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MDV-105
Development Planning and Management

Block

3

PROJECT MANAGEMENT TECHNIQUES

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Gujarat Institute of Development Research, Ahmedabad

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Jamia Millia Islamia, New Delhi

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IGNOU, New Delhi

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IGNOU, New Delhi

Dr. P.V.K.Sasidhar
IGNOU, New Delhi

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IGNOU, New Delhi

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IGNOU, New Delhi

Dr. Grace Don Nemching
IGNOU, New Delhi

COURSE PREPARATION TEAM

Unit Writer:

Prof. P.V.K. Sasidhar
IGNOU, New Delhi (Units 1 and 2)

Editors:

Prof. S.N. Laharia (Rtd.)
Haryana Agricultural University (Content Editor)

Mr. Praveer Shukla (Language Editor)

Prof. P.V.K. Sasidhar, IGNOU, New Delhi

Prof. B.K. Pattanaik, IGNOU, New Delhi

Prof. Nehal A. Farooquee, IGNOU, New Delhi

Course Coordinator :   Prof. P.V.K.Sasidhar, E-mail : pvksasidhar@ignou.ac.in
Programme Coordinators: Prof. P.V.K. Sasidhar, Prof. B. K. Pattanaik and
Prof. Nehal A. Farooquee

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BLOCK 3 PROJECT MANAGEMENT TECHNIQUES

Development professionals often depend on tools and techniques that are effective enough not only for drawing-up the best possible initial plan but also capable of projecting instantaneously the impact of deviations so as to initiate necessary corrective measures. This includes project planning and implementation with decision making related to a number of interrelated time bound project activities. The search for an effective tool has resulted in development of a variety of project management techniques. The purpose of this block is to make you understand SWOT analysis, bar charts and networks as project management techniques.

Unit 1, **SWOT Analysis and Bar Charts,** focuses on history, meaning, how SWOT analysis is useful as a project management tool and how to conduct SWOT analysis. The focus of second half of the module is on meaning and concept of Bar chart, Gantt chart and Milestone chart along with their advantages and limitations as project management tools.

Unit 2, **Networks,** gives an account of networks namely PERT and CPM, their application, preparation and analysis with the help of an example and diagrams.

UNIT 1   SWOT ANALYSIS AND BAR CHARTS

Structure

1.1   INTRODUCTION

Project planning and implementation involves decision making related to a number of interrelated time bound project activities. Development professionals therefore, often depends on tools and techniques that are effective enough not only for drawing-up the best possible initial plan but also capable of projecting instantaneously the impact of deviations so as to initiate necessary corrective measures. The search for an effective tool has resulted in development of a variety of project formulation and management techniques. These techniques can be classified under the following categories:

- SWOT Analysis

- Bar charts

- Networks.

In this module, we will discuss the meaning, concept, characteristics, advantages and limitations of SWOT analysis and bar charts.

After studying this unit you should be able to:

- understand the meaning and concept of SWOT analysis as a project management tool; and

- discuss the concept of Gantt and Milestone charts and use them as project management tools.

1.2   SWOT ANALYSIS

The origins of the SWOT analysis technique is credited by Albert Humphrey, who led a research project at Stanford University in the 1960s. The goal was to identify why corporate planning failed. The resulting research identified a number of key areas and the tool used to explore each of the critical areas was called SOFT analysis. Humphrey and the original research team used the categories "What is good in the present is **S**atisfactory, good in the future is

an **O**pportunity; bad in the present is a **F**ault and bad in the future is a **T**hreat." Later this concept was further practiced and evolved as SWOT analysis.

Factors internal to the system are strengths (S) or weaknesses (W) and those external are opportunities (O) or threats (T) and such an analysis of the strategic environment is referred to as a SWOT analysis (Bradford et al., 1999). As a project management tool, it provides information that is helpful in matching the resources and capabilities to the competitive environment in which any project operate.

1.2.1 SWOT As a Project Management Tool

SWOT is a strategic planning tool used to evaluate the strengths, weaknesses, opportunities, and threats to a project. It involves specifying the objective of the project and identifying the internal and external factors that are favourable and unfavourable to achieving that project objective. The strengths and weaknesses usually arise from within an organisation, and the opportunities and threats from external sources as described below.

Strengths: Strengths are the attributes of the organisation that help achieve the project objective.

Example: Track record of the organization in completing similar projects (similar successes), Resource availability, Skill levels, Processes and systems, Reputation etc.

Weaknesses: Weaknesses are the attributes of the organisation that stop achievement of the project objective.

Example: Gaps in knowledge and expertise, Timescale and deadlines, Budget and funding, Competing projects, Processes and systems etc.

Opportunities: Opportunities are the external conditions that help achieve the project objective.

Example: Technology and infrastructure development, Changing consumer behaviour, Emerging and developing markets, New innovations (R&D), Market demand etc.

Threats: Threats are the external conditions that could damage the project.

Example: Political influences, Environmental factors, Competitor activity, Economy, Seasonal effects etc.

SWOT analysis for project management is a simple, yet effective process. It allows the project manager to identify areas that needs improvement. By implementing the correct methodologies for the analysis, it is possible to ensure that a project will be completed on time and within budget.

The use of SWOT analysis lets the project manager to improve the whole project or individual tasks where better efficiency can be gained. It also mitigates risks associated with the tasks and optimizes the whole process. The team members get to do more with less. Because of the nature of the analysis, it is important to conduct the SWOT analysis during the startup phase. It can provide a solid backbone to the project plan (Rosanne Lim, 2012).

1.2.2 Conducting the SWOT Analysis

SWOT analysis can be conducted either at the initial or middle phase of the project. However, it is important to have a clear objective during SWOT analysis sessions. If the analysis is done during the initial startup phase, key members must come together and identify all required tasks and the potential risks to each step of the project. If it is done at the middle of the project, the main focus is usually to reassess the schedule, the budget, or to conduct a cost/ benefit analysis of certain processes. The common questions to be asked in SWOT analysis are summarized in Box 1(Rosanne Lim, 2012).

Box 1. Common Questions in SWOT Analysis

Strengths:

- Does the organization have all the necessary talent in-house?
- Is the budged sufficient to complete all the tasks involved?
- What are the benefits of completing the project?
- Has the project manager handled similar projects in the past?
- How experienced are the team members?

Weaknesses:

- Does the organization have the resources to provide contingency funding?
- If the team doesn't have all the necessary skills, what areas need to be outsourced?
- Is the schedule realistic?
- What are the potential drawbacks of the project?

Opportunities

- Will this project take advantage of competitor weaknesses?
- What are the latest trends in the industry?
- Are there new technologies that the organization should be aware of?
- Can this project help in different areas of the business?

Threats:

- Are the team members difficult to replace?
- Has the new technology (if it will be applied) been tested?
- Could changing trends affect the project?
- Can the capability be copied by competitors?

Source : Rosanne Lim (2012)

Advantages of SWOT

- Helps in identifying basic information for project planning and management.
- Assemble project's strengths and weaknesses, maximize opportunities and overcome threats.
- Helps in identifying core competencies of project team and setting of project objectives.

- Provide information that helps in synchronizing the project's resources and capabilities with the competitive environment in which the project operates.

Disadvantages of SWOT

- Categorizing aspects as strengths, weaknesses, opportunities and threats might be very subjective

- It stress upon the significance of SWOT aspects, but it does not tell how an organization can identify these aspects for itself.

- Government legislation and economic environment related problems. May persuade organisations to compile lists rather than think about what is essential to achieving objectives.

- Presents lists uncritically and without clear prioritisation so, for example, weak opportunities may appear to balance strong threats.

- Usually, a simple list and not critically presented.

Check Your Progress 1

Note: a)   Use the spaces given below for your answers.

b)   Check your answer with those given at the end of the unit.

1.   Ask some of your colleagues what they mean by SWOT analysis? Compare their views with the one given in this section and identify the common features.

....

....

....

2.   Do you agree that SWOT analysis is useful for project management? Support your answer with examples.

....

....

....

Activity 1: Identify a project and project objectives. Write two attributes on Strengths, Weaknesses, Opportunities and Threats related to the identified project objectives in the following grid.

Project Title :

Project Objectives:

Strengths	Weaknesses
1	1
2	2
Opportunities	**Threats**
1	1
2	2

1.3 BAR CHARTS

Bar charts are the pictorial representation of various tasks required to be performed for accomplishment of the project objectives. These charts have formed the basis of development of many other project management techniques. Two main bar charts are:

i.   Gantt chart

ii.   Milestone chart

1.3.1 Gantt Chart

A Gantt chart is a type of bar chart that illustrates a project schedule. For scheduling and reporting about the progress of projects, Henry L Gantt developed the system of bar charts in 1917. These charts latter were named after him as Gantt Charts. Although now regarded as a common charting technique, Gantt charts were considered revolutionary when they were introduced. For your understanding a Gantt chart showing the tasks of 12 months duration survey project is given in Fig. 1.1

Fig. 1.1: Gantt chart showing the tasks of 12 months duration survey project

Task	Duration (Months)	1	2	3	4	5	6	7	8	9	10	11	12
1. Literature collection and theoretical orientation	2*	▓	▓										
2. Identification of study area and selection of respondents	2*	▓	▓										
3. Interview schedule preparation	1			▓									
4. Pre-testing of interview schedule and modifications	1				▓								
5. Data collection	4					▓	▓	▓	▓				
6. Statistical treatment and analysis of data	2									▓	▓		
7. Report Writing	2											▓	▓

* Concurrent tasks - Time duration to complete both tasks is two months.

> ### Characteristics of Gantt Charts
>
> - Specify the start and finish time for various tasks on a horizontal timescale
>
> - Tasks are indicated by means of a bar, preferably at equi-distance in the vertical axis and time is plotted in the horizontal axis.
>
> - Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project - Terminal elements and summary elements comprise the work breakdown structure of the project.
>
> - Some Gantt charts also show the dependency relationships between activities.
>
>   Example: Unless task 3 is completed, task 4 cannot start (Fig 1.1).
>
> - Length of the bar indicates required time for the task, whereas the width has no significance.

Advantages

- Gantt charts have become a common technique for representing the phases and activities of a project work breakdown structure, so they can be understood by a wide audience.

- Useful and valuable for small projects that fit on a single sheet or screen.

Limitations

Though the bar chart is comprehensive, convenient, and very effective, it has the following limitations

- Like many other graphical techniques, often difficult to handle large number of tasks of a complex project. They can become quite unwieldy for projects with more than about 30 activities.

- Larger Gantt charts may not be suitable for most computer displays. A related criticism is that Gantt charts communicate relatively little information per unit area of display. That is, projects are often considerably more complex than can be communicated effectively with a Gantt chart.

- Does not indicate the interrelationship between the tasks i.e., if one activity overruns time what would be the impact on project completion.

- Gantt charts only represent part of the triple constraints of projects, because they focus primarily on schedule management. Moreover, Gantt charts do not represent the size of a project or the relative size of work elements, therefore the magnitude of a behind-schedule condition is easily miscommunicated. If two projects are the same number of days behind schedule, the larger project has a larger impact on resource utilization, yet the Gantt does not represent this difference.

- Although project management software can show schedule dependencies as lines between activities, displaying a large number of dependencies may result in a cluttered or unreadable chart.

- Because the horizontal bars of a Gantt chart have a fixed height, they can misrepresent the time-phased workload (resource requirements) of a project. In the example shown above, tasks 6 and 7 appear to be the same size, but in reality they may be different. A related criticism is that all activities of a Gantt chart show planned workload as constant. In

practice, many activities (especially summary elements) have front-loaded or back-loaded work plans, so a Gantt chart with percent-complete shading may actually miscommunicate the true schedule performance status.

1.3.2 Milestone Chart

Milestone chart is an improvement over the Gantt chart by introducing the concept of milestone. The milestone, represented by a triangle over a task in the bar chart indicates completion of a specific phase of the task. For example pre-testing of interview schedule and modifications (Task 4 in the Fig 1.1) includes pre-testing of interview schedule in the field (about 3 weeks) and modifications of interview schedule based on pretesting experience (1 week). From the simple Gantt chart, it is difficult to monitor progress of the task 4. Introduction of a milestone at the end of 3rd week and 4th week would specify that the pre-testing would be completed in 3 weeks time and modifications in interview schedule would be completed in 1 week time (Fig. 1.2).

Fig.1.2: Milestone chart showing the milestones in task 4 of a 12 months survey project

Task	Duration (Months)	1st Week	2nd Week	3rd Week	4th Week
Pre-testing of interview schedule and modifications	1			▲	▲

Characteristics

* In a milestone chart a task is broken down in to specific phases (activities).

* After accomplishment of each of the specific activity a milestone is reached or in other words an event occurs.

* The chart also shows the sequential relationship among the milestones or events within the same task but not the relationship among milestones contained in different tasks. For example in figure 1.2, the milestone 2 of task cannot be reached until the milestone 1 is crossed and the activity between milestone 1 and 2 is over.

Advantages

* A milestone chart depicts key events along a time scale.

* It indicates completion time of key events in a task.

* Useful for top level reporting, so management does not become bogged down in the minute details of project.

Limitations

* The relationships between the milestones in different tasks are not clear in the milestone chart.

* Does not show interdependence between tasks.

* Does not indicate critical activities.

* Does not consider the concept of uncertainty in accomplishing the task.

* Very cumbersome to draw the chart for large projects.

Check Your Progress 2

Note: a) Use the spaces given below for your answers.

b) Check your answer with those given at the end of the unit.

1. Ask some of your colleagues what they mean by bar charts? Compare their views with the one given in this section and identify the common features.

....

....

....

2. Do you agree that bar charts are useful for project management? Support your answer.

....

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3. Write two advantages of Gantt charts and Milestone charts.

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Activity 2: Draw a Gantt chart for the following project activities.

S.No.	Activity	Time requirement (weeks)
1	Development of land	9
2	Ploughing and minor leveling	4
3	Digging of pits for planting	5
4	Purchasing of farm yard manure	3
5	Purchasing of plants	10
6	Application of farm yard manure	2
7	Transplanting plants	2

1.4   LET US SUM UP

In this unit we started by looking into the history, meaning and how SWOT analysis is useful as a project management tool. Later we discussed how to conduct SWOT analysis, common questions to be asked, merits and demerits of SWOT analysis. In the second half of the module we discussed meaning and concept of Bar chart, Gantt chart and Milestone chart along with their advantages and limitations as project management tools.

1.5 KEYWORDS

SWOT Analysis: Factors internal to the system are strengths (S) or weaknesses (W) and those external are opportunities (O) or threats (T) and such an analysis of the strategic environment is referred to as a SWOT analysis

Strengths: Strengths are the attributes of the organisation that help achieve the project objective.

Weaknesses: Weaknesses are the attributes of the organisation that stop achievement of the project objective.

Opportunities: Opportunities are the external conditions that help achieve the project objective.

Threats: Threats are the external conditions that could damage the project.

Activity*:* Is the actual performance of a task.

Bar Charts: Bar charts are the pictorial representation of various tasks required to be performed for accomplishment of the project objectives.

Gantt Chart : Gantt chart is a type of bar chart that illustrates a project schedule.

Milestone Chart : It is an improvement over the Gantt chart by introducing the concept of milestone.

1.6 REFERENCES AND SELECTED READINGS

Bradford, R.W., Duncan, P.J. & Tarcy, B. (1999) Simplified Strategic Planning: A No-nonsense Guide for Busy People Who Want Results Fast. New York: Chandler House.

Duncan Haughey (2017). SWOT Analysis. Available at https://www.projectsmart.co.uk/swot-analysis.php (Accessed on 25th July 2017).

Rosanne Lim (2012). Why You Should Do a SWOT Analysis for Project Management. Available at https://project-management.com/why-you-should-do-a-swot-analysis-for-project-management/ (Accessed on 25th July 2017).

Srinath, L.S. (1975). PERT and CPM Principles and Applications, East-West Press, New Delhi.

Venkateswarlu, K and Raman, K.V. (1993). Project Management Techniques for R&D in Agriculture. Sterling Publishers Pvt.Ltd., New Delhi (Network analysis example discussed in this unit has been adopted from this book).

1.7 CHECK YOUR PROGRESS- POSSIBLE ANSWERS

Check Your Progress 1

1. Factors internal to the system are strengths (S) or weaknesses (W) and those external are opportunities (O) or threats (T) and such an analysis of the strategic environment is referred to as a SWOT analysis

2. Yes. SWOT analysis for project management is a simple, yet effective process. It allows the project manager to identify areas that needs improvement. By implementing the correct methodologies for the analysis, it is possible to ensure that a project will be completed on time and within

budget. SWOT stands for Strengths, Weaknesses, Opportunities and Threats.

Check Your Progress 2

1. Bar charts are the pictorial representation of various tasks required to be performed for accomplishment of the project objectives. These charts have formed the basis of development of many other project management techniques. Two main bar charts are: Gantt charts and Milestone charts. Compare this with the views of your colleagues.

2. Yes. Charts sspecify the start and finish time for various tasks ; charts illustrate the start and finish dates of the terminal elements and summary elements of a project ;

3. Gantt charts have become a common technique for representing the phases and activities of a project work breakdown structure, so they can be understood by a wide audience. They are also useful and valuable for small projects that fit on a single sheet or screen. Milestone charts depicts key events along a time scale. They indicate completion time of key events in a task and are useful for top level reporting, so management does not become bogged down in the minute details of project.

UNIT 2   NETWORKS

2.1 INTRODUCTION

Dear Learner

In the previous unit, we discussed the application of SWOT analysis and bar charts as project formulation and management tools. In this module networks, their terminology, rules for preparation of networks and their uses with examples are discussed for your understanding. To overcome the shortcomings in Gantt and Milestone charts, the networks are developed. The network is a logical extension of Milestone chart incorporating interrelationship between and among all the milestones in project.

After studying this unit you should be able to:

- describe the network as a project management technique; and

- draw and analyze a project network.

2.2 NETWORKS

Two widely used techniques for network analysis are:

i. Programme Evaluation and Review Technique (PERT)

ii. Critical Path Method (CPM).

The costs for various activities of the project / programme are introduced by CPM. While it does not mean that PERT deliberately omits the costs, one has to assume that costs vary with the time. For a particular project / programme, if time is reduced by 4 weeks, it implies that some money also saved. When time requirement for each activity is estimated accurately, then CPM is more appropriate and relevant. On the other hand, if accurate time estimation is difficult for each activity and need to overcome this uncertainty, then the PERT is the best choice.

Parameter	PERT	CPM
What ?	Project management model to analyze and represent the tasks involved in project completion.	Mathematically based algorithm for scheduling set of project activities.
Purpose	Analyze time needed to complete project tasks and identify minimum time needed to complete the project	For effective project management.
Time Estimate	Probabilistic	Deterministic
Application	Scheduling and monitoring the project	Optimizing resource allocation

When each activity is associated with the costs, application of CPM is more appropriate. For research projects, time is more important compared to costs because of uncertainty, then PERT is more useful. Let us discuss more about network terminology, network preparation rules and analysis of networks in the subsequent sections.

Check Your Progress 1

Note: a) Use the spaces given below for your answers.

b) Check your answer with those given at the end of the unit.

1. Expand PERT and CPM.

....

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....

2. Write two differences between PERT and CPM.

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2.3 NETWORKS TERMINOLOGY

The commonly used terms in the networks are given below for your understanding.

Activity: Is the actual performance of a task which consumes time, requires resources, and it can be understood as representing the time, effort, and resources required to move from one event to another. Activity is represented by an arrow (➔). Every activity lies between events.

Example: Interview schedule preparation, data collection.

Dummy activity: An activity that indicates precedence relationship and requires neither time nor resource. It is usually represented by a broken arrow (········►).

Event: Event is a point that marks the start or completion of one or more tasks. Event is usually denoted by a circle which is divided into two equal halves. The left half is meant for event number. The right half is further divided into two segments, the top representing Earliest Starting Time (EST) and the bottom Latest Starting Time (LST) (Fig.2.1).
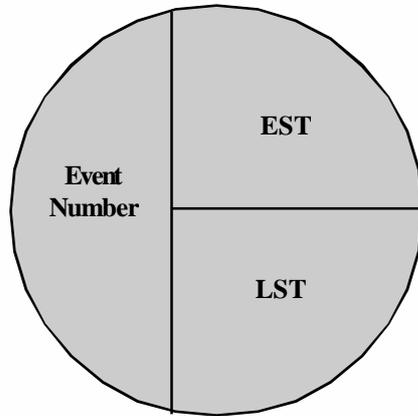
Fig 2.1: Event representation with EST and LST

Example: Interview schedule preparation completed, data collection started.

Predecessor event: An event that immediately precedes some other event without any other events intervening.

Successor event: An event that immediately follows some other event without any other events intervening.

Burst event: An event which gives rise to more than one activity.

Merge event: The event which occurs only when more than one activity are accomplished.

Earliest Start Time (EST): The earliest possible time at which the event can occur. The EST of an activity is the time before which it cannot commence without affecting the immediate preceding activity.

Latest Start Time (LST): The latest time at which the event can take place. It indicates the latest time at which an activity can begin without delaying the project completion time.

Critical Events: These are events which fall on the critical path. Every critical event will have the same EST and LST.

*Critical Path***:** The longest possible continuous pathway taken from the initial event to the terminal event. Any time delays along the critical path will delay the reaching of the terminal event by at least the same amount.

Critical Activity: An activity that has total float equal to zero.

Optimistic time (T_o): The minimum possible time required to accomplish a task, assuming everything proceeds better than is normally expected.

Pessimistic time (P_o): The maximum possible time required to accomplish a task, assuming everything goes wrong (but excluding major catastrophes).

Most likely time (T_M): The best estimate of the time required to accomplish a task, assuming everything proceeds as normal.

Expected time (T$_E$): The best estimate of the time required to accomplish a task, assuming everything proceeds as normal (the implication being that the expected time is the average time the task would require if the task were repeated on a number of occasions over an extended period of time) T$_E$ = (T_o + 4 T$_M$ + P_o) ÷ 6

Float or Slack: Is the amount of time that a task in a project network can be delayed without causing a delay in subsequent tasks (free float) or project completion (total float).

Event Slack: It is the slack time associated with an event. ES = LST – EST

Lead time: The time by which a predecessor event must be completed in order to allow sufficient time for the activities that must elapse before a specific PERT event is reached to be completed.

Lag time: The earliest time by which a successor event can follow a specific PERT event.

Fast tracking: Performing more critical activities in parallel

Crashing critical path: Shortening duration of critical activities

Activity Table: Table developed after breaking the project into activities indicating their symbols, time requirement and logical relationships (preceding and succeeding activities).

Danglers: Loosely attached activities. They may end abruptly without any succeeding activity / activities.

Normal Time: This is the time required when activities are performed in normal way. It is usually the longest time for the project and entails money saving is there.

Check Your Progress 2

Note: a)   Use the spaces given below for your answers.

   b)   Check your answer with those given at the end of the unit.

1.   Write two differences between EST and LST.

   ....
   ....
   ....

2.   What do you mean by critical event?

   ....
   ....
   ....

3.   Write the formula for calculating expected time (T$_E$) to accomplish a task.

   ....
   ....
   ....
   ....

2.4 RULES FOR PREPARATION OF NETWORKS

For your easy understanding, some basic rules for preparing networks are described below with diagrams.

• Activity is indicated by an arrow which is drawn from left to right. Neither the orientation of arrow nor its length has any significance. Every activity starts and ends with an event (Fig. 2.2)
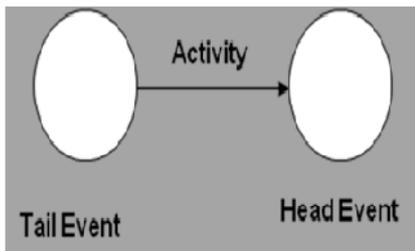

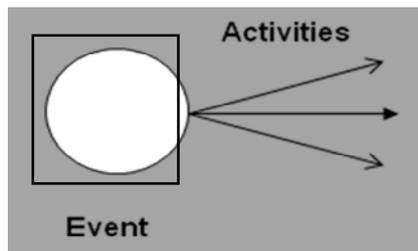**Fig. 2.2: Activity with tail and head events**   **Fig. 2.3 Burst event**

• Any number of activities may emerge out from an event. This event is named as burst event (Fig. 2.3).

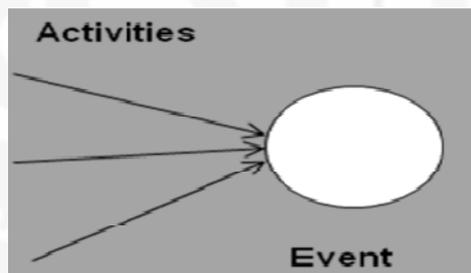• Any number of activities may merge with an event (Fig 2.4)

Fig. 2.4: Merging event

• When two or more activities have to be completed before the next event occurs, they should not be represented as merged activities as shown in (a), which is wrong. This can be represented as sequential activity by introducing the dummy activity as shown in (b) (Fig 2.5).
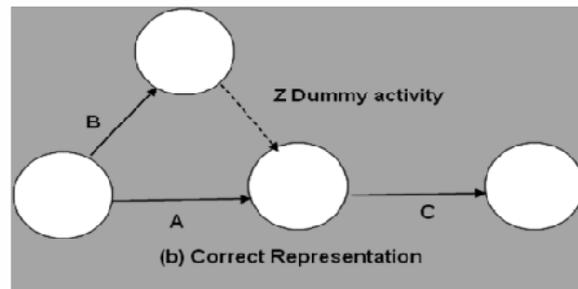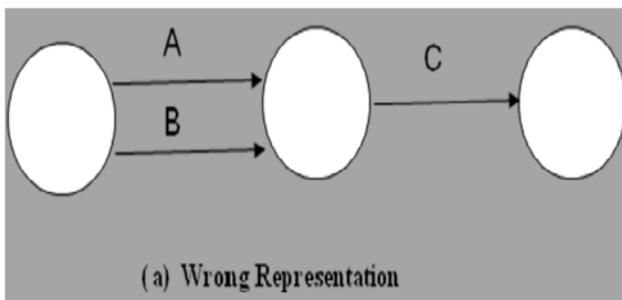

Fig. 2.5: Dummy activity representation in network

A project with 12 preceding and succeeding activities are given in Table 2.1.

Table 2.1 Preceding and succeeding activity relationships of a project activities

Activity	Preceding Activity	Activity	Preceding Activity
A	-	G	D, F
B	-	H	E
C	-	I	F
D	A,B,C	J	H
E	C	K	E, G
F	B	L	I, J, K

The network of the project is given in Fig.2.6 with dummies between B &D; C & D; F&G and E & K. The dummies are represented as Z_1, Z_2, Z_3, and Z_4 and so on.
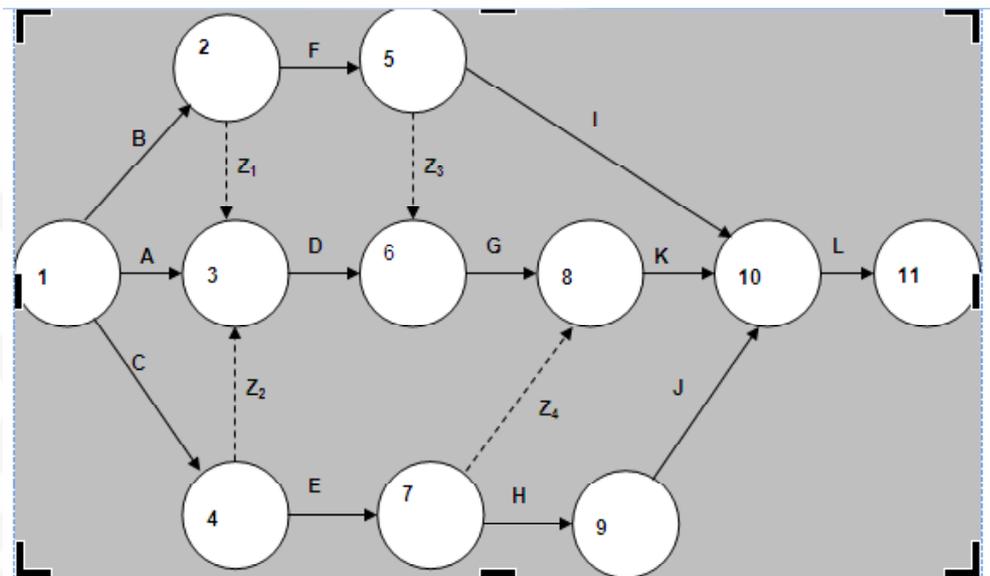
Fig. 2.6: Network of the project

It is preferable to use D.R. Fulkerson's rules to give numbering as indicated below.

i.   The initial event should be started with 1.

ii.   Eliminate all activities emerging out from event number 1 and give number 2 to the succeeding event. If two or more events occur concurrently after the first event, give 2,3,4 and so on for succeeding events.

iii. Delete all the activities emerging out from 2,3, 4 events and so on and give the new event numbers 5,6,7 and son on.

iv.   Continue this process till the entire network is completed.

This process is continued till the entire network with event numbers is completed (Fig 2.7).
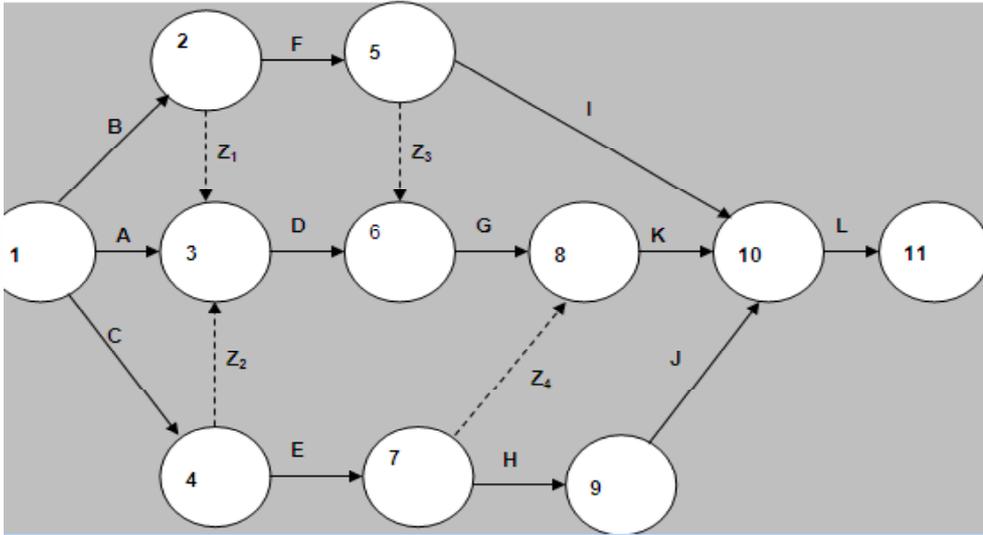
Fig. 2.7: Network of the project with event numbers

An event will occur only after all the activities merging into it are completed. Event numbers are shown in the left half of the circle and the EST and LST on the right half.

After drawing the network, the time requirement for each activity is indicated.

Check Your Progress 3

Note: a) Use the spaces given below for your answers.

   b) Check your answer with those given at the end of the unit.

1. Write D.R. Fulkersons' rules for numbering the events.

   ....

   ....

   ....

   ....

   ....

2. Prepare the network and give the event numbers for the following.

PERT Event	Preceding Event
Event No 1	–
Event No 2	1
Event No 3	2
Event No 4	2,3
Event No 5	4

2.5   NETWORK PREPARATION

Following steps are useful in preparing networks.

Step 1 : Write down the specific objectives of the project.

Step 2 : Based on the objectives, write technical programme details.

Step 3 : Break the technical programme into specific activities.

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Step 4 : List out all the activities showing the preceding and succeeding relationships.

Step 5 : Give symbols for activities with capital letters i.e. A,B,C,D,E and so on

Step 6 : Calculate the expected time by using the following equation.

Expected Time $T_E = (T_o + 4 T_M + P_o) \div 6$

Where,

- To is the Optimistic time,(minimum time assuming everything goes well)

- T_M is the Most likely time, (modal time required under normal circumstances)

- T_P is the Pessimistic time, (maximum time assuming everything goes wrong)

Step 7: Draw the flow chart as it helps in preparing the network

Step 8 : Draw the network by following the rules for preparation of networks as discussed in the previous section.

Step 9: Write the event numbers, EST and LST. By using forward pass (start to end) and backward pass (end to start), the network would be analysed as follows.

Event Numbers: Give numbers to various events (see the previous section for details on numbering)

Forward Pass: (a) Consider the EST of the first activity as zero (b) Start from the first event for computation of EST. Add the activity duration to the EST of preceding event to get the EST of succeeding event. Whenever an event is competing with two or more activities, the largest value must be considered to arrive at the EST of the succeeding event. EST is the result of forward pass.

Backward Pass: (a) Consider the LST value of the last event as equal to its EST value. (b) In contrast to the forward pass, start from the last event and subtract the activity duration from the LST of succeeding event to arrive at the LST of the preceding event. When two or more activities are backing to an event, the smallest of these must be taken into account for the LST of preceding event. LST is the result of backward pass.

Step 10: Compute the critical path taking into account all the critical activities. This is the longest path in terms of time for accomplishing the project.

Step 11 : Calculate activity slack (total float), event slack , free float and independent float by using the following formulae

Activity slack = LST of end event – EST of starting event – Duration of reference activity

Event slack = LST of event – EST of event

Free float = EST of end event –EST of starting event – Duration of reference activity

Independent float = EST of end event – LST of starting event – Duration of reference activity

Step 12: Establish job boundary limits for all the activities which include duration of activity, event number, EST, LST, EFT, LFT, event slack, total float, free float and independent float.

Note: a)   Use the spaces given below for your answers.

   b)   Check your answer with those given at the end of the unit.

1.   How do you calculate activity slack, free float and independent float?

....

....

...

2.6 NETWORK EXAMPLE

Let us assume that as a development worker, you are asked to complete a 'Garden Development Project' by a Municipality with seven project activities (Table 2.2). The network diagram is prepared for your easy understanding (Source: Venkateswarlu and Raman, 1993).

Table 2.2: Time duration estimates of activities

S.No.	Activity	Symbol	Preceding activity	Time (weeks)
1	Development of land	A	-	9
2	Ploughing and minor leveling	B	A	4
3	Digging of pits for planting	C	B	5
4	Purchasing of farm yard manure	D	B	3
5	Purchasing of plants	E	B	10
6	Application of farm yard manure	F	D,C	2
7	Transplanting plants	G	E, F	2

The network after computation of EST and LST are given in Fig.2.8.
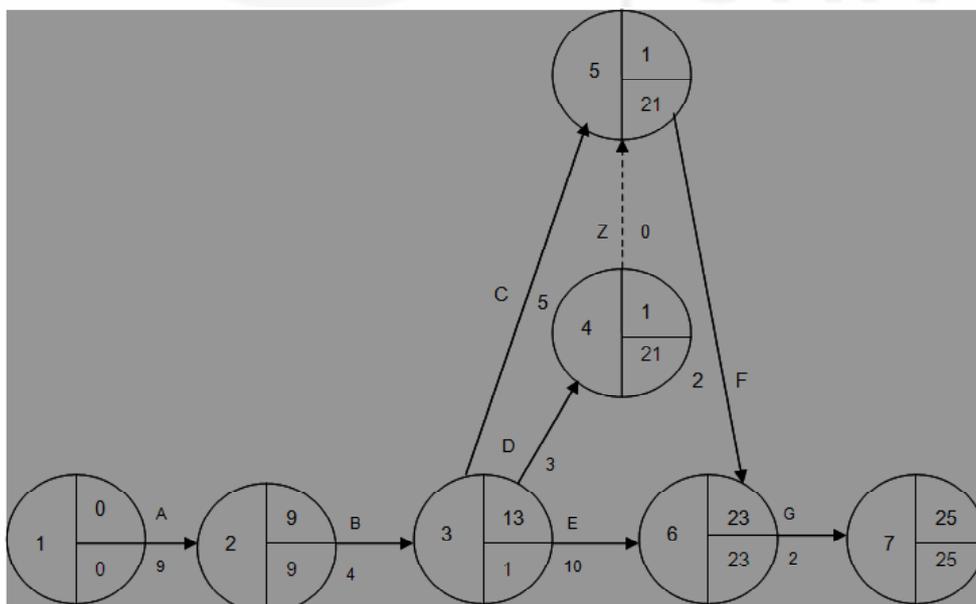
Fig. 2.8: Network after computation of LST

The analysis of the results of the network is given in Table 2.3 for your understanding

**Table 2.3: Analysis of the results of the network for garden
development project**

S.No.	Activity	Duration (weeks)	Preced-ing event	Succeed-ing	EST (weeks)	LST (weeks)	EFT (weeks)	LFT (weeks)	Clinical (Activities)
Activities									
1	A	9	1	2	0	0	9	9	A
2	B	4	2	3	9	9	13	13	B
3	C	5	3	5	16	16	18	21	-
4	D	3	3	4	18	18	16	21	-
5	E	10	3	6	13	13	23	23	E
6	F	2	5	6	21	21	20	23	-
7	G	2	6	7	23	23	25	25	G

Critical path is the longest path for project accomplishment. In the above example the critical path of the project is A-B-E-G (9+4+10+2) = 25 weeks

Uses of Networks

The important uses of networks are:

- Planning and scheduling of project activities
- Guidance, supervision of activities and organizing resources - personnel, money, time and material.
- Monitoring and controlling of project activities.
- Communication on costs and time in a concise manner.
- Responsibility and teamwork.
- Training, minimizing conflicts and performance appraisal.

Check Your Progress 5

Note: a) Use the spaces given below for your answers.

b) Check your answer with those given at the end of the unit.

1. What do you mean by critical path?

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    ....

    ....

2. Write three uses of networks.

    ....

    ....

    ....

    ....

2.7 LET US SUM UP

In this unit we started by looking into the meaning of Networks namely PERT and CPM , important differences and their application in project management. We also discussed the networks terminology and rules for preparation of networks. Later we discussed the network preparation, analysis and uses with examples and diagrams.

2.8 KEYWORDS

Activity: Actual performance of a task.

CPM: Mathematically based algorithm for scheduling a set of project activities.

Critical Activity: Activity that has total float equal to zero.

Critical Events: Events which fall on the critical path which will have the same EST and LST.

Critical Path: Longest possible continuous pathway taken from the initial event to the terminal event.

Event: Event is a point that marks the start or completion of one or more tasks.

Float or Slack: Amount of time that a task in a project network can be delayed without causing a delay in subsequent tasks (free float) or project completion (total float).

Network: Network is a logical extension of bar charts incorporating interrelationship between and among all the milestones in project.

PERT: Is a project management model designed to analyze and represent the tasks involved in completing a project.

2.9 REFERENCES AND SELECTED READINGS

Venkateswarlu, K and Raman, K.V. 1993. Project Management Techniques for R&D in Agriculture. Sterling Publishers Pvt.Ltd., New Delhi (Network analysis example discussed in this unit has been adopted from this book).

Srinath, L.S. 1975. PERT and CPM Principles and Applications, East-West Press, New Delhi.

2.10 CHECK YOUR PROGRESS-POSSIBLE ANSWERS
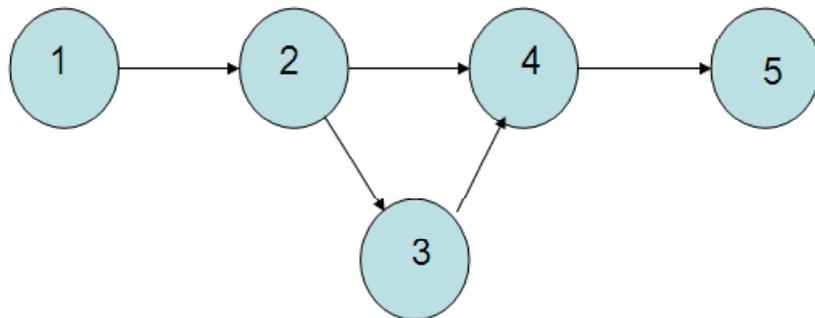
Check Your Progress 1

1. PERT : Programme Evaluation and Review Technique ; CPM : Critical Path Method

2. PERT is a project management model designed to analyze and represent the tasks involved in completing a project. Where as CPM is a mathematically based algorithm for scheduling a set of project activities.

Check Your Progress 2

1. EST is the earliest possible time at which the event can occur. It denotes the earliest start time of an activity. LST is the latest time at which the event can take place. It indicates the latest time at which an activity can begin.

2. Critical event is the event which falls on the critical path.

3. $T_E = (T_o + 4\ T_M + P_o) \div 6$

Check Your Progress 3

1. Initial event should be started with 1; eliminate all activities emerging out from event number 1 and give number 2 to the succeeding event. If two or more events occur concurrently after the first event, give 2,3,4 and so on for succeeding events; Continue this process till the entire network is completed.

Check Your Progress 4

1. Activity slack = LST of end event – EST of starting event – Duration of reference activity

    Free float = EST of end event –EST of starting event – Duration of reference activity

    Independent float = EST of end event – LST of starting event – Duration of reference activity

Check Your Progress 5

1. Critical path is the longest possible continuous pathway taken from the initial event to the terminal event.

2. Networks are useful for planning, scheduling, guidance and supervision, organizing resources, monitoring, controlling and performance appraisal.