Scheduling Techniques in Projects
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Lecture - 05
Line of Balance Method

Topic for today's lecture is Line of Balance Method. Line of balance method is not a new method, it is past 50-60 years. It is in industry and it is available. People have so much used line of balance method and we will see how to find the critical part of the line of balance method and before that we will have a short introduction on what is this repetitive projects all about or linear projects all about.

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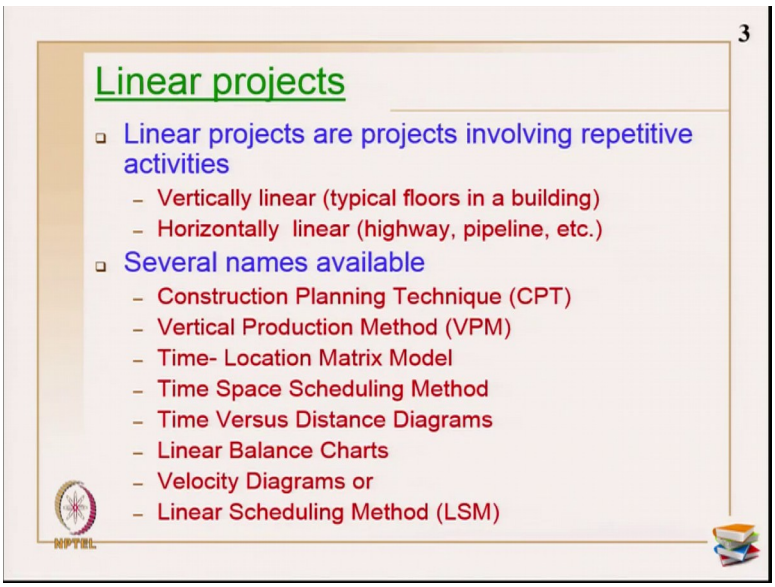

So Linear Projects; linear projects are the projects involving repetitive activities. It can be vertically or it can be horizontally repetitive in nature. Vertical repetitions primarily it is not linear. Vertical repetitions, For example, typical flows in a building. Horizontal repetitions can be highway projects pipeline projects and so on, ok.

Then several names are available to these methods and nobody knows where is the history and what is the origin of all these methods but there are n number of methods which are available and people are at most randomly used most of these methods. A few of them I have listed and the list is not complete list. Construction planning technique, vertical production method, time location matrix models, time space scheduling method,

location space matrix, time versus distance diagrams, linear balance charts, velocity diagrams, linear scheduling method and so on. So, there are so many names available to these type of repetitive projects.

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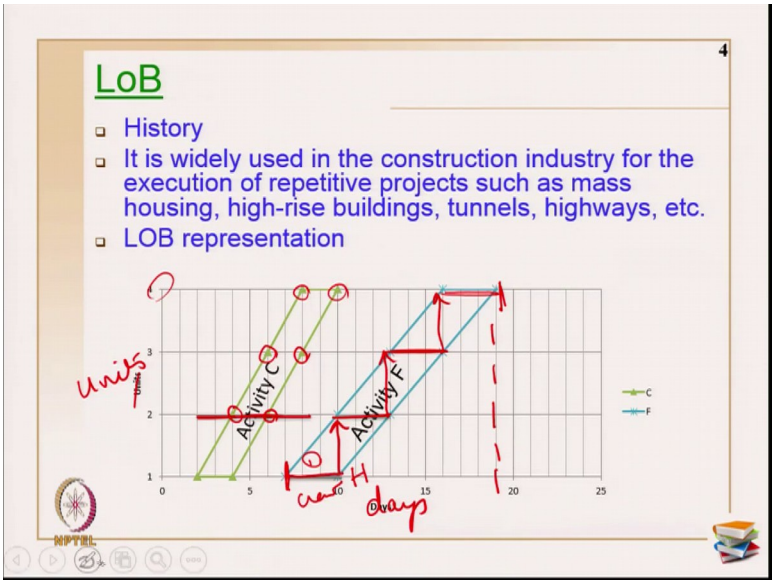

So, what do you mean by the repetitive projects and what is this LoB, all about say LoB and history. I told you it is a very old method existing ever since 50 years or something. It is very widely used in the construction industry even now for the execution of repetitive projects.

For example, for many projects like mass housing, high rise buildings, tunnels, highways etc people use this very widely and what is this representation on LoB and how do you represent a project in a LOB? As I told you this is a method for repetition, ok. So, if there are several activities which are repeating now when then, then this is a very good method to show it on that timescale. So, if you see here and this is a timescale.

So, I have written this in days and this is the units I have written here. So, this is a timescale, ok. I have just shown two activities here. So, this is activity C, this is activity C and this is activity F. So, how do I represent this? So, primarily this is a early start or the start of the segments and this is the finish of all the segments which implies I am starting my activity C on day 2 and I am starting and I am finishing my activity C on day 4 for unit number 1 which implies for the first time execution I am doing this maybe if it is for a pipeline project, maybe for one stretch I am starting my activity C on day 2 and

finishing it on day 4. On the 2nd unit I am starting it on day 4, finishing it on day 6 as the name implies here ok. So, these are the start and the finish of the segments in that particular unit, ok. That is what I have highlighted here.

So, for example this is unit 2. That is how we write. This is a short general notation for the repetitions to be shown. If it is multiple floors in a building, you can call it as floors 1 2 3 4. If it is like a pipeline project, you can call stretch of 100 kilometers or something.

So, like that you can vary this units but unit is a common name given to the repetitions and this can be a time-line. This is how the LoB is a two dimensional drawing, ok. Now if you see here, so at any point of time you are drawing a vertical line, horizontal line. So, it shows us our start and finish of that particular activity along that segment ok. Now what about these lines?

So, if you want to follow the crew continuity, so then I can also follow the crew continuity. For example this is the crew. So, generally default is one crew size in LoB diagrams. So, I have one group which is after finishing my 1st unit it is going to my second unit, finishing my 2nd unit and then it is going to the 3rd unit and then I finish and then I go to the last unit and this is my last unit completion.

So, if I want to know for example there is a crew composition called crew H or something. So, what is the time duration taken for a particular crew? It starts on day 7 and it is finishing on day 19, ok. So, day 19; so, that is how I have to interpret the crew representations also. Everything can be easily understood in LoB diagram, ok. Then, next suppose if I draw a vertical line on any point of time.

So, for example I have drawn this on 11 12 13th day, I have drawn a line. So, this shows what is the progress of the activities. For example, activity C has been completely done, activity F has been completed till unit two and it has started the work has just been started in unit number 3 and the remaining there are two units to be completed after this. So, primarily it shows the status update or progress update.

When you are drawing a vertical line anywhere you draw a vertical line, you will come to know what is the progress of the activity completions ok, then the next is a slope and symbol I have drawn here. So, the meaning of the slope is. So this I have drawn ok. I do

not know whether you can see. So, this slope symbol that shows the rate of progress of the activities.

So, if the activity is primarily close to the horizontal, it means a slower rate of progress if the bar primarily the bar which I have drawn here now for activity seen in green color activity or in blue color, if it is just close to the vertical, it means it has a fast progress or fast rate of progression, ok. So, which implies I may have multiple crew. When I have more than one crew, obviously the angle can be more ok. It starts tilting towards the vertical, then it means the rate of progress for the entire activity has become progressed very much, ok.

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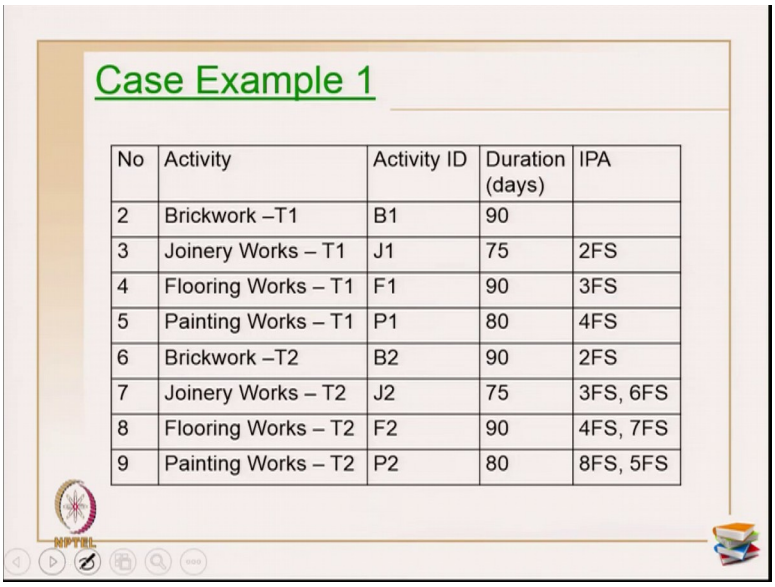

So, now let us take a case example to really understand what is the benefit of drawing a LoB diagram. We have so many methods why should we keep on learning. So many methods in scheduling that question can come to our mind.

So, for that the same example which I have showed you in the last class, I have just brought it up again.

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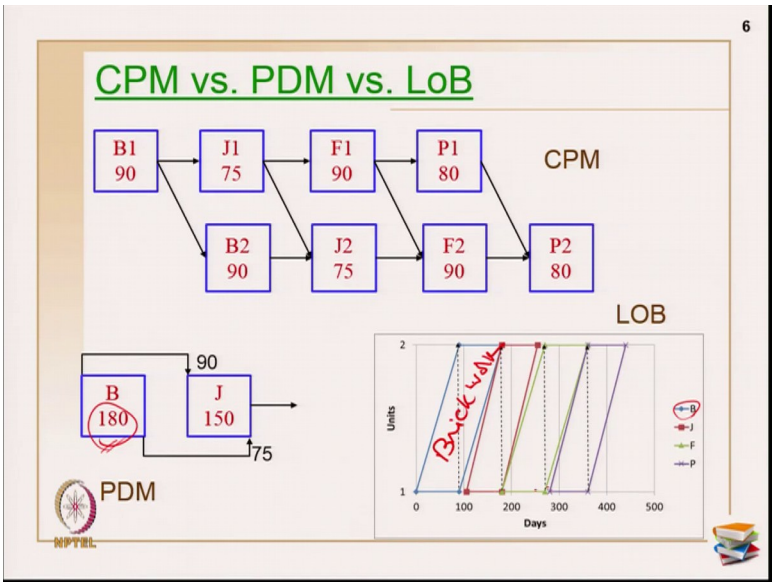

So, this is an example I have shown for discussing on the PDM example, ok. This you would remember right now. So, there are so many activities like brickworks, joinery, flooring, painting and so on. In two towers we have taken for example and only for two activities or so I have shown you how to represent it on a PDM, ok. CPM obviously is very boring because you may have to show all the activities repeating.

For example I may have 10 units, then all these activity will be coming in 10 unit in 10 times which is really boring and in case of CPM which is we call it as an activity based and more an abstract based you will call the representation in PDM but what happens they you will not even know when are the individual units completed started and so on.

Just with the 180 days you won't know when is the 1st unit completed, how many units are there, how many units are remaining, units are more to be completed. So, it is very difficult for you to understand in a PDM representation like this. So, next is a LoB representation I have shown for the same example. Same units is shown here and days are shown here. This example I have taken only two units.

So, I am only going to show the two units here. So, this is a real benefit of the LoB diagram which is a line of balance diagram, ok. So, the first activity which is the brickwork. So primarily you have to write it here. So, the brickwork starting on a day 0 and it is taking till 90 days here which is shown here and then the last unit 2nd unit is starting on 19, it is completed till 180. So, that is how we represent as I have shown here.

So, this entire project is completed on approximately up at 400 something, ok. So, easily you will interpret what is the different activities. It is not boring. You will also see what is a progress update, how many crews are acquired, everything can be visually seen with the help of a line of balance method, ok.

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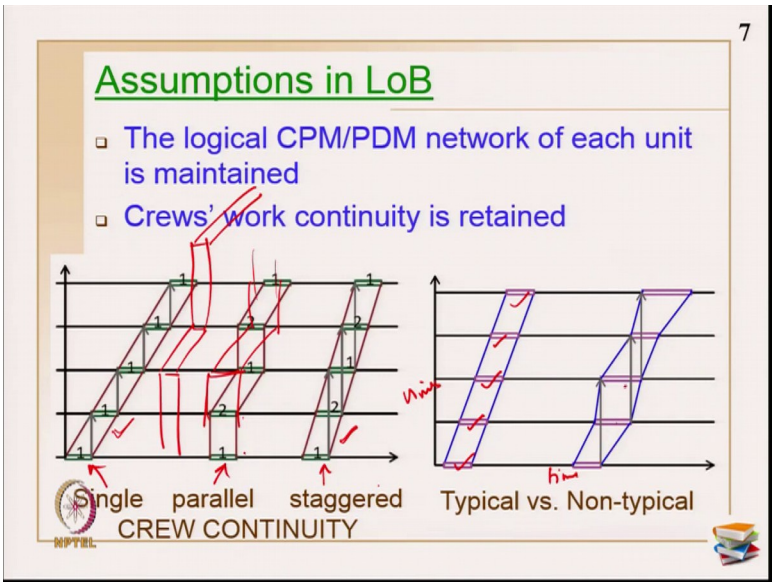

Now, with this example I have shown. Now what are the assumptions, how can I draw this diagram. So, that is what we are going to learn in today's class assumptions. Few assumptions I have brought it up here, the logical CPM PDM network in each unit is maintained which implies in this example if you see same example, I will just show you here. There is something called IPA, ok. For each of these activities this IPA has to be maintained for all the units in the in the network, ok.

For example, if you see here even in this LoB after this brickwork only, I am starting my joinery works, then I am doing my flooring, then I am having my painting works. The same thing is happening in unit number 2 walls. So, first brickwork, then joinery, then I am having flooring activities and then I am going to do my painting activities.

So, the logic of the relationship in standard CPM notation or PDM notation what you have followed it should be maintained in all the units. That is a number one condition that you have to maintain. Next, crews work continuity is retained, which is also I have told you. So, after the 1st unit the crew immediately has to move to the second unit. Once it is completely done, immediately it has to move to the 3rd unit and so on.

If you have multiple crews also, the same thing has to be done ok. For example, I brought multiple crew formations also here. So, this is primarily for single crew continuity, this is for parallel crew continuity and this is for staggered crew continuity.

There are three patterns available, and generally what we do, we follow only a staggered patterns in case of multiple crews and for single crews this is the only one pattern which we have and parallel is keeping the two crews in one or maybe if you want to have three crews, then keep all the three like this, then after then you start here and then you move all the crews. So, primarily you are having something like a tower formations, ok. So, I may have something like this and then this starts from here and then, I will have something vertical and then it goes on.

So, this maintain this form of a parallel notations is difficult to know model or represent. So, the assumption made in LoB is continuity we are maintaining, but we are maintaining in a staggered form only. That is what we are doing in LoB.

The next is typical and non typical. What is this typical and non typical? With this figure itself you will come to know. Durations. So, these are all the units and this is the timescale, ok. So, now if you see here the duration of the particular activity in all the unit is almost the same and that is also one of the assumption we have in LoB and but realistically in real world you may have different durations in different units, ok. That is not possible to be modeled in a normal LoB diagram, ok. So, generally we assume that durations are the same.

So, for example if you want to do the same painting work, it may take a different duration in one floor, it may take a different duration in other floor. There may be so many reasons for same set of activities, but duration can vary at every activity for different units at which you are working ok. But LoB does not assume all those. It assumes only to be in uniform duration, ok.

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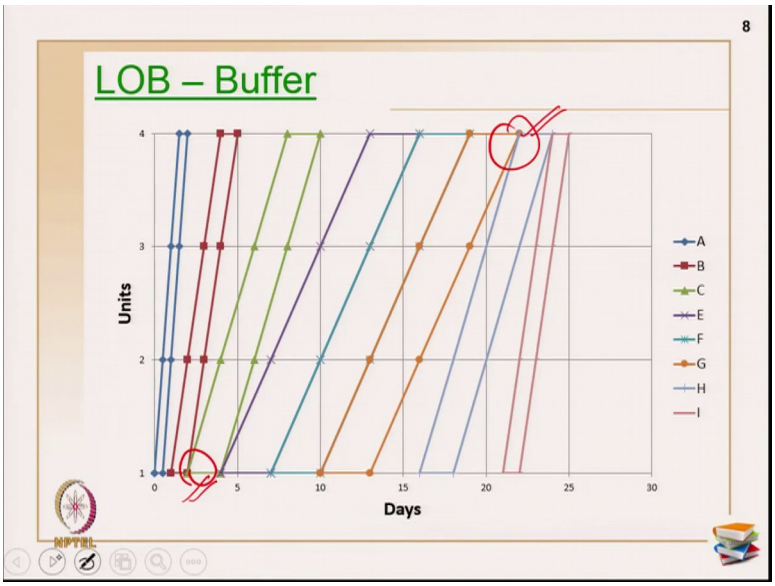

The next thing in LoB is the buffer. So, what happens in buffer and why should we introduce a buffer? Buffer is only for avoiding collision between the activities or we can say interference between the activities. Suppose if you do not introduce a buffer, you can see here the two activities are actually you know colliding with each other ok. There is something called collisions, ok. Primarily you need time for preparatory works or for setting up all your equipments and so on.

So, there should be a gap between these two activities, so that it is not really colliding with each other. For example, this is primarily in the start buffer, this is primarily we call it as an end buffer. Terminologies you will see later when we are working out on the problems ok. So, we should have a little gap between these two activities, so that they are not colliding or interfering with each other.

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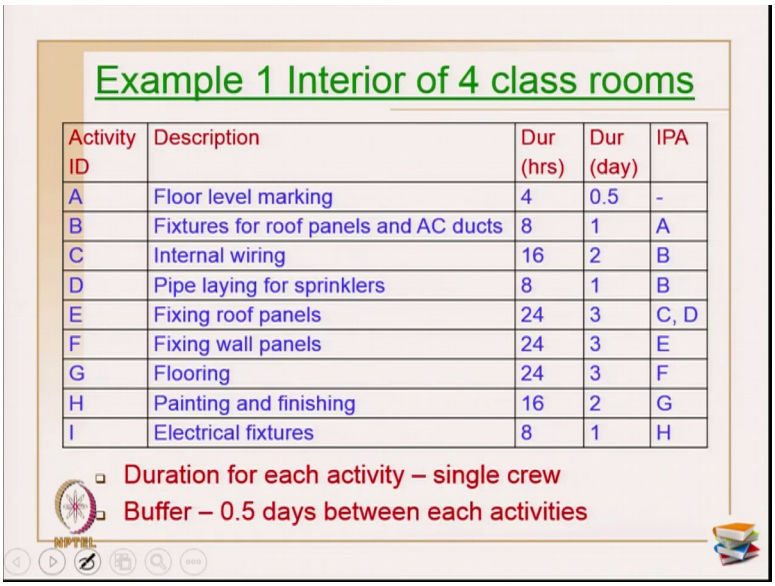

Now, let us move on for an example problem to really understand how to really do the critical path or calculating or drawing an LoB diagram on a for a simple example, ok. So, this is primarily an example on how do we do the interior for 4 classrooms, ok. We have taken for four classrooms, all are four identical classrooms. So, how do we do the interior works ok? So, these are the list of activities.

So, I have A,B,C,D, E, F till I activity and few activities only I have taken into consideration. One is floor level marking, fixtures for roof panels and AC ducts, then internal wiring, pipe laying for sprinklers, fixing roof panels, fixing wall panels, flooring, painting and finishing and electrical fixtures. Duration for all these activities for one unit we have worked out with one crew only which is taken as 4 hours 8 hours 16 hours 8, 20 24 and so on. The duration is as given here. Since hours is little difficult, we are converting into day. The assumption for conversion is what? The default working hours of 8 hours per day we have taken up and assumed to be assumed to be asked like this, ok. Duration in day we have taken. IPA for all these activities are here, almost all activities are in sequence except there are two parallel activities which implies this activity C and D are supposed to be in parallel, ok. Otherwise all the activities are in sequence. And 0.5 days buffer is given between each activities to avoid the interference between the activities. So, this is a sample data we have taken for showing the LoB calculations, ok.

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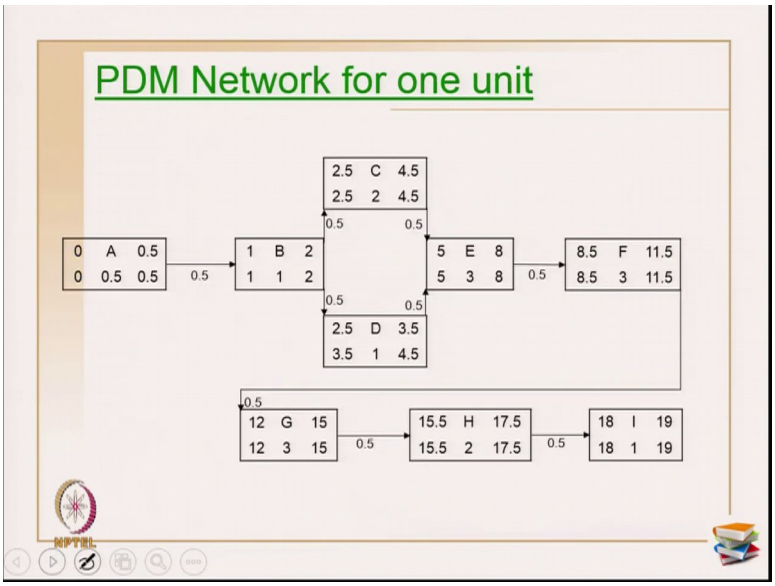

Now, first step is to do a PDM network on one unit. Why we cannot do a CPM network? It is because we have to show the buffers. The buffers are generally like a lag ok. If you want to show it on CPM, you may have to unnecessarily add an activity just to showcase a buffer. So, we are avoiding that. And it is better to go with the PDM network for one unit, ok. So, same activity A B, then I have C, then I have D. So, these two are in parallel, then I have E, then F G H I. As I told you all are in sequence except the C and D are in parallel and everywhere I have used the 0.5 buffer between the activities, ok. Here also 0.5 0.5; I have used.

And the calculations are done for forward pass and backward pass like in the last class and the project duration for one unit is coming out as 19 days, ok. So, just for the one unit if there is no break or something, so you will finish the entire one unit in 19 days. Now let us work on the LoB calculations, ok.

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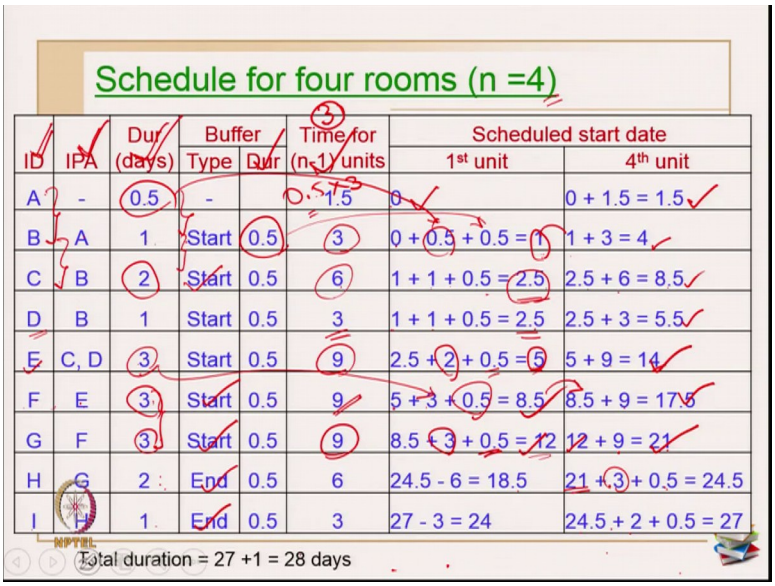

So, this is little a complex a table. So, if you follow along with me, then I think it is very easy for you to proceed. So, first what you do is forget about all the filled up data. So, just you have to take from your previous table on the activity ID, IPA for each of the activities, duration for all these activities, buffer, type, and duration. This generally I have written it in the second line onwards but primarily it is assumed to be between the two consecutive activities.

If you are if you are very comfortable in marking a line between these two activities, then you can also start writing. So, primarily it has to be like this and you can write along that ok, then time taken for n minus 1 units in this case n is equal to 4. So, this n minus 1 for us will become 3 units ok, then the schedule start date for the 1st unit and the nth unit is what you have to mark it.

1st unit is 1st unit that same and the nth unit for us is primarily the fourth unit because we are planning to work out for 4 classrooms, ok. So, the list of activities are taken from the previous table A till I. IPA for all of them is also known, duration also I have copied from the previous table only.

So, this is also there buffer type and duration cannot come right now. Only the duration or the buffer value between two activities is given as 0.5 0.5 0.5. That I have marked buffer type will not come. Now you have to start working it out, ok. So, this column is completely done, this column is also completely done, this column is completely done

because you are filling up data from the previous table, this column also you are completely taking from the data given in the problem only. The next is this. This you can fill it up. Primarily what are you going to do is, this is primarily 0.5 into 3. So, time taken for one unit is 0.5 and how many units I have? I have 3 units because n minus 1 is 4 minus 1 which is 3. So, this becomes 1.5.

Same way this is 1 into 3 is 3, 2 into 3 is 6, 1 into 3 is 3, 3 into 3 is 9, 3 3 are 9, 3 3 are 9, 2 3s are 6, 1 3 is 3. Like that you fill up this column. So, this column is also filled up ok, then now we have to start filling in the remaining part of the table. So, first schedule start day default we have to start on day 0 ok, then how do i. So, when do I start the 4th unit? the 4th unit I will start after 3 units are completed that will be 0 plus 1 and a half which becomes 0 plus 1 and a half. So, 1 and on 1.5 day you are going to start the 4th unit, ok. So, that is what we have to write.

Now, I am going to see the second activity. Now for that I have to see the IPA also. Second activity has an IPA with the first activity. So, I have to compare these two activities which implies A and B from a rate of progress. How do I show the rate of progress? The rate of progress since there are no multiple crews, the easy way to do is you can see the durations and then you can see the rate of progress. This duration for activity A is 0.5 duration, for activity B is 1.

Actually B is going little slower than A's progress. Half a day, half a day, I am finishing all my units in activity A. It takes one day for me to finish all my activities in activity B so which will be completed faster. Obviously A will be done faster than B. So, I can introduce this start buffer, ok.

So, I am going to introduce a start buffer. The minute you are going to introduce a start buffer, then you have to start filling up the first unit, ok. So, what will be the scheduled start date? This is 0 which is coming from here plus duration of activity A is coming from here which is 0.5 plus buffer between the A and B is again another 0.5. That is a next 0.5 which is coming here and this 0.5 is coming here. So, this becomes 1 for me and when can I start the last unit. As usual, this is 1 and plus, I need 3 days to fill up, to finish up all my 3 units. So, 1 plus 3 this becomes 4.

Now next activity is C. C has a sequential relationship or dependent relationship with B.

So, I have to look only for these two activities. What about the duration? This is 1; this is 2. So, it is still slower than the first activity. So, still I am going to say start buffer only. The minute I say start buffer, I have to fill up my 1st unit only first and then I have to fill up my 4th unit. So, this is again 1. It comes from here, this is 1 plus duration of activity B is 1, plus 0.5 is the buffer between B and C that is also 0.5. This becomes 2.5. So, schedule start date for the 4th unit will be 2.5 which is here and plus time taken for finishing my n minus 1 unit is 6. So, this becomes now 8.5.

Now the critical issue starts which is parallel activities ok. Now I am having activity D IPA is B. So, I should not look with C. I have to look with activity B only. So, what about activity D and B? So, activity B and D both are having duration as 1. So, what happens here? Start buffer, end buffer both are same because there is a same rate of progress between these two activities. It is comfortable for me to write start buffers. So, I am going to write start. If you want you can write end and then you can work backwards also. There is no harm in it, ok. So, now what I am going to do here?

So, now this is I am I am stopping B at 1. So, I have to take 1. Do not by mistake copy the 2.5 here. So, this is now 1, 1 plus duration of activity B is again 1, buffer is also 0.5 between these two activities. So, this is again 2.5 and this is this 2.5 plus 3. This becomes 5.5 here, ok. Now next is activity C.

So, for activity C, I have to check activity C and D. Both are my predecessors, ok. So, now activity C has a duration of 3, C has 2 and this has 1. So obviously this has a still a slower rate of progress. So, I am going to still introduce a start buffer only, ok. Now what am I going to do? So, both these values are 2.5. So, I am going to start at 2.5 plus duration of activity C is 2 which is coming from here. So, this is the 2 plus 0.5 is the buffer between the D and D, E or C and E. Both are same. So, I am going to add this 0.5. So, this becomes 5 for me, ok. Now here what happens this is 5 and the duration taken for n minus 1 unit is 9. So, 5 plus 9 becomes 14 here, ok.

So, this is done now. Activity F it has an IPA with E. So, I have to compare activity E and F. Only both are having same duration. So, again start or end buffers, both will have the same results only here. So, I am going to introduce the default start buffer here. So, this is now 5 plus duration of A is 3 here. So, this 3 is coming here buffer between E and F is 0.5, this is 0.5 and this becomes 8.5, ok.

Now scheduled start date of 4th unit is so this is 8.5 plus 9 units it takes for n minus 1 units it takes, 9-9 days. So, this becomes plus 9. So, this becomes 17.5, ok. So, now coming to the next activity G and IPA is F which is an immediate. So, I have to compare these two activities. Again, these two activities are having the same duration.

So, I am again introducing a start buffer here, ok. Now this is 8.5 plus time taken for activity F is 3, that 3 is coming here, plus 0.5 is the buffer between G and F that is 0.5. So, this becomes 12 now ok. Now for the 4th unit this is 12 plus time taken for n minus 1 is 9. So, this becomes now 21, ok. Now I am at activity H, IPA is G. What about the duration? I have to compare with H and G. This duration is 3, this duration is 2. So, what happens here? So, this has a little smaller a duration than the previous one. So, we may have to introduce an end buffer. So, we may have to introduce an end buffer here ok.

So, I have to start from the 4th unit only, ok. Listen carefully here. So, since the duration is little smaller, I am introducing a end buffer. The minute I am introducing end buffer, I may have to start from the last unit. So, this becomes 21 plus duration of G is 3, ok. That is coming from here and plus buffer is between G and H is 0.5. So, this becomes 24.5. How can I find out the scheduled rate of the start date of 1st unit? It is 24.5 minus 6. So, this becomes 18.5, ok.

If by mistake if I am starting on 12 plus duration of activities, 3 plus 0.5 which is 15.5 as by using a start buffer what will happen is after 2 or 3rd unit I may be just colliding or interfering with the F activity or something.

So, in order to avoid that only we are introducing an end buffer and then we are deciding the scheduled start date of H in order to avoid the interference between the activities. In the next activity is I and the IPA is H and if you compare the H and I, this is 2 and I is only 1. So, obviously it is a faster rate of progress and it will be finishing fast. So, again I am going to introduce an end buffer. When I am introducing an end buffer I have to come from the last.

This is 24.5 plus duration of H is 2, buffer between H and I is 0.5. So, this becomes 27. So, what about the scheduled start date of 1st unit of ith activity? So, this will be 27 minus 3 which is 24, ok. Now what is the project duration? I am having project total duration that is 27.

So, scheduled start date of 4th unit is 27 and plus 1 day duration of activity H you have to add. So, 28 days it takes to complete for the entire 4 units, ok. Now that is what we have to understand with the help of this LoB table. So, this table will help you to make the LoB diagram.

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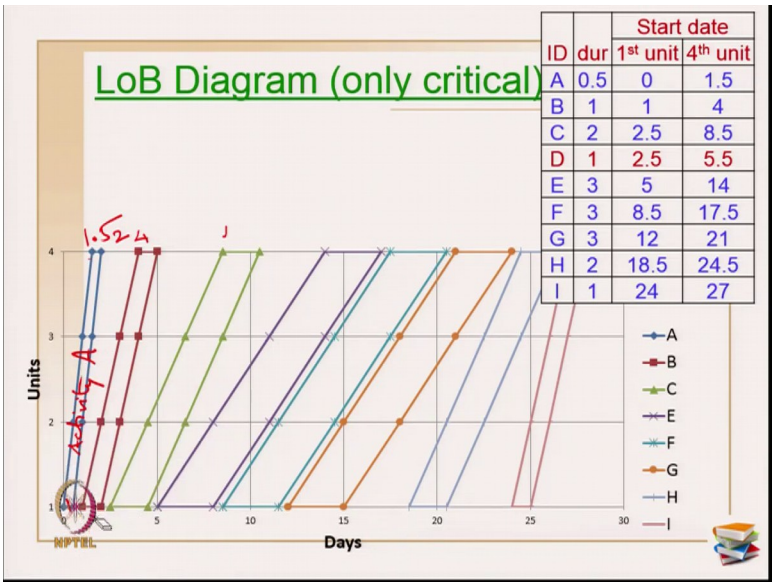

Now, what I am going to do, I am going to copy my 1st unit values, 2nd unit value, so that it is easy for me to show, it is easy for me to finish up the LoB diagram. So, I have copied my table here, ok. All these values still 27. I have taken start data 1st unit and the 4th unit of all the activities I have obtained with the previous table, ok. So, now I am going to plot the LoB diagram. Only for critical activities I am plotting right now.

So, the D is the non-critical activity which we have identified earlier, and which is also very clear with the duration also. So, D is the non-critical. So, I am not showing it right now. There is a purpose behind. I will show it later. So, same way so y axis I am having the number of units. So, 1 2 3 4 units four classrooms x axis I am keeping days and the duration is 27. So, I am having a unit till 30, ok.

Now what I need is these points will tell me what are the points to be plot on the graph. Maybe you can take a graph sheet or you can plot it on excel using charts. Whatever method you are comfortable, you can do. I have used charts for plotting the same. So, A activity. 1st unit, start of first is 0, start of 4th unit is 1.5. So, this value is actually 1.5 and this is 0 here ok.

Now what about the finish of activity A? 1st unit that will be 0 plus 0.5 adding up the duration. So, that is 0.5 here. 1.5 plus 0.5 this is now 2, ok. Now first you got all the four points. So, you can just plot the activity A. So, this is now activity A. Now I am starting with activity B. The 1st unit is starting on 1, ok. I am having a 0.5 buffer, start buffer that is why starting on 1 and the 4th unit is starting on 4, sorry is starting on 4 ok. So, this is also here. So, this is 1 and this is 4, ok.

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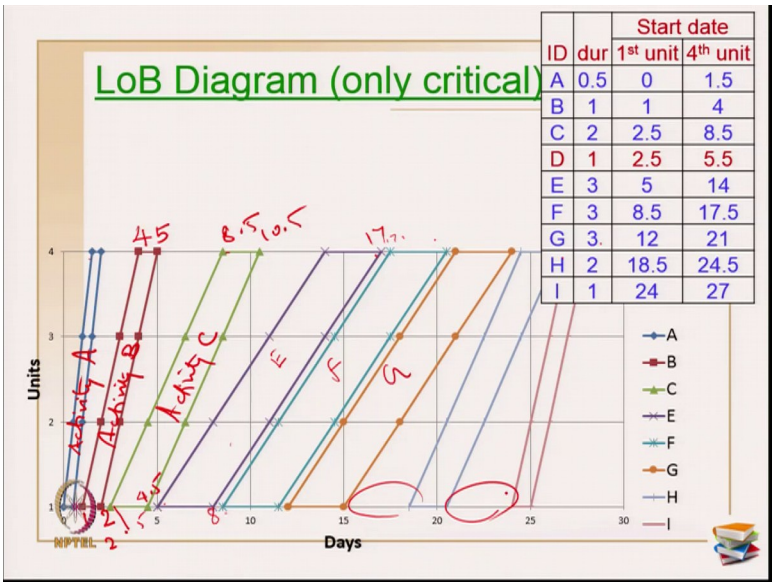

ID	dur	Start date 1st unit	4th unit
A	0.5	0	1.5
B	1	1	4
C	2	2.5	8.5
D	1	2.5	5.5
E	3	5	14
F	3	8.5	17.5
G	3	12	21
H	2	18.5	24.5
I	1	24	27

Adding duration of B. So, this is 1 plus 1 is 2, 4 plus 1 is 5, ok. So, now I got all the four values. So, I can plot my activity B ok.

Now next activity C. So, activity C first unit. So, this value is 2.5. So, this value is 2.5, and this value the start of 4th segments. So, this is now 8.5 adding the duration of activity C. So, this becomes 10.5. So, adding plus 2. So, this is 2.5 plus 2, this is now 4.5. So, now I have got my plots for my activity C ok. So, similarly we have to finish up for the all the other activities. So, activity D, I have skipped right now because it is not critical. There are other ways of showing D. We will show it later. Now activity E. So, starting as 5 and 4, the last unit is on 14. So, 14 plus 3 this is now 17, ok. So, 5 plus 3 this is now 8, ok. So, activity E is all the four points are obtained. Activity F, So, this is 8.5 duration for F is 3. So, this is now 10.5. sorry this is now 11.5 and the nth unit is now 17.5. So, this is activity E and I am on activity F. So, this is now 17.5 duration of F is 3. So, this becomes 20.5.

So, and I have got my bars. So, these three bars are in parallel because duration of the three activities are same that you can see here 3 3 3. So, all these three activities you can see E F and G are like parallel activities, ok. The bars are almost like parallel and since H and I are having a reduced duration than E F and G you will see here. I have introduced only n (Refer Time: 33:15) buffer in both the places. There is a lot of float in the starting place in the start units 1 and 2 in both these activities, ok.

So, that is what you can infer from these diagrams. Apart from a horizontal line what is the interfere meaning of the horizontal lines, any vertical line, What is the meaning? You can still capture with the help of or the LoB diagrams, ok.

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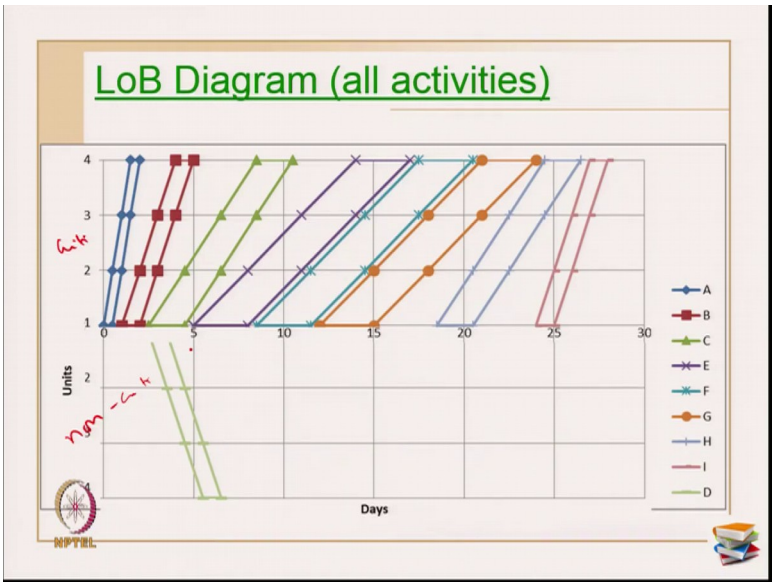

Now I am going to show all activities. There are two ways of showing all the activities. One is I have kept this activity D, this is activity D. You can overlap the non-critical activities also and merge along with the critical activities like how I have shown here, I have overlapped this. So, this is my activity D. I allowed it to overlap with activity C which is also possible that you can do or you can have two axis; one for critical. So, these are all for critical and you can keep the non-critical activities below the axis and you can still show the same all non critical activities down. So, both the ways are possible. You can use any one of the options you are comfortable ok.

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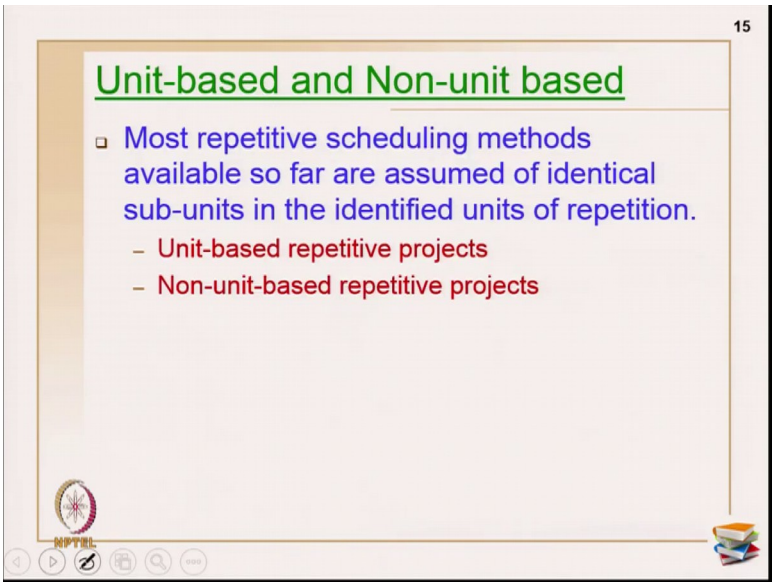

So, this is a very simple very simple case on how to represent a very typical duration on representing it on LOB. All units are same, everything is same, duration for all activities are same only. One crew we have used ok. Suppose if there is a pressure on completion and I have to finish this activity for example same example, we will take ok. This entire project is completing on 28 days.

Suppose if I have to finish the all the projects on day 15 or something if there is a pressure on completion happens, then where all I should employ multiple crews and how many crews I have to employ still how can I maintain the crew continuity, there are calculations done which I am not covering in this particular lecture, ok.

But people have worked on how to use multiple crews in order to shorten the project duration. So, this general assumption is I have used only one crew. You can see that you can calculate. See here this is the first crew. The same crew will be moving up for 2nd unit, the same crew is moving up for the 3rd unit and then it is moving up till the end for the last unit. You can see that in all the activities, the default assumption is only one crew is assigned for all these activities. That is where you have done, you have got the calculations like that ok.

Now, so that I have not covered. Another segment of work also I have not covered, but I will just introduce and complete this lecture which is called non-unit based. There is something in the literature which talks about unit-based repetitive activities and non-unit-

based repetitive activities. So, what is the meaning of unit-based and non-unit based; most repetitive scheduling methods available so far and assumed of identical sub units and identified units of repetition. For example, even in the same, let us assume I have an activity called Excavation sub base and so on. So, excavation may look same for the entire stretch maybe drawing you are laying a pipeline of 240 kilometers or something for the complete stretch in highway road or something.

So, for the complete stretch you may be having an activity called excavation, but the entire sub unit may not be the same. I may be having a different type of soil. I may be also landing upon rock excavation. So, the equipments may differ the way, number of sub activities in order to do the excavation may differ. I may not be having the same activity as such throughout in my sub units also throughout in my repetition stretch, ok. So, they are all called non-unit based of repetitive projects, ok.

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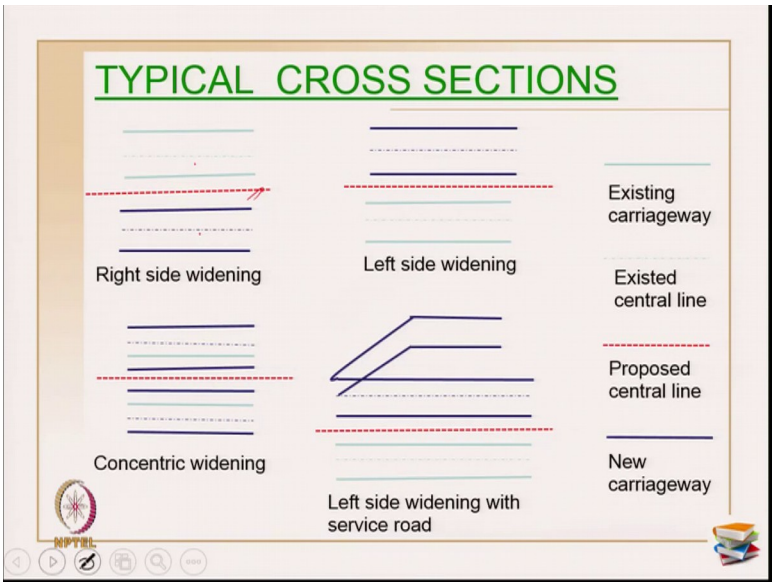

For example this is again I have taken two examples just to showcase, just to explain you or make you understand what is a non-unit based. I think you have heard of highway widening projects, 2 lanes to 4 lanes or 4 lanes to 6 lanes.

So, this is also a highway widening project if you see here. So, there is a proposed central line here. So, the existing carriageways this color shows the existing carriageway. This is the new carriage way, the violet ones are the new carriageway which is proposed

and the red one is primarily the proposed to central line. Earlier this is the central line for here and this is a central line for here.

Now this is a proposed central line as a result of the widening of the road projects, ok. This is primarily called right side widening. The same thing happens in left side widening, ok. So, this is an existing one, this is a proposed one and this is a proposed central line in case of left side widening.

Now, suppose if you want to have concentric widening then I may have the proposed central line and I may have to widen the project on both the sides ok. That may happen in the concentric widening, then the next is with service road left side widening with service roads. So, there is an existing carriage-way here and then I may have a service road connections in order to widen with the service roads.

Now what happens here in this particular cross section, suppose I am taking a highway project, I have to do let us I say 250 kilometers or 300 kilometers of a stretch of National highways. I am going to widen the highway in to 2 lanes to 4 lane or 4 lane to 6 lane whatever is a case what happens throughout the entire stretch if you want to draw a LoB diagram, you may be identifying few activities like For example weight mix macadam, then granular base, sub granular base like that excavation embankment, you will have similar set of activities throughout the entire stretch, but what happens the items or the sub steps under each of these activities will not be the same because of the differences you may have to go through in the project. Somewhere some place you may have to do right side widening some place.

You may have to do left side widening, some place you may have to do concentric widening and accordingly what happens the sub activities or the sub steps in each of these activities will start differing and this is widely very famously called as non-unit based repetitive projects.

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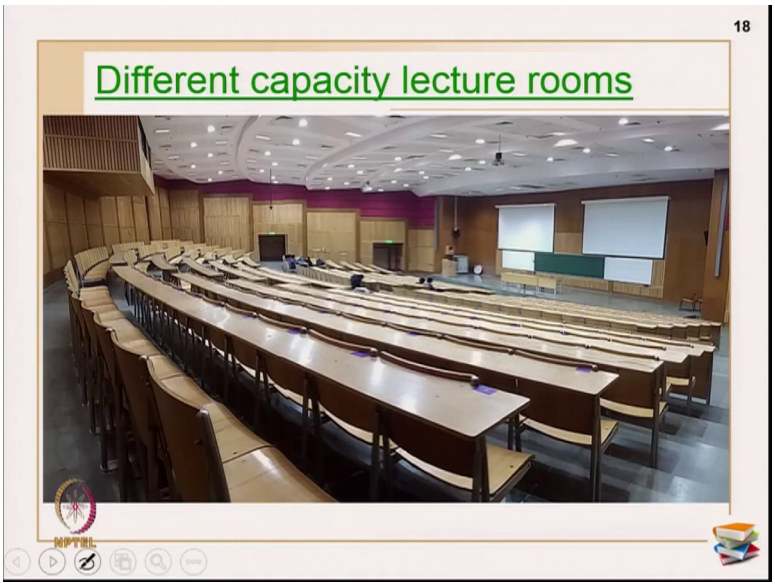

Now, for the same example which I have shown now as the interior of the classrooms, ok. I may be doing the interior of 4 classrooms maybe even 15 classrooms, I can even do for 20 classrooms. If you want to showcase an LoB diagram, the activity items which I have marked right now will be the same, but the number of sub steps will be different and hence, duration can also be different for all of them.

For example, I may have different capacity lecture rooms. I have taken few pictures just to show that the different room layouts itself can be very different. It is not just addition of table chairs and so on but it can be even the layout inside can also be totally different, ok. Here you do not have a projector or something. Only main projector with the fire protection systems and so on.

This is the arrangement little bigger classrooms, two projectors, two whiteboards, one blackboard. So, all the setups you will have more settings in the same room. So, a different way of setting up all your fire sprinklers, your(Refer Time: 40:53) ducks running up your AC services and so on.

So, this is very different, little more a larger a classroom. So, what happens is the items may be different ok. I may have the same activities like what I showed you earlier like floor marking, floor finishing and all these may be same but the number of units, sub units in all may be varying. So, with this I will just stop my lecture on Line of Balance Method.

So, today I have just introduced a small topic only which is how to calculate the critical path and how to just showcase a LoB diagrams. That is what we have seen and that too only for a regular case which is too simplistic in nature, only single crew on all activities and with sequential or parallel activities in place; how shall I you know plot my diagram that is all we have discussed but there is so many other things to cover which I am not covering as part of this lecture. If you are interested you can go through relevant literature and you can understand.

Thank you bye.