Software Project Management
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Lecture - 37
Resource Allocation
(Contd.)

Good morning. Now, now let us take up the next phases of Resource Allocation.

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We will see we have already seen identification of resources in the previous class. Now, we will see the scheduling of the resources; resource histograms; how to smooth the resources that is known as the resource smoothing; then the resource classes and how to prioritize the different activities.

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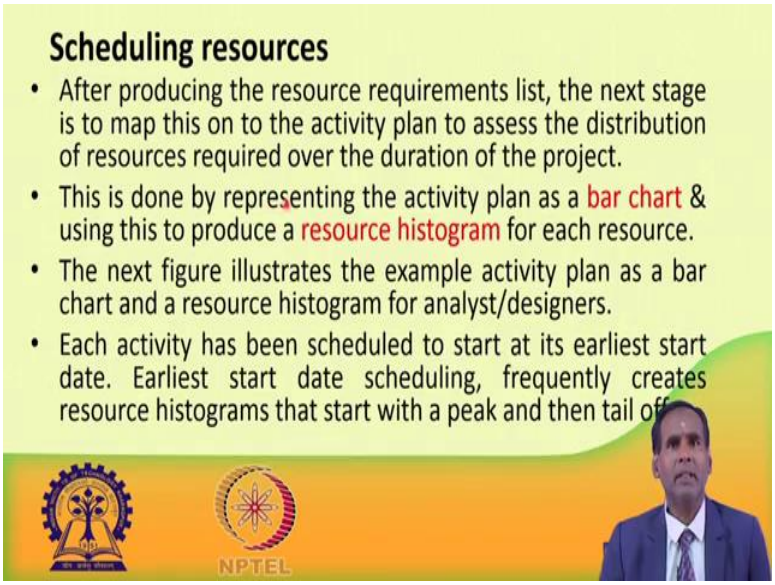

So, let us first discuss about the scheduling resources. I have already told you the first step in resource allocation is preparing a resource requirement list. After preparing the resource requirement list the next stage is to map this list into the activity plan. Why? To assess the distribution of resources required over the duration of the project.

So, this mapping can be done by representing the activity plan as a bar chat and then, using this bar chart, we can produce another diagram called as resource histogram for each resource. We will see I have taken an example in the next figure which illustrates an example activity plan as a bar chart and the corresponding resource histogram for the analyst and designers.

So, normally in this what mapping that we are doing. So, each activity has been scheduled to start at its earliest start date. I have already told you in the activity network, there are four important components; activity start sorry earliest start, earliest finish or earliest completion; then, latest start and latest completion.

So, in this kind of scheduling each activity has been scheduled to start at its earliest start time. So, let us see what is the, what problem with earliest start date scheduling. So, in case of or when you are using the earliest start dates for scheduling, then we will see it will frequently create the histograms, it frequently create resource histogram that start with a peak and then tail off; let us see how there will be so many what ups and downs will be there.

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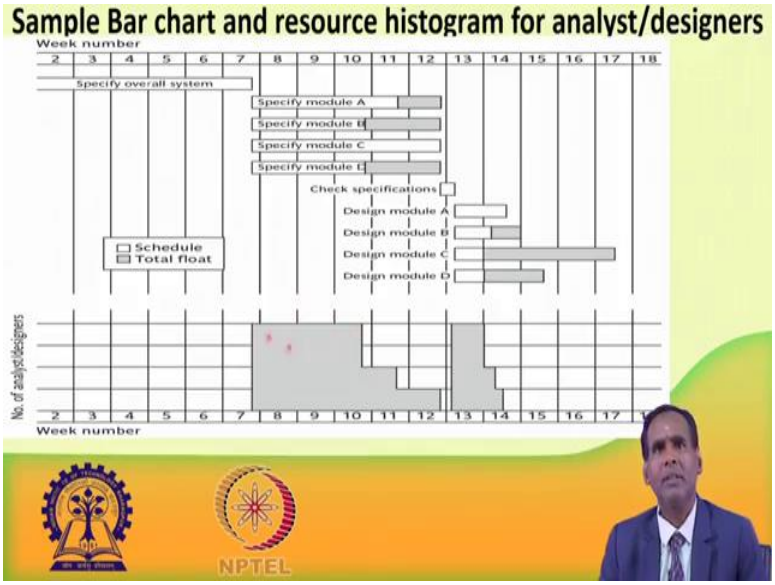

See. So, for the previous example that we have taken the earliest this activity network or the precedence network, from that activity network or the precedence network, we have created or the project manager can create a bar chart where in this you see the weeks the week numbers are written in the x axis and here, we are taken the different activities here, like in the here we have taken the specify the activity specify the overall system.

Then, what we can say specify module A, specify module B etcetera. Then, design module A, module B etcetera. So, like this you can see. So, this white space is required, what are the scheduling time and the shaded portion is known as total float. Total float means it is a measure of that time that you can see that how much time it is free and that is freely available this is slack time so that that activity can made little bit delay. So, that the whole project will not be affected, the completion date of the project will not be affected; so, float means the slack time, the free time that is available with the activity.

So, you can see that for what specify model A. So, this much time the shaded portion is what it is slack, it is free. So that means, if this starting time can be little bit delayed. So, that it will not what affect the completion of the project because this will be adjusted this free time can be adjusted so that this activity can be finished in proper time. So, you can say that for the previous diagram that we have shown, this is the sample bar chart, where the week numbers are written in the what x axis and in the y axis.

Here we have taken the different activities and the activities are consisted with the activity; what durations these timings are divided into two parts. What is the scheduling

time and this float time? Float time is the free time or the slack time available so that the project can be delayed by some amount so that the project duration the whole project duration the completion date would not be affected.

So, the upper part is this bar chart and this lower part is the called as this histogram. I hope histograms we have already discussed maybe in the matriculation or plus 2 carrier. So, this is a histogram and you can see that from this sample bar chart, we have prepared this what histograms. So, this you taken you have seen in the x axis again, we have taken the weeks and y axis we have taken the number of what developers, may be number of system analyst or the programmers or whatever that.

So, you can see that here, there will be and I have already told you this we are now scheduling the various activities. We are estimating how many numbers of manpower will be required. This scheduling is based on the earliest start date. We have assumed that the activity is started at the its earliest start time. So, then these kind of graphs you are getting you can see that if you are the scheduling is based on earliest start time, see there are so many ups and downs. There are peaks; then, suddenly it falls down. Again, there is a peak; then again, it is falling down.

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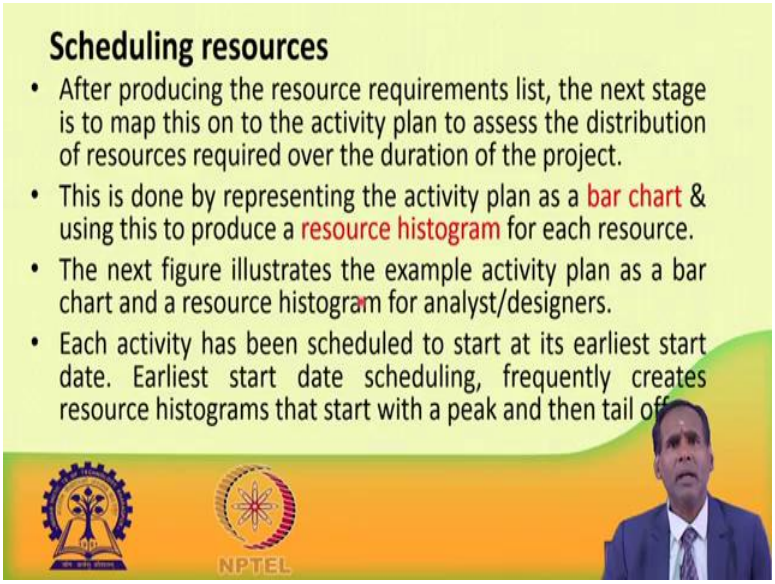

So, it is not uniform it is not even, this is the problem of what this is the problem of the scheduling based on earliest start time that I have already told you that, I have told you that this figure illustrates the example activity plan or the bar chart and then, the

histogram for the analysts designers. The upper part is the bar chart; the lower part is the what histogram. I have already told you that.

Here, this activity the activities or each activity has been scheduled according to the start at its earliest start date. The problem of earliest start date scheduling, I have already told you earliest start date scheduling. It will frequently create the resource histograms that starts with a peak and then tells up immediately that starts with a peak and then, it falls down, again It starts with a peak; then, falls down. It is not uniform, it is not even. So, this is the problem with earliest start date scheduling.

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So, changing the level of resources on a project over time particularly changing the personnel ok. So, you may change the level of resources, but, but changing the level of resources on a project over time particularly the personnel or the manpower, it generally adds to the cost of the project. You know that recruiting why because recruiting staff it also, it has also some cost. It takes some cost. Even if when staff are transferred internally, sometimes will be required for familiarization with the new project environment. So, this may also add some cost.

So, then we will see that the resource histogram shown in the previous figure, I have already shown you this is the resource histogram. So, the resource histogram shown in the previous figure, it poses it poses some kind of problems. Let us see what kind of

problems it faces? It leads to what kind of problems? It poses what kinds of problems? Some analysts or designers may sit idle for some days ok.

Let us see between the specification and design stage of the histogram, you see here. So, this is the specification phase of 2 and then, they started the design. You can see some people are idle during this see here you take this example. So, initially four people were required 1 2 3 4. Now, you see after this what analysis phase is over; now only 2 designers are used, another 2 designers are sitting idle. How many weeks? 2 weeks 2 designers are sitting idle.

So, similarly here only 1 is used. Then, I mean in 3 designers or 3 analysts, they are sitting idle and similarly here. So, this is the problem due to or since we have used the scheduling based on the earliest start date scheduling that is I have already told you the resource histogram shown in the previous figure poses some problems. The problems are due to the fact that we have used what kind of thing, we have used? The scheduling based on the earliest start date scheduling. Here, some analyst or designers may sit idle for some dates.

For example, between the specification the design phases stages of the histogram as I have told you. Initially, 4 system designers or this analyst were used; then, 2 are used and the 2 are sitting idle. Then, 1 is in the job and 3 are sitting idle. So, what will happen that it is it may not be possible that these idle persons, they will be required in another project requiring their skills for exactly those particular periods of time.

So, what will happen? So, this idle time then even if they sit idle, but their salary etcetera so that the idle time may also be charged to the project. So, that is why what we require? We have to smoothen this because see there are so many peaks and the ups and downs. So, if you can make it even we can make it uniform, then probably this idle time will be less.

So, now let us see how we can minimize the idle time; what should be the idle resource size histogram? The idle resource histogram should be smooth, should be nearly even with an initial build up and may be staged run down later on.

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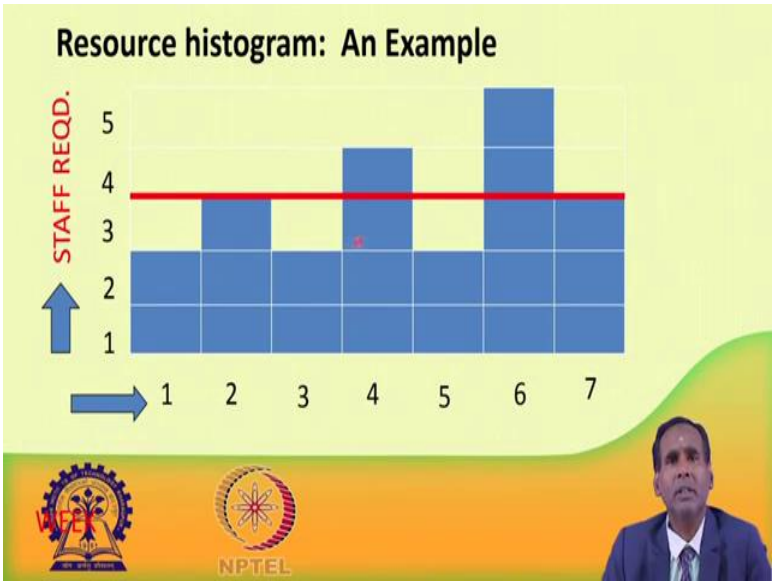

So, you see an example this is a resource histogram which is not even see so many ups and downs; peaks are there and so, this is what this is sample histogram which is not even which is not uniform. So, what we have to do? We have to smooth it. We this process we call as resource smoothing so that the idle time will be minimized.

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Like so, we have to go for resource smoothing. So, what is resource smoothing? Smoothing, it is usual difficult to get specially staff who will work odd days to fill in gaps. So, we cannot make busy all the persons always. It is very much difficult to get specialist staff who will work only odd days to fill in the gaps. There is a need of the

staff to learn about the application etcetera, it will take some time. So, staff often have to be employed for a continuous block of time.

So, we have to keep them busy staff often, they have to be employed for a continuous block of time. Therefore, it is desirable to employ a constant number of staff on a project. So, the good project manager always he will desire to employ a constant number of staff on a project, who as far as possible are fully important full time employees. So, hence, there is a need for resource smoothing ok.

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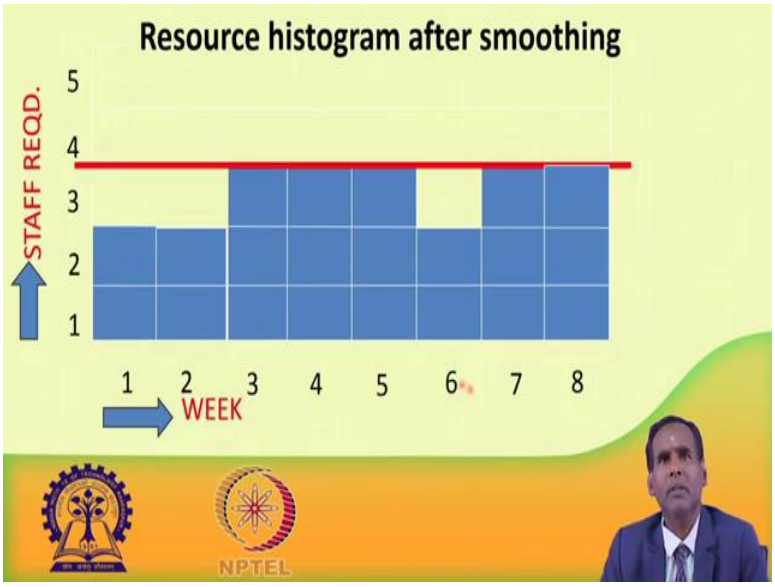

So, then that is why there is a need for resource smoothing and you see this is a example of resource smoothing. See the previous example I have taken see how many ups and downs are there. It is not even that means, here one person is sitting. So, one the person is sitting for yes; 1 person is sitting idle here, 1 unlike this, they are sitting idle. So, we have to what make it uniform, make it even, the histogram has to be smooth, the histogram has to be met even or just to met uniform see. Now, this it is more or less even and you see this person sitting idle it is very less.

So, this is the example resource histogram of smoothing the previous example here. So, this histogram is being what smoothened here and let us see how can smoothen the resource histograms.

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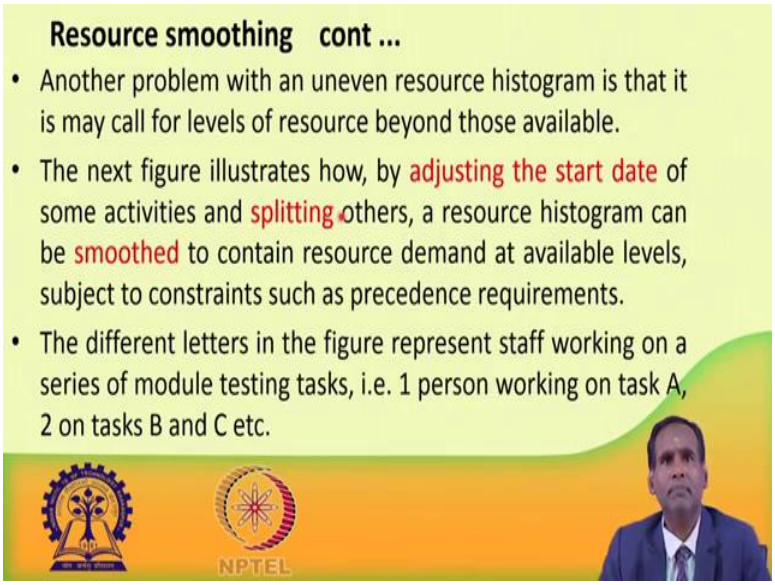

So, before smoothing this thing let us see what is the another problem with this uneven resource histogram. So, another problem with an uneven resource histogram is that it may call for the level of resource beyond those available; say few its or say 10 resources are available, but this type of histogram uneven resource histogram, it may require 15 number of what manpower. So, what to do? So, another problem with an even resource histogram is that it may call for level of resources beyond those available 10 are available, but it requires 15 resources.

So, the next the next figure, it shows how by adjusting the start of the some of the activities and splitting the other resource histogram can be smoothened to contain resource demand at available levels subject to the constraints such as precedence requirements. So, now, let us see how the need is now to smoothen the histogram. The question is how to smoothen the histograms?

So, this histograms can be smoothened by using two important what methods; one by adjusting the start date will not exactly what start from the earliest start date wherever some slack time is there, wherever some float time is there. We will avail will take advantage of the float time and we may little bit delay the starting time that is number 1; number 2 is these activities what are they are we not put in continuously wherever possible we may split some of the activities.

So, by using these two methods; that means, by adjusting the start date little bit or by delaying the start date little bit and then by splitting some of the activities, resource

histogram can be smoothened to contain the resource demand at available rates. So, what is available resources, we will only avail those many number of what manpower from the resources. Of course, subject to constraints such as the what are the precedence requirements that also has to be satisfied.

Now, let us say this what we have taken the first example we have taken this, you see this is looking very uneven. This is not smoothened. We will take the same example and here, you will see many activities they are having float times free time slack times decided portion. So, instead of starting from the very beginning, we can little bit what shift we can delay the start date so that the project completion date will not be affected because some free time is available here.

So, then we will we can minimize, then we can say that the resource requirement we can met and the resource histogram will be even or uniform. We will take the same example and we will show it here.

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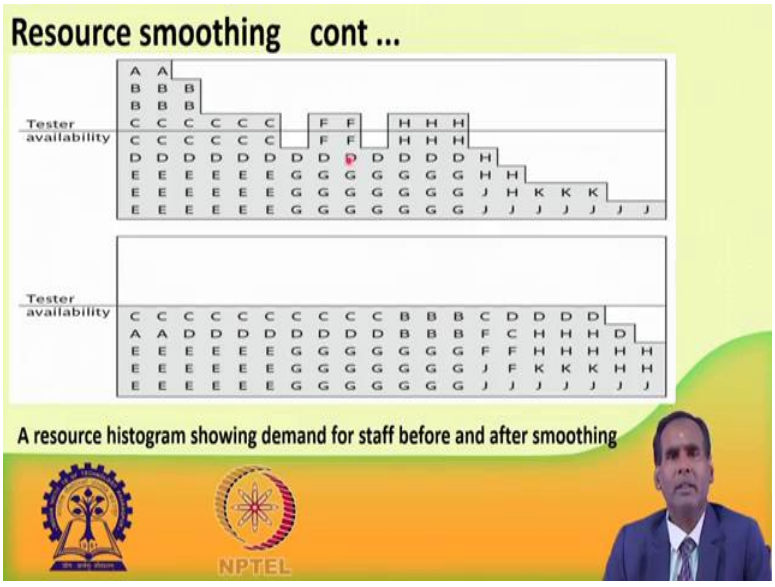

See it will take that same example. Here there or you can see that see from this you see what are the activities are there like A B C D different work activities are there and if we will take up a sample case and example of histogram, see for a project suppose the tester available like this. So, see this histogram is it is not smoothened properly. It is not a even see many times what are the resources the manpower, they are sitting just idle say it just idle. So, that is why we want to smoothen it.

How we can smoothen it? I have already told you we can follow these two important methods; we can adjust, we can delay the start date wherever float is available this slack time is available. Another is we can split some of the activities so that the resource histogram can be smoothed. Here you can see and here what A B C required the different letters in the figure represents staff working on a series of modules distinct task ok.

So, what are the staffs required in a series of what modules testing task. For example, 1 person working on task you can say. 1 person only working on staff. 1 person is working on activity A. Here one person is working on task A. Similarly, 2 persons are working on task B. 2 persons are working on task C like this it is explained and now, by delaying some of the activities and by splitting some of the activities, see this resource diagram which is not even here it is made even. So, what activities? So, you see some of the activities have started on late little bit delayed where free time is available and let see which tasks are splitted see C G are continuous here.

You can see that C G splitted. Here, you see up to this and again C is after some weeks again C is started. Then, D we can see that first these what it is it is performed here. These weeks D is performed and you see there is a break and again these performed here these. So, activities or task C and D they are splitted. So, this is the histogram which shows the demand of staff; this is before smoothing and this is the histogram after smooth after smoothing; that means, we are doing this smoothing.

The histogram is smooth smoothed by delaying some of the activities, where total float is there where start time is there and by splitting some of the activities or tasks such as C and D. So, this histogram is obtained this you can see it is much more even, it is must much more uniform than the previous one. So, another advantage you can get from this that here before smoothing, we require how many manpower? You can see 9 manpower we required my 9, but available how many? 5, but in this what you see A, B, C, D, E 5 what staff members are here. But it requires 9 staff members, but after smoothing you see now the requirement is 1 2 3 4 5.

So, now, 5 are 5 staff members are required and also how according to this resource scheduling, our resource scheduling is done by taking our resource scheduling is performed by taking those 5 staff members. You know only no extra staff members, this is the advantage of resource smoothing.

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In this figure, the original histogram was created by scheduling the activities at their earliest start dates. This one. This is done as I have told by using earliest start date scheduling. So, here you can see the resource histogram so that the typical peaked shape peaked shape caused by earliest start date scheduling and calls for a total of 9 staffs; whereas, 5 are available for project. I have already told you this you see count 1 A and 2 for B, 2 for C like this.

So, 9 staff members are required, but only 5 were available. So, that is why this is the unknown the problem of what uneven resource histogram. So, by as I have already told you we can smoothen this thing by 2 techniques; one is by delaying little bit the start of the some of the activities where float is available and another is by splitting some of the activities.

So, by delaying the start of some of the activities, it is possible to smooth the histogram and reduce the what manpower reduce the maximum level of demand for the resource and here, you can see after smooth smoothening, we require only 5 manpower, 5 designers or five testers.

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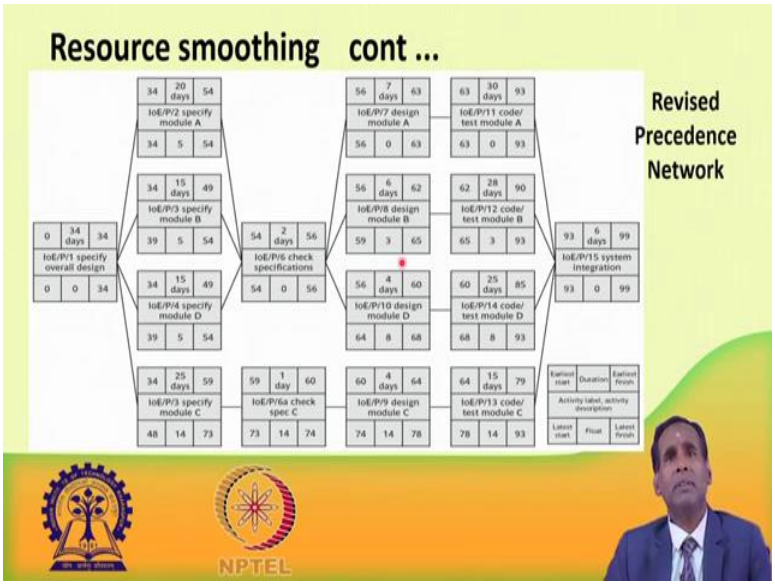

And I as have already told you by this process, we have to revise the precedence network. We have to slightly delay from the earliest start date, where total float available. So, you see so that is why the original what precedence network, we have already given earlier and this is the revised precedence network where the earliest start dates have been slightly delayed wherever float is there.

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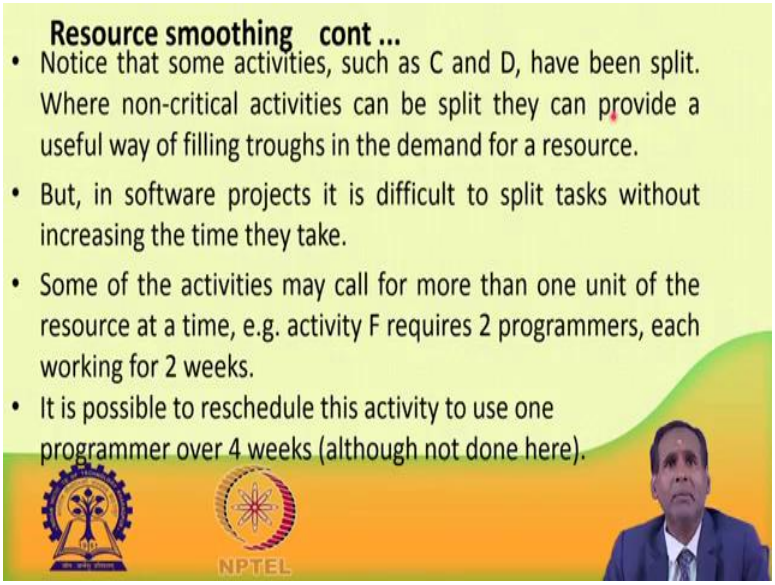

Please note that some activities such as C and D have been split. I have already told you in the what last example that here C the C it was not continuous here. It is delayed, it is splitted after see again these activities are followed then C and similarly D after this

again it is splitted and it is taken up in the other weeks. So, here C and D activities are splitted ok.

So, notice there are some activities such as C and D have been split where non-critical activities can be split they can provide a useful way of filling troughs in the demand of resource. So, whenever please remember that do not try to split the critical activities. So, only the non-critical activities can be split, where the non-critical activities can be split, they will provide useful way of filling the troughs. It will help in making even the histograms in the demand of in the demand for a resource.

But in software projects, it is very much difficult to split the tasks without increasing the time they take that is one that is another problem. Some of the activities may call for more than 1 unit of the resource at a time. For example, you see F if you will see here F requires see 2 2 persons for activity D and for 2 weeks; that means, we require if you this thing; that means, two 2 persons for activity F for 2 weeks, it can be replaced with if you are having less manpower. We can take only 1 person for activity F, what we can give for 4 weeks.

Of course, we have not shown it here, but that is another possibility that is what I am saying that activity F required 2 programmers each working for 2 weeks, but it is possible to reschedule this activity to use only 1 manpower, 1 programmer over 4 weeks that is another possibility.

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Then, we will say about the resource clashes. So, resource clashes means where same resource is needed in more than 1 place at a time. So, only 1 resource suppose that is needed in more than 1 place at the same time. So, this problem can be resolved by following one of these what methodologies.

First possible that you may delay one of the activities so that the work that one can wait for the available to be for the resource to be free to be freed; so, that can be allocated to the needed activity. You may take advantage or float to change the start date because I have already told you we can use the what you can what use the float time. So, take the advantage of the float time or the free time so that the start date can be little bit delayed.

Delaying start of one activity until finish of the other activity or the second possible that delay the start of one activity until the what previous activities finished that resource being used on puts ok. So, delaying start of one activity until finish of the other activity that resources being used on; so, but this will put back the project completion, the project completion might be delayed.

Another possibility is moving the resource from a non-critical activity. So, if a critical activity, there is targeted each appearing what we can do we can take away, we can migrate some of the resources from a little bit less critical or non-critical activity to one of the critical activity that will also this resource clashes can be solved.

Another possibility is the bringing in additional resource. If it is not possible to moving the resource from other activities or delaying the activity, it is not also possible. Then, what you can the project manager can do he can bring in additional resources he can hire additional resources to meet the target dates. Of course, this will increase the cost. So, these are some of the possible what methods solutions for resource classes.

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So, then the last activity will see it is called as prioritizing the different activities. In practice, the resources are allocated to a project on an activity by activity basis. Normally, in a real life project the project manager allocates what the resources on what allocates the resources based on activity by activity basis on an activity by activity basis. But finding the best allocation is very much time consuming and difficult.

Allocating a resource to one activity limits the flexibility for resource allocation and scheduling of other activities. Once you have allocated to some resource one activity means it will now limit the flexibility. You do not have that much flexibility to allot that resource to another activity and schedule the other activities. So, there is a need to prioritize the different activities based on their priority based on their importance; so, that the resources can be allocated to the different competing activities in some rational order. The priority must always be to what the priority must always be to allocate resources to critical path activities.

So, you must what given topmost priority for allocation of resources to the critical path activities. The next priority can go to that the activities which are most likely to affect other activities. In this way what will happen? The least priority will go to the what the activities, those are very what less of those are very less important. So, in this way the lower activities, they are made to fit around the more critical already scheduled activity.

So, in this case we are first what scheduling the highest priority activities. So, now, somewhat time gaps are there, around the critical activities. So, those gaps those free times can be what filled by the lower priority activities during scheduling.

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So, there are two main ways of prioritizing the activities; one is total float priority, another is order list priority.

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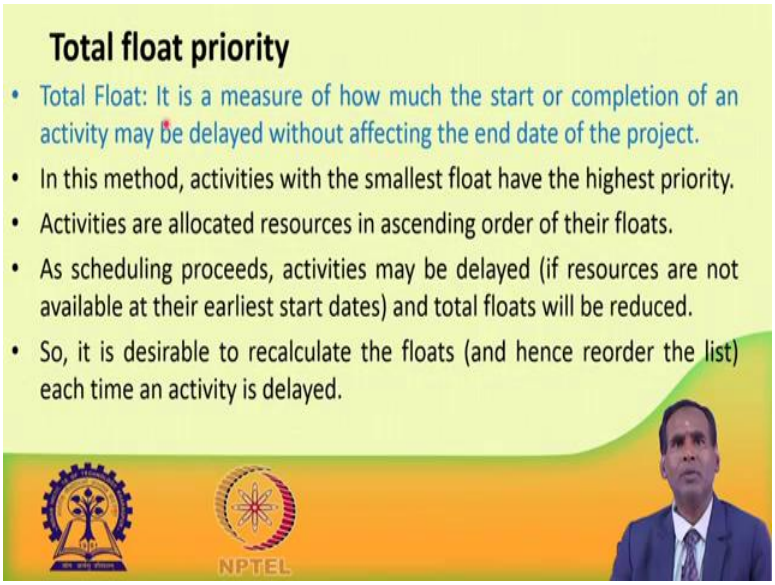

So, in total float parity, we have to see what you mean by total float. I have already told you total float means it is a measure of how much this start or completion upon activity

may be delayed without affecting the end date of the project that is some free time slack time is available. So, this float shows that by how much time, it is a measure by which says that by how much time; how much time the start or completion of an activity. It can be delayed without affecting the end date or the completion date of the project.

So, in this method; that means, in the total float priority method the activities which are having the smallest float; 0 float or 1 float, 2 float or 1 days, 2 days etcetera the float. So, the activities with the smallest float will have the highest priority because they do not have any free time. If you will delay, then obviously, project the completion date will be delayed. So, that is why in this method the activities with the smallest float. They are given the highest priority the activities are allocated resources in ascending order of their float.

So, in this method what you do? Arrange the activities according to or their floats arrange them in the ascending order of their floats as scheduling process the activities may be delayed. If resources are not available see while during scheduling or a scheduling proceeds, some of the activities may be delayed because some of the resources are not available at their earliest start dates and then, what will happen?.

It will consume from the total float and hence their total float will be reduced. So, it is desirable to recalculate the floats and hence, you have to reorder the list each time the activities delayed. So, each time the activities delayed, you have to re-compute the float because the float is changing it is consumed and the list may be changed. So, hence you have to reorder the list.

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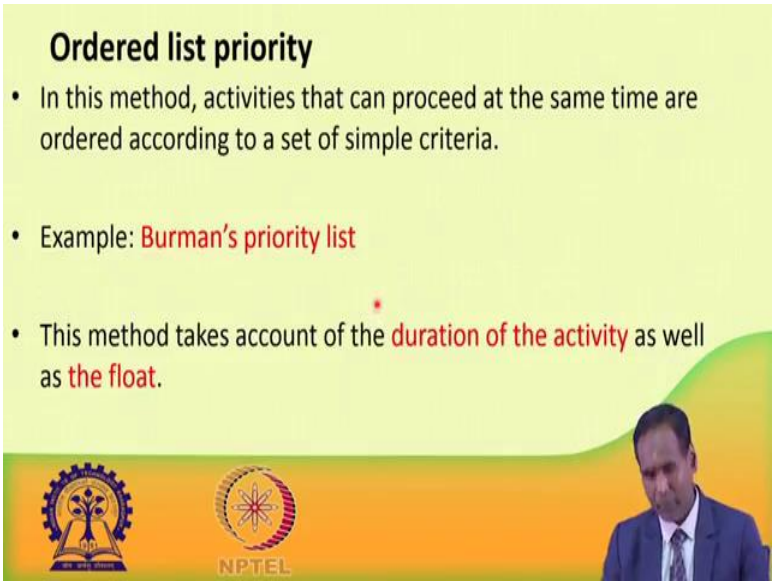

So, this is happening in total float priority. The next is order list priority. Here in these method activities that can proceed are they ok. Here activities that can proceed at the same time. So, in this method the activities that can proceed at the same time, they are ordered according to set up some simple criteria; one example is Burman priority list and in this method this method takes account of duration of the activity as well as the float. In the previous case, we have taken only float. This method takes into account both the things the duration of the activity as well as the float the total the float.

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So, in Burman's priority list, priority is given in this order first priority is given to the activities having this test what or we can say that the shortest critical activities; activities

having what very shortest what or we can say lowest float. So, shortest critical activities, they are giving first priority; then, other critical activities. Next priority go to the shortest non-critical activities; that means, what these non-critical activities having this what shortest time or so, and then non-critical activities with least float. So, non-critical activities what they are having what float is least and finally, which are the least priority will be given to the non-critical activity.

So, in this way Burman's priority list works priority given to the different activities in this way. First priority goes to the shortest critical activity. Then, next priority to other critical activities; next priority to shortest non-critical activities; next priority to non-critical activities with the least float and the least priority goes to non-critical activities.

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So, what are the alternative to resource smoothing? Resource smoothing is not always possible because deferring activities to smooth out smooth out resources, it peaks often, it puts back the project completion date. The project completion date may be delayed. So, in this case the project manager need to consider some alternative solutions such as he may have to increase the available resources resource levels in that case more cost will be incurred or he has to follow different working methods; he have to altering he may he is altering the working methods he may have to alter or change the working methods.

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Resource usage; the project manager needs to maximize the percentage of usage of resources; that means, he will he will he should what allocate the resources in such a way that it he should reduce the idle periods between the task. There is a need to balance the cost against the early completion date; also there is a need to allow for some contingency in hand.

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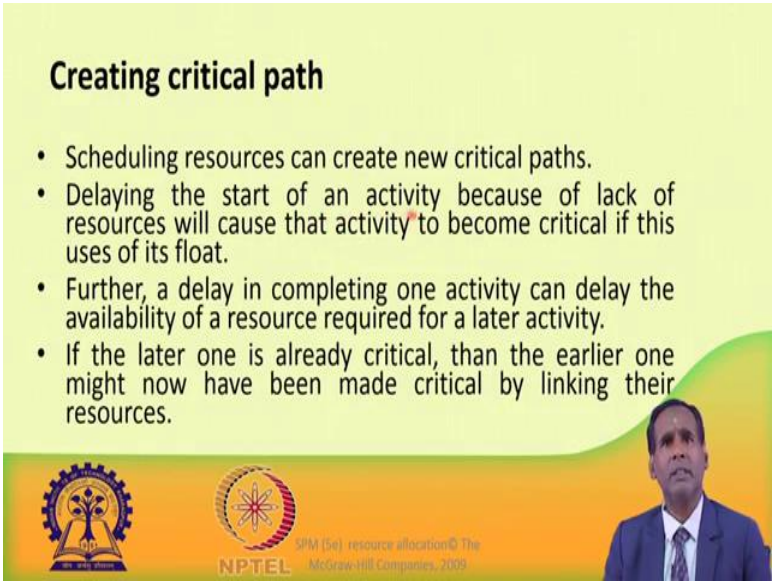

So, creating critical path scheduling the resources can create new critical paths because delaying the start of one activity because of lack of resource will cause that activity to become critical if it uses its float. So, further it delay in completing one activity can delay the availability of the resources required for a later activity. If the later one is

already critical, then the earlier one then the earlier one might now have been made critical by linking the resources. So, while scheduling the resources, it is possible that it can create a new critical paths because, what slack period the float period is changing.

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Scheduling the resources can create new dependencies between the activities. It is possible to while you are scheduling allocating resources or scheduling resources. It may create, it can create new dependencies between activities. So, that is why it is better not to add dependencies to the activity networks to reflect resource constraints. Why?

Because it will make the network very messy the activity network will be messy as well as a resource constraint may disappear during the project, but its links still remains in the activity network. So, that is why do not do not add the dependencies to the activity network to reflect the resource constraints rather you may amend dates on the schedule rather you may amend the dates on the schedule to reflect the resource constraints.

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So, we have seen these resources scheduling of resources and the resource histogram, resource smoothing. Also we have seen the fundamental concepts of resource clashes and we have also discussed the methods for prioritizing the prioritizing activities. Here we have seen two methods based on the total activity as well as these order priority list. These are the references.

Thank you very much.