Project and Production Management
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Lecture - 16
Project Monitoring and Control with PERT/Cost

The purpose of the various project management techniques that we have been studying so far has been to develop a project plan, a plan of action, a schedule of doing the various activities in the project so that the project can be implemented. We are now making a transition from this lecture from the phase of planning a project to the phase of project implementation. What we are assuming is that we have a project plan which is to be implemented and this particular project plan has to be implemented so that all the activities go as per the plan and there are very little departures in terms of deviations from either the expected costs or the scheduled slippages. The primary purpose in project monitoring and control is to ensure that the project proceeds as per the plan that you have set out to achieve. PERT/Cost is one technique which helps us to achieve this. In this lecture we are going to be talking primarily about how PERT/Cost can be used effectively as a project monitoring and control tool.

To give you a bit of a background PERT/Cost was developed in the United States by the department of defence and NASA way back in 1962. Subsequently it has been used as a kind of a tool in almost all projects that NASA has done which means that it's now a part and parcel of implementation of all projects as far as NASA is concerned. The basic idea here is that the costs are to be measured and controlled primarily on a project basis rather than according to the functional organization of the firm. That is one of the key concepts in PERT/Cost. It makes a departure from conventional cost accounting systems and it says that the departure is primarily in terms of how the costing is to be done rather than doing the costing on the basis of the functional organization of a firm as it's done conventionally. In a conventional accounting system what happens is that an organization says so much has gone to materials department, so much has gone to department a, so much has gone to department b and so on irrespective of how much work the individual departments have actually done. The focus here has shifted to looking at costs on the basis of the project and specifically with regard to the activities of the project. Cost is allocated to the individual activities and accounting and subsequent monitoring is done with regard to those activities.

This is the major departure that we have from conventional accounting in the PERT/Cost system and the activities or the groups of activities are in fact the micro cost centers. I think this is logical because if you have to control costs, costs should be controlled at the point where they are incurred.

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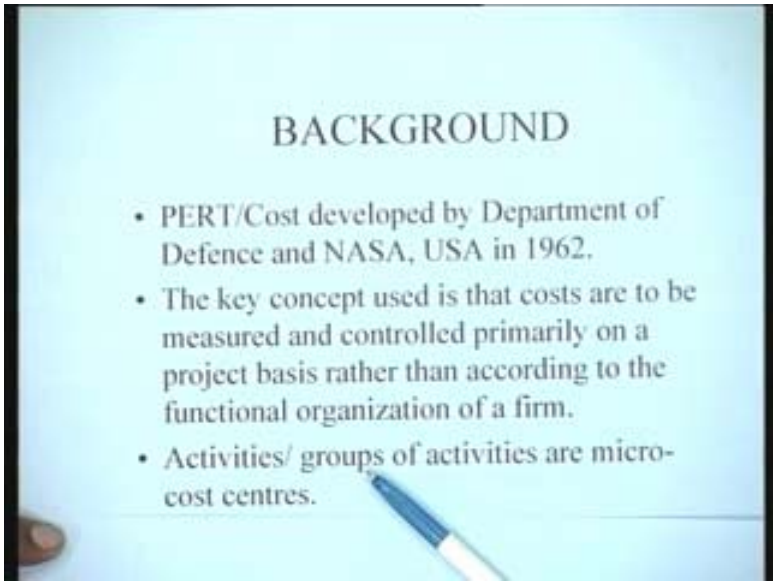

Costs are incurred on individual activities, on individual jobs. If you have to control the costs then the right place to control the costs is the individual activities or the jobs. This is in fact one of the significant things which is done in the PERT/Cost system. Another very logical thing that is done in the network cost accounting system is that the responsibility for expenditure should coincide with the responsibility for managing the activities that give rise to the expenditure. This is a very simple principle. If I am responsible for doing something and I have the budget for that thing then both the responsibility for the expenditure and the responsibility for doing that job should lie with me. Unlike a situation, in typical government departments here the sanctioning authority is located somewhere in some building. They sanction the money and immediately after sanctioning the money they forget about it till the end of the next financial year and the money comes to somebody who has the responsibility for doing the job. When you segregate the responsibility for doing the job and the responsibility for sanctioning that money then there is a greater likelihood that the job would not be done as per schedule. This is one thing here.

If the project manager gets a certain amount of money for performing a certain activity he is responsible for that activity and he should be caught if he doesn't do that activity as per the plan. This binding of the responsibility for both the expenditure and the responsibility for managing the activities both of them should go together and it is strange that one who sanctions the expenditure has nothing to do with the activity implementation and actual cost control.

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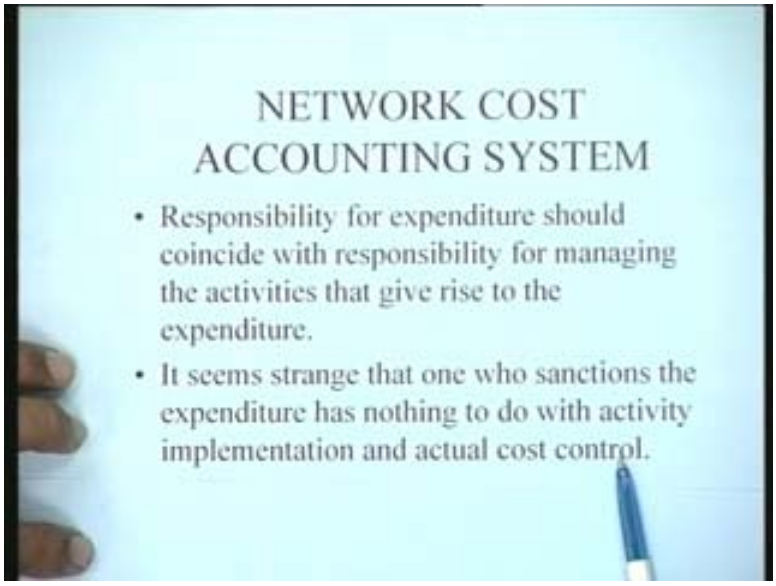

In fact this is one reason I think for the inefficiency of most of our government and public sector departments. Keeping these basic principles in mind the PERT/Cost system uses the notion of work packages to define the various stages in which the project ought to be monitored and also the manner in which it ought to be monitored.

What is a work package? A work package is nothing but a chunk of the project, a part of the project. It could be an activity or it could a set of activities. A project can be divided into work packages in various ways. We had seen this when we were talking about the work breakdown structure of a job. You can divide a project into individual work packages in a variety of ways just as you can cut a cake into a number of pieces depending upon the usage. You can cut it into 4 big pieces, 1 for each member of the family may be or you can cut it into 20 pieces; it depends. In the same way what would happen if we divide into too many small activities. A division of the project into too many small activities may facilitate detailed planning and scheduling because you have now detailed jobs which specify exactly what has to be done. From that point of view it is beneficial but it's not convenient for cost control purposes.

Why is it not convenient for cost control purposes? You have a project the total cost of which is let's say 1 crore and you have small activities which costs 8 annas, 1 rupee or 2 rupees. The number of activities that you will have will be phenomenal and keeping track of all those activities would be an enormous job in itself and therefore accounting would become very, very difficult for such things. It's not convenient for cost control purposes. On the other hand a division into very large chunks of work would deprive the project of the necessary detail. The project itself, if you don't divide it, is one project. Monitoring the project is a project because you wouldn't know which are the parts of the project which have to be monitored? So it deprives the project of necessary detail and is not conducive to effective monitoring and control.

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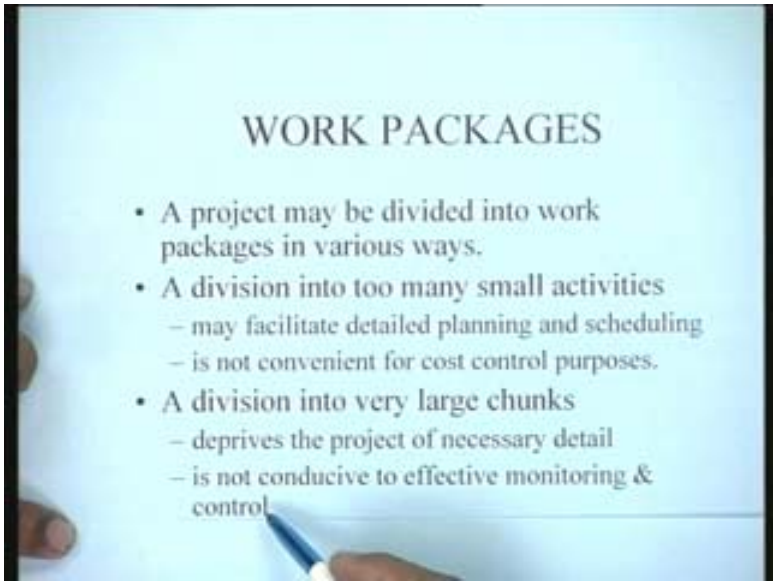

This kind of thing is not conducive to effective monitoring and control because there are no stages. There are no parts where you can check. If the project has 15 parts we will check each part and at the end of 2 parts we should be able to say 2 parts are over or 3 parts are over. In that sense large chunks are also not necessary. So the conclusion is that if you have to do effective monitoring of a project you should be able to divide the project into manageable work projects which are neither too big nor too small and in fact that is the key notion in PERT/Cost.

What should be the characteristic of the recommended work package? Work package is nothing but a collection, a chunk of the project or a collection of activities in the overall network. The recommended work package should be neither too small nor too big. I mean it should be manageable. That's what we have seen because if it's too small then also it's useless. If it's too big then also it's useless. But what do we mean by too small or too big? These are relative terms and would have to be defined for each project individually. The DOD and NASA guide considered 100,000 dollars worth and 3 months duration as appropriate. This was the recommendation of the Department of Defence/ NASA guide when they propose the work packages. They said each work package should be about so much worth in terms of money and should be about 3 months duration and this is appropriate. But these figures would depend upon the context and you can define your own figures.

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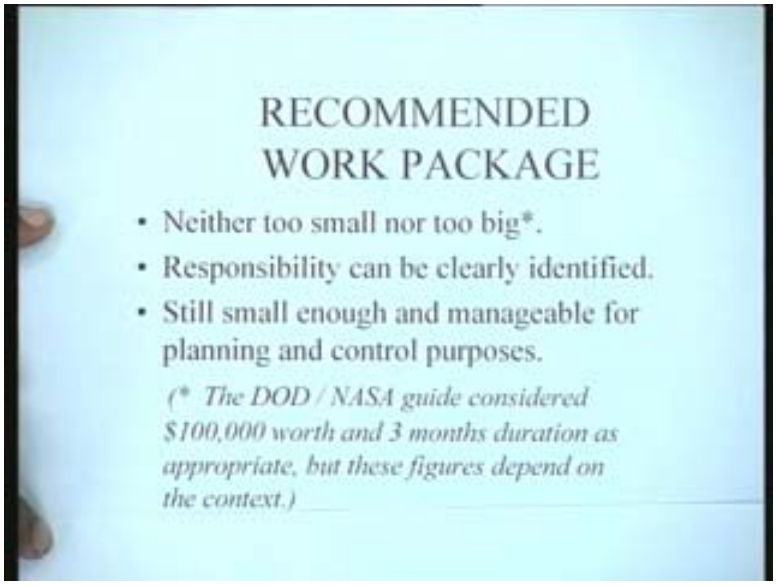

These are some guidelines that they had given. The second feature of a work package should be that the responsibility should be easy to identify. Preferably each work package should be or would be done by may be one particular individual or one particular agency. For instance if Engineers India limited has one large project of setting up may be a thermal power plant somewhere. May be the electrical installations and the ducting they would have probably subcontracted to some agency like Larsen and Toubro. Larsen and Toubro then becomes a subcontractor for Engineers India limited in doing this particular project and their job is to look after a couple of work packages pertaining to the electrical installations.

Whenever you are trying to monitor the progress of those work packages you can clearly identify the responsibility and the project manager can immediately identify that this is the responsibility of Larsen and Toubro. If there is something wrong he can immediately pick up the telephone, call up Larsen and Toubro immediately and get in touch and say that work package number 493 is not going as per schedule. One other advantage of a properly defined work package is that the responsibility can be clearly identified and work packages should be still small enough and manageable for planning and control purposes. These are the three major requirements you can say of a work package. The original project network is now conceived in terms of these manageable work packages and we develop the project network in terms of these work packages where the work packages are regarded as the activities of that particular project. The work packages could then be a combination of the original activities; some combination or a sub network of the original network could be a work package.

Let's now look at some of the assumptions in PERT/Costs. This seems to be a very limiting assumption. What it says is that it is assumed in PERT/Cost that the expenditure on a work package is uniform throughout its duration which means a work package might have duration of 3 months, 2 months or 6 months as the case may be. The assumption

being made is that during each month the total expenditure on a work package is constant. This could be true and this need not necessarily be true. We will talk about this assumption in a little greater detail, a little later. This particular assumption may be reasonable as a number of activities are included in the work package. This is true. When there are a number of activities included in the work package, say there are 8, 10 smaller activities; some activity is finishing and the other activity is going on. It's like a steady state situation. It's like trying to say, when you are talking about population control, total number of births is equal to the total number of deaths. Some number of activities is being finished; new activities are being added on and the overall population remains constant in a city or in an institution. That's the kind of thing that we are trying to say. This might be reasonable because of this assumption.

However if this is not reasonable the work packages could be redefined. How could they be redefined? Depending upon the pattern of expenditure you might have higher expenditure in the beginning, low expenditure here and then higher expenditure towards the end of the activity as the case may be and you might want to sort of break this entire activity or this work package into three work packages, something like this.

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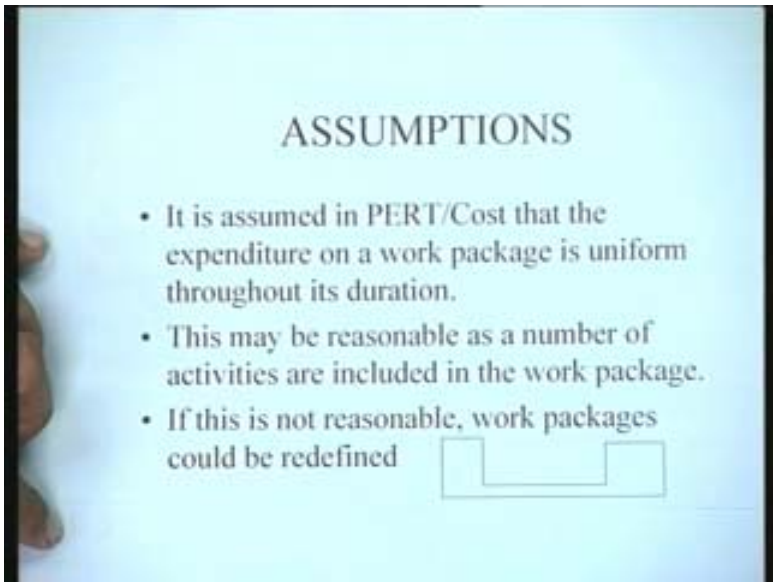

Let's look at this problem in a little greater detail and let's try to see how the spending typically occurs in an activity in a project. I plot the monthly expenses versus time in an activity. When you have to do some activity, normally in the initial period you have greater expenses and these greater expenses are probably you have to buy some materials. For example you want to paint your house. For painting the house initially the person who is going to do the painting, your contractor will tell you to buy the paint, buy this, this and this. So your expenditure will be pretty high in the beginning. Once you have given him all the stuff the pattern of expenditure will come down and it will be at a low level as the activity proceeds. Towards the end when the activity is over you got to make

payments to the labor and everything else. So there is again a peak towards the end. This is what happens.

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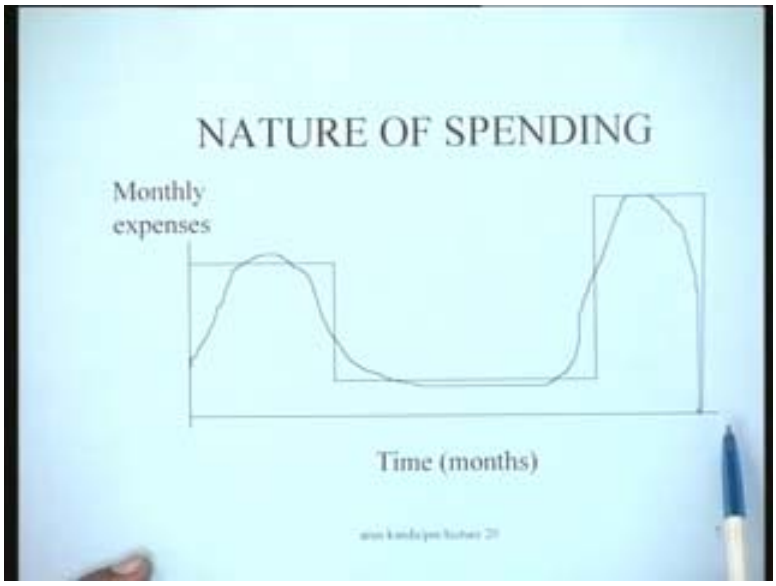

One can expect that in a typical activity, the pattern of expenditure will show an initial peak, then a common period when the activity is going on and finally a situation when there would be a final settlement of expenditure with all the contractors. All the money has to be shelled out during this particular period and this would be the nature of the activity.

One thing is if there are a number of activities of this kind, each with its own peak then it is quite likely that all of them added together will give you a uniform peak and therefore the assumption that you have made in the PERT/Cost about uniform pattern of expenditure would remain valid. But suppose this was a very critical activity and this was a single work package then this assumption is not valid. What you can do is you can sort of conveniently break this down into 3 distinct phases in this manner and I can then define as if it were 3 activities. The first activity when the pattern of expenditure is this high, the second activity from here to here when the pattern of expenditure is low and then the third period when the pattern of expenditure is high and then during each of those activities I would have a uniform pattern of spending. So even if the pattern of spending is not uniform by suitably redefining my work packages it is generally possible to conform to this assumption of uniform pattern of spending even when you have non-uniform patterns of spending just as I indicated here.

With this background let us now try to see how these concepts can be utilized for project monitoring and control. For that let us take a sample network. Let this be our sample network. This is a network which has 8 nodes as shown here. It’s an activity on arc representation and what you see here is that the first number we have in the parenthesis is the duration in months and the second number in the parenthesis is the cost in thousands

of rupees. What it means is simply that activity 1 2 is an activity which will take 2 months and will cost us 40,000 rupees and we have similar figures for each of the other activities in the project network.

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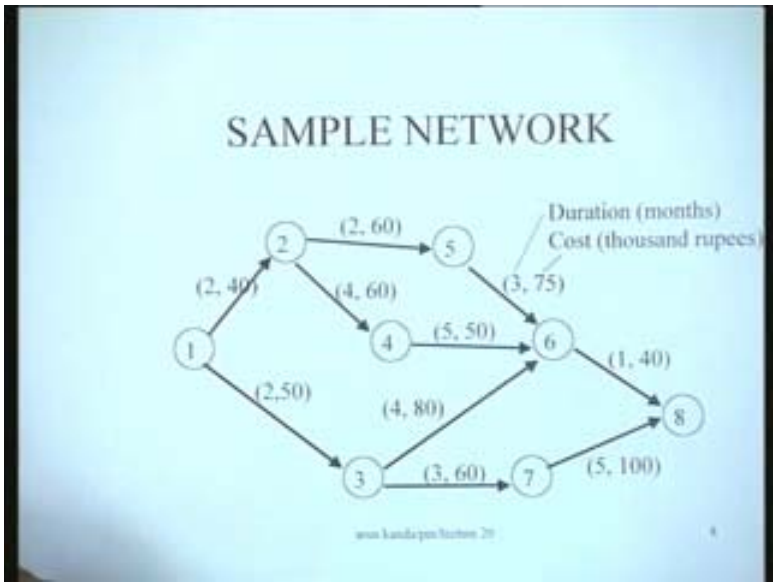

You imagine that these individual activities are nothing but work packages. That means you have already considered and may be combined certain activities and these are the revised work packages which have to be monitored and controlled as far as the project is concerned. We can very easily find out the duration of this project. How can we find out the duration? It's very simple you can do a forward pass. Let's do a forward pass for instance. This is time zero for the project and this is 2 months and this is going to be 2 months again. Then coming to node 5 this is going to 4 months. Coming to node 4 this is going to be 6 months and coming here from all the three sides the maximum is 11. This is 11 months and this particular value is going to be 5 months and this particular value is 12 months. This is the forward pass which reveals these particular times.

We can do a backward pass for this and determine the latest occurrence times for these nodes. You can find that this is 12 months latest occurrence time. This is going to be 12-5 which is 7 months. This value is going to be 12-1 which is 11 and then 11-5 is 6; 11-3 is 8 and then for node number 2 it's going to be 8-2 which is 6 and here you get 2. So 2 is the smaller value. You get this value here. Similarly here 11-4 is 7 and 7-3 is 4. This value is going to be 4 and what you get from here is going to be simply 0. We have just worked out the earliest and latest occurrence times and what you can see from this particular problem is that the critical path for instance is going to be this one. This is the critical path in this particular project.

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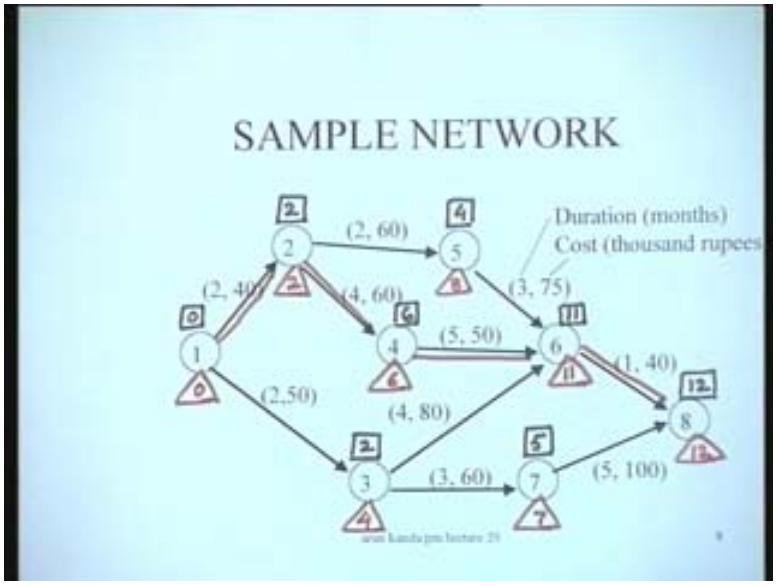

From this critical path we can identify the early start, later start for all activities. We can make a table. For each of the activities this is the duration in months, the early start of the activity and the late start of the activity. When the early start is equal to the late start it shows the activity is critical. For instance 1 2 is a critical activity and 2 4 is a critical activity and similarly 4 6 is a critical activity and 6 8 is a critical activity as we just determined and the total cost in thousands of rupees is known to us for each of these activities. We just write it down.

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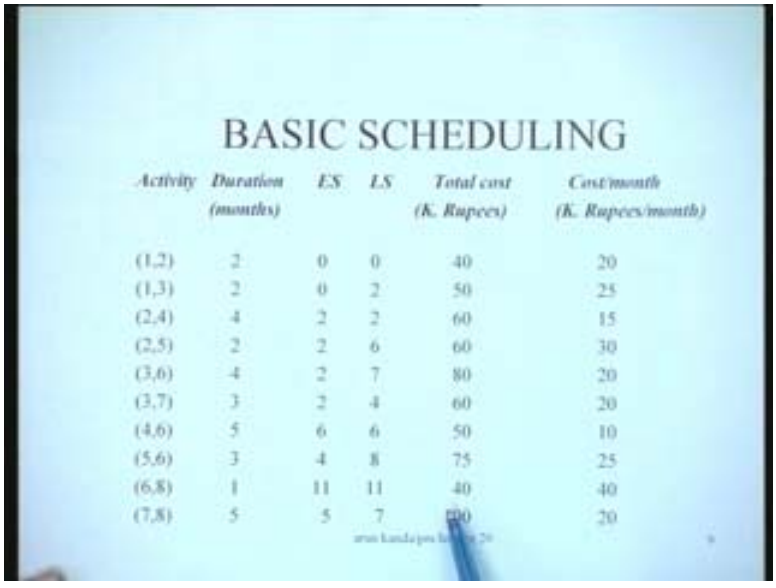

Then what we do is we compute the cost per month. Cost per month is obtained by dividing the total cost by the duration because we are now making an assumption that if this activity costs 40,000 rupees it means in each month you are spending 20,000 rupees and so on. We have computed this figure of 20, 25, 15, 30, 20, 20, 10, 25, 40 and 20 for each of these activities as we go along in each of these periods. Just to continue the computations we will have to first draw a sort of a time scaled network and we will consider the two possible extremes, the early start schedule and the late start schedule.

The early start schedule for this project looks like this. There are 8 nodes in the network. This is a time scaled network. This is the first period, second period and so on. There are 12 months in the project. This project lasts 1 year, 12 months and if we follow an early start schedule then these are in fact the floats associated with tasks 2 5 and 5 6. This is the early start schedule and the figures adjacent to each activity are the monthly costs which we have just computed.

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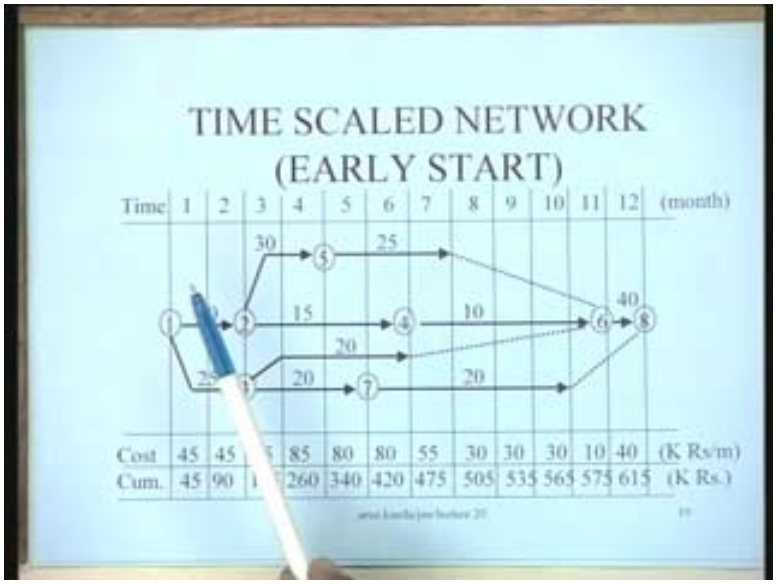

You can now do something like a resource aggregation exercise, which we …….. When you do a resource aggregation exercise you can find out the total expenditure that is being committed in each period. In the first period these two activities 1 2 and 1 3 are actually active. They are going on and the expenditure here is 20,000 rupees per month and 25,000 rupees per month. The total expenditure here is 20 + 25 which is 45,000 in this period; similarly 45 in this period. In this particular period 1, 2, 3, 4 activities are active. So 30 + 15 + 20 + 20 is 85; 85,000 rupees will have to be incurred in this particular month and similarly 85 here, 80 here, 80 here, 55, 30, 30, 30 and finally in the last period only 40 and only 10 is going on in this particular period because this is the only activity which is going on, all other activities are over. This is the monthly expenditure. This in itself is a very useful bit of information for purposes of implementation because it tells you the cash requirements for implementing this particular schedule. You require so much, so much, so much money in individual periods and the cumulative requirements

are 45, 90 and so on. The total sum of money that is being spent on the project is 615,000 rupees. That means 6 lakhs 15 thousand rupees is being spent on the project over a period of 1 year and the monthly spendings are shown as shown here and this is what the early start schedule is giving us.

You can do one more thing; you can look at the pattern of expenditure. Instead of the early start schedule if we follow a late start schedule what would be the implications? The implications are summarized here. We draw a time scaled network on a late start basis. Here all the activities are shifted as late as possible. You have the dotted lines here prior to the activities. Most of the activities are going on towards the later period. During this particular period you have number of costs which are sort of going on and these costs are only 20 here, 20 here. Mind you this should be a dotted here because this activity takes only 2 days. It's the latest possible schedule. This is actually a dotted line, this one, this one.

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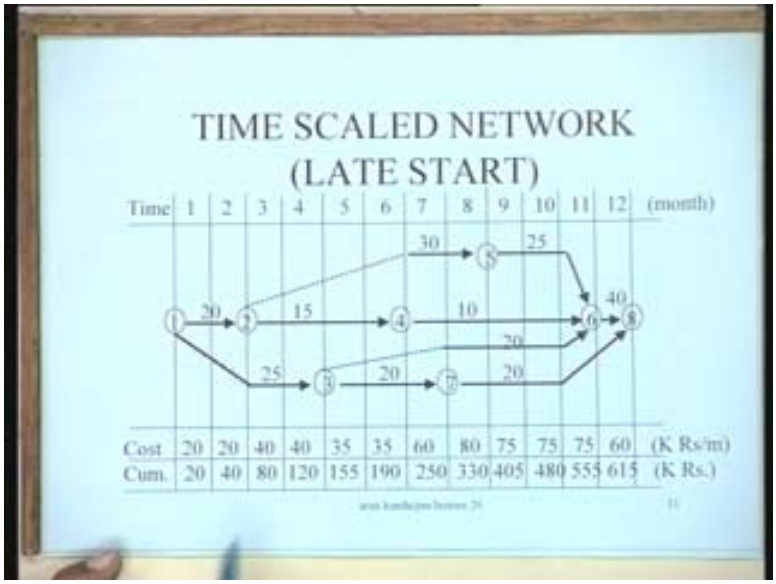

This is a late start schedule. This particular activity takes 2 periods; 20, 20, 40, 40 and then 35 and so on. When you look at the late start schedule the expenditure is shifted to the right as far as possible though the total expenditure is the same 615,000 rupees. The difference is only in terms of how you incur the expenditure. Suppose you have to get something done in your house. There is a man who comes and says he will charge 100 rupees for this. One possibility could be he could charge 100 rupees in advance. That is something like the early start schedule and the late start schedule is like saying I will do the job and at the end of it I will charge 100 rupees. Both are charging 100 rupees but it's the timing of the expenditure which is different. Something similar is happening in this particular example where you find that in the late start schedule the total expenditure is the same but the timing of the expenditure is very, very different.

If we now plot this information of cumulative costs on a graph, the graph looks something like this. At every month we have two values. The upper one is the cost corresponding to the early start schedule and the lower one is the cost corresponding to the late start schedule. For each of the 12 points we have these two points and so what you find is that the cumulative expenditure is much higher at every point of time in an early start schedule. It simply means that at the end of the 6 months here you have spent something like 405 kilo ? rupees whereas here you have spent less than 200 rupees so far. So you have greater money in your pocket when you are doing a late start schedule.

It's like saying I have a hundred rupee note and I have asked that man to do the repairs. If he charges me in advance I would have lost the 100 rupee note right away. But if I pay him at the end of the job I would retain the 100 rupee note till the job is over. I will remain richer till the end of that time and I can earn interest on that money for a longer period of time. The total NPV of expenditure is going to be lower when you are doing a late start schedule as compared to an early start schedule which means that if you have to raise the capital through equity loan or you have to raise the capital as loan from a bank, you will have to take a lesser loan if you follow a late start schedule as compared to an early start schedule by virtue of this particular fact.

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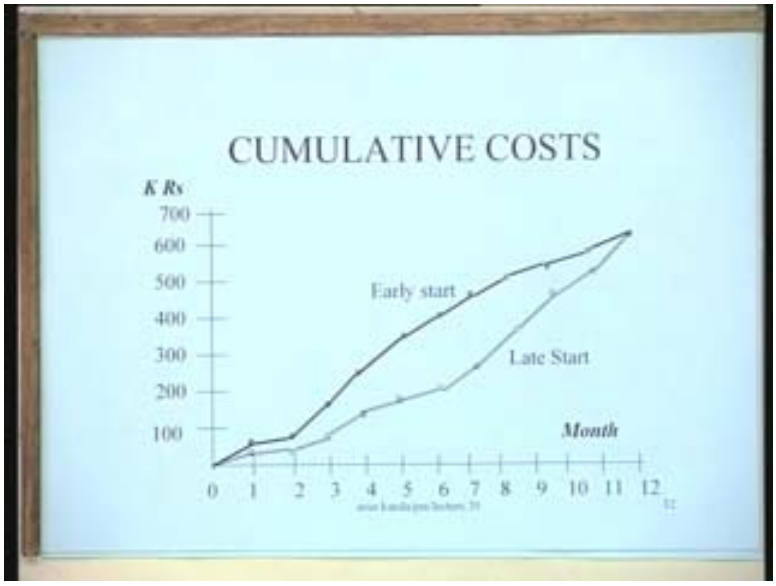

The question that naturally one has to answer is out of these two schedules which one is a better schedule to adopt for purposes of implementation? Both schedules guarantee that the project is done within 12 months if you follow those schedules. But which one is better? Any responses to that? Somebody would like to say which one is better? Should we follow an early start schedule or should we follow a late start schedule?

You correctly identified that the late start schedule will give us a lower value of the NPV of expenditure. If you want to minimize your costs totally the late start schedule would be the ideal thing. You can't have a cost lower than the cost that you get in a late start

schedule. But what happens in a late start schedule? In late start schedule you have postponed all activities to their latest possible value and therefore you have no slack available in case an emergency occurs or something happens. You cannot postpone any of the activities any further and therefore if you are operating in an environment where there is no risk, where all your suppliers are very reliable, that means you are operating in a Japanese environment, just in time system. Late start schedules are just like just in time system in the Japanese context and what it means is that suppliers will come on time. Everything will come as per time and therefore things will go on and very good. In that case, the late start schedule is very good.

But if you operate in a chaotic situation like we have in many situations in our country in India, what happens? You have kept a margin for something. The supplier tells you that he cannot send you the material today. Something has happened; there is a strike in the factory it will be delayed by 2 days or something. If you are following a late start schedule it would mean that your project would slip by 2 days. But if some of these activities had floats which you have not utilized you could absorb some of this uncertainty through the slack. So really speaking an early start schedule gives you a lot of buffer; gives you a buffer to act against uncertainties and you can utilize this buffer. What you can say is the additional cost in the early start schedule is only because you are providing this additional buffer to guard against the uncertainties.

Take the example from inventory. Just in time manufacturing says don't keep any inventories. So you don't keep any inventories and it is okay as long as everything is reliable. But suppose there is a fluctuation in demand and you are not able to satisfy that demand. What do you do? You typically keep inventories. So inventories are useful in situations where you have uncertainties. Similarly the early start schedule is useful in situations where you have these kinds of uncertainties and you want to guard against those uncertainties. So really speaking if you are a perfect just in time type of environment, you use the late start schedule. If you have lot of risks and other things, use the early start schedule.

If you are somewhere in between, then you can choose one of the many possible schedules in between this region. This region in between is the region of feasible schedules. How? Instead of shifting a job entirely by its total float you can shift it by only 1 day or 2 days, 1 month or 2 months. You can have some intermediate schedule and that intermediate schedule will be between this. You can have a compromise between an early start schedule and a late start schedule depending upon the context. Based on considerations like these you can select either an early star schedule or a late start schedule or any schedule in between for purposes of implementation and the schedule that we have chosen would obviously lie between these two limits in terms of the total expenditure.

Now let's assume that we have chosen a schedule. The schedule is chosen and we now go ahead with the process of monitoring and we want to implement this process. How do we go ahead? Project monitoring basically means we are concerned about three things. We are concerned about the performance of the project that things or activities are being done

as per specifications. They are being done at these appropriate times and we are doing them within the cost.

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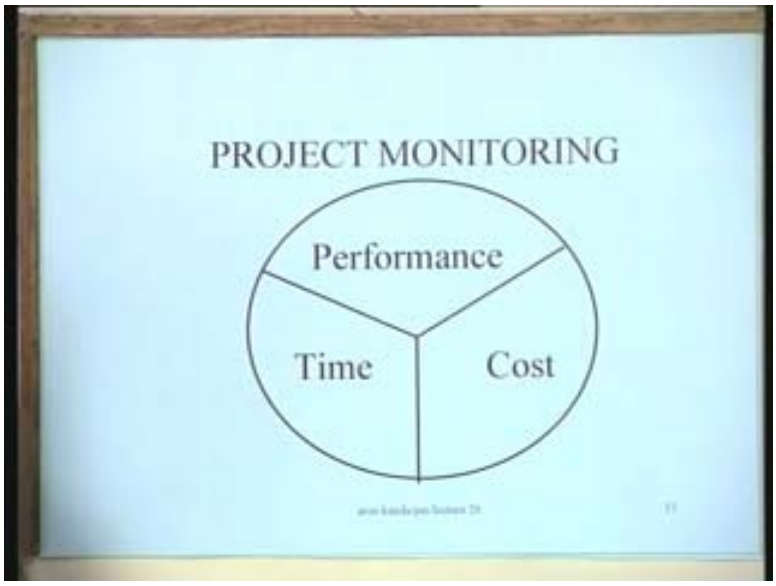

How do we take care of this? 3738

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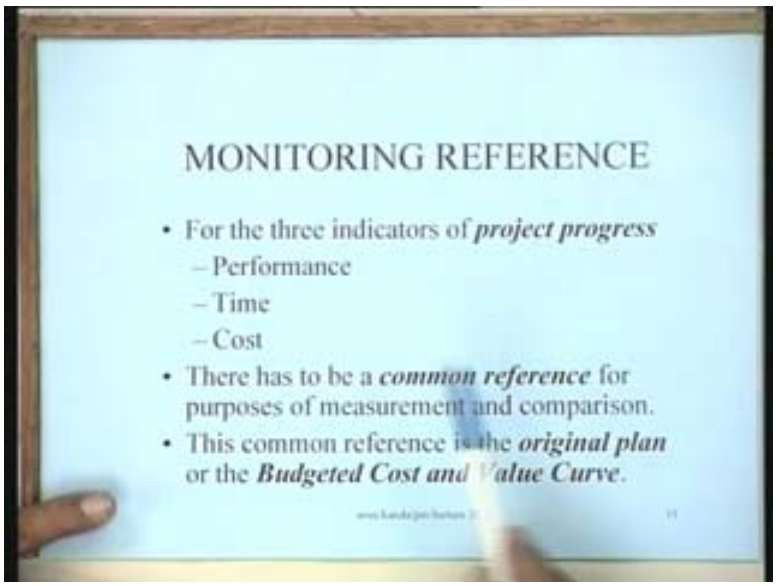

For the three indicators of project progress that is the performance, the time and the cost there has to be a common reference for purposes of measurement in comparison. The important thing is a common reference and this common reference is nothing but the original plan or the budgeted cost and value curve which we just determined. What we

just determined in form of the budgeted cost and value curve that is either an early start schedule or a late start schedule or any schedule in between that serves as a common reference and this is used for finding out how the project is performing as you keep going on. That's the important yardstick.

How exactly do we do the monitoring? How exactly do we go about monitoring the whole thing? Let's look at that. Basically we look at three curves. The first curve which we denote by capital A is the budgeted cost schedule and that is shown by a solid line here and this is that portion of the line which we just constructed for an early start schedule or a late start schedule or whatever it might be. We have the budgeted cost schedule. This is the budgeted cost schedule curve and small a is any point on the curve capital A. That's the notation that I am using. This is point a. If this is time, what it says is that the budgeted cost of the work completed by this particular time should be a. That's what it is saying this small a.

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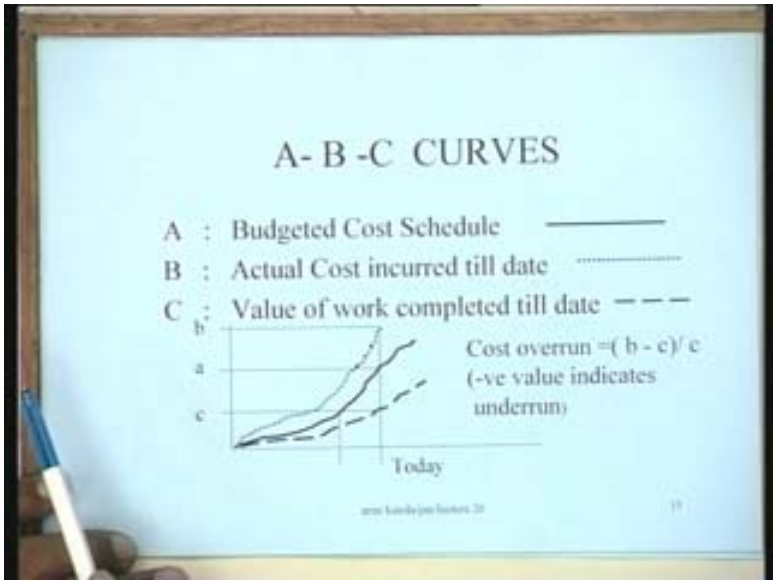

However the actual cost incurred till date is this dotted line. If you keep on plotting the doted line probably the actual cost would be something like b and b minus a is not the increase in cost. Why is it not the increase in cost? This is the budgeted cost and value curve. We should have done work up to value a and spent money equal to a but we have spent money b which is higher than this. But it all depends upon what you have done with that money. We have the third curve here, this particular curve which is the value of work completed till date. What we find is that today we assess the situation on the project and find out that only c worth of work is done.

c worth of work is done and we have spent b. The total over running cost is b minus c and this is the value of the work done. b minus c by c is in fact giving you a value of the cost overrun for the project. This is the formula that you will use for determining the cost

overrun; b minus c by c and if this value is negative it shows that there is an underrun. That means you are lower than the cost.

Let's try to see how you will measure the time overrun in a project. The time overrun is nothing but the horizontal distance between curve C and A. This is C and this is A. How? This is time today. Today I have done this much value of work. If I project this horizontal line this intersects this budgeted cost schedule at this particular point.

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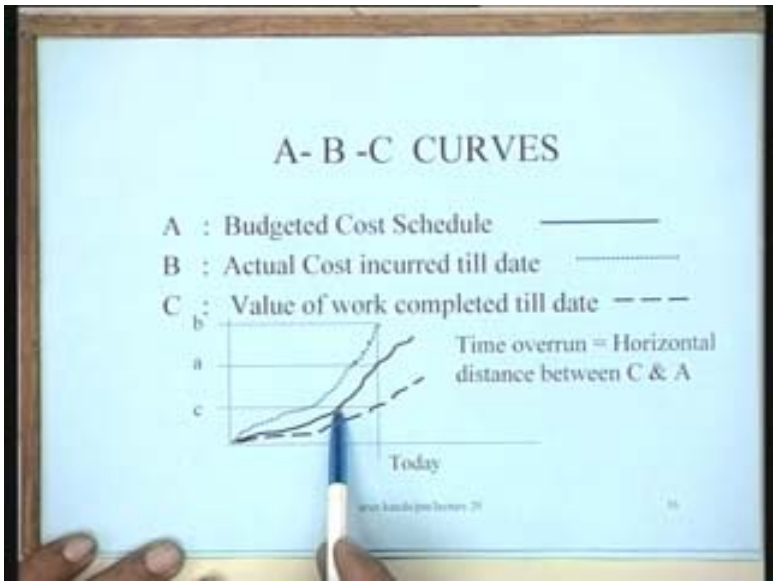

It shows that this much value of work should have been done actually at this point of time. This horizontal distance between today and this point between C and A actually tells you how many months behind I am. It's the relative placement of curves C and A. If C is below A, it shows that I am behind schedule. If C comes above A I am ahead of schedule. You can measure this by this horizontal intersect here. This is the manner in which we can determine the two most important parameters namely time overrun and the cost overrun for a project.

There are some cost schedule control systems criteria to the 3 curves that we call a, b and c they give this name. Budgeted cost of work scheduled which is a.

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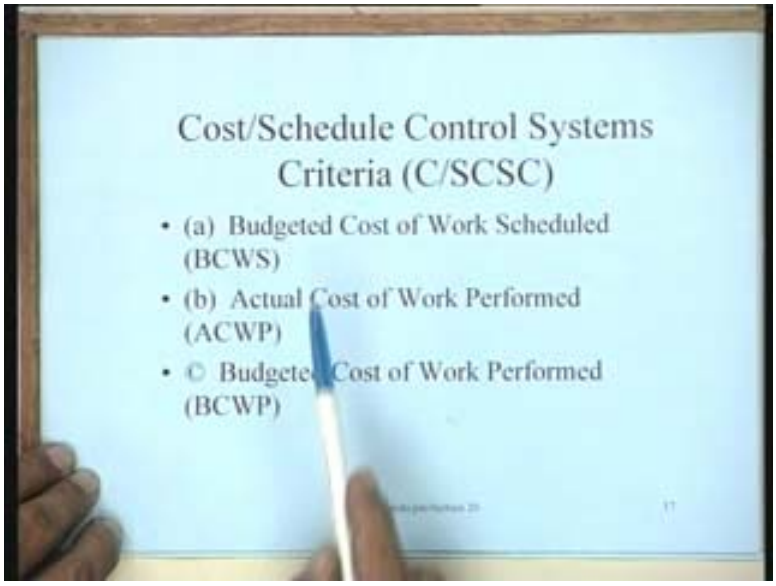

Actual cost of work performed is actual cost of work performed in that manner and the budgeted cost of work performed is BCWP and on the basis of these informations what you do is you can define a cost performance index and a schedule performance index.

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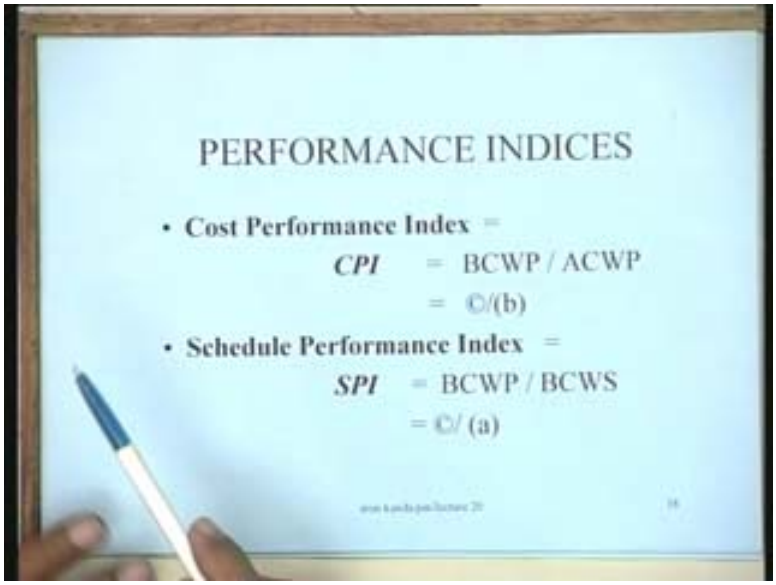

The cost performance index is nothing but the curve c divided by b as we had seen. The budgeted cost of work performed divided by the actual cost of work performed c by b, this ratio can be calculated. If the project is performing fine this will be 1. If the project is performing better than normal it will be greater than 1 and if it's less than 1 it shows that the project is not performing well. Similarly the schedule performance index measures

the relative placement of curve c with regard to a and the budgeted cost of work performed divided by the budgeted cost of work scheduled is c by a and in a same manner this can be computed. What can then be done is the cost performance and the schedule performance index is computed in this manner because the project manager is interested in both these bits of information together. It's good to look at both of them together.

You can have a graph which would typically be like this, the cost performance index. 1 is okay value. 1.5 is very good and 0.5 is here; similarly 0.5 and 1.5. For instance in the month of January you might have started off on a very good note. This is the month of January when you reviewed the project. It shows that both are favorable. What can happen is that in the month of February, you probably move to the marginal zone which means that you are still good on the schedule performance index but on the cost side you have dropped below average, below the normal value. Then in March you might go something like this to an unfavorable situation. Then in April you might go to something like this. Then in May you come here. Then in June you could probably be here. Then in July you could come here. Then in August you could probably be moving here and in September you could be moving here. The point really is that at one go you know that as the project has been progressing how it has been behaving with regard to the cost performance and the schedule performance and especially it should not come in this region of unfavorable. Unfavorable region means it is bad on both the schedule front and the cost front.

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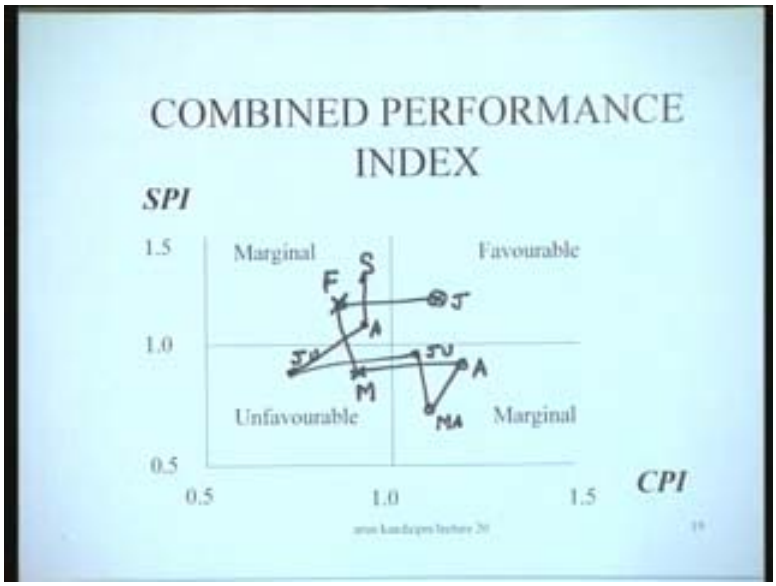

This is the unfavorable region. Try to remain here or these are two marginal regions. This gives you a device by which you can find out exactly how the project has been performing indifferent during different reviews and where the project is going on? Just to give you an idea of how this review is carried out we will actually do a review for the project that we had undertaken and we will try to compute these values for the three

curves a, b and c and see what is the cost overrun and the time overrun for a particular project.

Let's try to do this example of project monitoring and we will take the same example of the project that we had earlier namely we will take this very project that we were talking about for which we had computed the early start and the late start schedules we will try to work on this particular project.

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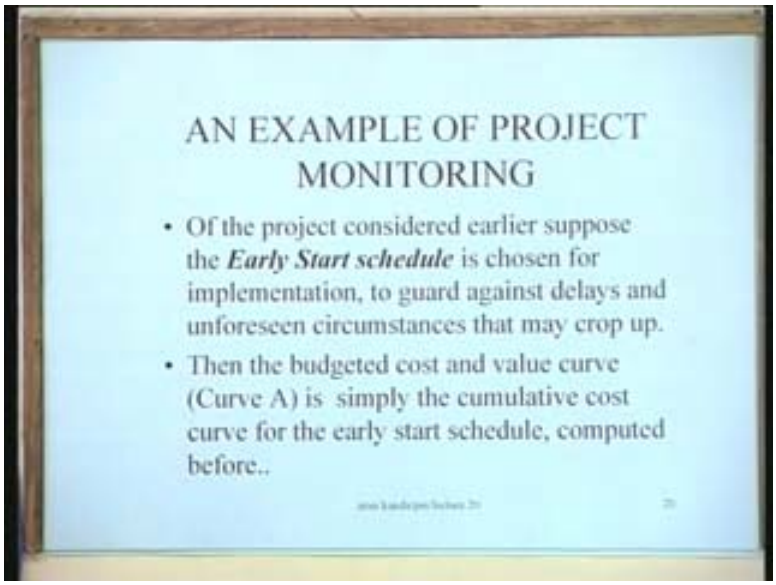

Of the project considered earlier suppose that the early start schedule is chosen for implementation. Why this is chosen is because you are assuming to guard against delays and unforeseen circumstances that may crop up. Although we know that the late start schedule will have a lower NPV but because of the chaotic conditions prevailing we would like to use the early start schedule for purposes of implementation. The early start schedule then becomes the basic figure which we will have to be guarding against. Then the budgeted cost and value curve which is curve A is simply the cumulative cost curve for the early start schedule computed before.

Let's look at the early start schedule for this particular project. This is the early start schedule and we are going to now take this schedule as the plan. We are saying that we are implementing the project as per this plan and suppose that the project is implemented and during this process of implementation we have we take a review at the end of the third month.

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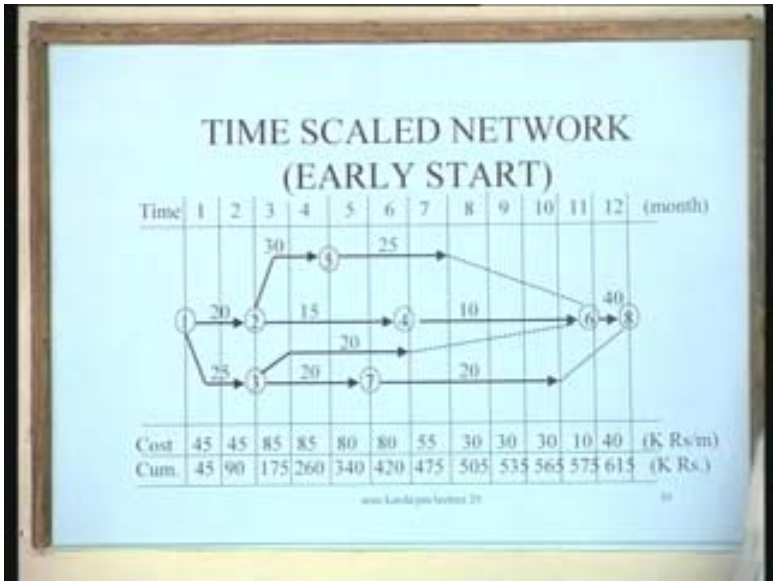

That means we take a review of this project on the completion of the third month which is this particular value. At the end of the third month we should have spent 175,000 rupees as per the plan and these should have been the monthly expenditures in the individual months. What happens on the site for this particular project at the end of the third month? Reviewing the project at the end of the third month we find that the budgeted cost should be 175. This comes directly from the plan. If you look at the plan at the end of your third month we should have spent 175,000. Curve A gives us point a which is 175. This is a figure that we have picked up directly from the plan. The actual money spent we find out from the people who are managing the show and we suppose that we have spent 150,000. That is the total money. This has to be found out from the actual site. How much money have you spent on the project? Actually we should have spent 175,000 but we have spent less. Actually we have spent 150,000 and how do we find out the value of the work completed? That is the most important thing.

How do we find out the value of work completed? We find that activity 1 2 has been completed. This is the actual status of activities. Activity (2 4) and (2 5) have not even started. This is a field report and activity (1 3) is 50% complete. This is what we find and as per plan, activity (1 2) has a cost of 40 and we have said that activity (2 5) and (2 4) have not yet been started whereas they should have been started by the end of the third division. We have done this much and this much of these and activity (1 3) is this one and this is only 50% complete. Out of 2 months work it's only 50% complete. Based on this information about the site report for individual activities we can say that activity (1 2) 40,000 units of work has been done; nothing has been done here, 25.

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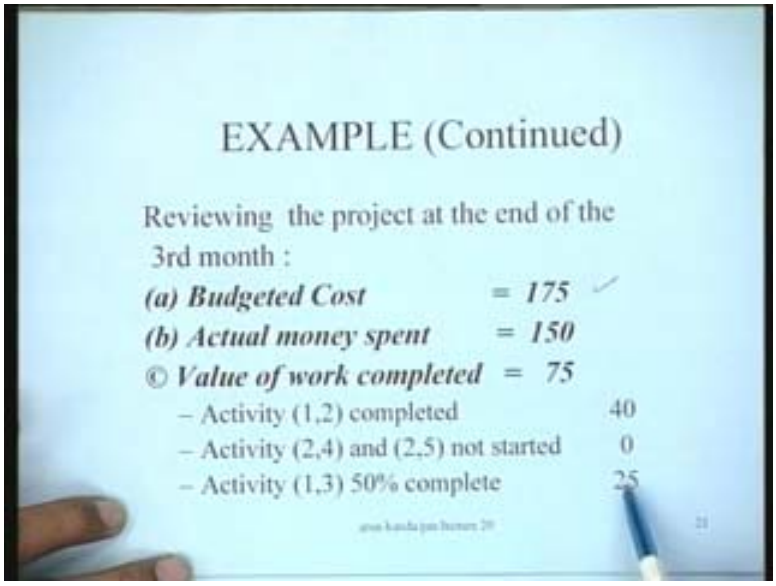

If you expect that some other work has been done the total amount of work done should be 40 + 25; it should be 65. Assume that 10 more units of work have been done somewhere; whatever it is. The value of work completed is then of the order of 75,000 units. The way you compute the value of work is simply look up the status of the individual activities and find out how much work has been done and sum it up and take the total and we say that this is the value of work completed. We get the three estimates a, b and c which we are interested in. That's all; you just have to compute a, b and c. Having obtained this information we then simply compute the time overrun and the cost overrun.

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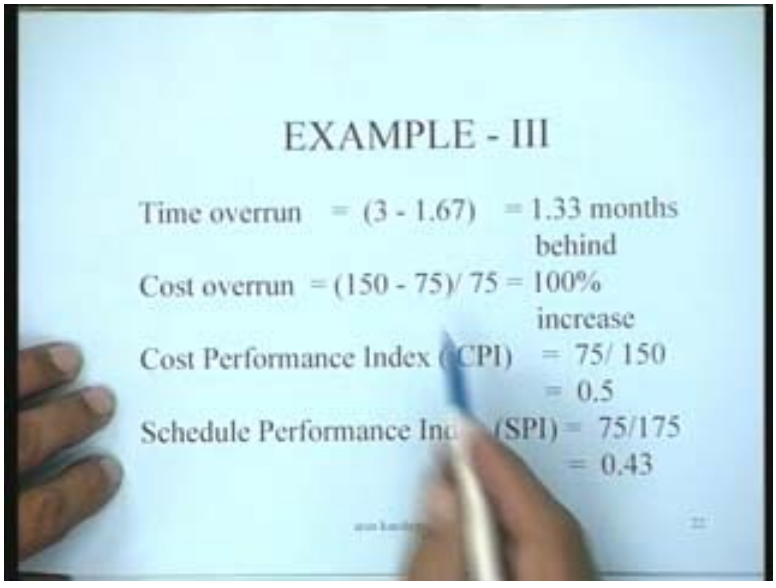

In three months we find that value of work completed is only 75,000. From the plan 75,000 units of work should have been done in months 1.67. We are actually 1.33 months behind at the end of the third month and the cost overrun is 150,000 is the cost; 75,000 is the value of work completed and so there is a 100% increase in cost. We are in a very bad situation both with regard to the time overrun and the cost overrun. Similarly the cost performance index and the schedule performance index are just 0.5 and 0.43 respectively corresponding to these two figures. With this performance the combined schedule performance index graph of this actually falls in the unfavorable region at this point which is very, very unfavorable situation. That is both 0.5 and 0.43. Something has to be done to improve the project.

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This is how we can get measures of the cost overrun and the time overrun in a project based upon the performance report of the various activities from the site which tell us the individual performance of the individual activities and then we have taken the actual figures of the money that has been spent and these are then compared with the original plan and on that basis we get these figures. This is, mind you, only a monitoring system. It tells you that something is wrong. It's like a thermometer which says that something is wrong with the patient. You have to devise your dose of antibiotics to actually improve the performance of the project.

This monitoring system will then initiate some control action on the part of the managers and the control actions will probably be in the nature of either reprimanding the people at site or trying to find out what are the genuine problems which have prohibited the project from being done and trying to make sure that those problems don't repeat in the future. This is the control action. Monitoring and control of a project is very much linked to the performance at every review of the project. This kind of a review can be repeated every time and this point must gradually improve and hopefully come to the favorable point as you keep on improving the old project situation and this movement will be done by

suitable medication or suitable control actions that managers will like to take. PERT/Cost as we have seen becomes a very effective tool for purposes of monitoring the progress of a project with regard to the time, the cost and its actual performance.

To summarize what we can say is that PERT/Cost provides a valuable framework for project monitoring by identifying the time and cost overruns at any stage of implementation. That is the primary contribution of a PERT/Cost system. Then it uses a cost accounting system based on the project activities rather than on the function organization of the firm because all the costing is done with regard to the individual activities and based on that system we have actually worked out how the expenditure is going to take place.

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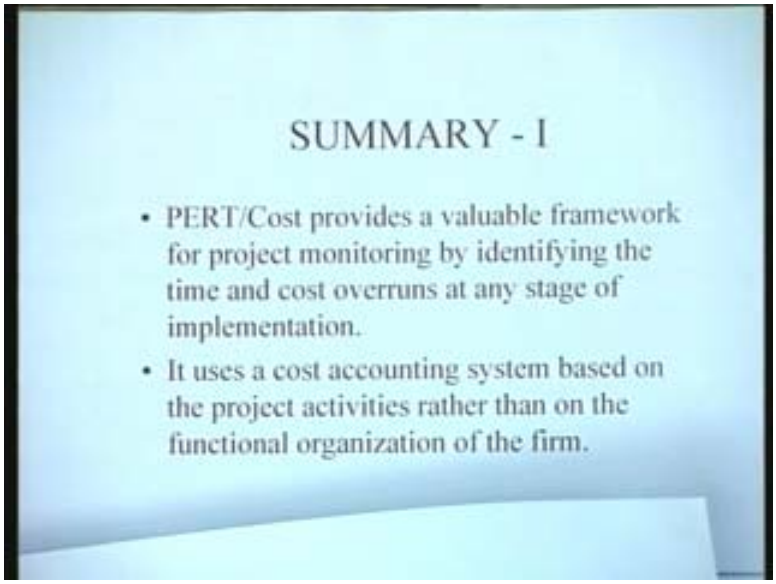

The notion of the work package is central to PERT/Cost: neither too big nor too small, well defined responsibility, sufficiently detailed for planning and monitoring and the possibility of schedules to be chosen for implementation.

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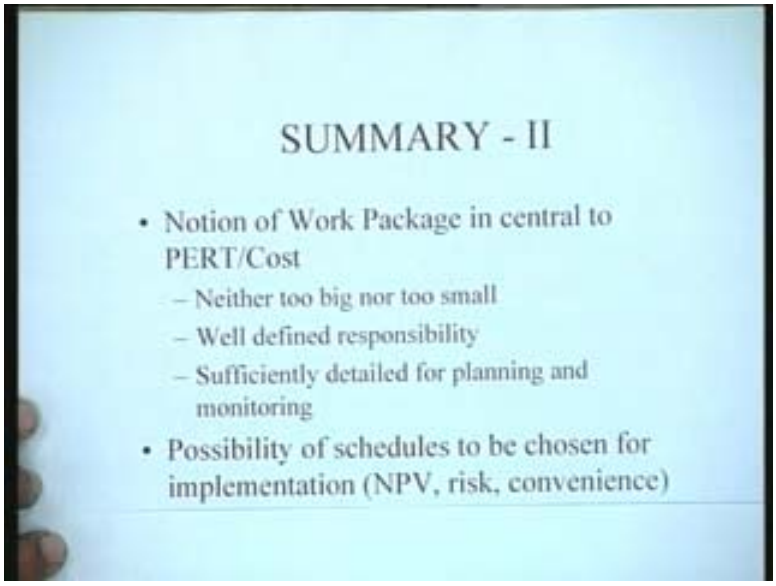

There is a large possibility of which schedule you choose. It has to be a tradeoff between the net present works, the risk and the convenience that you take whether you take an early start schedule or a late start schedule or whatever and finally project performance, time and cost are the major watch words in monitoring and control. Project performance, time and cost; these are the major watch words in planning and control. These can be evaluated and used to compute the time and cost overruns in a project at any stage, as we go along as we have tried to see and PERT/Cost mind you provides an aggregate measure of how the project is doing.

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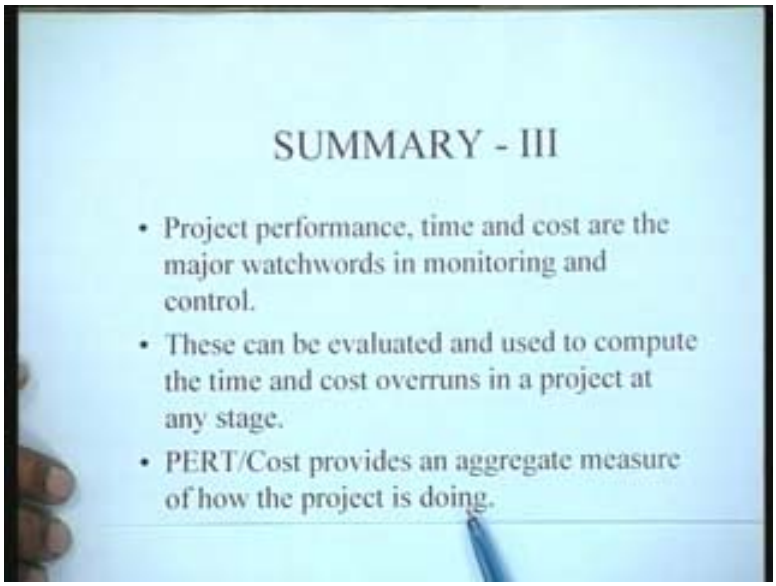

This is I think a very interesting point because the project can contain a large number of activities. Some may be ahead of schedule, some may be behind schedule. You want to find out how the project is performing on the whole. You are getting here an index of how the project as a whole is performing. May be the top management would be interested in this information on how a project is really performing on the whole. PERT/Cost can therefore be used as a very effective project monitoring and control tool. Thank you!