

IntroductionIndustrial Engineering :-

Industrial Engineering is a branch of Engineering which deals with the optimization of complex processes, systems or organizations. Industrial engineers work to eliminate waste of time, money, materials, manhours, machine time, energy and other resources that do not generate value.

According to American Institute of Industrial Engineering defines Industrial Engineering as "concern with the design, improvement and installation of integrated systems of people, materials, equipment and energy. It draws upon specialized knowledge and skill in the mathematical, physical and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems."

Industrial Engineering is mainly concerned with the improvement of productivity.

Applications of Industrial Engineering :-

→ Before 1940, Industrial Engineering was mainly applied to manufacturing industries for improving methods of production, to develop work standards or to formulate production control and wage policies.

→ Later on, the use of industrial Engineering also spreaded to non-manufacturing activities such

- as,
- (i) Construction and transportation
 - (ii) Air-line operations and maintenance.
 - (iii) Public utilities.
 - (iv) Government and military operations.

→ Still today, Industrial Engineering finds major applications in manufacturing plants and industries.

→ In an industry besides the production, other departments utilising industrial engineering concept are Marketing, finance, purchasing, Industrial Relations etc.

* Role of an Industrial Engineer :-

As Advisor

There are different types of Roles and Functions which has been performed by the industrial engineer. It is considered that more than form of role and functioning may occur simultaneously at the same time.

Role and Functions of Industrial Engineering :-

(*) Advisor :- They act as Interpreter, Reviewer.

(2) Advocate/Activist :- They facilitate in actively promoting a process.

(3) Boundary spanner - They help in removing the gap ⁽²⁾ between industrial engineering and user interest.

(4) Motivator - Provide stimulus and skill data availability to a group or individual.

(5) Decision maker - Select a performance from among many alternatives for topic of concern.

(6) Designer/planner - Produce the solution specifications.

(7) Innovator/inventor - Seek to produce a creative or advanced technology solution.

(8) Negotiator - Acts as negotiator while dealing with suppliers, peers, subordinates and also with parties of business.

(9) Expert - Provide a high level of knowledge, skill, and experience on a specific topic.

(10) Project manager - operate, supervise and evaluate projects.

(11) Trainer/educator - in the skills and knowledge of industrial engineering.

* Production Management :-

Production Meaning :-

Production may be referred to as the process concerned with the conversion of inputs (raw materials, machinery, information, manpower and other factors of production) into output. (Semi finished and finished goods and services)

Difference between Production Management and the ³

Industrial Engineering :-

Production Management

(1) Definition

Production management refers to the planning, coordinating and controlling the resources of production department.

(2) objective

Its main objective is to optimal utilization of resources so as to produce desired output.

(3) Functions :-

The Functions include Selection of material, machinery and the Equipment loading, Scheduling, dispatching, Inspection and Evaluation.

Industrial engineering

Industrial engineering refer to the process of designing, developing and installing integrated System to the available resources of a Production System.

Its main objective is to design such an integrated system which ensures the improvement in the Productivity.

The Functions include Advising, Advocating, Analysing, Decision-making, data gathering and measuring.

(4) Application

It is applied in the Production activities only.

(5) Area of Focus :-

It focus on the individuals to make them aware of using various tools, techniques.

(6) ~~to~~ operation :-

Production manager operates the design system.

(4) It can be applied to manufacturing and non-manufacturing activities.

(5) It focus on systems to make them highly production / productive.

(6) Industrial Engineers design the system, does not operate regularly.

* Quantitative Tools of Industrial Engineering

The various quantitative tools and techniques used in Industrial Engineering are,

(1) Network analysis.

(2) Inventory Models.

(3) Queuing Theory.

(4) Simulation technique.

(5) Mathematical programming.

(1) Network Analysis :- A network is defined as a combination of nodes which are linked by

(4)

activities (or) arcs. The network is represented by letters $\{N, A\}$.

where,

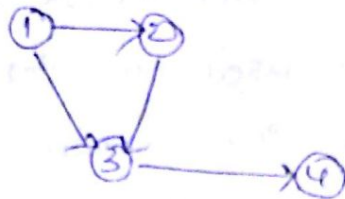
N = The set of nodes

A = The set of activities

$N = \{1, 2, 3, 4\}$

$A = \{(1, 2), (1, 3), (2, 3), (3, 4)\}$

Example :-



The two most widely used network techniques are PERT and CPM. CPM.

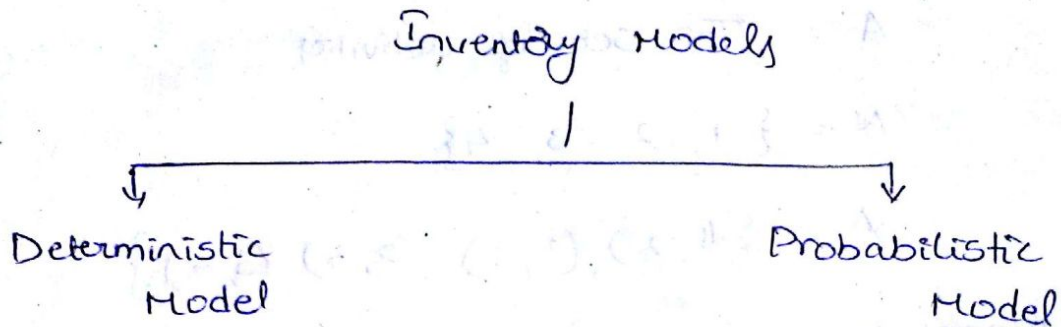
In almost all the Projects of Public Sector and Private Sector, there are significant delays due to lack of proper planning, scheduling and controlling. PERT and CPM helps in performing systematically to complete the job in the shortest possible durations.

(2) Inventory Models :- Inventory is maintained to meet the future requirements. So, a firm should maintain inventory due to the following reasons,

- (a) Inventory provides smooth and efficient running of business.
- (b) It reduces the possibility of duplicating of orders.

- (c) It gives adequate service to customers.
- (d) It increases the cashflow by timely shipment of customers orders etc.

Inventory models are two categories.



- (1) Deterministic model :- Deterministic models of inventory control are used to determine the optimal inventory of a single item when demand is mostly largely obscure. Under this model inventory is built up at a constant rate to meet a determined, or accepted, demand.
- (2) Probabilistic Model :- This model is based on the assumption that the average demand for inventory items is reasonably constant overtime.
- (3) Queuing Theory :- Customers arrive at some service station for some service and may have to wait for service. This gives rise to queues. A queuing model is used for analysis of a given queuing system, using the operating characteristics of the system.

Applications of Queuing Theory :-

- * Telecommunications
- * Traffic control
- * Determining the sequence of computer operations
- * Health services (e.g. control of hospital bed assignments).
- * Airport traffic, airline ticket sales
- * layout of manufacturing systems.

Models of Queuing Theory :-

The queuing models are two categories,

- (a) Deterministic model
- (b) Probabilistic model.

(a) Deterministic model :- If each customer arrives at known intervals and the service time is known with certainty, the queuing model is said to be deterministic in nature.

(b) Probabilistic model :- If either the arrival of the customer or the service times of the customer or both of the queuing system is not known with certainty and expressed only in probabilistic nature.

(4) Simulation Technique :- Simulation is the process of designing a model of real system.

and conducting experiments with this model for the purpose of understanding the behaviour for the operation of the system.

(5) Mathematical programming :- Mathematical programming techniques are linear programming, Integer Programming, Goal Programming and Dynamic Programming. These techniques are useful for maximization of profit and minimization of cost.

Productivity Measurement :-

Productivity meaning :-

Productivity is a measure of the efficiency of production. Productivity is a ratio of what is produced to what is required to produce it.

Productivity is the determinant of the efficiency of an enterprise to convert its variable resources into useful finished goods and services.

In other words, Productivity is a measure of how much input is required to produce a given output i.e., the ratio

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

⑥

When we consider an industry as a whole, the Productivity can be expressed in terms of the ratio between the value of the goods and services produced to the value of the resources utilized for this production.

$$\text{Productivity} = \frac{\text{Value of goods and services produced}}{\text{Value of resources utilized for this production}}$$

Productivity refers to efficient utilization of the resources. The resources utilized for production are;

land & Building

Materials

Machines

Manpower

Types of productivity Measurements

- (1) Material Productivity
- (2) Labour Productivity
- (3) Capital Productivity
- (4) Machine Productivity

(1) Material Productivity → Many industries have to import a very large proportion of their basic raw materials and pay for them in scarce

foreign currencies. under either of these conditions the productivity of materials became a key factor in economic production or operation.

$$\text{Material productivity} = \frac{\text{Number of units produced}}{\text{Cost of material}}$$

Raw material productivity can be increased by:

- (1) Proper choice of design
- (2) Proper training and motivating of workers by way of better handling of materials and reduction of rejection
- (3) Better material planning and control
- (4) waste reduction, Scrap control.
- (5) Recycling and reuse of materials.

(2) Labour Productivity — It is the relationship between total revenue from production and expenditure on labour.

$$\text{labour productivity} = \frac{\text{Total Revenue from Production}}{\text{Expenditure on labour}}$$

The labour Productivity can be increased by:

- (1) Providing training to use best method of production.
- (2) Constantly motivating workers by providing financial and non-financial incentives.
- (3) Keeping high morale of employees.

- (4) Improving working conditions in the plant. (7)
(5) By providing opportunities for self-development.

(3) Capital Productivity :- It is the relationship between Turn over and Capital Employed.

$$\text{Capital productivity} = \frac{\text{Turn over}}{\text{Capital Employed}}$$

Capital productivity can be improved by :

- (1) Better utilization of Capital resources like land, building, machines.
- (2) Careful make or buy decision.
- (3) By using modern techniques of production, maintenance, flexible manufacturing system, proper plant layout etc.

(4) Machine Productivity :- It is the relationship between output and Actual machine hours utilized.

$$\text{Machine productivity} = \frac{\text{output}}{\text{Actual machine hours utilized}}$$

Machine Productivity can be improved by following:

- (1) Preventive maintenance.
- (2) use of proper speed, feed, depth of cut etc.
- (3) using method study techniques
- (4) use of skilled, properly trained workers.

Concepts of Management :-

Management involves the activities to control and monitor the people in an organisation to achieve the desired goals of the organisation.

The roles of management include planning, organising, staffing, directing and controlling the employees.

Definitions of Management :-

Different experts expressed their views on what management is. The following explain the concept and nature of management.

Henri Fayol :-

" To manage is to forecast and plan, to organise, to command, to coordinate and control."

Peter F Drucker

" Management is concerned with the systematic organisation of economic resources and its task is to make these resources productive."

F. W. Taylor :-

" Management is knowing exactly what you want men to do and then seeing that they do it the best and cheapest way."

Nature of Management 8

- (1) Management is an activity!
- (2) Management is a social process
- (3) Multidisciplinary
- (4) Management is a group effort
- (5) Management is a profession
- (6) Management is situational in nature
- (7) Management is both a science and an art
- (8) Management is goal oriented.

(1) Management is an activity — It is a process of activity relating to the effective utilization of available resources.

(2) Management is a social process — Social process refers to the series of activities that are performed in the society.

Management is an integral part of the social process.

(3) Multidisciplinary — Management uses knowledge from many different subjects also. It draws knowledge and concepts from various disciplines. Management draws from economics, it draws the theories of consumption and production, from operations research - linear programming, queuing theory, from statistics - quality and quality

Control, Decision theory, from Psychology - Participative theories and Behavioural theories, from mathematics integral calculus, matrix, algebra and so on.

(4) Management is group effort - Management is an essential part of a group activity as no individual can do all the work by himself, so he combines his efforts with fellow beings and works in an organized group to achieve what he can not achieve individually.

(5) Management is a profession - Management helps to carry out every profession in a scientific manner. The managers are professional in their approach and are governed by code of ethics, if the manager violates the code of conduct, he can be dismissed from the organisation.

(6) Management is situational in nature - Managers adapt their style according to the situation. They adjust their plans, policies, decisions, and styles to suit different situations.

(7) Management is both a science and an Art - The management, as a science provides general principles, which can guide the managers in their professional activities. The management as an art, provides the best possible solutions.

(a)

of the problems and the best ~~are~~ possible exploitation of available resources.

(5) Management is Goal-oriented — The purpose of management is to achieve certain goals.

The main objective of management is to maximize efficiency and economy of human efforts.

* Importance of Management —

Management is compulsory for every enterprise.

The existence of management ensures proper functioning and running of an enterprise.

The importance of management is mentioned below.

(1) Management meets the challenge of changes.

(2) Accomplishment of Group Goals.

(3) Effective functioning of Business.

(4) Effective utilization of Business

(5) Sound organization structure.

(6) It facilitates the achievement of goals through limited resources.

(7) It is key to Economic growth.

(8) Management directs the organization.

(1) Management meets the Challenges of Changes —

An efficient management can save the business from the ~~damag~~ dangers brought in by the challenges of changes.

(2) Accomplishment of Group goals — Management organises available resources for the accomplishment of the goals of an enterprise. It adds effectiveness to the efforts of a group of persons organized to achieve objectives.

(3) Effective functioning of Business — Some of the factors responsible for the effective functioning of business are ability, experience, mutual understanding, coordination, motivation and supervision. Management make sure that the abilities of workers are properly used and cooperation is obtained with the help of mutual understanding.

(4) Effective utilization of Resources — There are eight 'M's in the business, which are men, money, material, machines, methods, motivation, markets and management. Management has control over other remaining M's.

(5) Sound organization structure — Management lays down the foundation for sound organization structure which clearly defines the relationship between authority and responsibility.

(6) It facilitates the achievement of goals through limited resources : — An organisation, if well managed, can accomplish its goals even

(10)

though its resources are limited. The resources are scarce, they have to be effectively allocated and utilised in an optimum manner. This is possible only through management.

(7) It is the key to the economic growths

Efficient management is equally important for the nation in terms of social and economic development. The economic development of a country largely depends on the quality of management of its resources.

(8) Management Directs the organization — Management directs ~~the~~ and controls the functioning of an organization just like the way a human mind directs and controls the functioning of the human body.

* Functions of Management!

There are five categories of functions.

The basic functions of management are,

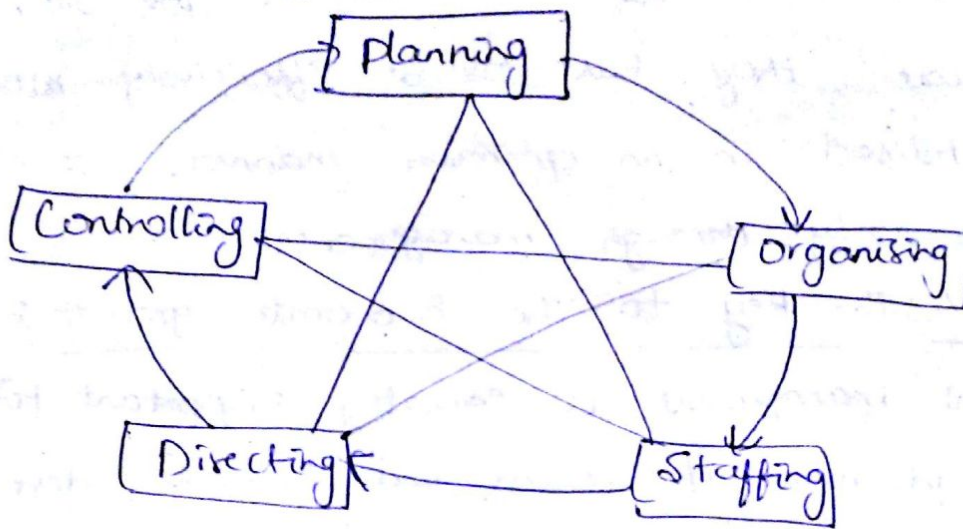
(1) Planning

(2) Organising

(3) Staffing

(4) Directing

(5) Controlling

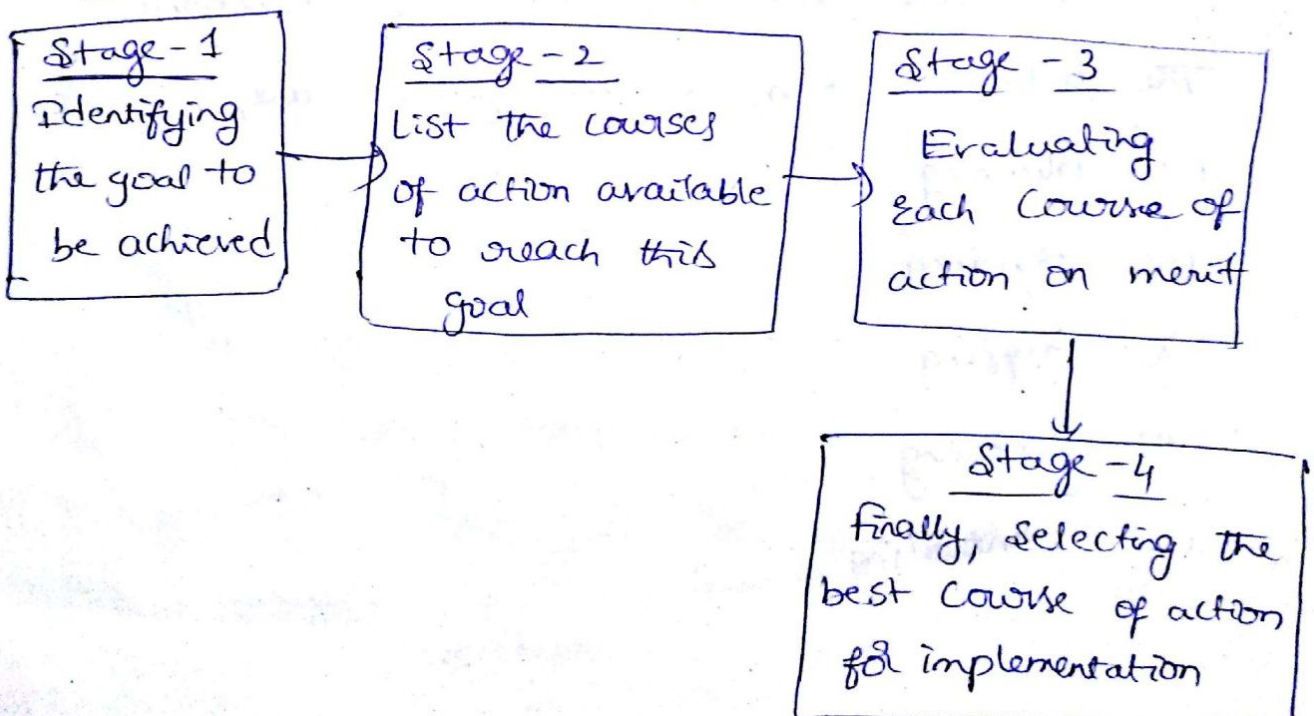


(1) Planning :- It refers to deciding now what is to be done in the future. It bridges the gap between the present and future. The Corporate goals set the direction for planning function.

planning is also referred to as the process of determining the best course of action to achieve the given goals.

Stages in planning

Planning consist four stages



(2) Organising :- Organising refers to the process of 11 grouping the related activities and assigning them to a manager with authority to supervise it. Organising is an essential function that makes the plans operational by identifying and classifying necessary activities.

Fayol explains organisation as a structure of relationships. It explains superior-subordinate relationships. Organising shows how the tasks can be achieved with the given resources.

Therefore, it involves the following steps:

- (a) Activities determination
- (b) Staff recruitment
- (c) Work allocation
- (d) Authority and duty determination
- (e) Power delegation

(3) Staffing :- Staffing refers to filling the position in the organisation with the right people.

Staffing function covers many jobs such as recruitment, selection, training, placement, appraisals, promotions and career planning.

(4) Directing :- Directing is concerned with issuing orders and guiding the subordinates so that they can perform their jobs as planned. A manager has to lead his group of people

Effectively, keep them motivated with financial and non-financial incentives, Communicating both form formally and informally, if necessary. It is necessary for the manager to be very good at coordinating the performance of his group of people.

(5) Controlling - Controlling consists of making the results tally with targets or achieving close correspondence between plans and performance. The process of measuring the current performance of the employees and assessing whether the given objectives are achieved or not.

Controlling is the actual measuring of the performance of employees and comparing the task to the desired goal or outcome.

Scientific Management :-

F.W Taylor is known as Father of the Scientific management the utility of scientific methods to the problems of management was first introduced by F.W Taylor.

Scientific management may be defined as "The Art of knowing exactly what is to be done and the best way of doing it."

(12)

Fredrick Winslow Taylor spent a lot of time looking for solutions to the problems on shop floors with an aim to increase efficiency.

Scientific management is the process of application of scientific principles to systematically analyse the work and to find solutions to all the problems associated with improving the efficiency and of the methods of working.

Principles of Scientific Management (F.W. Taylor)

- (1) Replacing the rule of thumb by scientific methods.
- (2) Selecting, training, teaching and develop the workman.
- (3) Division of work and responsibility.
- (4) Cooperation between management and workers.

* Theory X and Theory Y

(Douglas MC Gregor's Theory)

Douglas MC Gregor has formulated two theories based on the assumptions made by a manager about his employee's nature.

MC Gregor has characterized these assumptions into two opposite view points i.e., 'Theory X' and 'Theory Y'.

Theory X :- This is the traditional theory of human behaviour. The assumptions about the human behaviour are stated as negative in this approach. Based on these assumptions organizations and managers who believe in theory X kind of human nature attempt to structure, control and closely supervise their employees. These managers feel that internal control is a must as the employees are irresponsible.

Assumptions :-

- (1) Workers are inherently lazy.
- (2) They dislike work.
- (3) They have very little ambition.
- (4) They avoid responsibility, when a opportunity was given.
- (5) They require constant guidance and support.
- (6) They are inherently ~~self~~-self-centered.

Theory Y :- The assumptions in Theory Y are totally opposite to what we have seen in Theory X. This theory emphasizes the need for a cooperative effort from management of today i.e., to get maximum output with minimum amount of input, control and direction.

Assumptions:-

- (1) These employees are self direct and self controlled.
- (2) They face all types of challenges and are highly committed to the organization.
- (3) Whenever a responsibility is given they are ready to accept it.
- (4) They are committed to organizational goals.
- (5) Most of the workers are creative.

* Fayol's Principles of Management:-

Henry Fayol is known as father of Principles of management, Administrative management, Modern management. He was born in France. An important contribution of Fayol is that management is not restricted only to business organizations. But can be applied to all spheres of life.

Fayol defined management functions planning, organizing, commanding, coordinating, and controlling. While studying organizations, Fayol split all organizational work under six prominent functions.

- (a) Technical, for production
- (b) Commercial, for buying and selling

(c) financial , for procuring Capital

(d) security , for protecting organizational resources

(e) Accounting, for maintaining account books

(f) Managerial, for planning and controlling.

Fayol

Fayol's 14 Principles of Management

(1) Division of work

(2) Authority and responsibility

(3) Discipline.

(4) unity of command

(5) unity of direction

(6) Subordination of interest

(7) Remuneration

(8) Centralization of authority

(9) Scalar chain

(10) Order.

(11) Equity

(12) Stability of tenure

(13) Initiative

(14) Esprit de Corps

(1) Division of Work — Works in an organization must be divided among the various employees based on their skills and talents. Division of work helps avoid wastage of time and effort.

(2) Authority and responsibility :- Authority is the power & right to take decisions and responsibility is the obligation for accepting authority. Hence, authority must be equal to responsibility for the successful completion of any task.

(3) Discipline :- It means obedience of the rules and regulations set by the organization and also following of orders and instructions given by superiors that must be followed for the successful completion of any work.

(4) unity of Command :- A subordinate should receive orders from only one superior. In turn, the subordinate should report only to one superior. This helps in smooth functioning of the organization.

(5) unity of direction :- Same directions should be given to all employees performing similar activities. In the absence of the unity of direction, there would be confusion among the employees.

(6) Subordination of interest :- Every employee of a group that of an employee should work in the interest of the organization and not for his/her own self-interest.

(7) Remuneration :- The wages and salaries must be fair and bring out the best possible commitment in the employees to achieve the organizational goals. Equal pay for equal work.

(8) Centralization of authority :- Fayol stated that certain matters are to be centralized and others to be decentralized. Authority is to be centralized when decision-making powers are retained at the top level.

(9) Scalar chain :- There should be a scalar chain of authority and communication, ranging from the highest to the lowest and reverse. Each communication going up or coming down must flow through each position in the line of authority.

(10) order :- This principle relates to the arrangement of things and people in the organization. Every-thing in the organization should be at the right place.

(11) Equity :- Equity means social justice. Fayol stressed that managers must exercise justice and kindness while dealing with their subordinates.

(12) Stability of tenure :- An employee should be given basic security of job which will allow sufficient time to the employee to settle down and successfully perform.

(13) Initiative ⁽¹⁵⁾ Managers should encourage their employees to take initiative to generate suggestions and ideas, think out the plan of action, and execute it. This raises the morale of the employees and gives them a sense of belonging to the organization.

(14) Esprit de Corps This means "Union of Strength". Supervisors must encourage team spirit among their subordinates. It is team spirit that results in loyalty, dedication, and commitment of the employees toward their departments and organization in general.

(1) Introduction - This report is about the

importance of the study and the objectives of the

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(2) Methodology - This report is about the

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Development of Industrial Engineering (History) ¹⁶

- What industrial engineering is today and aspires to be in future is determined by what has gone before.
- Industrial engineering had its roots in the industrial revolution (around 1750). It was enriched by various management scholars.
- Industrial revolution was the result of new inventions, majorly in the textile industry, later steam engine, advanced metal cutting and manufacturing of machine tools. These resulted in factories with large number of workers.
- Management thought began with the growth in the size of industries. The application of the scientific method of analysis, experimentation and practical demonstration had been extended to the production of machine tools, more complicated processes, and better products. Now it was being extended to man's thinking on organization and management principles and methods.
- Frederick Taylor came up with the philosophies of management and the concept of productivity. He was father of industrial engineering and scientific management.

→ In United States during nineteenth century the formal education of industrial engineering was introduced. Few people who instigated the studies of industrial engineering are,

(1) Frederick A. Halsey who is the father of the Halsey premium plan of wage payment.

(2) Henry L. Grantt who introduced Grantt charts.

(3) Henry R. Towne, Towne emphasized the economic aspects and responsibilities of the engineer's job in a paper that he presented to the ASME.

→ Frederick W. Taylor who was a mechanical engineer, his writings was the initiation in the stream of industrial engineering under the aegis of ASME.

He suggested much logical and planned methods to the problems of production and shop management. Further, he was also involved in research on metal cutting and the technical issues of production.

→ A highly significant era in the development of industrial engineering began after World War-II.

A great many new activities developed and the application of principles and techniques was vastly broadened.

The activities were:

- (1) Industrial Engineering and Computer.
- (2) Development of system analysis and design.
- (3) Application of mathematical and statistical tools.
- (4) Network planning techniques and their application.
- (5) Value Engineering
- (6) Behavioural Science and human factors.

Difference between Management and Organisation

Management

- (1) Management is defined as the process by which managers in an organization accomplish things through the efforts of other people in a grouped activities.
- (2) Management is a profession which helps the the individuals to perform every profession in a scientific manner.

Organization

- (1) Organisation is an identifiable group of people contributing their efforts towards the attainment of common goals.
- (2) Organisation is a structure which defines the relationships b/w individuals and positions in an organisation.

(3) It helps in attainment of goals through limited resources.

(4) It makes sure that organizational operations are carried out smoothly without any difficulty

(5) It is an art and science

(3) Strong and result oriented internal organization helps in growing and diversifying the business.

(4) It makes sure that all the resources are utilized in an optimum manner.

(5) It is not an art or science. It is a social group designed for attaining certain goals.

Difference between Administration, Organisation and Management

Administration

(1) It mainly deals with the formulation of corporate policy and coordination of all the functional areas

Organisation

(1) It is a social group created mainly for attaining specific objectives.

Management

(1) It is a process of developing and maintaining an environment in which individuals work together in groups for attaining the organizational objectives.

<p>(2) It deals with the objectives, policies of the organization</p>	<p>(2) It is a framework for management process</p>	<p>(2) It performs these policies for attaining the organizational objectives.</p>
<p>(3) It provides adequate direction and is considered as a directing function</p>	<p>(3) It is machinery for aligning the objectives of the company in a team spirit.</p>	<p>(3) It implements the policies so it is considered as an execution function.</p>
<p>(4) It is regarded as legislative and determinative</p>	<p>(4) It is a system</p>	<p>(4) It is regarded as an art and science.</p>
<p>(5) It does not require technical ability</p>	<p>(5) Organization also needs technical ability for its progress and development</p>	<p>(5) It needs technical ability for its effective functioning.</p>
<p>(6) It is not productive in nature</p>	<p>(6) It is productive in nature</p>	<p>(6) It is productive in nature</p>