researchers started naming it as dependency structure matrix and the D was replaced, design was changed to dependency structure. People also have called it as problem solving matrix because it can handle information problems. Then design precedence matrix, information dependency methods because it handles a lot of information, incidents matrix. You may be working on matrix analysis and matrix calculations only, so, people also call this as incidence matrix. It is also called the N squared diagram because it has a set of N rows and elements, N rows and columns which are happened to be one element. It can be an activity, it can be a parameter, it can be a team whatever you want that is hence it was term does an N squared diagram. These are all the other names for DSM.

Now, what is this DSM? It is a compact matrix representation of a system or a project. This matrix contains a list of all constituent subsystems, activities whatever you want to you can still keep it, but it handles only one element at a time and the corresponding information exchange and dependency patterns between them. It is usually a square matrix having equal number of rows and columns and same number of rows and columns also.

History this is a technique which has come into existence only since 2000 and so on and right now there are several people and several applications on DSM and down the line DSM can be like superseding your CPM or PDM in future ok.

Now, let us take an example in order to see how to form this matrix or how to read the matrix.

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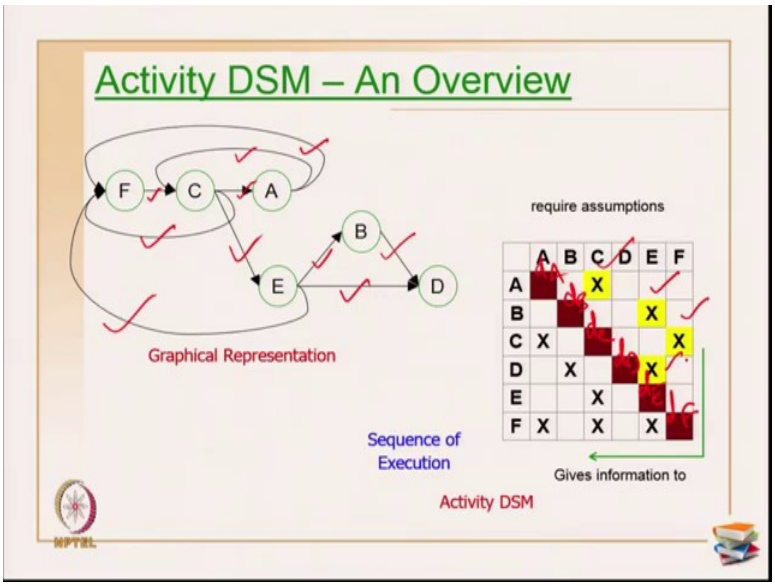

So, I am having an graphical representation on a project. You need not worry about what is a starting activity and so on. It can be F, it can be C, can be A whatever you want to start because the sequence of steps will help you to tell you what is the order of executing the list of activities.

So, I am having a graphical representation. There are six activities here. First step is I am just plotting a matrix. This is called a skeleton DSM. Skeleton DSM was nothing about which has a rows and columns and no relationships are generally marked ok. I am just using my alphabetical order A B C D E F. So, this but the A B C D generally shows my sequence of execution. After A, I can do B, then I can do C, then I can do D, then E, next F and the same list you will see along the column as well. So, since the number of rows and columns is same it is generally called as an N squared diagram ok.

Next, I am going to plot my relationships. What is the logic with which I am going to plot my relationships? So, this is arrow mark I have given here. So, you generally you have to read from top to bottom which primarily gives information to. For example: so, I am going to take B to D. So, this is B to D. So, so this relationship has. Let me use my pen ok. So, this is B to D and B to D is here ok, then A to C. So, A to C is here. So, this is A to C, then I have C to A. So, C to A is here. So, this is my C to A then I have E to B. So, E to B is this. So, E to B is this; the next is E to D. So, this is here and this is E to D

then I have F to C. So, this is F to C ok; C to E is here, then this is C to E. I have A to F. So, this is A to F. C to F. So, here C to F ok. Then I have E to F. So, E to F is here ok.

So, this is how I mark my relationships. In the website if you see it would have shown another way which is like this both are same as long as you are comfortable in doing it this way or that way. You should be sticking to the same representation till the end ok. So, I am comfortable in putting in this way. So, I have used from top to bottom. So, C to A this is read as E to B. So, this is F is giving information to C, this is like E is giving information to D that is how I am going to read this ok; that is what I have written it here as gives information 2 ok.

Now, what about the diagonal? Diagonal generally does not have any relationship, but if you want to do scheduling then you can add durations of each activity along the diagonal ok. For example: so, I am so, I can write here a duration of A, this is duration of B, this is duration of C, duration of D, duration of E and duration of F. If I wanted to really calculate my duration of this particular list of activities that we are going to see after few classes ok.

Now, what happens here is I am having some X marks which are above the diagonal. These are the highlighted ones I have shown here and all these primarily indicate to me that I have to make assumptions. The minute if you are having all lower diagonal triangular matrix, for example; now, below the diagonal I am having all my X marks then it implies it is a general CPM or PERT. The minute I am having my interdependency or my cycles or loops, then I may have X marks above the diagonal which I cannot avoid and that primarily are highlighted like this in yellow which is primarily indicates to me that I have to make assumptions for executing those activities ok.

And, now what you should also understand is. It is fine. Try to minimize the X marks above the diagonal. There are various steps for doing it in the next few slides you will understand that. Suppose, if you are not able to avoid X marks above the diagonal at least see to that you are pushing the X marks close to the diagonal, so that you are having only one or two activities within the loop on rework. If you are keeping the X marks far away from the diagonal many more activities will be falling in place into the X marks

and obviously, you may have been you may have to work in loops which you should avoid ok.

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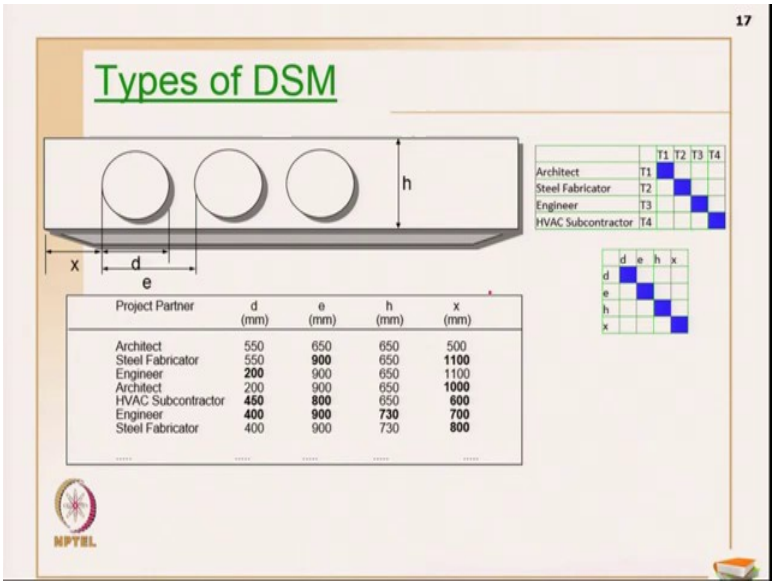

Now, one example I would like to show you on the types of DSM. This was taken from a paper which talks about positive and negative iteration ok. This is a very simple example there is a beam and I may have to lay ducts for all my cables. So, I have just put the ducts here and all these holes for the ducts are given in dimensions. X is primarily from the starting of the beam to the first says start off the duct d is the diameter of the holes and e is primarily the set distance between the center to center distance and h is the depth of the beam ok.

Now, these are all given in mm. Now, what happens architect he gives his dimensions the steel fabricator starts changing the dimensions. So, this happens ok. So, this is a live example, like this so many information exchanges may happen and so many iterations can also happen, this is what I want to call it as an iteration. So, this says there is a lot of revisions which has happened with the teams as and when they started working on the details of the calculations based on their acceptance and criteria levels ok. This is primarily called as an iteration and you want to know as such what time this entire process will take place that is what is the scheduling we are going to calculate in this particular DSM topic.

Now, if you want to model this, what are the ways to model? I can really plot a team DSM; I can really have a parameter DSM. So, how many teams I have so far listed here? architect, steel fabricator, engineer, HVAC subcontract like this the list goes on ok. I can put all these teams and I can plot relationships between this for the particular example and with this I can really derive my time which takes for all these teams to interact ok. I can also equally form a parameter DSM. Parameter DSM how many parameters I have? I have four parameters in this case d, e, h and x just you can plot a DSM with the same and this will become a parameter DSM.

Note down the relationship between these parameters and then you can get the scheduled for the same project I can also have activity DSM, I can also have a deliverable DSM, I can also have a component DSM. So, like this you may you can build so many types of DSMs are possible, but whatever it is you should keep in mind I can have the same list of elements in my rows and columns and you cannot have a different party. For example, I cannot have architect, steel fabricator, d, e, h and so on. So, if you want to take teams it should be completely teams, if you want to take parameters you should be completely parameters in your rows and columns that you should not forget ok.

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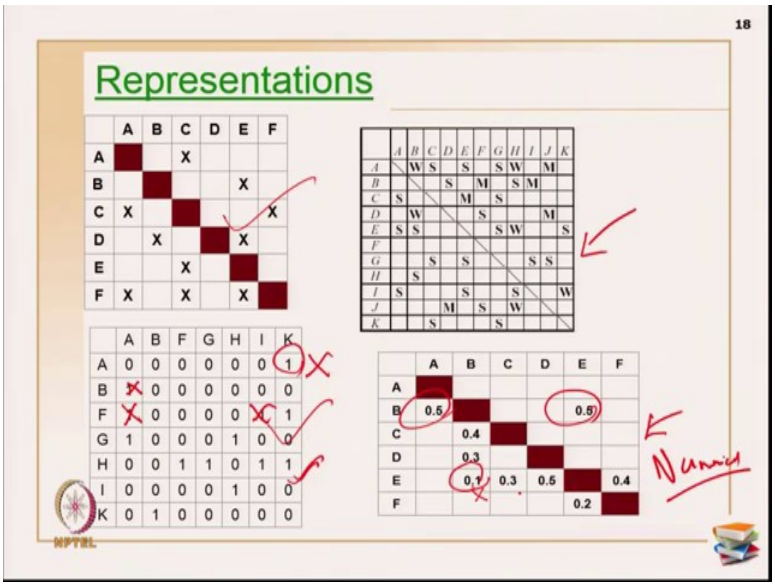

Then, talking about representations there are so many ways of representations. The default one I think I have told you, it is primarily X mark between the cells to show the relationship between the cells. I can have other forms as well. The same example

different examples sorry I have kept numbers as 0 1 this is called binary DSM and the one generally represents relationships between the between the two entities ok.

So, this means K gives information to A, A gives information to B, A gives information to F, I gives information to F and so on. So, I can still have a binary DSM on 0 and 1. This is also acceptable. I can also have variables for showing my for explaining my relationships. It can be weak, strong, moderate to show the strength of dependencies and varying you can try eliminate the weak dependencies for making assumptions and then you can go ahead in doing your schedules that is also possible, you can use variables, you can also use numbers ok. These type of DSM is primarily called numerical DSM and these numbers can mean anything to anyone.

This can also talk about strength of dependency. For example, E to B, it has a 0.5 as an indicator on strength of dependency. So, wherever I have less values like for example, 1, I can think of pushing this above the diagonals, so that even if I want to assume this I may land up in very little rework compared to breaking a relationship something like this or this with which you can still work it out and these are all the different ways of representing relationships on to a DSM ok.

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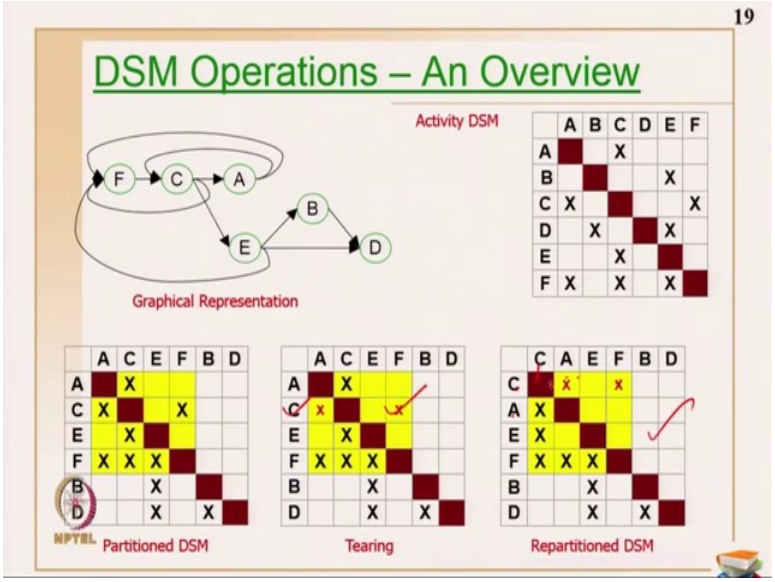

Now, let us move into operations. So, there are so many operations I have on the DSM. So, one is a graphical representation and the formation of DSM I have shown you for the same example how to form ok. Now, is as I told you this A till F shows a sequence of

execution. So, now, you will be very curious to know what is the nice sequence which can have a minimal rework and so on? So, for which there is a process called partitioning. Here if you see this block how many X marks are above the diagonal? Only two X marks are above the diagonal and compared to four X marks as seen in this figure ok. So, now, if you see the sequence of execution the sequence has changed from A, C, E, F,….. A, C, E, F, B, D and so on. So, this sequence shows that I have altered my sequence and so, that I have minimal X marks now above the diagonal ok.

So, now if you see here I have four X marks, here I have two X marks, still you can really work it out on this is to see whether you can still minimize the X marks and this entire block. Now, the shaded yellow portion is primarily called as a block. This block means these set of activities like A, C, E, F have to work together in order to finish off the whole work. That is what is the meaning of the block ok. Now, what I can do? You need to really know where I can choose my X marks so that I can make minimal assumptions and then I can work ahead in finishing my entire project. So, am I going to choose two assumptions. Assumptions are here for example, this place and this place and as a result my re-partitioning DSM is coming like this.

So, when I take these two assumptions. These two are the assumptions I have made. I am starting my C, then A, C, E, F when you are plotting your values on duration on D, C, D, A and D, E and for this sequence you will get a duration for what is the entire stretch on the project ok. So, that is what is primarily the basic operations you do. Then the next is primarily the iteration modeling wherein you plot the duration along the diagonal and then you really get the duration for the entire block.

Now, generally what we say is DSM generally has four operations: one is a formation – formation is not like a random case because a list of activities you identify itself is challenging which you should not miss. You can still go ahead with the same WBS structure and so on in identifying the list of activities there is still no harm, but if you fail to miss even a single relationship between the activities what happens is this complete partitioning and all will fail ok. You will get a different matrix at different a different solution altogether and you would not be able to work on the solutions. So, formation itself is very critical a task as such ok. So, let us see formation as a first step.

Next is partitioning, how to read sequence rows and columns simple excel we will be able to do it and I will show it to you. Next is tearing. For different combinations of assumptions, I will show you how are the different repartitioning happening ok. And, the last step is primarily called so, every tearing is generally associated with the re-partitioning and once a tearing operation is done then the last step primarily we call it as an iteration modeling ok. Iteration modeling only you plot the duration along the diagonal and then you work out as to what is the rework, how many times any activities repeated, what is the rework duration assumptions made and so on. So, these are the four steps we have in the DSM operations.

With this I am stopping for today's class. We will see partitioning in the next class.

Thanks.