PROGRAMMING TECHNIQUES

Chapter 5 (Part 2)
LEARNING OUTCOME

At the end of this lesson, students will be able to:

- Understand the different types of planning techniques.
- Understand the network analysis.
- Formulate a network diagram.
Planning Techniques Used in Construction

- Bar Chart
- Line of Balance
- Time Grid Diagram
- Network Techniques
  - CPM (Critical Path Method)
  - Precedence Diagram
  - PERT (Programme Evaluation & Review Technique)
BAR CHARTS

Who invented bar chart?
1. In 1917, Henry L. Gantt invented a chart for scheduling.

What is bar chart?
1. A graphical representation of planned construction activities, the estimated activity duration and the planned sequence of activity performance.

Why use bar chart?
1. It is simple, ease of preparation and easy to read in graphical format.
<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>WORKDAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Site clearing</td>
<td></td>
</tr>
<tr>
<td>Dig trench</td>
<td></td>
</tr>
<tr>
<td>Assemble pipe</td>
<td></td>
</tr>
<tr>
<td>Install pipe</td>
<td></td>
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<tr>
<td>backfill</td>
<td></td>
</tr>
</tbody>
</table>
Planning Techniques Used in Construction

• Bar chart weaknesses:
  – Does not show relationships between project activities
  – Does not identify activities which control a project's total duration (i.e., critical activities comprising critical path)
  – Does not relate delay or change of one activity to the entire project
Network planning methods remedy bar chart weaknesses:

- CPM - developed in late 1950s by industry to schedule maintenance & construction work utilizing computers

- PERT - *Programme Evaluation & Review Technique* - developed in late 1950s by U.S. Navy to support the Polaris missile weapons system acquisition

- CPM & PERT have much in common with PERT being somewhat more sophisticated with the use of probability concepts to deal with uncertain activity durations. CPM uses a single fixed duration for each activity
Choice of Scheduling Method

• Factors that governed the choice of factors are as follows:
  – Familiarity on the technique to be used
    • Acceptable by parties involved.
  – Type and size of project
    • Project with few but repetitive task-Line of Balance
    • Med to large project with numerous task-CPM or Precedence
    • Small project-Bar chart
  – Purpose of scheduling
Network Analysis

- Network analysis is a method of project planning done on activities so that it is connected to each other. This network is used to optimise the usage of resources and also for monitoring and controlling.

- The purpose is to ascertain the critical path for a certain project.
Network Analysis

• Type of network analysis
  – CPM
  – Precedence Diagram
  – PERT

• Techniques
  – Activity on arrow (CPM)
    • Arrow represents activity
    • Activities are represented by arrows whereas the start or end of each activity is represented by a node.
    • One of the main drawbacks of this technique is the existence of dummy activities, which might complicate the network and cause some confusion.
Network Analysis

- Activity on node (Precedence)
  - Node represents activity
Steps in building a network model

• Define activities
• Order activities
• Draw a network diagram
• Assign durations to activities
• Assign resources and cost
• Calculate early and late start/finish times.
• Schedule activity start/finish times.
Project Task or Activity

- An activity or task is a single work step that has a recognisable beginning and end and requires time and resources for its accomplishment.
Logical Relationship of Project Activities

• Very important for a planner to understand the order of how the job to be accomplished in the field.
• Should understand how various activities of the project related to each other in term of their logical sequence.
Example of logical relationships:
- Start of the cut & fill activity can only be accomplished upon the completion of the activity ‘strip top soil’.
Logical Relationship of Project Activities

- 'Formwork' and 'Rebar' activity must be accomplished before the start of activity 'Pour concrete'.
Developing an arrow diagram network

• Activity Relationship
  – Arrows should always be drawn showing progress from left to right.

• Basic types of relationship found in a network:
  – One on one relationship between 2 activities.

Activity B
Hang wallpaper on wall

Activity G
Install mirror
Many on one relationship among several activities.

**Activity B**
Hang wallpaper on wall

**Activity F**
Install vanity light

**Activity G**
Install mirror

**Activity H**
Install duplex cover plate
One on many relationship among several activities.
– Many on many relationship among several activities.

- Activity A: Install roofing
- Activity B: Install siding
- Activity C: Install windows & exterior doors
- Activity F: Install insulation
- Activity G: Install floor covering
- Activity H: Install drooped ceiling
CRITICAL PATH METHOD (CPM)

What is CPM?

1. A project scheduling method where activities are arranged based on interrelationships and the longest time path through the network.

Advantage of CPM?

a) Reduce the risk of overlooking essential task and provides a blueprint for long-range planning and coordination of the project.
b) Identify critical tasks
c) Easier to plan, schedule and control project
d) Determine the resource required
e) Improve productivity

Disadvantage of CPM?

a) Difficult to understand for beginner.
b) Computer software can be used but expensive.
Dummies

• The relationship that exist among activities cannot always be shown as simply as those demonstrated in the previous slides.
• Therefore it is necessary to include in the diagram a ‘pseudo activity’ called a dummy.
• Dummy is usually drawn as a dotted line but assigned no duration.
• Most dummies are required for unique activity designation and to maintain proper logic of various construction activities.
For Example:

- Activity A - Place concrete slab in garage
- Activity B - Install garage door
- Activity C - Install pre finished shop cabinets
- Activity D - Install garage door opener
From above network, you can conclude that Activity C and D can begin only after both Activity A and B have been completed.

Suppose Activity C can begin only after Activity A and B completed, but Activity D can begin as soon as activity B is completed. The corrected logical sequence can be achieved by using dummy.
For Example:

A

B

C

D
Formulating a Network Diagram

- Form an activity network for a seven-activity network with the following precedence:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Predecessors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>---</td>
</tr>
<tr>
<td>B</td>
<td>---</td>
</tr>
<tr>
<td>C</td>
<td>A,B</td>
</tr>
<tr>
<td>D</td>
<td>C</td>
</tr>
<tr>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td>F</td>
<td>D</td>
</tr>
<tr>
<td>G</td>
<td>D,E</td>
</tr>
</tbody>
</table>
Activity-on-Arrow
SOLUTION

• Forming an activity-on-arrow network for this set of activities might begin by drawing activities A, B and C as shown in Figure (a).

• At this point, we note that two activities (A and B) lie between the same two event nodes; for clarity, we insert a dummy activity X and continue to place other activities as in Figure (b).

• Placing activity G in the figure presents a problem, however, since we wish both activity D and activity E to be predecessors. Inserting an additional dummy activity Y along with activity G completes the activity network, as shown in Figure (c).
Solve this problem

<table>
<thead>
<tr>
<th>Activity</th>
<th>Depends On</th>
<th>Activity</th>
<th>Depends On</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-</td>
<td>H</td>
<td>B, C, E</td>
</tr>
<tr>
<td>B</td>
<td>A</td>
<td>I</td>
<td>F, G</td>
</tr>
<tr>
<td>C</td>
<td>A</td>
<td>J</td>
<td>B</td>
</tr>
<tr>
<td>D</td>
<td>A</td>
<td>K</td>
<td>H, I</td>
</tr>
<tr>
<td>E</td>
<td>D</td>
<td>L</td>
<td>H</td>
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<tr>
<td>F</td>
<td>D</td>
<td>M</td>
<td>I</td>
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<tr>
<td>G</td>
<td>D</td>
<td>N</td>
<td>K, L, M, J</td>
</tr>
</tbody>
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Solve this problem

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</tr>
<tr>
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