UNIT 3

In Project Management, **Baseline** refers to the accepted and approved plans & their related documents. Project baselines are, generally, approved by project management team and those are used to measure and control of project activities.

Though baselines are outputs of planning stage, but they are referred and updated during executing & monitoring and controlling process groups.

Baselines give the project manager a best way to understand project progress (by analyzing baseline vs. actual) and forecast the project outcome.

Baselines are important input to number of project processes and outputs of many processes raise change request to these baselines.

Project baselines include:

- Schedule baseline
- Cost baseline
- Scope baseline
- Quality baseline

Baselines are prepared on triple constraints – Scope, Time, Cost (and Quality) – management areas. The entire above are considered as components Project management plan. Often the scope, schedule, and cost baseline will be combined into a performance measurement baseline that is used as an overall project baseline against which project performance can be measured. The performance measurement baseline is used for earned value measurements.

Define the start and end date of your project to create duration. The start date is the date of the tentative date for the project to begin, and the end date is the scheduled end date of the project. This duration is the initial and baseline duration of the project.

Determine the work tasks to be completed. Work tasks are the activities to complete the project.

Apply your resource list to assign work tasks. This will determine whether or not you have enough manpower and funds to complete the project in the duration initially determined.

Determine the cost for the baseline. Once the work tasks and resources are assigned, the cost of the project will be determined from the work effort and resource rates. This is called the initial project cost.

Compile the information. The result is the baseline for your project plan. As your project is updated, you can compare your current status to your baseline.

BASELINE PLANNING PROCESS

A project has three constraints: scope, schedule and budget. The scope is what the project is to accomplish. Constraints guide the project manager in developing the project plan. First, he defines project requirements that establish the scope. Next, he identifies project activities and their dependencies. This determines the schedule and resource requirements, including staffing. The scope, schedule and resource needs establish the budget.

Baseline Information

The baseline project plan is not a separate project plan. Software copies the information into baseline fields contained in the original project plan. For example, software copies a task's start and finish dates into their respective baseline fields. If a project is complex, the project manager might create multiple baselines as an audit trail for numerous baseline changes occurring during project execution.

Baseline Updates

During project implementation, a project manager might update baseline information to reflect current conditions when unforeseen circumstances occur. For example, a union strike might prevent electricians from performing work. Therefore, the project manager reschedules this effort, as well as other tasks that must begin after the electrical work is completed.

Variances

A project manager establishes planned start and completion dates for a task. Software calculates the planned duration of the task. She records the start date in the project plan when the task begins. Upon the task's completion, she enters its completion date. The actual duration is compared to the planned duration to calculate the duration variance. A task's budget amount, less the task's total spent and committed amounts, determines the cost variance.

Project Control

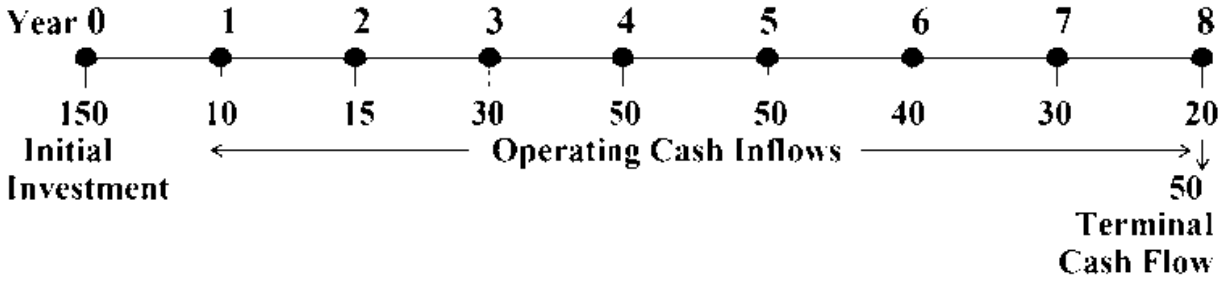
The project manager assesses cost and schedule variances to determine if the project is within budget and on schedule for completion. For example, schedule variances might indicate that project team members completed a group of tasks ahead of schedule. Therefore, the project manager might assign these members to tasks that are behind schedule. If cost variances indicate possible budget overruns, he might decrease the project scope to remain within budget.

Considerations

Project failure might occur as the result of requirements' creep, known as scope creep. This is work added to a project after it begins, increasing the cost. To address the cost of potential scope creep, you might include a contingency amount in the project. Typically, this amount represents a percent of the total estimated project cost.

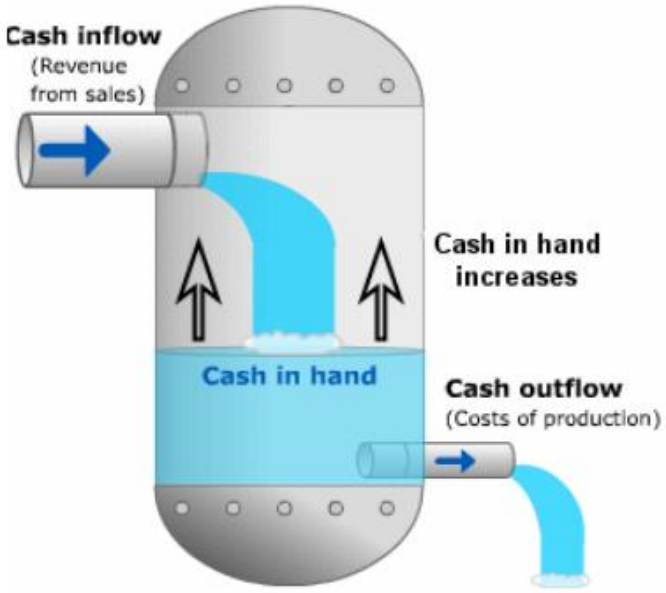
PROJECT CASH FLOW ANALYSIS

It is the analysis of invest inflows and cash inflows. It is most important and most difficult step in capital budgeting. It is important because of forecasting error. For example Alaska Pipeline project, initial cost estimate was about $700 million, however final cost was about $7 billion.



Estimating cash flows – the investment outlays and the cash inflows after the project is commissioned – is the most important, but also the most difficult step in capital budgeting.

Elements of the Cash Flow Stream-

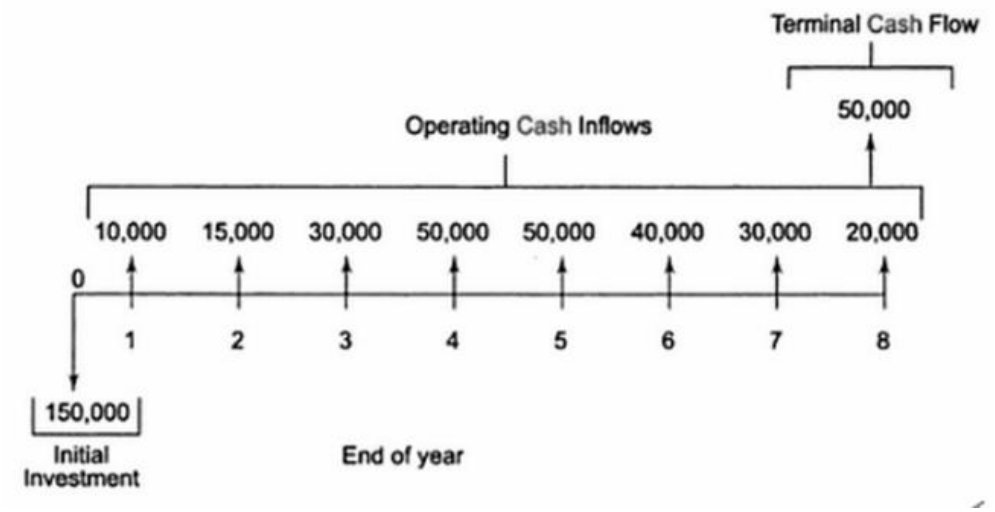


A project which involves cash outflows followed by cash inflows comprises of three basic components. They are,

1. **Initial investment:** Initial investment is the after-tax cash outlay on capital expenditure and net working capital when the project is set up.

2. **Operating cash inflows:** The operating cash inflows are the after-tax cash inflows resulting from the operations of the project during its economic life.

3. **Terminal cash inflow:** The terminal cash inflow is the after-tax cash flow resulting from the liquidation of the project at the end of its economic life.



The following principles should be followed while estimating the cash flows of a project:

1. Incremental principle
2. Separation principle
3. Post-tax principle
4. Consistency principle.

Basic Principles of Cash Flow Estimation:

INCREMENTAL PRINCIPLE:

- The cash flow of a project must be measured in incremental terms.
- To ascertain a project's incremental cash flow one has to look at what happens to the cash flows of the firm with the project and without the project.
- The difference between the two reflects the incremental cash flows attributable to the project.

(Project cash flow for the year T) = (Cash flows for the firm with the project for the year t) - (Cash flow for the firm without the project for the year t).

In estimating the incremental cash flows of a project, the following guidelines must be borne in mind:

- ✓ Consider all incidental effects.
- ✓ Ignore sunk costs.
- ✓ Include opportunity costs.
- ✓ Question the allocation of overhead costs.
- ✓ Estimate working capital properly.

Consider all incidental effects: In addition to the direct cash flows of the project, all its incidental effects on the rest of the firm must be considered. The project may enhance the profitability of some of the existing activities of the firm because it has a complimentary relationship with the; or it may detract from the profitability of some of the existing activities of the firm because it has a competitive relationship with them-all these effects must be taken into account.

Example of incidental effects: A company X introduce a new car model which caused a decrease in the sale of another model. Decreased CF per year on other lines would be a cost to this project. This is an incidental effect to the project.

Ignore sunk costs: A sunk cost refers to an outlay already incurred in the past or already committed irrevocably. So it is not affected by the acceptance or rejection of the project under consideration. Example, a company is debating whether it should invest in a project. The company has already spent R.O. 10,000 for preliminary work meant to generate information useful for this decision. This R.O. 10,000 represents a sunk cost as it cannot be recovered irrespective of whether the project is accepted or not.

Example of sunk costs You plan to produce a new car model using a technology you bought last year at 50,000 OMR. Should this 50,000 OMR cost from the previous year beλ included in the analysis? No, this cost is a sunk cost and should not be considered.

Include opportunity costs: If a project uses resources already available with the firm, there is a potential for an opportunity cost. The opportunity cost of a resource is the benefit that can be derived from it by putting it to its best alternative use. For example, if a project uses a vacant factory building owned by the firm, the revenue that can be derived from renting out this building represents the opportunity cost.

Question the allocation of overhead costs: Costs which are only indirectly related to a product (or service) are referred to as overhead costs. They include items like general administrative expenses, managerial salaries, legal expenses, rent and so on. When a new project is proposed, a portion of the overhead costs of the firm is usually allocated to it.

Estimate working capital properly: Outlays on working capital have to be properly considered while forecasting the project cash flows. In this context the following points must be noted: Working capital is defined as "Current Assets – Current Liabilities". The

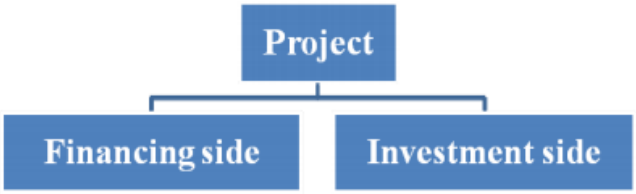
requirement of working capital is likely to change over time as the output of the project changes. Working capital is renewed periodically and hence is not subject to depreciation. Therefore, the working capital at the end of the project life is assumed to have a salvage value equal to its book value.

SEPARATION PRINCIPLE:

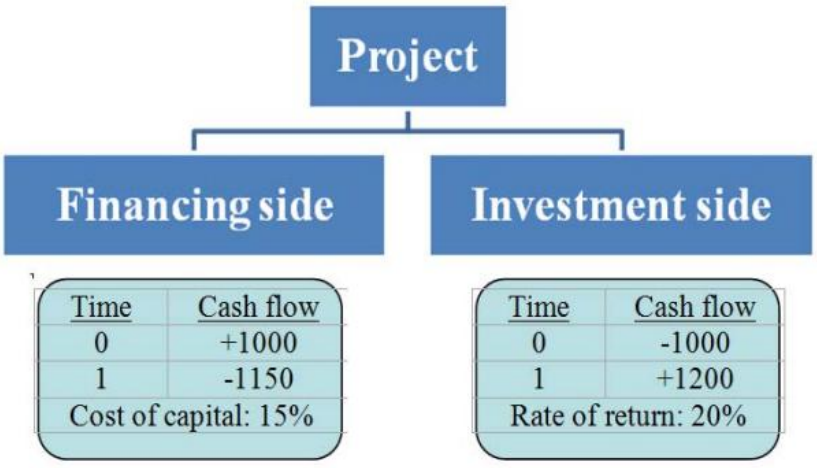
There are two sides of a project:

- ✓ The investment (or asset) side
- ✓ The financing side

The cash flows associated with these sides should be separated.



Example: Suppose a firm is considering a one-year project that requires an investment of R.O. 1000 in fixed assets and working capital at time 0. The project is expected to generate a cash inflow of R.O. 1200 at the end of year 1 (this is the only cash flow expected from the project). The project will be financed entirely by debt carrying an interest rate of 15 percent and maturing after 1 year. Assume there are no taxes.



The cash flows on the investment side of the project includes the rate of return of 20% and do not reflect the financing costs of 15% (interest in our example). The cash flows on the financing side of the project includes the financing cost of 15% (interest in our example) and do not reflect on the rate of return of 20%. The important point is that while estimating the cash flows on the investment side do not consider financing costs like interest or dividend.

POST-TAX PRINCIPLE: Cash flow should be measured on an after-tax basis. This is used to bring out the project cash flows with accuracy.

CONSISTENCY PRINCIPLE: Once you adopt an accounting principle or method, you should continue to follow it consistently in future accounting periods.

The cash flow stream relating to long-term funds consists of three components as follows:

- ✓ **Initial investment:** Long-term funds invested in the project. This is equal to: Fixed assets + working capital margin (this represents the portion of current assets supported by long-term funds)
- ✓ **Operating cash inflow:** Profit after tax + Depreciation + Other noncash charges + Interest on long-term borrowings (1-tax rate).
- ✓ **Terminal cash flow:** Net salvage value of fixed assets + Net recovery of working capital margin.

PROJECT SCHEDULING WITH LIMITED RESOURCES/RESOURCE ALLOCATION:

Planning is usually done for unlimited and readily available resources.

However, in practice, resources are usually limited and scarce. There are many jobs sharing common resources and available resources are not adequate enough.

But, the beauty of the scarce resources is that they can be managed.

- To finish a construction project at maximum efficiency of time and budget it requires the sound planning of schedule and allocation of available resources.
- Resources like man power, materials and equipment are of great importance and requires close attention.

The seasonal shortage, labor disputes, equipment breakdowns, competing demands, delayed deliveries and many other uncertainties affect supply and availability of resources so, this is seldom be taken for granted.

The Resource Allocation Problem-

- If all three variables - time, cost, specifications - are fixed, the system is "over determined"
- In this case, the project manager has lost all flexibility to perform the trade-offs that are so necessary to the successful completion of projects
- A system-constrained task requires a fixed amount of time and known quantities of resources

Most project managers problems:

- Relatively fixed manpower, a certain number of machines or equipment, and a limited budget.
- Jobs that occur on parallel paths through the network or concurrent activities may require the same resources, and even though precedence constraints would not prevent their being scheduled simultaneously, a limited supply of resources might force them to be scheduled sequentially.
- Lack of adequate resources may lead to the revision of established schedules.

If the resources demand exceeds the supply, remedial measures to combat inadequate resource supply is to be made. If there are conflicts among project activities for the same resource items, activity duration & precedence relationships should be considered and rescheduling the non- critical activities will often solve the problem.

In most project situations resources can be acquired or released in practically any desired amounts if one is willing to pay expenses involved in changing resource levels, such as the costs of hiring, training, unemployment insurance, and so on.

It is usually prudent, however, to maintain relatively stable employment levels and to utilize resources at a more constant rate.

The scheduler may use activity slack as a means of smoothing peak resource requirements.

Resource Leveling

It is the method of scheduling activities within their available float so as to minimize fluctuations in a day- to- day resource requirements. It is done by moving project activities.

Resource leveling is necessary to:

- Implement the project effectively.
- To reduce the cost of a project.

By resource leveling

- We try to optimize the use of resources required to complete a project.
- Resource leveling helps in obtaining uniformity (as far as possible) in resource requirement throughout the life of a project.
- It will ease resource management so that cost involved in managing resources can be minimized.

If resource is manpower, its leveling is called **"**Manpower Leveling**"**

- Like manpower, Materials schedule is also done based on CPM/PERT analysis.

- It helps to deliver materials at the site well in advance but avoids delivery far in advance, as a result of which deterioration, damages etc. are avoided.

Resource Smoothing

Resource smoothing is part of resource leveling process. It is defined as a technique that adjusts the activities of a schedule model such that the requirements for resources on the project do not exceed certain predefined resource limits.

- In itself, attempts to determine resource requirement that is "smooth" and where peaks and troughs are eliminated.
- Even if there is no limit to the amount of any resource available, it is desirable that resource usage is as smooth as possible.

TIME-COST TRADE-OFF

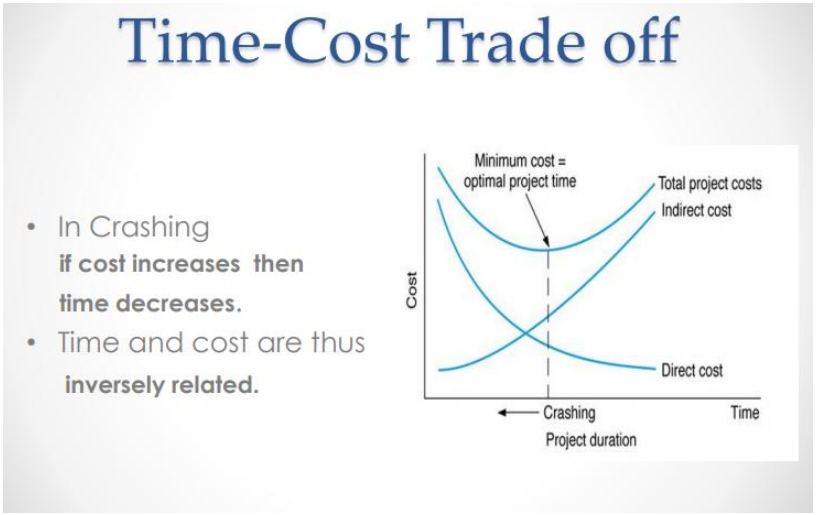
The objective of the time-cost trade-off analysis is to reduce the original project duration, determined form the critical path analysis, to meet a specific deadline, with the least cost. In addition to that it might be necessary to finish the project in a specific time to: -

- Finish the project in a predefined deadline date.
- Recover early delays.
- Avoid liquidated damages.
- Free key resources early for other projects.
- Avoid adverse weather conditions that might affect productivity.
- Receive an early completion-bonus.
- Improve project cash flow

Reducing project duration can be done by adjusting overlaps between activities or by reducing activities' duration. What is the reason for an increase in direct cost as the activity duration is reduced? A simple case arises in the use of overtime work. By scheduling weekend or evening work, the completion time for an activity as measured in calendar days will be reduced. However, extra wages must be paid for such overtime work, so the cost will increase. Also, overtime work is more prone to accidents and quality problems that must be corrected, so costs may increase. The activity duration can be reduced by one of the following actions:

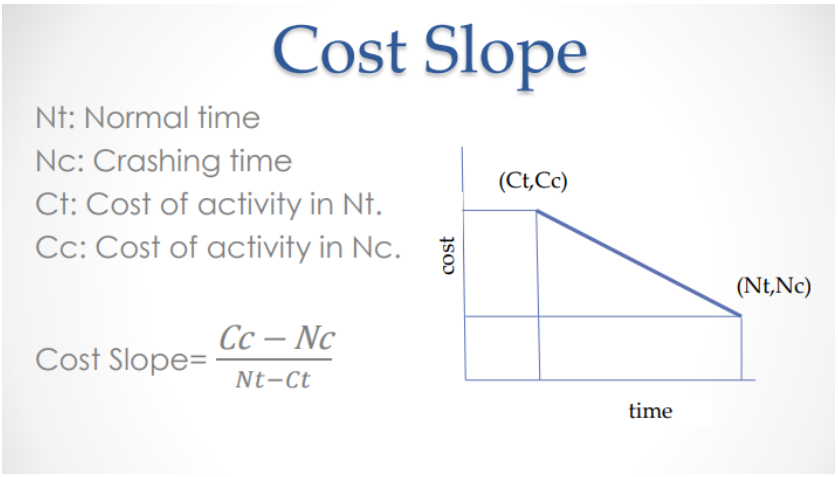
- Applying multiple-shifts work.
- Working extended hours (over time).
- Offering incentive payments to increase the productivity.
- Working on weekends and holidays.
- Using additional resources.
- Using materials with faster installation methods.

- Using alternate construction methods or sequence



Crashing is the procedures by which project duration can be shorten up by expediting selective activities within the project. But it requires allocating more resources than usual to compress an activity's duration, which in turns increases the budget of that activity. So, crashing is basically a time-cost trade-off by which specific deadline can be achieved.

Crashing is achieved by devoting more resources. Thus the cost associated with the project is increased. The Objective is to reduce project duration while minimizing cost of crashing.



Algorithm for Crashing

Step1: Determine the normal Critical path and identify the critical activities.

Step2: Calculate cost slope or increment cost per unit time for different activities.

Step3: Rank activities in ascending order as per their cost slopes.

Step4: i) Crash activities of critical path as per lowest cost slope first. ii) Calculate the new direct cost by adding cost of crashing to the normal cost.

Step5: Since Critical path duration is reduced so other path also becomes critical. Project duration can be reduced by simultaneously crashing activities in the parallel critical path.

Step6: By crashing as per step4 and 5, a point is reached when either no crashing is possible or crashing does not result in the reduction of project duration.

- ✓ Least cost slope activity of the critical path must be dealt with first and so on.
- ✓ If more than one critical path is generated after crashing then duration of activities on all these paths have to be curtailed.
- ✓ If time in critical path(say A) lowers below an alternative path (of time say X such that X>A)after crashing then crashing is done here in such a way that time in critical path is kept same as X, not below X.
- ✓ If crashing a low cost slope activity (say activity D) results in though lowering a single Critical path time but project time is not lowered then
    - Select common activities or activity combinations
    - Find least cost slope among these.

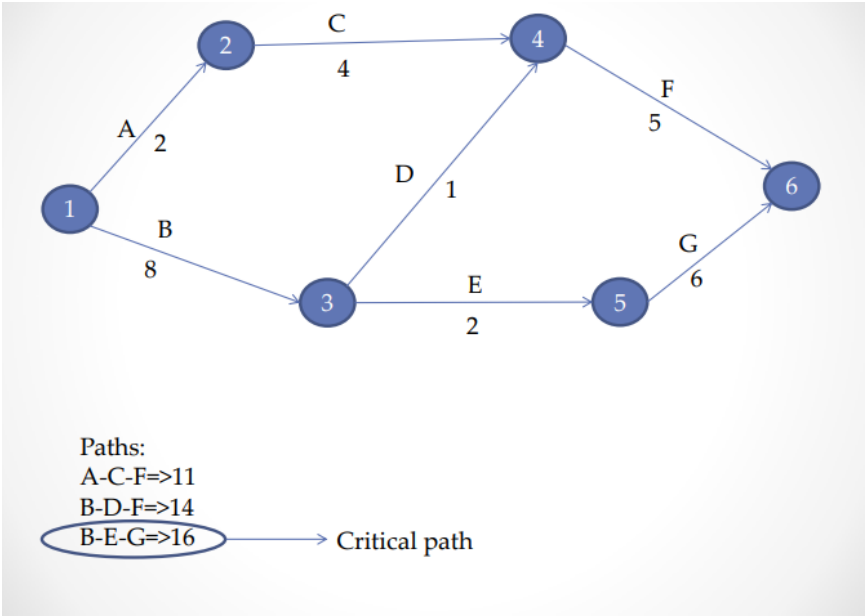
- ✓ Sometimes before Critical path other path gets crashed. Here the time of crashed path is the minimum limit of crashing time. Critical paths are crashed down to this time limit.

EXAMPLE-

Activity	Predecessor activity	Normal time	Crash time	Normal cost	Crash cost
A	-	2	1	10000	15000
B	-	8	5	15000	21000
C	A	4	3	20000	24000
D	B	1	1	7000	7000
E	B	2	1	8000	15000
F	C,D	5	3	10000	16000
G	E	6	2	12000	36000

Find the minimum possible time of the project and the cost associated with this.

SOLUTION: ***(on next page)***



Activity	Predecessor activity	Normal time	Crash time	Normal cost	Crash cost	Time can be Decreased	Increased cost	Cost slope	Crashed time
A	-	2	1	10000	15000	1	5000	5000	
B	-	8	5	15000	21000	3	6000	2000(1st)	3
C	A	4	3	20000	24000	1	4000	4000	
D	B	1	1	7000	7000	-	-	-	
E	B	2	1	8000	15000	1	7000	7000	
F	C,D	5	3	10000	16000	2	6000	3000(3rd)	2
G	E	6	2	12000	36000	4	24000	6000(2nd,3rd)	2,2

1. Comparing cost slope of B, E, G =>B minimum so crash B.

2. Next critical path also B-E-G => G next minimum.

3. Comparing between A, C, D, E, F, G => F is the minimum cost slope. Crash F. Again Crashing F alone will leave B-E-G path with value 11(project not benefited by crashing). So crashing G by 2 days to reach at 9 as in BDF and ACF.

path	Normal time	Crashing B by 3 days	Crashing G by 2 days	Crashing F by 2 days and G by 2 days
B-E-G	16	13 B*-E-G	11 B*-E-G′	9 B*-E-G*
B-D-F	14	11 B*-D′′-F	11 B*-D′′-F	9 B*-D′′-F* crashed complete
A-C-F	11	11 A-C-F	11 A-C-F	9 A-C-F*
Cost added	-	+6000	+12000	12000+ 6000
Total cost	82000	88000	100000	118000

Crashing G completely result in reducing below11.So to attain 11 days G is crashed for 2days only. Now 3 critical paths.