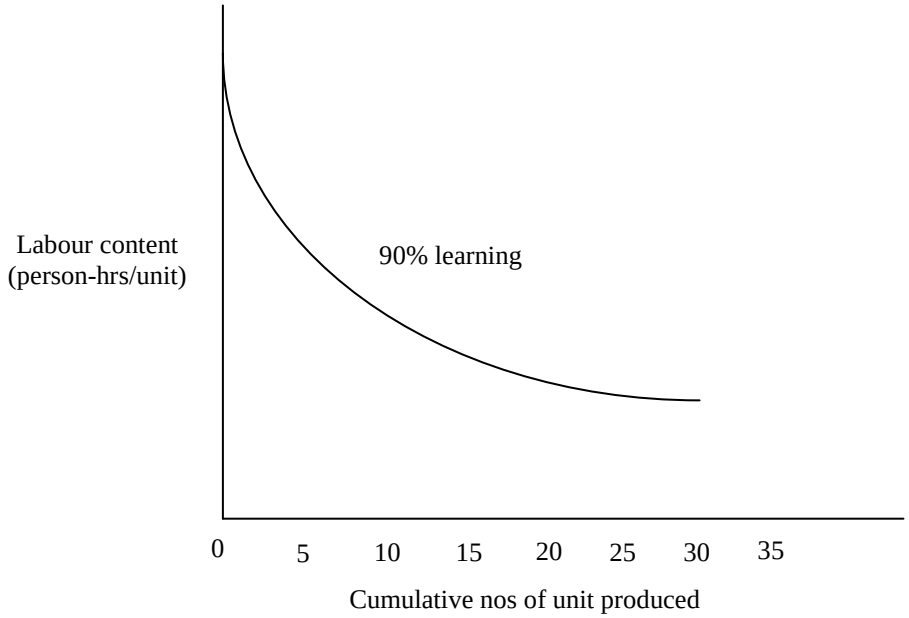


We normally express the rate of leraning in terms of how quickly the labour requirement decrease as we double the cumulative amount of output. We say that an activity exhibits an x% learning rate or has an x% learning curve, if the amounts of labour required to make the 2nth units of the product is x% of that required to make the nth unit. More generally, the amount of time required to make the nth unit of the product will be

$T_n = T_1 \times n^a$

where T_n = Time to make the nth unit.
T_1 = Time to make 1st unit.
a = (ln x/ln 2)
x = learning rate (expressed as decimal)

This learning data can also be represented in tabular form.

Chapter 7: Project Management

Project

A project is an interrelated set of activities that has a definite starting and ending point and those results in a unique product. That means projects are not repetitive. Few examples of projects are:

1. Constructing a bridge, dam, highway or building.
2. Producing an airplane, missile or large machine.
3. Introducing a new product.
4. Installing a large computer system.
5. Redesigning the layout of plant or office.
6. Construction of a ship.
7. Fabrication of a steam boiler.
8. Maintenance of major equipments/Plants.
9. Commissioning of a power plant/factory.
10. Conducting National Election.

Basic steps in project management

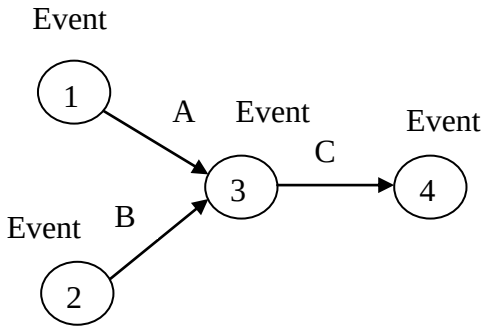
Managing a project, regardless of its size and complexity, requires identifying every activity to be undertaken and planning when each activity must begin and end in order to complete the overall project on time. Typically, all projects involve the following steps:

1. Describe the project.
2. Develop a network model.
3. Insert time estimates.
4. Analyze the model.
5. Develop the project plan.
6. Periodically assess the progress of the project and repeat steps 2-6 as needed.

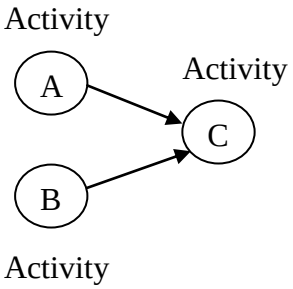
Network: A network is the graphical representation of the project activities arranged in a logical sequence and depicting all the interrelationships among them.

Terminologies used in Network diagram:

1. Activity: An activity means work/job. It is a time consuming process. It is represented by an arrow in the network diagram (AOA system).



Activity-on-arc (AOA) network



Activity on node (AON)

2. Event: An event is a specific instant of time marks the start and end of an activity.
3. Critical path: It is the sequence of activities which decides the total project duration.
4. Duration (d): Duration is the estimated or actual time required to complete a task or an activity.
5. Total project time: Time to complete the project. In other words, it is the duration of critical path.
6. Earliest start time (E): It is the earliest possible time at which an activity can start. It is calculated by moving from 1st to last event in the network diagram.
7. Latest start time (L_i): It is the latest possible time by which an activity can start.
8. Earliest finish time (E_j): It is the last event time of the head event. It is calculated by moving backward in the network diagram.
9. Latest finish time (L_j): It is the last event time of the head event. It is calculated by moving backward in the network diagram.
10. Float/Slack: Slack is with reference to an event and Float is with reference to an activity.
11. Free float: (Latest Finish Time – Earliest Start Time) – Activity duration.

Rules for Network Construction:

The following are the primary needs for constructing Activity on Arc (AOA) network diagram.

1. The starting event and ending event of an activity are called tail and head event respectively.
2. The network should have a unique starting node. (tail event)
3. The network should have a unique completion node. (head event)
4. No activity should be represented by more than one are (⟶) in the network.
5. No two activities should have the same starting node and same ending node.
6. Dummy activity is an imaginary activity indicating precedence relationship only. Duration of dummy activity is zero.
7. The length of the arrow bears no relationship to the activity time.
8. The arrow in a network identifies the logical condition of dependence.
9. The direction of arrow indicates the direction of workflow.
10. All networks are constructed logically or based on the principle of dependency.
11. No event can be reached in a project before the completion of precedence activity.
12. Every activity in the network should be completed to reach the objective.
13. No set of activities should form a circular loop.

Time estimation of an activity

If t_0 = Optimistic time (i.e. time estimate for fast activity completion).
t_p = Pessimistic time (maximum time duration an activity can take).
t_m = Most likely time
t_e = The expected time of an activity = $(t_0 + 4t_m + t_p)/6$

Variance of an activity time $\sigma_e^2 = \left[\frac{t_p - t_o}{6}\right]^2$

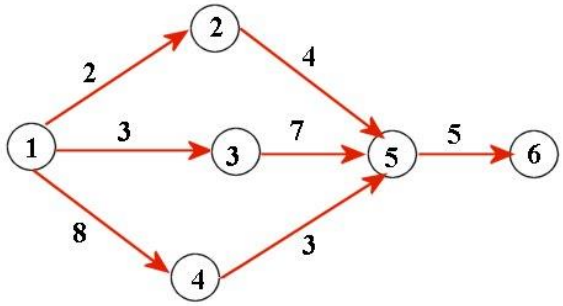
(c) Network scheduling

The biggest advance in project scheduling since the development of the Gantt chart in 1917 was made between1956-58. During this period, two new scheduling techniques were developed. These techniques are

(i) Program evaluation and review technique (PERT)
(ii) Critical path method (CPM)

Both are based on the use of a network/graphical model to depict the work tasks being scheduled. The popularity of network based scheduling can be attributed to its many benefits, especially its ease use. Other benefits include the following.

1. It provides a visual display of needed task and their temporal ordering, which makes it easy to see how tasks should be sequenced as shown below. This assists communication and co-operation among task teams because each team can see how its work affects other team.



2. It provides a relatively accurate estimate of the time required to complete the project at the proposed resource level.
3. It identified and highlights the tasks that are critical to keep the project on schedule.
4. It provides a method for evaluating the time-cost tradeoffs resulting from reallocating resources among tasks.
5. It provides a method for monitoring the project throughout its life cycle. As the project progresses, PERT/CPM easily identifies change in which tasks are critical and how the expected completion date is affected.
6. It provides a convenient method for incorporating uncertainty regarding task times into the schedule and it helps to evaluate the effect of this uncertainty on project completion time.

Difference between PERT and CPM

Sl. No.	PERT	CPM
1	PERT is a probabilistic model with uncertainty in activity duration. Activity duration is calculated from t_0, t_p and t_m.	CPM is a deterministic model with well known activity duration.
2	It is an event oriented approach.	It is an activity oriented approach.
3	PERT terminology uses word like network diagram, event and slack.	CPM terminology employs word like arrow diagram, nodes and float.
4	The use of dummy activity is required for representing the proper sequencing.	No dummy activity required.
5	PERT basically does not demarcate between critical and non-critical activities.	CPM marks the critical activities.
6	PERT is applied in projects where resources are always made available.	CPM is applied to projects where minimum overall cost is the prime importance.
7	PERT is suitable in Defence project and R&D where activity time can't be readily predicted.	Suitable for plant maintenance, civil construction projects etc. where activity duration is known.

Steps in using network techniques

1. Plan of project