Project Planning & Control

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Lecture – 27

Week - 05

Time–Cost Trade–off (Crashing)

This lecture will, we will cover this concept of what we call Crashing. So, crashing is nothing like, but reducing the duration of a project, by reducing duration of an activity. And we also call this time cost trade off and we will see in a few minutes why we call this time cost trade off.

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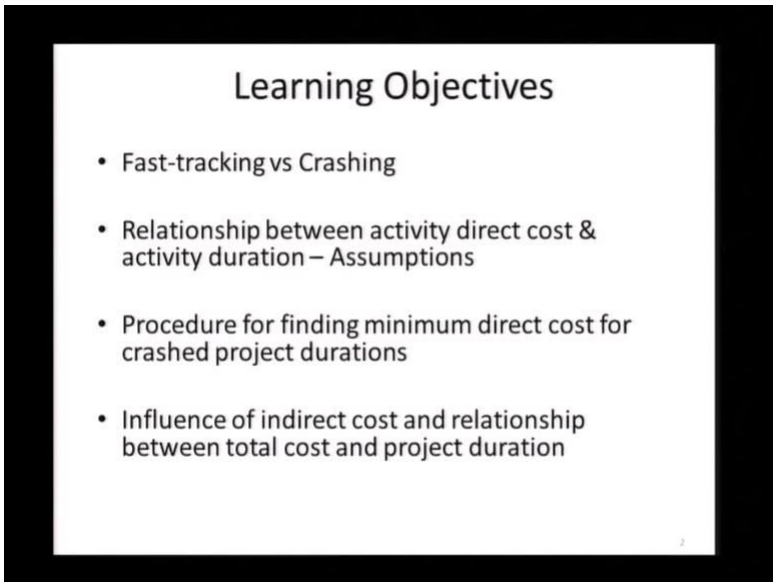

This is the first lecture, there will be another lecture which will again, we will work out problems in network and project crashing. So, we will cover these topics specifically, one is the difference between fast tracking versus crashing, then looking at relationship between activity direct cost, activity durations and the assumption in these. The procedure of finding the minimum direct cost for crash project duration, this will take bulk of our time today and finally, the influence of indirect cost and relationship between total cost and project duration. So, these are the learning objectives for this session.

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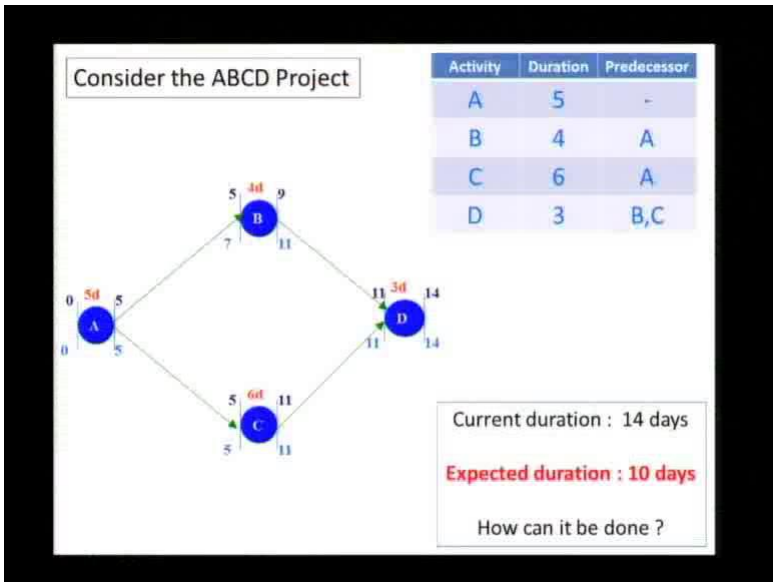

Now, let us get to our favorite project it is a simple what we called the ABCD project and as you can see here, we have a we have the 14 day completion and let us assume or let us say that the person, who gave you this project wants it done in 10 days; right now it is 14. What are your options?

Student: Reduce the project duration between activities.

What, so which project duration would I reduce, what activity duration would I reduce, is there anything else other then, so one is I reduce duration of activities. So, I have to focus on critical activities and reduce the duration of critical activities. Now, I can, so right now the critical path is going through A, C, D, so one option is to reduce either activity A, C or D and right now, we do not have enough information on what, but for example, this is I want to reduce it by 4 days, this activity is only 3 day duration.

So, I could actually reduce say this by 2, this by 1, this by 1; there are combinations of this which I could reduce. Is there any other way? We discussed something yes in the last class, when we did the bridge problem.

Student: In parallel.

Yes, so I could do, I could try to do more things in parallel and that is what we call fast tracking. So, it is not a standard definition, but a very well used definition, if I try to parallelize more things it is fast tracking. So, here is there anything I can parallelise?

Student: No.

Right now based on the relationships no, but you know if I could somehow start D you know before 11 or you know start B before A finishes, if I could start parallelizing, then I have to break these relationships.

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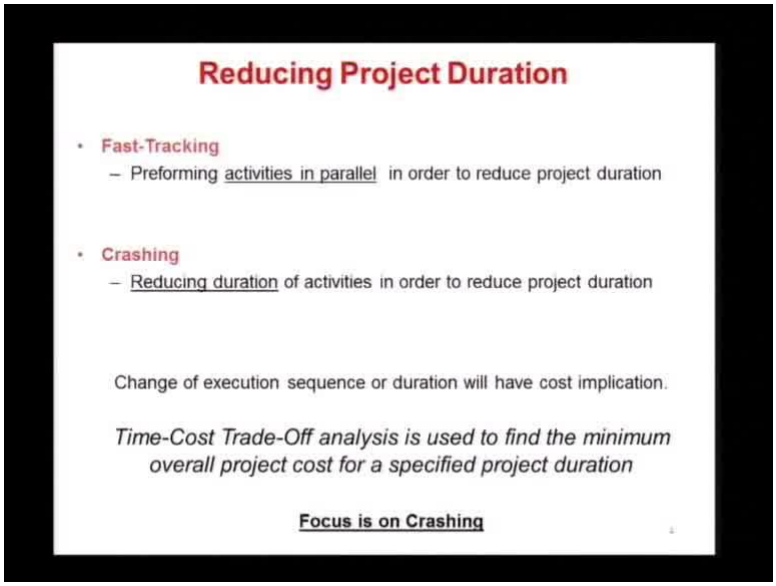

So, if we actually look at the, the ways you can reduce project duration will get say fast tracking, where we perform activities in parallel or crashing, which is reducing duration of activities to reduce project duration. So, what we are going to deal with in this session is crashing, fast tracking is possible, but; obviously, you know and in practice fast tracking is something that is used commonly.

But, as far as our network, sequence goes we do not want to change out the relationships as enough now; we will talk about more from a theoretical prospective how crashing can be done. We will look at, change I mean change of execution sequence or duration certainly have an impact on cost, we are again not looking at executions sequence we going to look at duration. And we will look at this time cost trade off, we will look at the analysis of this to find the minimum overall project cost for a specified project duration. So, we will take these elements and we move forward, so like we discussed the focus here is on crashing.

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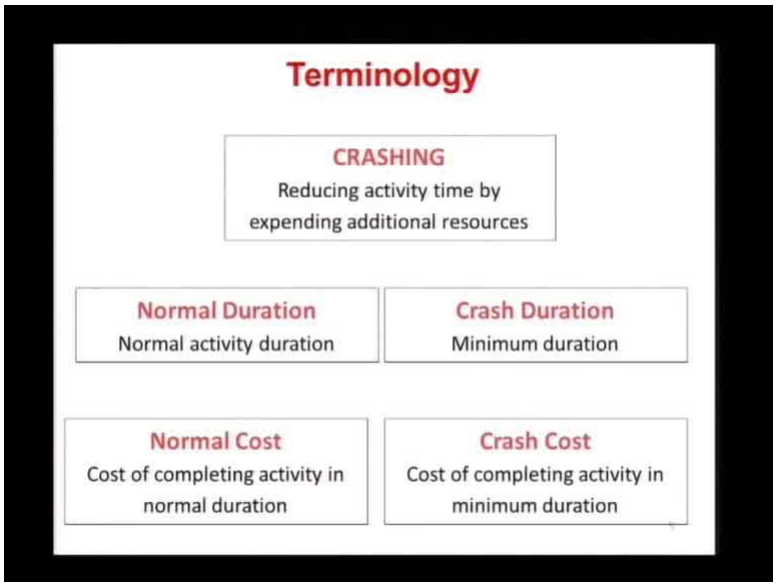

Now, some terminology when we talk about crashing, so it is very a kind of when you first time when you hear a project crashing you think of negative things, we know what is happening, but this is an accepted terminology; basically crashing is reducing activity time by expending additional resources or there are other ways to do it too. We have definition of, so far we have only talked about duration. When we talk about project crashing, we talk about normal duration, we talk about crash duration and this is with respect to an activity initially. Normal duration is a duration we have been using right now for all of our CPM analysis, there is also a crash duration, which we will come to later.

Now, more importantly we also have a normal cost and a crash cost. So, the normal cost is what we spent to do this in a normal duration, a crash cost is when I start compressing the activity, what is my cost that is going to happen. Now, if you take a look at these definitions and these terms, what you think is the relationship between cost and duration.

Student: Duration decreases cost will increase.

Duration decreases cost will increase, why? This is, remember we are talking with respect to only an activity, we are not talking with respect to the project here. We are talking with the only respect to the activity. So,

Student: Mostly when reduction duration satisfy employing additional resources.

Right, so when you reduce duration it is by employing additional resources, so we will come to the ways we can reduce duration we have to employe additional resources, what else?

Student: Adapt new technologies.

Yes, here we have adopt new technologies, so I know instead of using a particular method I will going for a more, let say prefab or something that reduce the duration there, in which case I have to pay more for it for the activity. Over all project we'll have to see how the reduction of duration affects; that is coming later. I might use alternate construction materials?

Student: Manpower and all the material is reduced, I mean we have to procure it in a very short period of time.

Right, so I will be paying a premium. If I want to mobilize more people on side I might have to pay a premium, if I need more material etc. I might have to pay a premium for that.

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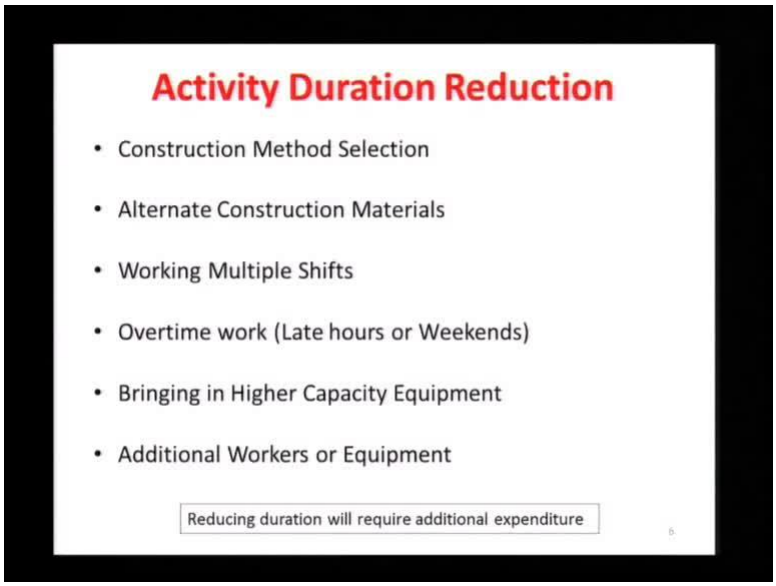

So, if I use alternate construction material for examples self compacting concrete will reduce my durations, but I might to have to pay additional cost for getting that in my formwork have to be different. I can work in multiple shifts, but every time you work in multiple shifts it is not the same cost people who work in the night shift have to be paid more. So, it will cost for the same output I'll have to pay more for it, but my duration

might my calendar duration reduced overtime work again I have to pay more for overtime work bringing in higher capacity equipment.

Again between I can get more output for a, but my cost might be more most likely it is going to be more we talked about this putting in additional workers which means, now I have a fairly crowded work site or work area and which case the productivity will be now lower output, might increase, but the productivity will be lower. So, in all these it is been found that reducing duration of an activity will typically result in increased cost.

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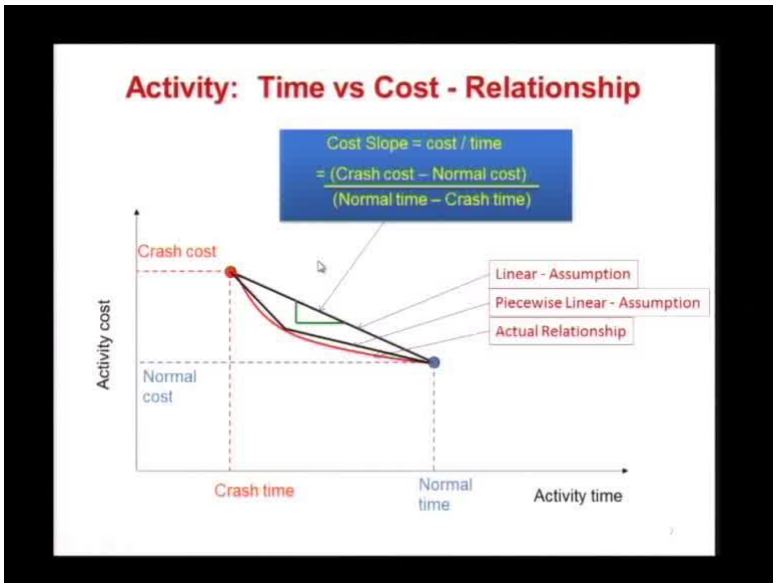

And if we look at the relationship, so here I have activity and you know have the time and the cost and again I am very I want to you know this is activity time cost relationship we will come into project time cost later. So, we look at the curve here, so we typically you find that the relationship is as time increases the cost will decrease and then, you actually might does continue this way if I am taking only direct cost and that is a normal duration, which is we based on normal productivity we will call this is the normal time or duration and this is the normal cost.

And as we reduce a duration we come into the crash time or the crash cost. Now, while this is kind of I mean people have shown and calculated this is a actual relationship you'll have to make assumptions on this if you have to work with it kind of in a classroom context. So, one assumption is we take a piecewise linear we assume this is a piece wise linear relationship in which case it is two steps or a simpler assumption is to

make a fully linear relationship in which case its one step from normal time and normal cost to crash time and crash cost.

So, this simplification assumption we make it for our calculations further while be as we know that this is actually some kind of a non linearity is there we know there are any effective ways of making piece wise linear to model the non linearity or model the non linearity directly for our purposes right now, we just going to make a full linear assumptions. Now, if I what will the slope of this line indicate.

Student: Cost per unit time

Cost for unit time being cost the unit time.

Student: Increase in cost.

Increase in cost per, so for each day of crashing yeah, each day of crashing how much additional money do you have to spend for that activity. So, we have this term which we have use, which is the, you have the cost per unit time and we are looking at it from a cost you have to spend point of you. So, we are just defining it as $\frac{Crash\ cost - Normal\ cost}{Normal\ time - Crash\ time}$

So, that will give us the how much money have to be spend for each day of decrease in duration, so this is a basic concept.