STUDY NOTE 6: PROJECT MANAGEMENT

PROJECT:

A project is defined as a combination of interrelated activities all of which must be executed in a certain order to achieve a set goal.

Some of the typical projects are:

- Construction of a house
- Construction of a factory
- Construction of a ship
- Research to develop a new technology

PROJECT MANAGEMENT:

Definition:

- Project management is the process and activity of planning, organizing, motivating, and controlling resources, procedures and protocols to achieve specific goals in scientific or daily problems.
- Project management is generally applied for constructing items of public utilities, large industrial projects, organizing mega events etc.

Example: Construction of railway coaches
Launching satellites and product launching
Organizing R & D activities, etc.

Three main managerial functions for any project are:

Planning: This phase involves **setting the objectives of the project**. For example men, machines, materials required for the project and also estimates of costs and duration of activities also determined.

Scheduling: Establishments of times at which to begin and/or complete each operation.

i.e. **When aspect**

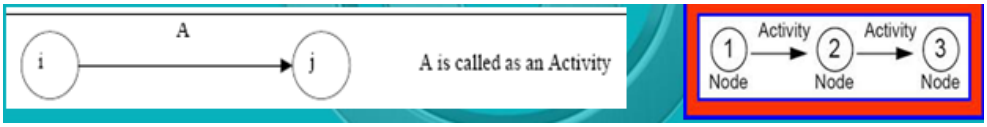
Controlling: It consists of **reviewing the process of the project** whether its process as per planned schedule.

Basic Terminologies used in CPM and PERT

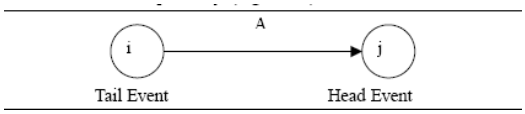
- Activity
- Event
- Merge and burst events
- Preceding, Succeeding, Concurrent activities
- Dummy activity
- Starting and terminal activities
- Common errors (Loop, Dangling, Redundancy)

Activity:

- Activity is a **task or item of work to be done in a project**. An activity consumes resources like time, money, labour etc. It is represented by an arrow.



Event or Node: An event will always occur at the **beginning and end of an activity**. The event has no resources and is represented by a circle.

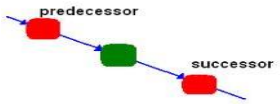


Merge and Burst Events:

- One or more activities can start and end simultaneously at an event

Preceding and Succeeding Activities:

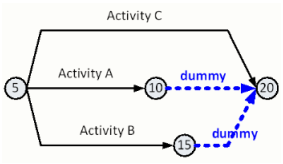
- Activities performed before given events are known as preceding activities and activities performed after a given event are known as succeeding activities.



- In the above diagram A is called immediate predecessor of B and B is called immediate successor of A.

Dummy Activity:

- An **imaginary activity** which does **not consume any resource** and time is called a dummy activity.
- Dummy activities are simply used to represent a connection between events in order to maintain logic in the network. It is **represented by a dotted line in a network**

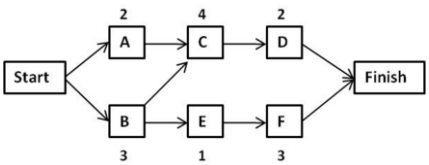


Start activity:

Activities which **have no predecessors** are called start activities of the project.

Terminal activity:

Activities which **have no successor are** called terminal activities of the project.



Note:

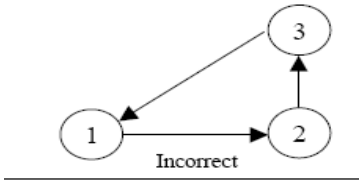
There are two methods of representing any project in the network form:

1. Activities on Arrow diagram (AOA)
2. Activities on Node diagram (AON)

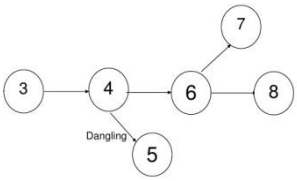
- **AOA diagram is commonly used in project management.**

COMMON ERRORS

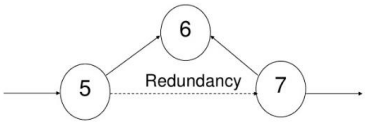
- **Looping or cycling error:** It is an edge connecting and operating itself



- **Dangling:** There are two or more end points in the network



- **Redundancy error**: When dummy activity is introduced but it is not required

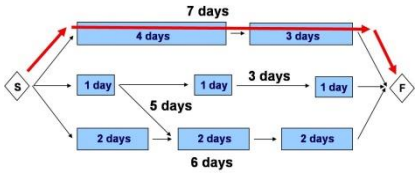


CPM& PERT

- **PERT & CPM are especially used for scheduling and controlling in project.**

Critical Path Method (CPM)

- The **path** from starting node to the end node which has **longest duration** in any project network is called critical path



- CPM was developed by E.I.Du Pont DE Nemours & company as an application to construction projects.
- Later it was extended by Mauchly Associates.
- In CPM, the activities timings are deterministic in nature.
- Nodes may be numbered using the Ford and Fulkerson's rule.
- Try to avoid arrows that cross each other.
- Use straight arrows.
- An event cannot occur twice, i.e. there must be no loop

STEPS IN CPM – Problems (refer notes)

- Specify the individual activities.
- Determine the sequence of those activities.
- Draw a network diagram.
- Estimate the completion time for each activity.
- Identify the critical path (the longest path through the network)
- Update the CPM diagram as the project progresses.

Formula Used – Problems (refer notes)

Formulas used to compute Critical Path are

- EARLIEST START TIME (ES_J) = MAX [ES_i+ T_{ij}]
  Where ES_j denotes the earliest start time of all the activities originating from node i and **T_{ij} is the estimated duration of the activity i-j**
- LATEST START TIME (LS_i) = MIN [LS_j- T_{ij}]
- EARLIEST FINISH = ES + T_{ij}
- LATEST START = LF - T_{ij}
- **Total float (T.F) of an activity i-j** = $(LF)_{ij} – (EF)_{ij}$
- **Free float (F.F) of an activity i-j** = T.F of i-j – (L-E) of event j
- **Independent float (I.F) of an activity** = F.F of i-j – (L-F) of event I
- **Interfering Float (INF) of i-j** = T.F – F.F

Thus T.F ≥ F.F ≥ I.F

Total float:

Total float of an activity is defined as **difference between latest finish and the earliest finish** (or) difference between latest start and earliest start of an activity.

Free float:

Free float of an activity is that portion of the total float which can be rescheduling that activity without affecting the succeeding activity.

Independent float:

Independent float of an activity is that amount of time by which can the activity be rescheduling that activity without affecting the preceding or succeeding activities of that activity.

PROJECT EVALUATION AND REVIEW TECHNIQUE (PERT)

- U S Navy (1958) for the POLARIS missile program
- Multiple task time estimates (probabilistic nature)
- This technique takes into account the uncertainty project durations. In certain projects like research and development, new product introductions, it is difficult to estimate the time of various activities.

PERT calculations depend on three time estimates.

- Optimistic (least)time estimate (t_0 or a)
- Pessimistic (gratest)time estimate (t_p or b)
- Most likely time estimate (t_m or m)

Optimistic time t_O:

- It is the shortest time taken to complete the activity. It means that if everything goes well then there is more chance of completing the activity within this time.

Most likely time t_m:

- It is the duration of any activity when sometimes things go on very well, sometimes things go on very bad while doing the project.

Pessimistic time t_p:

- It is the longest time that an activity would take to complete. It is the worst time estimate that an activity would take if unexpected problems are faced.

FORMULA USED - Problems (refer notes)

Expected duration of each activity

$$T_a = \frac{t_0 + 4t_m + t_p}{6}$$

Expected variance of each activity

$$\sigma_i^2 = \left(\frac{t_p - t_0}{6} \right)^2$$

Where as

t_O - Optimistic time

t_m - Most likely time

t_p - Pessimistic time

Standard normal deviate

$$\frac{T_S - T_E}{\sigma}$$

T_S - Specified or scheduled time to complete project.

T_E - Normal expected project duration.

- Probability of completing the project within the scheduled time is,

$$P(T \leq T_s) = P(Z \leq Z_0) \text{ (from normal tables)}$$

NETWORK CRASH - Problems (refer notes)

- **Cost slope**

  $$\text{Cost slope} = \frac{\text{Crash Cost} - \text{Normal Cost}}{\text{Normal duration} - \text{Crash duration}}$$

- Total Cost (without crash) = Direct cost + Indirect cost
  - Direct cost = Cost of total duration of the project (Critical path cost)
  - Indirect cost = Project time (Critical Path) × indirect cost (Given in problem)
- Total Cost (with crash) = Previous total cost + Increase in direct cost (crashed activity cost) + Decrease in indirect cost (indirect cost given in problem)

Solution: If the total cost of iteration is more than the previous iteration then stop the crashing procedure and treat the solution of the previous iteration as the best solution for implementation.

DIFFERENCE BETWEEN CPM AND PERT

CPM	PERT
CPM uses activity oriented network.	PERT uses event oriented Network.
Durations of activity may be estimated with a fair degree of accuracy.	Estimate of time for activities are not so accurate and definite.
It is used extensively in construction projects.	It is used mostly in research and development projects, particularly projects of non-repetitive nature.
Deterministic concept is used.	Probabilistic model concept is used.
CPM can control both time and cost when planning.	PERT is basically a tool for planning.

GANTT CHART

- **Henry Gantt, an American mechanical engineer**, designed the Gantt chart.
- A Gantt chart is a graphical interpretation of a project schedule. A Gantt chart is a type of bar chart that shows the start and finish dates of several elements of a project that include resources, milestones, tasks and dependencies.

This allows you to see at a glance:

- What the various activities are
- When each activity begins and ends
- How long each activity is scheduled to last
- here activities overlap with other activities, and by how much
- The start and end date of the whole project