Examples of plant layout and design

Principles of plant layout and design will apply to most industrial situations. The following layout examples encompass a wide variety of facility characteristics, and of process characteristics.

No example is likely to fit your exact needs, because buildings, dimensions, equipment and products vary so much. But flow and layout principles do apply widely. Call on JPR to develop effective layouts to fit your objectives, budget and schedule; perhaps if your resources don't have the experience, or time, for a project.

Please contact Jack Greene at 843-422-1298, or jack@jacksonproductivity.com

Plant Layout and Facility Planning, Edition 2, https://www.amazon.com/dp/1491222395/ref=cm_sw_su_dp offers a reliable source of layout and facility planning guidance when you want to keep it in-house and is found at

Index of examples

A. Single story building
1. Straight line flow
2. U shaped flow
3. In a building designed for distribution, to adapt to another use
4. To place permanent equipment and avoid later interference
5. Distribution center
6. Cellular flow
7. Modular work flow
8. Clean room for sterile or aseptic liquids
9. Clean room for devices, semiconductors
10. Primary Conveyor, fed from other conveyors, from above
11. One product, with several components, not conveyorized
12. Cell and modular elements in the same layout
13. Electronics fab and test
14. Integrated plastics product
15. From dedicated cells into modular packaging lines
16. Model and prototype shops, pilot plant

B. Multi-story building
1. Multi-story building, utilize vertical flow
2. Multi-story building, two elevators
3. Multi-story building, one elevator
4. Multi-story building, services on another floor

C. Buildings set on plot plans
1. Outside storage, liquid and dry bulk materials
2. Outside storage, large components and product handling
3. Constrained by adjoining property
4. Unconstrained by adjoining property
5. Details of dock characteristics
1 Straight Line Flow
Flow is essentially straight line, although it adapts to building design.
A 2 U Shaped Flow
In and out of the same dock

- Receiving
- Raw Materials Stores
- Support
- Operating offices
- Admin offices

- Receiving and Shipping dock
- Building amenities

- Shipping
- Finished Goods Stores
- Maintenance
In a building designed for distribution, to adapt to another use

Many of these facilities are empty and available. They are characterized by multiple docks and doors. Take advantage of the docks to improve process flow for your operation.

<table>
<thead>
<tr>
<th>Admin offices</th>
<th>Building amenities</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>In</td>
<td></td>
<td>Out</td>
</tr>
<tr>
<td>In</td>
<td></td>
<td>Support</td>
</tr>
<tr>
<td>In</td>
<td></td>
<td>Operating offices</td>
</tr>
<tr>
<td>Out</td>
<td>Product Line B</td>
<td>Out</td>
</tr>
<tr>
<td>Out</td>
<td>Product Line C</td>
<td>in</td>
</tr>
</tbody>
</table>
To place permanent equipment and avoid later interference

Position fixed, hard to relocate, functions and equipment along a wall that will not be used for later expansion. Place equipment outside as well as inside exterior walls.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoppers</td>
<td>Liquid waste disposal</td>
</tr>
<tr>
<td>Bins</td>
<td>Rest rooms</td>
</tr>
<tr>
<td>Tanks</td>
<td>Fire sprinkler risers</td>
</tr>
<tr>
<td>Solid waste</td>
<td>In power</td>
</tr>
<tr>
<td>Water tower</td>
<td>In gas</td>
</tr>
<tr>
<td>Dust collection</td>
<td>Water softening</td>
</tr>
<tr>
<td></td>
<td>Water purification</td>
</tr>
<tr>
<td></td>
<td>Blow-out walls</td>
</tr>
<tr>
<td></td>
<td>Plating, degreasing</td>
</tr>
<tr>
<td></td>
<td>Motor control centers</td>
</tr>
<tr>
<td></td>
<td>Process using mezzanine</td>
</tr>
</tbody>
</table>
5 Distribution center
A DC will have many docks, and many storage racks. Straight line or U-shaped flow will depend on dock location. Reduce travel by careful location of materials in racks; warehousing programs will help.
Cellular flow
An approach in which manufacturing work centers (cells) have the total capabilities needed to produce an item or group of similar items. Smooth flow both between and within cells.
A 7 **Modular work flow**

Modular work centers consist of similar equipment or capabilities, and products move among multiple work centers before they are completed. With or without conveyor lines.

<table>
<thead>
<tr>
<th>Saw module for all products</th>
<th>Products A, B, C are routed to the module if work is to be performed there; on a dedicated or a multi-product CNC module machine. Different product, different flow.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lathes module for all products</td>
<td>EDM module for all products</td>
</tr>
<tr>
<td>Mill module for all products</td>
<td>Coating module for all products</td>
</tr>
</tbody>
</table>
Clean room for sterile or aseptic liquids
Charaterized by material pass thru's, employee change rooms, sterilization.
With or without conveyor lines.

Container
Wash
Area, bulk or
In Line

In line sterilize Fill line one, HEPA filters Out conveyor To Inspection
Spatial or physical separation

In line sterilize Fill line two, HEPA filters Out conveyor and / or Sterilizing
Spatial or physical separation

In line sterilize Fill line three, HEPA filters Out conveyor and / or Packaging
Spatial or physical separation

In line sterilize Fill line four Out conveyor
Spatial or physical separation

Most rigorous room class

People, Material, Equipment

Rigorous room class
Clean room for devices, semiconductors
Characterized by material pass thurs, employee change rooms, superior HVAC
Usually involves conveyors

### Most rigorous room class
- **Employee Gowning Area**
- **Equipment Clean up Area**
- **Bulk Material Entry**

### Rigorous room class

<table>
<thead>
<tr>
<th>Parts</th>
<th>Wash</th>
<th>Assembly Area, bulk or Parts Prep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assembly line one</th>
<th>Out conveyor</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial or physical separation</td>
<td>Inspection</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assembly line two</th>
<th>Out conveyor</th>
<th>and / or</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial or physical separation</td>
<td>Sterilizing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assembly line three</th>
<th>Out conveyor</th>
<th>and / or</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial or physical separation</td>
<td>Packaging</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assembly line four</th>
<th>Out conveyor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial or physical separation</td>
<td></td>
</tr>
</tbody>
</table>

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#### Lower Room Class
- **People, Material Equipment**
- **Pass thru**

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#### Pass thru
- **Pass thru**
A 10 Primary Conveyor, fed from other conveyors, from above
Detail is driven by the product components and sequence of steps and assembly.
One product, with several components, not conveyorized

This example shows kitting, sub assemblies, final assembly, test, pack, ship in a U shape..

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Diagram:

- Shipping and receiving docks
- Raw materials
- Kitting
- Sub-assembly
- Pack
- Final test
- Final assembly
- Sub-assembly

Additional sections:

- Operating offices
- Building amenities
- Support
- Design and Engineering
- Maintenance
- Admin offices
**A 12  Cell and modular elements in the same layout**

Not an uncommon arrangement, especially when equipment has accumulated over time. With or without conveyor lines.
Integrated manufacture; subassembly, fab, assembly, and test in clean rooms. Because parts are small, materials handling moves many parts at one time.
Integrated plastics product
Molding, sub-assembly, tumbling barrels for smoothing, assembly, through distribution

Ramps, this DC was built without land fill for cost purposes.

DC administration

To DC

Assembly

Raw material stores

Sub-assembly

Tumbling barrels

Plant Receiving dock

DC In Docks
Distribution Center Racks

DC Out Docks
Pick and Pack

DC

Building amenities
Plastics Injection Molding

Plant admin and operation offices
A 15 From dedicated cells into modular packaging lines
A typical layout; in this example specialized product filling flows into general purpose inspection and packing.
**Model and prototype shops, pilot plant**

These operations will have both specialized and general purpose machines. They will be called on to produce any product, with as little subcontracted as possible. If associated with production operations, these shops should be able to match or simulate all production equipment.

<table>
<thead>
<tr>
<th>Specialty shops</th>
<th>Wood working</th>
<th>Plumbing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal working, classic</td>
<td>Metal working, Cad Cam</td>
<td>Electrical</td>
</tr>
<tr>
<td>Electronic</td>
<td>Sheet metal, cut and form</td>
<td>Sandblast</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Assembly</td>
<td>Design and engineering offices, Cad Cam equipment</td>
</tr>
</tbody>
</table>

Model and prototype shops are not the place for Just in Time material delivery, no matter what the black belts say. The predictability of work, the horizon, is not long enough to allow lead times. Don’t discard but keep on hand a wide variety of materials. The shop will be called on to produce and modify on short notice and the next model or prototype may well be able to use materials or subassembly from the retained inventory. Reliable local sources if any can allow a smaller inventory.

Layout of machines should concentrate on fitting them into the space with regard to safety and material handling, because the flow of materials will likely be unpredictable and irregular. If possible leave ample access space for material, and for new equipment and technology.
Multi-story building, utilize vertical flow
Where possible, utilize vertical flow to move product.
A practical handling system is necessary to place material on the upper floor to start.

Upper Level

1) Product Weigh and Compound
   Product Mix, drop to lower

2) Sub-assembly or
   Parts preparation, feed to lower via chute, dumbwaiter, slide.

3) Raw materials, where they can be placed to the upper floor readily.
   Feed to lower via chute, dumbwaiter or slide.

Lower Level

1) Product Package
   Product Fill Fed from Above

2) Product assembly
   Fed from above
   Test, pack

3) Product assembly, fill, package
   Fed from above
B 2 Multi-story building, two elevators
Except for the fact that material must use an elevator, flow can be productive. Many options are possible.

1) An elevator can be used to receive, or to ship, or to do both.

2) The floor can serve one department or product line, or multiple entities.

3) The floor can receive from, or feed, another location.

1) Flow can U-shaped, in and out the same elevator.

2) Flow can be straight line, essentially from one elevator to the other.

3) Or both, for different products.
3 Multi-story building, one elevator

The area near the elevator will be busy, and should be kept open. Careful layout will be useful to maintain productivity.

1) The elevator will be used to receive and ship.

2) Flow can only be U-shaped, in and out of the same elevator, unless vertical feed is possible through chute, slide, or dumbwaiter.

3) The floor can serve one department or product line, or multiple entities. Use will depend on size and ingenuity of layout applied.

Flow can only be U-shaped, in and out of the same elevator, unless vertical feed is possible through chute, slide, or dumbwaiter.

Cross flow is possible.
Multi-story building, services on another floor

The operations floor can be effectively laid out because services and amenities are on another floor. In this example, services are located on only a partial floor, under manufacturing.
Outside storage, liquid and dry bulk materials

Outside storage is often practical. Outside containers do not take up plant space, and they can be filled by truck easily. Be sure that permanent containers do not block future plant expansion.

Road Access

Liquid Tank

Fuel Oil

Dry Mat'l Hopper

Waste Tank

Feed Tank

Recycle Drums

Recycle Pallets

Dumpster

Road Access

Extended dock, at the level of the plant and recycle locations.

Plant Access

One corner of the production building.
C 2 Outside storage, large components and product handling

Large weather-proof components sometimes can be kept outside.
Be sure that permanent containers do not block future plant expansion

One corner of the production building.
C 3 Constrained by adjoining property
Placement of permanent equipment is key when building expansion is blocked in some directions. Locate permanent equipment along the sides that are already blocked.

- Place permanent equipment along these walls.
  Docks, utilities, plating, elevator and stairs, liquid waste disposal, rest rooms, fire sprinkler risers, water treatment, motor control centers, mezzanines

- Leave these walls available for expansion.

Property available for expansion
### Unconstrained by adjoining property

Placement of permanent equipment is key when building expansion is blocked in some directions. Locate permanent equipment along the sides that are already blocked.

<table>
<thead>
<tr>
<th>Available for expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial building</strong></td>
</tr>
<tr>
<td>Place permanent equipment along no more than two walls, or centrally.</td>
</tr>
<tr>
<td><strong>Expansion</strong></td>
</tr>
<tr>
<td>Probably locate docks first considering street access, grade levels, appearance, and distances. Then plan interior layouts accordingly.</td>
</tr>
</tbody>
</table>

Available for expansion
Details of dock characteristics

Plan general location of access roads and docks considering street access, grade levels, appearance, and distances. Then consider

<table>
<thead>
<tr>
<th>Paved area characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access from roads; route, distance and elevation change</td>
</tr>
<tr>
<td>Turning radius of semis; in, out, to park</td>
</tr>
<tr>
<td>Back into docks, think like a trucker; they want to back clockwise</td>
</tr>
<tr>
<td>Don't block future property use and plant expansion.</td>
</tr>
<tr>
<td>Non-dock parking for semis</td>
</tr>
<tr>
<td>Employee parking</td>
</tr>
</tbody>
</table>

Dock characteristics

Security plan
Internal flow to plant and stores
Number of docks
Dock height, door size
Space between docks
Man doors, stairs
Enclosed? Weather protected?
Trucker check in desk
Formal trucker lobby, restroom
Ramps for access of lift trucks
Battery charge and / or propane tank stores