Construction and Project Management

Lecture 3

Project Network

First activity. Activity is a basic of form any network. Activity is nothing but part of project which has duration for it and it consumes time as well as resource to the project. Example. Laying of a pipe. Laying of a pipe involves a human being is involved in a project as well as there is a time is involved for it. And it has the starting point as well as ending point. And the activities are represented by arrow with a time and resource description along the arrow. The tail of the arrow the starting point of the arrow is called as the tail of the arrow and the ending point of the arrow that is where we marked the arrow mark is called as the head of the arrow. The arrow can be straight line it can be bend but not it cannot be broken and the arrow need not be drawn to scale so that like 1 or 5 minutes can be same length. Length of the arrow does not indicate time duration of the activity. Normally arrows of activity of four types the predecessor activity, the successor activity, the concurrent activity and dummy activity. Now we see what the four types of activity are.

Predecessor activity is nothing but the activity which is done before this particular activity has started. Example for this activity A. X is a predecessor activity.

Successor activity is nothing but activity which is done after this particular activity follows this particular activity. So a activity X is a successor for activity A.

And concurrent activity. Concurrent activity are nothing but these two activities can be done simultaneously. They are independent of each other. In this network we can see A and B are concurrent activities. And dummy activity. Dummy activity is nothing but it is a hypothetical activity which doesn't consume any time or any kind of sources here but this dummy activity are used in the construction of network because there are few network rules that are there. So because fitting to the rules these activities called dummy activity are inserted.

To make the activities with common starting and finishing point distinguishable, see here activity A is there activity B is there, they both have the same starting point they both start from the activity X and end at the activity Y, so there is a requirement of a dummy activity here. To identify and maintain a proper relationship between activities that are not connected by events, this part which is rules of activity we will be seeing later on. To bring all loose ends

to a single initial to terminal events in network, this also will be seeing in the rules of the network formation.

EVENT

Event is nothing but where we talked about the head and tail of the activity know each head and each tail is called as an event. The beginning and end point of an activity is called as an event. An event are also called as node or connectors likewise activities are also called as task. An event is represented graphically by a numbered circle. Any circle a circle is drawn and it is numbered that is called an event. Example of event is like material procured, design completed, project started, bricks laid if you notice these things any particular activity is getting over or either it is getting started the material is procured the activity is completed whereas procurement is an activity and procured becomes an event, design is completed, designing is an activity it is a process whereas design completed is a completion of an activity which is an event. Project is getting started so starting is a start event and process of a construction is an activity

All activities in a network must commence from some event, such event are called as tail events, here if you see in the burst event this particular event is called as tail event and it is represented with 'I'and terminal points are called as head event, in this merge event if you see all the activities come and merge here, so this is called as head of the event because it is at the head of the activity.

The events are classified into 3 categories the merge event where all the activities comes and merge here. Burst event where the activity starts from here and there are certain events which acts both as merge event as well as the burst event, For example if you see for a merge event all the activities end towards the project closure this is the merge event the closure of the project is the merge event. Burst event if you see the start of the project. When you have the start of the project lot of activities start from that particular event, so that is called as burst event. All events apart from start and end events are called as merge and burst event, they have lot of activities coming to that event and lot of activities that are starting from that particular event those events are called merge and burst events.

Network Rules

As I told that they are few rules to follow when we develop a network and here are a few times flows from left to right as we all know we start the network

from the right we proceed it like as time moves the network start flowing and the end is at the right hand side, so the time flows fr9om left to right.

Head events always have a number higher than that of the tail events. Tail events are nothing but the starting point of an activity and head event is nothing but the ending point of an activity, So always the activity start event will always have a number which is lower and the head event will have a number which is always higher than the tail event.

Simple Dependency Rule

Any event can't occur until all activities leading to it are completed, Here if you merge event is there all the activities which come toward the merge event is to be completed then only this event can start, likewise that no event can start until the tail event is reached. If you see in the burst event all the activities 1, 2, 3, all these three arrows can start only after this particular event has been completed. In short no activity may start until all previous activities in the same chain are completed that is what we saw now.

Logical Sequencing and connection of Activities

Which activity must be completed before the start of a particular activity, which activity to follow, which activity can go simultaneously all these things are to be logically reasoned, depending upon the project these reasoning vary and depending upon those particular situation we need to ascertain those logical sequencing and then start our network.

There are few errors which are like so happening when we do the rules so those are to be avoided there are a few like looping. Looping is like activity 1,2,3,4 are their activity 4 and 3 if you see activity 4 starts after the completion of event 3 but activity 3 will start only after event 4 has started this is a wrong sense of doing

Dangling where all the network should have only one start event and one tail event in between there should be no hanging of events like here if use see 11 is a hanging event this is wrong either it should go to 10 and stop at 10 or it should continue. There should be only one start event and one end event for a network.

Redundancy is unnecessary dummy. Thou dummy doesn't have any value, resource or time we should not keep on using dummy wherever it is not necessary, so that need to be taken care of . That type of error where lot of dummies are there are called redundancy error.

Numbering of events

As we stated when we draw the network depending upon the relationships and all know we need to number the event then only we be knowing in the small circle we can't keep writing know like what is the start of project, internal painting work we can't keep writing everything in the small circle and it can be visible also, so we try to number the events depending upon the duration it takes and depending upon the timeline where it falls on, so those numbering there are certain rules which we have to follow on that was devised by Delbert Ray Fulkerson and the rule is also called as Fulkerson since it was devised by him. Following are the steps that we need to follow. All the project as I told has only one start event that we can also call as initial event, so the initial event is always called as 1 , then after 1 remove the activity that is coming from 1, so the next circle after 1 will become an empty circle it can have a numerous number activity merging to it so it can even be a burst event where lot of activities are going out from that particular event.

In this case it is a burst event where the next circle that is next to one will be named as 2 and then from 2 there are 3 particular different events that is going to happen after 2 event so 3,4,5 can be named either wise, so after 2 if you remove all these activities these 3 are their so these 3 can be named anyway and after that so on that needs to be continued till you reach the end event that will be the last event that will be numbered. An initial event is one which has arrows coming out of it and none of the arrow entering in it. That is the start event. In a network there will be one such event, we call it 1. Deleting all arrows coming from 1, this will give us at least one more initial event and that is numbered as 2 in this particular event. Deleting all arrows from the numbered events, this creates new initial events that is 3,4,5 in this case and they can be numbered anyway and even if you want to keep y axis as standard and you want number you can number or at any random you can number, these steps are to be followed until last event is numbered. So we have seen what is an activity? What is dummy? What is an event? How to number a network and how to form this network we will just see now.

DEVELOPMENT OF NETWORKS

There are two ways to develop a network one is the activity is on the arrow and the other is activity on the node. Activity on the arrow is nothing but as we represent activity on the arrow we will just mention the name of the activity there itself along with the duration that is activity on arrow, if you see in this picture one is node, two is a node, 3 is a node those are nothing but events again these arrows are nothing but the activities and if you mention the duration of the

activity below the arrow or above the arrow that becomes the duration of the activity which is been indicated. Activity on node is nothing but instead of leaving the 1, 2, 3 as node you should describe the activity as nodes itself and arrow marks is nothing but you just join these things and depending upon the dependencies with which activity starts.

For example there are four types of dependencies for any particular activity. Finish to start is nothing but activity A is there and then you have another activity B. Activity B can start only after activity A is completely over with lag of n days, this how we represent the lag. Lag is nothing but activity A takes 7 days for completion and then activity B takes another 5 days for completion, but activity B can start only after activity A is getting over and there is a lag of another 3 days in that case it means that like activity B can start only after the completion of A that is 7 days plus another lag of 3 days, so totally after 10 days only activity B can start and activity B gets completed only after 15 days that is the another 5 days for the duration of the activity B to happen. Next dependencies is start to start in this case activity B and A can start simultaneously if there is no lag that is if n=0 , if there is any lag is that after start of activity A after the nth day activity B can start this what start to start relationship, then finish to finish is nothing but A and B can end simultaneously when the lag is zero or A and B can finish simultaneously with the lag of n days, say activity A ends on September 2nd and there is a lag of 8 days for the activity B to end in that case B will end on September 10th. Start to finish is nothing but activity A starting and activity B ending are the same. For example you have external development works that is being done and filling works are going on, filling works can get completed on completion we can start our plumbing works, plumbing work in the sense drenching works and all will start so this is like start to finish, plumbing and drenching works will start after completion of my external filling works, so this is how it is start to finish dependency.

Development of a Network

So till now we were talking about what is network, how to develop a network and all, so why did we understand what is an activity, event and all, there are few things to develop a network we need to understand those things and by developing a network what we do is that we understand the network, we understand the project duration and what are the basic, what are the sub division in that particular project are there. There are few steps involved in drawing a network like you break up the entire project into smaller system known as a task, for each task ascertain the activities and events that are to be performed,

for each activity determine the preceding and succeeding activities, for each activity determine or estimate the time and resource needed and draw a network depicting the assembly of task into the project. So we will go one by one.

Breaking up the entire project into smaller system known as a task, It is nothing but constructing a house this is your project, so what all you need to do, you need to first search for land, get a land, complete your designs start your constructions and complete your construction, these are the major task that is involved in building a home.

So for each task ascertain the activities and events that are to be performed, for example buying a land, so buying a land has lot of values, you need to first finalize the location where you need to buy the land, see 4 to 5 lands you need to understand what is the requirement and which land suits your requirement that you need to understand, these are the various activities and events that are involved in particular selection of a land and buying of a land.

So for each activity determine the preceding and succeeding activities. For example you select the locality that is your starting point for the buying of a land and then you go around that particular locality to understand what are the plans that are available for sale, you visit all the lands, you see which is suitable for you. You determine the size which is required for you and then you buy. There are some inter dependency in these activities. You can't first go random see lands and then decide upon the location or randomly see and finalize size of it, so there is some inte5r dependency on that so we need to understand that before we develop any network.

For everything know we need to determine or estimate the time and resource that we will be requiring. Before buying of a land can be never ending process like you want to construct the home one year means at least your land should be bought one month or two months earlier.

Before we develop a network first list on the activity that used to be formed in the network, like here if you see A,B,C,D,E,F,G are the list of a activity for me and what are the relationship of the activities there. If you see here C activity will start only after B activity is getting over same way for D activity will start only after my activity B is over, E will start only after B is over and F will start after E is over and G will start only after A,D,C all the three are over. So here if you see A and B does not have any predecessor. Predecessor is nothing but activity which precedes the activity. Activity A and B does not have the predecessor means that activity A and B both are start activities and will start

from a single starting node that is we number it has 1 as per Fulkerson rule that has to be numbered as 1 an activity A is there and activity B is there is both start at the same time. And if you see C, D and E all three start from the activity B getting completed, so activity B gets completed at node 2 and with this C, D and E all the three start so we just draw these arrows C, D and E are there and then activity F is there activity F gets started only after activity E is getting over. So activity E starts from node number 2 and it continues here, all these 3 activities will be definitely getting completed so all the three we should draw a event and leave. And it can be numbered any way 3,4,5 either way. Here we number it has 3,4 and 5 so activity E gets completed to activity 5 and next is our last activity that is nothing but G activity G will start only after A,D.C all three are over, so my A goes complete on node number 4, C also goes complete on node number 4 but activity D goes complete on node number 3, now I need to merge those nodes 4 and 3 to merge that I introduce a dummy because C and D they can't have the same starting node and ending node that is not accepted as per the rules of networking so we need to merge C and D by use of a dummy. Now I hope you understood why we use dummy activities. And start the activity G which has the preceding of the activity A,C and D and you have the F which comes after E so this F and G goes and ends into the event that is 6 that will be the last event of this particular project to get over, thus we have formed one network.

We will see one more example for better understanding here in this case if you see the list of activities are from A to J , Activity A does not have a preceding activity which means that activity A is the starting node. So 1 is the node that starts activity A that gets completed to node 2, from node 2 if you see A is the preceding activity for three particular events that is B,C and E so all these three events starts after the completion of activity A from the node 2 and all the three events will have individual nodes and that can be numbered after 2 3,4 and 5 any particular these three can be interchangeably numbered as per the Fulkerson rule. And then from B you have the activity D that is getting started, so from B you need to draw the arrow activity D and that will have a node that is numbered as six and then after C you have G that is coming, so after C you need to draw this G and that will again have an end node. And then activity F, F will start only after B and E are over but this B and E arising out of the same node cannot go and join on the same node so we again introduce a dummy here and then you have a activity F that is again coming here and if you see here D and F are the merging event and before completion of E and D H can't start so F at D comes to this node 6 and then H event starts and then you have this I event, I event can only start after the completion of J event, so J event is here I event here. G has an end node that is 7 and after completion of this G activity I

activity will start and it will again have a completion node and there is a J activity which will not start before H and I are completed so if you again H activity is there and again I activity is there and J activity will start only after the completion of H and I, Thus J is the last activity for the project which will have a single node that is ending the project. So if you see in this network itself you will understand every network will have only a single start node and a single end node and there are various number of activities that are inter linked depending upon the precedence activity that are following it and succeeding activity which will be following this particular activity.

I f you see here H is the successor of the activity F and D that in turn reflects that H can't start before F and D so therefore that are interlinked here. Instead of giving here preceding activity you can write the succeeding activity and form a network and ascertain the duration for each activity we can come to know about the project duration. This is how it is being done. After you do the network know what you have to do is you have to ascertain the time of it.

Each activity as we told has resources to be allotted to it. It has time, man power, materials everything associated to it. To calculate time know we need to first understand the network, after understanding how the network is formed we need to give all the activity and the time duration it will take. Here we have 4 activities A,B,C and D here, and we will give the duration for each activity so that we will come to conclusion of the project time duration. Activity A will take 8 days, B will take 6 day, C will take 4 days and D will take 10 days. Activity A and B are the starting events which doesn't have any predecessor so A and B I have taken bursting from the event 1 and after the predecessor condition activity C can't start once B is completed, B will take 6 days to completed so C will start from 7^{th} day onwards and if you see D is preceding A and C, so D can't start unless the activity A and C are completed. Activity A will take 8 days to complete but activity C will start only on 7^{th} day and will take 4 days that is nothing but activity C will take 10 days to complete from the day 0 from the starting of the project so D will start only after 10^{th} day and D on its own will take another 10 days complete. So 10 days for the activity to start and 10 day for its own operation and totally it will take 20 days for the whole project to get completed. Thus we can arrive at the project duration.