METHODIST COLLEGE OF ENGINEERING & TECHNOLOGY

HYDERABAD

DEPARTMENT OF MECHANICAL ENGINEERING

LECTURE NOTES

FOR

ENTREPRENEURSHIP

UNIT-IV

Unit-IV

Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management. Assessment of tax burden.

Typically, a firm is organised into various departments -- production, purchasing, marketing, finance, personnel, engineering and research and development. Some of these have line function and the others a staff function.

Line managers have the principal responsibility for achieving the goals of the firm and are vested with decision making authority. Staff managers primarily serve in an advisory capacity and within the staff departments, they enjoy administrative powers. Traditional form of organisation is not suitable for project management. The reasons are:

i) A project is a non-routine, non-repetitive undertaking often plagued with many uncertainties.

ii) The relationships in a project setting are dynamic, temporary and flexible, and

iii) A project requires coordination of the efforts of persons drawn from different functional areas and contributions of external agencies.

Project work calls for design, development, procurement, construction and commissioning work.

Project management consists of

I. **Forms of project organisation**
II. **Project planning**
III. **Project control**
IV. **Human aspects of project management**
V. **Pre-requisites for successful project implementation**

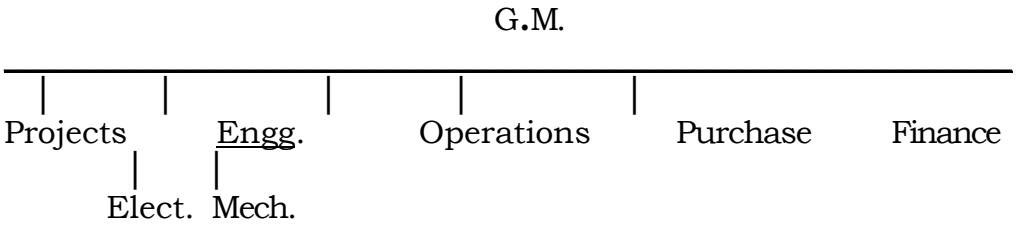
I. **Forms of project organisation**: - The responsibilities of a Project Manager or Project Cordinator are: integrating the activities and functions of various departments and external organizations involved in the project work. Depending upon the authority given to the project manager the following one of the three types of organisation take place:

i) Line and staff organisation: - This is suitable for effective realization of project objectives and effectively utilises resources. It can be best suitable for small projects.

ii) Divisional organisation: - In this form of organisation, unnecessary duplication of specialists in the company, because of the necessity to allocate them in total to each project. In this it is not possible to utilize resources effectively but can effectively realize the project objectives.

iii) Matrix organisation: - This type of organisation realises both project objectives and efficient utilises the resources. Personnel working in project have dual

responsibility to their functional superior as well as the project manager. The authority is shared between the both. It considerable improves the prospects fulfilling the time and budget targets.



Matrix Organisation

II. <u>Project Planning</u>: — without effective planning there may be chaos.
i) Functions of planning:—
— organising the work and allocating responsibilities to individuals
— it is a means of communication and coordination between all those involved in project
— induces people to look ahead
— instills a sense of urgency and time consciousness
— establishes the basis for monitoring and control
ii) Areas of Planning:—
— planning the project work - activities must be spelt out in detail. They should be properly scheduled and sequenced.
— planning the manpower and organisation (managers, technologists, operators and others) must be estimated and the responsibility allocates.
— planning the money — the expenditure of money in a time—phased manner must be budgeted.
— planning the information system — for monitoring the project (information required) must be defined.
3. Project objectives: — well defined objectives and policies serve the decisions to be made by the Project Manager. A clear articulation of the priorities of management will enable the project manager to take expeditious actions.
4. Work breakdown structure: — it helps in
— effective planning by dividing the work into manageable elements which can be planned, budgeted and controlled
— assigning the responsibility to project personnel and outside agencies.
— development of control and information system
'<u>Work breakdown and project organisation</u>': the work breakdown structure has to be integrated with the project organisation. This calls for blending the vertical breakdown of the work (as arrived in the work breakdown structure) with the project organisation structure. This results in delineation of project tasks which are the specific responsibilities of organizational units/managers. The technical make given to the project task is 'cost account'. A cost account represents a unit of work i) which is defined in fairly concrete terms, ii) for

which a single person is responsible and iii) for which a budget of expenditure and manpower requirements can be prepared meaningfully.

5. Life cycle of Project: — important stages are
— project development and preliminary engineering
— bidding and contract negotiations
— engineering design
— purchase and procurement
— construction
— commissioning

6. Tools of planning: — the oldest formal planning too1 is the bar chart or multiple activity chart. In the last four decades, network techniques have received considerable attention.

Bar Chart: — this is a pictorial device in which the activities are represented by horizontal bars on the time axis. The left hand bar shows the beginning time, the right hand end the ending time. The duration of the activity is indicated by the length of the bar. The manpower required for the activity is shown by a number on the bar.

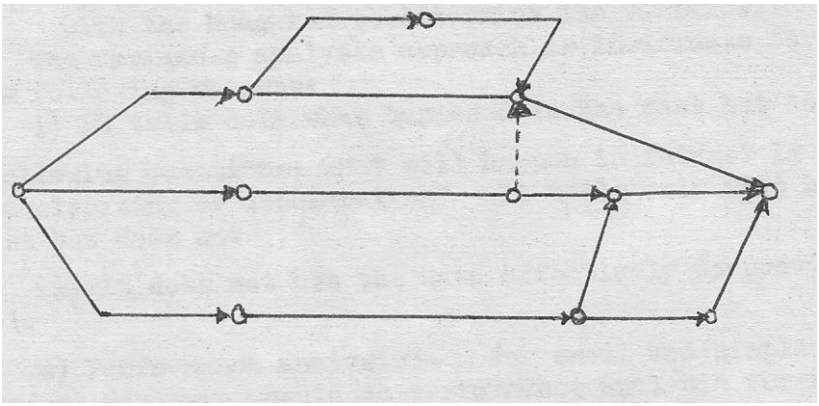
An illustrative bar chart

	Time in weeks from project start				
	10	20	30	40	50
Design	7 ⌊_____⌋				
Purchase of parts		2 ⌊_____⌋			
Fabrication			16 ⌊_____⌋		
Assembly				4 ⌊_____⌋	

The advantages of the bar chart are: i) it is simple to understand, ii) it can be used to show progress, and iii) it can be used or manpower planning. The bar chart, however, suffers from some disadvantages which limit its usefulness: i) it cannot show interrelationship among activities on large, complex projects, ii) there may be a physical limit to the size of the bar chart, which may limit the size of the project that can be planned with this technique, and iii) it cannot easily cope with frequent changes or updating

Network Techniques: — these are more sophisticated than the traditional bar chart. In these techniques, the inter—relationships are represented by an arrow diagram.

An illustrative Network Diagram



The advantages of network techniques are: i) they can effectively handle inter—relationships among project activities, ii) they identify the activities which are critical to the completion of the project on time and indicate the float (or spare time) for other activities, iii) they can handle very large and complex projects, and iv) they can be easily computerized and updated.

While the network techniques are a superior tool for project planning, they suffer from several drawbacks: i) being more complicated than the traditional bar chart they are not easily understood by the project personnel, and ii) they do not define an operational schedule which tells who does what and when.

III. <u>Project control</u>: — it concerns a regular compliance of performance against targets, a search for the causes of deviation and a commitment to check adverse variance. It serves two major functions: i) it ensures regular monitoring of performance and ii) it motivates project personnel to strive for achieving project objectives.

Reasons for ineffective control are:

a) Characteristics of the Project:

— Keeping track of physical performance and expenditure on hundreds or thousands (or tens of thousands) of activities which are often non—routine is a stupendous task.

— Coordination and communication problems multiply when several organizations are involved in the project.

b) People Problems: — Most of the operational managers, used to the steady rhythm of normal operations and routine work lack the experience, training, competence, and inclination to control projects.

c) Poor Control and Information System: Some of the weaknesses observed in the control and information system are:

delay in reporting performance

— Inappropriate level of detail

— unreliable information

d) Variance analysis approach:— The traditional approach to project control involves a comparison of the actual cost with the budgeted to determine the variance.

The variances analysis approach is inadequate for project control for the following reasons:

i) It tells only what happened in the past but does not answer the following questions: What will happen in future? Is the rate of work accelerating or decelerating? It tells only what happened in the past
ii) It does not use the data effectively to provide integrated control.
e) Performance analysis: — for small and simple projects, the project managers would do performance analysis for the project as a whole, or for its major components. As the project becomes larger and more complex, performance analysis needs to be done for individual segments of the projects which are referred to as 'cost accounts'.

As we have seen earlier, a 'cost account' is illogical management centre. Performance analysis is a modern approach to control.
IV. **Human aspects of project management**: — Project manager must successfully handle problems and challenges relating to

i) Authority
ii) Orientation
iii) Motivation
iv) Group functioning

i) Authority: The project manager has to explain the logic and rationale for the project activities, show receptivity to the suggestions made by others, avoid unilateral imposition of decisions, eschew dogmatic postures, and search for areas of agreement which can be the basis of acceptable solutions.
ii) Orientation: — Most of the managers working for a project are usually engineers (or technologists). Typically, an engineer
— works with physical laws, characterised by mathematical precision, as his tools
— Adopts a structured, mechanical approach to his problems
– seeks an enduring solution to his problems
– attaches a high value on technical perfection
But an engineer performs the tasks of planning, organising, directing, and, controlling the resources of the firm in a world of uncertainty. Adopts a more creative approach to solve non—programmed and unstructured problems. Attaches greater importance to efficient utilization of resources and resolution of human relation problems
Thus the project manager has to strengthen the managerial orientation of project personnel so that the project goals and objectives can be efficiently achieved within the constraints of time and budget.
iii) Motivation: — the principal behavioral factor which the project manager can influence is the motivation of the project personnel. Humans are motivated by a variety of needs: physiological needs, social needs, recognition needs, and self—actualization needs. The traditional approach to management was based on the assumption that human beings regard work as unpleasant, shirk responsibility, and ordinarily employ inefficient and wasteful methods. A great deal of pressure has to be applied to overcome this. Behavioura1 research, however, has shown that while some pressure is beneficial, an excess of it is undesirable. Beyond a certain point, pressure is

dysfunctional.
iv) Group functioning: — in a large complex project, many persons drawn from different functions, departments, and organizations are involved. This leads to formation of groups, formal and informal. These are of three types:
— Vertical groups consist of people drawn from different levels in the same department, or function, or company.
— Horizontal group consists of people drawn from different functions, departments, and companies, but occupying similar hierarchical positions.
— Mixed group consists of people drawn from different levels from various functions, departments, and companies.
Due to vertical group formation in the organisation conflicts may arise based on "we/they". The horizontal group serves as channels of communication, by their influence; they can strengthen the commitment to the project. The mixed group tends to promote greater cohesion of the total project organisation. It is very conducive in creating a project attitude and developing an overriding commitment for the project. Hence the project manager should strive to establish a mixed group as the principal group of the project. However, it is difficult to establish such a group because of the temporary nature of a project--when members of a group know that the group would be dissolved sooner or later, they retain strong links with their parent company or department.
'Building Effective Groups':— an effective group consists of members who are satisfied and committed and who strive for the attainment of project objectives, without dissipating their energies in inter—personal and inter—group conflicts. The manifest signs of an effective group are: pride in the project, supportive behavior, coordinated endeavor, mutual respect, and resilience during trying periods. An ineffective group, on the other hand, consists of disgruntled members who are more involved in inter—personal and inter—group rivalries and less concerned about project goals. Such a group is characterised by apathy, animosity, mutual bickering, disjointed efforts, cynical attitudes, and low morale.
For building an effective group, firm must pursue a genuinely participative style of management. With this manageria1 philosophy, the project manager can facilitate the development of mutual trust and acceptance, open communication, cooperation, and project attitude. In this task, he needs leadership capabilities, sensitivity to human nature, perceptiveness, concern for welfare of their maturity, and impartial approach. Clearly this is a difficult and challenging task.

V. Prerequisites for successful Project implementation: — Time and cost over—runs of projects are very common in India, particularly in the public sector. The Annual Report of the Ministry of Programme Implementation for recent year released that 65% of the projects have suffered time over runs, which have gone as high as about 200% -- the average delay in commissioning these projects was about 3 years and about 68% of the Central government projects, have suffered cost over—runs, which have been

as high as 75%. A similar analysis of state projects would perhaps reveal an even more dismal picture.
Due to such time and cost over—runs projects tend to uneconomical, resources are not available to support other projects, and economic development is adversely affected.

Some important things to be done to achieve successful completion of projects are:—

i) Adequate formulation: — Care must be taken to avoid superficial field investigation, cursory assessment of input requirements, slip-shod methods used for estimating costs and benefits, omission of project linkages, flawed judgments because of lack of experience and expertise, undue hurry to get started and deliberate over-estimation of benefits and under— estimation of costs so that the appraisal and formulation o± the project is thorough, adequate, and meaningful.

ii) Sound project organisation: — The characteristics of a sound project organisation are: it is led by a competent leader who is accountable for the project performance, the authority of the project leader and his team is commensurate with their responsibility, adequate attention is paid to the human side of the project, systems and methods are clearly defined and rewards and penalties to individuals are related to performance.

iii) Proper Implementation Planning:- Implementation planning before commencement of actual implementation should plan for a comprehensive time plan for various activities like land acquisition, tender evaluation, recruitment of personnel, construction of buildings, erection of plant, arrangement of utilities, trial production run etc., estimate meticulously the resource requirements (manpower, materials, money etc) for each period to realise the time plan$_t$ define properly the inter-linkages between various activities of the project and specify cost standards.

iv) Advance Action: - Advance action on the following activities may be initiated: acquisition of land, securing essential clearances, identifying technical collaborators/consultants, arranging for infrastructure facilities, preliminary design and engineering and calling tenders.

To initiate advance action with respect the above some investment is required. Clearly, if the project is not approved, this investment would represent an anfractuous outlay. However, the substantial savings (in time and, const) that are expected to occur, should the project be approved (a very likely event, given the prima facie desirability of the project) often amply justify the incurrence of such costs.

v) Timely availability of funds: - Firms which have a comfortable liquidity position are in general, able to implement Projects expeditiously and

economically. Such firms can initiate advance actions vigorously, negotiate with suppliers and contractors aggressively, organise input supplies quickly, take advantages of opportunities to effect economies, support suppliers in resolving their problems so that they can in turn rebound to the successful completion of projects, and sustain the morale of project-related personnel at a high level.
So, once a project is approved, adequate funds must be made available to meet its requirements as per the plan if implementation--it would be highly desirable if funds are provided even before the final approval to initiate advance action.
vi) Judicious equipment tendering and procurement: - Over reliance on indigenous suppliers may mean delays and higher uncertainty about the technical performance of the project. It is advantageous from the point of view of cost and time regarding foreign suppliers through global tendering but foreign exchange which is very valuable to the country flows out. Hence a judicious balance must be sought which moderates the outflow of foreign exchange and provides reasonable fillip to the development of indigenous technology.
vii) Better Contract Managements: - Help should be extended to contractors and suppliers when they have genuine problems--they should be regarded as partners in a common pursuit. Project authorities must retain latitude to off-load contracts (partially or wholly) to other parties well in time where delays are anticipated.
viii) Effective Monitoring: -In order to keep a tab on the progress of the project, a system of monitoring must be established. This helps in anticipating deviations from the implementation plan, analysing emerging problems, taking corrective action,

NETWORK TECHNIQUES FOR PROJECT MANAGEMENT:-
Financial institutions and Govt. of India insist that network plan should accompany feasibility reports. There are two basic network techniques: PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method).

PROJECT SELECTION

Project ideas thus identified are translated into project schemes/ profiles by further screening them on the basis of their technical, economic and financial soundness.

The project scheme/profile comprises the following in brief:

1. Economic size
2. Status of Industry or Scope
3. Raw Material availability
4. Cost of production
5. Capital costs
6. Utility requirements
7. Infrastructure facilities needed
8. Profitability
9. Government Policy

A SS1 unit (Small Scale Industrial unit) generally enters the market which is

localized, and already has existing manufacturers. The success of the new unit in competing with the existing manufacturers would depend upon a combination of its capability to identity and approach its targeted customer group and its marketing features like price, quality, delivery schedule, sales promotion, etc.

Criteria for Selecting a Particular Project:

After gathering a large number of project profiles, the entrepreneur should consider the following criteria for selecting a particular project:

PROJECT APPRAISAL FORMAT

Criteria	Project I	Project II	Project III	ProjectIV
1. Investment size				
2. Location				
3. Technology				
4. Equipment				
5. Marketing				
6. Power & Water				
7. Others' performance				
8. Working capital needs				
9. Labor component				
10. Economic viability				
Total				

1. Investment size: Professional managers who have worked in multi—national companies or large Indian companies, should think of starting medium—sized or large—sized units only. The investment size (project cost) should be at least Rs.3 to 5 crores. They should not commit the common mistake of restricting the project size to less than Rs.2 crores so that they need not go to the all—Indian financial institutions. In fact, under the present circumstances, it will be mach easier to get projects cleared by the all—India institutions,

requiring even lesser promoter's contribution.

2. Location: A new entrepreneur should locate his project to the extent possible, in and around a State headquarters. There are many backward areas around such cities. It is necessary to have such a location to attract competent managers. This will also facilitate liaison with the State Electricity Board, State Industrial Development Corporation and various other agencies.

3. Technology: The first project should not be for product which requires high technology, necessitating foreign technical collaboration. It is better to go in for a product with proven technology that is indigenously available. It makes life easier to begin with.

4. Equipment: The entrepreneur should select the best equipment based on the advice of experienced technical consultants. He should not compromise on the quality of the equipment. Many entrepreneurs enter into some sort of a deal with the equipment manufacturers for a "kick—back" and. in the process sacrifices quality. Industry is a goose that lays golden eggs. One should not be

short—sighted and kill the goose by going in for poor quality equipment.
5. Marketing: It is not advisable to get into a project particularly the first, which would mean survival amidst cut—throat dog—eat—dog competition involving direct selling to the ultimate consumer. One should go in for products with a limited number (say 10 to 20) of industrial customers.
6. Power & Water: One should ensure abundant supply of these two inputs. Power intensive and water intensive projects should be avoided.
7. Others' performance: How are others doing? A new entrepreneur should explore as to how those already in the field are doing. He should not get into areas where seasoned industrialists fear to tread. As a rule, he should get into a line in which others are doing reasonably well.
8. Working Capital requirements: It is not desirable to choose a project, which is working capital intensive and whose cash (operating cycle is too long. The lending policies of banks are rather unpredictable these days. An entrepreneur is likely to run into trouble on this front if he underestimates his working capital requirements initially (to keep his margin money low). His problems will be compounded, if he has to buy from any government source (by paying advance) or to sell to any government agencies (which are well known for their delayed settlement of bills).
9. Labor component: The project should not be labor intensive, at least in the first instance. Labor productivity in India is very low and Indian labor is ultimately very costly, contrary to popular belief. A shrewd entrepreneur will avoid unskilled and semi—skilled labor and minimise the material—handling labor with proper buy—out policies and use of better equipment.
10. Economic viability: Above everything, a project should be viable. It should break even on a cash basis in the first 6 — 8 months. It should break even (on cost basis) in the first 9 — 10 months. One must get an accounting profit no matter how small it is in the very first year. He should not think he cannot earn profits in the first year. He can if he is determined. He must declare a dividend of at least eight percent in the second year. Many entrepreneurs deceive themselves about the economic viability after fooling the financial institutions. An entrepreneur can least afford to deceive himself of all people.
Overall evaluation: He should evaluate all the projects on hand on a multi—point scale as indicated in the statement. The project which scores maximum points should be selected for further exploration.
Further exploration: After short-listing the projects on the lines suggested above, he should do further exploration by consulting people in that line, meeting technical consultants and discussing with financial institutions. If he is satisfied in the second round also, then he should commission a detailed project report, by
entrusting the job to some well—known consultants in the field. The maxims "Look before you leap" and "Think before you act" will save a new entrepreneur time and money.

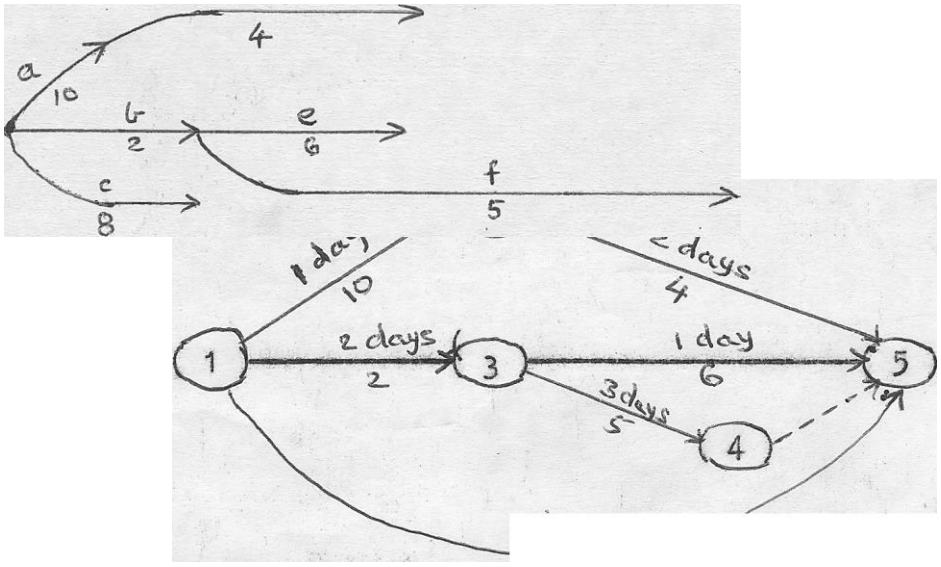
MEETING MANPOWER REQUIREMENT:-

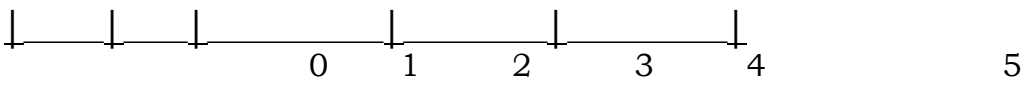
The manpower required for the activities is indicated by the length of the bar in the bar chart (most suitable for small projects). These bar chart can be used for manpower planning. For large and complex projects Network techniques can be used.

The manpower requirement is shown below the activity arrow. Let us consider a small project for which the network diagram in shown in below:–

Looking at the manpower requirement for the early start schedule we find that it is 20 for the first day, 14 for the second day, 15 for the third day, 5 *for* the fourth day, and 5 for the fifth day. Real life situations, however, there may be restrictions on the availability of resources. For example, manpower supply may be limited. When restrictions exist various schedules may have to be considered to find out which one is most appropriate in the light of these restrictions.

In the above network diagram, only 12 men are available for the project (manpower resource constraint). The early start schedule of this project is shown as a graph on the horizontal time scale.





Looking at the manpower requirement for the early start schedule we find that it is 20 for the first day, 14 for the second day, 15 for the third day, 5 *for* the fourth day, and 5 for the fifth day. Obviously, this schedule is unacceptable in view of the manpower constraint.

So, we explore the possibility of shifting activities. Our efforts at shifting activities, keeping the project duration at five days, soon reveals that no schedule is feasible with only 12 men. So we extend the duration of

the project, by one day end try various schedules to see whether we can find a feasible schedule. A little juggling of activities shows that a schedule like the one shown as below is feasible -- this is the best we can do.

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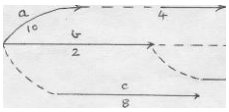

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Project management

1 Project management:

A traditional form of organization is not suitable for project management for the following reasons.

1. Project is non-routine, non-repetitive undertaking.
2. The relationships in a project setting are dynamic, temporary and flexible.
3. Project requires co-ordination of the efforts of persons drawn from different functional areas and contribution of external agencies.

Hence project management needs a different form of organization with sharper tools of planning and control and improved means of coping with human problems. Project management may be divided into

- Forms of project organization
- Project planning
- Project control
- Human aspects of project management
- Pre-requisites for successful project implementation

2 Forms of Project Organizations:

Project manager:

There is a need for identifying a person with responsibility for integrating the activities and functions of various departments and external organizations involved in the project work. This person may be called as project manager or project coordinator.

Project organization may take one of the three forms.

1. Line and Staff organization:
    - Primary responsibility of the person identified as project manager is coordinating the work of the people in the functional departments.
    - Project manager acts in a staff position.
    - He does not have the authority and responsibility of line management
    - He serves as a focal point for receiving the project related information.
    - It is a weak form of organization and not suitable for large projects.
2. Divisional organization:
    - A separate division is set up to implement the project headed by a project manager.
    - The project manager has full line authority.

- It facilitates the process of planning and control.
- Brings out the better integration of efforts.
- Strengthens the commitment for project related personnel to the objectives of the project.
- Improves the prospects of fulfilling time and budget targets.
    - It may suffer with inefficient use of resources.
    - It may result in unnecessary duplication of specialists.

3. Matrix organization:
   The line and staff organization is conducive to an efficient use of resources but not suitable for an effective realization of objectives. The divisional form is suitable for effective realization of objectives, but is not suitable for efficient use of resources. Both the above are realized in the matrix form of organization., but at the cost of greater organizational complexity.
   In the matrix organization, personnel working on the project have a responsibility to their functional heads as well as the project manager. The authority is shared between the PM and the functional manager.
   The matrix organization is incongruent with the traditional organization theory. There is dual sub-ordination. It involves greater organizational complexity. Yet it seems to be a better vehicle for simultaneous pursuit of the twin objectives.

3 Project planning:

There will be a need for formal planning when the projects are larger in size and complexity.

Functions:

- It provides a basis for organizing the work on the project and allocating the responsibilities to the individuals.
- It is a means of communications and coordination among all those involved in the project.
- It induces people to look ahead
- It instills a sense of urgency and time consciousness.
- It establishes the basis for monitoring and controlling.

Areas of planning:

- Planning the project work
- Planning the manpower and organization
- Planning the money
- Planning the information system.
- Work break down structure

  Logical and systematic break down of the project into component parts.

Project objectives and policies:

- Technical and performance objectives
- Time and cost goals
- Extent of sub-contracting
- Terms and conditions of contract.

4 Project Life Cycle:

1. Project development and preliminary engineering
2. Bidding and contract negotiation
3. Engineering design
4. Purchase and procurement
5. Construction
6. Commissioning

5 Assessment of tax burden:

Network diagrams

1.0 Network diagram:

Net work diagram is a mathematical model that uses small circles (nodes) connected by links (arrows) to represent precedence relationships.

Critical Path method (CPM) and Programme Evaluation and Review technique (PERT) are some of the network techniques.
Network diagrams are represented by 2 ways.

1. Activity on Arrow (AOA) - Arrows represent the activities.
2. Activity On Node (AON) - Nodes represent the activities. Arrows merely show the precedence relationships.

2.0 Terms:

Event :

It is a specific instant of time which marks the start or end of an activity.
It consumes no time.

Activity:

It is an operation or task in a project and consumes time and resources.

Critical activity:

The activity which, if consumes more than the estimated time, delays the project is called Critical activity. Those which do not delay the project are called Non-critical activities.

Dummy activity:

When two activities start at the same instant of time, the head events (Start event) are joined by a dotted arrow representing an activity called dummy activity. Dummy activity shows precedence relationship only and does not consume any time.

Critical path:

It is the longest path and consumes maximum time. Even if one activity on the critical path is delayed, the project time can not be met.

Earliest start Time (EST):

It is the earliest possible time at which an activity can start. It is calculated by moving from first event to the last.

Earliest finish Time (EFT):

It is the earliest possible time at which an activity can finish.

EFT = EST + Duration of the activity

Latest finish Time (LFT):

It is the latest possible time at which an activity can finish. It is calculated by moving from last event to the first.

Latest start Time (LST):

It is the latest possible time at which an activity can start.

LST = LFT - Duration of the activity

Float or Slack:

It is a spare time or a margin over and above the duration of a non-critical activity without affecting the project completion time.

Total float (TF):

It is the additional time which a non-critical activity can consume without increasing the project duration. It may affect the floats of the previous and subsequent activities.

TF = LST – EST or LFT - EFT

Free float (FF):

If all the critical activities start as early as possible, the surplus time is the free float.

FF = EST of tail event – EST of head event – Duration of the activity

(Preceding event is head event and Succeeding event is the tail event.)

Independent float (IF):

The use of independent float of an activity does not change the floats in other activities.

IF = EST of tail event – LFT of head event – Duration of the activity

3.0 PERT:

PERT can be employed where the project can not be defined easily in terms of time and resources required.

PERT utilizes the probability techniques in estimating the time required.

PERT is an event oriented system.

3.1 Time estimates:

1. Optimistic time (t_o): It is the shortest possible time in which an activity can be completed if every thing exceptionally well.
2. Most likely time (t_m): It is the time in which the activity is normally expected to complete under normal conditions.
3. Pessimistic time (t_p): It is the time in which an activity will take to complete if mostly the things go wrong. It is the longest of the three.

4. Expected time (t_e): $t_e = (t_o + 4t_m + t_p) /6$

5. Standard deviation (S_t): $S_t) = (t_p) - t_o) /6$
6. Variance = Square of the Standard deviation.

7. Probability that the project will meet the scheduled or due date is calculate from the equation:

$Z = (D-T_e)/ S_t$ Where D = Due date or schedule date
Z = No. of Std. Deviations by which D Exceeds T_e .
T_e = Total project duration (Critical path)

Probabilities of schedule date for various values of Z are available in tables.

4.0 CPM:

It is a technique used for planning and controlling the most logical and economic sequence of operations for accomplishing a project. It is similar to PERT and is shown on network diagrams. It is an activity oriented system.

4.1 Steps:

1. Break the project into various activities systematically.
2. Label all activities.
3. Arrange all activities in logical sequence.
4. Construct the arrow diagram following the logic and sequence.
5. Number all nodes and activities.

6. Find the time required for each activity by previous experience or data.
7. Mark the times on the arrow diagram.
8. Calculate EST, LFT, LST and EFT.
9. Tabulate various times and mark EST & LFT on the arrow diagram.
10. Calculate the total float for each activity.
11. Identify the critical activities and mark the critical path on the arrow diagram.
12. Calculate the total project duration.
13. Crash the critical activities on the arrow diagram if project time is to be reduced.
14. Optimize the cost.
15. Update the network.
16. Smooth the network resources.

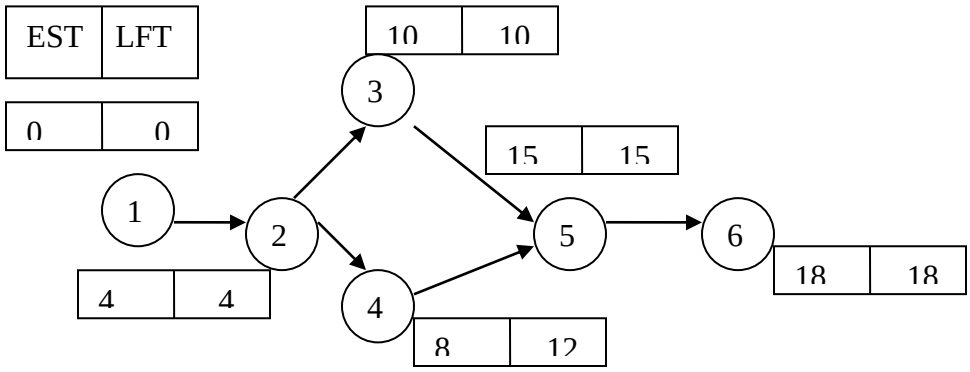
4.2 Differences between CPM & PERT:

	CPM	PERT
1	A deterministic model. Time is determined by past experience	A probabilistic model. Expected time is calculated from Optimistic, pessimistic and most likely times.
2		An event oriented approach
3	An activity oriented approach	Dummy activities may be needed
4	Use of dummy activities is not necessary CPM marks critical activities	Basically does not demarcate between critical and non-critical activities.

4.3 Example:

Activity	Duration in days
A	4
B	6
C	5
D	4
E	3
F	3

Draw the network diagram and calculate EST, LST, EFT & LFT and floats. Mark the critical path.



Activity 1	Duration 2	EST 3	LST 4 (6-2)	EFT 5 (3+2)	LFT 6	Total Float 7 (4-3)	Free Float 8	Independent float 9
A B C D E F	4 6 5 4 3 3	0 4 10 4 8 15	0 4 10 8 12 15	4 10 15 8 11 18	4 10 15 12 15 18	0 0 0 4 4 0	0 0 0 0 4 0	0 0 0 0 0 0