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.

Readers, this is the most popular page on jacksonproductivity.com. Thanks for your interest, and I hope you'll see an example that sparks an idea that leads to a workable layout for you. The examples are full of sound principles, and represent actual, productive, operations.

But frankly, there is a better way to create a superior layout. No example here is likely to fit your specific needs. None of these examples have buildings like yours or the same dimensions; the equipment and products and volumes won't match. (There won't be an answer elsewhere on the internet either, for your specific parameters.)

A better plan of action is to apply the principles of layout, to achieve a tailored layout for your parameters. Layout isn't rocket science, but you are better off knowing and using sound fundamentals.

Sound fundamentals will allow you to generate a smooth product flow; provide adequate space for all the equipment, people, processes, material, services and support, and inventory; utilize the building space well; consider how to integrate future technology and volume changes; accomplish the inevitable relocations with minimum interruption.

Now, for the only commercial you will get: There will be times when you need hands-on assistance with layout and facility planning; guidance or formal training, another pair of hands and eyes or simply to talk out an issue.

You are invited to contact Jack Greene, at jack@jacksonproductivity.com or 843-422-1298. There is no cost or obligation to discuss your situation and possible solutions, but if I can help, I'll outline how; tailored to the client's specific purposes, timing, and budget.

Meantime, JPR has plenty of guidance on line. See http://jacksonproductivity.com/layout.htm, for our Amazon books and on-line articles. If you like what you see there, let's talk.
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A 1 Straight Line Flow
Flow is essentially straight line, although it adapts to building design.
U Shaped Flow
In and out of the same dock
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.
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>Equipment</th>
<th>Location</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>
### 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.

<table>
<thead>
<tr>
<th>Shipping docks</th>
<th>Receiving docks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order accumulation</td>
<td>Storage racks</td>
</tr>
<tr>
<td>Picking</td>
<td></td>
</tr>
<tr>
<td>Offices</td>
<td></td>
</tr>
<tr>
<td>Support</td>
<td></td>
</tr>
<tr>
<td>Building amenities and Maintenance</td>
<td>Possible Docks</td>
</tr>
</tbody>
</table>
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.

Cell One for Product A

Cell Two for Product B

Cell Three for Product C
## 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>
A 8 Clean room for sterile or aseptic liquids
Characterized by material pass thru's, employee change rooms, sterilization. With or without conveyor lines.

In line sterilize Fill line one, HEPA filters Out conveyor To
Spatial or physical separation Inspection
In line sterilize Fill line two, HEPA filters Out conveyor and / or
Spatial or physical separation Sterilizing
In line sterilize Fill line three, HEPA filters Out conveyor and / or
Spatial or physical separation Packaging
In line sterilize Fill line four Out conveyor
Spatial or physical separation

Most rigorous room class

Most rigorous room class

Employee Gowning Area
Equipment Sterilization Area
Bulk Material Sterilize

Rigorous room class

People Equipment Material Pass thru
Pass thru

Lower Room Class

People, Material, Equipment Pass thru
Pass thru

Container
Wash
Area, bulk
or
In Line
Clean room for devices, semiconductors
Characterized by material pass thrus, employee change rooms, superior HVAC
Usually involves conveyors

Most rigorous room class

Rigorous room class
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.
**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.

<table>
<thead>
<tr>
<th>Support</th>
<th>Product One</th>
<th>R&amp;D Model Shop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Modular metals working</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distribute to any cell</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assembly Cell</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assembly Cell</td>
<td></td>
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<td></td>
<td>Assembly Cell</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assembly Cell</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engineering, Design</th>
<th>Product Two</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td>Modular plastics working</td>
</tr>
<tr>
<td>Admin</td>
<td>Distribute to any cell</td>
</tr>
<tr>
<td></td>
<td>Assembly Cell</td>
</tr>
<tr>
<td></td>
<td>Assembly Cell</td>
</tr>
<tr>
<td></td>
<td>Assembly Cell</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building Amenities</th>
<th>Docks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receive and Ship</td>
<td></td>
</tr>
</tbody>
</table>
A 13  Electronics fab and test
Integrated manufacture; subassembly, fab, assembly, and test in clean rooms. Because parts are small, materials handling moves many parts at one time.
A 14 Integrated plastics product
Molding, sub-assembly, tumbling barrels for smoothing, assembly, through distribution

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

Specialty shops will depend on the charter of the organization, and may contain one or more of the following:

- Metal working, classic
- Wood working
- Plumbing
- Electrical
- Composites working, layup
- Instrumentation
- Electronic
- Welding
- Fill
- Sheet metal, cut and form
- Plating
- Package
- Sandblast
- Paint
- Label
- Chemistry
- Multi-layer printing
- Exact measurement
- Assembly
- Signs, printing
- Optics

Design and engineering offices, Cad Cam equipment

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.
B 1 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

Product
Package

Product
Fill
Fed from
Above

Product assembly
Fed from above
Test, pack

Product assembly, fill, package
Fed from above
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.
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.
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.

Horizontal racks for long components

Horizontal storage of tall sections

Temporary trailer

One corner of the production building.
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.

<table>
<thead>
<tr>
<th>Street</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Street</td>
</tr>
</tbody>
</table>

- 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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Available for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion</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

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

**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