Project Planning & Control

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Lecture – 39

Lesson - 08

Applying Improvement Factor – Illustration

Now, let us take this into.. you know.. an application, you know.. a kind of exercise.

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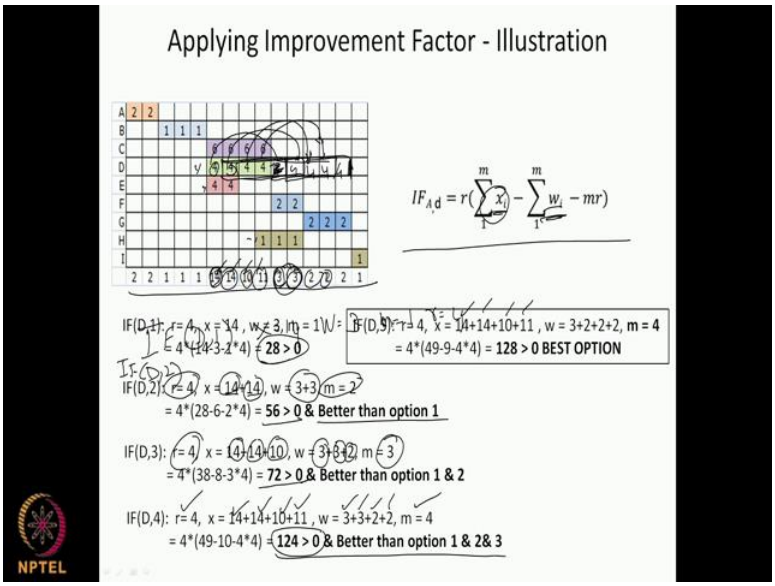

So, here we have the resource profile that's shown here and you know this is our same exercise, where D, you know.. D can be shifted and we also know that H can be shifted and E can be shifted. The other activities are critical. And here is our improvement function formula again and let us try to apply this in this particular case. So, with these are exiting resource profile, before the shift this is the resource profile.

If you see, we can start with D, so we start with improvement factor for D by 1 day, so this is what I would like to start my calculation with and you can see that if we take D by 1 day. So, here is D, the X_i will be 14, so X_i, X so in this case it is just X for 1 day is equal to 14. Now, what is going to happen is it is going to move on to this place, so W is 3, 'm'- the shift of resources is by one day is 1 and 'r' - which is the resource rate of this is equal to 4.

So, now, I have to apply this back into this equation and I should be able to get the, I should be able to see what is the result of that and when I apply it into the formula I get 28, which is greater than 0 and if because 28 is greater than 0; that means, the shift is going to be that is moving 4 to one spot here is going be beneficial to that. This will of course, change the resource profile. So, now, from the 14 would become 10 and things would change on this side.

Now, in the next step I want to see what is it, what is the improvement factor for changing D by 2. So, if we look at D by 2, so again we come with, see now 'r' remains to be 4, 'X' which is this factor is now 14 plus 14. This is sigma X, so this is 14, because I am moving this two step this time, I am going to move it here. So, the resources from this move here, so those 4's will go 4 and 4, so what happens to the…

So, this X remain, X is that 14, 14 plus 14 are the two X's and what happened to the W, the W's are what is here is now the 3 and the 3. So, these 3 are what is here and my shift of 'm' was by 2 days and if I substitute this into the formula I get 56, 56 is certainly more than 28, so shifting D by 2 days is better than shifting it by a single day. So, that is what the improvement factor indicates.

I go on to now trying to shift D by 3 days. Yes, I can shift D by 3 days. So what happens is the 3 days is my 14, 14 and 10.So, here we see 14, 14 and 10, this is what my sigma X_i is. So now all these, so this one also shifted here and on this side I have 3, 3 and 2, which is 3, 3 and 2 which was my W_i. My shift now is for 3 days, so that was 1, 2, 3 and my 'r' still remains at 4 and substitute back in the formula, I get an even better improvement of 72, it is better than option 1 and better than option 2.

So, we now go on to, can we move by more? Yes. So, if you recall, D can move all the way or at least we are going to say that D can move all the way up to here in this particular case. So, I can move it to the next step, so D is gone to 4 now, so which means this is also moved here. Yes, with this step my D has become 4, 4, 4; all of these have been cleared out, so 14, 14, 10 and 11, so that is 14, 14, 10 and 11 and on this side we had 3, 3, 2, 2, 3, 3, 2, 2; that is the whole 4 has come here, so you have 3, 3, 2, 2.

Now, my shift of m is by 4, so my 4 days of resources got moved, so 'm' is 4 and my "r is of course, 4. Again applied, I get even better reduction; that is 124, magnitude is higher than the other, so it is makes… The metric is telling me that this shift is better than the others. Can I shift D by any further? Yes, I can shift D by even one more day, but

remember the D's duration is 4. So, if I shift D by one more day what happens is D comes here, this goes off. I have move D by 4 days, I jumped this one day. So, if I look at my options, yes, I have my 14, 14, 10 and 11; that is where I am moved; that is my X_i that is where I moved it from and I moved it to these days. This is the 3, 2, 2 and 2; 3, 2, 2 and 2. So, this movement and now what is the value of 'm'? So this is the critical question. I have actually move D by 5 days, but 'm' remains at 4, because it is the number of days of resources that I have shifted.

The duration of D was 4 and I cannot shift more than 4 days of resource from one place to the other. So, 'm' remains at 4, 'r' remains at 4 and the value of improvement function function is 128 and not only it is greater than 0, it is greater than all of the others. So, this tends to me my best option, because I cannot shift D any further. So, if in the context when I have D and I could only move D to get the most the closest to a leveled histogram, I would move D by 5 days. So, you should review these steps and if there are any clarifications, do post you know the clarifications which you might have on this.

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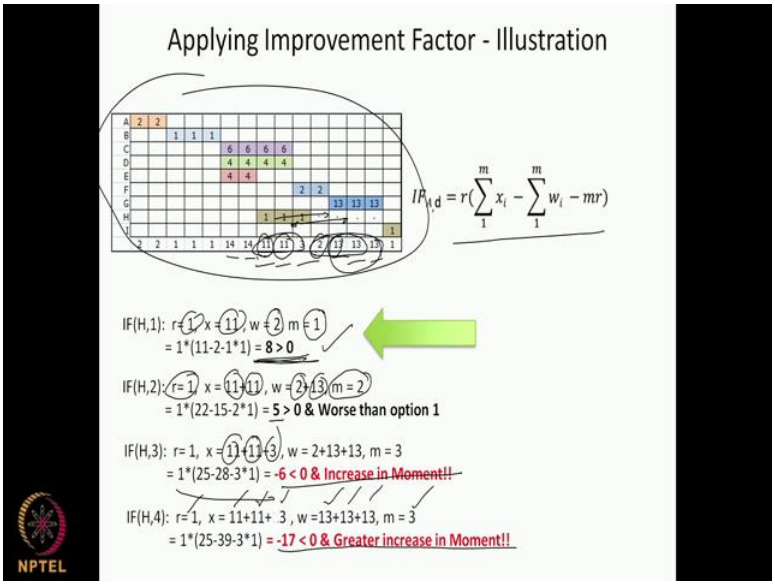

We will now go on to taking this in the next stage. So, now we are taking actually back to H, so now, this is the profile I am going to use. So, we have here 14, 14, 11 and we have now brought D back, we have H is starting from here, again I can do several steps of moving H. So, now, if you recall, H can move 1, 2, 3, 4 it can move up to four steps and H is an activity with duration of 3, it is resource load is 1. So, remember there is float in H to move all of these days.

So, we go back, again looking at the improvement function, I look at the… For moving H by 1 day; which means, it is moving from here to here, so 11 is my X, my W is 2, my shift is by 1 day, 'r' is 1, I get 8 which is my improvement factor. So, yes, if I do the shift I will be reducing the moment of the histogram. Now, similarly I can do H for going in for 2 day shift; if I am going in for the 2 days shift my sigma X_i becomes, there is two of them, so it goes to 11 and 11, my W is now 2 and 13, sigma W is 2 and 13, shift of resources of 2 resource days were shifted and D's resource level was 1. So, here I get 5. Now, although the shift will reduce the moment of the histogram from the original kind of allocation, it is not as good as option 1. So, option 1 gave me better results in terms of minimizing the moment of the histogram than option 2 here.

But, as you know H can be shifted further and so if you would actually notice, I change the resource load on G for this example, so that I could illustrate how always shifting does not take necessarily mean that you improve the resource level. So, here we have now H shifted by 3 and my original, the exercise from where I shifted it remains again 11, 11, 3; that is 11, 11, 3 here. W is gone to 2, 13, 13; it was 2, 13, 13; m is 3 because 3 days of resources was shifted, 'r' is 1 and when I apply it to the improvement function, I get a negative.

So, this is an increase in moment. So if I am going to increase that means, the shift causes an increase in moment as far as this profile is concerned and I do not want to increase more. So, I should not do the shift, let us go to 4, now again watch out, so I have moved. What I moved is from 11, 11, 3 which is here, I moved 3 days… My shift is by 4, but I have only moved 3 days of resources, because duration of H is 3.

I moved 1, 2, 3 here to 13, 13, 13; 'm' remains at 3 and r is at 1 and here is, here again is negative and it is the higher value of negative; which means there is even larger increase in moment due to the shift. So, based on this we have to be careful or we have to say that if I am going to move H, I am only going to move it by one step and that will give me the largest decrease in moment and that should be what I want or as close. If I could only move H, this would be where I would go to get the resource profile as close or to the minimum moment of the resource profile.

So, we have to be able to apply this into a kind of a procedure, we have to now change, so we have understood how to apply the improvement factor. This has to now be made into a procedure, a stepwise procedure which will then go through a series of steps to be

able to get what we want.

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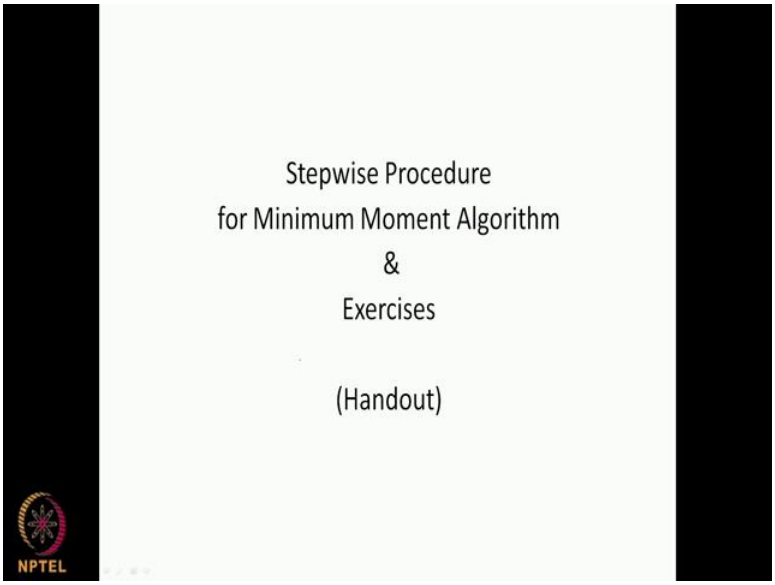

And this stepwise procedure is given in the handout as well as the exercises. So, there is, you know there are a series of steps which I would want you to review and go through the exercises and be able to see how this is done. And this is extremely useful in understanding what are the constraints and what are the issues that we have to come across when we really have to level resources.

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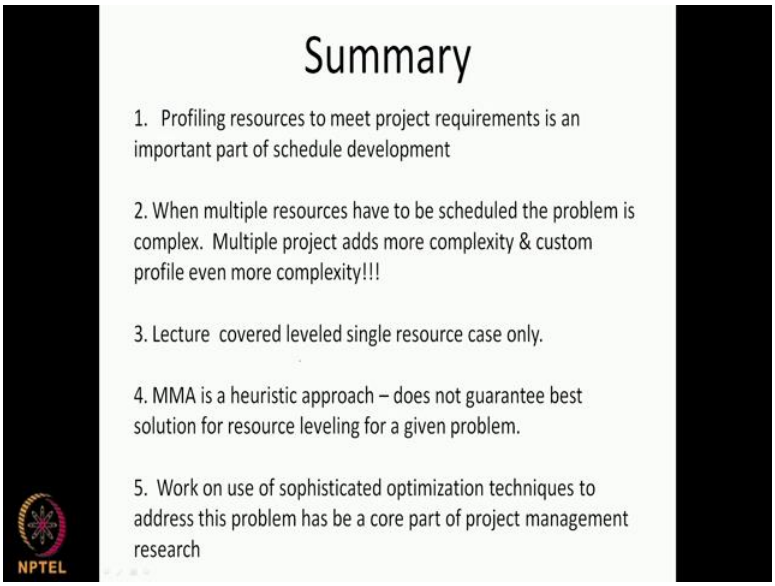

Now, to summaries this, we talked about profiling resources to meet project requirements, we said it is an important part of schedule development. So, without a doubt, whether we are talking about individual resources or we are talking about, you know equipment, people, all of these are resources; like, we talked on the first lecture on resource management. And without being able to profile these properly, the project will not be able to meet its targets and in addition ((Refer Time: 14:27)) here, in this particular lecture we are only talked about the single resource being profiled.

But, earlier we have talked about multiple resources and certainly when we have multiple resources, multiple projects; custom profiling it, it is certainly a challenge and that is what the project manager and the scheduling engineers have to face and there aren't too many algorithms and there aren't too many procedures. There is a lot of expertise and experience that goes on it and you know there is still a lot of work to be done to see, how this can be made into a procedure or how we can do this more scientifically.

But, certainly there are sophisticated algorithms available for it, I mean that are being explored I will not say they are available, they are being explored and there is a lot of work that is being done in this area to see how resources and multiple resources can be scheduled across multiple projects and not only to the rectangular profile we discussed here, but to custom profiles. And this is really a very important area in overall project management.

You know, the heuristic we covered was just an example for you to be able to understand, what a minimum moment algorithm is, how you apply a heuristic approach. And please realize that this is only a heuristic and when you follow the minimum moment algorithm procedure, it does not guarantee the best solution. The only way to get best solution in many ways is, I mean because it is a complex space, you are not going to be able to find and not only it is complex and it is also discrete, you are not going to able to find an algorithm which can search and find your minimum very easily.

So, this has been certainly an area for sophisticated techniques, you know whether it is generic algorithms, simulated annealing, lot of techniques have been applied and as the project requirements gets more intense, then there are challenges that researchers and practitioners facing in being able to address this issue. And I would like to end this lecture by saying I think this is an introduction to a very interesting area.

There is a lot of work that needs to be done in this area, to be able to understand and be able to meet the requirements for today's projects. And if there are any further algorithms or questions I mean, so this is certainly area of active research where lots of researchers are working on it. You will find that the software that come out today, whether it is you know the popular software like Primavera project.

They will have addins which can do kinds of resource optimization, resource levelling. And these tools are also getting more sophisticated and learning to use it also getting to be quite a challenge and quite specialised way to work. So, with this I would like to end this section on resources and we will go on to other topics from the next session.