PROJECT MANAGEMENT

MBA FINAL YEAR

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FOREWORD

Since its establishment in 1976, Acharya Nagarjuna University has been forging ahead in the path of progress and dynamism, offering a variety of courses and research contributions. I am extremely happy that by gaining a B++ (80-85) grade from the NAAC in the year 2003, the University has achieved recognition as one of the front rank universities in the country. At present Acharya Nagarjuna University is offering educational opportunities at the UG, PG levels apart from research degrees to students from about 300 affiliated colleges spread over the three districts of Guntur, Krishna and Prakasam.

The University has also started the Centre for Distance Education with the aim to bring higher education within reach of all. The Centre will be a great help to those who cannot join in colleges, those who cannot afford the exorbitant fees as regular students, and even housewives desirous of pursuing higher studies. With the goal of bringing education to the doorstep of all such people, Acharya Nagarjuna University has started offering B.A., and B.Com courses at the Degree level and M.A., M.Com., M.Sc., M.B.A. and L.L.M. courses at the PG level from the academic year 2003-2004 onwards.

To facilitate easier understanding by students studying through the distance mode, these self-instruction materials have been prepared by eminent and experienced teachers. The lessons have been drafted with great care and expertise within the stipulated time by these teachers. Constructive ideas and scholarly suggestions are welcome from students and teachers involved respectively. Such ideas will be incorporated for the greater efficacy of this distance mode of education. For clarification of doubts and feedback, weekly classes and contact classes will be arranged at the UG and PG levels respectively.

It is my aim that students getting higher education through the Centre for Distance Education should improve their qualification, have better employment opportunities and in turn facilitate the country's progress. It is my fond desire that in the years to come, the Centre for Distance Education will grow from strength to strength in the form of new courses and by catering to larger number of people. My congratulations to all the Directors, Academic Co-ordinators, Editors and Lesson - writers of the Centre who have helped in these endeavours.

Prof. K. Viyyannarao
Vice - Chancellor
Acharya Nagarjuna University

MBA Final Year

PROJECT MANAGEMENT

Syllabus

Project Formulation And Appraisal:

Project Management : An Overview – Feasibility and Technical Analysis – Market and Demand Analysis – Economic and Financial Analysis – Formulation of Detailed Project Reports.

Project Planning And Scheduling:

Planning Time Scales – Network Analysis – Materials and Equipment – Human Resources – Project Costing and Financing – Project Organisation.

Implementation and Control:

Project Management Information System – Material and Equipment – Human Resources – Financial Aspects.

Project Completion And Evaluation :

Integrated Project Management Control System - Managing Transition from Project tc Operations – Project Review.

Question Paper Pattern

Each paper carries 100 marks. 25 marks Internal assessment through assignments and 75 marks for year end examination. The duration of Examination for theory papers will be three hours.

Pattern :

The question paper is divided into 3 sections. Section A, Section B and Section - C

Section - A (3 x 5 = 15 marks)

Section A consists of 6 questions out of which the candidate has to write 3 questions. Each question carries 5 marks. Totally 15 marks.

Section - B (3 x 15 = 45 marks)

Section B consists of 6 questions out of which the candidate has to write 3 questions. Each question carries 15 marks. Totally 45 marks.

Section - C (15 marks)

Section C Consists of one compulsory question (either case study or problem) which carries 15 marks.

CONTENTS

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BLOCK 1 PROJECT FORMULATION AND APPRAISAL

This block has five units. The first unit (Unit 1) itself gives an overview of project management. It explains a project and the need of its management along with major concepts. PERT & CPM as the tools and techniques though discussed in MS-5, some insights are also given here. Feasibility studies in the context of selection and evaluation of projects, parameters regarding the feasibility studies, the importance and salient feature of commercial and technical analysis are elaborated in the second unit. Technical analysis explains the objectives, location and site, plant size, technology, construction process, inputs, manpower and so on. Unit 3 enumerates the importance of market and demand analysis in project management. Forecasting in diffeent situations and criteria for it one highlighted in this unit.

Techniques of financial and economic evaluations are elaborated in Unit 4. Return on investment (ROI), Payback period (PB), NPV and IRR etc. are discussed analytically. Unit 5 talks about formulation of detail project report (DPR). It discusses the equipment and process technology, location of the project, material balance of the project and so on.

UNIT 1 PROJECT MANAGEMENT : AN OVERVIEW

Objectives

After studying this unit, the student will be able to:

- understand the specialities of Projects and need for Project Management (PM)
- obtain a board overview of important PM concepts and different dimensions of PM
- know the types of tools, and computer programmes available to assist a Project Manager.

Structure

1.1 Introduction

1.2 Project Management Its Role & Scope

1.3 History of PERT/CPM

1.4 Need for Project Management

1.5 Some Major Project Management Concepts

1.6 Tools & Techniques in Project Management

1.7 Success Factors in Project Management

1.8 Summary

1.9 Self - Assessment Exercises

1.10 Bibliography & Further Readings

1.1 INTRODUCTION

This unit deals with the concept of project management. What is a project? Why it needs proper management?.etc. are explained early. The unit gives emphasis on the Project Life Cycle (PLC) and its different stages. Tools and Technologies of project management are highlighted with some success factors.

1.2 WHAT IS PROJECT MANAGEMENT?

Project Management is a specialised functional discipline that has carved out its own place in Management practice, education and literature. We shall briefly address ourselves to two questions in order to arrive at a first hand understanding of what is Project Management. These two questions are:

(a) What is Management?

and

(b) What is a Project?

Management is an age old function. It is as old as the history of human civilisation. Whenever more than one individual join together to form a group and strive to achieve some common purpose or objective, there arises a necessity to co-ordinate the efforts of individual members of the group so that the individual contributions add up to the largest total contribution possible. Symbolically, it is very similar to pulling a very big weight by a number of persons, the sum total of the force or pull that is exerted on the weight is a function of the individual forces as well as the directions in which each individual force is applied, relative to all other forces. If all the forces are applied in the same direction, the total force simply adds up. However, as soon as there is a slight deviation in the direction between the two individual forces, the resultant force is less than the sum of the two forces. The more diverse the directions of these forces are, the more are the loses. In an extreme situation, if the forces are applied in opposite directions, the resultant force is the diffeence of the two forces.

In large organisations where hundreds or thousands of individuals are employed, co-ordinating the efforts of various individuals towards the fulfillment of the organisaion's goal its, in a sense, the function of the management. Even the animal- world displays co-ordinated efforts like the ants, honey-bees, etc. Therefore, management as a function, has existed, all along and has flourished in several human organisations, like the army, the church, the missionary institutions, the government of a country and so on. However, management, as a special discipline of study, has come into the fore with the advent of the industrial revolution.

Let's now turn to projects. The word "Project" conjures up a picture of something special, something which is different from routine and regular activities. For example, writing this chapter of this book is a project for your author. He has dealt with this subject over a number of years, but still then, writing this chapter is a special 'task' which he has undertaken. Other examples of a project could be: building a house, organising a seminar, designing a new poduct in the market, shifting to a new location etc. Projects can, therefore, be differentiated from regular operations on a number of parameters as under:

Table 1

Project	Production
One time	Repetitive
Large Investment:	Revenues & Profits/losses
No Revenue	
Wide variety of skills used and of high calibre	Limited skills - learning effect is higher
Use of special purpose equipment for short duration	Equipment are in continuous use
Involvement of many specialised agencies	Outside agencies are primarily suppliers/buyers
Technology - wide variety	Limited variety

Explanation

Most of the projects are one time job as opposed to repetitive regular jobs undertaken in a normal production situation. While a project is in progress, usually, a large amount of resources are deployed in terms of many diverse human resources, materials, equipment, land, buildings, etc. However, while the project is on, no benefits directly accrue from these investments. Projects are, therefore,investments for future benefits. In accounting terminology,no revenues accrue during the project stage. In contrast to this, after a project is over and regular production starts, we start getting the results of these investments in terms of goods and/or services produced and revenues arising therefrom. It is the normal desire of each project owner that such revenues would exceed the costs and thereby net some profits. Yet another distinction of projects from regular operations arise out of a very wide variety of skills used during the project and a relatively high calibre of persons required possessing in these skills. This requirement arises out of the special tasks which are undertaken in a project which are not required to be carried out, once the poject is complete. For example, any LPG bottling plant has massive "Horton spheres" for bulk storage of LPG. These 'spheres' are made from special grade steel which must be welded together so perfectly that every centimeter of the weld must pass ultrasonic testing. Obviouslu, once a bottling plant has been constructed the plant operation would not require any welding of this high calibre. In contrast, in a regular operating situation a limited number of skills are required and due to the process of repetitiveness, learning by experience takes place. This reduces the initial skill requirements of employees.

Projects also call for using special purposes equipment for relatively short peridos during construction, testing and commissioning. These include heavy duty mobile cranes, special purpose testing equipment, and a host of construction equipment which would not be required afterwards. In contrast, in a regular operation situation, a limited number and variety of equipment are in continuous use. Projects are also characterised by the involvement of a large number of specialised agencies who can mobiles the specialised skills, technology and managerial expertise required for the project. Every phase of the project calls for different abilities that are generally not required in regular operations. The ability to identify feasible projects, the ability to amplify the feasibility export into a detailed project report capable of execution, to execute special tasks of constructing or executing projects and the ability of commissioning new projects are entirely different from the abilities of running an operating system. These abilities are so diverse in nature that it is not possible to find a single agency which can deliver the required results. Therefore, a host of specialised agencies have come up specialising in some particular sub-set of the overall tasks involed in a project. One cannot do away with the involvement of such specialised agencies in a porject set up. In contrast, in a regular operating system, few external agencies are involved and these are primarily restricted to the buyers and the suppliers to the firm. Finally, projects will use a wide vaiety of specialised technologies which would not be required in regular operations. For example, sand blasting may be used to remove rust from the surface of structural before painting; special epoxy grouting may be used to prevent water seepage in re-inforced cement concete foundations o in-situ heat treatment of massive structures may be undertaken. Similar technologies would never again be needed during the normal course of operations.

Activity 1

Draw up a list of characterisics that distinguish projects from other activities.

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....

1.3 HISTORY OF PERT/CPM

Project Management is, therefore, concerned with the management of projects, as opposed to management of regular production and operation systems. If you are new to the field of project management, you might wonder as to why do we need a separate discipline of project management. Couldn't the plethora of tools, techniques, principles, and concepts of management be used for managing projects as well? If you have this question, you are on the right track. Obviously, projects existed and were managed before the discipline of project management came to be, and in those days, the traditional tools of management applied to manage projects as well. One of the major tools used was the famous "Gantt Chart". However, you know that necessity is the mother of inventions. It so happened that around the middle of the fifties, the National Aeronautic and Space Administration (NASA) of USA was developing the Inter-Continental Ballistic Missiles (ICBM). Almost around the same time, the big chemical giant: Dupont, was engaged in a massive expansion pogramme requiring construction of new chemical plants on a large scale. The managers, incharge of these projects, found the existing approach to managing projects to be inadequate. The inadequacy stemmed from the complexities of the projects as well as a certain degree of uncertainties associated with the ICBM project. In order to overcome these shortcomings, NASA and Dupont independently came up with a new tool of planning and controlling projects. NASA called it. "Programme Evaluation and Review Technique (PERT)" and Dupont called their system "Critical Patch Method (CPM)". When their approaches were finally published and came to be known, it turned out that both the systems of planning and control were basically similar with one key difference. That difference arose from the fundamental difference in the situations faced by NASA and Dupont. Dupont has a vast reservoir of experience of constructing similar, if not exactly the same plants, ealier. It was, therefore, possible for the managers in Dupont to estimate fairly accurately, the time required for performing a given task. However, the same was not true for NASA. No ballistic missiles existed on earth when NASA undertook the project of developing these missiles. Therefore, even the task were not fully known and whenever tasks were fairly well-conceived, it was very difficult to estimate the time required to complete the given task. NASA adopted a simple but very effective tool for ovecoming this problem. Instead of trying to get a single estimate for the time required for completing the given task; NASA adopted a three time estimate framework for every task. NASA managers and designers estimated an optimistic time, the most likely time and a pessimistic time. With certain assumptions about the probability distribution of the time estimates (You will know more details in the next Section); NASA was able to handle the problem of uncertainties quite elegantly. In a sense, the new tool of planning and monitoring projects was born and is, today, widely known by the acronym PERT/CPM. This tool enables the managers to capture complex interrelationships between different tasks in large projects as well as enable them to handle uncertainties. The basic simplicity of these tools and their contributions to successful project management were soon realized worldwide and, therefore, the use of these tools spread very fast throughout the world. In our country also, many industries started making use of these tools and techniques in the early sixties.

1.4 NEED FOR PROJECT MANAGEMENT

However, it will be wrong to conceptualise project management as simply a bundle of techniques captured by PERT/CPM and similar other tools. Management as a discipline received wide scale attention throughout the industrialised world and so did the affairs of managing large projects. When the developing countries joined the race for industrialisation, they essentially had to manage large investments. Projects of increasingly complex sizes were and are being executed in these countries. In India, we have seen investments of the order of rupees one hundred thousand crores being made in the public sector alone over a period of four decades. Project Management, therefore, assumes an added significance for a developing country like ours. It's importance can be judged from the fact that we have a separate professional institute of project management in the country and the Government of India felt it necessary to set up a separate Ministry of Programme Implementation to ensure successful management of all government projects.

Write in your own words, answers to these questions:

1. What is project management?
2. Why is it important to study project management?
3. Give an example of a project in each one of the following sectors:
   --- Manufacturing
   --- Banking
   --- Marketing
   --- R & D
   --- Health
   --- Science
   --- Nation

1.5 SOME MAJOR PROJECT MANAGEMENT CONCEPTS

(a) Project Life Cycle

One of the most fundamental concepts in project management is the project life cycle concept.

The concept of a life cycle is widely used in the field of marketing management, where the life of a product is analysed with respect to the overall revenue generated from that product with time. At the point of introduction of a new product, product features are evaluated and revenues are slow to pick up. This phase is called "establishment" phase. This is followed by a rapid rise in revenues, in the "growth" phase. However, the revenues reach a plateau in its "maturity" phase and is followed by falling revenues - the "decline" phase.

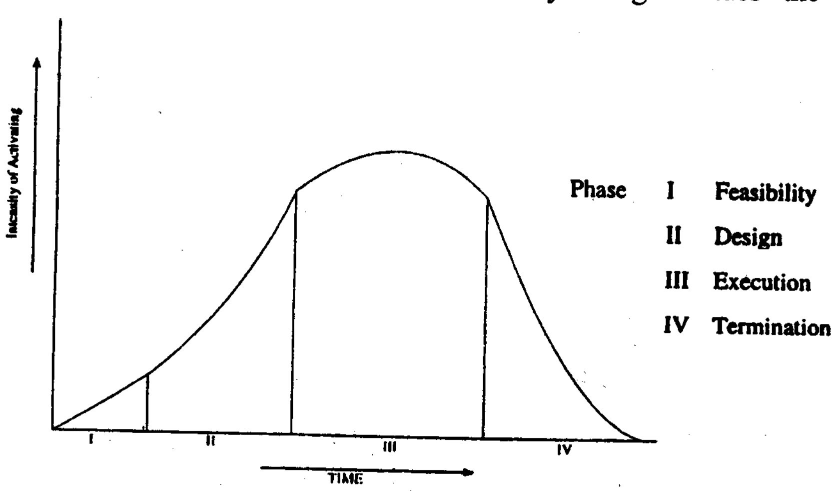


Fig.1.1: Project Life Cycle

Adapted from William R.King and David I. (Eds); Life Cycle in Handbook of Project Management is followed by falling revenues _ the "decline" phase.

Management expects have similarly examined the life cycle of a project with respect to the intensity of activity that is associated wih a particular project. Accordingly, a project is divided into four distinct phases as under:

--- feasibility

--- design

--- production, and

--- termination

Figure 1.1 gives a general idea of the nature of activities and its intensity during the entire life cycle of a project. Project Management can also be viewed from the angle of different functional specialisations in management. Viewed from this angle, every project would have the following dimensions:

--- Technical

--- Commercial

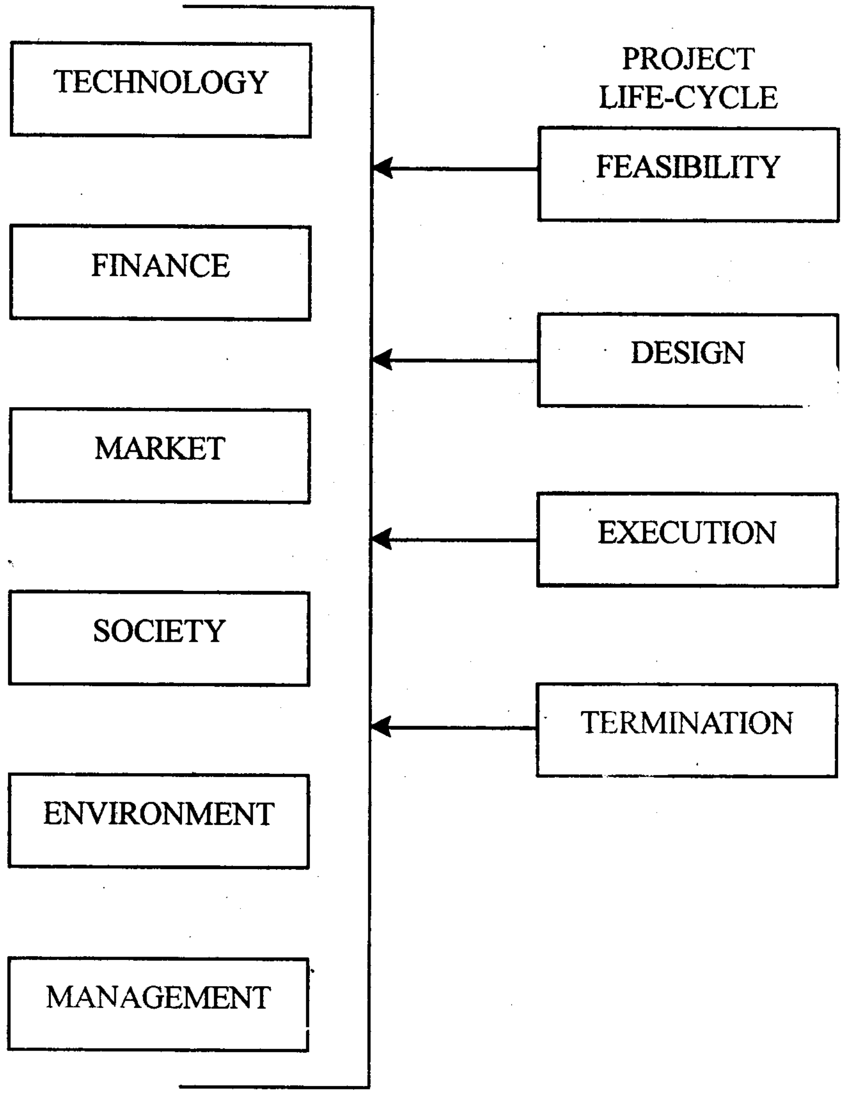
--- Financial

--- Socio-economic

--- Environmental, and

--- Managerial

During each phase of the project, the Project Manager, incharge of the project must take care of all these dimensions to manage the project must take care of all these dimensions to manage the project successfully. This concept has been shown schematically in figure 1.2.



Activity 2

Project Life Cycle should form the basic of formulating strategy for its implementaion - usually, termination phase is of shorter duration and any failure in mustering adequate resources during execution phase will inevitably lead to delays in completion. What would be your strategy for completing the project on time?

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(i) Feasibility

This phase of a project is an essential component of the project which begins with the identification of some unfulfilled need in the economy or the market. This need is at the root of a concept/idea where an entrepreneur or an enterprise gets an idea to design and establish a project that will fulfill this need. For example, you may consider power projects, two wheeler projects, fertilizer projects, oil refinery projects or any other project for that matter and you will notice that at the beginning there is a shortage in the areas of power, two wheeler, automobiles, fertilizer and so on. Based on this inital need and a body of information, knowledge and understanding of the possibilites open for fulfilling this need, several ideas are conceived and some of these ideas are found more probable than other ideas. Consider, for example, the case of power projects. In order to sustain the progressive development of our country, it was felt necessay to augment the availability of electric energy for meeting rising demands of industry, government and population at large. Looking at this basic need, one could think of a number of possibilities of generating electric energy. These could include thermal, hydro, geo-thermal, and solar, etc. Out of all these ideas, it was found that a thermal route of producing electric energy was the most promising route for our country. Simultaneously, it was felt that the magnitude of the basic need as so great that it requires attention and co-ordination at the national level and that is how the National Thermal Power Corporation was born.

These ideas are then subjected to some preliminary screening that enables one to ensure *prima facie* their feasibility. At this stage, one is only interested broadly, in the likely demand-supply gap, the technical possibility of meeting this gap and if one is willing to risk funding such a poject in general. After this preliminary screening, the project ideas is subjected to a detailed investigation of all the six dimensions which have their impact on a poject and finally a decision is taken to drop the idea or to go ahead with the concept. At this point an investment decision has to be taken because significant expenses would be involved to convert the idea into a detailed executable plant and finally to execute the plan.

You sho note at this point that the decision about the feasibility of a project is a decision taken at a certain point of time and is valid only for conditions prevailing at that point of time. Therefore, even if a project idea is discarded as being not feasible, it is generally archived, so that they can be recovered at a later date for reconsideration. For example, some of the mining projects for coal may become unviable at a given point of time because the coal layers are too deep inside the earth and it may not be economically viable to mine this coal out. But this viability takes into consideration the current prices of other sources of energy, particularly, that of oil. If fo some reasons, oil prices shoot up (as it happened during the two oil shocks!) some of the coal mining projects which were earlier found non-viable can later become viable. Human powered flying machines were technically not feasible due to non-availability of mateials which were light but strong. With the advent of new materials technology, it has been possible to overcome this barrier.

In case a project idea is generally found to be feasible from all considerations, it is then given a 'go-ahead' signal which indicates a commitment on the part of the authority giving the 'go-ahead' signal to provide necessary resources for carrying the project through, ~~to its~~ logical completion.

Phase-I of the project can be summarised as under:

a) Identification of the need

b) Establishment of the primary feasibility of project idea

c) Identification of alternatives

d) Evaluation (appraisal) of the alternatives

e) Investment decision.

(ii) Design

Once the investment decision is taken, the design or the planning stage of the project starts. In the design phase, the original project idea is amplified as much as possible so that a complete 'blue-print' of the project is available for the next stage. This means that the technical parameters are forzen, the basic designing of the project is completed,specifications for major plant and equipment are finalised, costs of the project are estimated in greater details, a time schedule for the project is planned and all necessary steps are taken to tie-up the required funds and other resources for successful execution of the project.

There is a significant increase in the activities and a number of people get involved and large amounts of money are spent. In the design phase also one is required to pay attention to all the six dimensions and specify fairly detailed plans of action. The feasibility and the design stages are similar in their contents but differ in the depth and details. At the end of the design phase, one is ready with a blue print for the execution of the project. The output of the design phase is usually called the Detailed Project Report (DPR). Normally an entrepreneur or an organisation and the Financial Institutions who may be participating in financing the project would again examine the DPR and approve it with changes, if any. During this second phase of the project life cycle, the intensity of activities continuously rises.

(iii) Production

After the design phase is over, a project moves into the execution or production phase where the emphasis is on giving a physical shape to the ideas that were elaborated in the DPR. Usually, this demands actions to procure the materials, machineries and equipment required for the project and construction of facilities like buildings, equipment foundations, infrastructure etc. at the project site, to receive these equipment. These activities are broadly classified as civil and structural work. After the plant and equipment are manufactured and delivered and civil and the structural work is completed to receive these equipment, they are erected and tested. A generalised bar chart for construction projects is shown in Fig. 1.3.

GANTT CHART

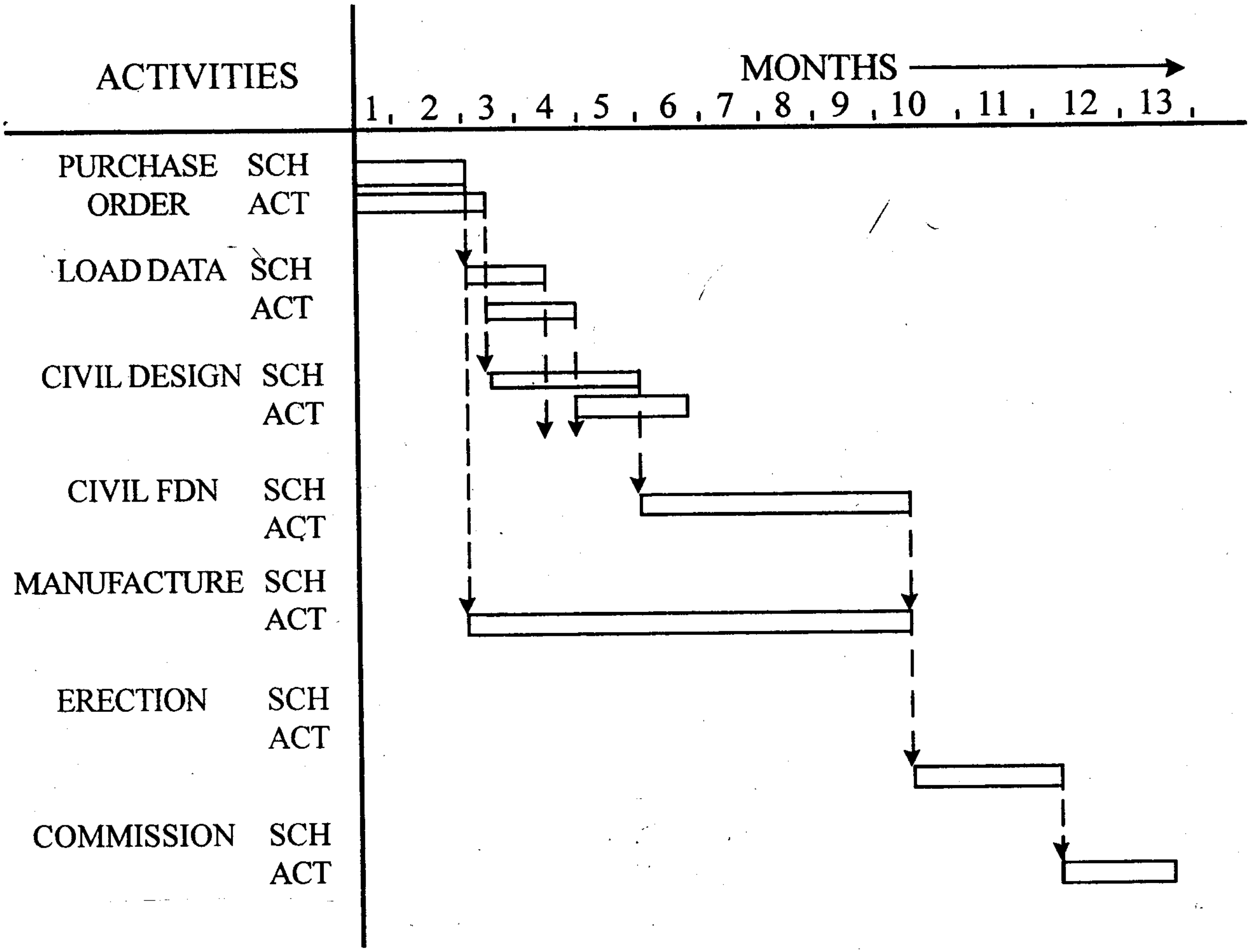

Fig. 1.3. A general sequence of a construction poject

The intensity of activities further builds up and reaches its peak somewhere during the execution phase. However, as the execution approaches its completion, the intensity of activities starts falling again. This is the most crucial phase of a project demanding the largest inputs of all resources. The demands on the Project Manager is at its peak, due to sudden escalation in the activity level. There is a great need for almost continuous monitoring and control of all activities, deciding and taking prompt corrective actions and attending to numerous conflicts that are inevitable when so many agencies get together to work.

(iv) Termination

Finally, the construction of the project reaches its end and the last phase of termination starts. During this phase, the newly constructed facilities are tried out one by one and then in an integrated fashion and finally teething poblems that might come up are resolved. In this phase, a set of persons are identified who would ultimately take over the operation of the facilities created during the project execution phase. These operations, maintenance and services personnel are bought in for the trial runs and commissioning. In other words, these trial runs and commissioning activities are jointly carried out by the project and operational personnel. Finally it leads to handing over of the newly created facilities to the operating personnel and winding up of the project team or its transfer to a new project. This might also include training of operating personnel, transfer of left-over materials, the releasing of specialised resources reserved for use in project, and reassignment of the project team to a new project.

(v) Organisation of this Book

This concept of a project life cycle has been found to be very useful and you would notice even this book is structured, more or less, on these lines. This book is idvided into four blocks:

Block-I	-	Project Formulation and Appraisal
Block-II	-	Project Planning and Scheduling
Block-III	-	Implementation and Control
Block-IV	-	Completion and Evaluation

(b) Project Interfaces

It should be noted that there cannot be a very clear demarcation between two consecutive phases and there always exists a kind of interface and a transitional stage between two successive phases. It is very important for a Project manager to understand and apppreciate the nature of activities undertaken during each phase and the kinds of transitions that are involved when the project is moving from one phase to another. Fundamentally the first two phases consist of an intellectual exerise where one is trying to design a facility and tries to achieve perfection in that design. The emphasis during the execution phase shifts from planning to execution. The primary focus during the execution phase should be on how well one can translate the design into reality. It is very important for the Project Manager to realise this fundamental difference and freeze the design before execution starts. It has been the experience in a number of projects that the execution phase has suffered many hold-ups, delays, changes and cost and time overruns; all arising out of changes in the design, sought to be carried out after the execution has commenced. The interfaces on the other hand represent a period of transition where both kinds of activities might be on hand and all the managerial skills available to the Project Manager must be put to work to manage the interfaces. Managing these interfaces pose the greatest challenge to any Project Manager.

You will find that the entire curriculum on Project Management is also built around this concept of project life cycle and you will learn more about each phase and its management in subsequent units.

(c) Project Organisation

This is another area of studying the management concepts of project. As you know, Organisation concerns the art of grouping various tasks into manageable sections, departments, divisions, business groups, etc. so that individual managers can be assigned responsibilities for overseeing the functions of a group; and the overall objective of the organization are smoothly achieved. As we have discussed earlier, the central objective of any organisation is to achieve a high degree of co-ordination. Any project constitutes interactions of a large and diverse set of agencies having a wide variety of skills, who contribute their efforts towards the realisation of the project. This diversity and complexity of activities undertaken, together with its uniqueness and a time bound plan for execution imposes special requirements on a project organisaion. A key to the success of a project lies in the ability to achieve a very high degree of integration of the efforts of different agencies involved in a project. In addition to the owner, a project might include the involvement of a Consultant carrying out the basic design and supervision work, a technical collaborator providing the technical know-how, a large number of manufacturers supplying the equipment and machinery, and a large number of construction agencies engaged in civil work, structural fabrication and erection, equipment erecions, trial runs and commissioning. Large projects would also involve different layers of contractors, since a major contractor would employ a number of sub-contractors and each sub-contractor would, in turn, employ sub-contractors. The owner's organization itself may be very large with a number of divisions or business groups. All members in the owner's organization itself may be very large with a number of divisions or business groups. All members in the owner's organization may not have the same interest with respect to the project. The task of coordination and integration of the activities of such a large number of agencies - both, within the owner's organisation and outside, is a complex one. Each specialist brings with him or her a certain degree of conviction and protectionist viewpoint regarding one's own specialisation. The objective of integration is further complicated by the need for allowing each specialised function, a certain degree of freedom to operate within one's own speciality and to perform creatively and deliver the best. This usually is known as "differentiation.". A successful project manager must strike a balance between the degree of differentiation allowed and the extent of integration demanded out of the functioning of different agencies and specialities. The role of a Project Manager is more of an integrator, that of synthesizing the efforts of different specialists into a meaningful whole, in consonance with the overall objectives of the project. All projects present a very fluid situation in which people face new situations and challenges every day and it is very difficult to fore see all situations and provide for standardized systems, procedures, rules, etc. to tackle every situation. It calls for a high degree of understanding, flexibility, team spirit and leadership qualities in the managers handling the projects. The structure of an organisation sometimes fosters certain environment and sometimes hinders coordination. The degree and the extent of the inter-dependency between different sub-systems of a project determines the nature of the integrating effort or "pulling together" that are required. Progressively, stronger integration is achieved through following organizational measures:

--- liaison positions

--- task forces

--- special teams

--- coordinators (or permanent integrators)

--- full project management

--- matrix organisations

These devises are arranged in the order of increasing complexities of projects and, therefore, increasing need for integration. However, the need for differetiation cannot be overlooked. You will learn more about the project organisations and the issues involved in project management in a subsequent unit.

A related issue in Project Management concerns the behavioural dimension of people engaged in projects. Projects present more than an average challenge to every member. Projects also provide less than average facilities to its people. Obviously, there is enough scope for behavioural problems to arise. Therefore, this requires special attention and calls for different kind of leadership for successful project management. Anybody who is not comfortable with a work situation which is changing every day may find it too difficult to adapt to a project environment. This essential changing situation needs to be captured in the psyche of every manager involved in projects. The situation is further aggravated when on looks at the trasition period from one phase to another phase of the project. The transition from the design to the execution phase is a most difficult transition. Design is much more creative in nature. Execution is much more hard work and field level organisation. It has been seen that managers who have excelled themselves in the design stage have found it very difficult to adjust to the din and bustle of execution. The interface period is a period when design has not yet been completed and execution has already commenced. The project manager has virtually to swim with his two legs on two different boats. How does one manage with situations and the behavioural consequences and demands on projects managers will be discussed in detail later.

(d) Project Monitoring and Control

As a student of management, you must, by this time, be familiar with the basic functions of management, namely planning, organising, staffing leading and control, planning, control and replanning constitute the end-less cycle of management. Project management is the concept of monitoring and control. Simply stated monitoring involves finding out the actual status of a project; and control involves comparing the actual status with the plan, find out the deviations and initiating corective actions so that the original plan could be fulfilled. You can derive a smile from the situation of a dog spotting a hare and running towards it to catch it. The hare, knowing that it has been spotted, starts to run away from the dog. The dog continuously monitors the location of the hare and keeps on changing its directions till it catches the hare. A project similarly begins with an original target, However, due to a number of interacting forces, the actual achievement with respect to various tasks seldom matches the planned achievement. This happens because it is impossible to foresee everything that one encounters while executing a plan and these unforeseen and uncontrollable factors cause deviations in the plan. A project manager, therefore, needs a very effective system of keeping abreast of what is actually happening and thereafter take steps to correct some of the deviations that have already taken place. Such corrective actions lie at the core of successful project management. Project management, therefore, must have a system to measure the results effectively at pre-determined intevals, comparing them with the planned results and deciding and taking corrective actions. This function is known as the Project Monitoring and Control function. For the successful execution of a project, it is essential that an appropriate monitoring and control system is also thought out and implemented.

(e) Project Management Information System (PMIS)

The monitoring and control system of a project needs the support of a suitable Project Management Infomation System (PMIS). A comprehensive PMS would cover the complete life-cycle of a project and would provide the necessary support for decision making. One important purpose of this information system is to receive the actual data about the status of a project at pre-determined intervals, process this information to evaluate the impact of these outcomes and project these impacts in terms of an expected date of completion and an expected cost of completion. These processed information are then made available to the Project Managemer and his team who would then use this to decide the necessary corrective actions and execute them. All projects should, therefore have a well thought out Project Management information system. Usually, the use of a computer for starting all information about a project and regularly updating this information based on the actual status: helps in successful monitoring and control. You will learn more about monitoring and control. PMIS and computer applications in project management in subsequent units.

1.6. TOOLS AND TECHNIQUES IN PROJECT MANAGEMENT

(a) PERT / CPM

As mentioned in the beginning, 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 programme Evaluation and Review Techniques (PERT) and Critical Path Method (CPM). These techniques enable a Project Manager to use the graphical network method of reperesentation 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. You will learn more about the network techniques subsequently.

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 wih each activity. With the in out of time, cost, resources and probability for each activity. It is possible to workout an overall project schedule, a schedule of funds required, a pojection of 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 alogorithms 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. You will learn more about these tools and techniques in a separate unit.

(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 vechicles 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, (See figure). The longest chain of activities start from the beginning and go all the way upto 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. The important point to note is that they are all in parallel.

The network models allows the planner to consider the requirements of various resources at nay point of time. This is called 'resource planning'. 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. If during this period any activity needs to be performed, which also requires the mobile crane we would require four mobile cranes.

Since resources are always in short supply in reality, planners look for ways and means of reducing the peak requirements of resources. Basically this can be achieved by rescheduling the non-critical resources. This is the essence of resource leveling. A number of algorithms and computer programmes/models are available which help managers to obtain a fairly balance resource profile for a project.

(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 pronciples of resource planning described earlier, it is possible to workout the requirement of funds at nay 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. As hypothetically depicted in Figure-1 we have 15 activities and the requirement of the funds for each activity in each tim period is also indicated. Adding these up, you can see very easily tha 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 carry 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 som e additional cost. However, there are some savings also. There are certain indirect costs of 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.

$$T_E = \frac{A+4M+B}{6}$$

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

As you have seen in discussions on the life cycle of a project, 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. Their interest stems from the fact that project. The viability of their appraisal 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 envionmental 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. You will learn more details about the feasibility and project appraisal in the subsequent units.

(f) Computer Applications

A number of computer routines are available for carrying out various exercises. In fact all the tools and techniques mentioned above like PERT, CPM. Resource Leveling, Cost Crashing, PERT Probability Calculations and Project Appraisal can be carried out 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. In fact, advantages of project management can be exploited far better with the added support from the computer. In the early days when computers were not available, one steel plant did make use of the project management techniques for the relining of their blast furnaces. The original schedule used to be of about 90 days. However, it was not possible to manually update and revise the network before one month. As a result, the impact of delays did not come forward quickly. With the introduction of computerised network management, it was possible for the project authorities to have field data on progress up to 6 AM collected and fed into the computer. The resultant critical path and the impact analysis could be carried out quickly and managers could discuss the implications of delays at around 2 PM and take suitable corrective measures. As a result of these quicker reviews, the overall delay in the project was brought down from an average of 40-50 days, to less than 10 days. In one instance, a very small non-critical activity which was assumed to have been completed, become critical, because in reality it was not completed. If this were not noticed in advance it could have resulted in a much longer delay.

1.7. SUCCESS FACTORS IN PROJECT MANAGEMENT

Baker, Murphy and Fisher have conducted a research survey of 650 projects to identify the success and failure factors. While the general perception of successful projects includes fulfillment of the time and cost schedule and technical specification, their research finding puts foremost emphasis on final project performance, achievement of the project's mission and perceptions of different stake holders of a project. They conclude that - "In the long run, what really matters is whether the parties associated with, and affected by a project are satisfied." Some of the prerequisites of project success may be identified as under:

1. A through feasibility study which does not overlook any significant element affecting the project.
2. A well planned DPR which is accepted by all concerned agencies, and frozen before execution.
3. A capable project manager and a good team around him, with involvement right through all four phases of project.
4. An adequate organisation with proper systems of communication, feedback and control mechanisms.
5. Adequate understanding of mutual roles and responsibilities of all interacting agencies with clear understanding of demarcations, dependencies and complementaries.
6. Quick identification and resolution of conflicts that are nonetheless inevitable.
7. Adequate and timely funding.
8. Certain degree of insulation to front line project managers from undue impacts from the environment.
9. Regular updation and appropriate actions to continuously correct the deviations, till the end of the project.

The above list is not at all exhaustive, but includes some of the more important elements for a successful project. We hope you would enjoy reading the subsequent units that would unfold this subject to you, in greater details.

1.8 SUMMARY

Concept of project management is explained in this unit. Project is differentiated from the regular operations in the number of parameters. MS-5 deals with the computational part of the CPM/PERT, when this unit deals with the history of CMP/PERT only. In the Project Life Cycle (PLC), a project is divided into four distinct phases: feasibility; design; production and termination. Details of each step is enumerated. CPM/PERT, Resource levelling, cost management, probability in networks are few tools and techniques in project management. Personal Computer is helpful in construction of CPM/PERT, resource levelling, PERT probability calculation, project crashing, and so on. Finally success factors in project management is analysed and some prerequisites are identified.

1.9. SELF - ASSESSMENT EXERCISES

1. Distinguish between project and production management, giving examples.
2. Describe the important phases of a project life cycle.
3. What is the concept of concurrent engineering in project management and how can it be used to optimise project durations?
4. What, according to you, are the critical success factors in project management?

1.10 BIBLIOGRAPHY & FURTHER READINGS

1. Choudhury, S., Project Scheduling and Monitoring in Practice. South Asian Publishers, New Delhi. 1983. Ch. 1 pp 1-43.
2. Goel, B.B., Project Management - a Development Perspective. Deep & Deep, New Delhi. 1987. Ch. 3 pp 99-112.
3. Goodman, L.J., Project Planning and Management - An Integrated System for Improving Productivity, Van Norstand. N.Y. 1988. Ch. I & II, pp 1-25.
4. Kerzner, H., Project Management : A System for Approach to Planning, Scheduling and Controlling, 2nd Rf/CBS Publishers, Delhi. 1984 Ch. 1 pp 1-57.
5. Lock, D.L., Project Management, 2nd Ed. Gower Press, London 1977. Ch. I & II. pp 1-22.
6. Murtin, C.C., Project Management - How to Make It Work, AmaCom, N.Y. 1976. Ch. I pp. 1-32.
7. Nicholas, J.M., Managing Business and Engineering Projects : Concepts & Implementation, Prentice Hall. N.J. 1990 Ch. I & 2, pp 1-50.

UNIT 2 FEASIBILITY AND TECHNICAL ANALYSIS

Objectives

After studying this unit, the student will be able to:

- understand what is meant by feasibility studies in the context of selection & evalution of projects
- explain in general how feasibility studies are conducted, and what parameters are considered
- understand in particular the importance and salient features of commercial & technical analysis.

Structure

2.1 INTRODUCTION

In this unit we will discuss the context and mechanics of conducting feasibility studies for projects. We will particularly study, in a relatively greater detail, the different aspects of techno-commercial analysis of projects.

2.2 NATURE OF PROJECT DECISION

Project decisions are usually complex and long-term invesment decisions involving commitment of not only financial but also other valuable resources, including personnel, facilities and time. These aim at the creation or improvement of new products or fixed assets (like land, buildings, hospital, factories, roads, power stations etc.) to meet certain needs and objectives of the investor. All such decisions, whether in public or private sector, necessarily entail some risk due to their future orientation. The risk may arise from miscalculate resources, from cost - and time - overruns, setting up of non-viable units, or building up excessive capacities, for example. Mangnitude of this risk can be reduced considerably by following a rational procedure in which

a) a sufficiently large number of good-quality **alternatives,** whether mutually exclusive or otherwise, is generated for consideration,

b) reliable and adequate **information** is gathered about each alternative including its sub-options, and

c) the sub-options and the alternatives are (in that order) subjected to systematic and objective **evaluation** in relation to technical, economic, financial, and other pertinent parameters for selection of the best course of action.

Most industrial and commercial projects require large outlays and are highly involved on account of geographical, technological, economic, environmental, legal and other factors including trans-national dealings. Once resources are committed to them, it is rather difficult to retract without suffering large losses. It is, therefore, important that project decisions are taken after careful consideration, so that the scarce resources are utilised in the most effective and economic manner.

On the other hand, rigoroulsy following the steps outlined above may prove too time-consuming the costly. For example, while considering the setting up a new steel plant, several man-months and lakhs of rupees may have to be spent to analyses the viability of all alternate processes/technologies and to evaluate the costs and benefits associated with each. And after going through this elaborate exercise the results may leave one with no alternative but to ababdon the proposal! It is, therefore, desirable to proceed in this matter in a systematic but are minimised, if not avoided altogether. Such an approach not only yields better project decisions but also assists greatly in project implementation.

2.3 THE PROJECT DEVELOPMENT CYCLE

A typical project would go through a **development process** having the following three distinct phases:

1. **Pre-investment** phase, leading to the authorization (investment decision) for a particular project ide under prevailing conditions;
2. **investment** phase, involving detailed design and actual implementation, leading to fructification of erection of relevant assests;
3. **operation** phase, following the "commissioning" (or start-up) of the completed project. Now the project would hopefully produce the stream of "benefits" for which it was originally conceived.

We shall briefly examine these phases in the following paragraphs, before proceeding to study the mai subject matter of this Unit in greater detail.

1. **The pre-investment phase.** This phase would usually involve the following four stages:
   a) **Identification** of relevant investment opportunities (or project ideas) through appropriate type c *opportunity studies;*
   b) **Preliminary filtration** of the project idea(s) through *pre-feasibility studies;*
   c) **Project formulation,** resulting in the detailed (*techno-economic*) *feasibility report* for the eac project idea considered worthy or futher examination at the previous stage;
   d) **Final evaluation and decision.** This is to be based on pre-selected, clear, and objective criter derived form legitimate and reasonable expectations and requirements of various stakeholders, an culminates in the *evaluation report.*
2. **The investment phase.** This phase involves several inter-disciplinary tasks and has the followir four stages. A task-force approach has generally been found to give the best results for successful conclusion of this phase.
   a) **Negotiation & Contracting.** In this stage basic specifications for project plant & equipment a drawn up (usually with the help of technical consultants), bids or tenders invited and evaluated, an

legally enforceable duties and responsibilities of different parties (like, for example, the owners, financiers, technical consultants, know-how providers, equipment suppliers, architects, and one incorporated into contracts, with expert legal assistance fo the more crucial aspects.

b) **Detailed Project Design & Engineering.** This covers detailed site investigations and tests, design and approval of plant lay-out, preparation and approval of engineering drawings and blue-pints, time schedules and PERT charts, final selection of technology and equipments, and detailed estimating of costs.

c) **Construction & Erection,** involving actual construction, erection, or installation work, interpretation and follow-up of the contracts, project management, and making suitable changes in design & engineering on account of unforeseen factors and changes in scope.

d) **Trial Runs, Commissioning and Optimisation,** followed by handling over of the *proven* poject by the contract (s) to the management or owners.

3. **The operation phase.** This phase involves day to day operation of the completed project, and is expected to yield results which meet the original objectives for which the project had been conceived, formulated and implemented.

2.4 OPPORTUNITY STUDIES

While no investor, whether an individual or an organisation, would like to miss out on profitable opportunities to either enter a new, attractive business, or to expand an existing business, out all opportunities are worth being so pursued. The task of sifting the two types of opportunities is facilitated by opportunity studies.

Identification of suitable industrial or commercial opportunities for investment necessitate, first and foremost, a delineation of the objectives of the investor. These should be carefully prioritized and as far as possible quantified, to reduce vagueness. Secondary, the investor needs to become aware of the existence of possible investment opportunities. Information brought out by various sources can be helpful to him in this direction. In India, such sources include government departments, various Chambers of Commerce and Industry (e.g CII, FICCI, NAFEN, PHDCCI and ASSOCHAM), National Small Industries Corporation, and several other institutions including the business press, CMIE, etc. They regularly publish valuable data and analytical reports about the trends of demand, supply, costs, installed and proposed additions to capacities, etc, in various segments of industry and business.

Another way of going about this part of the pre-investment studies is to carry out a systematic analysis of the following (illustrative) list of items. This is likely to reveal a number of potentially viable opportunity alternatives to an investor without much expenditure.

a) Agricultural outputs which can be processed further; e.g., soya can yield soya flour, proteins, protein concentrates, refined soyabeen oil, etc.

b) Packaging for various types of products (e.g. commercial, industrial, consumer durables, semi-durables, processed foods, etc.)

c) Forest produce and related industries; for example, timber rubber, paper, boards etc.

d) Substitutes of scarce items; for example, wood substitutes like concrete sleepers (for railways), metal frames for doors and windows, PVC partitions, and moulded plastic furniture.

e) Existing, and new, consumer products (durables or otherwise) for which demand is expected increase owing to favourable social, income, health demographic or other changes; for example, automobiles, personal computers, washing machines, LPG stoves, hair dyes, etc.

f) New and rapidly growing demands in service sector; for example, credit cards, information, databases, data-processing, financial intermediation, time-shared holiday resorts, marriage bureaus, etc.

g) Current imports, to identify opportunities for their local manufacture (import substitution) or for developing substitutes.

h) Manufacturing/service sector items successful in other countries with similar levels of development, capital, labour natural resources and economic backgound.

i) Possible interlinkage with other industries, indigenous or international.

j) Extension of existing products/services by backward or forward integration; for example, a down-stream TV unit for a company manufacturing picture tubes, or an

k) Diversification into related (or even unrelated) areas of activity, in which the investor's existing strengths are particularly helpul.

l) Emerging new technologies/processes; for example, genetically engineered medicines & pesticides, cellular telephones, parallel computing, etc.

m) Expansion, or modification/ modernisation, of existing facilities to attain economies of scale or technological benefits.

n) Incentives offered by local government for new units in specific sectors/locations.

o) Economic & industrial policies (e.g. duties and import or export restrictions) of local and foreign governments.

p) Export possibilities in areas having the benefit of comparative advantage. For Example, export-oriented labour-intensive units in a cheap-labour country, or orebenefaction plants for exports to a nearby country lacking in the resource.

By their very nature, opportunity studies are indicative rather than detailed and hence are generally based on macro-parameters and rough estimates. Such studies may also be carried out at a more general (or macro) level to identify opportunities in one of the following three directions:

a) a given geographical area (**Area studies**).

b) a specific sub-sector of economy or industry, like food-processing, pharmaceuticals, or power generation (**Sub-sectorial studies**).

c) exploitation of renewable and non-renewable natural, agricultural, or industrial produce like minerals, sugarcane, flash, fish, plants, and even geothermal energy sources, etc. (**Resource-based studies**).

Outlines of these general opportunity studies are given below to familiarise the reader with their nature and scope.

OUTLINES OF GENERAL OPPORTUNITY STUDIES

A. Outline of an Area Study

1. Basic Characteristics of the area:
   a) Geographical location;
   b) Size;
   c) Important physical features (e.g. forest, agrticultural, sandy, undulating, hilly, riverine, rocky, water-logged, etc.);
   d) Contour maps;
   e) Environmental sensitivity, if any.
2. Population size, and socio-economic data including background, employment and educational pattern and per-capital income, in the context of the country or state.
3. Major exports from, and imports into, the area.
4. Basic exploited and potentially exploitable factors of production (land, labour natural resources, etc.)
5. Structure of any existing manufacturing or service industry utilizing local resources.
6. Infrastructural facilities (like transport, power and telecommunications) necessary for developing new business or industry.
7. A comprehensive check-list of industries or businesses that can be developed exploiting the resources and facilities available in the area.
8. Revision of the above check-list of industries or businesses by excluding the following:
   a) Those for which present or anticipated local demand is too small and cost of transportation to other markets (including export markets) too high to yield acceptable pofit levels.
   b) Those facing rather insurmountable competition (local, or from nearby areas).
   c) Those which should and can be more favourably locate in other areas.
   d) Those for which the vital feeder organisations or industry are located too far away.
   e) Those for which the area's characteristics are not suitable.
   f) Those which do not meet the investor's priorities and resource allocations.
9. Estimates of present and expected demand-supply gaps based on other studies or publisher data.
10. Identification of approximate economic sizes of new or expanded business or industrial units, after considering estimates of both costs and revenues.
11. Estimated lump-sum capital costs of selected industries/businesses, taking into account
    a) Lnad, including site development;
    b) Essential civil works (buildings & outdoor works);

c) Technology or technologies;

d) Plant & Equipment (Main, Auxiliary, Standby, and Service);

e) Project implementation.

f) Priliminary expenses including for feasibility studies;

g) Working capital requirements.

12. Approximate operational requirements of major inputs for each project, classified according to the source of supply (local, national, imported). These should cover:

A. Material inputs

a) Raw materials (e.g. coal for a thermal power plant),

b) Processed materials (e.g. coke for a steel plant),

c) Manufactured goods (e.g. castings for a car plant),

d) Auxiliary materials (e.g. steel scrap in an integrated steel plant); and

e) Spares and other materials for plant & machinery.

B. Utilities like water, electricity, steam, gas, telecommunications, etc.

C. Manpower - managerial, technical, and other.

D. Information.

13. Estimate of production cost based on item 2 above.

14. Estimates of annual sales revenues and impact on market share/product-mix.

15. Organizational and management aspects of project sponsor(s) or potential enterprise.

16. An indicative time schedule for implementation.

17. Total investment contemplated in projects and peripheral activities like development of infrastructure, promotional activities, stock-yards, etc.

18. Source of finance visualized.

19. Estimated requirements/savings/earnings of foreign exchange.

20. Financial appraisal giving approximate pay-back peirod and rate of return on investment.

21. Indicative estimates of overall economic benefits (e.g. balanced regional growth, savings or earnings of foreign exchange, generation of employment, reduction of social disparities.

B. Outline of a Sub-sector Study

1. The place and role of the sub-sector in the economy.

2. The size, structure and growth rate of the sub-sector.

3. The present size and rates of growth of demand of items in the sub-sector which are

a) not imported,

b) partially or wholly imported.

4. Rough projections of future demand for each item.
5. Identification of the items in short supply that have good growth and/or export potenital.
6. A broad survey of the raw materials available indigenously.
7. Identification of opportunities for development using items 2, 5 and 6 and factors like infrastructure, transport costs, etc.
8. Identification of approximate economic sizes of new or expanded business or industrial units taking into consideration economics of scale in production and sales.

9-19. See items 11 to 21 of Section A.

C. Outline of a Resource-based Study

1. Nature of the resource, its prospected and proven reserves, past and expected future growth rates of its extraction/utilization, and future potential.
2. Role of the resource in national economy, pattern of its utilization and demand in the country, and exports.
3. Industries presently based on the resource, their status (e.g. small-scale, private, public) and growth pattern, capital employed and manpower engaged, productivity, future plans and growth prospects.
4. Major constraints and conditions in the growth of industries/businesses based on the resource.
5. Estimated growth in demand and prospects of export of items that could utilize the resource.
6. Identification of investment opportunities based on items 3, 4 and 5, and of costs, availability and requirements of factors like transportation, power and water.

7-17. See items 11 to 21 of Section A.

2.5 PRE - FEASIBILITY & FEASIBILITY STUDIES

As pointed out in Section 2.3 above, after the *identification* stage, the project ideas are subjected to a process of preliminary filtration through *pre-feasibility study*. This involves the study of the project idea at a *more elaborate level* than that carried out at the opportunity study state. This is an intermediate stage between an opportunity study and a full-fledged feasibility study primarily designed to probe relatively doubtful project ideas. This stage is recommended to be followed when *project formulation*, or a detailed *techno-economic feasibility study*, which would enable the investor to arrive at definite decision about the project is both costly and time consuming. However, but for the difference of depth of analysis and the level of detail in the study, the pre-feasibility study is on the pattern of the main techno economic feasibility study. Of course, if the preliminary projections thrown up at the stage of opportunity study are themselves quite encouraging or decisive, pre-feasibility study stage may be ignored and one may straightaway take up the feasibility study itself. A pre-feasibility study should not normally take more than three months to complete, and on the basis of its results the investor should be able to decide:

a) whether the project can be straightaway accepted or rejected,

b) the project requires a detailed analysis (i.e. a feasibility study), or

c) some aspects of the project need to be subjected to special investigations or studies such as market research, physical or mathematical modelling (e.g., for a complex nuclear plant), site surveys, laboratory tests, etc.

The basic aspects which need to be considered at the stage of pre-feasibility study ae quite similar to those dealt with earlier. For example, the first step would focus at the existing gap between the demand for and supply of the product (or service). This has to be refined further in terms of the **future** scenarios that are likely to emerge during the life of the project and estimates of sales made at different levels of market penetration. Next, the invesor has to look at the availability and costs of essential factors of production like land, labour, materials, technology, plant & machinery etc., which would determine successful execution and operation of the project. Finally, operational costs like overhead, wages, expenses and revenues have to be estimated at different levels of plant utilization.

As it is not practical to discuss all such aspects for various types of investment alternatives her, we will take a look at UNIDO'S outline of pre-feasibility study only for industrial projects, a modified version of which is given below.

Outline of a Pre-feasibility Study

1. **Executive Summary :** Gives the title, brief description and objevtives of the proposal, and a summary of all the essential findings and recommendations of the study in about two pages.

2. **Project background and history :** Identifies the project's sponsor(s) and gives a chronological account of the project and various studies, surveys or investigations carried out, alongwith their results.

3. **Analysis of demanded supply:**

a) **Demand capacities and market :** Outlines profiles of customers and their needs, estimates of present and future trends of gross demand, production capacities set up and their utilization levels, and imports/ exports. Describes the characteristics, potential and role of the industry in national and regional economy, and government's policy towards it.

b) **Sales forecast and marketing:** Covers the qualitative and quantitative aspects of competition to the project, distributional requirements of the product/service. Proposes viable sales organisation and sales programme, giving esimates of annual revenues and costs of marketing and sales (in local/foreign currencies).

c) **Production programme:** Proposes production levels of products and by-products. Estimates consequential wastes and emissions (solid/liquid/gas), and annual expenditure on their disposal or treatment.

d) **Plant capacity:** Determines feasible normal plant capacity (i.e. the production level achievable under normal working conditions duly taking into consideration the feasible equipped capacity; holidays; stoppages for shift-change, tooling, preventive maintenance and repairs, and other reasons; and nature of the production process - continuous, batch or job) and specifics quantitative relationship(s) between sales, plant capacity, and major inputs.

4. **Analysis of inputs:** Gives approximate requirements of raw, semi-processed/ processed materials, utilities, auxiliary materials, tools and spares, etc. alongwith availability, sources or supply and estimates of

annual costs (local/foreign).

5. **Location and site:** Recommends geographical location and sitting of the plant/ facilities and specifies essential related activities and cost-estimates.

6. **Engineering & technology:** Describes in suitable detail,

   a) the exact scope of the project,

   b) technology(ies) and processes that can be applied to the project considering the proposed capacity, location, and nature of inputs, and estimates of costs (local foreign) of the inputs.

   c) rough *layout* of the basic plant & equipments (covering production/auxiliary/service equipments) and related costs (local/foreign), and

   d) *Civil engineering works* (covering site preparation and development, buildings & structures, special civil works, and outdoor woks) together with rough cost estimates (local/foreign).

7. **Organisaion:** This gives,

   a) an outline of one recommended organisation structure for production, sales, and administration; and

   b) estimates of overhead costs (covering factory, administration and financial arrangements).

8. **Manpower:** Provides estimates of manpower requirements in different categories of levels and skills, alongwith estimates of annual direct and indirect costs of manpower, for different years of operation.

9. **Execution schedule & methodology:** Gives a rough time-schedule for implementing the project, and estimates of costs to be covered during the implementation phase. Broadly outlines the approach recommended to be followed for implementation, e.g. turnkey contracting, in-house construction, item-rate contracting, etc.

10. **Financial & economic evaluation:** This covers -

   a) estimates of total costs of investment and their cash-flow pattern,

   b) proposed capital structure, modes of financing, and annual financial costs (interest, lease-charges, etc.)

   c) estimates of total fixed and variable costs of production

   d) financial evaluation of the project, in terms of -

   - pay-back period
   - break-even point
   - return on investment
   - internal rate or return

   e) economic evaluation of the project using cost - benefit analysis (based on relevant show price for goods, services and foreign exchange.

   f) cost-effectiveness analysis for projects whose benefits cannot be quantified in money terms relative changes in the project's Net Present Value, Benefit-Cost ratio, or IROR with respect to marginal variations in key project variables like sales, product-milk, capacity utilization, operating costs, etc.

As compared to a pre-feasibility study the analysis involved in a feasibility study in much more rigorous and requires specialised skills of a higher order, even though the basic framework is similar to the outline presented above. Further, it is usually based on additional, and more reliable, data especially gathered through research, surveys, pilot plant studies or tests for the project idea, its location and its techno-economic environment.

One must not lose sight of the fact that a feasibility study is basically an aid to decision making, and hence the deployment of time, money, and other resources on it should never be allowed to outgrow the potentia benefits that it may hopefully yield. In terms of time, it has been preceded by a pre-feasibility study. Morever, it should be able to generate capital cost estimates with a margin of error not exceeding 25% and help the investor to decide whether to abandon, postpone, or go ahead with, the project. Its findings should also help one to assess the relative strengths and wea nesses of prospective participants in the project at the negotiation stage in the investment phase.

It seems appropriate to strike another note of caution. This relates to the fundamental distinction between form and content. In other words, even if a feasibility report has systematically covered all the relevant aspects, it may still lead to an incorrect project decision if -

a) the project formulation suffers from incomplete or inadequate data; or

b) the underlying data or assumptions are unrealistic or incorrect or incorporate excessive safety margins; or

c) the report has been deliberately tailored to meet (or fail) acceptance criteria, for example by inflating (deflating) revenues and deflating (inflating) outlays; or

d) unknown or unpredictable factors intervene.

2.6 THECHNICAL ANALYSIS

In this Section we will examine how the technical aspects of a typical project idea can be scrutinized in detail to evaluate its technical feasibility, as distinct from commercial, financial, economic and managerial feasibility. For the sake of comprehensiveness we will cover *Environmental Impact Analysis* (EIA) also as a part of this analysis. While the various aspects to be examined will obviously vary from project to project, the following summary covers the more common ones briefly.

1. **Objectives:** First, the project proposal must fall within the ambit of the stated *mission* of the sponsor(s). Next the proposal must be able to further the objectives and priorities of the sponsor(s). These must therefore be ascertained and clearly recorded, alongwith detailed specifications for the output (product/service). Together, these constitute the basic frame of reference for all future decisions.

   The private sector would usually expect a project to earn a high enough profit, i.e. a stated level of return on investment. Only for core projects (which are intended to basically support other highly profitable projects) may this requirement be relaxed. In contrast, the public sector generally has multiple objectives and profitability normally takes a back seat. In either case, it is essential for the project analyst to keep the organisation's objectives - a alongwith their inter-se priorities - in sharp focus, to ensure that his efforts follow the correct direction.

2. **Location and site:** Initially, as many locations as possible should be identified which meet the most fundamental operational requirements of the proposed project. These should then be evaluated and an optimum location selected using the ciriteria of material versus market orientation (see note below), quality standards, infrastructural status, local laws, and socio-economic and living conditions. Within the geographical location so selected, alternative sites are similarly identified and the most optimal one selected after considering factors like terrain, local climate (and its impact on plant & equipment and their operation), availability and cost of land (plus its development), local infrastructural facilities and their costs (power; water: road/air/water transport; telecommunications; etc.), socio-economic conditions, availability and quality of labour and construction equipment, valid waste disposal alternatives and their costs, local living conditions, public policies, local law, and taxes, etc. [**Note:** Resource-oriented projects like mining of minerals involve items like geological analysis covering geological structure, hydrological conditions, characteristics of the resource, resource reserves, prospecting status, and expected geological problems.

   The locational decision should be made after giving due consideration to various benefits and incentives offered by governments or local bodies for setting up production or service facilities in certain specified areas. These may include assistance in the form of or in respect of capital loans and grants, tax, concessions, clearances, subsidies, infrastructure, etc. One way to do this is to evolve (or use available). Location Cost Indices (LCI) for different sites. If the cost (in a specified currency) of setting up a plant is C_A at location A and C_B at location B, the LCI for location A is defined as $100 \times C_A/C_B$. If reliable values of LCI for different locations, whether within one or more countries, are available, the selection of an appropriate location becomes a bit more easy. Such valuable information is however kept a closely guarded secret by a consulting company and is therefore difficult to come by.

3. **Plant Size:** Determination of an optimum plant size is critical to the success of a project. A plant represents sunk costs and any under utilisation of its capacity means either reduced profits or, for levels below the Break-Even Point, losses. The adverse impact of an extra-large capacity is felt all the more keenly during the early years when profits are all the more important for survival. It is therefore normally better to err on the lower side and to build a plant havbing a capacity that is likely to be fully utilized quickly, rather than to go in for a large capacity in the fond hope of a growing share of the market.

   In a feasibility study, one begins by looking at projections of the demand-supply gap in the market and anticipated arrives at the possible range of project sizes after co nsidering various constants like availability of materials, technology, equipment. public policy (for example, a large company may be precluded from setting up capacities beyond a size) and finances, etc. The best possible size of plant & equipment is then recommended after analysing the availability, economics, and practicability of different size options.

4. **Technology:** The same product or service can genarally be obtained using quite different technologies. Electricity, for example, can be generated using solar panels, coal (thermal plants), hydraulic power plants, nuclear power plants and so on. Basic telephone services can similarly be provideed using manual, semiautomatic, or automatic exchanges. And, even the last-named category is available in various technological versions like stronger, Crossbar, Analogue electronic and Digital electronic. Needless to say, the latest technologies usually represent many improvements over the existing or older once. They may also offer certain unique features. However, newly emerging technologies may have some inherent dangers as well.

What is important for formulating a successful project is to weigh available alternative technologies and select the one that is most appropriate in the prevailling situation, rather than blindly adopt the latest, state-of- the- art technology assuming that it will work since it works elsewhere. A technology is considered appropriate only if it is assessed to be satisfactory, and relevant, vis-a-vis the following aspecting aspects in he specific situation of the project.

- Specifications of the task/product
- Task uncertainties and interdependence
- [Especially for public sector] Developmental imperatives (e.g. growth of employment; maximising use of local resoureces; reduction of disparities in income levels)
- Required gestation period versus the time actually available of the project.
- Source (s) and ease of availability. [Remember the Cray super computer deal between USA and India?]
- Indigenous avilability of comparable technology
- Field validation status in comparable situations.If necessary, field trials may have to be set up.
- Adaptability to the qualitative characteristics of the locally (or indigenously) available resources including energy and efficiency in their usage
- Dependence on nonrenewable sources of energy
- Capacity of the organisation to absorb/adopt the technology
- Required operational parameters of ambient environment. For example a technology which has proven itself in cold climates may fail in tropics.
- Timely availability of manpower with requisite skills for installation, operation and maintenance
- Cost of acquisition, installation, repairs and maintenance versus availability of funds (local/foreign)
- Safety characteristics
- Requirement or availability of R & D facilities
- Environmental and sociocultural sensitivities
- Likelihood, and time frame, of obsolescence

After the existing technologies have been ranked on the basis of the above point, these have to be further assessed vis-a-vis acquisitional aspects, viz., the available modes of procuring it and the associated costs in local or foreign currencies.The important questions to be asked include: Is the technology available as a technical know-how, or throgh a technical collaboration,or a joint venture?Are patents, trademarks, or licensing involved? At what terms and with what legal obligations? wil it tie down the investor to procure equipment(s) as well from a specific country or company?

5. **Design, Layout & plan & Machinery:** The feasibility study should broadly specify the recommended design of the processes and plant (giving essential assumptions and design calculations).It should also present a rough layout of various facilities and list out all the major equipments needed, with key specifications and available source (s) of supply. Moreover, it should consider, and evaluate, alternative equip-

ments as well and give reasoned recommendations about them.

The importance of thoroughness of planning at this stage of the feasibility study can hardly be overemphasized. Many delays, cost overruns, and even failures of projects can be avoided provided the design and physical formulation of the project are based on a sufficiently deep analysis and have the support of the owner at the highest level. Otherwise, the project is likely to encounter mid-steam changes, with untoward consequenses. There is a genaral impression that "minor" midstream changes would not pose much of a problem. This is not so. A project is a multitask entity with complex linkage and interrelationships between its various constituents, and even "small" changes, which may result in certain made-to- order procured equipments being rendered unsuitable and thus throw the project schedule and costs haywire.

The aim of all efforts at this stage is to design a viable operating entity which not only works, but works harmoniously (and with minimum costs) in relation to the stipulated inputs and local environment. Apparent as well as latent and relatively infrequent factors having a bearing on the effectiveness of the project must therefore be identified and considered. Neglect of climatic and geographical aspects (e.g.monsoons, floods,snowstorms, dust-storms, heat/cold-waves, earthquakes, typhoons, etc.) at this stage can prove quite costly late on. It is equally impotant to ascertain and give due consideration to local industrial and safety standards.

6. **Construction process:** This needs to be tackled in the feasibility study in terms of its five aspects. First, the methodology to be followed - viz., capital intensive or otherwise and its feasibility under prevailing conditions. Second, whether the constuction or installation is to be done in- house, or on a turnkey basis,or by farming out a number of contracts for different work packages, and thier feasibility. A recommendation may also be made whether any special agency(ies) should be engaged as a part of backup or contingency arrangements for critical activity(ies).Third, the determination of such construction equipments, materials and other essential inputs (like cement, sand, steel, stores etc.) as are to be arranged by the owner, alongwith their alternatives, availability, source of supply (local/foreign),lead-times, and infra-structural requirements (like uninterrupted supply of power, clean water, gas,steam, etc). Fourthly,the recommended sequence and time schedule of different activities in the form of a bar-chart/PERT network. Lastly, assessment of the financial implications of this phase based on the latest available unit costs and with provision for inflation and contingencies.

7. **inputs:** These relate to the operation phase of the project, but need to be identified at this stage of the feasibility study to examine the technical feasibility of the proposed system(s). For this, classification of the inputs into following categories will be found useful.

-- raw materials,

-- processed materials,

-- components & sub-assemblies,

-- spares and wear & tear parts,

-- water & steam,

-- gas, fuels and electricity.

Next, their qualitative requirements (including buffer stocks, where aplicable), availability, feasibility alternatives and reliable sources of supply should be carefully ascertained and record. The problems involved in thier storage and handling should be also assessed.

8. **Infrastructural Facilities:** Availability and characteristics of roads, bridges,railway facilities (like station,yards), air transportation, waterways, ports, etc.depending upon their relevance to the assessed requirements of the project at both implementation and operation stages need to be studied.After studying the appropriatenes of the infrastructure existing around the project location, the infrastructural requirements at the project site itself. A large part of the land area is normally required to be reserved for service roads, storm water mains,railways, over-ground or overhead gas, steam, and air pipelines, water reservoirs, and even harbors for certain large-scale industrial projects. A detailed study of all such requirements, and of their implications, in terms of time, resources, and approximate costs is necessary to avoid surprises later on.

9. **Manpower:** The availability in needed numbers, of manpower of requisite skills where and when required, has to be studied. This covers both the project implementation and the operation (& maintenance) phases. In case imparting of training is also involved, timely availability, and costs, of the training facilities have also to be assessed.

10. **Environment impact Assessment (EIA): This study -**

    a) identifies the environment in which a project is to be implemented,

    b) assesses the short - and long-term impacts the former is likely to be subjected to as result of the project activities during construction as well as operation phases, and

    c) generates preferred alternative courses of action, if possible.

Its inclusion at the feasibility study stage is necessary for certain projects since, under the Environmental impact Assessment Notification, 1994, issued by the Ministry of Environment & Forests, Goernment of India, any expansion or modernisation of an existing activity which is likely to increase the pollution load, or setting up of a new project listed in schedule I,ibid., is not permissible unless cleared by the Central Government. The Schedule covers about two and a half dozen projects including petroleum refineries, chemical fertilisers, bulk drugs, asbestos, thermal power plants, paper, cement, and even highway projects.

The EIA process can prove to be of immense benefit to the project promoter, if sincerely carried out, by ensuring that the natural resources are conserved or used efficiently and serious problems likely to arise out of any adverse effects on community or natural systems are duly anticipated and provided for at the planning stage itself. For identification of impacts, a list of parameters relevant to the project is drawn up, covering natural physical resources, natural biological/resources,and quality-of-life values including aesthetic and cultural values. For instance, for rail/road/highway project the following parameters have been identified:

a) surface water quality

b) air quality

c) seismology/geology

d) erosion

e) land quality

f) fisheries

g) forests

h) terrestrial wildlife

i) noise

j) aesthetics

k) industries

l) resettlement

m) archaeological/historical significance

n) public health

o) socio-economic factors

For each of these, the resulting impacts, whether beneficial or otherwise, are then identified and a detailed Environmental Management plan (EMP) prepared for such mitigation, protection and/or enhancement measures, as are considered ne essary.

In the above paragraphs we have briefly covered the salient aspects of technical analysis. In reality, technical analysis rarely proceeds in a linear fashion covering these aspects. There is a great deal of interactive information exchange in respect of many of these aspects. At the end, however, it should result in-

a) a fairly comprehensive recommendation about the "technical" parts of the project package,

b) a precise recommendation, with or without conditionalities, about the technical feasibility of the package (stating the assumptions, made), and

c) detailed project specifications, which should form the basis for calling bids,etc. during the implementation phase.

Ieedles to say, the great the thoroughness with which the technical analysis is carried out, the more reliable ıd complete the Project Specifications are, and the lesser the chances of major unforeseen problems crop-ing up and jeopardizing the project.

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ring out the importance of pre-feasibility, feasiability studies and technical analysis in ensur ing success in the peration phase of the project.

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.7 SUMMARY

entification of right project ideas is crucial to minimise risks inherent in capital investment. Opportunity udies help one in this direction. Next, pre-feasibility (or feasibility) studies, which are carried out in the present, help predict their workability and effectiveness when implemented in (often distant) future. The approach followed in such studies is that of subjecting all important aspects and activities of the project to a systematic and skillful analysis to bring into focus its likely viability on technical, commercial, financial, and other grounds. Clarity of purpose,reliable and relevant data, and objectivity are important requirements for getting the most out of the total called feasibility study.

Technical "analysis" of a project actually covers both analysis and formulation. It covers factors like location,technology, plant size, environment, and construction & operational requirements of materials, equipments, manpower, and infrastructure. It conceives and critically examines major alternatives of producing the product or service (to meet the predicted demand) in terms of their productivity, effectiveness, and main costs, and yields the basic *project specification* for the recommended course of action.

2.8 SELF - ASSESSMENT EXERCISES

1. What are the phases of a project development cycle? Give the salient tasks under each phase.
2. What are the outlines of opportunity studies in project management? How do there impact upon project feasibility studies?
3. What is the concept of cleaner technologies?
4. Should ecological analysis be separated for technical analysis of the project?

   Support your answer with reasoning and logic.

2.9 BIBLIOGRAPHY AND FURTHER READINGS

1. ILO.Project Management and the Environment, An ILO/UNEP Environment Management training programme. Edited by Dr. RGA Boland,ILO, Geneva 1986.
2. Franked, Ernest G. project Management in Engineering Services and Development Butterworths, London,1990.
3. Govt. of India. The environmental impact assessments motification, 1994. Ministry of Environment & Forest, New Delhi, 1994.
4. Ludwij, Ernest E. Applied project Mgt. for the process Industries, Gulf publishing co.; Houston, 1974.
5. Kharbanda, & Stallworking, EA, Successful projects with a moral for Mgt. Gower, England, 1996.
6. Mattoo, PK. Project formulation in developing countries. The Macmillan co. of India Ltd., 1978.
7. Clifton, David S. & Fyffe, David E. Project Feasibility Analysis. A guide to profitable New Ventlar. John Wiley & Sons, 1977.

UNIT 3 MARKET AND DEMAND ANALYSIS

Objectives

Study of this unit, will enable you to understand:

- importance of market and demand analysis in project management
- aligning all capital expenditure to serve and satisfy the customer's needs
- different methods of demand analysis, their comparative advantages and disadvantages
- increasing emphasis on accuracy in forecasting demands in the backdrop of fierce competition and changing customer preferences
- impact of errors in forecast and relationship between operating costs of forecasts and their accuracy.

Structure

3.1 INTRODUCTION

Emerging competition in market place is propelling managements to hear the voice of their customers. To survive in the market, management have to be forward-looking and carry out market and demand analyses of products and develop strategic business policies.Hower when it comes to working out methods and methodologies of demand forecasting, it presents a strange dilemma. Demand Burke had said that, "You can never plan the future by the past", whereas patrick Henry opines that, "I know of no way of judging the future but by the past".

As an essential part of project formulation and appraisal, market and demand amalysis is vital so that capacity and facility location can be planned and implemented in line with the market requirements. A major error in demand forecast can throw painstaking capital expenditure on plant capacity and other hardware facility totally out of gear. Such decisions are not easily reversible. Metal Box of India, a premier company in the field of metal, plastic and cardboard packaging became sick owing to ill-timed diversification into manufacture of bearings.

3.2 FORECAST VERSUS PREDICTION

Forecast is an estimate of future events and trends and is arrived at by systematically combining past data and projecting it forward in a predetermine a manner.

prediction is an estimate of future events and trends in a subjective manner without taking into account the past data. The subjective consideration may not emerge from any predetermined analysis or approach.

3.3 TIME HORIZON OF DEMAND FORECASTING

Market and demand analysis of various types are undertaken to meet specific requirements of planning and decision making. For example, short-term decisions in production planning, distribution etc and selling ir di-vidual products would require shortterm forecast, upto one year time horizon, which must be fairly accurate for specific product items, For long-term planning, time horizon being four to five years, infomation of techology, machine tools and other hardwares and their location. various time hori zons and corresponding information requirments are as below:

S.No.	Types of Decisions	Time Horizon	Types of Data/Info
i	Short-term planing planning decisions	One year	Specific items and, their demand
i i	Medium-term	Two to Three Year	Aggregate demand of technology and site selection
i i i	Long - term and site selection	Four to Five Year	Broad data on technology

Longer-term forecasting is also undertaken to determine trends in technology development so as to choose the technology for backing up and funding its research and development.

3.4 NEED FOR DEMAND FORECASTING

All business planning starts with forecasting. capital invistment, like procurement of raw materials and pro duction planning, has to relate to demand forecasting.High volume high technology mass production system: have further high-lighted the impor tance of accurate demand forecasts. Even in a batch type production, any major mismatch between forecast and manufacture will lead to higher capital tied up in finished products which are slow in selling.

3.5 UNCERTAINTIES IN DEMAND FORECASTING

Demand forecasting is the estimate of future demand. As the future is always uncertain, forecasting cannot be completely fool proof and correct. Hower, the very process of forecasting demand in future involves evaluating various forces and factors which influence demand. This exercise is very rewarding in itself as it enables the personnal to know about various market forces, currents, cross-currents relevant to the demand behavior.

3.6 LEVELS OF DEMAND FORECASTING

Demand forecasting can be at the level of a firm or an industry or the national or international level:

a) Firm Level

If the exercise aims at forecasting demand of firm's products locally at state, region or national level, it is a micro-level of demand forecasting. Sometimes, forecasts are required for company's products in specific industry or market segment.

b) Industry Level

Such a demand forecasting exercise focuses on an industry as a whole for the region and/or national level. These forecasts may be undertaken by a group of companies or by industry/trade associations.

c) National Level

Demand forecasts at national level include parameters like national income,expenditure, index of industrial and/or agricultural production etc. Estimating aggregate demand of products at national level facilitates governmental decisions for imports,exports, pricing policy etc.

d) International Level

Companies operating in multinational markets would require similar forecasting of demands for its products, trends in consumption etc at international level.

Managerial Economists play a leading role in masterminding these forecasts at firm, industry, national and international levels. Time horizon of these demand forecasts usually varies from 1 to 5 years and in rare instances upto 10 years.

3.7 DETERMINANTS OF DEMAND FOR CAPITAL GOODS

Capital gods are man-made equipment for the production of goods and series. Demand of consumer goods is autonomous and is forecast by direct measurements. However, demand forecast for capital goods is indirect and derived. Their demand is dependent upon profitability of the industries using these equipment and the ratio for production to installed capacitu (also called occupacity). For example, demand for cement manufacturing machinery will depend not only on the profitability of cement industry by also on the current surplus capacity in the industry. It surplus capacity is low or negligible, one can expect major expansion of existing cement manufacturing units. Similarly, demand for commercial vehicles is dependent upon.

- growth of Indian economy
- growth pattern of different modes of transport-rail, air and sea
- availability of bank finance for leasing etc
- growth of replacement market of commercial vehicles

3.8 CRITERIA FOR A GOOD FORECASTING METHOD

A good forecasting method should have the folowing attributes:

a) Accuracy in forecast

Accuracy in forecast is measured in terms of past forecasts against current sales and by the percentage of deviation form actual demand. It is important to not only check the accuracy of past forecasts but also the validity of assumptions in practice. Forecasts being future-oriented, cannot be always accurate although accuracy is the most important criterion.

b) Plausibility of forecasts

Forecasts of demand must be reasonable, consistent and plausible. Assumptons made shoule stand scrutiny and techniques adopted must be commensurate. Explanatory note on these aspects must be available in the write-up on methods and methodology employed in forecasting.

c) Economy of forecasts

Forecasting exercise should not be expensive in terms of efforts and costs. Additional costs of ways and means for improving the accuracy of forecasts should not exceed the extra gain expected.

d) Quick Results

Method of forecasting chosen should be capable of yielding quick and useful results,If method selected takes too long a time to yield accurate forecast, it may not be conducive for taking quick and effective decisions. Always remember not to 'best' enemy of 'good'.

e) Avaliability and Timeliness

Methodology of forecasting should be such that it can easily be updated when changes occur in the demand relationships.

f) Durability

Demand forecasts should not be changed frequently. Durability of forecast is subject to the followings:

i) Simple and reasonable relationship between price and demand, advertisement and sales, level of income and volume of sales etc.,

ii) Stability of relationship between the above variables

g) Flexibility

Flexbility of forecast is an added advantage. It is desirable to adjust 'co-efficient' of variables from time to time to cope with the changing conditions.

3.9 METHODS OF FORECASTING DEMAND

To facilitate proper and reliable appraisal of investment proposal, we require a reasonably accurate forecast of cemand. Starting with qualitative methods like survey or collective opinions, buyers' intention, Delphi approach and its variant, a number of quantitative methods are used for compiling and computing demand forecasts as detailed below:

a) Collective Opinion Survey

Sales personnel are closest to the customers and have an intimate feel of the market. Thus they are most suited to asess consumers reaction to company's products. Herein each salesperson makes an astimate of the expected sales in their respective area, territory,state and/or region, These estimates are collated, reviewed and revised to take into account changes in design/features of products, changes in selling prices, projected advertising and sales promotion campaigns and anticipated changes in competitors marketing policies covering product, people, price, promotion and place. Opinions of all managers involved at various levels of sales organisation are also included in the survey. Thus "collective opinion survey" forms the basic of market analysis and demand forecasting.

Although this method is simple, direct, first hand and most acceptable, it suffers from following weaknesses.

i) Estimates are based on personal judgement which may not be free from bias

ii) Adding together demand estimates of individual salespersons to obtain total demand of the country may be risky as each person has knowledge about a small portion of market only.

iii) Salesperson may not prepare the demand estimates with the requisite seriousness and care

iv) Owing to limited experience, usually in their employment, salesperson may not have the requisite knowledge and experience

This method may be useful for long-term forecasts. It is also used for new products or new variants of existing products.

b) Survey of customers Intention

Another method of demand forecasting is to carry out a survey of what consumers prefer and intend to buy. If the product is sold to a few large industrual buyers, survey would involve interviewing them. If it is a consumer durable product, a sample survey is carried out for questioning a few representative nor desirable to query all consumers either through direct contact or through printed questionnaire by mail. These surveys serve useful purpose in establishing relationships between:

- demand and price
- demand and income of consumers
- demand and expenditure on advertisement etc

This method is preferred when bulk of the sales is to institutions and industrial buyers and only a few of them have to be contacted.

Disadvantages are that costomers may know total requirements; in some cases they are not certain about quantity to be purchased. Besides during shortages there is a tendency to inflate their requirements. Survey method is not useful for households-interviewing them is not only difficult out but also expensive. They are not able to give precise idea about their intentions particularly when alternative products are available in the market.

c) Delphi Method of Demand Forecasting

Delphi method is a group process and aims at achieving a 'consensus' of the members. Herein experts in the field of marketing research and demand forecasting are engaged in

- analyzing economic conditions
- carrying out sample surveys of market
- conducting opinion polls

Based on the above, demand forecast is worked out in following steps:

i) Co-ordinator sends out a set of questions in writing to all the experts co-opted on the panel who are reqiested to write back a brief prediction.

ii) Written predications of experts are collated, edited and summarizing together by the co-ordinator.

iii) Based on the summary, Co-ordinator designs a new set of questions and gives them to the same experts who answer back again in writing.

iv) Co-ordinator repeats the process of collating, editing and summarizing the responses.

v) Steps 3 and 4 are repeated by the Co-ordinator to experts with diverse backgrounds until consensus is reached.

If there is divergence of opinions and hence conclusions, Co-ordinator has to sort it out through mutual discussions. Co-ordinator has to have the necessary experience and background as he plays a key role in designing structured questionnaires and synthesising the data.

Direct interaction among experts is avoid nor their identify is disclosed. Procedure also avoids inter-personnel conflicts nor strong-willed experts are able to dominate the group. This method is also used for technology forecasting.

d) Nominal Group Technique

This is a further modification of Delphi method of forecasting. A panal of seven to ten experts is formed and allowed to interact, discuss and rank all the suggestions in descending order as per the following procedure:

i) Experts sit around a table in full view of one another and are asked to speak to each other.

ii) Facilitator hands over copies of questionnaire needing a forecast and each expert is expected to write down a list of ideas about the questions.

iii) After everyone has written down their ideas, Facilitator asks each expert to share one idea out of own list with the group. The idea shared is written on the 'flip chart' which everyone can see.

iv) Experts give ideas in rotation until all of them are written on the 'flip chart'. No discussion takes place in this phase and usually 15 to 25 ideas emerge from this format.

v) In the next phase, experts discussed. During discussions similar ideas are combined and paraphrased appropriately. This reduces the number of ideas.

vi) After completing group discussions, experts are asked to give in writing ranks to ideas according to their perception of priority.

e) Simple Average Method

Among the quantitative techniques for demand analysis, simple Avarage Method is the first one that comes to one's mind. Herein, we take simple average of all past periods- simple monthly average of all consumption figures collected every month for the last twelve months or simple quarterly average of consumption figures collected for several quarters in the immdiate past. Thus,

$$\text{Simple Avarege: } \frac{\text{Sum of Demands of all periods}}{\text{Number of periods}}$$

f) Moving Average Method

Method of Simple Average is faulted on account of the fact that all past periods are given same importance whereas it is justifiable to accord higher importande to recent past periods. Moving Average Method takes a fixed number of periods and after the elapse of each period, data for the oldest time period is discarded and the most recent past period is included. Whatever the period selected, it must be kept constant- it may be three, four or twenty periods by once it decided, we must continue with same number of periods.

$$\text{Simple Average : } \frac{\text{Sum of Demands of chosen periods}}{\text{Number of chosen periods}}$$

g) Weighted Moving Average

In Moving Average Method, weighted given to the selected number of periods is same. This has been refined to include the weighted Moving Average which allows varying weightages for demands in old periods. Depending upon the age of the period, with-age can be varied:

Weighted Moving Average = $W1 \times D1 + W2D2 + \text{-------} + Wn \times Dn$

Where $W1, W2 + \text{-----}\ Wn$ are the weightages for the different periods in percentages so that

$$W1 + W2 + \text{--------}\ Wn = 1$$

This method has the advantage that it allows forecaster to compensate for some known trend in demand or seasonality of demand by carefully fitting appropriate co-efficients of weighted to those periods. The weightages have to be decided by the forecast analysts and this decision is critical to the accuracy of demand forecast.

h) Exponential Smoothing Methods

With the advent of computers and availability of software packages, Exponential Smoothing Methods have become popular. Besides, they donot require much data storage and computing. These methods are distinguished from the weighted average method by the way it assigns weightages to each past period. pattern of weightages assigned is exponential on form viz., demand for the most recent period and for each successive older periods, weightages decrease exponentially. The decrease in weightages in non-linear. For example, a first order smoothing is given by the expression:

Forecast of next Period's demand	= W	Actual Demand of Most Recent Period	+ (1 - W)	Demand F'cast for Most Recent Period

$$Ft = WX\,(Dt - 1) + (1-W)\,(Ft-1) \text{ ----------(1)}$$

Where 't' is the time period and value of 'W' varies between 0 to 1.

Continuing further, we have

$$Ft - 1 = wx\,(Dt-2) + (1-w)\,(Ft-2) \text{ and}$$

$$Ft-2 = wx\,(Dt-3) + (1-w)\,(Ft-3) \text{ and so on}$$

Substituting these values of Ft - 1 into Equation (1) above

$$Ft = w\,(Dt-1) + w\,(1-w)\,(Dt-2) + w\,(1-w)\,(Ft-2)$$

This can be rewritten as

$$Ft = w(1-w)\,(Dt-1) + w\,(1-w)\,(Dt-2) + w\,(1-w)\,(Dt-3) + \text{---------------}$$

Successive weightages are w(1-w), w(1-w), etc

For w = 0.3, these successive co-efficients will be 0.3, 0.21. 0.147 etc

When forecast have to be worked out successively for different periods, it is a simple computation as below:

Sl.No.	Month	Forecast	Demand	Weighted
1.	January	200	300	w=0.7
2.	February	0.7 x 300 + 0.3 x 200 = 270	350	w=0.7
3.	March	0.7 x 350 + 0.3 x 270 = 326	400	w=0.7
4.	April	0.7 x 400 + 0.3 x 326 = 378	- ?	

Choice of co-efficient of smoothing is critical:

i) a value of 0.7 to 0.9 may be more appropriate for new products or for items for which demand is shifting significantly

ii) a value of 0.1 to 0.3 denotes stable trend in demand and when demand is somewhat unstable

iii) value of 0.4 to 0.6 may be used for obtaining more accurate forecasts.

These methods are simple and with the speed amd accuracy of computers, are being increasingly used for determining 'quick and easy' forecasts within reasonable budgets.

i) Adaptive Exponential Smoothing

If demand is not stable or there is no known pattern of demand, Adaptive Exponential smoothing may be more appopoate. In this method value of 'w' is not fixed. After setting it initially, it is allowed to fluctuate over time in line with the changes in demand patten. Once again, decision of demand foecaster in assigning different values to 'w' is critical.

j) Exponential Smoothing with trend and Seasonal Data

So far all the methods of forecasting have assumed the entire demand as time series. In case there is a trend for a component of the demand, it can be forcast exponentially as a separate execise. Similarly seasonal component can be forecast separately. Thereafter composite forecast can be obtained by synchronising together the constant component, trend and seasonal components.

If the constant component of demand is 800, it can be asjusted for the trend component is 100, the forecast inclusive of trend component will be 900. Now let us assume that the seasonal factor is 90%. The overall composite forecast will be

$$0.9 \times 900 = 810$$

k) Double Exponential Smoothing

Sometimes there is too much 'noise' in a stable time series. In such cases, use of Double Exponential Smoothing is suggested. It smooths the first order exponential smoothing forecast as below:

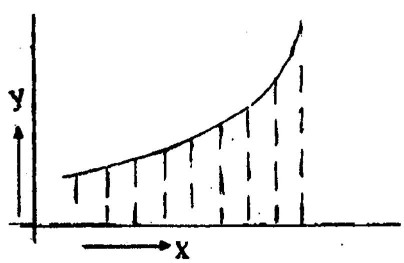
$$\text{Forecast of Next period} = w \begin{pmatrix}\text{First Order} \\ \text{Exponential} \\ \text{Smoothing} \\ \text{Forecast for} \\ \text{Next period}\end{pmatrix} + (1-w) \begin{pmatrix}\text{Double Exponential} \\ \text{Smoothing Foecast} \\ \text{For Most Recent} \\ \text{Period}\end{pmatrix}$$

Where 'w' varies between 0 to 1.

$$Fdt = w\,Ft + (1-w)\,Fdt\text{-}1$$

This method has been used extensively in forecasting demands of drugs in pharmaceutical industry.

l) Projection by Curve Fitting



Every company compiles data over time for different products. If it is arranged graphically as shown, we can establish a demand pattern. A curve can be fitted to the past data - it may be a linear or curve linear relationship. A mathematical expression can be evolved to denote the graphical pattern - values of constants can be worked for different group of products and an appropriate algebraic expressions cab be arrived at.

Once a curve is fitted, projecting demand forecast is rendered simple and inexpensive. The basic assumption is that past trend of change will continue in future also. Whenever pattern, formula breaks down. In such events, analysts have to anticipate the 'turning point' and lager foecast accordingly.

Since curve fitting is obtained by the application of the principle of 'Least Sum of Square', this model is also known by that name.

m) Regression Analysis

past data is used to establish a functional relationship between two variables. For example, demand for consumer goods has a relationship with disposable income of individuals and family; demand for tractors is linked to the agriculture income and demand for cement, bricks etc is dependent upon value of construction contracts at any time.

Forecasters collect data and build relationship through co-relation and regression analysis of variables.

n) Econometric Models

Econometric models are more complex and comprehensive as they interweave different factors together simultaneously. For example, demand for passenger transport is not only dependent upon the population of the city, geographical area, industrial units, their location etc.

It is not easy to locate one single economic indicator for determining the demand forecast of a product. Invariably, a multi-factor situation applies. Econometric models, although complex, are being increasingly used for market analysis and demand forecasts.

3.10 ERRORS IN DEMAND FORECASTING

There is a Chinese proverb which says, "To predict is hazardous, especially the future". Nevertheless, in industry, we cannot survive without predictions and forecasts, without scenaring building and analogies. Owing to fierce competition emerging in the market place, accuracy of forcasts is becoming a difinite competitive advantages as it improves planning and decision. Already it is hazardous to take short term marketing decisions without undertaking opinion polls, forecasts of customers preferences, trends etc.

Forecasting error may be defined as the numeric difference between forecasted demand and actual demand. Any method of forecasting yielding larger errors is less desirable. Following aspects are important in measuring the effictiveness of any method of forecasting:

a) Mean Absolute Deviating

It is a measure of the forecast error without regard to the different of the error, negative or positive. It is given by the expression:

$$\text{Mean Absolute Deviation} = \frac{\text{Sum of absolute values of forecast errors for all periods}}{\text{Number of periods}}$$

Absolute values of forcast errors mean values are taken without algebraic sings. Mean Absolute Deviation (MAD) is the average of the Absolute values of Forecast Errors. Forecast errors are, by themselves, normally distributed and there is a relashonship between MAD & Standard Deviation. If the forecast is reasonably to accurate, forecasts errors will be quite smooth. The above measure is then referred to as Smoothed Mean Absolute Devoting (SMAD), In such events, Standard Devoting = 1.25 SMAD

b) Bias

Bias is a less commonly used measure of forecast errors. It takes into account the direction of errors and sum of errors is the lagebraic sum of deviating and is expressed as:

$$\text{Bias} = \frac{\text{Agebraic sum of forecast errors of all periods}}{\text{Number of periods}}$$

If forecast are repeatedly overestimates, bias will have a positive value. Similarly, if forecasts are consistently underestimates, Bias will have a negative value

For a very accurate forecast, both MAD and bias will be zero. It is preferable to choose a method of forecasting wherein MAD can be controlled and brought nearer to zero Lowering MAD will reduce Bias also.

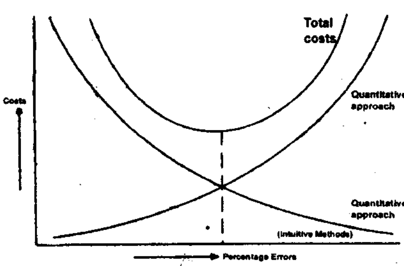
c) Costs of Forecast Errors

Important decision - short- term, medium and log-term, are based on forecasts. Large errors of forecasts can lead to costly mistakes, particularly, when used for evaluating investment proposals which are long-term and nearly irreversible.

Errors may be either in direction or in magnitude. In some situations, errors in direction can be critical which in other cases, errors in magnitude may be more damaging.

It is always difficult to complete the exact cost of forecast errors. It is advisable that such estimating of cost be undertaken, however approximate it may be.

Demand forecasts forming basis for production and inventory management can be evaluated on the basis of their impact on the overall manufacturing costs, Tanks to powerful computing facilities available, we can work out the entire simulating and find out the possible reduction in cost that we could achieve if we had more accurate demand forecast.



d) Cost and Accuracy of Forecasts

It is perhaps easy to visualize a relationship between percentage error of forecast and the costs involved in selecting, adopting, operating & maintaining that particular method of forecasting, these would entail less effort and expense but would also yield forecasts with higher percentage error. If we use time-series and other mathematical techniques, costs would increase but it would also reduce the percentage or errors. Similarly, using more sophisticated statistical tools shall further improve the accuracy of forecasts. Correspondingly, cost of operating and maintaining these forecasting techniques will vary as shown in the graphologists would be low when errors are low but costs would increase if we have to base our planning and decision making on of accosts with larger margin of errors.

Optimal region, corresponding to minimum overall costs, would be somewhere in the middle of the Total Cost Curve -- usually nestling between simple and sophisticated statistical techniques which can be complied on a computer.

Activity 4

A Large number of companies in India became such during 1970s because of investing heavily in projects and manufacturing products that had little market demand. Think and draw up the possible causes of much failures.

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3.11 SUMMARY

Economic and financial evaluation of an investment proposal must always be used on reasonably accurate market and demand analysis for forecasting. Depending upon demand pattern, length/time horizon of forecast, level of noise and degree of accuracy required, a suitable method of demeand forecasting should be selected as cost of operating not-so-accurate forecast can be exorbitant.

Although forecast are usually made with the help of statistical models, individuals can use the past data intuitively and forecast future events. The experience confirms that with a host of foctors impacting on demand pattern-noise level, complexity of operation etc, subjective approach decreases the level of accuracy.

Forecasting models are more reliable methods of ascertaining demand although a few individuals can consistently forecast better than models.

3.12 SELF - ASSESSMENT EXERCISES

1. What are the different levels of forecasting and their respective role in decision making?
2. What should be the decision criteria for selecting a suitable method for demand forecasting?
3. 'Collective opinion survey' method of demand forecasting has often resulted in faulty forecasts. What are the pitfalls of this method?
4. Describe the least sum of computerized environments.
5. How can we optimise the conflicting factors of cost and accuracy of demand forecasting?

3.13 BIBLIOGFAPHY AND FURTHER READINGS

1. V.L. Mote, Samuel paul, G.S. Gupta, Managerial Economics- Concept & Tata McGraw Hill.
2. James B, Dilworth, Production and Operations Management, McGraw Hill International Editions.
3. Joseph G. Monks, Operations Management - Theory and Problem, Mcgraw Hill International Editions
4. A Muhlemann, J.Bakland & K. Luckyer, Production and Operations Management, Macmillan India.
5. KPM Sundharam & EN Sundharam, Microeconomies, Sultan Chand & Sons.

UNIT 4 ECONOMIC AND FINANCIAL ANALYSIS

Objectives

After studying this unit, you will have:

- better understanding of the techniques of financial and economic evalution of projects
- relevant and comparative merits and demerits of the criteria used for financial and economic analyses
- better appreciation of critical resources for the success of proposed operations
- better comprehension of the cost drivers and their values in the successful completion of the project
- a reaffirmation that the project fits into the framework of national priorities and allocation of scarce resources to it is justifiable
- the confident that socio-cultural benefits far exceed the costs to community, state or the nation.

Structure

4.1 INTRODUCTION

This unit deals with some techniques of financial and economic evaluation of project and their comparison thereof. It explains the cost drivens and their values in successful completion of project.Social Cost Benefits for exceed. The cost to community on state as a whole. The need of Social Cost Benefit Analysis (SCBA) is discussed along with other factors relevant in the project.

4.2 FINANCIAL ANALYSIS

Implementing projects, involving large expenditure is a strategic decision-it is both long term and not easily reversible. Wrong decision can land the company into major problems. At the same, without taking up projects for expansion and upgradation, companies cannot maintain and improve their profitability. These projects involving large capital outlays have to be appraised from a 'private' or financial point of view-this evaluation is from the view point of promoters who may be individuals, corporate, commercial and development institutions, development corporations, central or state governments or their agencies. This evaluation is required before these are sanctioned for implementations. Method of evalution may be the traditional ones- unsophisticated like Average Rate of Return (or Return on Investment) and playback period or time-adjusted techniques like Net present Value, Internal Rate of Return etc.

4.3 AVERAGE RATE OF RETURN ON INVESTMENT (ROI)

This is an accounting method. There is no agreement on the definition and a number of alternative methods of calculating it are available. The most common ratio is:

$$\frac{\text{Average Annual Profit after taxes}}{\text{Average Investment over the Project life}} \times 100$$

- Average Annual Profit after taxes is calculated by adding up the after-tax profits for each year of project life and dividing it by the no. of years of estimated useful life (for annuities, after-tax profit is equal to one year's profit).
- Average Investment over the project file is computed by dividing the net investment by two (straight line depreciation is assumed) and adding the salvage value that would be received at the end of the projected life (since it remains invested throughout) and full amount of working capital required.

Example

Determine the ARR from the following data:

SI. No.	Item Details	Maching M (Rs.)	Machine N (Rs.)
1.	Initial purchase price	60,000	60.000
2.	Yearly Income after depreciation & Income Tax		
	---- First Year	4,000	12,000
	---- Second Year	5,000	9,000
	---- Third Year	7,000	7,000
	----- Fourth Year	9,000	5,000
	----- Fifth Year	12,000	4,000
		37,000	37,000
3.	Estimated Life (Years)	5	5
4.	Estimated Salvage Value	3,000	3,000
5.	work Capital required	-	-

ARR can be worked out as below:
(straight line depreciation is assumed)

Average Income after taxes/year	37,000 / 5	37,000 / 5
	i.e. 7400	7400

Average Investment over the project Life = 1/2 (initial cost -- Salvage Value) + Salvage Value + Working Capital
= 1/2 (60,000-3,000) + 3000 + 0
= 28,500 + 3,000
= 31,500 ------------(B)

$$\text{ARR} = \frac{7{,}400(A)}{31{,}500(B)} \times 100$$
= 23.5%

Alternative Computation of ARR

Some analysis use the Initial Cost instead of the Average investment over the project life, in which case,

$$\text{ARR} \quad \frac{7{,}400}{60{,}000} \times 100$$
= 12.3%

Companies select projects where ARR exceeds a 'predetermined value' or they rank the alternative proposals in the descending order of magnitude of ARR for selecting the most attractive one.

4.4 PAY BACK PERIOD (PB)

Pay Back period (PB) is a traditional method which is simple and most widely used for project evaluation. It is a measure, in terms of time, it will take to recover from proposed operations, the initial cash investment, which normally disregards the salvage value of the equipment at the end of its useful life.

$$\text{pay Back period (PB)} = \frac{\text{Initial Investment}}{\text{Constant Annual Cash Flow (CFAT)}}$$

Usually, the cash flows every year are not equal as they vary from year to year, in which case, the calculations are:

$$\text{Pay Back Period (PB)} = \frac{\text{Original Cost of Acquisition}}{\text{Cash Flow after Tax (CFAT)}}$$

Example

For the same example of Machine M and N, Pay Back Period can be calculated as below:

	Machine N			Machine N
	Annual CFAT (Rs.)	Cum CFAT (Rs.)	Annual CFAT (Rs.)	Cum CFAT (Rs.)
Year				
1.	16,000	16,000	24,000	24,000
2.	17,000	33,000	21,000	45,000
3.	19,000	52,000	19,000	64,000
4.	21,000	73,000	17,000	81,000
5.	24,000	97,000	16,000	97,000

Annul CFAT for first year for Machine M $\frac{4,000 + 60,000}{5} = 16,000$ etc.

From a quick glance, one can estimate that pay Back period for Mechine M is more than three years and for Machine N, it is less than three years-- this can be verified

For Machine M, pay Back period (no . of years)

$$= 3 + \frac{60,000 - 52,000}{21,000}$$

$$= 3 + \frac{8,000 - 45,000}{21,000}$$

$$= 3 + 0.38 \qquad = 3.38$$

For Machine N, pay Back period (no. of years)

$$= 2 + \frac{60,000 - 45,000}{19,000}$$

$$= 2 + \frac{15,000}{19,000}$$

$$= 2 + 0.79$$

$$= 2.79$$

Similar to ARR (ROI), PB can also be used as a criteria for selection of projects if it exceeds a predetermined value or it can be used for ranking the proposals in the ascending order of magnitude in number of years, the one with the lowest PB being the most attractive.

4.5 DISCOUNTED CASH FLOW TECHNIQUES

Traditional methods of project evaluation do not take into account the total benefits from the entire life cycle of a project not they consider the time value of money. The techniques described below, discount the cash flows by the cost of capital -a discounting factor for adjusting time value of money :

4.6 NET PRESENT VALUE (NPV)

Net present value (NPV) computes the net present of the cash inflows (CFAT) in each of the future year by discounting them suitably and then subtracting the cash outflow in each year, which in our example is Rs. 60,0000/ - for each of the two machines M and N.

A present Value of Cash Inflows, year after year

Year	Machine M			Machine N		
	Annual CFAT (Rs.)	**Present Value factor**	**Present value**	**Ann CFAT (Rs.)**	**Present factor**	**Present value**
1.	16,000	0.909	14,544	24,000	0.909	21,816
2.	17,000	08.26	14,042	21,000	0.826	17,346
3.	19,000	0.751	14,269	19,000	0.751	14,269
4.	21,000	0.683	14,343	17,000	0.683	11,611
5.	24,000	0.621	14,904	16,000	0.621	9,936
Total			72,102			74,978
B. Present Value of Cash outflow			60,000			60,000
Net Present Value (A-B)			12,102			14,978

Capital Expenditure proposal with a positive NPV or which exceeds a predetermind NPV, can be selected for implemenation. Alternatively, the proposals can be ranked in the descending order of the NPV.

4.7 INTERNAL RATE OF RETURN (IRR)

IRR method is know by many names - yield on investment method, marginal efficiency of capital method, marginal productivity of capital method, rate of return method, time adjusted rate of return method etc. It also takes into account time value of money by discounting Cash Inflows and Cash Outflows. This method is best described as the rate of return the project earns for itself because, it is that discounting factor (R) which equals the present value of the cash flow (CFAT) with the aggregate present value of the net cash outflows of the project i.e. this rate of discounting which gives zero NPV.

Projects one selected if the IRR is higher than the rate of return predetermined by the company. The same procedure is followed with the annuities also.

Example

Let us taken the same example:

		Machine M (Rs.)	Machine N (Rs.)
i)	Purchase Price (cash out flow)	60,000	60,000
ii)	Cash Inflows		
	First year	16,000	24,000
	Second year	17,000	21,000
	Third year	19,000	19,000
	Fourth year	21,000	17,000
	FiFth year	24,000	16,000
		97,000	97,000

What is the IRR?

Solution

We undertake a fellow fake calculation to seek a guideline for starting discouning at a rate nearer to the target.

	Machine M	Machine N
a) Fack annuity	$\frac{97,000}{5} = 19,400$	$\frac{97,000}{5} = 19,400$
b) Fack Pay Back Period	$\frac{60,000}{19,400} = 3.092$	

Consulting the table A - 4 for Present Value Interest Factor for an annuity (PVIFA), we find that for n = 5 years, the value nearest to 3.092 is 3.058 which corresponds to a discounting factor of 19%.

For Machine M, since Cash Inflows of initial years is lower than 19,400, we can reduce the discounting factor subjectively by 1% & for Machine N, cash Inflow of initial years is higher than 19,400, we can increase the discounting factor by 1%.

Present value of two investment proposals can be worked out as below:

Year	Machine M			Machine N		
	CFAT (Rs.)	PV Factor @18%	PV (Rs.)	CFAT (Rs.)	PV Factor @20%	PV (Rs.)
1.	16,000	0.847	13,552	24,000	0.833	19,992
2.	17,000	0.718	12,206	21,000	0.694	14,574
3.	19,000	0.609	11,571	19,000	0.578	10,982
4.	21,000	0.516	10,836	17,000	0.481	8,117
5.	24,000	0.437	10,488	16,000	0.401	6,416
Total Cash Inflow			58,653			60,141
Cash Inflow			60,000			60,000
			+ 1,347			-141

We can work out the present Value of two investment proposals by discounting Machine M @ 17% and Machine N @ 21% as below:

Year	Machine M			Machine N		
	CFAT (Rs.)	PV Factor @17%	PV (Rs.)	CFAT (Rs.)	PV Factor @20%	PV (Rs.)
.	16,000	0.855	13,680	24,000	0.826	19,824
..	17,000	0.731	13,427	21,000	0.682	14,322
.	19,000	0.625	11,875	19,000	0.563	10,697
	21,000	0.534	11,214	17,000	0.465	7,905
	24,000	0.457	10,968	16,000	0.384	6,144
Total Cach Inflow			60,164			58,892
Cash Out Flow			60,000			60,000
			-164			+1,108

RR
%)

$$17 + \frac{60{,}164 - 60{,}000}{60{,}164 - 58{,}603} \qquad 20 + \frac{60{,}141 - 60{,}000}{60{,}141 - 58{,}892}$$

$$17 + \frac{164}{1511} \qquad 20 + \frac{141}{1249}$$

$$17 + 0.11 \qquad 20 + 0.11$$

$$17.11 \qquad 20.11$$

IRR can be, thus, arrived at by working out the computations as outlined above. In real life, this is much simpler as computer softwares are available for working out the IRR.

4.8 PROFITABILITY PROJECTIONS

The traditional and sophisticated discounting methods of project evaluation have been falted because the financial anaysis looks at the capital expenditure proposal in isolation and works out the ROI, PB, NPV or IRR whereas it is more appropriate to work out the impact of expansion proposal on the working results of the company. This would highlight the working results - profit/loss statement without and with the new project.

This is computed as below:

1. Cost of production
2. Total administrative expenses
   - Administrative Expenses
   - Administrative Salaries
   - Remuneration etc. to directors
   - Professional and consultants fees
   - Light, Postage, Telegrams, Telephones, office stationery etc.
   - Insurance Taxes etc. on office property
   - Miscellaneous expenses
3. Total sales expenses
4. Royalty, know - how payable
5. Total cost of production (1 + 2 + 3 + 3 + 4)
6. Expected sales
7. Gross profit before interest and financial expenses (6 - 5)
8. Total financial expenses
   - Interest on term loans (long-term)
   - Interest on borrowings for working capital (short term)
   - Guarantee commissions etc.
9. Depreciation charges
10. Operating profits (7 - 8 -9)
11. Other incomes
12. Preliminary expenses written off
13. Profit before Taxation (10 + 1 - 12)
14. Provision for Taxation

15. Profit after Tax (14 - 13)

Less Dividend on preference Capital @

Less Dividend on Equity Capital @

16. Retained profits

Add Depreciation charges

Preliminary Expends written off

17. Net Cash Accruals (16 + 9 + 12)

These calculations are done for several years to cover 3 - 5 years of operations after commencement of commercial production.

Activity 5

Why is financial analysis described as 'private analysis? When it is used both by the promoters & financial institutions for sanctioning funds for the project?

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4.9 ECONOMIC ANALYSIS OF PROJECTS

Economic analysis is done from the viewpoint of society or economy as a whole. The evaluation is done from a wider angle not merely in financial terms. Economic analysis of projects should cover whether.

- It fits into national priorities
- it contributes to the development of that sector of economy
- benefits justify the consumption of scarce resources of the nation

This technique is now known as Social Cost Benefit Analysis (SCBA) - this concept has evolved over years since 1844 when Jules Dupuit, A French engineer, referred to it in his paper on the measurement of "Utilities of Public Works'. In 1936, Flood Control Act of 1936 of USA provided that a project should be deemed feasible only if **sumtotal of benefits to whom-so-ever they may accrue exceed the estimated costs,** highlighting the social nature of investment decision. In Uk, this was applied first time in 1917 for evaluating M1 Motorway project, and nationalized industries were directed to use SCBA. India is a pioneer in the third world countries and has applied SCBA in appraising projects especially in the public sector.

a) Need for SCBA

SCBA differs from monetary cost and benefits analysis (financial analysis) of the project because of the followings:

i) Imperfect competition in market

Financial analysis uses social only under conditions of perfect competition, which is rare in developing countries because of many restrictive legislation's viz. rationing, minimum wages act, foreign exchange regulation act etc.

ii) External Aspects of project

In variably new projects result in additional road or rail network which may benefit the neighbouring areas. Similarly, project may have adverse effect on the ecology and environments. External factors are rather important for SCBA.

iii) Taxes and subsidies

In financial analysis, taxes are treated as monetary costs and subsidies are considered as monetary gains. In SCBA, there are conceived as transfer payments and not considered at all.

iv) Consumption and savings

A private firm will not give differential value to consumption and savings in the financial analysis whereas in SCBA, money consumed because of the concern for the society - savings alone lead to investments for future and further development.

V) Retribution of benefits

In SCBA, monitory to poor is considered more valuable than an equivalent monetary gains to the rich and affluent but in financial analysis, entrepreneurs and promoters are not concerned about it.

vi) Consideration for merit or demerit wants of society

Government may be interested in spreading literacy or family planning which may not be sought by consumers in the market place. These aspects may be of no concern to individual private firm; these are important from society's point view.

b) UNIDO Method

UNIDO has spearheaded SCBA for projects in developing countries in 1960s & followed it by a detailed guideline in 1978, which suggests five stages as below:

- Calculation of financial profitability of the project measured as market prices
- Calculations of net benefits of projects in terms of economic prices
- Adjusting for impact of savings and consumptions's
- Adjusting for impact of income retribution
- Adjusting for merit goods and demerit goods for which social values differ from monetary values.

Calculation of financial profitability at market prices being identical to the evaluation methods discussed in foregoing sections, we briefly discuss the other four aspects:

i) Net benefits of projects in term of economic prices

Economic or efficiency rises are also called shadow prices. Market prices are identical to shadow prices under conditions of perfect competition which is rarely obtained in developing countries like India.

1) Choice of unit of currency

In what unit of currency, foreign or domestic, we should measure the costs and benefits? Should we measure the income in terms of consumption or investment? UNIDO specified that it should be measured in terms of net present consumption in the hands of people at the base level of consumption in the private sector in terms of constant price in domestic accounting rupees".

2) Concept of tradability

International price or border price of any item is a measure of its tradability because only then it can be substituted by imports or it can be exported.

3) Sources of shadow prices

UNIDO suggests that projects

-- increase or decrease the total consumption in the economy

-- decrease or increase production in the economy

-- decrease or increase imports

If impact of project is on the consumption, shadow pricing is based on consumers' willingness to pay, if impact is on production, shadow pricing is based on cost of production and if the impact is on international trade, the basis of shadow pricing is the foreign exchange value.

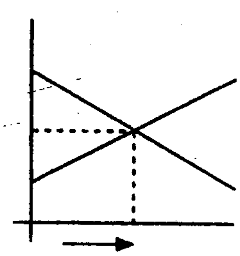
4) Taxes

UNIDO suggests that if project leads to diversion of non-traded inputs which are in fixed supply from producers or additons to non-trade consumer goods, taxes should be included and if project increase domestic production of other producers, taxes should be excluded and if goods are fully traded, taxes should be ignored.

5) Consumers' willingness to pay

Let us look at the Demand and Supply curves in relation to quantities. At the point of equilibrium, OQ is the quantity bought and OP is the price per unit.

However, for the first product consumer was willing to pay OD and the consumer who buys last unit, is willing to pay OP for that unit --- consumers; willingness to pay for different units is represented by DE. Total willingness is measured by area ODEQ whereas the price is OPEQ--- the difference DEP is called the **consumer surplus.**



Based on the above, the shadow prices of specific resources can be worked out.

i) Adjusting for impact of savings and consumption's

Most of the developing countries face problems on investible funds and are, therefore, anxious to know the impact of project on savings or consumptions and the social value of these savings or investments.

ii) Adjusting for impact of income retribution

In most developing economics, there is a unanimity that income retribution should favour economically weaker sections of society. The role of taxes, subsidies etc. in rather limited in terms of income retribution. As a consequence, project investments are good opportunities for retribution of income.

iii) Adjusting for merit goods and demerit goods

There is a difference between economic value and social value of resources fore both merit and demerit goods.

Social value for a merit good is more than its economic value e.g. In India, we may place a high or value on produce of petroleum crude oil because it reduced our dependence upon imports. Similarly, social value of a demerit good is less than its economic value e.g. we may accord a lower social value to a alcoholic drinks than its economic value.

There is a risk abuse of social values because politically desirable projects may be pushed under the grab of socially desirable ones. A number of such expedient decisions are available in India where politically expedient projects have been pushed at the cost of sound economically viable ones.

b) Little ---- Mirrless method (L-M Method)

This method was developed by I.M.D. Little and J A Mirrless. The approach has the following similarities and dissimilarities:

Similarities

- Calculations of shadow prices for foreign exchange savings and unskilled labour
- Considerations for equity
- Discounting method

Dissimilarities

- LM method measures costs and benefits in international (or border) prices whereas UNIDO suggests measuring costs and benefits in domestic currency.
- LM method measures costs and benefits in terms of uncommitted social income and UNIDO method measures them in terms of consumption.
- UNIDO suggests stage by stage analysis of efficiency prices, savings and retribution. However, L-M method reviews these together simultaneously.

c) SCBA in India

India has been one of the pioneers in the use of SCBA for public sector projects which were, at one time, at the commanding heights of the economy. ICICI was perhaps the first financial institution to introduce economic appraisal of projects. IFCI and IDBI followed with similar approach. The method followed by them, is a simplified version of L-M method. project Appraisal Division (PAD) of Planning Commission, Government of India, also follows economic analysis, they call it social profitability analysis, of all industrial projects. They also follow a simplified version of L-M method. The key elements of analysis are:

- Tradable inputs are valued at international prices
- Taxes, duties etc. Transfer costs, are ignored
- Non-tradable items like power & equipment are valued on marginal cost
- Foreign exchange for inputs and outputs is valued at a specified Premium
- Social wage rates are applied to unskilled and semi-skilled labour.
- Unit of currency is savings in rupees rather than foreign exchange.

Unfortunately, inspite of pioneering work done in India, there have been serious gaps in arriving at investment decisions which are financially and economically sound owing to political expediencies.

Activity 6

With the deregulation of economic and financial sectors of economy, what, in your opinion, will be the fate of Economic Evaluation & Social Cost Benefit Analysis.

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4.10 SUMMARY

The evaluation of project is mandatory before these are sanctioned for implementation. Average Rate of Return (ARR) or ROI, payback period on time adjusted techniques like Net present Value (NPV), Internal Rate of Return (IRR) are few techniques very important for financial evaluation of project. Social Cost Benefits for exceeds the cost to community, State on the nation as a whole.

4.11 SELF - ASSESSMENT EXERCISES

1. What are the traditional methods of financial evaluation of the projects? Why are they considered deficient?
2. What is Internal Rate of Return? Describe the method by giving details of a problem you are familiar with.
3. Projections of profit & loss account of the company inclusive of the impact of new capital investment is considered as the most accurate method of evaluating the new project; why?
4. Economic analysis is done from societal point of view in contrast to financial analysis which is a private appraisal from the viewpoint of a producer. How does it bring about a change in the methods of evaluation? Describe with examples.

4.12 BIBLIOGRAPHY & FURTHER READINGS

1. Prasanna, Projects Planning, Analysis, selection, implementation.
2. M Y Khan & P K Jain, Financial Management, Tata McGraw Hill.
3. P K Mathoor, project Formulation in Developing Countries, Macmillan India.
4. Ernst & Frankel, project Management in Engineering Services and Development, Butterworths, London.

UNIT 5 FORMULATION OF DETAILED PROJECT REPORTS

Objectives

After going through this unit, you would understand:

- the significance of design phase in project life cycle
- DPR and its importance in a project
- major contents of DPR
- the broad sequences to DPR formulation
- the capabilities required to prepare a DPR
- how to evaluate a DPR

Structure

5.1 INTRODUCTION

You have seen in the overview section that the second phase of the cycle of a project is the Design phase. This follows feasibility and is subject to an affirmative investment decision. This must give you a clue as to the importance of this phase.It is a costly and time consuming process, and therefore, it is taken up only after the feasibility stage leads to an investment decision. Typically about 10% of the total cost of a project is spent on its design. Hence it is important that Feasibility studies and Appraisals are adequately done and the decision to go ahead with the project is a well thought out corporate decision.

In this chapter, you would learn in some more details about the design phase of a project, the output of this phase being the Detailed Project Report (DPR)

5.2 PLANNING AS THE ESSENCE OF DESIGN PHASE

If you look at this phase in another way, it can also be called a planning phase and the DPR is nothing but a very detailed and elaborate plan for a project, indicating the overall programme, different roles and responsibilites, and activities and resources required. By now, through your experience and studies of Management, You are well acquainted with the important role that planning plays in any successful managerial endeavours. In fact, it is the key to the success in any human endeavour. Therefore, you would appreciate that the success of the design itself. The success of a project may be measured on the basis of a few critical parameters:

--- Whether the project was completed on time

--- Whether the actual cost of the project was within reasonable limits of escalation over the original estimates

--- Whether, after completion of the project, the facilities are able to generate the expected quantity and quality of the products and/or services at profitable costs

--- Whether the project's gestation period is within the planned duration

You must be careful to note that a good design is a necessary condition for the success of a project, but it is not a sufficient condition. The plan must be truthfully executed.

However, unless the design the comprehensive enough, the execution, howsoever accurate and true to plan, cannot lead to the success of a project.

The design provides a blue print for the construction of all facilities required in a project.It states on paper at great length and detail, what must be done to convert the corporate investment decision of a feasible project idea, into the reality of a successful, healthy profit making enterprise. It should adequately reflect top level policy guidelines on all aspects that has long term impact during the entire life of the project. It takes a relook at the appraisal, Particularly the financial viability, in much greater details.It also provides the basis for all specifications, contract drawings, detailed technical design and bidding. It touches on all aspects of a project, e.g. Marketing, Technology, Finance, Project execution and operations. It indicates the natures to counter the major risks. This plan becomes the reference point for all future monitoring and evaluation activities.

A DPR is a final, detailed, appraisal report on the project, and a blue print for its execution and eventual operation. It provides details of the basic programme the roles and responsibilities, all the activities to be carried out and the resources required and possible risks with recommended measures to counter them.

The following paragraphs would give you an idea about all aspects of a DPR. It is written with a manufactured product in mind. This would provide a most general coverage, although there may be other projects like housing, transport, hotels etc., mainly in the services sectors. Each project would have its specificity which cannot be foreseen and detailed out.in a chapter on DPR, not is it intended. We shall, therefore, attempt to provide a genaral coverage, which would cover most but not all aspects of a specific project. It might also contain some elements, thaat may not be present in one specific project.

5.3 MARKET PLANNING

The starting point of any project is a felt need which is awaiting satisfaction. It may be the need for more power, housing , consumer goods,transportation and communication services or any thing else. The first step in the design of a project, therefore, is to establish and understand the nature of the need. We shall call this exercise, Demand forecasting.The other market related aspect concerns those other organizations who may also be in the same game of providing goods/ services fulfilling the same needs. In the part and more so in the present liberalized economic condition, competition is the name of the game. The DPR must, therefore, lay down plans for effectively securing a desired share of the market and maintain/enhance it. We shall call this exercise the Marketing Strtegy.

They Marketing planning section of a DPR must cover Demand forecasts for the goods/services and a Marketing Strategy for ensuring a planned market share.

a) Demand Forecasting

is is probably the most crucial and at the same time most difficult task in the formulation of a DPR. It is ucial, because the complete design of the project, its capacity, investment required and financial viability is rectly related to this projection. If it is over estimated,the project would be burdened with excess capacity. low capacity utilization and eventual loss to the enterprise. On the other hand, if it is under estimated, the oject may find itself unable to meet the demand, inviting more competitors to enter the fray and mining on e opportunities derived from larger volumes of sales. It is difficult because one is trying to look into a fairly g future somewhere between 7 to 14 years. This includes about 5-10 years of the project life, over which e financial visibility is normaly examined, and about 1 1/2 to 4 years of the Project Phase itself, including part f the Design phase and the whole of the Execution and Termination phases, Even for products with a life ycle of just 5 years, the forecasting period would be about 7 years. This is the main reason why, Demand orecating for a project is significantly different from the routine annual, half yearly, quarterly and monthly emand forecasts carried out by all medium and large operating enterprises. This is not all. Once the extent of otal demand has been judged, it would be necessary to analyse the nature of the competition the project ight face, and the shaare of the market it may reasonably hope to corner for itself. The market share nsiderations get further complicated by the likelihood of new competitors entering the market for some or bstitute products.

n view of these complexities, demand forecasting for a project relies heavily on two basic approaches and nally arrives at certain projections based on the marriage of these two distinct approaches. These approaches e Econometric Methods and Comparative prediction.

) Economic Methods

hese methods rely heavily on past consumption data and tries to relate past demand with certain macro onomic/demographic indicators. The choice of such indicators or variables depends largely on the judge- nt of the analyst. The objective is to establish some functional relationship between demand (Y) as a depen- variable and the chosen independent variables. Once such a mathematical relationship has been established, the analyst uses time series data on these macro economic/demograpic indicators, to predict their values in future. These values are then invested into the functional relationship to forecast demand.

c) Comparative prediction

This method tries to predict new applications and new markets for an existing products. Such methods are particularly suitable for developing nations. A number of applications and uses may be prevalent in more developed countries, which may not be found in a developing nation.The reasons may be import restrictions, low level of supplies, high cost etc. Consider the case of stainless steel . A number of industrial, domestic and architectural applications of stainless steel is common in developed countries. Consider the example the equipment for dairy industry. As the availability of the right type of stainless steel increases, entrepreneurs may get motivated to set up dairy equipment within the country. This may open up nee avenues for generating demands that did not exist earlier. Similarly better avilability has encourage gas stove manufacturers to switch over from castings and mild steel shuts to stainless steel, owing to its superior qualities.

Yet another econometric method relies on estimation of disposable income and its relationship to the consumption of a product. For example, consumption of non essential items like soft drinks. This has a close relationship with disposable income. Affluent sections of any society would consume more soft drinks, as they have enough disposable income left over, after fulfilling the basic needs of food, clothing, health, education, transport etc. For such products, a good prediction of the income trends of different categories of households would serve as a reliable medium for demand forecasting.

Comparative predicting attempts to examine each area of possible applications and tries to predict the level of consumption in each sector. Consider the case of gas stoves. It has a close relationship with the number of new LPG connections that are planned. The Ministry of Petroleum draws up plans for new LPG connections. The share of stainless steel stoves out of total stoves can be obtained from the major stove manufacturers. This should enable a fairly accurate estimated of the demand of stainless steel sheets for this application. Following similar approaches, it is possible to find out an array of new applications and project demand in each area. The sum total of such new applications give another input for demand forecasting.

Yet another approach to locate and predict new sources of demand concerns a search for possible new markets for an existing product. In a country like India, where more than 70% of the population still lives in villages, rural demand and rural markets have often been targeted as potential new markets for so called urbanised products. Two wheelers that are designed to withstand rough driving conditions are a case in point. The growth in agricultural production and income generated from agriculture can serve as a good indicator of demand of products without any past record of consumption in these markets.

Similarly, rural electrification programmes open up possibilities of consumption of a most to electrical items like bulbs, fans, appliances, motors and pumps etc. New rural markets for such products could be estimated from the rural electrification targets in different states couples with estimates of rural household incomes.

d) The Nature of product/Service

It is very clear from the above discussions that the forecasting method adopted must be suited to the particular type of product/service being considered. The same approach cannot produce reliable forecasts for items as different as stainless steel and soft drinks. It is, therefore, customary to group items into different homogeneous categories, so that similar forecasting methodologies may be adopted within one given category. An indicative list of such categories is given below:

Categories of Products/ Services

Category	Examples
Basic materials/services	Cement, Steel, Power
Capital Goods	Construction Equipment
Consumer Durables	White goods, Automobiles, Furnitures
Industrial Consumables	Welding rods, nuts and bolts, POL items.
Consumer Goods	Food & Beverages, Textiles and Garments, Education.

e) Secondary Data Sources

You must be wondering at the wide variety of data that is required for Demand forecasting and, their source. Government departments constitute the most important source of data. The National sample survey, Census, Plan documents and Central Statistical Organisation publications provide important data sources. The National Informatics Centre (NIC) is carrying out pioneering work in marking a most of information being made available on its communication network- NICNET. For example, they have undertaken a project to link all district headquarters so that its central data bank can be assessed from every district in India. A recent example is the 1991 census data, which has a wealth of information on Indian population, education, income levels, professions and so on. One can access all these information from any district NIC centre's computer, provided it has been connected with the NICNET.

Some private organizations have help the need for specialized information and have started cataloging and publishing economic intelligences information. The Center for Monitoring Indian Economy (CMIE) is one such establishment which regularly publishes economic information. Many good libraries now subscribe to CMIE publications and can be used.

ne economic press also constitute a good source of secondary data. Every good economic news papers/ agazine establishes its own Research Bureau. In addition, they invite and receive well researched articles by ifferent professionals in academics and industry. Many libraries provide a press clippings services, enabling e to tap the information appearing in the economic media.

number of association of industries regularly collect information that is useful for their members. Market are information can usually be obtained from such associations.

Primary Data

nese may arise a situation where all available secondary (published) data may not be sufficient for the orecasting exercise. In such situations, it be become necessary to collect data from direct observations, nteriews, mail questionnaires etc. This is a specialized task, which forms part of Market Research. There are pecialized Market Research Bureaus, who undertake market research projects on behalf of clients, on yment of certain fees. A good bureau can be entrusted to carry out a reliable market research exercise, and is may form a good input for demand forecasting.

g) Estimation of Market Share

Demand forecasting methodology, described above, leads to an estimation of the total demand for the product/service under consideration. However, it is not sufficient to estimate the total demand above. It is necessary to identify the present and future suppliers and their output capacities, so as to be able to estimate a likely share of the overall market, that the project under consideration might capture.

Information about existing suppliers (producers and importers) are relatively easy to obtain. The more difficult part may be the information regarding additional supply sources in future. This would include expansion of capacity by present suppliers, entry of new suppliers,and additional imports. In the days of regulations and licensing, licenses is net served as a good indicator of prospective, suppliers. However, with most the industries have been de-licensed, one has to rely more on the economic media which publishes future plans of medium and large corporations.

International market trends and custom tariffs ans exchange rates can serve as good indicators for predicting imports. In any case, an organized effort must be made to estimate the total supplies, so as to be able to judge a market share for the project, when it goes on stream.

While carrying out this exercise of demand forecasting, it is very important to keep tract of substitute products/services. The impact on the demand for a product by substitutes have been thoroughly studied by economists. However, in case of demand and supply situation over the forecasting period and consider their impact on the demand under consideration.

If the end of this analysis, it should be possible to have a fair estimate of the market share for the project under consideration.

h) Marketing Strategy

In the previous section, you have seen how a project authority can set a target for achieving a particular share of the estimated total demand for the product/services under consideration. In this section, you would learn the basic planning and analysis necessary to chalk out are action plan, so that the targeted market share i actually achieved. But before we go into these details, a few lines in consideration of the relevance an importance of this exercise and its inclusion in the DPR may be necessary.

You might wonder as to what marketing strategy can realistically be chalked out at such an early stage, w. the DPR itself is not ready. It is true that nothing much can be done at the DPR formulation stage. However most Project Management authorities find themselves caught in a tine trap, once they concentrate on th myriad of activities concerning, technology, finance, construction, commercial negotiations etc. Thier en attention gets focused on DPR finalization and project execution. Marketing is often forgotten in the hecti atmosphere, so common in medium and large projects. Everyone tries to meet deliveries and schedules, one fine day, the trial runs begins, soon to be followed by commissioning. It is already too late for a beginnin on Marketing the product/service. The project may be successful, so far as fulfilment of time and cost sched ules are concerned, but these may not be any takers for the output. Such a begining can bring disaster to otherwise healthy organization. Therefore, the market must be prepared in advance, so that it is ready receive and but the products/services offered by the newly commissioned project. Thus marketing effor particularly those connected with advertising and distribution, must be initiated during the project executi stage itself.

As we have said at the beginning, a DPR is a blue print for action. Therfore, the DPR must also contain a section only the Mrketing Strategy, touching on all aspects of the marketing function that needs to be carried out during the project execution phase as well as theoperational phase. This should cover the overall ap proach, adiscussion on strategic alternatives and possible choice, a marketing organization, and a schedule for various marketing activites.

i) The Product-market Posture

As you might be aware, from your studies of Marketing Management, no market is homogeneous entity. Each market can and should be divided into as many segments as necessary so that each segment is distinct in its specific requirements, from others, while at the same time displaying requirements, from others, while at the same time displaying unifomity within. Such segmentation may be based on location or habitat of the customers like Rural, Urban and Metropolitan; or on the basis of the income level like middle class, upper middle class, or on the basis of their occupation/profession like students, housewives professional managers, academician etc.

The estimated total market (demand) for the product/service must now be divided into each market segment. At this point of time, it is necessary to identify competition in each segment and assess their strengths and weaknesses. This may lead to the identification of some desired market segments where the project authorities might enjoy special strengths and the competition is weak. Such segments would be most logical choice for targeting. Should such happy circumstances do not present themselves, the project authorities must still make a choice of the market segments, they would like to enter.Chojce of these segments would determine specific details and features, that the product/service must have and the corresponding marketing strategy to be adopted.

The next decision point would be to decide on a target market share in each segment, so as to attain the overall market share targeted earlier during demand forecasting. This would be a function of competition in each segment and the competitive strength that the project authorities wishes to build for themselves. This analysis also help the EPT (equipment and process technology) decisions, since the end product mix and their principal features get determind.

j) The 4 Ps

Armed with the segmented market share targets, it is now possible to design the product/price/promotion and place (distribution) strategies for the products/services. product decisions would concentrate on special features, add-one, options and other product design parameters to suit the specialized needs of each targeted market segment. Pricing for each segment may also be estimated in advance. These estimates would form useful inputs for estimation of sales revenue required in the finance section the DPR.

The next important decision point concepts the distrigbution strategy for the product/service. These decisions would in turn lead to the requirments for packaging materials and machinery and finished goods transportation and warehouding requirements. In case of a large number of industrial and household appliances, it would also include installation and commissioning of the product and after sales services.

The last but not the least, the promotional strategies each segment has to be chalked out. Most customers would not know by themselves, the emergence of a new supplier, as a result of the project undertaken. They must be informed. They must also be informed about the large range of products/services being/would be offered, their special characteristics and features and when and where would these be avalible.For new applications, users must be approached directly and new applications ideas must be pursued. For example, cycle manufacturers may be told the benefits derivable from stainless steel runs and their technical problems for adapting stainless, may have to be solved, A definitive promotional plan needs to be drawn up and included as part of the DPR.

k) Project Launch Strategy

Marketing experts often refer to the introduction of a new product into the market as a product launch. They devise a three step procedure involving i)test marketing in selected areas, ii) data collection and analysis from test markets and iii) final product launch. Detailed plans for the launch,including a separate network of activities are drawn up for succesful launching of a new product. The DPR may preferably contain a section devoted to the product Launch Strategy and Schedules.

l) Marketing Organization

The DPR must now turn towards the organization for carrying out the necessary marketing functions during the project phase and the operation phase, specialized one time activities like market survey etc.may be best entrusted on appropriate agencies. But the project authorities must retain some activities and decisions in its own hands. The marketing organization would be responsible for these decision, as well as, co-ordination with all the external agencies involved in the marketing efforts. Atleast one person (manager) must be in position from the very beginning. Futher additions may be planned depending upon the schedule of marketing activities.

m) Marketing Schedule

The DPR should draw up a separate schedule for all activities related with marketing of the product. The network for new product launch would be a part of this schedule. It would include other activities like recruitment and induction of marketing executives, appointment of specialized agencies, printing of information brochures and leaflets, media selection for promotional activities, and so on. A well planned marketing schedule in the DPR is a must for the success of a project.

n) Other Marketing Options

The planners might, at this stage, also consider a few special marketing options. These include:

--- Consumption within the same group of companies.

--- Guaranteed buy back arrangements

--- Exports

The first option is one of the easiest and one must not mix this opportunity.

In many instances, it may be possible to arrive at fixed or guaranteed buy back arraangements. In the more recent trend towards Just-in-time supply and much closer under relationship, a project may be conceived as a main supplier to a single major customer, with options to supply to other customirs as well. This is the other side of vendor development. In such cases, however, the product decision must be according to the requirements of the major customer and the EPT (Equipment and/Process Technology) must conform to these requirements.

Yet another tie up could be for exports. A number of mining projects in our country had export tie-up arrangements.

The market planning exercise should develop a product-mix, installed capacity, progressive capacity utilization targets and a strategy and organization for achieving these objectives.

Activity 7

" Marketing planning forms the cornerstone of any project formulation- we should never go in for a project for which customers and their demands have not been identified." Examine the statement and bring out strong iustification of marketing planning.

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5.4 EQUIPMENT AND PROCESS TECHNOLOGY

) Overview

ı ne market planning section laid down the product-mix and the installed capacity requirements for a project. 't is now time to devote our attention to the design of facilities, that would be able to produce and deliver these roducts

MATERIALS FLOW

VENDORS INPUTS PROCESSES OUTPUTS CUSTOMERS

DECISIONS FLOW

Fig.1

ɜrvices of the required quantity and quality. This exercise is broadly termed as the EPT (Equipment and ocess Technology) decision. In order to understand the nature of this exercise, it may be helpful to have a -y broad and general framework for discussion. Fig.1 depicts a general transformation systems, in which ..ndors supply certain inputs, These inputs are processed to add value of them, and are then supplied to ıstomers materials flow from vendors, through the processes,onto the customers. EPT decisions are conɜrned with the design of this entire chain. These may, very broadly be classified into

Output decisions

Process decisions

Inputs decisions

Transportation & Storage decisions.

!ot that these decisions are listed in reverse order of materials flow. This is depicted by the decisions flow row in fug. 1. This indicates the logical relationship between these decisions.

The market planning section has provided us with the output decisions. The EPT section must provide the remaining three decisions and a plan for their execution.

The inputs and process decisions have an element of complemantary built in. Together, they may be said to represent major "make or buy" decisions. A very wide choice exists between making almost everything required in-house, to subcontracting out all components and sub-assemblies to outside vendors, and keeping only final assembly and testing within the project facilities. Normal solutions usually fall in between these two extremes.

These decisions are usually governed by the strategic considerations, leading to a focus on selective compe tencies. All items requiring the application of sophisticated technologies are retained as 'make' items. In contrast, low technology, commonly available items tend to be subcontracted out, to derive cost advantages.Attempts are also made to identify high value addition items and retain them for in-hous processing. Yet another consideration is the entry barrier. Items with low barriers to entry are usually ear marked for buying, whereas, other items with high barriers to entry, are retained within. In this manne attempts are made to build in an element of strategic competencies within, so as to forestall future competi tion, as far as possible.

All of such considerations are dependent on the overall state of technological development within the countı and the region, where the project is likely to be set up. One has only to compare the design of projects durir the 2nd and 3rd five year plan periods, with those in the seventh and eighth plan periods for similar industries to see this effect. Earlier plants tended to be far more integrated, since the availability of suitable vendors wa extremely limited. Simple traditional machining facilities also, had to be provided in house. Now-a-days, fairl complex components and sub assemblies can be easily bought out.

b) choice of Technology

The make or buy decisions lead to the finalization of various inputs and thier processing and assembly requirmen. The next technological decision concerns the choice of technology for these processes. In the ultimate anal sis, this choice may be seen as a choice of the mix of capital and labour as the two principal factors production. A certain degree of substitution is possible, between capital and labour. Modern high tech. equi ment and processes are usually more automated, require much less labour, but are more costly. On the otl hand traditional equipment and process are less automated required more labour but are less costly. T trade-off lies between high capital and low labour cost on the hand; and low capital and high labour costs the other.

In addition to factor costs and their relative proportions, other considerations like scale of operations, qual and level of skills required, also influence the choice of technology decisions. Depending upon the mark share and capacity forecasts, a particular level of technology may be the optimum choice. High tech Hi volume EPT may not be suitable when the overall demand projections do not indicate such high volumes consumptions. Non-availablity of adequately skilled labour for operating and maintaining high tech equipme and processes have often led to sub-optimal use of such facilities. For example, modern machinery may ha automatic lubricating system, with functional interlocks which automatically stops the machine, when lubrication system fails. These have been instances, when plant authorities have removed such interloc when they were unable to maintain the lubrication system and still wanted to carry on with the machi operations, with a view to achieving production targets. Such short term measures cause irreparable dam to plant and equipment. These factors, coupled with the abundant supply of labour, has given rise to the concept of an "Appropriate Technology".

Whenever one considers adoption of a relatively new technology, the question of its reliability comes up. The decision maker is eager to know the experiences of other users in the use of similar technologies. Are the claims made by the suppliers substantiated by actual users' experiences? Normally one has to look beyond the boundaries of one's own country, for such information. Reputed provides of new technologies often realise this need and provides the experiences of their other customers, specially if requested. This choice lies between the so-called "proven tchnology" and later developments.

The choice of technology is, therefore, a complex task, requiring a wide knowledge and information about different options and their advantages and disadvantages. These are to be matched with the skills and competitors available, desired scale of operations, the competitive posture of the enterprise. Finally, it is a well considered judgement only on the part of the project authorities, which decides this ticklish issue.

c) Technology collaboration

The DPR has to consider the need for and sources to any specialised technical know-how for the project. For a number of modern technology projects, it may be necessary to have a technical collaboration agreement with some organization who have had considerable experience in the use of the same technology, and are in a position to impart their knowledge to others. Such a collaborating organization may be found within the country, but in most of the cases, one has to look for a technological collaborator, abroad.

Depending upon the chosen technology and the available/potential expertise within the project organization, the DPR might recommend the need for entering into a technological collaboration agreement. Once the recommandation is in the affirmative, it becomes necessary to elaborate it further.

The DPR must specify the broad objective and scope of the proposed collaboration. The ultimate objective would necessarily recalled full adaptation of the new technology by the project organisation. However, this may go beyond mere "know-why". It should also lay down the modalities for achieving these objectives. This might includes:

i) deputation of experts by the collaborator to advise and assist the project authorities during project Execution and Operation.

ii) training of project authorities personnel at the works of the collaborator, including on-the-job training.

iii) trasferring technical/process details in the form of documents, detailing out various processes, control parameters.

iv) transferring Quality Control documents detailing out control parameters, procedures, organisation and responsibilities.

v) assistance in the preparation of Operation and maintenance manuals.

vi) exchange of research and development findings on a periodic basis.

Cost estimates for the technical collaboration programme should also be indicated in the DPR and included in the overall project cost. This might include some one time down payment, defraying the travel, stay and per diem costs for deputation of experts, some periodic payments tied up with the submission of know-how documents according to some mutually agreed schedule,and some royalty payment during the operating phase, as a pre-determined percentage of sales.

These estimates should clearly state the Rupee (home country currency) expenses and foreign exchange component of the total costs. Care must be taken to ensure that the payment terms for foreign technical collaboration agreements do not violate any pertinent regulations in this regard prevailing in the country.

After detailing out the broad objective, scope and the cost of the proposed collaboration arrangement, the DPR should also indicate some creteria for selection of a collaborator and a broad time schedule for competition of the collaboration tie-up. In most of such situations, when a technical collaboration arrangement is seen to be essential for a project, it is scheduled to be one of the first milestones to be achieved. In this manner, it becomes possible to obtain their advise some fundamental aspects of the project like plant layout, selection of main plant and equipment suppliers, traning of project personnal, manpower planning, etc.

The DPR should establish a definite Equipment and Process Technology as the chosen, feasible option and outline the need for technological collaboration if any.

d) Equipment and process Technology Details

After laying down the broad choice of EPT, the DPR must now provide as much detailed specifications as may be required for actual tenders 'to be invited or the supply, (supervision of) erection, commissioning and guarantee tests of complete plant and equipment for the project. The totally of requirements may be broadly classified into the following categories:

--- Main plant and equipment.

--- Materials handling and storage.

--- Packaging and distribution equipment and facilities.

--- Utilities like power, fuel, air, gases, steam, water etc.

--- Pollution control and effluent disposal systems.

--- Services like canteen, medical, drainage and sewerage, roads, railways, offices, fire protection equipment etc.

--- Township and related facilities

5.5 LOCATION OF THE PROJECT

The DPR must consider this design issue and given its recommendation w.r.t. the location of the project. Basically, location decisions may be divided into two basic options: inputs or supplies oriented or outputs or market oriented. In the former option, the major considerations governing the location decision concerns the availability of various inputs for the project and their transportation from the resepective sources to the project site. Whenever a project entails processing of bulky raw materials and the processing reduces the bulk by refinements/processing operations, it makes economic sense to move the project nearer the supplies, so as to cut down on transportation costs. The strategy of National Thermal Power Corporation to locate major pit head thermal Power plants stems from this logic. Instead of transporting coal over long distances, it may be more economical to convert coal into electrical energy at the pit head itself, and then transmit the electrical energy through high voltage transmission systems to consumption centres. With the advent of High Voltage Direct Current (HVDC) transmission technology, such options have become more cost effective. On the other hand, gas based power plants may be located nearer the consumption centres, particularly if gas lines have already been laid near by, for other projects. This enables savings on the transmission line costs and power losses in transmission. The Dadri power project (also of NTPC) near Delhi is one such example, which took advantage of the HBJ gas pipeline.

As you might have guessed by now, the locational strategy is large by governed by total transportation costs for the entire chain, including transportation of all inputs from this sources, to the processing site and that of all outputs to the consumption centres. In fact,very standardized transportation models, which is a special form amongst a set of other- wise suitable options. This exercise needs the sources and quantities of all supplies available, their unit transportation cost to each location and the demands at different consumption centres, coupled with the unit transportation cost of finished goods to each consumption centre, from each location.

Let us now turn to the other considerations that govern location decisions. A major element in this respect is the packet if incentives that various state governments and the central government offers, to induce industries to be located in backward areas, to promote industrialization and development of such areas. Such incentives may include exception from sales tax for some inital years, concessional rates to income tax, availability of land in industrial estates, assurances of power and water supplies, and so on. Investors on the other hand, all concerned with the availability of infrastructural facilities and proximity to markets. Since an entire district is usually designated as such a backward area, industrialization usually takes place at the fringes of such areas, that are contagious with more advanced (industrially) districts, to derive the backward area benefits available at more industrially developed districts. For example, the south 24 'parganas district was declared as a backward area, and it is located just south of Calcutta, Industrialization has progressed on both sides of the Diamond Harbour Road connecting it to Calcutta, begining from the immediate borders with Calcutta. The Siemens factory is one such early example.

This leads us to yet another important set of considerations that govern the location of projects. These include:

--- The regulatory framework in the region

--- Availability of skilled manpower

--- Industrial relations situation

--- Infrastructural support

Quite often the environmental control regulations differ from state to state and their enforcement varies from state to state. This is an important consideration for those projects which have significant detailed impact on their environment.

Many projects are dependent upon the availability of skilled manpower and repair services which are generally available only in industrialized regions. In case these specialities are not available, it becomes necessary for the project authorities to build in such costly facilities and skills within the organization. This may not be the most cost effective solution because the need for such specialized services are not very regular and may lead to under utilization of highly skilled personnel. In such cases, project authorities would like to locate themselves nearer highly industrialized belts so that they can easily draw up such services.

The industrial relations situation vary significantly form one region to another. Labour unions are known to be better organized and capable of strong collective bargaining efforts in the highly industrilized locations in the country. Any new project coming up in the vicinity of such areas would most likely attract similar union activities. This is an important consideration with the project authorities,If the authorities feel that the benefits of locating in an industrialized area are high and they have sufficient experience and confidence in managing the insustrial relations, they may still decide to locate their industry in such an area. On the other hand, if locating an industry in a less developed and, threfore, more peaceful industrial relations climate they might as well so. These aspects of the DPR are to a large extent influenced by the perceptions of the owners in these respects.

Many medium end large projects could require the services of professional managers who would be enjoying good inforastructural facilities like education for their children, housing, health care, recreational facillities, public transport systems and communication facilities. For any new project to be able to draw talented manegerial and supervisory personnel it might be essential to ensure that equally adequate infrastructural support facilities would obviously be the winner.

5.6 LAYOUT OF THE PROJECT

The layout itself have profound implications on the profitability and efficiency of any enterprise. Even safety considerations can lead to major changes in layout. The layout for a project determines the location of various departments, processes, work centers, machines and service function as well as the transportation routes for movement of materials through these facilities. A good layout should try to reduce material handling cost to the minimum, ensure flow of men and materials between processes without any back tracking and or condition, provide adequate safety for men and equipment and enhance labour efficiency and a layout in the shape of a "U" pattern is one of the most favoured layouts since it facilitates communication between operators and provides an access to a number of machines. This is shown in Figure 1.Such layouts also provide certain degree of operational flexibility thereby helping in achievement of improved quality of work life.

Safety must be a very important consideration for deciding locations of potentially hazardous facilities. For example, storage facilities for acids and other hazardous items must be located as far away from the general center of activities as economically and parctically feasible. Facilities which are prone to fire hazards should be located in a fashion that easy and quick multiple accesses for fire tenders are possible. It may be worthwhile to give a specific safety check to a layout before finalizingit it. In an old plant which had not given due consideration to these factors a fire totally damaged two very important equipment simply because the fire tenders could not reach the sport easily.

5.7 MATERIALS BALANCE OF THE PROJECT CAPITAL

The DPR should provide an estimation of the total material balance for the project. This could include the quantities of all major material inputs for the capacity output. It would also specify various losses and bye products that may take place during handling and processing of these materials. It would also given the total quantities of each category of product which are expected at full capacity utilization for the project. This would obviously involve the application of certain norms for material losses and yields of different processes. The DPR should very specifically mention the assumptions with respect to these norms and the basis thereof. These standards become the first level targets for achievement before the plant operating agencies at the end of the project period.

5.8 SPECIFICATION FOR MAIN PLANT AND EQUIPMENT

You have noted in the beginning of this section that the DPR must provide detailed technical specifications for the purpose of tendering of all facilities that are required for the project. The specifications for the main plant and equipment, processing capabilities of each equipment and the outputs expected thereof. In other words, it is a materials balance for a new equipment. The specifications should also include all the consumption norms for major services and consumables required like power, fuel, steam, water, compressed air, etc. and all costly consumables, POL items and chemicals. These consumption levels have an important impact on the cost effectiveness of an equipment and, therefore, it is very important to specify these norms at the tendering stage itself.

The specifications should also include the throughout or output rates and the overall annualized capacity of each equipment. The specifications should also include the emission levels for all affluent the gases and their composition which must be adhered to. These requirements are set in accordance with the environmental regulations prevailing in the region.

5.9 ENVIRONMENT IMPACT ASSESSMENT

The EPT chapter of the DPR must devote a separate section on environmental impact assessment for the project. Such an assessment would have the specifications of the environment which is known as the base level specification before setting up a project. Thereafter, an estimate should be made as to the impact of the project's operations on various base level parameters. These could cover air, water and soil parameters. For example, this might include the sulfur dioxide level in the atmosphere or flourine level for water in the surrounding area. With the disposal of solid, liquid and gaseous effluents generated by the project, it is expected that these levels would shoot up. After estimating the impact of the project on the base level of the environment the DPR should recommend specific control measures and effluent treatment facilities so that the environment can be restored to permissible limits.

For example, there may be provisions for installation of electrostatic precipitators for arresting dust particles, chemical treatment plants to neutralise toxic elements in fluids before disposal, installation of useful by-products plants, etc. Sometimes schemes for planned tree plantations may also help to mitigate the otherwise unavoidable impact of pollution. In special circumstances, when the industry deals with some particularly hazardous material, arrangements for emergency treatment, in case of accidental exposures should also be included.

The DPR must ensure that the provisions are adequate for fulfilling all the legal requirements obtaining in the locality where the project is to come up. This calls for a detailed knowledge of all the state level and national level provisions w.r.t. environment protection. Many of the provisions call for obtaining specific clearances form controlling bodied. The DPR should also include a time schedule for obtaining all the required clearances.

Detailing of EPT provides complete specifications for all equipment and facilities; ready for issuing invitation of tenders. They would also include guidelines for information to be obtained from equipment suppliers. The details should also specify the location, layout, material balance and environmental impact assessment for the project with reasons thereof.

5.10 OPERATIONS

a) Capacity Planning

One of the important considerations in formulating a DPR involves capacity planning. The marketing exercise provides the basic input for deciding the installed capacity requirement for the project which must be sufficient to cater to meet the demand for the entire spectra of the plant product mix. Starting from this point, the DPR tries to forecast a progressive build up on capacity utilization over the initial years of the operation of the project and targets an initial period of 3-4 years within which the facility must attain its final capacity utilization level. This progressive built up of capacity is then translated into the number of shifts of operation that is required of each major plant and equipment. An attempt is made to economize on the number of shifts to be operated for each plant and equipment on the initial stages when the overall capacity utilization is not likely to reach its ultimate target. After arriving at this basic operational detail the DPR goes on to specify a broad requirement of manpower at different stages of capacity utilization.

b) Plant Organisation

The DPR also includes a recommended plant organization covering all functions at the three broad levels of management — junior, middle and senior. The issues concerning centralization versus decentralization are to be discussed and certain recommendations may be made in this regard keeping in view the technological requirements for successfully operating the plant facilities. Some of such considerations would involve maintenance functions. In a centralized maintenance set up all executive in the maintenance set up would come under one chief of maintenance, who would hold a position parallel in rank to the chief of operations. Both of them would be reporting to another top level executive. In a decentralised setup, separate unit level maintenance teams would be reporting to the operational head of that unit. There are advantages and disadvantages inherent in both the systems, and the designers should weigh them carefully, keeping in mind the nature of technology employed, and make a recommendation.

c) Personnel

The DPR includes a section on the overall personnel requirement for the project as well as the operation phase and a broad plan for recruitment, induction and training of requried personnel. The requirement of all technical, skilled manpower is derived from the capacity utilization plan discussed earlier. Depending the number of shifts of operation required for each major plant equipment, utilities and support services, the DPR can give a phased requirement of skilled and supervisory manpower for the operations of the project. The requirement for managerial positions can be derived from the recommendation for a plant organization. While these forecasts pertain to the period of plant operation, the DPR should also indicate the organization at the project phase that may be necessary. The requirement of personnel on the project phase would largely depend on the extent to which direct supervision and management of the. project is undertaken by the project authorities and the extent to which the project realize on specialists services from consultants and other consideration and erection specialists for project execution. Higher the number of services purchased from outside agencies, lower should be the requirement of having one's own personnel. However, it must be borne in mind that under no circumstances, the main control over time, cost and quality aspects of the project can be left to outside agencies. Therefore, during the project phase also the project authorities must have a pare minimum of project management executives entrusted with the responsibility for ensuring that these basic controls are not lost.

In many projects it is found that the large number of managers are required at the peak of the project execution phase. However, their need reduces as the project tenters the commissioning and guarantee test phase while the requirements for mangers to operate the facilities increases during the same period. It is, therefore, a good strategy to plan ahead for a transfer offer to some project personnel to more to operation, towards the end of the project execution phase. This becomes all the more important when the organization enters into a single large project and may not have another similar project to be handled after completion of the current project on hand. However, there may be a situation where an organization keeps on taking up a series of projects one after another. Under such situations it becomes preferable to build and retain the expertise in project management and, therefore, to transfer project personnel from one project to another, instead of absorbing them in the operating phase of a given project. The DPR should take into consideration these features of the project organization and accordingly draw up a phased recruitment, induction and training plan for all categories of personnel required for the operations phase.

The phased recruitment and training plan takes into account the timing of the availability of personnel for the purpose of training and subsequent placement during the project and operations phase of a plant. For example, key maintenance personnel can benefit significantly through their association with the erection of the equipment, which they would be required to maintain later. Such an association provides an opportunity for a practical exposure to various components and assemblies of major plant and equipment during their erection. Only .a major shut down in future can provide a similar opportunity to have a close view of the equipment. On the other hand, operating personnel may not-be- required to have such detailed knowledge of the internal constitution of major equipment and it may suffice to have them at the beginning of the trial runs. This would enable operating personnel to understand the operating characteristics of the equipment form the very beginning. Such an analysis would lead to scheduling the recruitment of maintenance, personnel well ahead of that of operations personnel.

Training of all key personnel is yet another important factor and sufficient care must be exercised of identifying the training needs of various categories of personnel and build these period in the recruitment plan so that people are trained before they are positioned to their respective assignments. Such training needs may include training inhouse, training within the country with some other organizations who are willing to accept the trainees, training abroad with the major equipment suppliers as well as with the technical collaborators if any. A well planned personnel recruitment, induction and training schedule can help significantly in the success of the project.

The DPR would also include an estimate of the different salaries and wages to be paid for all categories of personnel and this would provide an input for estimating the overall personnel costs for the project. These costs would be included in the overall cost estimates for the project.

d) Operations Planning

Any new project is very much similar to the setting up of a new household. Very simple items like salt or a scrubber need to be purchased before a new household can start functioning. Similarly, the operation of any new project would require a large variety of different items like minor consumable, stationary and safety related items which must be procured in order that the project facilities can be smoothly run. The DPR should devote a section on operations planning to recommend an organized approach for carrying out the operations planning exercise so that all trifling and minor items are available for the operation of the facilities. Experience with a number of projects show that a small cell managed by one or two persons can be entrusted with the operations planning activities while the project-is still under execution. This provides the project authorities adequate time and a guarantee that nothing will be missing at the time, of operations. This cell would first of all list all supplies and consumable required for the operation of all plant, equipment and services. They would try to identify the different sources of supply for each of such items - the reliability of the source, their delivery time requirement," quality and the cost. Based on these efforts, this group should place orders for the first supply to match the commissioning schedule and follow up with all the suppliers to ensure timely availability of all items.

While the DPR cannot lay down the details, it must emphasize a need to initiate actions for operations planning and indicate a schedule for carrying to this activity parallel with the project execution.

e) Vendor Management

All the items which are decided to be purchased inputs for the final product/services to be offered by the project needs vendor management functions. The DPR must provide guidelines indicating items where existing supplies can be relied upon and identify those cases where it would be necessary to develop new vendors. For new vendor development, the DPR might touch on such important issues as the need for know-how transfer to the prospective vendor, equity participation in the prospective vendors project, method of quality control on the prospective vendors supplies, delivery schedules, pricing of supplies and funding support, if any by way of facilitating term loans from financial institutions. In case of a project in which vendor development occupies a very critical role (for example a new automobile project) the DPR should also outline the organizational requirement for vendor development. The DPR should also provide guidelines for implementation of the vendor development strategy and its proper maintenance. This might include guidelines for the degree of coordination necessary with the vendors, more of information sharing with the vendors and approach to obtain synergy in the efforts towards vendor development.

f) The Quality Strategy

The operations section of the DPR should also touch upon the quality strategy to be adopted be the project authorities. This might include a statement of the basic approach to quality and go on to include wage and means to ensure the quality of all supplies, in-house process and distribution and after sales service management. It must be emphasized that in the hectic schedule of project execution and the initial days of commissioning, guarantee test and the thrust towards achievement of capacity utilization targets, quality very often takes a back seat. With the primary emphasis on quality targets quality may even be neglected and some undesirable operational practices lead to inferior quality may come in vogue. Once such wrong operating practices find a place within a enterprise, it becomes very difficult to correct them to introduce good practices later on. It is, therefore, very essential to have a quality strategy from the very beginning and stress the use of quality approaches from day one. This might also involve training all categories of personnel in quality including those involved in operation, maintenance and services at different levels. The principles of Total Quality Management and quality responsibility with direct operators need to be stressed from the very beginning to be able to derive the best advantage from such systems.

The DPR should, therefore, devote a section on the quality strategy to be followed by the project personnel,, the training needs and the need for emphasizing quality in all facts of the function of the project at the operating stage.

g) Operations Costing

The DPR should provide considerable details on the costing of the operations at different levels of capacity utilization. Fairly accurate estimates of expenses on account of input materials, labour, power, fuel, POL and other direct expenses should be provided in the DPR for each line of product mix. The DPR should also give fairly accurate estimates of other marketing, administration and other overhead expenses.

h) Management Information System (MIS)

The DPR should devote a section on the recommended outline of an MIS to be adopted for the operating system. The basic recommended approach for MIS should be explained. If any computer facilities are required, the hardware and software specifications should be laid down, the areas for computerization may be identified, a suitable organization for management information systems may be recommended.

i) Safety

Safety must be given adequate weightage in the DPR. All processes/areas which have potential hazards must be identified; overall approach for safety of personnel and facilities should be clearly indicated; safety devices for protecting of equipment/ appliances from damage through accidents should be specified. This might include the provision of limit switches, automatic interlocks for stoppage of plant and equipment, automatic sprinkler system for preventing fire accidents etc. some vital installations like LPG storage facilities may require special automatic safety devices and the application of a strict safety regime to prevent fire.

The DPR should specify the general safety requirements to be followed by the suppliers of all plant and equipment and these conditions should form a part of the general conditions of contract in all invitations to tender.

The DPR should also discuss the safety requirements of personnel, recommend a safety organization and a safety training system for all concerned people.

j) Finishing

The DPR should devote a section specifically to deal with packaging, storage and handling, and despatch, of the finished products. This might include specification of the packaging materials, specialized packaging equipment, if necessary, handling devices for handling the finished goods, provision of warehouses for proper storage of fished goods and some thoughts on the modes of transportation for the finished goods from the factory to the warehouses and from the warehouses to the dealers/retailers. An organization for the delivery system and recommendations for encouraging the services of any specialized agencies, if necessary, should be included in the DPR.

.11 COMMERCIAL ASPECTS

The DPR includes a section devoted to general guidelines and conditions that should govern all types of contractual relationships likely to be entered into, during the project. In particular, general guidelines for any eventual arbitration procedures are indicated, specifying the nature of issues that may be referred for arbitration, choice of the arbitrator by both the parties, and the place where such proceedings should be held. You might recall the Enron case, wherein it was a part of the contract that arbitration proceedings could be held in London, and arbitrators must be chosen from a third country, meaning that they cannot be citizens of either India or the US.

A number of general conditions covering the supply, (supervision of), erection, commissioning and guarantee tests of various equipment for the project need are drawn up. These terms and conditions must get inputs from technical as well as commercial departments. The DPR provides certain guidelines in these respects. An important issue may be the general procedure to be followed in the tendering process: like single stage or two stage tendering. It may contain a model invitation to a tender (ITT) document that specifies the inclusion of the following items, in all bids for the supply of major plant and equipment:

1) Recommended manpower requirement for operating and maintaining the equipment
2) Operations and maintenance manuals
3) Specific confirmation regarding adherence to all specifications laid down by the purchaser
4) Indicative load data and schedule of providing firm load data
5) Schedules for supply/delivery, erections and commissioning: and a periodic progress reporting system
6) Operators skills requirement
7) Training facilities offered by supplier
8) Experience of previous supplies

Generally the invitation to tended documents are prepared separately for the following categories of contracts:

1) Supply of plant and equipment
2) Supply, supervision of erection, commissioning and guarantee tests
3) Supply, erection, commissioning and guarantee tests
4) Erection and commissioning of equipment
5) Civil and structural work at site

For all major vendors the terms cover supply only whereas for most of the major plant and equipment the terms cover supply, supervision of erection, commissioning and guarantee tests. For specialized equipment which can only be erected by the supplier themselves, the terms include supply, erection, commissioning and guarantee tests.

Some of the important issues that may be touched upon are listed below:

— Commitment w.r.t. delivery period and penalty conditions, in case of a failure to fulfil the commitment
— General terms of payment, including progress payment
— Inspection and testing procedures, and customer hold points
— Network plan for the contract, and monitoring and control system
— Guarantee test: schedule, procedure, criteria for success, and accompanying Bank Guarantee
— Responsibility for damage in transit, or during erection and/or commissioning.
— Conditions for admissibility of any increase in the price .of the contract
— Contract variations and the manner of handling them
— Mobilisation advance (if nay) to be paid initially
— Responsibility to supply the "first fill", and spare parts for the first few years of operation

The guidelines w.r.t. the commercial aspects contained in a DPR can save a lot of problems form dragging on and adversely affecting the execution of the project.

5.12 FINANCIAL ASPECTS

The DPR incorporates a much detailed projection of the costs and revenues expected during the projected lifespan of the operation phase. The principal input to this comes from operations cost. However, all financing costs, like depreciation, interest on long term loans and short term working capital loans, writing off of pre-operative and preliminary expenses, guarantee commission etc. are included in the calculations. Income Tax calculations are also included. The DPR provides projections for:

— The Profit & Loss statement

— The Balance Sheet'

— The Fund Flow statement

for about ten years of operations.

For the Project phase, the DPR provides an estimate of the phased requirement of Capital. This plan forms the basis of a strategic plan for raising the funds from external sources, like term lending institutions and through public issue of stocks and/or bonds. The DPR would include a recommended schedule for ensuring adequate flow of funds for the timely completion of the project, with adequate provision for normal contingencies.

The DPR would also include for the project phase a recommended system for the monitoring and control of the financial progress of the project, is-a-vis the physical progress. This system is an essential ingredient for adequate financial control, during the execution and the termination phase of the project.

5.13 SOCIO ECONOMIC ASPECTS

Till recently, very little attention used to be paid to the Socio-economic impact of a project on its immediate surroundings. However, as the experience throughout the world shows, the attitude of the local residents where as new project is slated to come up, sometimes play very crucial role to the successful completion of the project. Generally, a moderate to large project causes some displacement of the original tenants of the land, brings in significant change in the pattern of earning livelihood, brings in wide disparity in the standards of living between those who are employed in the project and those who are left out of it, raises large employment expectations among the local popularise large employment expectations among the local populace vis-a-vis employment potential, and very soon leads to large scale disappointments. The effects are more glaring, bigger the size of the investment, higher, the level of technology used, and greener the pasture, where it is set up. Different combination of these effects may be present in a particular project. However, any such combination of impacts provide a fertile ground for the creation of a social discontent. The project is then seen as the root cause for all the turmoil, and its progress gets affected through different types of social unrest.

It is, therefore essential to make an effort at the early planning stage, to assess the area of population likely to be influenced by the project, carry out a demographic survey of the area to assess the potential for direct employment in the project, ascertain the overall nature of artisan training that could improve their employment potential, and seek avenues for the generation indirect employment for those who may not be provided employment directly. For example, some low skilled services requirements, like house keeping, general area cleaning, scrap handling, and general labour contracts may be kept aside for sourcing from local external sources.

Simultaneously, the DPR may include some provisions for community development plans, like building of roads, schools, dispensaries, provision of drinking water facilities, street lighting etc. A large corporation has even gone to the extent of building rest shade for the horse drawn carts plying in the area.

While in most of the projects, such activities are taken up only after the problems surface, it is a good idea that the DPR gives some serious considerations to these issues. It should include an estimate of the expenditure for these activities, and some assessment of the benefits and/or absence of potential troubles that may be expected.

The World Bank funded projects are witnessing a definite requirement form the Bank that Socio-economic surveys are carried out both before and after the project. Many national level progressive lending institutions may follow suite. The earlier one adopts a proactive stance to address this issue, the better for the project. Possibilities of involving local bodies, NGOs etc. towards the assessment and implementation of these activities may also be explored in the DPR.

5.14 WHO PREPARES A DPR?

You must be convinced that a very wide variety of expertise are required for the preparation of a DPR. A number of decisions are mutually related. For example, requirement and training plan is dependent on the nature of the technology, availability in the general employment market in the region need for foreign, collaboration and training, extent of specialised plant and equipment supplied for abroad, etc.

Financing requirements are dependent on the time schedule for the implementation of the project.

The nature of issues to be included in the commercial terms and conditions depend on the extent of the spread of the contractors. If only local and regional parties are in picture, the scope and jurisdiction for disputes get restricted.

A number of issues depend largely upon managerial perceptions and top management policies.

On the whole, preparation of a DPR is a complex task. Therefore, highly specialised agencies have come up in different areas, who undertake such tasks for clients. They are usually known as technical consultancy organisations. They specialise in some particular field. For example, Dasturco specialises in metallurgical industries. Engineers India Ltd. specialises in the oil sector. Even for a medium sized project, it is necessary that a capable consulting firm is entrusted with the task of formulating the DPR.

The process usually take the following shape:

- The client enters into a contractual relationship with a consultant
- The consultant receives all inputs from the client, carries out necessary studies, and submits a first draft to the client
- The client evaluates the draft, makes extensive comments, suggestions and requests for modifications/ further studies by the consultant

— The consultant submits the revised draft for approval

— The consultant submits the final DPR, after approval from the client, with all the details as Appendices and Annexures.,

5.15 EVALUATION OF DPR

The final responsibility for a project lies with the owners. Therefore, the owners organisation must have an appropriate mechanism for proper evaluation of a DPR (draft or final) submitted by a consultant. Apart from care in selecting a suitable consultant in the first place, the owners may pose the following questions:

What are the sources of critical data and information that have formed the basic premises of the DPR, like demand, capital costs, input costs, technological alternatives, etc.

The extent to which the strategic plans of top management have been reflected in the design

What were the various alternative considered, 'and the methodology followed for choosing one among them

The extent to which the design fulfils all applicable statutory regulations, both currently in force, and those that may be foreseen.

Identification of potential problems, bottlenecks and/or major risks involved in the project.

Influence of complementary/completing.projects

Degree of detailing.

Scope for future expansion/modifications/adaptation to new technologies, etc.

The above list is a sample of the types of questions that the owner may pose to the consultants, during the process of selection, appraisal of the first draft, and before giving final approval.

Activity 8

Quality of Design Planning that goes into the Detailed Project Report directly impacts on the quality of implementation and operation of the project. Elaborate the important role of design phase in all human endeavour.

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5.16 SUMMARY

Detail Project Report (DPR) in a very detailed and elaborate plan for a project indications overall programme, different roles and responsibilities, and activities and resources required for the project. Market planning sections of DPR must cover the demand forecasts for the goods/services. Data collection either by primary source on secondary source is most important in planning stage.

Process technology and choice of equipment are vital in project management. Choice of technology requires a wide knowledge and information about different options and thins advantages and disadvantages. DPR must consider the location of project depending on the input availability and output deliverability. DPR gives details about the project layout specification for main plant and equipment, processing capabilities of each equipment and the output expected thereof. Environment impact assessment would have the specifications of the environment which is known as the base level specification before setting up the project.

5.17 SELF - ASSESSMENT EXERCISES

1. "Decisions made during the design phase have major impact on the entire life cycle of a project". Justify with reasoning.
2. "Projects should be formulated primarily to meet the needs and wants of customers'". Highlight the importance of market analysis in project management.
3. "Choice of winning technology has become extremely important in the emerging scenario of global competition". Explain with examples of good and bad devices of technologies.
4. Bring out the importance of site selection for a new project. Is it an economic or personal issue?
5. "Doubled Project Report (DPR) forms the foundation on which the entire superstructure of the project is built — if it is weak, project cannot weather the turbulent times ahead." Bring out the do's and don'ts of a good DPR.

5.18 BIBLIOGRAPHY & FURTHER READINGS

1. P.K. Joy, Total Project Management, Macmillan India.
2. I.A. Stallworthy & O.P Kharbanda, Total Project Management — From Concept to completion, Gower Publishing Co., U.K.
3. UN Publications, Manual for Evaluation of Industrial Project, Oxford IBM Publishing Co., New Delhi.
4. UN Publications, Guide to Practical Project Appraisal, Oxford & IBM Publishing Co., New Delhi.
5. IDBI Publication, Project Finance Scheme, IDBI Bombay.
6. Indian Investment Centre, Financial Assistance by lending Institutions, llc, New Delhi.

BLOCK 2 PROJECT PLANNING AND SCHEDULING

There are six units in this block. Network analysis is carried out in the first unit (Unit-6). Network diagram of project, critical path determination and total float calculation etc. are the focus of this unit. Unit 7 deals with the key role of materials and equipment in project management. An attempt has been made to appreciate that projects entail designing and indenting materials, ordering and expediting materials and transporting and erecting materials.

Unit 8 tries to comprehend human aspects of Project Planning and Scheduling. One would appreciate the role of human resources in developing consensus and shared vision while evolving project schedules. Project costing and financing is dealt elaborating in unit 9. It has given a cleaner application of the role of cost estimation of projects for defining the scope of the investment proposal and increasing importance of computerisation and codification. Also given the in-depth knowledge of sources of project finance from domestic and foreign institution. Unit 10 explains process of organising resources, different types of organisation structures, advantages and disadvantages of matrix organisation.

UNIT 6 PLANNING TIME SCALE - NETWORK ANALYSIS

Objectives

After completion of this unit you should be able to:

- Develop a network diagram of projects
- Differentiate between various levels of networks
- Carry out time-analysis of networks
- Use time-analysis results for time management of projects
- Use probabilistic estimates of project activity durations to compute probability of completion in projects with high degree of uncertainty
- Develop time-scaled networks of projects
- Schedule projects through an iternative process

Structure

6.1 INTRODUCTION

Time is of great essence in all projects and one of the most important objectives of all project managers is to ensure completion of a project in time. In this unit we shall discuss the various tools and techniques as well as the concepts which are vital in effective planning, scheduling and control of projects.

As projects are unique, one-time endeavours, the normal planning and control tools are not very effective in the planning and scheduling of projects. Network diagrams provide a framework which can be used to develop project schedules and also for updating and control of projects. We begin our discussion by developing the concepts required to draw project networks and go on to use the same for scheduling of projects.

6.2 NETWORK DIAGRAMMING OF PROJECTS (AOA) DIAGRAMS

Network diagrams provide a mechanism to depict the interdependencies of various activities that constitute a project. We will first describe AOA (Activities on Arrows) diagrams which are the simplest and later, in section 6.5, we shall introduce some other types of diagrams.

6.2.1 Concept of Activity and Event

For effective monitoring and control, it is necessary to break-up a project into smaller activities. The basic idea is that if individual project activities are completed in time, the project itself should also be completed in time.

Activity

An activity is a homogenous element of work consuming some resources and requiring some definite amount of time for its completion. An activity is the smallest unit of productive effort to be planned, scheduled and controlled in a project and is represented by an arrow in a network diagram. The arrows are usually labelled by the activity codes and the estimated duration of the activity.

Event

The starting of an activity or the ending of an activity is called an event.

Activities are completed over a period of time (for example 2 weeks) while events take place at an instant of time. In AOA networks events are represented by small circles. Thus each activity has a head event as well as a tail event. For example, activity A in Figure 6.1 below has event 7 as the head event and event 6 as the tail event:

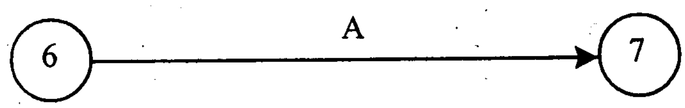

Figure 6.1: Head event (7) and tail event (6) of activity A

Completion of a Project

A project is completed only when all its activities have been completed. However, as many activities may be going on simultaneously, it is difficult to compute the project completion time even if the estimated duration of each activity is known. Except in a very rare case, the project activities are not all sequential in nature. Thus it becomes important for us to identify which activity may be going on simultaneously, and which others have to be done one after the other. The different types of events described in the next sub-section helps in this regard.

6.2.2 Simple, Merge and Burst Events

To get a clear understanding regarding the nature of activity interdependencies, it is important to understand different types of events.

Simple Event

A simple event is one which has only one preceding activity and only one succeeding activity. Thus in Figure 6.2 below, event 2 is a simple event and activity B can begin only after activity A has been completed.

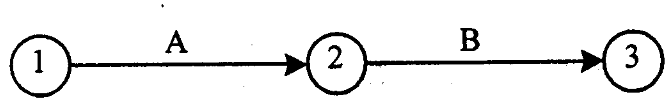

Figure 6.2: Event 2 is a simple event

Merge Event

A merge event is one which has more than one preceding activities and only one succeeding activity. For example, in Figure 6.3 below, event 4 is a merge event with C as the succeeding activity and A and B as two preceding activities. This shows that activity C can begin only after both the activities A and B have been completed.

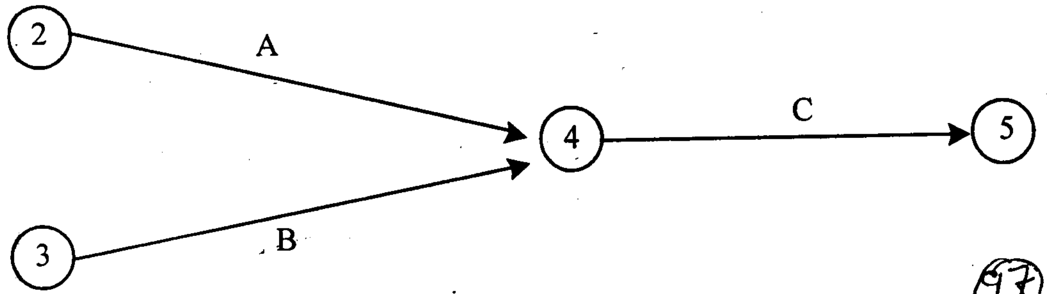

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Figure 6.3: Event 4 is a merge event

Burst Event

A burst event is one which has only one preceding activity and more than one succeeding activities. For example in Figure 6.4 below, activities B and C are the succeeding activities for the burst event 4, whereas A is the only preceding activity. This shows that activity B and activity C both of them can start only after activity A has been completed.

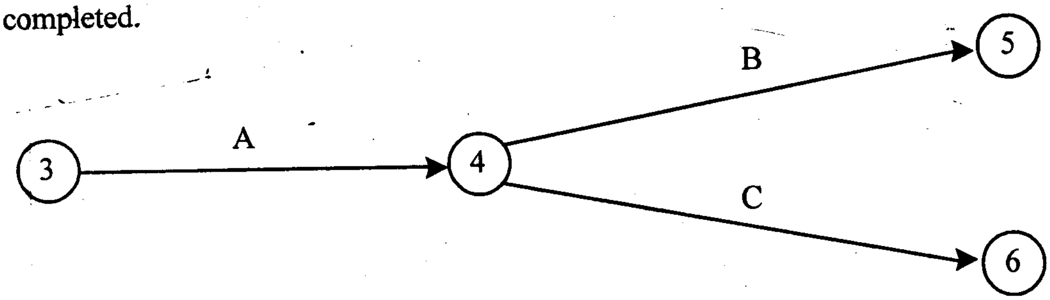

Figure 6.4: Event 4 is a burst event

Combined merge and burst event

An event having more than one preceding activities as well as more than one succeeding activities is a combined merge and burst event. For example, in Figure 6.5 below, event 4 is a combined burst and merge event, having C and D as succeeding activities and A and B as preceding activities. This shows that activities C and D can begin only after both activities A and B have been completed.

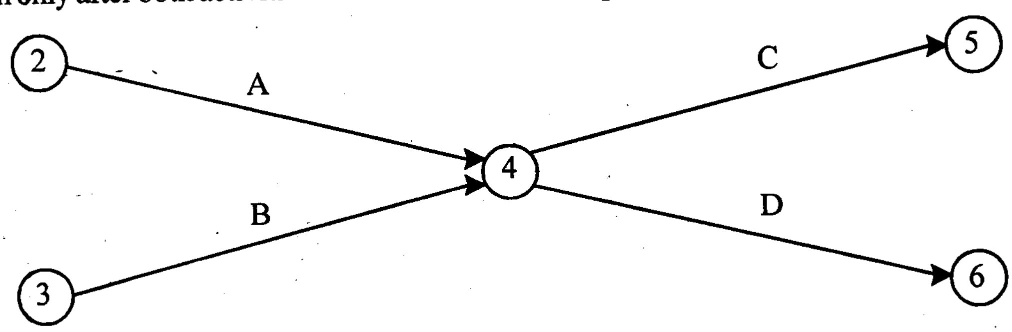

Figure 6.5: Event 4 is a combined merge and burst event

There are certain situations where the interdependency cannot be shown clearly using the above conventions. As an example, suppose activity D can start only after both A and B have been completed, whereas activity C can start only after the completion of A. This relationship cannot be shown using the simple conventions developed above.

To show the activity interdependency explicitly, we need to introduce dummy activities in our networks. A dummy activity is one which does not consume any resource and does not require any amount of time for its completion. Dummy activities are equired only for the purpose of explicitly depicting certain activity interdependencies which cannot be shown otherwise. Dummy activities are represented by dotted arrows in network diagrams. After a dummy activity has once been introduced in a network, it is treated exactly like any other activity for any further analysis. Figure 6.6 below uses a dummy activity connecting events 2 and 4 to resolve the difficulty in showing the activity interdependencies encountered above.

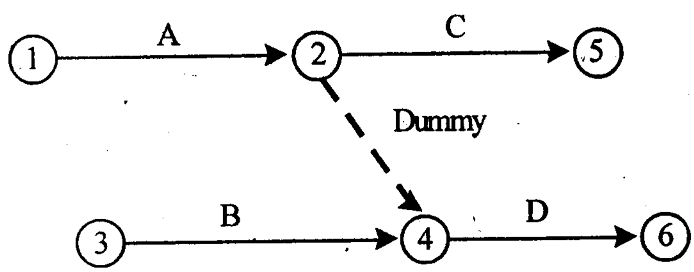

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Figure 6.6: Dummy activity is needed for explicity representation of interdependencies of activities C and D

If two or more activities have common tail and head events, then again dummy activities may be needed to diagram the network elegantly - e.g. in Figure 6.7 below, activities B and C have the same dependency relationships and a dummy activity has been used to have an elegant representation of the same.

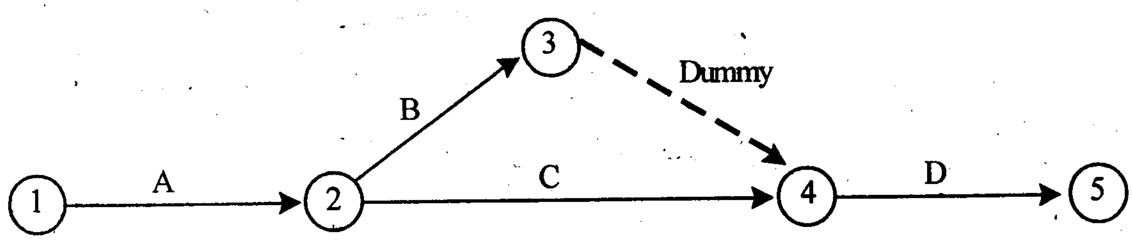

Figure 6.7: Need for dummy activity when activities B and C both have common predecessors and successors

Conventions while drawing network diagrams

A network diagram is a set of activities and events represented by arrows and circles, respectively. The length of an arrow does not represents anything, nor does its direction. Events are numbered as 1,2, 3, etc., while activities are labelled using activity codes as A, B, C, etc. By convention, the head event number for any activity is always larger than the corresponding tail event number. The orientation of the arrows is usually kept from left to right, signifying the flow of time from left to right in a general way. Criss-crossing of arrows are avoided as much as possible. It is a good practice to represent both the start of the project and its completion as single events. Similarly, one should use as few dummy activities as possible.

Information Required for Drawing of Networks

The basic information required for drawing of networks has two components, viz. a list of individual activities, and activity interdependencies. In order to be able to carry out time analysis, time estimates for individual activities are also typically collected at this stage.

Project Activities

A project has to be broken up into its constituent activities for detailed planning and scheduling. Each activity is homogeneous, requires specific amount of resources and is the responsibility of a specific individual. Work breakdown structure is usually employed to break a large project into its constituent activities.

Activity Interdependencies

The immediate predecessors of each activity are typically listed. When this listing is completed for all project activities, the relationship between any pair of activities can be known. If activity A is an immediate predecessors for activity B, this implies that activity B can begin only after activity A has been completed. The beginning activities do not have any predecessors, whereas the finishing activities are not the predecessors of any project activity. The precedence relationships are decided based on technological constraints (e.g. roof can be cast only after the walls have been built), management policy constraints and legal constraints. precedence relationships are sometimes used where the activities use a common critically scarce resources-e.g. equipment or money. However, this is not a good practice and it is better to look at resource constraints separately and explicitly.

Time Estimates

The time required for completion of each of these activities can be estimated by a person or a group of persons who are familiar with the activity and its details. These estimates can vary in terms of their reliability, depending on the nature of the activity as well as the relevance of prior experience in execution of the activity. While estimating the activity duration, an implicit assumption about some "normal" amount of resources is also made. It is possible to complete some activities quicker by employing a greater amount of resources and *vice-versa*. Similarly, the estimated duration of some activities (e.g. levelling a road) may be expressed in working time (e.g. 5 working days) while some other activities (e.g. curing of concrete) may be expressed in elapsed time (e.g. 15 days).

Levels of Networks

Large projects consume a. huge amount of resources and have to be planned, monitored and controlled at various levels. The top management may not be interested in the details, but would still be interested in knowing if the project is proceeding according to the schedule or not. On the other hand, the supervisor responsible for one activity is interested in all the details for that activity. This is achieved by drawing different levels of project network incorporating different levels of details. At the highest (say L1) level, the project may have 20 to 30 different major activities and it may be reviewed once every quarter at the top management level. At the lowest (say L3) level, the project may have 200 to 300 detailed activities - each activity may be the responsibilities of a specific supervisor. For the senior management, an intermediate level of detail (L2 say having 60 to 90 activities) may be adequate and this may be reviewed once every month for taking corrective actions. An activity in an L1 level network is actually a sub-project in an L2 level network and so on.

An Example

Let us consider a comprehensive example to highlight the concepts discussed in this unit so far. A company manufacturing and selling consumer products has recently developed a new brand of soap and has prepared a project for launching the new brand. An activity analysis is first carried out to breakup the project into homogeneous activities. From a careful analysis of the activities, the immediate predecessors for each activity is also determined. Finally, the duration of each activity is estimated based on previous experience of similar in the past. This information is presented as Table 6.1 below.

Table 6.1 Details of Activities for New Product Launch Project

Activity Code	Activity Description	Immediate Predecessor Activity	Estimated Duration (Weeks)
A	Finalise package design	---	2
B	Set up packaging equipment and procure raw materials	A	8
C	Produce the first batch	---	12
D	Package the first batch	B,C	4
E	Set up the sales office	---	4
F	Recruit salesmen	E	4
G	Train salesmen	F	6
H	Select retailers	E	8
I	Sell to retailers	G,H	3
J	Despatch to retailers	D,J	5
K	Select advertising agency	E	4
L	Plan advertisement campaign	K	9
M	Release pre-launch advertisements	L	1
N	Conduct advertisement campaign	J,M	4

From the information contained in Table 6.1, we can easily see that activities A, C and E do not have any predecessors and so all of them are starting activities. Activity B is the only one with activity A as its predecessor and so it is a simple event connecting activities A and B. Activity D has two predecessors - B and C and so it is a merge event connecting activities B and C to activity D. Again, activities F, H and K all have activity E as their predecessor and so the completion of activity E and the starting of activities F, H and K is a burst event. Working step by step in this manner, we build up the project network for this project. In this case it is possible to develop the project network without using any dummy activity as shown in Figure 6.8 on the next page.

6.3 TIME ANALYSIS OF NETWORKS

One of the key questions a project manager has to ask herself is "In how much time can I complete the project?" Time analysis helps us to answer such questions. Once the project network and the activity durations are known, time analysis is a relatively straight-forward exercise. In fact, at the end of time analysis we have much more insight into the project and its activities than merely the answer to the question asked earlier regarding the project completion. In this section, we shall describe the steps involved in performing a forward pass and a backward pass --- which together comprise time analysis. We shall again take the new product launch project as an example for this purpose.

6.3.1 Forward Pass

Each project has a zero date - the date when the project clock starts ticking. All references to time for any activity or event are made relative to the zero date of the project. As suggested by

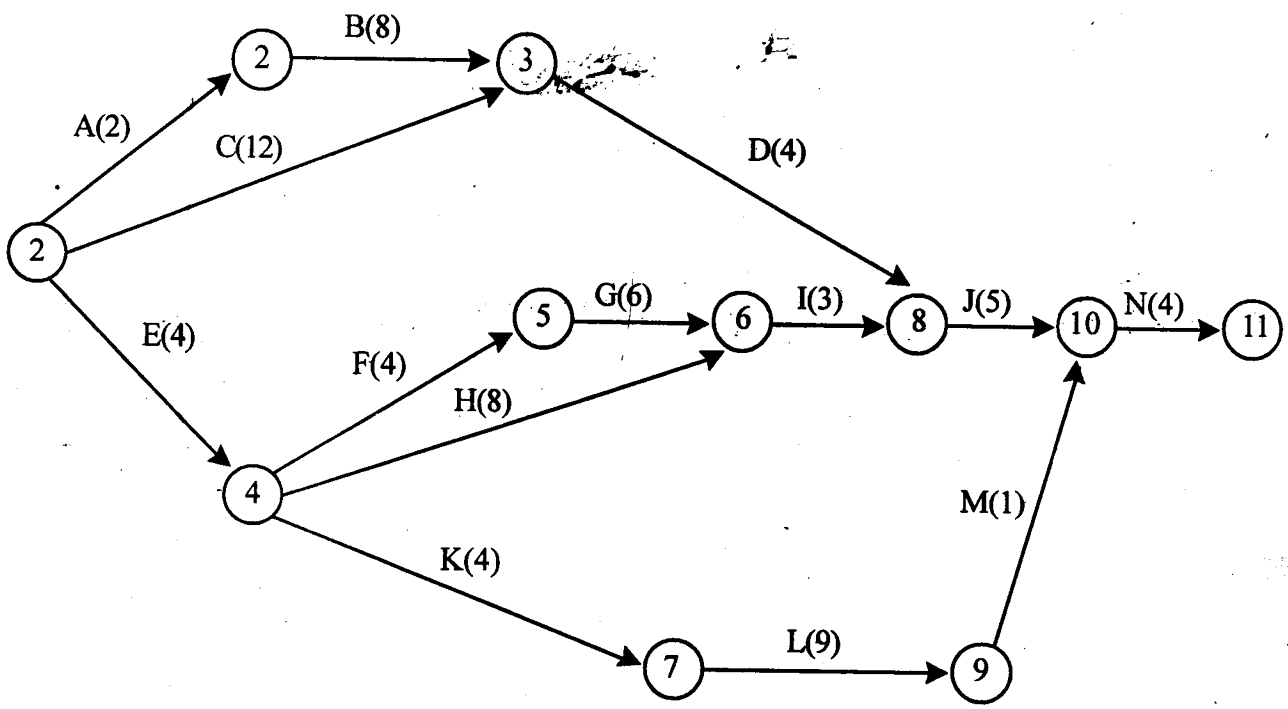

Figure 6.8 Network diagram for the New Product Launch Projects

its name itself, in forward pass we begin with the starting activity or the starting activities of the project and gradually move to their respective succeeding activities - i.e. move forward in time. Assuming our activity interdependencies and time estimates are correct, we ask two questions for each activity :

(1) What is the earliest time at which we can start the activity?

(2) What is the earliest time at which we can finish the activity?

In other words, for each activity, we shall be working out its Early Start (ES) time and its Early Finish (EF) time, relative to the zero date of the project.

For the new product launch project of Figure 6.8 we can easily see that ES for activity A is 0 as A is a starting activity with no predecessor. EF for activity A can then be computed as 2 weeks as it is not possible to finish A before this time. When we move to activity B, which is the successor to activity A, we find that ES for B is 2 weeks and its EF is 10 weeks, since activity B requires 8 weeks for its completion after its start. Similarly

ES and EF for activity C can be easily seen to be 0 and 12 weeks respectively. Now, activities B and C have a common successor - viz. activity D. Since activity D can start only after both B and C have been completed, ES for D will be 12 weeks and not 10 weeks because C cannot be finished before 12 weeks (its EF is 12 weeks). In a similar manner, this process can be continued till we have covered all the project activities.

For activity i, we can say that

$ES_i = \max\{EF_f, EF_g, EF_h, \ldots\}$

where f, g, h, ... are the immediate predecessors of activity i;

and $EF_i = ES_i + t_i$

where t_i is the estimated duration of activity i.

As the EF for activity N is 26 weeks, we can say that the earliest completion time for the new product launch project is 26 weeks. Table 6.2 lists the results of the forward pass for this project.

Table 6.2 ES and EF for all activities of New Product Launch Project.

Activity (i)	Estimated Duration (t_i) (Weeks)	ES_i	EF_i
A	2	0	2
B	8	2	10
C	12	0	12
D	4	12	16
E	4	0	4
F	4	4	8
G	6	8	14
H	8	4	12
I	3	14	17
J	5	17	22
K	4	4	8
L	9	8	17
M	1	17	18
N	4	22	26

6.3.2 Backward Pass

If the project has to be completed by a given date, then we can again ask two questions for each activity:

(1) What is the latest time by which the activity has to be finished?

(2) What is the latest time by which the activity has to start?

In other words, for each activity we can work out its Late Finish (LF) time and its Late Start (LS) time, given that the completion of the project must be achieved by a certain date.

After the LF and LS times for any activity have been worked out, the same can be done for its immediate predecessors. The process thus begins with the finishing activities of the project and continues through their predecessors till we reach the start of the project. Since we are moving backwards in time, the exercise is referred to as the backward pass.

For the new product launch project, we can conduct the backward pass assuming that the project has to be finished in 26 weeks - its earliest completion time. Thus, LF for N is 26 weeks and consequently its LS must be 22 weeks since it takes 4 weeks for N to be completed. For both activities J and M, LF is 22 weeks as N cannot start at 22 unless and until J and M are completed. The LS for J can then be worked out as (22-5) i.e. 17 weeks, where 5 weeks is the duration of J. Moving one further step backwards, the LF for D and I have to be 17 weeks. This process can be continued in a similar manner till we have covered all the project activities.

Table 6.3 LF and LS for all activities of New Product Launch Project

Activity (i)	Estimated Duration (t_i) (Weeks)	LF_i	LS_i
A	2	5	3
B	8	13	5
C	12	13	1
D	4	17	13
E	4	4	0
F	4	8	4
G	6	14	8
H	8	14	6
I	3	17	14
J	5	22	17
K	4	12	8
L	9	21	12
M	1	22	21
N	4	26	22

For activity i, we can say that

$$LF_i = \min \{ LS_j, LS_k, LK_L, ... \}$$

where j, k, l, ... are the immediate successors of activity i;

and $LS_i = LF_i - t_i$

where t_i is the estimated duration of activity i. Table 6.3 above lists the results of the backward pass for this project.

6.3.3 Total, Free and Independent Slack

If we look at the results of the forward and the backward pass together, as in Table 6.4 below, we observe some interesting facts. For activity A, although the ES is 0 weeks, its LS is 3 weeks showing that due to some reason if this activity is not started at 0 weeks but say at 1,2 or 3 weeks, even then the completion of the project is not delayed. On the other hand, for activity E both its ES and its LS is 0 weeks showing that any delay in its start will immediately affect the completion of the project. In other words, some activities have some looseness or cushion and some others do not. This property is referred to as activity slack and in this sub-section we shall try to develop a deeper understanding of the same. Activity slacks are very useful when preparing project schedules.

Table 6.4 Activity Slacks for all activities of New Product Launch Project

Activity (i)	Estimated Duration (Weeks)	ES_i	EF_i	LS_i	LF_i	Total $slack_i$	Free $Slack_i$	Independent $Slack_i$
A	2	0	2	3	5	3	0	0
B	8	2	10	5	13	3	2	0
C	12	0	12	1	13	1	0	0
D	4	12	16	13	17	1	1	0
E	4	0	4	0	4	0	0	0
F	4	4	8	4	8	0	0	0
G	6	8	14	8	14	0	0	0
H	8	4	12	6	14	2	2	2
I	3	14	17	14	17	0	0	0
J	5	17	22	17	22	0	0	0
K	4	4	8	8	12	4	0	0
L	9	8	17	12	21	4	0	0
M	1	17	18	21	22	4	4	0
N	4	22	26	22	26	0	0	0

Total Slack

Total slack for an activity is the difference between its LF and EF or that between its LS and ES. If the total slack for activity K is 4 weeks, then there can be a maximum delay of 4 weeks in the completion of activity K from its EF or a maximum delay of 4 weeks in its start from its ES, without affecting the timely completion of the project in 26 weeks.

On careful observation of Table 6.4 together with the network diagram of Figure 6.8, we find that activities K, L and M - all have a total slack of 4 weeks. However, this does not mean that each of the activities K, L and M can be delayed by 4 weeks without delaying the completion of the project. In fact, the total slack of 4 weeks is shared by activities K, L and M and that is why the total slack of an activity is sometimes referred to as its path slack as it is shared with other activities on the same path or sub-path. Another way to view total slack for an activity is that if all other activities take exactly the same time for their completion as given by their respective estimated durations, then the maximum delay possible in the execution of this activity form its estimated duration is its total slack.

The computation of total slack for activity can be done as follows:

$[\text{Total Slack}]_i = EF_i - ES_i$

Free Slack

Consider activities B, C and D in the network diagram of new product launch project shown in Figure 6.8 and its time analysis shown in Table 6.4. Activity B has a total slack of 3 weeks, whereas both C and D have a total slack of 1 week each. In other words, out of a total slack of 3 weeks for activity C, only 1 week is shared with its successor and other 2 weeks of total slack are not shared with its successor. We say that activity B has a free slack of 2 weeks, which it does not share with its successor(s). Free slack can occur for only those activities whose head events are merge events (or combined merge and burst events) and this slack is available only to the activity concerned and not to its successor. If the activity concerned cannot make use of the free slack, it is no longer available to any of its succeeding activities.

The computation of free slack can be done as shown below:

$$[\text{Free Slack}]_i = ES_j - EF_i,$$

where j is a succeeding activity of activity i.

e.g. [Free slack of activity B] = [ES of activity D] - [EF of activity B] = 12 - 10 = 2 weeks

Independent Slack

Some activities may have some slack which they do not share with any of their predecessors or any of their successors. This slack is referred to as the independent slack of the activity concerned.

If we take a closer look at activity H in the project network of Figure 6.8, we find that H does not share any of its total slack of 2 weeks with its predecessor E which does not have any total slack - nor does it share it with its successor I which again has a total slack of 0 weeks. Thus, the total slack of 2 weeks available to activity H is independent of any of its predecessor(s) or its successor(s). Independent slack can occur only for those activities where there is atleast one more sub-path between the tail event and the head event of the activity concerned. The tail event for activity H is 4 and the head event is 6 and the activity H provides a direct path between these two events. However, there is another sub-path between these two events - viz. via activities F and G and the difference between the two sub-path lengths i.e. between F and G on one side and H on the other is the independent slack of H. Activity H does not share its independent slack-with either its predecessor or its successor. Even if all its predecessors finish at their latest possible times (i.e. at their LF) and even if we want all its successors to begin at their earliest possible times (i.e. at their ES), even then activity H has its independent slack of 2 weeks.

The computation of independent slack for activity i can be done as follows :

$$[\text{Independent Slack}]_i = ES_j - LF_h - t_i$$

where j is a succeeding activity and h is a preceding activity of activity i.

e.g. [Independent Slack of activity H] = [ES of activity I] - [LF of activity E] - (Estimated duration of activity H]

= 14 - 4 - 8 = 2 weeks

6.3.4 Critical Path

If the project has to be finished at its earliest completion then some activities cannot be delayed at all. These are the activities with zero slack and they arc called critical activities as their timely completion is critically important for the timely completion of the project. From Table 6.4 we can see that activities E, F, G, I, J and N are all ~~critical~~ activities for the new product launch project. The path obtained by joining the critical activities is called the critical path of the project. Thus the path E-F-G-I-J-N is the critical path for the new product launch project as shown in Figure 6.9 below.

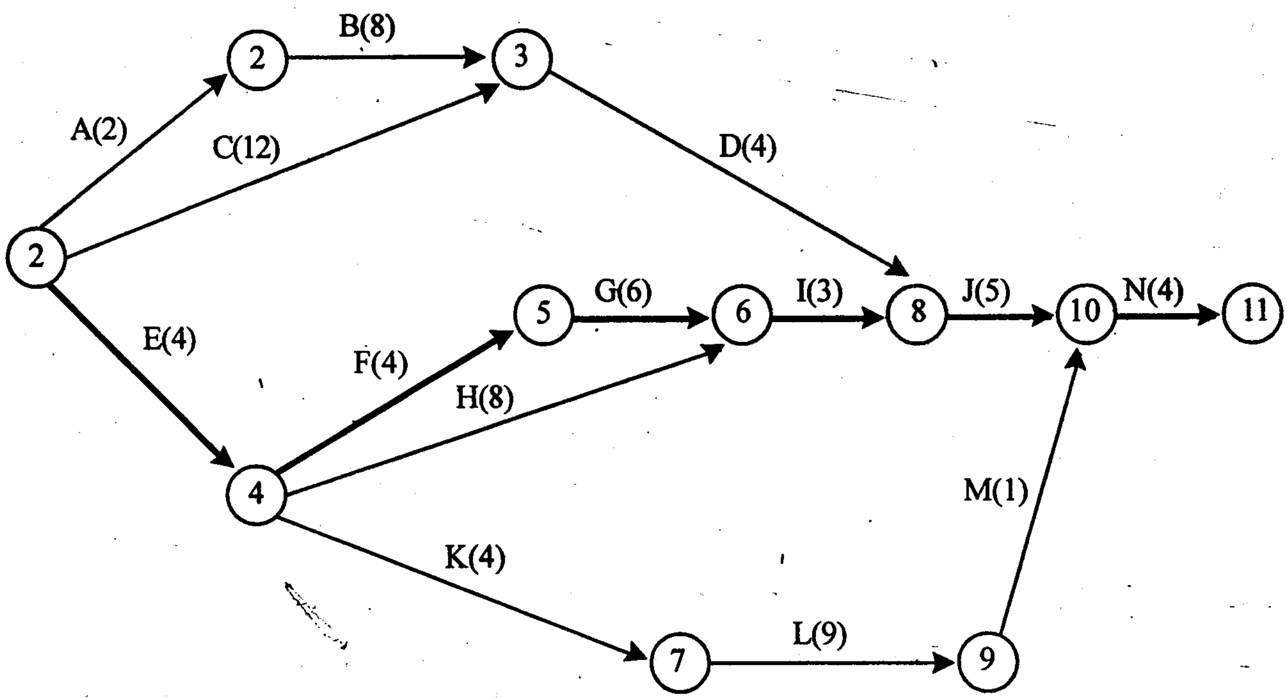

Figure 6.9: Critical Path for the New Product Launch Project

The critical path is also the longest path from the start of the project to its finish. However, a project may have more than one critical path. While a project is under execution, critical activities need to be monitored very closely as any delay in their completion is immediately reflected as a delay in the project completion.

6.3.5 Time-scaled Networks

As the network diagram are not drawn on time scale, they do not communicate much visually except showing the activity interdependencies. On the other hand, managers have always found it more convenient to interac with bar charts when it comes to monitoring and controlling the actual performance *vis-a-vis* the scheduled performance.

This anomaly can be removed by drawing time-scaled networks. In these networks, all activities are drawn horizontal arrows and the length of the arrows represent their durations. The critical path is first drawn as the longest path and then the other paths and sub-paths are drawn.

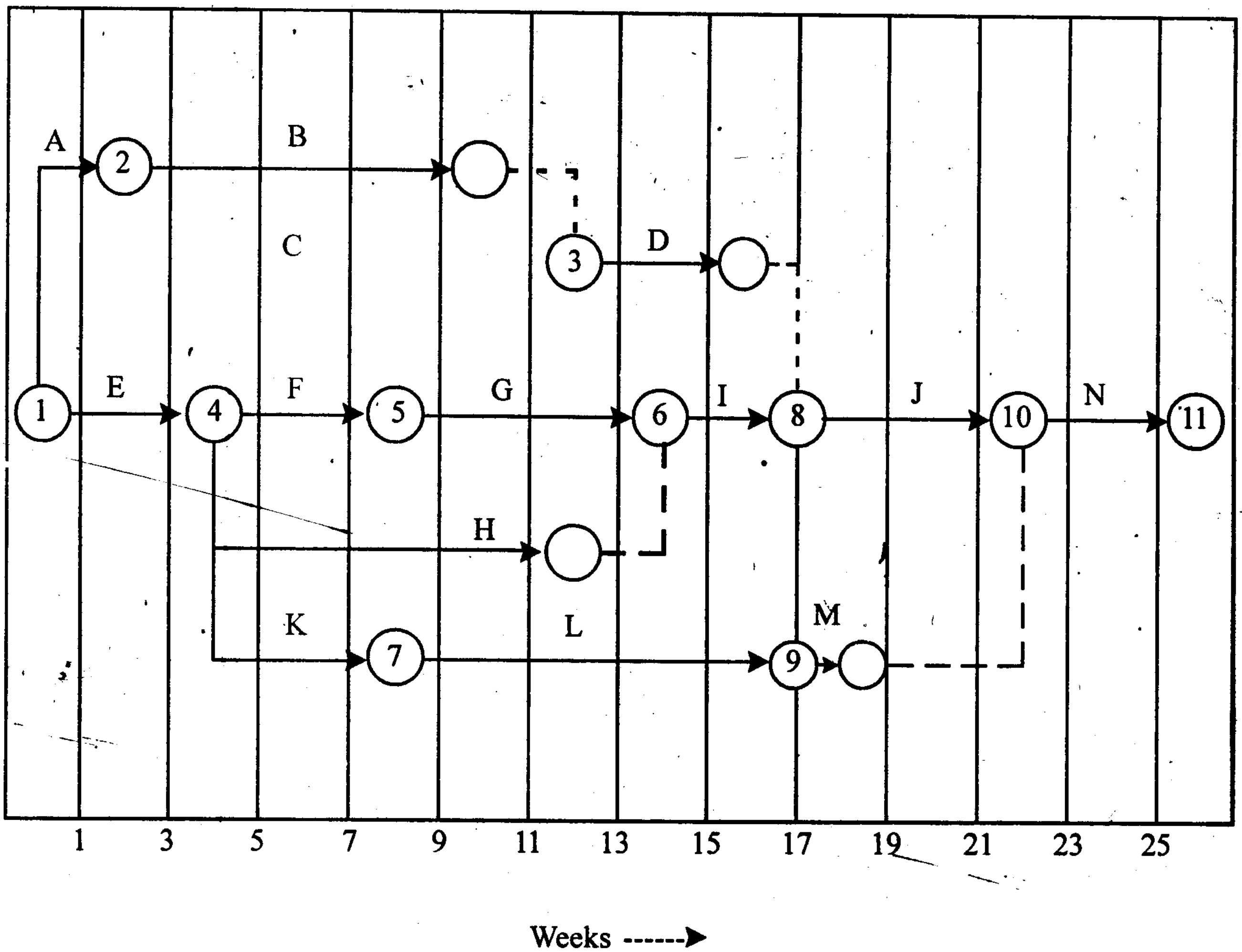

Figure 6.10 Time-scaled Network for the New Products Launch Project

The time-scaled network diagram for the new product launch project is shown in Figure 6.10 below. For easy reference, the event numbers used are exactly the same as used in Figure 6.8 earlier. The time-scaled networks show not only the activity interdependencies but also their durations and their slacks - dotted horizontal lines show the activity slacks and it is quite clear that activities K, L and M, each has a total slack of 4 weeks which they share among themselves. It is also clear that if there is any delay in the completion of activity K, the total slacks of activities L and M automatically get reduced to the same extent and hence the appropriateness of the term path slack. Free slack and independent slack for different activities can also be seen in the time-scaled network. In Figure 6.10, all the activities are shown at their respective earliest start and finish and so the ES, EF times can be seen directly. The LF and the LS times can also be interpreted from the figure.

Activity-1

What are the benefits to manager for determining the critical path of a project?

....

....

....

6.4 PROBABILISTIC DURATION

In many projects there are activities whose time durations cannot be estimated very precisely because of the high degree of uncertainty associated with them. In fact, it may become impossible to get satisfactory time estimates for some activities because of the unqertainty in their durations. In Programme Evaluation and Review Technique (PERT), one of the early network approaches to project management, a special mechanism has been developed to handle these uncertainties. We shall first develop the concepts in section 6.4.1, use the same in section 6.4.2 to answer questions regarding the probability of completion of a project in a given amount of time and finally in section 6.4.3 discuss some limitations of this approach.

6.4.1 Three Time Estimates

For some activities where the degree of uncertainty is high, it may be easier and more appropriate to get three different estimates for each activity duration rather than trying to get the best estimate. We can thus try to find an optimistic estimate, a pessimistic estimate and a most likely estimate of the activity duration.

Optimistic Time

If all conditions are favourable, then the minimum time in which an activity can be finished is called the optimistic time of the activity concerned. Of course the probability of all the conditions being favourable is very low and so the probability that the activity will actually be finished in its optimistic time is very low. In fact, we can say that it is impossible to finish an activity in less than its optimistic time.

Pessimistic Time

This is the reverse of optimistic time. If all conditions are unfavourable, then the maximum time in which an activity will be finished is called its pessimistic time. Using the same logic as earlier, we can say that the probability that an activity will require as much time as its pessimistic time for finishing is very low and that it is impossible for an activity to take longer than its pessimistic time for finishing.

Most Likely Time

In reality, some factors may be favourable and some others unfavourable for the timely finishing of an activity and so in almost all cases the actual time to finish an activity will be somewhere between the optimistic and the pessimistic times. The most likely time is that duration of the activity which has the highest probability of occurrence among all possible values of the activity duration.

Once the optimistic, pessimistic and the most likely times of an activity are estimated, one has a reasonable idea about the degree of uncertainty in the duration of that activity. It is also known empirically that the probability density function of activity duration closely follows a beta distribution as shown in Figure 6.11

below. The expected duration (or the mean duration) of the activity and its standard deviation are easily calculated as shown below:

expected duration of an activity, $$t_e = \frac{a + 4m + b}{6}$$

standard deviation of activity duration, $$\sigma = \frac{b - a}{6}$$

where, a = optimistic time of the activity

m = most likely time of the activity and

b = pessimistic time of the activity

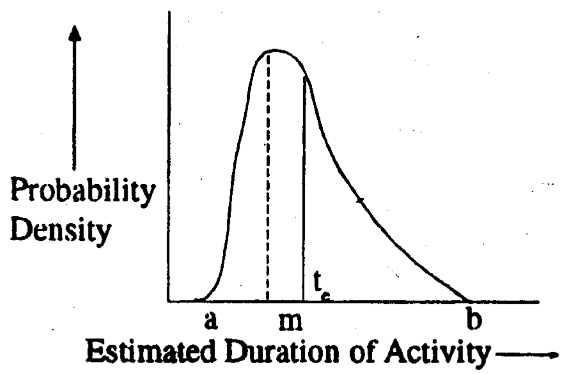

Figure 6.11 Probability Distribution of Activity Duration

Thus, it can be seen from the above expressions as well as from the Figure 6.11 above that if m is equidistant from both a and b, then the probability density function becomes a symmetrical curve with t_e = m. Also that the interval (b - a) governs the variability of the activity duration as measured by its standard deviation or its variance which is nothing-but the square of the standard deviation.

6.4.2 Probability- of Completion of a Project

A path on a project network diagram is simply a sequence of activities and the path length (or duration) is nothing but the sum of the durations of all the activities on the path. If the various activity durations are independent of each other, then the expected duration of a path is the sum of the expected durations of all the activities on the path and the variance of the path duration is the sum of the variances of all the activity durations on the path. Moreover, the general version .of the *central limit theorem* assures us that the sum of a large number of independent random variables will be approximately normally distributed, regardless of the distribution of the individual random variables. We can, therefore, not only find the expected duration of any path but also its variance and the shape of the distribution.

Earlier, we had defined the longest path in a project network diagram as the critical path. However, if the individual activity durations are uncertain, the longest path in the network may also not be known with certainty. If we now define the path with the longest expected duration as the critical path, we can find the expected time of completion of a project as well as its variance. Also, we can find the probability that the critical path will be completed within a given duration and this may be taken as the probability that the project itself will be completed within the specified duration. We now propose to show how all this can be done by taking the new product launch project as our example.

Table 6.5 Three time estimates of Activity durations for New Product Launch Project

Activity Code	Activity Description	Immediate Predecessor Activity	Estimated durtion (Weeks)				Standrd devation of duration (σ)
			Optimistic (a)	Most likely (m)	Pessimistic (b)	Expected duration (Weeks) (t_e)	
A	Finalise package design	-	1	2	3	2	0.333
B	Set up packaging equipment and procure raw materials	A	6	8	10	8	0.667
C	Produce the first batch	-	9	11	19	12	1.667
D	Package the first batch	B,C	2	4	6	4	0.667
E	Set up the sales office	-	3	3.5	7	4	0.667
F	Recruit salesmen	E	3.5	4	4.5	4	0.167
G	Train salesman	F	6	6	6	6	0
H	Select retailers	E	2	9	10	8	1.333
I	Sell to retailers	G,H	2	3		3	0.667
J	Despatch to retailers	D,I	4	5	6	5	0.667
K	Select advertising gency	E	3	4	5	4	0.333
L	Plan advertisement campaign	K	8	9	10	9	0.333
M	Release pre-launch advts.	L	1	1	1	1	0
N	Conduct advt. campaign	J,M	3	4	5	4	0.333

Table 6.5 above shows the three time estimates for each activity of the new product launch project. As can be seen from the table, some activities like G and M have no uncertainty (e.g. for activity G, optimistic, most likely and pessimistic times are all estimated as 6 weeks), whereas some other like activity C have a relatively high degree of uncertainty in their activity durations (this can be seen from the low optimistic time of 9 weeks and the high pessimistic time of 19 weeks for activity C), We can also see that some activities like B have a longer left tail, whereas some others like E have a longer right tail and many other activities like A, D, F etc.

have both their tails of equal length. The last two columns in Table 6.5 above show the computed values of the expected duration and the standard deviation of each activity. Figure 6.12 below shows the network diagram of the new product launch project where the expected value and the standard deviation of each activity duration is shown by the side of the respective activity code. The path with the longest expected duration is also identified as the critical path on this network diagram. As the expected duration of each activity has remained unchanged as compared to the earlier estimated single time estimate for each activity, the critical path is also unchanged.

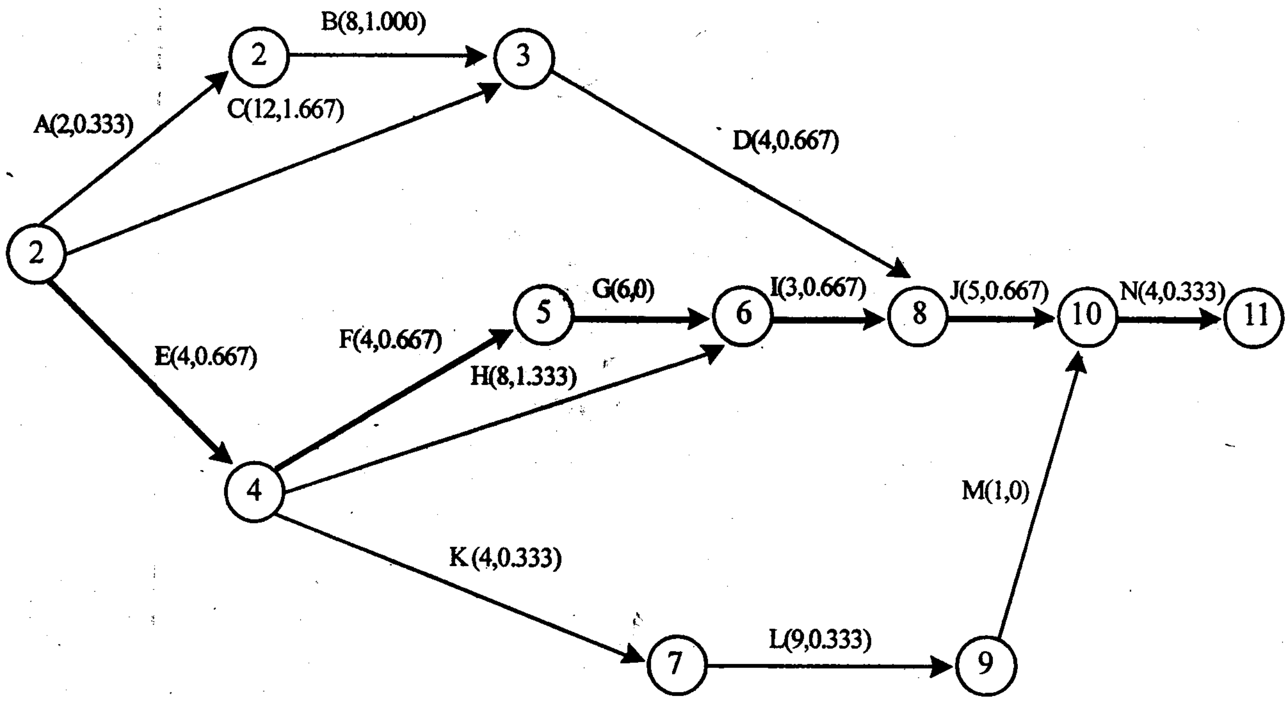

Figure 6.12 Critical Path for the New Product Launch Project with Expected Value and Standard Deviation of each Activity Duration

The expected duration of the critical path,

$$
\begin{aligned}
\mu &= \sum_{i=1}^{n} t_e \\
&= [t_e \text{ of } E + t_e \text{ of } F + t_e \text{ of } G + t_e \text{ of } I + t_e \text{ of } J + t_e \text{ of } N] \\
&= [4 + 4 + 6 + 3 + 5 + 4] \\
&= 26 \text{ weeks}
\end{aligned}
$$

The variance of duration of the critical path,

$$\sigma^2 = \sum_{i=1}^{n} \sigma_i^2$$

$$= [\sigma^2 \text{ of } E + \sigma^2 \text{ of } F + \sigma^2 \text{ of } G + \sigma^2 \text{ of } H + \sigma^2 \text{ of } I + \sigma^2 \text{ of } J + \sigma^2 \text{ of } N]$$

$$= [(0.667)^2 + (0.167)^2 + (0)^2 + (0.667)^2 + (0.667)^2 + (0.333)^2]$$

$$= 1.472 \text{ weeks}^2$$

Let t be the length of the critical path EFGIJN for this project. So, we know that t has a normal distribution with mean [4. = 26 weeks and variance a^2 = 1.472 weeks. Obviously, the probability that the critical path will be completed in 26 weeks is 0.50. As the critical path is the path with the longest expected duration, this may be taken as the probability of completing the project, in 26 weeks as well. What is the probability that the project will be completed in 28 weeks?

$$\Pr[t \le 28] = \Pr\left[\frac{t-\mu}{\sigma} \le \frac{28-26}{\sqrt{1.472}}\right]$$

$$= \Pr\left[Z \le \frac{2}{1.213}\right]$$

$$= \Pr[z \le 1.65]$$
$$= 0.9505$$

[From Tables of Area under the Standard Normal Curve]

This is shown in Figure 6.13 below as the shaded area under the standard normal curve. We can therefore say that the probability of completing the project in 28 weeks is 95.05%.

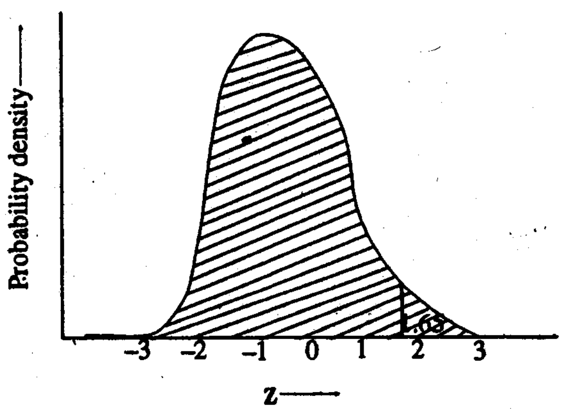

Figure 6.13 Area under the Standard No. mal Curve for $z \le 1.65$

6.4.3 Interpreting the Probability of Completion of a Project

We must keep in mind that what we computed as the probability of completion of the project is actually the probability of completing the critical path in the given time and the two may not be the same. In case there is another path which is near critical in terms of the expected duration but with a higher variability, then the probability of completing that near-critical path may be smaller than the probability of completing the critical path. It may be better to demonstrate this with an example and for this we go back to Figure 6.12.. The path CDJN has an expected duration of 25 weeks and a much higher variability than that of the critical path EFGIJN. For the near-critical path CDJN, we can compute the probability of completion in 28 weeks following the same steps as used earlier.

The expected duration of the critical path, CDJN,

$$\mu = \sum_{i=1}^{n} t_{ei}$$

$$= [t_e \text{ of } C + t_e \text{ of } D + t_e \text{ of } J + t_e \text{ of } N]$$

$$= [12 + 4 + 5 + 4]$$

$$= 25 \text{ weeks}$$

The variance of duration of the path CDJN,

$$\sigma^2 = \sum_{i=1}^{n} \sigma_i^2$$

$$= [\sigma^2 \text{ of } C + \sigma^2 \text{ of } D + \sigma^2 \text{ of } J + \sigma^2 \text{ of } N]$$

$$= [(1.667)^2 + (0.667)^2 + (0.667)^2 + (0.333)^2]$$

$$= 3.778 \text{ weeks}^2$$

Again, if t be the length of the path CDJN, then

$$\Pr[t \leq 28] = \Pr\left[\frac{t-\mu}{\sigma} \leq \frac{28-26}{\sqrt{3.778}}\right]$$

$$= \Pr\left[Z \leq \frac{3}{1.944}\right]$$

$$= \Pr[z \leq 1.54]$$
$$= 0.9382$$

[From Tables of Area under the Standard Normal curve]

We therefore conclude that the probability of completing the project in 28 weeks cannot exceed 93.82% which is lower than 95.05% which was obtained by considering the critical path EFGIJN.

In such cases the Project Manager may get false assurance of a relatively higher probability of completion of a project than is actually the case. In fact, one way of getting a valid probability distribution of project completion time is to perform a computer simulation of the project. In such a simulation, the project is run many times - say 100 times or 1000 times on the computer and by studying the project completion times in these runs, a probability distribution can be constructed. For each run, the computer first picks up one value randomly for each activity -representing the duration of the activity. These values are picked up such that for each activity, these values follow the probability distribution of the activity duration as known from its optimistic, most likely and pessimistic times. For each set of such values, (i.e. each run), the project is analysed to find the project completion time as well as the critical activities.

The distribution of project completion time can be used directly to answer questions like, "what is the probability of completing the project in n weeks?" One can also find out how frequently a particular activity became critical and interpret the same as the probability that the particular activity is critical. This is referred to as the criticality index of the activity when activity durations are uncertain and is a number between 0 and 1. For example, in the new product launch project of Figure 6.12, the criticality index of activity N would be 1.0 since activity N would always be critical, the criticality index of activity J is expected to be very high (close to 1.0) as activity J would be critical as long as any one of the paths ABDJN, CDJN, EFGIJN and EHIJN is critical, whereas the criticality index of activity M is expected to be low (close to 0.0) as activity M would be critical only when path EKLMN happens to be the longest path in the project network. In this analysis, the focus is on critical activities (more specifically the criticality index of activities) rather than on critical paths.

Activity 2

What is the probability of achieving the project duration computed on the basis of average or mean values of activity duration? How can we enhance the probability of achieving project completion within the deadlines agreed?

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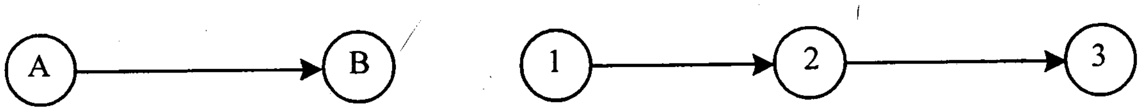
6.5 OTHER TYPES OF DIAGRAMS

We have so far been using Activities-On-Arrows (AOA) diagrams to represent activity interdependencies. Although these are still the most commonly used network diagrams, some other network diagrams are also used. In this section we present two of these - the first one is an Activity-On-Node (AON) diagram and the other one is the Precedence Network (PN) diagram which is an extension of both AOA and AON diagrams.

6.5.1 AON Diagrams

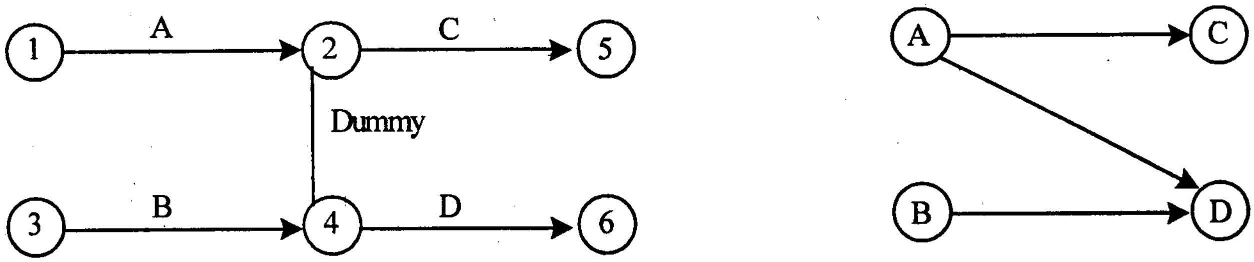
AON diagrams are similar to the AOA diagrams or the arrow diagrams that we introduced in section 6.2 earlier. In these diagrams also, we use circles and arrows, but the circles (or nodes) now represent activities. The arrows do not represent any entity but only show the precedence relationships between the nodes. The arrow head points to the succeeding activity. The precedence relationship "activity B can start only after activity A has been completed", will have an AON diagram as shown in Figure 6.14 (a) below. The Corresponding AOA diagram for the same precedence relationship is also shown as Figure 6.14(b).



a) AON Diagram b) AOA Diagram

Figure 6.14 Activity B can start only after activity A has been completed

In an AON diagram, each arrow represents a precedence relationship and so the number of arrows is simply the number of precedence relationship in the project. Also, in this case there is no need to use dummy activities as any complex set of precedence relationships can be explicitly represented without using any dummy.



(a) Dummy activity in needed for explicit representation of interdependencies of activities C and D in AOA diagram

(b) The corresponding AON diagram

Figure 6.15 No need for Dummy activities in AON Diagrams

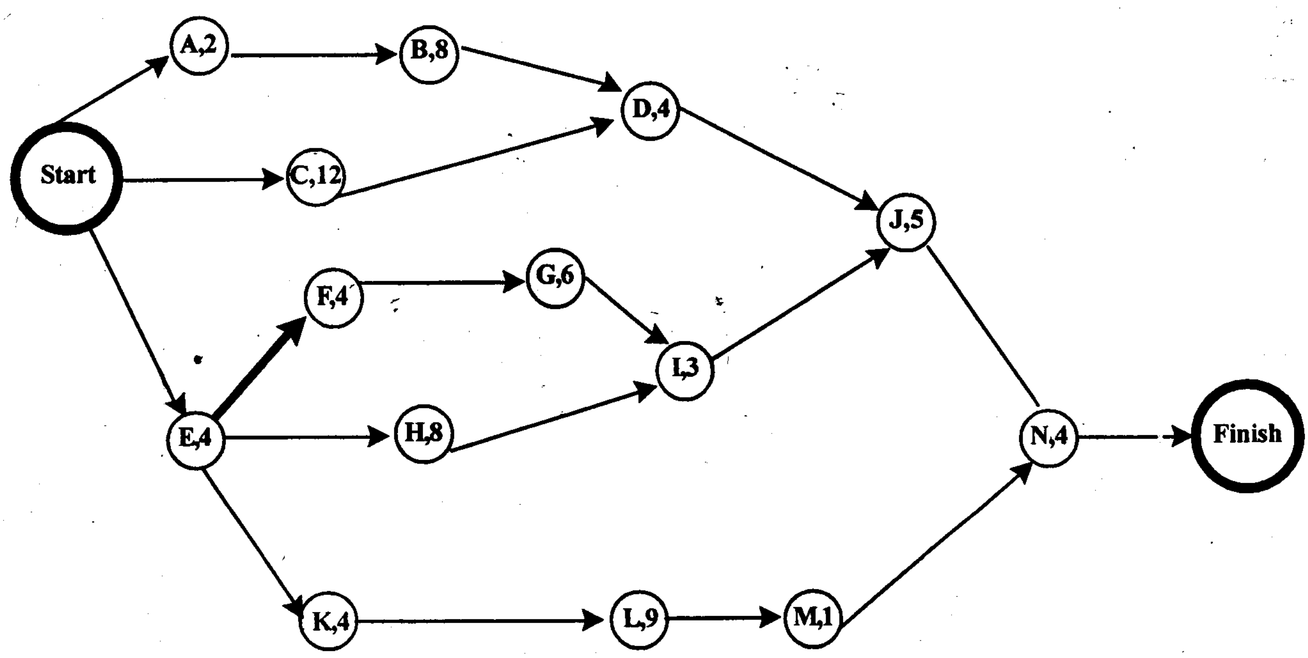


Figure 6.16 AON Diagram of the New Product Launch Project with the data given in Table 6.1

For example, the situation described earlier in Figure 6.6 to justify the use of dummy activities in AOA diagrams (and shown again as Figure 6.15a) can be easily represented by its AON diagram shown as Figure 6.15b above:

It should also be noted that there is no concept of an event in an AON diagram. However, if required, special events or milestones can also be represented as additional nodes in AON diagrams. However, they are not used as extensively as the AOA diagrams. This is largely due to historical reasons as PERT was based on an event-oriented approach. AON diagrams are now getting popular as some popular Project Management software use this form of diagramming as also because the Precedence Network (PN) diagrams, which are more versatile and which we describe in the next section, are based on AON diagrams.

The AON diagrams for the new product launch project, based on the data given in Table 6.1, is shown in Figure 6.16 above. As is generally done in AON diagrams, we have also added two fictitious nodes called Start and Finish in our diagram to identify the starting and the finishing activities clearly.

6.5.2 Precedence Network Diagrams

Both AOA and AON diagrams can represent only one type of interdependency between two activities - that of complete precedence. The successor activity can start only after the predecessor activity is completed. However, there may be partial precedence between two activities in the sense that one of them can start only after the other one has started or can be finished only after the other one has finished and so on. Precedence Networking (PN) or Precedence Diagramming Method (PDM) allows explicit representation of four types of precedence relationships and these are shown in Figure 6.17 below. In these diagrams, activities are represented as square or rectangular nodes. This allows easier depiction of the "start" (the left side of the rectangle) or the "finish" (the right side of the rectangle) of activities. The flow of time is again assumed to be from left to right. Arrows represent precedence relationships and they also have a symbolic representation with a precedence symbol (e.g. FS) and a lead-lag factor (e.g. n weeks).

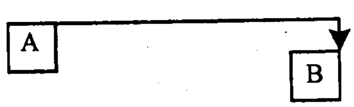
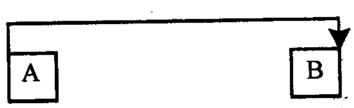
Precedence Relationship	Symbolic Representation	Description
	FS = n	Finish to Start: Activity B cannot start until n weeks after activity A is finished.
	SS = n	Start to Start: Activity B cannot start until n weeks after activity A is started.
	FF = n	Finish to Finish: Activity B cannot finish until n weeks after activity A is finished.
	SF = n	Start to Finish : Activity B cannot finish until n weeks after activity A is started.

Figure 6.17 Four types of Precedence Relationships in PN Diagrams

Table 6.6 Details of Activities for Drawing Precedence Network of New Product Launch Project

Activity Code	Activity Description	Precedence Relationship (Lead Lag Factor)	Estimated Duration (Weeks)
A	Finalise package design	-	2
B	Set up packging equipment nd procure raw materials	$F_AS_B = 0$	8
C	Produce the first batch	-	12
D	Package the first batch	$F_BS_D=3$ $F_CS_D=1$	4
E	Set up the sales office	-	4
F	Recruit slesmen	$S_ES_F=2$	4
G	Train salesmen	$F_FS_G=1$	6
H	Select retailers	$F_ES_H=0$	8
I	Sell to retailers	$F_GS_I=1$ $F_HS_I=1$	3
J	Despatch to retailers	$F_DS_j=0$ $F_iS_j=0$	5
K	Select advertising gency	$F_ES_K=0$	4
L	Plan advertisement campaign	$S_KF_L=12$	9
M	Relese pre-launch advertisements	$F_LS_M=0$ $S_JS_M=3$	1
N	Conduct advertisement campaign	$F_MS_N=0$	4

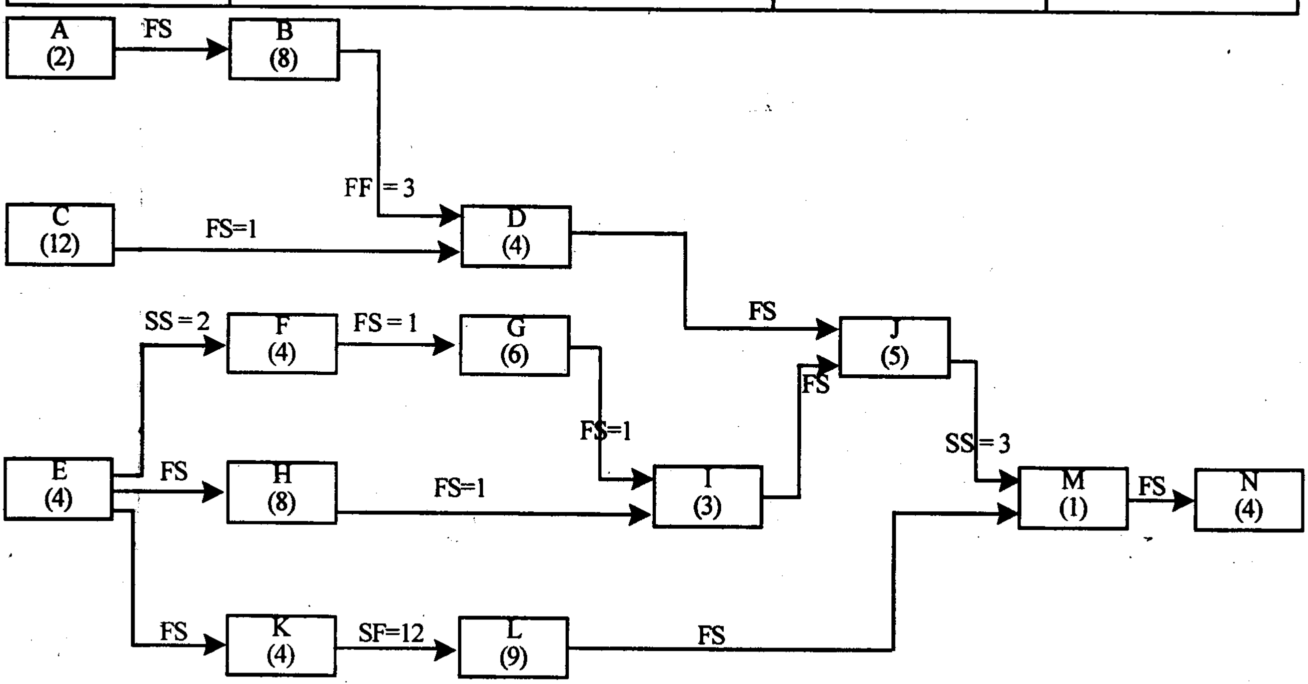


Figure 6.18 Precedence Network (PN) Diagram for the New Product Launch Project

FS Relationship

The first precedence relationship is an FS relationship. $F_G S_I = 1$ means that there is a finish to start relationship between the activities G and I with a lead-lag factor of 1. More specifically, activity I can start only 1 week after the finish of activity G and not before that. FS relationships are very common and are the only relationships which can be shown on AOA or AON diagrams (with a lead-lag factor of zero).

SS Relationship

This is a start-to-start relationship. $S_E S_F = 2$ would mean that activity F can start only 2 weeks alter the start of activity E and not before that. After activity F has started, it is possible for both activities E and F to continue simultaneously till one of them is finished.

FF Relationship

Two activities may have an FF relationship if one of them cannot be finished before the finish of the other. For example, $F_B F_D = 3$ would imply that activity D can finish only 3 weeks after the finish of activity B and not before that.

SF Relationship

The fourth and the least common precedence relationship between two activities is the start-to-finish relationships. $S_A F_B = 7$ would mean that activity B can finish only 7 weeks after the start of activity A and not before that.

It is perhaps possible to split some activities in two or more parts to represent some of these precedence relationships or introduce fictitious activities to represent lead-lad factors, but these are only crude approximations and not complete representations and may result in undesirable interruptions while working on some activities. PN algorithms are available to compute the ES and EF times of activities in the forward' pass and LS and LF times in the backward pass and thus to compute activity slacks and identify critical paths. However, because of the variety of precedence relationships, the interpretation of slack and critical path is not as straight forward as we developed in the AOA (or AON) diagrams and has to be done with great care.

If we go back to the new product launch project as an example and look at the data of Table 6.1, we may find that some of the precedence relationships may not have been of the type FS = 0. By questioning the Project Manager about each precedence relationship, suppose we find the precedence relationships as listed in Table 6.6 above. Activity B is related to activity A through the relationship $F_A S_B = 0$, which is the same as listed in Table 6.1 earlier while drawing the AOA diagram. On the other hand, earlier we had stated that activity D follows activities B and C. On closer scrutiny, the Project Manager finds that there has to be a minimum gap of 1 week between the finish of C (produce the first batch) and the start of D (package the first batch). This_is represented as $F_c S_D = 1$. Similarly, activity D can start before activity B (set up packaging equipment and procure raw materials) is completely finished - as soon as some raw materials are procured, but activity D can be finished only 3 weeks after the finish of activity B and not before that. This can now be represented as $F_B F_D = 3$. We can also agree with the Project Manager's view that the recruitment of salesman (activity F) may not wait till the setting up of the sales office (activity E) is finished but that we can start F 2 weeks after the start of E. This has been shown as $S_E S_F = 2$.

Figure 6.18 above shows the precedence network diagram (PN diagram) of the new product launch project based on the information contained in Table 6.6. Since the symbolic representations are associated with the arrows, no subscripts are used to identify the activities associated with a preceding relationship. Also, lead lag factors of zero are not mentioned separately and are implicit.

Activity 3

By and large, we launch the project based on Earliest Start Time (EST) schedule for all activities. Is there any justification?

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6.6 PROJECT SCHEDULING

In this unit, we have so far looked at time analysis of projects and worked out Early Start, Early Finish and Late Start, Late Finish times of different activities. In activities with a high degree of uncertainty in their durations, we have also seen the role of three time estimates - which allow us to compute the probability of completion of the project in a given amount of time. However, we still have not discussed how to obtain a project schedule in terms of setting dates for the start and finish of each activity and each milestone. In this section we propose to discuss project scheduling and while doing so - to introduce concepts of project resources and project costs.

6.6.1 ES and LS Schedules as Limits

Assuming that the activity durations estimated are correct, we can view the two schedules obtained - viz. the ES schedule and the LS schedule as the limits between which the actual schedule must lie - else the project completion will get delayed. This is because the ES time of an activity is the earliest time at which the activity can begin or the earliest time at which all its predecessors can be completed and so no feasible schedule can have a planned start time for an activity earlier than its ES time. Similarly, the LS time for an activity is the latest time by which the activity must start if the project has to be completed by a given date and if the planned start time is later than its LS time then again it will lead to an infeasible-schedule since the project cannot be completed by the given date. For the critical activities-the ES and the LS times are the same and for these activities their planned start .should also be the same as their ES or LS times. On the other hand, for those activities which have a slack, the LS times are later than their ES times and any feasible schedule must have the planned start times not earlier; than the respective ES and not later than the LS times. While deciding the planned tart time some other considerations like resource availability, unevenness of employment of workers, cost optimisation, etc. also need to be looked into. It may also be true that because of these considerations the planned start of some activity is scheduled after its LS time.

6.6.2 Resource Scheduling

Earlier in section 6.2.1 we defined an activity as a homogeneous element of work consuming some resources and requiring some definite amount of time for-its completion. Each activity will require some resources-which could be manpower, equipment, money, space or any other thing which is available in a limited quantity.

The cost incurred on an activity is largely due to the cost of the resources consumed and a better resource scheduling may be able to lower project costs or make the project more cost-effective.

Time analysis by itself may not produce a feasible schedule because resource availability constraints have not been considered. If we review the process of project planning discussed so far we find that we started with breaking up the project into its constituent activities, listed the activity interdependencies based on technological constraints, management policy constraints and legal constraints and finally estimated the activity durations based on an implicit assumption about some "normal" amount of resources available. with the data so generated proceeded to carry out time analysis. Stated differently we have not yet ensured that the resources required for an activity are actually available in the period when the activity is scheduled. For example, if activities A and B both require a crew of a mechanic and a helper and we have only one such crew assigned to the project, then A and B cannot be done simultaneously, even though the ES or the LS schedule calls for their parallel execution. This is because resource availability constraints have not yet been considered. If, however, the schedule is changed and the parallel activities A and B are made sequential - i.e. one after the other - then it becomes a feasible schedule although the project duration may get extended due to this change. This is the heart of resource Scheduling..

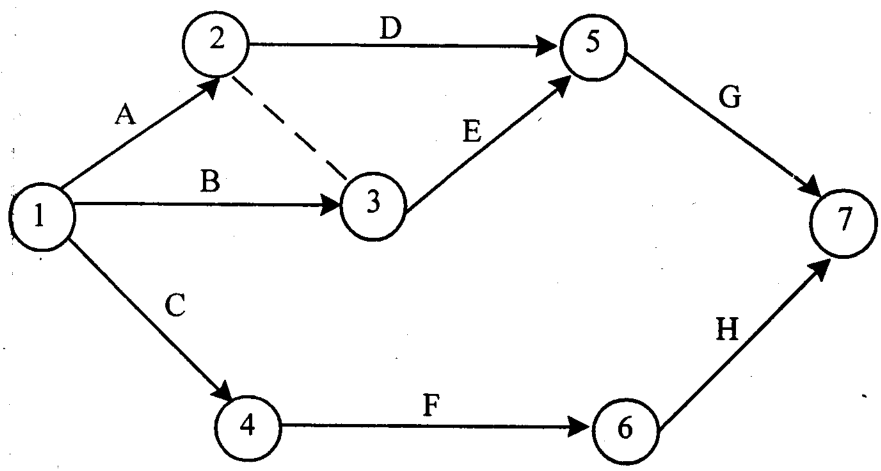
In resource scheduling, we first identify .resource conflicts - i.e. periods where the current schedule requires more resources than are available and then we try to remove the resource conflicts to get a feasible schedule. However, the problem is not as simple as it sounds here because the number of resources used-in a project is very large and any of these could give rise to a resource conflict. Secondly, even if a resource conflict is identified, its removal may have many consequences: it may increase the project duration, it may lead to uneven resource use rate and it may affect the resource utilisation. This, in turn, might complicate the process of removal of resource conflict because the alternative which minimises the increase in project duration may make the resource use more uneven and so on.

While manpower is usually a resource for most activities - in a large number of projects there are various skills of manpower required and each skill and each level of personnel is a separate resource. Not only that, when these people are grouped into sections and departments - each skill or level of workman in each section is a separate resource. It is therefore not unusual to have 100 or 200 different resources in large projects and a feasible schedule cannot have a resource conflict for any of its resources. Further, a resource may not be required for the complete activity duration (e.g. the activity "build a wall" may be estimated to take 3 weeks whereas the resource "painter" may be required only for the last three days of its estimated duration) or may not-be.required for the complete day (e.g. 8 working hours) even for those days when it may be required. There may be alternate resources which could be used - perhaps at a higher cost - e.g. an Electrician Grade I may also do the work of an Electrician Grade II but not vice versa. All these factors make the resolution of resource conflicts a very difficult problem and that is why computers are very helpful at this stage. There are very good software packages available in the market which carry out resource scheduling using their own individual procedures. Basically, these try to remove resource conflicts by first trying to change the use of the resource within the duration of the activity, then delaying some activities having a slack and finally by delaying the start of critical activities.

6.6.3 An Example

We shall try to understand this process by taking a small project whose details are shown in Figure 6.19. Here we make a simplifying assumption that the resource requirement is uniform and for the complete duration of the activity.

We can easily carrying out a time analysis of this project and identify AEG as the critical path having a length of 13 days. If each activity is scheduled at its earliest, we can get the ES schedule which is shown in the form of a time-scaled network in Figure 6.20(a). By summing up the number of men required to perform each activity, the resource requirement for the whole project can be easily computed. Figure 6.20(b) shows the resource requirement for the ES schedule of this project. For example, on day 1 - activities A, B and C are scheduled and this



Activity	A	B	C	D	E	F	G	H
Duration (Days)	5	2	4	3	4	2	4	2
No. of men Required	6	2	2	5	3	3	4	3

Fig. 6.19 A small project with eight activities, their Interdependencies estimated duration and resource requirements.

would require (6+2+2=) 10 men. We find that the peak resource requirement is of 11 men required on days 6,7 and 8. However, if only 8 men are available on this project, then this schedule is not feasible - for feasibility, the resource requirement on any day cannot exceed 8 men.

and Scheduling Suppose we use the following heuristic to remove resource conflicts:

Step 1: On the project schedule, locate the first period with a resource conflict as one move forward in time from the start of the project to its finish. If there is no such period, stop as the schedule is resource feasible - else go to step 2.

Step 2: Among all the activities scheduled to start at this period, pick up the one with the largest total slack (where Total Slack = Late Start - Planned Start for the activity) and delay its start. This activity cannot be performed alongwith the other conflicting activities - i.e. the remaining activities scheduled to start at this period and the ones continuing from a previous period. Schedule the start of this

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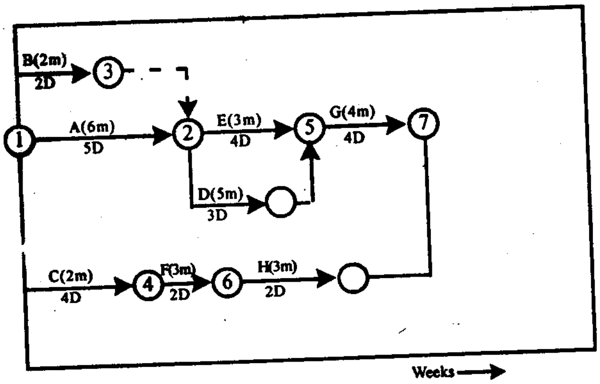
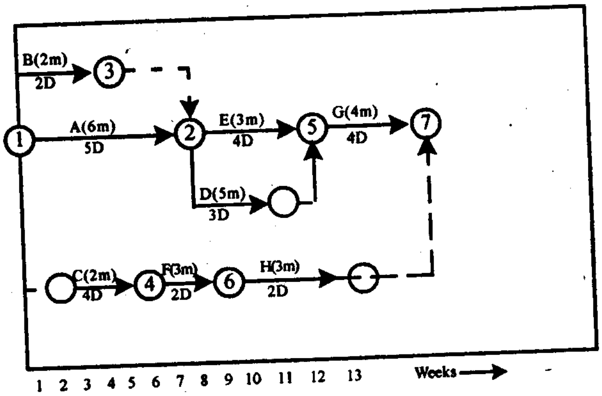
activity immediately after the first of the other conflicting activities is finished.

Step 3 : If there is no resource conflict in this period go to step 1, else go to step 2.

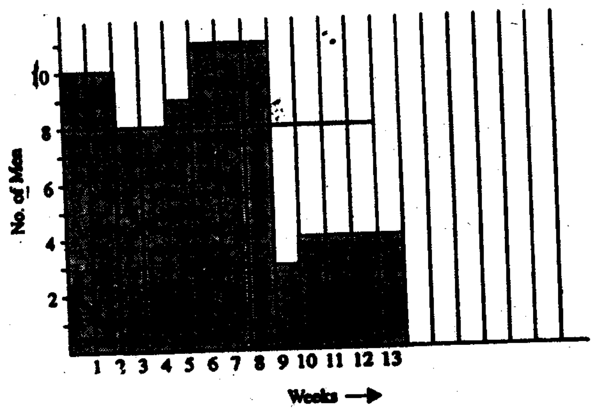
Let us apply this heuristic to the small project of Figure 6.19. We begin with thic ES schedule and the corresponding resource profile of Figure 6.20. At step 1, we find that day 1 is the first period with a resource conflict since the schedule requires 10 persons on that day whereas we have only 8. At step 2, we find from Figure 6.20(a) that three activities viz. A, B and C are scheduled to start on that day. Their total slacks are 0, 3 and 5 days respectively and so we pick up activity C and delay its start. The other conflicting activities are A and B and the first of these to get finished is B. So, we schedule the start of C immediately after the start of B. This schedule is shown in Figure 6.21. As there is no resource conflict on day 1 we go to step 1. The first period with a resource conflict is now day 6 and D and E are two activities scheduled to start on this day. As D. has a total slack of 1 day whereas E does not have any slack, we pick up D at step 2 and delay its start. The other conflicting activities are E - the other activity scheduled to start at this period - and C - continuing from a pervious period. Of these C is the one scheduled to finish first and so we schedule the start of D immediately after the finish of C. This schedule is shown in Figure 6.22. As there is no resource conflict on day 6, we go to step 1.



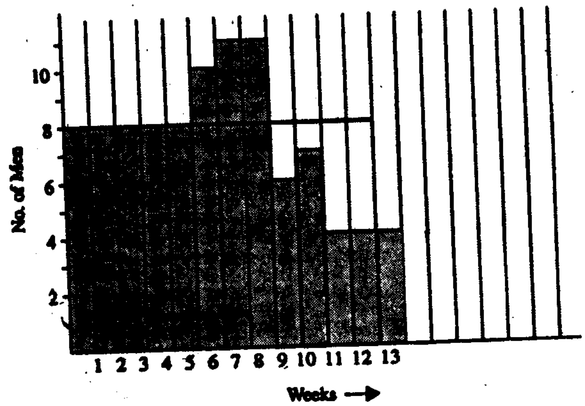
(a) ES Schedule for the project Figure 6.19



(a) Schedule with delayed start of C by 2 days

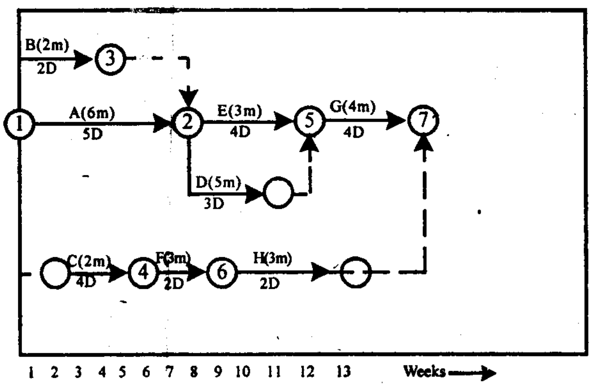


(b) Corresponding Resource Profile
Figure 6.20

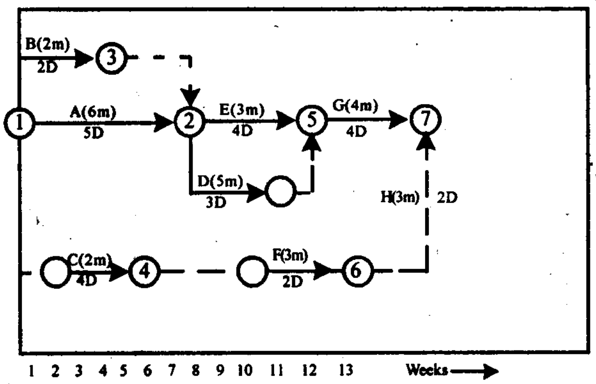


(b) Corresponding Resource Profile
Figure 6.21

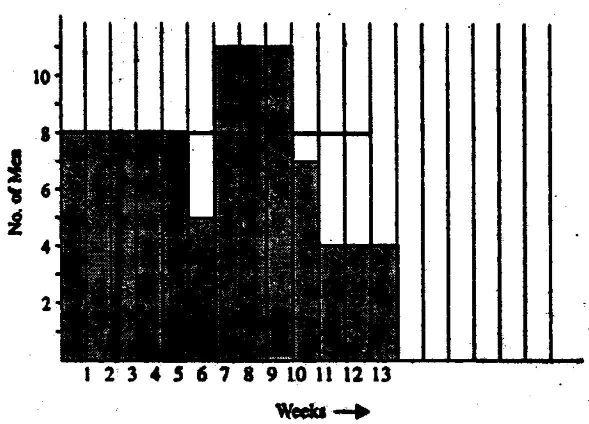
Day 7 is now the first period with a resource conflict and between D and F which are scheduled to start on this day, we delay the start of F as it has a total slack of 3 days whereas D has zero slack. As both the other conflicting activities D and E are scheduled to finish on day 9. We schedule the start of activity F immediately after this - i.e. on day 10. This schedule is shown in Figure 6.23. As there is no resource conflict on day 7, we go back to step 1 and as there is no resource conflict in any period, we stop as we have reached a resource feasible schedule. The heuristic seems to have worked very well since we could get a resource feasible schedule without any delay in the project completion from its earliest completion of 13 days.



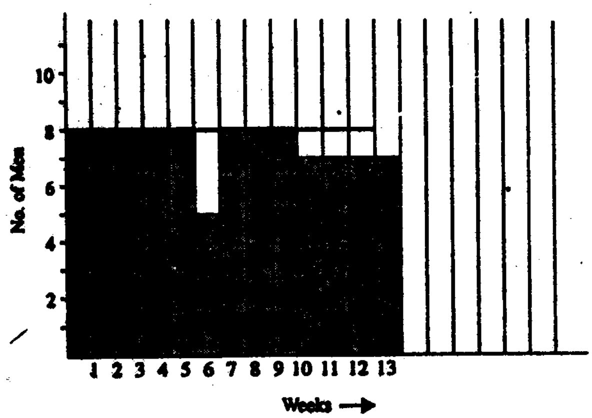
(a) Schedule with delayed start of activity D



(a) Schedule with start of F and H delayed



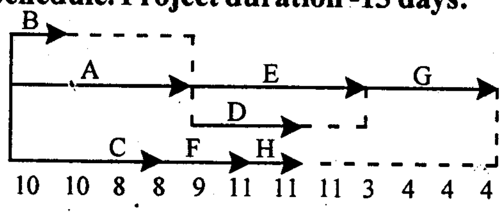
(b) Corresponding Resource Profile
Figure 6.22



(b) Corresponding Resource Profile
Figure 6.23

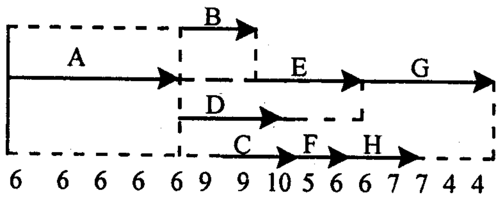
Now suppose that we had only six men available to work on this project. Figure 6.24(a) through (e) show the schedule as it evolves on application of the heuristic. We finally get a resource feasible schedule which shows that the project can be completed in 22 days with not more than men required on any day. Obviously, this is not the best as Figure 6.25 gives us a resource feasible schedule with 20 days as the project duration. The same heuristic which worked well with a resource constraint of 8 men does not work well when the constraint is 6 men. This is a general problem with all resource scheduling heuristics.

6(a) ES Schedule. Project duration -13 days:



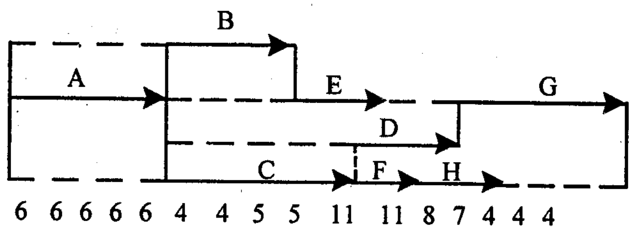
(no. of men reqd. on diff. days)

(b) Delay C by 2 days, B by 5 days and C by 3 Days, Project duration - 15 days:



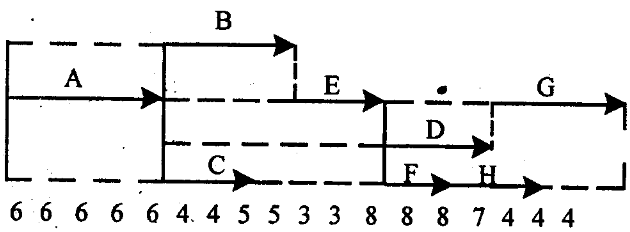
(no. of men reqd. on diff. days)

(C) Delay D by 2 days and again D by 2 days. Project Duration - 16 days:



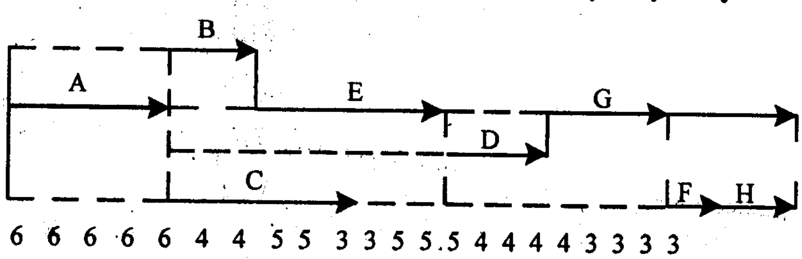
(no. of men reqd. on diff. days)

(d) Delay F by 2 days and D by 2 days. Project duration - 18 days:



(no. of men reqd. on diff. days)

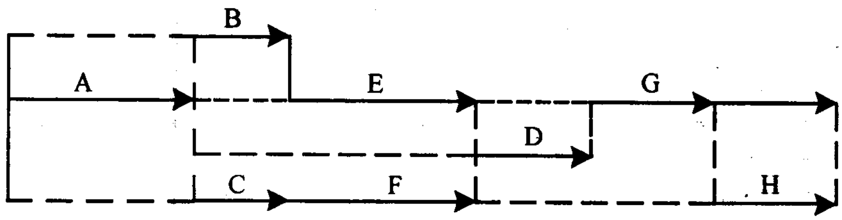
(e) Delay F by 3 days and again F by 4 days. Project duration - 22 days:



(no. of men reqd.)

Figure 6.24 Resource scheduling with only 6 men available

Imagine the complexities involved in a large project with hundreds of ,activities and scores of resources. The resource scheduling in such cases can be handled efficiently, only by computers. However, the heuristics or rules used by different project management software at proprietary and also none of them claim to give the optimal solution - but they do give



(no. of men reqd.)

Figure 6.25: Resource feasible schedule with 6 men and project duration of 20 days

good schedules. They all try to minimise the delay in project completion by altering the intensiveness of resource use (e.g. where the resource is not used for all 8 hours in a shift) altering the allocation of resource within an activity (e.g. where a resource is required only for a part of the activity duration and making use of different types of activity slack.

Activity 4

If resources for meeting the Earliest Start Time (EST)Schedule are available, is there any valid justification for undertaking resources planning?

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6.6.4 Time/Cost TVade-off

In most projects, many activities may be expedited - i.e. completed in a shorter duration by changing the intensiveness of resource use, changing the method or procedure, changing the resources, changing the material and so on. However, all such reductions in activity durations are accompanied by rise in activity costs and so all such activity duration reduction may not be desirable. This trade-off between the activity duration and the associated cost is the subject of interest in this sub-section.

The reduction in activity duration by any change in its resources, resource use, method, procedure or material is referred to as the crashing of the activity. There are activities (e.g. curing of concrete) which cannot be crashed, some others which can be crashed very marginally and still others which can be crashed by a significant amount of time. If we take a look at the details of activities for New Product Launch Project in Table 6.1, we may find that it is not possible to crash activity A "finalise package design" - from its "normal" duration of 2 weeks whereas activity B - "set up packaging equipment and procure raw materials" - having a "normal" duration of 8 weeks may be crashed to a "crash" duration of only 6 weeks. This is because, overtime may be used while setting up the packaging equipment and local purchase may be used while procuring raw materials. However, there is an overtime premium and local purchase is at a higher price resulting in an increase in the activity cost from a "normal" cost of Rs.10,00,000 to a "crash" cost of Rs 12,00,000. Table 6.7 lists all the normal and crash times and costs for all fourteen activities of the new product launch project.

From Table 6.7 we can easily see that the cost of the project will be Rs 46,98,000 if all the activities are executed as per their "normal" durations. We know from the earlier time analysis that the earliest project completion in such a case is in 26 weeks. However, if the project has to be finished sooner then we have to crash some activities. Let us now determine an efficient method of crashing the project duration.

Table 6.7 Normal and Crash Durations and Costs for New Product Launch Project

Activity Code	Activity Description	Immediate Predecessor Activity	Normal Duration (Weeks)	Normal cost Rs. ('000')	Crash Duration (Weeks)	Crash cost Rs. ('000')	Cost Slope Rs. ('000') Week
A	Finalise package design	-	2	10	2	10	-
B	Set up packaging equipment and procure raw materials	A	8	1000	6	1200	100
C	Produce the first batch	-	12	720	9	900	60
D	Packge the first batch	B.C	4	35	3	50	15
E	Set up the sales office	-	4	16	3	24	8
F	Recruit salesmen	E	4	52	3	63	21
G	Train salesman	F	6	108	6	108	-
H	Select retailers	E	8	144	6	152	4
I	Sell to retailers	G,H	3	60	3	60	-
J	Despatch to retailers	D,J	5	45	4	72	27
K	Select advertising agency	E	4	8	4	8	
L	Plan advertisement campaign	K	9	20	9	20	-
M	Release pre-launh advertisements	L	1	500	1	500	-
N	Conduct advertisement campaign	J,M	4	2000	4	2000	-
		Total			4698		5167

If the project duration has to be reduced, then the length of the critical path has got to be reduced. Obviously, there is no advantage in crashing a non-critical activity as that would not reduce the length of the critical path. On the other hand, if any of the critical activities is crashed, it would immediately result in a reduction in the length of the critical path and consequently the project duration.

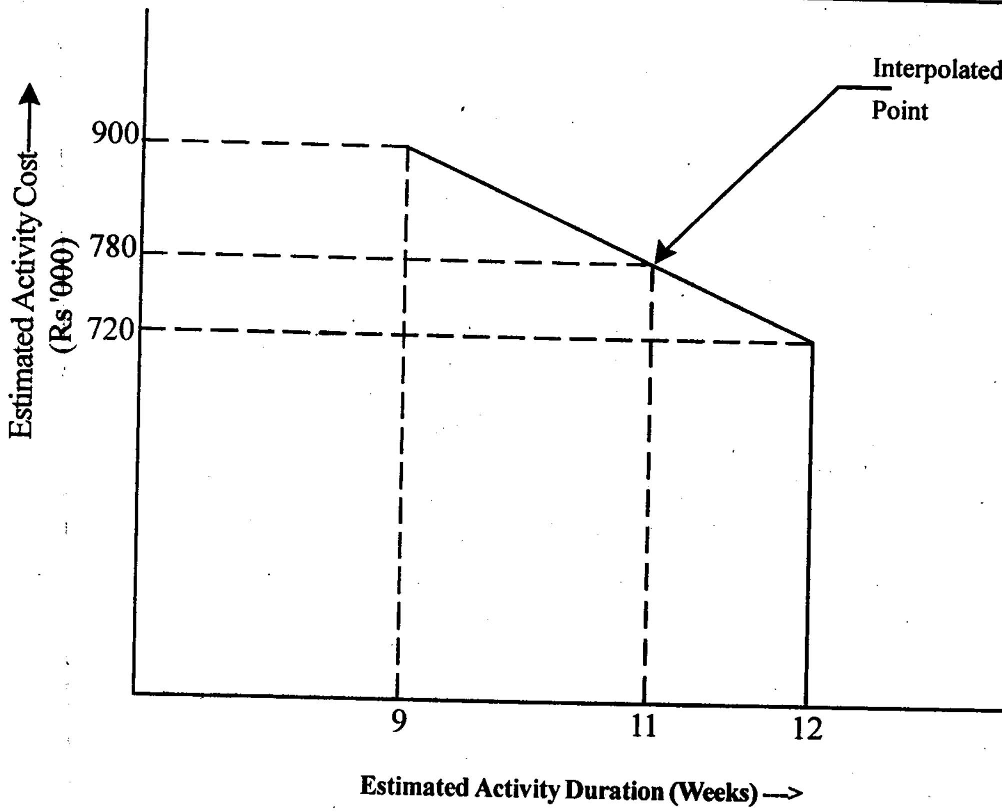

Figure 6.25 Linear interpolation of Cost for Activity C

The question then is, which critical activity should be crashed? The answer to this should be simple - the one which is the cheapest to crash i.e. where the increase in cost is the minimum

We assume that for activities whose durations could be crashed by 2 or more weeks, partial crashing is also possible and the cost increase can be estimated by linear interpolation of the activity cost curve as shown in Figure 6.25 for activity C. Thus, if the activity C is crashed to 11 weeks, the activity cost would increase to Rs 780,000. It is easier to capture the same information through computation of the cost slope for each activity as shown below:

$$\text{Cost slope for an activity} = \frac{\text{Crash Cost - Normal Cost}}{\text{Normal Duration - Crash Duration}}$$

The cost slope for each activity is also shown in Table 6.7 and it captures the increase in activity cost per week of crashing. However, no activity can be crashed beyond its crash duration which is an absolute minimum.

We know from Figure 6.9 that E, F, G, I, J and N are six critical activities. Of these G, I and N cannot be crashed and E, F and J can each be crashed by one week only at a cost of Rs. 8,000, Rs. 21,000 and Rs. 27,000 respectively. Hence the cheapest way of reducing the project duration from 26 to 25 weeks is by crashing activity E to its crash duration of 3 weeks. The project cost would rise to (Rs. 4698,000 + Rs. 8,000i.e.) Rs. 4706,000.

If we want to reduce the project duration by one more week we have to crash some critical activity again. However, now there are two critical paths - viz. EFGJN and CDJN and the project duration will reduce only if both the critical path lengths can be reduced. Of these critical activities only F can be crashed by 1 week at a cost of Rs. 21,000, J by 1 week at a cost of Rs. 27,000, C by 3 weeks at a cost of Rs. 60,000 per week and D by 1 week at a cost of Rs. 15,000. One way of reducing the project duration to 24 weeks is by crashing both D and F by 1 week each costing (Rs. 15,000 + Rs. 21,000 i.e.) Rs. 36,000. The other way is by crashing J by 1 week costing only Rs. 27,000. As J is an activity lying on both the critical paths -crashing it by 1 week will reduce the project duration by 1 week. This is the cheapest way of completing the project in 24 weeks and the project cost would rise to (Rs. 4706,000 + Rs. 27,000 i.e.) Rs. 4733,000.

We still have only two critical paths - viz. EFGIJN and CDJN and the only critical activities which can be crashed are - F which can be crashed by 1 week at a cost of Rs. 21,000, C which can be crashed by 3 weeks at a cost of Rs. 60,000 per week and D which can be crashed by 1 week at a cost of Rs. 15,000. The only way in which the project duration can be reduced from 24 to 23 weeks is by crashing both F and D by 1 week each costing (Rs. 21,000 - Rs. 15,000 i.e.) Rs. 36,000. The project cost will now increase to (Rs. 4733,000 + Rs. 36,000 i.e.) Rs. 4769,000.

At this stage no activity on the critical path EFGIJN can be crashed any further and so it is no possible to reduce the project duration beyond 23 weeks. Although it is possible to crash the project duration from 26 to 23 weeks, it may not be economically justified. Suppose the economic benefit of launching the new product earlier is Rs. 30,000 per week of early launch. Then we will crash the project duration by only 2 weeks as the incremental cost of crashing by one more week (i.e. the third week) is Rs. 36,000 whereas the incremental benefit is only Rs, 30,000. Some projects carry an incentive for early completion or a penalty for late completion and these can also be treated in the same way for determining the optimum project duration. The guiding principle in all crashing decisions is the same - the cost of crashing by 1 week (or 1 month or any other period) goes'on increasing with each successive round of crashing and we should crash only as far as it is economically beneficial and not beyond that.

6.6.5 Project Scheduling as an Iterative Process

As described in the previous sections, the steps involved in project planning and scheduling could be summarised as follows :

- Establishing the Project goals and objectives
- Defining the work - i.e. breaking up the project into its constituent activities
- Estimating the activity duration and defining activity interdependencies
- Carrying out time analysis of the project
- Establishing the resource availability and requirements
- Developing a resource feasible schedule
- Analysing activities to find feasibility of crashing
- Optimising the baseline plan and schedule
- Freezing the baseline plan and schedule

However, this is not a simple single-pass sequence of steps to be followed one after the other. As the objective is to get an optimised project schedule and baseline plan some of these steps may have to be repeated in an iterative way to get closer to the baseline plan. After going through the time/cost trade off analysis once, one may realise that it is better to. modify the resource allocated to a particular activity - say from 10 to 8. With this change, resource scheduling may have to be repeated with consequent changes in crashing of activities. Similarly, after one round one may realise that the resources available to the project must be increased to complete the project in time. This in turn calls for another iteration. The final outcome after this whole exercise is a project schedule and baseline plan which is feasible, meets the projects goals and has been optimised on cost. The baseline plan then becomes the basic document against which the project progress is monitored and controlled.

Activity 5

Project delays can be very costly and can impact adversely on the fiscal health of the company.. If we are engaged in crashing the overall project duration because of its high profitability, are there any other cost factors that must be taken into account?

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6.7 SUMMARY

Project Scheduling is quite a complicated exercise - especially for large projects. In this unit we have brought out the issues relevant to project scheduling and time analysis of projects and also tried to discuss some procedures for carrying out the same.

As projects are unique one-time endeavours having their own goals, we found that project network diagrams could provide the basic framework to carry out time analysis of projects. We described how project network diagrams could be drawn and then used for time analysis of projects. We did this through AOA network diagrams wherein activities are represented by arrows and events by small circles or nodes. The time analysis could give us Early Start and Early Finish times of different activities during the forwarded pass and Late Finish and Late Start times during the backward pass. We used these to define total slack, free slack and independent slack of different activities. We interpreted those activities having no total slack as critical activities as any delay in their execution would be immediately reflected in project delay and the path (or paths) formed by joining the critical activities together on the network diagram as the critical path. Finally, we combined the project network diagram and the time analysis results to.draw the time-scaled network of projects - which can visually deficit both the activity interdependencies and their durations and slacks.

We then took a look at those activities having a high degree of uncertainty in their estimated durations and discussed the role of three time estimates - viz. optimistic time, pessimistic time and must likely time in capturing this uncertainty.

We used the three time estimates to first compute activity expected duration and variance and then using the central limit theorem the project expected duration and variance. This information, once generated, can be used to answer question regarding the probability of completion of the project in a given amount of time.

We also introduced AON (Activity on Node) network diagrams in which activities are. represented as modes and there is never a need to use dummy activities. Precedence Network (PN) diagrams are then introduced and these network diagrams allow us to represent dependency relationships between a pair of activities other than the Finish - to Start (FS) which is used in AOA and AON networks. In PN networks, we discussed how to use Start-to-Start (SS), Finish-to-Finish (FF) and also the less commonly used Start-to-Finish (SF) relationships. Each of these precedence relationships can also have their respective lag times.

Time analysis alone does not give us a feasible schedule as we have not get ensured that resources required for different activities will actually be made-available. This is done in resource scheduling where we first identify resource conflicts and then try to remove the same through the use of heuristics. We showed the use of one simple heuristic which worked well with a resource availability of 8 men but did not work well when the resource availability was changed to 6 men. This is true of all heuristics including the ones used in computer packages to remove conflicts.

We also analysed time/ cost trade off in project scheduling. We found that the estimated duration of some activities can be crashed (i.e. reduced) from their normal durations. This can be achieved only by incurring a higher cost on the activity e.g. on overtime, local purchase, changed methods or procedures, etc. Project crashing can be used in situations where the incremental benefit for crashing is more than the incremental cost of crashing. It is true that the greater the crashing, the higher the incremental crashing per period and so beyond a point it may not be economical to resort to crashing.

The various steps involved in project scheduling may have to be used more than once in an iterative manner to get the project schedule which uses the right amount of resources, is estimated to be completed at the right time and at an optimised cost. Such a schedule called the

baseline schedule is used for monitoring and control of the project.

6.8 SELF-ASSESSMENT EXERCISES

1. Compare and Activity-on-Arrow (AOA) schools with Activity-on-Node (AON) networks and justify why AOA networks are preferred internationally.
2. Time-scaled networks are significant improvements over traditional networks and bar charts and their usage will grow in the next century." Justify with examples of their advantages.
3. What is the concept of "Free Float" (Primary slackness) and "Total Float" (secondary slackness)? Bring out their significance in project management.

4. A network comprises of the following activities:

Activity	Duration (Weeks)	Activity	Duration (Weeks)
1-2	6	2-7	4
1-4	6	5-7	Dummy
1-3	2	4-8	6
3-5	4	6-8	8
2-4	Dummy	7-8	8
5-6	2		

(a) Draw an AOA network

(b) Compute forward pass calculations (Earliest possible occurrences of nodes), Backward Pass calculations (Latest possible) occurrences of nodes), Free Float, Total Float of all activities and determine the critical path. Mark the critical path in the network.

(c) Prepare a time-scaled network and mark the critical path in the network.

5. Draw an AOA network of the following activities:

	Activity	Precedes	Duration (days)
Start	A	D	2
Start	B	E, H	3
Start	C	F,K	4
	D	G	7
	E	G	6
	F	E, H	5
Finish	G	-	8
	H	-	9
	K	-	10

(a) Carry out all the calculations on the network, determine and mark the critical path. What is the total project duration?

(b) Calculate the amount by which the duration of activity" 'A' may'increase without changing the total project duration.

(c) Draw the time-scale network and reconfirm the answer to (b) above.

6. A network has following activities their normal duration and costs as well as their minimal (crash) duration and costs are also indicated in the tabulation below:

Job	Predecessor	Normal		Minimal (crash)	
		Time (days)	Cost (Rs.)	Time (days)	Cost (Rs.)
A	-	10	5,000	10	5,000
B	A	8	4,000	8	4,000
C	A	8	4,500	8	4,500
D	C	4	6,000	4	6,000
E	B	7	5,500	5	6,500
F	B	9	3,750	4	13,750
G	D	8	2,000	1	4,800
H.	E,F,G,	15	6,500	12	14,900
I	H	10	5,000	10	5,000

(a) Draw the time-scales network.

(b) For the activities and their corresponding time and cost informations, determine how and at what additional cost, a deadline of completing the project in 48 days can be met.

7. A project comprising of eight tasks (A to H) has the following characteristics:

Tasks	Preceding Tasks	Time Duration in Weeks		
		Optimistic	Most Likely	Pessimistic
A	None	2	4	12
B	None	10	12	26
C	A	8	9	10
D	A	10	15	20
E	A	7	7.5	11
F	B,C	9	9	9
G	D	3	3.5	7
H	E,F,G	5	5	5

(a) Draw an AOA network. Carry out all the calculations, determine the critical path and mark it in the network. What is the total project duration.

(b) What is the probability of achieving the project within the deadline of 30 weeks?

6.9 BIBLIOGRAPHY AND FURTHER READINGS

1. Harrison, F.L., 1992. *Advanced Project Management: A Structured Approach*, Metropolitan Book Co.: New Delhi.

2. Harvard Business Review, 1989. *Managing Projects and Programs with a Preface by Norman R. Augustine*, Harvard Business Review: Boston, Massachusetts.

3. Kerzner, Harold, 1992. *Project Management: A Systems Approach to Planning, Scheduling and Controlling*, Van Nostrand Reinhold: New York.

4. Levine, Harvey A., 1986. *Project Managing Using Micro Computers,* Osborne McGraw-Hill: Berkley, California.

5. Moder J.J., Phillips C.R. and E.W. Davis, 1986. *Project Management with CPM, PERT . and Precedence Diagramming,* CBS Publishers : New Delhi

6. Saxena K.R. (ed.), 1991. *Project Management far Developing Countries,* Oxford & IBH Publishing Co. Pvt. Ltd.: New Delhi.

7. Stallworthy, E.A. and O.P. Kharbanda, 1983. *Total Project Management: From Concept to Completion,* Grover Publishing Co.: Aldershot, Hants, England.

8. Weist Jerome D and Ferdinand K. Levy, 1977. *A Management Guide to PERT/CPM with GERT/ PDM/DCPM and other networks,* Prentice-Hall of India: New Delhi.

UNIT 7 MATERIALS AND EQUIPMENT

Objectives

Perusal of this unit will enhance your

- understanding of the key role of materials and equipment in project management
- appreciation that projects, in essence, entail designing and indenting materials, ordering and expediting materials and transporting and erecting materials
- comprehension of prioritising sequencing of materials and equipment in such a manner as would facilitate their arrival at site in the sequence of erection
- clarity of basic concepts in effective materials management for ensuring timely delivery without compromising on quality and at reasonable prices
- capability for laying sound foundations for proactive vendor and contractor management, the two badly neglected parts of project management

Structure

7.1 INTRODUCTION

Project management entails designing, ordering, expediting, inspection, transportation of materials and equipment in an orderly sequence and then erecting them in dfferent geographical locations and commissioning them into viable operating plants. A large project, in totality, may appear to be very gigantic and complicated. Management of projects by network analysis provides an integrated technique of planning and control by breaking the entire project into various packages (systems) which are further blown into various functional components like mechanical, piping, civil, structural, electrical, instruments etc. Each of these functions is further divided into design and indenting, ordering and payment, expediting and inspection, transportation and storage, erection and commissioning.

7.2 IMPORTANCE OF PLANNING FOR MATERIALS AND EQUIPMENT

Procurement of materials and equipment spans across 80-85 percent of the overall project duration. If we carry out delay-analysis of projects in India, late delivery of materials and equipment would emerge as the most important factor contributing to delays in project implementation. If we skim through the annual reports of corporations implementing major projects, unforeseen delays (?) by vendors come in as a convenient alibi for all acts of omission and commission by the project managers.

The scenario in India is further complicated by the fact that most vendors overtrade themselves and book orders much beyond their capacity and capability. Project managers have to act proactively and anticipate problem areas and anticipate problems with contracts and supplies right at the stage of awarding contracts and\ or placing supply orders.

Besides, suppliers of speciality equipment have also a significant role to play in furnishing relevant data on loading, foundations, height, location of incoming power supply etc. without which design of civil and structural works, piping, electrical and instruments cannot be finalized nor basic documents like detailed layout drawings can be frozen. Supplies of high-technology equipment are also involved in erection, testing and commissioning of these equipment and their synchronised performance can make a major impact on the timely completion of the project.

7.3 NETWORK-BASED MATERIAL MANAGEMENT

Project management encompasses designing and indenting of materials, ordering and expediting them .and then transporting these materials to the construction site and erecting them in respective geographical locations. Management of projects through network analysis incorporates a systematic and comprehensive approach to materials management. Effective materials management ensures right materials, in the right quantty, at the right time, at the right place and at the right price.

Network analysis of projects leads to prioritisation of all activities such that work on the longest delivery items is started first, followed by not-so-long delivery items, followed by medium delivery items and ultimately followed by short delivery items and so on. For any functional area also, schedule, blown up item-wise, is as shown below:

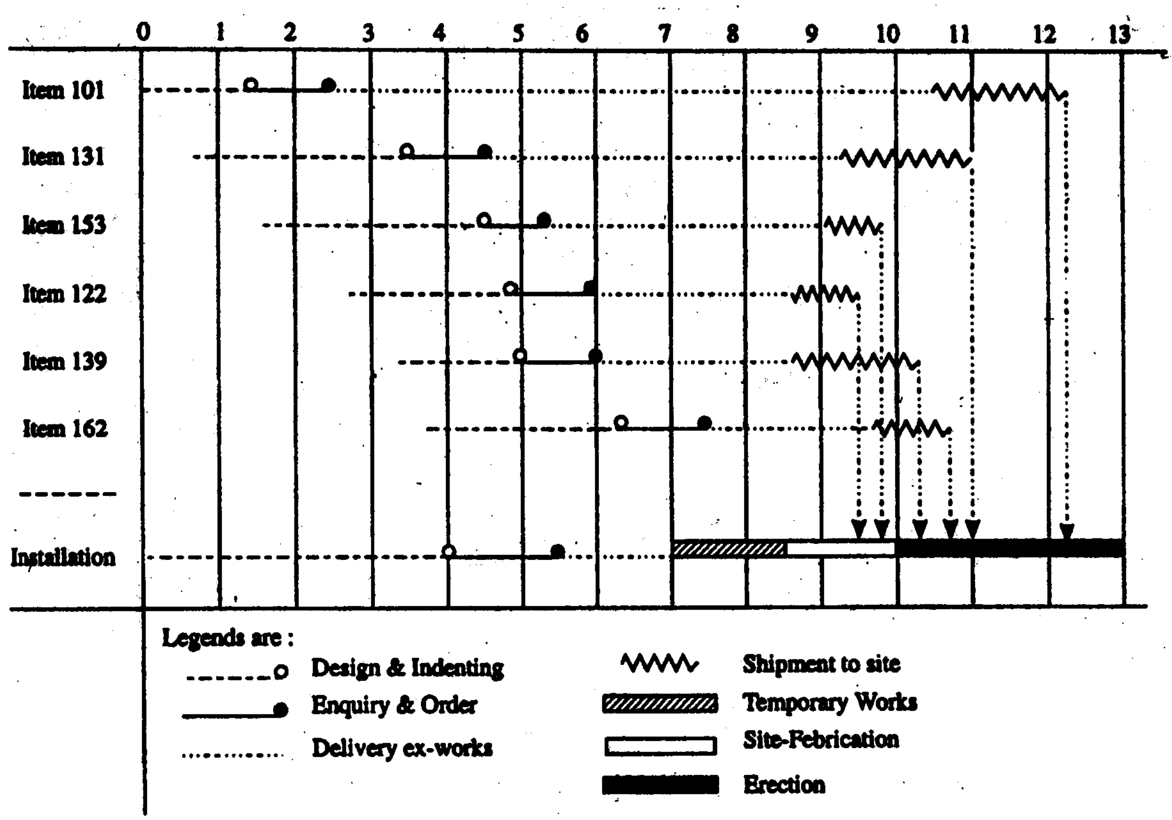

Figure 1:

In engineering and technical projects, management of materials forms the kernel of entire project management. The materials must be designed in the right sequence, ordered, expedited and delivered to site in the sequence of their erection such that the buildings and structures are constructed and otherwise made ready so that the equipment can be erected directly on the designated locations without prolonged storage and rehandling at construction sites.

Networks also provide a detailed basis for interaction among vendors and purchasers and contractors and clients. Close and intimate networking with vendors forms the sine qua non in projects - a large number of them are dependent upon purchaser for receiving information for completing their respective designs and specifications. Equally a number of suppliers specially for specialized and proprietory.equipment have to be furnished design data for proceeding with various components of the project. In addition, suppliers of specialised machinery should also provide the manuals for erection, testing, commissioning, operation and maintenance of their equipment so that purchaser is able to take timely action for their detailed planning and execution.

7.4 SECTIONALISING PLANNING OF MATERIALS

Projects comprise of various types of hardwares. For the ease of planning and scheduling, the entire project can be divided into several sectional components as below:

Designing, ordering, expediting and construction of -

(a) civil works

(b) structural works

(c) mechanical works

(d) piping works

(e) electrical works

(f) instrumentation works etc.

This can be schematically shown as below:

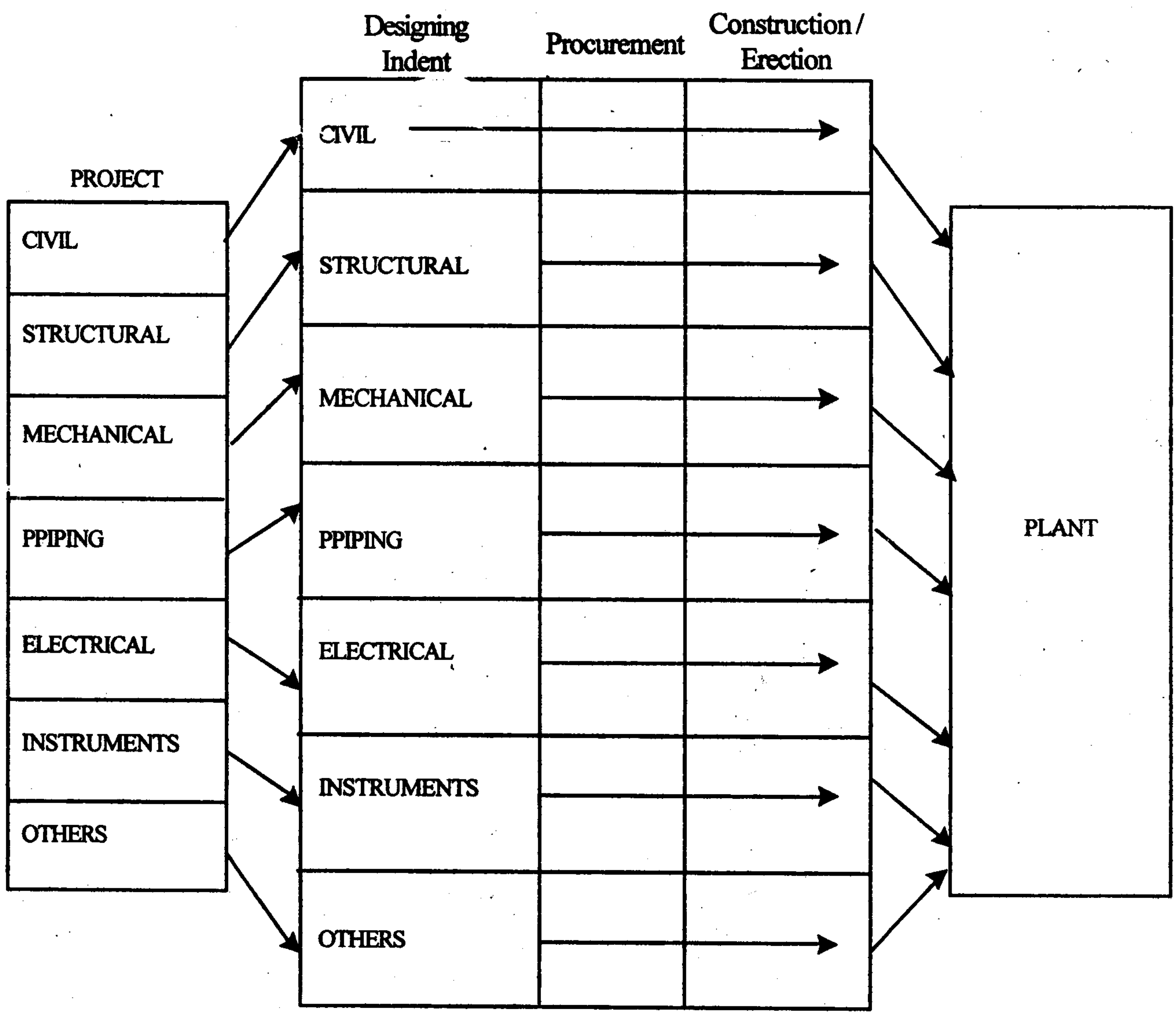

Figure 7.2

While doing this, projects can also be further classified geographical area wise on the following lines :

Within Battery Limits

Battery Limits refers to the main plant and equipment and may comprise, of -

(a) Plant I (or Main Building I)

(b) Plant II (or Main Building II)

Outside Battery Limits

These may be further grouped into -

a) Process Utilities such as

1. Raw Water including intake water works from canal, river etc. or tube-wells
2. Filtration Plant
3. Cooling Towers
4. Chilled Water
5. Distilled Water
6. Boilers and Steam Pipelines
7. Fuel Oil System
8. Petrol, Oil, Lubricants etc.
9. Incoming Power Supply and Distribution
10. Power Substations and Switch Rooms
11. Raw Material Storages of various kinds
12. Packaging Material Storage
13. Stores for Maintenance and Spare Parts
14. Specialised Stress within Production Department
15. Storage of Safety Equipment
16. Storage of Dresses and Uniforms
17. Storage of Stationery
18. Storage for Laboratory Chemicals
19. Finished Product Warehouse
20. Workshops for Civil, Mechanical, Electrical and Instruments
21. Laboratories for Testing Raw Materials, in-stage production materials, packaging materials and finished products
22. Fire Fighting System including Fire Engine/Tender
23. Inward Material receiving bay and area
24. Outward despatch bay and shipping area

) Amenities such as

1. Office Building
2. Training Centre

3. Security Office at the entrance gates for materials, workmen, staff etc.

4. Time Office

5. Change Rooms, Washrooms, Lockers, Toilets etc.

6. Canteens and Rest Rooms

7. Roads, Culverts and Drains

8. Street Lighting etc.

All main plants, process utilities, amenities etc. are inter-connected through service pipelines, power-cables etc. Proper well defined cut-off lines must be decided before hand so that responsibilities of individual persons get defined without any gaps and overlaps.

Each of the process utility or amenity may have all or few of the above six components. For example, project management responsibility of a general purpose office building or store may vest in a member of civil engineering group who would in turn have to seek assistance from other disciplines like electrical engineering for power/ electrification works within the proposed office, stores etc. Similarly, for office equipment, furniture, instruments etc., help of specialist functions as appropriate may be sought

Activity 1

If we are using computerised methods of project management, what is the justification of providing a facility in the software which would enable listing of activities separately for each section or function?

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7.5 LONGEST DELIVERY ITEM AND PROJECT DURATION

Procurement of materials and equipment spans accounts for upto 85% of the overall project duration. Their proper planning and scheduling assumes greater importance. It is perhaps easy to comprehend that the overall project duration is dependent upon the longest delivery item(s) of materials and equipment. An approximate method of arriving at the overall project duration is as below:

T = A+L+B

Overall

where A = Minimum time required to design, indent and order the longest delivery item

L = Longest delivery period

B = Minimum time required for the longest delivery item to be erected and commissioned

This can be illustrated as below:

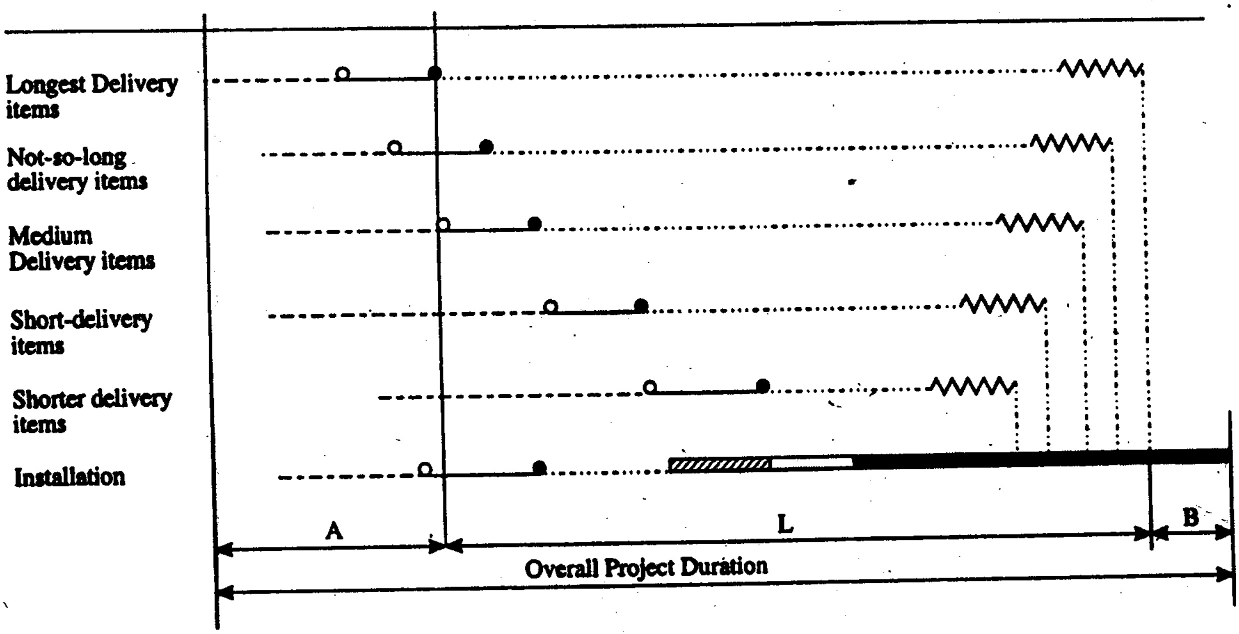

Figure 7.3

7.6 BEATING THE CRITICAL PATH

Projects do not sprout from nowhere - there is a phase of project conception, formulation, evaluation etc. During this period project contours are conretised and 'vision' is converted into 'mission'. During this phase, usually core equipment which are also normally among the longest delivery items get defined. These long-delivery group of items stand out like a 'tomb stone' in the network and all large organisations who have developed some maturity and capability in project implementation, seek out ways and means of beating the critical path.The possible courses of action are:

(i) If the company is certain of going ahead with the project, it can seek advance financial sanction of limited amount of funds for placing orders covering longest delivery items. The damage may be limited to the advance payments made and/or additional commitments as per the terms of contract.

(ii) The company could proceed and obtain quotations, negotiate prices and other terms and conditions and should be ready to place the order the moment the financial sanction is received.

Large companies and multinational corporations have more options and these can be exercised for containing overall project duration.

7.7 COMBATING INFLATION

In most economies of the world, inflation works out to be a significant factor; India is no exception. Materials constitute 65 to 80% of the total project costs and although project costs estimates provide for inflationary trends in economy in the form of contingencies, currency fluctuations etc., project management is a time-framed activity.

Other factors remaining same, a common index of measuring progress of project implementations is the 'speed at which we can commit and spend the sanctioned amount'.This is a very commonly accepted parameter of describing the capacity and capability of a project organisation. Once again, this brings into focus the importance of materials and equipment in project management.

Besides, by awarding contracts for supplies and services, we are able to combat the effect of inflation. After the project is financially sanctioned, the speed with which we can commit the materials, equipment and services covering the entire scope of the project will not only enable us to contain the impact of inflation on project costs but also achieve timely deliveries of equipment and consequently for the project as a whole.

7.8 CONSTRUCTION EQUIPMENT AND MATERIALS

In addition to direct materials like plant and machinery for the projects, we also require construction machinery and materials to aid and speed up construction. With the advancement in construction technology, the number and array of materials, tools and tackles and equipment required during construction have increased greatly The availability of tools and tackles and resource equipment, which are highly mechanised, has enhanced the quality and delivery of the construction phase with consequent reduction of costs of construction.

Thanks to the protective regime of our economy for the last four decades, India has lagged behind in the construction technology. With the current trend of liberalisation of economy, next few years will witness major strides in technology transfers and their absorption in construction.

By international standards, we take far too long time in executing projects despite the fact that we have also completed some projects in time periods we can be rightly proud of. For example, a flyover over the busy Kemp's Corner at Bombay was completed in sixties in seven months whereas similar project, thirty years later are taking two to three years, if not longer. Similarly, although Kudremukh Iron Ore project was completed in time period comparable with the world standard, we have taken a very long time in executing Vizag Steel Plant.

With the increasing use of expensive construction machinery we have to work out detailed planning and scheduling of construction is such a manner as would require these machines for short durations at one construction site. Pressures of competition arising from liberalisation, privatisation and globalisation will lead to drastic reduction in project durations.

Constructions schedules will have to be worked out in greater details so as to optimise the engagement of expensive construction machines and equipment for minimum periods for maximum output by working them for longer hours or round the clock. Periods of engagement of these machinery would require computing on per diem basis to minimise heavy cost debits and remain competitive..

The immense advantage Japanese car manufacturers have gained by reducing the launching period of new car model to 16 to 18 months in comparison to American car manufacturers' 30 to 36 months is worthy of emulation. Speedier implementation of projects can propell a company to that winning advantage. Planning, scheduling and deployment of construction machinery and materials play a vital role in this.

7.9 SUPPORTING SERVICE FOR CONSTRUCTION MATERIALS AND EQUIPMENT

Most large projects are located in remote areas requiring special efforts in reaching and servicing construction materials and equipment. Unfortunately, owing to protected and restrictive environments, supporting logistic and financial services have not grown at the rate they should have. With further liberalisation of economy, a large number .of specialist agencies are expected to start operating in the following areas of concern to project and construction management:

(i) Lease financing of construction machinery for the period of construction only

(ii) Renting of construction machinery

(iii) Maintenance and servicing of construction machinery

Besides, with heavy investment in infrastructure sector like roadways, railways, telecommunication and related facilities, access and reach to various nooks and corners of the country is expected to improve which in turn will give boost to the logistics and other supporting services for construction projects.

Besides, we have to develop suitable framework for buying old construction machinery reconditioning and retrofitting for hiring/leasing out to companies who need these services. -

India would require massive investment in supporting logistic activities before it can develop capabilities of quality, cost and timely deliveries of international standard.

Activity 2

Speeding up project implementation is a prerequisite for entry into global project management. Explain with justifications.

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7.10 SUMMARY

Materials and equipment play important role in project management, because the procurement of these requires 80-85 percent of the overall project duration. Management of projects through network analysis incorporates a systematic and compresive approach to materials management. Effective material management ensures right materials, in the right of quantity at the right time, at the right place and at the right price.

The overall project duration is dependent upon the congest delivery items of materials and equipments. Hence possible courses of actions are to be followed in beating the critical path. Consturction schedules shall have to be worked out in greater details so as to optimize the engagement of expensive construction machines and materials.

7.11 SELF - ASSESSMENT EXERCISES

1. "Management of materials and equipment forms the core of project management." Support your views giving supporting evidence.
2. How does management of projects with the aid of network analysis helps design and procurement of materials and equipment in line with the priorities?
3. Is there any quick method of estimating the overall duration of a project? Explain the process with suitable justifications.
4. "Meticulous Management of activities on the critical path is crucial to completing projects on time." How can we 'beat' the critical path and improve our on-time performance?
5. What do we need to do in India in order to speed up the projects and shorter overall durations?

7.12 BIBLIOGRAPHY AND FURTHER READINGS

1. Albert Bathersby *Project Management with Network Analysis,* Pitman, London.
2. S.Choudhary *Project Management,* Tata McGraw-Hill, India.
3. P. Gopalkrishnan Text Book of Project Management, Macmillan, India. VE Rama Moorthy
4. Vasant Desai *Project Management,* Himalaya Publishing House, India.

UNIT 8 HUMAN RESOURCES

Objectives

Study of this unit would enable you to:

- understand the importance of goals and objectives in projects
- comprehend human aspects of project planning and scheduling
- appreciate role of human resources in developing consensus and shared vision while evolving project schedules
- highlight critical aspects of human beings as a resource
- learn methods of levelling and allocating resources for effective project management
- harness potentials of human resources for accomplishing project goals

Structure

8.1 INTRODUCTION

Project Planning and Scheduling bridges the gap between 'where we are at present' to 'where we wish to go over a period of time'. Planning aims at consciously determining the courses of action for achieving the ultimate goal. Unless we plan, we are leaving too much to chance. It is always difficult to predict future precisely and factors beyond human control may interfere with the most well-thought plans.

Planning is defined as a detailed method, formulated before hand, of making or doing something. It concerns with the selection of goals and missions and then developing detailed action plans for their accomplishment.

8.2 PROJECT GOALS

Starting point of Project Planning and Scheduling is determining and defining the very purpose and objectives of the project, called 'Project Goals'. Clearer we are of the goals, easier it would be to draw up the action plan. These goals should be as focussed as the goal-post of the football field. It is advisable to put it in writing. While writing the goals, we must take into account the needs and wants of the customer or the end-user. Everybody has a customer, internal or external and his views must be sought and incorporated into the project goals.

These project goals should not only be circulated to members of project team but should also be discussed with them to bring out their full implications. Everyone on the project should be able to comment on the project and contribute to its fuller understanding. It would instill in them a sense of ownership and creation of shared vision leading to their increased involvement and commitment.

8.3 PROJECT PLANNING

General Eisenhower had said, 'Plans are nothing; planning is everything'. Develcping a detailed method to be followed during implementation is a strategy. Although each project is unique for its one time timeness, the experience and process of management tends to repeat.

a) Drawing a Network

Networking is an exercise in 'simulation' -mocking up real life situation - it is described as 'building the complete project from start to finish albeit on a piece of paper'. This exercise can be both educative and revealing. It is educative as it tells members how the work of other functional departments will be carried and it is revealing as one learns of the intimate of contours of the project. The detailed network analysis brings out its high and low points, its special features and areas of darkness / ignorance which are the breeding ground for unforeseen happenings on the project. If these areas can be spotted at the initial stage, it gives early advantage in identifying problems. After all problems are solutions in disguise and earlier we start solving them, better placed we would be.

At any rate project personnel become aware of the grey areas of uncertainties. Even alternative strategies can be thought of and agreed upon well before the hanpening.This can minimize the impact of unforeseen happenings on the project parameters.

Frequent and close interactions amongst team members at the initial stages of the project presumably to freeze the project schedule is very rewarding - it not only improves everyone's knowledge of the project but also enhances understanding among team members.These interactions for planning lay the foundation for developing 'anticipation' of team members. Anticipation is considered to be the 'winning streak' of all work teams. Imagine the frustration of the football player who, after dribbling the ball for a while, kicks it to the left and the team-mate is not there! Similarly team Members become of aware when to expect input data from other departments and sections and when they have to pass their data etc. on and formats thereof.

b) Estimating Time Durations

Most mature project organisations would have compiled performance data on the past projects which can be used for planning and scheduling new projects. However, a number of projects deal with new or developing,technologies or new locations and environments for which sufficient data from the previous projects may not be available. In all events, projects planners must consult all the specialist departments and seek their expertise and use their inputs.This ritual of meeting concerned people from all functions must be followed rigorously so that none feels left out. Time it will take to complete their component of the 'deliverable' is one aspect on which everyone can advise.

These discussions help a great deal in predicting and providing for unforeseen happenings and building them into project schedule to make it more realistic. During these discussions, we can discern possible areas of conflict among departments and individuals. Following this strategy project planners play a major role in reconciling conflicting requirements and arriving at a consensus. Schedules agreed after some debate and deliberations lead to deeper involvement and higher commitment. A committed person is a fountain head of immeasurable amount of energy and we can being to tap this vast reservoir

8.4 PROJECT SCHEDULING

When time durations are incorporated into networks and analysed, we obtain project schedules which represent the consensus of the team in a spirit of give and take.These agreed schedules should then become mission for all team members who would work towards achieving the same effectively, efficiently and enthusiastically. Once the project schedule has been accepted, we should refrain from commenting upon it as that undermines the mission. Agreed schedules are taken as a religion - you are born into it and you do not question it.

Agreed schedules help to orchestrate different notes in harmony which creates symphony. Teaming together for a mission works; it not only is more enjoyable but it also improves implementability and achievability. Team effort leads to quicker and better results which also last longer.

8.5 HUMAN BEINGS AS A RESOURCE

Human beings have often been bracketed with other resources like materials, machines and money. This is rather misplaced because the real job of a manager is to manage people and not machines and processes which can only be operated and not managed.

When networks were invented in late 50s, they were called 'activity networks'. In 60s and 70s these were described as 'communication networks' as arrows represented flow of information. These days arrow diagrams are described as networks of human beings who are senders and receivers of communication and form the most critical link in the chain. Management of human beings is not one chapter of the book of management, it is the entire book of management. It is inappropriate to deem human beings as one of the many resources available; it is the most critical element. They are the ultimate resources and most resourceful of all the resources.

Human beings are different from other living beings - they have a head that thinks and a heart that beats. It is important that the work in hand should be so organised that it not only appeals to the head but also tickels the heart. Commitment and excitement would ensure and the targets would be achieved automatically. Dr T Ishakawa, the famous management pioneer of Japan has said that it is the 'humanware', in sharp contrast to 'hardware' and 'software', who would be the key determinant for achieving excellence - they decide the aroma, taste and flavour of the organisation. This resources has to be nurtured with care so that it blossoms forth and attains its full potential.

Human beings form six different units in an enterprise - individual employees, jobs and roles, dyads and groups, cohesive teams, co-operation amongst teams for common objectives and organisation. Challenge before the management is to increase the effctiveness and potential of all the six units.

8.6 UTILIZING HUMAN RESOURCES

Resources have to be utilized optimal in line with the requirements of project schedule. This implies optimisation of resources of individual disciplines. For example, if we look at the requirements of resources of civil design, we are essentially examining one craft. Since each project manager negotiates and settles with the specialist departments the schedule of 'deliverables' on his project only, exercise boils down to resource utilization of single craft only although aggregation of resource requirement will emanate from multi-project situation. This is typical of all specialist functions in the central project office, viz., personnel for civil structural, mechanical, piping, electrical, instrument design etc. and for procurement, progressing, inspection, project planning, cost monitoring etc.

At construction sites, utilization of resources pertains to work assigned to different contractors and specialist agencies. However, within the scope of an individual contractor, more than one skill or craft may become critical owing to constraints on their availability.

Cash Inflow Problem to Site

One common constraint with construction representatives at site of contracting companies is the inadequate or non-uniform flow of funds from their central offices. We must examine such problems indepth and provide suitable safeguards in contracts. If such problems are not resolved in time, they can snowball into bigger ones with consequent delays in project completion.

8.7 TYPES OF PROBLEMS IN BALANCING HUMAN RESOURCES

While drawing up project schedules through network analysis, we assume that only constraint in scheduling an activity is technological in nature. If we are able to start an activity immediately after all the technological requirements have been met, we call it Earliest StartTime (EST) Schedule. Similarly working backwards in the network, if we provide for technological requirements of successor activities, we can arrive at latest Start or FinishTime (LST) Schedule. But implication, it means a number of other possible combinations lie in between EST and LST Schedules. However, 'Resource Scheduling' or projects should not only be possible but also realistic and reliable. There are two broad categories of resource balancing problems.as below:

a) Resource Levelling

Although while drawing up EST Schedules, we assume that all skills are available in abundance and can be made available at short notice, yet we have to balance the level of engagement of these resources individually and collectively. It is neither practical nor economical to manage fluctuating levels ofresources, Methods of 'Resource Levelling' aim to reduce the peak requirements and smooth out period to period assignment without prolonging overall project duration.

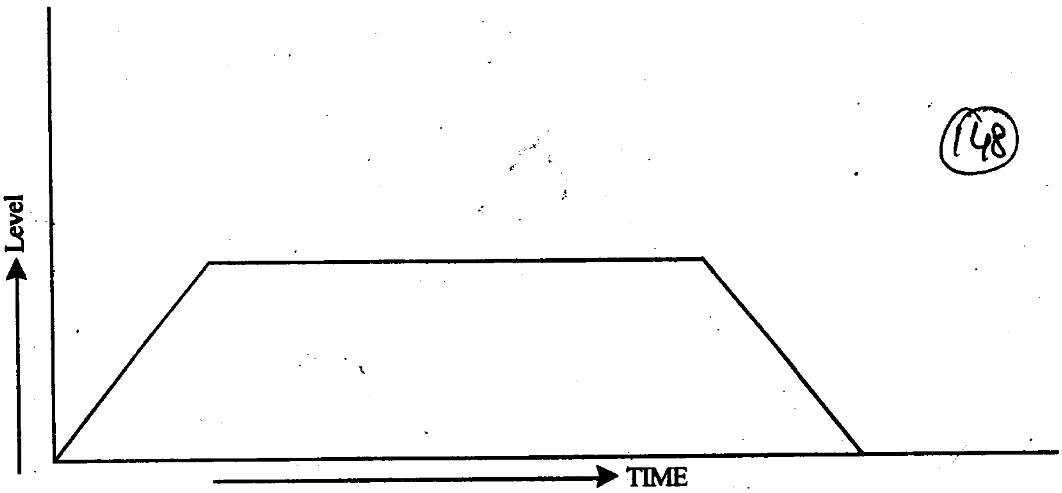
b) Resource Allocation

In some cases there may be severe constraint on the availability of a particular skill.We endeavour to allocate these resources such that its impact on the overall project duration is minimum. It is evident that if any critical skill or craft is in short supply project duration will increase.

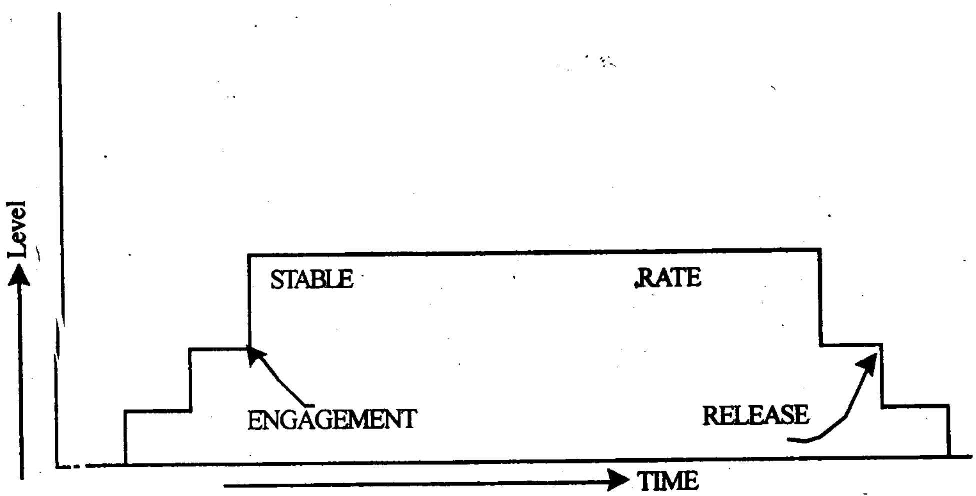
8.8 IDEAL RESOURCES PROFILE

Project Schedules are initially prepared on the simplifying assumption that human resources will be available as and when required. It is seldom possible to acquire and release resources in any desired amount even if we are willing to pay the expenses involved in frequent changes in levels of engagement viz., cost of hiring, training, unemployment wages etc. It is, therefore, advisable to maintain stable employment and utilize human resources at a more constant rate. The ideal profile of resource utilization is as shown below:

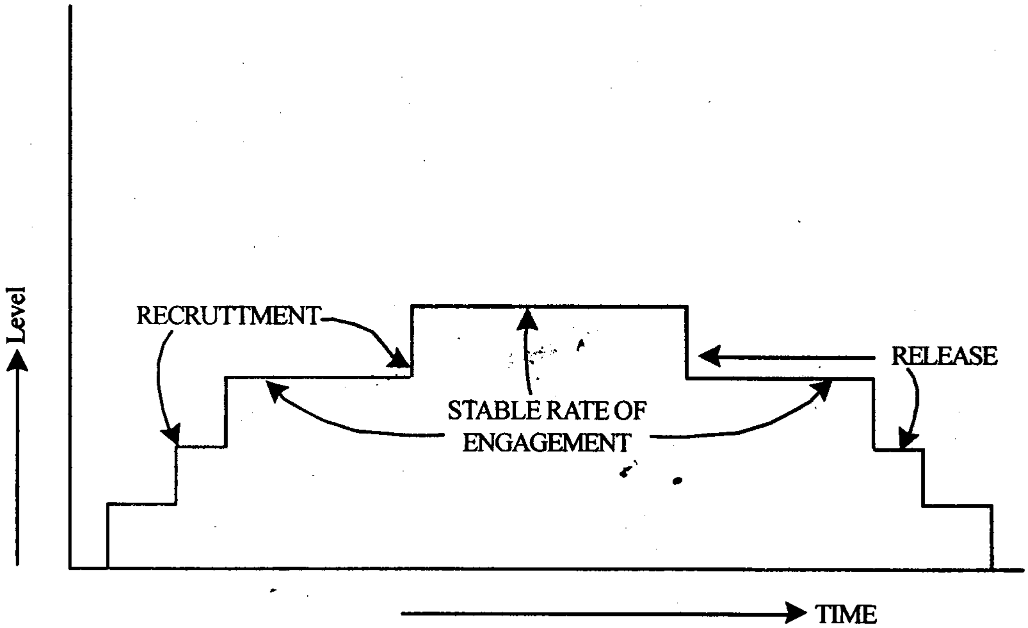
148



Since engagement and release of manpower has to be in concrete steps, the profile may be modified as shown:



in projects extending over longer duration, there may be two or more stable levels of engagement as in Figure:

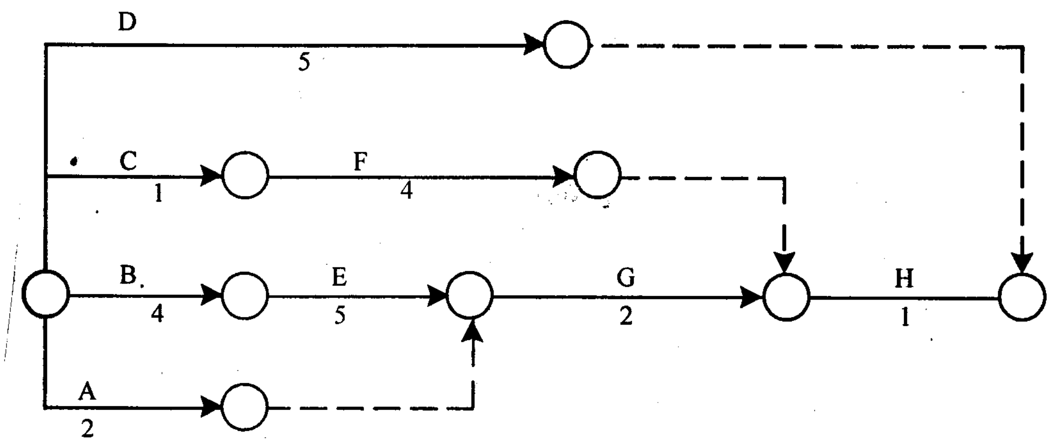


8.9 METHODS OF RESOURCE LEVELLING

Various methods are :

a) Trial and Error Method

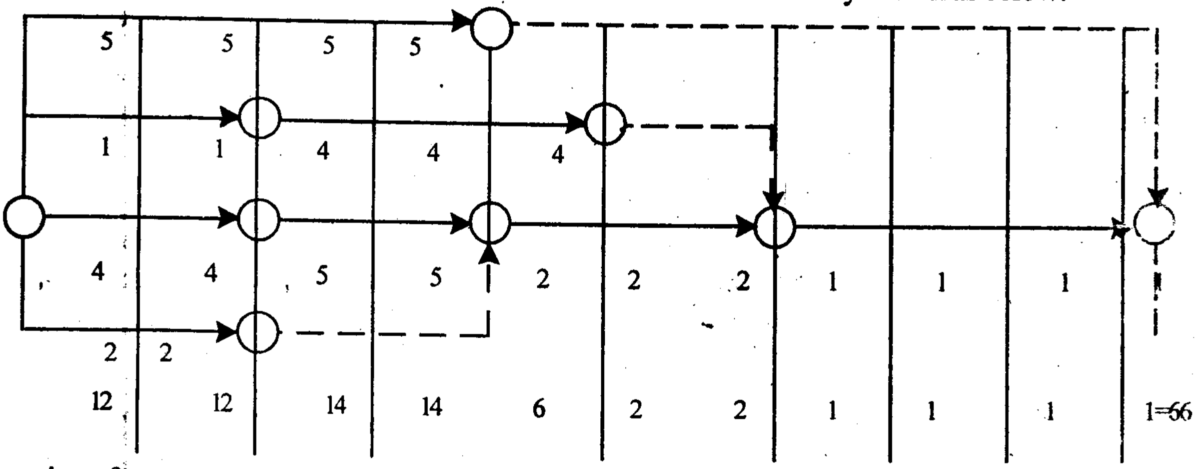
EST Schedule is drawn in the form of 'squared network' and resource scheduling is aggregated for different time periods and plotted graphically as shown :



Activities are moved forward or backward on the time scale to obtain more stable level of engagement of individual skills and also collectively. This may involve withdrawing resources from activities with 'free floats' and prolonging their durations or canabilising a part of 'total float' to arrive at constant or nearly constant rate of engagement.

Example

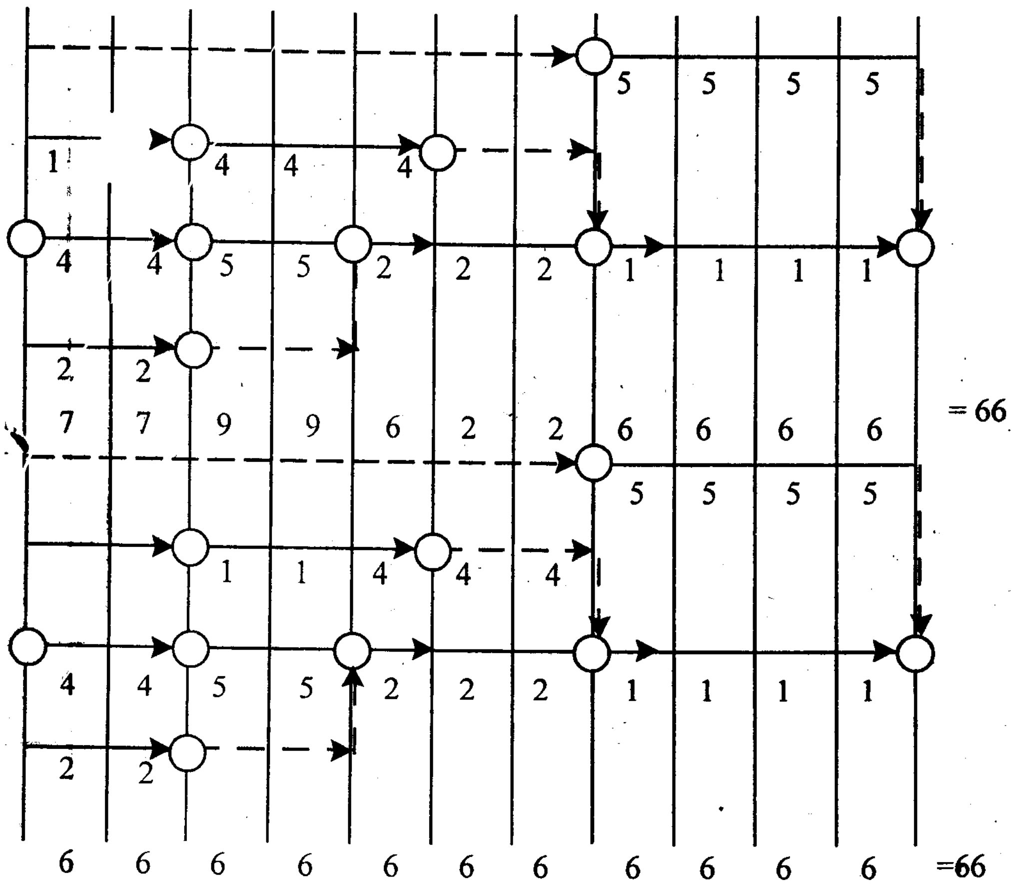
The schedule is drawn in the squared network format as floats can be clearly shown as below:



Aggregation of resource requirement for different time intervals is also tabulated - starting with 12 persons in the first two days, it increases to 14 on the third and fourth day and then falls to 6 on the fifth day and two on sixth and seventh day. Thereafter, we require one person from eighth to eleventh day.

Overall requirement is 66 mandays over a period of 11 days which is equivalent to 6 persons working for 11 days.

Various steps and corresponding resource requirement is shown below for progressive changes in the schedule:



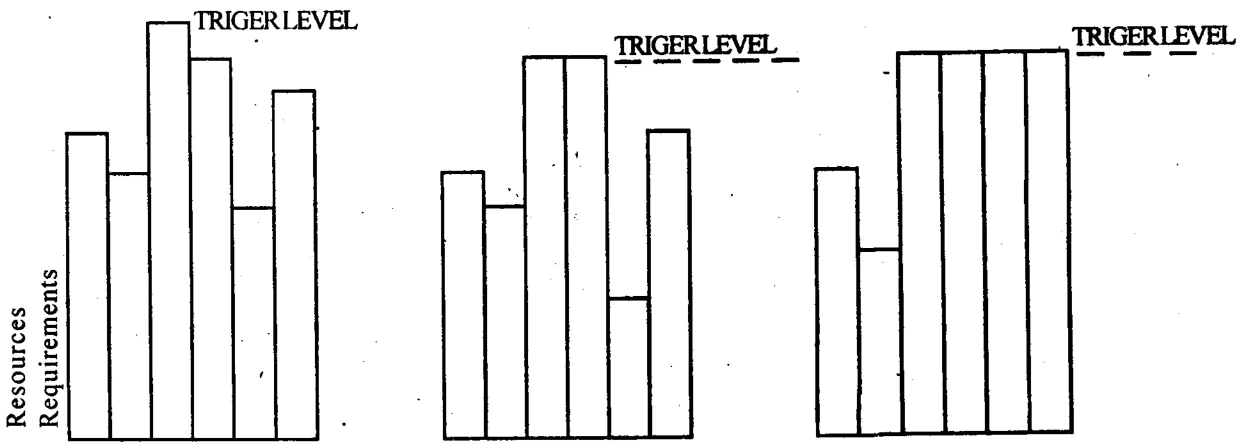
In this case, it is possible to work out a schedule requiring 6 persons for 11 days at a constant rate.

b) Trigger Level Method

In this method, approach is to smooth the peak requirement of resources by deferring 'slack' jobs beyond the period of peak requirements. Also called the multiship-multishop method, this was first invented in a naval shipyard.

The EST schedule is converted into manpower loading chart showing day to day requirement for each department. Trigger level is set one unit below the peak requirement and slack jobs rescheduled beyond the peak period so that peak requirement does not exceed the trigger level.

Once again the trigger level is fixed just one unit below and the entire process repeated several times until the resources are balanced. This way the schedule moves progressively towards an ideal resource profile as shown:



The process for levelling being iterative, it has been computerised with a few simple decision rules viz. jobs are deferred in the descending order of slackness. Some computer programs reschedule jobs with low value of slack first - this is logical because critical jobs (having no slack) should be rescheduled before other jobs.

Test Check for determining optimality of solutions

Whatever be the method used in resource levelling, 'principle of least sum of squares' can be applied as a test check to ensure if the new schedule is more optimal than the previous one. For example, various stages in the 'Trial & Error' method can be test checked as below:

	T I M E I N T E R N A L											
S1 Schedules	1	2	3	4	5	6	7	8	9	10	11	Total
1 Initial Schedule	12	12	14	14	6	2	2	1	1	1	1	66
Sum of Sq.	144 + 144 + 196 + 196 + 36 + 4 + 4 + 1 + 1 + 1 + 1											728
2 Intermediate Schedule	7	7	9	9	6	2	2	6	6	6	6	66

	Sum of Sq. Schedule	49 + 49 + 63 + 63 + 36 + 4 + 4 + 36 + 36 + 36 + 36											412
3	Final Schedule	6	6	6	6	6	6	6	6	6	6	6	66
	Sum of Sq.	36 + 36 + 36 + 36 + 36 + 36 + 36 + 36 + 36 + 36 + 36											396

It is apparent from the above that Intermediate Schedule is more optimal than the Initial one as the Sum of Squares is 412 against 728. Similarly final schedule with a Sum of Squares of 396 is more optimal than the Intermediate one having a Sum of Squares of 412.

c) Comprehensive Method

Computer Programs are now available for solving resource levelling problems in a systematic, iterative and comprehensive manner. We start with the EST Schedule, work out the Resource loading chart for the initial schedule and computes the corresponding Sum of Squares.

As the next step, we utilize all the free floats of the activities, starting with the activity with the longest free float. For each progressive schedule, we compute the Sum of Squares and compare it with the Sum of Squares of the Initial / Previous schedule to ensure we are moving in the right direction.

In the following step, we keep the critical path unaltered and choose last but one activity having some total float (last activity will always be a critical activity and will not have any float) and reschedule this activity by one unit of time at a time towards right i.e., forward - this may result in a number of interlinked activities getting rescheduled. In the event of any conflict in the selection of activity, one with higher total float will be taken up first for rescheduling to the right. For each possible solution, Sum of Squares is calculated and compared with the previous one unit l the next Sum of Squares is higher that the previous one. The optimal resource levelling solution is thus reached.

Activity 1

In most projects in India, we make use of only resources levelling methods, why?

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8.10 METHODS OF RESOURCE ALLOCATION

Sometimes the constraint on availability of some skills could be more severe which may imply that the project duration may have to be prolonged. Project Managers have to arrive at a solution which would minimize the impact of very limited availability of that skill on the project duration. Various methods for resource allocation are:

a) Progressive Scheduling Method

Also called scheduling by the day, it follows the principle that activity with lower slack is scheduled first. This is logical as the critical activities with zero slack should be taken up for implementation first.

If at any stage, a critical job cannot be taken up for want of scarce resource, the duration will increase. This may lead to fresh selection for rescheduling as increase in project duration will also change the quantum of slack for balance activities.

b) Analogue Method

When techniques of CPM/PEKT were rechristened as Network Analysis, it had upset the physicists and electrical engineers who have been solving problems in electrical networks for a long time. The search for finding suitable methods for resource allocation has led to identification of electrical networks resembling human networks of project management. Having established analogue electrical network, it is then solved as a problem in electrical engineering. After obtaining the solution, electrical parameters are translated back into project variables as below:

Work content of activities	--	Power
Resources	--	Current
Time	--	Potential
Duration	--	Potential Difference
Rate of consumption of resources	--	Conductance i.e. inverse of resistance

For different rates of consumption or engagement of resources, we can determine the project durations and then choose the one most appropriate to our capability of mobilizing resources.

c) Linear Programming or Integer Programming

Linear programming (LP) models can also be used for solving resource allocation problems~of project management. The objective function is the minimisation of project duration which is subject to the following constraints :

i) Requirements of scarce resources will be limited to their availability during that time period.

ii) No job can start until its predecessor jobs are fully complete

iii) No job can be split once it has been started

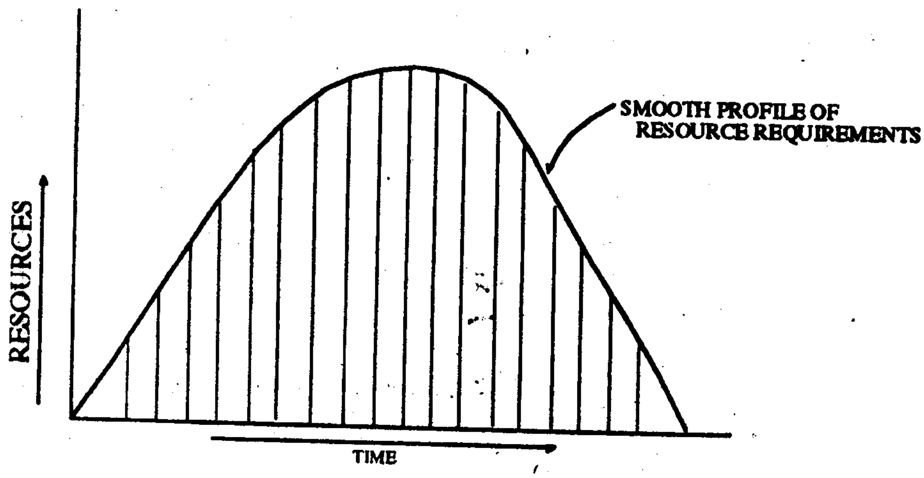
iv) Project duration shall be in whole numbers or integers

v) Resource requirement of different project durations shall also be in whole numbers or integers.

Since constraints under iv) and v) are in addition to the normal constraints of LP Models, these are also called Integer Programming Models. They permit solution only in integers or whole numbers.

Unfortunately, even for a medium size projects, number of constraints tend to be very large -precedence and splitting constraints add greatly to their number. As a result, most problems become rather large and are often beyond the capacity of computers.

Although considerable development work has been done in this area and it has given a lot of insight into problems of resource allocation, these have not invoked that much interest from the operating project personnel.



Profile Function

Studies conducted over a large number of projects reveal that, resources, in particular the manpower is built rapidly to the peak level and thereafter it tapers off gradually zero as shown: An IBM executive, Norden, fitted a curve to this profile which resembles a bell-mouthed curve of normal distribution, askewed somewhat to the left. Mathematical expression for the bell-mouthed curve of normal distribution is

$$y = \frac{1}{2\pi} e^{\frac{1}{2}t^2}$$

correspondingly, Norden's profile function is expressed as below:

$y = k.a.t.e^{-at^2}$

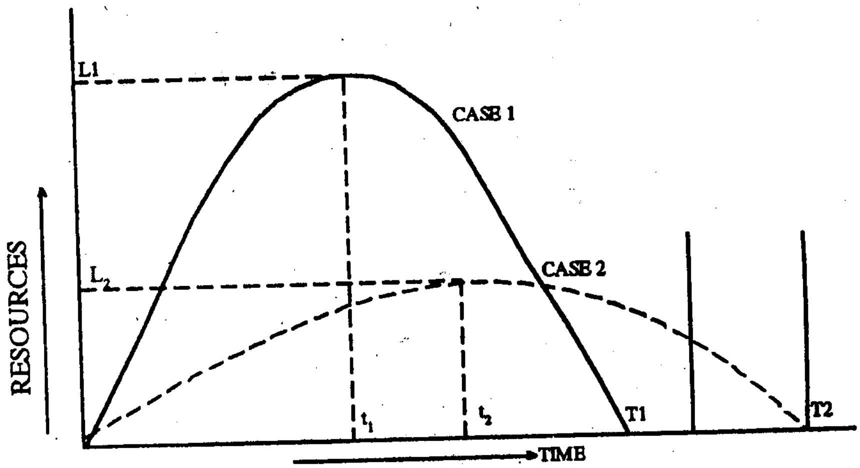
y = No. of member at any time 't'

where, k = Total work content of the project

a = A factor called the 'Urgency Factor'

e = Base of Natural Logrithms (value = 2.1718)

If the client wants the project completion on priority we have to quickly build resources to peak level 'LI' in time 'tl' as shown in Case 1 below. However, when the customer is not so demanding, we build to a lower peak 'L2' at a time period 't2' which is lower than in the Case 1 .Although the work content is same, the completion time also increases from'T1 to T2'.



In Norden's Function, the two cases are distinguished by the value of urgency.Factor 'a' - its value may be higher in Case 1 (a = 0.056) as against Case 2 (a = 0.014).

This function has been found to be very useful for companies offering package systems like computers, refrigeration, air-conditioning, furnace etc. or utilities like water treatment, cooling towers, filteration plants, effluent treatment plants etc. In these systems, size and specifications may vary but the configuration remains broadly the same. Setting up these systems are essentially repeat experience and it should be possible to fit a suitable profile function to it. Obviously the values of k, a and y will vary.

Most companies dealing with these type of systems use this concept albeit empirically. By past experience, they have a fairly good idea of the resources needed including the split between different trades from day to day for the completion of the project within the quoted due dat. They also know the limits within which they can move the peak requirement forward or backward.

Besides, most of these companies operate with a small team of core technicians on their permanent rolls and build the remaining complement around it as per their conceptual understanding of the profile of manpower requirements for the project on hand. Each firm has to arrive at its own value of the 'Urgency Factor' which would vary for the system and for the customer.

e) Least sum of squares

This method is the extension of the comprehensive method of resource levelling described in Section 8.09. If, after the exercise of resource levelling, overall requirement of scarce resource works out to be higher than its availability' we have no alternative but to extend the project duration by one unit of time at a time and work out the changed manpower loading chart. At every step, the sum of squares is calculated and the process is continued iteratively until the requirement of confining skill falls in line with its availability.

Conclusion

A number of algorithms have been designed for balancing resources in large projects. However, the package based on the 'Principle of least Sum of Squares' is the most comprehensive. It is a systematic approach encompassing all the three facets of resource balancing problems viz., resource scheduling, levelling and allocation and has been computerised. We are likely to hear more of it in years to come.

Activity 2

Experts are of the opinion that the use of "Least Sum of Squares" method of Resource Planning will grow rapidly in coming years; discuss with justifications.

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8.11 HARNESSING HUMAN RESOURCES

Project Planning and Scheduling is undertaken to develop a framework for human beings to implement the project. Even so how to get anybody to do something? There is only one sure way and that is, to make it interesting for him. And the only way to make it interesting for him is to give him what he wants. One of the basic human wants, besides food, shelter clothing etc. is the 'craving to feel important'. It is not 'wish' nor 'desire' nor 'longing' but a 'flaming urge' for a feeling of importance. It is this motive force or reservoir of energy that has distinguished human society from other living beings.

During the phase of developing project planning and scheduling of projects, it is extremely vital to consult specialist functions, seek their opinions, tickle their ego and expertise and give them the feeling of importance by making them feel that they are the authors and architects of project plans and schedules. Let us not deny ourselves of the wise counsel of our fellow team-mates. Everyone is superior to us in some ways and it is for us to-seek,that out.

People are known to feign sickness to win attention and get a feeling of importance. Some people are so hungry for this feeling of importance that they actually go insane to get it. We should prevent our team-mates from becoming sick or insane by making them feel involved and interested and this can be easily achieved by consulting them while doing planning and scheduling of projects.

One may get the feeling that valuable time is being spent on seemingly inocuous activiy. It is a sound investment to make as it will repay manifolds throughout the project execution phase. Three days spent in the initial stages may save us months of delays later". Project teams can then march forward with the consensus slogan that 'nothing less than a disaster would be accepted as an excuse for delays'

8.12 SUMMRY

Planning determines the courses of actions for achieving the goals.The project goals should not be circulated to memebrs of project team but should be discussed with them to bring out their implications. Drawing a net work and estimating the time for the project are most important is a project work.

In project scheduling, all the team members would work towards achieving the goal efficiently and effectively.

Human beings are treated as a resource like machine, material and money .Hence human resources are to be utilised optimally .Various methods of Resource with suitable examples are discussed in the unit. Resource allocation in addition to resource levelling with different methods are highlighted.

8.13 SELF - ASSESSMENT EXERCISES

1. How does a clearer understanding of the goals by everyone working on the project leads to deeper involvement and commitment?
2. "Network analysis of a project highlights interdependence of individuals and functions and leads to better understanding among team members" Justify
3. Among the various methods of resourcing planning, which are has the potential of highest growth and why?
4. What is an ideal resources profile and how does it get influenced by practical considerations of project execution?
5. If your company is engaged in the business of customised central air conditioning systems, which technique of resources planning would be most suitable for you. Describe it and what are the types of data you would need to collect from past projects so as to enable better resource planning in future?

8.14 BIBLIOGRAPHY AND FURTHER READINGS

1. E.A. Stallworthy & O.P. Kharbanda *Total Project Management from Concept to Complextion,* Gover Publishing, London.
2. Albert Battersby *Project Management with Network Analysis*, Pitman, London.
3. JD Weist & F.K. Lovy *A Management Guide to PERT/CPM*, Prentice Hall, India.
4. F.L. Harrison Advanced Project Management: A Structured Approach, Metropolitan, New Delhi.

UNIT 9 PROJECT COSTING AND FINANCING

Objectives

After the perusal of the unit, student will have

- deeper understanding of cost estimating of projects at preliminary feasibility techno-economic feasibility and detailed project report stages for seeking and obtaining financial sanctions within the company and also negotiating for securing project finances with appropriate financial institutions.
- clearer application of the role of cost estimating of projects for defining the scope of the investment proposal and increasing importance of computerizing and codifying cost-estimates which form the basis not only of financial sanction but also for basic design, detailed engineering, procurement, construction and commissioning it into a viable and operable plant.
- in - depth knowledge of sources of project finance from domestic and foreign institutions, investors and lenders.
- capability to work out the most-suitable mix, of source of fund so as to minimize the cost of capital for optimal results.

Structure

9.1 INTRODUCTION

Owing to difficulties involved in estimating costs of projects, many people consider it is an art. To be able to do a good job, one has to compile and analyze a lot of cost data on past projects completed within the company and keep these data updated by collecting the latest price estimates from the market. Market intelligence has to be quite reliable. However, we must always remember that only thing worse than missing information is get i wrong or misleading information, which must be avoided in all eventualities.

9.2 COST OF PROJECTS

A large number of companies who are in the business of project design, engineering, procurement and construction, use cost data for arriving at the price of the project as they have to participate in competitive bidding for securing future business. Pricing of a project, although based on quite a great deal of cost data, may still be construed as an art albeit partially. At any rate, it is a strategy - ***Those who talk, don't know and those who know, don't talk.***

9.3 COSTING AND PRINCING OF PROJECTS

Starting with the concept to commissioning of projects, we may need different types of cost estimates. Obviously, their level or degree of accuracy is dependent upon the type and detail of information and data available at that stage of the project.

(a) Order-of-Magnitude Cost Estimates

This type of cost estimate is made without any detailed engineering data.This cost estimate may be accurate + 25% within the scope of the project. It may be based on past experience in India or abroad with foreign, principals or it be based on capacity estimates. Companies operating in international project Business, use quite a great of information from their home projects .and use broad "scaling factors" to obtain the cost in the currency of the customer country. Another broad parameter used is in terms of rupee crores per megawatt of electricity •generation for power plants, per kilometer railway track in plains or per kilometer of railway. electrification for single, double, triple or quadruple tracts or per kilometer of road (to a known specification) to be constructed. These order-of-magnitude cost estimates are useful for preliminary discussions and project formulation.

(b) Approximate Cost estimate (PFR Estimates)

Also called top-down estimate, it is done without detailed engineering data and may be accurate +15%. This type of estimate is under taken at the time of **Preliminary Feasibility Report (PER) stage**. Here we use various techniques of costing like pro-rata estimate from experience of doing similar projects in the past and updating for inflation. It may also be described as estimating by analogy or rule of thumb estimates. We extensively use indexing costs of similar activities. These are adjusted for capacity and technology. Since detailed engineering data is not available, estimator is likely to conclude that since this component is 20% more difficult than a similar one completed in another project, it is likely to cost 20% more overall or in terms of materials or labour or overhead, as appropriate.

(c) Economic Feasibility Cost Estimate (TEFR Estimates)

As we progress further in the project formulation, we are to prepare an Economic Feasibility Cost Estimate of the project. This is used for working out the product cost and pricing and consequently the profitability analysis of the project depends on this cost estimate.This is based on a reasonable degree of detailed engineering data and should be accurate + 10% for **Techno Economic Feasibility Report (TEFR) stage**. This exercise is blown up into much details, function-wise and for specialist equipment; budget quotations from vendors are also obtained. A great deal of cost data, compiled from past projects, is used extensively so as to obtain accurate cost estimates of all main plant items (within the battery limits) and for all service or utility plants and systems outside the battery limits. For each type of equipment used or system installed, it is possible to compile overall cost data and the same can be used at this stage for arriving at Economic Feasibility Cost Estimate.

This cost estimate formed the basis of companies applying to Government of India for obtaining industrial licence and for capital goods licence for imported plant and machinery. With deregulation, it is required only for industries on the restricted list.

(d) Detailed Project Cost Estimate (DPR Estimates)

As we progress further with the project formulation, a number of aspects get defined. Some preliminary drawings like layouts, process flow diagrams, piping and instruments (also called engineering line) diagrams are prepared and company firms up its action plan by preparing a detailed project cost estimate -*corresponding to Detailed Project Report (DPR) stage* and is expected to be accurate to + 5%. At this state, costing exercise is very detailed and costs of all major plant items are supported by proper price quotations from the intended suppliers. Even at this stage Cost of construction and erection labour and cost of overheads are estimated factorial.

(e) Control Cost Estimates

After making some progress on the basic design viz. drawing up of detailed scheme, flow diagrams and layouts, a very detailed exercise on cost-estimates is undertaken. When basic documents as above are sufficiently frozen, we have, more or less, defined the scope of the project in hand. Consequently, the aim is to arrive at an accuracy of + 2.5% although it may be more precise to say that is lower than + 5% as, achieving an accuracy lower than + 5% is very much dependent upon economic stability, inflationary trends on prices, balance of payment, fluctuations in currency exchange rate etc.

As the name signifies, these estimates are used for controlling the costs while plant and equipment are being designed, indented and ordered and serve as a very useful frame for controlling expenses as they are incurred.

Until the Control Cost Estimates (CCE) are finalized, the previous DPR estimates are used for indenting and ordering any critical long-delivery items of equipment and the same figures are adopted/incorporated into the CCE.

Activity 1

In India, a large number of projects in public/govt. sector are overspent mainly because their costs are underestimately initially; elaborate with reasons.

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9.4 TYPES OF COST ESTIMATES IN PROJECTS

All large and mature project organisations are giving greater attention to this detailed exercise of compiling CCE - these are being computerised and suitably codified so that these can be referred to while indenting the equipment for procurement.

Increasingly CCE is being used as the basis for defining the scope of the project and should be fully aligned with the cut-off lines of responsibilities agreed with the end customer/user or purchaser.

Owing to greater awareness, thanks to Total Quality Management environments, on designing and operating 'fail-safe' or 'fool-proof systems of project management, the importance of an exhaustive procedure of CCE has increased and is becoming the basic document for defining the project scope.

The TQM philosophy enjoins project management personnel to design whatever is included in the cost control estimates and therefore, we have tied up procedures wherein whatever is designed is indented on purchase/contracts and whatever is indented is, infact, ordered and whatever is ordered must be delivered at the proposed project site at the designated construction warehouse. Correspondingly, whatever is delivered at the warehouse is erected at the designed location provided in the drawings, oil-topped, no load tested etc. before taking up the trial production and commissioning of the plant.

9.5 PROJECT SCOPING

Project entail massive capital expenditure - the requirements of capital investment usually for exceeds the financial capability of the entrepreneur (or promoter group) or the company. The sources of project financing of public sector, joint sector and private sector projects may vary very significantly. However, these funds may be long-term for capital investment and short term for meeting the requirements of working capital.

9.6 PROJECT FINANCING

The sources, common to projects from all the three sectors, are as below:

a) Equity and Preference Share Capital

Equity is one of the principal sources of fund available to promoters and shareholders and its main features are:

i) **Promoter groups contribution :** Promoters either along or together with their friends, associates, relatives etc., are expected to bring in 25% of the total issue of equity capital for projects upto Rs. 100 crores and only 20% if cost exceeds Rs 100 crores or as laid down by Securities and Exchange Board of India (SEBI) from time to time. Promoters' share is locked in (without transfer or withdrawal) for a period of specified number of years from the date of commencement of production or date of allotment of shares whichever is later.

ii) **State Governments Contributions:** State Governments may, through State Financial Corporations (SFCs), subscribe to the capital issue subject to a certain maximum limit; they may not take up equity in companies whose net worth is more than a specified value.

iii) **Public Subscriptions:** Public subscription to the equity issue of the company is governed by SEBI guidelines and certain sections of the Companies Act of 1956 and must be taken into account; your bank, financial institutions subscribing, merchant bankers etc. may be able to advise appropriately.

There days over the counter (OTC) facility is also available who handle issues of equity capital between Rs 30 lacs to Rs 25 crores with a maximum of 40% issued capital or Rs. 20 lacs worth of shares whichever is higher.

iv) **Seed Capital Assistance:** Operated by IDBI, this financial assistance scheme is available for medium scale units set up and run on a whole-time basis, by technically and/or professionally qualified and experienced entrepreneurs and is offered through SFCs and SIDCs and the same may be checked with concerned units for details.

v) **Venture Capital Assurance:** Risk Capital & Technology Finance Corporation Ltd. (RCTFC) is a subsidiary of Industrial Finance Corporation of India (IFCI) and Technology Development & Information Company of India (TDICI) is a counter part of Industrial Credit and Investment Corporation of India (ICICI) and may be approached for "venture capital assistance" in line with their rules.

vi) **Share Subscription by Financial Institutions and Mutual Funds:** Financial Institutions and Mutual Funds, to create confidence amongst investing public, take up some equity in companies in the initial stage and later sell it to public or promoters as appropriate at a profit and provide a useful basis for ensuring success of equity share issue.

vii) **Share Subscription by Non Resident Indians (NRI's)** Government of India & Reserve Bank of India are permitting investment by NRIs in equity on both with or without repatriation facilities and can provide a good source for meeting the foreign exchange requirements of the project.

viii) **Employees Stock Options:** Public companies are obliged to reserve 5% of the public issue for allotment to employees. However, shares remaining unsubscribed can be offered to the public.

ix) **Preference Shares (preferred stock):** As the name signifies, this class of shares gets precedence over ordinary shares. Unlike ordinary shares, they carry a fixed rate of dividend and is independent of profit. They may have limited voting rights. Various types are:

- Cumulative preference shares
- Non-redeemable preference shares
- Convertible preference shares
- Non-convertible preference shares
- Cumulative convertible preference shares

x) **Government Subsidies:** In India, state governments give incentives which may include:

- Fiscal relief in the form of refund of sales tax, octroi or entry fax.
- Land for new units and for expansion of existing units at reserved prices.
- Contribution towards cost of feasibility and project report
- Subsidy on power.
- Financial assistance like term loans, underwriting shares, share subscription, working capital loar etc.
- Exemption from payment of water rates in developed growth centres of the state.
- Housing schemes for workers etc. in their colonies for industrial workers.
- Supply of raw material.

- State Purchases
- Subsidy on purchase/installation of captive power generating sets.
- Relaxation of terms and conditions for sales tax loans.
- State Capital Investment subsidy.
- Development loans.
- Concessional rent for lease of plot or sheds.
- Tax holiday for payment of corporate tax for a block of five years in the first eight years of operation.
- Clubbing of Net Foreign Exchange (NFE) earned by the unit with the NFE of parent/ associate company for the purpose of according "Export House" status based on export earnings.
- International Price Reimbursement Scheme (IPRS) on the purchase of iron and steel to help units to price exporting products competitively
- Concessions on duties and taxes.
- Foreign equity participation upto 100%.

Adhoc subsidies for implementing projects may have to be refunded if the project fails to go into commercial production within a reasonable period.

b) Internal Generation of Funds

There are not available to new companies. There are profits retained after payment of dividends and provisions for depreciation.

c) Lease Financing

A large number of private financing companies, All India Financial Institutions and banks are doing lease financing of capital equipment; they pay full price of the required equipment to the supplier and then lease it to the purchaser under an agreement to repay the principal and interest in monthly/quarterly instalments. At the end of leasing period, old equipment is transferred to you at a nominal residual value. Herein\debt-equity is not the main factor of credit worthiness and lessor charges interest rates which are a little higher than the bank lending rates.

d) Debentures

These are debt instruments issued by companies to borrow money from public at fixed rate of interest with different redemption periods after expiry of which the company would either buy back or convert them into ordinary equity shares at predetermined premium rates of conversion. This means of project financing is becoming very popular and there are four types of debentures:

- Fully Convertible Debentures (FCDs)
- Partially Convertible Debentures (PCDs)
- Non-Convertible Debentures (NCDs)
- Optionally Convertible Debentures (OCDs)

9.7 SOURCES OF LONG TERM RUPEE FUNDS

This is the largest single source of project financing. Many national and international financial institutions either lend their own funds or channelize funds from government or bigger lending institutions or foreign governments' funds by way of refinancing or acting as their designated agents. Various institutions are:

a) Developments Banks like

--- Industrial Development Bank of India (IDBI)

--- Industrial Finance Corporation of India (IFCI)

--- Industrial Credit & Investment Corporation of India (ICICI)

--- Small Industrial Development Bank of India (SIDBI)

Concerned Institutions have to be contacted for applying etc.

b) Investment Institutions like

--- Life Insurance Corporation of India (LIC)

--- Unit Trust of India (UTI)

--- General Insurance Corporation (GIC)

They may offer loans as a part of syndicate arrangements with the above development banks.

c) Development Financing Institutions

There are about 50 development financing institutions in India like

--- National Small Industries Corporation (NSIC)

--- State Industrial Development Corporation (SIDC)

--- State Financial Institutions (SFI)

--- State Industrial Investment Corporations (SIIC)

--- Housing and Urban Development Corporation (HUDCO)

--- National Housing Bank (NHB)

--- Power Finance Corporation (PFC)

--- Indian Railway Finance Corporation (IRFC)

Besides, commercial banks also give long-term loans for specific projects either directly or as a member of syndicates organised by Development Banks.

Housing and Urban Development Corporation (HUDCO), National Housing Bank (NHB), Power Finance Corporation (PFC), Indian Railway Finance Corporation (IRFC) etc. have been formed as Direct Finance Institutions for servicing specific sectors of economy.

d) Long term loans for revival of sick units

Industrial Rehabilitation Bank of India (IRBI) grants concessional assistance for reviving sick units. Major revival proposals have to be cleared by Bureau of Industrial & Financial Reconstruction (BIFR). National Renewal Fund (NRF) has been set up by the government with a corpus of Rs 2,200 crores for restructuring sick units.

e) Funds for modernizing existing undertaking

Financial assistance on long term basis is also available to projects for replacement, revamping, and renovation of existing units and/or adding balancing facilities for optimising productivity enhancing project quality, conserving energy etc.

f) Supplier's deferred credit

This is becoming available through various Deferred Payment Schemes of SIDB I for small units. For large units, ICICI has been operating a similar scheme with the help of commercial banks. ICICI pays full value of equipment through your bank, who would honour the quarterly payment towards repayment of capital and interest, against bank guarantees issued by the bank in favour of ICICI on your behalf.

g) Intercorporate loans

Companies operating under the same umbrella of management resort to temporary transfer of funds from are unit to another to keep meeting the financial needs of the loanee. A reasonable interest is charged. Public Sector Undertakings (PSUs) under the same ministry also help one another on similar basis.

9.8 SOURCE OF LONG TERM RUPEE LOANS

It may be available from Foreign Exchange dealers after the project has been approved either by Reserve Bank of India {RBI), based on foreign collaboration applicable or by Government of India, based on foreign collaboration secretariat of industrial approvals. You can avail the foreign exchange as stated in your approved application. Commercial Banks and Financial Institutions are authorized to buy and sell foreign exchange and you can arrange for direct remittances to foreign party against genuine bills and documents.

Development Financial Institutions are authorized to disburse a part of your rupee loan is foreign exchange i there is a delay in receiving your remittances against external financing. Foreign Exchange is also availabl under the following schemes.

a) Technical Development Fund (TDF)

Administered by Secretariat of Industrial Approval (SIA) and IDBI, companies can import capital equipment know-how, technical consultancy services, technical drawings and designs etc. There is a maximum ceiling c Rs. 50 millions per unit per annum. A part of import duty and incidental charges is also re-imburseable upto maximum of 25% of GIF value of the Import License under TDF.

b) Import of Designs and Drawings

Under this scheme, RBI limits the ceiling of foreign exchange to Rs. 10 millions per unit per annum.

c) Equipment Finance Scheme

Operated by IDBI, foreign exchange is available under automatic clearance or specific capital goods clearanc against import license. This is also available through SIDCs and loan can be paid in Indian rupees.

d) Specific programmes for advancement of commercial technology

Foreign countries provide funds for joint ventures for research and development and technical co-operation programmes. There are usually administered through one of the all India Financial Institutions (AIFIs).

c) External Commercial Borrowings (ECBs)

ECBs are dealt with by ECB Division of Department of Economic Affairs (DEA). These are generally done directly by Government of India or through its designated agents and AIFIs. Government has borrowed large sums of money in international money market in 1991 and 1992 through International Monetary Fund (IMF) and Asian Development Bank (ADM). Government may permit ECB to companies in the private sector for mobilizing funds in international money market and export credit assistance by foreign governments and overseas buyers, foreign supplier's deferred credit etc. Under this scheme, industrial undertakings with "good credit rating" by a reputed agency, as listed below, may be able to mobilise large amount of money:

Foreign

- World Bank
- International Monetary Fund
- IMD International
- Standard & Poor Corporation
- Moody's Investors' Services Inc.
- Fitch Investors' Services Inc.

Indian

- Credit Rating information Services of India Ltd. (CRISIL)
- Investment Information & Credit Rating Agency of India Ltd. (ICRA)
- Credit Analysis and Research Ltd. (CARE)

There are three options under' ECB viz.,

(i) Loans from foreign commercial banks
(ii) Borrowings through Bonds.
(iii) Suppliers countries export credit
--- Buyers Credit
--- Supplier's Credit

f) External Aid

These might be ensuring:

i) Bilateral Aid : It is available from affluent countries, many of them have set up their own corporations for administering the aid :

- Kreditansalt fur Wiederaufau (KFW) of Germany
- Overseas Economic Co-operation Fund. (OECF) of Japan
- Overseas Development Administration (ODA) of UK

These aids are conditional to buying equipment and know-how from their respective countries. Countries like SaudiArabia, Kuwait etc. also offer special assistance at concessional rates of interest and easy repayment terms. Erstwhile USSR gave aid against rupee payments which they used for buying lage quantities of Indian consumer goods.

ii) Multilateral Aid : It is available from multilateral development financial institutions like:

- International Bank for Reconstruction & Development (IBRD)
- International Development Agency (IDA)
- International Finance Corporation (fFC)
- Multilateral Investment Guarantee Agency (MIGA)
- Asian Development Bank (ADB)
- United Nations Development Programme (UNDP) etc.

g) Investments from Oil Exporting Developing Countries (OEDC)

Indian Government has been inviting individuals and institutions from OEDCs to invest in the form of equity, loan, debentures, bonds etc. They arc restricted to investing in new companies, hotels, hospitals etc. subject to a certain ceiling.These are subject to the approval of Secretariat of Industrial Approval (SIA) and RB1.

h) Collaborator's Equity Participation

Foreign investment by collaborators can also be in the form of equity of Indian company. A number of rules have been relaxed since 1991 and further relaxation of Foreign Exchange Regulation Act (FERA) is on cards.

i) Share subscription by overseas investors

Major institutional and individual investors in developed countries are showing interest in equity participation of large companies with good track record. As a result, Euro-Convertible Bonds (Euro Cbs) and Global Depository Shares (GDS) are becoming popular as investment instruments abroad.

ii) NRI share subscription

NRIs investing in Indian Companies' share equity in foreign exchange can meet the long-term requirements and can often be sufficient to meet company's entire foreign exchange requirements.

Activity 2

In the light of above discussions indicating a large number of sources for securing long term project finance, we can save considerably if we are able to secure the optimum mix of cash inflow. What would you advise to companies Contemplating major capital expenditure?

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9.9 SOURCES OF LONG TERM FREE EXCHANGE

Short term funds are required for meeting the working capital requirements of the company and it comprises of margin money (to be provided by the promoters) and the remaining bulk requirements which is met by borrowing from commercial banks, public deposits, debentures and suppliers' credit.

As a rule, short term funds are costlier than long term one. Margin money for securing loans for bulk portion of the requirements of working capital, should be included in the fixed capital requirements of the project although it is understood that it is required only towards the end of the project execution. Various sources for short term rupee fund are :

a) Commercial banks

For securing working capital credit facility, company has to apply in prescribed forms, giving details of accounts, estimates, projections, documents hypothecating current assets etc. and comply with the conditions stipulated by the banks for both funded (cash) and non-funded (guarantees, letters of credit etc.) credit facilities.

There is an erroneous belief that the entire requirement of working capital of all companies is met by credit from commercial bank. A study carried out in 1991 showed that only about 30% of the total working capital requirement of companies was provided by bank credits.,

There are two methods of computing the working capital financing by banks :

i) Prakash Tandon Committee (1974)

It is worked out as below:

Total current assets	= Rs 200 lacs
Current liabilities other than bank borrowings	= Rs 100 lacs
Work Capital requirements	= Rs 100 lacs
To be funded from Long Term funds @ 25%	= Rs 20 lacs
Short term bank finance @75%	= Rs 75 lacs

ii) Chore Committee (1981)

It suggested a revised method of computing the working capital financing as below:

Total current assets	= Rs 200 lacs
To be financed by long term funds @ 25%	= Rs 50 lacs
Balance current assets @ 75%	= Rs 150 lacs
Current liabilities other than bank borrowing	= Rs 100 lacs
Short term bank finance	= Rs 50 lacs

RBI has suggested that Chore Committee's formula should be used by banks for arriving at short term bank finances.

Activity 3

Explain why we need long term funds to secure short term funds from commercial banks for meeting working capital requirements?

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b) Short term public deposits

Public Deposits are regulated by Government through Companies Act and Public Deposit Rule, which pro restrictions on the quantum of deposits intake and rate of interest.

c) Debentures

These loan instruments have also been used for short term requirements of working capital besides mee long term needs of funds..

d) Suppliers' credit

It is possible to organize 1-3 months' requirements of raw materials and other inputs, as a source of short financing but its usefulness can be debated.

9.10 SOURCES FOR SHORT TERM RUPEE FUNDS

1. What are the different types of cost estimating in the life cycle of a project and how does the lev accuracy increase progressively?
2. "Costing is a guestimate and pricing is a strategy". Elaborate.
3. Should we always award the contract for a project to the longest bidder? What are the pitfalls o policy and how can we obviate these in public sector/government undertakings?
4. "Tapping the right source of funds can materially effect the profitability of the company". Explain reasons.
5. What are the fiscal incenturies offered by various state and central government for promoting indu development?
6. "For securing short-term funds for working capital requirements, we also require long-term funds" ju

9.11 SUMMARY

Cost estimation of projects plays an important role at priliminary feasibility technoeconomic feasibilit detail project report stages. Different types of cost estiamtes are highlighted in this unit equity and prefe share, internal generations of funds, lease finance and debentures are few important sources of fun project. National and international financial Institutions help project funding. Short term funds are nece for meeting the worthing capital requirements of the projects.

.12 SELF - ASSESSMENT EXERCISES

Vasant Desai *Project Management*, Himalaya Publishing House, New Delhi.

Prasanna Chandra *Project Planning, Analysis, Selection, Implementation and Review* Tata McGraw Hill.

JM Nicholas *Managing Business and Engineering Projects*: Concepts and Implementation, Prentice Hall, New York.

DL Lock Project Management, Gower Press, London.

UNIT 10 ORGANISATION STRUCTURES IN PROJECTS

Objectives

Alter learning this unit you should be able to understand:

- process of organising resources
- linkage between staffing and organisation structure
- different types of organisation structures
- evolution of organisation structure for project work
- relevance of matrix organisation structure
- advantages and disadvantages of matrix organisation

Structure

10.1 INTRODUCTION

Project require a large number of persons during execution. The limitation of number of subordinates that a person can effectively manage would have restricted the size of an organisation if we were not able to group activities and people into departments. Although, for a long time, there has been one pattern of grouping, considerable developments have taken place in the manner of grouping people and activities and arriving at an organisation structure.

There is an increasing realization that organisations must be dynamic in nature and should be able to restructure themselves to respond to changes in the environment. Last few years have seen major organisational restructuring which has been, largely dictated by increasing competition, rapid changes in technology, high cost of marketing and changing consumer demands and expectations.

10.2 TYPES OF ORGANISATION STRUCTURES

There is no single best method of departmentalizing which would be applicable to all organisations and in all situations. Over a period of time, a number of patterns of departmentalizing have emerged as below:

a) Departmentation by Numbers

This originated with tribes, clans and armies. The approach is to band together persons doing similar jobs and put them under a manager. Owing to changes in technology and consequent increase in diversity of skills, this grouping is found to be inadequate, particularly for higher management.

b) Departmentation by Time

When people worked in multiple shifts, it was common place to group them by time; each complement in the shift was assigned a shift manager and all skills/functions reported to him.

c) Departmentation by Functions

Grouping of activities by functions is most common. For example, people working in production - creating goods and services - are grouped under production manager; people working in selling - finding customers what are ready to buy goods and services at a price -are grouped under a sales manager. Similarly, persons engaged in finance - raising, collecting and safeguarding funds are put under a finance manager and so on.This is most widely employed basis for grouping activities and would be found at certain levels in all organisations.

d) Departmentation by Territories

This is common among organisations operating over a wide geographical area.Transactional corporations use this method although within the territorial organisation, division might be on function or any other basis. All government departments - revenue collection, welfare, judiciary, education, post & telecommunication are grouped on territory basis. Department store chains are also grouped on geographical zones; nearer at work, peons, floor cleaners security guards etc .are also assigned location-wise.

e) Departmentation by Customers

This grouping primarily focuses on customer or customers in a market segment.A company may be having industrial sale and retail sale and may decide to group selling force into two categories. A large bank may group its marketing department into individual, corporate, merchant banking etc.

f) Departmentation by Process on Equipment

Grouping people as per the type of process is also prevalent - all persons in foundry paintshop, heat treatment or machine shop are grouped under the specialist managar. Similarly, computers or electronic data processing, legal affairs are grouped into separate departments.

g) Departmentation by Products

Grouping of activities on the basis of product or product groups has been gaining importance in multi-product enterprises. These days it is rather rare to come across companies with one or two products. Organisations are typically structured along functions. When the firms become large, the need for departmentation by product becomes necessaiy. Large product volumes are divisionalised into autonomous operations complete with their own finance, marketing, personnel and production functions.

10.3 HIERARCHICAL ORGANISATION STRUCTURES

Herein organisation is structured into divisions, departments and sections. Work flows along the line of command. A typical organigram is as below :

In this form organisational structure, each individual reports to one person only. Communication channels are well defined.

a) Advantages

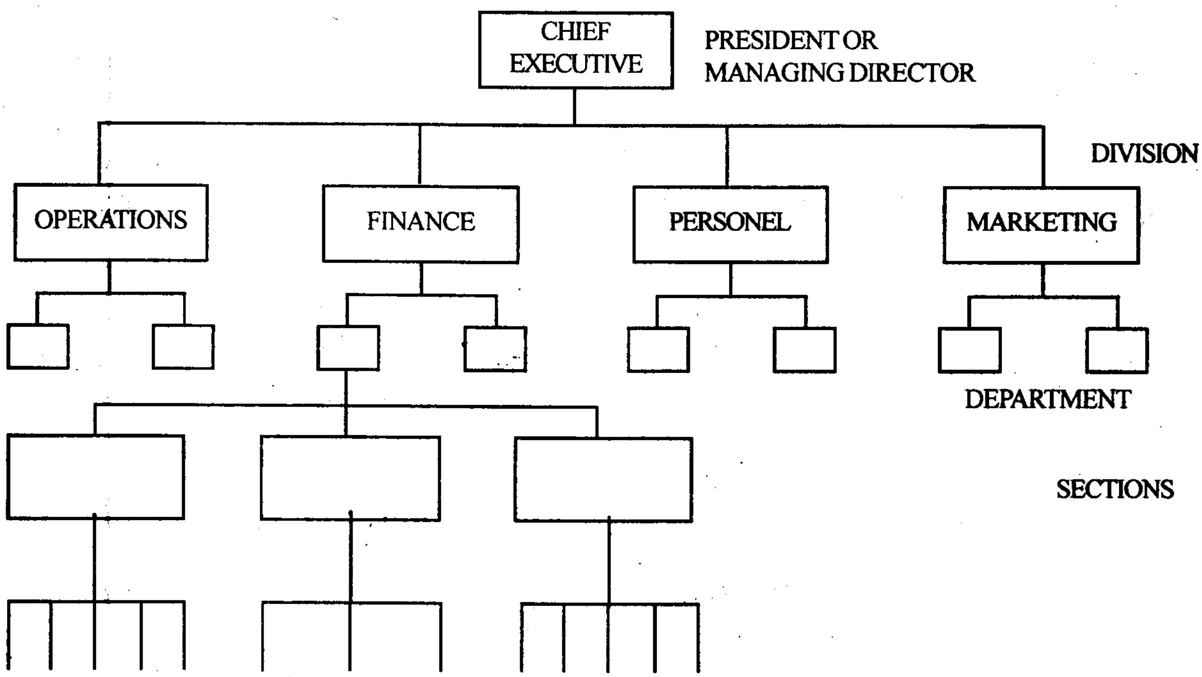
i) Budgeting and cost control is easier

ii) Technical skills are better.

--- specialists can be grouped to share knowledge/responsibility

--- persons can be assigned to many projects.

--- most advanced technology/skill are available to all projects.



iii) Flexibility in use of manpower

iv) Large manpower base to work with.

v) There is continuity in functional disciplines - policies, procedures, line of authority etc.

vi) Can easily cope with mass production activities to established specifications.

vii) Good control over personnel.

viii) Communication channels are vertical and well established.

ix) Capability of quick response exists although it may get influenced by functional priorities.

b) Disadvantages

i) No one individual is responsible for the total project.

ii) Project-oriented emphasis for achieving project goals is lacking.

iii) Co-ordination is complex and longer lead time required for decisions.

iv) Decisions normally favour the strongest functional groups.

v) No customer focal point.

vi) Response to customer needs is slow.

vii) Difficult in pin-pointing responsibility - no project-oriented planning, no project reporting, no project authority etc.

viii) Loss of motivation or innovation.

ix) Ideas are function-oriented and not project-oriented.

With the growth of project management activities, it was increasingly realized that the traditional hierarchical organisational structure was inadequate.

Activity 1

What is the critical role of appropriate organisation structure in effective management of projects?

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10.4 INTEGRATING PROJECTS IN FUNCTIONAL ORGANISATION

To overcome lack of focus on individual projects, efforts were made to develop work integration of functional departments by :

i) Specifying Rules and Procedures

Even though most projects are different, actions required by functional departments are repetitive and predictable. It should, therefore, be possible to integrate flow of work of individuals by drawing up and specifying rules and procedures.

ii) Undertaking Detailed Planning of Projects

Functional representatives were asked to be present in all planning, scheduling and budgetting meetings of individual projects so that they are involved in their schedules.

iii) Senior Level Intervention

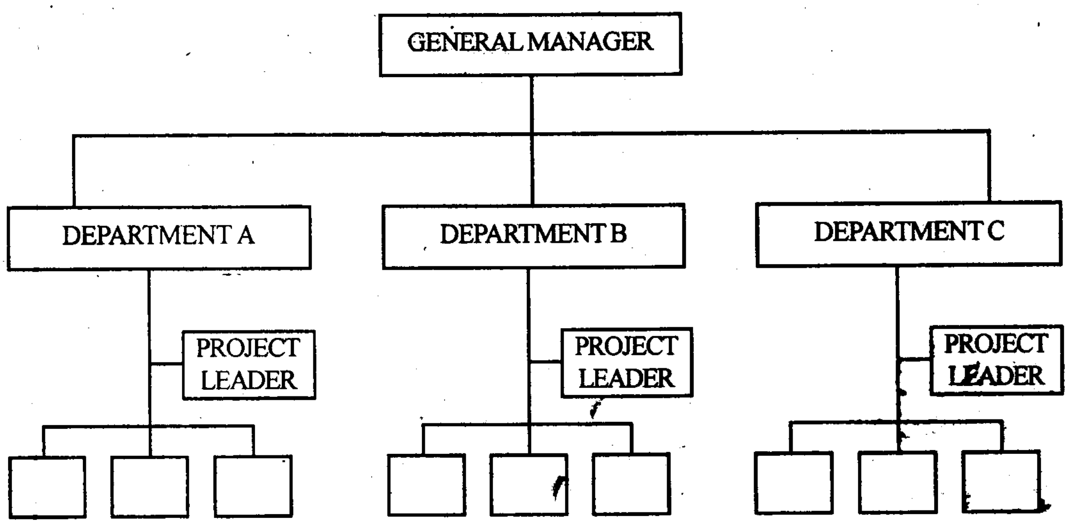
Continuous conflicts and struggle for power between functional departments required regular intervention by the senior level executives for resolving problems and conflicts arising from non-routine or unforeseen situations for which no rules or policies were framed.

iv) Direct Contact by Functional Managers

Although rules and procedures were framed and detailed planning undertaken aimed at resolving and minimising areas of conflicts, senior executives spent a great deal of their time in 'arbitrating' rather than 'managing'. Although direct contact among functional managers are encouraged, it proved to be rather ineffective.

10.5 EVOLUTION OF ORGANISATION STRUCTURES IN PROJECTS

Following are the various stages of development while evolving an appropriate oganisational structure for project work :



a) Project Leader or Co-ordinator

As a first step to resolve the problem, each department assigned somebody as a project leader or co-ordinator for the project. It was a temporary assignment and the oganisation structure was as shown in the above figure.

This mechanism proved quite effective for co-ordinating work within the department with the exception of stray case of wrong choice of project leader Conflicts did arise because many section managers were afraid that if they took direction from the project leader it would be an admission by them that he was next in line of succession to the department manger's job.

Besides when project leaders had to co-ordinate with other departments, conflicts arose. Project leader of one department did not have the authority to lease with other departments' personnel. Creation of these positions led to internal conflicts within the departments and many individuals loathed the job of project leaders and wanted to return to their safe jobs in the department. Where intra-department effort was required, General Manager had no option but to act as the Project Manager.

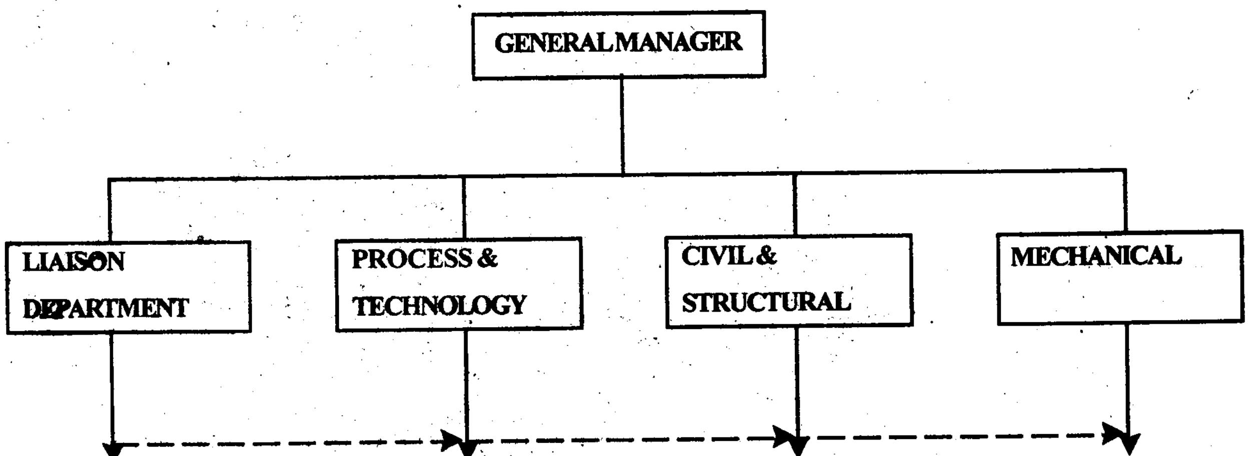
b) Task Force Concept

Owing to problems with the framework of 'project leaders', it was felt that integration of work of an individual project could be achieved if each department placed a representative on the task force who would jointly solve the problems as they occurred. Task force consisted both full time and part time personnel from each department. Meetings were held every day to review the progress and to discuss potential problem areas. Functional managers soon discovered that their nominees were spending too much time in unproductive meetings than in performing their own functional jobs. Many functional managers positioned unqualified and inexperienced individuals on task forces. As a result, they became ineffective.

This concept was a major step for resolving conflicts and for integrating work and in most case things improved. These could be formed very rapidly. However, integration was rather complicated-work flow was difficult to control as functional support was difficult to obtain as it was in the hands of functional managers. Also for external projects, task force concept was grossly ineffective.

c) Liaison Department

Next step in the evolution process of integrating project work was the induction of liaison departments in project engineering oiganisations handling many projects at the same time as shown in the following figure :

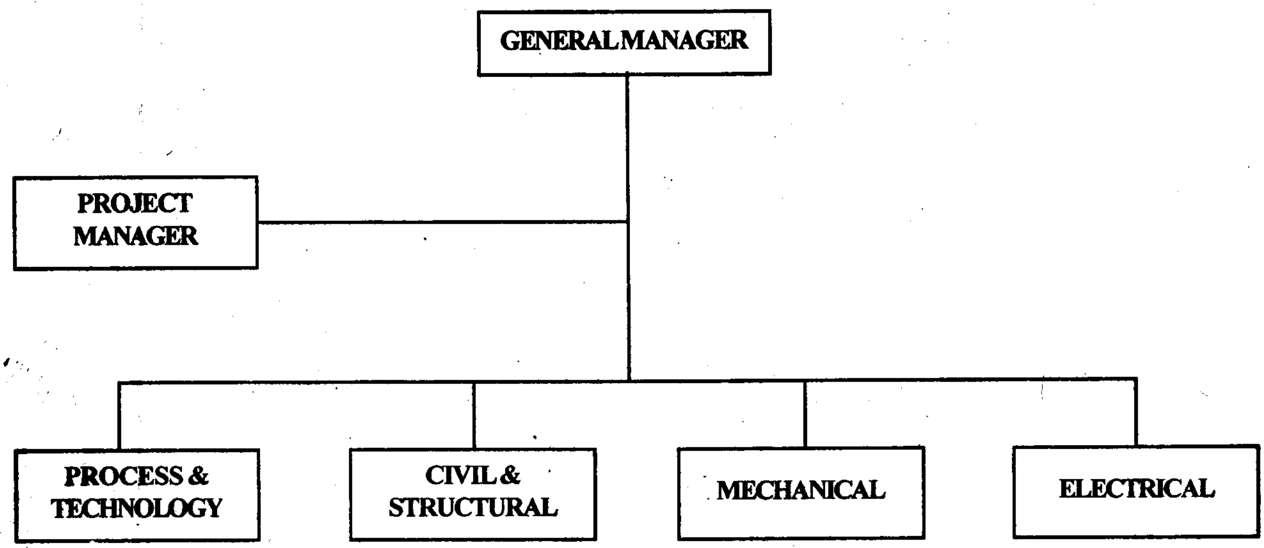


Liaison departments were created to handle transactions between functional department within the Engineering Division. Deriving their authority from the General Manager of the division, their prime function was to ensure that all departments worked to the same project requirements and goals. In some organisations, these liaison departments still exist and their functions extend to provide single-window contact with the customers.

Liaison departments were merely enlarged version of the old concept of 'project leaders'. They did not have any authority to resolve the conflicts as their authority was limited to the outer boundaries of functional departments. Whenever there was a conflict between departments, General Manager's intervention was unavoidable.

d) Project Manager as a Staff Function

It was becoming increasingly evident that control of a project must be given to personnel whose loyalty is directed towards the completion of that project on time, within budgets and performance parameters. Accordingly, the position was separated and he was slotted in the organisation as shown in the following Figure :



Project Managers served as a focal point - a centre for information and his main function was to keep the General Manager informed of the status of the project and to push papers and production people into completing activities on time. Project Managers had the monitoring authority. However, work allocation and performance appraisal reports of individuals on the projects continued to be made by the functional departments who refused to take instructions from the project managers as it would amount to admitting that they are in line of succession to the post of General Manager.

e) Project Managers with Shared Authority

In this situation, project managers were given some authority vested in the General Manager -they could assign work or prioritise duties in functional departments. However functional managers still had the authority of performance appraisals and enforcement of professional and organisational standards in the completion of the activities. Individuals on the job were caught up in a web of conflicting relationships which got aggravated as functional managers were forced to share their authority with project managers.This could not last long because:

i) Shared responsibility led to major conflicts.

ii) Functional managers were reluctant to give their authority to project managers.

f) Project Managers with Line Authority.

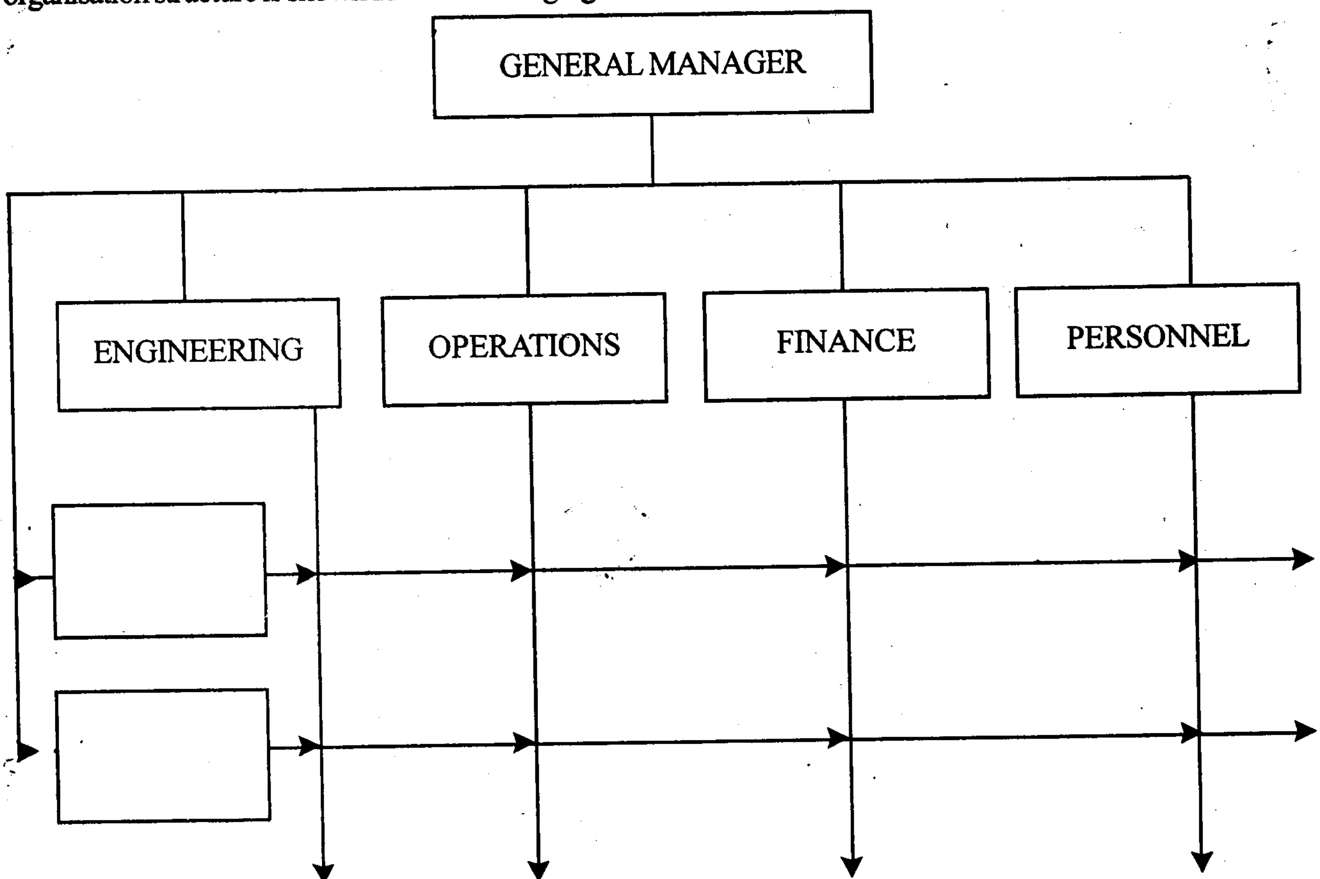
In large organisations, project managers were given all the staff on full time basis to work exclusively for achieving the project goals. It operates like a division within a division.This type of organisation can work as long as there is a continuous flow of projects. As long as the work is stable, conflicts will be minimum. Project managers not only assign work but also conduct performance appraisals and merit-reviews. Each individual reports to one person only Communication channels are strong and reaction time is very rapid.

The major disadvantage with this pure form of organisation is the cost of such organisation. There is no possibility of sharing individuals with other projects in order to reduce costs. Personnel tend to stay longer than they are needed as project managers know that once they released an employee, it will be almost impossible to get him back. As each project nears completion, personnel become uneasy and try to prove their worth. Although in such organisations, responses are fast and projects get completed on schedule, technology sufers owing to lack of strong functional support. The experience gained on one project may not be available to other projects and duplication of effort might ensue.

Conflicts occur with other similar project organisations whenever two projects use the same piece of equipment of facility at the same time.

10.6 MATRIX ORGANISATION

Matrii form of organisational structure combines advantages of pure functional structure and pure project structure and is ideally suited for companies which are project driven.A typical matrix, also called grid, organisation structure is shown in the following figure:



Each Project Manager derives his authority from the General Manager and represents a profit centre. He has total responsibility for the project and is accountable for its success. Functional Departments have responsibility to ensure technical and professional standards on the project. Functional Managers ensure unified technical expertise and complete exchange of information and experience on other projects. Matrix management is a collaborative function and decision making rests with the team instead of the project manager in a pure project oganisation.

a) Basic approach in Matrix Organisation Structures

Matrix approach is an attempt to create synergy through shared responsibility between project and functional management. No two working environments are identical, therefore, no two companies will have same design of matrix structure. Both project and functional managers maintain some degree of authority, responsibility and accountability on each project. They should, therefore, continuously negotiate with each other - Project Manager might consider what is best for his project whereas functional manager might consider his departments' interests more important than the project.

Since project managers do not have any formal authority they have to resort to their technical competence and their interpersonnel skills in order to be effective. Project Manager acts as a unifying force for project control. He must maintain open channels with the functional departments.

Individuals at the interface level have two bosses - he must take direction from both project manager and functional manager. The performance appraisal rests with the functional manager who normally consults the project manager. Even so there can be conflicts but the individual at the interface can help by suggesting to both the managers to communicate with each other and resolve the problem. This poses two kinds of challenges to the project manager viz.,

i) How to motivate individuals working on the project - full or part time - so that their loyalties are with die project?

ii) How to convince individuals to work to project directions when they might coflict with department policy or it the individual feels his functional boss may not regard these instructions favourably'?

b) Rules for matrix Organisation Structure

i) If individuals spend more time on the project, it ensures loyalty

ii) Horizontal as well as vertical channels exist for making commitments

iii) Conflict resolution should be quick and effective,

iv) Communication channels and access between managers must be good

v) All managers must provide input for the detailed project planning.

vi) Both horizontally and vertically oriented managers must be willing to negotiate for resources.

vii) Horizontal lines must be permitted to operate as a separate entity except for administrative matters.

10.7 COMPLEXITIES OF MATRIX ORGANISATION STRUCTURE

Researchers have identified nine pathological complexities of matrix system of management:

i) Power struggle between horizontal and vertical hierarchy

ii) Formation of organisational islands during period of stress leading to anarchy

iii) Decision-making by group may degenerate into groupitis.

iv) Matrix system flourishes during periods of growth but may collapse during lean times

v) Critics voice their concern whether excessive supervision of matrix structure is really necessary.

vi) Too many people involved in decision-making may stifle (strangulate) the process.

vii) Pushing matrix structure too much down into the depth of organisation may sink it completely.

viii) It might lead to layering by creating matrix within a matrix structure.

ix) Organisations might start suffering by being overly obsessed with internal relationships to the detriment of external relationships.

10.8 ADVANTAGES OF MATRIX ORGANISATION STRUCTURE

The main advantages are:

i) Project managers maintain control over project resources and costs through functional managers.

ii) Policies and procedures for each project can be spelt out separately provided they do not contradict company policies and procedures.

iii) Project managers can commit company resources if that does not conflict with other projects' requirements.

iv) Organisations can respond rapidly to changes, conflict resolution and other project requirements.

v) Functional organisations exist primarily to support the projects.

vi) Each person has a home where he returns after project completion. Each person can be motivated showing him his career path.

vii) Strong technical base and problem solving capability can be developed and expert knowledge is available to all projects.

viii) Key people can be shared and cost on projects can be minimised. Since people work on a variety of jobs, it provides challenges and opportunities and consequently higher job satisfaction.

ix) Conflicts are minimal and can be solved easily and quickly

x) We obtain better balance between time, cost and performance.

xi) Development of skills of specialists and generalists is rapid.

xii) Authority and responsibility are shared.

xiii) Stress is distributed among the team and functional managers.

10.9 FITTING MATRIX STRUCTURE INTO THE ORGANISATION

Matrix structure should be introduced into the organisation when :

i) Short run projects are the primary output.

ii) Complicated design calls for both innovation and timely completion.

iii) Several kind of skills are needed in designing, building and testing the product and these skills need constant upgrading and updating.

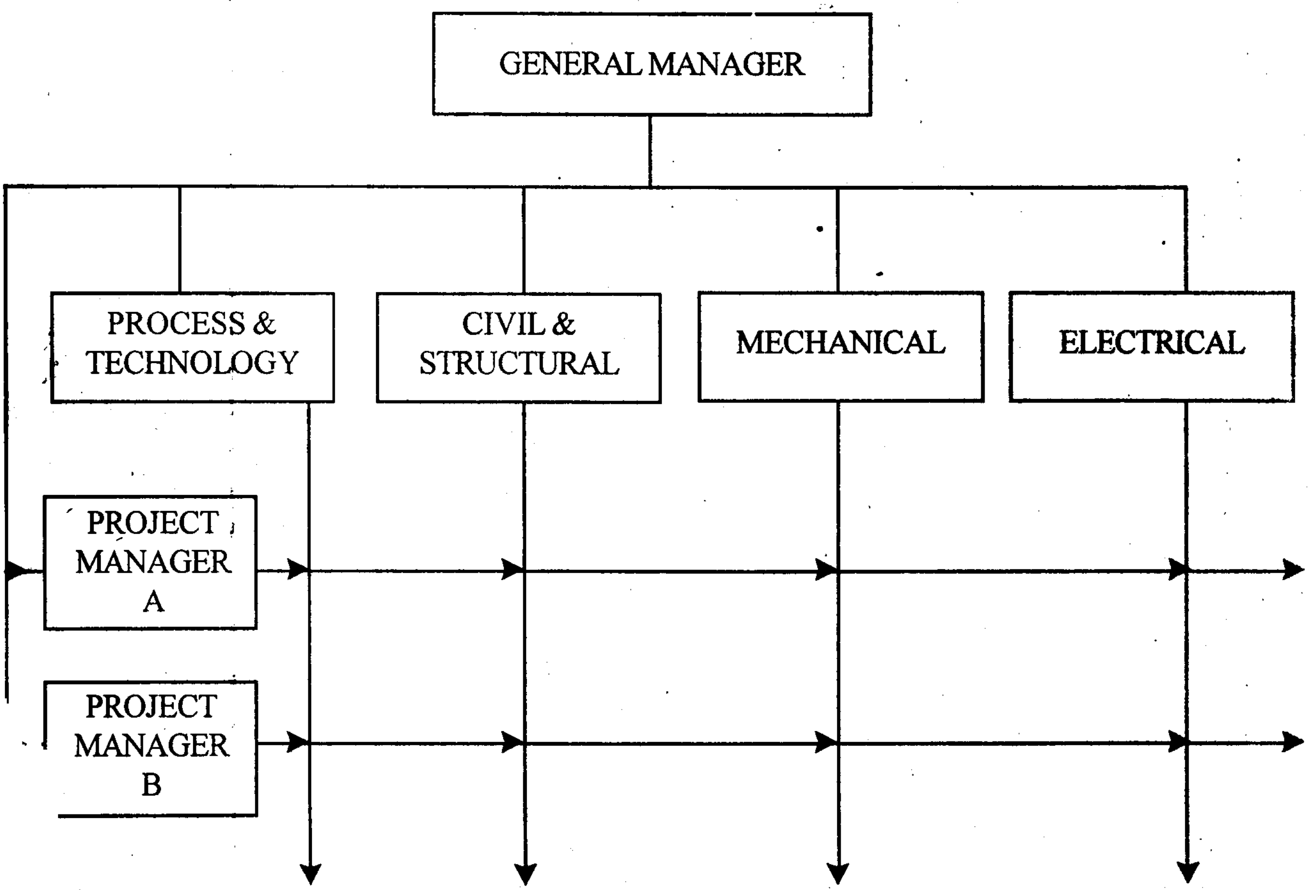
iv) Rapidly changing market place calls for significant changes in products.

10.10 TYPES OF MATRIX ORGANISATION STRUCTURES

There are three variants of the matrix structure:

(a) Medium Size Organisation

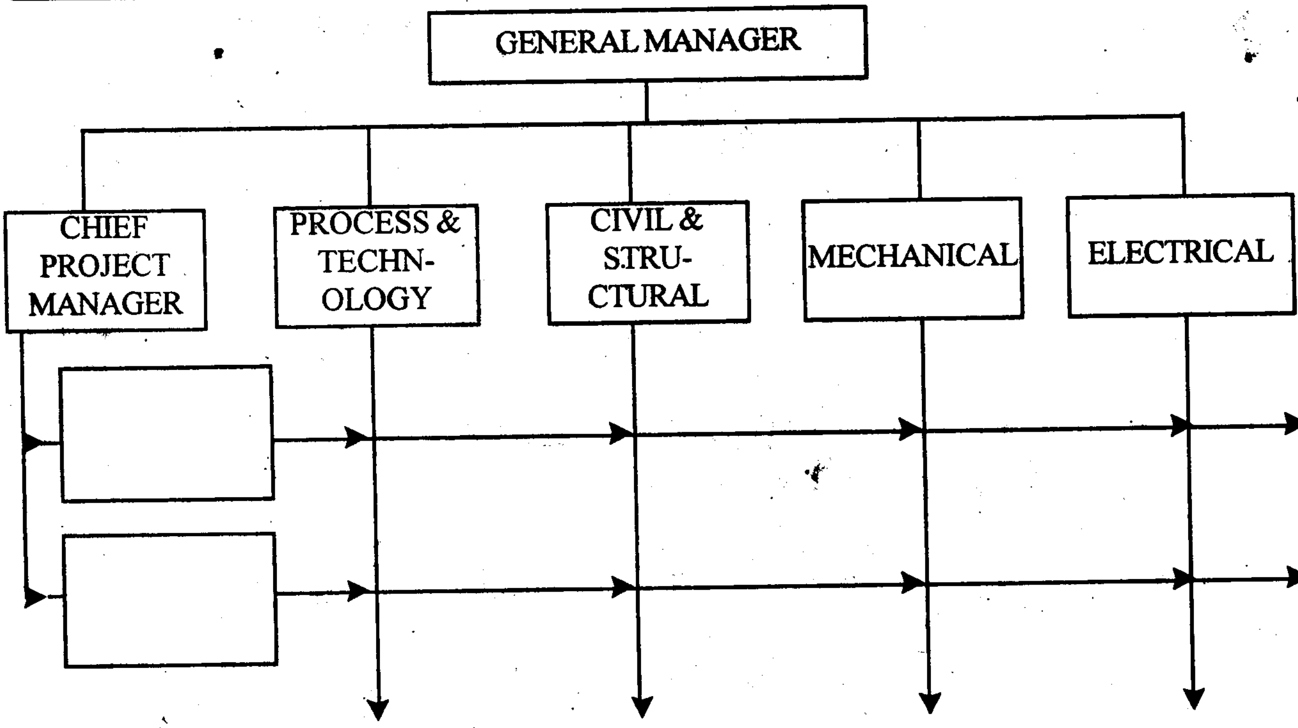
The structure is shown in the following figure :



The above diagram shows that individual project managers report to General Manager. This kind of Organisation works satisfactorily when the number of projects is not large and organisation is quite small. As a result, General Manager has sufficient time to co-ordinate activities of project managers.

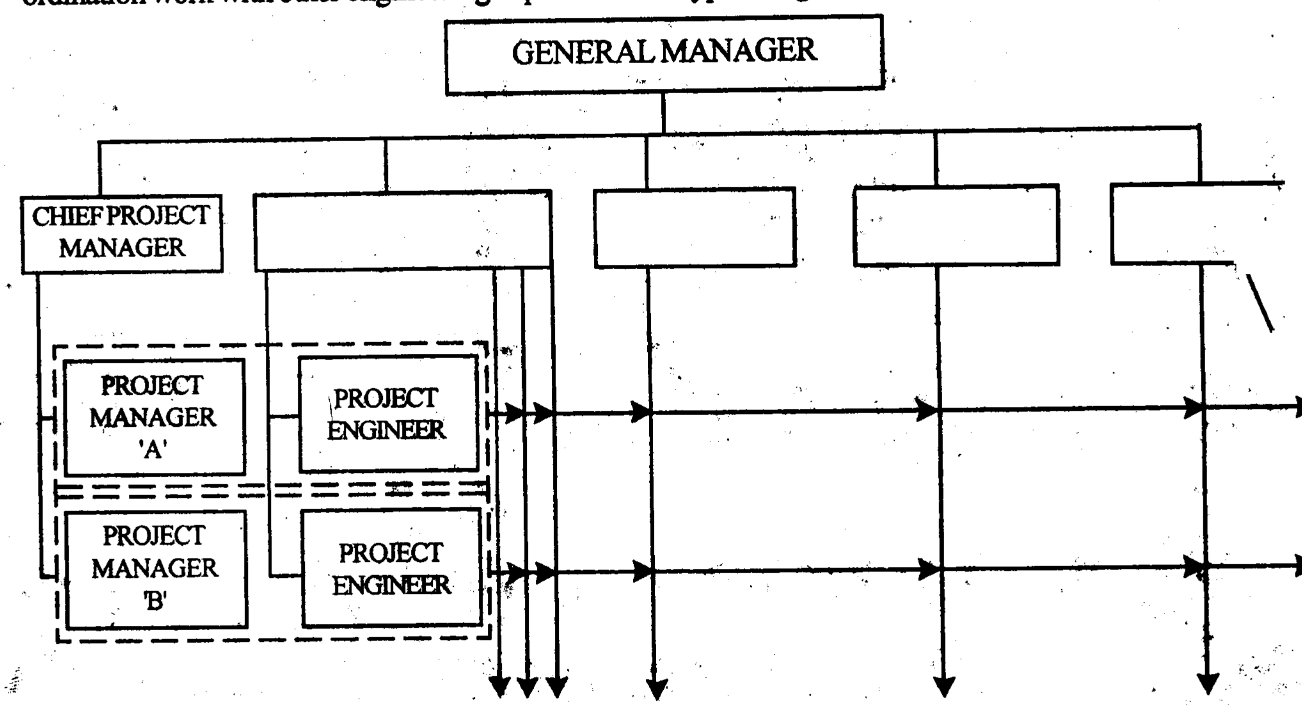
(b) Large Organisation

When number of projects is large and companies grow in size, General Manager may not be able to co-ordinate that many projects. In such events, a new position is created - Chief Projects Manager or equivalent as shown in the figure :



(c) Matrix with Separate Project Engineering Functions

In the above two variants, we have visualised project manager's job as a composite one which included project engineering functions. In some organisations, it is not so project engineering is a separate functior under the engineering division. In such organisations, we create another cell of Project Engineering whr operate as Deputy Project Managers but control all other functions and act as a focal point for all co-ordination work with other engineering departments. A typical organisation chart is shown in the figure :



10.11 ORGANISATION STRUCTURES IN TWENTY-FIRST CENTURY

Horizontal lines of matrix organisation structure are profit centres; consequently project management would offer the best opportunity for training future managers and executives to be cost conscious and profit-oriented. Owing to increasing competition of global economy and rapid changes in technology and communication network, there will be a shift in favour of flat organisations by doing away with several layers of functional managers. Project matrix structure is expected to increasingly dominate the style of management in future. Project teams will be responsible for the complete operations of existing products.

Increasing use of computers and information technology will further integrate functional departments and 'smart terminals' will play major role in project control.

Top managers will be more directly involved in the control of total business oganisations with the help of project managers who would span the middle level and lead project teams to look after specific tasks of operational management.

Activity 2

~~Compare and contrast~~ the matrix type of project organisation structure with the traditional hierarchical structure where 'unity command" is the rule.

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10.12 SUMMARY

Involvement of large number of personnel for execution of project heads to systematic formulation of organisation. Over a period of time a number of departmentalisation have emerged. Advantages and disadvantages of hierachical organisation are discussed. A typical matrix, called grid organisation structure is shown and discussed with respect to project. Both complexities emphasized in this unit. Owing to increasing competition of global economy and rapid changes in technology and communication network, there will a shift in favour of flat organisations by doing away with several layers of functional managers.

10.13 SELF-ASSESSMENT EXERCISES

1. What are the different organisation structures recommended for project organisations and what are their advantages and disadvantages?
2. What is matrix organisation and what are the advantages of the organisation design for project management?
3. What are the trends in organisation design for the next century?
4. Compare and contrast product organisation structure with project organisation structure?
5. "Structure supports strategy" justify in the context of project management environments.

10.14 BIBLIOGRAPHY AND FURTHER READINGS

1. Harold Kerzner Project Management- *A system approach to Planning, Scheduling and Controlling..*
2. R L Martino *Project Management and Control- Three Volumes,* American Management Association.
3. L J Goodman *Project Planning and Management -An Integrated System for improuing Productivity,* Van Norstand, New York.
4. C C Martin *Project Management - How to Make it Work,* Ama Com. New York.

BLOCK 3 IMPLEMENTATION AND CONTROL

This block contains four units. The first unit (Unit 11) gives an insight into the project implementation and control: An attempt has been made to explain the advantage of integrating MIS with planning, scheduling, reporting, reviewing and updating of projects. Effective cost control system is explained clearly along with project monitoring and reporting. Unit 12 explains the vital role of material and equipment in project implemention and control. Human being acts as a driver in project implementation which is explained in unit 13. It has been elaborated on vitalizing project terms, empowering project personnel and feed forward project control. Unit 14 explains the essential aspects of fund and expenditure management. Factors affecting the control of project cost, PERT - Cost system, performance analysis approach etc. are elaborated in this unit.

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UNIT 11 PROJECT MANAGEMENT INFORMATION SYSTEM

Objectives

Study of this unit will enhance your understanding of:

- role of management information system (MIS) in implementation and control of projects
- vital role of feed back from events generated by project implementation for all the phases of project management
- advantages of integrating MIS with planning, scheduling, reporting, reviewing and updating of projects
- productive role of MIS in evaluating impact of delays on future events and triggering of corrective remedial measures
- appreciation of different types of reports and their frequency
- role of computers in accelerating compilation and transmission of reports to aid decision making at all levels and in dispersed locations.

Structure

11.1 INTRODUCTION

A project is typically an assignment that has identifiable start and finish and consists of a series of discrete, finite tasks. Setting up an industry, building a house, publishing a book or introducing a new product are all example of projects. All of them have identifiable beginnings, endings and are comprised of a series of finite tasks. In contrast, maintaining a clean office, using a product or understanding a book are not projects -they are continual and repeating processes with no predictable starts or finishes. Project Management offers methods and techniques for planning and Controlling projects. A good Project on time and at cost closest to the one originally envisaged. Any delay in the implementation, delays the anticipated benefits which were planned from the establishment of the project. In certain cases minor delays can often result in major losses. Similarly, any increase in the project cost adversely affects economic viability of the project. In the cases of large cost overruns, it may not of the project. In the cases of large cost overruns, it may not be possible to arrange sufficient funds to complete the project in time causing unplanned delays in the project implementation.

The three primary phases of project management are :

a) Planning : In this phase, you identify the general requirements of a project, break it down into discrete activities, determine the sequence and interdependence of these activities, estimate resource requirements and find the "Critical Path".

b) Scheduling : This phase overlaps with the planning phase. You give actual calendar dates to the activities and determine the overall project dates. Calculate the early and late start and finish times for each activity of the project.

c) Implementation and Control : The implementation phase which is also the control phase begins once the project is underway. Here you employ a variety of techniques to achieve optimisation of resources usage, monitor progress and cost, forecast completion dates and overall project cost and ensure that critical activities are completed on time.

A major project encompasses numerous areas and disciplines. Each operates as a separate autonomous unit. Integration is the approach of bringing them together. It is the key to effective project management. Project success is completely dependent on adequate planning, direction, scheduling, monitoring and control.' These project functions must be closely bound together by an adequate information and control system if project performance is to be adequately measured and controlled. For efficient project operation, a single information and control system should be used, not separate project and functional department cost control systems. The integrated information and control system should be compatible with the needs of the project and the functional managers.

The success of timely implementation of projects depends on the availability of essential information at appropriate time. Normally, the information needed at different levels would depend on the hierarchical structure in a project. In large projects, there could be three distinct levels, viz., the top or corporate level, the general -or executive management level and the functional or operating management level. The information needs of all these three levels are not the same. Therefore, the information system has to be designed in such a way that the needs of all these three levels are adequately taken care of. In a project, the information reports are basically used for project monitoring and control with the idea to ensure that the projects are executed as per schedule and at minimum cost. The social cost of delay can be of a very high order and, therefore, the need for timely completion of the projects is of paramount importance.

11.2 OBJECTIVES OF PROJECT MANAGEMENT INFORMATION SYSTEM

The project information/monitoring system would have to have the following objectives.

— Record and report relevant information and the status of various components of the project in such a manner as to bring the most critical activities directly to the attention of concerned managers at appropriate level.

— Highlight deviations from the plan, if any, in respect of every component of the . project and also to indicate the effects of such deviations on the overall status and completion of the project as a whole.

— Form the basis of updating of project schedule wherever necessary.

— Identify and report on critical areas which are relevant to different levels of management and to highlight the corrective action that needs to be taken.

— Sift the information and report on an exception basis. In other words, emphasis is focussed on those activities that are not going according the plan.

— Provide a basis for the evaluation of the performance of the functions of various managers and departments by regular comparisons with budgets/plans/schedules.

Mere physical progress reporting and monitoring does not ensure timely completion of the project at the minimum cost. Along with monitoring on physical status, another parameter namely, value of work done and cost implication of delays in commissioning the project should also be monitored. For this purpose, the physical progress of each activity has to be converted into monetary terms, using unit rates established by apportioning the cost over all the activities.

In designing project management information system, the following have to be spelt out clearly :

— The objective of each format or report in brief.

— The distribution chart.

— The periodicity of the reports.

— The persons responsible for preparation of the reports.

— The timing of the reports.

— The sources from which information has to be gathered in the preparation of reports.

11.3 PLANNING BY NETWORK ANALYSIS

The basic premise of the project network planning method is that a network can be used to reasonably represent performance sequence of a project. Complexities of modern projects have made network scheduling mandatory for adequate project control. Experience shows that total project duration derived by breaking project down into discrete activities and basing each activity estimate on the planner's experience and historical data is valid and useful.

a) Resource Allocation

By using positive float available on non-critical path through the project, the project planner can arrange a schedule of work that accomplishes the result in the same time while smoothing or levelling the peaks and valleys in the resources to be consumed.

b) Work Breakdown Structure (WBS)

Project WBS breaks the total task into a logical series of smaller tasks, each of which is chosen for size and scope to fit in with the management structure of the project so that it can be subject to efficient planning and execution. The WBS of a large construction project is depicted in figure-1 (a) and 1 (b). It may be observed that work package is a logical chosen to suit the requirement of engineering, planning, contract administration and cost control. Each work package carries a duration and cost control.

The essentials of WBS are :

— Work packages are related to organizational break down for effective control and performance measurement.

— Cost estimates are built up by aggregating the cost of work packages following a logical WBS of the project.

— Work packages must be related logically to the code of account applicable to the project to enable exercise of effective cost control function.

Activity 1

Time is one of the most critical success variable in projects. List down the advantages of monitoring and controlling 'time duration' of projects.

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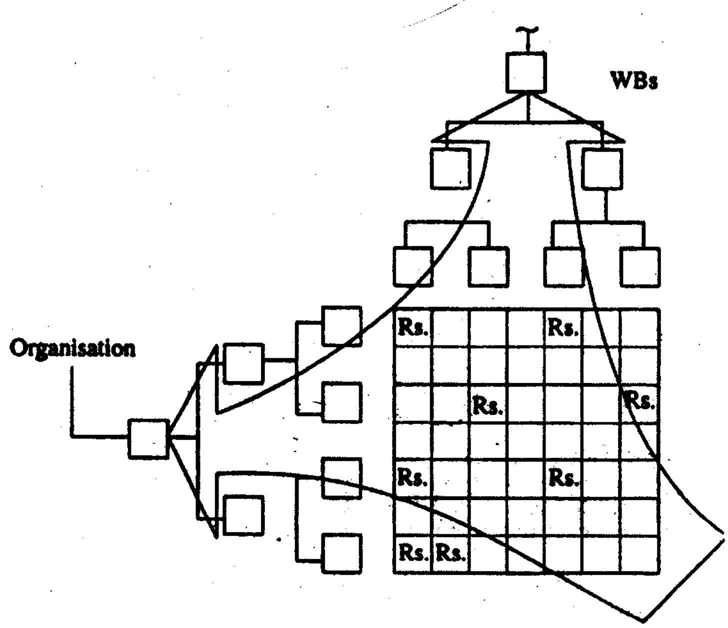

Fig 11.1 : (a) Work Breakdown Structure

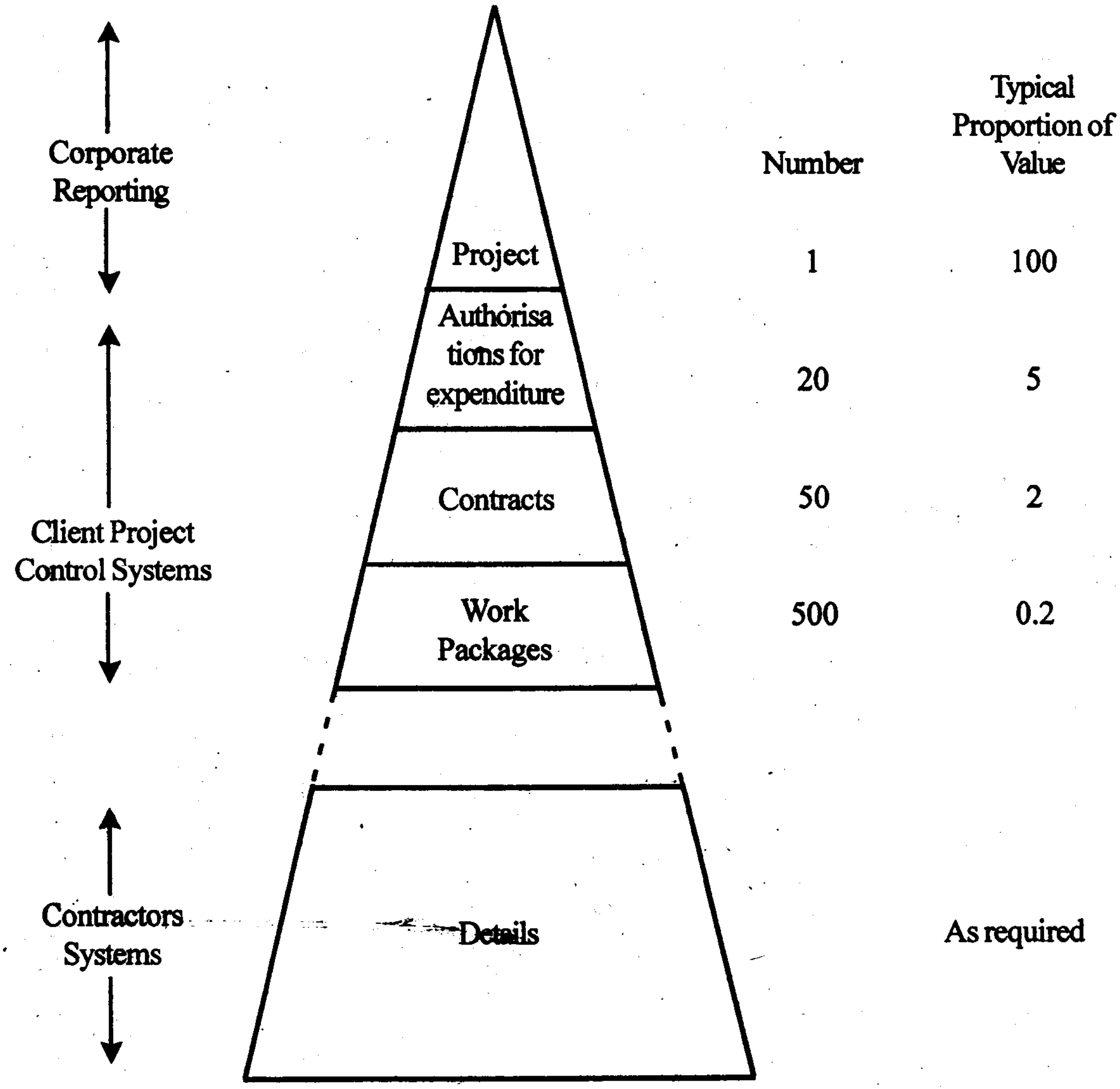

Fig 11.1 : (b) Work Breakdown Structure for Large Civil Engineering or Construction Project

11.4 COST CONTROL SYSTEM

Effectiveness of the project cost control system is largely dependent upon the following :

a) Realistic estimation of cost at initial stages.

b) Adequate provisions for contingencies at initial stages.

c) Effective cost reporting system.

d) Timely identification and implementation of effective cost control measures.

Realistic estimation of cost at initial stages practically forms the back-bone of any effective cost control system. Typical elements that affect estimate accuracy are generally known and well documented in technical publications and elsewhere, although their effect may be difficult to quantify.

There will be an element of risk in a cost estimate for there is no such thing as an "Accurate cost estimate". What exactly contingencies are intended to cover should be made perfectly clear.

The efficacy of the project cost control system is largely dependent upon the cost reporting system. Effective cost reporting system should not only incorporate information on actual cash flows but also full information on commitments being made or likely to be made by various responsible executives for the activities under their control.

Periodic review of estimated cost to completion (ECTC) is an essential feature of an effective cost control system. ECTC for each package or activities according to responsibility centres, should be compiled on the basis of actual commitments entered into, likely commitment under processing as well as anticipated commitments to completion of the pacakage/activity during every reporting cycle. The ECTC for all the packages/activities comprising the total project, scope will' give the latest estimated cost to completion for the project.

Adoption of best possible methods for realistic estimation of cost, making adequate provisions for contingencies at 'initial stages as well as having appropriate cost reporting system alone is not enough for controlling the project cost, Identification of problem areas and timely implementation of effective remedial measures only can help in keeping the project cost in check.

Periodicity of project cost review should be established on the basis of the ability of the organization to furnish information required for the cost reporting system as well as the extent of delays that can be tolerated by the management in the identification and implementation of cost control measures. In case it is practical to install effective cost reporting system for. weekly cost reporting, the same would be ideal. However, for a large organization, collection and compilation of reliable information related to project cost for various package/activities for all on going projects and forwarding the same to the Corporate Head-quarters becomes an problem in the absence of effective channels of communications. In such cases atleast a monthly review should be undertaken. Periodicity should certainly not be less than once a quarter to be able to exercise any meaningful control on project cost.

Activity 2

Think of a procedure of cost monitoring of projects which aims to support cost-efficient design and engineering.

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11.5 INTEGRATED PROJECT MANAGEMENT INFORMATION SYSTEM

Structure of a typical integrated project management information system is depicted in figure-2. It allows total project information to be structured into a number of data sets which are integrated by the software. Some of the relevant datasets for a large project are:

------ Drawing dataset

------ Network dataset

------ Cost dataset

------ Material dataset

------ Vendor dataset

------ Job card dataset

------ Rates dataset

------ Resources dataset

------ History dataset, etc

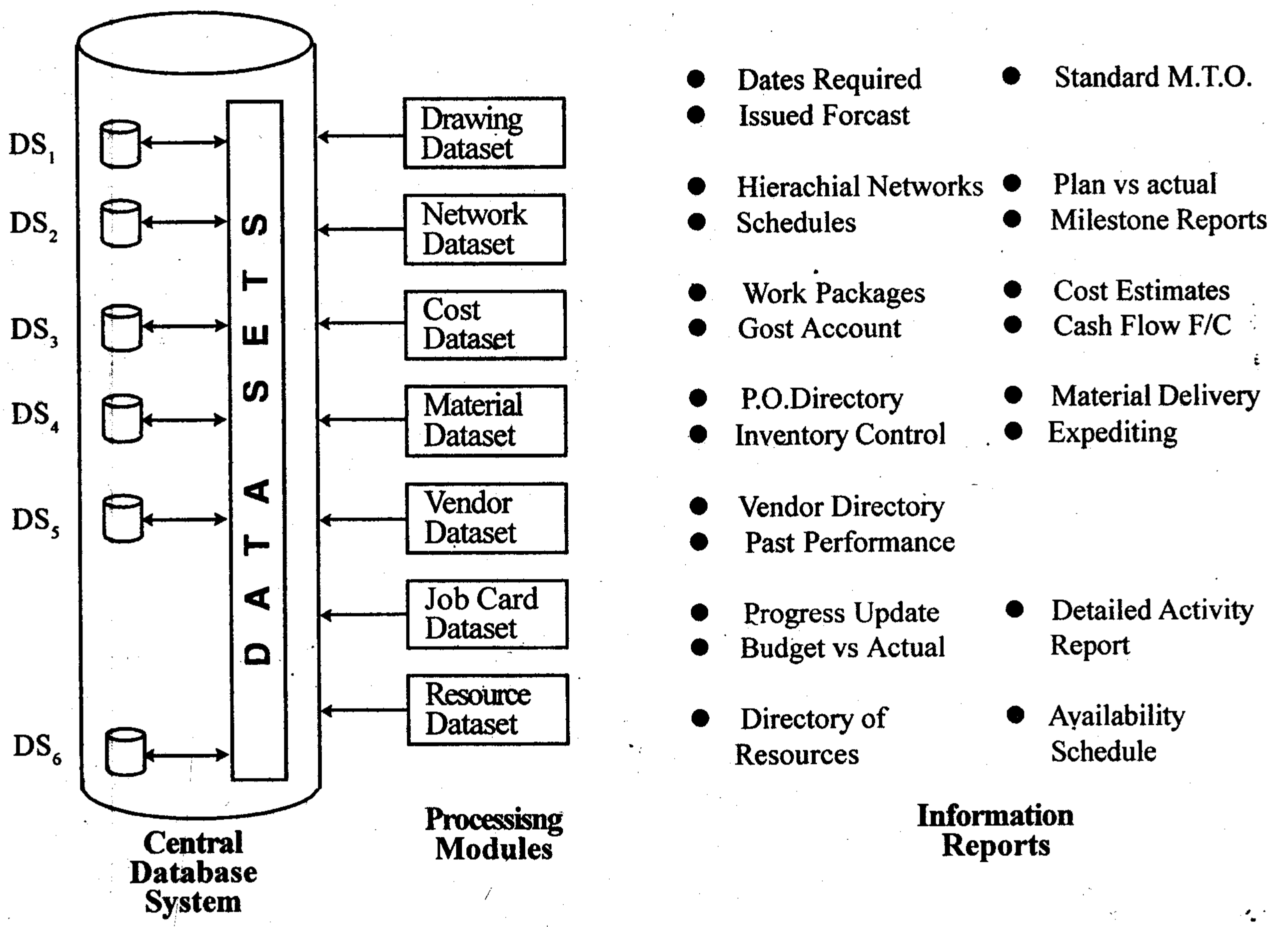

Fig. 11.2 : Integrated Project Mangeraent System

Integration of these independent datasets through various processing modules enables high control of projects; It permits.:

— Horizontal integration between disciplines, e.g., cost/schedule integration, or, cost estimates, cost accounts and project schedule integration via Work Breakdown Structure.

As illustrated in figure 11.3, availability of integrated performance reports to higher management is thus possible.

— Vertical integration. Data can be aggregated ('rolled up') to any required level to produce desired summary reports.

Standard processing modules are available for all important project management methods plus other modules for special requirement.

a) Drawing Dataset it contains information on :

— Drawing number
— Drawing description or title
— Date drawn
— Date first issued
— Subsequent revision numbers and issue dates
— Draughtsman's name and his department
— Schedule of quantities (standard material take off), etc.

Management control is exercised through queries such as :

— Identify all drawings which are not yet approved.
— Drawings which are due for issue in the next four weeks.
— Listing of drawing for a specific area of the project.

By linking the Drawing Dataset with Network Dataset, anticipated drawing issue dates can be compared with on-site required dates for various activities. Efficient retention and easy access of information are the key to several record management applications.

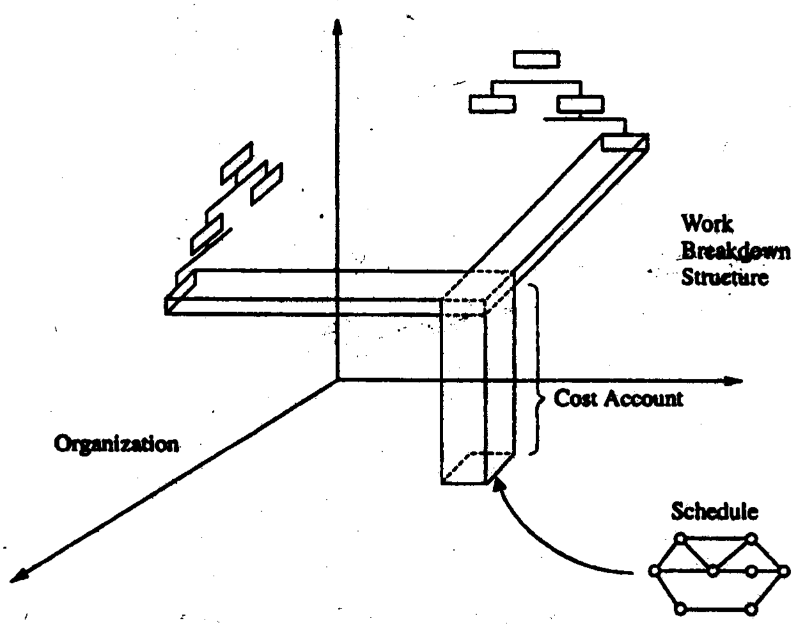

Fig. 11.3 : Project and Scehdule Integration

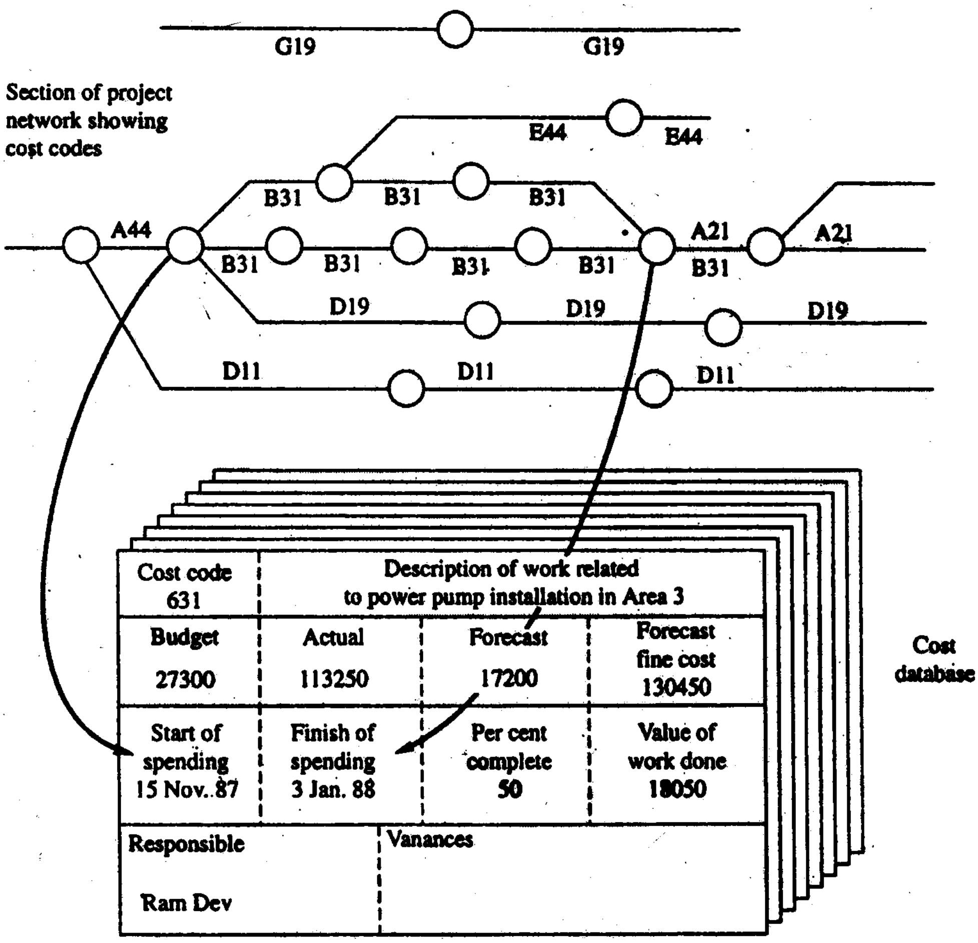

Fig. 11.4 : Linking the project network to the cost database

b) Network Datasct : Vertical integration enables a project to be structured into hierarchical networks, where a top level network may contain about 150 to 200 activities and this is driven by a second or third level network having many more activities.

— Progress information on lower level networks can be 'rolled up' and summarised to the management level network.

— Key events or milestones reports highlight the deadlines.

c) Cost Dataset : This dataset contains details of each project cost account. This is based on a defined work package with an identified manager and reflects the logical WBS of the project discussed earlier. A large project could contain several thousand records, usually structured so that the cost can be 'rolled up' to show the position on each section of the project and the overall position. The fields of information usually include.

— Account code or cost code
— Description of the work package
— Person responsible

— Budgeted provision
— Actual cost of date of work completed
— Cost forecast of residual works taking into account 'change orders', etc.

As a result of integration of cost data set with project schedule, effective cost control is now possible. As shown in figure-11.4, dynamics of time/cost trade-off can be examined in a more scientific manner after assessing overall implications before a final decision is made. Cost dataset in conjunction with current schedule can be used for cost forecasting.

d) **Material Dataset :** It contains all the information on the materials required, the dates when they are required, and the manufacturing location for each item. A typical material management system begins with material take-off (MTO) from the drawings, covers the entire bidding, procurement, expediting and shipping process, and extends through to site inventory control. Examples of specific functions served by a material control system include :

— Material Register
— Inventory Control
— Delivery Analysis
—. Bulk order discounts
— Purchase order
— Material Quality Assurances

Typical management queries from such a system relating to a specific area, such as "expediting" would include

— Materials required at the site in the next 4 weeks.
— Late materials only, grouped by vendor or manufacturer.
— All materials expected ex-works this week.

e) **Vendor Dataset :** This provides a record for each supplier, his name, address, telephone and telex numbers, the name of the usual person to contact and line of business. The details of past performance will be included for use in vendor rating and initial choice of vendor.

The terms and conditions of contract, progress, payment schedule, history of delivery and many other pieces of information about vendor can all be stored, related and accessed. Because information relationship can be identified to properly linked multiple datasets, data duplication is reduced in the project data base. For example, the vendor's code is identified on the material package record in the material dataset that is also linked to the vendor dataset which contains names, addresses and other pertinent information.

f) **Job Card Dataset :** Job Card carries details of each job performed on the project. Typically, the job card level is directly below network planning in the project hierarchy and facilitates day to day planning.

— Job Description
— Budgeted amount
— Planned start and finish dates
— Resources required for executing the job

It includes procedures for progress control and effectively provides the mechanism for allocating work, collecting project information and (via the relational data base) updating the rest of the project systems.

A large organisation engaged in a large number of power projects has evolved a system of information reporting, covering the project as a whole and construction activities separately. A last of a model reporting and monitoring system in line with the system of the above company is indicated later in this chapter.

This very comprehensive and detailed system has been given only as a model as it covers every area of Project Implementation. Each project has to, on the basis of nature of the project requirements and its management set up, design its own information/ monitoring system. The underlined idea is that the information required for corrective action should be available at the appropriate time. In addition to these reports, it would be more appropriate, to deliberate and take stock of the situation periodically by having meetings with all the functional heads wherein critical analysis of the performance in all areas of the project management can be made and decision on the course of action taken.

11.6 PROJECT MONITORING AND REPORTING

In order to keep track of the project's status and head off problems before they occur, it is important to regularly report activity progress.

You report progress along the dimensions applicable to the activity. For example, certain activities involving creative work can not be accurately assessed in terms of physical percent completion. However, for certain other activities you can easily gauge duration complete and remaining duration. By regularly reporting progress you can anticipate the shifts in float and criticality that inevitably occur. An activity not previously on the critical path might become critical if the start of its predecessor is delayed. By the same token if an activity finishes sooner than expected, it may create some float for a previously critical activity. Thus reporting progress allows you to anticipate resources shortages and schedule delays and with luck, to work around them. After reporting progress against each date, you should create a new schedule. This schedule reflecting actual performance, is referred to as a Current Schedule. You compare your first set of current schedules to your target schedules. Then as the project proceeds, establish new targets to compare to current schedules. In this way you can always identify where the project is deviating from the goals you have established.

a) Project Monitoring Reports

i) Overall Status Reports

1. Monthly project status report
2 Delay report assessment
3 Township progress report

ii) Value Reports

4. Format for contract, cost allocation
5. Activity cost breakup
6. Record for compilation of value of work done
7. Value of work done (project)
8. Summary of value of work done (site)

9. Report on value of work done (site)
10. Contract progress report
11. Project value report

iii) **Contracts**

12. Schedule for contract activities
13. Schedule for mile-stones activities
14. Contract package-wise activities
15. Contract progress summary
16. Departmental performance summary
17. Contract progress summary
18. Delay report - contracts

iv) **Contractor's Works**

19. Activities schedule - contractor's works
30. Physical progress summary - contractor's works
21. Bulk material procurement progress
22. Delay report - contractor's works
23. Schedule activities
24. Physical progress targets
25. Delay report-site
26. Physical progress report
27. Report on construction machinery deployed
28. Contractor's manpower status report
29. Bulk material procurement progress
30. Daily critical activities progress report
31. Daily progress record
32. Daily progress report

v) **Infrastructure**

33. Schedule for site contracts
34. Site contracts progress summary
35. Infra-sturcture progress report
36. Infra-structure progress summary

b) Management Reports

The fundamental principle on which the management reporting, structure is to be built up is the "Exception basis of reporting". The system must provide for comparison of actual performance and expenditure with plans and budgets and an analysis of deviations from plans reason-wise. To a large extent the reports should highlight information for effective control on quantity, time and cost of activities within a function. In certain

.as like rejection of incoming material which are not planned, the reporting would not be against budget or gets but in absolute terms.

e reporting system assumes a comprehensive system of performance budgeting and activity planning. In signing the reporting systems the activities of the undertaking have to be broken up functionally according to e current and planned organisation structure .and further into sub-functions depending on the nature. As far possible the system should cover each such sub-function. Each report could cover one of the sub-function l analyse the performance.

e forms should be designed to print the actual results (for the period and cumulative for the year) and mparisons with previous periods and with what was planned (for the current period and cumulative for the :). All forms can provide a remarks column for explanatory notes, overall remarks, and notes on extraordinary ents which have a bearing on the period performance.

Technical Services

1. Status on project engineering report
2. Contracts status report
3. Achievement of objectives report

Materials

4. Inventory status report
5. Inward rejection report
6. Material issued to contractors report
7. Delays in procurements report
8. Delays in supplies report
9. Demurrage paid report

Construction Facilities

10. Construction equipment control report
11. Construction utilities control report
12. Maintenance report
13. Auto base control report

Personnel

14. Manpower and recruitment report
15. Staffing report
16. Training and development report
17. Manpower cost report
18. Divisional manpower cost report

V) **Finance**

19. Funds report
20. Loans utilisation report
21. Payments to contractors report
22. Cash flow report
23 Cash flow analysis report
24. Divisional cash flow report
25. Indirect expenses report
26.. Indirect expenses analysis report
27. Divisional indirect expenses report
28. Divisional indirect expenses analysis report
29. Expenses control report.

11.7 SYSTEM AUTOMATION AND COMPUTERISATION

Modern project control methods are most successful when automated, as has been found necessary handle today's very complex and large projects. Considerable thought has to be given in the developmen appropriate system to take care of collections of reliable information, its compilation, analysis and presentat of the same to various levels of management according to their own requirement and spans of control. T system will generally comprise of an extensive electronic data bank, development of detailed reports various users and identification of effective control measures at appropriate levels which percolate dow time to be able-to achieve their envisaged objectives?

Activity 3

Computerization enjoys quantification. List down some aspects of reporting on vendors management wh cannot be quantified but are rather important feedbacks for project management.

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11.8 SUMMARY

MIS forms the nervous system of the entire project. It can be clustered as the monitoring of a patient in intensive care centre of a hospital. The various components and levels of MIS should be so designed as to decision-making as we proceed with project implementation. Projects involve very large matrix of organisat MIS design and administration should be able to provide the vital link of communication and foster heal competition. In projects, techniques of information is extremely important- if information is 24 hours late, ıl it a 'stale' information, if it is 48 hours late, we call it a 'ruined' information and it is seven days late, we call ancient history'.

.9 SELF-ASSESSMENT EXERCISES

Draw of an MIS for a 4-storeyed brick and residential building assuming that there is a magnificant component of marbling, tiling and sanitary work.

Design a simple reporting format which monitors conversion of purchase indents with orders. Assuming that no purchase indent shared be delayed more than eight weeks, how would you incorporate it in the above report.

Comment an, "MIS is not new but computerisation of MIS has added new dimension to it."

MIS is a 'feedforward' rather than a 'feedback' system in project management. Justify.

List down specific areas at a construction site where computers can be used for eftective project management,

.10 FURTHER READINGS

Davis GB & Olson M.H., *Management Information Systems*, McGraw- Hill International Editors.

McRae. TW, *Management Information Systems*- Selected Readings, Penguin.

Basandara, S.K., *Computers for Management*, Global Press, New Delhi.

Kanter. J, *Managing with Information*, Prentice Hall of India, New Delhi.

UNIT 12 MATERIAL AND EQUIPMENT

Objectives

Study of this unit will sharpen you:

- understanding of vital role of materials and equipment in project implementation and control
- Appreciation of how arrival of materials and equipment in the sequence of their erection smooths construction without any holdup or hindrance
- Comprehension of intimate relationship among arrivals of materials and equipment and their erection, testing and commissioning
- Competence in planning, negotiating and administering contracts and enhance your skills in achieving quality, cost and timely deliveries of projects.

Structure

12.1 INTRODUCTION

Materials and equipment form the-core of entire project. Besides, these are rather expensive. Direct materials and equipment have to be pieced together like the various cut pieces of a jigsaw puzzle. Every machine or equipment may have components procured from different suppliers spread across the countries or continents. These must be ordered and delivered in a sequence that facilitates their erection and commissioning as a composite plant which performs the functions it was designed for.

Even construction services have to synchronise with the availability of materials and equipment - different agencies should harmonise like individual artists who execute their piece of music to create a symphony.

In hard projects all engineering and technical functions aim to organise flow of materials and equipment in a manner that leads to their uninterrupted implementation and control.

12.2 IMPORTANCE OF MATERIALS AND EQUIPMENT IN PROJECT IMPLEMENTATION AND CONTROL

Project construction involves civil works which require materials like cement, stone, sand, brick etc, and structural works which need rolled steel sections, plates welding machines, electrodes or welding rods etc.

Mechanical equipment result from a large number of manufacturing processes which require different types of materials, consumables, tools, tackles and machines. Similarly, pipig, electrical and instrumentation works entail a large array of materials, equipment etc.

For smooth management of construction jobs, it is essential that the requisite materials, equipment and drawings/ instruction reach construction sites on time. It is easy to comprehend that it may be possible to manage the project construction if drawings are not available but. it is impossible to build the project without the materials and equipment which form the core of organisation's hardware.

Project implementation flounders if the materials and equipment donot arrive on time or if they arrive in haphazaed sequence or if they get damaged during transportation to contraction sites or after arrival there. Problems arise if there is faulty erection, testing and commissioning damaging the costly equipment. The problems crop up largely because most of these equipment are of specialised nature which are made to order and their replacements are not easy to organise. Mature project organisations have developed procedures which take care of all such eventualities. Nowhere the following principles are more applicable as in project implementation and control of materials and equipment :

1) if anything can go wrong, it will.

2) If everything is going right, something will wrong.

Effective management of materials and equipment, therefore, plays an vital role in enhancing our skills in project management.

Activity 1

A critical equipment was air-freighted to construction site to save time on its erection and commissioning. On its receipt at site, it was discovered that the 'foundation bolts' for the equipment were neither designed nor procured nor were they embedded in the foundation cost. What are the lessons to be learnt?

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12.3 FINANCIAL ASPECTS OF MATERIALS AND EQUIPMENT

Project materials and equipment are expensive. For all major equipment, one has to make advance payments immediately after the purchase order has been placed. Thereafter, progressive payments have .to be made on- delivery, on satisfactory commissioning either by suppliers' personnel or in their presence. Usually, such contracts provide for a percentage of money to be retained by the purchaser which is released back to him on the satisfactory completion of defect-liability period. Various milestones linked with progressive payments should be defined clearly and unambiguously to preclude the possibility of multiple interpretation.

Since transactions for materials and equipment are directly linked to money payments, adequate care has to be taken at the stage of planning of these packages i.e., even before these are floated for obtaining .competitive bids for contracting projects cannot be implemented alone — a large number of suppliers and contractors are required and have to be completed in specific timeframe, suppliers and contractors have to be viewed as our extended arms and resources purchase orders negotiated and contracts awarded to them must be fair, equitable and rumenerative. If these purchase orders or contracts are good for only one party, it would be the germination ground for major conflicts. The approach in India of outwitting each other has already snowballed into .a grave situation - a large number of contracts, notably from government and public sector undertakings, are landing into arbitration.

At any rate, faulty contracts act as major stumbling blocks to project implementation leading to protracted delays and procrastination when everyone around is expecting its commissioning and contributing to revenue generation.

12.4 CONTRACTING FOR MATERIALS AND EQUIPMENT

Project require a large variety of materials and equipment for which purchase orders have to be placed for supplies and contracts have to be negotiated for services. Purchasing plays a major role in ensuring our capability to achieve quality, cost effectiveness and timely completion and delivery - the three key critical success factors. In India, owing to feudal and bureaucratic systems inherited from colonial regime, we have to discard and revise many of the terms and conditions of contract and bring them in line with, if not better, the current practices in internationally funded contracts. FIDIC guidelines for model contracts provide comprehensive directions.

A number of our public sector organisations who have been beneficiary of loan from the World Bank, Asian Development Bank etc have already incorporated quite a number of these practices in their contracts and are reaping the benefits but a large number of organisations like Public Works Departments, Railways, Military Engineering Services who have mothered project management in India, today are struggling with nineteenth century tools in solving problems of almost twenty-first century.

A large number of knowledgeable persons were surprised when a multi-billion project in Europe which was considered to be almost impossible to be executed within set targets was completed on time. A survey conducted among the personnel of various agencies connected with its implementation returned the verdict in favour of rather imaginative terms of payment evolved for the project. A number of computers were installed at site as a part of project implementation and control systems and every week, representatives of .contractors and clients would agree and capture into the computers the quantities completed by them. Since the data on agreed rates .and schedules of work were already input the computers, it was possible to work out the total value of works completed by all the construction companies on the last working day of the month and consequently the total payment that became due to them for the works completed during the month.

All data on payments etc made to the parties was also entered into the computers and the net amount payable to them was worked out - 90% was teletransferred to their bank accounts on that day itself and remaining 10 % was paid within seven days thereof after 'crossing all the ts and dotting all the is'.

Indian contracts notably from government organisations are totally one-sided - they would define all the obligations of contractors in details but clines major obligation viz., making periodic payments to their contractors is often not spelt out in any detail or is kept blissfully vague. The ancient system of making payments through 'measurement books (MBs) needs to be discarded without delay since although it is not difficult to request the client's supervising engineers to record measurements of work done, it is well high impossible to hold their hands to make these entries into MBs - they are so used to greasing !

Good contracts should be based on a realistic appraisal of cash inflow and outflow of the concerned contractors so that there is a reasonable return to them: instead with the tyranny of lowest tender unleashed and clever manouvers to outwit each other, a large number of contracts in government and public sector undertaking are landing into arbitration. It is being increasingly talked about in contractors' circles that one cannot make money at the time of executing the project but only later when it is arbitrated upon.

Contracting has three phases viz.,

a) Contract Planning

b) Contract Negotiations

c) Contract Administration

Most companies tend to focus on the last two stages-contract negotiations and administration; negotiations are conducted centrally and consequently role of construction sites is reduced to contract administration only. Correct understanding of project management would reveal that contract planning is like the foundation and contract negotiation and administration are the 'superstructure' of a building. The superstructure can be as strong as the foundation to which little or no attention is given in conventional contracts management.

a) Contracts Planning

Experience gained in executing past projects are a great source of learning. Unfortunately, persons engaged in contract administration are quite different from those who negotiate the contracts and there is no regular communication among them. As a result, the learnings from past projects donot get reflected in future contracts. Learning from past projects would highlight those terms and conditions of the contract which are restrictive and unsatisfactory in resolving issues and require rephrasing or rewriting. If these changes are not incorporated in the new contracts, these would, once again, lead to :

— inadequate or ineffective communication between the contracting parties

— defective, unsatisfactory or incomplete specifications

— ambiguous contract language

— lack of timely notice

— cashflow problems resulting from one-sided terms of payment

However, for arriving at contracts that can be managed effectively, we must define the followings clearly :

i) conceiving and specifying work packages

ii) ensuring timely availability of work fronts

iii) choosing among suitable and comparable parties

iv) obligations of both parties are reasonable

b) Contract Negotiation

In this phase the objective should be the highest utilization of resources, engineering skills, labour, materials, time and money such that both the parties receive maximum benefit from the contract. A contract is not good if it is good only for one party. If an agreed contract is not capable of being executed by reasonable means, it will call for unreasonable effort and resources to succeed. To ensure that contracts are negotiated and executed within the realms of possible only and not transcend into 'probable state, following aspects must be gone into:

i) determining suitability of a party for a specific task at the time of floating the tender.

ii) negotiating prices that are remueneratïve to the contractor

iii) choosing contract language which is not subject to wrong interpretation

iv) cautious use of safety and protective clauses in the contracts

We should always remember that safety provisions by owners are construed as risk clauses by the contractors. These are :

— indemnity

— guarantees and liabilities

— liquidated damages

— time extensions

— suspensions

— termination

c) Contract Administration

During execution, difficulties between contracting parties can arise as below :-

— extra work including excess quantities of work

— deleted work including lower quantities of work

— non-compliance with specifications

— delays in time schedules

— late payments

— takingover of completed works

— warranties

— contract close out

As and when problems arise, these must be resolved by agreeing to procedures based on the provisions of agreed contract. These procedures must cover checks and hold points, known and unknown deviations, non-compliance with contracts and dealing with emergencies. Procedure for obtaining approval of higher authorities must be laid out in respect of the followings :

i) value of individual variations

ii) aggregate value of all variations

iii) extension of\time completion

iv) effect on design or operating costs

Resolution of conflicts must be done with speed and efforts should be directed towards avoiding negative aspects of delays besides avoiding further delays. This can ensue from an approach of constructive negotiations or proactive strategy to solve problems before they blow up into major disputes. This is possible by:

— reviewing the progress under the contract at regular intervals- estimated value of the contract to complete balance work has a direct impact on the smooth -running of contracts or taking advance action

— issuing promptly certificates.of interim and final payment,provisional completion certified, takeover certificates etc.

— Settling contractors claims expeditiously

— providing comprehensive procedure for recording, approving, dispensing with changes from the scope of contract.

Activity 2

Usually contract planning and contract negotiation stages are located in a control project office and contract administration is done at remote construction sites What are the disadvantages of this distance gap?

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12.5 FAIL-SAFE MANAGEMENT OF MATERIALS AND EQUIPMENT

For want of a nail, a battle was lost. Projects can also get completely out of gear, if any component of it is not engineered and indented in correct sequence so that it can be procured and erected on time. In a large project involving a very reputed project consultant when everyone thought that project was coming on time and would be commissioned shortly, it was suddenly discovered that a system, although small, was missed out; some people had overlooked designing the system; consequently, the materials and equipment required for it was neither indented nor procured nor erected. This put off commissioning of the plant by nearly six months. As a result, heavy investment made in erecting most of the main plant and utilities had to remain idle until the materials and equipment for that small system were designed, procured and erected.

It is perhaps easy to understand the extreme importance of total quality management environments for project work and the need to make everyone on the project loyal to project procedures and documentation. Project teams have to learn to do the right thing right first time always. Experienced and mature project organisations operate procedures and systems such that all the items covered in the scope of project at the time of cost-estimating are designed and indented, all the items materials and equipment indented are ordered on vendors and contractors, all items ordered are infact delivered to site in good conditions (if anything, is damaged enroute, replacement or alternate solutions are worked out and implemented) and lastly, all materials received at site are properly tagged before storage and erected at the designated positions. If there is any one weak link in the long chain, it would make the entire project vulnerable. There is just not time available later to correct the mistake as any slip would have major consequences on project parameters of time and cost. Organisations which donot have stable systems, work by fits and starts lead to situations that result in impairment of quality and higher levels of inter-personal conflicts.

A large number of projects get delayed in execution because the requisite materials and equipment donot arrive on time upsetting the construction tempo, momentum and schedule which has a catastrophic effect on time cost and performance parameters. These types of delays lead to tantrum in working, frayed tempers and inter-personal conflicts. A failsafe procedure for ensuring against these pitfalls would involve additional checks and balances inspecified formats, at specified intervals sothat project are completed on time, within budgeted costs.

Activity 3

Think of a basic document in project work so that it can be adopted as the basis for defining the ' scope' of the Project.

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12.6 SUMMARY

Materials form the kernel of project management, we design materials & equipment, we procure materials, equipment & services for erecting them and then we assemble these materials and equipment in a predesigned sequence to convert them into a viable, operable plant after duly testing and commissioning these equipments. Any slippage or gap in designing, procurement or erection of these materials and equipment can be very costly and can impact very adversely on the profitability of projects.

12.7 SELF-ASSESSMENT EXERCISES

1. What is the role of project cost-estimates in defining the total scope of a project?
2. 'Contract Planning' phase of project is often compared with constructing the foundations of a building — building will be as strong or as weak as its foundation. Justify.
3. Describe the advantages and disadvantages of locating project procurement functions at a construction site.
4. What is the role of progressing and expediting vendor supplies in project management?

12.8 FURTHER READINGS

1. Donald W Dobler & Darid N Burt, *Purchasing and Supply Management - Text and Cases,* Tata MçGraw Hill.
2. Gopalakrishnan, P. and Sundaresan, *M., Materials Management - An Integrated Approach,* Practice Hall of India.
3. World Beaut and UNDP *Guidelines on Contracts.*
4. FIDIC *Guidelines on Contracts.*
5. Fearon, HE., Dobler WE & Killen KH, *The Purchasing Hand book,* McGraw Hill, New York.

UNIT 13 HUMAN RESOURCES

Objectives

Perusal of this unit will enable you to understand :

- the pervasiveness of planning and control processes
- human aspect of implementation
- methodology of 'driver' in project work
- project control based on feedforward rather than feedback

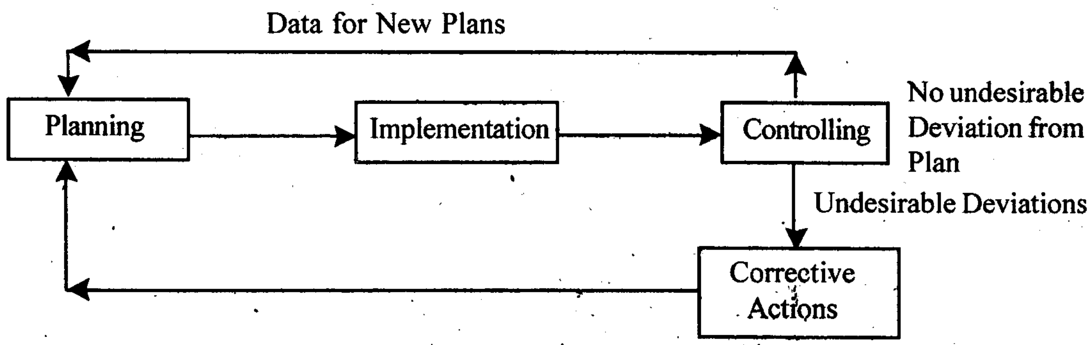
Structure

13.3 INTRODUCTION

Project management can be viewed as a process comprising of two distinct phases -planning and control. They are the Siamese twins of project management. Good planning systems provide the comprehensive framework for good monitoring and control; conversely, good control procedures would generate sufficient and reliable data for better planning of new projects or even replanning of the existing projects.

13.2 SCHEMATIC OF PLANNING AND CONTROL

Managing projects with the help of network analysis provides a comprehensive and integrated technique of planning and control. Fig. below illustrates the relationship between these two aspects;



If we donot wish to control, the very need of planning can be questioned. Also, controlling without planning is meaningless.

13.3 PROJECT IMPLEMENTATION

Project planning encompasses not only what is to be done but also when is it to be done. It is synonym to decision -making which is normally followed by action and implementation. Do all plans get implemented automatically and achieve.their objectives? Do they achieve the core purpose for which they were drawn up in the first place. Sigmund Freud had said that everything that you and I do springs from two motives - the sex urge and the desire to be great. Whereas the first motive has been extensively employed and exploited commercially. not much attention has been given to the second. We have discussed in Unit 8 the need for satisfying this basic hunger of all the human beings -craving to feel important. Managers can incorporate this in their style of decision-making and become more subordinate oriented as shown in the Fig.

	Boss-Orieted Decision Making						Subordinate-Oriented Decision-Making
Manager	Manager Makes Decisions and Announces It	Manager Sells Decision	Manager Presents Ideas & Invites Suggestions	Manager Presents Tentative Decision that the subject to change	Manager Presents Problems & get Sugges-tions before Taking Desitions	Manager Defines Limits & Asks Group to take Decision	Manager Permits Subordinates To function within the Limits Defined
	Tells	Sells	Talks	Consults		Joins	

If decision-making is left to the group within broad parameters, it has the highest chance of implementation. When manager joins the subordinates, it gets them together into a team. The team spirit propells plans towards better accomplishment and enhances achieve-ability because everyone on the project works more effectively, efficiently and enthusiastically.

Activity 1

Think and describe the advantages of management by consensus over autocratic management.

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13.4 CONCEPT OF PROJECT 'DRIVER'

We may be able to carry out an indepth analysis of the project and understand the contours of the project. We may draw up comprehensive milestones and other salient features of the route map of implementation. However, to ensure that projects are implemented within schedules and budgets and ensuring achievement of project performance parameters without any major conflicts, we may have to ensure that the project personnel are fine-tuned to work as a team. Methodology of 'driver' facilitates this to a great extent. It involves the following six strategies:

1) D - Directing individuals and teams
2) R - Reinforcing commitment and excitement
3) I - Informing everyone on the project
4) V - Vitalizing teamwork
5) E - Empowering at all levels
6) R - Risk taking and creativity

13.5 DIRECTING INDIVIDUALS AND TEAMS

Projects cannot be implemented alone; we need collaborators and supporters. To secure willing co-operation of personnel, we have to know them - their strength and weaknesses, their prides and prejudices, their personality traits etc. Before you can understand others, you have to know your ownself - 'know thyself and you begin to understand others'.

Nobody is stupid in this world. Even when people act stupid in the eyes of others, they are convinced that they are doing the right thing. A lowly clerk or a peon may be engaged in doing something which supports the projects only partially. However, when it comes to doing something to secure his personal goals, the same person works like a motivated individual. Everyone, therefore, is motivated - a few might be motivated to achieve project goals while others might be motivated to accomplish personal goals. Challenge before the managers is how to modify their attitudes and re-orient their mindsets so that they work single-mindedly towards achieving the project goals.

For managers to be effective leaders, they have to know their colleagues and subordinates with open mind and without bias or prejudice. People branded as high performers generally perform better than those not so labelled. Similarly, bright students continue to do better in studies even though there may be other more intelligent students in the class. Researches have confirmed that in the same way, people branded as 'lazy', perform low as if to retain their image Managers are, therefore, advised to look at people differently and not in set grooves.

Innovative and human approach by many managers has resulted in uncovering good people who started performing better. We all look alike but we have different tastes -some like it hot, some like it sweet while others like it cold or sour or saltish. Further, everyone wants love and affection but our individual responses vary widely - some are extrovert and become friendly quickly; others take a long time to become friendly. Some are friendly but would like to be a little distant too. Managers have to know every employee and there are no identical methods of directing individuals and teams of all shades and opinions. We are all equal but still quite unequal - 'there is nothing so unequal but the equal treatment of unequals'. Rules of organisations tend to be unifonn for all employees; however, treatment to them has to be different and varying and we must accept this uniqueness of individuals.

Each individual must be encouraged to perform in a way that suits his style so that he can, at the end of the day, stand in front of mirror, and look into the eyes of his 'image' and say to himself that he has done his best in achieving the project goals.

13.6 REINFORCEMENT OF COMMITMENT AND EXCITEMENT

We need people who are behind the project instead of being in front of it acting as roadblocks. People should be involved and interested in the project. A committed person can be the fountainhead of immeasureable amount of energy. Each and every person on the project should feel that he is executing an important job. All mature project organisations are convinced that 'kick-off' conference at the beginning of the project execution goes a long way in bringing about consensus on project goals, agreements on departmental objectives and deliverables by specialist functions, resolution of administrative and co-ordination procedures, assigning job responsibilities with no gaps or overlaps and even agreeing to procedures to be followed for resolving conflicts.

Project management teams are, unique in the sense that project managers are expected to lead individuals nominated by specialist departments, on adhoc basis, to complete the project. As a rule, project managers do not have any line authority on the personnel.

Through continued interaction with team personnel, project managers have to necessarily develop a participatory approach wherein every individual member of the team contributes and participates in evolving the project goals and departmental objectives.

Description of the project goals should be as focussed as the 'goal posts" in a football .game. If goals are specific, measurable, agreed, realistic and time-framed, it leads to creating a shared vision amongst project personnel. Only then they perform like football players who would dribble the ball, once a while sideward. only to kick it towards the goal post of the opponent despite continuous opposition from the other team.

The approach is to have frequent meetings and discussions, after the formal two or three day 'kick-off conference, to achieve clarity of purpose, consensus, strong organisational values and measurable standards of performance.

Man is a unique living being -it has a 'head' that thinks and a 'heat' that beats. Whatever we do should no only 'appeal to the mind but also 'tickle' the heart. We must create conditions during project execution tha excite the heart. This can be done in the following ways:.

i) create a few challenging jobs, assign individuals sothat they can get the satisfaction in achieving those jobs successfully.

ii) Increase visibility of your subordinates by allowing them to interact directly with senior personnel

iii) Spread good word about your staff who have performed well - this will beckon them to take on more challenges confidently.

iv) Delegate power and authority and encourage them to exercise the same. Even if they are not swimmers, push them into the swimming pool - they would invariably swim to safety

v) Acknowledge good performance publicity and immediately after it has been noticed.

vi) Praise (and not flattery) is the cheapest tool of management. Use it judiciously. Criticism has rarely helped and if it has to be administered, do it as a sandwich between two layers of praise so as to prepare individuals to receive 'counselling' in the right spirit.

If we follow the above approach, we can reinforce commitment and excitement of project personnel. Researches have confirmed that even in North America, average tapping of individuals potential is no more that 30 %. In India, it is likely to be around 20 %. Imagine the human energy that can be harnessed by increasing this to say 60 % - it will mean threefold increase in productivity. Let us begin to tap this vast reservoir of energy

Activity 2

More we discuss and debate the project goals and schedules for achieving them with everyone connected with the project, higher is his commitment and involvement. Elaborate.

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13.7 INFORMING EVERYONE ON THE PROJECT

In business and industry, nobody like surprises and shocks. It is one of the bounden duties of project manager to inform everyone of what is happening on the project. If we keep our top management posted of the progress of execution, major problems and how they are being solved, we can secure their support if we land into any major problem. If they are caught unaware, considerable time will be lost in recrimination and procrastination. It is equally important to keep subordinates informed - they should not only be told 'what is to be done' but also 'why it is to be done'. It ensures their continued interest in the project.

Informing is a form of communication - written, oral and non-verbal. To ensure effective communication, we should adopt the following rules :

i) Communicators must focus on the receiver wherever he is. It is more important that the message is clear to the receiver. 'Gift wrap whatever you want to say or write' -you must market the message such that receiver finds it easy to tune with you.

ii) Message must highlight the needs and interest of the important who must be made aware of why the message is important to him. It should aim to do 'benefit selling' to the receiver.

iii) Good project performance does not mean just achieving the final goal'. We have to perform well on all the steps from start to finish. Regular monitoring and reporting and feedback communication of performance in practice is the key to avoiding communication problems.

iv) Communicate assertively, not aggressively or be submissive when informing. A typical matrix of different styles of communication is :

Your Style	Other's Style	Effect of communication
Aggressive	Submissive	You are heard
Submissive	Aggressive	Others are heard
Assertive	Assertive	Both hearing each other

There are four possible outcomes:

— If you are aggressive and the other person is submissive, your idea will get adopted

— If you are submissive and the other person is aggressive, his idea will be accepted

— If both are assertive, both are listening to each other which is a good thing, it may lead to a compromise which is a happy mix of both the ideas.

— Since they are listening to each other, a totally new idea, not thought of before by either may emerge.

Usually this alternative is most rewarding - 'Two heads are always better than one'.

v) We should be good listeners. Managers must practise this style of communication. Tests confirm that we retain only about 25 % of information received. No good idea has ever entered the head of a person with an open mouth. Listening is a good management skill and must be cultivated assiduously.

vi) Providing feedback is an integral part of good communication. Communication remains a mere transmission of message if there is no feedback. In projects, we must introduce, 'say-back rule'. It facilitates proper communication. This improves project personnels skill in being a better listener and a better sender of message.

13.8 VITALIZING PROJECT TEAMS

Disagreements and conflicts in projects are not only unavoidable but also quite desirable. Conflicts ensure continued interest and commitment; they encourage novel and integrative solutions.

Conflicts are born out of 'caring'; people would not fight about issues they do not care about. Energy is created by conflicts. It is common observation that when people are in conflict, it unleashes people's imagination. Conflict, by itself, is neither good nor bad; it is the outcome of conflict which may be good or bad, functional or harmful, positive or negative. Conflict is a process which must be managed and not eliminated. Conflicts can occur during the various phases of the life cycle of a project viz.,

i) In Formative Phase - regarding schedules, costs, priorities, staffing etc.

ii) In early project Build-up Phase - regarding scheduling, priorities, staffing, technical issues etc.

iii) In main project Implementation Phase - revolving around scheduling, forecasting, thinking ahead, informing everyone etc. about changes.

iv) End of the Project (conversion) Phase - pertaining to costs, schedules etc.

Negotiating Conflicts

Agreements on conflicts can be reached by :

— giving in to the other person

— smoothing disagreements

— suppressing points of contention

— splitting the differences

— finding common ground to bargain and negotiate

People tend to use logic and reasoning in trying to resolve the conflict. Since conflict is an emotional outburst, it cannot be solved by cold-blooded logic and analysis. Usually conflicts are resolved through negotiations wherein the objective is satisfaction of both the parties. Satisfaction is an emotional and not a logical experience. Following techniques help a successful negotiator of conflicts :

i) Be direct - act rather than react

ii) Clarify by asking leading questions

iii) Avoid arguments which are emotional; conflicts can seldom be solved with logic and facts.

iv) Sincerity to the perception of others and not logic is vital and approach of 'what appears reasonable to you, is reasonable to me' can pacify emotions.

v) Nobody can read your mind nor you can read other's mind. Assertive expression of needs and interests etc move negotiations along.

vi) Persist in stating your needs and interests and do not let other persons off easily. This helps in building areas of common ground and enlarge it by enabling other person to say 'yes'.

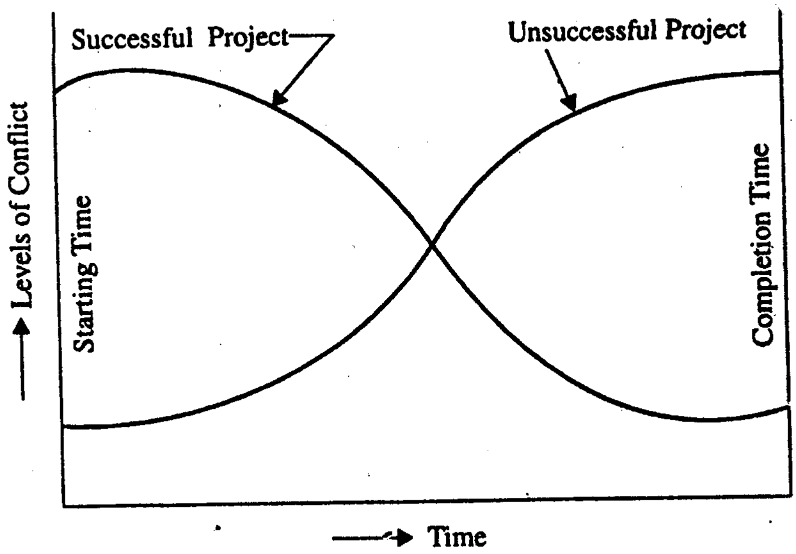
vii) Justifications make the case weak; do not justify. It is better to be assertive and back your data by facts and figures.

viii) Focus on issues and not on persons. Do not push the other person into corner; if cornered, he would either fight or flee.

ix) Basic approach is to satisfy both parties. Inflate trial balloons and float them for arriving at agreements.

x) Whenever possible, involve other people in resolving the conflicts. People involved is shaping agreements to resolve conflicts are likely to follow through the implementation of agreement and avoid/minimize further conflict.

Project organisations have discovered that two or three days 'kick-off' conference at the beginning of the project goes a long way in laying the foundation for relatively conflict free project management. In this conference, in addition to arriving at a consensus through participatory approach, even procedures to be followed for resolving conflicts can be established. This aspect has been researched considerably and recent findings have confirmed the following:



Successful projects start with higher level of conflict. There is a perceptible fall in level and no of conflicts at the time of commissioning and handingover. A slight rise in the initial stages arises from the efforts at uncovering possible areas of conflict during the 'kick-ofF stage and a slight upward trend at the end is almost unavoidable when plant is handed over to operation personnel or end users.

Unsuccessful projects, in sharp contrast, show low level of conflict in the initial stages and when the project is nearly ready for handing over, level of conflict is at the peak, leading to frayed tempers, loss of energy and effort and delays in completion at a time when everyone is anxiously looking forward to project's successful completion so that it can start generating some revenue.

Activity 3

Unsuccessful projects are marked with high levels of dys-functional conflicts nearerthe commissioning time. Illustrate, with examples.

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13.9 EMPOWERING PROJECT PERSONNEL

Power implies ability to make something happen. Everybody wants more power. Few admit they have enough of it. At all levels, people feel that their situation would have been better if they had more 'power is also a great motivator. Broadly, there are two types of power viz.,

a) Positional Power : It is the power associated with authority emanating from hierarchial location. It can be :

i) Ligitimate Power

This is institutional power or formal authority and it emanates from the belief that boss has the legitimate right to request certain actions and we have to comply.

ii) Reward Power

It is based on the perception that the person has the ability to reward or grant resources we desire.

iii) Coercive Power

It is based on the understanding that the person can punish or withhold reward from us.

b) Personal Power : It is the personal competence - skills and abilities possessed by individuals and travels with him. Since project managers usually do not have any hierarchical power, they have to resort to 'personal power' and rarely on 'positional power'. Personal power covers following two aspects :

i) Referent Power

It originates from the belief that by going along with a person's request will facilitate inter-personal relationship and foster mutual respect.

ii) Expert Power

It is based on the perception that other person has special knowledge or relevant information for problems on hand,

Exercising Positional Power

There is always a limit to using positional power. How often we cannot give raise or promotion to a person nor we can sack him. Legitimate power has also a limited scope as we cannot invoke rules everytime we request a subordinate.

It is rather rare to find ideal conditions for exercising reward power. Besides, in their earnestness to secure reward, people tend to take short cuts. Any reward scheme, after some time, becomes dysfunctional and there is resistance and resentment. It is always better to focus on intrinsic needs like recognition, self-esteem and opportunities for growth it helps win supporters; you are liked and respected.

If co-ercive power is used there is no chance of securing commitment from employees; even willing compliance is difficult to achieve. Strategies for 'positive' discipline rather than 'punitive' approach helps in enforcing discipline. However, there is one exception to this rule - co-ercion is most appropriate in the case of theft, violation of safely rules or ins ubordination.

Exercising Personal Power

There is no limit to the amount of personal power one can possess. Project managers use their personal power as a routine. When one is respected and admired the way you treat people, show concern for their needs and feelings, deal with each person or stand for the group by setting a personal example, one can enjoy a lot of personal power.

Referent Power calls for a lot of sincerity and commitment. It can be built over a period of time.

Regarding expert power, it is not enough to be an expert; others must recognize you as one. Others must be made aware of your background, experience and accomplishment. Recognizing others' contribution, respecting their ideas and incorporating them into action leading to their perception of your expertise, is better.

Prognosis of Power

Power is dynamic. It is not a fixed sum of commodity; it is virtually infinite in its potential. It expands with use and makes people feel stronger and richer.

Researches have confirmed that in the same company, one department may be effective owing to the key factor of how the boss exercises 'his power and its distribution'. High performing departments share power ; everyone- in the department feels that they are responsible for its effectiveness.

Laggard departments have managers who hoard power; who believe that sharing power would reduce their authority. On the contrary, more power you distribute among your subordinates, more powerful you become. When people feel they have power, productivity improves.

13.10 RISK TAKING AND CREATIVITY

Business demands innovation. Every organisation has to innovate if it has to remain competitive. Organisations must encourage risk-taking and creativity. Unfortunately, there are many roadblocks to creativity - anxiety, fear, defensiveness etc. If we are prepared to accept failures, we can promote risk taking and creativity. Thomas Edison had said, 'I failed my way to success'. A highly centralised and unstable organisation breeds anxiety and inhibits creativity and innovation.

You are allowed to make mistakes but you must not repeat them. You must learn from experience; only then failures will become pillars to success.

Creativity is an unprogrammed activity. Everyone collects data, excepts or other useful information without any specific task on hand but with the hope that he would be able to use it at a future date. This is, in management parlance, known as 'bootleg research'. Companies who encourage innovation, expect their engineers and scientists to spend about 15 % of their working time on such non-programmed activity. Japanese have a slogan, 'A Kaizen a day'.

Facilitating Creativity

Although intrinsic reward of satisfaction and feeling of accomplishment are powerful stimulators for innovators, they also need and respond to 'recognition, reward and praise'. World's, masterpieces in painting, music, sculptory etc have been produced when these artists were commissioned to do them. Numerous innovations during war situations confirm that time pressures can be productive.

Impressions about a problem tend to be erroneous and if followed, can send the organisation a wild goose chase. Usually, ideas in problem solving are not new - it is the different way of adopting the existing idea which is new. What we think as a breakthrough' research is usually a logical culmination of efforts of researches.

Working together as a team, communicating assertively, listening to others and being flexible instead of stereotype, permit looking at problems differently. Every problem has a solution; identifying the problem is half way to solution. Henry Ford had said that if a large problem is split into small parts, it becomes easy.

Network Analysis does just that to large and daunting projects. Besides, since these are time-framed, in the event of delays or unforeseen problem, it provides the framework for creating challenges while back-tracking the project to its original schedule and calls for considerable risk-taking and creativity,

13.11 FEEDFORWARD PROJECT CONTROL

There is an inevitable time lag in the process of management control because causes of deviations have to be identified and programme, has to be drawn up before these becomes actionable. It is, therefore, desirable to have the control directed towards future. For example, data received from accounting cannot serve the purpose of taking decisions about future. If the data tells managers in February about money lost in January about decisions taken in November, it is interesting but historical. Since we are heavily dependent upon accounting and other statistical data about the past, we are not able to institute future-directed control or what is known as feedforward control.

This should be similar to information generated by the dashboard instruments in an aircraft. Readings of various parameters of flight and understanding the gyration of their movements enables pilots to make necessary adjustments and correction so that the aircraft arrives its destination as per the schedule.

Project management by network analysis also provides the framework for all future milestones and facilitates detection of early warnings of deviations and taking corrective measures.

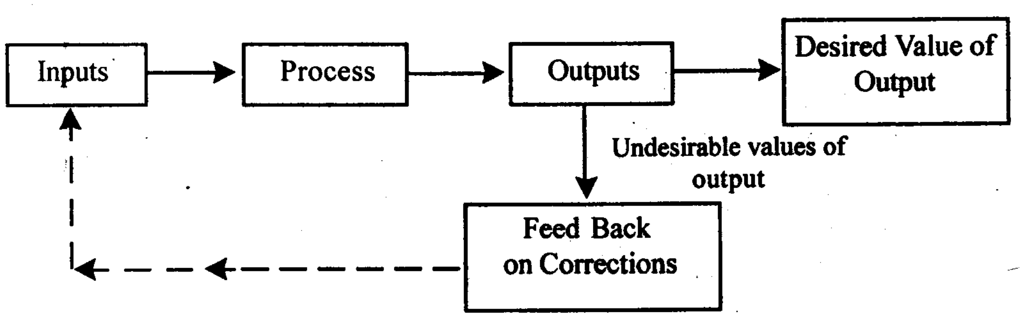
Feedforward in Human Beings

We come across a number of examples of feedforward control among human beings -slowing down of vehicles by easing the accelerator when the driver sees the crowd or when he sees the school children crossing the road. Also when drivers are negotiating the climb, they would automatically press on the accelerator so that speed is maintained. Similarly, we always shoot a little ahead of a moving bird.

Feedback vs Feedforward Systems

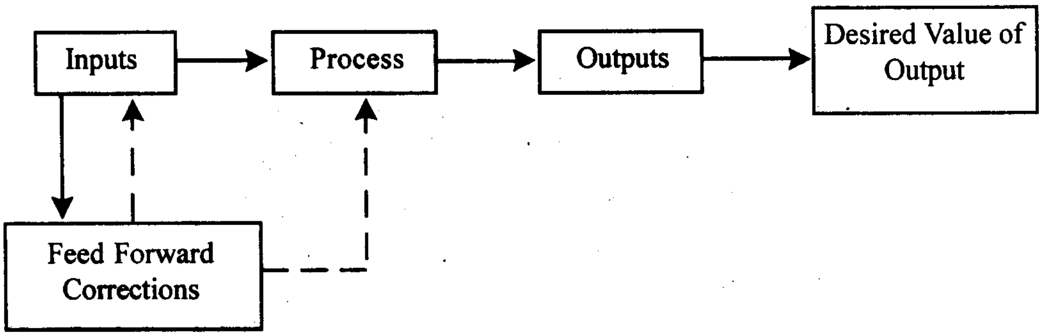
The nature of feedback system can be easily compared with feedforward system as shown in the Fig.

Feedback System



Feedback actuates modifications to process and inputs

Feedforward System



The significant difference is that feedback in the feedforward system is at the input stage itself so that corrections can be made in the system well before the output is affected. However, existing feedback control would also continue as managers are interested in knowing whether output is as per the desired values.

Feedforward system of control is operable whenever we are able to forecast reasonably accurately. Using the latest available information and making forecasts more promising, proactive actions can be taken so that corrections are introduced before the damage occurs.

In project management, it is possible to take proactive corrective actions, the moment we have an early signal that the next milestone is not likely to be achieved by the due date. Through the process of regular monitoring, we are able to discern early warning of unforeseen happenings. This helps project team to prepare for those eventualities and work out alternative action plans before the happening.

Management Information System for project work aims at identifying areas of weakness or ignorance and making everyone aware of it by keeping them informed. It promotes 'anticipation' of problems by giving early warning of possible threats. And the best mode of tackling a problem is to anticipate it and then solve it in good time.

13.12 SUMMARY

Human resource must be recognised as the most resourceful resource in management, particularly in project management where teamwork is the key to everything. Mature project organisations focus a great deal on developing self directed work teams. Once they are is place, projects are likely to be accomplised within agreed time schedules, conforming to approved cost budgets without compromising an quality and free of any major dysfunctional inter-personal conflict.

13.13 SELF-ASSESSMENT EXERCISES

1. A good team-work speeds up project implementation justify.
2. Developing self directed project teams is the key to improving effectiveness in project management. Elucidate.
3. Describe the art and science of conflict resolution.

4. Explain how managing creativity and risk-taking go hand in hand.

5. Lean and virtual organisations cannot function without empowerment. Explain.

13.14 FURTHER READINGS

1. Robbins SP, *Organisation Behaviour,* Prentice Hall of India, New Delhi.
2. Rao P.C.K., *Project Management & Control*, S. Chand, New Delhi.
3. Kergner, H, *Project Management*, CBS Publishers, Delhi
4. Bhasin ML, *Managing People Effectively*, Global Business Press, New Delhi.

UNIT 14 FINANCIAL ASPECTS

Objectives

After studying this unit, you should be able to understand, in the context of project execution:

- the features required in the accounting systems
- the essential aspects of fund and expenditure management
- the concept of control, and the factors that affect project costs
- the PERT-COST system and variance/performance analyses of a project for cost and performance control
- the significance & use of S-curves.

Structure

14.1 INTRODUCTION

In previous units we have studied about planning for projects, including planning for their various aspects. We have also studied about the sources of finance available for project implementation and the methodologies for their procurement. In this unit we will examine issues to be kept in mind while actually procuring funds and while using them.

14.2 ACCOUNTING SYSTEM

A good accounting system is a sine-qua-non for the success of any organised business activity. It is no less so for project management which involves execution of diverse and complex tasks in a tight time-frame through the involvement of a number of persons and agencies. The accounting system has to be designed to particularly meet the requirements unique to each project. The classification of receipts and expenditures must be structured into "head of accounts" in such a manner that financial information sought by various entities - internal and external - may be readily and economically compiled.

In so far as implementation of the financing plan for a project is concerned, only a few heads of account would be relevant. These usually relate to Capital (equity and preference shares, loans and debentures, etc.), Discount or Premium on shares, Brokers' Commission, Preliminary Expenses, and Bank Accounts. However, when we consider physical aspects of the project, a number of other account heads shall be needed to allow for proper categorisation of the expenditures incurred. All these are context- dependent and have to be carefully planned by the owner in the beginning itself. Introducing changes in mid-stream is in-advisable, being both cumbersome and likely to affect normal pace of work.

Some typical broad heads of account used in this area are given below. Some of these may be combined or even broken down further into suitable categories as required.

Land

Buildings

Plant & equipment

Vehicles

Furniture. & Fittings etc.,

Depreciation for asset accounts

Capital Works-in-Progress

Preliminary Expenses

Loans and Advances granted

Cash and Bank balances

Current Liability heads

Deferred Revenue expenditure

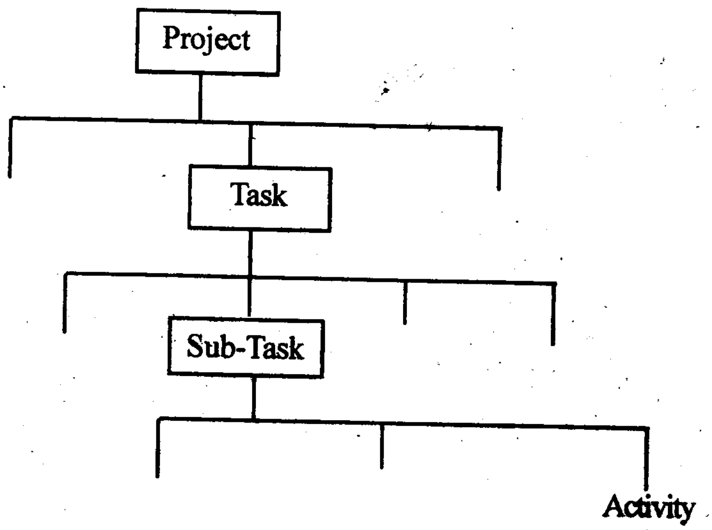
In case a project is implemented through a "turn-key" contractor who would hand over the completed project against payments released to him as per agreement, the owner's accounting system naturally becomes simpler. The burden of control then largely shifts to the contractor.

At this stage of project management some basic points relating to the accounting procedure are relevant :

First, in so far as requirements under the Companies act are concerned, no profit and loss account need be prepared unless a project is completed and starts incurring "revenue expenditure". The balance sheet has however to be prepared and shall show the balances under above-mentioned heads of account.

Second, the cost of acquisition of a capital asset would include all expenditures which are incurred for bringing the asset into productive existence. This would cover the basis procurement cost inclusive of taxes, freight and insurance, and all costs of erection and supervision. Thus, basically, all project-related expenditure on equipments, materials supplies, salaries, wages, transportation, interest, power, water etc. incurred during the implementation stage is capital expenditure and has to be charged to either specific asset accounts or to the works-in-progress account.

Third, the accounting system must ensure that all relevant expenditure data are captured and compiled speedily, accurately, and at a reasonable cost. No type of expenditure transaction should be allowed to go unreported, particularly advance payments and adjustment transactions. Accumulation of costs on the Work Breakdown Structure (WBS) would go a long way in integrating cost and performance management. As you know, WBS breaks down a project (or a programme comprising several projects) into smaller, measurable, and managerially useftil constituents having well defined scope. These are so woven into a logical tree-hierarchy that the elements at any level are fairly independent and combined together yield the more meaningful higher level constituent useful for controlling performance as well as costs. A simple WBS could, for example, be organised as follows.



The various work elements and the heads of accounts (a.k.a. codes of accounts) should have a clear logical relationship to facilitate budgetary and output controls. In fact, properly designed WBS and Accounts Code structure can immensely enhance a management's capability by enabling it to speedily utilize past or present data from one set of projects for improved formulation or control of others, for evaluation of bids, or even for making bids. Needless to say, the coding structure needs to be designed keeping the operating environment and users in mind. It may for example differ considerably (especially in term of the degree of sophistication) in manual versus computerised environments.

14.3 IMPLEMENTING THE FINANCING PLAN

In Unit 9 we learnt how the financial requirements of a project are determined and appropriate sources tied up. When giving effect to the financing plan, the project's finance manager must keep in mind the following basic tenets:

a) Procurement of funds involves certain costs in the form of cash outflows.

b) Idle funds always incur direct or indirect (opportunity) costs, which grow with time at a compounded rate.

c) Deployment of funds into productive avenues is the only way to counter the costs mentioned at "b" above.

d) Varying amounts of cash must be readily available to meet different liabilities as the ' project progresses. Failures may give rise to their own costs in the form of interest payments, demurrage, penalties, drop in quality, delay in completion of (and hence in earnings from) the project and various missed opportunities.

What it all amounts to is that requirements of funds must be matched as closely as possible with the availability of the lowest-possible-cost funds, over the entire duration of the project, and idle funds should be kept to the minimum. This makes it imperative that the project's cash requirements are forecast as accurately as possible. We will briefly consider this aspect in one of the Sections that follow.

14.4 AUTHORISATION OF EXPENDITURE

When implementing a project, money is spent on a wide variety of items. For example, some would be spent on office equipments, supplies and furnishings etc. for the project office(s). Salaries would have to be paid to the managers, supervisors, and various office staff engaged in connection with the project. Payments would also be made, whether as advances, "on-account" payments, or as price-escalations, to construction contractors and to suppliers of plant, equipment, and construction materials. Periodic payments of wages to labourers is an essential feature of any construction project. Charges have to be also paid, first for obtaining connections for water, electricity, gas etc. and subsequently for their consumption.

Though a suitable accounting structure may exist for ensuring that all these items are duly segregated at the level of detail considered necessary by the project management, that by itself is not enough to either ensure smooth expenditure transactions or enforce effective control over expenditures vis-a-vis the project budget. It is equally important to have in place a framework which determines who will authorise what type of expenditure and upto what limit. A suitable scheme of delegation of financial powers has therefore to be evolved to ensure that depending upon the need and factors like frequency, nature and value of a transaction, employees at different levels are allowed to authorise expenditures within well-defined limits.

We have considered in an earlier unit the methodology followed for estimating the cost of the project and for the formulation of an appropriate project budget (also known as capital budget). This takes care of the requirement of resources allocation amongst various project activities (and/or functions). As far as possible, such a budget should

a) be consistent with the objectives of the project

b) be consistent with the functions and quality standards of the project,

c) be realistic, i.e. be neither an over-estimate nor an under-estimate.

d) smoothly integrate with the accounts classification system, and

e) provide for the estimate of expenditure plus provisions for contingency and escalation for each activity. (This would help make realistic forecasts of costs since inflation may affect different activities differently).

During the implementation stage the budget become a yardstick for ensuring that the project expenditure stays on course. The scheme of expenditure authorisation that is devised by the project management therefore must incorporate a check to the effect that no authorisation for any expenditure is given (or atleast given effect to) by any employee unless suitable provision for the expenditure is available vis-a-vis the latest approved budget under the relevant head of account. This can contribute considerably towards controlling project expenditures provided the accounting and information dissemination processes (MIS) are efficient and well organised.

Activity 1

How is capitalization of project expenditure trated in accounting? What are the usual capitalization heads and what is their significance?

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14.5 THE CONCEPT OF CONTROL

As you know, control is an integral part of any management process which comprises of planning, organising, actuating and controlling. Fundamental to control is the existence of a norm (the "should be") with which the measured results of actual actions (the "what is") are compared. The norm has, of necessity, to be both appropriate and right to ensure that the efforts at control yield the desired results. With a properly selected norm, significant adverse deviations constitute a signal for undertaking analysis and for initiating necessary corrective action. In so far as project expenditure is concerned a basic norm would appear to be the sanctioned costs of the project, which in turn are based on the estimated costs for the project. (Note : There is a slight complexity involved in selection of normative values during the execution of the project, which shall be elaborated later in Section 14.7)

Now, the faster an adverse cost variation is noticed, analysed, and acted upon, the better the chance of ensuring that unfavourable deviations of the project's cost from the permissible sanctioned amount are minimal. For effective control, therefore, up-to-date and precise costing and performance data must be available at brief intervals of time. Further, the management structure should be so trim and well-knit as to be able to respond . speedily and decisively. The essence of control is illustrated in figure 1.

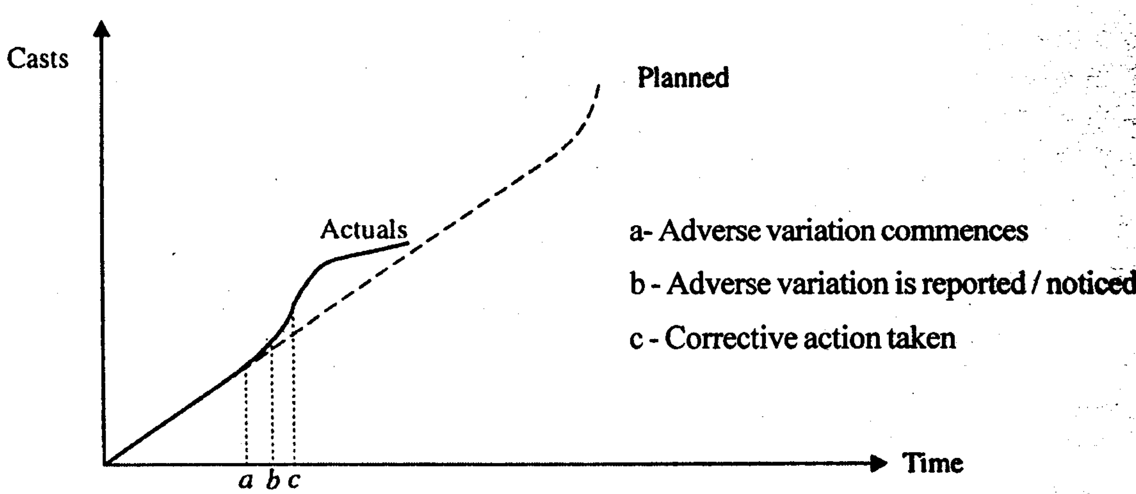

Fig. 1: What Constitutes Control

Having explored the basic features of a control process, it is time to recognise the distinction that exists between factors which can be controlled by the owner, or project manager, and those which cannot be. Realisation of this difference helps one to focus one's energies only on the former and thus be more productive. It must however be noted that this classification is not rigid. Projects are managed in a dynamic environment and it may so happen that what was an uncontrollable factor yesterday becomes controllable today. The owner or manager who is not alert to such changes in likely to lose touch with important aspects of managerial reality. Finally, even if a factor is uncontrollable, its impact on costs may be amenable to control. We will illustrate this with an example. Suppose a firm is procuring technology as well as major plant and equipments from USA. The project cost in rupees will be directly influenced by the foreign exchange rate (between the rupee and the dollar) over which the owner -has no control. He may however adopt a suitable hedging strategy to greatly curtail his foreign exchange risk and thus save the project cost from erratic fluctuations.

14.6 FACTORS AFFECTING CONTROL OF PROJECT COST

a) General

Irrespective of the size and nature of a project, one basic objective of the owner is to complete it to the specifications in time and at the lowest cost. In other words, time, performance and cost constitute the triad which demands to be managed in an integrated manner. Now a project's total cost is made up of various components which are incurred at different times starting from the stage of feasibility study through commissioning and take-over. What is often not realised, however, is that the very capability of the owner to control the cost declines over the project's life cycle. Figure 2 shows this relationship. You will observe that the greatest scope for containing the overall project cost exists at the stage of feasibility study, when all possible options are open to the owner. Thereafter, the potential for cost reduction steadily declines through the stages of design, engineering, etc. before encountering a steeper decline during the construction phase when most orders already stand placed and it is impractical, if not impossible, to reverse the decisions already taken.

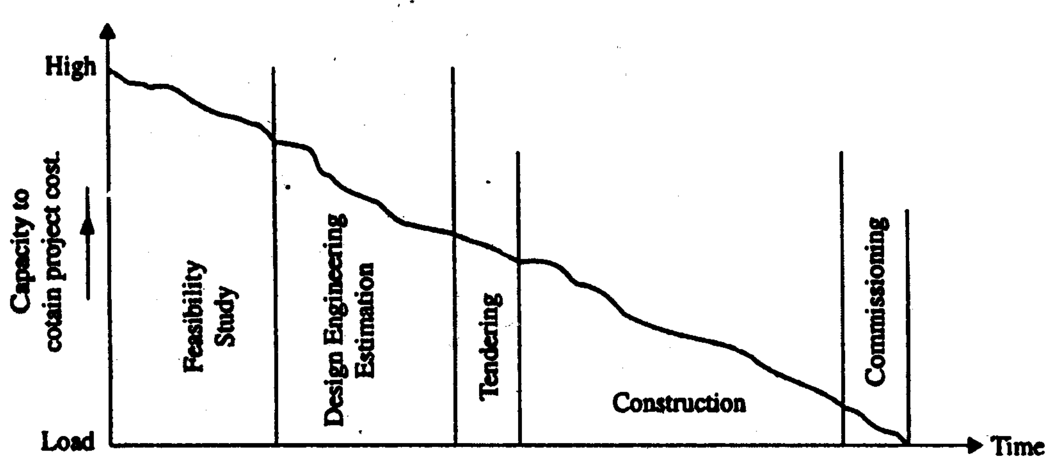

Fig. 2 : Potential for reducing project cost as a function of time.

Please note that the message from this diagram is not that efforts need not be made for cost control in the later stages of a project's life cycle. On the contrary, once the basic decisions on site, process, technology, design, and construction methodology have been taken, it is all the more important for the project manager to make all-out efforts at cost containment till the project concludes.

It is often assumed that the main role for controlling costs is only that of the management. This is not true. Real cost control demands cost consciousness right from top management to the lowest levels of the project organisation. All must be properly motivated towards cost control to make it successful. Ensuring such motivation, constitutes and important responsibility of the management.

Another common confusion relates to what constitutes control. Often a manager may act in a manner which amounts to substituting reporting for control, whereas the former is in fact only an instrument for control.

b) Contracts

An important factor which affects project costs and the owner's capacity to control them is the nature of agreement(s) entered, into with the construction contracter(s). Such agreements usually assume one of the following five forms.

a) Firm Fixed Price or Lump Sum (FFP)

b) Fixed Price Plus (FPP)

c) Schedule of Rates (SR)

d) Fixed Fee Costs (FFC)

f) Cost Plus (CP)

In an FFP contract, the owner agrees to pay a definite sum of money to the contractor for assuming full risk and responsibility for completing the work to prescribed drawings and specifications. This type is usually resorted to when the project is well defined in terms of both scope and cost. It involves little effort at control of costs on the part of the owner, but is somewhat costlier since the contractor would cover his risks by increasing the tender price.

Fixed Price Plus agreements involve a provision for paying either escalation or incentive fee to the contractor in addition to the fixed price. The former type is normally used when the project is well defined but involves uncertainties in costs of inputs over its relatively long gestation period. It stipulates periodic (upward or downward) adjustment of the fixed price in accordance with a formula which normally incorporates specified cost indices for labour, material, fuels and lubricants. The adjustments may be upward or downward depending upon the changes in the indices. The incentive fee version, on the other hand, provides for paying definite amounts as incentive fee for measurable performance improvements relating, say, to cost, duration, and quality. It is particularly useful when cost estimates or project-specifications are not sufficiently precise for adopting an FFP contract. In both these version the cost control effort required by the owner is more than in the FFP type, but is still quite moderate.

The Schedule-Of-Rate contract incorporate unit prices offered by the successful bidder for must elements of the work roughly quantified by the owner in the "bill or quantities". The contractor raises bills for work performed at regular intervals. Amounts in these bills are arrived at by multiplying measured quantities of the specified items of work with their corresponding unit prices as laid down in the contract. The owner however releases payments to him based on the quantities of work ascertained through a thorough physical verification (re-measurement), of the work claimed to have been performed. For this reason such contracts are also known as remeasure contracts. The owner has to make considerable efforts to reduce delays and to control costs in such cases. This is particularly so if the project's gestation period extends beyond two to three years. Furthermore, the owner has to ensure not only that all work performed by the contractor(s) is measured regularly .and accurately, but also that such measurements are made according to a standard methodology and are acceptable to the contractor(s).

The cost plus fixed fee contracts are usually used where the project costs, specifications, and processes are quite uncertain. These stipulate that the owner pay the contractor a fixed amount (or percentage) of fee in addition to the cost actually incurred by him. These place the burden of cost verification and control on the owner and tend to reward, if not actually encourage; inefficiency on the part of the contractor. The owner has to be constantly alert to ensure that the contractor performs efficiently and his cost records and data are both accurate and correctly complied:

A better version of the cost plus type of reimbursement is the target cost contract. In it the two parties agree at the very outset to a target cost. Any increase or decrease in the actual cost vis-a-vis the target cost is shared between the parties as an adjustable fee calculated in accordance with a previously agreed formula. Often, the maximum and minimum limits for such fee are also laid down.

c) Changes in Scope

The very purpose of conducting a feasibility study and then going in for detailed process and engineering design is to eliminate, as far as possible, any scope for mid-stream changes in the planned work programme. Such changes are not only troublesome to implement, invariably they also result in large cost increases. And yet it is a rare project indeed in which changes in scope do not occur during implementation. These have however to be rigorously controlled to minimise dislocations in project cost, duration, and quality. This can be done by insisting that, like for the main projects, every single proposal for change in scope in ruthlessly analysed in terms, of-

- description
- justification of the need,
- alternatives considered
- requirements of plant, equipment, and other resources,
- schedule for implementation and
- financial implications on the project

d) Delays

Delays, also called time over-runs, are a major factor for project costs going through the roof. Projects in the public sector in developing cuntries have been particularly susceptible to large delays for various reasons. Studies conducted by (the then) Bureau of Public Enterprises, Government of India, indicated the following six major causes for delays in project completion in Indian public enterprises :

1) Inadequacies including unrealistic cost and time estimation in techno-economic feasibility reports.

2) Weaknesses in project management organisation.

3) Delay in selection of the detailed engineering consultants.

4) Indigenisation of equipment without advance planning.

5) Non-availability of power, steel, cement, etc.

6) Labour unrest.

From the list it.is evident that but for the last two, all other factors lie within the domain of control of the owner. You may like to have another look at figure 1 of this Unit at this stage.

The government of India has set up, in 1985, the Ministry of Programme Implementation (now called the Department of Programme Implementation - DPI) with the sole objective of independently monitoring large scale public sector projects funded by the Central government. In its annual report for the year 1994-95, the DPI has stated that several projects get delayed and though "some of the factors may. be beyond the control of the enter prises in some sectors the project management is not .satisfactory". Analysing the delays observed in government funded projects in 16 sectors of the economy the report lists the following factors as most important :

a) acquisition of land

b) constraints of funds, particularly owing to thin dispersal of limited resources over a large number of projects.

c) slow progress of civil works by contractors.

d) delayed award of contracts.

e) delayed supply of equipment

f) slow progress in engineering, release of design drawings, erection, and commissioning of equipment

g) delays in government clearances, law and order problems, and inadequate infrastructure.

Activity 2

Think of the relationship between time and costs and describe the advantages if we speed up project implementation.

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14.7 THE PERT - COST SYSTEM

Use of network techniques like CPM and PERT is essential for large projects. As you know, these involve the preparation of a detailed schedule of construction and allied activities and its translation into a network diagram after considering precedence requirements. For practical reasons the activities are generally delineated in such a manner that none has a duration of more than three weeks. The diagram shows the critical path and also the "slacks" available at different "nodes".

Initially, the Programme Evaluation and Review Technique (PERT) focussed only on the time management aspect of a. project. It was in 1962 in the USA that a PERT cost system was developed to control costs. It involves assignment of costs to individual project activities rather than to functions or organisational units as in traditional cost accounting systems. Low cost activities are usually grouped together for this purpose. This system uses the following two sets of data for activity-wise cost control.

a) Estimates of costs for activities (or groups of activities)

b) Actual costs for the same activities/groups.

It is in estimating the activities' costs that the greatest difficulty in encountered. This usually involves estimating the material costs, labour costs, and expenses, besides supervisory and administrative overheads that can be attributed to each activity (or a group for activities). However, once this has been done, the evaluation of a project's progress is possible on the more transparent basis of completed activities, rather than on the traditional basis of estimating percentage physical progress and comparing it with expenditures. Usually, activities are so chosen that the expenditure on each may be assumed to occur relatively uniformly over its duration.

We had mentioned in Section 11.3 about the need to have reliable estimates of cash requirements. Such projections for the project can be easily derived on, say, a monthly basis using the activity-wise cost estimates. This helps the owner or manager, in planning his cash flows so as to minimise financial costs. For an example, study the bar chart in figure 3 below.

Name of activity	Month 1	2	3	4	5	6	7	8	Total Cost
Activity A	10	5							15
B	6	12	12	6					36
C		20	20	20	20	10			90
D			7	14					21
E			8	16	16	16	16	10	98
Costs in the month	16	45	55	56	36	26	16	10	260
Com. Costs	16	61	116	172	208	234	250	260	

Fig. 3 Estimating monthly cash requirements using activity liar chart.

In our discussions so far we have assumed that the activities commence on the "early start" dates. Cost estimates can however be built up using the "late start" timings as well. Plotting these two sets of cumulative costs against time would yield two curves which together enclose the zone of feasible budgets for a given project duration without any resources restrictions (i.e. without crashing, etc.). This is depicted in figure 4.

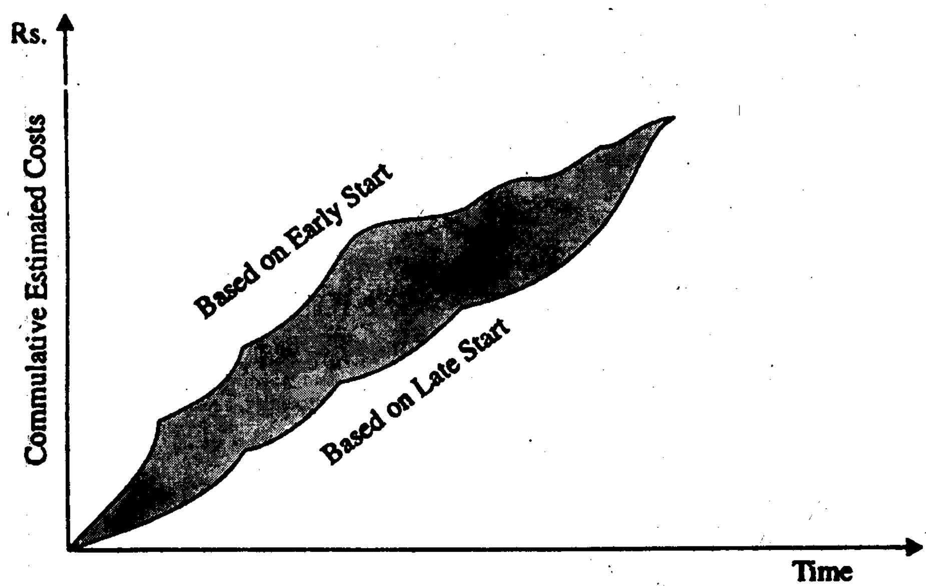

Fig. 4 : Zone of feasible budgets for a given project duration.

During the implementation of the project, the following information is periodically ascertained from WBS/activity-based cost recording and accounting system.

a) Cumulative actual cost to date.

b) Budgeted (estimated) cost to date.

c) Value of actual work done to date, based on cost estimates.

From these, cost over-runs (when a exceeds c) or cost-inns (when c exceeds a) can be computed as a percentage using the formula given below. Figure 5 shows the relationship between these three different variables and the cost over-run

$$\text{Cost over - run} = 100 \times \frac{\text{Cum. actual cost} \qquad \text{Value of work done}}{\text{Value of the work done}}$$

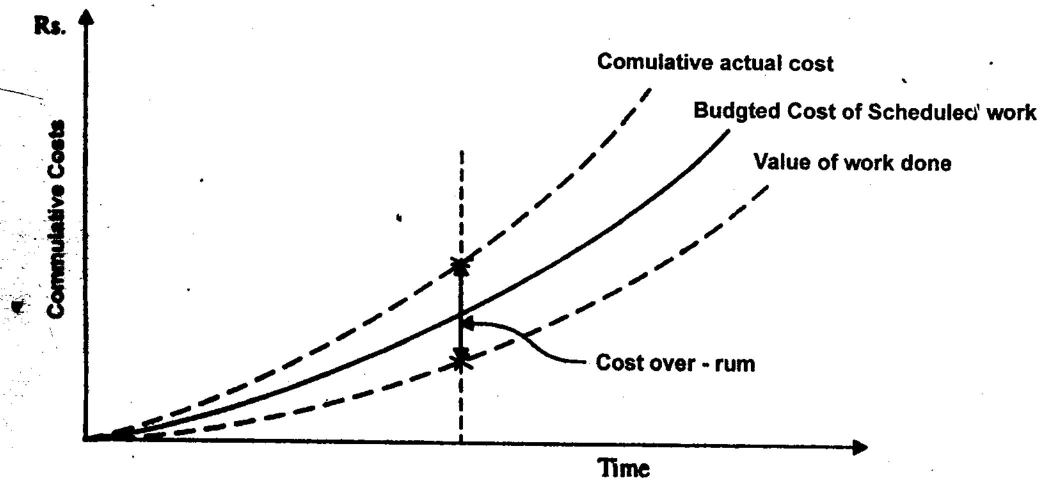

Fig. 5 : The concept of cost over- rum

14.8 PROJECT CONTROL CURVES (OR S-CURVES)

In section 14.7 be had used a detailed bar chart derived from a PERT plan, in which expenditure on each activity had been estimated on a monthly basis. The cumulative totals of monthly expenditure estimates derived this way indicate the "value" of work planned to be done upto different dates. When these totals are plotted against time they yield the typical project control curve having the shape of "S" (see fig 6). Now, if the cumulative values of actual work done are similarly plotted against time, we get another S-Curve showing the "performed value". Thus, these curves based on financial data alone can help the management in monitoring the progress of the project by depicting under - or over-spending and delays, etc.

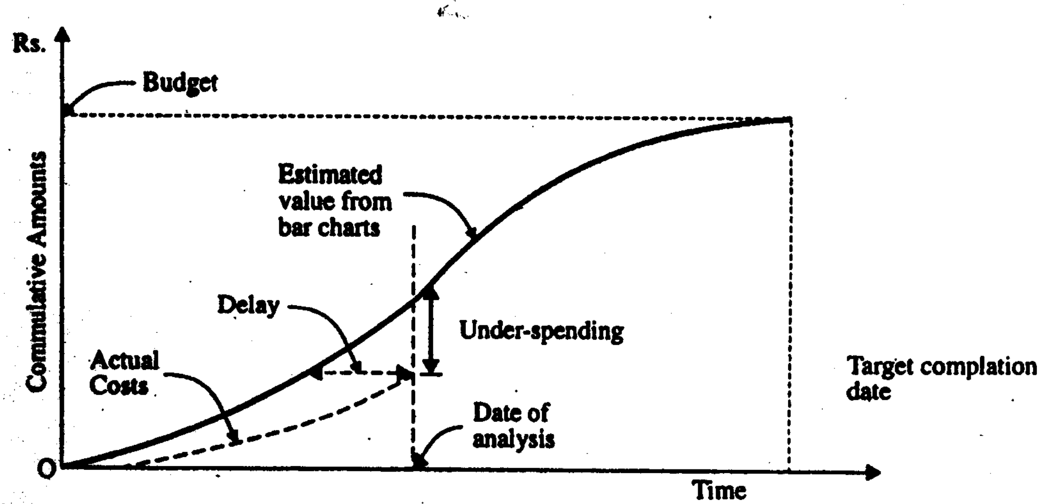

Fig. 6 : "S" curves for planned and actual values

14.9 VARIANCE ANALYSIS APPROACH TO COST CONTROL

This is .the traditional approach to controlling project costs. It involves ascertaining, periodically, variations betwuen the actual and the budgeted costs, both for the periods and cumulatively. The lesser the variation the more "controlled" the project is supposed to be. The approach is not considered suitable for effective project control since it neither gives any clue to the owner about the value of work already done, nor does it help him in knowing the direction in which the project is heading.

14.10 THE PERFORMANCE ANALYSIS APPROACH

Performance analysis constitutes an improvement over the variance analysis approach. Use of the technique involves certain terms and concepts which need to be first understood. These are explained below.

1) Budgeted Cost of Work Scheduled (BCWS): Budgeted cost of work scheduled is the sum of the budgets for all work scheduled to be done (including in-process work), plus an appropriate portion of the budget for overheads for the relevant timeperiod

2) Budgeted Cost of Work Performed (BCWP) : This is the sum of the budgets for work packages (including in-process work) or their portions actually completed, plus an appropriate portion of the overheads budget for the relevant time period. BCWP is also rerefred to as "earned value". The earned value concept assigns "base budget unifs" (in man-hours or rupees) for work to be performed for every measurable WBS element in the execution of the project.

Each activity is time-phased using the target schedule. This should include quantities, work to be performed, man-hours and budget value.

Conventional cost reporting (see Section 14.8 above) compares budgets with, actual expenditures and slippages in schedule with agreed schedule. The concept of earned value, on the other hand, looks at the value of the actual work performed in base budget units regardless of the actual costs incurred, and hence puts the comparison on a more rational basis.

3) Actual Cost of Work Performed (ACWP) : This is the sum of the direct costs actually incurred and the indirect costs applied in accomplishing the work performed within a given time period.

4) Budgeted Cost of Total Work (BCTW) : This is the sum of budgeted costs of all activities plus the overheads for the entire projects.

5) Cost Variance (CV) equals the Budgeted Cost of Work Performed (BCWP) less the Actual Cost of Work Performed (ACWP).

$$CV = (BCWP - ACWP)$$

Adverse (negative) cost variances indicate cost over-runs, and hence, if CV exceeds the threshold level prescribed by the management, it should be analysed to identify possible causes such as technical problems, inaccuracies in original estimates, lower productivity, and unanticipated increases in equipment, material or labour costs.

The cost variance can also be expressed as a percentage (CVP):

$$CVP = \frac{CV}{BCWP}$$

6) Schedule Variance (SV) is equivalent to the Budgeted Cost of Work Performed (BCWP) minus Budgeted Cost of Work Scheduled (BCWS)

$$SV = BCWP - BCWS$$

The Schedule Various measures the schedule progress of the project in monetary units rather than time units Its relationship to time is thus not directly recognizable. The SV can however be converted into time units by measuring the horizontal distance between the point representing the data date on the BCWP curve and the horizontal projection of the point on the BCWS curve.

A negative schedule variance indicates slippages (behind schedule status), and hence a value exceeding the threshold level should be analysed to ascertain the underlying reasons. Like for the CV, the Schedule Variance can also be expressed in a percentage form

$$SVP = \frac{SV}{BCWS}$$

By comparing the values of BCWS and BCWP on the one hand, and of BCWP and ACWP on the other, we can easily determine whether the project is on behind, or ahead of schedule, and whether it is on cost, or having a cost over-run or under-run on the date of analysis. Thirteen different types of relationship are possible amongst the values of these three parameters. The following table lists all these cases based on hypothetical values of the parameters, and indicates the broad conclusions about performance and cost that can be derived therefrom.

BCWS	BCWP	ACWP	Remarks	
100	80	60	Behind Schedule,	Under Cost
100	80	80	Behind Schedule,	On Cost
100	80	90	Behind Schedule,	Over Cost
100	80	100	Behind Schedule,	Over Cost
100	80	120	Behind Schedule,	Over Cost
100	100	80	On Schedule,	Under Cost
100	100	100	On Schedule,	On Cost
100	100	120	On Schedule,	Over Cost
100	120	80	Ahead of schedule	Under Cost
100	120	100	Ahead of schedule	Under Cost
100	120	110	Ahead of schedule	Under Cost

100	120	120	Ahead of schedule	On Cost
100	120	140	Ahead of schedule	Over Cost

7) Cost Performance Index (CPI) : This is defined as the ratio of BCWP to ACWP. A value less than 1 indicates cost over-run and a value greater than 1 signifies cost under-run (i.e., the work is costing less than budgeted).

$$CPI = \frac{BCWP}{ACWP}$$

8) Schedule Performance Index (SPI) : This is defined as follows.

$$SPI = \frac{BCWP}{BCWS}$$

A value less than 1 indicates slippages and greater than 1 that the project is progressing ahead of schedule.

9) Accounting Variance (AV): This is equal to the Budgeted Cost of Work Scheduled minus the Actual Cost of Work Performed.

$$AV = BCWS - ACWP$$

The conventional cost control reporting used to be based on this parameter only. It is however not a reliable indicator of actual progress. For example, a large negative variance (AV) could occur both when a project is progressing ahead of schedule, and when significant cost inefficiencies and wastes arise.

You may have by now observed that Cost Variance, Schedule Variance, and Accounting variance bear a simple relation to one another. What is that? For confirmation, see figure 7

10) Estimated Duration at Completion (EDAC) : This can be calculated using the SPI as follows :

$$EDAC = \frac{\text{Original Planned Duration}}{S.P.I.}$$

Using the OPD and EDAC, the project manager can forecast the project time over-run, if any, as follows :

Projected time over-run = (EDAC — OPD)

11) Estimate at Completion (EAC): The manager is also in a position to make a forecast of the cost of the project at its completion (assuming the present trends continue) using the formula-

$$EAC = \frac{BCTW}{CPI} = (ACWP/BCWP) \times \text{Total Budget}$$

From this the projected cost over-run (aka Variance at Completion, or VAC) can also be computed.

Projected cost over-run = ECAC — BCTW

$$= \frac{BCTW}{CPI} - BCTW = BCTW\,(1/CPI - 1)$$

Analysis of the cost over-run (or VAC) may reveal causative factors such as changes in scope, incorrect estimate at completion, engineering design changes, low productivity or wastes.

Using the Approach

Analysis of a project's performance using this approach is today greatly facilitated by ready-made computer software packages. The manager can thus keep a close watch on various parameters and initiate action as soon as adverse trends come to his notice. Such action may involve re-scheduling, re-deployment of resources, or extension of the target date. In fact, using a computer, the manager should be able to choose the best possible course of action by looking at different alternatives and carrying out performance analysis for each.

Finally, it must be kept in mind that the analysis can yield good results for remedial action only if the original plan and various data about costs and work activities are reasonably accurate and are not distorted by sporadic singular features.

14.11 INTEGRATED COST/SCHEDULE GRAPH

Integrated cost schedule graph is shown in Fig. 7. The graph depicts the three variances (described in the previous Section) on a particular data date. From the graph one can ascertain "projected cost to completion" alongwith forecast of "delays at completion" and "cost overrun at completion".

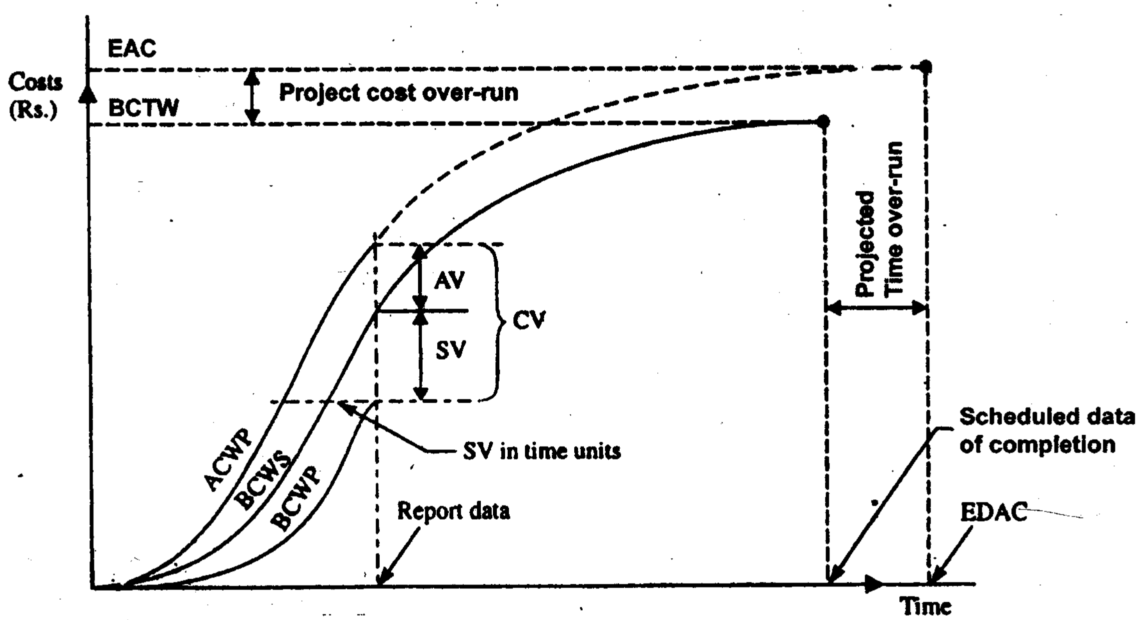

Fig. 7 The integrated cost/schedule graph

14.12 SUMMARY

In this unit we studied the salient aspects of financial management in so far as they relate to implementation and control of projects. We saw the importance of having a proper system of accounting and budgeting, and of using the approach of performance analysis for not only cost control but also overall monitoring of the project's progress. We also learnt the use of S-curves in monitoring the performance as well as cost of projects.

14.13 SELF-ASSESSMENT EXERCISES

1. What are the pitfalls in the - traditional method of cost accounting & expenditure control in projects?
2. "Scheduling of projects-shared be so organised as to facilitate - plarining of cash flow and fund management." Comment.
3. Elaborate on the concept of 'Earned Value of the Budget' in PERT/COST system:
4. Once we switch over to PERT/COST system, can we do away with time-based - project control. Explain with reasons.

14.14 FURTHER READINGS

1. *Project Management for Small and Medium, Size Businesses* - Harold Kerzner and Hans Thamhain; Van Nostrand Reinhold Co.; New York; USA.
2. *Project Management Handbook*, Edited by Dennis Lock Gower Technical Press Ltd.; UK; 1987.
3. *Managing Construction Projects*; Edited by AD Auster and RH Neale; ILD; Geneva; 1984.
4. *Projects - Preparation, Appraisal, Budgeting and Implementation*, Prasanna Chandra; Tata McGraw Hill Publishing Co. Ltd: New Delhi; 1987.

BLOCK 4 PROJECT COMPLETION AND EVALUATION

This Block comprises of three Units.

Unit 15, titled, "Integrated Project Management Control System" describes the need for computerisation in Project Management, basic areas of computerisation and also gives information on commonly available softwares in India. Useful information about various computer programmes and their output is given as appendics to this unit.

In Unit 16, the process of Transition from Project to Operations is explained. It also high-lights the role of various disciplines in testing and commissioning of projects and the importance of advance planning in commissioning. The procedure and concept of Quality Assurance and Total Quality Management in projects is also explained in this unit.

Unit 17, titled, "Project Review" discusses the process of planning and control in projects and importance of project review during implementation. This unit covers the mechanics of coordination in projects and also describes the critical elements in control. Another important thing covered in this unit is the concept of cybernetics team work and motivational aspects of monitoring projects.

UNIT 15 INTEGRATED PROJECT MANAGEMENT CONTROL SYSTEM

Objectives

After going through this unit you will be able to understand:

- the need for computerisation in Project Management
- the basic areas of computerisation
- the availability of some common softwares in India

Structure

15.1 INTRODUCTION

The tools and techniques of Project Management lend themselves to easy computerisation. Introduction of computers in business and industry in our country initially faced some resistance, as people feared that most of the applications arc in the area of finance and accounting and would lead to a high degree of unemployment Most of the computer, vendors were, therefore, keen to provide some softwares alongwith their computer hardware which would take up non-finance and non-accounting applications. PERT / CPM happen to be one such application. Programmes for using the computer, for doing time calculation and obtain bar charts were available even for the IBM 1401 computer which used punched cards as inputs. Since then, both the computer hardware and the softwares have been greatly improved, for carrying out advanced project management applications. Today a wide variety of programmes are available — in text books, journals and from major softwares vendors. These programmes have been specifically written for the entire range of computers starting from the micro computers (PCs) to the mini and main-frame computers.

Simultaneously the field of Project Management has also expanded to include a variety of tools and techniques including resource leveling, minimum cost crashing and an integrated project management information system. The integrated softwares in project management usually provide all these features.

You have seen earlier that the success of a project is largely dependent on effective monitoring and controlling system. This essentially entails finding out the status of a project after its beginning, relating it to the original network plan, finding out deviations, deciding on corrective actions and representing these decisions on the network. This process is called "updating." Any manual updating of a real life network involves a lot of redrawing of the original network and carrying out afresh, time, cost and resource calculations. Even for a project of moderate size, these calculations and other manual activities proved to be too big and, therefore, it was not possible to undertake these exercises at desired intervals. As a result the potential of project management tools were largely underutilised. With the advancement of computers and computer softwares in project management, it became possible to put the entire project network alongwith its resources and costs in the computer. The initial computerisation task is voluminous in terms of data preparation and entry of activities and high manual work content is involved. However, once a network is computerised any change, modifications or upgradation of the network becomes very easy and one is free to undertake an updation at any desired interval. For example, one of the early applications of computerised network in the steel industry was for the relining of blast furnaces. In the early 60s when the first three public sector steel plants required relining of blast furnaces, it used to take anywhere between 120 to 150 days inspite of the fact that project management was applied. When manual updating was done it could be done only once in a month. With the introduction of the computers, it was possible to have weekly updatings. This resulted in quick and more accurate feedback to management about the status of the project and provided them with an opportunity to take corrective actions at an early stage. When a review meeting was taken up at 2.00pm on any day, the actual status obtaining on the ground at 6 a.m. on the same day could be collected and processed in the computer and results including the expected date of completion, activities delayed and their impact on the overall project was available for managerial considerations.

It is thus clear that computers provide a means for quick and accurate feedback to management and is particularly suited for medium and large project where manual computations are cumbersome.

A part from the basic time calculations, computer programmes are also available to carry out resource levelling, cost crashing and printing of different user oriented reports also. From a humble beginning to facilitate network computation of time, costs and resources, computer softwares have today graduated into a comprehensive project management information system providing the users with different levels and degrees of control.

15.2 COMPUTER APPLICATIONS

15.2.1 CPM/ PERT Time Calculations

As we have said in the beginning, the critical path calculations are highly amenable to computerisation. The essential inputs for these Calculations are the following:

— The start node (I node) number

— End node (J node) number

— Duration

— Description of the activities

— Resource requirement

— Cost

— Agency responsible

Please note that in the time calculations, only the first three elements are essential. The description can provide an identity of the activity for the user. The programme does not process this information. Originally all the programmes were written in a fashion that required these inputs to be given in ascending i node number sequence and within a given i node, in ascending i node number sequence. Subsequently, programmes have been developed which do not require a user to provide the inputs in these sequences. The programme itself reorganises the inputs in these sequences before it starts forward pass calculations.

You will get some idea of a computer programme which gives you the basic logic of a forward pass calculations as it is executed in a computer. Appendix-I gives us listing in BASIC language, of a programme which enables you to feed information about a network and obtain the critical path calculations and print a bar chart of the activities. In case, you have an access to any personal computer with the BASIC language compiler or interpreter, you may feed this programme and run it to see the outputs.

Activity - I

With the help of personal computer, run the programme in appendix - 1 and calculate the critical path, and print the bar chart of the activities.

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15.2.2 PERT Probability Calculations

Computer programmes are available for carrying out .the PERT probability calculations also. These programmes can accept either three time estimates or single time estimate for every activity. For all those activities where three time estimates have been provided, the programme works out the variance of the activiiy time by using the following formula:

$$\text{Variance } \sigma^2 = \left(\frac{b - a}{6}\right)^2$$

Thereafter it calculates the variance of the critical path by simply adding the variances of all the activities of .the critical path. It then works out the standard deviation of the project by taking a square root of the variance of the critical path. With this information it is now ready to work out the probability of completion of the project within any desired time. The normal probability distribution is a standard input, already provided to the computer which enables the programme to work out these probabilities. As a user, you may provide any desired duration and the programme would work out the probability of completing the project within that duration.

15.2.3 Resources Calculations

The next enhancement of computer programme in project management comprises of the capability to handle resources. Each activity may require certain number and types of resources which can be input to the programme. After the time calculations are done, the computer can obtain two schedules; one is the earliest start schedule in which all the activities are assumed to start at the earliest possible moment. The other is a latest start schedule. In this schedule all the activities are assumed to start al the latest permissible lime. For a particular resource, the computer can be programmed to work out the required resource over time, based on one of these two schedules. The programme simply adds the requirement of the desired resource in a day on all the activities that are scheduled on that day which consume this resource. Suppose one is interested in finding out the need for a particular type of crane. All that one is required is to input the number of such cranes required by each activity. Based on this information, the programme can work out the number of cranes required from day one to the last day of the project. If on a given day, three activities are scheduled, each of them require the use of one such crane, the computer will add up and indicate that three such cranes are required on that day. In this manner the simplest output that one can get from the computer is a resource requirement profile.

The requirement of resources will show a varying pattern. However it can generally be stated that for an early start schedule, the requirement of the resources would be larger in the beginning of the project and would slowly taper down, In contrast, for a late start schedule, the requirement of resources will be low in the beginning and gradually would rise to a peak towards the end of the project. Both these requirements are not the best possible options because the peak would be much above the average requirement

The next enhancement in any computer resource programme concerns its ability to carry out leveling of resources. For all non-critical activities it is possible to shift them within the early start and late start schedule with out affecting the overall project duration. Computer programmes are available which carry out these types of shifts for non-critical activities. It reduces the peak requirement of a given resource. This procedure is known as "leveling". After this leveling activity, the programme gives a particular schedule giving definite start and end date for all non-critical activities also. You would recall that the critical path calculations do not provide definitive start and finishing dates for non-critical activities. Resource leveling provides such a definitive schedule. Whenever any updating of the network is carried out, the leveling exercise can be run again in the computer with reference to critical resources and a target schedule for all activities can be arrived at.

Some computer programmes are also designed to work out resource constrained networks. Here one is concerned with certain limitations on some particular type of resources. Such a programme would receive as input, the quantum of this resource required for each activity. It would also receive an input with respect to maximum quantum of the resource available with the Project Manager at any point of time. Based on these inputs, the computer programme would first work on an unconstrained schedule and work out the peak requirement of the constrained resource. If these peak requirements are within the total availability, the programme will stop. However, if the peak requirement exceeds the total availability the programme will look at the requirement for critical activities only. If this leaves some additional resource, the programme would try to shift the non-critical activities within the floats available so as to minimise the peak requirement If such an adjustment is possible, the programme will slop with an output of the specific schedule of all activities that resulted in containing the peak requirement within the availability. However, if such an adjustment is not possible, the programme then attempts to extend the project duration so as to shift some of the activities requiring the use of the constrained resource beyond the peak requirement periods. The programme continues to carry out these adjustments in small amounts of time till a situation is reached where the peak demand of the resource is satisfied by its availability. The programme then prints out the corresponding extended project schedule. In essence it means that the limit on the availability of the resource causes the overall duration of the project to be extended. The computer programme arrives at the minimum possible extension in the project duration which satisfies this constraint.

The last enhancement in the capability of the computer programmes for handling resources concerns multiple projects. One can visualise a situation in which a Project Manager with a resource constraint is executing more than one project and the given resource is required by both the projects. For example, a Project Manager could have two different projects in progress simultaneously. Both the projects may require the services of an Instrumentation Engineer. The Project Manager may have only two Instrumentation Engineers available. Computer Programmes are available which can take care of such a situation and provide the Project Manager with the schedule for multiple projects with common resource constraints.

Activity 2

i) Mention the limitation of critical path method. How it can be eliminated by resource leveling?

....

....

....

ii) Describe how computer programmes facilitate the resource allocation.

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....

....

15.2.4 Cost Calculations

Project management softwares can also handle cost information for each activity. Basically there are two types of cost information. One relates to the basic cost of carrying out the activity in the estimated time and the other information relates to the additional cost to be incurred in reducing the duration of the activity per unit time. This information should be accompained by the minimum time that must be allowed for carrying out the activity. These information are known as the "normal Cost", the cost slope and the crash duration for an activity, respectively. Figure 15.1 indicates these concepts of cost of an activity.

The first cost calculation relates to the normal cost of all activities. This is similar to the resource calculations. Given a particular schedule of activities the computer can work out a schedule of expenditure to be incurred against each activity and thereby finds out an overall budget for carrying out the project. This is arrived at by adding the expenditures incurred over a period of time for the activities which are scheduled to take place at a given point of time. From this exercise, it is possible to derive a cumulative expenditure curve for the project. This expenditure curve becomes a useful aid in subsequent monitoring and review of the projects. Actual cumulative expenditure can be compared against the scheduled cumulative expenditure. This comparison provides the Management with an important indicator of the progress of the project. This can also serve as a tool for providing budgetary allocation of funds for a project.

The next step in processing of cost information concerns crashing. Computer routines are available which would undertake crashing of the critical paths of a network, and given the overhead rate for a project, it would work out the minimum cost solution for the project. For this solution, the total project cost, which includes the direct activity costs as well as the

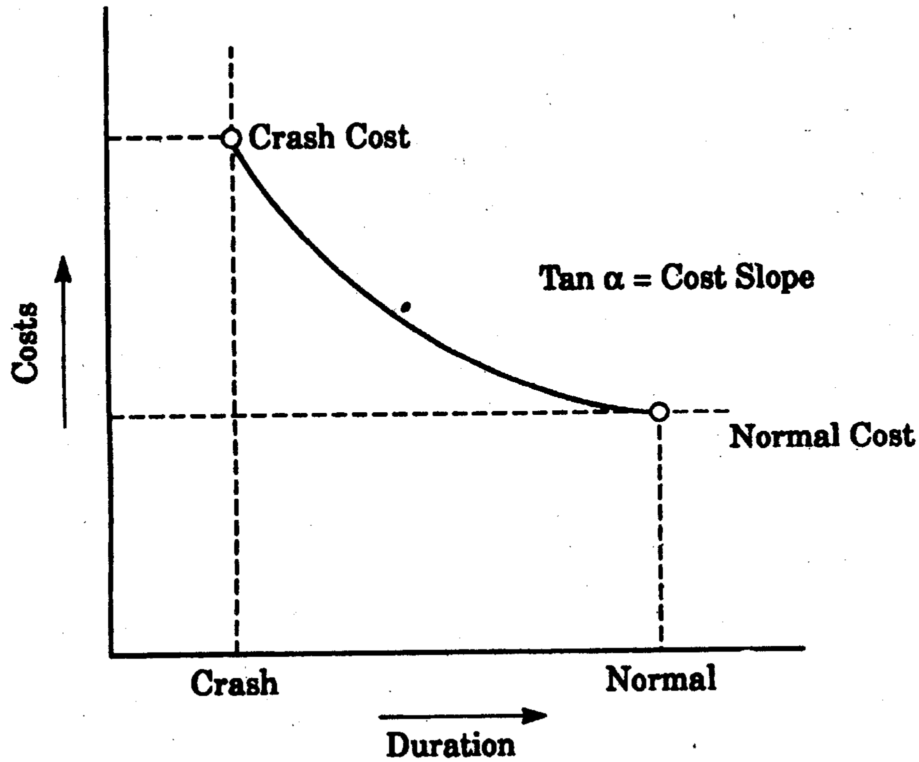


Fig. 15.1 : Activity Cost Curve

indirect overhead cost, is minimum. Please note that although computer programmes are available for carrying out the crashing exercise, it requires a lot of cost information for all critical and sub-critical activities which is very difficult to obtain in the real life. While basic cost estimates for a given activity can be obtained, it is very difficult to obtain the cost slopes and the crashed duration of an activity. Due to the non-availability of such information, cost crashing on a computer has found limited applications.

Activity 3

i) How cost calculation is done by Computer Programming?

....

....

....

....

ii) Why cost crashing on a computer has found limited applications?

....

....

....

....

....

15.2.5 Scheduling and Updating

Most of the computer programmes are capable of printing schedules for a project. The schedules are of two types. One is a tabular listing of all activities giving the name of activity and the other is in the form of a bar chart. Sample outputs of both types are at Appendix-II.

The real benefit of computerisation is obtained through updalings. Project Management softwares are designed to receive modification in an existing network. These modifications may be with respect to the durations of activities, their sequencing, breaking up of an activity into two or three components, introduction of new activities and so on. These modifications . are usually grouped as additions, modification and deletions. Once these modifications are carried out, we have a new updated network in the computer, which can then be processed to obtained fresh activity schedules, bar charts, resource leveling, cost schedules etc. These fresh schedules then form the basis of all subsequent execution, monitoring and control by the Project Manager and his team.

15.2.6 Multiple Levels in Project

Most complex and large projects are managed at about three different levels. The first level concerns managers who are directly responsible for execution of some activities on the ground. They are interested in the greatest details of each activitity to be undertaken. The second level concerns the Project Manager and his immediate team members responsible for the entire project They are also interested in sufficient details, but it is neither possible nor desirable for them to go into every detailed break-up of each activity. Consider a simple activity of building the RCC framework of a multistoreyed building. The first level managers must-go into such details as bar bending schedules, positioning and fixing the re-inforcements, carpentry work for putting the shuttering work in position, planning of casting each lift for each column and so on. However, the Project Manager is interested in the entire project, where few similar civil works are going on and in addition; a large number of other activities like structural fabrication, design, manufacturing, tendering and order placement etc. are also on hand. It is, therefore, essential for the Project Manager to consider each activity at an aggregate level. He may only be able to follow-up construction of columns for each floor and casting of respective slabs.

The third level of Project Management may be. the Corporate Headquarters and different funding agencies as well as government agencies. Such agencies / bodies are to monitor many large and complex projects and they need to look at the projects at a much higher level of aggregation. For them, construction of the entire building may constitute an activity.

The normal practice in Project Management of such large projects, is to have different network drawn for different levels of projects.

All modern PM software allows multiple levels of networks with interlinks between two successive levels. Any modification carried out on any network at any level would automatically get reflected in the other networks by virtue of the programmes available in the software. This is a very powerful feature of most modern PM software package, allowing the user to choose different degrees of detailing and its monitoring, reporting and control.

Activity 4

i) What are the different levels of Project Management?

....

....

....

....

....

ii) Name any Computer Programmes available in sheduling of Projects with its features.

....

....

....

....

....

15.2.7 Calendar

Most PM software packages have provision for one or more calendars. The calendar helps to convert numerical start and finish times of activities into actual dates. The software allows you to specify Sundays / Holidays and different modes of working for different activities. Some activities may be carried out round the clock on all 7 days in a week. Some other may be carried out only during office hours on working days only. The calendar option allows you to specify your own work plan for each activity. The software is programmed to consider all these variations and furnish calendar dates in the schedule. Advanced softwares allow you provision of multiple calendars, each one specific to a group of activities / resources.

15.2.8 Project Management Information System

A comprehensive PM software provides all the above features and integrates them to develop a Project Management Data Base which is used by the software to provide required information, in the form of reports to different levels of Project Management. When the Management Information System gets built into all other technical capabilities discussed above, we get a computerised Project Management Information System.

15.2.9 Reports

A PM software incorporating a PMIS is designed to give a variety of reports and graphs to facilitate decision making. In addition to schedules, bar charts, resources required, cost schedules etc. these softwares are capable of providing a number of special purpose and exception reports, rulled out of the Project Data Base. Reports could be obtained for activities to be done by specific agencies, activities scheduled over the next week, fortnight or month, critical activities delayed, field reports to be used for actual progress checking and so on. These reports generation facilities include some "what if" calculations and processing. The Project Manager may like to test the impact of enhancing some critical resource by a predetermined quantity, to see its impact on the project completion.

A number of graphical reports are usually supported. These might Include resources and cost graphs. Graphs can be either bar charts or line graphs showing cumulative positions with respect to scheduled and actual progress. A few typical reports that can be generated are shown in the Appendix-III.

15.3 COMPUTER SOFTWARES

As mentioned earlier, a large number of computer softwares have been developed to facilitate the application of Project Management using the computers. Before discussing some major softwares available, we would turn our attention to some basic logic of network computations in a computer.

15.3.1 Alogrithm for Critical Path Calculations

Figure 15.2 shows a broad step by step outline for designing a programme for carrying the critical path calculations. This can be divided into ten steps as under:

1. Input the number of activities (N) and the last event number (NLAST) and the I node and J node number of each activity and its duration.
2. Begin the process by initialising the following indices:

   1 = 1

   X = 101

   X$ = "01"

   "I" indicates the count for the number of activities completed and "X$" indicates the I node number under consideration at a point of time. Note that this algorithm has a limitation that it can treat up to 99 nodes only.
3. Obtain an I node sequence arrangement of all activities in ascending I node number.
4. Obtain a J node sequence of all input activities in descending J node number.
5. Calculate EST and EFT for all activities starting from the start node. This-is done by simply equating EFT to the respective activity durations, because the EST in all these cases are equal to zero(o).

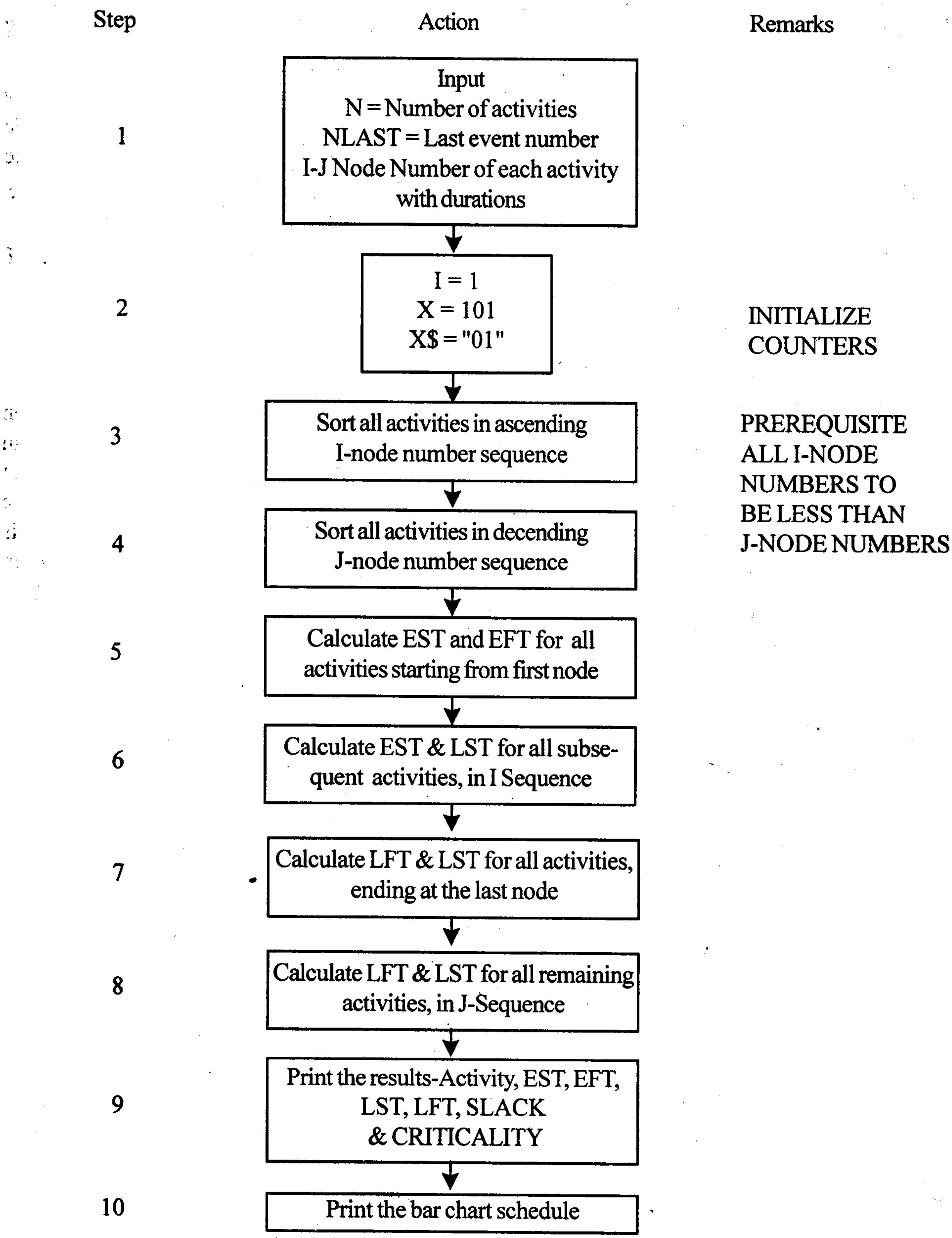
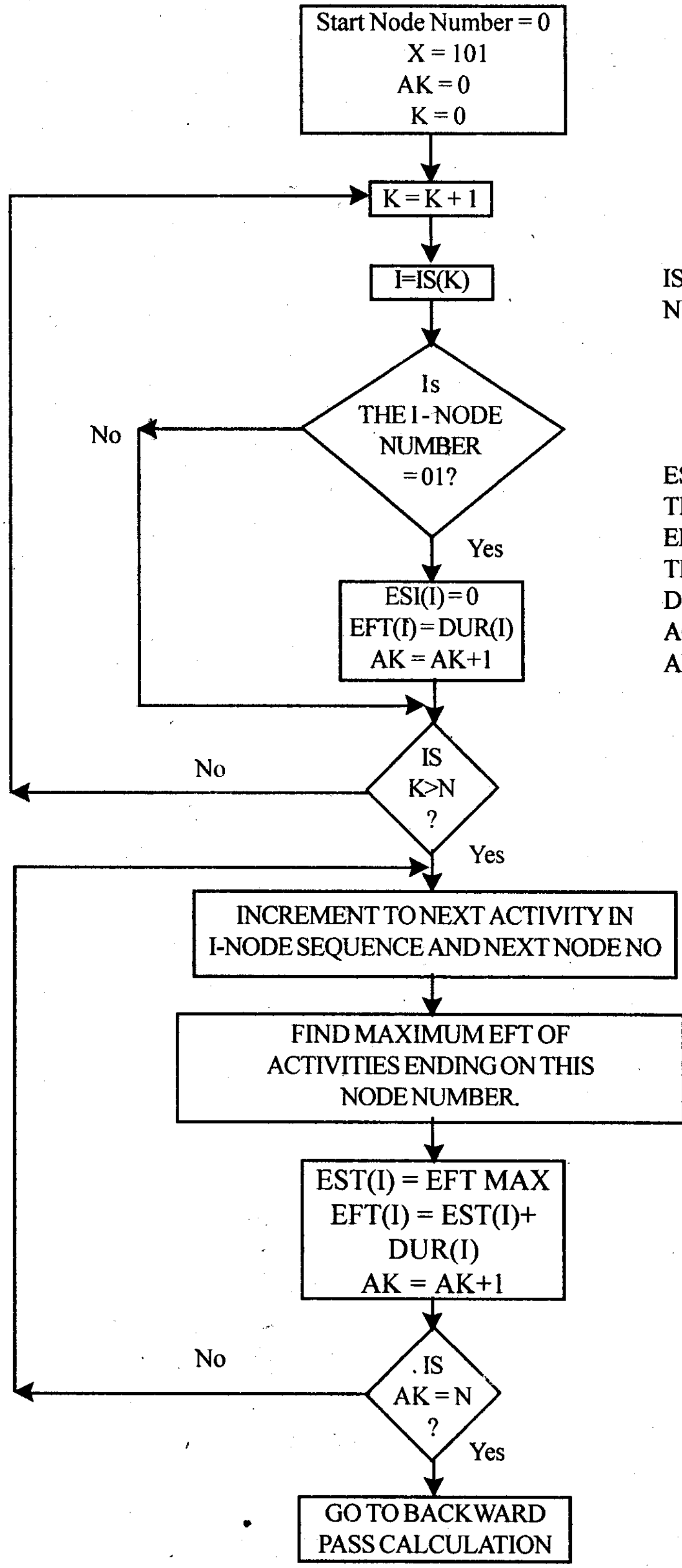


Fig. 15.2: Algorithm for Critical Path Calculations

6. Calculate EST and EFT for all subsequent activities in the I node sequence. This sequencing ensures that EST can be derived from previous computations.
7. Calculate LFT and LST for all activities ending at the last node. This can be easily done by considering the activities in J node sequences and picking up the top few activities with the J node number being equal to the last node number. The LFT for all these activities is same as the maximum of the EFT of these activities calculated earlier. The LST for each activity is obtained by subtracting the activity duration from the LFT.
8. Consider the remaining activities in descending J node sequences number and calculate the LFT and LST.
9. Print the resultant activity schedule including the critical paths and floats.
10. Print the resultant bar chart.

Figure 15.3 indicates a flow chart for the forward pass calculations for a network. This same logic has been followed in the accompanying programme listing. This programme can receive a maximum of 99 activities in a network and does not require inputs of the activities in any particular sequence. The only constraints are that for all activities, the I node number must be less than the J node number and the first I node number should be 01. It also requires the user to feed the last node number and the total number of activities involved. It is recommended that you feed this programme in a micro computer using BASICA or GW-BASIC and then run it. This would enable you to get a feel of processing a network on a computer.



IS (K) IS I-NODE SEQUENCE NUMBER OF ACTIVITIES

ESI (I) IS EARLY START TIME FOR ACTIVITY I,
EFT(I) IS EARLY FINISH TIME FOR ACTIVITY I,
DUR (I) IS DURATION OF ACTIVITY I.
AK = ACTIVITIES COMPLETED

Fig. 15.3 : Flow Chart of Forward Pass Calculations

15.3.2 Text Book Softwares

Project Management Softwares with some more features are also available in various text books. Some of these text books are as follows:

Quant Systems	Ylh-longChang	Prentice Hall
Quantitative Systems for Operations Management	-do-	-do-
Softcover Software	Gary E. White house (Ed.)	Industrial Engg. & Management Press.

Most of these text book softwares are limited to the critical path calculations, printing of bar charts and in some cases a capability to handle time estimates and carrying out the probability calculations.

Prof. Koregaonkar of IIM Ahmedabad has developed a software which enables the user to carry out resource leveling on multiple networks.

You may try to have access to any of these softwares and use them for carrying out network calculations. However, in case you are not able to lay your hands on any of these books and have access to a micro computer, you can feed the programme in the Appendix-I and run it.

15.4 PROJECT MANAGEMENT SOFTWARE PACKAGES

As indicated earlier a number of integrated project management software packages have been developed and are locally available. The principal features of three software packages available on the micro computer — INSTAPLAN III, HTPM and Micro Soft Project are given in Appendix-IV. to Appendix-VI.

15.5 COMPUTER APPLICATIONS IN PROJECT APPRAISAL

Computers can be very conveniently used for financial and economic appraisal of projects. S. Banerji and S.K Chaudhari of Management Development Institute, Gurgaon have developed a package using Lotus 1-2-3 for carrying out the financial appraisal of projects. This is a menu programme which allows the user to furnish inputs with respect to various project parameters as under:

a) The project life, pattern of capacity utilisation and various costs of production including direct costs, factory overhead and financing costs.

b) Project costs estimates including land, building, plant and machinery and other items.

c) Means of finance and the debt-equity ratio.

The Programme provides the following outputs:

1. Estimates of cost of production and profitability
2. Financial expenses
3. Breakeven analysis

4. Internal rate of return calculations
5. Sensitivity analysis
6. Repayment schedule
7. Income Tax calculations using two methods of depreciation
8. A summary of the appraisal

Sample inputs and outputs are shown in appendix-VII.

15.5.1 Computers Simulation in Project Appraisal

The sensitivity analysis in Project Appraisal considers changes in only one parameter of the project at a time. All other parameters are assumed to be fixed. The sensitivity index for IRR, indicates the proportional change in project IRR for a given proportional change in certain input parameter. For example, a sensitivity index of -1.5 with respect to material cost means that if the material costs are increased by 10% the IRR will be reduced by 15%.

However, in all real life situations, the assumption that all other factors will not change do not hold true. Quite often these parameters would change simultaneously. The situation is further complicated by the fact that one is not very sure of the exact amount of change that would take place; Experts can probably give different probabilistic estimates of the nature of changes that are likely.

A Project Manager concerned with the appraisal of a large and complex project would be interested in assessing the combined impact of all these anticipated changes on the project IRR. One could pick up some other parameters of the project like, the debt service coverage ratio or the breakeven point. But the IRR is the most critical financial parameter which is examined before the final go ahead decision is taken. We shall, therefore, examine how a computer model can assist the Project Manager in assessing the impact of simultaneous and probabilistic changes in project parameters.

S.Banerji of Management Development Institute, Gurgaon, has developed a'package using Lotus 1-2-3 which is an extension of the appraisal package, mentioned earlier. The additional inputs are, probability estimates of the likely variation in a few important project parameters. For example, one could say that the overall cost of the project could vary with the following probabilities:

The Project Cost	Probability (%)
-0.95 x Base	10
-1.00 x Base	20
-1.05 x Base	25
-1.10 x Base	30
-1.15 x Base	10
-1.20 x Base	5

ar probabilistic statements about the likely variation in some other important with high sensitivity index l also be fed into the model.

The model then carries out a number of simulation exercises. Each simulation run consists of the following steps:

1. Generate a random number for each of the probabilistic variables.
2. Use this random number to select a sample value of the probabilistic variable.
3. Substitute these sample values into the respective inputs for IRR calculations.
4. Calculate the resultant IRR and store the value.

The computer is programmed to repeat the above calculations a large number of times as desired by the user (it may be 500 or 1000 or 10,000). As a result of these calculations, a frequency distribution of the IRR is obtained which is the outcome of random variation of the input parameters within the probability framework imposed by the user. In simple terms, it means that if the parameters were to vary in the manner predicted by their respective probabilities, the combined resultant impact of these variations on the IRR of the project can be captured by means of the distribution of the IRR.

Figure. 15.4 shows a histogram obtained through such a model.

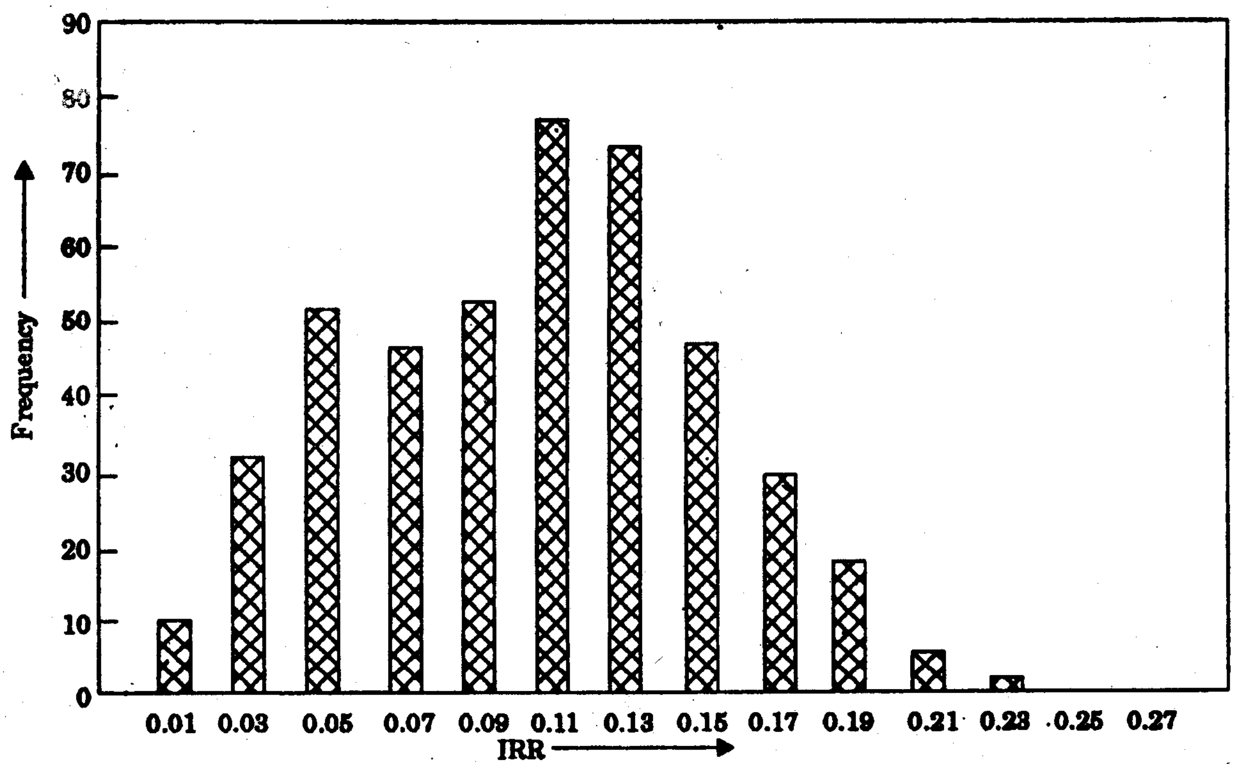


Fig. 15.4 : Simulated Frequency of IRR

15.6 SUMMARY

In this unit, you have had a broad overview of computer application available in the area of Project Management. You have seen that computers can and do play a critical role in managing large and complex projects. Successful project management depends largely on the capability of the computers to update projects status and feed timely and critical information to Project Managers. Various applications using PERT/CPM, time calculations, probability estimates, cost estimates and cost crashing and resource leveling are possible. A variety of outputs including schedules, bar charts and reports can be generated using the computer.

Spme text books softwares for doing the basic calculations and providing the bar charts have been indicated. You also have a listing of a computer programme for simple network calculations. You have also information on more comprehensive project management software packages including packages that carry out financial appraisal of projects. Finally, you have seen the concept of simulation that can be applied to assess the simultaneous and probabilistic impact of a number of project parameters on the project IRR

15.7 SELF-ASSESSMENT EXERCISES

1) Explain the benefits of computerization of Project Management

2) Take any network and develop the computer inputs required for its computerization. Indicate which inputs are required for what purpose.

3) Briefly describe the features you would expect to find in an integrated PM software package.

4) How can computers help in monitoring and control of projects? Explain with an example.

15.8 FURTHER READINGS

Badiru, A.B., *Project Management in Manufacturing and High Technology Operations*, John Wiley, Canada, 1988. Ch. 11, pp 252-277

Gray, C.F., *Essentials of Project Management*, PBI, N.J. 1981 pp. 167-184

Kerzner, H, *Project Management: A Systems Approach to Planning, Scheduling and Controlling*, 2nd Ed. CBS Publishers, New Delhi 1987, Ch. 17, pp 789-806

Lee, S.M. et. al., *Network Analysis for Management Decision*, Kluwer-Nijhoff, Boston, 1982, Ch.8 and Appendix

Barrit, D.A., *Project Management Handbook, Dennis Lock.*, Ed. Gower England, 1987, Ch. 20 and 21, pp 405-462

Nicholas, J.M, *Managing Business and Engineering Projects: Concepts and Implementation*, Prentice Hall; N.J., 1990 Ch. 16, pp. 406-445

APPENDIX-I

```
10  REM PROGRAMME FOR PERT ACTIVITIES NOT EXCEEDING 99
20  REM FIRST EVENT IS 01
```

```
30  DIM IS(99), JS(99), EST(99), LST(99), C$(99), DUR(99), EFT(99), LFT(99)
40  INPUT "NO OF ACTIVITIES";N
45  INPUT "LAST EVENT NUMBER"; NLAST
50  FOR I = 1 TO N
60    INPUT "ACTIVITY & DURATION DAYS, E.G. 01-02, 5"; C$(I),DUR(I)
61  NEXT I
62  I =1
63  X=101
64  X$ = "101"
65  FOR  J = 1 TO N
66  IF LEFT $ (C$(J),2) X$ THEN 70
67  IS(I) = J : I = I + 1
70  NEXT J
71  IF I > N THEN 1062 : REM J SEQUENCE CALCULATION
72  X = X + 1
73  X$ = RIGHT$(STR$(X),2)
74  GOTO 65
80  REM ROUTINE FOR FORWARD PASS CALCULATION
81  X = 101 : AK = 0: REM AK IS A COUNT FOR THE NO OF ACTIVITIES COMPLETED
82  FOR K=1 TO N
84  I = IS(K)
86  IF LEFT $ (C$(I), 2) = "0"' THEN EST(I) = 0: EFT(I) = EST(I) +
    DUR(I): AK = AK+1
88  NEXT K
89  REM CALCULATION OF EFT &EST FOR OTHER ACTIVITIES:
    FIND NEXT ACTIVITY
90  REM SET START NODE TO BE CALCULATED NEXT
92  X$ = LEFT$(C$(IS(AK+1)),2)
96  I = IS(AK+1)
115 REM FIND EFTMAX FOR IDENTICAL END NODE NUMBER
120 EFTMAX = 0
```

```
130   FOR KK=1 TO N
140         IF RIGHT $(C$(KK), 2) < > X$ THEN 170
150          C = EFT(KK)
160         IF EFTM AX C THEN EFTMAX = C
170    NEXT  KK
180 EST(I) = C
190 EFT(I)=EST(I) + DUR(I):AK = AK + 1
195 IF AK > N THEN 201
200 GOTO 92
201 REM ROUTINE FOR BACKWARD PASS CALCULATION OF LST & LFT OF
    ENDING ACTIVITIES
205 X= 100 +NLAST :AK = 0
208 X$ = RIGHT $ (STR$ (X), 2)
209 REM X$ REPRESENTS LAST NODE NUMBER. ROUTINE FOR FINDING OUT MAXIMUM
    EFT VALUE FOR ACTIVITIES ENDING ON LAST NODE
210 EFTMAX = 0
215       FOR KK = 1 TO N
220             IF RIGHT$(C$(KK), 2) < > X$ THEN 235
225              C = EFT(KK)
230             IF EFTMAX <C THEN EFTMAX = C
235        NEXT  KK
237 REM ROUTINE FOR LFT / LST CALCULATIONS FOR ALL ACTIVITIES ENDING
    AT THE END NODE.
238 FOR K = 1 TO N
240  J = JS(K)
242  IF RIGHT$ (C$(J), 2) < >X$ THEN 244
243  LFT(J) = EFTMAX:LST(J) = LFT(J)-DUR(J):AK = AK+1
244  NEXT  K
245  REM CALCULATION OF LFT & LST FOR OTHER ACTIVITIES : FIND NEXT
     ACTIVITY
246  REM SET END NODE TO BE CALCULATED NEXT
```

```
249  X$ = RIGHT$ (C$(JS(AK + 1)), 2)
255    I = JS(AK+1)
275    REM FIND LSTMIN FOR IDENTICAL START NODE NUMBER FOUND ABOVE
280    LSTMIN = 99999.9
290       FOR KK=1 TO N
300                IF LEFT$(C$(KK),2) < > X$THEN330
310       C = LST(KK)
320       IF LSTMIN >C THEN LSTMIN = C
330     NEXT KK
340   LFT(I) = C
350   LST(I) = LFT(I)-DUR(I):AK = AK+1
355   IF AK>N THEN 400
360 GOTO 249
400 REM ROUTINE FOR OUTPUT
405 PRINT "            CRITICAL PATH CALCULATION"
406. PRINT "---------------------------------------------------------------------"
407 PRINT
408 PRINT
410 PRINT "---------------------------------------------------------------------"
420 PRINT
430 PRINT "ACTIVITY DURATION  EST EFT LST LFT SLACK CR.  PATH"
440 PRINT "  NO       DAYS                                REM*
450 PRINT "---------------------------------------------------------------------"
460 PRINT
470 FOR K=1 TO N
475     I = IS(K)
480     SLACK = LFT(I)-EFT(I)
490     IF SLACK = O THEN S$ = "*"
500    PRINT TAB(2); C$ (I) TAB(12); DUR(I); TAB (21); EST (I); TAB(26); EFT(I);
       TAB(31); LST(I); TAB(36); LFT(I); TAB(43); SLACK; TAB(50); S$
510    S$= "        "
```

```
520          PRINT
530 NEXT K
540 PRINT
550 PRINT "---------------------------------------------------------------------------------------------------------------"
555 INPUT DUMMY
560 REM ROUTINE FOR PRINTING BAR CHART
570 PRINT
580 PRINT
590 PRINT                          BAR    CHART
600 PRINT "---------------------------------------------------------------------------------------------------------------'
605 PRINT "---------------------------------------------------------------------------------------------------------------"
610 PRINT
660 FOR 12 = 1 TO N
665      I = IS(12)
670      IF EFT(I) = LFT(I)-THENS$ = "*"ELASE="
690      SLACK = LST (I)-ESI (I)
700      PRINT TAB (1); S$; TAB(4); C$(I); TAB(10); DUR(15); TAB(iS)pSLACK:
         TAB(EST(I) + 20)
710      FOR J= 1 TODUR(I)
720           PRINT " $ ";
730 NEXT J
740 FOR K= 1 TO SLACK
750                PRINT ":";
760           NEXT K
770           PRINT
775           PRINT
780 NEXT 12
790 PRINT
795 PRINT
800 PRINT "---------------------------------------------------------------------------------------------------------------
880 END
```

```
1062  I = 1
1063  X=100 + NLAST
1064  X$ = RIGHT$ (STR$ (X), 2)
1065  FOR J = 1TON
1066      IF RIGHT $ (C$(J), 2) < > X$ THEN 1070
1067      JS(I) = J: 1 = 1 + 1
1070  NEXT  J
1071  IFI>N  THEN 80
1072  X = X - 1
1073  X$= RIGHT$ (STR$ (X), 2)
1074  GOTO 1065
```

APPENDIX-II

Input Data of the problem NPLAUNCH Page : 1

Activity number	Activity name	Start node	End node	Normal duration	Crash duration	Normal Cost	Crash cost
1	<DESIGN >	<1 >	<3 >	<+5.00000>	<0 >	<0 >	<0 >
2	<RESEARCH >	<1 >	<5 >	<+1.00000>	<0 >	<0 >	<0 >
3	<ANALYSIS >	<3 >	<9 >	<+2.00000>	<0 >	<0 >	<0 >
4	<MODEL >	<3 >	<7 >	<+3.00000>	<0 >	<0 >	<0 >
5	<BROCHURE >	<3 >	<5 >	<+2.00000>	<0 >	<0 >	<0 >
6	<COST >	<9 >	<13 >	<+3.00000>	<0 >	<0 >	<0 >
7	<TESTING >	<7 >	<13 >	<+4.00000>	<0 >	<0 >	<0 >
8	<TRAINING >	<5 >	<11 >	<+2.00000>	<0 >	<0 >	<0 >
9	<PRICING >	<11 >	<13 >	<+1.00000>	<0 >	<0 >	<0 >
10	<REPORT >	<13 >	<15 >	<+1.00000>	<0 >	<0 >	<0 >

APPENDIX - III : TYPICAL REPORT CPM SOFTWARE

CRITICAL PATH CALCULATION

Activity No.	Duration Days	EST	EFT	LST	LFT	Slack	Cr.Path Rem *
03	5	0	5	0	5	0	*
05	1	0	1	6	7	6	
09	2	5	7	7	9	2	
07	3	5	8	5	8	0	*
05	2	5	7	5	7	0	*
11	4	7	11	7	11	0	*
13	4	8	12.	8	12	0	*
13	3	7	10	9	12	2	
13	1	11	12	11	12	0	*
15	1	12	13	12	13	0	*

BAR CHART

```
-----------------------------------------------------------
1 - 03    5    0    $$$$$
1 - 05    1    6    $::::::
3 - 09    2    2         $$::
3 - 07    3    0         $$$
3 - 05    2    0         $$
5 - 11    4    0            $$$$
7 - 13    4    0              $$$$
9 - 13    3    2            $$$::
1 - 13    1    0                   $
8 - 15    1    0                     $
-----------------------------------------------------------
```

APPENDIX-IV

InstaPlan-III

Insta Plan is an innovative project planning software package that helps you plan with power. Manage with perspective, and communicate with clarity. It's a fast and natural way to plan. Start with broad objectives and as you progress, get down to detailed action plans. You can manage your operations efficiently and effectively using techniques like PERT and CPM without going through a whole learning process.

The multi-project outlining feature of InstaPlan lets you define activity lists for the different projects which use common resources of your organisation, into a single plan. Now Outlining supports codes for activities and lines to display the structure. You can then view the load on each resource for the combination of activities of the entire project. Based on the loading you can prioritise resources allocated in eight different ways.

Planning with InstaPlan

You can use any of three different options for planning in InstaPlan or a combination of these within the same plan.

Normal Planning follows the standard Critical Path Method. In this case, InstaPlan assumes that all activities lead to one objective, showing the earliest start dates and slack for each activity.

Deadline Planning works backwards from the fixed end-date of the project and shows you the latest possible start dates for each activity. Here, slack for the activity is shown before the duration of the activity.

The Critical Path and the slack are computed for each project based on the planning option when either of the above methods is used.

Open-ended Planning can be used when there is no single final objective to be met but several separate activities are to be scheduled, assigned and managed.

Scheduling

InstaPlan schedules activities sequentially in the order they are entered. Complex scheduling links between activities can be handled through a separate Schedule option. You can schedule an activity to start or end on a definite calendar date or mark it as an independent activity. You can "pad" an activity for extension of duration or mark it as a "Milestone".

Resource Allocation

InstaPlan allows you to define resources such as people and equipment for the project or activity in the Resource View. Once the resources have been defined for capacity, unit cost and its accrual period are allocated to various activities. You can enter assignments such as hours of work required or units of money, in the Spreadsheet View.

InstaPlan automatically computes the cost of the activity and sums up the total for the project. If any of the resources are overloaded, you can shift work to another resource or increase the time allocated for the project. Now, you can save the plan as a Reference Plan for tracking the Project.

Views

InstaPlan allows you to look at your plan through seven different views.

- Activity View shows you the activities and the time estimates.
- Gantt View shows you the activities as bars against time in days, weeks, months, quarters or years.
- PERT View represents activities with their linkages and highlights the Critical Path.
- Resource View allows you to define resource capacity, cost and accrual period. Resources could be in units of time or money.

- Spreadsheet View helps you to allocate resources to activities and computers costs for the activities and plan.
- Resource Loading View shows you the load histogram of resources utilised in the plan / activity. It helps you to identify overloads and level resources.
- Calendar View lets you define calendars for each of the resources, taking into account their individual holidays and workloads.

In all the above views, the Focus Form can be used to define very specific sets of activities based up conditions such as date range and status of activities. The view of the plan then displays only the activities that meet the Focus conditions. You can use Focus Form to search for activities based on their code, with a "wild card" option.

Tracking

The tracker option enables you to create a reference plan at the beginning of your project to record Project History as the project progresses and adjust dates. The progress for an activity can be given as percentage of total quantum of work. You can view the variance and progress in the Gantt View. InstaPlan keeps track of the commitment for each activity in its Project History database. This can be viewed at the stroke of a key. It lists the details of past work done and its progress.

Forecasting

This option helps you estimate the future schedule of the plan based upon the current actual data. You can use this as a quick "What if" tool. InstaPlan provides three special screen displays to help you can compare the current status of your project with the Reference Plan:

- The Gantt Variance View, to show changes in schedule.
- The Spreadsheet Variance View, to show changes in schedule and cost.
- The Loading Variance View, to show changes in cost versus time.

Annotation

The electronic Notepad of InstaPlan lets you annotate activities, resources and assignments in detail. These notes can be selectively viewed, printed or included in the Activity or Resource reports. There is also a pop-up calculator. You can move the result calculated to a cell in the Spreadsheet or to the Notepad.

Transfer

Activity and Resource lists may be imported into InsiaPlan from ASCII or Ready files. They may also be exported to ASCII or Ready files from InstaPlan. Information from the Spreadsheet View and on Resource usage, can be exported to either 1-2-3. WKS of dBase.dbf file.

Networking with InstaPlan

InstaPlan on LAN facilitates the consolidation of individual department plans to an organisation plan of a larger size. This is possible with one of the nodes having EMS for accommodating larger size of plans. Also allows sharing / view of plan files across users in the network in a distributed environment of LAN installation.

The basic networking requirements of file sharing, security and data integrity is fully implemented. This supports an unlimited number of nodes on the network.

Reporting

A variety of reports and charts can be defined and made available as you need them. The Report Definition option enables you to view projects on different criteria and to do exceptional reporting.

The basic management reports are Activity Report, Resource Report and Schedule Report. The Spreadsheet Report presents activities in rows and resources in columns for a specified time period and gives you information on cash outflow and "to do" activities.

The presentation charts are the Gantt chart, Resource Usage chat and Activity chart.

The network diagram of your plan can be printed using the PERT module available. InstaPlan supports a variety of dot matrix printers and HP Laser Jet Plus compatible laser printers for outputs.

For the best quality presentation outputs, the charts can be scaled and printed on any HPGL compatible single or multi-pen plotters of any size.

Technical Specifications

GENERAL

— Seven integrated views and three,variance views

— 14 basic menu commands (Insert, Edit, Move Focus, Print etc.)

— Extensive on-screen context sensitive help

— Monochrome, Colour, EGA and VGA monitor support

— Allows Batch Append of departmental plans

— Totally compatible files with IP II

— Percent indicators for all operations

— Export of Lotus 1-2-3 and dBASE III Plus with focus conditions and current expansion

— Capacity of 400 activity plans in normal usage without Expanded Memory Specification. The actual limits with EMS (LIM 3.2 and above) can be computed from the following table with an activity description of 10 characters and resource description of 10 characters.

Spreadsheet cells per activity	Max. no. of activities	Memory Required thousand activities
0	30000	190k
2	15000	350k
3	10000	440k
4	8000	500k
5	6000	[illegible]
6	5000	650k

Without notes, the maximum plan size requires 6 MB of EMS. While notes do not use memory, they do require disk space. The maximum IP Plan size is limited to 15 MB. Hence one will be limited to 9 MB of notes on a maximum plan size of 6 MB.

ACTIVITY OUTLINE

— 11 level outline format with code and line support for work Break Down Structure. Each level summarize schedule, manpower and cost.

— Collapse, Expand and Focus for display and printing

— Estimate in worktime, work quantity or elapsed time

— Unlimited sequential and overlapped connections at any level and across levels

— Focus form with option for search based on Activity Code with wild card possibility

— Optional delays on connection, starts and completions

— Schedule by hours, reported by days, using estimates, connections, assignment and multiple calendars

— Easy insert, delete, editing and reorganisations

— Reference scheduled saved for true variance analysis

RESOURCE OUTLINE

— 11 -level outline for resource breakdown on skill / function, indented on screen. Each level agregates cost, capacity and loading.

— Collapse, Expand and Hide for display and printing

— Time or money category of resources

— 4 ways to accrue cost

— Individual Resource Calendars, capacity set by day

— resource leveling to % of capacity by day / week / month

— 8 ways of adjusting Resource loading within MultiProject Plans

— Locate overload facility

— Reference cashflow saved for true variance analysis. Spreadsheet and presentation chart format output

WORK ASSIGNMENT SPREADSHEET

— Activity outline rows by Resources outline columns

— Simple notations for assignment

— Assign work by rate, amount, durations and combinations

— Rollup on all group rows and columns in cost and man hours

— Sparse Matrix Memory Management and extensive format control

— Move and copy command to Shift Work among people

— Allows positives and negatives for cash outflow and income

— Tabular and spreadsheet format output

— Reference assignments saved for true variance analysis

SYSTEM REQUIREMENTS

— IBM PC-XT or PC-AT or AT-386 or 100% compatible with 640 KB RAM, one floppy disk drive 5¼" or 3½" and one hard disk drive

— Dot matrix printer 80 / 132 column or HP Laser Jet plus compatible Laser printer

— HPGL compatible Plotter

— EMS cards of minimum 1MB RAM with LIM 3.2 or LIM 4.0 specification, optional

— DOS ver 3.2 or higher

FOR NETWORKING

— Novell Netware ELS Ver 2.12 upwards with a 80286 / 80386 based dedicated server with appropria disk storage and RAM of minimum 2 MB

— Nodes to the server as PC-XT / PC-AT with 640 KB RAM and hard disk for local storage

— EMS card of 1MB at nodes, optional. All trade marks used are registered trademarks of their respective owners.

APPENDIX -V

What HTPM Does

If you manage projects and resources, HTPM enhances your ability to control your work. It helps you design projects, track them, predict their cost and resource needs, use time and money efficiently, and produce regular and informative reports.

- You can build and refine a project on the screen as a network (called a roadmap) so you can see how the tasks arc related to each other. The roadmap is easy to change when you want to consider what-if questions, or to reflect changes in a developing project.
- A completed roadmap shows the critical path (the set of tasks that determine the length of your project). You can direct your attention to where it will do the most good.
- HTPM translates lengths and costs of tasks into a schedule bar chart and a cost graph. You can track a project as closely as you wish.
- You tell HTPM what your resources are and how you're using them on each task. HTPM draws up allocations and loading graphs to show how each resource is allocated, and how much of each resource is in use. It's easier to minimize time and costs, and to use resources efficiently.
- HTPM lets you tailor the project calendar to your company.

- If your projects are large and complex, you can break them down into any number of subprojects, and combine them into one superproject. HTPM handles all the computations and automatically carries information from subprojects to the next higher project level.
- HTPM can print a variety of reports on your projects and resources. You can transfer project and resource data to a form that most spreadsheet programs accept.

APPENDIX-VI

ABOUT MICROSOFT PROJECT

Creating schedules and figuring costs with Microsoft Project

Microsoft Project can help you with a variety of scheduling and costing tasks. You can use it for handling schedules that range from the simple to the complex.

Microsoft Project is flexible. Whether you are a novice or a seasoned scheduler, you will be able to use Microsoft Project to schedule projects in the way you find most comfortable.

Microsoft Project is versatile. You can use it to schedule individual, small group, or departmental projects; to plan projects for a staff of four, or to oversee and integrate activities for several departments. You can also combine separate schedules into a master schedule.

Microsoft Project is fast. If you change information about a project, you can instantly see the impact of the changes.

When you enter information about your project, the program does time and cost calculations, and displays a graphic schedule. This schedule, sometimes called a Gantt chart, shows not only when each activity begins and ends, but also which activities need the most attention to make sure the project gets done on time.

Microsoft Project can also display another kind of graphic schedule — a PERT chart. A PERT chart is a kind of flow chart, focusing on the order of the activities and the way they interrelate rather than on the start date and finish date for each activity.

Microsoft Project can help you answer such questions as these:

- How long will this project take? Can we meet the contract completion date?
- If this activity is delayed, will the entire project slide? If so, by how much?
- How can we tell if we are on schedule in time to correct any problem?
- What are the critical relationships between specific activities? Can they be rearranged to provide a smoother flow of operations?
- Carry the resources of an external project over to the master project.
- Store special or additional notes on any given activity using the new Jot command.
- Set standard workdays and workweeks using the new Standard command.

APPENDIX-VII

MANAGEMENT DEVELOPMENT INSTITUTE: PROJECT APPRAISAL PROGRAMME INPUT FORMAT

NAME OF THE FIRM: XYZ&CO.		PROJECTED SLAES	
DATE: 16/03/92		@100%CAP.UT 5500	
PROJECT LIFE:	10	1st. YR OF REPAYME	4
COSTS		ANNUAL RATE OF INC. IN:-	
CAPACITY UTILIZATION YR 1	50.00%	SALES PRICE	14.27%
MATERIALS COST AS % OF SALES	34.20%	MAT.COST	10.00%
UTILITIES AS % OF SALES	3.70 %	UT.COST	7.00%
1st YR LAB COST(% SALES)	18.60%	LAB. COST	15.00%
1st YR FACT O/H (% SALES)	14.20%	FAC.OV-HDS	15.00%
1st YR R&d EXP(% SALES)	0.50%	R&D EXPENSES	2.00%
CAPACITY UTILIZATION FINAL	85.00%	CAP. UTILIZATION	7.50%
1st YR. ADMN. EXPENSES(Rs.)	39	ADMN. EXPENSES	15.00%
TOTAL SALES EXPENSES AS % OF SALES	1.63%	SALES EXPENSES	5.00%
ROYALTY AS % OF SALES	12.40%	YEARS TO BE CHARGE	4
RAW MAT INVENTORY-DAY	35	WIP INVENTROY DAYS	25
% SALES	3.28%	-%SALES	4.84%
FIN. GOODS INVENTORY-DAYS	30	RECEIVABLES - DAYS	30
% SALES	7.01%	%SALES	7.01%
INCREMENTAI CAP EXPENDITURE	6961	INCOME TAX CODE	3
SALVAGE VALUE	5.0%	1= => NO BENEFIT	22.4%
		2 = = > 80HH BENEFIT	
WORKIG CAPTI AL AS % OF SALES	22.1%	3 = = > 80HH & 801 BENEFIT	
TAX HOLIDAY IN YEARS	4	RATE OF SUBSIDY	20.00%
FINANCIAL EXPENSES			
INT. ON TERM LOANS(SCHEME)	14.0%		
INT. ON WORKING CAPITAL	16.0%		
INT. ON TERM LOANS (EXISTING)	12.0%	TERM LNS (EXISTING)	0
INT. ON UNSECURED LOANS	15.0%	UNSECURED LOANS	253
INT. ON DEBENTURE	13.5%	DEBENTURES	0
INT. ON DEFERRED CREDIT	12.0%	DEFERRED CREDIT	0
RATE OF GUARANTEE COMMISSION	11.50%	GUARANTEE AMOUNT	0

OTHER INCOME (NETT)	0	0	0	0	0	0	0	0	0	0
MISC.EXP. W/OFF	0	0	0	0	0	0	0	0	0	0
DISC. FAC. FOR NPV	0	0	0	0	0	0	0	0		
MAX. EQUITY DIVIDEND*****			EQUITY			204				
PREFERENCE DIVIDEND *****			PREF DI			30				

NRD/PURCH.TAX	0	0	0	0	0	0	0	0	0	0
(SUGAR ONLY)	0	0	0	0	0	0	0	108	114	115

DATA ENTRY FORMAT

ITEM OF COST	Rs. in Lacs	Cont. Rate	Dcpn. Rate	Repair & IstYr.	2ndYr.
LAND & LAND. DEV.	250.00	0.5%	0.00%	0.00%	0.00%
BUILDING & CIVIL WORKS	500.00	10.0%	10.00%	1.00%	1.50%
PLANT AND MACHINERY	2000.00	10.0%	33.33%	2.00%	2.50%
AUXILLIARY EQUIPMENTS	750.00	10.0%	20.00%	2.00%	2.50%
MISC. FIXED ASSETS	350.00	10.0%	15.00%	2.00%	2.50%
VEHICLE	500.00	10.0%	20.00%	2.00%	2.50%
TECHNICAL KNOW-HOW	1000.00	10.0%			
CONTINGENCIES	511.25				
PREL. EXPENCES	350.00				
PRE-OPERATIVE EXPN.	400.00				
MARGIN FOR W.C.	349.97				
TOTAL PROJECT COST	6921.22			77.00	97.50
MEANS OF FINANCE	DEBT-EQUITY RATIO				2

PROMOTERS CONTB.	700		
EQUITY (FIN. INST.)	1000		
SEED CAPITAL (IDBI)	200		
INVESTMENT SUBSIDY	20		
TEFR SUBSIDY	100	2320	
PREFERENCE EQUITY	300		
UNSECURED LOAN	263		0.06

TERM LOAN			SHARE OF TERM LOAN
A) SIDC	584		0.13
B)SFC	1751		0.38
C) COM. BANK	876		0.19
DEFERRED PAYMENT	1167	4641	0.25
TOTAL PROJECT COST	6941		

MANAGEMENT DEVELOPMENT INSTITUTE:
PROJECT APPRAISAL PROGRAMME OUTPUT FORMAT

Estimates of cost of production & profitbility

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cap. Utilization	50.0.%	57.5%	65.0%	72.5%	80.0%	85.0%	85.0%	85.0%	85.0%	85.5%
Total Melcrial Cost	941	1190	1479	1815	2203	2575	2832	3116	3427	3770
Total Utilities	102	125	151	181	213	243	260	278	297	318
Total Labour Cost	512	676	879	1128	1431	1749	2011	2313	2660	3059
Total Factory OV-HDS	391	516	671	861	1093	1335	1536	1766	2031	2335
R&D and other Expens	14	16	19	21	24	26	26	27	27	28
Total Manufacturing	1958	2524	3200	4006	4965	5928	6665	74499	8443	9510
Total Admn. Expenses	39	45	52	60	69	79	91	104	120	138
Total Sales Expenses	45	54	64	75	87	97	102	107	113	118
Royalty	341	392	443	494	546	580	580	580	580	580
Total Cost of Produce	2383	3015	3760	4636	5666	6683	7438	8290	9255	*****
Total Sales Revenue	2750	3163	3575	3987	4400	4675	4675	4675	4675	7675
	2750	3614	4668	5950	7502	9108	*****	11893	*****	*****
Gross Profit	367	598	908	1314	1836	12425	2970	3603	4336	5184

2. Financial Expenses	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Int. on Term Loans(s)	613	613	613	613	587	485	383	281	179	77
Int. on Term (Loans E)	0	0	0	0	0	0	0	0	0	0
Int.on Working Capital	97	112	127	141	156	166	166	166	166	166
Int. on Unsec. Loans	39	39	39	39	39	39	39	39	39	39
Int. on Debentures	0	0	0	0	0	0	0	0	0	0

Int. on Deferred Cre	0	0	0	0	0	0	0	0	0	0
Guarante Commission	0	0	0	0	0	0	0	0	0	0
Total Financial Expe.	750	764	779	794	783	690	588	486	384	282
Depreciation	375	375	375	375	375	375	375	375	375	375
Financial Expenses	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Operating Profit	-758	-541	-246	145	678	1360	2007	2742	3577	4527
Other Income(Nett)	0	0	0	0	0	0	0	0	0	0
Misc. Exp. W/Off	0	0	0	0	0	0	0	0	0	0
Profit before Tax	-758	-541	-246	145	678	1360	2007	2742	3577	4527
Tax	0	0	0	38	228	454	664	895	1162	1451
Profit After Tax	-758	-541	-246	107	451	906	1344	1846	2415	3076
ADD										
Depreciation	375	375	375	375	375	375	375	375	375	375
Misc.Exp. w/of	0	0	0	0	0	0	0	0	0	0
Gross Cash Accruals	-383	-166	130	483	826	1281	1719	2222	2790	3451
Less										
Equity Dividend	-758	-541	0	77	204	204	204	204	204	204
Preference Divi	0	0	-246	30	30	30	30	30	30	30
Net Cash Accruls	375	375	375	375	592	1047	1485	1988	2556	3217

3. Break Even as Percentage of Installed Capacity:

--------------	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sales	2750	3614	4668	5950	7502	9108	*****	11893	*****	*****
Variable Costs	1525	1873	2265	2707	3205	3660	3939	4246	4582	4951
Fixed Costs	1983	2282	2649	3097	3619	4089	4462	4906	5431	6051
Fixed Costs	1607	1906	2274	2722	3243	3714	4086	4530	5056	5676
Break Even	0.81	0.75	0.72	0.69	0.67	0.64	0.59	0.55	0.51	0.49
Cash Break Even	0.66	0.63	0.61	0.61	0.60	0.58	0.54	0.50	0.48	0.46

4. Repayment Schedule

NO.OF 1/2 YRS.	OPENING BALANCE	REPAY INST.	1/2 YR. INTT.	YRLY. INTT.	YRLY. REPAY
1.	4378.12	0.00	306.47		
2.	4378.12	0.00	306.47	612.94	0.00
3.	4378.12	0.00	306.47		
4.	4378.12	0.00	306.47	612.94	0.00
5.	4378.12	0.00	306.47		
6.	4378.12	0.00	306.47	612.94	0.00
7.	4378.12	0.00	306.47		
8.	4378.12	0.00	306.47	612.94	0.00
9.	4378.12	364.84	306.47		
10.	4013.28	364.84	280.93	587.40	729.69
11.	3648.44	364.84	255.39		
12.	3283.59	364.84	229.85	485.24	729.69
13.	2918.75	364.84	204.31		
14.	2553.91	364.84	178.77	383.09	729.69
15.	2189.06	364.84	153.23		
16.	1824.22	364.84	127.70	280.93	729.69
17.	1459.37	364.84	102.16		
18.	1094.53	364.84	76.62	178.77	729.69
19.	729.69	364.84	51.08		
20.	364.84	364.84	25.54	76.62	729.69

5. Debt Service

Coverage Ratio	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Gross Cash Accruals	-383	-166	130	483	826	1281	1719	2222	2790	3451
Add										
Int. on Term Loans(SC	613	613	613	613	587	485	383	281	179	77
Nrd/Purch.Tax Deff (Sugar Only)	0	0	0	0	0	0	0	0	0	0
Less										
Deposits (IDBI)	0	0	0	0	0	0	0	108	114	115
Cash Available for Debit Servicing	230	447	742	1096	1413	1766	2102	2394	2854	3413

Int. on Term Loan(SC)	613	613	613	613	587	485	383	281	179	77
Instalments on Prin 730	0	0	0	0	730	730	730	730	730	730
Debt.to be Serviced	613	613	613	613	1317	1215	1113	1011	908	806
D.S.C.R.	0.38	0.73	1.21	1.79	1.07	1.45	1.89	2.37	3.14	

6. Tax Calucation

PBT+Depreciation	-383	-166	129	521	1053	1735	2382	3117	3952	4902
Less WDV Depreciation	1019	734	535	394	294	223	170	132	78	65
Taxable Income	*****	-900	-405	126	759	1512	2212	2985	3874	4837
Tax Income Under 80H	*****	-675	-304	95	569	1134	1659	2239	2906	3628
Tax Income under 80H	-841	-540	-243	76	228	907	1327	1791	2325	2902
Tax	-421	-270	-122	38	228	454	664	895	1162	1451

Depreciation Calculation : Written Down Value Method.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Building & Civil Wor	50	45	41	36	33	30	27	24	22	19
Plant and Machinery	667	444	296	198	132	88	59	39	0	0
Auxilliary Equipment	150	120	96	77	61	49	39	31	25	20
Misc. Fixed Assets	53	45	38	32	27	23	20	17	14	12
Vehicle	100	80	64	51	41	33	26	21	17	13
Total Depreciation	1019	734	535	394	294	223	170	132	78	65

7. Ratios

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gross Profit/Sales %	13%	19%	25%	33%	42%	52%	64%	77%	93%	111%
Raw Mat/Val of Output	34%	38%	41%	46%	50%	55%	61%	67%	73%	81%
Wages/Sales%	19%	21%	25%	28%	33%	37%	43%	49%	57%	65%
Interest/Val of Output	27%	24%	22%	20%	18%	15%	13%	10%	8%	6%
Operating Profit/Sale	-28%	-17%	-7%	4%	15%	29%	43%	59%	77%	97%
D.S.C.R.	0.38	0.73	1.21	1.79	1.07	1.45	1.89	2.37	3.14	
Average D.S.C.R.	1.56									

UNIT 16 MANAGING TRANSITION FROM PROJECT TO OPERATION

Objectives

After going through this unit you will be able to understand:

- the process of transition from project, usually construction phase, to operation
- the role of various disciplines in testing and commissioning
- the importance of advance planning of commissioning and integrating it with project execution
- the need of close co-ordination amongst internal and external agencies for fail-safe commissioning
- development of agreed procedures of handing over and taking over
- criticality of proofing runs and trial production where applicable
- costing and capitalisation of assets

Structure

16.1 INTRODUCTION

Projects are plans of action for 'pushing forward' or 'hurling forward' an organisation in the comity of the corporate world. Projects are also construed as processes of transition and signify management of change. However, within a project, changeover from construction phase to operational phase is the most crucial and critical. Pictorially this phase can be shown as in Figure 16.1:

Fig. 16.1

The project is initially visualised as one entity but as soon as it is sanctioned, it is divided into functional segments viz., civil and structural engineers are engaged in designing, procuring, expediting supplies for delivery to construction site and erection of civil building and structures in various geographical zones. Mechanical engineers are concerned with designing, ordering, expediting and inspection during manufacturing at suppliers' works and later erection at site. Similarly pipingengineers, electrical engineers, instruments engineers look after their respective areas of specialisation.

However, when the entire project has been erected as per the design / drawings, it gets converted into a viable and integrated plant only after it has been successfully put through the transition of testing and commissioning. (Fig. 16.2).

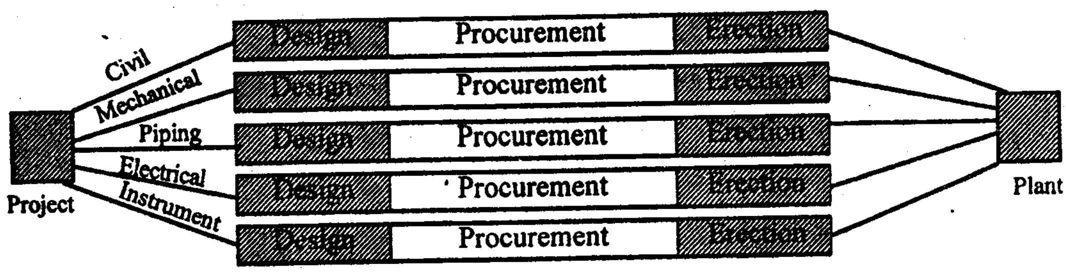


Fig. 16.2

16.2 OBJECTIVE OF COMMISSIONING

Project implementation is accompanied by large outflow of capital expenditure. Naturally, entrepreneurs keenly look forward to the earliest possible day when the new plant will start producing goods and services which would generate revenue as they are sold in the market. It is, therefore, important that commissioning of the plant achieves the following:

i) Commissioning proceeds smoothly without any conflict among the project and operating personnel

ii) Minimal problems arise from unforeseen accidents leading to damage to equipment, personnel and materials

iii) Commissioning is completed in the minimum possible time

iv) Commissioning is planned and phased such that it evens out the workload of commissioning crews

v) All raw materials, spares etc. for commissioning and trial production have been ordered alongwith the equipment and are received at the construction sites well on time.

vi) All check sheets for precommissioning tests and written commisioning procedures incorporating the manuals of equipment suppliers etc. are available complete with requisite drawings.

vii) Where warranties are applicable and contracts provide for commissioning and first charge of raw materials in the presence of representatives of equipment suppliers, they are available on hand to meet the schedule.

16.3 ORGANISATION MATRIX FOR COMMISSIONING

In large organisations, commissioning is handled in the following two ways:—

a) Commissioning by Operations

Project management is a multi-faceted activity-simultaneous to project engineering and execution. Organisations have to nominate the 'operations and start-up' team—which is a group of persons who would man the manufacturing unit As a rule, they should be brought in early to learn and train themselves in the new technology or liaise with project team to ensure that the ultimate purpose of the project is adequately taken care of. Start-up or commissioning teams are multi-disciplinery and have representatives from process, mechanical, electrical, instrumentation etc. Operations / Production Managers assign various commissioning teams who would take over the plant, unit by unit, after physical checks from the project construction team and then proceed to carry out all no-load tests as stipulated. This is followed by loading of equipment including topping up of oils and lubricants of the specified grade and quantity and carrying out tests as per the written procedures for commissioning prior to undertaking trial runs for production. During this period, project construction personnel are expected to standby and render whatever help is requested by the start-up team.

b) Independent Commissioning Teams

Arising from the requirements of increasing sophistication in technology, automation and consequently low intervention of human beings, there is a trend in large companies to create specialist commissioning groups who are assigned the responsibility of taking over plants from construction teams and then carrying out thorough testing and commissioning checks and handing over to operations personnel for regular production. Creation of specialist commissioning group by large companies like ICI has enabled them to.

i) reduce time in testing and commissioning

ii) minimise untoward technical / engineering problems

iii) ensure better checking and documentation for subsequent use by operations and maintenance

iv) provide independent check on quality of construction and facilitate / promote quality in projects

v) improve inter-personnel relations by playing 'honest brokers' between project construction and operations teams

16.4 PLANNING FOR COMMISSIONING

Large manufacturing plants comprise of the main plant-battery limits and a host of service and utility plants, amenities etc. Service Plants might cover incoming power supply and receiving station, power distribution substations, raw water, filtered water, treated water, cooling towers, boilers, fuel oil, hot oil, gas or compressed air, diesel generating sets etc., besides central workshops for mechanical, electrical, instruments, materials etc., craft training centre, storage buildings for raw materials, packaging, maintenance spare parts, tools and finished products, welfare amenities, canteen, offices etc.

For commissioning the main plant or a portion of it, we require to commission all the related service plants and utilities, amenities etc. For example, if we arc to commission the Main Plant by March, we would have to make all the service units operational before that. Similarly, service plants are also interconnected. We cannot commission boilers until the water treatment plant is operational and water treatment plant cannot be commissioned until both raw water and power supply and distribution arc established and so on.

It is also prudent to phase out the commissioning of these service plants so as to optimize the utilisation of scarce resources of professional commissioning personnel.

16.5 FORECASTING REQUIREMENTS OF COMMISSIONING

A number of organisations have learnt at their own cost, the peril of delayed commissioning and dangers of not predicting and providing requirements of commissioning. These days rigorous drills like 'Hazardous & Operabilily Study' at the early design stage have been made mandatory in project- driven organisations. These exercises examine the operability of the plant in diverse situations in a systematic manner. In the process they enhance the technical knowledge and skills of project and operations personnel besides highlighting the additional safety features required to be built to ensure trouble free commissioning and subsequent operations. Forecasting of commissioning requirements has to start from the design stage itself-design engineers must have the necessary training and orientation to incorporate all the data / information including requirements of recommended commissioning spares with the requirements of erection viz.,

i) mechanical drawings for equipment

ii) circuit drawings for equipment

iii) commissioning manual for the equipment spelling out checks to be carried out at the time of commissioning.

iv) recommended spares for commissioning

v) related guarantees, warranties and expert supervision required and offered.

All the above requirements for commissioning besides inspection and quality checks / tests at manufacturers' works must be included in the design engineers' requisition on procurement. In India, suppliers of equipment do not furnish these informations and are loath to offer inspection / quality checks unless specified in the purchase order. It is imperative that these are suitably incorporated in the contract. Wherever possible, payment to vendors may be linked to their furnishing these vital documents and drawings.

Activity 5

Cite an example of the organisation structure and procedure in an organisation for the commissioning of project.

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16.6 QUALITY ASSURANCE DURING MANUFACTURING

Smooth, uninterrupted commissioning results from a large number of factors which need to be monitored and controlled from the early stages of project execution. The role of quality management is paramount. This must include the following aspects:

i) Determining quality assurance plans and procedures and' agreeing upon these with the suppliers.

ii) Instituting checkpoints for raw materials, in-stage inspection during manufacturing and final check / performance test at the manufacturers' works prior to despatch of the equipment.

iii) Prescribing third parly, statutory check and enjoining submission of all test reports as an essential part of the contract and linking it with payments to the suppliers.

16.7 QUALITY CHECKS OF EQUIPMENT ON ARRIVAL AT SITE

As an essential part of the comprehensive system of project management, all equipment and materials, immediately upon arrival at site, must be subjected to formal inspecting and checking even though the same has been carried out at suppliers works prior to their despatch. This will bring out any possible damage to the equipment enroute owing to accident, malhandling, transhipment etc. This check is extremely important for fragile equipment like instruments and other electronic equipment. In the event of damage, replacement must be ordered / arranged simultaneous to lodging and processing of claims for insurance etc.

Besides; transportation of materials from suppliers to construction sites should be handled through nominated carriers as information regarding carriage of materials and their status of movement plays a major role in penultimate stages of project completion.

16.8 TOTAL QUALITY MANAGEMENT IN PROJECTS

Total Quality Management (TQM) stands for total Quality Mindsets. If we are to achieve (TQM) fail-safe system of project management, we not only require an unimpeachable commitment to quality but also to the necessary supporting procedures and documentation. If we have to achieve excellence in project management, we must endeavour to accomplish tasks right first time every time. Any cutting of corners on procedures and documentation may land us in serious problems-remember even a needle can hold us back from our target.!

The following checks should be incorporated into the project management procedures and documentation:

a) Materials

i) Whether all the systems, equipment and items included in the scope of project and in the initial cost estimates have been designed and indented for procurement

ii) Whether all items indented for procurement have been fully ordered out on suppliers and contractors

iii) Whether all items ordered have been manufactured and delivered to site and paid for

iv) Whether all items delivered at site have been properly checked, inspected, tagged suitably and stored safely

v) In the event of any damage to materials and equipment, whether replacement supplies have been ordered.

b) Drawings / Documentation

i) Whether there is a fool-proof method of sending all drawings, however preliminary to construction site duly marked 'for information' or 'for construction'. Also, to check if there is a reliable procedure of sending all revision drawings to site

ii) Whether there is a proper procedure of sending all documentations, sketches, material lists, manuals for erection, testing and commissioning to site as soon as the same arc received in the central project office

iii) Whether there is a proper system of receiving, filing, storage and distribution of drawings, documentation at the construction site. Also old issues of drawings are not mixed with the current drawings. There should be a system of maintaining one set of master drawings centrally and in safe custody to avoid pilferage, loss or spoilage.

Activity 6

Describe the quality control procedure in project management existing in an organisation you know of

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16.9 HANDING OVER/TAKING OVER PROCEDURES

When the project construction reaches the stage of physical completion, it is customary for the construction team to prepare a certificate for handing over of the entire plant or in units complete with drawings, documents etc. All project organisations have pre-agreed procedures in a standard format to avoid any confusion. On receipt of the same, the operations department checks the building, structures, plant and machinery from the viewpoint of taking over the same in relation to the agreed scope — detailed project report, process flow diagrams, line diagrams etc. This detailed scrutiny may result in the followings :

a) Deviations

Deviations represent major departures from the agreed scope. Components of job included in the scope and not built are stated here. As a rule, project personnels have to install these to agreed schedules. This also reflects poor project execution. However, once a while, there might be agreed deviations and operations department may take over the plant as these deviations, albeit major ones, may not impinge upon its current production schedules.

b) Exceptions

These are departures of minor nature. Based on the preliminary list prepared by the operations department, project personnel complete these in the spirit of give and take. Usually a mutually acceptable time table is worked out and adhered to.

16.10 PROOFING RUNS AND TRIAL PRODUCTION

Arising from accepted practice in the industry or contractual agreement, project personnel are required to support trial production. Proofing runs for continuous plants should cover three days continuous operations and for batch plants, these extend over three batches of production. Generally an overall output of 85% of the designed capacity is acceptable. Liquidated damages, if any for not achieving the designed capacity would be as per the stipulations of the contract. Procedures for proofing runs have to be detailed in the technical specifications. Likewise predetermined procedures for documenting Proofing Runs should be followed. The initial trial runs of production arc chargeable to capital account and should be monitored accordingly.

16.11 COSTING AND CAPITALISATION

Expenses incurred during this conversion process viz. testing and commissioning including trial runs of production arc collected separately under a suitable cost centre. Costs include expenses on raw materials, oils, lubricants, greases etc., as also cost of spare parts used during commissioning. Besides, testing and commissioning costs cover all expenses incurred on wages and salaries etc., of commissioning team and are compiled under this cost head.

As a part of commissioning, project department must compile the capital asset register complete with all the relevant costs of major equipment and ancillarics under various capitalisation heads viz,., buildings plant and machinery including supporting structures, office equipment, furniture, rolling stock etc. The comprehensive list of assets in the register and the associated costs have to be authenticated by the engineers for the finance department before these are capitalised. The entire process is also subject to usual financial audit. It is, therefore, imperative to compile all expenses during the testing and commissioning phase in a proper and systematic manner.

16.12 SUMMARY

A project is a multifunctional activities involving a number of specialists from different fields. Entrepreneurs keenly look forward to the earliest possible day when the new plant will start producing goods and services. Forecasting of commissioning has to start from the design stage itself. Smooth, uninterrupted commissioning results from a large number of factors which need to be monitored and controlled from the early stages of project execution. Total quality management in project requires an uninterrupted commitment to quality alongwith supporting procedures and documentation.

16.13 SELF-ASSESSMENT EXERCISES

1) Describe the objectives, planning procedure and organisational structurc required for commissioning of projects.
2) What quality control methods are prevalent in project management?
3) What is the costing and capitalisation procedure adopted for project management?

UNIT 17 PROJECT COMPLETION AND EVALUATION PROJECT REVIEW

Objectives

After going through this unit you will be able to understand :

- the process of control and its indivisibility from planning
- the role of project review during implementation
- the mechanics of co-ordination in projects
- the critical elements in control
- the universality of control & communication among men and machines
- the motivational aspects of monitoring

Structure

17.1 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.

17.2 INDIVISIBILITY OF PLANNING AND CONTROL IN PROJECTS

All projects must be planned in great details before they are launched for implementation. Planning by network analysis is a graphical exercise and is described as literally building the entire project on a piece of paper before its actual execution. This is a simulation of how the project will be split into various packages, engineered through design, procurement, manufacturing with suitable quality checks, delivering to construction site and then erecting at different geographical locations as per the design. These physical assets are then thoroughly tested and commissioned into a viable plant. A schematic of the entire process of project management is as shown in Figure below:

A Project Manager draws up a detailed action plan for the entire project in consultation with members of his team belonging to specialist functional departments and then, as the project implementation proceeds, data relating to innumerable events is collected, measured and evaluated, through a monitoring cell, and used as input for replanning of the current project or for planning new projects in future. Management of projects has two distinct phases viz.,

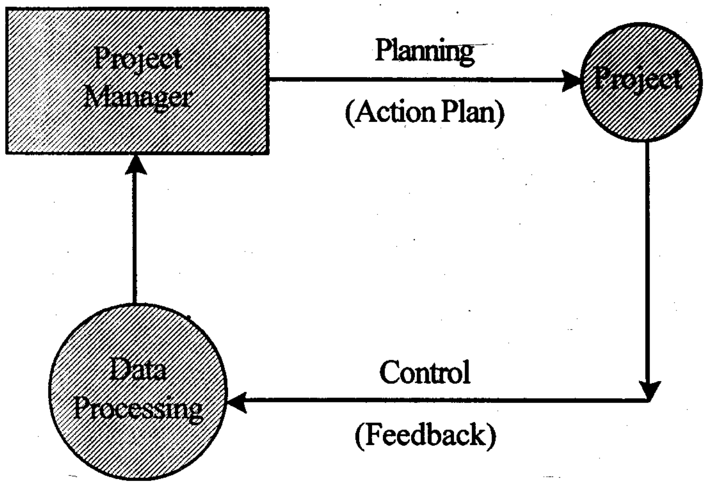

Fig. 17.1

Planning, signifying 'Plan your Work' phase and Controlling; implying 'Work your Plan' phase: If any one of the two phases is missing or is curtailed, it will snap the loop or the chain and will impair the process of effective project management. In project management, planning and control are the two indivisible sides of the same coin of management —one cannot function without the other. (Fig. 17.1).

17.3 IMPORTANCE OF PROJECT 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. These meetings are held at various levels as below:

a) Project Team review meetings usually chaired by the project manager.

b) Top management review meeting where project manager reports the status of the project and highlights problem areas and how the same are being resolved.

c) 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 unforseen situations arise and require concerted and co-operative effort allround 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 gaps 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 and should be designed to achieve specific tasks. Calling review meetings for the sake of it should be avoided at all costs.

17.4 PROJECT CO-ORDINATION PROCEDURES

A traditional definition of management is the process of planning, scheduling, co-ordinating and controlling activities with a view to achieving the objective(s). Network-based project management being an integrated technique of planning and controlling, also covers all the above aspects as shown Fig. 17.2.

Project matrix is rather large—a number of people have to be involved to ensure that project execution is orderly, balanced and free of conflicts. Those projects which start with exclusive kick-off conferences, followed by frequent meetings in the early stages usually start with a higher level of disagreements and conflicts. This is a blessing because identification of such problems in early stages leads to their resolution. As a result, when the project is orchestrate better with commensurate improvement in their performance and accomplishment

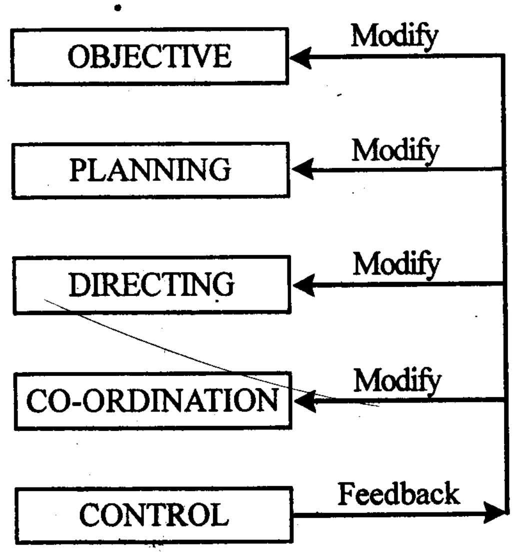

Fig. 17.2

The initial phase calls for resolution of a number of administrative and technical issues as below:

i) Filing/documentation for the project

ii) Cost coding of the project

iii) Resolving areas of functional responsibility

iv) Co-ordination procedures amongst specialist functions and project office

v) Procedures for indenting, ordering, bill certification, bill payment etc. including limits of financial authority

vi) 'Deliverables' and their scope and schedule of release by functional departments

vii) Planning and reporting procedures

viii) Schedule of project review meetings and their frequencies

ix) Co-ordination procedures with construction site

x) Co-ordination procedures for reporting to top management

xi) Co-ordination procedures for reporting to customer

xii) Responsibility for compiling testing and commissioning procedures

xiii) Handingovcr / takingovcr procedures

xiv) Data compilation for current project for use in future project planning and replanning

xv) Close-out reports

17.5 ELEMENTS OF CONTROL IN PROJECTS

Project implementation rarely proceeds as per the forecasts detailed, in the network. Project execution is not a rail-road journey in sometimes we arc off-rail i.e., behind schedule and at other times, we might be on rail i.e., on schedule or ahead of it. Periodic review of the project is essential to take stock of the situation, to determine the current status, to measure and evaluate with respect to agreed checkpoints or milestones and to take corrective / remedial measures to bring the project back on schedule by updating the activities, to increase / decrease their durations and level of engagement of resources and hence costs. The key elements in control process are:

a) Establishing standards

If we cannot measure a thing, we cannot manage it. Network analysis helps us to devise the yardstick for measuring our performance in execution. We establish checkpoints or milestones which arc simple criterion of performance and are preselected for the entire route of project execution. These should be distinguishable, measureable and verifiable so that when reached, there should not be any controversy.

The 'principle of critical point control' enjoins us to give attention to those factors that are critical to evaluating performance against agreed / specified targets. Ability to select critical points of control is the quintessence of management since sound control depends upon this selection. Management of 'hard' projects comprises control of time, cost and performance parameters which are all tangible and can be quantified. In industry particularly, in the management of 'soft' projects, one has to deal with intangible standards e.g., measuring the degree of success of a public relations compaign-or improving the response of personnel in an organisation. Considerable research work is being done to measure the degree of success by developing suitable yardsticks for evaluating these in 'soft' projects and then evaluating the feedback with regard to the yardstick.

b) Measuring performance against standards

Measurement of performance against standards should ideally be a forward-looking or on proactive basis with a view to detecting deviations in advance of their occurrences, and should be avoided by appropriate corrective action 'in advance'. An alert project manger can often predict probable perceive much ahead of schedule, it should be uncovered as early as possible. Every problem has a solution — it is and consequently impacts adversely on the project completion.

In technical and engineering projects, measurement of performance is relatively easy as the milestones are specific, measureable, agreed and time-framed. However, measuring performance against vague standards like enthusiasm and loyalty of personnel, absence of strikes etc is difficult.

c) Correcting variations from standards

If performance is measured in accordance with the organisation structure and responsibility, it is easier to correct the deviations because managers know exactly where, in the assignment of individuals or groups, remedial measures have to be applied. Correction of deviation is the point at which 'control' functions as a part of the whole system of management and can be related to other managerial functions. Corrections may lead to modifying, planning or scheduling or co-ordiantion or control procedures or in modifying / revising the goals. This is the 'principle of navigational change'. Corrections may be effected by re-assigning or clarification of duties, additional manpower, better selection and training of personnel or through bcilcr leadership — fuller explanation of jobs and other more effective techniques of leading project management.

Activity 7

Describe the project planning, co-ordination and control procedure in an organisation you know of

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17.6 CONCEPT OF CYBERNETICS

Norbet Weincr who founded the science of Cybernetics described it as .the science of control and communication in animals and machines. It is derived from the Greek word meaning 'steerman' signifying 'steering' or 'piloting'. It now implies the general theory of control applicable to men, groups of men, machines, factory, industry, society or national economy. Since management is a profession of control, it can reap the greatest benefit from Cynbernetics, the science of control. Its approach is multi-disciplinery. Herein, concept of control does not imply coercion or repression—it stands for self-regulation. It deals with those attributes which make a system regulate itself to respond to its environments and to adopt, to survive and evolve like living animals who are far superior than any of the instruments of control derived by men. Cybernetics aim to imitate such mechanisms of nature.

Living organisms regulate themselves and respond to environments through feedback. Feedback device in living animals makes he 'effect' to act back on the 'cause' or 'causes'. This mechanism called the 'homostasis' regulates organs, glands etc. and regulates various functions of body such-as maintaining body temperature, stabilising the acidity ;value of blood, regulating sugar content of blood or for expelling foreign body from the eye, nose or throat. It is the deviation from the normal (standard in our case) that causes the secretion of some harmones or chemical substances or cause to operate the reflex mechanism in order to combat the imbalance and restore normal conditions.

Managers also measure actual performance, compare it against standards, identify / analyse deviations, develop a programme of corrective action and implement it in order to arrive at the performance desired as shown in the Fig. 17.3.

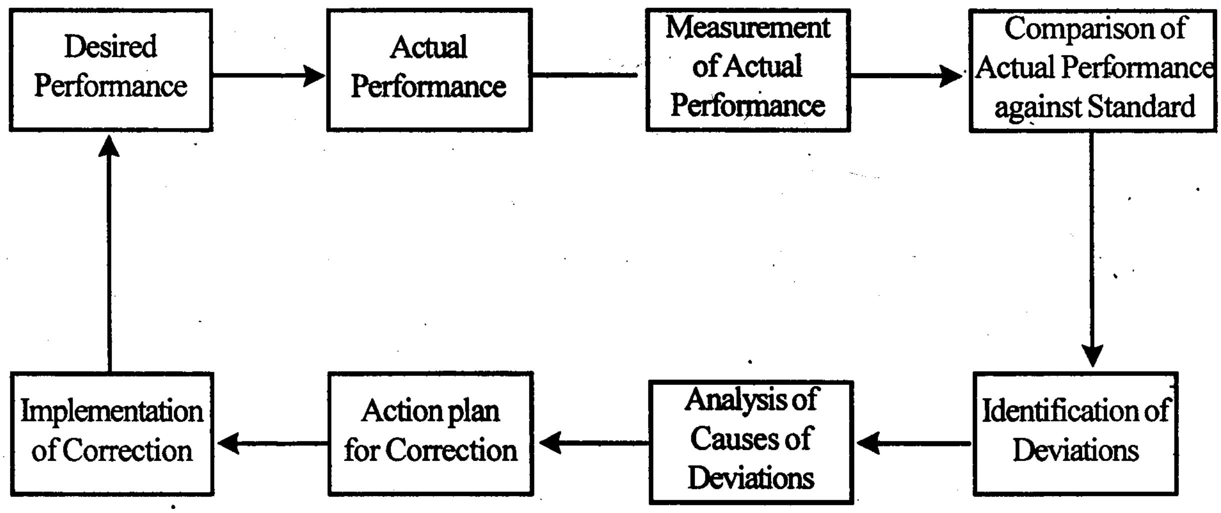

Fig. 17 3

Activity 8

Describe a real-life application of the cybernetic approach to project management control.

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17.7 PROJECT PLANNING PROCEDURES

A) Squared Networks

Since the quality of control is dependent upon the planning procedures, there has been considerable innovation in this field. The development of the technique of network analyses—both Critical Path Method (CPM) and Project Evaluation & Review Technique (PERT) was necessitated because of the inadequacy of Henry Gantt's Barcharts in the changing and dynamic conditions of real-life. However, the use of Barcharts as a method of planning and control has persisted largely because it is easy to understand, learn and implement. This had been engaging the attention of researchers and has resulted in the development of 'Squared Networks'. These networks combine the advantage of both Barcharts and Networks. Herein the length of arrow in networks is proportional to the activity duration and all interdependencies are denoted by dropping 'dummy' activities vertically from one node to another. It is easy to conceive that critical path will be a continuous path, from start to finish, without any floats. All other paths, being non-critical, will have floats. Squared networks have revolutionised the concept of control because it is now possible to use progressing and measurement techniques of the Barchart as also take advantage of the interdependencies of network for tracking back the project to schedule by modifying planning, scheduling, co-ordinating and controlling procedures and updating activities as appropriate. A typical network for the manufacture of Vessel and Stirrer Assembly has been drawn in the following page. (Fig. 17.4).

The network spells out the jobs of different sections and departments clearly so as to facilitate identification of responsibility of individuals or groups. It may also be noted that the critical path lies through all activities relating to vessel — be it design (preparation of drawings), customer's approval, issue of manufacturing / purchase indent, ordering, delivery, receipt and final assembly. All other paths, being non-critical, have floats shown as appropriate to the logic of network.

Progressing & Measuring Performance on Squared Networks

This is a further refinement of the use of curser for reviewing the progress of jobs on the Barchart. Herein, we use a number of coloured pens or pencils to record the progress during the review period which is usually a month. The review period can be made shorter or longer as appropriate for reporting progress to operating or senior managers. Timing of review is indicated in any one colour, say green, by a vertical line on the squared network. This is a substitute for the curser. Since the choice of colour is unique for a time period, overlines drawn in that colour represent all jobs done, complete or partial, during that time period. The overlines in green for the time period on the activity arrows will be drawn proportional to the work done viz., for a job which is 100% complete, overline will span across the entire length of the arrow and so on. It is rather easy to plot these overlines on the activity arrows — since squared network is drawn on a time scale, overline can be drawn upto 50% of the length of the arrow if it is half complete. Alternatively, if it is going to take two more weeks to complete, overline can be drawn upto the point which is two weeks short of completion shown in the network etc. All progress made during the period of review, represented by vertical green line, will be shown by horizontal overlines in-the same colur. For the next review period, another colour can be chosen and the entire process repeated in the new colour as above. Figure 17.5 illustrates the process by adopting a few legends viz :

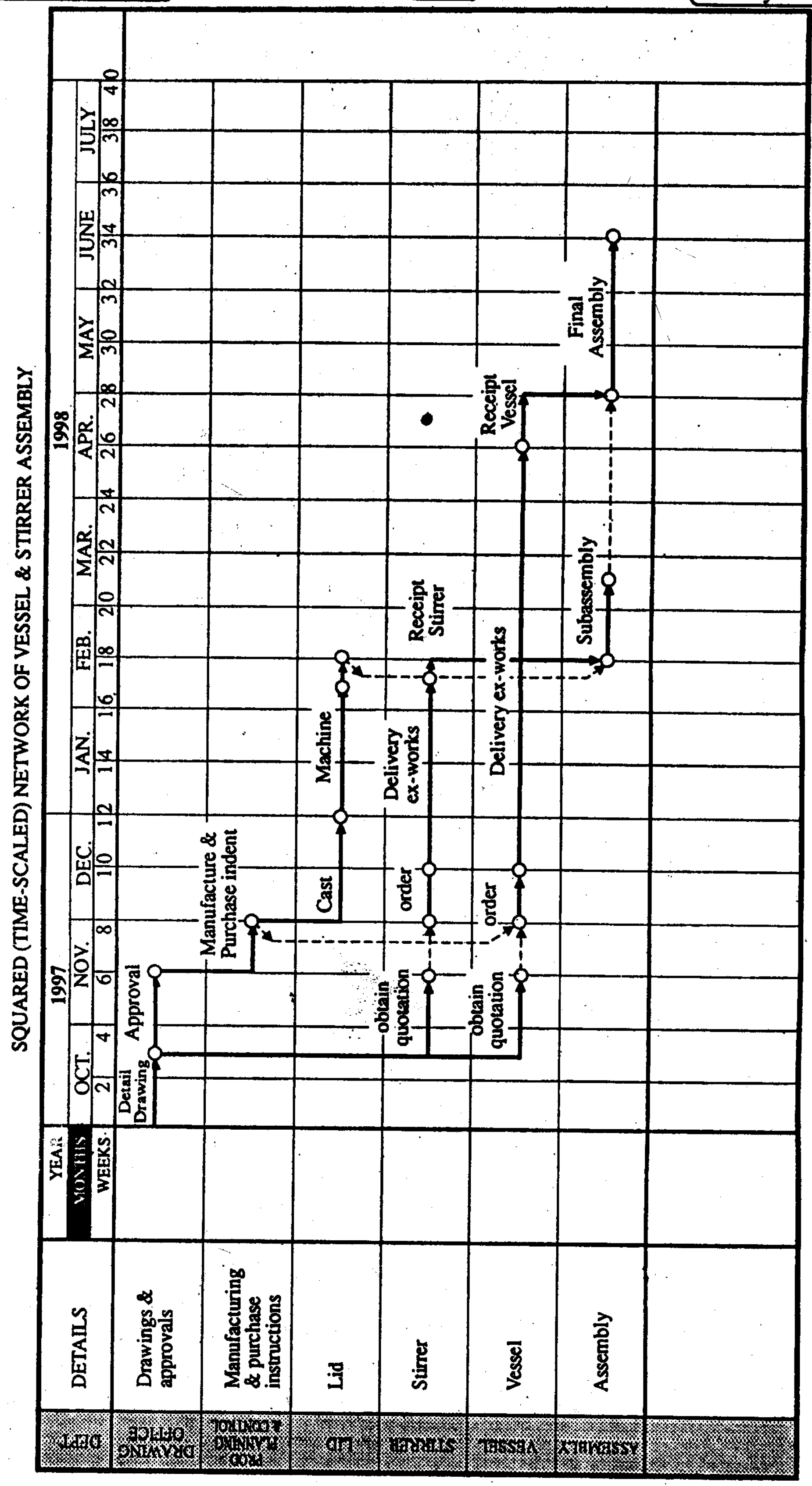
If we use the above colour scheme, the following decision rules would emerge:

i) If horizontal overline for an activity that continues beyond the vertical line, remains to the left of it, that activity is behind .schedule.

ii) If for an activity which continuous beyond the vertical line, horizontal overline just touches it, it is on schedule.

iii) If horizontal overline has crossed over to the right side of the vertical line, the activity is ahead of schedule.

Progress of all other activities is marked with the overlines in the same colour in proportion to their completion. This process, being graphical, brings into focus the current status of the project at a glance and is extremely useful for marking and updating overall / summary schedules, in squared network format, on a single sheet of paper. This is also a convenient method of retaining a brief history of the project from start to finish.



SQUARED (TIME-SCALED) NETWORK OF VESSEL & STIRRER ASSEMBLY
DEPT
DETAILS
YEAR
MONTHS
WEEKS
1997
1998
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
DRAWING OFFICE
Drawings & approvals
PROD. PLANNING & CONTROL
Manufacturing & purchase instructions
LID
Lid
STIRRER
Stirrer
VESSEL
Vessel
ASSEMBLY
Assembly
Detail Drawing
Approval
Manufacture & Purchase indent
Cast
Machine
obtain quotation
order
Delivery ex-works
Receipt Stirrer
obtain quotation
order
Delivery ex-works
Receipt Vessel
Subassembly
Final Assembly

Fig. 17.4

b) Network-based Milestone Charts

As the project implementation progresses beyond the formative stage into basic design, our knowledge about the scope and details of equipment etc. becomes better. At this point of time, a very detailed network, equipment-wise is prepared for the project as a whole. The format is such that it incroporates details of works for each and every department or section.

Conventional barcharts have not been found to be helpful as they do not represent interdependencies nor the sequential relationships very clearly. These barcharts also do not highlight the milestones which are the natural critical points of control because, they are easily recognizeable, measureable and verifiable. A significant improvement in this area has been the development of Milestone Charts wherein each item of equipment can be shown in Fig. 17.6.

For each department, one barline for each of the equipment is drawn showing clearly the milestones by using the above legends.

Management by network analysis is not only a systematic indepth analysis of all activities but it also helps to prioritize the sequence of activities such that the overall duration is minimum. In simple parlance, it implies that network analysis guides us to design, indent and order longest delivery items first, followed by not-so-long delivery items, followed by

PROGRESSING & MEASURING PERFORMANCE ON SQUARED (TIME-SCALED) NETWORKS

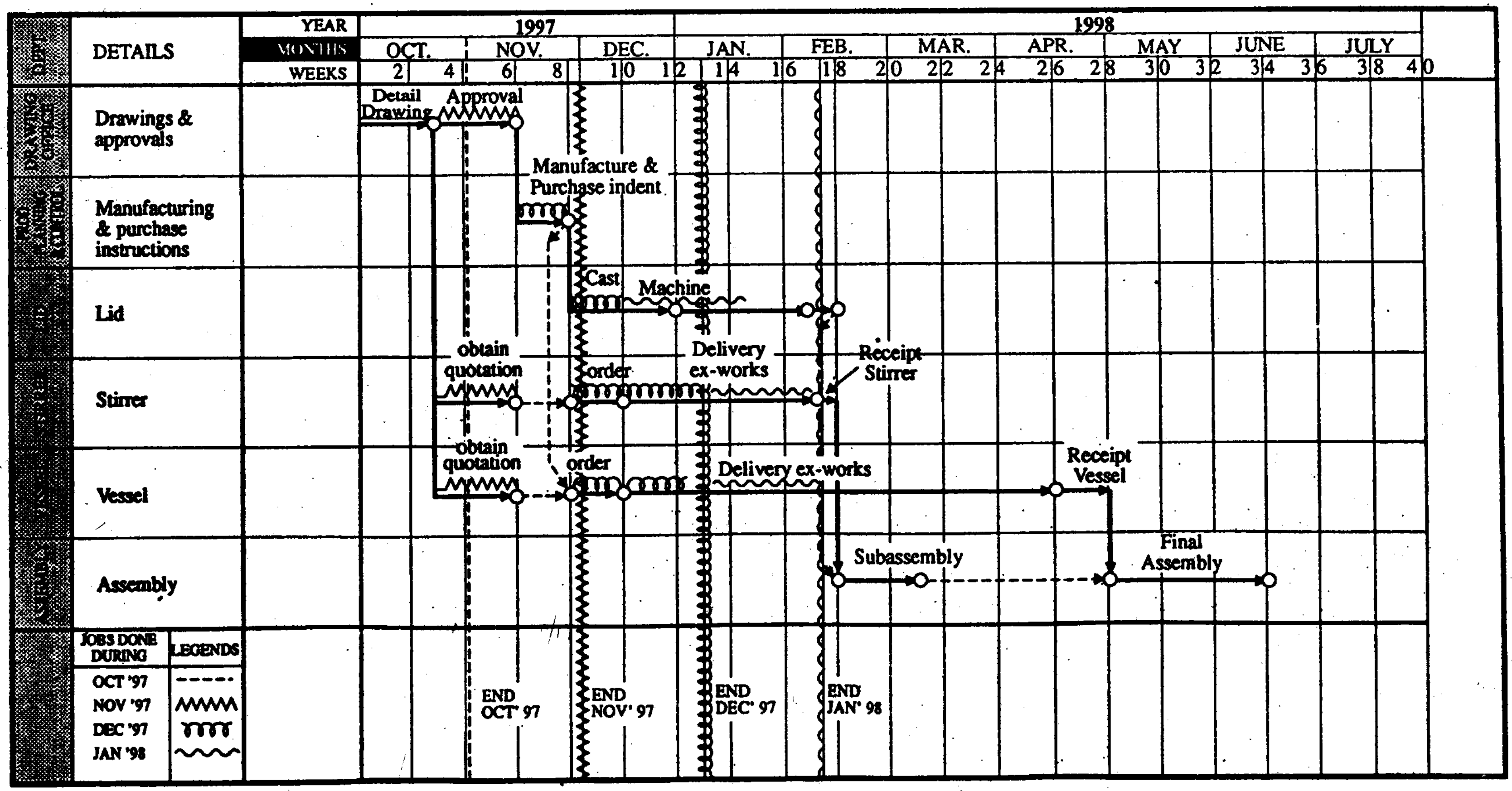
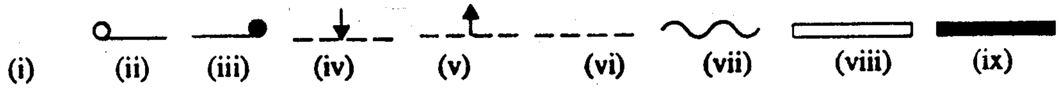


Fig. 17.5



Where
- represents design, freezing specification etc. (i)
- stands for indenting for purchasing (ii)
- signifies order placement (iii)
- Information / drawing to vendor (iv)
- Information / drawing from vendor (v)
- Delivery ex-works (vi)
- Shipment to site (vii)
- Fabrication at site (viii)
- Erection at site (ix)

Fig. 17.6

medium delivery items, short delivery items and so on. A typical Milestone chart of a Department is shown in the Fig. 17.7.

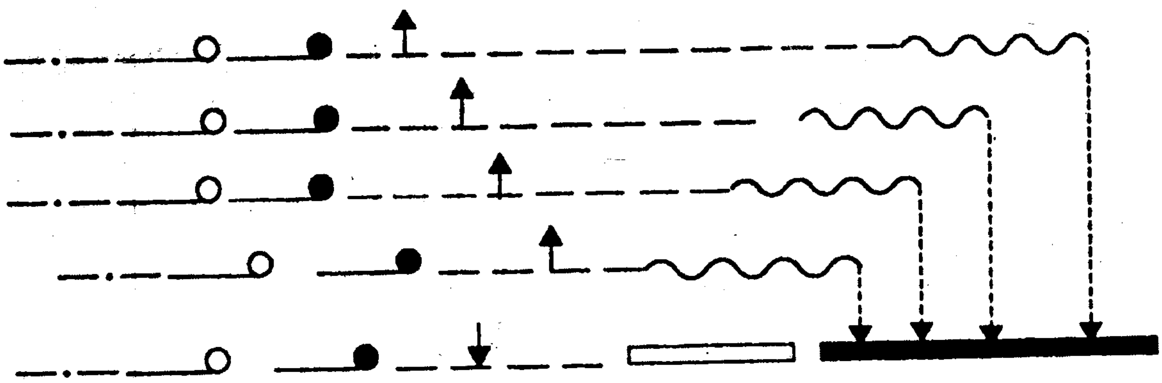


Fig. 17.7

In the first part of the Milestone Chart, all items of equipment are stated giving details of indenting, ordering, delivery ex-works, shipment / arrival at site. Usually, most equipment suppliers have to furnish data and drawings / documentations such as erection, testing, commissioning, operation and maintenance manuals etc. At the end, usually the last row, the barline represents the activities relating to construction or erection contract This has also alt the elements of finalizing specifications and tender documents and indenting, award of contract for which a longer period is indicated, reporting to site, establishing at site and finally the erection work. Since contractors have to be provided with drawings and other related documents, suitable notation is shown in the Milestone Chart.

These Milestone Charts provide the basis of day-to-day review and control of projects on a continuing basis. Besides, a formal review can be done once a week or a fortnight as convenient. These Milestone Charts form the basis of all reporting and monitoring of projects.

Activity 9

Draw a squared network showing project review status as appropriate and draw the network based Milestone Chart for the same of a Project you know of.

....

....

....

....

....

17.8 PROJECT REPORTING

Project management by network analysis provides a comprehensive yardstick for progressing, for measuring pace of implementation, for evaluating the status of execution from time to time and for devising remedial actions to bring the project back on schedule.

Distinguishable and verifiable milestones provide convenient reference points for arriving at the precise status of project implementation.

Each facet of project viz., design and indenting, enquiry and ordering, vendor management and delivery, transportation and receipt of plant and machinery at construction sites, construction and commissioning can be split into various components and the progress monitored accordingly. For example, design and indenting is usually divided into

(i) no. of drawings/specifications

(ii) no. of indents for procurement.

(iii) liaison with suppliers, inspection, contractors etc. enquiry and ordering is split into

- (i) no. of orders placed
- (ii) value of orders placed
- (iii) value of bills passed
- (iv) no. of orders closed vendor management and delivery is split into
  - (i) no. of orders delivered
  - (ii) value of orders delivered

Subject to suitable modifications, one of the following formats may be adopted for reporting:

a) Based on Numbers

SL. NO	Items of drawings	Programmed on date	Actual on date	Important Jobs behind schedule
1.	Civil	16	12	... ...
2.	Mechanical	11	9	... ...
3.	Piping etc.	35	32	... ...

b) Based on Weightages

SL. NO	Item	Weightage in %	Actual % Completed	Overall % Completed	Important Jobs behind schedule
1.	Package 1	25	60	15	... ...
2.	Package 2	20	50	10	... ...
3.	Package 3	10	80	8	... ...
		--	--	--	
4.	etc. etc	100		33	

17.9 MONITORING AND MOTIVATION

With the development of on-line computer systems, it is now possible to collect data about 'what is happening' while it is happening. These data can also be used for measuring performance, evaluating it and identifying the deviation. However, analysing causes of deviation, developing remedial action plan and implementing it takes time. Real-time data can be converted into real-time information but still, it is not possible to have a real-time control. However, it does not mean that timeliness of feedback information is not important on the contrary, it is vital. That is why we say that information received 24 hours late is 'stale';' if is 48 hours late, it is 'rancid' and if it is seven days late, it is 'ancient' history.

However, management by network analysis focusses on identifying and highlighting checkpoints which stand out like lighthouses for the shipping lines. Checkpoints help in preparing route map of the project journey from start to finish. One can measure one's location from time to time. Besides, it prevents losing way enroute.

Feedback with respect to progress is useful for monitoring; it helps people to be more responsible and accountable. It gives project personnel a clear direction on where they are going, how they are being tracked and what needs to be done enroute.

Feedback is called the breakfast of the champions — it helps project personnel to stay committed and motivated and beckons them to double up their efforts to reach the finishing line or to the next milestone as the case may be. Feedback and monitoring enables tracking down one's location with respect to the targets and keeps everyone excited. In the event of delays and problems, it promotes decision route to follow and to ach the next milestone on time. Monitoring facilitates developing contingency / alternate plans well before e unforeseen events for bringing it back on track.

Monitoring helps the project manager to assure himself that the team members stay committed to the project objectives and goals. Motivation is the desire to satisfy a want e.g., achieving an outcome and satisfaction is experienced when the outcome has been accomplished. Project work provides ample opportunities by pre-specifying milestones and if they are achieved as per the target persons experience satisfaction which normally propels them to work harder for the next target. Monitoring, therefore, tickles both the head and the heart and leads to motivated individuals and teams.

17.10 TEAMWORK IN PROJECTS

When networks were invented they were called 'activity networks'. It was soon realised that these networks represent communication channels and were accordingly described as 'communication networks'. These days we describe them as 'networking of human beings' who form the vital and critical point, of action. Projects arc action-oriented and unless we have effective networking of human beings who vibrate well together, we cannot be confident of achieving project completion on time, within budgets, conforming to agreed performance parameters and without any major conflicts. We need to have not a team of brilliant individuals but a brilliant team of individuals. Today we believe project management is primarily developing teamwork, if we have teamwork, ordinary people perform extra-ordinarily.

a) Developing anticipation

When a number of people work together in a team, they inter-act regularly in meetings and in bilateral discussions which leads to better understanding and appreciation of each other's job. Team develops that winning streak called 'anticipation'. In a football game, this is developed by frequent practice and playing together. Imagine the frustration of a player in the centre field if he kicks the ball, after some dribbling, to the left and the guy is not there. When people work together, even hierarchical level melt away and 'esprit de corps' prevails.

b) Self-directed project teams

Project teams play a major role in defining the project goals and department objectives. They also decide their own checkpoints and action plans i.e., operating managers not only decide for themselves the goals and objectives, but also the ways and means of achieving them. In addition, they also decide the co-ordination and reporting procedures for measuring their own progress from time to time.

In line with the above, management information reports are compiled and circulated to everyone giving the deviations from their own target and other relevant details. Members of the team are expected to institute suitable remedial measures in the event of slippage. The entire system is so designed that project teams are their own watch dogs — they for correction and then go ahead remedying it, similar to self-correcting mechanisms in living beings.

17.11 SUMMARY

Projects are time, cost and resources bound one-time operations for setting-up a specific operational facility of a desired quality and capacity.

Planning is the initial stage of a project. In project management, planning and control are the two indivisible sides of the same coin.

Project review in which orderly progress of the project is measured from time to time at pre-determined stages of the project to correct deviations from standards is held. It also helps to motivate the project team members.

Network based management is an integrated technique of planning—controlling which covers monitoring of the objectives, planning, directing, coordination and control of the project.

The key element in the control process are:

i) Establishing standards;

ii) Measuring performance against standards; and

iii) Correcting variations from standards.

Cybernet concepts which deal with making a system self regulating like living animals is applied to project management.

Squared networks combining the advantage of both Barsheets and Networks (CPM and PERT) is used in the planning and control of projects. This has proved to be especially useful as it uses the progressing and measuring techniques of the Barsheet and also takes interdependencies of networks into account for planning and control purposes.

Milestone charts incorporating details of works are used since conventional barsheets have not been found to be helpful as they do not represent interdependence nor the sequential relationships very clearly.

Computers are used for real-lime data processing in project management

Concept of projects as 'activity networks' has evolved into 'communication networks' consisting of common channels and gradually into 'networking of human beings' who form coherent and synergistic team.

17.12 SELF-ASSESSMENT EXERCISES

1) Explain the importance of 'project review' in the context of control of a project.

2) How are cybernetics concepts applied to project management?

3) Explain the use and advantages of squared networks in project management.

4) What are network-based milestone charts and what are their advantages and disadvantages as compared to squared networks?

(DBUS 33)

M.B.A. FINAL YEAR, DEGREE EXAMINATION, MAY 2011.

A-Financial Management

Paper III — PROJECT MANAGEMENT

Time : Three hours — Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Answer any THREE of the following.

1. (a) Feasibility study
   (b) Cost overruns
   (c) NPV
   (d) Project formulation
   (e) Selection of materials handling equipment
   (f) Project idea.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE of the following.

2. Discuss the conduct of technical analysis.
3. State the phases in the formulation of Project report.
4. Describe the significance of economic analysis in project management.
5. What are the sources of financing projects in India?
6. Describe the management of transition from project to operations.
7. Elucidate the uses of management information system in the implementation of Project.

SECTION C — (15 marks)

Compulsory

8. Case study

Draw a network from the following activities and find the Critical path. Also Calculate the earliest time and latest time of each node and explain the nature of the slack of the nodes.

Activity	immediate predecessor	Duration (Days)
A	–	4
B	–	7
C	–	6
D	A.B	5
E	A.B	7
F	C.D.E.	6
G	C.D.E.	5

(DBUS 33)

M.B.A. FINAL YEAR, DEGREE EXAMINATION, DECEMBER 2010.

(A – Financial Management)

Paper III — PROJECT MANAGEMENT

Time : Three hours | Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Answer any THREE of the following.

1. (a) Delphi technique.
   (b) Discounted cash flow technique
   (c) Cost over runs
   (d) Project control
   (e) Project idea
   (f) CPM

SECTION B — (3 × 15 = 45 marks)

Answer any THREE of the following.

2. Explain the considerations in the design of project report.
3. How do you underatake feasibility analysis for establishing a chemical plant?
4. State the applications of PERT in project planning.
5. Enumerate different sources of obtaining finance for a new project.
6. What are the considerations for materials and equipment while implementing a new project?
7. State the process of integrated project management control system.

SECTION C — (15 marks)

Compulsory

8. The activities involved in Alpha Garment Manufacturing Company are listed below with their time estimates:
   (a) Draw the network for the given activities.
   (b) Carry out the critical path calculations.

Activity	Description	Immediate Predecessor(s)	Duration (Days)
A	Forecast sales volume	-	10
B	Study competitive market	-	7
C	Design item and facilities	A	5
D	Prepare production plan	C	3
E	Estimate cost of production	D	2
F	Set sales price	B, E	1
G	Prepare budget	E, F	14

(DBUS 33)

M.B.A. FINAL YEAR, DEGREE EXAMINATION, JUNE 2010.

(A-Financial Management)

Paper III — PROJECT MANAGEMENT

Time : Three hours Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Answer any THREE questions.

1. (a) What is feasibility Analysis?
(b) What is Planning Time Scales?
(c) What is Project Control?
(d) What is Project Evaluation?
(e) What are the equipments used in project planning?
(f) What is data and information?

SECTION B — (3 × 15 = 45 marks)

Answer any THREE questions.

2. Explain the steps in formulation of detailed project reports.
3. Describe the similarities and dissimilarities between PERT and CPM.
4. Discuss the objectives of Network Analysis.
5. Explain the role of Human Resource in implementation of the Project.
6. Discuss the significance of computers in evaluation of the project.
7. Describe the process of integrated Project Management Control System.

SECTION C — (15 marks)

Compulsory.

8. Soft Drinks Ltd., processes and distributes frozen Orange juice and other citrus products. The company owns a few groves, but most of its oranges are supplied by independent growers under long term contracts.

The firm's plant in Ooty is a highly profitable operation, which will continue as long as Oranges are available in the area. However, at the end of 10 years the firm's contract with the Ooty growers expires, and the company does not expect it to be renewed. Since the groves are in the rapidly expanding Kodai Road area, which will be ripe for development within 10 years, the company will probably have to shift its operation to new location. However, because the of the contract with the growers, the company has an assured source of supply for atleast 10 years. Management analyses all decisions relating to Ooty plant on the assumption that the operation will close down in exactly 10 years.

The plant is currently using a juice press that has been fully depreciated. The existing press can be used to another 10 years, but maintenance costs are high, the press extracts less juice per orange than do new presses, and operating labour costs are higher than with new presses. Although the old press has been completely written off and has a zero book value, it could be sold for Rs. 37,500 (but taxed as ordinary income).

An equipment supplier has offered Soft Drinks Ltd., a choice of two new juice presses. Machine

A has a cost of Rs. 3,97,500, an expected life of 5 years, and a calculated savings in costs of Rs. 1,09,500 p.a. Machine B costs Rs. 6,64,500, has an expected life of 10 years, and will provide savings of Rs. 1,14,525 p.a. The Company's management does not expect any improved presses to come on the market during the next 5 years. If estimates that machine A can be bought for Rs. 3,63,600 in 5 years. Moreover in decisions such as this one, Soft Drinks makes the assumption that inflation will push up operating costs and revenues by equal amounts so that operating cash flows will remain the same in years 6-10 as in years 1-5. Further the management feels that new machines will have no salvage value and depreciate accordingly by straight line method.

The company is in the 40% tax bracket, it uses 10% cost of capital for replacement decisions, and it is not subject to capital rationing. Its tax position permits it to use the maximum investment tax credit, currently 10% on assets with lives of eight or more years, two-thirds of 10% for assets with six or seven years lives, and onethird of 10% for assets with four or five year lives. In addition, management expects the tax credit to still be in effect five years from now. Mr. Raj, assistant to financial vice-president of the company must make a recommendation on the replacement. Should he recommend for replacement and if so, which Machine A or B?

Questions :

(a) Calculate the NPVs for machines A and B.

(b) How would each of the following factors affect your recommendation?

(c) The company is subjected to severe capital rationing.

(DBUS 33)

M.B.A. DEGREE EXAMINATION, MAY 2008.

Final Year

A – Financial Management

Paper III — PROJECT MANAGEMENT

Time : Three hours

Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Answer any THREE questions.

1. (a) What is market analysis?

   (b) What is a project?

   (c) What is PERT and CPM?

   (d) What is data and information?

   (e) What is project implementation?

   (f) What is project review?

SECTION B — (3 × 15 = 45 marks)

Answer any THREE questions.

2. Explain the economic and financial analysis.
3. Explain the importance of network analysis in project planning.
4. What are the components in the detailed project reports?
5. Explain the financial aspects in implementation of the project.
6. Discuss the role of computers in evaluation of the project.
7. Explain the process of integrated project management control system.

SECTION C — (15 marks)

Compulsory.

8. Delta and Tellabs Seek Higher Return on Investment

In these days of performance-based information systems, managers have to work hard to get their information system requests approved. Requests to develop a new information system or improve on existing systems are closely scrutinized by senior managers to assure that the investment is effectively supporting corporate goals and will bring in a quick return.

Delta Technology, the information technology arm of $16 billion Atlanta-based Delta Air Lines, presents a good example of this trend. "We have been carefully reviewing every project and every spend (expense) with approvals at the senior vice president level. Before, we delegated decisions to a lower level," says Curtis Robb, senior vice president and chief technology officer. "Finance is also much more actively involved in business cases that are developed (for IT projects)". In other words, Delta and many other companies have found it necessary to implement return on investment (ROI) standards and procedures for measuring return on information system investment.

Curtis Robb says there are critical issues that businesses must address to ensure ROI. The first is total cost of ownership. Each of Delta's business teams mud develop plans that look ahead four years, he says. They look at not only the purchase price but also the "tail behind that purchase price" – hardware, software, maintenance and support, Robb says. The second issue is finding the right level of support for the system once it is in place. Right sizing maintenance contracts has helped Delta shed $10 million in expenses. Standardizing technology has also helped the company save on training and development costs. Rather than building new systems from scratch, Delta designs generic systems to allow portions of systems to be reused on new projects as they arise. The final issue is time to market. At Delta, "solution architects" are assigned to projects from the start to help create a blueprint and determine a timeline.

Once an information system project is under way, it is important to provide oversight to ensure that the project brings in a return. Some companies create technology review boards to provide monthly reviews of IS proposals. Projects are reviewed each month to make sure scope, costs and time frames are on target.

Implementing a system such as Delta's often meets with a considerable amount of cultural resistance. Tellabs, a Naperville, Illinois-based communications equipment maker, has faced obstacles in implementing its new procedures for measuring return on IT investment. When information system proposals were reviewed for approval. CIO Cathy Kozik found a number of inaccuracies and a general lack of honesty. Managers and staffers were finding it hard to be objective due to concerns over budget cuts and worries about automating themselves out of their jobs. To overcome the honesty and accuracy problems, Kozik asked financial controllers from each unit to oversee the calculations of each proposal.

Implementing ROI standards must be a gradual process, Kozik warns. If Tellabs forced its ROI process on workers, "it would have collapsed under its own weight", she says. "Instead of going from 0 to 120, we're going from 0 to 30, 30 to 60".

The role of the CIO becomes all the more valuable to an organization when striving toward a high ROI. The CIO bridges the gap between top-level executives who may be technically native, and lower-level staff who may be more interested in preserving their jobs than saving the company money. Only the CIO can assure that the organization is getting the highest possible return on its information system investments to gain an advantage over the competition.

Discussion Questions :

(a) How might a CIO motivate the information system staff to assist in assessing return on investment and to overcome fears of job less?

(b) How does the trend of involving upper management in information system management decisions affect the balance of power within the organization? Does this under mine previous efforts to empower lower-level employees? Is it possible to have both a high ROI and empowered employees?

(DBUS 33)

M.B.A. FINAL YEAR, DEGREE EXAMINATION, DECEMBER 2009.

(A-Financial Management)

Paper III — PROJECT MANAGEMENT

Time : Three hours

Maximum : 75 marks

PART A — (3 × 5 = 15 marks)

Answer any THREE questions.

1. (a) Feasibility study
   (b) Time overruns
   (c) Project financing sources
   (d) Project MIS
   (e) Integrated project management
   (f) Social costs.

PART B — (3 × 15 = 45 marks)

Answer any THREE questions.

2. How is technical analysis organised while formulating of project?
3. State the application of CPM in the formulation of a project.
4. How do you select HR for project implementation?
5. State different methods of estimating demand for proposed products.
6. How is the liability of industrial projects assessed?
7. Give an account of the organisation for planning and scheduling.

PART C — (15 marks)

(Compulsory)

8. Given below are 4 sets of 3 items each. In each set, the first is a resource which is required for the production of two different "product" ; these two "product" are the next two items in the set. Indicate for any two of the sets, your assessment about whether the resource is to be considered as "merit" or "demerit" type and which of the two "products" is more of a "merit" good than the other. Justify your response and indicate how the NPV of projects involving the use of a given resource adjusted downwards or upwards.

(a)	Land ;	Sugar can ;	Rice
(b)	Petroleum Gas (which is currently burnt away as refinary flame)	Bottled in Cylinders for domestic consumption	Piped or supplied in bulk tankers to industries
(c)	Diesel-oil	Railway transport for moving commodities	Read transport for passengers
(d)	Steel	Automobiles	Machine tools

(DBUS 33)

M.B.A. FINAL YEAR, DEGREE EXAMINATION, MAY 2009.

(A-Financial Management)

Paper III — PROJECT MANAGEMENT

Time : Three hours Maximum : 75 marks

PART A — (3 × 5 = 15 marks)

Answer any THREE questions.

1. (a) New venture.
   (b) Project report.
   (c) Time preference.
   (d) Selection of materials.
   (e) Cost over runs.
   (f) PERT.

PART B — (3 × 15 = 45 marks)

Answer any THREE questions.

2. How do you assess the financial profitability of a project?
3. Discuss the process of preparing feasibility report.
4. Describe the significance of scheduling in project management.
5. Give an account of project management information system.
6. State the factors that may be considered in project review.
7. How do you evaluate the economic viability of a project?

PART C — (15 marks)

Compulsory

8. Draw the network diagram and determine the critical path activities of project X.

Project X

Activity	Time		Cost	
	Normal	Crash	Normal	Crash
1–2	6	4	8,000	10,000
2–4	7	3	9,000	12,000
1–3	8	4	10,000	13,000
3–4	7	5	8,000	11,000
3–5	5	3	7,000	10,000

Find the minimum cost of project schedule if the indirect costs are

(a) Rs. 1,500/week

(b) Rs. 2,000/week.

(DBUS 33)

M.B.A. FINAL YEAR, DEGREE EXAMINATION, DECEMBER 2008.

A–Financial Management

Paper III — PROJECT MANAGEMENT

Time : Three hours | Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Section A consists of SIX questions out of which the candidate has to write THREE questions.

1. (a) What is a project?
   (b) What is a project report?
   (c) What is a time scale?
   (d) What is project scheduling?
   (e) What is project review?
   (f) Define MIS.

SECTION B — (3 × 15 = 45 marks)

Section B consists of SIX questions out of which the candidate has to write THREE questions.

2. Discuss the methods demand forecasting.
3. Explain the feasibility and technical analysis.
4. Discuss the network analysis and project costing.
5. Explain the components and structure of Project Management Information System.
6. What are the financial factors which influence the project implementation and control?
7. Explain the methods of transition from Project to operations

SECTION C — (15 marks)

(Compulsory)

Case Study

8. GE Medical Systems Builds Nation's First All Digital Hospital

If you've ever filled out a patient profile or medical history form for a family physician you've had a good introduction to the complexities of medical record keeping. Such forms typically consist of several pages including dozens of questions about not only your own medical history but also your parents', siblings, and entire family tree's. As your life progresses and you experience the typical medical complications, your medical history becomes larger and more complex. Some of this information is added to your medical records by physicians; other information depends on your own recollections. If you switch doctors, you face the danger of having to start over from scratch.

Keeping up with patient records, along with continuously changing medical knowledge, is a considerable challenge for hospitals and the healthcare industry. This information management challenge has sparked the creation of a new area of specialized research known as medical informatics. The Department of Medical Informatics at Columbia University defines medical informatics as the scientific field that deals with the storage, retrieval, sharing, and optimal use of biomedical information, data, and knowledge for problem solving and decision making.

In short, medical informatics deals with information systems for the medical community.

GE Medical Systems is an $8 billion global leader in medical imaging, healthcare services, and information technology, and it is a pioneer in the medical informatics industry. It is working on several fronts to provide solutions to the complexities of medical record keeping. The Indiana Heart Hospital in Indianapolis has partnered with GE Medical Systems to build the nation's first all digital cardiac hospital. At this new paperless facility, doctors and nurses are able to access patient records and other medical information inside or outside the hospital from a Pocket PC or similar wireless, handheld computer. The new system does away with the need for nursing stations and medical records file rooms. This all-digital hospital has the highest degree of technology infusion and diffusion–all for efficiency and accuracy.

The system that GE has installed, the Centricity Information System, is an enterprisewide clinical information system that integrates patient information—including images, diagnostic readings, and medical history—from every area of the hospital into a single electronic record that can span a patient's entire lifetime. Bringing this variety of information into one easily accessible, centralized system will save healthcare professionals valuable time. Current healthcare trends, including nursing shortages, make the all-digital concept crucial," David Veillette, — boomers means we have to find more efficient ways to take care of three times as many Patients, with staffing levels that will be decreasing", he said. "The only way to do that is with information technology." With electronic records, hospital personnel won't have to struggle to read someone else's handwriting because data will be entered with a keyboard. Also, doctors and nurses won't have to search for paper files–reducing the possibility of errors, according to hospital officials. GE Medical Systems has an operations staff at the hospital to maintain the system and provide support to the medical staff.

GE Medical Systems has a vision of a massive healthcare network that can be accessed by any subscribing healthcare provider, where a patient's medical experience can be merged into a single electronic record that spans care given throughout the healthcare network. This practice echoes a common information management strategy used in all industries : digitize centralize, and deliver. Digitize all data and information so that it can be stored electronically, store it centrally so that all information is accessed through one system, and then create easy access to that system.
In most industries, creating effective and efficient information systems saves the company money and helps it gain a competitive advantage. In the healthcare industry, an effective and efficient information system saves lives.

Questions :

(a) How will the staffing of the Indiana Heart Hospital differ from that of a traditional hospital?

(b) What type of privacy issues arise when developing a central healthcare network? What types of medical information might some patients want to keep private? What policies and procedures might be developed to safeguard private patient information?

(కత్తిరించి పంపవలెను)

అధ్యాపకుల, విద్యార్థుల సలహాలు, సూచనలు :

అధ్యాపకులు, విద్యార్థులు ఈ స్టడీ మెటీరియల్‌కు సంబంధించిన సలహాలు, సూచనలు, ముద్రణ దోషాలు తెలియపరచినచో, పునర్ముద్రణలో తగు చర్యలు తీసుకొనగలము. తెలియపరచవలసిన చిరునామా : **డిప్యూటీ డైరెక్టర్, దూరవిద్యా కేంద్రం, ఆచార్య నాగార్జున విశ్వవిద్యాలయం, నాగార్జున నగర్ - 522 510.**

Course	Year	Title
M. B.A.	Final Year	Project Management

(కత్తిరించి పంపవలెను)

(కత్తిరించి పంపవలెను)