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Process Layout

Chapter 8

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Layout Planning

- **Layout planning** is planning that involves decisions about the physical arrangement of economic activity centers needed by a facility's various processes.
 - Layout plans translate the broader decisions about the competitive priorities, process strategy, quality, and capacity of its processes into actual physical arrangements.
 - **Economic activity center:** Anything that consumes space -- a person or a group of people, a customer reception area, a teller window, a machine, a workstation, a department, an aisle, or a storage room.

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Layout Planning Questions

Before a manager can make decisions regarding physical arrangement, four questions must be addressed.

1. What centers should the layout include?
2. How much space and capacity does each center need?

Excessive space is wasteful, can reduce productivity, and can isolate employees

Inadequate space can reduce productivity, deprive employees of privacy, create safety hazards

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Layout Planning Questions

Before a manager can make decisions regarding physical arrangement, four questions must be addressed.

1. What centers should the layout include?
2. How much space and capacity does each center need?
3. How should each center's space be configured?
4. Where should each center be located?

Relative location:
The placement of a center relative to other centers

Absolute location:
The particular space that the center occupies within the facility

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Strategic Issues

- Layout choices can help communicate an organization’s product plans and competitive priorities.
- Altering a layout can affect an organization and how well it meets its competitive priorities in the following ways:
 1. Increasing customer satisfaction and sales at a retail store.
 2. Facilitating the flow of materials and information.
 3. Increasing the efficient utilization of labor and equipment.
 4. Reducing hazards to workers.
 5. Improving employee morale.
 6. Improving communication.

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Types of Layouts

- Flexible-flow layout
- Line-flow layout
- Hybrid layout
- Fixed-position layout

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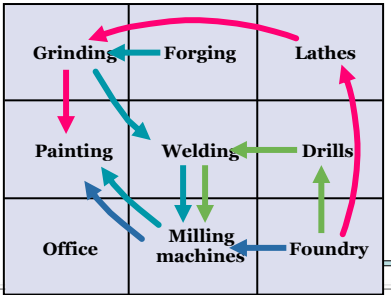


Types of Layouts

➤ **Flexible-flow layout:** A layout that organizes resources (employees) and equipment by function rather than by service or product.

A job shop has a flexible-flow layout.

Low volume,
high customization



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Advantages of Flexible-Flow Layouts

- + Can handle a variety of processing requirements
- + Not particularly vulnerable to equipment failures
- + Equipment used is less costly
- + Possible to use individual incentive plans
- In-process inventory costs can be high
- Challenging routing and scheduling
- Equipment utilization rates are low
- Material handling slow and inefficient
- Complexities often reduce span of supervision
- Special attention for each product or customer
- Accounting and purchasing are more involved

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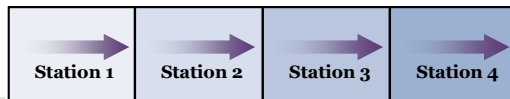


Types of Layouts

- **Flexible-flow layout:** A layout that organizes resources (employees) and equipment by function rather than by service or product.
- **Line-flow layout:** A layout in which workstations or departments are arranged in a linear path.

A production line has a line-flow layout.

high volume, low customization



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Designing Line-Flow Layouts

Line balancing is the assignment of work to stations in a line so as to achieve the desired output rate with the smallest number of workstations.

- **Work elements** are the smallest units of work that can be performed independently.
- **Immediate predecessors** are work elements that must be done before the next element can begin.
- **Precedence diagram** allows one to visualize immediate predecessors better; work elements are denoted by circles, with the time required to perform the work shown below each circle.

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How Measure Line Flows? Desired Output and Cycle Time

- **Desired output rate, r** must be matched to the staffing or production plan.
- **Cycle time, c** is the maximum time allowed for work on a unit at each station:

$$c = \frac{1}{r}$$

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Other Considerations

In addition to balancing a line, managers must also consider four other options:

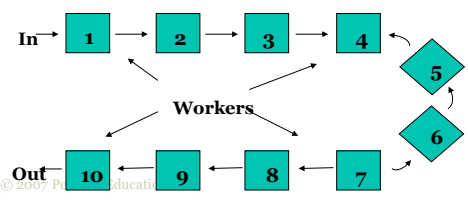
1. **Pacing:** The movement of product from one station to the next as soon as the cycle time has elapsed.
2. **Behavioral factors** of workers.
3. **Number of models** produced: A **mixed-model line** produces several items belonging to the same family.
4. **Cycle times** depend on the desired output rate, and efficiency varies considerably with the cycle time selected. Thus exploring a range of cycle times makes sense.

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A U-Shaped Production Line

- + More compact (requires half the length of a straight line)
- + Allows increased communication among workers on the line
- + Flexibility in work assignments



Advantages/Disadvantages of Line-Flows

- | | |
|---|--|
| + High rate of output | - Creates dull, repetitive jobs |
| + Low unit cost | - Poorly skilled workers may not maintain equipment or quality of output |
| + Labor specialization | - Fairly inflexible to changes in volume |
| + Low material handling cost | - Highly susceptible to shutdowns |
| + High utilization of labor and equipment | - Needs preventive maintenance |
| + Established routing and scheduling | - Individual incentive plans are impractical |
| + Routing accounting and purchasing | |

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Types of Layouts

- **Flexible-flow layout:** A layout that organizes resources (employees) and equipment by function rather than by service or product.
- **Line-flow layout:** A layout in which workstations or departments are arranged in a linear path.
- **Hybrid layout:** An arrangement in which some portions of the facility have a flexible-flow and others have a line-flow layout.

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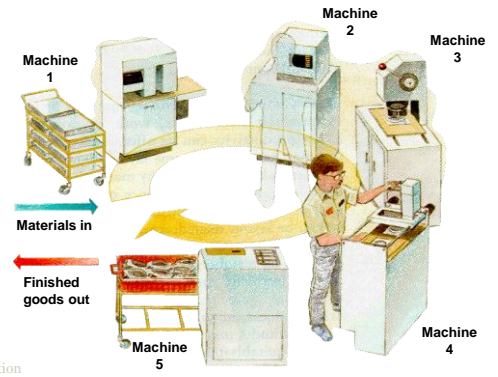
Creating Hybrid Layouts

- **Layout flexibility** is the property of a facility to remain desirable after significant changes occur or to be easily and inexpensively adopted in response to changes.
 - A **Cell** is two or more dissimilar workstations located close together through which a limited number of parts or models are processed with line flows.

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A **One-worker, multiple-machines (OWMM) cell** is a one-person cell in which a worker operates several different machines simultaneously to achieve a line flow.



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Group Technology (GT)

➤ **Group Technology (GT)** is an option for achieving line-flow layouts with low-volume processes; this technique creates cells not limited to just one worker and has a unique way of selecting work to be done by the cell.

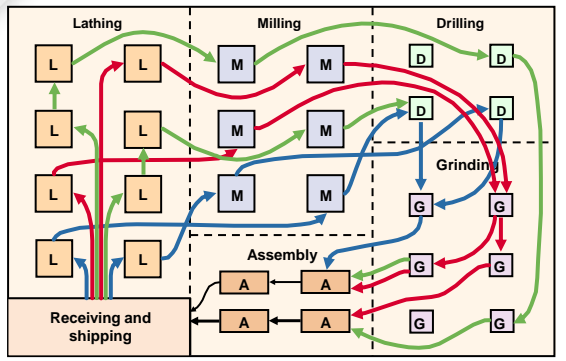
➤ The GT method groups parts or products with similar characteristics into families and sets aside groups of machines for their production.

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Before Group Technology

Jumbled flows in a job shop without GT cells

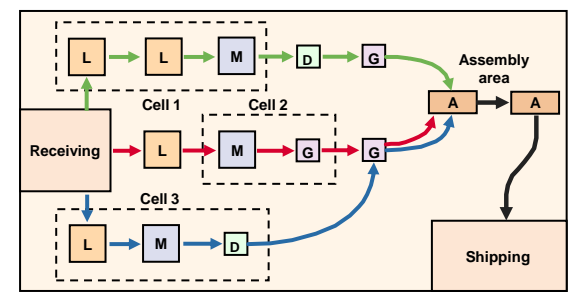


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Applied Group Technology

Line flows in a job shop with three GT cells



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Back to hybrid layouts...

Designing Flexible-Flow Layouts

- Step 1: Gather information
- Step 2: Develop a Block plan
- Step 3: Design a detailed layout.

↔

Designing Flexible-Flow Layouts

- Step 1: Gather information
 - Space requirements by center
 - Available space
 - Closeness factors: which centers need to be located close to one another.
 - **Closeness matrix**: A table that gives a measure of the relative importance of each pair of centers being located close together.
- Step 2: Develop a **Block plan**: A plan that allocates space and indicates placement of each department.
- Step 3: Design a detailed layout.

↔

How to Develop a Block Plan

- Trial and error
- Weighted distance score

↔

Gather Information

Example 8.1 Office of Budget Management

Space Requirements

| Department | Area Needed (ft ²) |
|--------------------|--------------------------------|
| 1. Administration | 3,500 |
| 2. Social services | 2,600 |
| 3. Institutions | 2,400 |
| 4. Accounting | 1,600 |
| 5. Education | 1,500 |
| 6. Internal audit | 3,400 |
| Total | 15,000 |

Current Block Plan

↔



Closeness Matrix

Example 8.1 Office of Budget Management

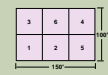
| Department | Trips between Departments | | | | | |
|--------------------|---------------------------|---|---|---|---|----|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. Administration | — | 3 | 6 | 5 | 6 | 10 |
| 2. Social services | — | — | 8 | 1 | 1 | — |
| 3. Institutions | — | — | — | 3 | 9 | — |
| 4. Accounting | — | — | — | — | 2 | — |
| 5. Education | — | — | — | — | — | 1 |
| 6. Internal audit | — | — | — | — | — | — |

Departments 1 and 6 have the most interaction.
 Departments 3 and 5 have the next highest.
 Departments 2 and 3 have next priority.

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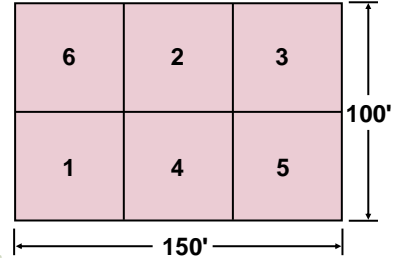


Trial and error.



Proposed Block Plan

First put departments 1 and 6 close together
 Next put departments 3 and 5 close together
 Then put departments 2 and 3 close together



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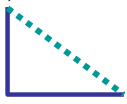


Applying the Weighted-Distance Method

Weighted-distance method: A mathematical model used to evaluate flexible-flow layouts based on proximity factors.

- **Euclidean distance** is the straight-line distance, or shortest possible path, between two points.

$$d_{AB} = \sqrt{(x_A - x_B)^2 + (y_A - y_B)^2}$$



- **Rectilinear distance:** The distance between two points with a series of 90 degree turns, as along city blocks.

$$d_{AB} = |x_A - x_B| + |y_A - y_B|$$



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Other Decision Support Tools

- **Automated layout design program (ALDEP):** A computer software package that constructs a good layout from scratch, adding one department at a time.
- **Computerized relative allocation of facilities technique (CRAFT):** A heuristic method that begins with the closeness matrix and an initial block layout, and makes a series of paired exchanges of departments to find a better block plan.

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Types of Layouts

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- **Hybrid layout:** An arrangement in which some portions of the facility have a flexible-flow and others have a line-flow layout.
- **Fixed-position layout:** An arrangement in which service or manufacturing site is fixed in place
 - Employees along with their equipment, come to the site to do their work
 - The nature of the product dictates this kind of layout (weight, size bulk, etc.)
 - commonly used in farming, firefighting, road building, home-building, etc.

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Other than Processes...

- Warehouse Layouts
- Office Layouts
- Retail Layouts

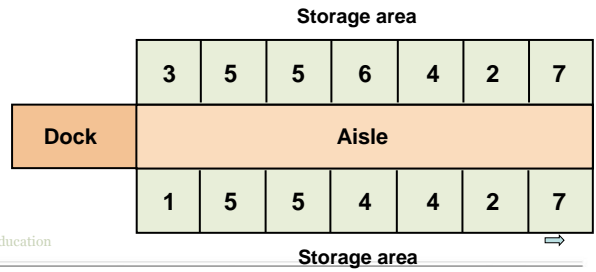
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- Warehouse Layouts
- Office Layouts
- Retail Layouts

Warehouse Layouts Out-and-back Pattern

Objective is to optimize trade-offs between handling costs and costs associated with warehouse space

- Maximize the total "cube" of the warehouse – utilize its full volume while maintaining low material handling costs
- The most basic warehouse layout is the *out-and-back pattern*. The numbers indicate storage areas for same or similar items.

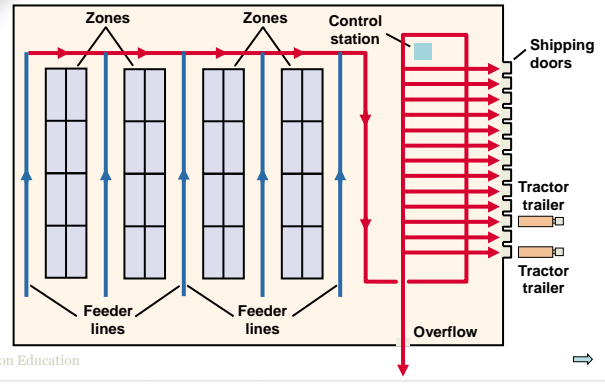


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- Warehouse Layouts
- Office Layouts
- Retail Layouts

Warehouse Layouts Zone System



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- Warehouse Layouts
- Office Layouts
- Retail Layouts



| | | Storage Requirements | |
|------------------|------|--|--|
| | | High | Low |
| Picking Activity | High | <p>High Density Storage Automated Handling</p> | <p>Picking Dominates Dedicated Location Low Density Storage Automated Handling</p> |
| | Low | <p>Storage Dominates Random Location Dense Storage Manual Handling</p> | <p>Dedicated Pick Location Dual Storage Low Density Storage Manual Handling</p> |

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- Warehouse Layouts
- Office Layouts
- Retail Layouts

Office Layouts

- Office productivity is influenced by a number of factors, one of which is office layout. Because office layout influences the entire white-collar-employee segment of the organization, its importance to organizational productivity should never be underestimated. Answers.com
- Office layout is based on the interrelationships among three primary factors:
 - employees,
 - flow of work through the various work units, and
 - equipment.

- Warehouse Layouts
- Office Layouts
- Retail Layouts

Office Layouts

- Four common office layouts:
 1. Traditional layouts
 2. Office landscaping
 3. Activity settings
 4. Electronic cottages

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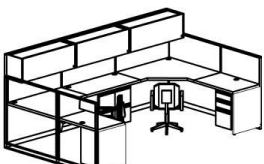
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- Warehouse Layouts
- Office Layouts
- Retail Layouts

Office Layouts

Most formal procedures for designing office layouts try to maximize the *proximity* of workers whose jobs require frequent interaction.

- *Privacy* is another key factor in office design.
- Four common office layouts:
 1. **Traditional layouts**



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High blood pressure? Blame the office layout

By Nic MacBean
 Posted Tue Jan 13, 2009 6:48pm AEDT

Working in open-plan offices is bad for the health and productivity of workers, a Queensland study has found.

Workers are more likely to experience high levels of stress, conflict and blood pressure leading to a high turnover of staff, says study author Dr Vinesh Oommen from the Queensland University of Technology (QUT).

Dr Oommen reviewed all the available literature on the effects of open-plan offices on employees and he said the evidence was "absolutely shocking".

"It has been found that the high level of noise causes employees to lose concentration, leading to low productivity," he said in a statement.

"There are privacy issues because everyone can see what you are doing on the computer or hear what you are saying on the phone, and there is a feeling of insecurity.

"There is also a higher chance of workplace conflicts - sitting so close to someone that each time their phone rings you can get irritated. I think most of us, including myself, can relate to that."



He says 90 per cent of the research found the effects of working in open-plan offices were negative and the conclusion of his study was that small, private, closed offices were better for productivity.

- Warehouse Layouts
- Office Layouts
- Retail Layouts

Office Layouts

Most formal procedures for designing office layouts try to maximize the *proximity* of workers whose jobs require frequent interaction.

- *Privacy* is another key factor in office design.
- Four common office layouts:
 1. Traditional layouts
 2. Office landscaping (cubicles/movable partitions)

- Warehouse Layouts
- Office Layouts
- Retail Layouts

Office Layouts

Most formal procedures for designing office layouts try to maximize the *proximity* of workers whose jobs require frequent interaction.

- *Privacy* is another key factor in office design.
- Four common office layouts:
 1. Traditional layouts
 2. Office landscaping
 3. Activity settings


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- Warehouse Layouts
- Office Layouts
- Retail Layouts

Office Layouts

Most formal procedures for designing office layouts try to maximize the *proximity* of workers whose jobs require frequent interaction.

- *Privacy* is another key factor in office design.
- Four common office layouts:
 1. Traditional layouts
 2. Office landscaping
 3. Activity settings
 4. Electronic cottages (Telecommuting)



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➤ Warehouse Layouts
➤ Office Layouts
➤ Retail Layouts

Retail/Service Layout

A well-planned retail store layout is crucial – it allows a retailer to maximize sales for each square foot of selling space within the shop.
<http://www.james-blake.co.uk/>

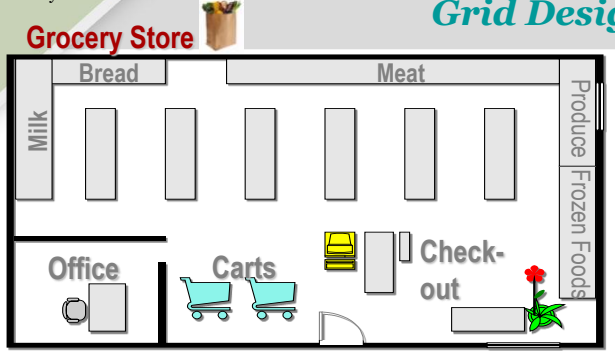
- Design maximizes product exposure to customers
- Decision variables
 - Store flow pattern
 - Allocation of (shelf) space to products
- Types
 - Grid design
 - Free-flow design



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➤ Warehouse Layouts
➤ Office Layouts
➤ Retail Layouts

Retail /Service Layout Grid Design



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➤ Warehouse Layouts
➤ Office Layouts
➤ Retail Layouts

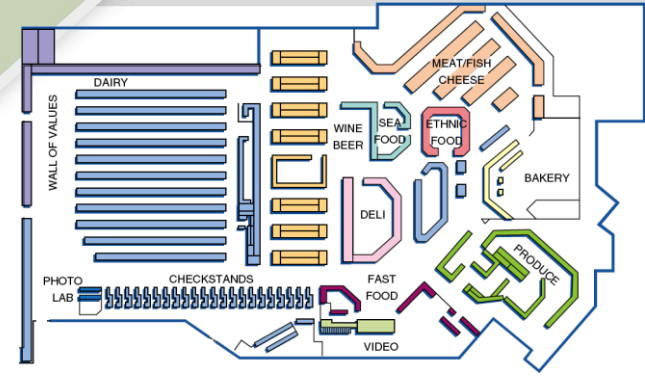
Five Helpful Ideas for Supermarket Layout

1. Locate high-draw items around the periphery of the store
2. Use prominent locations for high-impulse and high-margin items
3. Distribute power items to both sides of an aisle and disperse them to increase viewing of other items
4. Use end-aisle locations
5. Convey mission of store through careful positioning of lead-off department

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➤ Warehouse Layouts
➤ Office Layouts
➤ Retail Layouts

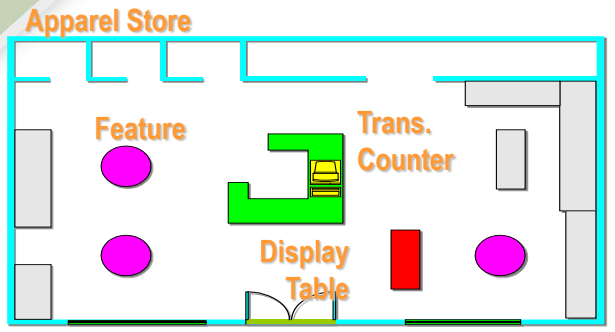
Store Layout



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- Warehouse Layouts
- Office Layouts
- Retail Layouts

Retail/Service Layout Free-Flow Design



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- Warehouse Layouts
- Office Layouts
- Retail Layouts

A Good Service Layout Considers...

- **Ambient conditions** - background characteristics such as lighting, sound, smell, and temperature.
- **Spatial layout and functionality** - which involve customer circulation path planning
- **Signs, Symbols, and Artifacts** - characteristics of building design that carry social significance

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