7.0 PLANT LOCATION AND SITE SELECTON

The geographical location of the final plant can have strong influence on the success of the industrial venture. Considerable care must be exercised in selecting the plant site, and many different factors must be considered. Primarily the plant must be located where the minimum cost of production and distribution can be obtained but, other factors such as room for expansion and safe living conditions for plant operation as well as the surrounding community are also important. The location of the plant can also have a crucial effect on the profitability of a project. The choice of the final site should first be based on a complete survey of the advantages and disadvantages of various geographical areas and ultimately, on the advantages and disadvantages of the available real estate. The various principal factors that must be considered while selecting a suitable plant site, are briefly discussed in this section. The factors to be considered are:

1. Raw material availability.
2. Location (with respect to the marketing area.)
3. Availability of suitable land.
4. Transport facilities.
5. Availability of labors.
6. Availability of utilities (Water, Electricity).
7. Environmental impact and effluent disposal.
8. Local community considerations.
9. Climate.
10. Political strategic considerations.
11. Taxations and legal restrictions

(1) RAW MATERIALS AVAILABILITY:

The source of raw materials is one of the most important factors influencing the selection of a plant site. This is particularly true for the sulfuric acid plant because large volumes of sulfur is consumed in the process which will result in the reduction of the transportation and storage charges. Attention should be given to the purchased price of the raw materials, distance from the source of supply, freight and transportation expenses, availability and reliability of supply, purity of raw materials and storage requirements.

(1) LOCATION:

The location of markets or intermediate distribution centers affects the cost of product distribution and time required for shipping. Proximity to the major markets is an important consideration in the selection of the plant site, because the buyer usually finds advantageous to purchase from near-by sources. In case of sulfuric acid plant, the major consumers are fertilizer industries and hence the plant should be erected in close proximity to those units

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(2) AVAILABILITY OF SUITABLE LAND:

The characteristics of the land at the proposed plant site should be examined carefully.
The topography of the tract of land structure must be considered, since either or both may have a pronounced effect on the construction costs. The cost of the land is important, as well as local building costs and living conditions. Future changes may make it desirable or necessary to expand the plant facilities. The land should be ideally flat, well drained and have load-bearing

characteristics. A full site evaluation should be made to determine the need for piling or other special foundations.

(3) TRANSPORT:

The transport of materials and products to and from plant will be an overriding consideration in site selection. If practicable, a site should be selected so that it is close to at least two major forms of transport: road, rail, waterway or a seaport. Road transport is being increasingly used, and is suitable for local distribution from a central warehouse.
Rail transport will be cheaper for the long-distance transport. If possible the plant site should have access to all three types of transportation. There is usually need for convenient rail and air transportation facilities between the plant and the main company headquarters, and the effective transportation facilities for the plant personnel are necessary.

(4) AVAILABILITY OF LABOURS:

Labors will be needed for construction of the plant and its operation. Skilled construction workers will usually be brought in from outside the site, but there should be an adequate pool of unskilled labors available locally; and labors suitable for training to operate the plant. Skilled tradesmen will be needed for plant maintenance. Local trade union customs and restrictive practices will have to be considered when assessing the availability and suitability of the labors for recruitment and training.

(5) AVAILABILITY OF UTILITIES:

The word "utilities" is generally used for the ancillary services needed in the operation of any production process. These services will normally be supplied from a central facility and includes Water, Fuel and Electricity which are briefly described as follows:

(i) Water: -

The water is required for large industrial as well as general purposes, starting with water for cooling, washing, steam generation and as a raw material in the production of sulfuric acid. The plant therefore must be located where a dependable water supply is available namely lakes, rivers, wells, seas. If the water supply shows seasonal fluctuations, it's desirable to construct a reservoir or to drill several standby wells. The temperature, mineral content, slit and sand content, bacteriological content, and cost for supply and purification treatment must also be considered when choosing a water supply. Demineralized water, from which all the minerals have been removed is used where pure water is needed for the process use, in boiler feed. Natural and forced draft cooling towers are generally used to provide the cooling water require on site.

(ii) Electricity: -

Power and steam requirements are high in most industrial plants and fuel is ordinarily required to supply these utilities. Power, fuel and steam are required for running the various equipments like generators, motors, turbines, plant lightings and general use and thus be considered as one major factor is choice of plant site.

(6) ENVIRONMENTAL IMPACT AND EFFLUENT DISPOSAL:

Facilities must be provided for the effective disposal of the effluent without any public nuisance. In choosing a plant site, the permissible tolerance levels for various effluents should be

considered and attention should be given to potential requirements for additional waste treatment facilities. As all industrial processes produce waste products, full consideration must be given to the difficulties and coat of their disposal. The disposal of toxic and harmful effluents will be covered by local regulations, and the appropriate authorities must be consulted during the initial site survey to determine the standards that must be met.

(7) LOCAL COMMUNITY CONSIDERATIONS:

The proposed plant must fit in with and be acceptable to the local community. Full consideration must be given to the safe location of the plant so that it does not impose a significant additional risk to the community.

(8) CLIMATE

Adverse climatic conditions at site will increase costs. Extremes of low temperatures will require the provision of additional insulation and special heating for equipment and piping. Similarly, excessive humidity and hot temperatures pose serious problems and must be considered for selecting a site for the plant. Stronger structures will be needed at locations subject to high wind loads or earthquakes.

(9) POLITICAL AND STRATEGIC CONSIDERATIONS

Capital grants, tax concessions, and other inducements are often given by governments to direct new investment to preferred locations; such as areas of high unemployment. The availability of such grants can be the overriding consideration in site selection.

(10) TAXATION AND LEGAL RESTRICTIONS:

State and local tax rates on property income, unemployment insurance, and similar items vary from one location to another. Similarly, local regulations on zoning, building codes, nuisance aspects and others facilities can have a major influence on the final choice of the plant site.

7.1 PLANT LAY OUT

After the flow process diagrams are completed and before detailed piping, structural and electrical design can begin, the layout of process units in a plant and the equipment within these process unit must be planned. This layout can play an important part in determining construction and manufacturing costs, and thus must be planned carefully with attention being given to future problems that may arise.

Thus the economic construction and efficient operation of a process unit will depend on how well the plant and equipment specified on the process flow sheet is laid out. The principal factors that are considered are listed below:

1. Economic considerations: construction and operating costs.
2. Process requirements.
3. Convenience of operation.
4. Convenience of maintenance.
5. Health and Safety considerations.
6. Future plant expansion.
7. Modular construction.
8. Waste disposal requirements

(i) COSTS:

The coat of construction can be minimized by adopting a layout that gives the shortest run of connecting pipe between equipment, and least amount of structural steel work.
However, this will not necessarily be the best arrangement for operation and maintenance.

(ii) PROCESS REQUIREMENTS:

An example of the need to take into account process consideration is the need to elevate the base of columns to provide the necessary net positive suction head to a pump.

(iii) CONVENIENCE OF OPERATION:

Equipment that needs to have frequent attention should be located convenient to the control room. Valves, sample points, and instruments should be located at convenient positions and heights. Sufficient working space and headroom must be provided to allow easy access to equipment.

(iv) CONVENIENCE OF MAINTENANCE:

Heat exchangers need to be sited so that the tube bundles can be easily withdrawn for cleaning and tube replacement. Vessels that require frequent replacement of catalyst or packing should be located on the outside of buildings. Equipment that requires dismantling for maintenance, such as compressors and large pumps, should be places under cover.

(v) HEALTH AND SAFETY CONSIDERATIONS:

Blast walls may be needed to isolate potentially hazardous equipment, and confine the effects of an explosion. At least two escape routes for operators must be provided from each level in process buildings.

(vi) FUTURE PLANT EXPANSION:

Equipment should be located so that it can be conveniently tied in with any future expansion of the process. Space should be left on pipe alleys for future needs, and service pipes over-sized to allow for future requirements.

(vii) MODULAR CONSTRUCTION:

In recent years there has been a move to assemble sections of plant at the plant manufacturer's site. These modules will include the equipment, structural steel, piping and instrumentation. The modules are then transported to the plant site, by road or sea.
The advantages of modular construction are:
1. Improved quality control.
2. Reduced construction cost.
3. Less need for skilled labors on site.

The disadvantages of modular construction are:
1. Higher design costs & more structural steel work.
2. More flanged constructions & possible problems with assembly, on site.

7.2 THE PLANT LAYOUT KEYWORDS

1. Raw material Storage

2. Maintenance Workshop
3. Process Site
4. Stores for maintenance and operating supplies
5. Product Storage
6. Canteen & Change house
7. Fire Station and Fire Brigade
7. Central Control Room
8. Security office
9. Administrative Building
10. Site for Expansion project
11. Effluent treatment plant
12. Power house
13. Emergency water storage
14. Plant utilities
15. Vehicle parking space
16. Library and Laboratories
17. Training Centre
18. Research and Development Centre
19. Green Belt Area

A detailed plant layout is drawn and submitted with this thesis report. This plant layout is just a reference plant layout. There may be a lot of changes in actual plant layout.

7.3 FACILITY LAYOUT

A facility layout is an arrangement of everything needed for production of goods or delivery of services. A facility is an entity that facilitates the performance of any job. It may be a machine tool, a work center, a manufacturing cell, a machine shop, a department, a warehouse, etc.

The layout design generally depends on the products variety and the production volumes. Four types of organization are referred to, namely fixed product layout, process layout, product layout and cellular layout.

7.3.1 FACILITY LAYOUT PLANNING

INTRODUCTION.

Plant layout planning includes decisions regarding the physical allocation of the economic activity centers in a facility. An economic activity center is any entity occupying space.

- ❑ The objective of plant layout planning is a more effective work flow at the facility, allowing workers and equipment being more productive.

- Facility layout techniques apply to the case where several physical means have to be located in a certain area, either industrial processes or services.
- The objective of this topic is not only Plant layout but re-layout also (most common situation for a company).
- To carry out an appropriate plant layout, it's important to take into account the business strategic and tactical objectives

- To make a decision about layout planning, 4 different questions must have an answer:
  - **Which centers do we have to consider?**
  - **How much space and capacity is required for each center?**
    (1) If there is not enough space, productivity may be reduced.
    (2) Too much space is expensive and may also reduce productivity.
  - **How must the space be configured at each center?**
    (1) Space quantity, shape and the elements of the work center are related to each other.
  - **Where should each center be located at within the facility?**
    (1) The allocation of the different centers may affect productivity.
- The plant layout process starts at an aggregate level, taking into account the different departments. As soon as we get into the details, the different issues arise, and the original configuration may be changed through a feedback process.
- Most (if not all of them) layouts are designed properly for the initial conditions of the business, although as long as the company grows and has to be adapted to internal and external changes, a re-layout is necessary.

  - The reasons for a re-layout are based on 3 types of changes.
  - Changes in production volumes.
  - Changes in processes and technology.
  - Changes in the product.

The frequency of the re-layout will depend on the requirements of the process.

(i) Symptoms that allow us to detect the need for a re-layout:

- Congestion and bad utilization of space.
- Excessive stock in process at the facility.
- Long distances in the work flow process.
- Simultaneous bottle necks and workstations with idle time.
- Qualified workers carrying out too many simple operations.
- Labor anxiety and discomfort. Accidents at the facility.
- Difficulty in controlling operations and personnel.

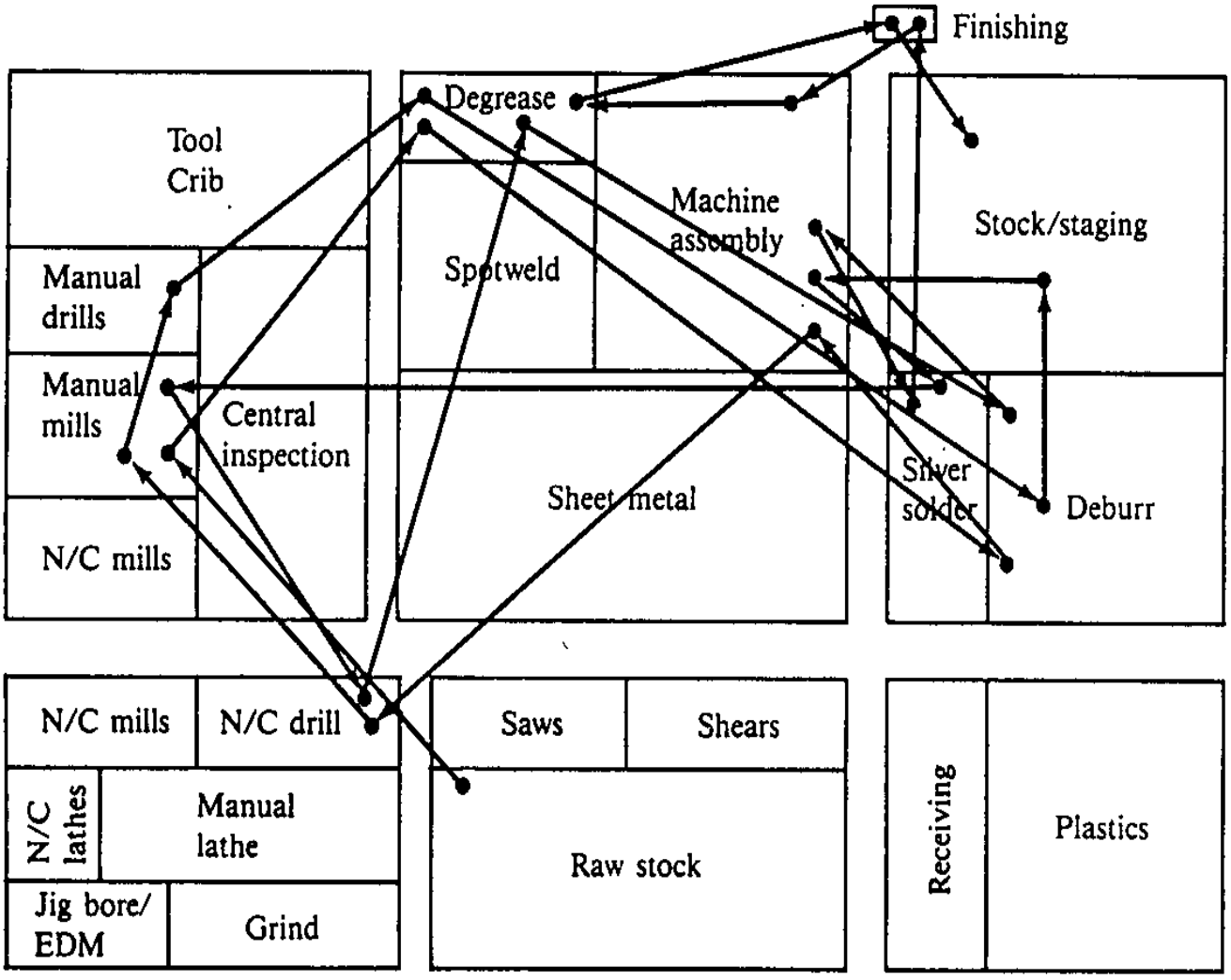
Finishing
Degrease
Tool Crib
Machine assembly
Stock/staging
Manual drills
Spotweld
Manual mills
Central inspection
Sheet metal
Silver solder
Deburr
N/C mills
N/C mills
N/C drill
Saws
Shears
N/C lathes
Manual lathe
Raw stock
Receiving
Plastics
Jig bore/ EDM
Grind

Fig. 5

7.3.2 OBJECTIVES OF PLANT LAYOUT.

The main objective consists of organizing equipment and working areas in the most efficient way, and at the same time satisfactory and safe for the personnel doing the work.

- Sense of Unity
- The feeling of being a unit pursuing the same objective.
- Minimum Movement of people, material and resources.
- Safety
- In the movement of materials and personnel work flow.
- Flexibility

❑ In designing the plant layout taking into account the changes over short and medium terms in the production process and manufacturing volumes.

These main objectives are reached through the attainment of the following facts:

(ii) Congestion reduction.
(iii) Elimination of unnecessary occupied areas.
(iv) Reduction of administrative and indirect work.
(v) Improvement on control and supervision.
(vi) Better adjustment to changing conditions.
(vii) Better utilization of the workforce, equipment and services.
(viii) Reduction of material handling activities and stock in process.
(ix) Reduction on parts and quality risks.
(x) Reduction on health risks and increase on workers safety.
(xi) Moral and workers satisfaction increase.
(xii) Reduction on delays and manufacturing time, as well as increase in production capacity.

(i) All these factors will not be reached simultaneously, so the best solution will be a balance among them.

7.3.3 FACTORS AFFECTING PLANT LAYOUT.

■ The final solution for a Plant Layout has to take into account a balance among the characteristics and considerations of all factors affecting plant layout, in order to get the maximum advantages.

The factors affecting plant layout can be grouped into 8 categories:

(I) Materials
(II) Machinery
(III) Labor
(IV) Material Handling
(V) Waiting Time
(VI) Auxiliary Services
(VII) The building

(VIII) Future Changes

(I) Materials

- The layout of the productive equipment will depend on the characteristics of the product to be managed at the facility, as well as the different parts and materials to work on.
- Main factors to be considered: size, shape, volume, weight, and the physical-chemical characteristics, since they influence the manufacturing methods and storage and material handling processes.
- The sequence and order of the operations will affect plant layout as well, taking into account the variety and quantity to produce.

(II) Machinery

- **H**aving information about the processes, machinery, tools and necessary equipment, as well as their use and requirements is essential to design a correct layout.
- The methods and time studies to improve the processes are closely linked to the plant layout.
- Regarding machinery, we have to consider the type, total available for each type, as well as type and quantity of tools and equipment.
- It's essential as well to know about space required, shape, height, weight, quantity and type of workers required, risks for the personnel, requirements of auxiliary services, etc.

(III) Labour

- Labor has to be organized in the production process (direct labor, supervision and
- Environment considerations: employees' safety, light conditions, ventilation, temperature, noise, etc.
- Process considerations: personnel qualifications, flexibility, number of workers required at a given time as well as the type of work to be performed by them.

(iv) Material - Handling

- Material handling does not add value to the product; it's just waste.
- Objective: Minimize material handling as well as combining with other operations when possible, eliminating unnecessary and costly movements.
- The factors affecting plant layout can be grouped into 8 categories:

(i) Waiting time - Stock

- Objective: Continuous Material Flow through the facility, avoiding the cost of waiting time and demurrages that happen when the flow stops.
- On the other hand, the material waiting to flow through the facility not always represents a cost to avoid. As stock sometimes provides safety to protect production, improving customer service, allowing more economic batches, etc.
- It's necessary then to consider space for the required stock at the facility when designing the layout.
- Resting time to cool down or heating up…

(V) Auxiliary Services

- Support the main production activities at the plant:
- Related to labor: Accessibility paths, fire protection installations, supervision, safety, etc.
- Related to material: quality control.
- Related to machinery: maintenance and electrical and water lines.
- The auxiliary services represent around 30% of the space at a facility.
- The space dedicated to auxiliary services is usually considered as waste.
- It's important to have efficient services to insure that their indirect costs have been minimized.

(VI) The building

- If it has been already selected, its characteristics will be a constraint at the moment of designing the layout, which is different if the building has to be built.

(VI) Future changes

- It's important to forecast the future changes to avoid having an inefficient plant layout in a short term.
- Flexibility can be reached keeping the original layout as free as possible regarding fixed characteristics, allowing the adjustment to emergencies and variations of the normal process activities.
- Possible future extensions of the facility must be taken into account, as well as the feasibility of production during re-layout.

7.3.4 TYPES OF PLANT LAYOUT.

- The production process normally determines the type of plant layout to be applied to the facility:

(I) Fixed position plant layout: Product stays and resources move to it.

(1) Product oriented plant layout: Machinery and Materials are placed following the product path.

(2) Process oriented plant layout (Functional Layout): Machinery is placed according to what they do and materials go to them.

(3) Cell Layout: Hybrid Layout that tries to take advantage of different layouts types.

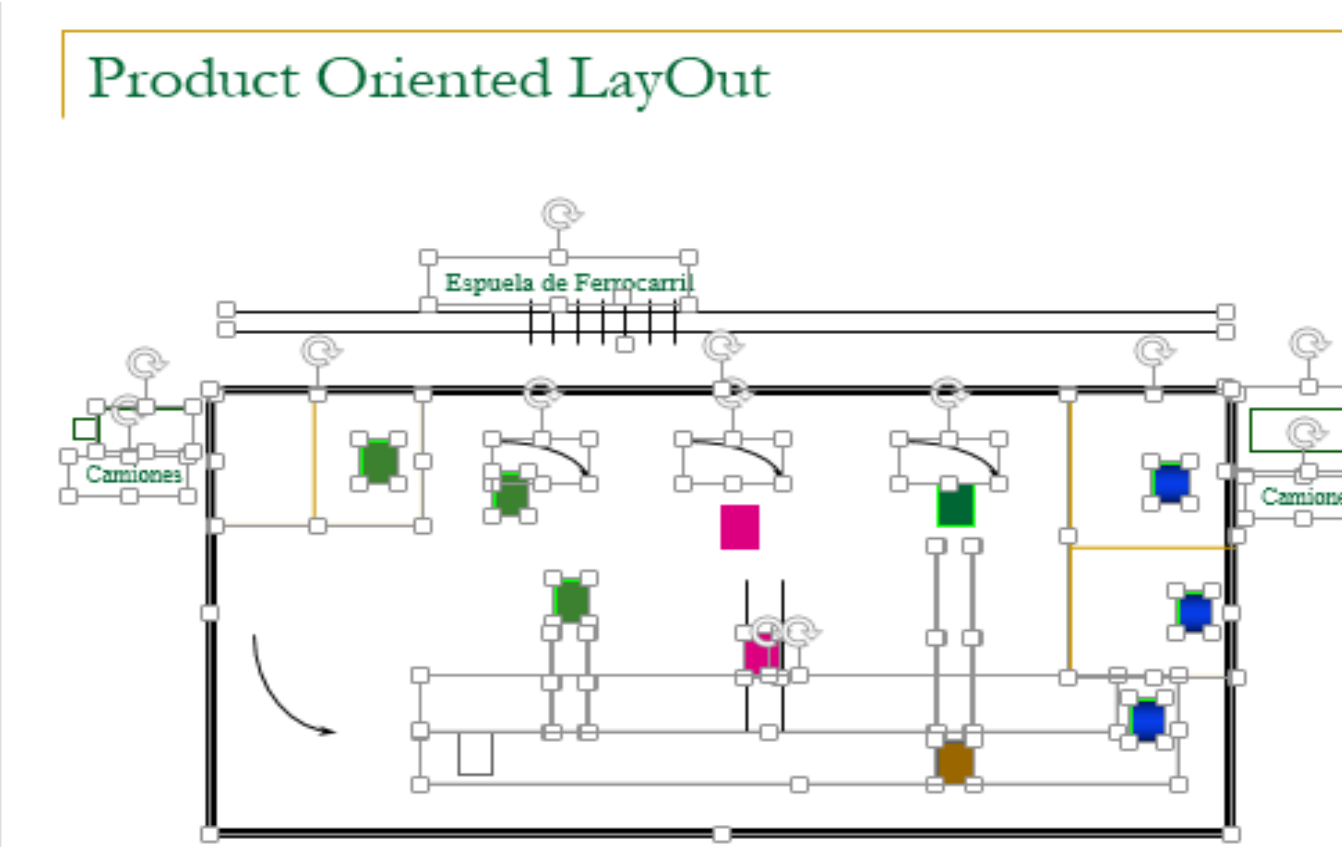

Fig. 6 Product oriented plant layout

- **Product oriented plant layout**
  - This type of plant layout is useful when the production process is organized in a continuous or repetitive way.

Continuous flow: The correct operations flow is reached through the layout design and the equipment and machinery specifications.

Repetitive flow (assembly line): The correct operations flow will be based in a line balancing exercise, in order to avoid problems generated by bottle necks.

  - The plant layout will be based in allocating a machine as close as possible to the next one in line, in the correct sequence to manufacture the product.

Advantages:

(ii) Reduced material handling activities.
(iii)Work In Process almost eliminated.
(iv)Minimum manufacturing time.
(v) Simplification of the production planning and control systems.
(vi)Tasks simplification.

Disadvantages:

(i) No flexibility in the production process.
(ii) Low flexibility in the manufacturing times.

(iii)High capital investment.
(iv)Every workstation is critical to the process.- The lack of personnel or shut down of a machine stops the whole process.
(v) Monotonous work.

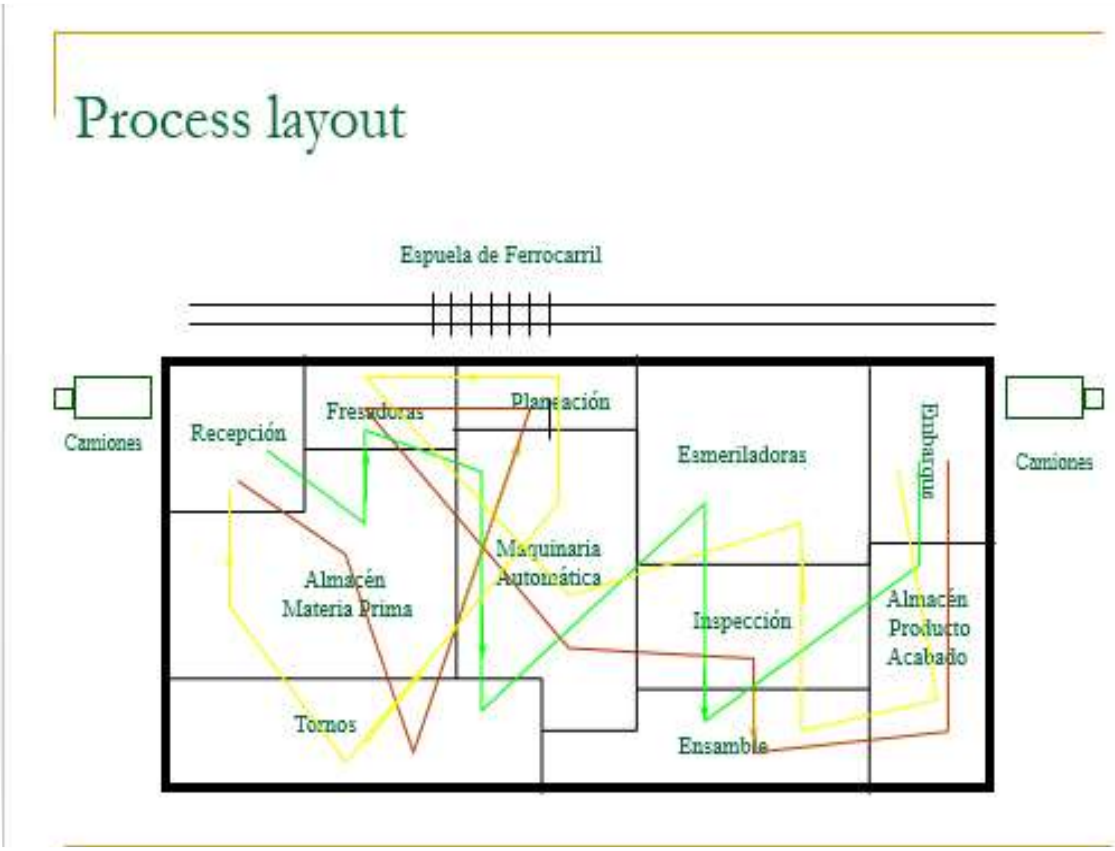

Fig. 7 Process oriented plant layout

Process oriented plant layout
Analysis
Process:
Information gathering.
Plan development.
Quantitative criteria: transportation costs.
Qualitative criteria: closeness priorities.

(i). Information gathering
We have to know the space requirements by working area.

- Demand forecast – production plan – working hours – number of workers and equipment. Consider demand and production fluctuations

- Plant layout planning includes decisions regarding the physical allocation of the economic activity centers in a facility.
- An economic activity center is any entity occupying space.
- The objective of plant layout planning is a more effective work flow at the facility, allowing workers and equipment being more productive.
- Facility layout techniques apply to the case where several physical means have to be located in a certain area, either industrial processes or services.
- The objective of the chapter is not only Plant layout but re-layout also (most common situation for a company).
- To carry out an appropriate plant layout, it's important to take into account the business strategic and tactical objectives
- Example: space requirements/cost per m2 in Malls; accessibility/privacy in offices.
- To make a decision about layout planning, 4 different questions must have an answer:
- The plant layout process starts at an aggregate level, taking into account the different departments. As soon as we get into the details, the different issues arise, and the original configuration may be changed through a feedback process.
- Most (if not all of them) layouts are designed properly for the initial conditions of the business, although as long as the company grows and has to be adapted to internal and external changes, a re-layout is necessary.

Process oriented plant layout (Functional Layout)

This type of plant layout is useful when:

- the production process is organized in batches. The personnel and equipment to perform the same function are allocated in the same area,
- the different items have to move from one area to another one, according to the sequence of operations previously established.t
- the variety of products to produce will lead to a diversity of flows through the facility.
- the variations in the production volumes from one period to the next one (short periods of time) may lead to modifications in the manufactured quantities as well as the types of products to be produced.

The reasons for a re-layout are based on 3 types of changes:

- Changes in production volumes.
- Changes in processes and technology.
- Changes in the product.

The frequency of the re-layout will depend on the requirements of the process.

Symptoms that allow us to detect the need for a re-layout:

- Congestion and bad utilization of space.
- Excessive stock in process at the facility.
- Long distances in the work flow process.
- Simultaneous bottle necks and workstations with idle time.
- Qualified workers carrying out too many simple operations.
- Labor anxiety and discomfort. Accidents at the facility.

- Difficulty in controlling operations and personnel.