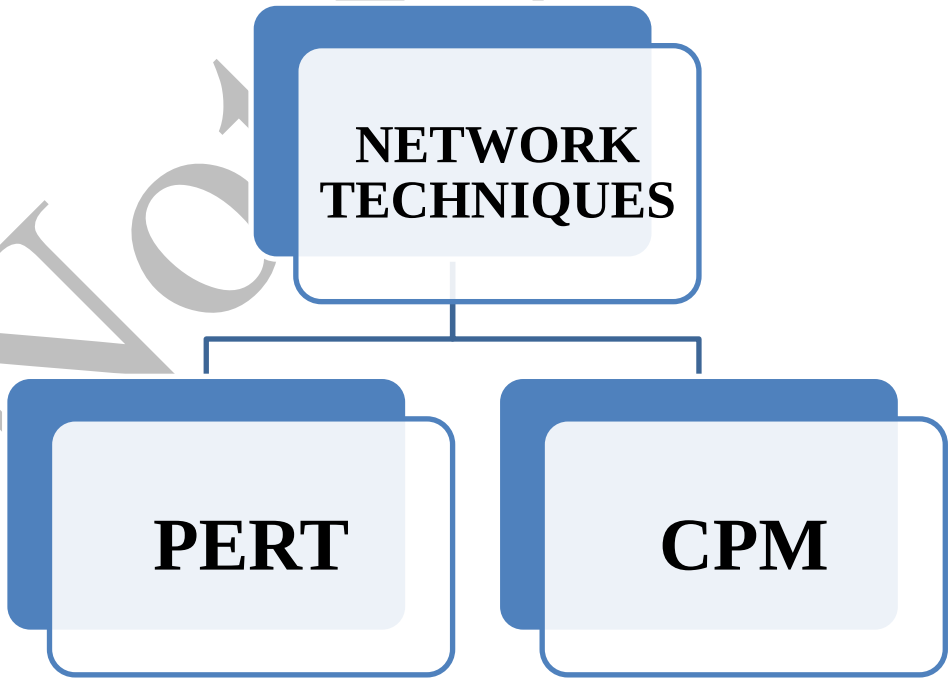
# Network Technique

Network is a technique used for planning and scheduling of large projects in the fields of construction, maintenance, fabrication, purchasing, computer system instantiation, research and development planning etc. There is multitude of operations research situations that can be modeled and solved as network. Some recent surveys reports that as much as 70% of the real-world mathematical programming problems can be represented by network related models. Network analysis is known by many names _PERT (Programme Evaluation and Review Technique), CPM (Critical Path Method), PEP (Programme Evaluation Procedure), LCES (Least Cost Estimating and Scheduling), SCANS (Scheduling and Control by Automated Network System), etc.

## Network

It is a graphical representation of logical and sequentially connected activities and events of a project. Network is also called arrow diagram. PERT (Programme Evolution Review Technique) and (Critical Path Method) are the two most widely applied techniques.

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## Activity

Any individual operation, which utilizes resources and has an end and a beginning, is called activity.

- A task or a certain amount of work required in the project
- Requires time to complete
- Represented by an arrow

These are usually classified into four categories:

- Predecessor activity
- Successor activity
- Concurrent activity
- Dummy activity

**Dummy Activity**

It Indicates only precedence relationships and does not require any time of effort.

## Programme Evaluation and Review Technique (PERT)

PERT is a method of analyzing the tasks involved in completing a given project, especially the time needed to complete each task, and to identify the minimum time needed to complete the total project. It incorporates uncertainty by making it possible to schedule a project while not knowing precisely the details and durations of all the activities. It is more of an event-oriented technique rather than start- and completion-oriented, and is used more in these projects where time is the major factor rather than cost. It is applied on very large-scale, one-time, complex, non-routine infrastructure and on Research and Development projects.

PERT offers a management tool, which relies "on arrow and node diagrams of activities and events: arrows represent the activities or work necessary to reach the *events* or nodes that indicate each completed phase of the total project."

PERT and CPM are complementary tools, because "CPM employs one time estimation and one cost estimation for each activity; PERT may utilize three time estimates (optimistic, expected,

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and pessimistic) and no costs for each activity. Although these are distinct differences, the term PERT is applied increasingly to all critical path scheduling.

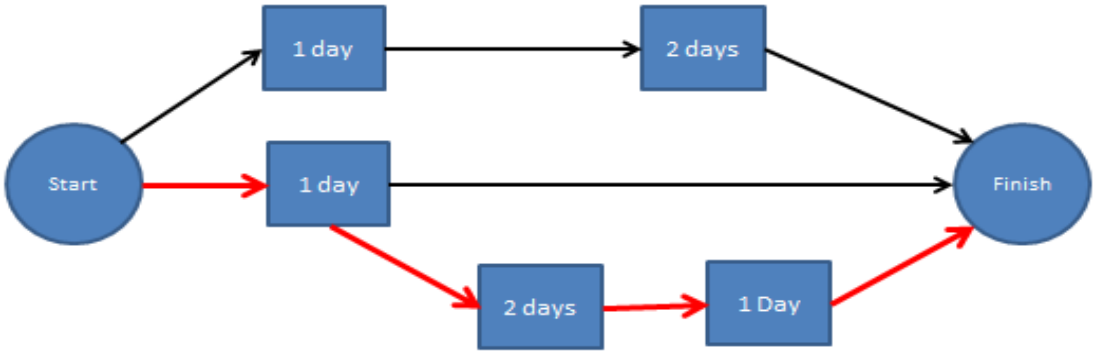
To conduct PERT Analysis, three time estimates are obtained (optimistic, pessimistic, and most likely) for every activity along the Critical Path. Then use those estimates in the formula below to calculate how much time for each project stage:

**Formula: (P+4M+O)/6**

- **Optimistic Time (O):** the minimum possible time required to accomplish a task, assuming everything proceeds better than is normally expected.
- **Pessimistic Time (P):** the maximum possible time required to accomplish a task, assuming everything goes wrong (excluding major catastrophes).
- **Most likely Time (M)**: the best estimate of the time required to accomplish a task, assuming everything proceeds as normal.

| Task | Optimistic (O) | Most Likely (M) | Pessimistic (P) |
|---|---|---|---|
| Task A | 2 Wks | 4 Wks | 5 Wks |
| Task B | 1 Wks | 2 Wks | 3 Wks |
| Task C | 2 Wks | 3 Wks | 4 Wks |
| Task B | 3 Wks | 5 Wks | 8 Wks |
| **Completion** | **8 Wks** | **14 Wks** | **20 Wks** |

Example of the three time estimates




Critical Path = 4 Days

Example of a Critical Path Nodal Diagram

## Advantages of PERT

### 1. Facilitate Planning of Large Projects

The program evaluation and review technique enables the project manager to schedule the project very easily. It is mainly active in the case of a large project.

To be more precise, it such requires three elements to define the event. What is the time required to do that event, what comes after the event and what comes before the event? This makes the scheduling easy and clear

### 2. Critical Path is visible

The PERT method shows the critical path in a clearer manner. The critical path is the path whose activities cannot be delayed.

An easy understanding of slack values with limited conditions of dependencies make the project manager take a fast and good decision which would favor the performance of the project.

### 3. Activity Analysis

A project manager views information about the likely completion of a project on time and on a budget by viewing PERT activities and events independently and in combination.

### 4. Coordination

PERT facilitates integration and data submission from various department of the construction organization. This will improve the planning and the decision-making capabilities of the project team.

A Large amount of data which gains qualitative, as well as quantitative values, are combined which helps in proper coordination of the project. This help in good communication between different departments, as lack of communication, is one of the important factor affecting the development of an organization. This clearly helps in identifying the responsible roles of everyone in the whole team.

### 5. What-if Analysis

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A what-if analysis identifies possibilities and uncertainties related to project activities, which is read from the formation of critical paths.

Many sets of permutations and combinations are performed differently with the activities and the most useful possibility selected. The set with minimum cost, best result and economy is chosen. It also helps us to identify the activity that is a risk.

## Disadvantages of PERT

### 1.Time Focused Method - PERT

The method of PERT is a time-oriented method, where the time required to complete the respective activity is of higher importance. Hence the time determination of each activity and its allocation is very much necessary. This is done based on an assumption and within this time the work will be completed. If this is not the case issues will arise.

### 2. Subjective Analysis in PERT

The activities for a project are identified based on the data available. This is difficult in case of PERT as these are mostly applied for a project that is newly conducted or those without repetitive nature. The project dealt by PERT will be fresh project data that make the collection of information to be subjective in nature. This will bring less accuracy on the time and the estimated time. There are chances to have inaccuracy and bias in the sources of data. This makes it unreliable. As this is not repetitive in nature, there is no sense in bringing the records from the past historical data.

### 3. Prediction Inaccuracy of PERT

As there is not past record or assistance to bring an outline for the project, predictions take their role. The overall project may move to total loss if the predictions and the decisions are inaccurate. No trial and error method can be employed.

### 4. PERT Technique is Expensive

As this method is carried out based on predictions overall, they find too expensive in terms of methods employed, the time consumed and the resources used.

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**5. Other Issues with PERT**

This method is highly labor-intensive in nature. As there are chances of increase in project activities large and complicated networks are developed as many task dependencies come into existence. If two activities share common resources, this technique won't find very apt for the project.

## Critical Path Method (CPM)

Critical path is the sequential activities from start to the end of a project. Although many projects have only one critical path, some projects may have more than one critical paths depending on the flow logic used in the project.

If there is a delay in any of the activities under the critical path, there will be a delay of the project deliverables.

Most of the times, if such delay is occurred, project acceleration or re-sequencing is done in order to achieve the deadlines.

Critical path method is based on mathematical calculations and it is used for scheduling project activities. This method was first introduced in 1950s as a joint venture between Remington Rand Corporation and DuPont Corporation.

The initial critical path method was used for managing plant maintenance projects. Although the original method was developed for construction work, this method can be used for any project where there are interdependent activities.

In the critical path method, the critical activities of a program or a project are identified. These are the activities that have a direct impact on the completion date of the project.

The CPM differentiates between planning and scheduling of the project. While planning refers to determination of activities to be accomplished, scheduling refers to the introduction of time schedule for each activity of the project. The duration of different activities in CPM is deterministic. There is a precise known time that each activity in the project will take. Let us illustrate the CPM technique with an example of a research project.

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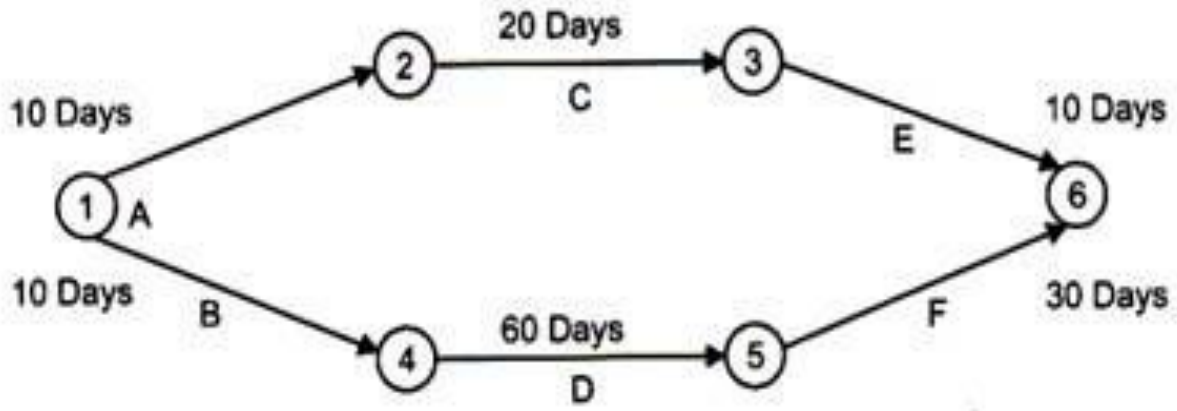
**The following activities are identified in the project:**

| *Job Identification* | *Job Description* | *Activity* | *Time Required* |
|---|---|---|---|
| A | Preparation of dealer questionnaire | 1-2 | 10 Days |
| B | Preparation of consumer questionnaire | 1-4 | 10 Days |
| C | Dealer Survey | 2-3 | 20 Days |
| D | Consumer Survey | 4-5 | 60 Days |
| E | Processing and interpretation of Dealer Data | 3-6 | 10 Days |
| F | Processing and interpretation of consumer survey data | 5-6 | 30 Days |
| | **Total** | | **36 Days** |




## Advantages of CPM

The important advantages of CPM technique are:

1. It helps in ascertaining the time schedule of activities having sequential relationship.

2. It makes control easier for the management.

3. It identifies the most critical elements in the project. Thus, the management is kept alert and prepared to pay due attention to the critical activities of the project.

4. It makes better and detailed planning possible.

## Limitation of CPM:

The main limitations of the CPM are:

1. CPM operates on the assumption that there is a precise known time that each activity in the project will take. But, it may not be true in real practice.

2. CPM time estimates are not based on statistical analysis.

3. It cannot be used as a controlling device for the simple reason that any change introduced will change the entire structure of network. In other words, CPM cannot be used as a dynamic controlling device.

## Benefits of CPM/PERT

1) Useful at many stages of project management

2) Mathematically simple

3) Give critical path and slack time

4) Provide project documentation

5) Useful in monitoring costs

## Distinguish Between PERT and CPM

| **PERT** (Programme Evaluation Review Technique) | **CPM** (Critical Path Method) |
|---|---|
| 1. PERT is event oriented. | 1. CPM is activity oriented. |
| 2. PERT is probabilistic. | 2. CPM is deterministic. |
| 3. PERT is primarily concerned with time only. | 3. CPM places dual emphasis on project time as well cost. |
| 4. PERT is generally used for projects where time required to complete the activities is not known a priori. Thus PERT is used for large, R&D type of projects. | 4. CPM is used for projects which are repetitive in nature and comparatively small in size. |
| 5. Three time estimates are possible for activities linking up two events. | 5.One time estimate is possible for activities (No allowance is made for uncertainty) |

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