

# Technical Guide On “Factory Layout Planning”



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## Table of Contents:

<b>1</b>	<b>Disclaimer:</b> .....	<b>3</b>
<b>1.1</b>	<b>Introduction to SMEDA:</b> .....	<b>4</b>
<b>1.2</b>	<b>Industry Support Program</b> .....	<b>4</b>
<b>4.</b>	<b>Objectives of Factory Layout Planning?</b> .....	<b>5</b>
<b>5.</b>	<b>Types of Plant Layout:</b> .....	<b>5</b>
<b>5.1.</b>	<b>Process / Functional / Job shop Layout:</b> .....	<b>6</b>
<b>5.1.1.)</b>	<b>Advantages of Process / Functional / Job shop Layout:</b> .....	<b>6</b>
<b>5.1.2.)</b>	<b>Disadvantages of Process / Functional / Job shop Layout:</b> .....	<b>6</b>
<b>5.2.</b>	<b>Product / Line Processing / Flow Line Layout:</b> .....	<b>6</b>
<b>5.2.1.)</b>	<b>Advantages of Product / Line Processing / Flow Line Layout:</b> .....	<b>7</b>
<b>5.2.2.)</b>	<b>Disadvantages of Product / Line Processing / Flow Line Layout:</b> .....	<b>7</b>
<b>5.3.</b>	<b>Fixed Position / Static Layout:</b> .....	<b>7</b>
<b>5.3.1.)</b>	<b>Advantages of Fixed Position Layout:</b> .....	<b>8</b>
<b>5.3.2.)</b>	<b>Disadvantages of Fixed Position Layout:</b> .....	<b>8</b>
<b>5.4.</b>	<b>Combined / Hybrid Layout:</b> .....	<b>8</b>
<b>5.4.1.)</b>	<b>Advantages of Combined/Hybrid Layout:</b> .....	<b>9</b>
<b>5.4.2.)</b>	<b>Disadvantages of Combined/Hybrid Layout:</b> .....	<b>9</b>
<b>5.5.</b>	<b>Cellular Manufacturing Layout:</b> .....	<b>9</b>
<b>5.5.1.)</b>	<b>Advantages of Cellular Manufacturing Layout:</b> .....	<b>9</b>
<b>5.5.2.)</b>	<b>Disadvantages of Cellular Manufacturing Layout:</b> .....	<b>9</b>
<b>6.</b>	<b>Factors Affecting Factory Layout:</b> .....	<b>10</b>
<b>7.</b>	<b>Layout Planning Process Steps:</b> .....	<b>12</b>
<b>8.</b>	<b>Optimizing Factory Layout Design For Increased Productivity:</b> .....	<b>14</b>

## **1 Disclaimer:**

This information memorandum is to introduce the subject matter and provide a general idea and information on the said matter. Although, the material included in this document is based on data/information gathered from various reliable sources; however, it is based upon certain assumptions, which may differ from case to case. The information has been provided on AS IS WHERE IS basis without any warranties or assertions as to the correctness or soundness thereof. Although, due care and diligence has been taken to compile this document, the contained information may vary due to any change in any of the concerned factors, and the actual results may differ substantially from the presented information. SMEDA, its employees or agents do not assume any liability for any financial or other loss resulting from this memorandum in consequence of undertaking this activity. The contained information does not preclude any further professional advice. The prospective user of this memorandum is encouraged to carry out additional diligence and gather any information which is necessary for making an informed decision; including taking professional advice from a qualified consultant/technical expert before taking any decision to act upon the information.

## **1.1 Introduction to SMEDA:**

The Small and Medium Enterprises Development Authority (SMEDA) was established in October 1998 with an objective to provide fresh impetus to the economy through development of Small and Medium Enterprises (SMEs).

With a mission "to assist in Employment Generation and Value Addition to the national income, through development of SME sectors, by helping increase the number, scale and competitiveness of SMEs", SMEDA has carried out 'sectoral research' to identify Policy, Access to Finance, Business Development Services, strategic initiatives and institutional collaboration & networking initiatives.

Preparation and dissemination of prefeasibility studies in key areas of investment has been a successful hallmark of SME facilitation by SMEDA.

Concurrent to the prefeasibility studies, a broad spectrum of Business Development Services is also offered to the SMEs by SMEDA. These services include identification of experts and consultants and delivery of need-based capacity building programs of different types in addition to business guidance through help desk services.

For more information on services offered by SMEDA, please contact our website: [www.smeda.org](http://www.smeda.org)

## **1.2 Industry Support Program**

In order to enhance competitiveness of SMEs and achieve operational excellence, SMEDA established an Industry Support Cell (ISC) for provision of foreign technical support and knowledge transfer in collaboration with International Development Organizations. SMEDA's Industry Support Program (ISP) initially launched with Japan International Cooperation Agency (JICA) and actively engaged in reducing energy inefficiencies and improving production and quality of products with the support of Japanese Experts. Later on, similar activities with other international partner organizations like German Corporation for International Cooperation (GIZ), Training and Development Centers of the Bavarian Employers' Association (bfz), Germany, and United Nations Industrial Development Organization (UNIDO) were also successfully implemented

## 2. What is a Factory?

A factory is defined as an industrial site filled with machinery, where workers manufacture items by operating machines.

## 3. What is Factory Layout Planning?

Bad layout results in wasting of time, energy and valuable resources. In a manufacturing concern “**layout planning**” is described as the plan for the **most critical parts** produced in the new/existing facility. It is the top physical arrangement of all resources that consume space within a facility. Layout planning is done in order to facilitate expansion in the facility due to space constraints or shifting to any new facility.

**In parts manufacturing industry almost 80% of quality and productivity is decided in layout planning stage.** This guide will help to improve layout planning not only in new facility but also assist in the existing factory layout.

## 4. Objectives of Factory Layout Planning?

The factory layout planning should be done keeping in mind the following objectives.

1. Optimum utilization of man, machine, materials and available space.
2. Reducing handling/travel/motion of man and materials.
3. Sequenced process flow in forward direction towards process completion.
4. Reducing delays, bottlenecks and maintaining flexibility in the production system.
5. Minimizing W.I.P. (work in process) inventory.
6. Make problems visible by utilizing visual control in production & operations.
7. Flexibility to incorporate future developments i.e. increase in Production & New designs handling provision.
8. Disaster prevention measures like Fire Safety, Earthquake, accidents & theft prevention measures.
9. Corporate social responsibility activities for surrounding areas and society.
10. Proper lighting & ventilation of workspace. Thus overall satisfaction to all concerned.
11. High Quality, High Productivity, Lowest Cost to compete in the market.

## 5. Types of Plant Layout:

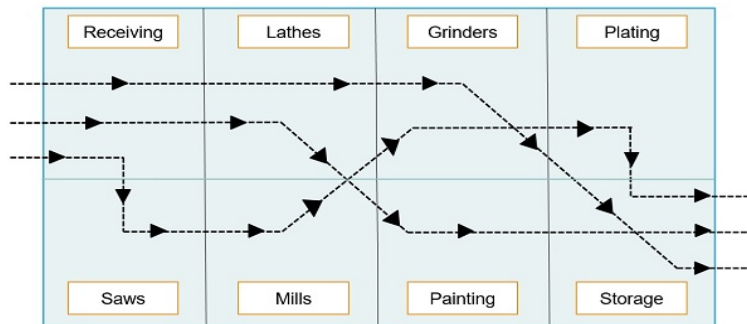
The organization may decide and select the type of plant layouts based on the type of industry, nature of the product, the size of the company, volume of production and predictable future production plan. The following are the major types of plant layout:

1. Process layout/ functional layout/ job shop layout.
2. Product layout/ line processing layout/ flow line layout.
3. Fixed-position layout/ static layout.
4. Combination layout/ hybrid layout.

## 5. Cellular manufacturing layout

### 5.1. Process / Functional / Job shop Layout:

In **Process/Functional/Job shop layout** is a design by arranging machines and equipment according to its function. Refer to **figure # 1**, similar operations / machinery in each department are assembled together (for example, a stamping department, a machining department, plating department etc.) and machines are not arranged according to a particular production sequence.



*Figure 1: Example of Process/ Functional/Job shop Layout*

#### 5.1.1.) Advantages of Process / Functional / Job shop Layout:

- Lower initial capital investment
- The optimum level of degree of machine use.
- Breakdown of one machine does not affect the entire production process.

#### 5.1.2.) Disadvantages of Process / Functional / Job shop Layout:

- More floor space is required
- Better coordination and planning is required

### 5.2. Product / Line Processing / Flow Line Layout:

In the **Product/ Line Processing/ Flow Line** layout machines are organized according to the sequence of operations of the product where an only a single type of products is produced in an operating area. This type of layout is suitable for standardized products which are produced in large quantities.

Refer to **figure # 2**, in this type of layout, raw material moves from one machine to another machine & the output of one machine becomes the input of the next machine.

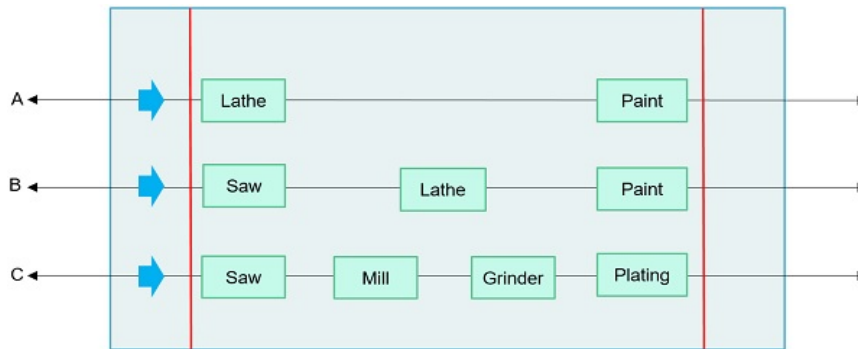


Figure 2: Example of Product layout/ Line Processing Layout/ Flow Line Layout

### 5.2.1.) Advantages of Product / Line Processing / Flow Line Layout:

- Low cost of material handling
- Lesser inventory and work in progress
- The continuous flow of work
- Smooth and continuous operations

### 5.2.2.) Disadvantages of Product / Line Processing / Flow Line Layout:

- Large capital investment because of special purpose machines
- Lack of flexibility of operations
- Dependence of whole activity on each part any breakdown of one machine in the sequence may result in stoppage of production.

### 5.3. Fixed Position / Static Layout:

In a **Fixed Position/Static Layout**, the part in production stays in a fixed location; instead, the tooling, machinery, manpower, raw materials and other supporting equipment are taken to this location.

In this layout, refer to **figure # 3** the product to produce is too heavy or difficult to move from a place to another, so it is easier and economical to bring the necessary tools and equipment's to workplace along with the manpower. The example of fixed-layout manufacturing is the manufacture of hydraulic and steam turbines, boilers, and ships, etc.

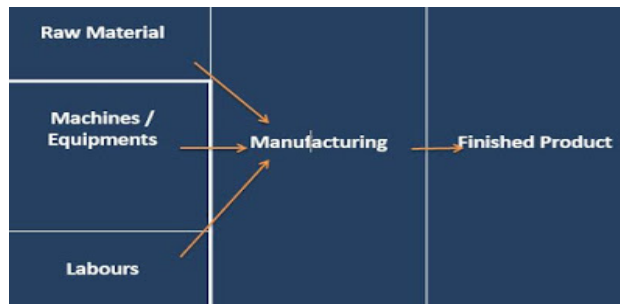


Figure # 3: Fixed Position Layout/ Static Layout

### 5.3.1.) Advantages of Fixed Position Layout:

- Independent Production centres of fixed-layout ensure effective planning and loading.
- Greater flexibility for change in product design, product mix and production volume.

### 5.3.2.) Disadvantages of Fixed Position Layout:

- Fixed Position Layout requires highly skilled manpower
- Time-consuming due to movement of machines equipment's to production center
- It require complicate work schedule

### 5.4. Combined / Hybrid Layout:

In **Combined/ Hybrid Layout** the merits of both process & product layout are combined. In this type refer to **figure # 4** the product layout is used to manufacture the main product i.e. the final assembly and process layout is used to manufacture sub-assemblies or joint products. This layout is helpful in enhancing the idle capacity of the product layout. For example, refrigerator and soap manufacturing uses a combination layout.

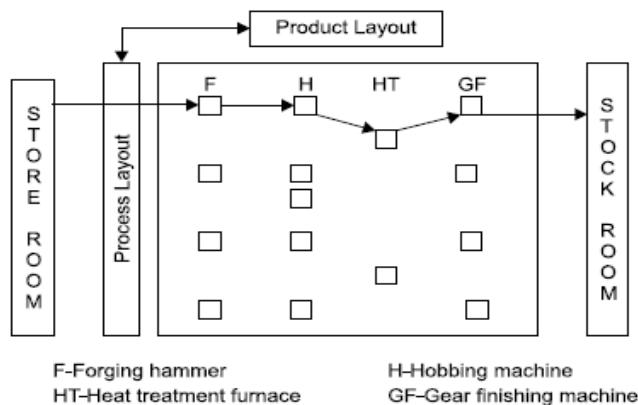


Figure # 4: Example of Combined / Hybrid Layout



#### 5.4.1.) Advantages of Combined/Hybrid Layout:

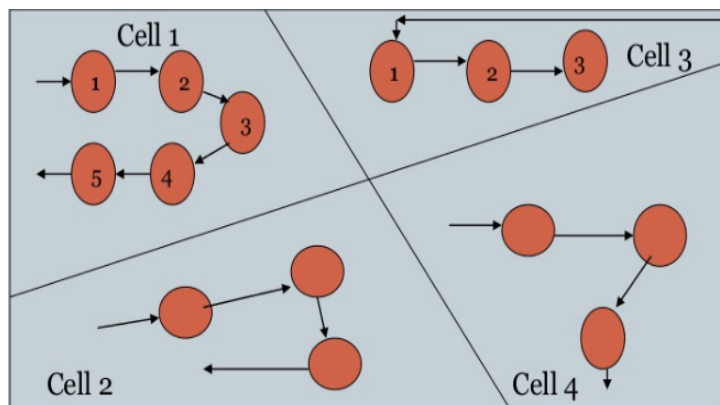
- Optimum utilization of resources can be done best in this layout.

#### 5.4.2.) Disadvantages of Combined/Hybrid Layout:

- More investment is needed in this layout

### 5.5. Cellular Manufacturing Layout:

In **Cellular manufacturing layout** refer to *figure # 5* machines are grouped into cells and the cells function somewhat like a product layout within a larger shop where each cell performs an entire production function from starting to end. It offers more control than a static process layout and is more flexible than a line layout.



*Figure 5: Example of Cellular Manufacturing Layout*

#### 5.5.1.) Advantages of Cellular Manufacturing Layout:

- Work can be done at high productivity.
- Production cost and delivery time decrease.
- Quick Setup changeover
- Low stock of inventories needed

#### 5.5.2.) Disadvantages of Cellular Manufacturing Layout:

- High capital requirement due to duplication of equipment.
- Chances of Idle capacity in cellular layout.

## **6. Factors Affecting Factory Layout:**

Some of the major factors which affect factory layout are as follows.

### **1. Plant Location:**

Location of a plant greatly influences the layout. The basic idea is to maximize the utilization of space. Weather conditions, geographical features, shape & size of the site selected influence the general arrangement of the layout and the flow of work.

### **2. Nature of the product:**

The product to be manufactured has a significant influence on plant layout. Small and light products can be moved from one machine to another with minimum effort and time and therefore line layout would be more suitable. Stationary layout would be suitable for heavy and bulky products. In case of production of large variety of non-standardized products, process layout is ideal.

### **3. Production Volume & Nature of Product:**

Plant layout is generally determined by the nature and the quantity of the product to be produced. There are three systems of production depending on the nature of product.

#### **3(a) Job production:**

In job production system non- standardized products are produced in accordance with the customer requirement. As each product is different, it requires different process for production. The machines are adjusted in such a manner so as to suit the requirements of a particular job. Job production involves intermittent process as the work is carried as and when the order is received. Ship building is an appropriate example of this kind.

#### **3(b) Mass production:**

In mass production system, continuous production of standardized products on large scale is done. Standardization is the basis of mass production. Standardized products are produced under this method by using standardized materials and equipment. There is a continuous or uninterrupted flow of production obtained by arranging the machines in a proper sequence of operations. Product layout is best suited for mass production units.

#### **3(c) Batch production:**

In batch production system, identical products are produced in batches based on customer demand or forecast. This method is generally similar to job production except the quality of production. Instead of making one single product as in case of job production a batch or group of products is produced at one time, It should be remembered here that one batch of products has no resemblance with the next batch. This method is generally adopted in case

of biscuit and confectionary manufacturing, medicines, tinned food and hardware's like nuts and bolts etc.

#### **4. Type of Machines:**

If machines are heavy & difficult to move stationary layout is preferable. Adequate space should be provided for the location of machines and also there should be sufficient space in between them to avoid accidents.

#### **5. Climate:**

Temperature, lighting, ventilation should be considered while deciding on the type of layout. These factors should be considered in order to improve the health & welfare of employees.

#### **6. Service facilities:**

The layout must provide the comforts and improve morale of the employees. It should have adequate provision for rest rooms, drinking water and cleanliness. There should be sufficient space for free movement of workers.

#### **7. Safety of employees:**

While deciding on a particular type of layout, the safety of employees should be given prime importance. The layout should provide for obstruction free floors, non-slippery floors, protection against dangerous fumes, grinding particles, excess heat & strong odor Etc.

#### **8. Type of process:**

In the case of intermittent type of production (bi-cycle manufacturing, electronics), process layout is suitable. For synthetic type of Production (cement and automobile industries), product layout is preferable.

#### **9. Management policies:**

Policies of the top management relating to type of product, quality, scale of production, level of plant integration, type of production, possibility of future expansion etc., influence the type of layout to be adopted.

## 7. Layout Planning Process Steps:

The specific procedures and key points of layout plan are described below. Consider layout plan by following these steps and record all proposals on paper in sequential order, which could be utilized for layout changes in future.

Especially in the factory layout plan for mass production, the following three points should be the basic idea regardless of whether it is a **large factory or a small or medium-sized factory**.

1. Straight line layout
2. Material inlet and product outlet are separate locations
3. Minimum material handling distance for material and equipment placement

**The specific procedures and key points of basic layout plan are as follows:**

1. Tentative annual production plan, production parts and annual production volume.
2. Decide the basic manufacturing process based on available manufacturing facilities.
3. Draft receiving orders, raw material, production, stock, delivery schedule/volume.
4. Draft annual production lots & production sequence.
5. Annual production line wise & calculate machine cycle times.
6. Calculate standard work process planning chart/ Fundoshi for each product.
7. Prepare straight line layout as per the machines set operation time.
8. Describe the required production machines, jigs, racks, pallets in the above mentioned straight line layout. Incorporate the concepts of 5T & FIFO.
9. Describe the material, in-process parts, production parts flow frequency from factory in & out gates for the above mentioned straight line layout.
10. Draft factory layout plan: considering factory size, space in between pillars, and in principle based on minimum logistic flow concept, draft layout considering nature and volume of product (refer to heading # 5, Types of Plant Layout above) , allocate machines & production lines by utilizing factory space effectively.
11. In the above-mentioned layout plan describe worker location & movement range (based on Fundoshi, refer to point # 6).
12. For the above-mentioned on the layout specify,
  - a. Gemba (production floor) & QC area
  - b. Obeya Room / Visual control area, training room/Dojyo etc.
13. For the above-mentioned layout specify,

- a. Office Space, Office Washroom
  - b. Factory entrance & exit, shop floor toilet
  - c. Power room, store, material store, delivery space,
  - d. Canteen area etc.
14. Describe factory appearance, worker flow and emergency exits, also calculate separately the store, raw material store, delivery area, draft the specifications and size.
15. Draft layout plan adjustable with further expansion on an annual basis.
- a. incorporate future expansion term wise.
16. Connect the factory machines & lights with power source.
- a. Electricity (electrical single line diagram including machines & lighting) layout draft.
  - b. Plumbing work (water, air, gas, drain) piping layout draft
17. Power source specification (incoming transformation electricity, water source, water treatment) plan and final location & construction specification, draft.
18. To factory plot site,
- a. factory building layout drawing
  - b. passages inside the building
  - c. parking area
  - d. allocate maintenance room etc.
19. Consider the following constraints or assumptions while planning layout.
- Before finalizing the layout consider constraints about land & factory layout depending on area, customs and religion. In such a case maximum effort to be carried out to consider this.
  - Consider factory building direction in the land plot by daylight, wind & rain direction, appearance from the road.
  - Follow environmental regulations of local area regarding air pollution and waste water treatment.
20. Check the final logistics flow, man flow, power flow and layout plan will be finalized.

## **8. Optimizing Factory Layout Design for Increased Productivity:**

The main objective of the optimizing factory layout design is to improve workflow and to improve productivity of machines, material flow and workers. The most general process of layout redesign is the following:

- a. At first, the problem has to be defined (e.g. bottlenecks, lack of space, etc.)
- b. The defined problem should be analysed
- c. Alternative solutions (e.g. layout variations) should be elaborated, discuss with all stakeholders and get their inputs
- d. Elaborated alternatives (2-3 different ideas) have to be analyzed and evaluated based on key performance indicators
- e. The best layout design has to be selected and Preferred solution should be implemented
- f. To make improvement sustainable adopt following lean practices:
  - Give preventive maintenance a priority
  - Implement 5S
  - Training & Education of workers
  - Introduce employee suggestion system for further improve efficiency.