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Project Maintenance Scheduling

BY

Dr. ABDUL-MOHSEN AL-HAMMAD

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The Bar Chart Model

The Bar Chart Model is a graphical schedule rating progress of items of work to a time schedule.

Developed by Henry L. Gantt so called Gantt Chart.

Despite the advances in network models, the bar chart is still widely used. This may be due to:

- **Its simplicity**
- **Its visual (Graphical) effectiveness**

A Typical Example

Its disadvantages:

- **It does not show the interrelation among the project activities.**
- **It does not show the critical activities in the project.**

Pipeline Project: Progress Date Sept. 27.

Estimated Progress
Actual Progress

Activity	Quant	Start	Finish	Sept. 4-8	Sept. 11-15	Sept. 18-2	Sept. 25-29	Oct. 2-6	Oct. 9-13	Oct. 16-20	Oct. 23-29	Oct30 Nov.3
Dig Hole	8 cu. Yard	Sept. 11	Sept. 20									
Obtain Sub-base	2 cu. Yard	Sept. 11	Oct. 2				100					
Obtain Pipe	8 Pipes	Sept. 11	Oct. 12				75					
Have Pipe		Oct. 13	Oct. 16				50					
Fine Grade		Sept. 21	Sept. 27									
Place sub-base		Oct. 3	Oct. 6				100					
Compact Sub-base		Oct. 9	Oct. 18									
Place Pipe		Oct. 19	Oct. 26									
Excess sub-base		Oct. 9	Oct. 10									
Back Fill	7 cu. Yard	Oct. 27	Nov. 2									

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Development of network planning methods in 1957-1958.

- **CPM (Critical Path Method) was developed by Du Pont and Remington Rand Companies as method for planning and scheduling large projects.**
- **PERT (Program Evaluation and Review Technique) was developed by V.S. Navy for planning and controlling weapons systems.**

Both CPM and PERT use network diagram to graphically represent the major activities of a project and to show the relationship between activities.

NETWORK DIAGRAM AND PROJECT PLANNING

With regard to Project Planning, a network is a diagrammatic representation of the project activities. For representing a project by a network there are two methods:

1. **Arrow Notation**
2. **Circle Notation**

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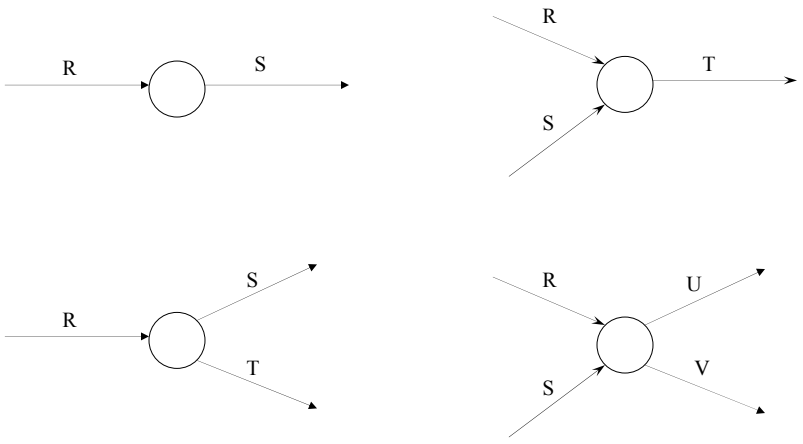
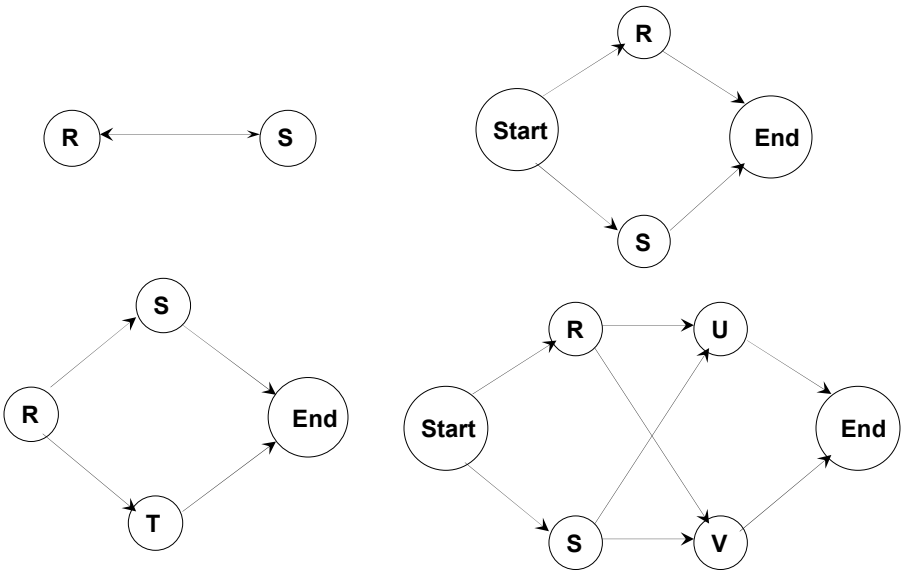


There are two different ways of drawing Critical Path Diagrams. This is an illustration of arrow notation.



This is an example of circle notation

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Structure / Parameter	Deterministic	Stochastic
Deterministic	CPM	Decision Tree
Stochastic	PERT	GERT

CPM scheduling is only one of several alternative scheduling techniques.

CPM can aid in Planning, Scheduling, and Control of a project as follows:

1. **<u>Project Planning</u>**
   a. **Objectives**
   b. **Content of project**
   c. **Arrow diagram**

2. **<u>Project Scheduling</u>**
   a. **Time estimates**
   b. **Timing calculations**
   c. **Job scheduling**

3. **<u>Project Control</u>**
   a. **Follow-up**
   b. **Updating**
   c. **Reporting**

BASIC CPM CALCULATION OBJECTIVES

1. **Determine the completion time (minimum) or duration of the maintenance or construction project.**

2. **Determine which of the activities of the project are critical, i.e. which activities determine the completion time of the project.**

3. **Determine how much time of the project activities may be delayed without affecting the completion time of the project as determined in objective number one.**

To satisfy the above objectives, the contractor must perform the following:

1. **Define project activities**
2. **Determine project activity duration**
3. **Determine technological logic between activities**
4. **Perform CPM calculations**

We will now illustrate basic CPM calculation. The calculations have the above three objectives.

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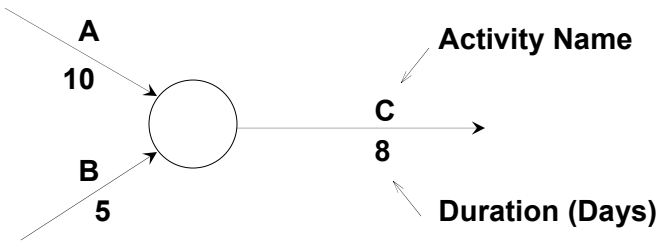
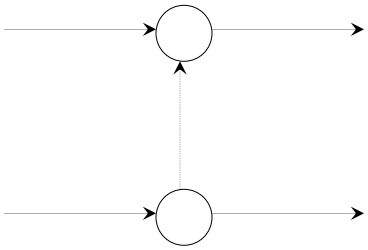


The parameters in basic CPM diagrams is time.



One disadvantage of arrow notation is that we may need to use "dummy activities".

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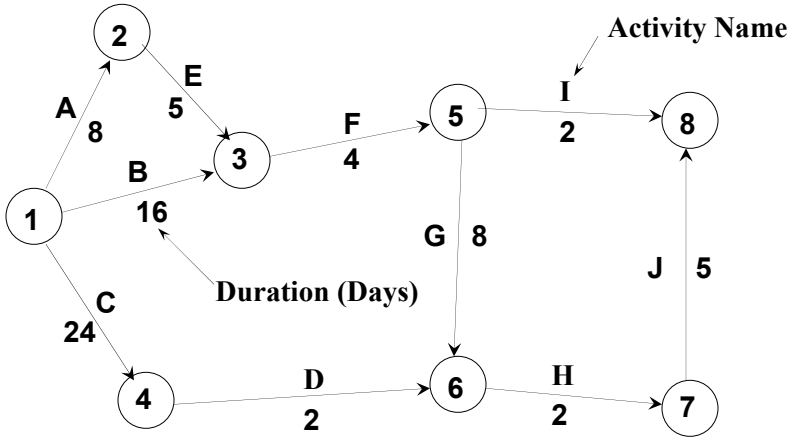
A project has been divided into the following activities:

Activity A can be done initially and takes 8 working days.
Activity B can be done initially and takes 16 working days.
Activity C can be done initially and takes 24 working days.
Activity D can be done after C and takes 2 working days.
Activity E can be done after A and takes 5 working days.
Activity F can be done after B and E and takes 4 working days.
Activity G can be done after F and takes 8 working days.
Activity H can be done after D and G and takes 6 working days.
Activity I can be done after F and takes 2 working days.
Activity J can be done after H and takes 5 working days.

We will now illustrate basic CPM calculation. The calculations have the above three objectives.



This arrow notation CPM diagram illustrates the project described on the previous page.

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BASIC CPM CALCULATION FORMULAE

EARLIEST START TIME (EST) = The earliest possible time at which an activity can start.

EARLIEST START TIME (EST) = The maximum of the EFT's of the activities that directly precede the activity in question.

EARLIEST FINISH TIME (EFT) = The earliest start time for the activity plus the duration of the activity.

FREE FLOAT (FF) = The amount of time an activity can be delayed without affecting the earliest start time for any other activity.

FREE FLOAT (FF) = The earliest start time of the activity or activities immediately following the activity in question minus the earliest finish time for the activity in question.

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BASIC CPM CALCULATION FORMULAE (Continued)

LATEST FINISH TIME (LFT) =	**The latest possible time an activity can finish without affecting the completion time of the project.**
LATEST FINISH TIME (LFT) =	**The minimum latest start time of the activities that directly follow the activity in question.**
LATEST START TIME (LST) =	**The latest finish time for the activity minus the duration of the activity.**
FREE FLOAT PRIME (FFP) =	**The amount of time an activity can be delayed without affecting the latest start time for any other activity.**
FREE FLOAT PRIME (FFP) =	**The latest start time for the activity minus the latest finish time of the activity or activities immediately preceding the activity in question.**

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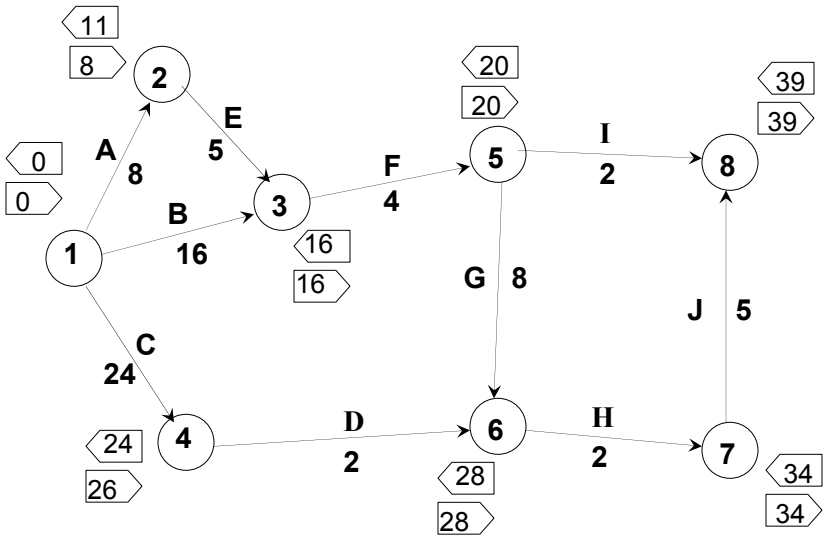
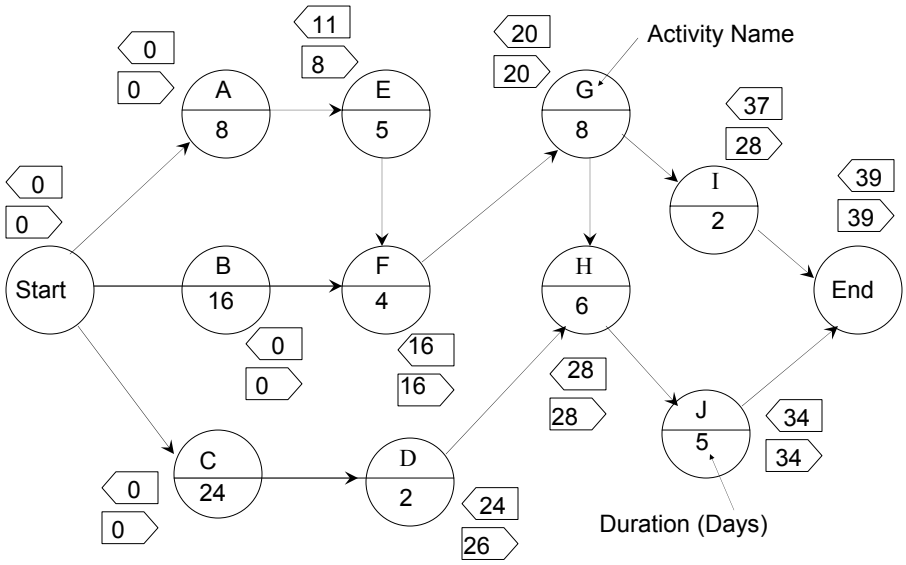
BASIC CPM CALCULATION FORMULAE (Continued)

TOTAL FLOAT (TF) =	**The amount of time an activity can be delayed without affecting the minimum project completion time.**
TOTAL FLOAT (TF) =	**The latest start time for an activity minus the earliest start time for the activity.**
TOTAL FLOAT (TF) =	**The latest finish time for an activity minus the earliest finish time for the activity.**

The formulae are used for the basic CPM calculations.



This illustrates how it is possible to do some of the CPM calculations on the network.



This is how the example CPM project would look in circle notation CPM.

Activity	DUR	EST	EFT	LST	LFT	FF	FFP	TF
A	8	0	8	3	11	0	3	3
B	16	0	16	0	16	0	0	0
C	24	0	24	2	26	0	2	2
D	2	24	26	26	28	2	0	2
E	5	8	13	11	16	3	0	3
F	4	16	20	16	20	0	0	0
G	8	20	28	20	28	0	0	0
H	6	28	34	28	34	0	0	0
I	2	20	22	37	39	17	17	17
J	5	34	39	34	39	0	0	0

This Tableau represents the solutions of the example CPM project.

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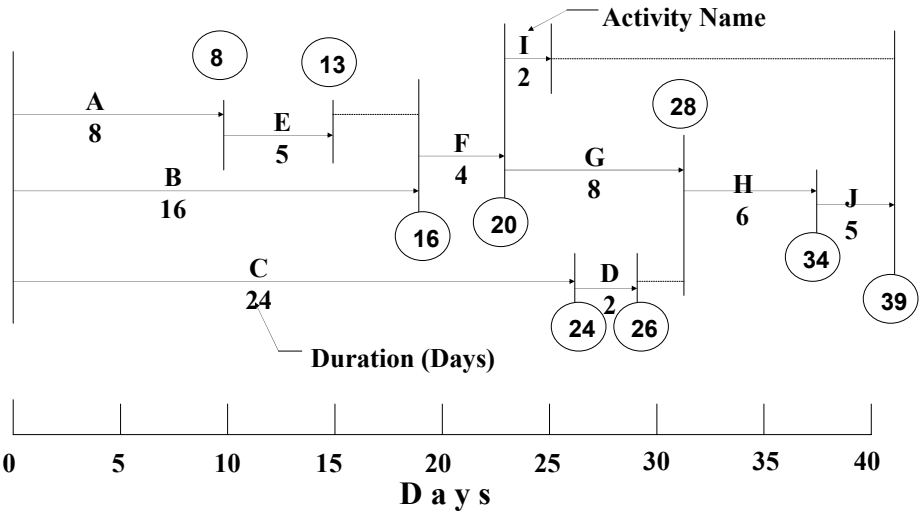
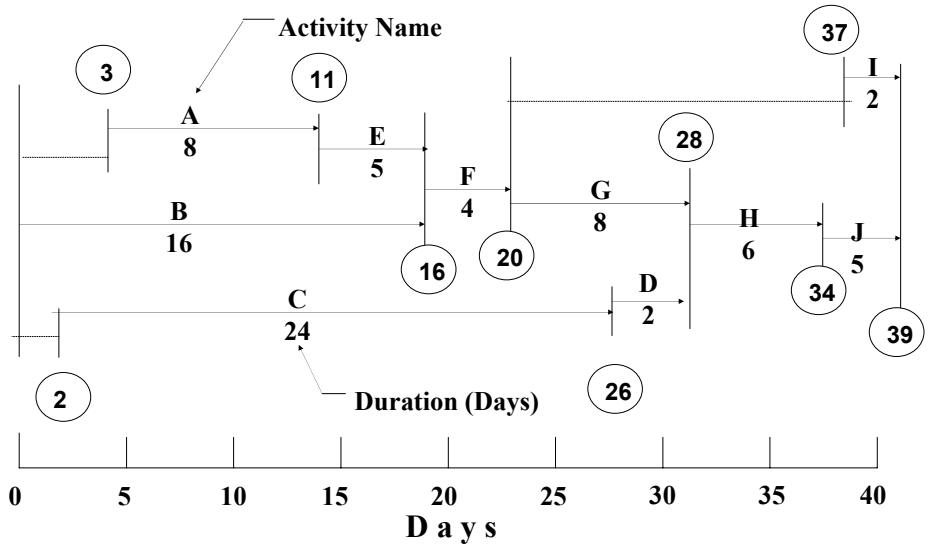


This represents a time scale earliest start schedule CPM for the previous project example. Notice the improved visual effect.



This is the time scale latest start time schedule CPM for the same project.

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EXAMPLE

A project has been divided into the following 7 activities:

Activity A takes 8 working days and can be done initially.
Activity B takes 9 working days and can be done initially.
Activity C takes 4 working days and follows activity A.
Activity D takes 5 working days and follows activity C.
Activity E takes 7 working days and follows activity A.
Activity F takes 11 working days and follows activity B.
Activity G takes 2 working days and follows activities D and F.

Determine: **Minimum project completion time.**
Critical Activities.
Possible delay time for the activities.

This is another example CPM project. Draw the arrow notation CPM diagram and perform the basic CPM calculations.

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ANSWERS FOR EXAMPLE CPM PROJECT NETWORK

Minimum project completion time – 22 days

Critical Activities-activities B, F, G.

Total float – A=3, B=0, C=3, D=3, E=7, F=0, G=0

These are the answers for the project on the previous page.

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THANK YOU