CPM: COST MODEL

Chapter: 9

Introduction

In CPM, time is related to cost and the object is to develop an optimum time-cost relationship. Many times it becomes necessary to complete the project earlier than the normal time (latest allowable time).

The ultimate object of the network techniques is not only to bring improvement in planning, scheduling and controlling of the project but also to access the possibility of arriving at a feasible and desirable time-cost relationship.

So, the overall project duration can only be dropped by reducing the duration of critical activities and could be only possible in two ways:

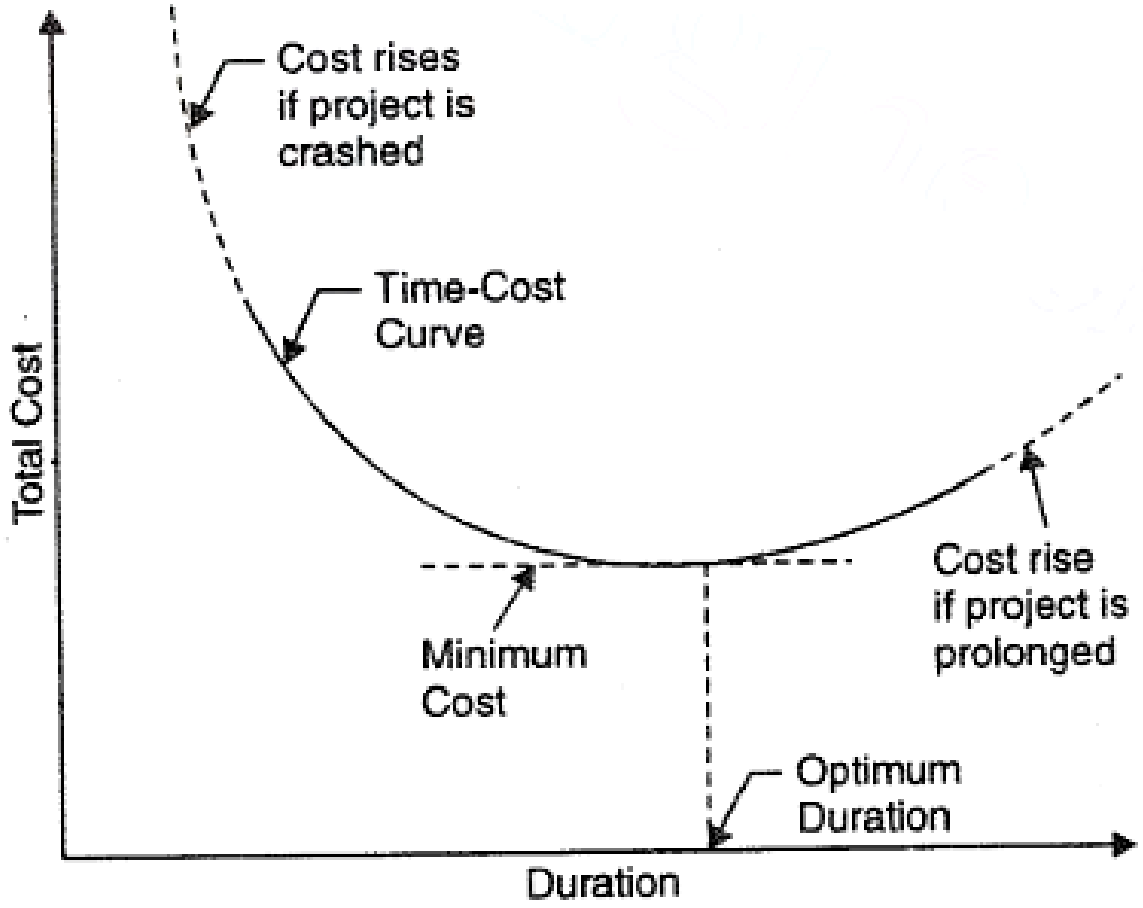
1. By deploying more resources for the early completion of the such activities.
2. By relaxing the technical specifications for such activities.

But, If the duration is made larger, cost will be reduced. On the other hand, reducing the project duration, would increase the cost. And the optimum duration will be one which gives the most economic cost for the completion of the project.

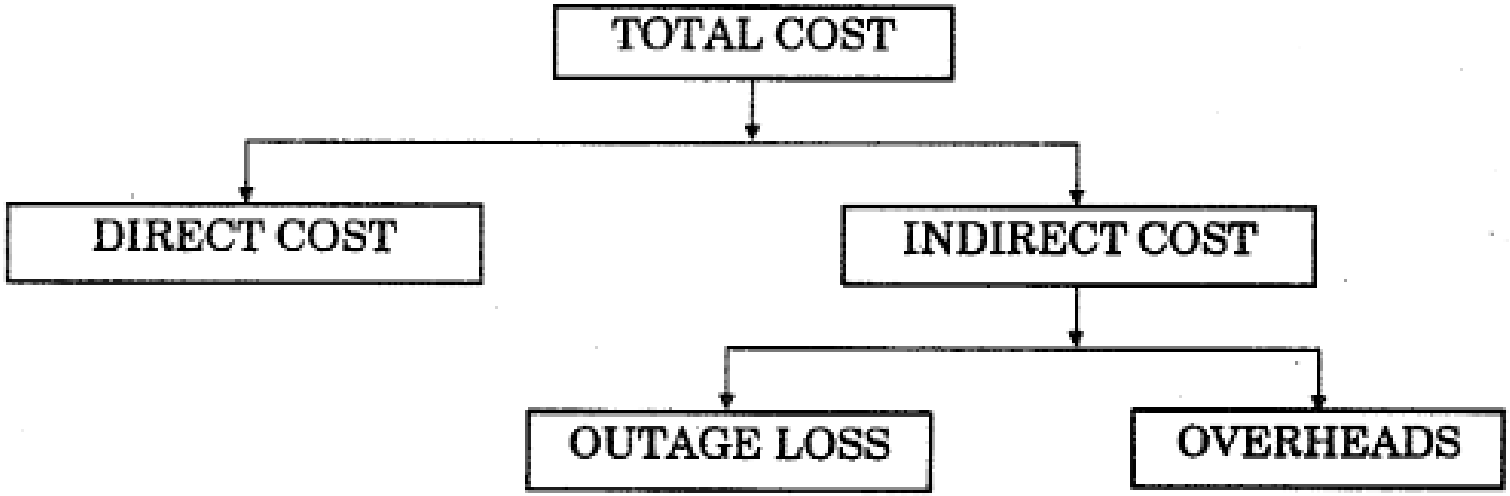
Time and Cost Estimates in CPM

- **Normal Estimate:** In normal estimate, the emphasis is on the minimum cost with the associated time.
- **Crash Estimate:** It involves the absolute minimum time required for the job and the cost necessary to achieve it.

Project Cost



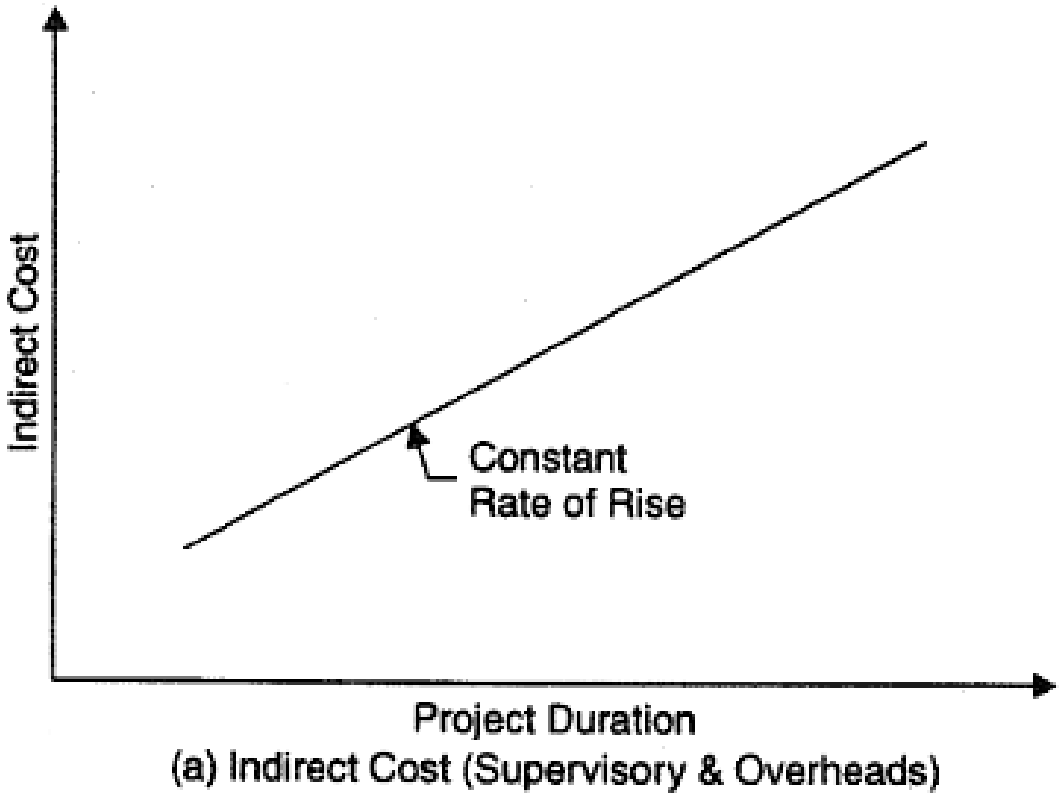
Variation of Total Project Cost with Duration



COMPONENTS OF PROJECT COST.

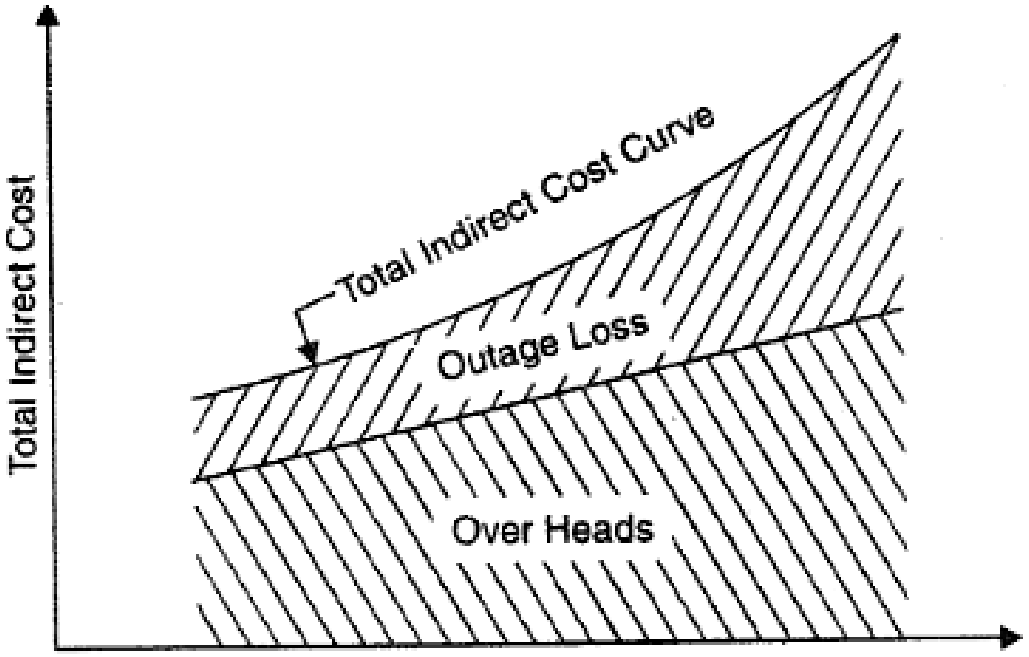
Indirect Project Cost

Indirect costs on a project are the expenditures which cannot be apportioned or clearly allocated to the individual activity of a project, but assessed as a whole. It includes the expenditures due to administrative and establishment charges, overhead, supervision, loss of revenue, lost profit, penalty, etc.



(a) Indirect Cost (Supervisory & Overheads)

- Indirect cost rises with increased duration.



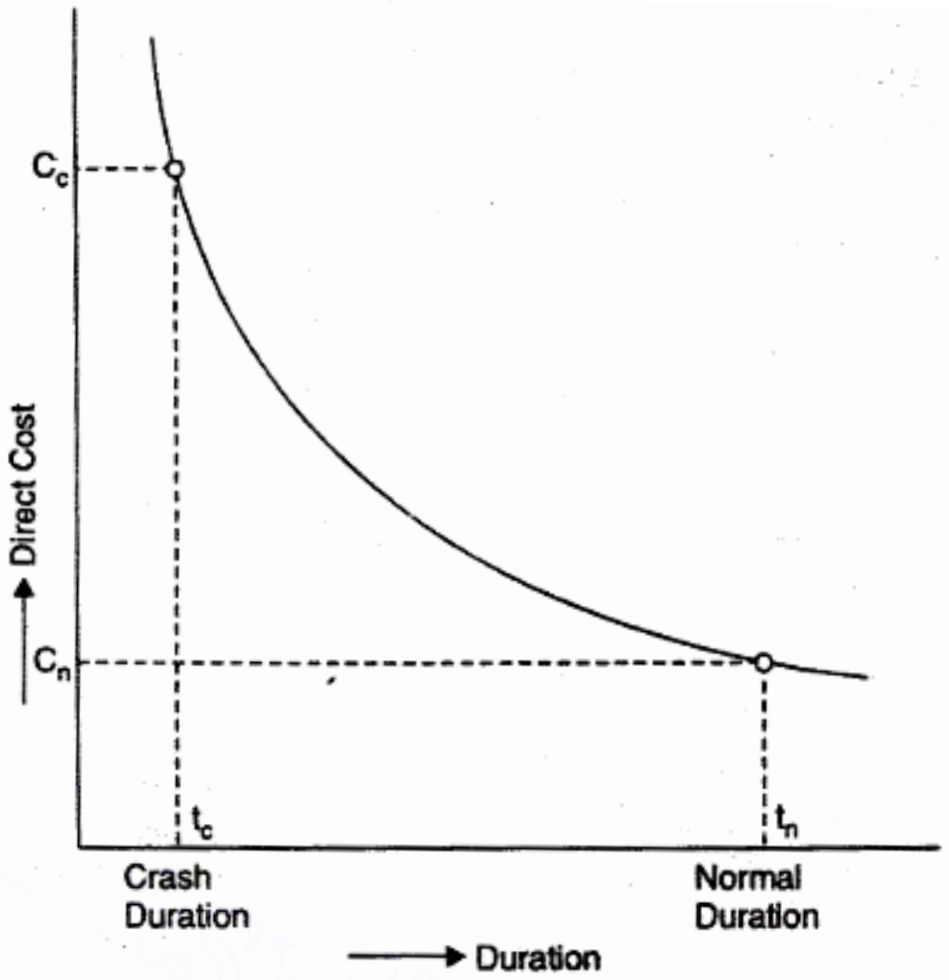
(b) Indirect Cost (Overhead + Outage Loss)

But when there is a loss in profits, due to inability to meet demand or due to some penalty due to delay, a corresponding cost increase must be added to the cost of overheads, producing the curve as shown in Fig. 9.3 (*b*). Such a loss is called the *outage loss*.

The total *indirect cost curve* will thus be curved.

Direct Project Cost

Direct costs are those expenditures which are directly chargeable to and can be identified specifically with the activities of the project. These includes labour cost, material cost, equipment cost, etc.



GENERALISED DIRECT COST-TIME CURVE.

Normal time (t_n). Normal time is the standard time that an estimator would usually allow for an activity.

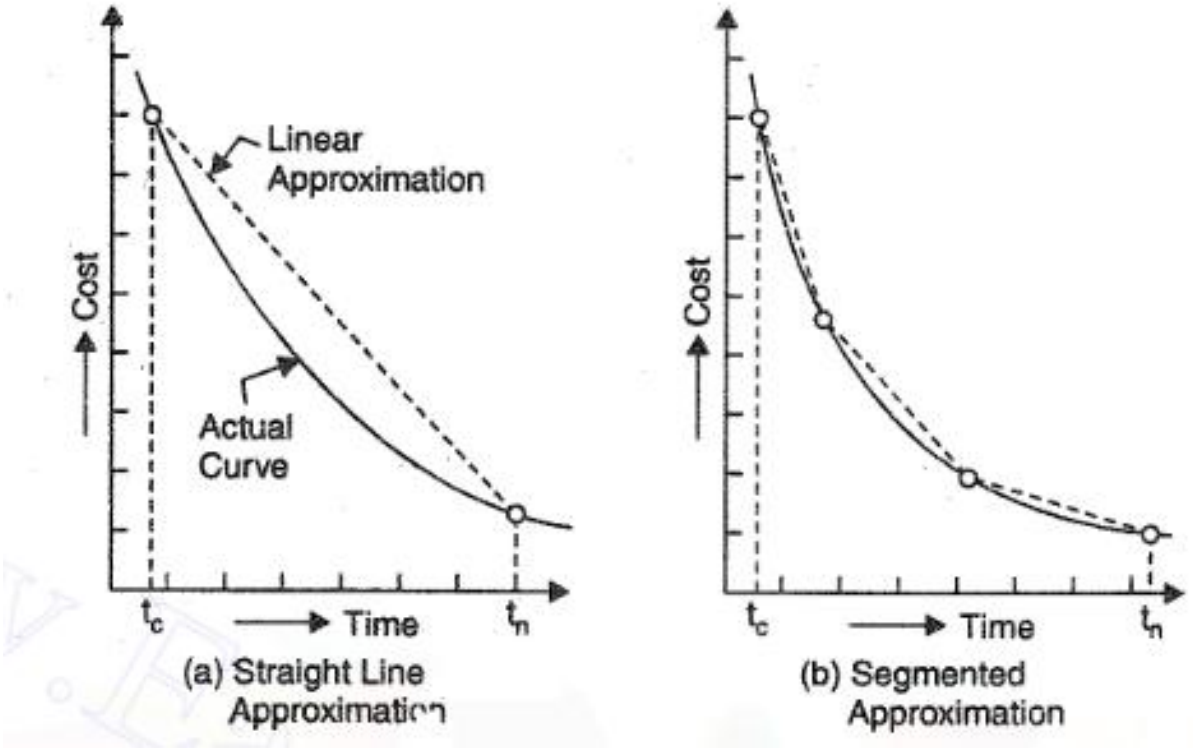
Crash time (t_c). Crash time is the *minimum possible* time in which an activity can be completed, by employing extra resources. Crash time is that time, beyond which the activity cannot be shortened by any amount of increase in resources.

Normal cost (C_n). This is direct cost required to complete the activity in normal time duration.

Crash cost (C_c). This is the direct cost corresponding to the completion of the activity within crash time.

Slope of Direct Cost Curve

The curve can be approximated by a straight line or more than one straight line depending up on the flatness of the curve.



Cost Slope

Cost slope is the slope of the direct cost curve, approximated as a straight line.

$$\text{Cost slope} = \frac{\text{crash cost} - \text{normal cost}}{\text{normal time} - \text{crash time}}$$

or

$$\text{CS} = \frac{C_c - C_n}{t_n - t_c} = \frac{\Delta C}{\Delta t}$$

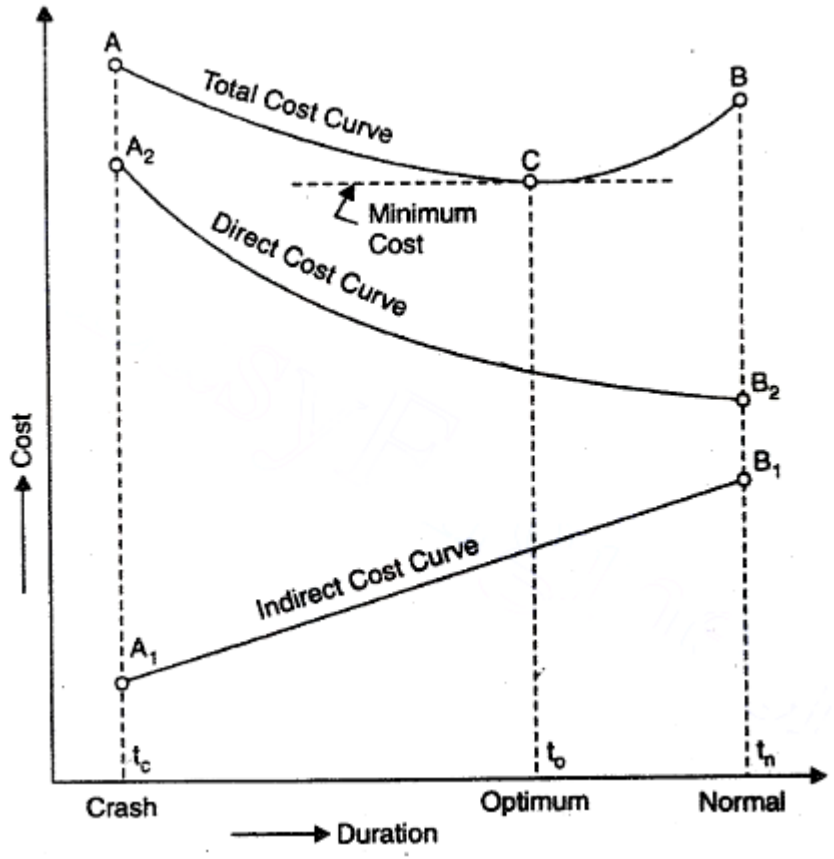
where CS = cost slope

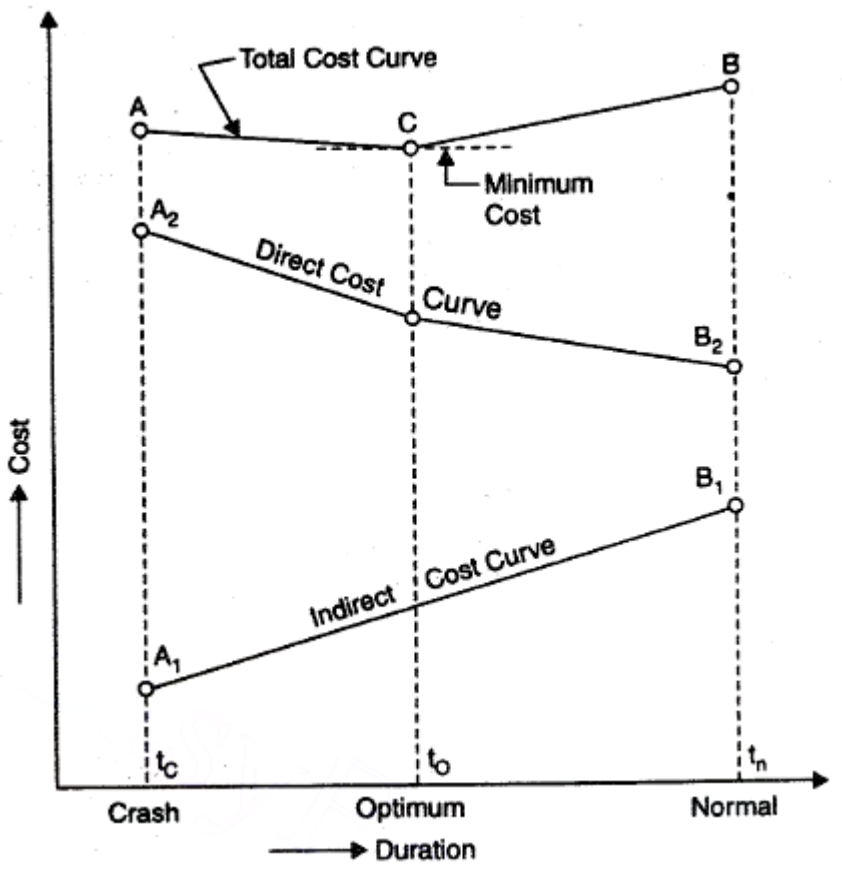
ΔC = increase in cost

Δt = decrease in time.

Total Project Cost and Optimum Duration

Total Project Cost = Direct costs + Indirect costs





Contracting the Network for cost optimization

After having the *critical path* in a network corresponding to the given normal durations of the activities, the next question is “what will be the cost structure of the project if some or all of the activities are crashed?”

If all the activities (critical as well as non-critical) are crashed, the cost will be very high without any additional advantage over and above the one obtained by crashing only the critical activities.

Steps in Time Cost Optimization

1. ESTABLISH	:	direct cost-time relationships for various activities of the project, by analysing past cost records.
2. DETERMINE	:	cost slopes for various activities and arrange them in the ascending order of cost slope.
3. COMPUTE	:	direct cost for the network with normal duration of activities.
4. CRASH	:	the activities in the critical path as per ranking, *i.e.* starting with the critical activity having the lowest slope.

5. CONTINUE	:	crashing the critical activities in the ascending order of the slope.
6. CRASH	:	parallel non-critical activities which have become critical by the reduction of critical path duration due to crashing in steps 4 and 5.
7. CONTINUE	:	crashing process through steps 4 to 6, till a stage is reached beyond which no further crashing is possible.
8. FIND	:	total cost of project at every stage by adding indirect costs to the direct costs determind above.
9. PLOT	:	total cost-duration curve.