MBA-CC (SECOND YEAR) Semester-III

SCHOOL OF MANAGEMENT STUDIES
PUNJABI UNIVERSITY

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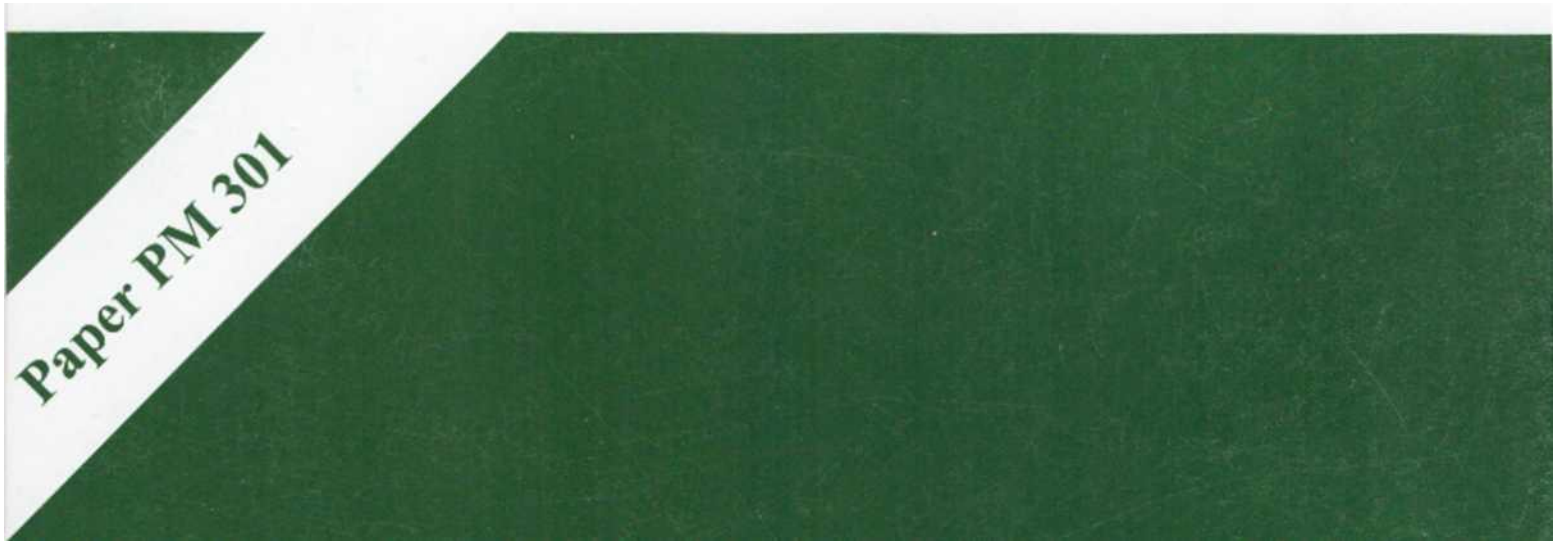

Project Management

LESSON NO. 1: PROJECT MANAGEMENT : AN OVERVIEW

STRUCTURE

1.0 AIMS AND OBJECTIVES

This lesson deals with the concept of project management. What is a project? Why it needs proper management? etc. After reading this lesson, you will be able to :

- Understand the concept of a Project
- List the major features of a project
- Understand Project Life Cycle
- Importance of Project Management
- Concept of mission in project

1.1 INTRODUCTION

Essentially, a project is a task with a known end point. For example, building a new house is a project, the end point being when the house is built. Similarly, creating a new piece of computer software is a project, as is launching a new product for a business. Projects can*be used to complete many different types of tasks. Project management is a formal discipline for managing projects. Project management has been developed over the past few decades as it has become apparent that without a structured approach, people are not very good at completing projects successfully. The aim of project management is to ensure that projects are completed and that the end point (the new house, computer system or new product) is achieved. More than this, project management is about reaching that end point predictably, which usually means to a given cost and within a planned amount of time.

1.2 WHAT IS A PROJECT?

Usually the term project' is applied to tasks with some degree of complexity. Projects fulfil some clear pre-defined objective, in a planned period of time, and to a planned cost. Once the project is complete something will have changed - for example, you have a new house, a new computer system or a new product.

The Project Management Institute defines a project as a temporary endeavour undertaken to create a unique product or service. There is a rich variety of projects to be found in our society. Although some may argue that the construction of the Tower of Babel or the Egyptian pyramids was some of the first projects, it is probable that cavemen

formed a project to gather the raw material for mammoth stew. Modem project management, however, is usually said to have begun with the Manhattan Project. In its early days, project management was used mainly for very large, complex research and development (R&D) projects like the development of the Atlas Intercontinental Ballistic Missile and similar military weapon systems. Massive construction programs were also organized as projects ? the construction of dams, ships, refineries, and freeways, among others.

1.3 INTRODUCTION TO PROJECT MANAGEMENT

The successful project management is all about structure, control, sufficient attention to detail and continuously driving action. The role of the project manager is to understand enough project management to apply its structure and ensure that project is successfully completed within the time and cost required. The things you must do as a project manager are :

- Ensure there is a clear understanding why a project is being done, and what it will produce.
- Plan the project - to understand how long it will take and how much it will cost.
- Manage the project - to ensure that as the project progresses, it achieves the objectives you have defined within the time and cost specified.
- Complete the project properly - to make sure everything produced by the project is of the quality expected and works as required.

Project Management has emerged because the characteristics of our turn-of-the-century society demand the development of the new methods of management. Of the many forces involved, three are paramount :

— • The exponential expansion of the human knowledge;
— The growing demand for a broad range of complex, sophistically, customized goods and services;
— The evolution of worldwide competitive markets for the production and consumption of goods and services.

A11 three forces combine to mandate the use of terms to solve problems that used to be solvable by individuals. These three forces combine to increase greatly the complexity of goods and services produced plus the complexity of the process used to produced them and all this in turn leads to the need for more, sophisticated systems to control both outcomes and processes.

As the techniques of project management were developed, the use of project organization began to spread. Private construction firms found that project organization was helpful on smaller projects, such as the building of a ware-house or an apartment complex. Automotive companies used project organization to develop new automobile models. Both General Electric and Pratt & Whitney used project organization to develop new jet aircraft engines for airlines, as well as the Air Force. Project management has even been used to develop new models of shoes and ships.

More recently, the use of project management by international organizations, and especially organizations producing services rather than products, has grown rapidly. Advertising campaigns, global mergers, and capital acquisitions are often handled as projects, and the methods have spread to the non-profit sector. Functions, weddings, fund drives, election campaigns, par-ties, recitals etc. all make use of the principles of project management. Most striking has been the widespread adoption of project management techniques for the development of computer software.

SELF CHECK EXERCISE

1. What are the key responsibilities of a project manager?

a) Ensure chaos and lack of structure and timelines

b) Ignore project objectives

c) Plan, manage, and complete the project successfully

d) Avoid understanding why a project is being done

2. **What is the primary aim of project management?**

   a) Increase project complexity b) Ensure projects are never completed

   c) Complete projects predictably within a planned timeframe and cost

   d) Avoid project structure and control

3. **The use of project management techniques has been limited to the production of goods and not widely adopted in the non-profit sector or for service-oriented projects. T/F**

4. **Projects are typically ongoing and have no known end point. T/F**

1.4 CHARACTERISTICS OF A PROJECT

Now we know that a project is a specific, finite task to be accomplished. Whether large or small scale or whether long or short run is not particularly relevant. What is relevant is that the whole project should be taken as a single unit. There are, however, some attributes that characterize projects.

1.4.1 Project Life Cycle

Every project goes through various stages in its development. These stages vary depending on the type of project. For example, a project to build a new car has different stages compared to a project to develop an advertising campaign for a new type of washing detergent. However, at a generic level projects must go through common steps such as:

1. Specifying in detail what the project is for.
2. Planning the project and working out how it will be done.
3. Doing the project and creating the deliverables according to the plan.
4. Checking that the deliverables are as you originally wanted and meet the needs.
5. Closing the project down.

These five steps defined are a simple project lifecycle. The lifecycle is a skeleton framework which you can build your project around. From a slow beginning, they progress to a buildup of size, then peak, after that a decline, and finally they are terminated. Some projects end up by being phased out into the normal, ongoing operations of the parent organization.

1.4.2 Delivery and deliverables

There is a word that project managers and people involved regularly in projects use all the time; it is delivery. Delivery in the context of projects simply means getting the things done you set out to do. The role of a project manager is therefore to deliver the project. Delivery is a useful piece of jargon as it saves having to write ‘completing the project to the expected time and cost with the desired outcome’ again and again!

Deliverables are what is delivered by a project - so taking the examples above, the deliverables from the respective projects are a new house, a new computer system or a new product. In a project the deliverables wanted are defined at the start of the project, and your success as a project manager is in delivering them in the planned time and to the expected cost.

1.4.3 Overlapping of Activities

Projects often interact with other projects being carried out simultaneously by their parent organization; but projects always interact with the parent organization's standard, ongoing operations. Although the functional departments of an organization (marketing, finance, manufacturing, and the like) interact with one another in regular, patterned ways, the patterns of interaction between projects and these departments tend to be changeable. Marketing may be involved at the beginning and end of a project, but not in the middle. Manufacturing may have major involvement throughout. Finance is often

involved at the beginning and accounting at the end, as well as at periodic reporting times. The PM must keep all these interactions clear and maintain the appropriate interrelationships with all external groups.

1.4.4 Uniqueness

Every project has some elements that are unique. No two construction or R & D projects are precisely alike. Though it is clear that construction projects are usually more routine than R&D projects, some degree of customization is a characteristic of projects. In addition to the presence of risk this characteristic means that projects, by their nature, cannot be completely reduced to routine. The PM's importance is emphasized because the PM will find there are a great many exceptions to manage.

1.4.5 Goal and Purpose

A project is usually a one-time activity with a well-defined set of desired end results. It can be divided into subtasks that must be accomplished in order to achieve the project goals. The project is complex enough and the subtasks require careful coordination and control in terms of timing, precedence, cost, and performance. Often, the project itself must be coordinated with other projects being carried out by the same department or organization.

1.4.6 Sharing of Resources

More than most managers, the PM lives in a world characterized by conflict. Projects compete with functional departments for resources and personnel. More serious, with the growing proliferation of projects, is the project versus project conflict for resources within multi-project organizations. The members of the project team are in almost constant conflict for the project's resources and for leadership roles in solving project problems.

SELF CHECK EXERCISE

5. What does term "delivery" mean in the context of projects?

i) Initiating a project **ii)** Completing a project on time

iii) Closing down a project **iv)** Getting things done as planned

6. What is a significant challenge faced by project managers in terms of resources?

i) Abundance of resources **ii)** Lack of conflict for resources

iii) Competition with functional departments **iv)** Absence of project versus project conflict

7. Uniqueness is a characteristic of projects, making them distinct from routine and repetitive tasks. T/F

8. The project life cycle is a rigid framework that remains the same for all types of projects. T/F

1.5 ROLE AND IMPORTANCE OF PROJECT MANAGEMENT

The basic purpose for initiating a project is to accomplish specific goals. The reason for organizing the task as a project is to focus the responsibility and authority for the attainment of the goals on an individual or small group.

In spite of the fact that the manager often lacks authority at a level consistent with his or her responsibility, the manager is expected to coordinate and integrate all activities needed to reach the project's goals.

In particular, the project form of organization allows the manager to be responsive to:

(1) the client and the environment,
(2) identify and correct problems at an early date,
(3) make timely decisions about trade-offs between conflicting project goals, and
(4) ensure that managers of the separate tasks that comprise the project do not optimize the performance of their individual tasks at the expense of the total project? that is, that they do not sub-optimize.

Actual experience with project management indicates that the majority of organizations using it experience better control and better customer relations, and probably an increase in their project's return on investment. A significant proportion of users also report shorter development times, lower costs, higher quality and reliability, and higher profit margins. Other reported advantages include a sharper orientation toward results, better interdepartmental coordination, and higher worker morale.

On the negative side, most organizations report that project management results in greater organizational complexity. Many also report that project organization in-creases the likelihood that organizational policy will be violated ? not a surprising outcome, considering the degree of autonomy required for the manager. A few firms re-ported higher costs, more management difficulties, and low personnel utilization.

The tremendous diversity of uses to which project management can be put has had an interesting, and generally unfortunate side effect. While we assert that all projects are to some extent unique, there is an almost universal tendency for those working on some specific types of projects to argue. The fundamental similarities between all sorts of projects, be they long or short, product? or service oriented, parts of all ? encompassing programs or standalone, are far more pervasive than are their differences.

1.6 IMPACT OF DELAYS IN PROJECT COMPLETIONS

The most important problem faced in the implementation phase of a project is delay in execution. This is also referred to as slippage of projects, which results in escalation of costs and also the loss of revenue. The result is that the initial assumption in the feasibility report are thrown completely out of gear. The delays may be caused by internal as well as external factors.

The internal factors, which cause delays are :

— Inadequate planning based on wrong and inadequate information
— Inadequate financing
— Choice of wrong technology
— Lack of coordination among execution departments
— Absence of delegation of power
— Lack of reasonable norms of accountability
— Poor industrial relations
— Wrong selection of agents
— Non-involvement of people

The external factors, which may cause delays are :— Input problems
— Transportation problems
— Frequent change in administration at the senior level, affecting the continuity of policy
— Lack of public cooperation.

Despite taking all the care, there are bound to be factors beyond the control of a manager, which are likely to -cause delay in project implementation. Therefore, it is necessary to build a system, which can correct deviations from the initial expectations and ensure that the schedule of the project is not disturbed. To perform such tasks, there needs to be a scientific system of flow of management information to the executive at various levels in the organization. The system of monitoring and control is more effective when, along with the time-frame, there is linkage between the physical work to be performed in each activity and the financial expenditure to be incurred.

The operational plan should include the following aspects :

— The breakdown of the project's final objectives into various subsystems and these subsystems into activities and sub-activities.

— The time schedule for starting and completion of each activity and sub activity and their sequencing.
— Linking of physical work involved in each activity with financial expenditure.
— The timetable indicating the requirements of financial resources during the pre-implementation phase.
— Monitoring and control system.

SELF CHECK EXERCISE

9. Why does the project form of organization allow managers to be responsive?

a) To optimize individual task performance b) To increase organizational policy violations

c) To coordinate and integrate activities for goal attainment

d) To decrease worker morale

10. What is a potential negative outcome of project organization?

a) Better interdepartmental coordination b) Higher personnel utilization

c) Greater organizational complexity d) Improved worker morale

11. Project management typically results in lower costs, higher quality, and higher profit margins according to reported advantages. T/F

12. Delays in project completion can be solely attributed to internal factors, such as inadequate financing and poor industrial relations. T/F

1.7 TOOLS AND TECHNIQUES IN PROJECT MANAGEMENT

(a) PERT/CPM

A number of tools and techniques were developed in the very beginning of the development of the discipline of project management. The most important tools are known as program. Evaluation and Review Techniques (PERT) and Critical Path Method (CPM). These techniques enable a Project Manager to use the graphical network method of representation of a project with indications of the time required to complete each activity. A network depicts the sequential relationship of different activities. The time taken by each activity and the longest chain of the activities from the beginning to the end known as the "Critical path. This chain of activities controls the total time required to complete a project and deserves the greatest attention from the Project Manager. These methods of working out the time required for project completion have been extended to include the costs for each activity, the resources required for each activity and the uncertainties involved with each activity with the in-out of time, cost, resources and probability for each activity. It is possible to work-out an overall project schedule, a schedule of funds required, a projection of the resources necessary for the life cycle of the project and to work out the probabilities of completing the project within a given time-frame., Modern computer algorithms are available which will enable a manager to find out optimum project duration that will minimize the total cost of a project. It also allows a manager to see the profile of resources required and to try to level off the peak requirements of certain critical resources.

(b) Resource Levelling

Any project would use a variety of resources. These might include equipment of specialized nature like heavy duty crawler, cranes, concrete misers, transport vehicles etc. Resources would also include various categories of skilled manpower for carrying out

different activities in a project. One of the fundamental benefits of the network planning tool is the ability to plan for parallel action. This means that the proposed activities would be carried out simultaneously by different agencies using different resources. You can imagine a network to comprise of a series of parallel lines, each line representing one chain of activities with some interconnections. The longest chain of activities starts from the beginning and go all the way up to the end of the total project duration. This chain of activities is known as "critical path". However, there would always be a number of other parallel chains of activities which will also span part of the entire duration of the network. They important point to note is that they are all in parallel.

The network models allow the planner to consider the requirements of various resources at key point of time. This is called 'resource planning[1]. For example, if there are three activities running in parallel and each one of them require the services of a mobile crane then the project would need three mobile cranes at the point of time. It will continue to need three mobile cranes as long as these three activities are going on simultaneously. It during this period any activity needs to be performed, which also requires the mobile crane we would require four mobile cranes.

(c) Cost Management

An important dimension of project management includes management of the expenditure incurred on the project. Money could be considered to be a resource. Applying the principles of resource planning described earlier, it is possible to work-out the requirement of funds at any point of time during the execution of the project. One needs to know the pattern of expenditure with each activity and simply add them up over the entire time period to get the requirement of funds for the entire project.

We can identify the activities and the requirement of the funds for each activity in each time period. Adding these up, you can see very easily that the total funds requirements for this project and for this schedule can be easily worked out. These requirements can then be plotted against time, as cumulative requirement of funds as planned.

Against these, the actual expenditure can be measured and thereby a graphical picture of the budgeting position can be obtained. This provides a very strong management control tool in the hands of the project manager.

Project management also offers yet another tool which allows a manager to consider various cost options for carrying out individual activities and finding out a minimum total cost solution for the project. It is necessary to have data or estimates of different costs of carrying out an activity and the associated duration for each activity. Normally, it would cost more to cany out an activity, if its duration is to be reduced. By spending more on the activities on the critical path it is possible to reduce the total duration of the project at some additional cost. However, there are some savings also. There are certain indirect costs of a project which are proportionate to the overall duration of the project and are independent of the individual activity costs. For example, the site office expenses, power, lighting of the project site, salaries of the project managers and other managerial personnel are not linked to individual activities, If the total duration comes down, it is possible to save on these costs. It is possible to carry out an exercise which will minimize the total project cost, by spending more on direct activities and thereby cutting down on the indirect cost.

(d) Probability in Networks

The basic difference, as you already know, between the PERT and CPM, concerns uncertainties, PERT was applied for ICBM where activities durations were not known. In order to overcome this follow BETA distribution and obtained three estimates - Pessimistic (B). Most Likely (M) and Optimistic (A) - for each activity. Using these estimates and the following relations, it is possible to work out the Expected Time (TE) for each activity.

It is also possible to calculate the standard Deviation (SD) for each activity by the following expression :

$$S.D. = \frac{B-A}{6}$$

Using these expressions, planners can work out the expected completion time of the project and the Standard Deviation for each activity. For a large project where the critical path contains a number of activities, it is possible to make the assumption of normal distribution and draw further inferences. You will learn more details of these aspects later.

(e) Project Appraisal

There is a decision element at the end of the feasibility phase: the 'question mark' whether to go ahead or, not, with the project. The whole process of answering this question is called 'Project Appraisal'. Financial institutions as well as promoters of projects are keenly interested in this process. If the appraisal is unrealistic, then it is possible to drop a very good investment proposal and thereby lose a good investment opportunity. On the other hand, if inadequate appraisal leads to investments in an unviable project, investments would not generate the expected returns and may lead to sickness of the project/enterprise. It is, therefore, essential to consider all aspects of project viability; before deciding on further investments in the project.

The following specific aspects must be covered

1. Technical Viability
2. Commercial Viability - Market Demand
3. Financial Viability
4. Economic Viability
5. Environmental Viability
6. Managerial Viability

In essence, the project should be technically feasible and adequate demand should exist for selling the products generated by the operation of the project facilities. There should be adequate financial returns, and adequate returns to the National economy. All environmental requirements must be possible to be fulfilled and the enterprise must have the capability to manage the facilities efficiently and effectively after the project is over.

(f) Computer Applications

A number of computer packages are available for carrying out various exercises. In fact, all the tools and techniques mentioned above like PERT, CPM, Resource Levelling, Cost Crashing, PERT Probability Calculations and Project Appraisal can be carried cut with the help of a computer. Routines are available which are suitable both for applications on the personal-computers (PCs) as Mini-computers (MCs). Computers have also been extensively used as a base for Project Management Information system.

SELF CHECK EXERCISE

13. **Which tools are considered the most important in project management?**
    a) Risk Analysis and Mitigation b) Resource Levelling and Cost Management
    c) Program Evaluation and Review Techniques (PERT) and Critical Path Method (CPM)
    d) Feasibility Analysis and Project Appraisal
14. **What aspect does Project Appraisal cover before deciding on further investments in the project?**
    a) Technical Viability b) Managerial Viability
    c) Environmental Viability d) All of the above
15. **Probability in Networks involves applying the principles of PERT to calculate the expected completion time of the project and the standard deviation for each activity. T/F**
16. **Resource Levelling aims to increase the peak requirements of critical resources in a project. T/F**

1.8 SUMMARY

The activities inside an organization are generally organized into groups, which fall into two categories-operations and projects. Operations usually consist of ongoing routine

work, whereas a project has a goal to generate a unique product, service, or result in a finite time ? -that is, it has a planned beginning and a planned end. Organizations launch projects for different reasons, such as to meet a business or legal requirement, or to take on an opportunity offered by the market. A project, like anything else in an organization, needs to be managed. The project management is the application of knowledge and skills to project activities in order to meet the project objectives. It involves performing a set of processes that constitute nine knowledge areas of project management: communication management, cost management, human resource management, integration management, procurement management, quality management, risk management, scope management, and time management. Each process is part of a knowledge area and has a membership in one of five process groups: initiating, planning, executing, monitoring/controlling, and closing. The process groups represent different stages of a project lifecycle.

Each project has a set of individuals or organizations that it influences positively or negatively, and these individuals and organizations are accordingly called positive and negative stakeholders. Some of these stakeholders may influence the project. Therefore, you must identify all the project stakeholders, positive and negative. The different project stakeholders might have different and conflicting expectations, which you need to analyze and manage.

1.9 KEYWORDS

- **Project Management** : The means, techniques, and concepts used to run a project and achieve its objectives.
- **Deliverables** : The desired outcomes or results of a project.
- **Interdependencies** : Relations between organizational functions where one function or task is dependent on others.
- **Parties-at-interest** : Individuals or groups with a special interest in a project, usually the project team, client, senior management, and specific public interest groups.
- **Program** ; Often not distinguished from a project, but frequently meant to encompass a group of similar projects oriented toward a specific goal.
- **Task** : A subset of work elements in a project.

1.10 QUESTIONS FOR REVIEW

- Name and briefly describe the societal forces that have contributed to the need for project management.
- Describe the life cycle of a project in terms of (1) the degree of project completion;
  (2) required effort.
- Describe the limitations of project management.
- List the five main characteristics, Oka project and briefly describe the important features of each.
- Name and briefly describe the three primary goals of a project.
- Discuss the advantages and disadvantages of project.
- How do projects, programs, tasks, and work pack-ages differ?
- How would you define a project?

1.11 FURTHER READINGS

1. Clifford F. Gray and Erik W. Larson, **Project Management,** Publication : TATA McGraw HILL
2. ***Prasanna Chandra,*** *Projects - Planning, Selection, Financing, Implementation, and Review,* ***Sixth Edition, Publication : TATA McGraw HILL***
3. Dennis Lock, **Project Management,** Ninth Edition, Publication : Gower
4. P.C.K. Rao, **Project Management and Control,** Publication : Sultan Chand & Sons
5. Vasant Desai, **Project Management,** Second Revised Edition, Publication : Himalaya Publishing House
6. Clements / Gido, **Effective Project Management,** Publication : Thomson
7. K. Nagarajan, **Project Management,** Third Edition, Publication : New Age

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ANSWER KEY:

1. c, **2.** c, **3.** F, **4.** F, **5.** d, **6.** c, **7.** F, **8.** F, **9.** c, **10.** c, **11.** T, **12.** F, **13.** d,

14. c, **15.** T, **16.** F

LESSON NO. 2: PROJECT LIFE CYCLE PHASES

STRUCTURE

2.0 AIMS AND OBJECTIVES:

This lesson deals with the concept of project management. What is a project? What are the characteristics of a project? etc. After reading this lesson you will be able to understand :

- ^Essentials of a Project
- Project Objective
- Phases in Project Life Cycle
- Importance of planning and control
- Characteristics of Projects

2.1 INTRODUCTION

A project is a set of tasks or activities related to the achievement of some planned objective, normally where the objective is unique or non-repetitive in nature. Thus, a project is usually distinguished from repetitive or continuous production process by the characteristic of uniqueness or the one-shot nature of the objective. Projects may involve routine procedures where project planning techniques are useful for detailed analysis and optimization of the operating plan.

Planning is the process of preparing for the commitment of resources in the most effective fashion. Controlling is the process of making events conform to schedules by coordinating the action of all functions of the organization according to the plan established for attaining the objective. It can also be said that project management is a blend of art and science of getting things done through and with people in formally organized groups; and the science of handling large volume of data to plan and control so

that project duration and costs are balanced and excessive and disruptive demands on scare resources are avoided. According to the definition provided by the World Bank, project is an approval for a capital investment to develop facilities to provide goods and services. A project can be anything. **A** project has the following as its basic components :

2.2 SETTING CLEAR GOALS AND OBJECTIVES

A project has a set of objective or a mission. Once the objectives are achieved, the project is treated as completed. For example, the objective of a project may be construction of a highway connecting two cities A' & B', covering a distance of 20 kilometres. Once the construction of the highway is completed the project comes to an end.

Projects must have a clear and single goal. However, very large or complex projects may be divided into several subprojects, each of which is a project in its own right. This division makes for better management control. For example, subprojects can be defined at the department, division, or geographic level. This artificial decomposition of a complex project into subprojects often simplifies the scheduling of resources and reduces the need for interdepartmental communications while a specific activity is worked on. The downside is that the projects are now interdependent. Even though interdependency adds another layer of complexity and communication, it can be handled.

Following points must be borne in mind while setting the goals and objectives of a project for better clarity.

- Deliver quality systems which meet or exceed customer expectations when promised and within cost estimates
- Develop quality systems using an identifiable, measurable, and repeatable process.
- Establish an organizational and project management structure with appropriate levels of authority to ensure that each system development project is effectively managed throughout its life cycle.
- Identify and assign the roles and responsibilities of all affected parties including functional and technical managers throughout the system development life cycle.
- Ensure that system development requirements are well defined and subsequently satisfied.
- Provide visibility to the State of Maryland functional and technical managers for major system development resource requirements and expenditures.
- Establish appropriate levels of management authority to provide timely direction, coordination, control, review, and approval of the system development project.
- Ensure project management accountability.
- Ensure that projects are developed within the current and planned information technology infrastructure.
- Identify project risks early and manage them before they become problems.

SELF CHECK QUESTIONS

1. What distinguishes a project from repetitive or continuous production processes?

a. Uniqueness or one-shot nature b. Routine procedures

c. Large volume of data d. Optimization of operating plans

2. How is project management defined in the text?

a. A repetitive process b. The art of doing things individually

c. A blend of art and science in organized groups d. The science of avoiding scarce resources

3. Project management is solely a science, not an art. T/F

4. Interdependency in projects adds complexity but can be managed effectively. T/F

2.3 PROJECT ESSENTIALS

Mazor essential elements of a project are us below :

2.3.1 Specified Time

Projects have a specified completion date. This date can be self-imposed by management or externally specified by a customer or government agency. The deadline is beyond the control of anyone working on the project. The project is over on the specified completion date whether or not the project work has been completed.

2.3.2 Uniqueness

Every project is unique and no two projects are similar. Setting up a Cement plant and construction of a highway are no doubt two different projects having unique characteristics. Constructing a highway between cities A and B and constructing another highway between cities C and D are also unique in themselves, in view of the differences existing in the organization, infrastructure, location, technical specifications and the people behind the projects.

2.3.3 Team work

A project normally consists of diverse areas. There will be personnel specialized in their respective areas. Any project calls for the services of experts from a host of disciplines. Co-ordination-among the diverse areas calls for teamwork. Hence a project can be implemented only with teamwork.

2.3.4 Complexity

A project is a complex set of activities relating to diverse areas. Technology survey, choosing the appropriate technology, procuring the appropriate machinery and equipment, hiring the right kind of people* arranging for financial resources, execution of the project in time by proper scheduling of the different activities etc. contribute to the complexity of the project.

2.3.5 Sub-contracting

This characteristic stems forth in view of the complexity of functions and activities of a project. Some of the activities are entrusted to sub-contractors to reduce the complexity of the project. Sub-contracting will be advantageous if it reduces the complexity of the project so, that the project manager can co-ordinate the remaining activities of the project more effectively* In general, the greater the complexity of the project, the larger will be the extent to which sub-contracting will be resorted to. Sub-contracting is also helpful if the subcontractors are specialized in their field of activity since this will improve the quality of the project.

2.3.6 Risk and Uncertainty

Risk and uncertainty go hand in hand with project. A risk-free project cannot be thought of Even if a project appears to be risk free, it only means that the risk element is not apparently visible on the surface and it will be hidden underneath. The risk factor will come to surface when conditions become conducive to it. Some of the risk elements can be foreseen and the project can be strengthened to encounter the risk as and when it emerges. Some other risk elements cannot be foreseen.

For example, assume that putting up a cotton yarn-spinning mill is the project on hand. If during the project feasibility study, it is learnt that there has been a gradual shift among consumers from the usage of cotton yam to the usage of synthetic yam, and if it is apprehended that at one stage synthetic yam will rule over, the machinery can be so chosen that they can be used for both types of yams. If this is not entirely possible, the choice of machinery can be so done as to avoid major conversion cost while switching over from the manufacture of cotton yam to the manufacture of synthetic yam in case the need

arises. Such eventualities can be foreseen and planned for.

On the other hand, the sudden entry of a strong competitor who can upset all our forecasts and projections cannot be anticipated. Sudden fall of Government in a country, which is not anticipated may turn the calculations wrong and make the forecasts/projections meaningless.

2.3.7 User Specific Nature

A project is always customer specific. This is because the products produced or services offered by the project are necessarily to be customer oriented. It is the customer who decides upon the product to be produced or services to be offered and hence it is the responsibility of any organization to go for projects/services that are suited to customer needs.

2.3.8 Change

A project is not rigid in its life span. Changes occur throughout the life span of a project as a natural outcome of many environmental factors. The changes may vary from minor changes which may have very little impact on the project to major changes which may have a big impact or even may change the very nature of the project.

During the course of implementation, the technology would have improved further and equipment with the latest technology would have already started arriving. In such a case, if the equipment originally planned had not yet been procured, it would be wise to switch over to the equipment with the latest technology. There could also be latest technological innovations in the manufacturing process which may deserve a switch over. All such changes are necessitated in order to keep the project update.

2.3.9 Response to Environments

Projects take shape in response to environments. Indian Government soon after independence set up major projects, in the public sector, in the sectors of iron and steel, coal, power generation, heavy equipment manufacture etc. This was in tune with the then need for the development of infrastructure and heavy industries.

2.3.10 Forecasting

Forecasting the demand for any product/service that the project is going to produce is an important aspect. Only if the forecast gives positive indications, the project is taken up for further study. Thus, all projects involve forecasts and in view of the importance attached to forecasts, they must be accurate and based on sound fundamentals.

2.3.11 Rational Choice

Since a project is a scheme for investing resources, the choice of a project is done after making a study of all the available avenues for investing resources and a rational choice among the available avenues is made.

2.3.12 Principle of Succession

How a project is going to be implemented is not fully known beforehand. More about a project is known and project intricacies come to light only with the passage of time and hence project components get modified and finalized successively with the passage of time as the project progresses.

2.3.13 Optimality

A project is always aimed at optimum utilization of resources for the overall development of the organization/economy. Resources are scarce and resources have a cost. Hence, optimum utilization of resources is a must for any project. Many project management concepts have evolved with the aim of achieving optimum utilization of available resources

2.3.14 Control Mechanism

All projects will have predesigned control mechanisms in order to ensure completion of projects within the time schedule, within the estimated cost and at the same time achieving the desired level of quality and reliability.

SELF CHECK QUESTIONS

5. What contributes to the complexity of a project?

a. Single goal
b. Routine procedures
c. Simplified scheduling
d. Technology survey and diverse

activities

6. **When is sub-contracting advantageous in a project?**
   a. When it increases complexity b. When it reduces complexity
   c. When it eliminates risks d. When it's cost-effective
7. **Projects are always user-specific and customer-oriented. T/F**
8. **Changes in a project can range from minor to major and may impact the project's nature. T/F**

2.4. THE PROJECT LIFE CYCLE

The project management lifecycle defines how to manage a project. It includes processes such as origination, initiation, planning, execution/control, and closeout. While no two projects are exactly alike, the project management lifecycle will always be the same, regardless of the project type.

All projects should progress through these same five project management phases :

2.4.1 Project Origination

In Project Origination an individual proposes a project to create a product or develop a service that can solve a problem or address a need in the Performing Organization. The Performing Organization then submits the proposal to an evaluation and selection process. If selected, a budget or further management commitment for the project may also be required before a Project Manager is actually assigned and the project is authorized to progress to Project Initiation. Depending upon the standards and practices of the Performing Organization, a time delay between the project's proposal and selection and its actual initiation may occur.

2.4.2 Project Initiation

At the beginning of Project Initiation, a Project Manager is assigned. The Project Manager works with the Project Sponsor to identify the necessary resources and team members needed to further develop the key project parameters - Cost, Scope, Schedule, and Quality (CSSQ). The Project Team documents its charge in the form of a Project Charter, which is based on the Project Proposal and Business Case. Approval of the Project Charter by the Project Sponsor authorizes the designated team to begin Project Planning.

2.4.3 Project Planning

Project Planning builds on the work done in Project Initiation, through the development of a Project Plan. The Project Plan defines CSSQ, and includes plans for involving and communicating with all the parties that are affected by the project, as well as identification of an initial set of foreseeable risks that can threaten the Project. Additional key elements included in the Project Plan are the change control process and externally focused items such as organizational change management and project transition plans. At the conclusion of Project Planning, the Business Case is revised and re-evaluated based on the completed planning documents and a decision is again made either to halt the project, or to commit the resources necessary for Project Execution and Control.

2.4.4 Project Execution and Control

Project Execution and Control is where most of the resources are applied/expended on the project. A significant number of team members will join the project at the beginning of this phase. The primary task of the Project Manager during Project Execution and Control is to enable the Project Team to execute the tasks on-the defined Project Schedule and develop the product or service the project is expected to deliver. The Project Manager uses the processes and plans prepared during Project Initiation and Project Planning to manage the project, while preparing the organization for the implementation of the product/service and for transitioning the product/service responsibility from the Project Team to the Performing Organization.

2.4.5 Project Closeout

In Project Closeout, the Project Team assesses the outcome of the project, as well as the performance of the Project Team and the Performing Agency. This is accomplished

primarily through soliciting and evaluating feedback from Customers, Project Team members, Consumers and other stake hold*, 's. The primary purpose of this assessment is :o document best practices and lessons learned for use on future projects. Key project metrics are also captured to enable the Performing Organization to compare and evaluate performance measurements across projects.

SELF CHECK EXERCISE

9. What document is developed during Project Initiation to define key project parameters and gain approval from the Project Sponsor?

a. Project Charter b. Business Case

c. Project Plan d. Risk Assessment

10. Which phase builds on the work done in Project Initiation and involves developing a Project Plan, including CSSQ parameters?

a. Project Origination b. Project Initiation

c. Project Planning and Control d. Project Execution

11. Project Planning includes the development of a Project Plan, change control process, and risk identification. T/F

12. Project Closeout assesses project outcome and performance through feedback from stakeholders. T/F

2.5 SUMMARY

The prime objective of project management is to meet specified performance within cost and on schedule. Projects are characterized by a singleness of purpose, a definite life cycle, complex interdependencies, some or all unique elements, and an environment of conflict. Project management, though not problem-free, is the best way to accomplish certain goals. Projects also start slowly, buildup speed while using considerable resources, and then slow down as completion nearby.

2.6 GLOSSARY

- **Deliverables** : The desired outcomes or results of a project.
- **Interdependencies** : Relations between organizational functions where one function or task is -dent on others.
- **Life Cycle** : A standard concept of a product or project wherein it goes through a start-up phase, a building phase, a maturing phase, and a termination phase.
- **Parties-at-Interest** : Individuals or groups with a special interest in a project, usually the project team, client, senior management, and specific public interest groups.
- **Program** : Often not distinguished from a project, but frequently meant to encompass a group of similar projects oriented toward a specific goal.
- **Project Management** : The means, techniques, and concepts used to run a project and achieve its objectives.

2.7 REVIEW QUESTIONS

1. Discuss the essentials of a project.
2. Discuss the importance of objective in project.
3. Explain various phases of Project Life Cycle.
4. Fill in the blanks :

(1) The ..... will come to surface when conditions become conducive to it.

(2) ..... for any product/service that the project is going to produce is an important aspect.

(3) A project is always aimed at .....for the overall development of the organization/economy.

2.8 FURTHER READINGS

1. Prasanna Chandra, **PROJECTS** - **Planning, Selection, Financing, Implementation, and Review,** Sixth Edition, Publication : TATA McGraw HILL
2. Dennis Lock, **Project Management,** Ninth Edition, Publication : Gower
3. P.C.K. Rao, **Project Management and Control,** Publication : Sultan Chand & Sons
4. Vasant Desai, **Project Management,** Second Revised Edition, Publication : Himalaya Publishing House
5. Clements / Gido, **Effective Project Management,** Publication : Thomson
6. K. Nagarajan, **Project Management**, Third Edition, Publication : New Age International.

ANSWER KEY:

1. a, **2.** c, **3.** F, **4.** T, **5.** d, **6.** b, **7.** T, **8.** T, **9.** c, **10.** c, **11.** T, **12.** T.

LESSON NO. 3: PROJECT PLANNING

STRUCTURE

3.0 AIMS AND OBJECTIVES:

This lesson deals with the concept of project planning. After reading this lesson you will be able to understand :

- Project Planning
- Objective of Project planning
- Project Planning and Risk & Uncertainty
- Components of a Good Planning Technique
- Role of a project manager

3.1 INTRODUCTION

Project planning is a common thread that intertwines all the activities from conception to commissioning and handing over the clockwork to clients. Project planning encompasses the essential activities such as work break-down structure, statement of work, and accurate time estimates and schedules which help further in anticipating snags in a project and over-come them. A plan is the first step in providing the means to satisfy the needs of a project sponsor and help in paving the way to reach desired goal. It is a beginning of the project manager's input to ensure that potential problems are identified timely and car. easily be assessed ‘on the basis of which further estimating and resource allocation may be comfortably done. That means, prevention is better than cure' philosophy is adhered to while drafting the project plans. Usually most of the project decisions are taken during the preliminary planning stage. Unless the preliminary planning is carefully done, decisions based on those plans may go awry. Hence considering project planning from its initiation as a crucial function, though spasmodic it may be, planners have to be committed to the satisfactory performance. Consequently, such a well-planned approach grazes through even dwarfed tasks and seeks a fruitful symbiosis to reach the goal.

In the process, it clears up the estimation and allocation of resources (time and material) which are vital for the performance of all project activities. Such early decisions in a project will often have a profound influence on the success of successive activities. This is especially true of project planning. Therefore, before arranging to draw up a plan and setting the premises, it is infallible to establish the targets, level of details, and time-scale of plans. It is essential to give a careful thought to establish a strategic framework before starting on the planning in detail. All these above factors focus on the fundamental objectives of planning in projects.

3.2 OBJECTIVES OF PROJECT PLANNING

Analyzing: The aim of project planning is to visualize how the job will be done, in what order and with what resources by syncopating the project, or part of the project, to a

number of manageable activities. Each activity should be readily identifiable as a definite piece of work, ideally relating to the project management structure and thus under the control of a specific individual.

- **Anticipating** : The second objective is to focus on probable potential problems, to plan and overcome, and is to predict associated risks so that their effects can be minimized. It. can be argued that this is the major objective of project planning, may it be for any civil construction, oil rigs, or public sector dams and bridges, or a chemical plant, as civil engineering is fairly high-risk business, and the planning of many such activities is fraught with uncertainty.
- **Scheduling** : The next important objective is to identify appropriate resources to enable optimum utility of the available scarce resources at each aspect of the project and also considering multiple projects together-for the organization as a whole.
- **Coordinating and Controlling** : Another supporting objective is to seek for an uninterrupted network on the shop - floor as well as wit outside parties and contractors involved in the project so as to develop a platform for appropriate estimating and controlling the time and costs.
- **Information Management** : Finally, the aim of project planning also to furnish' the relevant information to help planning better present the facts on the project and also derive some more addition data that can be put to use in the preparation of future plans

. However, there are two important factors to be considered while paying attention to the above list of objectives on their fulfilment that are :

- commitment of the senior management towards making the planning function more effective and gain control over planning premises;
- v* providing sufficient resources both men and material to smoothen then the planning process.

3.3 PROJECT PLANNING TO REDUCE RISK AND UNCERTAINTY

The potential of project planning corresponds to that of an artist facing a blank canvas perched on a studio easel, with paints, brushes, and inspiration, the painter can make virtually any image appear on the canvas. Similarly, with skilful and imaginative planning the team of project can picturize the project's format and destiny. Through the planning process, organizations can be changed and adjusted, philosophies formed, teams built, and projects accelerated or slowed down. Project planning must start by tackling major project management issues and progressively moving down the scale to the detail. The project plan acts as a tall standing beacon for guiding the project through sometimes treacherous **waters**. Without such a guide, projects are almost surely doomed to face repeated crises. Crisis cannot be avoided, or even diminished if detailed plans leapfrog ahead of broad project plans. Project details must be subordinate to and coherent with the overall project plans.

The project plan is fluid and malleable, not a rigid prescription of work to be followed. The philosophy of the project management discipline acknowledges that there is more uncertainty at the beginning of a project than there is near the completion. Since the future cannot be seen in advance, project planning involves certain amount of guesswork. As the project is implemented, there is less guesswork involved because less of the project remains to be implemented in future.

Thus, plan serves two major purposes :

- to minimize as much guesswork and uncertainty as possible at the beginning of a project;
- to form a baseline for making and communicating changes as status information is gathered during the implementation of a project.

Uncertainty is the enemy of stable planning. When uncertainty is high the whole project planning process needs to be sufficiently flexible to cope with the consequences of change. Projects with high uncertainty are likely to be especially difficult to define and set realistic objectives for. If the exact details of a project are subject to change during the

course of its execution, the planning process is particularly difficult. Resources may be committed; times may be agreed but if the objectives of the project change or if the environmental conditions change, or if some activity is delayed, then all plans will go wrong and may need to be redrawn. The recent political debacle is a perfect example of lack of control over issues and lack of certainty in plans. Both lead to disastrous results.

SELF CHECK EXERCISE

1. **What is the primary purpose of project planning?**
   a. To create a detailed work breakdown structure
   b. To satisfy the needs of the project sponsor
   c. To overcome potential problems in a project
   d. To allocate resources effectively
2. **According to the text, why is uncertainty considered the enemy of stable planning?**
   a. Because it leads to disasters
   b. Because it requires flexibility in the planning process
   c. Because it makes projects difficult to define and set objectives for
   d. Because it minimizes guesswork in the planning process
3. **Project planning must start with tackling minor project management issues and progressively move up to major issues. T/F**
4. **The primary purpose of a project plan is to serve as a baseline for making and communicating changes during the implementation of a project. T/F**

3.4 COMPONENTS OF A GOOD PLANNING

TECHNIQUE Activities

Which means being busy, spending energy, consuming resources and time in planning for a job to be done; for example, preparing a drawing, preparing to give final examination, preparing for an interview, an order to be placed, a hole to be dug, bricks to be laid in a wall, a flow of water to be diverted.

Activity Durations

This refers to the time required for the completion of an activity. For example, appearing in the examination successfully requires three hours, preparing for the examination requires thirty days, preparing for the interview needs three days whereas giving interview may consume only three minutes. The actual time spent on the performance of an activity is activity duration'.

Project Time-scale

This is a time structure of the project which is usually done by giving a numerical value to each calendar week for making the calculations simple. Again, these values will be converted in terms of calendar dates to make out the total number of working days and holidays if any. For example, preparing for the final examination starts on March 24th and scheduled till 18th June.

This may be referred as an occurrence at a specific point in time; for instance, the selection of a plan by the board members, or the beginning of site clearance for the construction. For example, completing one section of the examination paper within the time schedule, reaching a reasonable level on the schedule determined, reaching the examination hall with confidence, completing the examination in a pleasant mood.

Work Method

All the plans essentially to be expressed in some logical way, indicating the sequence of operations, and which activities and events are interrelated; this*may be implicit with bar charts or explicit through the network analysis where the work method is generally called logical. For example, the sequence of tasks undertaken to complete, completing the most difficult and practical portion of the subject first and then taking up the next best difficult topics and so on.

Resources

Often called the four M's (men, machines, materials, and money) but can also include overheads like site accommodation and even such essentials as managerial skills. For example, subject books, attending classes, procuring necessary paraphernalia for writing etc., and resources with money. Also, some contingency allowances may ever be

needed on either side (time and costs).

Costs

This defines the actual and anticipated cost of work performed as well as pending and is mostly derived directly from the unit costs of the individual resources.

Value

This refers to the revenue that can be earned in monetary terms for the work performed and future works (contractual payments) by furnishing all the necessary of quantities and estimated budget reports. The calculation of value—date can be used as an overall measure of project progress.

3.5 PLANNING TECHNIQUE

The main techniques are the bar chart, the line-of-balance, the linear program and network analysis. There are other tools, such as physical models in two and three dimensions, and computer models.

3.5.1 The Bar-chart

Perhaps the best known of all planning techniques is the Gantt chart, which was developed by Henry L. Gantt, an American pioneer of scientific management era. The conventional bar chart usually represents historical data, or analysis of a certain condition, or interrelated facts in a manner more easily understood than in a table of figures or written descriptions, whereas the Gantt chart shows a plan of action and how well progress is going hand-in-hand with the-plan.

The basic principle of the chart is that vertical lines (columns) provide divisions of space which represent both equal division of time and the amount of work to be done during the span. Horizontal lines drawn through the columns indicate the relationship of the amount of work actually done in relation to amount scheduled. The columns are headed with dates. A description of the activities is entered in an index column on the left-hand side. The date upon which any activity is to start is indicated by a right angle opening to the right and the date upon which it. Should be completed by a right angle opening to the left. A light line joining the right angles indicates the total time scheduled for the activity in question. Heavy lines drawn under the light lines indicate the amount of work actually done. The length of these lines has literarily no meaning indicating the same amount of work performed in either case. The bar chart is everybody's favourite. It is easy to draw, easy to understand, and not too searching of managerial skill; it is best used for straightforward, well-understood construction work, with simple relationships between the activities. This graphical technique still fens the basis for most resource scheduling. One of its main disadvantages is that changes in plan require extensive redrafting.

3.5.2 Line-of -Balance

Line-Of-Balance (LOB) is a specialized technique for repetitive tasks. This technique was developed to handle bulk activities in reasonably sized batches of a similar task-group. In the construction world it has an application in the building of a housing estate where several houses are being worked on simultaneously, or in the finishing off of a multi store building.

It was derived from manufacturing industry, and has been found quite effective in planning truly repetitive tasks. Examples of successful applications (see fig) include planning the construction of sky-scrapers having identical floors and large housing development colonies in metros. The basis of this technique is a 'setback chart' or family tree showing the make-up of the product. This is merely a modified form of milestone chart. LOB has been found to be difficult to use on projects which require a large number of trades or operations to construct each identical unit. The problems arise not from the technique. Itself, but from the difficulty of showing all the information on one chart, especially when using the technique to monitor progress. When used to plan, it can be an excellent means of relating resources, activity durations and the general pace of work on site. Other than simplicity and easy to understand the demerits dominate this technique especially for complex projects. The following are the merits and demerits of this technique:

3.5.3 Linear Programming

Linear programming is a specialized technique for linear work. This is a special tool for the road contractors. This has been in use successfully in the construction of large canals and drainages in underdeveloped regions and especially useful in tunnelling for industrial effluvium. Similar to that of LOB, this is a simple two- dimensional graphical technique and can show clearly the quantum of information and relationship between the jobs to a limited scale and degree of complexity.

3.5.4 Network Analysis

Network analysis is a powerful, logical and analytical technique. It is most effective hence used for complicated projects, especially those with external constraints and complex interrelationships. The technique is based on drawing the logical relationships between construction operations and establishing which operations have the most crucial effect on the project duration. This is performed through PERT and CPM techniques. Network analysis has a good and comprehensive logical basis, ends itself easily to computer processing, and can be used as an effective control 001. These excellent characteristics are also its principal weaknesses, because it is easy for the planner to be drawn into a level of planning and analysis that is much detailed and advanced for most construction projects.

3,6 PROJECT MANAGER ROLES AND SKILLS

Generally, the project manager is responsible for the overall accomplishment of the project, and accountable for ensuring objectives of the project's assignment. One foremost responsibility of the project manager is; the very project itself. The person who takes this ultimate responsibility and guarantees for the desired result to be achieved on time, and within budget is the Project Manager. And his job is to coordinate a project from initiation to completion; using maximum utilization of project management tools, techniques, experience, creativity, and management skills, to reach the predetermined objectives.

In a project as a Role his "Leadership quality" and as a Skill his "Management excellence" is accredited. The role a project manager performs is in many ways similar to those performed by other operation managers; however, there are some important differences; as Project managers have a wide range of backgrounds and experience levels and are often “generalists" differentiating themselves from an operational type role to one whom specialized in the respective areas of management. In addition, project managers play specific roles to facilitate the project team rather than supervising them.

Role of the Project Manager :

As a role, project managers must satisfy these sets of needs: Task Needs, Team Needs and Individual Needs. The project manager should meet his Task Needs as follows;

- Attaining team objectives
- Planning work
- Allocating resources
- _ Defining tasks
- Assigning responsibility
- Controlling and monitoring quality
- Scrutinizing progress
- Checking performance

The project manager should meet his Team Needs as follows :

- Appointing secondary leaders
- Building and upholding team sprit
- Setting standards and maintaining regulation
- Training the team
- Setting up systems to facilitate communication with the team
- Developing work methods to craft team function cohesiveness

The project manager should meet his Individual Needs as follows :

- Developing the individual
- Balancing team needs and task needs
- Balancing team needs and individual needs
- Performance appreciation and rewards

- Helping with other team members personal

problems **Skills for Project Manager :**

Furthermore, in order for an effective project manager, he needs the following core skills;

- Leadership skill to arouse action, progress, and change.
- Contractual skills to organize subcontractors.
- Legal knowledge. \
- Evaluation of alternatives and ability for decision making.
- Planning and controlling for necessary counteractive measures.
- Financial familiarity for budget risk management.
- High communication skills.
- Negotiating abilities.
- People management to motivate them towards the project goal.
- System designing and maintenance.

Overall, a project manager has responsibilities from the beginning of project initiation, planning, controlling, and executing to both management and to the project team. A project manager must steer his project towards the bigger picture and be responsible for the job, a project manager must be experienced, committed, dependable and flexible, as his position remains in the nucleus of the system and success and failure centralizes on the project manager's shoulders.

SELF CHECK EXERCISE

5. **What is the primary purpose of the Line-of-Balance (LOB) technique?**
   a. Handling bulk activities in similar task-groups
   b. Planning linear work for road contractors
   c. Managing complex interrelationships in network analysis
   d. Representing historical data in a graphical form
6. **Which planning technique is most effective for complicated projects with external constraints and complex interrelationships?**
   a. Bar-chart
   b. Line-of-Balance
   c. Linear Programming
   d. Network Analysis
7. **Linear programming is a specialized technique for handling repetitive tasks in construction. T/F**
8. **The Line-of-Balance (LOB) technique is effective for projects requiring a large number of trades or operations for each identical unit. T/F**

3.7 SUMMARY

In this lesson, we initiated planning for the project in terms of identifying and addressing the tasks required for project completion. We emphasized the importance of initial coordination of all parties involved and the smooth integration of the various systems required to achieve the project objectives. Specific points made in the lesson were these:

- The preliminary work plans are important be-because they serve as the basis for personnel se-lection, budgeting, scheduling, and control.
- Top management should be represented in the initial coordinating meeting where technical objectives are established, participant responsibility is accepted, and preliminary budgets and schedules are defined.
- The approval and change processes are com; and should be handled by the project manager.
- Common elements of the project plan are overview, statement of objectives, general approach, contractual requirements, schedule budget, cost control procedures, evaluation procedures, and potential problems.
- Systems integration concerns the smooth -coordination of project systems in terms of cost performance, and effectiveness.

3.8 GLOSSARY

- **Parent Organization** : The firm or organization within which the project is being conducted.

- **Program Manager** : This person is typically responsible for a number of related projects, each with its own project manager.
- **Contingency Plan** : An alternative for action if the expected result fails to materialize.
- **Culture** : The way of life of any group of people.
- **Risk** : The chance that outcomes will not turn out as planned.

3.9 REVIEW QUESTIONS

1. List the planning sequences of a project.
2. Any successful project plan must contain some key elements. List these items and briefly describe the composition of each.

3 What are the basic guidelines for systems design which assure that individual components of the system are designed in an optimal manner?

4 What are the general steps for managing each work package within a specific project?

3.10 FURTHER READINGS:

- Clifford F. Gray and Erik W. Larson, **Project Management,** Publication : TATA McGraw HILL
- Prasanna Chandra, **PROJECTS** - **Planning, Selection, Financing, Implementation, and Review,** Sixth Edition, Publication : TATA McGraw HILL
- Dennis Lock, **Project Management**, Ninth Edition, Publication : Gower
- P.C.K. Rao, **Project Management and 'Control,** Publication : Sultan Chand & Sons
- Vasant Desai, **Project Management, Second Revised Edition,** Publication : Himalaya Publishing House
- Clements / Gido, **Effective Project Management,** Publication : Thomson
- K. Nagarajan, **Project Management,** Third Edition, Publication : New Age International

ANSWER KEY:

1. c, **2.** a, **3.** F, **4.** T, **5.** a, **6.** d, **7.** F, **8.** F.

LESSON NO. 4: WORK BREAKDOWN STRUCTURE (WBS)

STRUCTURE

4.0 OBJECTIVES

The purpose of this lesson is to provide guidance on the practice of developing a Work Breakdown Structure and to describe the practice overview, requirements, best practices, activities, and related key terms.

4.1 INTRODUCTION

The Work Breakdown Structure (WBS) organizes and defines 100% of the scope of project work to be accomplished and displays it in a way that relates work elements to each other and to the project's goals. The Project Management Institute (PMI) Project Management Body of Knowledge (PMBOK) defines a WBS as a deliverable-oriented hierarchical decomposition of the work to be executed by the project team.

A WBS is not a project schedule. The WBS defines the "what" of a project and the project schedule defines the "When" and "Who" of a project. **A** WBS uses nouns and adjectives to define work, not verbs; it contains no dependencies, durations, activities, or resource assignments. **A** project schedule uses verbs and nouns to define scheduled activities, outlines task dependencies, and resource assignments.

A WBS provides an efficient format to define project work and for planning and tracking a project's success. The WBS organizes the necessary work by decomposing it into smaller, manageable pieces that can be scheduled, cost estimated, monitored, and controlled. Each descending level of the WBS hierarchy represents an increasingly detailed definition of the project work to be accomplished.

The PMI defines decomposition as a planning technique that subdivides the project scope and project deliverables into smaller, more manageable components, until the project work associated with accomplishing the project scope and providing the deliverables is defined in sufficient detail to support executing, monitoring, and controlling the work. This is known as the work package level and is the lowest level in the WBS.

A WBS makes the relationship of work packages clear by decomposing larger work into smaller, more manageable components that outline the work needing to be accomplished for the project to succeed. The process of decomposing project work into a WBS involves :

- Identifying project deliverables
- Identifying work related to project deliverables
- Building a high-level WBS based on the above information
- Decomposing the high-level WBS into -work packages

The resulting WBS can take a number of forms such as :

- Using major project deliverables and/or subprojects as the first level of the WBS

- Using the phases of the project life cycle as the first level of the WBS with the project deliverables inserted as the second level
- Using a combination of phases and project deliverables within each branch of the WBS

A WBS is the cornerstone of effective project planning and is an excellent team collaboration tool for identifying missing deliverables. However, excessive decomposition can actually lead to non-productive management effort, inefficient use of resources, and decreased efficiency in performing project work. The mistake of excessively subdividing the WBS into too many tasks can actually turn the WBS into an ineffective “to do" list rather than a valuable project planning tool.

A WBS can actually be decomposed to any level of detail. However, three levels are usually adequate unless the work item at that level is still considered to be high cost and/ or high risk. Then it may be necessary to further decompose the work of that specific item into additional, more manageable work packages. The WBS should be structured, at its lowest level, into elements that can be:

- Managed
- Estimated
- Measured

When developing a WBS, consider the relationship between WBS elements, project goals, and federal regulations and policies. For example, defining a WBS to the third level may be adequate for the project team to deliver on project goals. However, further decomposition may be necessary to meet federal regulations and/or policies.

As part of developing a WBS, the project manager should also develop a WBS Dictionary. The WBS Dictionary is a document that describes each component in the WBS by describing each element and the resources and processes required to produce it. The WBS Dictionary is usually developed to the second level of the WBS and includes a brief definition of the scope or statement of work, defines deliverables, lists associated activities, milestones, and other information. It includes performance measurement criteria, statement of work paragraph number, contract line item, start and end dates, resource requirements, cost estimates, quality requirements, technical content, contact information, revision history, etc.

4.2 WHAT IS A WBS?

A Work Breakdown Structure is a result-oriented family tree that captures all the work of a project in an organized way. It is often portrayed graphically as a hierarchical tree; however, it can also be a tabular list of "element" categories and tasks or the indented task list that appears in your Gantt chart schedule.

Large, complex projects are organized and comprehended by breaking them into progressively smaller pieces until they are a collection of defined "work packages" that may include a number of tasks. A Rs. 1,000,000,000 project is simply a lot of Rs.50,000 projects joined together. The Work Breakdown Structure (WBS) is used to provide the framework for organizing and managing the work.

In planning a project, it is normal to find oneself momentarily overwhelmed and confused, when one begins to grasp the details and scope of even a modest size project. This results from one person trying to understand the details of work that will be performed by a number of people over a period of time. The way to get beyond being overwhelmed and confused is to break the project into pieces, organize the pieces in a logical way using a WBS, and then get help from the rest of your project team.

The psychologists say our brains can normally comprehend around 7-9 items simultaneously. A project with thousands or even dozens of tasks goes way over our ability to grasp all at once. The solution is to divide and conquer. The WBS helps break thousands of tasks into chunks that we can understand and assimilate. Preparing and understanding a WBS for your project is a big step towards managing and mastering its inherent complexity.

The WBS is commonly used at the beginning of a project for defining project scope, organizing Gantt schedules and estimating costs. It lives on, throughout the project, in the project schedule and often is the main path for reporting project costs. On larger

projects, the WBS may be used throughout the project to identify and track work packages, to organize data for reporting, for tracking deliverables, etc.

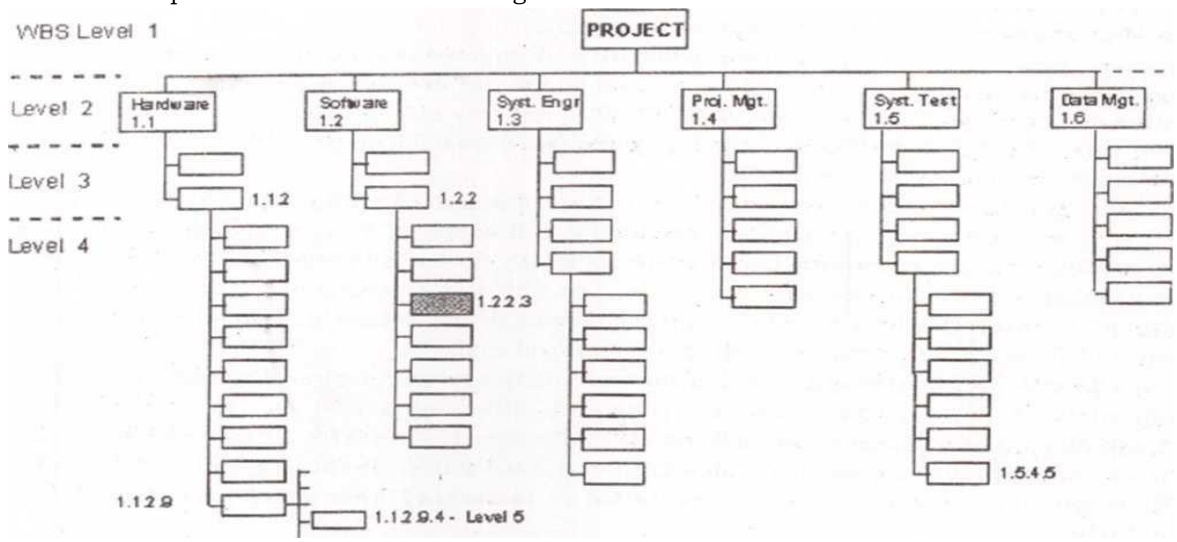
4.3 HISTORY OF THE WBS

The WBS was initially developed by the U.S. defense establishment, and it is described in Military Standard as follows: "A work breakdown structure is a product-oriented family tree composed of hardware, software, services, data and facilities .... [it) displays and defines the product(s) to be developed and/or produced and relates the elements of work to be accomplished to each other and to the end product(s)."

It requires some mental discipline to develop a product-oriented or deliverable-oriented grouping of project elements adding up to comprise the entire project scope. Intuitively, we tend to start out with a task-oriented approach. This is OK for very small projects where extensive project management controls will not be used. The task-oriented approach is easy to understand, because we can easily think of projects as collection of tasks. A task-oriented WBS can be developed by beginning with a simple "to-do" list and then clustering the items in a logical way. The logical theme could be project phases, functional areas, or major end-products.

If your organization will be collecting historical data to form a cost database, you should try to select a standard approach consistent with the organization's long term data collection needs.

A sample WBS is shown in the figure below :



WBS Format for System Development Projects

Additional level 2 elements not shown here might include development environment support, logistics and training, and installation and startup. A WBS for a large project will have multiple levels of detail, and the lowest WBS element will be linked to functional area cost accounts that are made up of individual work packages. Whether you need three levels or seven, work packages should add up through each WBS level to form the project total.

SELF CHECK EXERCISE

1. **According to PMBOK, how does PMI define a WBS?**

   a. A schedule-oriented decomposition of project work
   b. A chronological breakdown of project tasks
   c. A deliverable-oriented hierarchical decomposition of project work
   d. A resource-oriented representation of project activities

2. **What is the potential risk of excessively decomposing the WBS?**

   a. Improved efficiency in project planning
   b. Non-productive management effort and inefficient resource use

c. Enhanced collaboration among project teams
d. Clear communication of project goals

3. **The WBS helps break down complex projects into manageable pieces and is primarily used during project execution. T/F**
4. **The WBS was initially developed by the U.S. Défense establishment and is described in Military Standard. T/F**

4.4 EVELOPING THE WORK BREAKDOWN STRUCTURE

The process of developing a WBS is primarily concerned with the actions necessary to define, organize, and subdivide work required to meet project goals to a work package level. The WBS is usually drafted jointly the Project Manager, the project team, and stakeholders.

A good WBS is not necessarily lengthy. The content of the WBS will vary depending upon the complexity of the project. The size of and time invested to develop a WBS should be balanced with the size and complexity of the project. Large, more complex projects justify a significant effort in developing a comprehensive WBS.

Both the WBS and WBS Dictionary are living documents that should be updated continually throughout the life of the project as changes occur.

4.5 THE METHODOLOGY

The 'following best practices are recommended for Work Breakdown Structure development :

- **Product Elements** - Do not include elements which are not product related. The WBS addresses product requirements, not product functions or cost.
- **No Acronyms** - Use actual system names and nomenclature or acronyms to avoid confusion.
- Make **Updates** - As the project environment changes updates in the form of appended change requests should reflect any changes to the WBS and/or the WBS Dictionary.
- **Review** - Review the completed WBS with the customer before creating a schedule.
- **Jointly Developed** - The WBS should be drafted jointly by the Project Manager, the project team, and stakeholders.

Product or Process Oriented?

The WBS was initially defined as a product-oriented family type, however subsequent definitions have introduced more flexibility — so a WBS can also be deliverable or process oriented. Your WBS can be built on nouns or verbs. If the results of your project are primarily verbs, then a verb based or process based WBS may make more sense. If your WBS is to be product or deliverable oriented, then you can start by thinking of the WBS as a parts list for the ultimate end-items of your project. See below for a simple illustration of a product or process based WBS orientation. These differences are not shown to tell you what is the right way for your project, but just to familiarize you with the distinctions, so you can think about them and choose what's best for your project.

WBS Numbering

WBS elements are usually numbered, and the numbering system may be arranged any way you choose. The conventional numbering system is shown in the figure. The shaded box shown in the above slide. Could be numbered 1.2.2.3, which would tell you it was in the second box in level 2, the second box in level 3, and the third box in level 4.

WBS Dictionary

If a WBS is extensive and if the category content is not obvious to the project team members, it may be useful to write a WBS dictionary. The WBS dictionary describes what is in each WBS element, and it may also say what is not in an element, if that is unclear. Here is a sample of a WBS dictionary description :

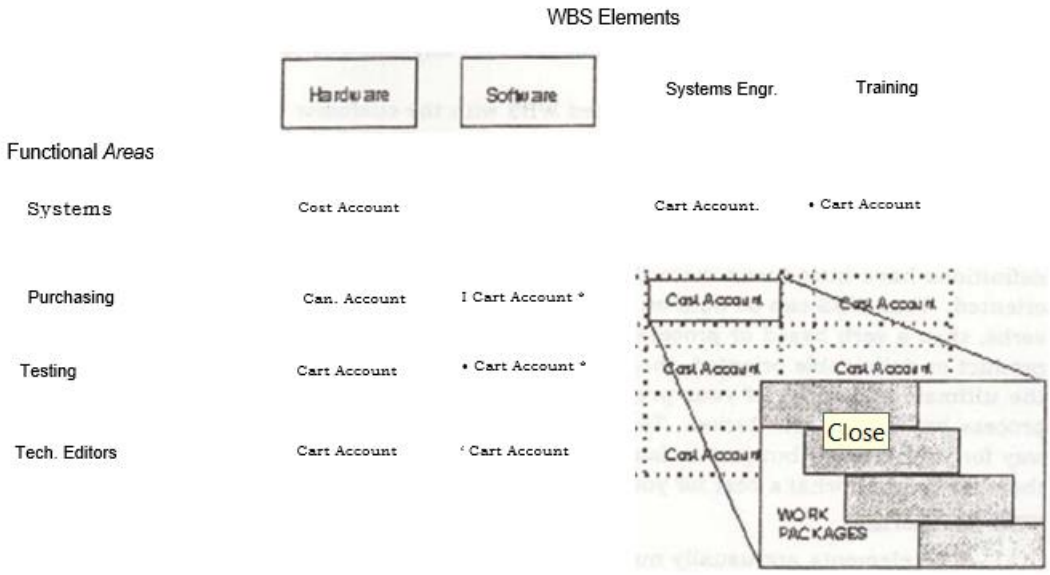
4.6 MAPPING WBS FOR COST MANAGEMENT

In a product-oriented WBS, functional categories of work may form "cost accounts" within a WBS element. Cost account managers are responsible for a functional area's contribution to a WBS element. Cost accounts from several departments or functions may combine into one WBS element.

Internal department planning for a cost account will be made up of individual work packages. A work package will typically have its own budget and schedule. Work packages should be small enough to be executed by individuals or small groups in a single department, and they should be of relatively short schedule duration. A small project might define a maximum work package size as two weeks of effort. Larger projects will assemble larger work packages that can be appropriately managed and controlled.

The project manager will have to decide to what degree employment of various details of WBS implementation will benefit the efficient management of the project. On a very small project, a formal WBS may serve no useful purpose, but it can become valuable if project size or complexity start to increase.

As an organization's project management environment matures, or as larger size and complexity are encountered, application of the WBS concept can evolve from an ad hoc list of tasks, to time-phased activity lists, task lists clustered by project deliverables and services, or an end-product focused WBS fed by cost accounts and work packages.



If you are using MS-Project or a similar project management software application, you may encounter the WBS as a vertical list with indents to show structure. This will be compatible with the Gantt View data entry screens. While some software packages provide a separate WBS view, you could prepare your WBS in the vertical format using a word processor, and then cut and paste your WBS into your project management software package.

SELF CHECK EXERCISE

5. What is the primary purpose of the WBS Dictionary?

a. Describe project schedule
b. Define project dependencies
c. Detail each component in the WBS
d. Identify project stakeholders

6. How are WBS elements usually numbered?

a. Sequentially based on time
b. Randomly for flexibility
c. Any way chosen by the project manager
d. Alphabetically for organization

7. **WBS and WBS Dictionary are static documents and do not need continuous updates throughout the project. T/F**

8. **Internal department planning for a cost account will consist of individual work packages, each with its own budget and schedule. T/F**

4.7 PROGRAM AND CONTRACT WBSS

A top-level WBS for a large program is sometimes called a Program WBS (PWBS) or Program Summary WBS (PSWBS). If a project involves several organizational participants or contractors, guidance for one contractor can be provided in a Contract WBS (CWBS). The project manager may provide a high-level CWBS for each developer, perhaps to level 2 or level
3. The developer will then fill in the details of lower WBS levels to reflect the work to be accomplished and the data flow in that organization.

4.8 ORGANIZATIONAL STANDARDS

Your organization may want to decide on a standard WBS format or group of formats, use these across all projects, and communicate definitions widely so everyone will be speaking the same language. This can save re-learning project lessons and can lay the groundwork for successful data gathering to aid future cost estimates.

4.9 WPS IMPLEMENTATION

When you set up a project WBS, think about how you will be using it later in the project. Try to consider how you will organize the WBS, schedule format, manager assignments, and charge numbers,' in your early project planning. These days, the WBS in smaller projects ends up automatically the indent structure in your Gantt schedule, so pay attention to those indents, and make sure that is the WBS you want for rolling up costs in your project, especially if you will be using EVM. It will be helpful if you can map the charge numbers, managers, and task groups to each other. This will help you track costs and progress for each manager. If your project schedule will on MS-Project, you may want to insert "text" columns into your schedule (Gantt View) for project charge numbers and manager names.

If your project charge numbers cannot be linked to groups of tasks assigned to specific managers, you will have no way to provide performance measurement feedback to managers. Some project management environments have definite conventions for grouping items in a WBS. The best method is to have a WBS that works for your particular project environment. The WBS should be designed with consideration for its eventual uses. Your WBS design should try to achieve certain goals:

Be compatible with how the work will be done and how costs and schedules will be managed,

1. Give-visibility to important or risky work efforts,
2. Allow mapping of requirements, plans, testing, and deliverables,
3. Foster clear ownership by managers and task leaders,
4. Provide data for performance measurement and historical databases, and
5. Make sense to the workers ana accountants.

There are usually many ways to design a WBS for a particular project, and there are sometimes as many views as people in the process. Experience teaches that everyone takes a slightly different slice of the apple, so make sure WBS arguments seeking metaphysical certainty are quickly brought to closure. Simple practicality combined with enlightened trial and error usually is the best approach.

4.10 GENERATING A WBS FROM MICROSOFT PROJECT

There is a third-party add-on software application for MS-Project called W'BS Chart

Pro that will convert Gantt chart task list with indents into a standard WBS graphic in a few clicks. We can also use this application to create a WBS and transfer it back MSP. This software is very valuable in organizing project work into a WBS, reviewing the scope of proposed projects, and helping managers visualize the WBS implicit in their MS-Project schedules.

SELF CHECK EXERCISE

9. What is a top-level WBS for a large program sometimes referred to as?

a. Project WBS
b. Program WBS (PWBS)
c. Contract WBS (CWBS)
d. Summary WBS

10. Why might an organization decide on a standard WBS format across all projects?

a. To limit project complexity
b. To simplify project documentation
c. To save re-learning project lessons
d. To reduce project costs

11. The Contract WBS (CWBS) is often created by the project manager, specifying detailed tasks for contractors. T/F

12. The WBS Chart Pro is a standard feature in Microsoft Project, used for creating graphical representations of project schedules. T/F

4.11 SUMMARY

A Work Breakdown Structure is a result-oriented family tree that captures all the work of a project in an organized way. It is often portrayed graphically as a hierarchical tree; however, it can also be a tabular list of "element" categories and tasks or the indented task list that, appears in your Gantt chart schedule. The WBS is commonly used at the beginning of a project for defining project scope, organizing Gantt schedules and estimating costs. It lives on, throughout the project, in the project schedule and often is the main path for reporting project costs. On larger projects, the WBS may be used throughout the project to identify and track work packages, to organize data for reporting, for tracking deliverables, etc.

4.12 GLOSSARY

- **Project** : A single bounded effort with a defined beginning, a defined end, a specific deliverable and a budget.
- **Program** : A group of two or more dependent projects or activities, which obtain synergistic benefit by being managed at a high level by a single Program Manager.
- **Project Management** : The competency of managing a single effort that has a specified beginning and end date, defined deliverables, and a specified budget.
  Is/Is Not List : A list defining what the deliverable is or includes and what it is not or does not include.
- **Facilitative Leadership** : The competency of leading a team by practicing "effective facilitation (which) involves using processes and tools to maximize the collective intelligence of individuals in a group to determine the right course of action and to then build a template for acting on the choices they make. Facilitation..., actually encompasses a broad mix of consulting and coaching skills....*
- **Stargate** : A point in time during the project planning and managing process set aside to review the organizational context and validity by (1) obtaining confirmation and support from the Project Sponsor, or (2) integrating the project into a program or other interdependent projects.

- **Constraint Matrix** : A 3 x 3 table indicating the comparative restriction assessment of the project's scope, schedule, and resources. Each of the project parameters (scope, schedule, and resource) has a different constraint assessment (most, moderately, least). No two parameters should have the same level of constraint. The Constraint Matrix is an explicit communication from the project Sponsor to the Planning Team, and ultimately the Project Team, regarding the limitations and changes during the life of the project. The Constraint Matrix can change throughout the life of the project as issues arise within Scope, Schedule and Resources.
- **Resourced Schedule** : An integration of the project work, timeline, and resource utilization represented in a format that allows for monitoring ana tracking.
- **Work Breakdown Structure** : An organized hierarchical system for defining project work.
- **Governance Framework** : The determination and agreement of management policies and procedures for the project.
- **Dependency Diagram** : A graphical representation of the flow of work as determined by the Planning Team and Task Owners. Also called a PERT chart, Network Diagram, or Logical Network, the Dependency Diagram is built by the Planning Team in order to place a sequence on the work that has been identified in the Work Breakdown Structure.

4.13 QUESTIONS FOR REVIEW

1. Define the scope of the project on the first level of the WBS?
2. At what level of the WBS Project management deliverables should be outlined?
3. Show graphically the decomposition of project deliverables into work packages, to a level that can be scheduled, cost estimated, monitored, and controlled.
4. Show graphically the decomposition of project work packages into scheduled activities that can be used to build a schedule, estimate work effort, and assign resources.

4.14 FURTHER READINGS

1. ***Prasanna Chandra,*** *PROJECTS- Planning, Selection, Financing, Implementation, and Review,* ***Sixth Edition, Publication: TATA McGraw HILL***
2. Dennis Lock, **Project Management,** Ninth Edition, Publication: Gower
3. P.C.K. Rao, **Project Management and Control,** Publication: Sultan Chand & Sons
4. Vasant Desai, **Project Management,** Second Revised Edition, Publication: Himalaya Publishing House
5. Clements / Gido, **Effective Project Management,** Publication: Thomson
6. K. Nagarajan, **Project Management,** Third Edition, Publication: New Age International.

ANSWER KEY:

1. c, **2.** b, **3.** F, **4.** T, **5.** c, **6.** c, **7.** F, **8.** T, **9.** b, **10.** c, **11.** F, **12.** F.

LESSON NO. 5: ECONOMIC, FINANCIAL AND COST ANALYSIS

STRUCTURE

3. AIMS AND OBJECTIVES

This lesson deals with the Financial and Cost Analysis. After reading this lesson, you will be able to understand :

- Financial Cost Benefit Analysis
- Tools & Techniques for Financial analysis
- Payback Period (PB) method
- Accounting rate of return (ARR) method
- Present Value (NPV) method
- Internal Rate of Return (IRR) method
- Profitability Index (PI) method
- Benefit Cost Ratio (BCR) method

5.1 INTRODUCTION

A project should earn sufficient return on the investment. The very idea of promoting a project by an entrepreneur is to earn attractive returns on investment on the project. Projects sponsored/undertaken by Government may take into account social cost benefits of the proposed project and in such cases, financial return alone needs not be the criterion. But for such Government projects, all other projects have the prime motive of getting maximum return on investment. If there are many alternative projects, all of which, prima facie, appear to be more or less equal in profit earning capacity, the investor should make a comparative study of the return on the different alternative proposals before choosing one.

5.2 TECHNIQUES OF FINANCIAL AND COST ANALYSIS

Such financial analysis broadly falls under two categories :

- No discounted cash flow techniques.
- Discounted cash flow techniques.

The subdivisions within these two techniques are as under :

Non discounted cash flow techniques :

1. Payback Period (PB) Method
2. Accounting Rate of Return (ARR) Method

Discounted cash flow techniques :

1. Present Value (NPV) method
2. Internal Rate of Return (IRR) method
3. Profitability Index (PI) method
4. Benefit Cost Ratio (BCR) method

5.2.1 Payback Period Method (PBP)

This is one of the simple methods of evaluating investment proposals and also widely used. Payback period is defined as the length of time required to recover the original investment on the project, through cash flows earned. The cash inflow includes operating profit, less income tax payable, plus depreciation.

The following illustration explains the method.

Practical Example :

The likely investment on a project is Rs. 14,00,000.00. It is expected to take 2 years for implementation of the project and the project is expected to earn profits from the third year onwards. The estimated profits, tax, depreciation are as under:

	3rd year	4th year	5th year	6th year	7th year
Operating profit [Rs	1,50,000.00 <	1,75,000.00	2,00,000.00	2,25,000.00	2,00,000.00
Tax (Rs)	50,000.00	60,000.00	68,000.00	75,000.00	68,000.00
Depreciation [Rs.]	3,30,000.00	2,21,000.00	1,48,000.00	99,000.00	67,000.00
Solution :	3rd year	4th year	5th year	6th year	7th year
(Profit Tax + Depreciation]: [Rs]	4,30,000.00	3,36,000.00	2,80,000.00	2,49,000.00	1 99,000.00

Year	**Cumulative cash inflow [Rs.]**
3rd year	4,30,000.00
4th year	7,66,000.00
5th year	10,46,000.00
6th year	12,95,000.00
7th year	14,94,000.00

The initial investment of Rs. 14,00,000/- is likely to be received after the

sixth Cumulative profit (4 years after implementation)	Rs. 12,95,000.00
Cumulative profit (5 years after implementation)	Rs. 14,94,000.00
Difference	Rs. 1, 99,000.00

Payback period = * 4 years + ^ $\frac{12 \text{ x}(14,00,000-12,95,000}{1,99,000}$ months

r 12x1.05,000]

= 4 years + [woo-Jmon

= 4 years + 6.33 months

- 4 years and 6 months.

- **Average Rate of Return (ARR) Method**

The average rate of return is also called the accounting rate of return.

Average rate of return = [Book value of(Profit after Tax ^i^st^J

Profit after tax is the average annual post tax benefit over the life of the project. Unlike payback period method, under ARR method, the entire life of the project is taken into account.

The following illustration explains the comparison of projects by ARR method. **Practical Example**

There are three projects A, B and C. The details about the three projects are as under. Compare the three projects by ARR method and choose the one that is most attractive among the three.

Profit after tax (Rs.)

	Project A	Project B	Project C
Life of the project	4 years	5 years	6 years
1st year	Rs. 4,00,000/-	Rs. 3,00,000/-	Rs. 2,50,000/-
2nd year	Rs. 4,50,000/-	Rs. 4,50,000/-	Rs. 3,00,000/-

3rd year	Rs. 5,00,000/-	Rs. 5,00,000/-	Rs. 4,00,000/-
4th year	Rs. 4,50,000/-	Rs. 5,50,000/-	Rs. 5,00,000/-
' 5th year		Rs. 5,00,000/-	Rs. 3,00,000/-
6th year			Rs. 2,50,000/-
	Rs. 18,00,000/-	Rs. 23,00,000/-	Rs. 20,00,000/-

Book value of Project A		Project B •
1st year	Rs. 15,00,0001	Rs. 12,00,000/ Rs.' 10,00,000/
IInd year	Rs. 13,50,000/	Rs. 10,80,000/ . Rs. 9,00,000/
IIIrd year	Rs. 12,15,000/	Rs. 9,72,000/ Rs. 8,10,000/
IVth year	Rs. 10,93,500/	Rs. 8,74,800/ Rs. 7,29,000/
Vth year	Rs. 7,87,320/	Rs. 6,56,100/
VIth year		Rs. 5,90,490/

Solution:

	Project-A	**Project-B**	**Project-C**
Total profit over the			
life of the project	**Rs. 18,00,000/-**	**Rs. 23,00,000/-**	**Rs. 20,00,000/-**
Average annual Profit	**Rs. 18,00,000/-**	**Rs. 23,00,000/-**	**Rs. 20,00,000/-**
	4	**5**	**6**
	i.e., Rs. 4,50,000/-	**Rs, 4,60,000/-**	**Rs. 3,33,333/-**
Average	**[15,00,0001**	**[12,00,C>W/- .**	**[10,00,0001**
Investment .	**+ 13,50,000/-**	**+ 10,80,000/-**	**♦9,00,000/-**
	+ 12,15,000/-	**+9,72,000/-**	**+8,10,000/-**
	+ 10,93,500/-J	**+8,74,800/-**	**+7,29,000/-**
	+4	**+7,87,320/-) +5**	**+656,100/- + 5,90,490/] + 6**
	i.e., Rs. 12,89,625/	**Rs.9,82,824/**	**Rs. 7,80,932/-**
Return on average			
investment	**4,50,000 MOO**	**4,60,000 *100**	**3,33,333 *100**
	12,89,625	**9,82,824**	**7,80,932**
i.e.,	**34.89%**	**46.80%**	**42.68%**

As per ARR method, Project 'B' gives a higher return on investment than projects A and C.

However, this method, also does not take into account the time value of money. Moreover, this method is based on accounting profit and not on cash inflows.

5.2.2 Net Present Value (NPV) Method

This method is one of the discounted cash flow techniques and it recogni**2**es the time value of money.

Net present value [Present value of all (Present value of (NPV) of cash flow = future cash inflows - cash out flow]

over the
life of the
project.)

The Present value of future cash inflows is, arrived at by discounting the future cash inflows at an interest rate equal to the cost of capital.

Symbolically it can be expressed as

$CF, CF_2 CF_3 \qquad CF_n$

$$NPV = \frac{CF_1}{(1+r)} + \frac{CF_2}{(1+r)} + \frac{CF_3}{(1+r)} + \ldots\ldots\ldots\ldots + \frac{CF_n}{(1+r)^n}$$

Where,

$CF_1, CF_2 \ldots\ldots$ Future cash inflows occurring at the end of first year, second year etc.,

n = life of the project in years,

r * discount rate (cost of capital)

-CFO = Present cash out flow.

if

NPV - 0, it indicates that the present cash outflow and the present value of future cash inflows are equal.

NPV < 1, it indicates that the present value of future cash inflows is less than the present cash out flow.

NPV > 1, it indicates that the present value of future cash inflows is more than the present cash out flow.

5.2.3 Internal Rate of Return (IRR) Method

The internal rate of return of a project is the discount rate that makes the net present value equal to zero. In other words, internal rate of return is that rate of discount which would equate the present value of cash out flows (investments on the project) to the present value of cash inflows.

In the calculation of net present value of a project, the discount rate (cost of capital) is assumed and the net present value is calculated by discounting future cash inflows at the assumed discount rate. In the calculation of internal rate of return from a project, the net present value is set equal to zero and the corresponding discount rate is determined; the discount rate at which the net present value is zero is the internal rate of return.

Practical Example

The following example will explain the method of arriving at the IRR. For a project with the given data, calculate the internal rate of return.

Year	Cash outflow	Cash inflow
0	Rs. 10, 00,000/-	
1	—	Rs. 4, 00,000/-
2	—	Rs. 2, 50,000/-
3	—	Rs. 2, 50,000/-
4	—	Rs. 2, 00,000/-
5	—	Rs. 2, 00,000/-
6	—	Rs. 1, 50,000/-

Solution:

Let Y be the internal rate of return. The IRR is arrived at by equating the present value of cash out flow and the present value of cash inflows.

$$10\,00_{00Q} = \frac{4,00,000}{(1+r)^1} + \frac{2,50,000}{(1+r)^2} + \frac{2,50,000}{(1+r)^3} + \frac{2,00,000}{(1+r)^4} + \frac{2,00,000}{(1+r)^5} + \frac{1,50,000}{(1+r)^6}$$

The IRR is arrived at by trial and error.

Let us first assume r - 12% p a

Present value of

* . . . 4,00,000 2,50,000 2,50,000 2,00,000 2,00.000 1,50,000

Cash inflows $= \frac{}{(1+0.12)} + \frac{}{(1+0.12)^2} + \frac{}{(1+0.12)^3} + \frac{}{(1+0.12)^4} + \frac{}{(1+0.12)^5} + \frac{}{(1+0.12)^6}$

- 3,57,143 + 1,99,298 + 1,77,949 + 1,27,105 + 1,13,488 + 75,996
= Rs. 10,50,979/

The present value of cash inflows is nearly equal to the present value of cash outflow at a discount rate of 12% p.a. If we want a more accurate result, we can arrive at the present value of cash inflows assuming a slightly higher discount rate than 12%.

Let us assume a discount rate of say, 13% p.a. Present value of cash inflows at a discount rate of 13% p.a.

4,00,000 2,50,000 u 2,50,000 ^ 2,00,000 ^ 2,00,000 ^ 1,50,000
(1 + 0.13)[1] "(1 + 0.13)[2] (1 + 0.13)[3] (1 + 0.13)[4] (1 + 0.13)[5] (1 + 0.13)[6]
= 3,53,982 + 1,95,788 + 1,73,263 + 1,22,664 + 1,08,552 + 72,048
= Rs. 10,26,297/-

Though r = 13% p.a. is a closer approximation than r = 12% it can further be improved.

Assume r - 14% p.a.

Present value of cash inflows at a discount rate of 14% p.a.

= Rs. 10,02,587/-

The difference between the present value of cash outflow and the present value of cash inflows (discounted at a rate of 14% p.a.) is only Rs. 2,587/-. Hence, the IRR can be taken as 14% p.a.

However, for academic interest let us workout the present values of cash inflows at a discount rate of 15% and see the results.

Present value of cash inflows at a discount rate of. 15% p.a. » Rs. 9,79,879/-. At a discount rate of 15% p.a. the present value of cash inflows falls short of the present value of the cash out flow by Rs. 20,121.00 (10,00,000 9,79,879).

Thus, the correct value of Y lies between 14% and 15%. The correct value of Y at which the present value of cash outflows is equal to the present value of cash inflows can be arrived at by interpolating between 14% and 15%.

$$IRR(r) = 14\% + \frac{(15-14)*(10,02,587-10,00,000)\%}{(10,02,587-9,79,879) > (1*2587)\%}$$

$$= 14\% + 22,708$$

$$= 14\% + 0.1139\%$$

$$= 14.1139\%$$

$$= 14.114\%$$

Data required for the calculation of NPV / IRR

For the calculation of the above factors the following information are relied upon

(a) Life of the project.
(b) Cash outflow.
(c) Cash inflow.
(d) Cost of capital.

SELF CHECK EXERCISE

1. What is the primary motive of projects sponsored or undertaken by entrepreneurs?

a. Social benefits
b. Technological advancements
c. Maximum return on investment
d. Government regulations

2. In financial analysis, what are the two broad categories of techniques?

a. Capital budgeting and operating costs

b. Cash flow and cost analysis
c. Discounted cash flow and non-discounted cash flow
d. Government-sponsored and private projects

3. Which method recognizes the time value of money in evaluating investment proposals? a. Payback Period (PBP) Method
b. Accounting Rate of Return (ARR) Method
c. Net Present Value (NPV) Method
d. Profitability Index (PI) Method

4. What does the Payback Period (PBP) Method measure?

a. Internal rate of return
b. Time required to recover the original investment
c. Net present value of a project
d. Cost of capital

5. What does the Internal Rate of Return (IRR) Method determine?

a. Time required to recover the original investment
b. Present value of cash inflows
c. Discount rate that makes NPV zero
d. Profitability index of a project

6. Payback Period is a discounted cash flow technique. T/F

7. The Net Present Value (NPV) is calculated by discounting future cash inflows at the assumed discount rate. T/F

8. Internal Rate of Return (IRR) is the rate of discount that makes the Payback Period zero. T/F

9. Profitability Index (PI) is another term for Accounting Rate of Return (ARR). T/F

10. Internal Rate of Return (IRR) is the discount rate at which NPV equals zero. T/F

5.3 SUMMARY

A wide range of criteria has been suggested to judge the performance of investment projects. They fall into two broad categories: discounting criteria and non-discounting criteria. The important discounting criteria are: net present value, benefit-cost ratio, and internal rate of return. The major non-discounting criteria are: payback period and accounting rate of return.

NPV has certain properties that make it a very attractive decision criterion: NPVs are additive; the NPV rule assumes that the intermediate cash flows of a project are reinvested at a rate of return equal to the cost of capital; NPV calculation permits time varying discount rates. The benefit cost ratio is defined as the present value of benefits (cash inflows) divided by the present value of costs (cash outflows). A project is considered worthwhile if the benefit-cost ratio is more than 1 and not worthwhile if the benefit-cost ratio is less than 1. The internal rate of return (IRR) of a project is the discount rate which makes its NPV equal to zero. In the NPV calculation we assume that the discount rate is known and determine the NPV. In the IRR calculation, we set the NPV equal to zero and determine the discount rate that satisfies this condition. The decision rule for IRR is as follows: Accept the project if its IRR is greater than the cost of capital; reject the project if its IRR is less than the cost of capital. The IRR and NPV rules lead to identical decisions provided two conditions are satisfied. First, the cash flows of the project: must be conventional, implying that the first cash flow (initial investment) is negative and the

subsequent cash flows are positive. Second, the project must be independent meaning that the project can be accepted or rejected without reference to any other project. There are problems in using IRR when the cash flows of the project are not conventional or when two or more projects are being compared to determine which one is the best. In the first case, it is difficult to define 'what is IRR' and in the second case IRR can be misleading. Further, IRR cannot distinguish between lending and borrowing. Finally, IRR is difficult to apply when short-term interest rates differ from long-term interest rates. There are two possible economic interpretations of internal rate of return: (i) The internal rate of return represents the rate of return on the unrecovered investment balance in the project, (ii) The internal rate of return is the rate of return earned on the initial investment made in the project.

5.4 GLOSSARY

- **Risk** : The chance that outcomes will not turn out as planned.
- **Payback Period** : Payback period is defined as the length of time required to recover the original investment on the project, through cash flows earned.
- **Present value of future cash inflows** : The Present value of future cash inflows is arrived at by discounting the future cash inflows at an interest rate equal to the cost of capital.
- **Internal Rate of Return (IRR)** : The internal rate of return of a project is the discount rate that makes the net present value equal to zero. In other words, internal rate of return is that rate of discount which would equate the present ' value of cash out flows (investments on the project) to the present value of cash inflows.

5.5 REVIEW QUESTIONS

1. What is NPV?
2. What are the implications of the additivity property of NPV?
3. Discuss the general formula of NPV when discount rates vary over time.
4. What is the rationale for the NPV rule?
5. How is modified NPV calculated?
6. How would you determine the capital budget under conditions of increasing marginal cost of capital?
7. What are the limitations of NPV?
8. What are the two ways of defining the benefit-cost ratio?
9. Evaluate the benefit-cost ratio as an investment criterion.
10. What is IRR and how is it calculated?
11. Discuss the problems associated with IRR.

5.6 FURTHER READINGS

1. Prasanna Chandra, **PROJECTS- Planning, Selection, Financing, Implementation**, **and Review,** Sixth Edition, Publication: TATA McGraw HILL
2. Dennis Lock, **Project Management,** Ninth Edition, Publication: Gower
3. P.C.K. Rao, **Project Management and Control,** Publication: Sultan Chand & Sons
4. Vasant Desai, **Project Management,** Second Revised Edition, Publication: Himalaya Publishing House
5. Clements / Gido, **Effective Project Management,** Publication? Thomson
6. K. Nagarajan, **Project Management,** Third Edition, Publication: New Age International.

ANSWER KEY:

1. c, **2.** c, **3.** c, **4.** b, **5.** c, **6.** F, **7.** T, **8.** F, **9.** F, **10.** T.

LESSON NO. 6: PROJECT FINANCING

STRUCTURE

4. AIMS AND OBJECTIVES

This lesson deals with the Financing aspect of a project. After reading this lesson you will be able to understand :

- • Project Financing for a project
- Sources of Finance for a project

6.1 INTRODUCTION TO PROJECT FINANCING

Project financing, as a concept is very old. But it has gained prominence during the last two decades. There was a time when project finance was a fairly simple banking exercise. That time is now past. Of late, many changes in the economic environment have taken place. The figures for total investment in almost any major capital plant development have, by the joint action of inflation and technical innovation, reached dimensions which have become too large for an individual company to accommodate. Again, high rates of inflation have made cost escalation provisions assume very large proportions, particularly in relation to the basic price of any capital plant where a long period of manufacture is required before it can be erected and start functioning on site.

Finance is one of the basic requirements of a project which entrepreneur needs to start with in every stage of the project. Project finance is both for short-term and long-term. The sources from which the entrepreneurs can meet their financial needs for their projects are: internal source and external source. Besides, the entrepreneur raises his finance by availing of available subsidies, state aid to industries, etc. Project finance, therefore, is very crucial to the success of a project.

6.2 SELECTING AN APPROPRIATE SOURCE OF FINANCE

A business faces three major issues when selecting an appropriate source of finance for a new project :

- Can the finance be raised from internal resources or will new finance have to be raised outside the business? [1] * r- •;
- If finance needs to be raised externally, should it be debt or equity?
- If external debt or equity is to be used, where should it be raised from and in which form?
- Can the necessary finance be provided from internal sources?

In answering this question, the company needs to consider several issues :

How much cash is currently held? The company needs to consider the amount held in current cash balances and short-term investments, and how much of this will be needed to support existing operations. If spare cash exists, this is the most obvious source of finance for the new project. If the required cash cannot be provided in this way then the company should consider its future cash flow. If the company's projected cash flow is not sufficient to fund the new project then it could consider tightening its control

of working capital to improve its cash position.

Pressurizing debtors for early settlement, running down stock levels and lengthening the payment period to creditors could increase cash resources. Note however, there are dangers in such tactics. For example, lost customer / supplier goodwill and production stoppages due to running out of stock etc.

If the necessary finance cannot be provided internally then the company has to consider raising finance externally.

6.3 MAJOR SOURCES OF FINANCE

Sources of project finance can be divided into two broad categories : Long-term Sources and Short-Term Sources. When financial Institution looks at a project, they consider only long-term sources of finance. Following are the prime sources of finance:

6.3.1 Equity Finance

Large and well-known industries generally raise a major portion of their funds to meet their capital demands by selling shares of different types, namely, equity or ordinary shares, cumulative and non-cumulative preference shares. The trend in recent times have been to issue shares of Rs. 10, Rs. 50 and Rs. 100 to enable persons in the middle-income group to subscribe to the share capital. Because of substantial money with the public, well- known industrial concerns find it quite easy to raise funds by selling equity shares, which are often oversubscribed.

For companies who already have shares in issue rights, issues are mandatory under company law. This means that any new shares have to be offered to existing shareholders in proportion to their existing holdings. This is to protect existing shareholders from the company selling shares to new investors at a low price and diluting the wealth of existing shareholders. This requirement may be overcome if existing shareholders are prepared to vote to 'waive their pre-emption rights'. The current status of the company is important. Companies listed on the Stock Exchanges can raise new equity finance by selling new shares on these markets by way of rights issues, offers for sale or placing. Other companies which lack access to the stock exchange find it more difficult to raise equity finance and may need to turn to venture capitalists if they require equity finance.

Equity capital represents ownership capital as equity shareholders collectively own the company. They enjoy the rewards and bear the risks of ownership. However, their liability, unlike the liability of the owner in a proprietary firm and the partners in a partnership concern, is limited to their capital contributions.

6.3.2 Debt Finance

Debt finance comes in many different forms. The major considerations in raising debt finance are detailed below.

Duration of the loan

Generally, short-term borrowing (loans for less than one year) is cheaper than longer- term borrowing (loans for more than one year). This is because many lenders equate time with risk. The longer they lend for, the more risk is involved as more things can go wrong. Hence they charge a higher interest rate on longer-term lending than on short-term lending. However, short-term borrowing has a major disadvantage - renewal risk. Short-term loans have to be regularly renewed and the company carries the risk that lenders may refuse to extend further credit. This risk is at its highest on overdraft borrowing where the bank can call in the overdraft 'on demand'. With long-term borrowing, as long as the borrower does not breach the debt covenants involved, the finance is assured for the duration of the loan.

In choosing between short-term and long-term borrowing, the firm should consider the rule of thumb for prudent financing: 'finance short-term investments with short-term funds and long-term investments with long-term funds'. Simply, this means use cheap short-term borrowing where it is safe to do so (investments that are short-term in nature and hence renewal risk is not a problem) but use long-term finance for long-lived investments. Fixed versus floating-rate borrowing

Many lenders offer the borrower the choice between a fixed rate of interest and one that floats (i.e., varies) with the general level of interest rates. Fixed-rate borrowing has the attraction of certainty but on average is more expensive. This is because lenders see themselves as taking more risk on fixed-rate lending as they may lose out if interest rates increase. Generally, floating (variable) rate borrowing is cheaper, but it carries more risk to the borrower as interest payable may increase if interest rates rise. If a firm is already highly geared it may consider the risks of floating-rate borrowing too high.

Status of the Company

Some types of debt finance are only available to large listed companies. Small companies are usually restricted to short-term borrowing. If long-term debt finance is available it is usually in the form of leasing, sale and leaseback, hire purchase or mortgage loans on property.

It is not possible to recommend an ideal source of finance for any project. What is important is that one should know the advantages and disadvantages of different financing methods and then can decide the source (s) accordingly.

6.3.3 Preference Capital

Preference capital represents a hybrid form of financing it partakes some characteristics of equity and some attributes of debentures. It resembles equity in the following ways :

(i) preference dividend is payable only out of distributable profits;
(ii) preference dividend is not an obligatory payment (the payment of preference dividend is entirely within the discretion of directors); and
(iii) preference dividend is not a tax-deductible payment.

Preference capital is similar to debentures in several ways :

(i) the dividend rate of preference capital is usually fixed;
(ii) the claim of preference shareholders is prior to the claim of equity shareholders; and
(iii) preference shareholders do not normally enjoy the right to vote.

Advantages of Preference Capital

Preference capital offers the following advantages :

- There is no legal obligation to pay preference dividend. A company does not face bankruptcy or legal action if it skips preference dividend.
- There is no redemption liability in the case of perpetual preference shares. Even in .the case of redeemable preference shares, financial distress may not be much because (i) periodic sinking fund payments are not required and (ii) redemption can be delayed without significant penalties.
- Preference capital is regarded as part of net worth, if its redemption is subordinated to repayment of debt.
- Preference shares do not, under normal circumstances, carry voting right. Hence, there is no dilution of control.
- No security of assets is provided to preference shareholders. Hence, the mortgageable assets of the firm are conserved.

SELF CHECK QUESTIONS

1. What is project financing primarily concerned with?

A. Short-term financial needs
B. Long-term financial needs
C. Both A and B
D. None of the above

2. What does "renewal risk" refer to in the context of debt finance?

A. Risk of interest rate fluctuations
B. Risk of lenders refusing to extend credit
C. Risk of inflation
D. Risk of project failure

3. If a company's projected cash flow is not sufficient to fund a new project, it should

consider tightening control of working capital. T/F

4. Short-term borrowing is generally more expensive than long-term borrowing. T/F

6.3.4 Internal Accruals

The internal accruals of a firm consist of depreciation charges and retained earnings. Depreciation represents the allocation of capital expenditure to various periods over which the capital expenditure is expected to benefit the firm. Suppose a machine costs Rs.100, 000 and has an economic life of five years at the end of which its expected salvage value is 0. If the machine is depreciated using the straight-line method the annual depreciation charge will be Rs 20,000. Each year a depreciation cost of Rs 20,000 is shown in the profit and loss account. This cost merely represents a periodic write off of a capital cost incurred in the beginning, put differently, it is a non-cash charge. Hence, it is considered an internal source of finance.

Retained earnings are that portion of equity earnings (profit after tax less preference dividends) which are ploughed back in the firm. Because retained earnings are the sacrifice made by equity shareholders, they are referred to as internal equity. Companies normally retain 30 percent to 80 percent of profit after tax for financing growth. If you look at a sample of corporate balance sheets you will find that reserves and surplus (other than share premium reserve and revaluation reserve), which essentially represent accumulated retained earnings, are an important source of long-term financing. Even this is an understatement of the contribution of retained earnings to long-term financing because a portion of reserves and surplus would have been capitalized by the firm if it had issued bonus shares.

6.3.5 Term Loans

Firms obtain long - term debt mainly by raising term loans or issuing debentures. We have discussed at length the features and types of debentures. Historically, term loans given by financial institutions and banks have been the primary source of long-term debt for private firms and for most of the public firms. Term loans, also referred to as term finance represents a source of debt finance which is generally repayable in less than 10 years. They are employed to finance acquisition of fixed assets and working capital margin. Term loans differ from short term bank loans which are employed to finance short-term working capital need and tend to be self-liquidating over a period of time, usually less than one year.

Features of Term Loans

The following features of term loans may be discussed as below:

- Currency
- Security
- Maturity
- Loan covenants

Currency

Financial institutions, commercial banks, and insurance companies also give long term loans as well as foreign currency loans. The most significant form of assistance provided by financial institutions are given directly to industrial concerns for setting up new projects as well as for expansion, modernization, and renovation projects.

These funds are provided for incurring expenditure on land, building, plant, machinery, technical know-how, miscellaneous fixed assets, preliminary expenses or preoperative expenses, and margin money for working capital.

Financial institutions provide foreign currency term loans for meeting the currency expenditure towards import of plant, machinery and equipment, and payment, foreign technical know-how fees. The periodical liability for interest and principal in the currency/ currencies of the loan is translated into rupees at the prevailing rate of exchange for making payments to the financial institutions.

Security

Term loans typically represent secured borrowing. Usually assets, which financed

with the term loan, provide the prime security. Other assets of the firm may as collateral security.

All loans provided by financial institutions, along with interest, liquidated damages, commitment charges, expenses, etc., are secured by way of:

1. First equitable mortgage of all immovable properties of the borrower, both present and future; and
2. Hypothecation of all movable properties of the borrower, both present and future, subject to prior charges in favor of commercial banks for obtaining working capital advance in the normal course of business.

Maturity

The term loans mature after a specific period say 5, years, 7 years, 10 years' time. The business firm must pay back the principal amount on the given date otherwise lenders may force winding up of the company through legal action. Moreover, a business firm also cannot forgo the payment of interest payments, as specified in the loan agreement, irrespective of its financial position.

Loan Covenants

Loan covenants are conditions relative to a loan where both parties will negotiate to protect their individual interests. How is it going to be resolved is a question of bargaining and the strengths of both parties. For example, an imposition on a minimum current ratio may imply that: the lender will be assured that your ability to pay your obligations is not eroded, however the firm may not be in a position to exploit some opportunities because of the imposition. Finally, covenants will always be pursued where :

1. The lender will insist on protective clauses in order to protect its interests. This is based on its desire to exercise its fiduciary responsibility.
2. The client will prevent undue interference in its operating procedures because any form of interference constitutes a cost in the form of operating disturbance.

6.3.6 Venture Capital

A young company that is not yet ready or willing to tap the public financial market may seek venture capital. Such capital is provided by venture capital funds which are prepared to finance an untried company that appears to have promising prospects. Venture capital represents financial investment in a risky proposition made in the hope of earning a high rate of return.

Preparing a Business Plan

If you are approaching a venture capitalist to finance your project, how should you prepare your business plan? Here are some guidelines :

- Use simple and clear language. Avoid bombastic presentation and technical language.
- Focus on four basic elements, viz. people, product, market, and competition.
- Give projections for about two to five years with emphasis on cash flows.
- Identify risks and develop a strategy to cope with the same.
- Convince them that the management team is talented, experienced, committed, and determined.

6.4 MODE OF FINANCING

Thus, finance can be raised from a variety of sources in different ways. A firm can raise equity and debt capital from both public and private sources. Capital raised from public sources is in the form of securities offered to public through an offer document filed with the Securities Exchange Board of India'. These securities can be traded on public secondary markets like the National Stock Exchange or the Bombay Stock Exchange, which are recognized-stock exchanges that facilitate the trading of public securities.

Private capital comes either in the form of loans given by banks and financial institutions or in the form of issue of securities like equity shares, preference shares, and debentures which are privately placed with a small group of sophisticated investors like private equity funds, venture capital firms, financial institutions, insurance companies,

mutual funds, and wealthy individuals. This, however, does not apply when a firm raises fixed deposits or issues commercial paper.

When a company is formed, it first issues equity shares to the promoters (founders) and also, in most cases, raises loans from banks, financial institutions, and other sources. As the need for financing increases, the company may issue shares and debentures privately to promoters' relatives, friends, business partners, employees, financial institutions, banks, mutual funds, venture capital funds, and others venture capital funds are likely to be an important source of finance for a nascent venture. Such investors are specific and small in number.

As the company grows further, it may have to raise capital from the public. The first issue of equity shares to the public by an unlisted company is called the initial public offering (IPO). Subsequent offerings are called seasoned offerings.

SELF CHECK QUESTIONS

5. What does internal accrual in a firm primarily consist of?

A. Short-term loans
B. Depreciation charges and retained earnings
C. Venture capital
D. Foreign currency loans

6. What is the primary security for term loans?

A. Equity shares
B. Hypothecation of movable properties
C. Commercial paper
D. Retained earnings

7. The first issue of equity shares to the public by an unlisted company is known as an Initial Public Offering (IPO). T/F

8. Venture capital is often sought by well-established companies ready to tap the public financial market. T/F

6.5 SUMMARY

Financial institutions appraise a project from the marketing, technical, financial, economic, and managerial angles. Apart from the principal sources like equity, internal accruals, term loans, debentures, working capital advance there are several other ways in which finance may be obtained. These include deferred credit, lease finance, hire purchase, unsecured loans and deposits special schemes of institutions, subsidies, sales tax deferments and exemptions, commercial paper, factoring, and securitization. A young company that is not yet ready or willing to tap the public financial market seek venture capital which represents financial investment in a risky proposition mal the hope of earning a high rate of return. An Indian firm can access the Euromarkets to raise a Eurocurrency loan or issue a Eurobond. Eurocurrency loans, which represent the principal form of external commercial borrowing are syndicated loans carrying a floating rate generally linked to LIBOR. While the Eurocurrency loan is the most popular form of external commercial borrowings Indian firms also raise money by issuing Eurocurrency bonds (or notes).

6.6 GLOSSARY

- **Capital Structure** : Refers to the kind of securities that make up the capitalization.
- **Capital Gearing Ratio** : The ratio of debt finance to equity finance.
- **Business Risk** : Refers to the volatility of operating profit.
- **Operating Gearing** : Refers to the proportion of a company's operating costs that are fixed as opposed to variable costs.
- **Uncertainty** : Having only partial information about the situation or outcomes.
- **Risk** : The chance that outcomes will not turn out as planned.
- **Benefit-Cost Ratio** : A ratio to evaluate a proposed course of action.

6.7 REVIEW QUESTIONS

1. Discuss the sources available for project financing.
2. When should a firm use more equity and when should a firm use more debt?
3. Discuss the following:
   a Lease and hire purchase
   finance b. Unsecured loans
   and deposits
4. What are the pros and cons of going public?
5. What are the feature of debenture?

6.8 FURTHER READINGS

1. Prasanna Chandra, **PROJECTS**- **Planning, Selection, Financing, Implementation, and Review,** Sixth Edition, Publication: TATA McGraw HILL
2. Dennis Lock, **Project Management,** Ninth Edition, Publication: Gower
3. P.C.K. Rao, **Project Management and Control,** Publication: Sultan Chand & Sons
4. Vasant Desai, **Project Management,** Second Revised Edition, Publication: Himalaya Publishing House
5. Clements / Gido, **Effective Project Management,** Publication: Thomson
6. K. Nagarajan, **Project Management,** Third Edition, Publication: New Age International

ANSWER KEY:

1. b, **2.** b, **3.** T, **4.** T, **5.** b, **6.** b, **7.** T, **8.** F.

LESSON NO. 7: TIME PLANNOING FOR PROJECTS

STRUCTURE

7.0 AIMS AND OBJECTIVES

This lesson deals with the concept of time planning. After reading this lesson you will be able to understand :

- Time Planning for Projects
- Objective of Time Schedule
- Time Planning Tools and Technique

7.1 INTRODUCTION

Some people tend to be late. It might be only a few minutes on occasion, or just a couple of times a week, but people are often behind on their daily schedules. (However, because denial is another great skill human beings seem to have, I'll understand if you refuse to admit that this claim applies to you.) High school students are late for class, adults are late for meetings at work, and friends arrive 10 minutes late at party. It seems that' subconsciously we often believe that being on time isn't about targeting a specific moment but instead is about being within a range of moments, and for some people, that range is wider than for others. An interesting example is the many hostesses who greet us at restaurants. They tell us a table will be ready soon, but often we're made to wait quite a while. It's these experiences of delayed schedules, being put on hold on the telephone, or waiting in the doctor's office, that have caused us to become cynical about schedules we have so much experience with life not working out according to them.

It isn't a surprise then that so many projects come in late. As human beings, most of us arrive at the task of scheduling projects with a questionable track record for delivering or receiving things on time. We tend to estimate based on weak assumptions, predict outcomes for work based on the best possible set of circumstances, and given our prior experiences simultaneously avoid placing too much confidence in any schedule we see or create. But before we can figure out how to make better schedules, we first have to understand what problems schedules solve. If they are so unreliable, why bother with them at all? Schedules serve several different purposes only some of which are focused on measuring the use of time.

7.2. PURPOSE OF TIME SCHEDULE

All schedules, whether for planning a weekend party or for updating an intranet site, serve three primary purposes. The first, and the most well-known, is to make commitments about when things will be done. The schedule provides a form of contract between every person on a team or in an organization, confirming what each person is

going to deliver over the next week, month, or year. Generally, when people think about project schedules, it's this first purpose that they're thinking about. Schedules are often focused externally, outside the project team rather than within, because they are used to help close a deal or comply with a customer's timeline. Often, the customer is explicitly paying for the timeline as well as for the service provided. In order to allow customers or partners to make plans based on a given project, a time has to be agreed upon for when specific things will happen.

The second purpose of a schedule is to encourage everyone who's contributing to a project to see her efforts as part of a whole, and invest in making her pieces work with the others. Until there is a draft schedule suggesting specific dates and times for when things have to be ready, it's unlikely that connections and dependencies across people or teams will be scrutinized. Instead, everyone will work on her own task, and tend not to think about how her work will impact others.

It’s only when the details are written down, with people's names next to them that real calculations can be made and assumptions examined. This is true even for small teams or for individuals working alone. There is psychological power in a schedule that externalizes and amplifies the commitment that is being made. Instead of dates and commitments existing only inside someone's mind, they are written down and exist in the universe all on their own. It is not as easy to forget or ignore something when it's posted on a whiteboard in the hallway, reminding you or the team of what needs to be done. And specific to PMs: with a draft schedule in place, questions about how realistic certain things are can be raised, and comparisons can be made between what the project is being asked to do with what appears to be possible in a given period of time.

This psychological or pressure shift is what’s called a forcing function. A forcing function is anything that when put in place naturally forces a change in perspective, attitude, or behavior. So, schedules are important forcing functions for projects. If used properly by a PM, schedules force everyone whose work appears on them to carefully think through the work they need to do and how it fits into what others are doing. This awareness of the relationship between parts is somewhat independent of the schedule itself. This forcing function is a critical step toward realizing the project's potential. Even if the schedule slips, is doubled, is halved, or goes through a variety of other torturous permutations, the commitments and connections everyone has made with each other will be maintained. So, this second purpose of a schedule can be achieved and can be entirely worth the effort of creating a schedule, even if the schedule itself turns out to be seriously inaccurate. For example, if the project comes in very late, the existence of a schedule will be critical in helping the project reach completion at all.

The third purpose of schedules is to give the team a tool to track progress and to break work into manageable chunks. Breaking things down into one- or two-day. sizes actually helps people to understand what the work is that they need to do. Imagine if, when building a house, the builder gave one line item: ''House: 120 days." With such low granularity, it's difficult for anyone, including the builder himself, to understand which things need to be done first, or which work items are the most expensive or time-consuming. But if the builder can provide a week-by-week breakdown of activities, everyone has a clearer understanding of what tasks will be done when, and each team member has a greater opportunity to ask good questions and clarify assumptions. From the PM's perspective, a good schedule gives a clearer view of the project, flushes out challenges and oversights, and increases the odds that good things will happen.

The larger and more complex the project, the more important schedules are. On larger projects, there are more dependencies between people, and decisions and timings have greater odds of impacting others. When you have a handful of people working on a small team, the odds of people recognizing problems in each other's work are much higher. Schedule slips on small teams aren’t good news, but, in such a case, a half-day slip represents an additional half-day of energy for three people only, so recovery is possible. Someone can stay late one night, or, if necessary, the team can all come in together and agree to help make up the time. On a larger project, with dozens or hundreds of people and components, a one-day slip can quickly cascade and create problems in all sorts of unforeseen ways, which is often beyond a team's point of recovery. Either way, big

team or small, schedules give managers and bean counters the opportunity to ask questions, make adjustments, and help the team by surfacing and responding to issues as they arise.

SELF CHECK EXERCISE

1. **According to the text, what does a schedule help achieve even if it turns out to be seriously inaccurate?**
   A) Completion of the project
   B) Strict adherence to timelines
   C) Increased team collaboration
   D) Greater understanding of work items

2. According to the text, what is the first primary purpose of all schedules?
   A) Encouraging collaboration
   B) Making commitments
   C) Tracking progress
   D) Externalizing assumptions

3. The third purpose of schedules is mainly to create strict timelines that everyone must adhere to. T/F

4. The second purpose of a schedule is primarily focused externally, outside the project team. T/F

7.3. TOOLS AND TECHNIQUES

There are many different systems for how to plan and manage the development of *A* projects. These systems are often called methodologies or tools and techniques, which means a body of practices aimed at achieving a certain kind of result. Common software methods include the waterfall model, spiral model, Rapid Applications development, Extreme Programming, and Feature-driven development. All of these methods attempt to solve similar organization and project management problems. They each have strengths and weaknesses, and it takes knowledge and experience to decide which one is right for what kind of project.

There are concepts and tactics that underlie them all and which need to be mastered in order to succeed with any methodology. In all cases, methodologies need to be adjusted and adapted to fit the specifics of a team and a project, and that's possible only if you have a foundation of knowledge that's deeper than the methodologies themselves.
Although methods and processes for software development are very important, they are not in and of themselves silver bullets, or deliverers of successful outcomes. The worst thing is to blindly follow a set of rules or procedures that are clearly not working, simply because they show up in some famous book or are promoted by a well-respected guru. More often than not, I've found that obsessing on process is a warning sign of leadership trouble: it can be an attempt to offload the natural challenges and responsibilities that managers face into a system of procedures and bureaucracies that cloud the need for real thought and action. Perhaps even more devastating to a team is that methodology fixation can be a signal of what is truly important to the organization.

By focusing on method and procedure, instead of building procedures to support and amplify the value of people, projects start the scheduling process by limiting the contributions of individuals. They can set a tone of rules and rule following, rather than thinking and rule adjusting or rule improving. So, be very careful of how you apply whatever methodology you use: it shouldn't be something inflicted on the team. Instead, it should be something that supports, encourages, and assists the team in doing good work on the project.

7.4 THE RULE OF THIRD

There is one basic rule of thumb for all schedules: the rule of thirds. It's an extremely rough estimation and back-of-the-envelope kind of thing, but it's the simplest way to approach and understand schedules.

The simplified model for scheduling for any project is: break the available time into three parts one for design, one for implementation, and one for testing. Depending on the methodologies you use, these phases will be called different things, or they may overlap with each other in certain ways, but all methodologies have time dedicated to these three activities. On any given day, you're either figuring out what should be done (designing), actually doing it (implementing production code), or verifying, analyzing, and refining what's been done (testing).

7.4.1 Applying the Rule

As the general rule goes, for every day you expect to write production code, a day should have been spent planning and designing the work, and a day should be planned to test and refine that work. It's the simplest thing in the world, and it's an easy way to examine any existing schedule or to start a new one from scratch. If the total amount of time isn't roughly divided into the three kinds of work, there should be well-understood reasons why the project demands an uneven distribution of effort. Imbalances in the rule of thirds say, 20% more time dedicated to testing than implementation are fine as long as they are deliberate.

Consider a hypothetical web development project: if you're given six weeks to launch it, the first step should be to divide that time roughly into thirds, and, using those divisions, make calculations about when work can be completed. If this doesn't provide enough time to do the work expected at a high level, then something is fundamentally wrong. Either the schedule needs to change, or the amount of work expected to be completed needs to be reduced (or any expectations of quality need to be lowered). Trimming from the design or testing time will only increase the odds that the time spent actually writing code will be misguided or will result in code that is harder to manage and maintain. The rule of thirds is useful in that it forces the zero-sum nature of projects to surface. Adding new features requires more than just a manager implementing them; there are unavoidable design and testing costs that someone has to pay. When schedules slip, it's because there were hidden or ignored costs that were never accounted for.

7.5 PIECEMEAL DEVELOPMENT

For completeness, it's worth considering the simplest case possible: there is no project. All work is done on a piecemeal basis requests come in, they are evaluated against other work, and then they are put into the next available slot on the schedule. Some development teams, web site developers, or IT programming departments work in much this way. These organizations rarely make investments or commitments in large increments. Agile methods are often recommended to these teams as the most natural system for organizing work because these methods stress flexibility, simplicity, and expectations of change.

However, the rule of thirds still applies to these situations. Even if each programmer is working alone on small tasks, he is probably spending about one-third of his total time figuring out what needs to be done, one-third of his time doing it, and one-third making sure it works properly. He might jump back and forth between those uses of time, but as a rough way to understand any kind of work, the rule of thirds applies well at any scale.

7.6 DIVIDE AND CONQUER

If you examine most development methodologies, you can see the outlines of the rule of thirds. The specific goals and approaches used to design or implement things may be very different, but at the highest level, the desired results are similar.

Where it gets complex is on larger or longer projects, where schedules are divided into smaller pieces, with each piece having its own design, implementation, and testing time. Extreme Programming (known as XP) calls these pieces iterations; the spiral model calls them phases; and some organizations call them milestones. While XP implies that these chunks of time are only a few weeks, and the spiral model implies that they are months, the fundamental idea is the same: create detailed schedules for limited periods of time only.

The more change and project volatility that is expected, the shorter each milestone

should be. This lowers the amount of overall risk in the schedule because the master plan has been divided into manageable pieces. Those breaks between chunks of the schedule provide natural opportunities to make adjustments and improve the chances that the next milestone will more accurately direct its work.

7.7 AGILE AND TRADITIONAL METHODS

XP and other agile methods assume the future is always volatile, so they bet on processes that incorporate direction changes easily. Projects that have very high production costs go the other way and invest heavily in planning and designing activities. It can be done, but everyone has to commit to the decisions made during planning, and the prohibitive cost for changes tends to be the only way that happens.

Most development projects are somewhere in the middle. They have some initial planning, but to help manage future volatility of requirements and customer demands, the work is divided into phases that have allocated time for design, implementation, and quality assurance. If a new issue arises, it can be considered for the current phase or put in the bucket of work to be properly investigated and understood during the next phase.
For most projects, that initial planning time is used to capture enough information from customers and businesses to define how many phases are needed and what the focus should be for cache one. Depending on the larger plan, each phase might dedicate more time to design or test. A phase could be divided into two smaller phases (approaching a more agile style of development), or two phases could be combined together (approaching more monolithic development). But in all cases, time should be allocated between phases to take advantage of what has changed. This includes responding to problems that arose during the previous phase, which couldn't be addressed fully during that phase.

SELF CHECK EXERCISE

5. What is the primary caution given regarding methodologies in the text?

A) Blindly follow famous methodologies
B) Obsess on process for successful outcomes
C) Choose methodologies based on gurus' recommendations
D) Adapt methodologies to fit the team and project

6. What is the significance of the rule of thirds in project scheduling?

A) It emphasizes precision over accuracy
B) It forces the zero-sum nature of projects to surface
C) It discourages adjustments in the schedule
D) It supports blind adherence to rules

7. In piecemeal development, requests are evaluated and put into the next available slot on the schedule. T/F

8. Agile methods, according to the text, assume that the future is always stable, allowing for rigid planning. T/F

7.8 WHY TIME SCHEDULES FAIL

Project schedules are the easy scapegoats for everything that can possibly go wrong. As much as people loathe schedules, they still hold them up to an unachievable standard. Even the best schedulers in the world, with the smartest minds and best tools at their disposal, are still attempting to predict the future something our species rarely does well.

But if a team starts a project fully aware of the likely reasons schedules fall apart and takes some action to minimize those risks, the schedule can become a more useful and accurate tool in the development process.

7.9 THINKING IN THE DISTANT FUTURE

If a schedule is created during initial planning, hundreds of decisions that may impact the schedule have yet to be made. There will be issues and challenges, which no one can foresee, and there is no way an early speculative plan can possibly account for

them. Until requirements are understood and high-level design is well underway, a project manager is too blind and has too little information to make realistic predictions. Yet much of the time, a rough-cut schedule is created with made-up numbers and wild speculations, and this straw man is handed to the team under the guise of a believable project plan. Often, people fall victim to the precision versus accuracy trap: an impressive-looking schedule with specific dates and times (precision) isn't necessarily close to reflecting reality (accuracy). Precision is easy, but accuracy is very difficult.

However, it is true that all projects and schedules have to start somewhere. A shot in the dark can be used to energize a team and put some boundaries in place. It can begin a process of investigation to flesh out schedules and raise and answer important questions. But if an unverified and unexamined sweeping speculation is used as the basis for a schedule without further refinement great risks await. There is strong evidence that it is difficult for anyone to estimate the amount of time required early on in a project.

The project managers need to understand that schedule estimation grows in accuracy over time. Schedules demand that attention is paid to them as progress is made, and that adjustments are made as the project moves forward.

7.10 ESTIMATING IS DIFFICULT

During the design process a part of the work for designers, managers, and testers is to break down the design into small chunks of work that can be built. These chunks, often called work items or a work breakdown structure, become the line items in the master schedule for the project. The work items are intelligently distributed across the team, and by tallying them up, a schedule is created. Each of these work items has to have an amount t of time assigned to it by the manager, and on the basis of those estimates, the schedule is built.

By the simplest definition, good work estimates have a high probability of being accurate, and bad work estimates have a low probability. It requires an active process of reviewing estimates and pushing, leading, and nudging others to get them to the level they need to be.

7.11 GOOD ESTIMATES COME FROM GOOD DESIGNS

The most important thing is that good estimates only come from credible designs and requirements^ Good engineering estimates are possible only if you have two things: good information and good engineers. This means that good estimates are everyone's business, and it should be the work of the entire team project managers and designers in particular to do what they can to support engineers in making credible estimates. If estimating feels like a chore and an accounting project, or if team leaders aren't invested in the process, don't expect reliable or probable estimates.

If leaders acknowledge weak estimates in the schedule and are comfortable with greater schedule risk, there's nothing wrong with weak estimates. On smaller, faster projects, rough estimates may be all that the project needs. Requirements may be changing often, and the nature of the business or organization might demand less structure and more flexibility. There's nothing wrong with low-quality estimates, provided no one is confusing them with high-quality ones. * •

Here are some additional ways to ensure good estimates :

Establish baseline confidence intervals for estimates. A guess - 40% confidence in accuracy. A good estimate * 70%. A detailed and thorough analysis - 90%. Team leaders need to agree on how accurate they want estimates to be, as well as the amount of time managers will have in order to make them and how the risks of missed estimates will be managed. Don't fix the numbers: just use them to help make the quality of estimates concrete. A 90% estimate should be 9 times out of 10. If you decide to ask your team to improve the quality of estimates, you must match this request with more time for them to do so.

There are 'known techniques for making better estimates. The most well-known technique is PERT which tries to minimize risks by averaging out high, medium, and low estimates for work. This is good for two reasons. First, it forces everyone to realize estimates are predictions, and that there is a range of possible outcomes. Second, it gives

project managers a chance to prove how aggressive or conservative the schedules are.

SELF CHECK EXERCISE

9. **According to the text, why are project schedules often blamed for problems?**
   A) Precision issues
   B) Accuracy trap
   C) Unachievable standards
   D) Lack of information
10. **What is emphasized as essential for good estimates in the text?**
   A) Detailed analysis
   B) Good engineers and good information
   C) Rough estimates for small projects
   D) Minimal schedule risk

11. The PERT technique aims to minimize risks by providing a single estimate for work. T/F

12. According to the text, leaders should not be concerned if estimates are weak, as long as the project is smaller and faster. T/F

7.12 SUMMARY

Time Schedules serve three functions: allowing for commitments to be made, encouraging everyone to see her work as a contribution to a whole, and enabling the tracking of progress. Even when schedules slip, they still have value. Big schedules should be divided into small schedules to minimize risks and increase the frequency of adjustments. All estimates are probabilities. Because schedules are a collection of estimates, they are also probabilities. This works against schedule accuracy because probabilities accumulate (80% x 80% « 64%). The earlier that estimates are made, the less accurate they are. However, rough estimates are the only way to provide a starting point for better ones. Schedules should be made with skepticism, not optimism. Invest in design to shed light on assumptions and generate reliable confidence.

7.13 GLOSSARY

- **Contingency Plan** : An alternative for action if the expected result fails to materialize.
- **Culture** : The way of life of any group of people.
- **Risk** : The chance that outcomes will not turn out as planned.
- **Project Proposal** : A document used to explain project needs and establish direction from the perspective of the customer and sponsoring organization.
- **Sponsor** : A ranking representative of the organization. In our case-a team leader or other member of Cabinet.
- **Planning Team** : Those persons associated with the planning process, including the Project Sponsor, customer/user, and representatives of the various functions that are affected by or will contribute significantly to the project output.

7.14 REVIEW QUESTIONS

1. List the sequences for setting a time schedule of a project.
2. Any successful project must complete on time. Discuss and justify.
3. What are the basic guidelines for a time schedule which assure that individual components of the system are designed in an optimal manner?
4. What are the general steps for a good time schedule?

7.15 FURTHER READINGS

1. Clifford F. Gray and Erik W. Larson, **Project Management,** Publication : TATA McGraw HILL
2. ***Prasanna Chandra,*** *PROJECTS- Planning, Selection, Financing, Implementation, and Review,* ***Sixth Edition, Publication : TATA McGraw HILL***
3. Dennis Lock, **Project Management,** Ninth Edition, Publication : Gower

4. P.C.K. Rao, **Project Management and Control,** Publication : Sultan Chand & Sons
5. Vasant Desai, **Project Management,** Second Revised Edition, Publication : Himalaya Publishing House
6. Clements / Gido, **Effective Project Management,** Publication : Thomson
7. K. Nagarajan, **Project Management,** Third Edition, Publication : New Age International

ANSWER KEY:

1. a, **2.** b, **3.** F, **4.** F, **5.** a, **6.** b, **7.** T, **8.** F, **9.** c, **10.** b, **11.** F, **12.** T.

LESSON NO. 8: PROJECT APPRAISAL

STRUCTURE

8.0 AIMS AND OBJECTIVES

This lesson deals with the concept of project appraisal. What is a project? Why it needs proper management? After reading this lesson, you will be able to understand the following :

- Project Appraisal
- Technical Feasibility
- Issues related to Technical Feasibility

8.1 WHAT IS PROJECT APPRAISAL?

Project appraisal is an exercise, which is required before a project is sanctioned. Appraisal means the act of working out the value, quality and/or condition of the project. The appraisal using ex-ante feasibility analytical techniques is carried out at ar. early date in the pre-plan phase. At this time, the working life lies completely in the future. The future costs and benefit of the project are mere estimates based on certain technical relationship amongst the inputs. These estimates have to be brought back to the present time in order to take a decision on the worthiness of the project. Hence, at the formulation stage, appraisal needs to be carried out in order to help recommend a project strategy to the sanctioning authorities. And, at the sanctioning stage, appraisal is to be used to select and approve the best (most beneficial or least costly) project (or a set of projects) from those recommended by various project formulators and promoters. It, therefore, suggests that perspective and considerations in the project appraisal of the formulators may differ from those of the sanctioning authorities. However, from an overall development perspective, projects need to be appraised in terms of various consideration like technical, implementational, commercial, organizational, managerial, economic-social

and uncertainty-risk. It is to be understood, however, that these components of project appraisal are interdependent and not mutually exclusive.

Let us now discuss how the technical considerations are to be appraised.

8.2 TECHNICAL FEASIBILITY

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The broad purpose of technical Feasibility is

(a) to ensure that the project is technically feasible in the sense that all the inputs required to set up the project are available

(b) to facilitate the most optimal formulation of the project in, terms of technology, size, location, and so on.

While technical Feasibility is essentially the area of the technical expert, the financial analyst participating in the project appraisal exercise should be able to raise basic issues relating to technical Feasibility using common sense and financial prudence. Project engineering team is central to the technical decision-making where the technical intricacies and their wider impact on overall performance of a project can be well defined. This team of experts and engineers having technical fervor may need to exercise caution while monitoring any technical haywire that might hinder a project progress or proves to be fatal and costly while retrieving and rectifying. Devoid of such scrupulous technical clairvoyance would land the projects in jeopardy. Distinctly, this is an exclusive feature mega projects such as infrastructure and core sector projects. The infrastructure projects consist of heavy engineering works at site (civil, mechanical, electrical) generally involving high-tech cryptograms both on and off the site. These infrastructure projects shall have to face a tough and volatile environment in terms of geotechnical and asymmetric vicinity, severe seismic effects, extreme climates, innovative and fleeting works, ill-timed material supplies, construction chaos and many more spontaneous nightmares. Therefore, the project site engineers and other related technical staff have to be more cautious, responsible and hardworking than their counterparts working at the headquarters.

8.2.1 Manufacturing Process/Technology

For manufacturing a product/service, often two or more alternative technologies are available. For example :

- Steel can be made either by the Bessemer process or the open-hearth process.
- Cement can be made either by the dry process or by the wet process.
- Soda can be made by the electrolysis method or the chemical method.
- Paper, using bagasse as the raw material, can be manufactured by the kraft process or the soda process or the Simon Cusi process.

8.2.2 Choice of Technology

The choice of technology is influenced by a variety of considerations :

- Plant capacity
- Principal inputs
- Investment outlay and production cost
- Use by other units
- Product mix
- Latest developments
- Ease of absorption **Plant Capacity**

There is a close relationship between plant capacity and production technology. To meet a given capacity requirement perhaps only a certain production technology may be viable.

Principal Inputs

The choice of technology depends on the principal inputs available for the project. In some cases, the raw materials available influence the technology chosen. For example, the quality of milestones determines whether the wet or dry process should be used for a cement plant.

Investment Outlay and Production Cost

The effect of alternative technologies on investment outlay and production cost

over a period of time should be carefully assessed.

Use by Other Units

The technology adopted must be proven by successful use by other units, preferably in India.

Product Mix

The technology chosen must be judged in terms of the total product mix generated by it, including saleable by products.

Latest Developments

The technology adopted must be based on the latest developments in order to ensure that the likelihood of technological obsolescence in the near future, at least, is minimized. **Ease of Absorption**

The ease with which a particular technology can be absorbed can influence the choice of technology. Sometimes a high-level technology may be beyond the absorptive capacity of a developing country which may lack trained personnel to handle that technology.

8.2.3 Appropriateness of Technology

This refers to those methods of production which are suitable to local economic, social, and cultural conditions. In recent years, the debate about appropriate technology has been sparked off mainly by Schumacher and others. The advocates of appropriate technology urge that the technology should be evaluated in terms of the following questions :

- Whether the technology utilizes local raw materials?
- Whether the technology utilizes local man power?
- Whether the goods and services produced cater to the basic needs?
- Whether the technology protects ecological balance?
- Whether the technology is harmonious with social and cultural conditions?

8.2.4 Technical Arrangements

Satisfactory technical arrangements must be made to obtain the technical know-how needed for the proposed manufacturing process. When collaboration is sought, inter-alia, the following aspects of the agreement must be worked out in detail:

- The nature of support to be provided by the collaborators during the designing of the project, selection and procurement of equipment, installation and erection of the plant, operation and maintenance of the plant, and training of the project personnel.
- Process and performance guarantees in terms of plant capacity, product quality, and consumption of raw materials and utilities.
- The price of technology in terms of one-time licensing fee and periodic royalty fee.
- The continuing benefit of research and development work being done by the collaborator.
- The period of the collaboration agreement.
- The assistance to be provided and the restrictions to be imposed by the collaborator with respect to exports etc.

8.2.5 Material Inputs and Utilities

An important aspect of technical Feasibility is concerned with defining the materials and utilities required, specifying their properties in some detail, and setting up their supply program. There is an intimate relationship between the study of materials and utilities and other aspects of project formulation, particularly those concerned with location, technology, and equipment. Material inputs and utilities may be classified into four broad categories:

(i) raw materials
(ii) processed industrial materials and components
(iii) auxiliary materials and factory supplies
(iv) utilities

8.2.6 Product Mix

Product mix choice is guided by market requirements. In the production of most of the items, variations in size and quality are aimed at satisfying a broad range of customers. For example, a garment manufacturer may have a wide range in terms of size and quality to cater to different customers. It may be noted that variation in quality can enable a company to expand its market and enjoy higher profitability.

While planning the production facilities of the firm, some flexibility with respect to the product mix must be sought. Such flexibility enables the firm to alter its product mix in response to changing market conditions and enhances the power of the firm to survive and grow under different situations. The degree of flexibility chosen may be based on a careful Feasibility of the additional investment requirement for different degrees of flexibility.

8.2.7 Plant Capacity

Plant capacity or production capacity refers to the volume or number of units that can be manufactured during a given period. Plant capacity may be defined in two ways: feasible normal capacity (FNQ and nominal maximum capacity (NMC). The feasible normal capacity refers to the capacity attainable under normal working conditions. This may be established on the basis of the installed capacity, technical conditions of the plant, normal stoppages, down time for maintenance and tool changes, holidays, and shift patterns. The nominal maximum capacity is the capacity which is technically attainable and this often corresponds to the installed capacity guaranteed by the supplier of the plant. Our discussion will focus on the feasible normal capacity. Several factors have a bearing on the capacity decision. These are

- Technological requirement
- Input constraints
- Investment cost
- Market conditions Resources of the firm
- Governmental policy

SELF CHECK EXERCISE

1. What is the purpose of technical feasibility in project appraisal?

a. To evaluate financial viability

b. To assess organizational structure

c. To ensure the availability of project inputs and optimize project formulation

d. To select and approve projects based on commercial considerations

2. The appropriateness of technology in project appraisal refers to:

a. The use of the latest technology available

b. The utilization of local resources and alignment with economic, social, and cultural conditions

c. The highest level of technology regardless of local conditions

d. The ease of absorption of technology by a developing country

3. Technical feasibility is primarily the responsibility of financial analysts in project appraisal. T/F

4. The feasible normal capacity is the capacity that is technically attainable and often corresponds to the installed capacity guaranteed by the supplier. T/F

8.3 LOCATION AND 8ITE DECISIONS

The choice of location and site follows an assessment of demand, size, and input requirement. Though often used synonymously, the terms' location' and site should be distinguished. Location refers to a fairly broad area like a city, an industrial zone, or a

coastal area; site refers to a specific piece of land where the project would be set up. The choice of location is influenced by a variety of considerations: proximity to raw materials and markets, availability of infrastructure, labor situation, governmental policies, and other factors.

8.3.1 Access to Raw Materials and Markets

An important consideration for location is the proximity to the sources of raw materials and nearness to the market for the final products. In terms of a basic locational model, the optimal location is one where the total cost (raw material transportation cost plus production cost plus distribution cost for the final product) is minimized. This generally implies that:

- a resource-based project like a cement plant or a steel mill should be located close to the source of the basic material, for example, limestone in the case of a cement plant and iron-ore in the case of a steel plant
- a project based on imported material may be located near a port
- a project manufacturing a perishable product should be close to the center of consumption.

However, for many industrial products proximity to the source of raw material or the center of consumption may not be very important. Petro chemical units or refineries, for example, may be located close to the source of raw material, or close to the center of consumption*or at some intermediate point.

8.3.2 Infrastructure

Availability of power, transportation, water, and communications should be carefully assessed before a location decision is made. Adequate supply of power is a very important condition for location-insufficient power can be a major constraint, particularly in the case of an electricity intensive project like an aluminum plant. In evaluating power supply the following should be looked into: the quantum of power available, the stability of the power supply, the structure of the power tariff, and the investment required by the project for a tie- up in the network of the power supplying agency.

For transporting the inputs of the project and distributing the outputs of the project, adequate transport connections whether by rail, road, sea, inland water, or air are required. The availability, reliability, and cost of transportation for various alternative locations should be assessed.

Given the plant capacity and the type of technology, the water requirement for the project can be assessed. Once the required quantity is estimated, the amount to be drawn from the public utility system and the amount to be provided by the project from surface or sub surface sources may be determined. For doing this the following factors may be examined : relative costs, relative dependability, and relative qualities. In addition to power, transport, and water, the project should have adequate communication facilities like telephone and internet.

8.3.3 Labor Situation

In labor-intensive projects, the labor situation in a particular location becomes important. The key factors to be considered in evaluating the labor situation are:

- Availability of labor, skilled, semi-skilled and unskilled[1]
- Prevailing labor rates
- Labor productivity
- State of industrial relations judged in terms of the frequency and severity of strikes and lockouts
- Degree of unionization

8.3.4 Government Policies

Government policies have a bearing on location. In the case of public sector projects, location is directly decided by the government. It may be based on a wider policy for regional dispersion of industries. In the case of private sector projects, location is influenced by certain governmental restrictions and inducements: The government may prohibit the setting up of industrial projects in certain areas which suffer from urban

congestion. More positively, the government offers inducements for establishing industries in backward areas. These inducements consist of subsidies, concessional finance, sales tax loans, power subsidy, income tax benefits, lower promoter contribution and so on.

8.3.5 Selection of Site

Once the broad location is chosen, attention needs to be focused on the ^election of a specific site. Two to three alternative sites must be considered and evaluated with respect to cost of land and cost of site preparation and development. The cost of land tends to differ from one site to another in the same broad location. Sites close to a city cost more whereas sites away from the city cost less. Sites in an industrial area developed by a governmental agency may be available at a concessional rate. The cost of site preparation and development depends on the physical features of the site, the need to demolish and relocate existing structures, and the work involved in obtaining utility connections to the site. The last element, viz., the work involved in obtaining utility connections and the cost associated with it should be carefully looked into. It may be noted in this context that the cost of the following may vary significantly from site to site: power transmission lines from the main grid, railway siding from the nearest railroad, feeder road connecting with the main road, transport of water, and disposal of effluents.

8.3.6 Other Factors

Several other factors have to be assessed as well before arriving at a location decision. These are :

- Climatic conditions
- General living conditions
- Proximity to ancillary units
- Ease in coping with pollution

SELF CHECK EXERCISE

5. Which of the following is NOT a factor to be considered in evaluating the labor situation for a project location?

a. Availability of labor

b. Prevailing labor rates

c. Frequency and severity of natural disasters

d. Degree of unionization

6. What should be assessed when selecting a specific site for a project?

a. Climatic conditions only

b. Proximity to urban areas

c. Cost of land and cost of site preparation and development

d. Availability of skilled labor

7. Government policies may include inducements such as subsidies, concessional finance, and tax benefits for industries in certain areas. T/F

8. The selection of a specific site involves evaluating factors such as the cost of land, labor situation, and availability of infrastructure. T/F

8.4 PROCUREMENT OF MACHINERIES AND EQUIPMENTS

The requirement of machineries and equipment is dependent on production technology and plant capacity. It is also influenced by the type of project. For a process-oriented industry, like a petrochemical unit, machineries and equipment required should be such that the various stages are matched well. The choice of machineries and equipment for a manufacturing industry is somewhat wider as various machines can perform the same function with varying degrees of accuracy. For example, the

configuration of machines required for the manufacture of refrigerators could take various forms.

To determine the kinds of machinery and equipment required for a manufacturing industry, the following procedure may be followed:

- Estimate the likely levels of production over time.
- Define the various machining and other operations.
- Calculate the machine hours required for each type of operation.
- Select machineries and equipment required for each function.

The equipment required for the project may be classified into the following types:

- plant (process) equipment,
- mechanical equipment,
- electrical equipment,
- instruments,
- controls,
- internal transportation system, and
- others.

In addition to the machineries and equipment, a list should be prepared of spare parts and tools required. This may be divided into:

- spare parts and tools to be purchased with the original equipment, and
- spare parts and tools required for operational wear and tear.

8.4.1 Constraints in Selecting Machineries and Equipment

In selecting the machineries and equipment certain constraints should be borne in mind :

- there may be a limited availability of power to set up an electricity intensive plant like, for example, a large electric furnace;
- there may be difficulty in transporting heavy equipment to a remote location;
- workers may not be able to operate, at least in the initial periods, certain sophisticated equipment such as numerically controlled machines;
- the import policy of the government may preclude the import of certain machineries and equipment.

8.4.2 Procurement of Plant and Machinery

For procuring the plant and machinery, orders for different items of the plant and machinery may be placed with different suppliers or a turnkey contract may be given for the entire plant and machinery to a single supplier. The factors to be considered in selecting the supplier of the plant and machinery are the desired quality of machinery, the level of technological sophistication, the relative reputation of the various suppliers, the expected delivery schedules, the preferred payment terms, and the required performance guarantees. If in-house technical expertise is inadequate, external consultant may be employed to select the plant and machinery and supervise the installation of the same.

8.4.3 Structure and Civil Works

Structures and civil works may be divided into three categories :

- site preparation and development,
- buildings and structures, and
- outdoor works.

8.4.4 Site Preparation and Development

This covers the following :

- grading and leveling of the site;
- demolition and removal of existing structures;
- relocation of existing pipelines, cables, roads, power lines, etc.;
- reclamation of swamps and draining and removal of standing water;
- connections for the following utilities from the site to the public network: electric power (high tension and low tension), water for drinking and other purposes, communications (telephone, telex, internet, etc.), roads, railway

sidings; and
- other site preparation and development work.

8.4.5 Buildings and Structures

Buildings and structures may be divided into :
- factory or process buildings;
- ancillary buildings required for stores, warehouses, laboratories, utility supply centers, maintenance services, and others;
- administrative buildings;
- staff welfare buildings, cafeteria, and medical service buildings; and
- residential buildings.

8.4.6 Outdoor Works

Outdoor works covers :
- supply and distribution of utilities (water, electric power, communication, steam, and gas);
- handling and treatment of emission, wastages, and effluents;
- transportation and traffic signals;
- outdoor lighting;
- landscaping; and
- enclosure and supervision (boundary wall, fencing, barriers, gates, doors, security posts, etc.)

SELF CHECK EXERCISE

9. What are the types of equipment required for a project?

a. Only plant (process) equipment

b. Plant (process) equipment, mechanical equipment, electrical equipment, and others

c. Only electrical equipment

d. Instruments and controls only

10. What constraints should be considered in selecting machineries and equipment?

a. Availability of skilled labor b. Government import policies

c. Market demand d. Marketing strategy

11. Buildings and structures in a project may include administrative buildings, staff welfare buildings, and residential buildings. T/F

12. Outdoor works in a project may involve landscaping, enclosure, and supervision such as boundary walls and security posts. T/F

8.5 SUMMARY

Project appraisal is an exercise, which is required before a project is sanctioned. Appraisal means the act of working out the value, quality and/or condition of the project. The appraisal using ex-ante feasibility analytical techniques is carried out at an early date in the pre-plan phase. The choice of technology is influenced by a variety of considerations: plant capacity, principal units, investment outlay, production cost, use by other units, product mix, latest developments, and ease of absorption. Satisfactory arrangements have to be made to obtain the technical know-how needed for the proposed manufacturing process. An important aspect of technical Feasibility is concerned with defining the materials and inputs required, specifying their properties in some detail, and

setting up their supply program. Materials may be classified into four broad categories : (i) raw materials, (ii) processed industrial materials and components, (iii) auxiliary materials and factory supplies, and (iv) utilities. The acquisition of technology from some other enterprise may be by way of (i) technology licensing, (ii) outright purchase, or (iii) joint venture arrangement. Appropriate technology refers to those methods of production which are suitable to local, economic, social, and cultural conditions. Several factors have a bearing on the plant capacity decision: technological requirements input constraint, investment cost, market conditions, resources of the firm, and governmental policy. The choice of location is influenced by a variety of considerations: proximity to raw materials and markets, availability of infrastructure facilities, and other factors. Once a broad location is chosen, the attention needs to be focused on the selection of a site a specific piece of land where the project would be set up.

8.6 GLOSSARY

- **Contingency Plan** An alternative for action if the expected result fails to materialize.
- **Culture** : The way of life of any group of people.
- **Discipline** : An area of expertise.
- **Environment** : Everything outside the system that delivers inputs or receives outputs from the system.
- **Facilitator** : A person who helps people overcome problems, either with technical issues or with other people
- **Function** : One of the standard organization disciplines such as finance, marketing, accounting, or operations.
- **Micro culture** : The corporate culture within the organization or even project

8.7 REVIEW QUESTIONS

1. What aspects are considered in Technical Feasibility?
2. List the key issue covered in Technical Feasibility.
3. How would you evaluate the appropriateness of a technology?
4. Describe the different charts and layout drawings.

8.8 FURTHER READINGS

1. ***Prasanna Chandra,*** *PROJECTS- Planning, Selection, Financing, Implementation, and Review,* ***Sixth Edition, Publication: TATA McGraw HILL.***
2. Dennis Lock, **Project Management,** Ninth Edition, Publication: Gower.
3. P.C.K. Rao, **Project Management and Control,** Publication: Sultan Chand & Sons.
4. Vasant Desai, **Project Management,** Second Revised Edition, Publication: Himalaya Publishing House.
5. Clements / Gido, **Effective Project Management,** Publication: Thomson.
6. K. Nagarajan, **Project Management,** Third Edition, Publication: New Age International.

ANSWER KEY:

1. c, **2.** b, **3.** F, **4.** T, **5.** c, **6.** c, **7.** T, **8.** T, **9.** b, **10.** b, **11.** T, **12.** T.

LESSON NO. 9: RISK ANALYSIS AND MANAGEMENT

STRUCTURE

9.0 AIMS AND OBJECTIVES

This lesson deals with the concept of Risk Analysis and Management of Projects. What is Risk? Why it needs proper management? etc. After reading this lesson, you will be able to understand :

- Risk in Project Management
- Risk Management Process
- Probability Analysis in Risk Management
- Contingency Planning
- Detailed Project Report

9.1 INTRODUCTION

A good planning phase for a project includes many things like time analysis, assignments of the tasks etc. and among them it also includes a risk analysis which consists primarily of a collective brain storming involving all project team. It is recommended to be done after the plan has been elaborated. During the risk analysis you must not focus only on the technical risk because many times risks come up from places that you expect the less, like organization, team problems, partnership problems etc. Remember that everything that you do is connected to people, and people can be wrong sometimes. People can also argue and this can seriously affect the project.

Thus, risk is always inherent in a project. No amount of planning can overcome the inability*to control chance events. In the context of projects, risk is an uncertain event or condition that, if it occurs, have a positive or negative effect on project objectives A risk has a cause and occurs as a consequence. For example, a cause may be a flu virus or change in scope requirements. The event is that team members get stricken with the flu or the product has to be redesigned. If either of these in events occurs, it will impact the cost, schedule, and quality of the project.

Some potential risk events can be identified before the project starts such as equipment malfunction or change in technical requirements. Risks can be anticipated consequences, like schedule slippages or overruns.. Risks can be beyond imagination like the September 11, 2001, attack on the Twin Towers of New York City.

Risk management attempts to recognize and manage potential and unforeseen trouble spots that may when the project is implemented. Risk management identifies as many risk events as possible can go wrong), minimizes their impact (what can be done about the event before the project be manages responses to those events that do materialize (contingency plans), and provides contingency funds to cover risk events that actually materialize.

9.2 WHAT IS PROJECT RISK?

A risk is any factor that may potentially interfere with successful completion of the project. A risk is not a problem - a problem has already occurred; a risk is the recognition that a problem might occur. By recognizing potential problems, the project manager can attempt to avoid a problem through proper actions.

9.3 RISK MANAGEMENT PROCESS

The chances of a risk event occurring (e.g., an error in time estimates, cost estimates, or design technology) are greatest in the concept, planning, and start up phases of the project. The cost impact of a risk event in the project is less if the event occurs earlier rather than later. The early stages of the project represent the period when the opportunity for minimizing the impact or working around a potential risk exists. Conversely, as the project passes the halfway mark, the cost of a risk event occurring increases rapidly. For example, the risk event of a design flaw occurring after a prototype has been made has a greater cost or time impact than if the event occurred in the startup phase of the project. Clearly, identifying project risk events and deciding a response before the project begins is a more prudent approach than not attempting to manage risk.

Risk management is a proactive approach rather than reactive. It is a preventive process designed to ensure that surprises are reduced and that negative consequences associated with undesirable events minimized. It also prepares the project manager to take risk. Successful management of project risk gives the project manager better control over future and can significantly improve chances of reaching project objectives on time, within budget meeting required technical (functional) performance.

The sources of project risks are unlimited. There are sources external to the organization, such as inflation, market acceptance, exchange rates, and government regulations. In practice, these risk events often referred to as threats to differentiate them from those that are not within the project management or team's responsibility area. Since such external risks are usually considered before the decision to go ahead with the project, they will be excluded from the discussion of project risks. However, external risks are extremely important and must be addressed.

The major components, of the risk management process are explained below:

9.3.1 Step 1: Risk Identification

The risk management process begins by trying to generate a list of all the possible risks that could affect the project. Typically, the project manager pulls together, during the planning phase, a risk management team consisting of core team members and other relevant stakeholders. The team uses brainstorming - and other problem identification techniques to identify potential problems. Participants are encouraged to keep an open mind and generate as many probable risks as possible. More than one project has been bushwhacked by an event that members thought was preposterous in the beginning. Later during the assessment phase, participants will have a chance to analyze and filter out unreasonable risks.

One common mistake that is made early in the risk identification process is to focus on consequences and not on the events that could produce consequences. For example, team members may identify failing to meet schedule as a major risk. What they need to focus on are the events that could cause this to happen (i.e., poor estimates, adverse weather, shipping delays, etc.). Only by focusing on actual events can potential solutions be found.

The focus in the beginning should be on risks that can affect the whole project as opposed to a specific section of the project or network. After the macro risks have been identified, specific areas can be checked. An effective tool for identifying specific risks is the work breakdown structure (WBS). Use of the WBS reduces the chance a risk event will be missed. On large projects multiple risk teams are organized around specific deliverables and submit their risk management reports to the project manager.

A risk profile is another tool that can help management teams identify and eventually analyze risk profile is a list of questions that address traditional areas of uncertainty on a project. The questions have been developed and refined from previous, similar projects.

Good risk profiles are tailored to the type of project in question. For example, building an information system is different from building a new car. They are organization specific. Risk profiles recognize the unique strengths and weaknesses of the firm. Finally, risk profiles address both technical and management risks.

Risk profiles are generated and maintained usually by personnel from the project

office. They are dated and refined during the post project audit. These profiles, when kept up to can be a powerful resource in the risk management process. The collective experience of the firm's projects resides in their questions.

The risk identification process should not be limited to just the care team. Input from customers, sponsors, subcontractors, vendors, and other stakeholders should be solicited. Relevant stakeholders can be formally interviewed or included on the risk management team. Not only do these players have a valuable perspective, but by involving them in the risk management process they also become more tied to project success.

> One of the keys to success in risk identification is attitude. While a "can do" attitude is essential during implementation, project managers have to encourage critical thinking when it comes to risk identification. The goal is to find problems before they happen, and participants need to believe in Murphy's "anything that can go wrong, will go wrong."

9.3.2 Step 2: Risk Assessment

Step 1 produces a list of potential risks. Not all of these risks deserve attention. Some are trivial and can ignored, while others poise serious threats to the welfare of the project. Managers have to develop methods for sifting through the list of risks eliminating inconsequential or redundant ones and stratifying worthy ones in terms of importance and need for attention.

9.3.2.1 Scenario analysis

It is the easiest and most commonly used technique for analyzing risks. Team members assess each risk in terms of.

1. The undesirable event.
2. All the outcomes of the event's occurrence.
3. The magnitude or severity of the event's impact.
4. Chances/probability of the event happening.
5. When the event might occur in the project.
6. Interaction with other parts of this or other projects.

For example, assume the chances of a resource shortage of a particular skill are about 80 percent. The outcomes could be a delayed project, tighter scheduling and less flexibility, increased cost, etc. The impact could be a 10 percent increase in cost and a 5 percent delay in project duration. The shortage will show up in the design stage of the project. A delay in this project may delay other projects or require a change in priorities. Having this information available facilitates the assessment of each risk event worthy of attention. Documentation of scenario analyses can be seen in various risk assessment forms used by the companies. The project team identifies risk including interface problems with current software systems, the system freezing after installation, end-users resisting and complaining about the changes, and hardware equipment malfunctioning. In addition to assessing the chances, severity, and when the event is likely to occur, the project team also assesses whether they would be able to detect that the event was going to occur in time to take mitigating action.

Often organizations find it useful to categorize the severity of different risks into some form of assessment matrix. The matrix is typically structured around the impact and likelihood of the risk.

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The matrix is divided into red, yellow, and green zones representing major, moderate, and risks, respectively. The red zone is centered on the top right comer of the matrix, (high impact/high likelihood), while the green zone is centered on the bottom left comer (low impact/low likelihood). Moderate risk, yellow zone extends down the middle of the matrix. Since impact is generally considered more important than likelihood, the red zone (major risk) extends farther down the high impact column.

Using the Windows Office 2000 project again as an example, interface problems and system freezing would be placed in the red zone (major risk), while user backlash and hardware malfunctioning be placed in the yellow zone (moderate risk).

The risk severity matrix provides a basis for prioritizing which risks to address. Red zone risks receive first priority followed by yellow zone risks. Green zone risks are typically considered inconsequential and ignored unless their status changes.

9.3.2.2 Sensitivity Analysis

Given the uncertainty that is attached to parameters of all projects, sensitivity analysis is a useful tool for the analysis of projects from all sectors. It involves recalculating project results for different values of major variables that should be varied one at a time. The key issue is to identify the variables to which a project is most sensitive and to take mitigating action to ensure, as much as possible, that unfavorable shifts in these variables do not occur. For projects, key areas of uncertainty are likely to occur in relation to project costing (have capital and operating cost estimates been prepared accurately?) and project coverage (what proportions the project is able to reach?).

There are several procedures for sensitivity analysis which can be used,

(i) list the variables to which the project is likely to be most sensitive and based on experience and past data, assume alternative values for these variables that differ from the value used in the original or base case project calculation;

(ii) recalculate the project analysis using the alternative values for the key variables, changing these independently of each other;

(iii) compare the percentage change in the measure of project worth with the percentage change in the key variables to give a sensitivity indicator;

(iv) for variables to which the project is sensitive, show the switching value (that is, the percentage change in a variable which is sufficient to alter the original decision on the project) to make it acceptable if it was previously unacceptable, or vice versa; and

(v) if it is judged likely that some variables may move together, the impact of a change in a combination of two or more variables on project worth can also be tested.

Productive sector projects are normally appraised using the net present value(NPV) and IRR indicators of project worth. The sensitivity indicator and switching value should be calculated using a change in a project's NPV measured either at financial or economic prices, or both.

9.3.3 Step 3: Risk Response Development

When a risk event is identified and .assessed, a decision must be made concerning which response is appropriate for the specific event. Responses to risk can be classified as mitigating, avoiding, transferring, sharing, or retaining. .

Mitigating Risk

Reducing risk is usually the first alternative considered. There are basically two strategies for mitigating (1) reduce the likelihood that the event will occur and/or (2) reduce the impact that the adverse would have on the project. An example of the former can be found in an information systems project. The project team was responsible for installing a new operating system in their parent company: Before implementing the project, the team tested the new system on a smaller isolated network. By doing so they discovered a variety of problems and were able to come up with solutions prior to implementation. The team still encountered problems with the installation but the number and severity were greatly reduced. Other examples of reducing the probability of risks occurring are scheduling outdoor work during the summer months, investing in up front safety training, and choosing high quality materials and equipment.

When the concerns are that duration and costs have been underestimated; managers, will augment estimates to compensate for the uncertainties. It is common to use a ratio between old and new project to adjust time or cost. The ratio typically serves as a constant. For example, if past projects have taken 10 minutes per line of computer code, a constant of

1.10 (which represents a 10 percent increase) would be used for the proposed project time estimates because the new project is more difficult than prior projects.

An alternative mitigation strategy is to reduce the impact of the risk if it occurs. For example, a bridge building project illustrates risk reduction. A new bridge project for a coastal port was to use an innovative, continuous cement-pouring process developed by an

Australian firm to save large sums of money and time. The major risk was that the continuous pouring process for each major section of the bridge could not be interrupted. Any interruption would require that the whole cement section (hundreds of cubic yards) be turn down and started over. An assessment of possible risks centered on delivery of the cement from the cement factory. Trucks could be delayed, or the factory could break down. Such risks would result in tremendous rework costs and delays. Risk was reduced by having two additional portable cement plants built nearby on different highways within 20 miles of the bridge project in case the main factory supply was interrupted. These two portable plants carried raw materials for a whole bridge section, and extra trucks were on immediate standby each time continuous pouring was required. Similar risk reduction scenarios are apparent in system and software development projects where parallel innovation processes are used in case one fails.

Avoiding Risk

Risk avoidance is changing the project plan to eliminate the risk or condition. Although it is impossible to eliminate all risk events, some specific risks may be avoided before you launch the project. For example, adopting proven technology instead of experimental technology can eliminate technical failure. Choosing an Australian supplier as opposed to an Indonesian supplier would virtually eliminate chance that political unrest would disrupt the supply of critical materials.

Transferring Risk

Passing risk to another party is common; this transfer does not change risk. Passing risk to another almost always results in paying a premium for this exemption. Fixed-price contracts are the classic example of transferring risk from an owner to a contractor. The contractor understands his or her firm pays for any risk event that materializes; therefore, a monetary risk factor is added to the contract price. Before deciding to transfer risk, the owner should decide which party can best control activity that would lead to the risk occurring. Also, is the contractor capable of absorbing the risk? Clearly identifying and documenting responsibility for absorbing risk is imperative. Another more obvious way of transfer of risk is insurance. However, in most cases this is impractical because defining the project: event and conditions to an insurance broker who is unfamiliar with the project is difficult and usually expensive. Of course, low probability and high consequence risk events such as acts of God are more easily defined and insured. Performance bonds, warranties, and guarantees are other financial instruments used to transfer risk.

Sharing Risk

Risk sharing allocates proportions of risk to different parties. An example of risk sharing was the Airbus A340. Research and development risks were allocated among European countries including Britain and France. Alternatively, the entertainment industry formed a consortium to define a common operating format for Digital Video Disc (DVD) to ensure compatibility across products.

Sharing risk has drawn more attention in recent years as a motivation for reducing risk and, in' some cases, cutting project cost. Partnering between an owner and contractors has prompted the development of continuous improvement procedures to encourage contractors to suggest innovative ways for project implementation. The new method will probably include additional startup costs and the risk that the new process may not work. Usually, the risk costs and benefits of the improved process are shared on a 50/50 basis between the owner and contracting firms.

Retaining Risk

In some cases, a conscious decision is made to accept the risk of an event occurring. Some risks are so large it is not feasible to consider transferring or reducing the event (e.g., an earthquake or flood). The project owner assumes the risk because the chance of such an event occurring is slim. In other cases, risks identified in the budget reserve can simply be absorbed if they materialize. The risk is retained by developing a contingency plan to implement if the risk materializes. In a few cases a risk event can be ignored and a cost overrun accepted should the risk event occur.

The more efforts to risk response before the project begin, the better are the chances of minimizing project surprises. Knowing that the response to a risk event will be

retained, transferred, or shared greatly reduces stress and uncertainty when the risk event occurs.

SELF CHECK EXERCISE

1. **What is the primary recommendation regarding risk analysis in a project?**
   a. It should be done before project planning.
   b. It should focus only on technical risks.
   c. It should involve only the project manager.
   d. It is recommended to be done after the plan has been elaborated.
2. **According to the text, what is a risk in the context of projects?**
   a. A problem that has already occurred
   b. An event that will definitely occur
   c. An uncertain event or condition with potential effects on project objectives
   d. A positive outcome that might happen
3. **What is the purpose of risk management in a project?**
   a. To eliminate all risks
   b. To recognize and manage potential and unforeseen trouble spots
   c. To transfer all risks to external parties
   d. To create uncertainty and challenges for the project team
4. **What is sensitivity analysis used for in the context of project risk management?**
   a. Identifying potential risks
   b. Analyzing project results for different values of major variables
   c. Developing contingency plans
   d. Avoiding risks altogether
5. **What is the purpose of a risk severity matrix?**
   a. To ignore inconsequential risks
   b. To prioritize risks based on impact and likelihood
   c. To transfer risks to external parties
   d. To eliminate all risks from the project
6. **Risk management is a reactive approach designed to deal with problems after they occur. T/F**
7. **Mitigating risk involves reducing the likelihood that a risk event will occur or reducing its impact. T/F**
8. **Risk avoidance is changing the project plan to embrace all identified risks. T/F**
9. **Transferring risk to another party usually results in not paying any premium for the exemption. T/F**
10. **Retaining risk means accepting the risk of an event occurring without any contingency plan. T/F**

9.4 SUMMARY .

To put the processes discussed in this lesson in proper perspective one should recognize that the essence of project management is risk management. Project selection systems try to reduce the likelihood that projects will not contribute to the mission of the firm. Project scope statements, among other things, are designed to avoid costly misunderstandings and reduce scope creep. Work breakdown structures reduce the likelihood that some vital part of the project will be omitted or that the budget estimates are unrealistic. Teambuilding reduces the likelihood of dysfunctional conflict and breakdowns in coordination. All of the techniques try to increase stakeholder satisfaction and increase the chances of project success. From this perspective managers engage in risk management activities to compensate for the uncertainty inherent in project management and that things never go according to plan. Risk management is not reactive. It reduces the number of surprises and leads to a better understanding of the most outcomes of negative events.'

9.5 GLOSSARY

- **Project Risk** : A risk is any factor that may potentially interfere with successful completion of the project.

- **Risk** : The possibility of suffering harm or loss.
- **Risk Assessment** : Consists of the two traditional components: risk identification and risk prioritization.
- **Risk Control** : Minimizing and reacting to problems arising from risks throughout the project life.
- **Risk Planning** : Includes making contingency plans where appropriate, adding these plans into the project's overall task structure

9.6 REVIEW QUESTIONS

1. . Project Risk can/cannot be eliminated if the project is carefully planned. Explain.
2. The chances of risk events occurring and their respective costs increasing change over the project life cycle. What is the significance of this phenomenon to a project manager?
3. What is the difference between avoiding a risk and accepting a risk?

9.7 FURTHER READINGS

1. Clifford F. Gray and Erik W. Larson, **Project Management,** Publication: TATA McGraw HILL
2. Prasanna Chandra, **PROJECTS**- **Planning, Selection, Financing, Implementation, and Review,** Sixth Edition, Publication: TATA McGraw HILL
3. Dennis Lock, **Project Management,** Ninth Edition, Publication: Gower
4. P.C.K. Rao, **Project Management and Control,** Publication: Sultan Chand & Sons
5. Vasant Desai, **Project Management,** Second Revised Edition, Publication: Himalaya Publishing House
6. Clements / Gido, **Effective Project Management,** Publication: Thomson
7. K. Nagarajan, **Project Management,** Third Edition, Publication: New Age International.

ANSWER KEY:

1. d, **2.** c, **3.** b, **4.** b, **5.** b, **6.** F, **7.** T, **8.** F, **9.** F, **10.** F.

Lesson No. 10_____ AUTHOR : NEERAJ SHARMA

RISK AND UNCERTAINTY IN PROJECTS

STRUCTURE

10.0 *AIMS AND OBJECTIVES*

This lesson deals with the concept of Risk Analysis and Management of Projects. After reading this lesson, you will be able to understand :

- Risk in Project Management
- Risk Analysis and Management
- Contingency Planning
- Detailed Project Report

10.1 *INTRODUCTION TO CONTINGENCY PLANNING*

A contingency plan is an alternative plan that will be used if a possible foreseen risk event becomes a reality. The contingency plan represents actions that will reduce or mitigate the negative impact of event. Like all plans, the contingency plan answers the questions of what, where, when, and how action will take place. The absence of a contingency plan, when a risk event occurs, can cause manager to delay or postpone the decision to implement a remedy. This postponement can lead to panic, and acceptance of the first remedy suggested. Such after-the-event decisions making under pressure are potentially dangerous and costly. Contingency planning evaluates alternative remedies for possible foreseen events before the risk event occurs and selects the best plan among alternatives. This early contingency planning facilitates a smooth transition to the remedy or work around plan. The availability contingency plan can significantly increase the chances! for project success.

Conditions for activating the implementation of the contingency plan should be decided and documented. The plan should include a cost estimate and identify the source of funding. All parties affected should agree to the contingency plan and have authority to make commitments. Because implementation of a contingency plan embodies disruption in the sequence of work, all contingency should be communicated to team members so that surprise and resistance are minimized.

10.2 *METHODS FOR HANDLING RISK*

Some of the most common methods for handling risk are discussed below:

- Technical Risk
- Schedule Risk
- Use of Slack
- Imposed Duration Dates
- Compression of project Schedules

Technical Risks

Technical risks are problematic; they can often be the kind that causes the project to be shut down. What if system or process does not work? Contingency or backup plans are made for those possibilities that Eire beyond control. For example, Carrier Transcicold was involved in developing a new Phoenix refrigeration unit for truck and trailer applications. This new unit was to use rounded panels made of bonded metals, which at the time was new technology for Transcicold. Furthermore, one of its competitors had tried unsuccessfully to incorporate similar bonded metals in their products. The project team was eager to make the new technology work, but it was not until the very end of the project that they were able to get the new adhesives to bond adequately to complete the project. Throughout the project, the team maintained a welded panel fabrication approach just in case they were unsuccessful. If this contingency approach had been needed, it would have increased production costs, but the project still would have been completed on time.

In addition to backup strategies, project managers need to develop methods to quickly assess whether technical uncertainties can be resolved. The use of sophisticated CAD programs has greatly helped resolve design problems. At the same time, Smith and Reinertsen, in their book Developing Products in Half the Time, argue that there is no substitute for making something and seeing how it works and feels. They suggest that one should first identify the high-risk technical areas, then build models or deign experiments to resolve the risk as quickly as possible. By isolating-and testing the key technical questions early on in a project, project feasibility can be quickly determined and necessary adjustments made such as reworking the process or in some cases closing down the project. Usually the owner and project manager make decisions concerning technical risks.

Schedule Risks

Managing scheduling risk usually requires trade off decisions. It is ironic that practicing managers actually increase schedule risk by some of their decisions.

Use of Slack

When some managers see network slack, they cease to worry about completing their activity on time - why worry if there are 10 days of slack! Unfortunately, that slack may be needed by another activity on le path that now must start later and leave little or no slack available because the path slack has already been used up. Managing slack can be an excellent method for reducing schedule risk. Remember, use of slack moves more activities nearer their late start, and thus the risk of project delay is increased.

Imposed Duration Dates

About 80 percent of all projects have imposed duration dates. Usually this means someone (with authority) has determined that the project or milestone(s) can or must be completed by a specific date. Examples might be completing a road by January 10th or developing a video game for the Diwali festival. The specified project duration is frequently a top down decision that does not include bottom up planning and often understates the normal time required to complete the project. If this is the case, meeting the required, specified project duration will result in activities being performed more rapidly than the normal, low-cost method. This hurried approach increases cost and the chance of activities being late and reduces flexibility in the total scheduling system. There are times when completing a project by an imposed duration is necessary, but in almost all cases of imposed project durations, both risks of being late and greater costs are increased.

Compression of Project Schedules

Sometimes before or midway through the project, the need to shorten the project duration arises. Shortening project duration is accomplished by shortening (compressing) one or more activities on the critical path. Shortening activity/work package duration increases direct cost. In addition, compressing the, critical path decreases total slack mother paths, and more paths become critical or near critical. The more critical activities or near critical activities there are, the higher the risk of delaying project completion. Some contingency plans can avoid costly procedures.

10.11.1 Self-Check Exercise- 1

- A Contingency Plan is an alternative plan used when a foreseen risk event becomes a reality. It helps reduce or mitigate the negative impact of the event. (True/False)
- The absence of a contingency plan when a risk event occurs can lead to panic and acceptance of the first remedy suggested. (True/False)
- Conditions for activating the implementation of the contingency plan should be decided and documented. (True/False)
- Technical Risks are problematic and can often cause a project to be shut down. (True/False)

10.3 *COST RISKS*

Given some of the reported cost overruns, cost risks are significant and carry heavy consequences. Most cost risks are created through schedule and technical estimate errors and omissions. In addition, some management decisions actually increase cost risks. A few selected cost risks found in practice are given below.

- Time/Cost Dependency Link
- Cash Flow Decision
- Price Protection Risk

10.4 *FUNDING RISK*

What if the funding for the project is cut by 25 percent or completion projections indicate that costs greatly exceed available funds? What are the chances of the project being canceled before completion? Seasoned project managers recognize that a complete risk assessment must include an evaluation of funding supply. Just as government projects are subject to changes in strategy and political agenda, business frequently undergo changes in priorities and top management. Resources become tight and one way to fund new projects is to cancel other projects. Severe budget cuts or lack of adequate funding can have a devastating effect on a project. Typically when such a fate occurs, there is a need to scale back the scope of the project to what is possible. "All-or- nothing projects" are ripe targets to budget cutters. On a much smaller scale, similar funding risks may exist for more mundane projects. For example, a building contractor may find that due to a sudden downturn in the stock market the owners can no longer; afford to build their dream house.

10.1.1 **Self-Check Exercise- 2**

- About 80 percent of all projects have imposed duration dates, often set without bottom-up planning. (True/False)
- Funding Risk is evaluated by considering the possibility of a project being canceled due to budget cuts or lack of adequate funding. (True/False)
- The last step in the risk management process is Risk Response Control, which includes executing the risk response strategy and monitoring triggering events. (True/False)
- Project managers need to establish an environment where participants feel comfortable raising concerns and admitting mistakes to facilitate effective Risk Control. (True/False)

10.5 *RISK RESPONSE CONTROL*

The last step in the risk management process is risk control executing the risk response strategy, monitoring triggering events, initiating contingency plans, and watching for new risks. Establishing a change management system to deal with events that require formal changes in the scope, budget, and/or schedule of the project is an essential element of risk control.

Project managers need to monitor risks just like they track project progress. Risk assessment and updating needs to be part of every status meeting and progress report system. The project team needs to be on constant alert for new, unforeseen risks. Management needs to be sensitive that others may not be forthright in acknowledging new risks and problems. Admitting that there might be a bug in the design code or that different components are not compatible reflects poorly on individual performance. If the prevailing organizational culture is one where mistakes are punished severely, then it is only human nature to protect oneself. Similarly, if bad news is greeted harshly and there is a propensity to "kill the messenger," then participants will be reluctant to speak freely. The tendency to suppress bad news is compounded when individual responsibility is vague and the project team is under extreme pressure from top management to get the project done quickly.

Project managers need to establish an environment in which participants feel comfortable raising concerns and admitting mistakes. The norm should be that mistakes are acceptable, hiding mistakes is intolerable. Problems should be embraced not denied. Participants should be encouraged to identify problems and new risks. Here a positive attitude by the project manager toward risks is a key.

On large, complex projects it may be prudent to repeat the risk identification/ assessment exercise with fresh information. Risk profiles should be reviewed to test to see if the original responses held true. Relevant stakeholders should be brought into the discussion. While this may not be practical on an ongoing basis, project managers should touch base with them on a regular basis or hold special stakeholder meetings to review the status of risks on the project.

A second key for controlling the cost of risks is documenting responsibility. This can be problematic in projects involving multiple organizations and contractors. Responsibility for risk is frequently passed on to others with the statement, "That is not my worry." This mentality is dangerous. Each identified risk should be assigned (or shared) by mutual agreement of the owner, project manager, and the contractor, or person having line responsibility for the work package or segment of the project. It is best to have the line person responsible approve the use of budget reserve funds and monitor their rate of usage. If management reserve funds are required, the line person should play an active role in estimating additional costs and funds needed to complete the project. Having line personnel participate in the process focuses attention on the management reserve, control of its rate of usage, and early warning of potential risk events. If risk management is not formalized, responsibility and responses to risk will be ignored it is not my area.

The bottom line is that project managers and team members need to be vigilant in monitoring potential risks and identify new land mines that could derail a project. Risk assessment has to be part of the working agenda of status meetings and when new risks emerge they need to be analyzed and

10.6 *DETAILED PROJECT REPORT*

Preparation of detailed project report is further step in firming up the proposal. When an investment proposal has been approved on the basis functional report and the proposal is a major proposal, it would be necessary to detailed project report to firm up the proposal for the capital cost as well as the various facilities. It includes:

- Examination of technological parameters
- Description of the technology to be used
- Broad technical specification
- Evaluation of the existing resources
- Schedule plan
- General layout
- Volume of work

Hence, these reports are to be made before investment is made into project. Thus formulation of investment is based on the studies is made. These can be considered as pre-investment decision. Detailed project report is prepared only for the investment decision-making approval, but also execution of the project and also preparation of the plan. Detailed project report additionally includes that is contents in addition to Feasibility study reports are.

- Project description
- Planning and implementation of the project
- Specifications
- Layouts and flow diagrams

Detailed project report is a complete document for investment decision-making, approval, planning whereas feasibility study report is a base document for investment decision-making. Detailed project report is base document for planning the project and implementing the project.

During the process of execution of projects, an important tool of management system is reports and reporting system for the progress monitoring of the projects. The objective of the reports is to inform to all concerned agencies and departments about the project on its physical as well as financial progress. During the execution process, certain problems are faced and at the same time, certain facilitating factors also come across.

These favourable and unfavorable factors become important lessons for ongoing as well as future projects. Therefore, it becomes necessary to examine the aspects on completion of the projects. It is the practice in many organizations to prepare the post project evaluation and completion audit report.

Usefulness of reporting system in project management :

- Accomplishments since prior submitted reports
- Address important points in the reports
- Status of project performance
- Identifying potential problems
- Planned action
- Milestone expected to achieve.

Unless there is a proper reporting and monitoring system, people as well as departments concerned with the projects, may not know the complete details of the project. Thus, DPR is an important role in the execution and management of projects. Reports are

prepared and submitted on physical as well as financial progress. Thus, preparation of reports will depend upon types of organization. During the commissioning of the project, reporting may be more frequent.

These reports may be required to be submitted to various authorities within the project management itself, executive director, manager Monthly reports are submitted to chief executive officer highlighting the action points at the higher levels. The project report are prepared by,

(a) Report prepared by consultants, the consultant will substitute the function of an in-house project department reports will be more or less on the same lines as prepared by the in-house departments for the projects supervised departmentally.

(b) Report prepared by the turnkey contractors, summary of important events in the months, key areas for action future, progress under various activities planned, submission and approval of design algorithm of the projects, procurements.

(c) Reports prepared by the in-house project department, project department prepare two types of reports. One type of reports is supervising the projects being executed by the non-turnkey basis and the other type o ' report shall be a report as an independent project department. This report would be prepared and submitted to all the authorities.

Usually, a Project requires preparation and submission of the following reports

1. Monthly progress report — Important events.
   — Profitability achieved for that period.
   — New projects signed.

2. Summary report — Status report for the on going project, it includes status of activities, sanctioned costs, schedule of commissioning.

3. Chairman's report — Highlights on the achievements of milestones. Physical progress on contract packages which includes project sanction date, commissioning date, total sanctioned cost of the project, activity-wise progress. Project-wise milestones include activities, remarks about the status, schedule completion date.

10.6.1 ***Detailed project report versus feasibility study report***

• Feasibility study report is prepared to support the investment proposal. Feasibilities for the various aspects related to technical, commercial and financial are examined in detail by the experts and consultants brought in feasibility study report. Feasibility study report is 'termed as a techno economic feasibility study.

It is the primary report for the formulation of the investment proposal. Investment decisions are taken based on the details incorporated in the study. Thus feasibility is prepared only for the formulation and investment decision-making. The first step in feasibility study is the needs analysis. The purpose is to define overall objectives of the system proposed to be designed. The second and perhaps the most important thing is system

identification. This is referred to as activity analysis.

A Feasibility study report contains :

- A broad indication of demand and availability of the product.
- Required sources for the development of the project.
- Selection of suitable process and technology.
- Fixation of capacity on the basis of the project.
- Process description and layout plans for the project.
- Available facilities.
- Evaluation of available facilities.
- Capital cost.
- Profitability analysis.
- Project schedule and schedule control.
- Design and flow diagrams.

After the preparation of feasibility study report has been prepared, it should be submitted to the experts the concerned departments of operation such as finance, commercial, project etc examine this. In case of any differences, the feasibility study report is discussed with the experts, consultants and is modified according to it.

10.7 *SUMMARY*

Although many managers believe that in the final analysis, risk assessment and contingency depend on subjective judgment, some standard method for identifying, assessing, and responding to risks should be included in all projects. The very process of identifying project risks forces some discipline at all levels of project management and improves project performance. Contingency plans increase the chance that the project can be completed on time and within budget, Responsibility for risks should be clearly identified and documented. It is desirable and prudent to keep a reserve as a hedge against project risks. Use of contingency reserves should be closely monitored, controlled, and reviewed throughout the project life cycle.

Experience clearly indicates that using a formal, structured process to handle possible foreseen and unforeseen project risk events minimizes surprises, costs, delays, stress, and misunderstandings. Risk management is an iterative process that occurs throughout the lifespan of the project. When risk events occur or changes are necessary, using an effective change control process to quickly approve and record changes will facilitate measuring performance against schedule and cost. Ultimately successful risk management requires a culture in which threats are embraced not denied and problems are identified not hidden.

10.8 *GLOSSARY*

- *Risk Management Plan* : A coordinated and planned approach to minimize evepts that would have a negative impact on the project.
- *Constraint* : An imposed restriction or limitation that may impact the project execution or outcome.
- *Program Management* : The competency of managing the interdependency between projects.
- *Risk Monitoring* : It is an ongoing activity throughout the whole project to monitor the likelihood of a hazard; and the impact of the problem caused.

10.9 *SHORT QUESTIONS*

1. What is the difference between mitigating a risk and contingency planning?
2. Discuss where in the five-phase life cycle of a project do you thir.k the most failures occur? Defend your answer.
3. You are the project manager of a caveman group going out to hunt some animal. Describe your efforts at risk mitigation.
4. For each of the project management approaches identify a project from your experience that seems to be a good fit. Explain your choices.

10.10 **Answers to Self-Check Exerciese:**

- **Exercise 1:**
  - True
  - True
  - True
  - True
- **Exercise 2:**
  - True
  - True
  - True
  - True

10.11 *FURTHER READINGS*

1. Clifford F. Gray and Erik W. Larson, *Project Management,* Publication: TATA McGraw HILL
2. Prasanna Chandra, *PROJECTS' Planning, Selection, Financing, Implementation, and Review,* Sixth Edition, Publication: TATA McGraw HILL
3. Dennis Lock, *Project Management,* Ninth Edition, Publication: Gower
4. P.C.K. Rao, *Project Management and Control,* Publication: Sultan Chand & Sons
5. Vasant Desai, *Project Management,* Second Revised Edition, Publication: Himalaya Publishing House
6. Clements / Gido, *Effective Project Management,* Publication: Thomson
7. K. Nagarajan, *Project Management,* Third Edition, Publication: New Age International

SOCIAL COST BENEFIT ANALYSIS

STRUCTURE

11.0 *AIMS AND OBJECTIVES*

This lesson deals with the Social Cost Benefit Analysis. After reading this lesson, you will be able to understand :

- The concept of Social Cost Benefit Analysis
- Rationale Behind SCBA
- UNIDO Approach
- Shadow pricing

11.1 *INTRODUCTION*

Social Cost Benefit Analysis (hereafter referred to as SCBA), called economic analysis, is a methodology developed for evaluating investment projects from the point of view of the society (or economy) as a whole. Used primarily for evaluating public investments (though it can be applied to both private and public investments), SCBA has received a lot cf emphasis in the decades of 1960s and 1970s in view of the growing importance of public investments in many countries, particularly in developing countries, where governments have played a significant role in the economic development. SCBA is also relevant, to a certain extent, to private investments as these have now to be approved by various governmental and quasi governmental agencies which bring to bear larger national considerations in their decisions.

In the context of planned economies, SCBA aids in evaluating individual projects within the planning framework which spells out national economic objectives and broad allocation of resources to various sectors. In other words, SCBA is concerned with tactical decision making within the framework of broad strategic choices defined by planning at the macro level. The perspectives and parameters provided by the macro level plans serve as the basis of SCBA tohich is a tool for analysing and appraising individual projects.

This lesson discusses various aspects of SCBA. It is divided into ten sections as follows :

- Rationale for SCBA
- UNIDO approach
- Net benefit in terms of economic (efficiency) prices

- Savings impact and its value
- Income distribution impact
- *Adjustment for merit and demerit goods*
- Shadow prices
- SCBA by financial institutions
- Public sector investment decisions in India

11.2 *RATIONALE FOR SCBA*

In SCBA the focus is on the social costs and benefits of the project. These often tend to differ from the monetary costs and benefits of the project.

The principal sources of discrepancy are :

- Market imperfections
- Externalities
- Taxes and subsidies
- Concern for savings
- Concern for redistribution
- ***Merit Wants Market Imperfections***

Market prices, which form the basis for computing the monetary costs and benefits from, the point of view of the project sponsor reflect social values only under conditions perfect competition, which are rarely, if ever, realised by developing countries. When imperfections exist, market prices do not reflect social values.

The common market imperfections found in developing countries are : (i) rationing (ii) prescription of minimum wage rates, and (iii) foreign exchange regulation. Rationing of, a commodity means control over its price and distribution. The price-paid by'a consumer under rationing is often significantly less than the price that would prevail in a competitive market. When minimum wage rates are prescribed, the wages paid to labour are usually more than what the wages would be in a competitive labour market free from such wage legislations. The official rate of foreign exchange in most of the developing countries, whhic6h exercise close regulation over foreign exchange, is typically less than the rate that would prevail in the absence of foreign regulation. This is whv foreign exchange usually commands a premium in unofficial transactions.

Externalities

A project may have beneficial external effects. For example, it may create cert infrastructural facilities like roads which benefit the neighboring areas. Such benefits a considered in SCBA; though they are ignored in assessing the monetary benefits to the, project sponsors because they do not receive any monetary compensation from those who enjoy this external benefit created by the project. Likewise, a project may have a harmful external effect like environmental pollution. In SCBA, the cost of such environmental pollution is relevant, ' though the project sponsors may not incur any monetary costs. It may be emphasized that externalities are relevant in SCBA because in such analysis all costs and benefits, irrespective to whom they accrue and whether they are paid for or not, are relevant. *Taxes and Subsidies*

From the private point of view, taxes are definite monetary costs and subsidies are definite monetary gains. From the social point of view, however, taxes and subsidies are generally regarded as transfer payments and hence considered irrelevant. .

Concern for Savings

Unconcerned about how its benefits are divided between consumption and savings, a private firm does not put differential valuation on savings and consumption. From a social point of view, however, the division of benefits between consumption and savings (which leads to investment) is relevant, particularly in the capital scarce developing countries. A rupee of benefits saved is deemed more valuable than a rupee of benefits consumed. The concern of the society for savings and investment is duly reflected in SCBA wherein a higher valuation is placed on savings and a lower valuation is put on consumption.

Concern for Redistribution

A private firm does not bother how its benefits are distributed across various groups in the society. The society, however, is concerned about the distribution of benefits across different groups. A rupee of benefit going to an economically poor section is considered more valuable than a rupee of benefit going to an affluent section.

Merit Wants

Goals and preferences not expressed in the market place, but believed by policy makers to be in the larger interest, may be referred to as merit wants. For example, the government may prefer to promote an adult education programme or a balanced nutrition programme for school going children even though these are not sought by consumers in the market place. While merit wants are not relevant from the private point of view, they are important from the social point of view.

11.3 *UNIDO APPROACH*

Towards the end of the 1960s and in the early 1970s two principal approaches for SCBA emerged: the UNIDO approach and the Little-Mirrlees approach. This section discusses the UNIDO approach; the following discusses the Little-Mirrlees approach.

The UNIDO approach was first articulated in the Guidelines for Project Evaluation which provides a comprehensive framework for SCBA in developing countries.

The UNIDO method of project appraisal involves five stages :

1. Calculation of the financial profitability of the project measured at market prices.
2. Obtaining the net benefit of the project measured in terms of economic (efficiency) prices.
3. Adjustment for the impact of the project on savings and investment.
4. Adjustment for the impact of the project on income distribution.
5. Adjustment for the impact of the project on merit goods and demerit goods whose social values differ from their economic values.

Eafch stage of appraisal measures the desirability of the project from a different angle. The measurement of financial profitability of the project in the first stage is similar to the financial evaluation discussed at great length in the previous lessons of this book. So, skipping the first stage, we will discuss the remaining stages here.

11.3.1 Self Check Exercise:

- Social Cost Benefit Analysis (SCBA) is primarily used for evaluating private investments.
- SCBA is relevant only for developing countries where governments play a significant role in economic development
- Market imperfections, externalities, taxes, and subsidies are sources of discrepancy between social costs and benefits in SCBA.
- The UNIDO approach for SCBA involves five stages, including the calculation of financial profitability at market prices.

11.4 *SHADOW PRICING*

Impacts of the new working places from the realization of the development projects are frequently the only ones that are valued in monetary terms and get their shadow price enabling the input into the calculation of the economic cash-flow of the project and resulting in indicators. But the methodology of their valuing (setting the shadow price) is often very contradictory, its choice has an important effect on the results of the evaluation and in some cases can also lead to incorrect conclusions and decisions. Among the most important variables with the influence on the setting of the shadow prices of the projects have the following aspects :

- number of the net jobs created;
- benefits from project created;
- time period of the evaluation of the benefits from the project created.

Number of the net jobs created - in the project proposal of the investment activity the number of the new jobs created or jobs necessary for the project sustainability is often indicated. This indicator should be called the gross number of the jobs created, for the economic evaluation it is necessary to convert this value into the net number of the jobs created.

Substitution effect, displacement effect, dead weight effect or multiplication effect can be mentioned as the most important effects with the influence on the conversion. Substitution effect is negative; it covers the project closed down by the project holder because of the realization of the project. A typical example of this is the close down of the manual working places because of the installation of the new full-automatic assembly line. The displacement effect has negative impact as well as the substitution effect. It takes into account close down of the working places elsewhere in-the society. This effect is often neglected during the evaluation of the project, mostly by the intended limitation of the economic jurisdiction of the project. The last negative effect is the dead weight effect representing the jobs created by the project holder and described in the project proposal but not.created independently on the project realization. Against these three negative effects there is only one positive - the multiplication effect. This effect concerns the new working places created in the economy because of the project realization, for example by the suppliers, in services, etc. The individual effects are graphically described in the scheme below. The coefficient of conversion (size of the individual effect) depends on sector characteristic and local conditions of the project realization.

11.5 SUMMARY

Social Cost Benefit Analysis (hereafter referred to as SCBA), called economic analysis, is a methodology developed for evaluating investment projects from the point of view of the society (or economy) as a whole. Used primarily for evaluating public investments (though it can be applied to both private and public investments), SCBA has received a lot of emphasis in the decades of 1960s and 1970s in view of the growing importance of public investments in many countries, particularly in developing countries, where governments have played a significant role in the economic development. SCBA is also relevant, to a certain extent, to private investments as these have now to be approved by various governmental and quasi governmental agencies which bring to bear larger national considerations in their decisions. SCBA aids in evaluating individual projects within the planning framework which spells out national economic objectives and broad allocation of resources to various sectors. In other words, SCBA is concerned with tactical decision making within the framework of broad

strategic choices defined by planning at the macro level. The perspectives and parameters provided by the macro level plans serve as the basis of SCBA which is a tool for analysing and appraising individual projects.

In SCBA the focus is on the social costs and benefits of the project. These often tend to differ from the monetary costs and benefits of the project. The principal sources of discrepancy are :

- Market imperfections
- Externalities
- Taxes and subsidies
- Concern for savings
- Concern for redistribution
- Merit Wants

Towards the end of the 1960s and in the early 1970s two principal approaches for SCBA emerged: the UNIDO approach and the Little-Mirrlees approach. The UNIDO approach was first articulated in the Guidelines for Project Evaluation which provides a comprehensive framework for SCBA in developing countries.

11.6 *GLOSSARY*

- *Social Cost Benefit Analysis (SCBA)* : That is Economic analysis, a methodology developed for evaluating investment projects from the point of view of the society (or economy) as a whole.
- *Analytic Approach* : Breaking problems into their constituent parts to understand the parts better and thereby solve the problem.
- *Benefit-Cost* : A ratio to evaluate a proposed course of action.
- *Champion* : A person who spearheads an idea or action and "sells" it throughout the organization.
- *Contingency Plan* : An alternative for action if the expected result fails to materialize.
- *Culture* : The way of life of any group of people.
- *Discipline* : An area of expertise.
- *Environment* : Everything outside the system that delivers inputs or receives [1] outputs from the system.
- *Facilitator* : A person who helps people overcome problems, either with technical issues or with other people
- *Functional* : One of the standard organization disciplines such as finance, marketing, accounting, or operations.
- *Micro culture* : The corporate culture within the organization, or even within the project.
- *Systems Approach* : A wide-ranging, synthesizes method for addressing problems that considers multiple and interacting relationships. Commonly contrasted with the analytic approach.
- *Technological* : Having to do with the methods an' techniques for doing something.
- *Trade-Off* : Allowing one aspect to get worse in return for another aspect getting better.
- *Risk* : The chance that outcomes will not turn out as planned.

- *Payback Period* : Payback period is defined as the length of time required to recover the original investment on the project, through cash flows earned.
- *Present value of future cash inflows* : The Present value of future cash inflows is arrived at by discounting the future cash inflows at an interest rate equal to the cost of capital.
- *Internal Rate of Return (IRR)* : The internal rate of return of a project is the discount rate that makes the net present value equal to zero. In other words, internal rate of return is that rate of discount which would equate the present value of cash out flows (investments on the project) to the present value of cash inflows.

11.7 SHORT ANSWER QUESTIONS

1. What is the rationale for the SCBA?
2. How would you determine the SCBA?
3. What are the two ways of defining the benefit-cost ratio?
4. Evaluate the benefit-cost ratio as an investment criterion.
5. Discuss the problems associated with SCBA.

11.8 Answer to Self Check Exercise:

- *False*
- *False*
- *True*
- *True*
- *False*

11.9 FURTHER READINGS

1. Prasanna Chandra, *PROJECTS- Planning, Selection, Financing, Implementation, and Review,* Sixth Edition, Publication: TATA McGraw HILL
2. Dennis Lock, *Project Management,* Ninth Edition, Publication: Gower
3. P.C.K. Rao, *Project Management and Control,* Publication: Sultan Chand & Sons
4. Vasant Desai, *Project Management,* Second Revised Edition, Publication: Himalaya Publishing House
5. Clements / Gido, *Effective Project Management,* Publication : Thomson
6. K. Nagarajan, *Project Management,* Third Edition, Publication : New Age International

SOCIAL AND ENVIRONMENTAL ANALYSIS

STRUCTURE

12.0 *AIMS AND OBJECTIVES*

This lesson deals with the concept of Social and Environmental Analysis. Why it needs proper management? After reading this lesson, you will be able to understand the following :

- Social and Environmental Analysis
- Environmental Resources
- Objective of EIS

12.1 *ECOLOGICAL ASPECTS OF A PROJECT*

A project may cause environmental pollution in various ways: it may throw gaseous emissions; it may produce liquid and solid discharges; it may cause noise, heat, and vibrations. Projects that produce physical goods like cement, steel, paper, and chemicals by con-verting natural resource endowments into saleable products are likely to cause more envi-ronmental damage. Hence the environmental aspects of these projects have to be properly examined. The key issues that need to be considered in this respect are :

- 4j> What are the types of effluents and emissions generated?
- What needs to be done for proper disposal of effluents and treatment of emissions?
- Will the project be able to secure all environmental clearances and comply with all statutory requirements?

12.2 *PROJECT CHARTS AND LAYOUTS*

Once data is available on the principal dimensions of the project market size, plant capac-ity, production technology, machineries and equipment, buildings and civil works,

condi-tions obtaining at the plant site, and supply of inputs to the project - project charts and layouts may be prepared. These define the scope of the project and provide the basis for detailed project engineering and estimation of the investment and production costs.

The important charts and layout drawings are briefly described as follows :

Functional Layout

This shows the general relationship between equipment, buildings, and civil works. In preparing this layout, the primary consideration is to facilitate smooth and economical movement of raw materials, work-in-process, and finished goods.

This means that :

- The layout should seek to allow traffic flow in one direction to the extent possible, with a minimum of crossing.
- Godowns, workshops, and other services must be functionally situated with respect to the main factory building.

Material Flow Diagram

This shows the flow of materials, utilities, intermediate products, final products, by products, and emissions. Along with the material flow diagram, a quantity flow diagram showing the quantities of flow may be prepared.

Production Line Diagrams

These show how the production would progress along with the key information for the main equipment.

Transportation Layout

This shows the distances and means of transport outside the production line.

Utility Layout

This shows the principal consumption points of utilities (power, water, gas, compressed air, etc.) and their required quantities and qualities. These layouts provide the basis for developing specifications for utility supply installations.

Information Layout

This shows how the various parts of the project will be connected with telephone, internet, intercom, etc.

Structural Layout

This shows the organizational set up of the project along with information on personnel required for various departments and their inter relationship.

Plant Layout

The plant layout is concerned with the physical layout of the factory. In certain industries, particularly process industries, the plant layout is dictated by the production process adapted. In manufacturing industries, however, there is much greater flexibility in defining the plant layout.

12.3 *SOCIAL AND ENVIRONMENTAL ANALYSIS*

- Economic development is the result of the interaction between natural resources and technology supported by and designed for people. People are the centre for development. Therefore, it is rightly said that all human activity, be it economic, social or anything else is

essentially directed at satisfying needs and wants of man through altering and using environmental resources.

In this context, the environmental impact assessments/ appraisals are considered to be the first step in this process because they give an opportunity to man to consider the effects of his actions on the environment. Environmental management or planning is the study of the unintended consequences of a project. Its purpose is to identify, examine, assess, and evaluate the likely and probable impacts of a proposed project on environment and, thereby, to work out the remedial action plans to minimize the incidence of adverse impacts. It is not anti development nor is it against the projects. Its goal is development without damage or least damage.

12.4 TAXING THE ENVIRONMENT

Environmentalists have identified four types of different stresses or pressures that are being continuously inflicted on environment.

They are :

- ***Eutrophic Stress : Refers to the release of various kinds of wastes into the river and other water bodies and their consequent drying.***
- ***Exploitative Stress : Refers to the exploitation of natural resources endowment for production and consumption purposes through agriculture, industry, extraction, fishing etc. It is important to note that the rate of exploitation has a relevance to the nature's capacity to reproduce.***
- ***Disruptive Stress : Refers to the physical alterations in nature resulting from such activities like forest clearance, highways, railways, factory buildings, and so on. These physical changes disturb the environmental and ecological balance.***
- ***Chemical and Industrial Stress : This results mainly from the developments in science and technology and their applied fields like industry, warfare, and agriculture. This comprises mainly the pollutants and effluents of all types, radiation etc.***

Strategies to meet these threats to natural environment through pollution, destruction and over use can be: (a) preventive or (b) regulatory. It is in this context that the environmental appraisal of projects is gaining significance with a hope of achieving sustainable development in harmony with environment.

12.5 ENVIRONMENTAL RESOURCES /VALUES (ER/VS)

Since the word environment is an all - inclusive concept encompassing everything external to us, it is difficult to operationalise and apply to particular situations like the projects. For the purposes of operationalisation and practical application, the environmentalists have developed a concept called 'Environmental Resources / Values (ER/ Vs). It is defined as an aspect of environment which is of benefit to man. The environmentalists have identified and classified various components of environment (that is, ER/Vs) into four levels as below:

(a) ***Level 1 : Physical Resources, covering land, water and air.***

(b) ***Level 2 : Ecological Resources, consisting of aquatic, terrestrial and endangered (rare) species (other than man).***

(c) ***Level 3 : Human Use Values, covering transport, agriculture, water supply, recreation, mining, industry, flood control, etc.***

(d) Level 4 : Quality of Life Values, covering socio economic, cultural and aesthetic as-pects.

Thus the whole environment is decomposed into several operationally feasible components or elements. These elements can further be subdivided into several related items. Alternatively, some other environmentalists identify and classify the various elements of environment broadly under eight types which are called Environmental Attributes (EA). They are: (a) air, (b) water, (c) land, (d) ecology, (e) sound, (f) human aspects, (g) economics, and (h) resources. Each one can further be subdivided into different related elements.

In the context of environmental appraisal of projects, one can follow either of the classifications, viz., Environmental Resources /Values (ER/Vs) or the Environmental Attributes (EA). As a matter of fact, they can be evaluated and assessed individually with respect to the impacts they receive or the changes they undergo due to the proposed project. Since there will be a variety of types of impacts of varying degrees from a project, the decomposition of environment unit into various quantifiable elements will enable the analyst to give focus and direction to his impact assessment analysis.

An environmental effect is considered as the effect of natural or man made actions which alter environment (as measured by physical, chemical, and biological parameters). Our concern is, however, on man made actions. The nature and extent of environmental impacts including magnitude, severity, urgency, risk etc., of a project in the ultimate analysis depends upon :

(a) Nature, size and type of the project: such as manufacturing, services, agriculture, mining, logging, power, harbour, chemicals, sugar, etc.

(b) Technology.

(c) Location /eco-region: such as urban or rural areas, coastal, river valley, forest/hill areas or any of the eco systems as described earlier.

12.5.1 *Environmental Impact Assessment (EIA) and Environmental Impact Statement (EIS)*

Environmental Impact Assessment (EIA) and the Environmental Impact Statement (EIS) are said to be the instruments through which the environmental management tries to accomplish its objective. The basic premise behind the EIS/EIA is that no one has any right to use the precious environmental resources resulting in greater loss than gain to society. From this, it follows that the aim of EIS is to seek ways by which the project can proceed without any irreparable losses to environment and minimum losses if any, so that the net effect will be a desirable gain.

Environmental Impact Assessment (EIA) is defined as: "An activity designed to identify, predict, interpret, and communicate information about the impact of an action on man’s health and well being (including the well being of ecosystems on which man's survival depends). In turn, the action is defined to include any engineering project, legislative proposal, policy programme, or operational procedure with environmental implications." An EIA, therefore, is a study of the probable changes in the various socio economic and biophysical attributes of the environment which may result from a proposed action.

On the other hand, Environmental Impact Statement (EIS) can be defined as: A report, based on studies, disclosing the likely or certain environmental consequences of a proposed action, thus alerting the decision maker, the public and the government to environmental risks involved; the findings enable better informed decisions to be made,

perhaps to reject or defer the proposed action or permit it subject to compliance with specific conditions.

The EIS is a document prepared by an expert agency on the environmental impacts of a proposed action/project that significantly affects the quality of environment. The EIS is used mainly as a tool for decision making. At times, the EIA and EIS are used interchangeably as synonyms. But both are different activities with a lot of commonalities and with a common purpose. The basic difference between the two is that the EIA is carried out by the expert agency while the EIS as a tool is given to the decision makers in different formats. As a matter of fact, the EIS is the outcome of EIA. It is better to consider the environmental consequences during the project planning and design stage itself so as to avoid higher costs of future remedial actions by prudent planning and early preventive measures.

12.5.2 Objectives of BIS

(a) ***To identify and describe (in as quantified a manner as possible) the environmental resources/ values (ER/Vs) or the environmental attributes (EA) which will be affected by the proposed project, under existing or with or without project conditions.***

(b) ***To describe, measure, and assess the environmental effects that the proposed project will have on the ER/Vs (again, in as quantified a manner as possible), including posi-tive effects which enhance ER/Vs as well as the negative effects which impair them. Direct or indirect and short term or long term effects are to be considered. This would also include the description of the specific way; by which the project plan or design will minimize the adverse effects and maximize positive effects.***

(c) ***To describe the alternatives to the proposed project which could accomplish the same results but with a different set of environmental effects. Energy generation by thermal, hydel, and nuclear modes would explain the case in point. Further, alternative locations are also considered.***

12.5.3 GUIDELINES ON THE SCOPE AND CONTENTS OF ELS / ELA

The following are the commonly accepted points to be covered in an EIS study / report :

(a) ***A description of the project proposed action; a statement of its purpose and a description of all relevant technical details to give a complete understanding of the proposed action, including the kinds of materials, manpower/ resources etc., involved.***

(b) ***The relationship of the proposed action to the land use plans, policies and controls in the affected area or the project vicinity. It is necessary to gain a complete under-standing to the affected environment. What is the nature of biophysical and Vocio-economic characteristics that may be changed by the action?***

(c) ***The probable impacts of the proposed project on environment is a very important aspect to be considered in detail. It is necessary to project the proposed action into the future and to determine the possible impacts on the environmental attributes. The changes are to be quantified wherever possible.***

(d) ***Alternatives to the proposed action, including those not within the existing authority/ agency.***

(e) Any probable adverse environmental effects that cannot be avoid6d and stating how each avoidable impact will be mitigated.

(f) The relationship between local short term uses of man's environment and the main-tenance of an enhancement of long term productivity.

(g) Any irreversible and irretrievable commitments of resources (including natural, cul-tural, labour, and materials).

(h) An indication of what other interests and considerations of governmental policy or programmes are thought to offset the adverse effects identified.

12.5.4 ***Some Major Issues in the Preparation of EIS/EIA***

The following are the major issues reported to be encountered commonly while conduct-ing and preparing the EIS/EIA. Some of the issues cannot be resolved. In the absence of better alternatives, the analyst has to accept the issues as they are;

Determining the Environmental Impacts

This is the central theme in any EIS/EIA. It is a very complex process. At the outset, a distinction has to be made between the environmental impact and the changes in environmental attributes. Our interest is on the "impacts" and not on the ‘changes' which normally take place even without the project. The determination of environmental impacts involves; (a) identification of impacts on environmental attributes or the ER/Vs, (b) measurement of impacts on attributes, and (c) aggregation of impacts on attributes to reflect the total impact on environment.

With and Without the Project

The environmental impacts are measurement of attributes with and without the project or activity at a given point in time. But the changes in the attributes take place over time without the activity. Therefore the impact must be measured in terms of "net" change in the attribute at a given point in time.

Identifying the Impacts

The number of attributes to be evaluated is practically infinite because any characteristic of the environment is considered to be an attribute. Therefore, they have to be reduced to manageable numbers. Thus,-duplicative, redundant, difficult to measure, and obscure attributes may be eliminated in favor of those that are more tractable. This implies that some attributes which are difficult to measure or conceptualize, may still remain to be examined. In this case, bias and subjectivity are likely to be crept in.

Characteristics of the Base

Conditions Prior to the Activity : The nature of the impact is determined by the conditions of the environment existing before the project. The assessment of the characteristics of the base is a critical factor.

Geographic Characteristics

The same activity produces different impacts on a particular attribute, say water quality, over different geographical areas. The spatial distribution of different activities introduces one of the difficult elements in comparing one activity and its impact on another. This issue becomes particularly critical while making choices between projects.

Role of Attributes

Though the impacts are considered to be the effects on the definite discrete attributes of the environment, the actual impacts are not correspondingly well categorized. Nature does not necessarily respect man's discrete categories. Rather, the actual impacts may be the effects,of varying severity on a variety of interrelated attributes. The issue is one of identifying and assessing the cause - condition effect in order to work out the remedial measures. *Measurement of Impact*

Ideally, all impacts must be translatable into common units. However, this is not possible because of the difficulty in defining impacts in common units e.g., on income and on water quality. In addition, the quantification of some impacts may be beyond the state of the art.

Aggregation Problem

After measuring the project impacts on various individual attributes or ER/Vs, one encounters the problem of how to aggregate all impacts (quantitative and qualitative) thus assessed to arrive at a single composite measure to represent the total activity impact. This would involve expressing the various impact measures in common units which is very difficult. Some use a weighting procedure to accomplish this which is again subjective. There is another associated problem of summing up and comparing with the impact of an alternative activity.

Secondary Impacts

Secondary or indirect impacts on environment should also be considered particularly in relation to the infrastructure investments that stimulate or induce secondary effects in the form of associated investments and changed patterns of social and economic activity. Such induced growth brings significant changes in the natural conditions. Similarly, there can also be significant secondary impacts in the biophysical environment.

Cumulative Impacts

Here, Cumulation refers to the similar activities spread over in an environmental setting like hotels, beach resorts, surface or underground mines, industrial estates, etc. A single individual activity may produce a negligible effect on environment. However, a series of similar activities may produce significant cumulative effect on certain aspects of environment. This raises the question of how to deal with these significant cumulative effects. Therefore, it is suggested to prepare an environmental impact assessment (EIA) on broad programmes rather than on a series of component actions (e.g., industrial estates, mining sector, tourism industry, etc.). Or, alternatively, one can prepare an EIA for a particular geographical area where a series of similar activities are located (e.g., mining areas, coastal line for beach resorts, etc.).

Reporting Findings

The results should be displayed in such a way that it makes easy and clear to comprehend the total impacts of an activity from a brief review. It is suggested to display the impacts on a summary sheet in a matrix form.

The knowledge about the issues as explained above; however complex they are will be useful in understanding the processes and complexities involved in preparing an EIS/EIA. Such awareness will help improve the understanding of EIS, leading to more objective, informed and unbiased decision-making on activities /projects

12.5.5: Self Check Exercise:

- Environmental _____ is the focus of this lesson, aiming to understand the importance of proper management.
- A project's potential environmental damage lies in its ability to produce _____ emissions, solid discharges, and noise, among other factors.
- In project charts and layouts, the _____ layout emphasizes facilitating smooth movement of materials within the factory.
- The _____ layout is concerned with the physical arrangement of the factory, dictated by the production process in certain industries.
- Economic development is a result of the interaction between natural resources,

12.6 *METHODOLOGY*

Many impact assessment methodologies have been developed in the Western industrialized countries as a response to the various legislative control and regulatory measures as also to suit divergent environmental situations and purposes.

The choice will decide the depth of analysis to be carried out in a particular impact assessment. The choice of a methodology depends on: (a) needs of the user, (b) type of project; its size and technology, and (c) location; type of ecosystem.

Depending on these factors, one may be more useful than the other methodology. There-fore, the analyst must decide which one will best fit for a given task and situation. The following are the important considerations for making a choice on the methodology for preparing an EIS/EIA.

(i) *Use* : Is the EIS for a decision or for information? If it is for a decision, it requires greater emphasis on identification of key issues, quantification and comparison of alternatives. If it is for information, it requires a more comprehensive analysis and concentration on interpretation of the significance of a broad list of possible impacts.

(ii) *Alternatives* : Are alternatives fundamentally or incrementally different?

(iii) *Resources* : How much time, skills, money, and data are available? More in-depth and quantitative analysis requires more of everything.

(iv) *Familiarity* : Is the analyst familiar with both the types of project proposed and the physical site?

(v) *Issue Significance* : How big is the issue? The bigger the issue, the greater the need to be explicit, to quantify, and to identify key issues.

(vi) *Administrative Constraints :* Are choices limited by governmental procedures and format requirements? Some policy guidelines may rule out some tools by specifying the range of impacts to be addressed.

12.6.1 *Impact Assessment Methodologies*

The impact identification and assessment can be made through several ways. Each one represents a methodology. Besides the one already explained, there are six other different methodologies in the literature based on the way the impacts are identified and assessed.

(1) *Ad Hoc :* These methodologies provide a minimum guidance for impact assessment. They merely suggest broad areas of possible impacts (e.g., impacts on lakes, forests, etc.,) rather than defining specific parameters to be investigated. This is given exog-enously to the analyst.

(2) *Overlays :* These methodologies depend upon a set of maps on the environmental characteristics (physical, social, ecological, and aesthetic) of the proposed project's vicinity. These maps are overlaid to produce a composite characterization of the Regional environment. Impacts are then identified by noting the impacted environmental attributes within the project boundaries.

(3) *Checklists :* The methodologies present a specific list of environmental attributes to be investigated for possible impacts. They need not necessarily attempt to establish the cause effect links to project activities. They may or may not include guidelines about how attribute data are to be measured and interpreted.

(4) *Matrices :* These methodologies incorporate a list of project activities with a

checklist of potentially impacted environmental attributes. Then, the two lists are related in a matrix form which identifies the cause effect relationships between specific activities and impacts. The matrix methodologies may either specify which actions affect which attributes, or may simply list the range of project activities and environmental attributes in an open matrix to be completed by the analyst.

(5) *Networks* : These methodologies work from a list of project activities to establish cause - condition effect relationships. It is generally felt that a series of impacts may be triggered by a project action. They define a set of possible networks and allow the user to identify impacts by selecting and tracing out the appropriate project actions.

(6) *Combination Computer Aided* : These methodologies use a combination of matrices, networks, analytical models, and a computer aided systematic approach. Since this is a combination of difficult methodologies, it is a' multiple objective approach to; (a) identify activities associated with the governmental policies and programmes; (b) identify potential environmental impacts at different levels; (c) provide guidance for abatement and mitigation techniques; (d) provide analytical models to establish cause effect relationships and to quantitatively determine potential environmental impacts, and (e) provide a methodology and a procedure to utilize this comprehen-sive information in decision making.

12.7 *SUMMARY*

A project may cause environmental pollution in various ways: it may throw gaseous emissions; it may produce liquid and solid discharges; it may cause noise, heat, and vibrations. Projects that produce physical goods like cement, steel, paper, and chemicals by converting natural resource endowments into saleable products are likely to cause more environmental damage. Hence the environmental aspects of these projects have to be properly examined. Economic development is the result of the interaction between natural resources and technology supported by and designed for people. People are the centre for development. Therefore, it is rightly said that all human activity, be it economic, social or any:hing else is essentially directed at satisfying needs and wants of man through altering and using environmental resources.

In this context, the environmental impact assessments/ appraisals are considered to be the first step in this process because they give an opportunity to man to consider the effects of his actions on the environment. Environmental management or planning is the study of the unintended consequences of a project. Its purpose is to identify, examine, assess, and evaluate the likely and probable impacts of a proposed project on environment and, thereby, to work out the remedial action plans to minimize the incidence of adverse impacts. It is not anti development nor is it against the projects. Its goal is development without damage or least damage.

12.8 *GLOSSARY*

- *Contingency Plan* : An alternative for action if the expected result fails to materialize.
- *Culture* : The way of life of any group of people.
- *Discipline* : An area of expertise.
- *Environment* : Everything outside the system that delivers inputs or receives

outputs from the system.

- *Facilitator* : A person who helps people overcome problems, either with technical issues or with other people
- *Function* : One of the standard organization disciplines such as finance, marketing, accounting, or operations.
- *Micro culture* : The corporate culture within the organization or even project

12.9 *SHORT ANSWER QUESTIONS*

1. What aspects are considered in Ecological analysis?
2. List the key issue covered in Ecological analysis.
3. How would you evaluate the appropriateness of a technology?
4. Describe the different charts and layout drawings.

12.10 Answers to Self Check Exercise:

- Analysis
- Gaseous
- Functional
- Plant
- Man

12.11 *FURTHER READINGS*

1. Prasanna Chandra, *PROJECTS- Planning, Selection, Financing, Implementation, and Review,* Sixth Edition, Publication : TATA McGraw HILL.
2. Dennis Lock, *Project Management,* Ninth Edition, Publication : Gower.
3. P.C.K. Rao, *Project Management and Control,* Publication : Sultan Chand & Sons.
4. Vasant Desai, *Project Management,* Second Revised Edition, Publication : Himalaya Publishing House.
5. Clements / Gido, *Effective Project Management,* Publication : Thomson.
6. K. Nagarajan, *Project Management,* Third Edition, Publication : New Age International.

Lesson No. 13 ***AUTHOR : NEERAJ SHARMA***

PROJECT ACTIVITIES AND NETWORK TECHNIQUES

STRUCTURE

13.0 *AIMS AND OBJECTIVES*

This lesson deals with the concept of project management network techniques. After reading this lesson, you will be able to understand :

- Network Technique for Project management
- Characteristics of Network Technique
- PERT
- CPM

13.1 *INTRODUCTION*

The activities of a project have inter relationships arising from physical, technical, and other considerations. For proper planning, scheduling, and control of the activities of a project, given their inter relationships and constraints on the availability of resources, network techniques have been found quite useful. It may be noted that financial institutions and the Government of India insist that a network plan should accompany feasibility reports. Once a project is selected, the focus is shifts to its implementation. This involves the completion of numerous activities (project components) by employing various resources men, materials, machine, money, and time so that a project on paper is translated into concrete reality.

13.2 *NETWORK TECHNIQUES*

There are two basic network techniques — PERT and CPM. PERT, an acronym for Program Evaluation Review Technique was originally developed to facilitate the planning and scheduling of the Polaris Fleet Ballistic Missile Project of the US government. Designed to handle risk and uncertainty, PERT is eminently suitable for research and development programmes, aerospace projects, and other projects involving new technology. In such projects the time required for completing various jobs or activities can be highly variable. Hence, the orientation of PERT is probabilistic'.

CPM, an acronym for Critical Path Method, is akin to PERT. It was developed independently in 1956

 by the Du Pont Company in the US to solve scheduling problems

in industrial settings. CPM is primarily concerned with the trade off between cost and time. It has been applied mostly to projects that employ a fairly stable technology and are relatively risk free. Hence, its orientation is 'deterministic'.

Widely diverse projects are amenable to analysis by PERT and CPM. Here is an illustrative list :

- Launching a spaceship.
- Research and development programme..
- Construction of a plant.
- Building a river valley project.
- Overhaul of an organisation.
- Training of manpower.
- Starting a new venture.
- Adult literacy programme.

The common characteristics of the above projects which make them amenable to analysis by PERT or CPM are :

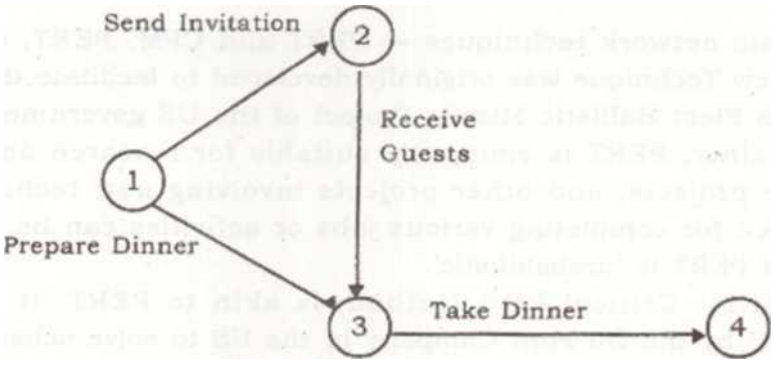
1. The project can be broken down into a well defined set of jobs or activities.
2. The activities must be performed in a certain sequence which is technologically ordered.
3. Within a defined sequence, the activities may be started and stopped in an independent manner.

This lesson discusses the basics of PERT, CPM, and network cost system. It is organised into seven sections.

- Development of Project Network
- Time Estimation
- Determination of critical path
- Scheduling when resources are limited
- PERT Model
- CPM Model
- Network Cost System

13.3 *DEVELOPMENT OF PROJECT NETWORK*

Basic to PERT as well as CPM is the network diagram. The network diagram, also referred to as the project graph, shows the activities and events of the project and their logical relationships. A simplified network diagram for a dinner project is shown in Fig 1.



The network diagram is constructed in terms of activities and events. An activity is a

definite task, job, or function to be performed in a project. For example, prepare dinner (see fig 1) is an activity. An activity is represented by an arrow. The head of the arrow marks the completion of the activity and the tail of the arrow marks its beginning. (The length and 'compass' direction of the arrow have no significance.) An event is a specific point in time indicating the beginning or end of one or more activities. It represents a milestone and does not consume time or resources.

Since activities are the basic building blocks of a network diagram, it is necessary to enumerate all the activities of the project. For this purpose, it is helpful to break the project into several steps. The number of steps, of course, would depend on the magnitude and complexity of the project. For industrial projects generally a two step procedure could suffice. In the first step, the major parts of the project are identified and in the second step the activities of each major part are delineated. Activities should be so defined that they are distinct, reasonably homogeneous tasks for which time and resource requirement can be estimated.

Once the activities are enumerated it is necessary to define for each activity, the activities which precede it, the activities which follow it, and the activities which can take place concurrently. Given this information, the network diagram, showing the logical relationship between activities and events may be developed following either the forward method or the backward method.

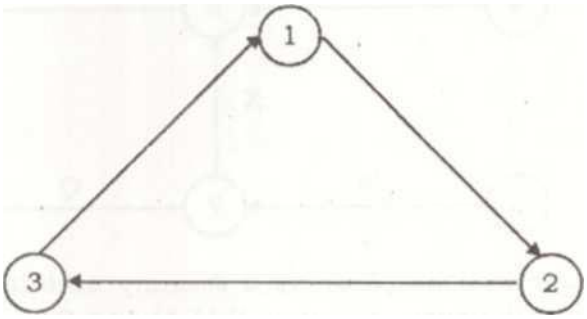
The forward method begins with the initial event, marking the beginning of the project, and proceeds forward till the end event is reached. The backward method begins with the end event and works backwards till the beginning event is reached.

RULES FOR NETWORK CONSTRUCTION

The rules to be observed in constructing the network diagram are discussed below:

1. Each activity must have a preceding and a succeeding event. An activity is numerically denoted by the pair of preceding and succeeding events. In the dinner project, for example, the activity 'send invitations' is designated as (1 2).
2. Each event should have a distinct number. The number given to an event can be chosen in any way, provided this condition is satisfied. In practice, however, events are so numbered that the number at the head of the arrow is greater than that at its tail.

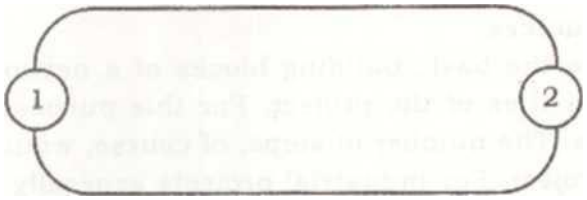
Fig. 2 A Network Diagram



3. There should be no loops in the project network; A situation like the one shown in Fig. 2 is not permissible.

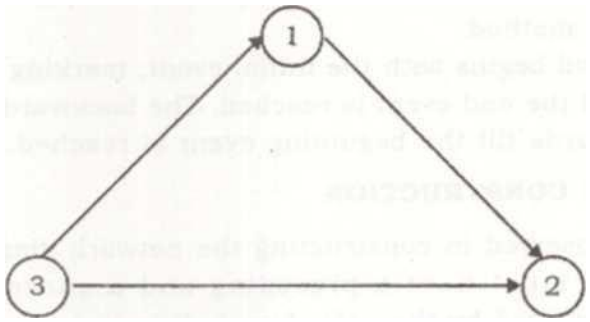
4. Not more than one activity can have the same preceding and succeeding events. This means that each activity is represented by a uniquely numbered arrow and a situation like the one shown in Fig. 3 is not permissible.

Fig 3 A Loop



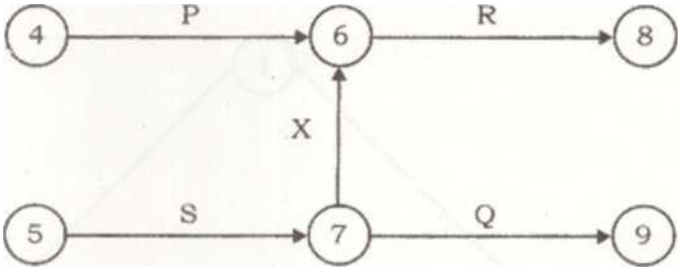
To ensure that each activity is uniquely numbered it may be necessary sometimes to introduce dummy activities: A dummy activity is an imaginary activity which can be accomplished in zero time and which does not consume resources. It is represented by a dashed arrow. Fig 4 shows a variant of Fig 3 with a dummy activity (3 2) introduced to conform to the rules of network construction.

Fig 4 A Dummy Activities



A dummy activity may also be used to represent a constraint, necessary to show the proper relationship between activities. Fig 5 shows part of a network diagram having a dummy activity.

Fig 5. A Dummy Activity



In Fig. 5, X, represented as (7 6), is a dummy activity showing a certain logical relationship. According to this figure, activities P (4 6) and Q (5 7) must be completed before activity R (6 8) can start.

Illustration :

A building project consists of the following activities :

A = Lay foundation
B = Erect framework
C= Install millwork
D * Install wiring E
■ Install plumbing F
- Plaster walls G -
Install siding H-
Decorate the interior
I = Finish the exterior

The interrelationship among these activities is as follows:

1. A should precede B.
2. B should precede C, D, E, F, and G.
3. C, D, E, and F should precede H.
4. G should precede L

Given the above interrelationship the network diagram for the project is developed, in several steps, using the forward method, as shown in Fig. 6.

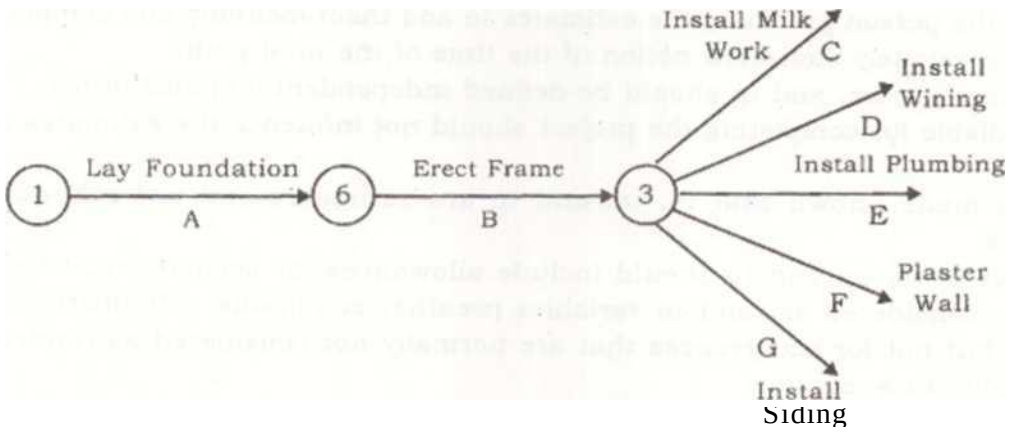
Time Estimation

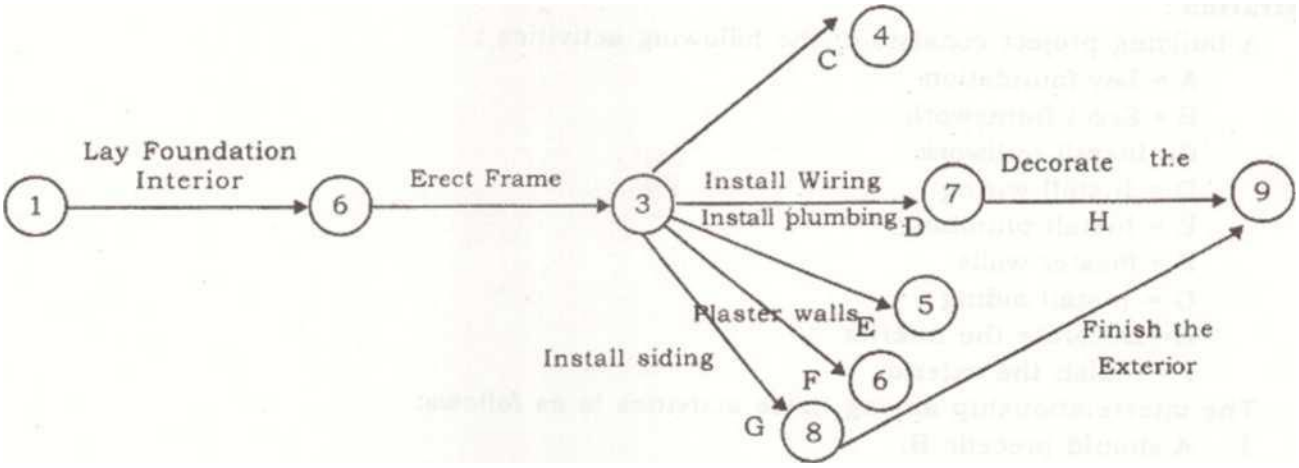
Once the logic and detail of the network have been established, time estimates must be assigned to each activity. Generally, three time values are obtained for each activity:

1. Optimistic time (to)
2. Most likely time (tm)
3. Pessimistic time (tp)

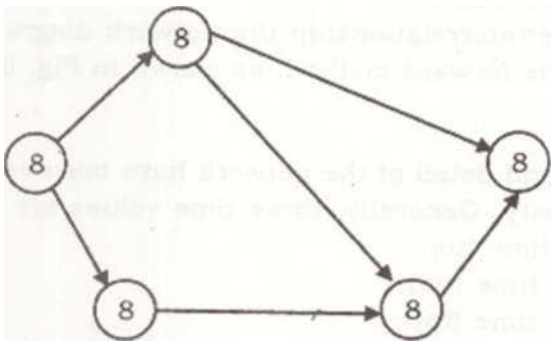
The optimistic time, tot is the time required if no hurdles or complications arise. The most likely time, tm is the time in which the activity is most likely to be completed. This estimate takes into consideration normal circumstances, making allowance for some foreseen delays. The pessimistic time, tp, is the time required if unusual complications and., or unforeseen difficulties arise.

O Loy Foundation Erect Frame





A Network Design



Plaster walls

13.4 *OBTAINING TIME ESTIMATES*

Time estimates should be obtained by the PERT planner from persons who are responsible for estimation. The following points should be borne in mind while obtaining time estimates:

1. Time estimates should be obtained by skipping around the network rather than by following a specific path. If estimates are obtained by following one path, there is a tendency for the person providing the estimates to add them mentally and compare them with a previously conceived notion of the time of the total path.
2. The estimates of to, tm, and tp should be defined independently of each other.
3. The time available for completing the project should not influence the estimates of to, tm and tp.
4. It should be made known that to, tm and tp are estimates and net schedule commitments.
5. The estimates of to, tm and tp should include allowances for occurrences which are generally considered as random variables (weather conditions, administrative delays, etc.) but not for occurrences that are normally not considered as random variables (flood, wars, etc.)

13.5 *CRITICAL PATH*

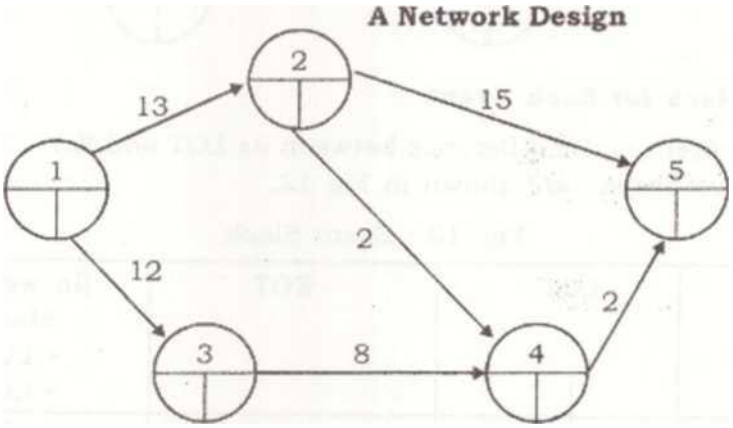
Once the network diagram with single time estimates has been developed, the following

computational procedure may be employed for determining the critical path/s, event slacks, and activity floats.

1. ***Calculate the Earliest Occurrence Time (EOT) for Each Event***

An event occurs when all activities leading to the event have been completed. In the network diagram shown in Fig. 9, for example, event 4 occurs when activities (2 4) and (3 4) are completed. Obviously activity (2 4) cannot begin unless event 2 occurs, which in turn requires the completion of activity (1 2). Likewise, activity (3 4) cannot begin unless event 3 occurs which in turn requires the completion of activity (1 3). Thus we find that event 4 occurs when activities (1 2), (2 4), (1 3), and (3 4) are completed. In other words, event 4 occurs when paths (12 4) and (13 4) are completed.

The EOT of an event refers to the time when the event can be completed at the earliest. Looking at event 4 we find that since the paths leading to it, viz., (1 2 4) and (1 3 4) take 15 weeks and 20 weeks, respectively, the EOT of event 4 is 20 weeks. In general terms, the EOT of an event is the duration of the longest path (from the beginning event whose EOT is set at 0) leading to that event. The EOTs of various events in our illustrative project are shown in Fig 10. It may be noted that in Fig 10 and subsequent figures an event is represented by a circle. The upper half of the circle denotes the event number, the left quarter in the lower half denotes the EOT, and the right quarter in the lower half denotes the latest occurrence time.



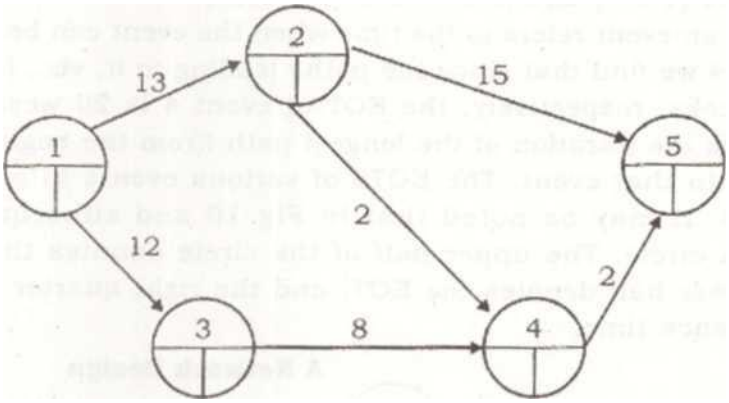
The EOT of the end event obviously represents the minimum time required for completing the project. To obtain the EOT of various events we start from the beginning event and move forward towards the end event. This computational procedure is referred to as the forward pass. In this computation we assume that each activity starts immediately on the occurrence of the event preceding it. Hence the starting and finishing time for various activities obtained from this computation are the earliest starting time (EST) and the earliest finishing time (EFT).

2. ***Calculate the Latest Occurrence Time for Each Event***

The LOT for an event represents the latest allowable time by which the event can occur, given the time that is allowed for the completion of the project (occurrence of end event). Normally, the time allowed for the completion of the project is set equal to the EOT of the end event. (In other words, the project is supposed to be completed at the earliest possible time.) This means that for the end event the LOT and EOT are set equal. The LOT for various events

is obtained by working backward from the end event. This procedure is known as the backward pass. The LOT for event 4 in our illustrative project, for example, is equal to the LOT for event 5, the end event, minus the duration of the activity (4 5) which connects event 4 with 5. Since the LOT for event 5 is 28 weeks and the duration of activity (4 5) is 2 weeks the LOT for event 4 is 26 weeks (28 2). This represents the latest time by which event 4 should occur to enable the project to be completed in 28 weeks. Likewise, the LOT for other events can be calculated by moving backward. The LOT for various events is shown (in the right quarter of the lower half of event nodes) in Fig. 11.

FIG. 11



3. ***Calculate the Slack for Each Event***

The slack for an event is the difference between its LOT and EOT. The slacks for various events of our illustrative project are shown in Fig 12.

Fig. 12 : Event Slack

Event	LOT	EOT	weeks) Slack = LOT = EOT
5	28	28	0
4	26	20	6
3.	18	12	6
2	13	13	0
1	0	0	0

4. ***Obtain the Oitical and Slack Paths***

The critical path starts with the beginning event, terminates with the end event, and is marked by events which have a zero slack. This is obviously the path on which there is no slack, no cushion. Other paths are slack paths with some cushion. The critical path for our illustrative project is (1 2 5). It is indicated by doubled arrows in Fig. 13.

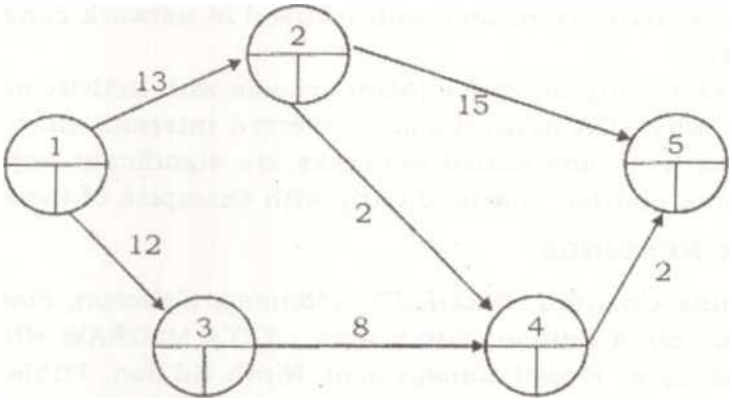
The critical path is the longest path from the beginning event to the end event. Since the end can be reached, i.e., project completed, only when this longest path is traversed, the minimum time required for completing the project is the duration on the critical path. The duration on the critical path of our project is 28 weeks; this is the minimum time required for

completing the project. (It is already indicated by the EOT of event 5, the end event.)

5. ***Compute the Activity Floats***

Given the estimates of activity time and event slacks, activity floats can be calculated. There are three measures of float: (i) total float; (ii) free float; and (iii) independent float. For illustrating these measures, let us consider activity (2 4) of our illustrative project. Activity (2 4) is shown in Fig 13.

Fig. 13 : A Network Diagram



13.6 SUMMARY

- For proper planning, scheduling, and control of the activities of a project, given their interrelationships and constraints on the availability of resources, network techniques have been found quite useful.
- The network diagram is constructed in terms of activities and events. An activity is a definite task, job or function to be performed in a project. An event is a specific point of time indicating the beginning or end of one or more activities.
- The rules to be observed in constructing the network diagram are:
  (i) Each activity must have a preceding and succeeding event.
  (ii) Each event should have a distinct number.
  (iii) There should be no loops in the project network.
  (iv) Not more than one activity can have the same preceding and succeeding events.
- To ensure that each activity is uniquely numbered it may be necessary to introduce dummy activities. A dummy activity is an imaginary activity which can be accomplished in zero time and which does not consume resources. A dummy activity may also be used to represent a constraint necessary to show the proper relationship between activities.
- Once the logic and detail of the network have been established, time estimates may be assigned to each activity.

13.6.1 Self Check Exercise:

- Financial institutions and the Government of India insist that a network plan should accompany _____.
- PERT, an acronym for _____, was originally developed for the Polaris Fleet Ballistic Missile Project.
- CPM, an acronym for _____, is primarily concerned with the trade-off between cost and time.
- PERT is suitable for projects involving _____, while CPM is applied to projects with _____ technology.

13.7 GLOSSARY

- Activity : A specific project task that requires resources arid time to complete.
- Activity-On-Arc (Node) : The two ways of illustrating a network: placing the activities on the arcs or on the nodes.
- *Arc* : The line connecting two nodes.
- *Milestone* : A clearly identifiable point in a project or set of activities that commonly denotes a requirement or completion of a large or important set of activities.
- Network : A combination of interrelated and events depicted with arcs and nodes.
- *Node* : An intersection of two or more I rows, commonly used for depicting an event or activity.

13.8 SHORT ANSWER QUESTIONS

1. Define activity, event and path as used in network construction. What is a dummy activity?
2. Discuss Activity-on-Arrow (AOA) schools with Activity-on-Node (AON) networks and justify why AOA networks are preferred internationally.
3. Discuss how time-scaled networks are significant improvements over traditional networks and bar charts. Justify with examples of their advantages.

13.9 Answers to Self Check Exercise:

- feasibility reports
- Program Evaluation Review Technique
- Critical Path Method
- risk and uncertainty; stable

13.10 FURTHER READINGS

1. Prasanna Chandra, *PROJECTS- Planning, Selection, Financing, Implementation, and Review*, Sixth Edition, Publication : TATA McGRAW HILL
2. Dennis Lock, *Project Management*, Ninth Edition, Publication : Gower
3. P.C.K. Rao, *Project Management and Control*, Publication : Sultan Chand & Sons
4. Vasant Desai, *Project Management, Second Revised Edition*, Publication : Himalaya Publishing House
5. Clements / Gido, *Effective Project Management*, Publication : Thomson
6. K. Nagarajan, *Project Management*, Third Edition, Publication : New Age International.

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NETWORK TECHNIQUES FOR PROJECT MANAGEMENT

STRUCTURE

14.0 AIMS AND OBJECTIVES

This lesson is in continuation with the previous lesson which also dealt with the concept of project management network techniques. After reading this lesson you will be able to understand :

- Network Technique for Project management
- PERT
- CPM

14.1 PERT MODEL

In the previous lesson, so far, the analysis was focused on the determination of the critical path, event slacks, and activity floats. For this purpose we used single time estimates of activity duration though initially three time estimates were developed for each activity. Now we consider the variability of project duration.

Measures of Variability

Variability in PERT analysis is measured by variance or its square root, standard deviation. Variance of a set of numbers is the average squared difference of the numbers in the set from their arithmetic average. A simple example may be given to illustrate the calculation of variance. Let a series consist of numbers 4, 6, and 8. The average of this series is 6. The differences of various numbers in the series from this average are 2, 0, and 2. Squaring them we get 4, 0 and 4. Hence, variance, the average of squared difference, is 8/3 and standard deviation is *■)&/3.

The steps involved in calculating the standard deviation of the duration of critical path are as follows :

1. Determine the standard deviation of the duration of each activity on the critical path.
2. Determine the standard deviation of the total duration of the critical path on the basis of information obtained in step 1.

For determining the standard deviation of the duration of an activity we require the

entire probability distribution of the activity distribution. We, however, have only three values from this distribution : t_p, t_m, and to. In PERT analysis, a simplification is used in 2 calculating the standard deviation. It is estimated by the formula Standard deviation * (tp - to) / 6 where t_p = pessimistic time t_0 = optimistic time Variance is obtained by squaring standard deviation.

The standard deviation and variance of the activities on the critical path of our illustrative project are shown in Fig 14.

Activity	V		0-VV6	Variance=0^2
(1-2)	21	9	2	4.00
(2.5)	24	10	2.33	5.43

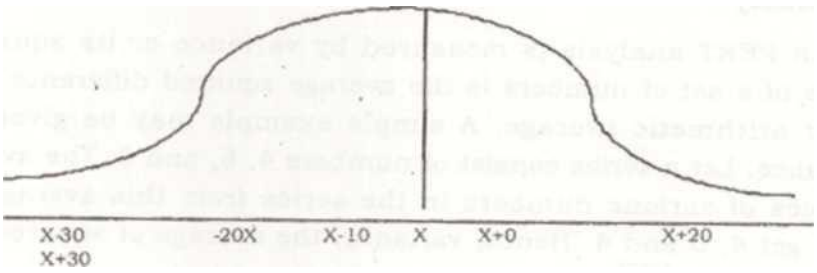
Assuming that the probability distribution of various activities on the critical path is independent, the variance of the critical path duration is obtained by adding variance of activities on the critical path

For real life projects which have a large number of activities on the critical path we can reasonably assume that the critical path duration is approximately normally distributed, with mean and standard deviation obtained by the method described above.

A normal distribution looks like a bell shaped curve as shown in Fig 15. It is symmetric and single peaked and is fully described by its mean and standard deviation." The probability of values lying within certain ranges is as follows :

Range	Probability
Mean ± One standard deviation	0.682
Mean ± Two standard deviations	0.954
Mean ± Three standard deviations	0.998

Fig 15 Normal Distribution



Probability of Completion by a Specified Date

Armed with information about mean (T) and standard deviation (a) for critical path duration, which is normally distributed, we can compute the probability of completion by a specified date (D) as follows :

1. Find Z *= (D T) / S.D. ^
2. Obtain cumulative probability up to Z 6 by looking at the probability distribution of the standard normal variatc.

This is shown below

Cumulative Probability up to Z for Standard Normal Distribution

z	Cumulative probability
-3.0	0.001
-2.8	0.003
-2.6	0.005
-2.4	0.008
-2.2	0.014
-2.0	0.023
-1.8	0.036
-1.6	0.055
-1.4	0.081
-1.2	0.115
-1.0	0.159
-0.8	0.212
-0.6	0.274
-0.4	0.345
-0.2	0.421
0.0	0.500
0.2	0.579
0.4	0.655
0.6	0.726
0.8	0.788
1.0	0.841
1.2	0.885
1.4 '	0.919
1.6	0.945
1.8	0.964
2.0	0.977
2.2	0.986
2.4	0.992
2.6	0.995
2.8	0.997
3.0	0.999

The above procedure may be illustrated for our project which has T - 28 and SD = 3.07. The probability of completing this project by certain specified dates is shown in fig 16.

Fig. 16

Specified	Z	Probability of completion by D
20	20-28 3.07 ”2*6	0.005
25	25-28 3.07	0.159
30	30-28 3.07 " 0-6	0.726

14.2 CPM MODEL

The PERT model was developed for projects characterized by uncertainty and the CPM model was developed for projects which are relatively risk-free. While both the approaches 'begin with the development of the network and a focus on the critical path, the PERT approach is 'probabilistic' and the CPM approach is 'deterministic'. This does not, however, mean that in CPM analysis we work with single time estimates. In fact, the principal focus of CPM analysis is on variations in activity times as a result of changes in resource ass:gnments. These variations are planned and related to resource assignments and are not caused by random factors beyond the control of management as in the case of PERT analysis. The main thrust of CPM analysis is on time cost relationships and it seeks to determine the project schedule which minimizes total cost.

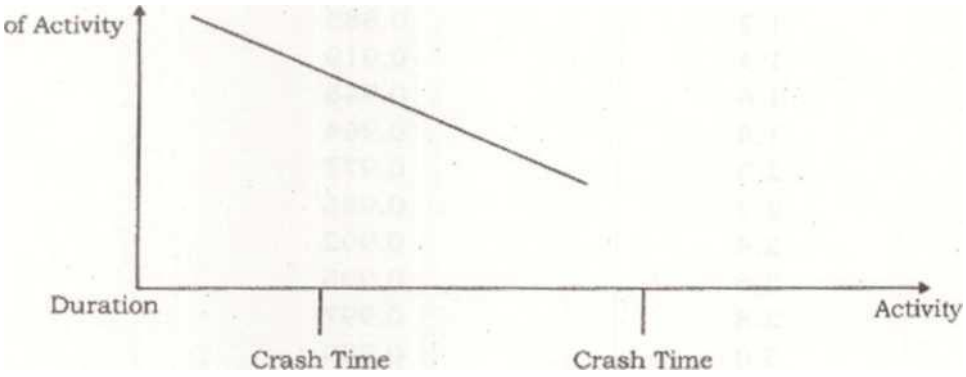
14.2.1 Assumptions

The Usual assumptions undcrtying CPM analysis are:

1. The costs associated with a project can be divided into two components: direct costs and indirect costs. Direct costs are incurred on direct material and direct labour. Indirect costs consist of overhead items like indirect supplies, rent, insurance, managerial services, etc.
2. Activities of the project can be expedited by crashing which involves employing more resources.
3. Crashing reduces time but enhances direct costs because of factors like overtime payments, extra payments, and wastage. The relationship between time and direct activity cost can be reasonably approximated *by* a downward sloping straight line.

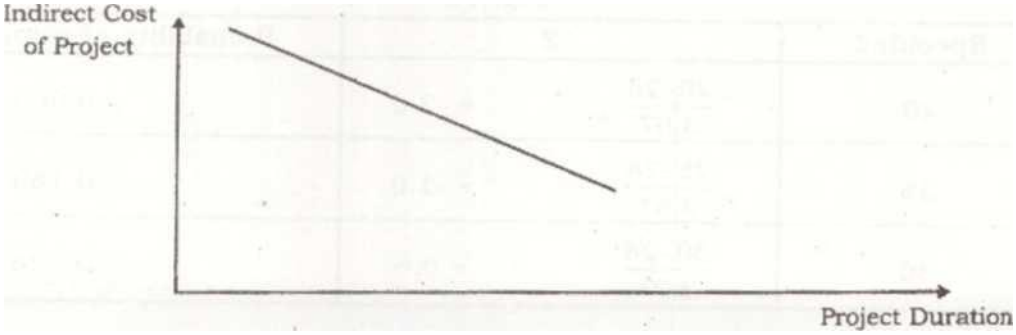
A typical cost time line is shown in Fig 17.

Direct cost



1. Indirect costs associated with the project increase linearly with project duration. A typical line for indirect costs is shown in Fig 18.

Fig. 18 : Indirect Costs



14.2.2 Procedure

Given the above assumptions, CPM analysis seeks to examine the consequcnces of crashing on total cost (direct cost plus indirect cost). Since the behaviour of indirect project cost is well defined, the bulk of CPM analysis is concerned with the relationship between total direct cost and project duration. The procedure used in this respect is generally as follows:

1. Obtain the critical path in the normal network. Determine the project duration and direct cost.
2. Examine the cost - time slope of activities on the critical path obtained and crash the activity which has the least slope.
3. Construct the new critical path after crashing as per step 2. Determine project duration and cost.
4. Repeat steps 2 and 3 till activities on the critical path (which may change every time) are crashed.

Practical Example

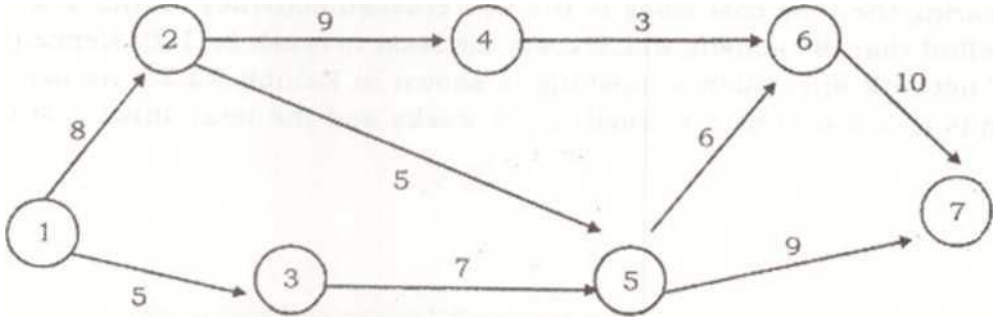
The above procedure may be illustrated with an example. The activities, durations, and direct activity costs of a project are shown in Fig 30. The indirect cost is Rs 2,000 per week.

Fig. 19 : Normal and Crash Time and Cost

Activity	Time in Weeks		Cost		Cost to Expedite per Weeks *Rs.*
	Normal	Crash	Normal *Rs.*	Crash *Rs.*	
1-2	8	4	3,000	6,000	450
1-3	5	3	4,000	8,000	2,000
2-4	9	6	4,000	5,500	500
3-5	7	5	2,000	3,200	600
2-5	5	1	8,000	12,000	1,000
4-6	3	2*	10,000	11,200	2,400
5-6	6	2	4,000	6,800	700
6-7	10	7	6,000	8,700	900
5-7	9	5	4,200	9,000	1,200
			45,200	70,400	

The project network with normal duration is shown in Fig 20

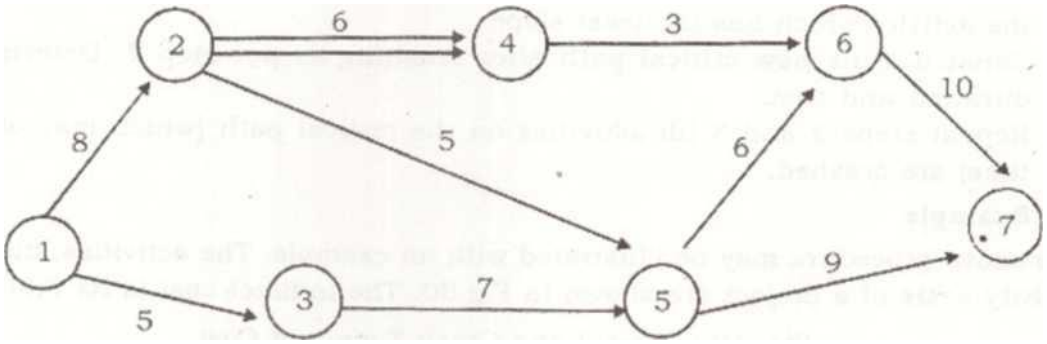
Fig. 20 : Project Network



The critical path in the all normal network is (1 2 4 6 7). The project duration is 30 weeks and the total direct cost is Rs 45,200.

Examining the time cost slope of activities on the critical path we find that activity (2 4) has the lowest slope; in other words, the cost to expedite per week is the lowest for activity (2 4). Hence activity (2 4) is crashed. The project network after such a crashing is shown in Exhibit.

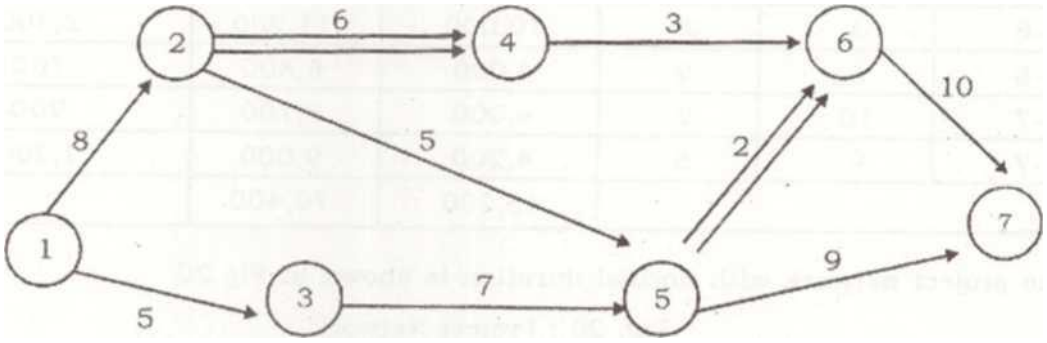
Fig. 21



As per Fig 21 the critical path is (1 2 5 6 7), with a length of 29 weeks, and the total direct cost is Rs 46,700.

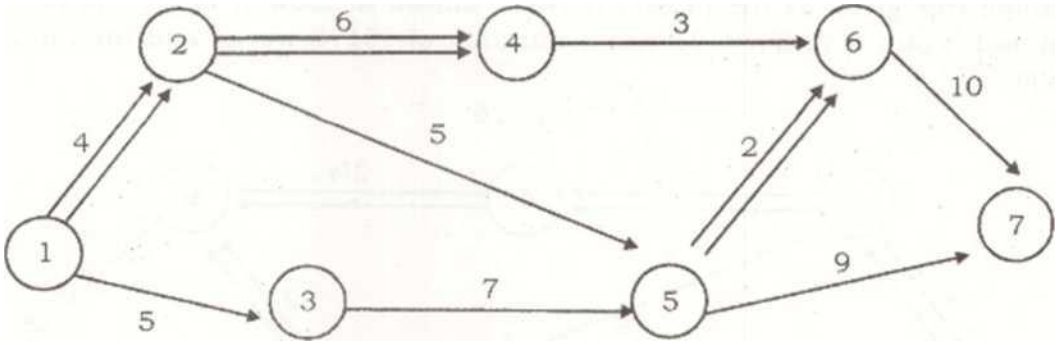
Looking at the time cost slope of the activities on the new critical path (1 2 5 6 7), we find that the activity (5 6) has the lowest slope. Hence this activity is crashed. The project network after such crashing is shown in Fig 21 As per this figure, the critical path is (1 2 4 6 7) with a length of 27 weeks and the total direct cost is Rs 49,500.

Figure 22



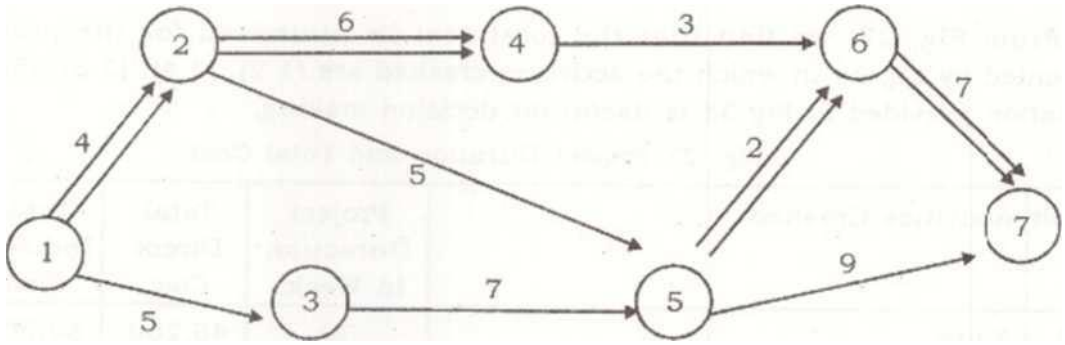
Comparing the time cost slope of the non crashed activities on the new critical path (1 2 4 6 7), we find that the activity which costs the least to crash is (1 2). Hence this is crashed. The project network after such a crashing is shown in Exhibit 22.23. As per this figure the critical path is (1 3 5 6 7) with a length of 24 weeks and the total direct cost is Rs 52,500.

Fig 23



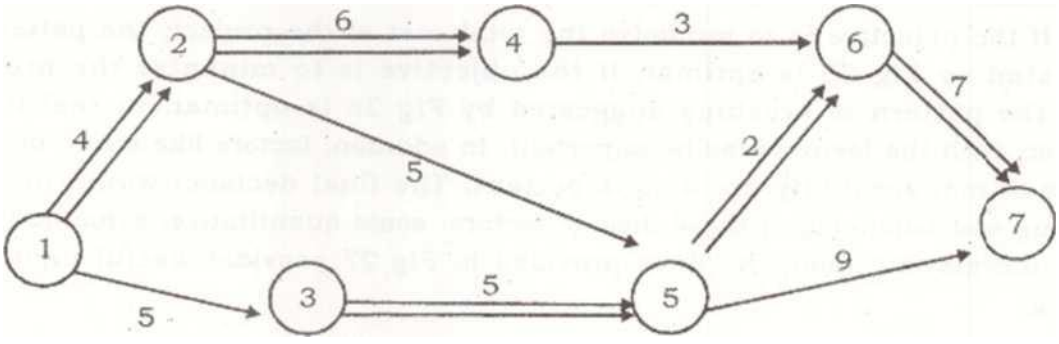
Looking at the time cost slope of the non crashed activities on the new critical path ,(1 3 5 6 7), we find that activity (6 7) has the lowest slope. Hence it is crashed. The project network after such a crashing is shown in Exhibit 22.24. As per this figure there are two critical paths (1 3 5 6 7) and (1 3 5 7), both with a length of 21 weeks, and the total direct cost is Rs 55,200.

Fig. 24



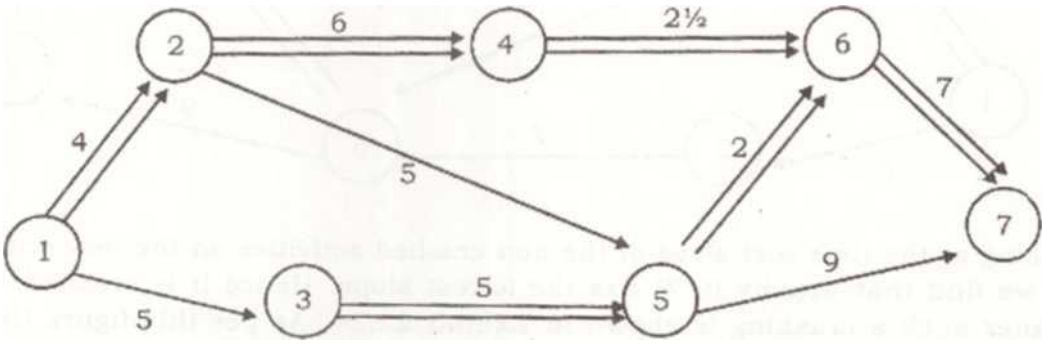
Considering the time cost slope of non crashed activities on critical paths (1 3 5 6 7) and (1 3 5 7), we find that activity (3 5) which is common to both the critical paths is the least, costly to crash. Hence, it is crashed. The project network after this crashing is shown in Exhibit 22.25. As per this figure, the critical path is (1 2 4 6 7) with a duration of 2014 weeks and the total direct cost is Rs 56,400.

Fig. 25



Looking at the new critical path (1 2 4 6 7) we find that the only non crashed activity is (4 6). Crashing this gives us the project network shown in Exhibit 22.26. As per this figure, the critical path again is (1 2 4 6 7) with a duration of 191/2 weeks and the total direct cost is Rs 57,600.

Fig. 26



Since all the activities on the critical path (1 2 4 6 7) are crashed, there is no possibility of further time reduction. Hence, let us now look at the time-cost relationship. Fig 27 shows this.

From Fig. 27, we find that the total cost is minimised for the project schedule represented by Fig 36 in which the activities crashed are (1 2), (2 4), (3 5), (5-4). (6-7).. The information provided in Fig 38 is useful for decision making.

Fig. 27 Project Duration and Total Cost

Exhibit	Activities Crashed	Project Duraction in Weeks	Total Direct Cost	Total Indirect Cost	Total Cost
22.31	None	30	45,200	60,000	105,200
22.32	(2-4)	29	46,700	58,000	104,700
22.33	(2-4 and (5-6)	27	49,500	54,000	103,500
22.34	(1-2), (2-4) and (5-6)	24	52,500	48,000	100,500
22.35	(1-2), (2-4), (5-6), and (6-7)	21	55,500	42,000	97,200
22.36	(1-2), (2-4), (3-5), (5-6), and (6-7)	20	56,400	40,000	96,400
22.37	(1-2), (2-4), (3-5), (5-6), (4-6), and (6-7)	$19^{1/2}$	57,600	39,000	96,600

If the objective is to minimize the total cost of the project, the pattern of crashing suggested by Fig 25 is optimal. If the objective is to minimize the project duration then, the pattern of crashing suggested by Fig 26 is optimal. In real life situations, however, both the factors may be important. In addition, factors like strain on resources and degree of manageability are also important. The final decision would involve a careful weighing and balancing of these diverse factors, some quantitative, some qualitative. In any case, information along the lines provided in Fig 27 provides useful input for decisionmaking.

14.3 NETWORK COST SYSTEM

The techniques of PERT and CPM discussed above are essentially time oriented. They seek to answer questions like:

- What is the most desirable time schedule of activities?
- How much time would it take, on an average, to complete the project?
- What is the probability of completing the project in a specified time?

Such analysis largely overlooks the cost aspect which is usually as important as the time aspect and sometimes even more. To provide a vehicle for cost planning and control of projects, the network cost system was developed. This represents a very useful supplement to the traditional time-oriented network analysis. Let us look at cost projection and cost analysis and control under the network cost system.

CHECK YOUR PROGRESS

1. • Once a project is selected, the focus is shifts to its.....
2. The activities of a project have inter relationships arising from .... and other considerations.
3. There are two basic network techniques: .....and .....
4. Activities are the basic building blocks of a ..... . it is necessary to

enumerate all the activities of the project.

5. .....The forwa], marking the beginning of the project, and event is reached.

14.4 SUMMARY

- There are two basic network techniques: PERT and CPM. PERT is applied mostly to projects characterized by uncertainty; its orientation is probabilistic. CPM is applied to projects which are relatively risk-free; its orientation is deterministic. Widely diverse projects are amenable to analysis by PERT and CPM.
- The steps involved in PERT analysis are: (i) development of project network, (ii) time estimation, (iii) determination of critical path, event slacks, and activity floats, (iv) development of project schedule, and (v) calculation of the variability of project duration and the probability of completion in a given time.

14.5 GLOSSARY

- *Crash* : In CPM, an activity can be conducted at a normal pace or at an expedited pace, known as crash-ing, at a greater cost.
- *Critical* : An activity or event that, if delayed, will delay project completion.
- *Event* : An end state for one or more activities that occurs at a specific point in time.
- *Gantt Chart* : A manner of illustrating multiple, time based activities on a horizontal time scale.
- *Project Management Information System* : The systems, activities, and data that allow information flow in a project, frequently compute -always.

14.6 REVIEW QUESTIONS

1. What are two factors compared by the Gantt Charting

2. How the GERT technique is different from the PERT technique.
3. When each scheduling technique appropriate to use?

14.7 FURTHER READINGS

1. Prasanna Chandra, PROJECTS- Planning, Selection, Financing, Implementation, and Review, Sixth Edition, Publication : TATA McGRAW HILL
2. Dennis Lock, *Project Management,* Ninth Edition, Publication : Gower
3. P.C.K. Rao, *Project Management and Control,* Publication : Sultan Chand & Sons
4. Vasant Desai, *Project Management,* Second Revised Edition, Publication : Himalaya Publishing House
5. Clements / Gido, *Effective Project Management,* Publication : Thomson
6. K. Nagarajan, *Project Management,* Third Edition, Publication : New Age International

MBA-CC (Second Year)
Semester-Ill
Lesson No. 15

PM 301
PROJECT MANAGEMENT
AUTHOR : NEERAJ SHARMA

RESOURCE ALLOCATION IN PROJECT MANAGEMENT

STRUCTURE

15.1 *AIMS AND OBJECTIVES*

This lesson deals with the Resource Planning in Projects. After reading this lesson you will be able to understand :

- Project Management and Resource Allocation
- Type of Resources
- Planning and Life Cycle
- The Resource Allocation Problem
- Resource Loading
- Resource Leveling
- Leveling Within the Project

15.2 *INTRODUCTION*

A project is a major one-time undertaking dedicated to some well-defined objective and involving considerable money, personnel, and equipment. It is usually initiated either by some need of the parent organization or by a customer request. The life cycle of a project can be structured into five consecutive phases involving specific managerial tasks. Starting with some proposal, several preliminary studies such as a feasibility study, an economic analysis, or a risk analysis are conducted in the project conception phase in order to decide whether or not a corresponding project will be performed. In the project definition phase, :he objectives of the project are formulated, the type of project organization is selected, resources are assigned to the project, and different tasks with associated milestones are identified. + Subsequently, the project planning phase at first decomposes each task into precedence- related activities by means of a structural analysis of the project.

The time and resource estimations then provide the duration and resource requirements for each activity as well as temporal constraints between activities that are

connected by precedence relationships. The result of the structural analysis and the time and resource estimations is the representation of the project as a network modeling the activities and the prescribed precedence relationships among them. Next, the temporal scheduling of the project provides the earliest and latest start times as well as the slack times of the activities, limitations with respect to resource availability yet being disregarded. The last and most complex issue of project planning consists in allocating the scarce resources over time to the execution of the activities. During the project execution phase, the implementation of the project is controlled by monitoring the project progress against the schedule which has been established in the project planning phase. In case of significant deviations from schedule, the resource allocation has'to be performed again. The final project :crmination phase evaluates and documents the project after its completion to facilitate the management of future projects.

15.3 TYPE OF RESOURCES

A project resource is any person, object, tool, machine or sum of monej^ needed for work on a project. Resources can be categorized in several ways and it is interesting to start by identifying three classes.

15.3.1 Exhaustible resources

Once an exhaustible resource has been used, it is no longer available for use on a replenishment is physically impossible.

Time is the most important exhaustible resource. Time is truly exhaustible. Once spent, gone forever and can never be renewed. Time is a very special resource, needing its own techniques for planning and scheduling.

Fossil fuels (such as coal, oil and natural gas) and mineral deposits (like the ores used in are exhaustible resources. Once the deposits in a particular region have been used up, they be replaced and the life cycle of the project that exploited them must end.

Exhaustible resources feature in project feasibility and strategic studies and in total life analysis but (with the exception of time) they do not generally feature in project resource scheduling.

15.3.2 Replenishable resources

Materials and components obtained through purchasing are replenishable resources. Although stocks of these resources might become exhausted when they are built into a project, they usually be replenished by buying fresh supplies. The principal methods for scheduling m come within the realm of stock control and purchasing, but information from project p provides the control framework for purchasers and stock controllers by stating how much needed and when.

Although not considered specifically in this chapter, agricultural crops and their products are replenishable resources. However, they may not all be replenishable in the short term for example).

Some project management programs can schedule replenishable resources directly it re scheduling might include, for instance, the phasing of materials deliveries to a construction site so the quantities on site match the rate of progress expected from the project critical path network.

Money, especially when it is scarce, might be regarded by some as an exhaustible

resource. Strictly, however, it is replenishable. There are many examples of projects where the sponsors been persuaded to provide more money for an ailing project rather than see it and their initial investment sink into oblivion. As with materials, project management data can determine much cash will be needed and when. Cash flow predictions are a form of project resource scheduling and all competent project management software can be used to generate cash flow schedules.

15.3.3 Reusable resources

Reusable resources are assets that are required for use on project work but which remains available reuse after each task has been performed. They can be compared to catalysts in a chemical reaction; they are necessary to promote the reaction but at the end they emerge unchanged. Levels of re resources tend to remain fairly stable over the longer term. They might, however, be scarce; in which case their use requires careful planning and scheduling.

People, with their particular skills and aptitudes, are the most common type of reusable resource. Some might claim that people do not emerge from a project unchanged, but (ageing apart) should be available for work on consecutive projects.

Industrial plant and machinery, other manufacturing facilities, test centers and so on can also be considered and treated as reusable resources. Although people and machines are very different resource the same techniques and computer programs can be used to schedule them, provided that their use can categorized by a simple code and their quantity can be specified in straightforward units.

Factory or office space is, of course, a reusable resource. One usually has to consider not only the number of space units (square meters or square feet) but also the shape of the space and, sometimes, also its volume. In heavy machine tool design and manufacturing projects, for example, machines setup for pre shipment testing might have to be positioned in the assembly and test bay according to their height and foundation requirements, and it might be necessary to save space by allowing for machines from different projects to overhang each other. Project management software is not capable of dealing with these aspects of scheduling. In practice the solutions are best left to production engineers (for factory space) or facilities managers (for office space). They would use floor plans or three-dimensional models, either with or without the aid of a computer. However, & project manager still has a vital role to play, because it is principally he or she who can tell the production engineer or facilities manager when the space will be needed for each project.

15.4 PLANNING AND LIFE CYCLE

Each phase in the project life cycle requires specific project management techniques. Several recent textbooks on project management are devoted to the managerial and behavioral aspects of project conception, project definition, project planning, project execution, and project termination. Project The complexity of resource allocation arises from the interaction between the activities of a project by explicit and implicit dependencies, which may be subject to some degree of uncertainty. Explicit dependencies are given by the precedence relationships between activities emanating from technological or organizational requirements. In the course of time estimation, those dependencies are transformed into temporal constraints between activities.

The scarcity of the resources used establishes an implicit dependency between activities, which can be formulated as resource constraints referring to sets of activities competing for the same resources or in terms of an objective function penalizing excessive resource requirements. The resource allocation problem consists in assigning time intervals to the execution of the activities while taking into account the prescribed temporal constraints and resource scarcity. If resource constraints are given, we also speak of a resource-constrained project scheduling problem. We distinguish between two sub problems: sequencing and time-constrained project scheduling. The limited availability of resources necessitates the definition of additional precedence relationships between activities when performing resource allocation task. Again, those precedence relationships can be expressed in the form of temporal constraints. In contrast to the structural analysis, however, the precedence relationships to be introduced arc subject to decision. This sequencing problem forms the core problem of projcct planning. Time-constraincd project scheduling is concerned with computing the project schedule such that all temporal constraints - predetermined by the structural analysis or arising from sequencing - are observed arid some objective function reflecting the managerial goal of the project is optimized.

In that case, the time and resource estimations provide the sets of alternative execution modes, and solving the mode assignment problem constitutes the first step of resource allocation. Depending on whether the sets of execution modes are countable or uncountable, we speak of a discrete or a continuous mode assignment problem. A resource allocation problem that comprises a mode assignment problem is termed a multi-mode resource allocation problem.

15.5 The Resource Allocation Problem

A shortcoming of the scheduling procedures covered in the previous chapter is that they do not address the issues of resource utilization and availability. They focus on time rather than physical resources. Also, in the discussion that follows it will not be sufficient to refer to resource usage simply as "costs." Instead, we must refer to individual types of labor, specific facilities, kinds of materials, individual pieces of equipment, and other discrete inputs that are relevant to an individual projcct but are limited in availability. Last, we must not forget that time itself is always a critical resource in project management, one that is unique because it can neither be inventoried nor renewed.

The relationship between progress, time, and resource availability and usage is the major focus of this chapter. Schedules should be evaluated not merely in terms of meeting project milestones, but also in terms of the timing and use of scarce resources. A fundamental measure of the Ws success in project management is the skill with which the trade-offs among performance, time, and cost are managed. It is a continues process of cost

- benefit analysis: "I can shorten this project by a day at a Rs.400. Should I do it?" "If I buy 300 more hours of engineering time, I may be improving performance by 2 or 3 percent. Should I do it?"

Occasionally it is possible that some additional (useful) resources can be little or no cost to a project during a crisis period. At other times, some resources abundant supply may be traded for scarce ones. Most of the time, however, trades entail additional costs to the organization, so a primary responsibility for PM is to make do with what is available.

The extreme points of the relationship between time use and resource use are

- *Time Limited* : The project must be finished by a certain time, using few resources

as possible. But it is time, not resource usage, that is critical

- *Resource Limited* : The project must be finished as soon as possible, without exceeding some specific level of resource usage or some general source constraint.

The points between these two extremes represent time / resource use trade, they spccify the times achievable at various resource levels. Equivalently, they specify the resources associated with various completion times. C the range of time or resource variability is limited.

Occasionally, both time and resources may be limited, but in this case, the specifications cannot also be fixed. If all three variables time, cost, specification fixed, the system is "over - determined." The PM has lost all flexibility to perform trade offs that are so necessary to the successful completion of projects. Of course it is possible that all three variables might be fixed at levels that allowed the p of maneuvering room, but this is most unlikely. Far more likely, our project acquaintances tell us is the case in which senior management assigns budgets, schedules, and specifications without regard for the uncertainties of reality. It is e responsibility, possibly with help from the project's champion, to warn senior management of the impropriety of such restrictions in spite of the chance that a manager might respond with "I'll get someone who can...!"

On occasion, it may be that one or more tasks in a project are system - constrained. A system constrained task requires a fixed amount of time and known quantifies resources. Some industrial processes heat treating, for instance are s constrained. The material must "cook" for a specified time to achieve the desired effect. More or less "cooking" will not help. When dealing with a system constrained task or project, no trade offs are possible. The only matter of interest in these cases' to make sure that the required resources are available when needed.

In the following sections we discuss approaches for understanding and using relationships in various project situations.

15.6 RESOURCE LOADING

Resource loading is used to determine how resources will be allocated over the duration of a project and how to verify that they are being allocated correctly. In other words, the purpose is to ensure that no team members are ever overloaded. There are several options to determine resource loading:

1. Verify by name of employee that the number of activities (or projects) any one person (or pool) is working on simultaneously is reasonable.
2. Sum the percentage of time each team member plans to commit to each activity (or project) in a single time frame in order to determine a total percentage greater than or less than the time the individual has available. The diagram shown in Figure 5- 10, for example, indicates that MS has scheduled 150 percent of her time between Months 9.5 and 10.
3. Calculate the individual effort allocation for each team member.

Resource loading describes the amount of individual resources existing schedule quires during specific time periods. Therefore, it is irrelevant whether we are considering a single work unit or several projects; the loads (requirements) of each resource type are simply listed as a function of time period. Resource loading gives a general understanding of the demands a project or set of projects will make on a firm's resources. It is an excellent guide for early, rough project planning. Obviously, it is also a first step in attempting to reduce excessive demands on certain resources, regardless of the specific technique used to reduce the demands. Again, we caution the PM to recognize that the use of resources on a project is often nonlinear. Much of the project management software does not recognize this fact.

15.6.1 Self Check Exercise

- Project management and resource allocation are key aspects of understanding _____.
- A project is a major one-time undertaking involving considerable _____.
- The life cycle of a project can be structured into five consecutive phases, starting with _____.
- Project resources can be categorized into three classes: Exhaustible resources, Replenishable resources, and _____.
- Time is considered the most important _____ resource.
- Materials and components obtained through purchasing are examples of _____ resources.
- People, with their particular skills and aptitudes, are the most common type of _____ resources.

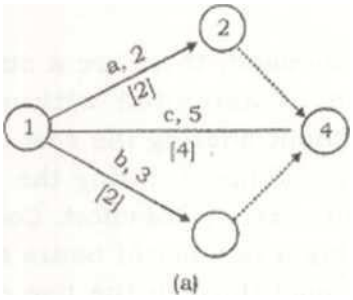
15.7 RESOURCE LEVELING

In the preceding example, we noted that the project began with the heavy use of resource A, used smaller amounts during the middle of the project, and then continued with rising usage during the project's latter stages. Usage of B started low and rose throughout the project s life. Large fluctuations in the required loads for various resources arc a normal occurrence and arc undesirable from the PM's point of view. Resource leveling aims to minimize the period by period variations in resource loading by shifting tasks within their slack allowances. The purpose is to create a smoother distribution of resource usage.

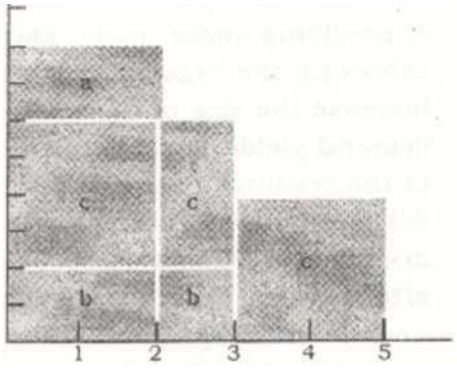
There are several advantages to smoother resource usage. First, much less hands- on management is required if the use of a given resource is nearly constant over its period of use. The PM can arrange to have the resource available when needed, can have the supplier furnish constant amounts, and can arrange for a backup supplier if advisable. Moreover, the PM can do this with little error. Second, if resource usage is level, the PM may be able to use a "just-in-time" inventory policy without much worry that the quantity delivered will be wrong. If the resource being leveled is people, leveling improves morale and results in fewer problems in the personnel and payroll offices because of increasing and decreasing labor levels.

Not only are there managerial implications to resource leveling there are also important cost implications. When resources are leveled, the associate costs tend to be leveled. If resource use increases as time goes by, and if resources are s closer to the present by leveling, costs will be shifted in the same way. The op is true, of course, if resource usage is shifted to the future. Perhaps most important from a cost perspective is leveling employment throughout a project or task. For organizations, the costs of hiring and layoff are quite significant. It is often less pensive to level labor requirements in order to avoid hiring a d layoff, even i means some extra wages will be paid. In any case, the PM must be aware of the flows associated with the project and of the means of shifting them in ways that useful to the parent firm.

The basic procedure for resource leveling is straightforward. For example, consider the simple network shown in Fig. The activity time is shown above the arc, and resource usage (one resource, workers) is in brackets below the arc. Activities a, b, and c follow event 1, and all must precede event 4. Activity a requires two workers and takes two days, b requires two workers and takes three days, and c needs four workers and five days. If all these tasks are begun on their early start dates, the resource loading diagram appears as shown in Fig, steps of decreasing labor demand varying from eight workers to four workers. If, how task b is delayed for two days, the full length of its slack in this particular case, the source loading diagram is smoothed. The same result have occurred if were started as early as possible and task a were delayed day 3.

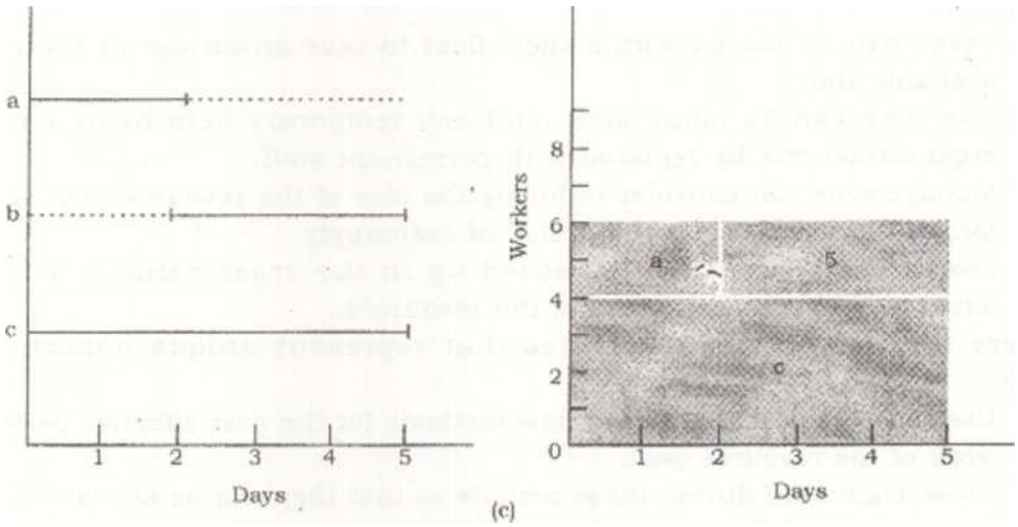


35 b



I I I I I
1 2 3 4 5
Days

<b)



(c)

a The network, *b* Before resource leveling, c .* After resource leveling.

Resource leveling is procedures that can be used for almost all projects, who or not resources are constrained. If the network is not too large and there are only a few resources, the leveling process can be done manually. For larger networks multiple resources, resource leveling becomes extremely complex, far beyond power of manual solutions. Fortunately, a number of computer programs can most leveling problems efficiently.

15.7.1 Leveling Within the Project

If there arc resources that have been overloaded after they have been allocated, how do

you level (or smooth) them out?

When supply falls short of demand, there are a number of approaches to leveling :

- Tasks can be shifted or extended within their float. This may eliminate unacceptable peaks without altering the cost of any part of the workload.
- Use overtime to meet the demand during the period of forecasted over utilization.
- Ask the team members to exert extra effort. Compensation or time off can be offered to staff members working a number of hours substantially in excess of the norm.
- Augment the resource pool through the use of temporary help. (This is often not feasible, however, due to the need to provide work space, tools, and facilities to the temporary workers.)
- Contract out a portion of the workload. This relieves the organization of the burden of providing space, tools, and facilities, but it also potentially increases the cost of achieving the organization's objectives.
- Increase the size of the resource pool permanently. If the forecast of supply versus demand yields multiple periods of over utilization well into the future, adding staff to the resource pool may be the most effective approach to manage the workload.
- Select a portion of the workload to be delayed beyond its approved completion date in order to eliminate the peaks in the demand for the resource. Performing this alternative, referred to as resource-constrained scheduling, requires an understanding of the relative priorities of each component of the project and nonproject workload of the resource pool.

When supply exceeds demand, some of these same approaches can be used to level demand :

- Tasks can be moved within their float to take advantage of the resource pool's available time.
- Overtime can be eliminated, and any temporary help being employed by the organization can be replaced with permanent staff.
- Management can consider reducing the size of the resource pool selectively if the forecast shows a prolonged period of oversupply.
- Low-priority work can be moved up in the organization s schedule to take advantage of the availability of the resources.

There are two other possibilities that represent unique opportunities during oversupply :

- Use these periods to develop new methods for the cost-effectivc performance of the work of the resource pool.
- Cross-train staff during these periods so that they can be allocated in the future to components of the workload they are not now qualified to perform.

15.8 SUMMARY

In this lesson, we have been concerned with models, algorithms, and applications of deterministic resource allocation problems in project management. A special emphasis has been placed on developing a unifying framework within which a variety of project scheduling problems can be treated. Those problems involve general temporal constraints given by prescribed minimum and maximum time lags, different types of scarce resources, and a broad class of regular and non-regular objective functions. The diversity of the models proposed allows to cover many features arising in applications beyond the proper field of project

management like short-term production planning in the manufacturing or process industries.

15.9 GLOSSARY

- *Cost Time Slope* : The ratio of the increased cost for expediting to the decreased amount of time for the activity.
- *Followers* : The tasks that logically follow a particular task in time.
- *Heuristic* : A formal process for solving a problem, like a rule of thumb, that results in an acceptable solution.
- *Mathematical Programming* : A general term for certain mathematical approaches to solving constrained optimization problems, including linear programming, integer programming, and so on,
    - *Predecessors* : The tasks that logically precede a particular task in time.
- *Priority Rules* : Formal methods, such as ratios, that rank items to determine which one should be next.
- *Resource Leveling* : Approaches to even out the peaks and valleys of resource requirements so that a fixed amount of resources can be employed over time.
- *Resource Loading* : The amount of resources of each kind that are to be devoted to a specific activity in a certain time period.
- *Tree Search* : The evaluation of a number of alternatives that logically branch from each other like a tree with limbs.

15.10 SHORT ANSWER QUESTIONS.

1. Identify several resources that may need to be considered when scheduling projects.
2. What are the resources loading? How does it differ from resource leveling?
3. What is the average resource load factor? How is it used to determine project completion time?
4. When might a firm choose to crash a project? What factors must be considered in making this decision?

15.11 Answers to Self Check Exercise:

- Resource Planning in Projects.
- Money, personnel, and equipment.
- Proposal and preliminary studies.
- Reusable resources.
- Exhaustible.
- Replenishable.
- Reusable.

15.12 FURTHER READINGS

1. Clifford F. Gray and Erik W. Larson, *Project Management,* Publication : TATA McGRAW HILL
2. Prasanna Chandra, *PROJECTS- Planning, Selection, Financing, Implementation, and Review*, Sixth Edition, Publication : TATA McGraw HILL
3. Dennis Lock, *Project Management,* Ninth Edition, Publication : Gower
4. P.C.K. Rao, *Project Management and Control,* Publication : Sultan Chand & Sons
5. Vasant Desai, *Project Management, Second Revised Edition,* Publication : Himalaya Publishing House

STRUCTURE

16.0 AIMS AND OBJECTIVES

This lesson deals with the Overview of MS-Projcct 2000. After reading this lesson you will be able to understand :

- Project Management Information System
- Overview of MS-Project 2000
- Features of MS Project Software

16.1 INTRODUCTION

Real projects are often extremely large, with hundreds of tasks and thousands of work units. Diagramming, scheduling, and tracking all these tasks is clearly a job for the computer, and computerized PMISs were one of the earlier business applications for computers. Initially, the focus was on simple scheduling pack, ages, but this quickly extended to include costs, earned values, variances, management reports, and so on.

16.2 HISTORY

The earlier packages ran on large, expensive mainframe computers; thus, only the larger fipns had access to them. Still, the use of these packages for managing projects on a day-to-day basis was not particularly successful. This was because of the inability of project managers to update plans in real time, mainframe computers typically being run in a batch rather than online mode. With the development and proliferation of micro computers, and the corresponding availability of a wide variety of project management software, project managers use one or more PMISs.

This new microcomputer based PMISs are considerably more sophisticated than

earlier systems and use the microcomputer s graphics, color, and other features more extensively. Many systems can handle almost any size project, being limited only by the memory available in the computer. Many will handle multiple projects and link them together to detect resource over allocation; e.g., Microsoft Project 2000 can consolidate more than 1000 projects. The PMIS trend of the early 1990s has bed to integrate the project management software with spreadsheets, databases, world processors, communication, graphics, and the other capabilities of Windows based software packages. The current trend is to facilitate the global sharing of project information, including complete status reporting, through local networks as well as the Internet.

In this section, we will illustrate some output from one project management software package, Microsoft's Project 2000. The development of this and other powerful software system was accompanied by the development of desktop computers with memory, power, and speed undreamed of a few years ago. With project files stored in large memory banks on anything from a mainframe machine, to a minicomputer, and mom frequentl}' to workstations, servers, and PCs the software and project files became available on LAN and W^{T}AN systems, as well as through the Internet.

16.3 SOFTWARE REQUIREMENT

The explosive growth of project management software during the early 1990s saw creation of more than 500 packages. This software came in a wide variety of cities and prices. Some packages cost around Rs 50,000 and a few cost more than Rsl ,00,000.00, A large majority, however, fall in the Rs 400,000 Rs 500,000 bracket. The mainstream products have roughly similar capabilities, width having its individual strengths and weaknesses. The simple fact that the lower programs generally do not have the ability to dc everything an experienced manager might want has led to the rapid growth of a different type of software, Add on software is specially crafted to accomplish specific tasks and was fully compatible, sometimes almost seamlessly so, with specific general project management packages. Microsoft's market dominance means that a lion's share of the software is compatible with MP 2000.

Until recently, most project management software was unable to handle time PERT input, and even now the ability to deal with cost and schedule risk management problems is quite limited. The result is that there are risk ma add on programs available. These add ons can handle quite sophisticated stochastic problems and transport information easily between the add on and the host program. With the ability to perform simulations on project schedules or resource usage, the PM can observe the probable result s of many different assumptions about resource availability and schedule uncertainties.

The prevalence of multiple project firms as well as the increasing number of firms that are project oriented have lead to the demand for software that will combine the data records for all projects into a single database. The purpose is to allow the PM to aggregate resource requirements, more easily spot resource and schedule conflicts, and to report on resource usage, personnel time charges, and the like to the firm's accounting system. These add ons are often referred to as "consolidators" or "repositories" and "time capture" programs. Additional add ons deal with extensions to the earned value calculations, conformity with C/SCSC accounting and reporting rules, specialized cost management programs, responsibility charts, preparation of files for Internet use, e mail systems, a variety of templates for project reports, LAN and WAN communication systems anc workgroup

capability, and so on. AH this, of course, is useful if the basic project management software does not already have sufficient abilities and if the PM needs them. While no single tool is a panacea, MP2000 is a competent, easy to use software package and its popularity means that a large number of "add - on" are available.

16.4 CHOOSING SOFTWARE

When choosing project management software, the potential user should read several software surveys conducted with project managers. All of these' now last year's news and thus, obsolete, but they clearly indicate the sorts of capabilities that are important to most users. Software warns against reviews in computer magazines because software specialists who know little or nothing about project management often write them. We suspect that this warning is not as relevant today as it was a few years ago. W[r]e would, however, strongly warn against allowing the organization's software technicians from making the choice, unaided. So that appeals to software specialists is not necessarily the optimal choice for project manager.

16.5 MICROSOFT PROJECT 2000 SOFTWARE

Microsoft Project (MS Project) is the most popular among the available project management ware packages. This software supports many project management areas like scheduling, budge resource management, charting, performance monitoring, risk management, analysis, reporting communication.

MS Project also offers the facility to manage multiple projects. It also provides for sharing forces between the projects and export/import of project data among :he multiple systems being handled. The various features and facilities available in MS Project package are explained below.

16.5.1 Gantt chart

A Gantt chart shows the sequence of activities. While a traditional Gantt chart shows the relationship between various activities by way of a bar diagram, MS Project uses a modified Gantt chart includes links to show the relationship between the activities. Adding link lines to Gantt chart indicates the series and parallel relationships between the activities.

16.5.2 Project Baseline

Any project plan is finalized after a lot of deliberations, corrections, modifications and revisions. Once the project plan is finalized, it is to be 'stored' as a reference. MS Project uses a 'baseline' for storing the project plan. A baseline is a project plan containing the original estimates for tasks, resources, assignments and costs. Data as per the plan like start and finish dates of tasks, duration of tasks, splits in tasks, costs of tasks etc., are captured in a baseline. Once a baseline is formed and stored, it is used as a reference for comparing the actual progress with the planned progress. The comparison can be made cither in term of cost or in term of time.

16.5.3 Splitting Tasks

When a project is under implementation, a task may need to be spitted. Suppose a person who is attending to a particular task requiring two months duration, goes on leave after one month. Instead of waiting for one month till the person rejoins, the task can be

split so that a portion is completed before the person goes on leave and the remaining portion after the person rejoins the team. The rest of the tasks can be accordingly realigned provided that such splitting of a task does not bring forth any error in the logical sequence of tasks. MS Project provides facilities for splitting tasks and revising the project schedule suitably.

16.5.4 Schedule Processing

Tasks in a project are to be properly linked. Once proper link is established between the different tasks, the project schedule can be altered suitably whenever there are changes in the start/completion time (s) of some of the tasks. MS Project links the tasks by establishing the relationship between the different tasks. When tasks are linked, the task that must be started or completed first is called the predecessor and task that depends on the predecessor is called the successor. MS Project uses the following relationships for linking the tasks.

- Finish to start
- Start to start
- Finish to finish
- Start to finish

The Finish to start relationship is the default Relationship in MS Project, since it is the relationship that is most commonly come across. If there is a finish to start relationship between two one task can not start until another task finishes. A start to start relationship is one in which one can not start until another task starts. A finish to finish relationship is one in which one task can finish until another task finishes. In a start to finish relationship, the finish date of one task on the start date of another task. The relationship between the different tasks of a project is to be carefully studied before establishing the links. Any error in establishing the links properly will in faulty scheduling logic and the results will be wrong. Links between the different tasks can establish in MS Project using any one of the following facilities available:

1. Toolbar or menu commands
2. Task information dialog box or task tables
3. Drag and drop using the mouse

MS Project also provides facilities for modifying the task relationships. It may be likely that task relationship is not correctly established for all the tasks at the first instance itself, especially, bigger projects. Further, when a task is removed or a new task is inserted or a task is moved, 1, Project automatically repairs the broken links created due to such modifications when 'Auto' option is enabled.

16.5.5 Project Cost Estimation

MS Project arrives at the project cost by arriving at the costs of individual tasks indirectly. Each activity consumes resources. Costs are assigned to resources and resources are in turn assigned tasks. Cost of a task is arrived at by the software by multiplying the resource required to comp task with the cost of the resource. A resource pool is created that includes all the resources used the project. Resources are grouped into two categories, viz., work resources and material resources. Work resources are the people and equipment assigned to a task. Material resources are supplies stock and other consumable items used to complete the tasks. Details about the work resources material resources are entered in

the Resource Sheet'. The resource sheet contains, inter alia, like resource name, resource type (work or material), standard rate etc. Apart from creating resource pool, the resource must be assigned to tasks so that cost of each task can be arrived at. Resource assignment relates a task to the resources responsible for the task. Resources assigned to tasks by using the 'Assign Resources Dialog Box' or by using the 'Task Form'. After tasks, resources and their costs and resource assignments are entered, project budget estimated project cost) can be arrived at easily.

16.5.6 Self Check Exercise:

- Real projects are often extremely large, with _____ and _____.
- Initially, the focus of computerized PMISs was on simple scheduling packages, but this quickly extended to include _____, _____, _____, management reports, and so on.
- The earlier packages ran on large, expensive mainframe computers; thus, only the larger firms had access to them. With the development of microcomputers, project managers began to use _____.
- Microcomputer-based PMISs are considerably more sophisticated than _____.
- Microsoft Project 2000 can consolidate more than _____ projects.
- The PMIS trend of the early 1990s aimed to integrate project management software with _____, _____, _____, and the other capabilities of Windows-based software packages.
- The explosive growth of project management software during the early 1990s saw the creation of more than _____ packages.

16.5.7 Monitoring the Progress of Project (Earned value analysis)

MS Projcct includes tools for Earned Value Analysis, also called BCWP (Budgeted Cost of Performed) analysis. Earned Value Analysis measures key performance indicators and co them to the baseline parameters. The difference (or variance) between the baseline and performance can be calculated which indicates whether the project is being implemented as planned. MS Project can measure both Cost Variance (the difference between the task's planned Cost actual costs) and Schedule Variance (the difference between the actual progress and the scheduled progress of a task).

For calculating the variance, the up-to-date progress of the project is to be entered into package. Project data can be updated using 'Tracking Table' in the 'Task Sheet View'. This contains fields like actual start date, actual finish date, and percentage of actual completion, actual duration, remaining duration, actual cost and actual work. Once all the required data on the actual progress of the project are entered, MS Project can calculate the variances. Variances can be viewed by switching to 'Tracking Gantt View' and selecting 'Variance Table'. The variance table gives the baseline data and the variances of all tasks

'Earned Value Table' of MS Project gives the following estimates at any paint of time.

BCWS : Budgeted Cost of Work Scheduled

BCWP : Budgeted Cost of Work Performed

ACWP : Actual Cost of Work Performed

SV : Schedule Variance [BCWP BCWS]

CV : Cost Variance [BCWP ACWPJ

EAC : Estimate At Completion (i.e., the estimate of cost if the remainder of the task's work is completed as budgeted.)

BAC : Baseline cost At Completion

VAC : Variance AT Completion [BAC EAC)

Using the above information furnished by MS Project, two important indices can be calculated, viz.,

Schedule Performance Index (SPI) : BCWP/BCWS and Cost Performance Index (CPI) BCWP/ACWP

16.6 RESOURCE LEVELING

MS Project provides two options for resource leveling. Resource leveling can be done within a specified range of dates or for the entire project. MS Project allows two methods of leveling, viz., automatic' and 'manual' levelling. When automatic levelling option is chosen, the project will adjust tasks as soon as a task is changed or assigned a resource that results in over allocation, i.e., the software checks for over allocation after each entry. Hence,

choosing automatic levelling option will slow down the overall performance of the software. If manual option is chosen, the discretion to level the resources is given to the project manager. When he chooses to level the resources, he can open Resource levelling Dialog Box' and click 'Level now' to level the resources.

MS Project, will not delay tasks that have the following constraints.

- Must finish on
- Must start on
- As late as possible (for projects scheduled from the start date)
- As soon as possible (for projects scheduled from the finish date)

Before using MS Project s levelling feature, the constraints and priority settings for the critical tasks are to be defined. Priority setting for tasks can be given in the range 0 to 1000. If a task is set a priority of 1000, MS Project will not delay this task.

16.7 **RESOURCE POOL**

A resource pool is a project file that contains resource information of an organization. The main idea behind creating a resource pool is to facilitate sharing of resources among multiple projects. When an organization handles multiple projects at a time, it becomes efficient to distribute resource from' the resource pool instead of allocating resources for the individual projects exclusively. The multiple projects that arc under implementation/to be implemented can be assigned priority, by assigning a number from 0 to 1000 in order to rank them in the order of their relative importance. A project that is given the highest priority (i.e., assigned the highest number) will receive top consideration while allocating resources from the resource pool; projects with lower priority will receive lower consideration while allocating resources. This arrangement will help to handle situations in which there is a conflict for resource sharing among the multiple projects.

16.8 **PERT**

As wc know three time estimates are used in PERT, viz., the optimistic time, the pessimistic time and the most likely time. The three time durations are we.ghted and averaged to determine the expected duration of the tasks. Weights are to be assigned to the three time estimates so that MS Project cm arrive at the expected time of the tasks and use the same in PERT calculations. The default setting for weights are as under:

Optimistic : 1
Expected : 4
Pessimistic : 1

After the three time estimates and their weights Eire fed in, MS Project provides views of Gad charts based on the three time estimates, i.e., views of optimistic Gantt chart, pessimistic Gantt chart and expected Gantt chart can be seen. Critical path can be viewed by choosing 'View' menu and further choosing ’Network diagram' from ‘View' menu. MS Project also provides filter facility view network diagram. When the filter facility is used, the network diagram will display only critical tasks on the screen that require the attention of the project manager.

16.9 **REPORTS**

MS Project 2000 provides the following built-in reports •. •

- Current activity reports
- Cost reports
- Assignment reports
- Workload reports

16.10 SUMMARY

In this lesson, we discussed MS-Project 2000. We also discussed the need and importance of Project Management Information System, Errors managed by PMIS and major Features of MS Project Software. Project reports are of three types: routine, exception, and special analysis. Project reports should include an amount of detail appropriate to the target level of management with a frequency appropriate to the need for control (probably not weekly or other such regular basis). More commonly, reports occur near milestone dates. Three common project reporting problems arc too much detail, poor correspondence to the parent firm's reporting system, and a poor correspondence between the planning and monitoring systems. The earned value chart depicts scheduled progress, actual cost, and actual progress (earned value) to allow the de-termination of spending time, schedule, and time variance. There exist a great number of computerized PMISs that are available for PMs, evaluations occurring regularly in various magazines.

16.11 GLOSSARY

- *Computer Paralysis* : Excessive fascination or activity with the computer rather than the project itself such that the project suffers.
- *Cost Variance* : The budgeted cost of the work performed less the actual cost of the work performed.
- *Earned Value* : An approach for monitoring project progress that relies on the budgeted cost of activities completed to ascribe value.
- *Hard Copy* : Printed information output, as opposed to screen output.
- *Information Overload* : Having an excess of information so that the information desired is difficult to locate.
- Migration : The ability to move files and data between software packages.
- *Monitor* : To keep watch in order to take _____ progress fails to match plans.
- *Schedule Variance* : The budgeted cost of work completed less the budgeted cost of work scheduled time.
- *Software* : The instructions for running a computer.
- *Spending Variance* : The budgeted cost of work completed less the actual cost at this time.
- *Spreadsheet* : A matrix of data used with a computer. As the data in particular cells are changed, of other cells change also to keep in accordance.
- *Time Variance* : The scheduled time for the work completed less the actual time.
- *Variance* : A deviation from plan or expectation.
- *Windowing* : A computer software feature -different functions to be conducted in a separate section of the screen, called a window.

16.12 SHORT ANSWER QUESTIONS:

1. Give an overview' of MS-Project 2000.

2. Define monitoring. Are there any additional activities that should be part of the monitoring function?
3. Identify the key factors that need to be considered when setting up a monitoring system.
4. List some factors that would be difficult to monitor.
5. Describe routine reports generated by MS-Project 2000.

16.13 **Answers to Self Check Exercises:**

- hundreds of tasks and thousands of work units.
- costs, earned values, variances.
- one or more PMISs.
- earlier systems.
- 1000.
- spreadsheets, databases, word processors.
- 500.

16.14 **FURTHER READINGS**

1. Prasanna Chandra, PROJECTS- Planning, Selection, Financing, Implementation, and Review, Sixth Edition, Publication : TATA McGraw HILL.
2. Dennis Lock, *Project Management,* Ninth Edition, Publication: Gower.
3. P.C.K. Rao, *Project Management and Control,* Publication: Sultan Chand & Sons.
4. Vasant Desai, *Project Management,* Second Revised Edition, Publication: Himalaya Publishing House.
5. Clements / Gido, *Effective Project Management,* Publication : Thomson.
6. K. Nagarajan, *Project Management,* Third Edition, Publication : New Age International.

PROJECT CONTROL SYSTEMS

STRUCTURE

17.0 AIMS AND OBJECTIVES

This lesson deals with the concept of controlling and monitoring of projcct operations. After reading this lesson, you will be able to :

- Control techniques and systems
- Develop change management plan
- Ensure project deliverables conform to quality standards

17.1 INTRODUCTION

You need to continually monitor and control your project. Executing a project means executing the project work according to the project management plan based on some baselines, such as a schedule baseline, a scope baseline, and a cost baseline. In general, monitoring means watching the course, and

the course or change the wrong course. You monitor the project by generating, collecting, and distributing information about project performance against the baselines. Deviations of the performance results from the plan might indicate that some changes to the original project plan are required. Other change requests might come from stakeholders, such as expanding the project scope by adding new requirements. You control all these changes by influencing the factors that generate them, processing them through a system called the integrated change control system that contains a process called the integrated change, evaluating their impact across the project, and ensuring the implementation of the approved change requests.

In addition to the schedule activities that need to be executed, the project management plan also contains a list of risks and the risk management plan. You monitor the risks by looking out for the risk triggers (the alerts that tell you, a risk has occurred or is about to occur) for the already identified risks and by identifying new risks as the project progresses. You control the risks by executing the risk response plan and taking corrective and preventive actions. Therefore, the core question in this lesson is, how do you monitor and control a project? In search of an answer, we will explore three avenues in the area of monitoring and controlling performance, changes, and risks.

17.2 MONITORING AND CONTROLLING THE PROJECT WORK

You monitor and control your project by monitoring and controlling the project performance, changes, and risks. Monitoring includes measuring the project performance, collecting and distributing information about the project performance, and evaluating the performance information to see the trends. Continuous monitoring helps the project management team identify the areas that need to be controlled closely by, for example, taking corrective or preventive actions.

Some of the major tasks involved in monitoring and controlling the project are the following :

- Monitoring project performance by measuring it against the project management plan in terms of parameters such as cost, schedule, and scope
- Monitoring the project by collecting information to support status reporting progress measurement, and predictions, and then distributing this information among the stakeholders
- Evaluating performance to determine whether it needs to be controlled by taking corrective or preventive actions
- Monitoring risks by tracking and analyzing the already identified project risks and by identifying new risks
- Controlling risks by managing the execution of risk response plans when the risks occur
- Maintaining an accurate and timely information ban regarding the project as it progress
- Monitoring and controlling changes and monitoring the implementation of approved changes

A project is monitored and controlled using the monitor and control project, work process, which is a high-level process that is performed by executing more specific processes, such as cost control, schedule control and scope control. All these processes are

in the monitoring and controlling process group.

The change requests arising from monitoring and controlling the project or originating from any other source, such as the stakeholders, must be processed through the integrated change control process.

17.3 INTEGRATED CHANGE CONTROL PROCESS

The integrated change control process is used to manage changes to the project from project initiation through project closure. *A* project rarely runs exactly according to the project management plan, and therefore changes will inevitably appear. The change requests can come from evaluating the project performance to bring the projcct in line with the project management plan, or they can come from other sources, such as the stakeholders. Regardless of where they originate from, all changes need to bu managed (monitored and controlled), which includes getting the changes rejected or approved, seeing the approved changes implemented, and changing the affected plans accordingly. You, the project manager, must manage changes proactively, which includes the following activities :

- Identifying a change that has occurred and receiving a change request.
- Getting the requested changes approved or rejected. Depending on the project and the performing organization, the authority to determine whether a change is eventually rejected or approved might lie with the project manager, a customer, a sponsor, or a committee.
- Monitoring and controlling the flow of approved changes, which includes :
  - — Making sure they are implemented.
  - — Maintaining the integrity of the project baseline (cost, schedule, and scope) by updating it to incorporate the approved changes.
  - — Coordinating changes and their impact across the project and updating the affected documentation. For example, an approved schedule change might impact cost, quality, risk, and staffing.
- Controlling project quality for example, through defect repairs and recommended corrective and preventive actions.
- Making sure that only the approved changes are implemented, Input to Integrated Change Control

17.4 INPUT TO INTEGRATED CHANGE CONTROL

Each requested change and recommended action must be processed through the integrated change control process. The approved changes have their effects on the project management plan, and therefore the plan needs to be updated accordingly. Following are the input items to the integrated change control process :

- *Requested changes* : This is the obvious input. *A* requested change goes through the integrated change control process.
- *Recommended items* : The following recommended items should also go through the integrated change control process.
  - — Recommended corrective actions
  - — Recommended preventive actions
  - — *Recommend defect repairs*

These recommendations might arise from performance evaluations, and they are the

output of various processes discussed in this lesson.

- Project management plan, including deliverables. This is needed to help identify the changes and make updates after the changes have been approved.
- Work performance information. The performance information is the input because performance deviations from the plan will trigger change requests or recommended corrective or preventive actions to improve the situation

17.5 TOOLS AND TECHNIQUES FOR INTEGRATED CHANGE CONTROL

You can use project management methodology and project management information system to implement the integrated change control process. You can also use the expertise of the stakeholders to approve and reject change requests. Following are the tools and techniques available for the integrated change control process.

17.6 PROJECT MANAGEMENT METHODOLOGY

Recall that the project management plan contains the output of the projec: planning processes. This plan defines how the project is executed, monitored / controlled, and closed. But how do you implement (that is, execute) the project management plan? Every organization will have its own method for implementing the project management plan for its projects; this is called its project management methodology. The project management methodology of an organization will also define the high level process for the project management team to implement the integrated change control for the project. For example, different organizations might have different answers to the following questions :

- Mow will the change requests be submitted?
- Who will reject or approve the change requests?

Once you have the methodology in place, you need a system to implement the methodology.

17.7 PROJECT MANAGEMENT INFORMATION SYSTEM

This is a collection of tools and techniques (manual and automated) used to gather, integrate, and disseminate the output of project management processes. This system is used t.o facilitate processes from the initiation stage ail the way to the closing stage. A Microsoft Project, a product that lets you create a project schedule, is an example of such a tool. Another example of the components of the project management information system could be a document management system to create, review, change, and approve the documents to facilitate the change control procedure.

The project management information system might also have tools that can help the project management team implement the integrated change control process.

17.8 EXPERT JUDGMENT

The project management team can use the experts on the change control board to make approval or rejection decisions about change requests. The rejection or approval of the change request is an obvious output of the integrated change control process.

17.9 OUTPUT FROM INTEGRATED CHANGE CONTROL

The changes that are processed through the integrated change control process will either be rejected or approved. As a result of the approved changes, the project management

plan might need to be updated.

Accordingly, following are the output items of the integrated change control process:

Approved and rejected items

The items processed through the integrated change control process will either be approved or rejected. These items include change requests, suggested defect repairs, recommendations for corrective actions, and recommendations for preventive actions.

Validated items

Some change related items that have been implemented, such as dcfect repairs, will be validated.

Updates

As a result of approved changes, items such as the project management plan and the project scope statement might need to be updated. So, the requested changes are either rejected or approved in the integrated change control process. Project performance, a factor that you monitor and control, is closely related to quality which is the degree to which the project requirements are fiilfilled. For example, a good quality project is a project that is completed within its planned cost, scope, and schedule. Any variations from the planned cost, schedule, and scope performance indicate the degradation of project quality. So, controlling the performance correlates strongly to controlling the quality.

17.10 CONTROLLING CHANGES IN COST, SCHEDULE, AND SCOPE

Changes to cost, schedule, and scope are controlled using the cost control, schedule control, and scope control processes, respectively. These three project parameters comprise a triple constraint that is a framework for evaluating competing demands. A triple constraint is often depicted as a triangle, with each comer (or side) representing one of the three parameters.

For example, assume you are being interviewed by a functional manager for a project manager position. Don't be surprised if you are asked a question based on the following situation :

1. The project is way behind the schedule.
2. No extra resources, such as money or project team members to perforin activities, are available. ' *
3. You have to implement all the planned features.

The question is, what you will do to meet the deadline that is approaching within a week? From a project management viewpoint, this situation is a good example of the triple constraint. The project is. behind schedule, which means there is a schedule change (or a change in time available to finish the remaining project). Therefore, at least one of the other two parameters must change. If you want to 'meet the deadline, either you should be allotted more funds to hire more human resources, or the scope of the. project should be changed, which means some of the features would be left out. Depending upon the knowledge level of the functional manager about project management, this answer might not get you the job, but as a project manager, you must stand your ground. Project management is not magic; it involves dealing with cold, hard reality in a realistic way, thereby establishing clear and achievable objectives.

You can see the relationship of triple constraint with quality by recalling that a high

quality project delivers the required product on time and within planned scope and budget. Therefore, while balancing between these three constraints, the quality (after as a result customer satisfaction) might be affected. The triple constraint is also a good example of how- one change can give rise to other changes across the project. This highlights the importance of managing and controlling changes.

17.11 SCHEDULE CONTROL

Schedule control has two pronged goal to ensure that the project is progressing on time as planned, and to monitor any changes to this progress. As a project manager, you should be out in front of the project, performing the following tasks on regular basis :

- Determine the current status of the project schedule.
- Influence the factors that generate schedule changes.
- Determine whether the project schedule has changed for example, il some activities are running late.
- Manage the changes as they occur.

You detect a schedule change by comparing the execution time against the time in the schedule baseline, which is a major input item to the schedule control process.

17.11.1 Input to Schedule Control

To control the project schedule, you need to know what the schedule baseline is, how the project is performing from the perspective of schedule, and what the plans are to monitor the schedule. Accordingly, the input items to the schedule control process are the following :

- *The schedule management plan* : This plan specifies how to monitor and control the project at hand.
- *Schedule baseline* : This is the approved version of the schedule, against which the schedule performance of the project will be measured.
- *Performance reports* : These reports provide information on the schedule performance of the project, such as missed and met planned dates.
- *Approved change requests* : These are requests to change the schedule or other change requests that will affect the schedule. Approved change requests can update the schedule baseline.

17.11.2 Tools and Techniques for Schedule Control

The schedule is monitored by progress reporting and performance measurements and is controlled using the schedule control system. These and other tools and techniques arc- discussed in this section.

17.11.3 Progress Reporting

Progress reports and current schedule status are key items to monitor the schedule. They can include the finished activities, the percent of in progress activities that has been completed, and remaining durations for unfinished activities.

17.11.4 Self Check Exercise:

- Monitoring means _____, and controlling means _____.
- You monitor the project by generating, collecting, and distributing information about project performance against the _____.
- The core question in this lesson is _____.
- The project is monitored and controlled using the _____ process.

17.11.5 Schedule Change Control System

This is the system you use to receive, evaluate, and process schedule changes. It can include forms, procedures, approval committees, and tracking systems.

17.11.6 Performance measurement and analysis:

The following tools and techniques can be used to measure and analyze the schedule performance of the project :

- *Performance measurement techniques* : These techniques are used to calculate the schedule valiance and schedule performance index and are discussed in the "Measuring Performance" section later in this lesson. The schedule variance discussed there is in terms of cost, but you can also perform a barcbones schedule variance analysis based on the start and end dates of the schedule activities.
- *Variance analysis* : Performing a barebones schedule variance analysis is crucial to schedule monitoring because it reveals the deviation of the actual start and finish dates from the planned start and finish dates cf schedule activities. It might suggest corrective actions to be taken to keep the project on track.
- *Schedule comparison bar charts* : Bar charts can be used to facilitate the schedule variance analysis. You can draw two bars corresponding to one schedule activity. One bar shows the actual progress, and the other bar shows the expected progress according to the baseline. This is a great tool to visually display where the schedule has progressed as planned and where it has slipped.

17.11.7 Project management Software

You can use project management software for scheduling to track planned start./finish dates versus actual dates for schedule activities. This software also enables you to predict the effects of project schedule changes. These are important pieces of information for monitoring and controlling the schedule.

17.11.8 Output of Schedule Control

Schedule performance measurements and recommendations for actions based on the measurements and progress reports are the important output items of the schedule control process.

17.11.9 Performance Measurements

The results from schedule performance measurements, such as the schedule variance (SV) and schedule performance index (SPI), should be documented and communicated to the stakeholders. These measurements might trigger recommendations for corrective actions and change requests.

17.11.10 Recommendation Corrective Actions

The goal of schedule related corrective actions is to bring the future schedule performance in line w[r]ith the schedule baseline that is, the approved version of the planned schedule. To that end, the following actions can be taken:

- Expedite the execution to ensure that schedule activities are completed on time or with minimal delay.
- Perform a root cause analysis to identify the causes of the schedule variance.
- Make plans to recover from the schedule delay.

17.11.11 Updates

The following updates can result from the schedule control process.

- *Schedule Updates* : Schedule changes can happen at the activity level (the start/ end date of an activity has changed) or at the project level (the start/end date of the project has changed). A schedule change at the project level is called a schedule revision. For example, when the schedule scope is expanded, the project end date might have to be changed to allow the extra work. All significant schedule changes must be reported to the stakeholders.
- *Activity Updates* : The schedule changes and the project progress will cause changes in the activity list and in the list of activity attributes. These changes must be documented.
- *Project Management Plan* : The schedule management plan, a component of the project management plan, is updated to reflcct the changes that occur7daring the schedule control process.
- *Organizational Process Assets* : The lessons learned from the schedule control process can be documented to the historical database. Following are some examples :
  - The causes of schedule variance
  - The reasons for choosing the corrective actions that were taken
  - The effectiveness of the corrective actions Future

projects can make use of this information.

17.11.12 Change requests

The schedule performance analysis and progress report review result in requests for changes to the project schedule baseline. These changes must be processed through the integrated change control process for approval. As with any other change, you must think through whether a change to the schedule baseline has an}' other effect across the project. If it does, you might need to update the corresponding component of the project management plan accordingly. The projcct schedule is there to execute the project work within the scope of the project. So, the project scope must be controlled as well.

17.12 SUMMARY

You need to monitor and control your project throughout its lifecycle, which includes monitoring and controlling performance, changes, and risks. Change requests might arise from-the evaluation of performance results to bring the performance in line with the project management plan, or they might originate from other sources, such as project stakeholders. Regardless of their origin, all change requests must go through the integrated change control process, which will approve them of reject them.

17.13 GLOSSARY

- *Actual Cost* : The total cost actually incurred until a specific point on the timescale in performing the work for a project or a project activity.
- *Budget at Completion (BAC)* : The total budget authorized for performing the project work. This is the planned budget for the projcct, the cos: that you originally estimated for the project.

- *Change Control System* : A collection of formal documented procedure that specifies how the project deliverables and documents will be changed, controlled, and approved.
- *Cost Baseline* : The planned budget for the project over a time period, used as a basis against which to monitor, control, and measure the cost performance of the project. The cost performance is measured by comparing the actual cost to the planned cost over a time period.
- *Cost Performance Index (CPI)* : A measure of cost efficiency of a project calculated by dividing earned value (EV) by actual cost (AC).
- *Cost Variance (CV)* : A measure of cost performance obtained by subtracting actual value (AV) from earned value (EV). A positive result indicates good performance, whereas a negative result indicates bad performance.
- *Defect* : An imperfection or deficiency that keeps a component from meeting its requirements or specifications. A defect is caused by an error (problem) and can be repaired by fixing the error.
- *Earned value (EV) or budgeted cost of work performed (BCWP)* : The value of the actually performed work expressed in terms of the approved budget for a project or a project activity for a given time period.
- *Estimate at Completion (EAC)* : The estimate from the current, point in time of how much it will cost to complete the project or a project activity. The value of EAC is obtained by adding the value of ETC to AC.
- *Estimate to Complete (ETC)* : The expected cost, estimated from CPI, to complete the remaining work for the project or for a project activity.
- *Inspection* : A technique to examine whether an activity, component, product, service, or result conforms to specific requirements.
- *Performance Measurement Baseline* : An approved integrated plan for scope, schedule, and cost for the project, against which the project execution is compared to measure the, project performance.

17.14 SHORT ANSWER QUESTIONS

1. Discuss the major task involved in monitoring and controlling the project.
2. Discuss the various tools and techniques for Integrated Change Control.

17.15 Answers to Self Check Exercise

- watching the course, taking action to either stay the course or change the wrong course.
- baselines.
- how do you monitor and control a project
- monitor and control project work

17.16 FURTHER READINGS

1. Prasanna Chandra, PROJECTS- Planning, Selection, Financing, Implementation, and Review, Sixth Edition, Publication : TATA McGraw HILL.
2. Dennis Lock, *Project Management,* Ninth Edition, Publication : Gower.
3. P.C.K. Rao, *Project Management and Control,* Publication : Sultan Chand & Sons.
4. Vasant Desai, *Project Management,* Second Revised Edition, Publication : Himalaya Publishing House.
5. Clements / Gido, *Effective Project Management,* Publication : Thomson.
6. K. Nagarajan, *Project Management,* Third Edition, Publication : New Age International

CONTROL OF CONSTRAINTS IN PROJECT MANAGEMENT

STRUCTURE

18.0 AIMS AND OBJECTIVES:

This lesson deals with the concept of controlling of project operations. After reading this lesson you will be able to :

- Measurement of Project Performance
- Control techniques and systems
- Verify and Manage changes to the project
- Monitor all risk

18.1 SCOPE CONTROL

Controlling the project scope includes influencing factors that create changes to the scope, as well as managing change requests and controlling their impact when the change actually occurs. While controlling the scope, you focus on the following tasks :

- Watch out for scope creep : Determine whether it has happened and correct the situation. Scope creep refers to scope changes applied without processing them though the change control process.
- Process the scope change requests through the integrated change control process for approval

- Manage the implementation of scope changes after approval, as well as their impact across the project.

The obvious input items to the scope control process are the elements that define the scope, such as the project scope statement, the scope baseline, the WBS, the WBS dictionary, and a scope management plan that describes how to manage the scope. The performance reports might help to detect a scope change, and some change requests in other areas can result in scope change, as well.

The main output of the scope control process is the update to scope related input, elements, such as the project scope statement, the WBS, the WBS dictionary, and the scope baseline. The components of the project management plan affcctcd by these changes might also need to be updated. Change requests and recommendations for corrective actions arc other obvious output items from the scope control process.

The main tools used in the scope control process are the change control system and the project performance analysis, including the scope variance and the schedule variance. Schedule variance can have an effect on the scope if you want to finish the project on time and there are no additional resources available. The change control system of an organization is a collection of formal documented procedures that specify how the project deliverables and documents will be changed, controlled, and approved.

You monitor the project by watching its progress, which is a measure of its performance. There-fore, performance measurement and analysis arc an important category of tools and techniques in monitoring and controlling the project.

18.2 MEASURING PERFORMANCE . ,

Project performance is measured by comparing the project, execution against the performance measurement baseline, which is an approved integrated plan for scope, schedule, and cost for the project, as explained here:

- *Cost Baseline* : This is the planned budget for the project over a time period, used as a basis against which to measure, monitor, and control the cost performance of the project. The cost performance is measured by comparing the actual cost with the planned cost over a time period.
- *Schedule Baseline* : This is a specific version of the project schedule developed from the schedule network analysis and the schedule model data, discussed in Lesson 5. This is the approved version of the schedule with a start date and an end date, and it is used as a basis against which the project schedule performance is measured.
- *Scope Baseline* : This is the approved project scope that includes the approved project scope statement, the WBS based on the approved project scope statement, and the corresponding WBS dictionary.

The elaborate nature of the performance measurement analysis can be seen in the cost control process.

18.3 PERFORMANCE MEASUREMENT ANALYSIS FOR COST CONTROL

Cost control includes influencing the factors that can create changes to the cost

baseline. But to detect the arising changes, you need to detect and understand variances from the cost baseline by monitoring cost performance.

In general, variance is a measurable deviation in the - value of a project variable (or parameter), such as cost or schedule from a known baseline or expected value. Variance analysis is a tech-nique used to assess the magnitude of variation in the value of a variable, such as cost from the baseline or expected value, determine the cause of the variance, and decide whether a corrective action is required. A common technique to assess the cost variance is called the earned value technique (EVT); in this technique, you calculate the cumulative value of the budgeted cost of work performed in terms of the originally allocated, budgeted amount and compare it to the following :

1. Budgeted Cost of Work Schedules
2. Actual cost of work performed

The EVT involves calculating some variables where you will see the interplay of schedule (work) and cost. I will work through an example to help you understand the variables. Assume you are a project manager for the construction of a 16 mile road. Further assume that the work is uniformly distributed over 12 weeks. The total approved budget for this project is Rs.600,000. At the end of first four weeks of work, Rs. 125,000 his been spent, and four miles of road have been completed. We will use this example to perform the cost performance analysis and the schedule performance analysis in terms of cost.

18.4 COST PERFORMANCE

Cost performance refers to how efficiently you are spending money on the project work, measured against the expectations set in the project management plan that is, the cost baselines. The total cost approved in the baseline is called the budget at completion (BAC).

18.5 BUDGET AT COMPLETION (BAC)

This is the total budget authorized for performing the project work (or a project activity), also called the planned budget. In other words, it is the cost originally estimated in the project management plan. You use this variable in defining almost all the following variables. In our example, the value of BAC is S600, 000.

18.6 EARNED VALUE (EV) OR BUDGETED COST OF WORK PERFORMED (BCWP)

This is the value of the actually performed work expressed in terms of the approved budget for a project or a project activity for a given time period. In this variable, you see the relationship of schedule (work) and cost in action. BAC represents the total value of the project. But when you perform some work on the project, you have earned some of that value, and the earned value is proportional to the fraction of the total work performed, as shown by the formula here:

EV - BAC * (work completed / total work required)

So, in our example, EV can be calculated as :

EV - Rs.600,000 * (4 miles / 16 miles) - Rs. 150,000

This is the earned value of the work, which may or may not be equal tc the actual money that you spent to perform this work

18.7 ACTUAL COST OR ACTUAL COST OF WORK PERFORMED (ACWP)

This is the total cost actually incurred until a specific point on the timescale in performing the work for a project. In our running example, Rs. 125,000 has already been used up to this point. So the actual cost at this point in time is Rs. 125,000. This cost is to be compared with the earned value to calculate the cost variance and cost performance.

18.8 COST VARIANCE (CV)

This is a measure of cost performance in terms of deviation of reality from the plan, and is obtained by subtracting the actual cost, as shown in the formula here:

CV - EV - AC

So, in our example, CV can be calculated as shown here :

CV = Rs. 150,000 - Rs. 125,000. Rs.25,000

The expected value of CV is zero because we expcct the earned value to be equal to the actual cost. The positive result indicates better cost performance than expected, whereas a negative result indicates worse cost performance than expected. Deviation is the way of comparison, and ratio is another.

18.9 COST PERFORMANCE INDEX (CPI)

Earned value represents the portion of the work completed, and actual cost represents the money spent. So, the CPI indicates whether you are getting a fair value for your money. This is a measure of cost efficiency of a project calculated by dividing earned value (EV) by actual cost (AC), as shown in the formula here:

CPI EV / AC

So, the CPI for our example can be calculated as:

CPI Rs.150,000 / Rs.125,000 - 1.2

This means you are getting Rs. 1.20 worth of performance for every dollar spent. A value of CPI greater than one indicates good performance, whereas a value less than one indicate bad pcr-formance. The expected value of CPI is one.

So, both the CV and the CPI indicate that you are getting more value for each dollar spent. Hold back a little before opening the champagne, though. If you read the text of our example again, note that four out of 12 weeks have already passed, and only four out of 16 miles of mad have been built. That means that only one fourth of the work has been accomplished in one third of the total scheduled time. This means we are lagging behind in our schedule. Although cost performance is good, schedule performance needs to be investigated, too.

18.10 SCHEDULE PERFORMANCE IN TERMS OF COST

Schedule performance refers to how efficiently you are executing your project schedule. We as measured against the expectations set in the project management plan. It can be measured by comparing the earned value to the planned value, just like cost performance is measured by comparing the earned value to the actual cost. Planned value refers to the value that we planned to create in the time spent so far.

18.10.1 Planned value (PV) or budgeted cost for the work scheduled (BCWS)

This is the authorized cost for the schedule work on the project or a project activity

up to a given point on the time scale. The planned value is also called the Budgeted cost for the work scheduled (BCWS). PV is basically how much you were authorized to spend in the fraction of schedule time spent so far, as shown in the formula here:

PV = BAC * (time passed / total schedule time)

Therefore,, the planned value for the project in our example at the end of first four weeks is calculatcd as shown here:

PV = Rs.600,000 * (4 weeks / 12 weeks) Rs.200, 000 So, PV represents the planned schedule in terms of cost. You can calculate the schedule per-formance by comparing the planned schedule to the performed schedule in terms of cost.

18.10.2 Schedule variance (SV)

This is the deviation of the performed schedule from the planned schedule in terms of cost. No confusion is allowed here because you already know that the schedule can be translated to cost. SV is calculated as the difference between EV and PV, as shown in the formula here :

SV = EV PV So, the SV in our example can be calculated as:

SV = Rs. 150,000 Rs.200,000 - Rs.50,000 The negative value means we are behind schedule. Deviation represented by schedule variance is one way of comparison, and ratio represented by schedule performance index is another.

18.10.3 Self Check Exercise:

- In scope control, scope creep refers to_____applied without processing them through the change control process.
- The change control system is a collection of formal documented procedures that specify how the project deliverables and documents will be _____, controlled, and approved.
- Project performance is measured by comparing the project execution against the performance measurement baseline, which includes plans for scope, schedule, and cost, known as the _____.
- The Cost Baseline is the planned budget for the project over a time period and is used as a basis against which to measure, monitor, and control the cost performance of the project. Cost performance is measured by comparing the actual cost with the planned cost over a time period, which is known as _____.

18.10.4 Schedule Performance Index (SPI)

Earned value represents the portion completed in terms of cost, and planned value represents how much work was planned by this point in time in terms of cost. So, the SPI indicates how the performed work compared to the planned work. This is a measure of the schedule efficiency of a project calculated by dividing earned value (EV) by planned value (PV), as shown in the formula here:

SPI = EV/ PV

So, the SPI for our example can be calculated as shown here:

SPI - Rs. 150,000 / Rs.200, 000 - 0.75 , ; •

This indicates that the project is progressing at 75% of the planned pace not good. You should note that all these performance variables except the BAC are calculated at a given point in time. As shown in Figure below you can maintain a graphic that presents the values of these variables against points in time as the project progresses. Note that the value of the BAC does not change with time because it is the cost at completion time. Further note that given the BAC, the PV can be calculated at any point in time, even before the project execution starts. EV and EC are accumulated as the project execution progresses.

18.0 FORECASTING TECHNIQUES

Forecasting refers to predicting some information about the project in the future based on the performance in the past. lie forecasting is regularly updated as the project progresses and more data of the past performance becomes available.

18.11.1 Estimate to complete (ETC)

This is the prediction about the expected cost to complete the remaining work for the project or for a project activity; This is basically how much value remains to be earned in terms of the BAC. Therefore, the value of the ETC is obtained by subtracting the earned value (EV) from the budget at completion (BAC), as shown in the formula here:

ETC - BAC - EV

So, in our example, the value of ETC can be calculated as :

ETC = Rs. 600,000 - Rs. 150,000 - Rs.450,000

The next question that can be asked about the future is how much it will cost to complete the whole project.

18.11.2 Estimate at completion (EAQ)

This is the estimate made at the current point in time for how much it will cost to complete the project or a project activity. The value of the EAC is obtained by adding the value of ETC to AC, as shown in the formula here :

EAC - ETC + AC

Accordingly, the value of EAC for our example can be calculated as :

EAC * Rs.450,000 + Rs. 125,000 = Rs.575,000

Another useful prediction to be made is how much performance you need in the future to complete the remaining work within budget.

18.11.3 To complete performance index (TCPI)

This is the variable to predict the future performance needed to finish the work within budget. It is calculated as the ratio of the remaining work to the remaining budget, as shown in the formula here :

TCPI * Remaining work % Remaining funds - (BAC - BCWP) % (BAC - ACWP)

" (BAC - EV) / (BAC - AC)

Therefore, the value of TCPI in our example can be calculated as:

TCPI = (Rs.600,000 - Rs.150,000) / (Rs.600,000 - Rs. 125,000)

= 450,000 / 475,000 = 0.95 -

95%.

So, during the executing stage, the obvious items that need to be executed the schedule activities, and while these activities arc being executed, the attached cost, schedule, and scope need to be monitored and controlled. However, there is another important component of the project that needs to be monitored and controlled the risk.

18.1 SUMMARY

In an ideal world, there should be no changes to or variations from the planned baselines, such as cost, schedule, and scope baselines. A good quality project is completed within the planned cost, schedule, and scope. However, in the real world, there are changes and variations, and therefore quality needs to be monitored and controlled, which involves monitoring certain project results by making measurements and taking actions based on those measurements. The three project parameters cost, scope, and schedule are collectively known as a triple constraint because if one of them changes, at least one

of the other two parameters must change. Therefore, project monitoring and controlling includes monitoring and controlling these three parameters, which involves measuring cost, schedule, and scope performance and taking actions based on performance. The most commonly used technique to measure cost and schedule performance is known as the earned value technique (EVT), and it measures the performance by comparing the earned value of the actual work performed to the actual cost and to the planned value that was supposed to be earned according to the plan. In addition to monitoring and controlling the cost, schedule, and scope of the project work, you also need to monitor and control the identified risks and watch out for new risks that might appear. The recommendations for actions and change requests from monitoring and controlling the project go through the integrated change control process for approval and, if approved, go though the direct and manage project execution, process for implementation.

18.2 KEYWORDS

- *Schedule Baseline* : A specific version of the project schedule developed from the schedule network analysis and the schedule model data. This is the approved version of the schedule with a start date and an end date, ar.d it is used as a basis against which the project schedule performance is measured.
- *Schedule Performance Index (SPI)* : A measure of the schedule efficiency of a project calculated by dividing earned value (EV) by planned value (?V).
- *Schedule Revision* : An update to the project schedule that includes changing the project start date, end date, or both.
- *Scope Baseline* : The approved project scope, which includes the approved project scope statement, the WBS based on the approved project scope statement,
  . and the corresponding WBS dictionary.
- *Variance* : A measurable deviation in the value of a project variable, such as cost from a known baseline or expected value.
- *Variance Analysis* : A technique used to assess the magnitude of variation in value of a variable (such as cost from the baseline or expected value), determine the 6ause of the variance, and decide whether a corrective action is required.
- *Workaround* : A response to a negative risk that has occurred. A workaround is base, on a quick solution and is not planned in advance of the risk occurrence event.

18.3 SHORT ANSWER QUESTIONS

1. Discuss the various tools and techniques for Quality Control.
2. Read the following case and answer the questions given at the end.
   You are the project manager for a software product and your project is in the execution stage. You have learned that Maya, a developer, has started adding some new features to the deliverable she is working on. What is the best action for you to take?
   A. Tell Maya to delete the code corresponding to these features because this is a scope creep, and scope creeps are not allowed.
   B. Learn from Maya what those features are and how much time they will take, and make necessary updates to the WBS, the WBS dictionary, and the

schedule. Also tell Maya that in the future she should get approval from you before adding any new features.

C. Determine where the request for the new features came from and process the change request through the integrated change request process.

D. Contact Maya's functional manager and ask the manager to replace Maya with another developer.

18.4 Answers to Sel Check Exercise:

- Changes
- Changed
- integrated plan
- cost variance

18.5 FURTHER READINGS

1. Prasanna Chandra, *PROJECTS- Planning, Selection, Financing, Implementation, and Review,* Sixth Edition, Publication: TATA McGraw HILL
2. Dennis Lock, *Project Management,* Ninth Edition, Publication: Gower
3. P.C.K. Rao, *Project Management and Control,* Publication: Sultan Chand & Sons
4. Vasant Desai, *Project Management,* Second Revised Edition, Publication: Himalaya Publishing House
5. Clements / Gido, *Effective Project Management,* Publication: Thomson
6. K. Nagarajan, *Project Management,* Third Edition, Publication : New Age International.

MBA-CC (Second Year)
Semester-Ill
Lesson No. 19

PM 301
PROJECT MANAGEMENT
AUTHOR : DHIRAJ SHARMA

PROJECT CONTROL AND REVIEW

STRUCTURE

19.0 *AIMS AND OBJECTIVES*

This lesson examines various facets of project review. It also discusses administrative aspects of capital budgeting and the devices for mitigating agency problems. After reading this lesson you will be able to understand the following :

- Project review and its importance
- Control of in progress projects
- Post-completion audits
- Abandonment analysis
- Administrative aspects
- Agency problem

19.1 *INTRODUCTION*

Project work requires a large number of persons of different disciplines and specialisation. Projects are assignments which are unique and non-repetitive and have to be accomplished within agreed schedules, budgets, performance parameters of capacity and quality. Project reviews play a vital role in taking stock of the progress by measuring and evaluating the current status and in the event of slippage, to take appropriate

remedial measures in all areas and at all levels. A project is monitored during the implementation phase so that time and cost over runs are minimized. Further, after a project is commissioned its performance is periodically reviewed to see whether its performance has been in line with expectations. If things turn sour, the question of abandonment may also have to be examined.

The focus has been mainly on the techniques of project analysis and selection and the supporting theoretical constructs. Capital budgeting, however, does not occur in a vacuum. Rather, it takes place in a real organization with its attendant complexities such as compartmentalized thinking, multi layered decision making, uneven knowledge of finance, bureaucratic red tape, and agency problems. To cope with these problems, firms develop suitable administrative procedures and try to mitigate agency problems through a combination of monitoring and incentives.

19.2 IMPORTANCE OF PROJECT CONTROL AND REVIEW

The entire aspect of 'control' is covered by the concept of project review which must be carried out from time to time as the project journeys forward during implementation. Project review meetings are necessary to convince key personnel that orderly progress is being made on the project. Project Team review meetings- usually chaired by the project manager. Top management review meeting where project manager reports the status or the project and highlights problem areas and how the same are being resolved. Customer Review meetings wherein prime focus is to report the status of the project to the customer or to the end-user, highlighting problem areas and mode of resolving them. The approach should be to involve them and welcome their help and input in resolving problems and expediting implementation.

Keeping everyone on the project informed prevents surprises and shocks and builds up involvement and commitment. This paves a reliable way to secure support from all quarters when any unforeseen situations arise and require concerted and co-operative effort around to retrieve the project and put it back on the rails. Project review meetings are like the practice sessions of a football team. They improve understanding, enhance team spirit and inculcate understanding among project personnel. These also remove gags and overlaps, reduce friction and resolve conflicts with or without external intervention. Project review meetings set the tone, tenor, speed and momentum of project execution anc should be designed to achieve specific tasks. Calling review meetings for the sake of it should be avoided at all costs.

19.3 CONTROL OF IN-PROGRESS PROJECTS

Though a lot of effort is expended in selecting capital projects, things often go wrong in the implementation phase. This is evident from the frequent cost and time over runs witnessed in practice. Hence it is necessary to exercise strict control on in progress capital projects. There are two aspects of controlling in progress capital projects.

19.3.1 Establishment of Internal Control Procedures

For every in-progress capital project, proper control accounts are set up. These are charged with all relevant expenditures, which are further classified into capital and revenue items. These accounts reflect out-of-pocket payments as well as allocated expenses. The project-by-project segregation of costs ensures that proper attention can be directed to projects as they approach various milestones.

19.3.2 Use of Regular Progress Reports

Periodic progress reports compare actual expenditures against estimates. They offer several benefits: (a) They provide timely information so that corrective action can be initiated to tackle potential problems, (b) They generate inputs for cash budgeting and fund raising, (c) They serve as the basis for calculating variances and explaining variances.

19.4 POST COMPLETION AUDITS

An audit of a project after it has been commissioned is referred to as a post audit or a post completion audit. Most firms do a post-audit for projects above some threshold level. Regular post-completion audits of capital projects: (i) provide a documented log of experience that may be valuable in improving future decision making, (ii) enable the firm in identifying individuals with superior abilities in planning and forecasting, (iii) help in discovering systematic biases in judgment, (iv) induce healthy caution among project sponsors, and (v) serve as a useful training ground for promising executives who need broader business experience and exposure.

It is a common practice to use book ROI defined as Net

Income Book Value of Assets

for evaluating existing businesses and projects on a continuing basis. Though widely used, the book ROI has two serious flaws :

- Even though a project may earn a constant economic rate of return, its book ROI displays wide variation across time.
- There is an upward bias in the book ROI of a business which has substantial investment in intangible assets.

19.4.1 Constant Economic Rate of Return but Variable Book ROI

Performance evaluation may be done in terms of economic rate of return or book return on investment :

$$\text{Economic rate of return for a given year} = \frac{\text{Cash flow + Change in present value}}{\text{present value at the beginning of the year}}$$

$$\text{Book return on investment for a given year} = \frac{\text{Cash flow + Change in book value}}{\text{book value at the beginning of the year}}$$

The popularity of book ROI, a flawed measure, seems to impair the quality of capital budgeting decisions. If managers are evaluated on the basis of book ROI they are likely to pay lip service to net present value. They may salute net present value but walk in the direction of book ROI.

As the American Accounting Association Committee on Managerial Decision Models observed :

* "The use of traditional accrual accounting methods for evaluating performance is a critical roadblock to implementation of present value models. Clearly, there is an inconsistency between citing present value models as being superior for capital budgeting decisions and then using entirely different concepts for tallying performance. As long as such practices persist, managers will often be tempted to make decisions which may be non-optimal under the present value criterion but optimal, at least

over short or intermediate spans of time, under conventional accounting methods of evaluating operating performance."

19.4.2 Bias in Book ROI

Book ROIs are biased upwards for businesses that make substantial intangible investments in R&D, brand building, and so on, simply because these outlays are not reflected on the balance sheet.

19.4.3 A Possible Way Out

The problem with book ROI stems from using book depreciation rather than economic depreciation. Why not then switch to economic depreciation? This is difficult because it calls for reestimating each asset's present value each year. No wonder accountants set up a depreciation schedule right in the beginning, however arbitrary it may be, and adhere to it.

One solution may be to use a depreciation schedule that conforms to the expected economic depreciation which is known right in the beginning. This way you do not have to restate each asset's present value every year. Despite forecasting inaccuracies this may be better than the accounting depreciation.

19.5 ABANDONMENT ANALYSIS

Capital expenditure management is a dynamic process. A capital investment cannot be regarded as a commitment till the end of the project life. As time rolls on, changes occur which can alter the attractiveness of projects or even entire divisions. Hence capital investments must be reappraised periodically to determine whether they should be continued or terminated or divested.

The techniques used to analyse a new project can also be used to analyse whether an existing project should be continued or terminated. However, there are some differences between an existing project and a new project:

Consider Divestment as one of the Many Responses to a Situation. There are several options available when a business or project is under performing. It may be continued as it is; it may be shut down till business conditions improve; new product lines may be added; an aggressive cost reduction programme may be initiated; manufacturing and/or distribution arrangements may be strengthened. When none of these alternatives seem feasible or desirable, consider divestment seriously.

Since divestment is one of the many responses, it must be considered as an integral part of the regular planning process. The planning group should be assigned responsibility for initiating divestment moves.

19.6 ADMINISTRATIVE ASPECTS OF CAPITAL BUDGETING

The discussion on administrative aspects of capital budgeting has been organized as follows :

- ^Identification of promising investment opportunities
- Classification of investments
- Submission of proposals
- Decision making
- Preparation of capital budget and appropriation
- Implementation
- Performance review

19.6.1 Identification of Promising Investment Opportunities

Often firms have an abundance of investment proposals but a dearth of really worthwhile proposals. For identifying promising investment opportunities the following points should be borne in mind:

1. Monitor changes in market demand, sources of supply, profitability, competition, governmental policies, economic conditions, and technological developments.
2. Formulate long-range plans and perspectives based on analysis of opportunities and threats in the environment and assessment of internal strengths, weaknesses, capabilities, and limitations.
3. Communicate long-range plans and corporate perspectives to all persons who are likely to be involved in capital budgeting.
4. Encourage, employees to make suggestions and reward them suitably for valuable suggestions.

In short, the relationship between the firm and its environment should be regularly analysed, corporate plans and perspectives must be widely shared, and the creativity and imagination of the employees must be tapped.

With regard to tapping the imagination of employees, it may be noted that in most organisations; personnel at middle and lower levels do not contribute much to the pool of investment proposals. This is often due to the failure of the administration to cull out good ideas emanating from different echelons of the organisation. To generate ideas, suggestion schemes are usually recommended. Suggestion schemes by themselves, however, cannot achieve the objective. According to John B. Mathews, Jr.: "The solution seems to lie in that intangible thing known as 'climate', meaning in this case a receptivity to suggestions at all company levels and a pervading opinion that management has no monopoly on ideas and welcomes them from any and all sources."

19.6.2 Classification of Investments

The classification of capital expenditure proposals refers to the grouping of similar proposals into separate categories. Classification helps in decision making, budgeting, and control.

Investment proposals may be classified in many ways. We suggest below a scheme of classification which can, with minor modification, be adopted for most manufacturing enterprises :

1. *Replacement Investments :* These represent capital expenditures for the replacement of existing fixed assets this may become necessary because of the expiry of normal life or because of a change in technology.
2. *Modernisation and Rationalisation Investments :* These comprise capital expenditures for improving productivity, increasing efficiency, reducing costs, and ensuring greater reliability.
3. *Expansion Investments :* These represent capital expenditures for increasing capacity.
4. *New Product Investments :* These represent capital expenditures to manufacture new products.
5. *Research and Development Investments* : These represent capital expenditures on basic research and development.

6. *Obligatory and Welfare Investments* : These represent expenditures on facilities which are obligatory and/or conducive to employee welfare.

19.6.3 Submission of Proposals

To ensure that all relevant information for proposals is gathered systematically, a standardised proposal form may be used by all the sponsors of investment projects. To help the sponsor of the project in filling and submitting the form :

1. Procedures manual setting forth in detail the firm's capital budgeting policy and techniques may be prepared and widely disseminated.
2. Short duration training programmes may be organised.
3. The help of a staff person may be made available to the sponsor of the project.

The proposal form, before it reaches the capital budgeting committee, should normally be routed through persons who can comment on the estimates furnished by the sponsor. The routing channel, however, cannot be standardized. It will vary from one organisation to another and, perhaps, from one proposal to another.

Routing a proposal through several persons provides a mechanism for obtaining the views and judgments of others. For example, a proposal submitted by :he plant superintendent may be routed through the production manager, sales manager, and engineering manager for their comments on different aspects of the project. This also facilitates coordination of inter related activities. Obviously this system would yield benefits only when the persons through whom the proposal is routed give thought to it rather than merely forward it in a routine manner.

19.6.4 Decision Making

It may be argued that the optimal capital budget for the firm as a whole can be drawn up only when capital investment decisions are completely centralised. This, however, is not desirable in most cases because some decentralisation is required to facilitate quick decisions, develop executives, and conserve top management time for important matters. That is why most of the companies empower executives at different levels to take investment decisions involving outlays up to certain limits. In one company, for example, the plant, superintendent can okay investment outlays up to Rs 50,000, the factory manager up to Rs 100,000, the capital budgeting committee up to Rs 250,000, and the managing director up to Rs 500,000. Investments involving larger outlays need the consent of the board of directors.

While the system of rupee gateways has considerable merit there may be certain pitfalls. Managers may break a project into several parts so that no decision at a higher level becomes necessary. For example, a production manager who is empowered to undertake a project up to Rs 100,000 may split a project involving an outlay of Rs 150,000 into two parts of Rs 80,000 and Rs 70,000 so that it is not sent upwards for review. This tendency can be countered by asking managers, when they seek budgetary appropriations, to indicate the additional investment required in related areas in the future.

19.6.5 Preparation of Capital Budget and Appropriation

Smaller projects which can be approved at lower levels may be covered by a blanket appropriation so that they can be undertaken expeditiously. Since these projects require small outlays, no elaborate funds planning are required for them. Projects of larger magnitude (which generally require the approval of the capital budget committee or managing director

or the board of directors) may be included after approval in the tentative capital budget. The final capital budget, which serves as the basis of budgetary appropriations, should be drawn up after the availability of funds is ensured. Often careful planning of funds is required before budgetary appropriations are made.

While the capital expenditure budget is usually drawn up for one to two years, it is desirable to have a perspective plan ranging from 3 to 5 years. In some cases it may even be of a longer duration.

The capital expenditure budget, though it is based on a careful review of various factors, should not be regarded as inviolate. Changes in circumstances may warrant changes in the budget not originally contemplated. This is perhaps the reason why a final sanction is required before actual expenditure in many companies. The coordination of the capital expenditure budget should preferably be done by a financial officer of the firm. In firms where a financial officer is not in charge of coordination, the budgetary process and the analysis of individual projects tend to be somewhat loose and sloppy.

19.6.6 Self Check exercise:

- Project work requires a large number of persons of different disciplines and specializations. Projects are assignments that are_____ and_____ and have to be accomplished within agreed schedules, budgets, performance parameters of capacity, and quality.
- Project reviews play a vital role in taking stock of the progress by measuring and evaluating the current status and, in the event of slippage, to take appropriate_____ measures in all areas and at all levels.

19.6.7 Implementation

Delay in implementation and the consequent increase in the project cost are very common. Cases are not infrequent where the actual time for execution has exceeded planned time by 50 percent. Cost over runs are also very common. In many cases over runs have been between 30 percent and 100 percent. These facts emphasize the need for expeditious implementation at a reasonable cost. For this the following points are helpful:

1. Formulation of Projects

Often delays occur because of insufficient preliminary studies and inadequate formulation of the project. Cases have come to notice where due to inadequate or limited investigation in regard to suitability of site, availability of required natural resources, other raw materials, etc. the execution of project has subsequently been delayed considerably resulting in substantial increase in cost and adversely affecting their economies.

Such delays can be mitigated by bestowing greater care and attention on preliminary investigations and project formulation. The responsibility of investigation should be properly determined.

2. Responsibility Accounting

By assigning definite responsibilities to project managers for completing the project on time, a sense of time consciousness can be instilled. This helps in expeditious implementation.

3. Network Techniques

Network techniques like PERT (Programme Evaluation Review Technique) and CPM (Critical Path Method) are helpful in project planning and control. With the help of these techniques, progress reporting becomes rather easy. Precise, prompt, and brief report said the managemeht in appraisal and corrective action so as to ensure the successful completion of projects.

4. Control

Once an appropriation is established, the sponsor (or manager) of the project is authorised to incur expenditure. Proper control over this expenditure needs to be exercised. Periodical reports on expenditure along with information on the degree of physical

completion are helpful in this respect. Note that unless information regarding physical completion is available control becomes difficult.

19.6.8 **Performance Review**

Performance review is meant for evaluating actual performance vis-a-vis projected performance. It is concerned with the verification of assumptions regarding both revenues and costs. In scope, it is broader than the popularly used accounting review which is concerned only with costs. Despite its importance, performance review is one of the most neglected aspects of capital budgeting. The reasons seem to be:

- It is difficult to isolate the cash flows attributable to individual investments from financial accounts which are compiled for the firm as a whole and which are based on the accrual principle.
- There is an apprehension, that a performance review may be used for punitive purposes.

The first problem can be overcome largely by using estimates and approximations wherever it is not possible to obtain accurate data. For example, if costs relating to a project have not been recorded separately, a reasonable estimate can usually be made on the basis of information relating to total costs and the activities of the firm. Likewise, cash flows from sales arising from a project can be roughly estimated by looking into the collection pattern of receivables as a whole.

The second problem can be overcome by making it clear to all project sponsors that the purpose of post-audit is to promote learning and not to penalise the persons involved. It provides feedback that is necessary for future improvements.

19.7 **SUMMARY**

- It is necessary to exercise a strict control on in-progress projects. There *Eire* two aspects of controlling in-progress capital projects: (a) establishment of internal control procedures, and (b) use of regular progress reports.
- An audit of a- project after it has been commissioned is referred to as post-audit or post completion audit. It is a useful feedback and review tool.
- It is a common practice to use book ROI (net income/book value of assets) for evaluating existing businesses and projects on q continuing basis.
- Although widely used, the book ROI has two serious flaws: (a) Even though a project may earn a constant economic rate of return, its book ROI displays wide variation across time, (b) There is an upward bias in the book ROI of a business which has substantial investment in intangible assets.
- A capital investment cannot be regarded as a commitment till the end of the project life. Hence it has to be periodically reappraised to determine whether it should be continued or terminated or divested.
- ‘The techniques used to analyse a new project can also be used to analyse whether an existing project should be continued or not.
- To decide whether a project should be continued or terminated or divested, calculate PVCF (present value of expected cash flows), SV (salvage value), and divestiture value (DV). Choose the option that has the highest value.
- It appears that managers often overlook the logic of net present value in evaluating "continuation versus abandonment" decisions and have a tendency to get

entrapped into losing projects. To overcome this tendency, the following measures may be used: (i) follow certain rules, (ii) develop proper rewards and penalties, and (iii) institute relatively independent reviews.

- For identifying promising investment opportunities, the relationship between the firm and its environment should be regularly analysed, corporate plans and perspectives must be widely shared, and the creativity and imagination of the employees must be tapped.
- Investment proposals may be classified in many ways. The following scheme of classification can with minor modification be adopted for most manufacturing enterprises : (i) replacement investments, (ii) modernisation and rationalization investments,

19.8 GLOSSARY

- *Pro Forma* : Projected or anticipated, usually applied to financial data such as balance sheets and income statements.
- *Programming* : An algorithmic methodology for solving a particular type of complex problem, usually conducted on a computer.
- *Sensitive Analysis* : Investigation of the effect on the outcome of changing some parameters or data in the procedure or model.
- *Stochastic* : Probabilistic or not deterministic.

19.9 SHORT ANSWER QUESTIONS

1. Why should post-audit be done?
2. Explain the bias in book ROI.
3. Discuss the procedure for determining whether a project should be continued, terminated, or divested.
4. What need to be done to identify potential investment opportunity? .

19.10 Answers to Self Check Exercise:

- unique; non-repetitive
- remedial

19.11 FURTHER READINGS

1. Prasanna Chandra, *Projects - Plaining, Selection, Financing, Implementation, and Review,* Sixth Edition, Publication : TATA McGraw HILL
2. Dennis Lock, *Project Management,* Ninth Edition, Publication : Gower
3. P.C.K. Rao, *Project Management and Control,* Publication : Sultan Chand & Sons
4. Vasant Desai, *Project Management,* Second Revised Edition, Publication : Himalaya Publishing House
5. Clements / Gido, *Effective Project Management,* Publication : Thomson