

Session 5 - MECHANICAL ENGINEERING PROFILE, ITS IMPORTANCE AND APPLICATION

Definition of Industrial Engineering

- The formal definition of industrial engineering has been adopted by the Institute of Industrial Engineers (IIE):

“Industrial Engineering is concerned with the design, improvement, and installation of integrated systems of people, materials, information, 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 system”.

Scope

- The degree of industrial engineering is evidenced by the wide range of such activities as research in biotechnology, development of new concepts of information processing, design of automated factories, and operation of incentive wage plans.

Diversity

- Industrial engineering is a diverse (various) discipline concerned with the design, improvement, installation, and management of integrated systems of people, materials, and equipment for all kinds of manufacturing and service operations.
- Industrial engineering is concerned with performance measures and standards, research of new products and product applications, ways to improve use of scarce (limited) resources and many other problem solving adventures.
- An Industrial Engineer may be employed in almost any type of industry, business or institution, from retail establishments to manufacturing plants to government offices to hospitals.
- Because their skills can be used in almost any type of organization, and also industrial engineers are usually distributed among industries than other engineers.
- For example, industrial engineers work in insurance companies, banks, hospitals, retail organizations, airlines, government agencies, consulting firms, transportation, construction, public utilities, social service, electronics, personnel, sales, facilities design, manufacturing, processing, and warehousing.

Efficiency

- Industrial engineers determine the most effective ways for an organization to use the basic factors of production - people, machines, materials, and energy. They are more concerned with people and methods of business organization than engineers in other specialties.
- To solve organizational, production, and related problems most efficiently, industrial engineers design data processing systems and apply mathematical analysis such as operations research.
- They also develop management control systems to help in financial planning and cost analysis, design production planning and control systems to coordinate activities and control product quality, and design or improve systems for the physical distribution of goods and services.

- Industrial engineers conduct surveys to find plant locations with the best combination of raw materials, and transportation.
- They also develop wage and salary administration systems and job evaluation programs.

-Activities

- Install data processing, management information, wage incentive systems.
- Develop performance standards, job evaluation, and wage and salary programs.
- Research new products and product applications.
- Improve productivity through application of technology and human factors.
- Select operating processes and methods to do a task with proper tools and equipment
- Design facilities, management systems, operating procedures
- Improve planning and allocation of limited resources
- Enhance plant environment and quality of people's working life
- Evaluate reliability and quality performance
- Implement office systems, procedures, and policies
- Analyze complex business problems by operations research
- Conduct organization studies, plant location surveys, and system effectiveness studies
- Study potential markets for goods and services, raw material sources, labor supply, energy resources, financing, and taxes.

The evolution of the industrial and systems engineering profession has been affected significantly by a number of related developments.

Impact of Operations Research

- The development of industrial engineering has been greatly influenced by the impact of an analysis approach called operations research.
- This approach originated in England and the United States during 2nd World War and was aimed at solving difficult war-related problems through the use of science, mathematics, behavioral science, probability theory, and statistics.

Impact of Digital Computers

- Another development that had a significant impact on the IE profession is the digital computer. Digital computers permit the rapid and accurate handling of huge quantities of data, so permitting the IE to design systems for effectively managing and controlling large, complex operations.
- The digital computer also permits the IE to construct computer simulation models of manufacturing facilities in order to evaluate the effectiveness of alternative facility configurations.

Computer simulation is emerging most widely used IE technique. The development and widespread utilization of personal computers is having an exciting impact on the practice of industrial engineering.

Emergence of Service Industries

- In the early days of the industrial engineering profession, IE practice was applied almost fully in manufacturing organizations. After the 2nd World War there was a growing awareness that the principles and techniques of IE were also applicable in non-manufacturing environments.
- Thousands of Industrial Engineers are employed by government organizations to increase efficiency, reduce paperwork, design computerized management control systems, implement project management techniques, monitor the quality and reliability of vendor-supplied purchases, and for many other functions.

Industrial and Systems Engineering (I&SE) Design

- Industrial and systems engineers (I&SEs) design systems at two levels.
 - The first level is called **human activity systems** and is concerned with the physical workplace at which human activity occurs.
 - The second level is called **management control systems** and is concerned with procedures for planning, measuring, and controlling all activities within the organization.

Human Activity System

The human activity system within an organization consists of the following elements:

- The manufacturing process itself (or the processing procedures of a service organization)
- Materials and all other resources utilized in the production process.
- Machines and equipment.
- Methods by which workers perform tasks.
- Layout of facilities and specification of material flow.
- Material handling equipment and procedures.
- Workplace design.
- Storage space size and location.
- Data recording procedures for management reporting.
- Procedures for maintenance and housekeeping.
- Safety procedures.

Management Control System

The management control system of an organization consists of the following elements:

- Management planning system.
- Forecasting procedures.
- Budgeting and economic analyses.
- Wage and salary plans
- Incentive plans and other employee relations systems.
- Recruiting, training, and placement of employees.
- Materials requirement planning.
- Inventory control procedures.
- Production scheduling.
- Dispatching (sending out)
- Progress and status reporting.
- Corrective action procedures.

- Overall information system.
- Quality control system.
- Cost control and reduction
- Resource allocation.
- Organization design.
- Decision support systems.

Although the elements just described are expressed in manufacturing terminology, the framework is applicable to any system.

Production Operations

A. Related to Product or Service:

1. Analyze a proposed product or service.
 - Determine whether it would be profitable, at various production volumes.
 - Is it compatible (well-suited) with the existing product line?
 - Assess the manufacturability of the design, as prepared by the engineering design department.
 - Determine the best (most cost-effective) material utilization.
2. Constantly attempt to improve existing products or services.
3. Perform analyses relating to distribution of the product or delivery of the service.

B. Related to Process of manufacturing the product or producing the service:

- Determine the best process and method of manufacture.
- Select equipment; determine degree of automation, use of robots, and so on.
- Balance assembly lines.
- Determine the best material flow and material handling procedures and systems.

C. Related to Facilities:

- Determine the best layout of equipment.
- Determine the appropriate storage facilities for raw materials; work in process, and finished goods inventory.
- Determine appropriate preventive maintenance systems and procedures.
- Provide for appropriate inspection and test facilities.
- Provide sufficient utilities for the operation.
- Provide for security and emergency services.

D. Related to Work Methods and Standards:

- Perform work measurement studies; establish time standards and update them as required.
- Perform methods of improvement studies.
- Perform value engineering analyses, eliminating cost and waste to the maximum level possible.

E. Related to Production planning and control:

- Forecast the level of activity. (How many units will be sold)?
- Analyze the capacity and resource constraints.
- Perform operations planning:
- Perform inventory analysis:
- Perform materials requirement planning (MRP)
- Perform operations scheduling:
- Design the quality control system and inspection procedures.
- Design systems and procedures for shop floor control

Management Systems**A. Related to Information Systems:**

- Determine management information requirements:
 - Identify the decisions that are made by managers at all levels; specify timing of each decision.
 - Determine the specific data/information needed for each decision.
 - Identify the sources of each data element.
 - Determine the preferred form of data.
- Design the data base to support the information system:
 - Specify input formats from data sources.
- Design the management reports that will be produced:
- Perform data analyses, as required.
- Provide feedback to all levels of the organization.
- Develop and implement decision support systems.
- Analyze the requirements for data communications and computer networks.

B. Related to Financial and Cost Systems:

- Design a budgeting system.
- Perform a variety of engineering economy studies.
- Design, implement, & follow cost-reduction programs.
- Design procedures for systematically updating standard costs.
- Design systems for generating cost estimates for various purposes.
- Develop procedures for tracking and reporting cost data for management decision making.

C. Related to Personnel:

- Design procedures for employee testing, selection, and placement.
- Design training and education programs for personnel at all levels in the firm.
- Design and install job evaluation and wage incentive programs.
- Design effective labor relations programs and procedures.
- Apply the principles of ergonomics and human engineering to the design of jobs, workplaces, and the total work environment.
- Develop effective programs of job enhancement.
- Coordinate the activities of quality circle groups.
- Design, implement, and monitor effective safety programs.

Corporate Services

A. Comprehensive Planning:

- Design, implement, and monitor a multilevel planning system:
 - Specify mission of organization.
 - Identify key results areas.
 - Specify long-term goals.
 - Determine short-term objectives.
- Assist corporate management in performing strategic planning.
- Assist corporate management in rationalizing the firm's strategy in the international arena.
- Perform enterprise modeling:
- Develop a high-level "business model," in which the major data flows are mapped between the major corporate functions.
- Employ structured modeling methods to develop a hierarchical break down structure of the enterprise functions, sub-functions, and so on.
- Perform systems integration activities:
 - Determine interdependencies between functions.
 - Perform capacity analyses.
 - Participate in decisions relative to plant expansion and new plant setting.
 - Provide project management services:
 - Project definition and planning.
 - Work breakdown structures.
 - Network analysis.
 - Project tracking and follow-up.
 - Assist in implementing the concepts of total quality management through out the organization.
 - Provide leadership in resource management:
 - Provide investigative services regarding utilization of energy, water, and other resources.
 - Develop effective systems for the management of hazardous wastes, scrap, and other by-products.