Module-1

INTRODUCTION TO INDUSTRIAL ENGINEERING

BVCOENM - Vision & Mission

INSTITUTE

VISION: "Social transformation through dynamic education"

MISSION: To impart quality education to meet the needs of industry, profession and society; and to achieve excellence in teaching, learning and research.

DEPARTMENT

VISION: "To be recognized as leading mechanical engineering discipline by enhancing the knowledge and skills for the sustainable development."

MISSION:

Sociotechnological Skills: To educate students through various activities including technical education, research and social service.

Centre of Focus: To promote prevailing challenges based projects and activities for socio-economic development.

Competitiveness: To develop competency in graduates for their career development to sustain in challenging environment.

Content

1. History and contribution
2. Industrial engineering approach
3. Techniques of industrial engineering
4. Objectives of industrial engineering
5. System approach to industrial engineering
6. Definition and concept of productivity
7. Productivity measurements
8. Factors influencing productivity
9. Productivity improvement techniques.

Course Outcome

1. ***Illustrate the need for optimization of resources and its significance***
2. Develop ability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.
3. Demonstrate the concept of value analysis and its relevance.
4. Manage and implement different concepts involved in method study and understanding of work content in different situations.
5. Describe different aspects of work system design and facilities design pertinent to manufacturing industries.
6. Illustrate concepts of Agile manufacturing, Lean manufacturing and Flexible manufacturing

Industrial Engineering

- Industry is an organization or enterprise where things are produced/distributed in form of products and services
- There are three types of the industries;
  - one is the primary industry - it uses the natural resources for obtaining the goods, agricultural, mining
  - Second is the secondary industry – it use the output of primary industries to produce usable goods, bakery ,steel
  - Third is tertiary industry - their output is in form of the services they offer, transport, hospitals ,education, banking, insurance hospitality industries like hotels.
- The purpose of these industry is to produce more and more products and services at low cost and then these can easily be availed by the users or the society. For each type of the product and the services there are many-many producers. There are many-many industries and organizations. These organizations produce the products of the similar type.

Industrial Engineering

- Any industry involved in production or providing the goods or the services must be in position to provide the required output in the *desired quantity*, *desired quality* at the *low cost* and that too *on time*, so that the customers or the users of the product and services can effectively avail.
- Industrial engineering plays a central role in facilitating the production of the goods and services and their distribution so that the required quantity, quality, cost and the on time delivery of the goods and services can be facilitated

Industrial Engineering

- So what industrial engineering does basically for any organization or industry, which are having the different processes, procedures using the different resources in form of man, material, machine?
- IE - Analyze, Improve method/procedure to reduce waste and increase utilization of resources through optimization of processes by developing, improving and implementing an integrated system of resources, man, material, machines, money, energy, knowledge and information
- It is a **Multi-disciplinary approach** as it uses the science, maths, management, manufacturing, production, ergonomics, work-study and value analysis, engineering economy, financial analysis.

History and Contribution

- **A. Smith [1776]- Book on Wealth of Nations highlights the scientific manufacturing through**
  - **Division of labour - The people are having the different kinds of expertise, is to take the work more effectively so development of expertise as per the need of the work**
  - Skill Development - so that the people are able to take up the variety of jobs which are needed
  - Time saving - How to reduce the wastages and ineffective times
  - Specialized machines - Need of developing these which can give the more output at a high rate
- **James Watt [1864] - Developed the steam engine**
  - Mechanical power can effectively be used to increase the productivity

History and Contribution

- F. Taylor [1859-1945] – Initiated study on the work method and he proposed
  - Data collection - About the way by which work is being done so that it can be analyzed, analyzed for possible improvements in the process.
  - Standard for workers - standard output and wages for the better output with respect to the set standards . Also accordingly their efforts were acknowledged for the better, average and the poor performances.
  - Scientific training to the workers - so that they understand what is the importance of the scientific approach in undertaking the variety of jobs and the wastage of the resources in terms of the material, machine and the time can be reduced

History and Contribution

- F. Taylor [1859-1945] – Continue…
  - Cooperation between the management and workers - management takes care of the interest of the workers and the labour, and the workers do the jobs expected so that the more effective output can be realized and they work together for realizing the objectives and the goals of the organization
  - Divide the work of between the management and labour – For reducing the conflicts if there is a proper deviation of the work between the management and the labour.
  - Assignment of the work as for the competence- considering the ability of the workers, suitable work is assigned, so that they can really give the output effectively

History and Contribution

- H.L. Gantt [1893] -
  - Development of bonus plans - for those which those workers who were performing good.
  - Gantt chart - to see the kind of for effectively scheduling or giving the load to the different machines and workers for the utilization index of the resources (man and machine) and to know what is the status of any work, at any moment of time.
  - Social responsibilities of the businesses and in industries – To take care of the responsibilities of the things which are to be done by the society and for the society by the business and industrial entities
  - Advocated the need of training to the workers by the management - Time to time training of the worker is important to update their knowledge and their trainings are too updated with the development of the technology in different fields

History and Contribution

- Frank and Al Gilbreth [1917] - Especially worked on the work study related aspects
  - Method study – The method of working can be improved by work analysis so that if there is any ineffective element of work involved in existing procedure, then this can be eliminated.
  - Micro motion studies - Therbligs - Which help in breaking down the job into the very-very small elements to identify the presence of the productive and non-productive elements

History and Contribution

- H. Emerson [1913] –
  - Emerson's efficiency plan (bonus plan and incentive plan) - Those which are doing good, their efforts are acknowledged in form of the additional payments, while guaranteeing some basic payments to the workers
- Then L Tippet [1937] –
  - Work sampling method- This is basically the random sampling approach to identify the percentage utilization of the manpower or machine to set the performance standards for the workers and the machines.
- Once the performance standard is set, it would be possible to see that how much time a job will take and it can be used for capacity assessment. We know that in a one day or in one month, what is the volume that can be produced in a given setup. It can also be used it to see the kind of estimating the manpower or the machine requirement to satisfy a given target. So, once the capacity assessment is done, then if there is a fluctuating demands then to estimate what kind of manpower and machines will be needed in light of the set standard of performance.

Industrial Engineering Approach

- In general the idea of the industrial engineering to reduce the wastage of resources and increase the effective utilization
- And the purpose of both these is to
  - increase the productivity, so that the less resources, more output can be realized and
  - that in turn will be helping in to make the things increased quantity at low cost and hence the more and more the goods and services can be made available to the society, to the public
  - so that their standard of living can be enhanced
- But how these wastage can be reduced and the utilization can be enhanced so that there is the improvement of the productivity.
- For that there is a general approach which is used

Industrial Engineering Approach

- First, we collect the factual information about the existing things which are being done.
- We analyze and present the data in graphical form or in chart and form of charts and the models, and
- Then critical analysis is done to find out the productive and non-productive activities and which can be used to simplify the methods, to come up the new method or to modify the existing methods so that the non- productive elements and activities can be eliminated.
- And then we develop, out of the developed options in light of the constraints present, we try to choose the best option available so that it can improve the situation in more effective manner.

Industrial Engineering Approach

Collect data and analyze using Charts, Diagrams or Models

Critical Examination

Develop alternative options considering all the constraints (Internal & External)

Choose the best option for implementation based on criteria fixed for evaluation

Techniques of Industrial Engineering

Various tools and techniques available with the industrial engineering which can be used for optimum utilization of the resources, reducing the wastage and increasing the productivity, reducing the cost of the goods and services which are being produced.

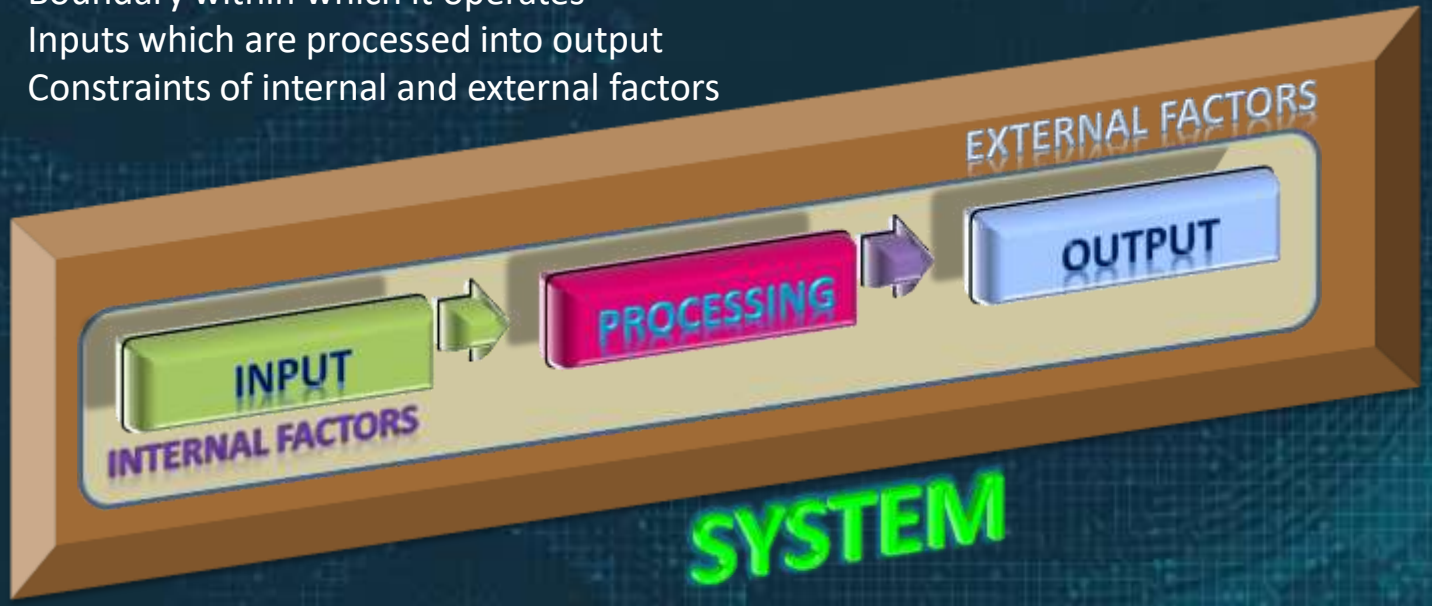
Work study- Method study, work measurement	**Job evaluation**
Motion economy	**Material handling analysis**
Financial & non financial incentives	**Human engineering**
Value analysis	**Operation research**
Production planning & control	**System analysis**
Inventory control	

Objectives of Industrial Engineering

- ***General Objectives of IE-***
  - Enhancing Productivity
  - Reducing/Eliminating Waste and Non-productive activities
  - Increasing and Effective utilization of resources
- ***Specific Objectives of IE-***
  - To improve and effectiveness of organization
  - Development of procedures for administration and operations
  - Designing Tool, Equipment, Work Method, Work Place
  - Development of performance standard and work measurement
  - Developing the vision & Mission of the organization and long range strategy

System Approach to Industrial Engineering

- System is
  - A collection of elements which are independent
  - It self independent to achieve objectives
- Characteristics of system: Every system has
  - Specific objectives to achieve
  - Boundary within which it operates
  - Inputs which are processed into output
  - Constraints of internal and external factors



System Approach to Industrial Engineering

- The industrial engineering, the most significant department in the industry, is generally compared to as the brain that directs the methods of working to nervous systems for the human being.
- IE, relies on system approach and therefore in solving the problems, instead of analyzing problem in isolation, at the subsystem level, an integrated view is considered including influencing factors, internal and external
- Industrial engineering system seen as a whole is composed of many subsystems.
- The subsystems are mutually interactive and closely connected to one another with their relations.
- The subsystems in the Industrial Engineering System are
  - Work Measurement (Time Study) Subsystem
  - Method Study Subsystem


Productivity

Definition of Productivity

- Productivity = Output of work /Input of resources
- Productivity is an attribute of mind
- It is being able to do better than yesterday and continuously
- It is an effort to apply new techniques and methods for continuous *PROGRESS*
- It is the concept that guides the production system
- It is an indicator of how well the factors of production that is land, capital, labour and energy are utilized to convert the raw materials into the final product

Productivity and Performance

Productivity	Performance
Output in relation to input	Considers the output alone
Basic definition of productivity is output/input	Performance index is given by actual work done/expected or standard work

Concept of Productivity

- How production is different from productivity:
  - Production is related to the activity of producing goods and services. It is the process of converting input to value added output
  - Productivity is related to the efficient utilization of input resources to produce output in the form of value-added goods or services.

Concept of Productivity

- Productivity & Engineering:
  - Engineering: Effective utilization of resources
    - Better standard of living
    - Availability of materialistic items
- Standard of living:
  - Needs:
    - Individual's responsibility
      - Food- energy requirement to do work
      - Cloth- to protect body
      - Shelter- stay comfortably
    - Government's responsibility- (Against paying)
      - Security- protection against ill health, old age, robbery, poverty
      - Essentials- medical care, drinking water, public transport etc.

Concept of Productivity

- Goods and Life:
  - Greater the availability of consumable goods better the standard of living
  - It can be achieved by:
    - Increasing employment
    - Increasing productivity
- Goods and Society:
  - Productivity and Agriculture- more quantity , cheaper food
  - Productivity of industry- more quantity, cheaper cloths and shelter
  - Overall increase in productivity- more security & essential services for public

Concept of Productivity

Productivity Measurements

Objectives of productivity measurement:

- To compare an organization with its competitors in the market
- To find out the relative performance of different employees, units and as well as department
- To compare relative benefits of different types of input according to their output

Productivity Measurements

1. Partial Productivity Measures (PPM)
2. Total Productivity Measures (TPM)
3. Total Factor Productivity Measures (TFP)
4. Multi Factor Productivity Measures (MFP)

Productivity Measurements: PPM

Partial Productivity Measures (PPM)

- Depending upon the individual input, Partial productivity measures are expressed as :
  - Partial productivity = (output)/(Individual input)
  - Labour productivity = (output)/(Labour input)
  - Capital productivity = (output)/(Capital input)
  - Material productivity = (output)/(Material input)
  - Energy productivity = Output / Energy input
- The major disadvantage of partial productivity measures is that there is an over emphasis on one input factor only to the extent that other inputs are underestimated
- partial productivity measure cannot represent the overall productivity of the firm

Productivity Measurements: TPM

Total Productivity Measures (TPM)

- Based on all input
- This model can be applied to any manufacturing organization or service sector company
- Total productivity = (Total Tangible Output)/(Total Tangible Input)
- **Total Tangible Output** = Value of finished goods produced + value of partial units produced + dividends from securities + interest+ other income
- **Total Tangible Input** = value of human + material +capital + energy + other inputs
- Note: Tangible here refers to measurable

Productivity Measurements: TPM

- Gives both firm level and detailed unit level index
- Helps to find out the performance and productivity of the organization or the operational unit
- Helps to plan, evaluate and control
- An important information to strategic planners regarding expansion or phasing out decisions

Productivity Measurements

Total Factor Productivity Measures (TFP)

- Labour and capital are always considered important contributors to the process of production
- Data is easy to obtain in TFP
- Does not consider the impact of material, energy, input even though material constitute 60% of the cost.
  Total Factor Productivity = (Net output) / (Labour + Capital input)

Productivity Measurements

Multi Factor Productivity Measures (MFP)

- MFP Model considers labour, material and energy as major inputs
- Capital is left out since it is very difficult to estimate how much capital is being consumed in a unit of time
- MFP = (Net output) / (Inputs (labour + energy + material))

Advantages & Limitations of Productivity Measures

Advantages	Limitations
Partial Productivity Measures:	
1. Easy to understand and calculate. 2. A tool to pinpoint improvement.	1. Misleading if used alone. 2. No consideration of overall impact.
Total productivity measures:	
1. Easy and more accurate representation of the total picture of the company 2. Easily related to total cost 3. Considers all quantifiable outputs and inputs	1. Difficulty in obtaining the data 2. Requirement of special data collection system
Total Factor productivity measures:	
1. data from company records is relatively easy to obtain 2. It is a value-added approach	1. No consideration for material and energy input 2. Difficult to relate it to the value-added approach to production efficiency

Productivity - Example

The following information regarding the output produced and inputs consumed for a particular company is given below.

- Output =Rs. 10,000
- Human input = Rs. 3,000
- Capital input = Rs. 3,000
- Material input = Rs. 2,000
- Energy input = Rs. 1,000
- Other miscellaneous inputs = Rs. 500

Compute the various productivity indices.

Productivity - Solution

1. Labour productivity = (Output)/(Labour input) = 10,000/3000 = $\mathbf{3.33}$
2. Capital productivity = (Output)/(Capital input) = 10,000/3000 = 3.33
3. Material productivity = (Output)/(Material input) = 10,000/2000 = 5.00
4. Energy productivity = (Output)/(Energy input) = 10,000/1000= 10.00
5. Other Misc. expenses = (Output)/(Other misc. input) = 10,000/500 = 20.00
6. Total Productivity = (Total output)/(Total input)
   = (10,000)/(3000+2000+3000+1000+500)
   = 10,000/9500=$\mathbf{1.053}$

Productivity - Example

- A wrapping paper company produced 2000 rolls of paper in a day. Standard price is $1 per roll, labour cost was $160, material cost was $50 and overhead cost was $320, determine the multifactor productivity.
- Multifactor productivity

  = Quantity produced at standard price /(Labor cost + Material cost + Overhead)

  = 2,000 rolls x $ 1 /($160+ $ 50 + $320)

  = 3.77

Productivity - Example

Long beach bank employs 3 loan officers, each working 8 hours per day. Each officer processes an average of 5 loans per day. The bank's payroll cost for the officers is $820 per day and there is a daily overhead expenses of $500.

- Compute the labour productivity
- Compute the multifactor productivity using loans per dollar cost as the measure.
- Solution :-
  - Labor productivity is simply the ratio of loans to labor-hours
    = Output/Input = 3 officers × 5 loans/day/3 officers × 8 hrs./day
    = 0.625 loans/labor-hr.
  - Multifactor productivity accounts for both labor cost and overhead:
    = Output (loans) /Input (labor cost + overhead)
    = 3 officers × 5 loans/day /$820 + $500
    = 0.0113 loans/$

Factors Influencing Productivity

Controllable or Internal factors

- ***Plant and Equipments:*** Availability and reduction of idle time
- ***Technology:*** Automation
- ***Work Methods:*** Improvement in the way of doing things

Uncontrollable or External factors

- ***Natural resources:*** Man power, land , raw material
- ***Government and Infrastructure:*** Rules and regulations, various policies
- ***Structural adjustments:*** Economic change, Social changes

Productivity Improvement Techniques

- Technology Based
- Employee Based
- Material Based
- Process Based
- Product Based
- Management Based

Productivity Improvement Techniques

Productivity Improvement Techniques

Technology Based

- Computer Aided Design (CAD) , Computer Aided Manufacturing (CAM) And Computer Integrated Manufacturing (CIM)
- Robotics
- Laser technology
- Modern maintenance techniques
- Energy technology
- Flexible technology
- Etc…

Productivity Improvement Techniques

Employee Based

- Financial and non-financial incentives
- Employees promotion
- Job design, job enrichment, job enlargement and job rotation
- Worker participation in decision making
- Quality circles (QC)
- Small group activities (SGA)

Productivity Improvement Techniques

Material Based

- Materials planning and control
- Purchasing
- Logistics of material flow
- Material storage and retrieval
- Source selection and procurement of good quality material
- Eliminate of waste

Productivity Improvement Techniques

Process Based

- Methods engineering and work simplification
- Job design, job evaluation, job safety
- Human factors in engineering (Ergonomics)

Productivity Improvement Techniques

Product Based

- Value analysis and value engineering
- Product diversification
- Standardization and simplification
- Reliability engineering
- Product mix and promotions

Productivity Improvement Techniques

Management Based

- Style of management
- Communication Channel in organization
- Work culture within the organisation
- Motivation
- Promoting group activity

University Questions

1. What are the different techniques of Industrial Engineering ?
2. What are the factors influencing productivity?
3. Short Note: Measures of Productivity
4. Define IE, State objectives of IE, Explain system approach to IE with suitable example.
5. Define productivity, Discuss the government, employers and employees in the productivity improvement.
6. Short Note: Productivity improvement techniques
7. Define productivity, why productivity is important in production management?
8. Short Note: Contribution of F. W. Taylor in IE
9. Define productivity, Explain Partial measures of productivity with suitable example.
10. How is system approach is useful in IE?
11. Define productivity, what are the different techniques to improve productivity?
12. Short Note: contribution of Frank Gilbreth
13. Describe the development of IE, what is scientific management, Explain the contribution of F. W. Taylor in the development of scientific management.
14. Define productivity, what are the factors influencing productivity of an enterprise?
15. What was the contribution of different researchers in IE?