UNIT 5: Technical Analysis

5.1. Introduction

Analysis of technical and engineering aspects is done continually when a project is being examined and formulated. Other types of analysis are closely intertwined with technical analysis. The broad purpose of technical analysis is (a) to ensure that the project is technically feasible in the sense that all the inputs required to set up the project are available, and (b) to facilitate the most optimal formulation of the project in terms of technology, size, location, and so on.

While technical analysis is essentially the preserve of the technical expert, the financial analyst participating in the project appraisal exercise should be able to raise basic issues relating to technical analysis using common sense and economic logic. To this effect, this chapter covers these issues very broadly in terms of:

- Manufacturing process/technology
- Technical arrangements
- Materials and inputs
- Product mix
- Plant capacity
- Location and site
- Machineries and equipments
- Structures and civil works
- Environmental aspects
- Project charts and layouts
- Project implementation schedule
- Need for considering alternatives

5.2 MANUFACTURING PROCESS/TECHNOLOGY

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

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

5.2.1. Choice of Technology

The choice of technology is influenced by a variety of considerations. Some of these are:

1. **Plant Capacity**. Often, there is a close relationship between plant capacity and production technology. To meet a given capacity requirement perhaps only a certain production technology may be viable.

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

3. **Investment Outlay and Production Cost**. The effect of alternative technologies on investment outlay and production cost over a period of time should be carefully assessed.

4. **Uses by Other Units.** The technology adopted must be proven by successful use by other units.

5. **Product Mix.** The technology chosen must be judged in terms of the total product mix generated by it, including saleable byproducts.

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

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

5.2.2. Appropriateness of Technology

Appropriate technology refers to those methods of production, which are suitable to local economic, social, and cultural conditions. The advocates of appropriate technology urge that the technology should be evaluated in terms of the following questions:

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

5.3 THCHNICAL ARRANGEMENTS

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

- The nature of support to provided by the collaborators during the designing of the project, selection and procurement of equipment, installation and erection of the plant, operation and maintenance of the plant, and training of the project personnel.

- Process and performance guarantees in terms of plant capacity, product quality, and consumption of raw materials and utilities.
- The price of technology in terms of one-time licensing fee and periodic royalty fee.
- The continuing benefit of research and development work being done by the collaborator.
- The period of collaboration agreement.
- The assistance to be provided and the restrictions to be imposed by the collaborator with respect to exports.
- The level of equity participation and the manner of sharing management control, especially if the technical collaboration is backed by financial collaboration.
- Assignment of the agreement by either side in case of change of ownership.
- Termination of the agreement or other remedies when either party fails to meet its obligation.
- Approach to be adopted in force majeure situations.

5.4 MATERIAL INPUTS AND UTILITIES

An important aspect of technical analysis is concerned with defining the materials and utilities required, specifying their properties in some detail, and setting up their supply programmes. There is an intimate relationship between the study of materials and utilities and other aspects of project formulation, particularly those concerned with location, technology, and equipment.

Material inputs and utilities may be classified into four broad categories: (i) raw materials, (ii) processed industrial materials and components, (iii) auxiliary materials and factory supplies, and (iv) Utilities.

5.4.1. Raw Materials

Raw materials (processed and/or semi-processed) may be classified into four types: (i) agricultural products, (ii) mineral products, (iii) livestock and forest products, and (IV) Marine products.

1. Agricultural products. In studying agricultural products, the quality must first be examined. Then, an assessment of the quantities available, currently and potentially, is required. The questions that may be raised in this context are: What is the present marketable surplus? What is the present area under cultivation? What is the likely increase in yield per acre?

2. **Mineral Products**. In assessing mineral raw materials, information is required on the quantum of exploitable deposits and the properties of the raw materials. The study should provide details of the location, size, and depth of the deposits and the viability of open cast or underground mining. In addition, information should be generated on the composition of the ore, level of impurities, need for beneficiation, and physical, chemical and other properties.

3. **Livestock and Forest Products**. Secondary sources of data on livestock and forest products often do not provide a dependable basis for estimation. Hence, in general, a specific survey may be required to obtain more reliable data on the quantum of livestock product and forest products.

4. **Marine Products.** Assessing the potential availability of marine products and the cost of collection is somewhat difficult. Preliminary marine operations, essential for this purpose, have to be provided for in the feasibility study.

5.4.2. Processed Industrial Materials and Components

Processed industrial materials and components (base metals, semi-processed materials, manufactured parts, components, and sub-

assemblies) represent important inputs for a number of industries. In studying them the following questions need to be answered: In the case of industrial materials, what are their properties? What is the total requirement of the project? What quantity would be available from domestic sources? What quantity can be procured from foreign sources? How dependable are the supplies? What has been the past trend in prices?

5.4.3. Auxiliary Materials and Factory Supplies

In addition to the basic raw materials and processed industrial materials and components, a manufacturing project requires various auxiliary materials and factory supplies like chemicals, additives, packaging materials, paint, varnishes, oils, grease, cleaning materials, etc. The requirements of such auxiliary materials and supplies should be taken into account in the feasibility study.

5.4.4. Utilities

A broad assessment of utilities (power, water, steam, fuel, etc.) may be made at the time of the input study though a detailed assessment can be made only after formulating the project with respect to location, technology, and plant capacity. Since the successful operation of a project critically depends on the adequate availability of utilities, the following questions should be raised while conducting the inputs study. What quantities are required? What are the sources of supply? What would be the potential availability? What are the likely shortages/ bottlenecks? What measures may be taken to augment supplies?

5.5. PRODUCT MIX

The choice of product mix is guided by market requirements. In the production of most of the items, variations in size and quality are aimed at satisfying a broad range of customers. For example, a garment manufacturer may have a wide range in terms of size and quality to cater

to different customers. It may be noted that variation in quality can enable company to expand its market and enjoy higher profitability. For example, a toilet soap-manufacturing unit may, by variation in raw material, packaging, and sales promotion, offer a high profit margin soap to consumers in the upper-income brackets.

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

5.6 PLANT CAPACITY

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

- Technological requirement
- Input constraints
- Investment cost
- Market conditions

- Resources of the firm
- Governmental policy

5.6.1. Technological Requirement

For many industrial projects, particularly in process type industries, there is a certain minimum economic size determined by the technological factor. For example, a cement plant should have a capacity of at least 300 tones per day in order to use the rotary kiln method; otherwise, it has to employ the vertical shaft method, which is suitable for lower capacity.

5.6.2. Input Constraints

In a developing country, there may be constraints on the availability of certain inputs. Power supply may be limited; basic raw materials may be scarce; foreign exchange available for imports may be inadequate. Constraints of these kinds should be borne in mind while choosing the plant capacity.

5.6.3. Investment Cost

When serious input constraints do not exist, the relationship between capacity and investment cost is an important consideration. Typically, the investment cost per unit of capacity decreases as the plant capacity increases. This relationship may be expressed as follows:

$$C_1 = \left(\begin{array}{c} C2 \\ \end{array}\right) \left(\frac{Q_1}{Q_2}\right)^a$$

Where C1 = derived cost for Q1 units of capacity

C2 = known cost for Q2 units of capacity

A= a factor reflecting capacity – cost relationship. This is usually between 0.2 and 0.9.

Suppose the known investment cost for 7,000 units of capacity for the manufacturer of a certain item is Br. 2,000,000. What will be the

investment cost for 14,000 units of capacity if the capacity-cost factor is 0.8? The derived investment cost for 14,000 units of capacity may be obtained as follows:

$$C_1 = 2{,}000{,}000 \times \left(\frac{14{,}000}{7{,}000}\right)^{0.8} = \text{Br. } 3{,}482{,}202$$

5.6.4. Market Conditions

The anticipated market for the product /service has an important bearing on the plant capacity. If the market for the product is likely to be very strong, a plant of higher capacity is preferable. If the market is likely to be uncertain, it might be advantageous to start with a smaller capacity. If the market, starting from a small base, is expected to grow rapidly, the initial capacity may be higher than the initial level of demand and further additions to capacity may be effected with the growth of the market.

5.6.5. Resources of the Firm

The resources, managerial and financial, available to a firm define a limit on its capacity decision. Obviously, a firm cannot choose a scale of operations beyond its financial resources and managerial capability.

5.6.6. Government policy

The capacity level may be influenced by the policy of the government. Traditionally, the policy of the government was to distribute the additional capacity to be created in a certain industry among several firms, regardless of economies of scale. This policy has been substantially modified in recent years and the concept of ‘minimum economic capacity’ has been adopted in several industries.

5.7 LOCATION AND SITE

The choice of location and site follows an assessment of demand, size, and input requirement. Though often used synonymously, the terms ‘location’ and ‘site’ should be distinguished. Location refers to a fairly

broad area like a city, an industrial zone, or a coastal area; site refers to a specific piece of land where the project would be set up.

The choice of location is influenced by a variety of considerations: proximity to raw materials and markets, availability of infrastructure, labor situation, governmental polices, and other factors.

5.7.1. Proximity to Raw Materials and Markets

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

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

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

5. 7.2. Availability of Infrastructure

Availability of power, transportation, water, and communications should be carefully assessed before a location decision is made.

Adequate supply of power is a very important condition for location-insufficient power can be a major constraint, particularly in the case of an

electricity-intensive project like an aluminum plant. In evaluating power supply the following should be looked into: the quantum of power available, the stability of the power supply, the structure of the power tariff, and the investment required by the project for a tie-up in the net work of the power supplying agency.

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

Given the plant capacity and the type of technology, the water requirement for the project can be assessed. Once the required quantity is estimated, the amount to be drawn from the public utility system and the amount to be provided by the project from surface or sub-surface sources may be determined. For doing this the following factors may be examined: relative costs, relative dependability, and relative qualities.

In addition to power, transport, and water, the project should have adequate communication facilities like telephone and Internet.

5.7.3. Labor Situation

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

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

5.7.4. Government Policies

Government policies have bearing on location. In the case of public sector projects, location is directly decided by the government. It may be based on a wider policy for regional dispersion of industries.

In the case of private sector projects, location is influenced by certain governmental restrictions and inducements. The government may prohibit the setting up of industrial projects in certain areas, which suffer from urban congestion. More positively, the government offers inducements for establishing industries in backward areas. These inducements consist of subsidies, concessional finance, tax, loans, power subsidy, income tax benefits, lower promoter contribution, and so on.

5.7.5. Other Factors

Several other factors have to be assessed as well before arriving at a location decision

These are:

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

Climate Conditions

The climatic conditions like temperature, humidity, wind, sunshine, rainfall, snowstorm, dust, flooding, and earthquakes have an important influence on location decision. They have a bearing on the cost as they determine the extent of air-conditioning, de-humidification, and refrigeration, special drainage, and so on required for the project.

General Living Conditions

The general living conditions like the cost of living, housing situation, safety, and facilities for education, health care, transportation and recreation need to be assessed carefully.

Proximity to Ancillary Units

Most firms depend on ancillary units for components and parts. If the ancillary units are located nearby, coordination becomes easy, transportation costs are lower, and inventory requirements become considerably less.

Ease in Coping with Environmental Pollution

A project may cause environmental pollution in various ways: it may throw gaseous emissions; it may produce liquid and solid discharges; it may cause noise, heat, and vibrations. The location study should analyze the cost of mitigating environmental contamination to tolerable levels at alternative locations.

5.8. Site Selection

Once the broad location is chosen, attention needs to be focused on the selection of a specific site. Two or three alternative sites must be considered and evaluated with respect to cost of land and cost of site preparation and development.

The cost of land tends to differ from one site to another in the same broad location. Sites close to a city cost more whereas sites away from the city cost less. Sites in an industrial area developed by a governmental agency may be available at a concessional rate.

The cost of site preparation and development depends on the physical features of the site, the need to demolish and relocate existing structures, and the work involved in obtaining utility connections to the site. The last element, viz., the work involved in obtaining utility connections and the

cost associated with it should be carefully looked into. It may be noted in this context that the cost of the following may vary significantly from site to site: power transmission lines from the main grid, railway siding from the nearest rail road, feeder road connecting with the main road, transport of water, and disposal of effluents.

5.9 MACHINERIES AND EQUIPMENT

The requirement of machineries and equipment is dependent on production technology and plant capacity. It is also influenced by the type of project. For a process-oriented industry like a petrochemical unit, machineries and equipment required should be such that the various stages are matched well. The choice of machineries and equipment for a manufacturing industry is somewhat wider as various machines can perform the same function with varying degrees of accuracy. For example, the configuration of machines required for the manufacture of refrigerators could take various forms. To determine the kinds of machinery and equipment required for a manufacturing industry, the following procedure may be followed: (i) Estimate the likely levels of production over time. (ii) Define the various machining and other operations. (iii) Calculate the machine hours required for each type of operation. (iv) Select machineries and equipment required for each function.

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

(i) Plant (process) equipment,
(ii) Mechanical equipment,
(iii) Electrical equipment,
(iv) Instruments,
(v) Controls,
(vi) Internal transportation system, and others.

In addition to the machineries and equipment, a list should be prepared of spare parts and tools required. This may be divided into: (i) spare parts and tools to be purchased with the original equipment, and (ii) spare parts and tools required for operational wear and tear.

5.9.1. Constraints in Selecting Machineries and Equipment

In selecting the machineries and equipment, certain constraints should be borne in mind. Some of these are:

(i) There may be a limited availability of power to set up an electricity-intensive plant like, for example, a large electric furnace;

(ii) There may be difficulty in transporting heavy equipment to a remote location;

(iii) Workers may not be able to operate, at least in the initial periods, certain sophisticated equipment such as numerically controlled machines;

(iv) The import policy of the government may preclude the import of certain machineries and equipment.

5.9.2. Procurement of Plant and Machinery

For procuring the plant and machinery, orders for different items of the plant and machinery may be placed with different suppliers of a turnkey contract may be given for the entire plant and machinery to a single supplier. The factors to be considered in selecting the supplier(s) of the plant and machinery are the desired quality of machinery, the level of technological sophistication, the relative reputation of the various suppliers, the expected delivery schedules, the preferred payment terms and the required performance guarantees. Performance guarantees provided by machinery suppliers may take three forms; namely, mechanical guarantee, input guarantee, and output guarantee. If in-house technical expertise is inadequate, external consultant (s) may be

employed to select the plant and machinery and supervise the installation of the same

5.10. STRUCTURE AND CIVIL WORKS

Structure and civil works may be divided into three categories: (i) site preparation and development, (ii) buildings and structures, and (iii) outdoor works.

5.10.1 Site Preparation and Development

This covers the following: i) grading and leveling of the site; (ii) demolition and removal of existing structures; (iii) relocation of existing pipelines, cables, roads, power lines, etc.; (iv) reclamation of swamps and draining and removal of standing water; (v) connections for the following utilities from the site to the public network: electric power (high tension and low tension), water for drinking and other purposes, communications (telephone, telex, internet, etc.), roads, railway sidings; and (vi) other site preparation and development work.

5.10.2 Buildings and Structures

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

5.10.3. Outdoor Works

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

5.11 ENVIRONMENTAL ASPECTS

A project may cause environmental pollution in various ways: it may throw gaseous emissions; it may produce liquid and solid discharges; it may cause noise, heat, and vibrations.

Projects that produce physical goods like cement, steel, paper, and chemicals by converting natural resource endowments into saleable products are likely to cause more environmental damage. Hence, the environmental aspects of the projects have to be properly examined. The key issues that need to be considered in this respect are:

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

5.12 PROJECT CHARTS AND LAYOUTS

Once data is available on the principal dimensions of the project (market size, plant capacity, production technology, machineries and equipment, buildings and civil works, conditions obtaining at the plant site, and supply of inputs to the project) project charts and layouts may be prepared. These define the scope of the project and provide the basis for detailed project engineering and estimation of the investment and production costs.

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

1. **General functional Layout**. This shows the general relationship between equipment, buildings, and civil works. In preparing this layout, the primary consideration is to facilitate smooth and economical movement of raw materials, work-in-process, and finished goods. This means that:
   a. The layout should seek to allow traffic flow in one direction to the extent possible, with a minimum of crossing.

b. Godowns, workshops, and other services must be functionally situated with respect to the main factory building.

2. **Material flow diagram.** This shows the flow of materials, utilities, intermediate products, final products, by-products, and emissions. Along with the material flow diagram, a quantity flow diagram showing the quantities of flow may be prepared.
3. **Production Line diagrams**. These show how the production would progress along with the key information for the main equipment.
4. **Transport Layout.** This shows the distances and means of transport outside the production line.
5. **Utility Consumption Layout.** This shows the principal consumption points of utilities (power, water, gas, compressed air, etc.) and their required quantities. These layouts provide the basis for developing specifications for utility supply installations.
6. **Communication Layout**. This shows how the various parts of the project will be connected with telephone, intercom, etc.
7. **Organizational Layout**. This shows the organizational set-up of the project along with the information on personnel required for various departments and their interactions (See Unit Six for detail)
8. **Plant Layout**. The plant layout is concerned with the physical layout of the factory. In certain industries, particularly process industries, the plant layout is dictated by the production process adopted. In manufacturing industries, however, there is much greater flexibility in defining the plant layout. The important considerations in preparing the plant layout are:
    - Consistency with production technology
    - Smooth flow of goods from one stage to another
    - Proper utilization of space
    - Scope of expansion
    - Safety of personnel

5.13. SCHEDULE OF PROJECT IMPLEMENTATION

As part of the technical analysis, a project implementation schedule is also usually prepared. In order to prepare the project implementation schedule, the following information is required:

- List of all possible activities from project planning to commencement of production.
- The sequence in which various activities have to be performed.
- The time required for performing the various activities.
- The resources normally required for performing the various activities.
- The implications of putting more resources or less resources than are normally required

The schedule of project implementation begins with the identification of key stages. There are two ways of identifying the key stages. These are:

1. **Top- down Approach**

   This involves the listing of all interim and final deliverables (outputs) of the project as outcomes from a collection of activities that forms a key stage

2. **Bottom up Approach**

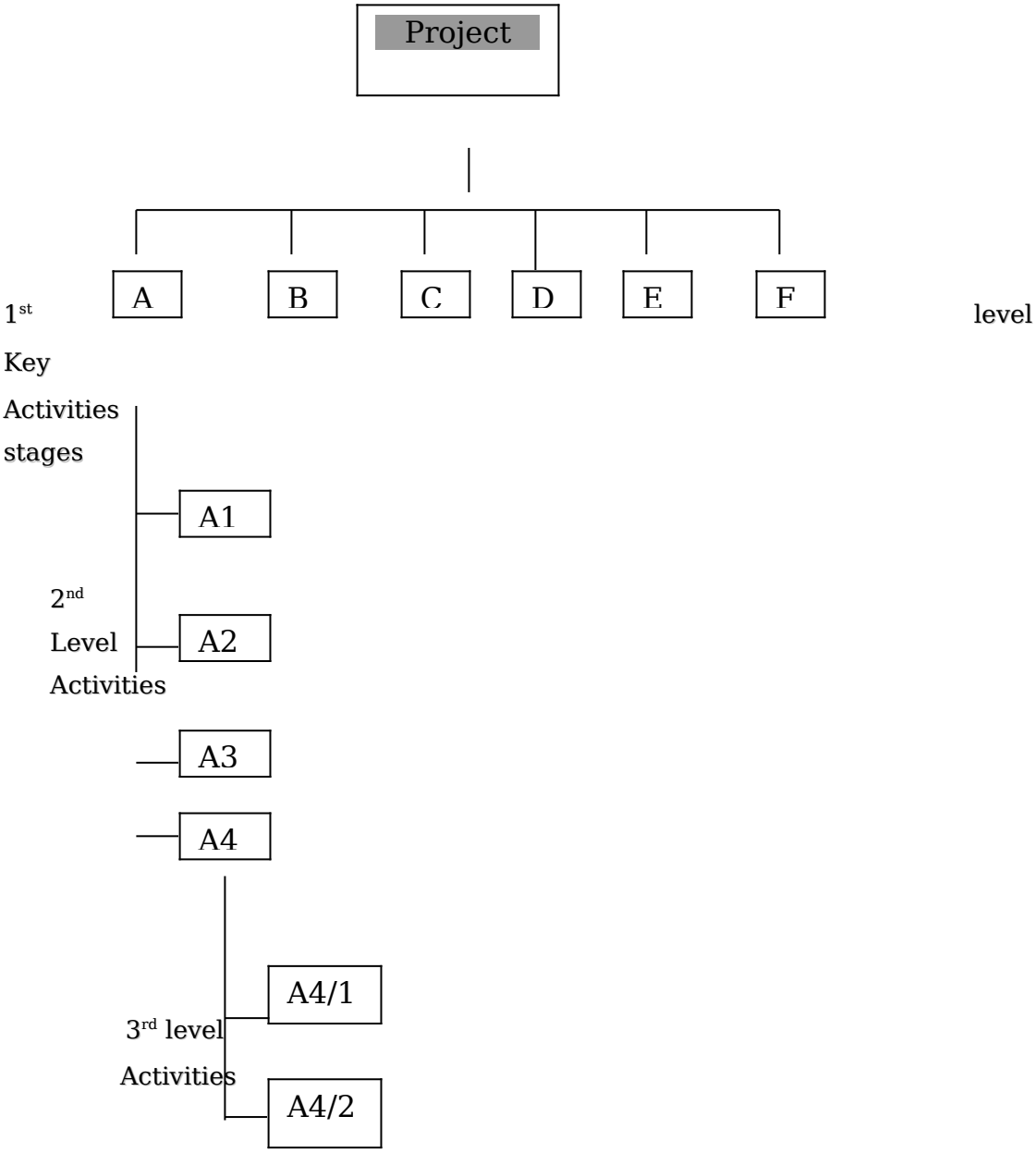
   It involves identifying as many activities as possible and the grouping of related activities together to form the key stage.

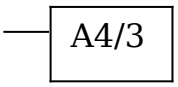
Once the key stages are identified, they are organized in a logical sequence to maximize concurrency and to generate logical dependency (i.e. which key stage is dependent on which). The next step is to derive the project logic diagram. The logic diagram contains input dependency and output dependency. In this diagram, every key stage has at least one arrow leaving an output dependency. The key to successful scheduling using this logic diagram is to ensure you have well defined dependencies. Some of the project Scheduling techniques are explained below:

1. The Work Breakdown Structure (WBS)

It is a convenient means of graphically presenting the work of the project in readily understandable format. The project key stages form the highest level of the WBS, which is then used to show the detail at the lower levels of the project. The WBS does not show dependencies and is not time based (no time scale on the drawing).

The sample of WBS is shown bellow:





According to the above figure, each key stage is expanding to show 2nd level activities. Each 2nd level activities is further expanded to the 3rd level and lower levels as appropriate. The WBS is the basis for budget derivation when all activities are identified.

2. **Gantt chart.** It is a convenient graphical means of picturing a schedule. Gantt chart, developed by Henry L. Gantt, is a useful project scheduling method for small projects with few activities. Gantt chart is also called bar chart. It does not show the precedence constraints.

3. **Critical path method (CPM).** Critical path method is useful for purely deterministic problems in which each activity has definite time of completion. In order to apply CPM, the project is first represented as a network. Network explicitly shows the precedence constraints. A network is a collection of nodes and direct arcs. A node represents an event and an arc represents an activity.

4. **Project Evaluation & Review Technique (PERT)**
   PERT is a generalization of CPM to allow uncertainty in the activity times. It allows randomness in the activity times. PERT is useful for more complex projects having many activities.

5.14. NEED FOR CONSIDERING ALTERNATIVES

Although the need for considering alternatives has been touched upon earlier, this point needs to be emphasized. There are alternative ways of transforming an idea into a concrete project. These alternatives may differ in one or more of the following aspects:

- Nature of project
- Production process
- Product quality
- Scale of operation and time phasing
- Location

1. Nature of Project. The project may envisage the manufacture of all the parts and components in a vertically integrated unit or it may consist of an assembly type unit, which obtains the bulk of the parts and components from outside suppliers. The project may consist of processing up to the finished stage or may stop at a semi-finished stage. These alternatives are available with respect to the nature of the project.

2. Production Process. There may be several alternatives with respect to the production process. The availability and characteristics of raw materials, the cost structure, and the nature of markets served are factors that have to be borne in mind while deciding about the process.

3. Product Quality. Barring a few products where a certain standard has to be maintained, the choice with respect to quality is fairly wide. This is particularly true in the case of consumer products like textiles, footwear, etc. The quality and product range decisions would depend on the characteristics of the market, the elasticity of demand, consumer preferences, and the nature of competition.

4. Scale of Operation and Time phasing. In many cases several scales of operation are feasible technically and financially. The choice of a particular scale would depend on the financial resources available, the nature of competition, the nature of demand, and the economics of scale. Further, a given capacity may be installed in one stage or in phases. The capital cost of capacity installation is usually lower when it is done in one stage. The cost of idle capacity, however, is higher when it is built in a

single stage. The trade-off between these costs would determine the optimal pattern of time phasing.

5. Location. Location and size are closely interrelated. Perhaps the same demand could be satisfied by: (i) a single plant for the entire market; or (ii) one large plant for the bulk of the market with a few smaller plants for the remaining market; or (iii) several plants of a similar size spread over the market areas. The choice would depend mainly on the trade-off between economies of scale in manufacturing and economies of distribution.

5.15. Key Project Inter-linkages

While evaluating various alternatives, the inter-linkages among key facets of the project like product (or service), demand, plant capacity, production technology, location, investment outlay, financial resources, production costs, selling price, and profitability must be borne in mind.

Unit 6: Project Organization and Management

6.1 Introduction

What type of organization structure will be appropriate for managing projects? Before we seek an answer to this question, we should know the various types of organization structures.

6.2. Project Organization Structure

6.2.1 Traditional Organization Structure

The traditional or classical organization is also referred to as the functional organization. In this type of organization structure, the chief

executive has beneath him all of the functional entities necessary to either perform Research & Development, Manufacturing and Operations, Administration, Marketing, and so on. All activities are performed within the functional groups and are headed by a divisional/departmental manager as shown in Fig. 6.1 each department maintains a strong concentration of technical expertise.

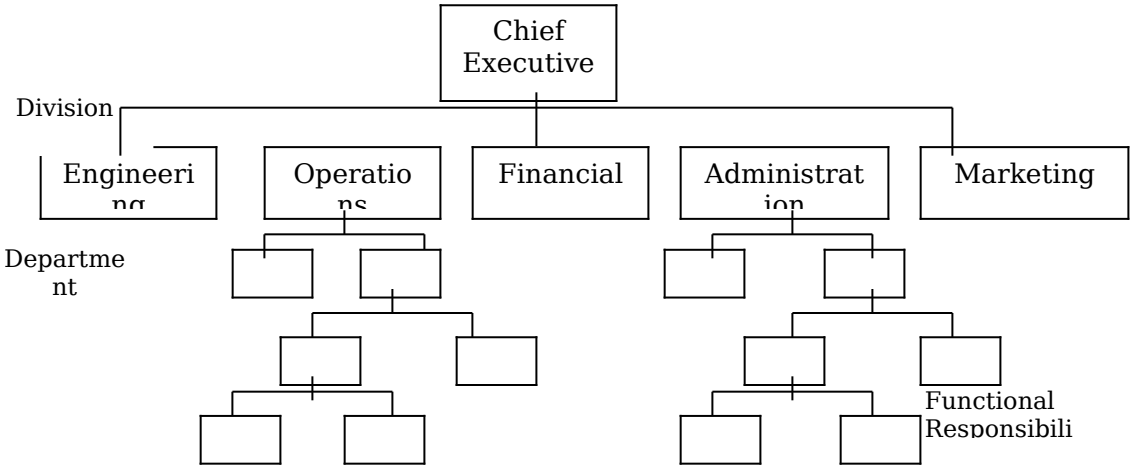


Fig. 6.1 Traditional Organization Structure

In a classical organization, the levels of authority and responsibility are clearly defined. Because each person reports to only one individual, communication channels are well structured. It facilitates better technical control, since specialists can be grouped to share knowledge and responsibility and they can also be used on may different projects.

The major drawback of the classical organization structure is that there is no strong control authority or individual responsible for the total project. Consequently, integration of activities that cross functional lines become a difficult chore. Conflicts occur as each functional group struggles to assert their position. The strongest functional group dominates the decision making process. Functional managers tend to favor what is best for their group, rather than what is best for the project.

Recognizing that traditional organization structure lacked a focal pointer for the project to ensure that all activities are properly integrated, an

attempt is made to develop project leaders or coordinators within each functional department. Section-level personnel are assigned the role of project leaders, who returned to their former position after the project is completed. While this arrangement proved effective for coordinating and integrating work within one department, the project leader failed. Leader in one department did not have the authority for coordinating the activities in another department. Further, the creation of project leader position caused internal conflicts within each department.

An alternative arrangement is to identify a manager responsible for the project, and placing him as a staff assistant to the Chief Executive. The project manager virtually has no authority, does not make any decisions relating to the project, and does not provide any staff service to the functional departments who make all the decisions relating to the project. The project manager simply collects information and communicates the same to the chief executive. This arrangement may be chosen by a chief executive who wants to directly control the project. This may work for small projects, but cannot work for large projects.

6.2.2. Task Force Oriented Organization Structure

Under this approach, the task force drawn from various departments is put under a project manager. The staff assigned continues to receive administrative support from their parent departments but they will respond only to project manager.

Manager’s directions violate the policies and procedures of the functional departments; the task force will bring it to the attention of the functional head and the project manager. If the matter is not settled between the functional manager and the project manager, the matter is taken to the higher management for resolution. If the project manager takes the task the task staff into confidence when making decisions, the need to bring to

the attention of the functional manager or higher management can be avoided.

The organization structure based on task force concept is shown in Fig 6.2

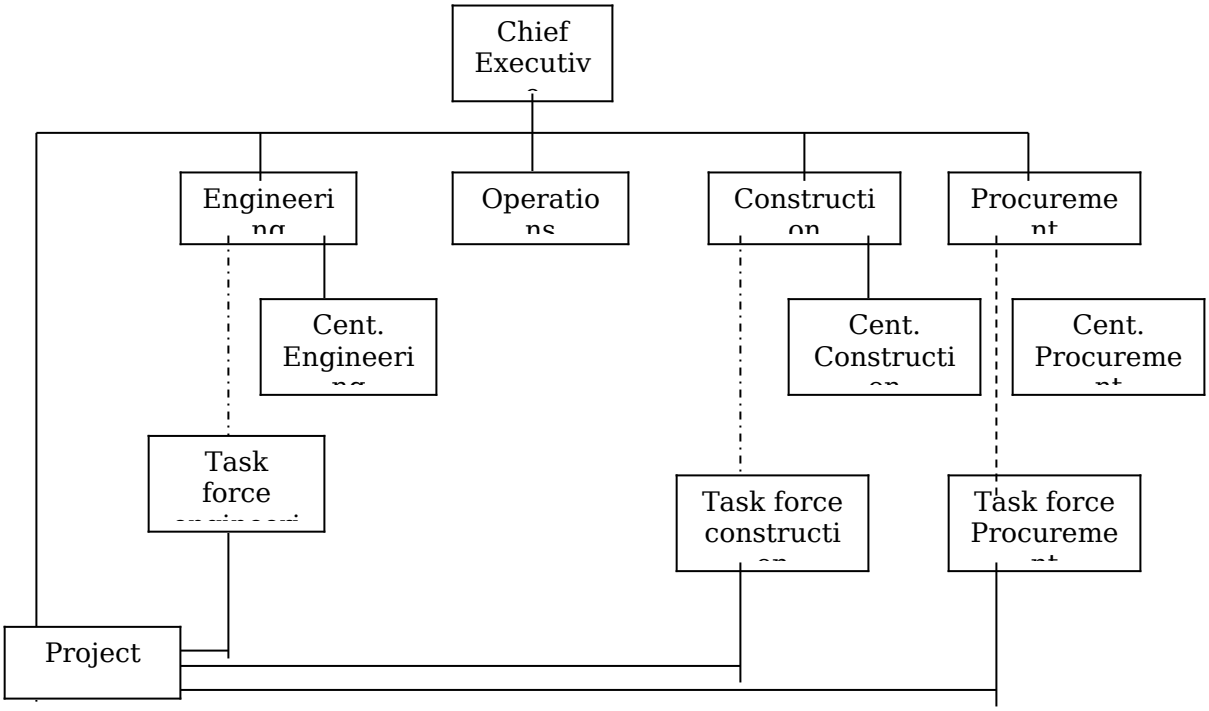


Fig. 6.2 Task Force Organization Structure

The project manager's authority is indicated and the dotted lines show the relationship between the task force staff and the functional manager. The dotted lines enable communication between the task force staff with their respective functional departments for obtaining technical support or additional staff support, but not decisions relating to the project. All communication between the task force and their respective functional departments is routed through project manager. In the task force organization structure, the loyalty of the functional staff is with the project, and the functional department's influence is virtually non-existent.

Under this arrangement, the project department assumes dominant line role, while the functional departments are relegated to the staff position. It is therefore natural that the time and cost objective of the project are given maximum attention, but one cannot be too sure about the quality. The project moves very fast and for this reason, many people tend to prefer task force organization structure.

6.2.3 Product Type Organization Structure

Product type organization structure consists of divisions within divisions. Under this structure, one individual, the project manager, maintains complete line authority over the entire project. The project manager's responsibilities are entirely new, and he derives authority from the senior management. The project manager can maintain strong communication channel with the people under him, since the project participants work directly for the project manager. Staff can maintain expertise on a given project without sharing key personnel. Further, the staffs have loyalty to the project, showing better morale and satisfaction. As the project manager handles all conflicts, interface management becomes easier rendering senior management concentrate on decision making rather than on conflict resolution.

The major drawback of the product form of organization is the cost of maintaining the organization due to duplication of effort, facilities, and personnel. There is no chance for sharing an individual with another project or order to reduce cost.

6.2.4 Project Management as a Staff Function

A project management division under the chief executive may render special staff service function to all other functions in relation to a project. The project manager in this role provides schedules, budgets and information to the various functional departments who will execute the project. The project manager in this case, will be a specialist in project

management tools and techniques, and in view of his superior knowledge relating to scheduling, budgeting and information systems, he is in a better position to advice other functions. A project manager also performs certain service other functions. A project manger also performs certain service activities like collection and transmission of data, follow-up of one functional group to serve another group, measure progress and prepare progress reports. He also acts as a single focal point for communication between participating functions.

The organization structure with project management as a specialized staff function is shown in Fig 6.3

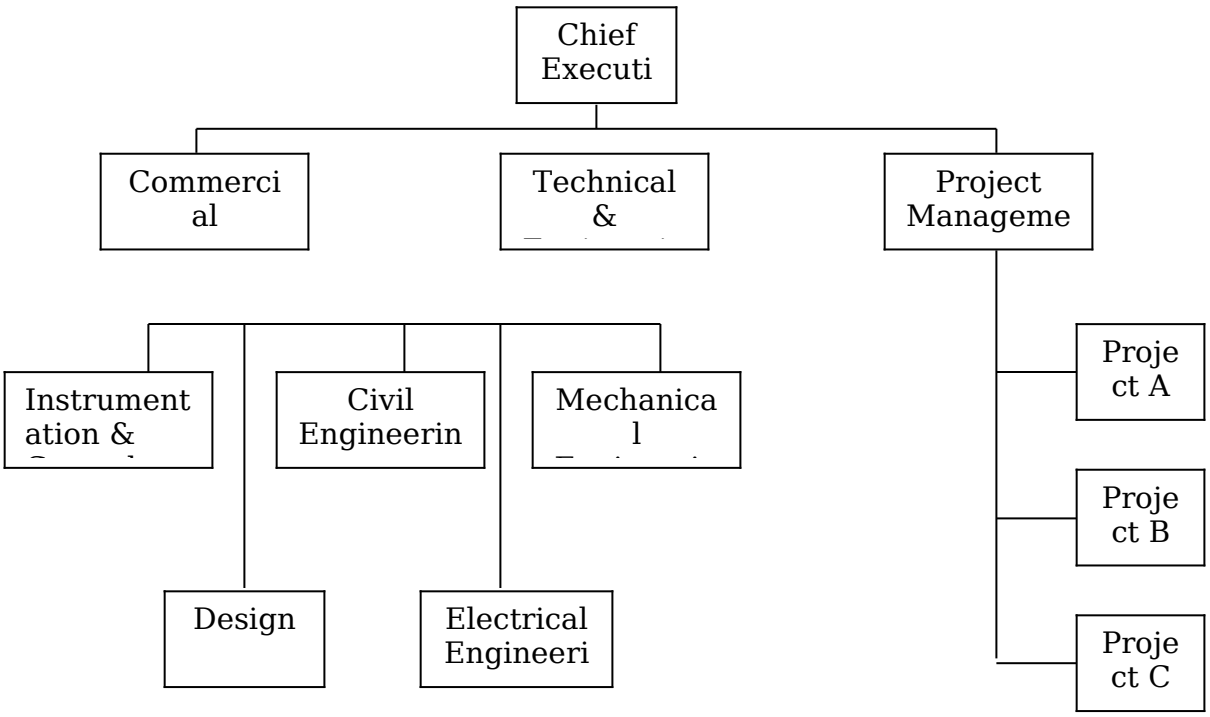


Fig. 6.3 Organization Structure with Project Management as staff function

When an organization uses project management for the first time, this type of organization structure is followed since it does not require much

change in the working of the organization. Whether the objective of project management are achieved by this structure is another issue but a focal point for a project is recognized and provided under this structure.

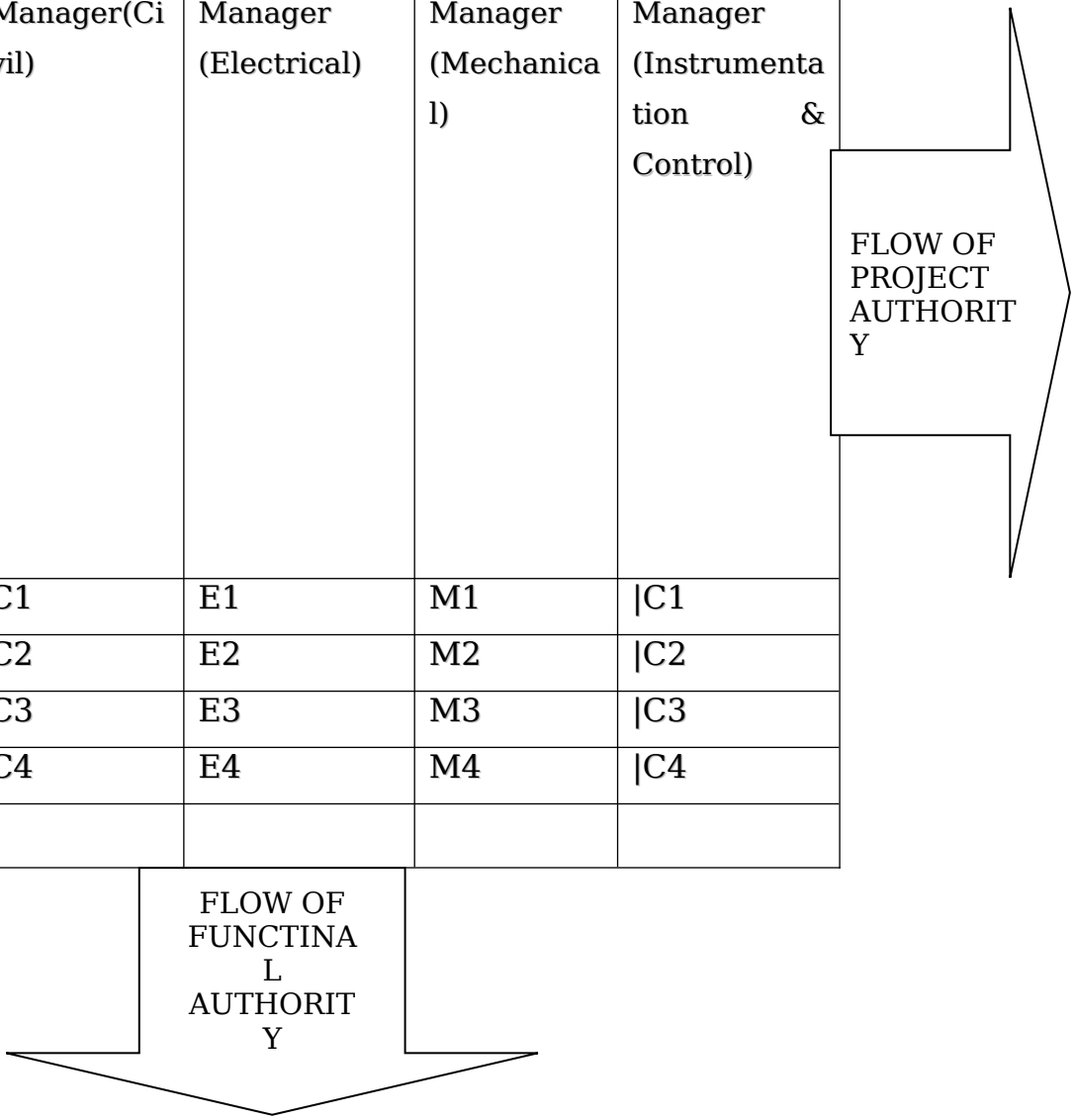
The project manager under this arrangement fully identifies himself with the project and considers himself responsible for the successful completion. But at times of advertisity the project manager is liable to throw up his arms and declare that he could not be held responsible for achieving project goals, as he had no voice in its execution.

6.2.5 Matrix Organization

Although the project manager is not formally granted any authority under the type of organization structure discussed in 6.4, a competent project manager will succeed eventually in acquiring some authority due to his identification with the project and working for its success. To the extent a project manager is able to acquire the authority, the functional managers will be forced to dispense with the same. When there is a sharing of authority between a project manager and other functional managers, formalizing such an arrangement is what is known as the matrix form of organization. The concept of matrix organization can be shown as in Table 6.1

Table 6.1: Matrix Concept

Functional Managers	Functional Manager(Civil)	Functional Manager (Electrical)	Functional Manager (Mechanical)	Functional Manager (Instrumentation & Control)
A	C1	E1	M1	|C1
B	C2	E2	M2	|C2
C	C3	E3	M3	|C3
D	C4	E4	M4	|C4



A matrix is a concept where an individual will abide by the decisions made by two superiors-one belonging to the project and the other to the specialized function. Both are responsible for the successful completion of the project and, therefore, both ought to have authority over the working force through whom the project is being executed. The matrix organization is shown in Fig. 6.4.

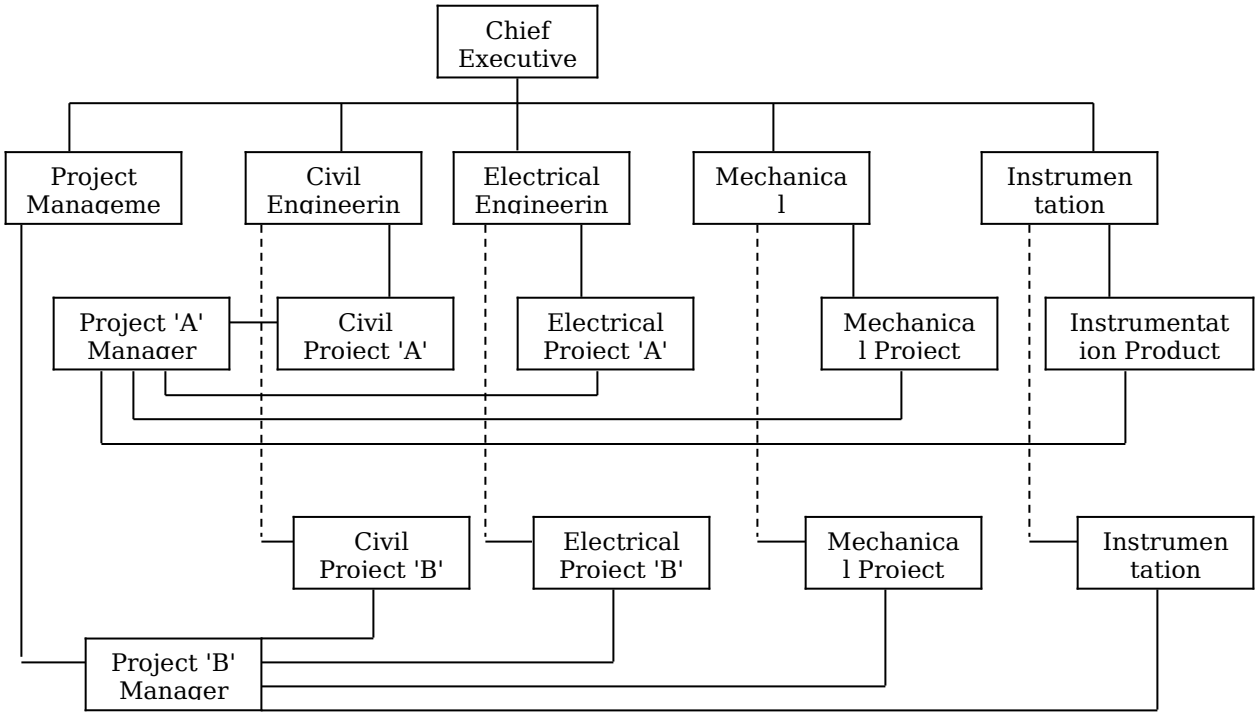


Fig. 6.4. Matrix Organization

Those who are used to single reporting relationship may find this arrangement confusing. But, all people since childhood are used to dual reporting relationship. But industrial organizations are different, no matter how much the family concept is propagated. Still, the dual reporting relationship can work satisfactorily if the roles are clearly defined. A mutually supportive relationship should exist between the partners in a matrix set up for the successful execution of project.

6.2.6 Project-Oriented Organization Structure

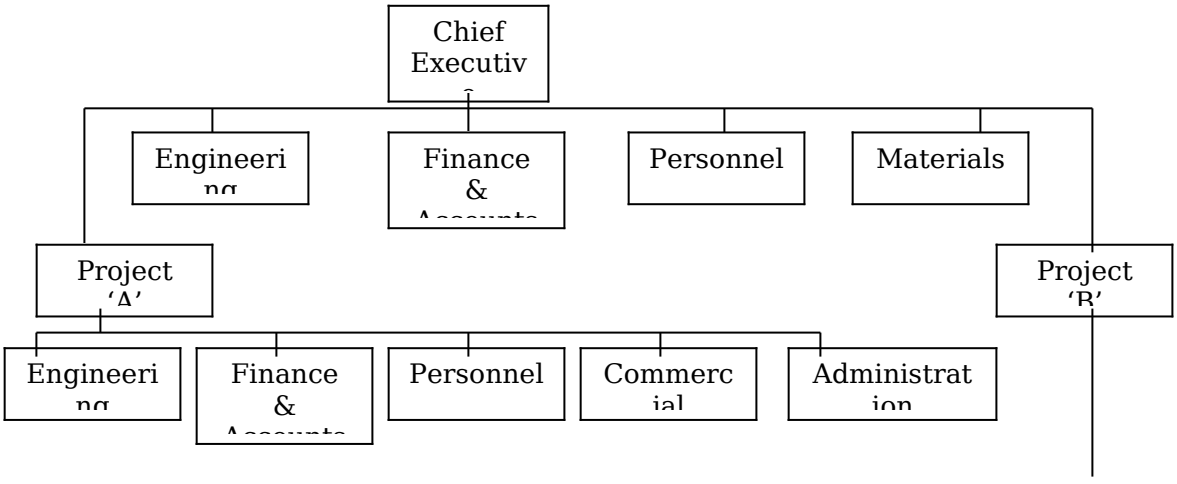
A totally project-oriented organization structure is an arrangement in which the project manager has total authority even regarding functional policies and procedures. There are no constraints with respect to any

function. The function specialists have no one to report to, and they will be carrying out the instructions of the project manager and do what the project demands.

Project-oriented structure is completely autonomous organization in which the project manager is the chief executive. Such an organization will have several departments/divisions needed by senior functional specialists who can function independently. They will be functioning on behalf of the project manager and will have authority delegated to them by the project manager for taking decisions in their area of competence.

Project-oriented organization becomes necessary when a project is too large and complex or geographically so located that here is no way of managing it without granting autonomy to the team handling the project. The project manager for such a project will obviously be a senior person to justify delegation of so much authority by the company. Under this arrangement, the project manager will have to perform a lot of administrative functions, besides carrying out the main project activities.

Fig. 6.5 represents a typical project-oriented organization. It differs from the task force organization structure in the not only the dotted line relationship is eliminated, but not-technical departments like personnel, finance and accounts, etc., are included and which come under the direct purview of the project manager.



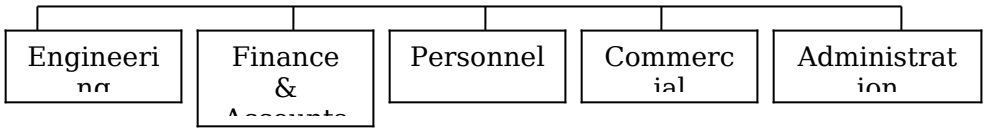


Fig. 6.5 Project-oriented organization structure

6.3 Project Management

Project management is an exciting managerial activity. Wherever there is a need for a specified time-bound work, project management is called for – whether it is a publishing house, a university, agricultural rural development, social work or industrial construction projects. A project is not a physical objective nor is it the end result, it is concerned with the going-on in-between, which must be the same, whether a high technology process plant is involved or an election is held. A project initiated for achieving a mission gets completed as soon as the mission is fulfilled. In other words, it lies between these two out of points, which time span, is known as project life cycle.

The traditional forms of organization with functional divisions of management and a well-defined hierarchical relationship are suitable only for established operations, characterized by a continuous flow of repetitive work with each department attending top precise functions. This is because a project is characterized by certain distinctive features, such as:

- A non-routine and non-repetitive undertaking, often plagued with uncertainties,
- Requirement of coordinated efforts of persons drawn from different sections and disciplines as also contributions from external agencies and
- Relationships in a project, which are dynamic, temporary and flexible.

These make management of a project different from management of operations, as the former calls for sharper tools of planning and control and improved ways of coping with human problems caused in a project setting. Project management involves issues, like forms of project organization, project planning, project control and human aspects of project management. The following aspects are to be studied in the understanding of project management, along with the application of quantitative/network techniques.

i. Scope of management, its types and objectives.
ii. The project phase concept.
iii. The feasibility study involving thorough project report preparations and project selection
iv. Financial evaluation, cost and time overruns
v. Implementation phase in project management.
vi. Other aspects like specifications and contracts, foreign exchange and import controls, power shortage, labor and tax incentives etc.

Work in the context of a project is not mere processing or conversion of input to output. The concern for the ultimate objective is the motivating force for the project management approach. Project management means dedicating us to the end objective and keeping totality in focus all the time. The emphasis in project management is on results and on the holistic approach. This approach ensures delivery of goods. A good project management seeks to remove, amongst other things delays in execution, avoid cause of delays and identification of technical flaws on difficulties in executing projects.

In a project management, all work has interdependence and inter-relationship with others. To practice project management requires the distinguishing between what is part and what is whole, what is motion

and what is work. Project management approach differs from the functional management approach in that the later does not hold responsible any one individual for a work from A to Z. This crates problems of communications, coordination, commitment and control. No good decision could be taken without considering all inter-related things and no useful things can be achieved without completing the whole. The importance of any work depends on how it stands in relation to others and to the whole. The inter-relationships and even the work to be performed is liable to be changed, but the objective does not change. In project environment the future is uncertain unlike in a routine functional management. In project management it is necessary to keep an eye on the future and adapt to very fast changed needs of the future. Quick responses and flexibility are essential for dealing with ever-changing dynamic saturations which pervade the project management.

6.3.1. Aims and Objectives of Project Management

Peculiarities of the nature and category of projects call for a special approach to ensure the success of project. This is called Project Management. Success of a project refers to the following:

1. The project must get completed
2. It must be completed within the allocated funds
3. It must be completed within the allocated time
4. It must be completed to the satisfaction of users.

The aims and objectives of a project management are therefore timely completion, avoidance of delay, technical flaws and drawings defects, proper fund flow, control over chain reaction activities, and proper tooling and techniques

6.3.2. Systems

The main thrust in the implementation stage is the evolution or designing of systems and their operations. Systems are the only means that bring

the people and projects ideas together. A project team leader manages his projects through systems. A system consists of men machinery and materials and interaction between them in implementation. Procedures are part of systems. They are planned sequence of operations to do a work which is part of a system.

The characteristics of a system are

- It is a set of elements organized systematically
- The elements are inter-related
- It is a self-sufficient organic whole
- It has a behavior characteristic of its own
- It has a hierarchy

Human system is a natural system and is a perfect system. By study of natural systems, ingredients of a successful system are evolved. In a project management system the two main systems are the project work and project control systems. Project work systems design, calls for visualizing the total system so that inter-related elements are created in a way as to lead to their self-regulation without external intervention. Work breakdown structure (WBS) technique enables the integration of people with the machinery and material. To inter-relate executing agencies with the soft and hardware of a project, a project execution plan is conceived. This consists of contracting plans, work packing plans, organization plan and system and procedure plan.

6.3.3 Manual

A project procedure manual is the right answer to achieve the required coordination. This manual is prepared in such a way that the interacting agencies are able to see their roles and mutual relationships in pursuance of the common goal. The preparation of this manual commences right with each sub-system. A system analysis, element wise, is carried out with each sub-system to identify the need for procedure write-ups. In doing this analysis, the aspects, the system or sub-system seeks to achieve, is developed and a complete picture about the system is available. It may

however be cautioned that while a project procedure manual would meet the day-to-day transaction-need, it may not be an end in itself. Procedures are only guidelines and not laws.

6.4. Organizing and Staffing Projects

Whatever organization structure is chosen for a project, its successful management is only as good as the individuals and leaders who manage the key purposes. Project management requires a group of dedicated individuals for achieving the specific project goals. Project management includes a project manager, project office, and project team. There may not be any need for a project office for small projects, and just one person may perform all project office functions. But when a company, for its continuous growth undertakes a stream of projects extending over several years, there is need for establishing a project office.

6.5. Project environment

The project management process cannot be isolated from the project environment. An appreciation or an awareness of the project environment is necessary to understand fully the problems of staffing, Personnel performance problems and personnel policy problems are the two major kinds of problems related to project environment. Personnel performance is difficult for many individuals because it represents a change in the way of doing things. Some individuals, however, competent they are find it difficult to adapt continuously to a changing situation in which they report to multiple managers. Most individuals prefer stable situations; but projects, by definition, are temporary assignments. On the other hand, there are some other individuals who thrive in temporary assignments. These are usually highly creative and challenging work; they resent stable repetitive jobs. The second major performance problem lines in the project/functional interface where a person finds himself reporting to two bosses, the project manager and the functional manager. If the two managers are in total agreement with the work to be accomplished, then performance at the interface may not be affected. But

if conflicting directions are received, then the individual at the interface, regardless of this capabilities and experience, may allow his performance to suffer because of his compromising situation.

Project management is successful only if the project manager and his team are totally dedicated to the successful completion of the project. The project team, therefore, should have a good understanding of the fundamental project requirements, viz., project planning, project control, project evaluation, and project reporting. Since these requirements cannot generally be fulfilled by single individuals, members of the project of office as well as functional representatives, must work together as a team. Teamwork concept is vital to the success of a project.

The person with the maximum influence during the staffing phase is the project manager. The personal attributes and abilities of project managers will either attract or deter highly desirable individuals. A project manager should not hesitate to face trouble: on the other hand he should welcome them. Besides having the capability to evaluate risk and uncertainty, a project manager's characteristics should include honesty and integrity sympathetic understanding of personnel problems, understanding of project technology, managerial competence and communication skills, alertness and quickness, versatility, energy and toughness, and the ability to take decisions. The project manager's objectives during staffing are to acquire the best available people and try to improve them, provide a good working environment for all personnel, and make sure that all resources are applied effectively and efficiently so that all constrains are met, if possible.

6.6 Selection of Project manager

Probably the most difficult the senior management faces is the section of the project manager. Some managers work best on long-duration projects where decision-making can be slow; others may do well on short-duration projects that can result in constant pressure environment. Senior

management must know the capabilities and weaknesses of their project managers.

The project manager must learn from his own mistakes so that they will not be repeated again. The responsibilities of the project manager include:

- to produce the end item with the available resources and within the constraints of time, cost and performance/technology
- to meet contractual profit objectives
- to make all required decisions whether they be for alternatives or termination
- to act as the customer (external) and upper-level and functional management (internal) communications focal point
- to “negotiate” with all functional disciplines for accomplishment of the necessary work packages within time, cost and performance/technology.
- To resolve all conflicts as far possible

In order for project managers to fulfill their responsibilities successfully, they are constantly required to demonstrate their skills in interface, resource, and planning and control management. These implicit responsibilities are:

1. Interface management, which includes project interface including performance of parts or subsections and physical connection of parts or subsections;
2. Project interfaces that include customer, management (functional and senior level), and change of responsibilities information flow material interfaces (inventory control);
3. Resources management covering time (schedule), manpower, money facilities, equipment, material, information/technology; and planning and control management

4. Increased equipment utilization. This includes increased performance efficiency, reduced risks, and identification of alternatives to problems, identification of alternative resolutions to conflicts.

Finding a suitable person is not easy task because the selection of project manager is based more on personal characteristics than on the job description. Many companies prefer to find project managers from within. However, this is easier said than done. On this point, Robert Fluor, in his keynote address to Project Management Institute's Ninth International Seminar, remarked that on-the-job training is probably the most important aspect in the development of a project manager. This includes assignments to progressively more responsible positions in engineering and constructing management and project management. It also includes several rotational assignments in several engineering department disciplines, constructing, procurement, cost and scheduling, construct administration and others. There are great advantages to developing project managers from within the company. There are three good reasons for selecting a project manager from within.

i) They know the organization, policies, procedures, and they key people. This allows them to give quality performance.
ii) They have an established performance record which permits placing them at the maximum level of responsibility and authority.
iii) Clients prefer a proven track record within the project manager's present organization.

There is also good case for selecting project manager from outside. A project manager from outside is less likely to have strong informal ties to any one line organization and therefore could show impartiality on the project. A good project manager, whether from inside or outside, must

show ability to understand and know both themselves and their employees in terms of strengths and weaknesses.

6.7 Skill Requirements of Project managers

The implementation phase of a project is the most important activity in the life of a project. A substantial portion of work is done during this phase and calls for the application of all techniques of project management. It is in this phase that several activities require to be done parallel to each other, simultaneous and complimentary to other activities mutually. Time is the essence of this phase. The time over-runs so far occurred are to be made good, besides ensuring the timely completion of the project within the targeted time schedule. This calls for crashing of activities attendant with additional cost and other management problems.

A high degree of coordination and control not only inter with activities of this phase but also with those of earlier phases is required. The personnel involved in this phase of activity are normally those not associated with the earlier phases of project management. A project manager, therefore, has the important task of bringing together the goal congruence of the project and the participants. This calls for identification and developing systems to ensure proper implementation of the activities envisaged so that the goals set are attained.

Projects are often complex and multifaceted. Managing complex projects is a challenge requiring skills in team building, leadership, conflict resolution, technical expertise, planning, organization, entrepreneurship, administration, management support, and the allocation of resources. A key factor to good project performance is the project manager’s ability to integrate personnel from many disciplines into an effective work team.

6.8 The Organization staffing process

Once the project manager is selected and put in place, the immediate task facing him is staffing the project organization. In large complex

projects, this task can be long and tedious. The task involves determining people resources required and the source from which people can be hired.

To determine the people resources required, the types of individuals (possibly job descriptions) as well as the number of individuals for each job category, and when these people are needed must be decided.

The project manager, at times, may remain content with second best: this is not a bad arrangement as long as the people continue with the project till the end. The project manager may therefore, prefer continuity to highly efficient, since there is always the risk of the highly efficient being withdrawn and put on some of the more complex project. So, the project manager may have to compromise with functional managers in accepting some people who may not be the best. Mutual trust between project manager and functional manager is crucial, especially during staffing sessions. Once a project manager has developed good working relationship with employees, the project manager would like to keep those individuals assigned to his activities.

Once the people resource are defined, the next question will be whether the staffing will be from within the organization, or from outside sources, such as new hirer or consultants. Outside consultants are advisable, if internal manpower resources are being fully utilized on other projects, or if the company does not possess the required project skills.

The final step in the staffing of the project office is a meeting between the senior management, the project manager on whose project the requested individuals are currently assigned, and managers of the projects. Project managers, generally, are reluctant to give up qualified and experienced personnel to the staff of other project offices. The presence of senior management shows to all negotiating parties that top management is concerned with maintaining the best possible mix of individuals from available resources and to help resolve staffing conflicts. Staffing from

within is a negotiation process in which senior management establishes the ground rules and priorities.

6.9 Project Office

The project team is a combination of the project office and functional employees. The project office is intended to support the project manager in carrying out his duties. Project office personnel must have the same dedication towards the project as the project manager and must have good working relationships with both the project and functional manager. The responsibilities of the project office include: (i) acting as the focal point of information for both in-house control and customer reporting, (ii) controlling time, cost, and performance to adhere to contractual requirements, (iii) ensuring that all work required is documented and distributed to all key personnel, and (iv) ensuring that all work performed is both authorized and funded. The major responsibility of the project office personnel and the project manager is the integration of work across functional lines of the organization. Functional units, such as engineering, manufacturing, research and development, together with subcontractors, must work toward the same specifications, design, and objectives.

6.10 Functional Team

The functional personnel, who report horizontally as well as vertically for information flow, are part of the project team; the other members of the project team being the project manager and the project office personnel. Senior management may have a say in the selection of functional team members, as in the case of project office personnel. It may be desirable for the senior executive not to take an active role unless the project and functional managers cannot come to an agreement.

Functional team members can be full-time either during of the project of only for specific phases. In the selection of functional team members, any special requirements of the project must be taken into account. The special requirements may develop from changes in technical specifications, special customer requests, organizational restructuring because of deviation from existing policies, and compatibility with the customer's project office.

For large complex projects, it is desirable to have full-time functional representative from each major department or division assigned permanently to the project. Such representation might include program management, project engineering, engineering operations, manufacturing operations, procurement, quality control, cost accounting, marketing and sales. The project manager and the functional team members must understand fully the responsibilities and functions of each other team member, so that total integration can be achieved as effectively as possible.

6.11. Project Management Functions

As discussed earlier, the project manager's success is measured by how well he can negotiate with his senior management and functional management for the resources necessary to achieve the project objective. The project manager may have a great deal of delegated authority but very little power. Hence, the managerial skills he requires for successful performance may be drastically different from those of his counterparts in functional management. The difficult part of the project management environment is that at the individuals at the project-fictional interface must report to two bosses. Functional managers and project managers, by virtue of their different authority levels and responsibilities, treat their people

differently, according to the management project philosophy believe in.

6.12 Motivating Project Staff

A project manager, as part of controlling and directing, has to motivate his employees so that they feel secure on the job. Since project managers cannot motivate by promising material gains, they must appeal to each person's pride. The guidelines for proper motivation are: (i) adopt a positive attitude, (ii) refrain from criticizing management, (iii) avoid making promises that cannot be kept, (iv) circulate customer reports, (v) give each person the attention he requires. Some effective ways of motivating project personnel are giving assignments that provide challenges, clearly defining performance expectations, giving proper criticism as well as credit, giving honest appraisals, providing a good working atmosphere, developing a team attitude, and providing a proper direction.

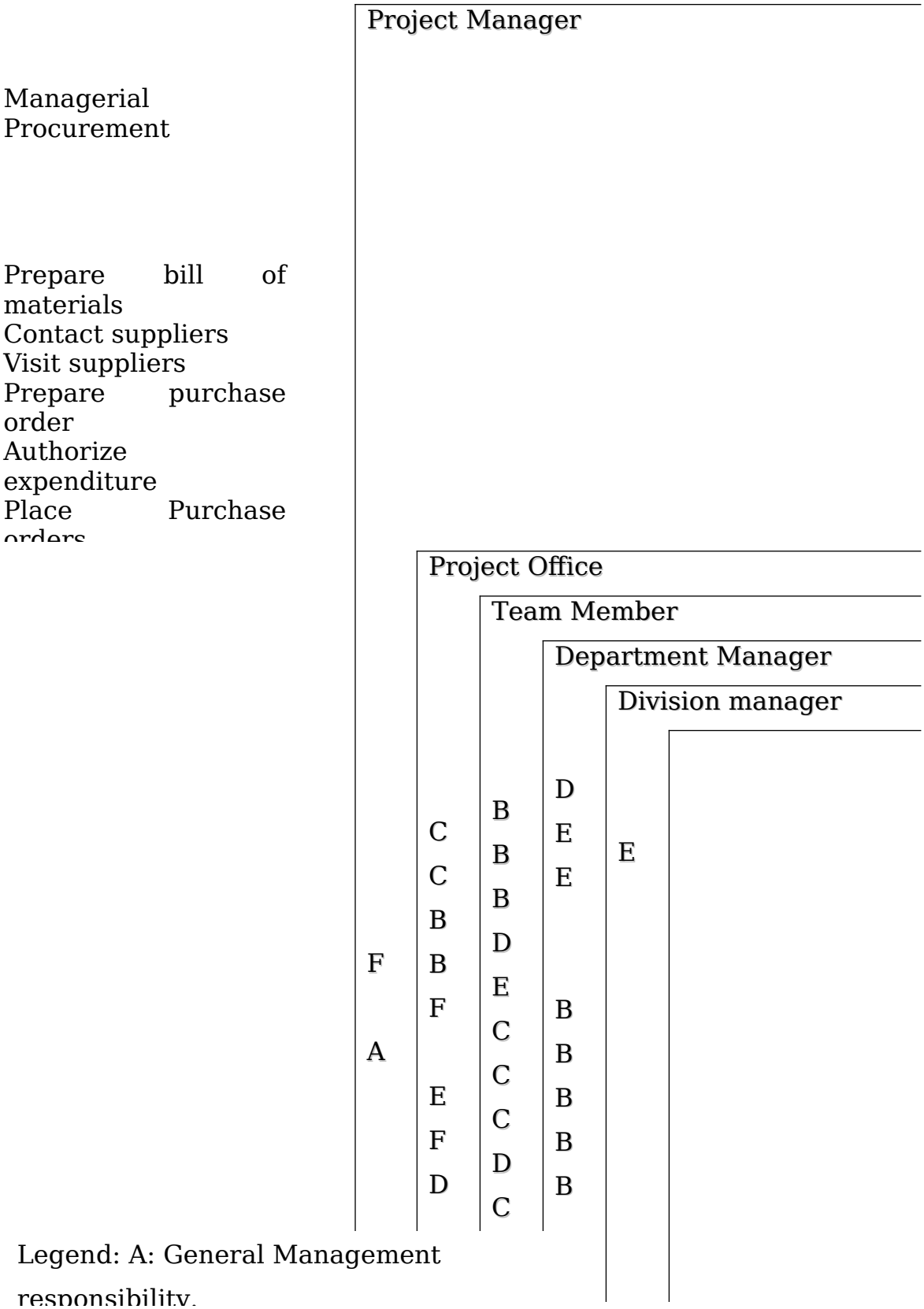
6.13 Project Authority

Project management structures create a web of relations that can cause chaos in the delegation of authority and the internal authority structure. One form of the project manager's authority can be defined as the legal rightful power to command, act, or direct the activities of others. Authority can be delegated from one's superiors. Power, on the other land, is granted to an individual by his subordinates and is a measure of their respect for him. A manager's authority is a combination of his power and influence such that subordinates, peers, and associates willingly accept this judgment. In the project structure, power comes from credibility, expertise, or being a sound decision maker.

The key to project management process is authority. Project authority provides the way of thinking required to unify all organizational activities towards accomplishment of the project regardless of where they are located. The amount of authority given to a project manager depends upon the project size, management philosophy, and management interpretation of potential conflicts with functional managers. There are,

however, certain fundamental elements over which the project manager must have authority in order to maintain effective control. The project manger should have broad authority over all elements of the project. His authority should be sufficient to permit him to engage all necessary managerial and technical actions required to complete the project successfully. He sould have appropriate authority in design and making technical decisions in development. He should be able to control funds, schedule production activities and ensure quality of product. If subcontractors are used, he should have maximum authority in their selection. Generally speaking, the authority of project manger must be commensurate with the risk he undertakes; the greater the risk, the greater the amount of authority. The most common sources of power and authority problems in a project environment are poorly documented or no formal authority, power and authority perceived in correctly, dual accountability of personnel, two bosses who often disagree with each other, project organization encouraging individualism, sub-ordinate relations stronger than peer or superior relationships, shifting of personnel loyalties from vertical to horizontal lines, group decision-making based upon the strongest group, ability to influence or administer rewards and punishment, and sharing resource with several projects.

The authority relationship must be clearly established and they must exist for the duration of the project. The responsibility matrix or the Linear Responsibility chart attempts to clarify the authority relationship that can exist when the functional units share common work. Fig. 6.6 shows a typical Linear Responsibility Chart (LRC). The rows, which indicate the activities, responsibilities, or functions required, can be all of the tasks in the work breakdown structure. The columns identify positions, titles, or the people themselves. The symbols indicate the degrees or responsibility existing between the rows and columns.



Legend: A: General Management responsibility.

Fig. 6.6 Linear Responsibility Chart

bility.

C: Must be consulted.

D: May be consulted.

E: Must be notified

The LRC attempts to answer such question as:

(a) Who has the signature authority?

(b) Who must be notified?

(c) Who can approve?

These questions can be answered by clearly defining the term authority, responsibility, and accountability.

Authority is the right of an individual to make the necessary decisions required to achieve his objectives or responsibilities.

Responsibility is the assignment for completion of a specific activity or event.

Accountability is the acceptance for success or failure.

The LRC is no doubt a valuable tool for management, but it has a weakness in that it does now describe how people interact with each other.

6.14. Project Team development

Most people within project-oriented and non-project oriented organizations have differing views on project management. These differing views can create severe barriers to successful project management operations. The understanding of barriers to project team building can help in developing an environment conducive to effective teamwork. The barriers to team building typical in many project environments are:

(a) Team members outlooks, priorities and interests are different from project objectives
(b) Role conflicts among team members
(c) Lack of clarity in project objectives and outcomes
(d) Project environment in which the project scope, objectives, resource base, client needs, etc., keep changing continuously
(e) Competition over team leadership
(f) Lack of clearly defined task responsibilities and reporting structures
(g) Improper selection of team personnel
(h) Poor credibility of project leader
(i) Lack of commitment on the part of team members
(j) Poor Communication among team members, between project team and top management, between the project leader and team members, and between the project leaders and the client.
(k) Lack of senior management support.

While proper attention of team building and development is critical during the early phases of a project, it is a never-ending process. The project manager is continuously monitoring team functioning and performance to see what corrective action may be needed to prevent to correct various team problems. Several barometers provide good clues of potential team disfunctioning. First, noticeable changes in performance levels for the team and/or for individual team members should always be investigated. Second, the project leader and team members must be aware of the changing energy levels of team members. Third, verbal and non-verbal clues from team members may be a source of information on team functioning. And finally detrimental behavior of one team member toward another can be a signal that a problem within the team warrants attention. It is highly recommended that all the project leaders, hold regular meetings to evaluate overall team performance and deal with

team functioning problems. The purpose of these review meetings is to focus on actual or potential problem areas.

6.15. Leadership in project environment

Leadership can be defined as a style of behavior designed to integrate both the organizational requirement and one's personal interests into the pursuit of some objective. All managers have some sort of leadership styles. Project managers prove to be ineffective leaders if they show their inability to balance the technical and managerial project functions. The greater the project manager's technical expertise, the higher his propensity to over involves himself in the technical details of the project. The greater the project manager's interest in the technical details of the project, the more likely it is that he will defend on the project manager's role as one of the technical specialist. The lower the project manager's technical expertise, the more likely it is that he will overstress the non-technical project functions.

The literature on leadership techniques in organizations deals with two most desirable leadership techniques human-relations-oriented, and formal authority-oriented. Under human relations-oriented leadership technique, the project manager must make all the team members feel that their efforts are important and have a direct effect t on the outcome of the project. The project manager must educate the team concerning what is to be done and how important its role is. Project manager should make the team members feel and believe that they play a vital part in the success of failure of the team. By working closely with members of the team, the project manager can win their loyalty to the project. By knowing the project team members individually, the project manager can increase their motivation level by making them understand that they are an indispensable part of the team. The most effective way of overcoming the authority-gap is by understanding as much as possible the needs of

the individuals with whom the project manager deals, and over whom he has no direct authority.

Using formal authority-oriented leadership technique, the project manager can point out how great the loss will be if co-operation is not forthcoming. He can put all his authority in functional statements. Further, he can apply pressure beginning with a tactful approach and minimum application warranted by the situation and then increase it. If the performance of some team members continue to be unsatisfactory, the project manager may threaten high-level intervention and do so, if necessary. He can convince the team members that what is good for the organization is also good for them. The project may place authority to full-time assigned people in the operating division to get the necessary work done. The project manager should maintain control expenditure. It is most important that the team members recognize that the project manager has the mandate to direct the project.

6.16. Role of communication in project environment

Both written and oral communications, formal as well as informal, are vital for the success of a project. The communication process is more than simply conveying message; it is also source control. Communication must convey both information and motivation. Knowing how to communicate does not guarantee that clear message will be generated. The various techniques used to improve communications include:

a) Obtaining feedback, possibly in more than one form
b) Establishing multiple communications channels
c) Using face-to-face communications if possible
d) Determining how sensitive the receiver is to communication
e) Being aware of symbolic meanings such as expressions on people’s faces
f) Communicating at appropriate time

g) Reinforcing words with actions
h) Using a simple language
i) Using redundancy whenever possible (i.e., saying it in two different ways)

The actual use of techniques can vary from project to project. With every effort to communicate, there are always barriers. Some of the barriers of effective communication are:

b) Receive hearing what he wants to hear. This results from people doing the same job so long that they no longer listen
c) Sender and receiver having different perceptions. This is vitally important in contractual requirements, statements of work, and proposal information requests.
d) Receiver evaluating the source before accepting the communications
e) Receiver ignoring conflicting information and doing as he pleases
f) Words meaning different things to different people
g) Communications ignoring non-verbal cues
h) Receiver being emotionally upset.

Three important conclusions can be drawn from communications techniques and barriers;

a) Not to assume that the message sent by the sender will be received in the form in which it is sent.
b) The swiftest and most effective communications take place among people with common points of view. The manager who fosters good relationship with his associates will have little difficulty in communicating with them.
c) Communications must be established early in the project.

In a project environment, communications are often filtered. There are several reasons for the filtering of upward communications, such as

unpleasantness for the sender: receiver cannot obtain information from any other source, embarrass a superior: lack of status or mobility for the sender; insecurity; or mistrust.

Team meetings are supposed to be meetings of the mind where information giving, receiving, and listening take place. It is the responsibility of the project manager to ensure that meetings are valuable and necessary for the exchange of information. Team meetings quite often provide individuals with mean of exhibiting suppressed ideas.

Project review meetings are necessary to convince key personnel that orderly progress is being made on a project. There are three types of project review meetings; (i) project team review meetings, (ii) executive management review meetings, and (iii) customer project review meetings. Periodical meetings weekly and monthly-are held in order to keep the project manager and his team informed about the project's status. These meetings are flexible and should be called only if positive benefit will result. Executive management has the right to require monthly status review meetings. Customer review meetings are the most critical and most inflexibly scheduled. Project managers often overlook the fact that their project is simply one of several interrelated project for the customer. Project managers must allow time to prepare the necessary materials well in advance for the meeting.