References

2. Richard L. Francis, Facility Layout and Location.
OUTLINE

• Classification of Layout Problems
• Layout of a new Plant
• Revising and Improving Existing Layout
• Operational Analysis
• Weaknesses of a poor layout
A layout problem might arise because of:

- A change in the design of product,
- The addition or deletion of a product from a company’s product line,
- A significant increase or decrease in the demand for a product,
- Changes in the design of process,
- Replacement of one or more pieces of equipment,
• Adoption of new safety standards,

• Organizational changes,

• A decision to build a new plant, or

• Gradual changes over time developing bottlenecks in production, crowded conditions, delays, idle time, backtracking, poor housekeeping, excessive temporary storage space, obstacles to materials flow, failure to meet schedule etc.
Communication links among product, process, schedule and layout design
In addition, there may also exist a number of constraints on the solution:

- Local, state, and federal governmental restrictions on allowable air and noise pollution level,
- Standards concerning aisle widths, ventilation, temperature, lighting etc
- Building geometry,
- Building site and building construction in an existing building,
- Building site can restrict the shape of the building, and consequently, and
- Cost of relocating the existing facilities should be weighed with the advantages derived from the relocation.
Steps to consider in designing a plant layout:

1. **Procure the basic data**
   - The basic data to be obtained must be related to products, materials, manufacturing process, existing machines, production schedule, existing material storage and handling equipment, existing plant services, existing building and existing layout.
2. Analyze the product and production process
   • Consists of breaking down the product into sub-assemblies and the sub-assemblies into their individual parts.

3. Make or Buy parts decision
   • Factors considered for taking such a decision are: relative cost of both the alternatives, reliability of suppliers regarding quality and delivery, policy of the management regarding amount of capital to be invested.
4. Plan the material flow pattern

- Material flow pattern should be designed to ensure minimum movement in terms of distance and expenditure of time.

5. Consider general material handling plan

- A system should be designed to take care of all the activities necessary for handling the material, i.e. right from unloading of materials received from suppliers till the finally loading of finished goods on their way to customers.
6. Calculate equipment requirement

• Requirements, accurate and reliable data should be collected.

7. Plan individual work stations

• Each operation, process, etc. must be planned in detail and the inter-relationship between machines, operators, and auxiliary equipment must be worked out.

• Work stations should match the flow pattern of the material.
8. Select specific material handling equipment
   • Many factors should be considered.

9. Coordinate groups of related operations
   • Inter relationships between the work area is also planned while designing the individual operations or work areas.

10. Construct flow diagram for production centers
    • Flow diagram show to scale all machines, storage space, benches and other auxiliary equipment necessary for proper functioning of the particular department or production areas.
11. Plan service and auxiliary activities
   • Its necessary to inter-relate the supporting activities with production activities with respect to degree of closeness required by material, personnel and information flow.

12. Determine the space requirements

13. Allocate activity area and plot plan

14. Consider building types

15. Construct master layout
16. Seek opinions and suggestions

- The best layout can only be obtained with the cooperation of all persons who are involved in the process.

17. Evaluate, adjust and select the best layout

18. Check final layout

19. Obtain official approval

20. Installation of the layout

21. Follow-up the implementation of layout
LAYOUT OF A NEW PLANT

1. Select equipment on the basis of product design and expected volume of production
2. Collect layout data: machine data, machine load charts and templates of equipment
3. Develop process chart
4. Develop an overall flow plan of operations for processing and material handling
5. Select best suited type of building
6. Develop a tentative plot plan
7. Layout template or models of individual product machines according to flow-plan of operations

8. Layout templates and space for a service activities: materials handling, receiving and shipping, inspection, storage, maintenance, building services, offices and employees facilities

9. Develop building specifications to house the layout, and modify floor plan considering building limitation

10. Make a detailed layout drawing, plot plan drawing, and a layout model (if required)
11. Make a flow-process chart and flow-diagram to verify the attainment of the objectives of an efficient layout

12. Seek opinions and suggestions on these layout drawings and charts from specialist in various fields, and make modification if necessary

13. Seek management approval on final layout drawing

14. Construct plant and install equipments

15. Make a test run and adjust layout where required
• Layout changes are necessary due to various reasons including \textit{expansion}, for \textit{adopting technological improvements}, and \textit{changes in production method}. 
Expansion

• Growth of the plant should be properly planned, otherwise expansion will not be an orderly profitable growth.

• The firms whose future expansion is well planned, will be better organized, and will grow faster, and will enjoy lower operating costs.
Technological improvement

• Influence the operating industrial plant,
  1. Increasing mechanization
  2. Developments in fuel and energy
  3. Developments in processes
  4. Developments in materials
  5. Improvements in product design
  6. Developments in scientific management
Production method

• Plant productivity can be increased by adopting advanced production method:

1. Replacement or improvement of machinery
2. Improved material handling systems
3. Securing an effective workplace layout together with an efficient work cycle

   With a minimum of capital investment
REASONS FOR INEFFICIENT LAYOUT

1. Non qualified or un-experienced personnel when assigned with the task of layout

2. When layout revisions is delegated to various department head and foremen, each department makes whatever revisions it feels necessary.

3. A poor site for a particular plant may mean the inaccessibility to the street and rail lines, illogical arrangement of shipping and receiving facilities ...
4. When layout has no provision for future expansion

5. Due to poor judgment or inadequate forecast of future sales

6. The use of a building unsuited to the layout requirement also accounts for high production costs

7. Inefficient plant maintenance practices

8. When management fails to adopt farsighted equipment replacement programmes
REASONS FOR REDESIGN OF LAYOUT

1. Expansion of capacity
2. Shrinkage in output
3. Change in product design
4. Replacement of equipment
5. Poor working environment
6. To reduce material handling
7. Frequent accidents
8. Delay in process and idle time
9. Relocation of department
10. Backtracking and bottlenecks in material flow
11. Poor lighting, ventilating, heating, housekeeping facilities in the layout.
1. Determination of objectives to be achieved and scope of the study
2. All the data relevant to the present layout, equipment, and existing buildings must be collected before the work for re-layout is started
3. Cost details are collected
4. Analyze all the data on the present layout, study current problems with the help of:
   • Flow process chart analysis
   • Flow diagram analysis
   • Man-machine chart
   • Analysis of service activities

5. Examine feasibility of change
6. Develop the improved and revised layout that attains:
   • An improved flow diagram
   • An improved process chart
   • Improved productivity

7. Installed the new improved method
Plant services
PLANT SERVICES

Some of the important activities are:

- Receiving, storage/warehouse and shipping
- Tool crib
- Inspection
- Maintenance
- Employees facilities
- Administrative or offices
- Factory services or utilities, etc
Receiving

• Concerned with the orderly receipt of all materials and supplies coming into the factory and their proper storage and disposition.

• Main activities related to receiving
  i. Prompt and accurate processing of receipts
  ii. Plan location of goods
  iii. Unloading the good
iv. Maintain record of received material
v. Physical check materials against delivery documents
vi. Move the materials to the desired area
Layout of receiving

- The size and design of the receiving section vary with:
  i. Rate of production and capacity of production
  ii. Type of products
  iii. Plant layout
  iv. Receiving lot sizes
• The size and design of the receiving section vary with:

v. Characteristics of goods received including size, shape, weight, etc

vi. Quantity in each order

vii. Unloading method and time required

viii. Inspection requirement

ix. Market fluctuations, etc
Factors considered for receiving layout

1. Types of carrier
2. Climate/weather
3. Mechanization
4. Inspection
Shipping

• Concerned with the disposition of stock selected to fill orders, the packaging of items for shipment and loading them into the carrier for delivery.

• Main activities related to shipping
  
  i. Holding area in which items are placed awaiting packing and shipping
  
  ii. Packaging area
  
  iii. Space for carrying vehicles
Storage

- The objective of storage is to maintain ‘constant flow’, and to have inventory holding at an optimum level to prevent *over-stocking* or *under-stocking*.

- It’s necessary to have storages before production, between production stages and after production.
Types of store items

a) Raw materials
b) Spare parts
c) General supplies
d) Tools
e) Finished products
Storage requirements

• Stores should be suitably located so that load-distance must be minimized

• Size of the storage depends on a number of parameters and variables.

• Material characteristics

• Inventory profile, Cost parameter, storage method and storage system layout.
Storage location

i. Centralized store

- It is desirable to *centralize* the materials so that they may be brought under the control of a single storekeeper and store room should be as close as possible to the place where materials are to be used.

- If there are several manufacturing departments, the store room will be most conveniently situated, where it is *near to all departments*. 
Storage location

ii. Decentralized store

- In large factories, where there are several departments, each using different types of materials, it becomes beneficiary to separate stores.
Planning the stores layout

• A separate room adjacent to the store room should be kept for keeping the received material till it is accepted.

• It should enable to carry out functions of receipt, custody and issue of materials properly and effectively.

• Minimum handling of materials

• Optimum utilization of floor space and height

• Proper and well defined lanes of shelves, racks, bins etc. be provided
Planning the stores layout

• Sufficient spacing between two lanes of racks etc

• Protection facilities to prevent theft, pilferage, damage, deterioration and fire etc.

• Materials should be stored separately according to their characteristics like inflammable stores, tyres and other rubber items, cement, welding electrodes etc.

• Aisles should usually be 1.5 to 3 meters wide depending upon type of material.
Planning the stores layout

- Fast moving items should be stored near
- Layout should encourage the FIFO
- Sufficient space should be left for future expansion
- Adequate clear lighting arrangement should be made
- Adequate arrangement for safety provisions
Inspection in the Layout

• Receiving Inspection
  - Inspection of incoming materials and parts can be done either adjacent to the receiving area or the storage area.
  - Inspection area must be free from dirt, greases, vibrations, etc.
  - Properly illuminated and must have arrangements for humidity and temperature controls, where required.
• **Process inspection**
  - At the *end* of the department.
  - After those operations where there is a high probability of defects.
  - Before those operations where defective items would be subsequently involved in costly operations.
  - At those place in the process where succeeding operations would conceal the defect and make it costly to eradicate.
• Final inspection
  - Varies from a visual check to a through inspection employing numerous instruments and devices.
  - Finished products are functionally checked to assure that the assembly unit will perform as intended.
Maintenance in the layout

- *Centralized maintenance* repair shops must be provided for the repair and overhaul of machines, equipment and parts.

- General machine shops, welding etc may be included in the maintenance repair shop layout.

- For very large plant *decentralized maintenance* shop may be provided.
Employee facilities

• Organizational successes
  - efficient management, better planning, good market, efficient personnel, etc.,
  - the most important factors is the morale of the workers and their productivity.

• Comfort, convenience and safety of the employee must be under consideration.
• Facilities should be planned based on *employment procedure* being used and the *volume of employment*.

• The employment procedure usually consists of certain sets such as *filling of an application form, interview with the officer, physical and/or written tests, medical examination* before employment, *assignment of the employee to job, training or orientation to the work, counseling* the employee regarding his/her work, etc.
Personnel employment

- Should be located such that it be accessible for the main road, so that applicant can enter it without having to be processed through the protective systems, and reasonable accessible to the medical center for convenience in securing medical examination.
Lockers and washrooms and toilets

• The personal facility most frequently used by the employees.

• Well lighted and well ventilated so that the workers will not experience unpleasant sensation in them.

• Factory acts of all states provide for a minimum number of facilities, depending upon the number upon the workers.
• These facility can be placed in *populated work centers* but should be located to avoid disturbing the layout of production facilities.

• It’s advisable to locate locker room, washroom and toilet in *each division* of the plant rather than to provide one or two main facilities.

• It’s desirable to locate these facilities within **200 feet (61 meters)** of all workers.
• If the work is particularly dirty, the workers will require more time to wash or they will need to take a shower before leaving, for safety and health reasons, the required facility should be increased from 20 to 50 percent.

• Workers clothes quickly become soaked with perspiration and locker rooms soon become filled with very objectionable odor, should be well ventilated.
Medical services

- A productive worker must be kept in *good health*.
- Industrial medical services may be provided in the following situation:
  - Physical examination for job applicants and periodic check-up examination.
  - Emergency first-aid for minor injury or illness.
  - Professional medical services for major injury or illness.
  - Control of occupation diseases.
• In general it can be anticipated that 3 to 6% of the total plant force will be treated daily by the medical facility in an eight hour day.

• First aid facilities should be provided throughout a large plant to take care of very minor injuries scratches and abrasions and should be located within 200 to 300 feet' (61 to 91m) of all employees.
• The nature and time of occurrence and the treatment for every accident should be noted on permanent record, which can be passed over to the company’s doctor and personnel department.
## Guide lines for determining medical services

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Medical Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 25</td>
<td>One first aid station, at least two persons trained in first aid and a contract with a local doctor</td>
</tr>
<tr>
<td>25-100</td>
<td>2-3 first aid stations, 6 to 10 persons trained in first aid and a contract with a local doctor</td>
</tr>
<tr>
<td>101-200</td>
<td>One full time nurse and a nurse office equipped for routine examination and a complete first aid kit.</td>
</tr>
<tr>
<td>201-400</td>
<td>A full time nurse and half-time doctor, a complete equipped office for doctor, an examination room and an office or treatment room for the nurse.</td>
</tr>
<tr>
<td>401-600</td>
<td>A full time nurses and one full time doctor. The same equipment and facilities as in the case of 201-400 employees.</td>
</tr>
<tr>
<td>601-1000</td>
<td>Two full time nurses and one full time doctor, equipment for the doctor but two treatment rooms for the nurses</td>
</tr>
<tr>
<td>Over 1000</td>
<td>One doctor and two nurses for each 1000 employees.</td>
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</tbody>
</table>
• The layout man is concerned with the *number of people* on the medical staff only as it influence his layout planning.

• Medical authorities generally suggest a minimum of three rooms for a plant dispensary— a waiting room, a treatment room and an examination room or consultation room/office.

• The layout man must locate the facility properly.
Food services

• The company must provide or outsource the service.

• Tea and lunch time is a time not only for nourishment but also for recreation.

• The location of food services should be such that it is convenient to all the employees of the plant.

• It is important that the location be *centralized*, all employees will be able to reach the lunchroom, eat their meals and return to their work places without having to rush.
• Factors to be considered in determining the type and size of cafeteria suitable for a given plant are:

1. Proximity to outside lunchrooms and restaurants
2. Number of workers in each shift
3. Number of meals to be prepared
4. Length of lunch periods
5. Plant are available for catering use
6. Distribution of employees throughout the plant
Provisions of Factory Act

• **Ventilation and Temperature**
  - Effective and suitable provisions shall be made
  - Walls and roofs should be of such materials and so designed that temperature shall not be exceeded but kept as low as practicable.

• **Artificial humidification**

• **Overcrowding** - 14.2m³ must be provided for every worker.
• Lighting
  - Sufficient and suitable lighting where natural or artificial or both shall be maintained.
  - All glazed windows and skylight shall be clean.
  - Glare and formation of shadow should be prevented.

• Drinking water
  - Drinking water should be made available to all workers at all working hours and maintained at suitable points.

“DRINKING WATER”
• Precautions against fire

- Every factory shall be provided with means of escape,
- Doors affording exist from any room shall not be locked or fastened,
- Every window, door or other exit affording means of escape,
- Effective way of giving warning,
- Free passage way giving access to escape shall be maintained in case of fire.
In general...

- The proper location of essential facilities such as lockers, washrooms, toilets and medical service in reference to the work areas and the provision of sufficient amount of space for the will tend to prevent waste of time in their use.
Systematic Layout Planning

• Over the years, the most popular approach used in designing plant layouts has been the *Systematic Layout Planning* approach developed by Richard Muter.