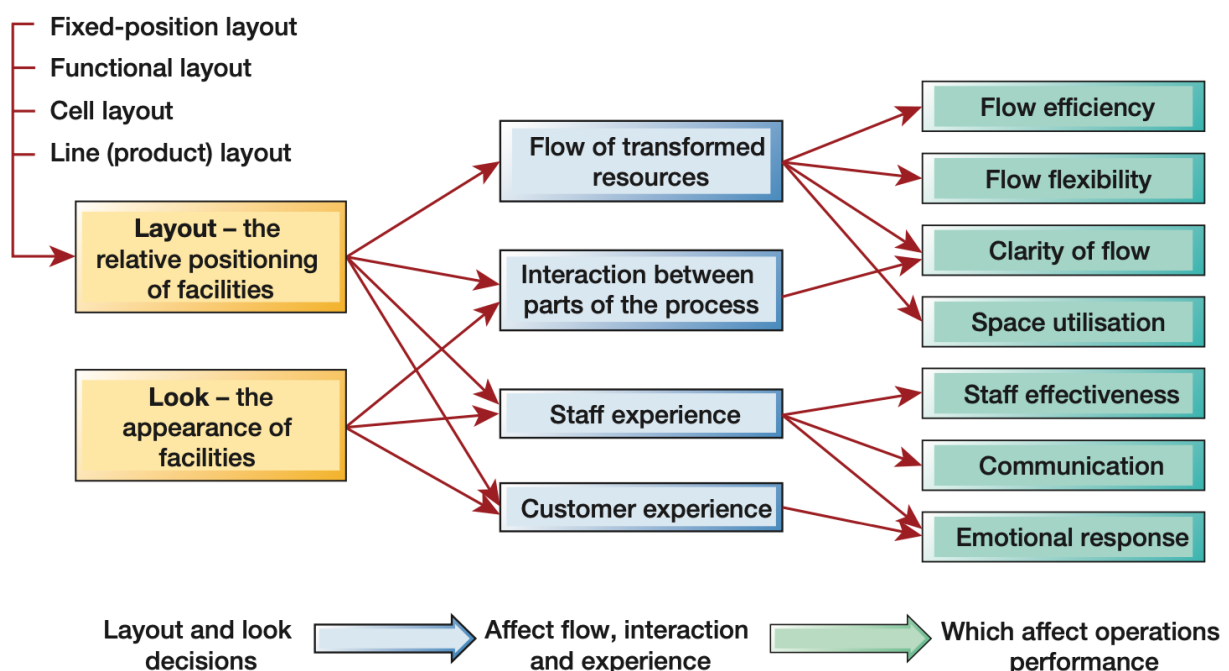


The layout and look of facilities

7.1 How can the layout and look of facilities influence performance?

The layout and look of an operation or process means how its facilities are positioned relative to each other and how their general appearance is designed.

Those decisions dictate the pattern and nature of how transformed resources progress through the operation or process and also affect both how the people who staff the operation and, in high-visibility operations, how customers judge their experience of being in the operation



What makes a good layout?

Common set of criterias that any specific operation is judged against are:

- **Flow of transformed resources** = the route taken by transformed resources as they progress through an operation or process is governed by how its transforming resources are positioned relative to each other. Objective is often to achieve high flow efficiency that minimizes distance travelled, which sometimes only can be achieved by sacrificing **flow flexibility** = the ability of transformed resources to take many different routes
- **Interaction between parts of the process** = individual facilities or parts of a process can suffer or benefit from being positioned close to each other. Dirty processes should not be located near to other parts of the process where their pollution could reduce its effectiveness. May be a positive effect of locating

parts of an operation close to each other (i.e. encourage communication between staff)

- **Staff experience** = layout should not constitute any physical or emotional danger to staff. Unnecessary movement caused by poor layout will take productive time away from value adding tasks
- **Customer experience** = in high-visibility operations the layout and look of an operation can help to shape its image and experience of customers

Reconciling objectives

Some objectives are absolutely required (safety, security, staff welfare) while others can be compromised or traded off with other objectives.

Good use of capital when multiple processes manage to share the same equipment and resources but it could also mean longer and more confused process routes.

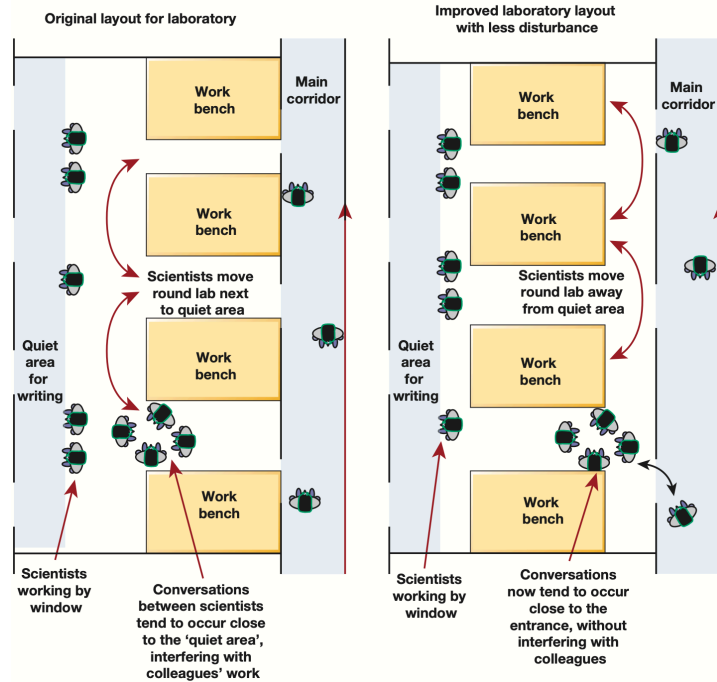
7.2 What are the basic layout types and how do they affect performance?

The four basic layout types from which most practical layouts are derived from are fixed-position, functional, cell, and line/product layout

Manufacturing process type	Potential layout types		Service process type
Project	Fixed position layout Functional layout	Fixed position layout Functional layout Cell layout	Professional service
Jobbing	Functional layout Cell layout	Functional layout Cell layouts	Service shop
Batch	Functional layout Cell layout		
Mass	Cell layout Product layout	Cell layout Product layout	Mass service
Continuous	Product layout		

Fixed-position layout

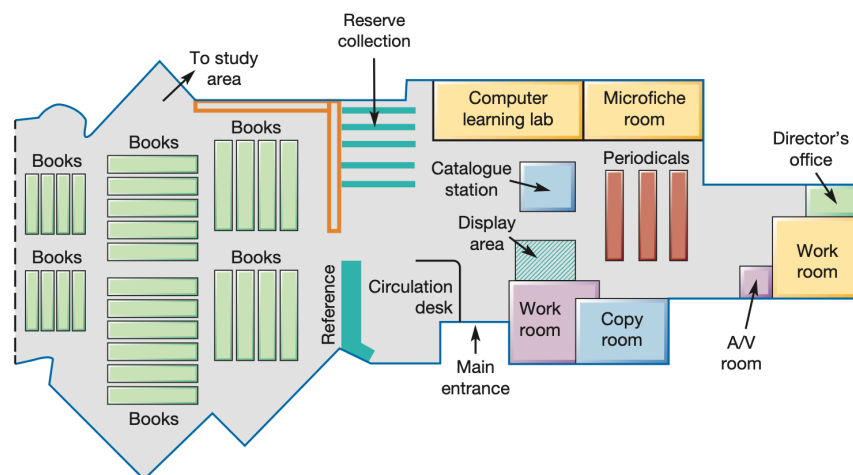
Transformed resources do not move between the transforming resources, instead they flow through an operation where the recipient of the processing is stationary and the facilities and people who do the processing move as necessary.



Functional layout

Similar transforming resources are located together, either because it is convenient to group them together or because their utilization is improved. When transforming resources flow through the operation they take a route from activity to activity according to their needs.

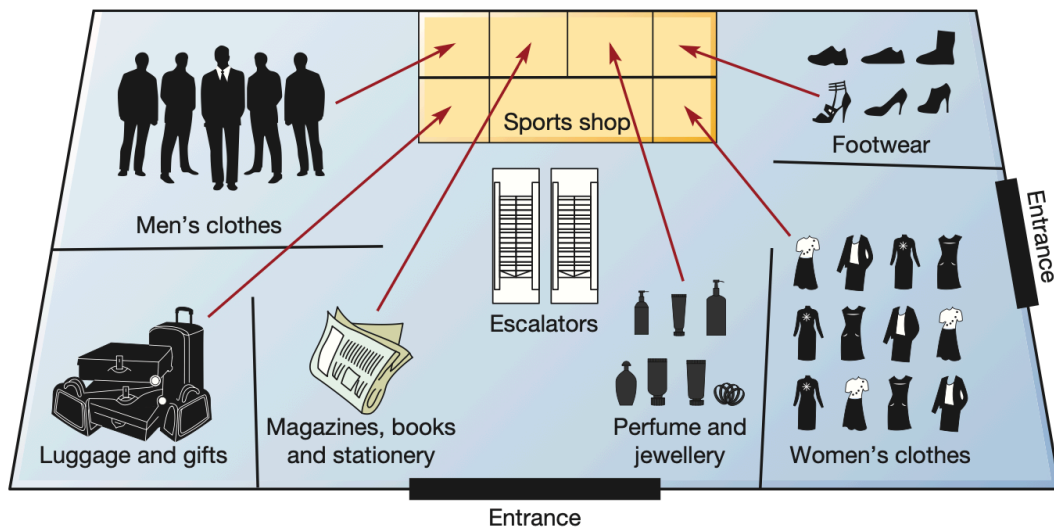
Different products or customers will have different needs and take different routes which usually makes the flow pattern in the operation very complex



Cell layout

Transformed resources entering the operation are pre-selected to move to one part of the operation in which all the transforming resources are located to meet their immediate processing needs. After being processed in the cell the transformed resources may go on to another cell

The cell/operation may be arranged in either a functional or line layout



Line layout

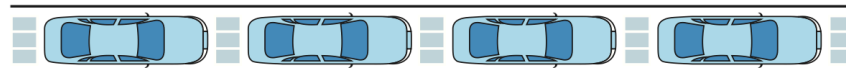
Locating the transforming resources entirely for the convenience of the transformed resources. Each product, piece of information or customer follows a prearranged route in which the sequence of activities required corresponds to the sequence in which facilities have been located.

The transformed resources flow along a line according to their product needs

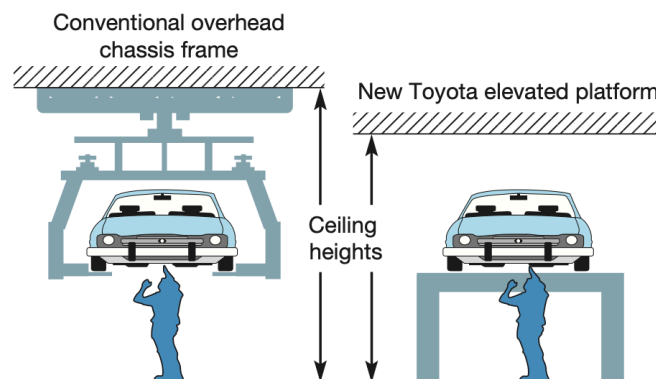
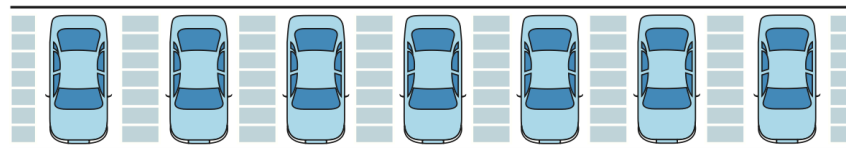
Flow is clear, predictable and easy to control.

The standardized requirements of the product or service usually lead to operations choosing line layouts.

Conventional lengthways assembly line

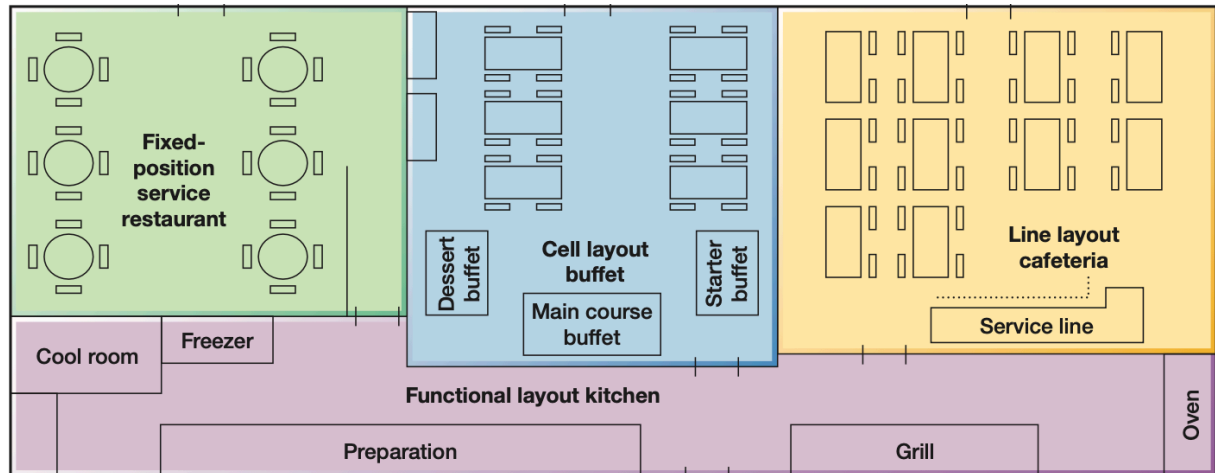


New Toyota sideways line



Mixed layouts

Many operations either design hybrid layouts that combine elements of some or all of the basic layout types or use the pure basic layout types in different parts of the operation.



What type of layout should an operation choose?

The importance of flow to an operation depends on its volume and variety characteristics.

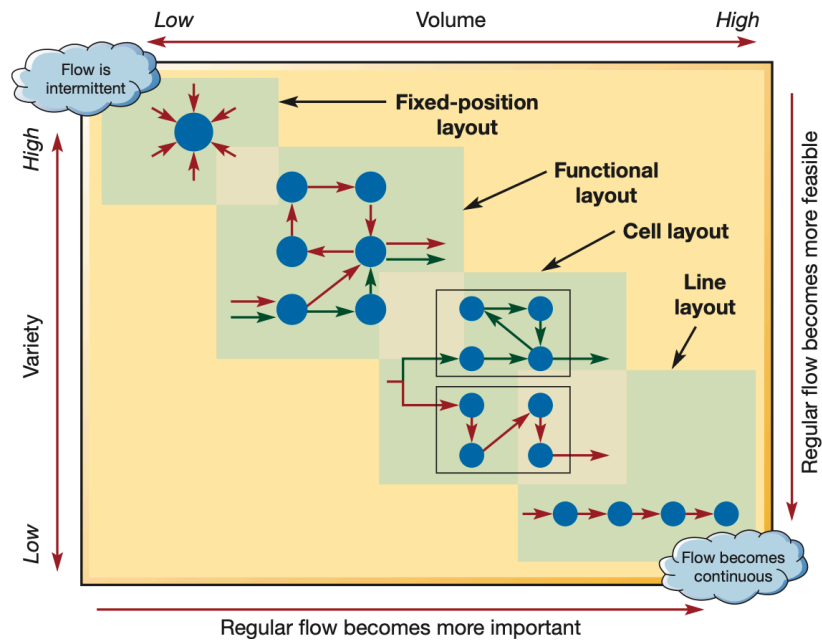
Flow is **not an issue** when **volume is low and variety is high**, but with **high volume and low variety it is problematic**.

High volume and high variety makes it **difficult for an entirely** flow-dominated arrangement since there will be different flow patterns

When customers' needs vary, the layout must be arranged to satisfy the majority of the customers.

When the variety of products/services reduces to the point where a distinct category with similar requirements becomes evident but variety is still not small, cell layout is appropriate

When variety is small and volume high, flow can become regularized and a line layout is appropriate



Advantages

- Very high mix and product flexibility
- Product or customer not moved or disturbed
- High variety of tasks for staff

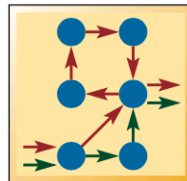
Fixed-position layout



Disadvantages

- Very high unit costs
- Scheduling of space and activities can be difficult
- Can mean much movement of equipment and staff

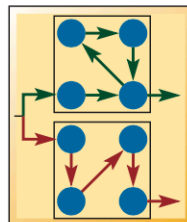
Functional layout



- High mix and product flexibility
- Relatively robust in the case of disruptions
- Relatively easy supervision of transforming resources

- Low facilities utilisation
- Can have very high work-in-progress or customer queuing
- Complex flow can be difficult to control

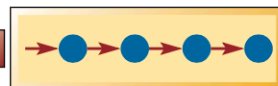
Cell layout



- Gives a compromise between cost and flexibility for relatively high-variety operations
- Fast throughput
- Potential good staff motivation

- Can be costly to rearrange existing layout
- Can require more equipment
- Can give lower equipment utilisation

Line layout



- Low unit costs for high volume
- Gives opportunities for specialisation of equipment
- Materials or customer movement is convenient

- Can have low mix flexibility
- Not very robust if there is disruption
- Work can be very repetitive

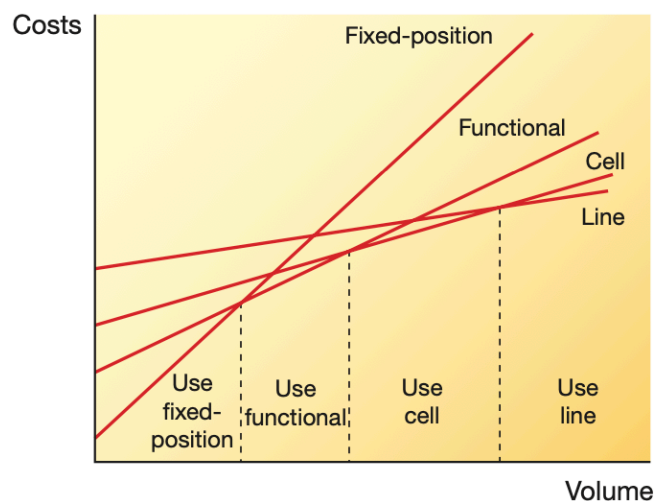
Cost analysis

The unit cost implications of layout choice is understood by distinguishing between the fixed and variable cost elements of adopting each layout type.

For any product/service the fixed costs of physically constructing a fixed-position layout are relatively small compared with any other way of producing the same product or service. The variable costs of producing each individual product or service are relatively high compared to the alternative layout types

Fixed costs tend to increase as one moves from fixed-position through process and cell to line layout, while variable cost per product tend to decrease

Total costs for each layout type depends on the volume of products/services produced



7.3 How does the appearance of an operation's facilities affect its performance?

The aesthetics of an operation can evoke positive or negative emotional response in people and therefore affect their behavior and well-being

The effect of workplace design on staff

Some aspects of workplace design that affects the working people are the temperature, light and other physiological aspects of working – how one fits in the physical working environment

The aesthetics of the workplace reflects the culture of the organization

The Allen curve

Arranging the facilities in any workplace directly influences how physically close individuals are to each other and influences the likelihood of communication between individuals

Allen curve = shows a powerful negative correlation between the physical distance between colleagues and their frequency of communication. It estimates that we are 4 times as likely to communicate regularly with a colleague sitting 2 meters away compared to 20 meters.

The effect of workplace design on customers - servicescapes

Servicescape = the look and feel of the environment within an operation from a customer's perspective

Ambient conditions, space factors and signs and symbols in a service operation will create an environmental experience both for employees and for customers, and the experience should support the service concept

The experience leads to 3 main categories:

1. **Cognitive** (what people think)
2. **Emotional** (what people feel)
3. **Physiological** (what people's bodies experience)

7.4 What information and analysis is needed to design the layout and look of facilities?

Designing the layout and look of any operation's facilities will move on to considering the details of the design by operationalizing the principles that governed the choice of whichever basic layout type was chosen and whatever aesthetic effect is wanted.

Any detailed design should be based on the collection and manipulation of information regarding the nature and volume of the flow that the layout must accommodate and the behavior and preferences of staff and customers.

Information for flow analysis of layouts

Combinatorial complexity = the amount of ways to position facilities relative to each other, it is N factorial ($N!$) and makes optimal layout solutions difficult to achieve in practice

Heuristic procedures = used to treat the combinatorial complexity issue by trying to derive a good suboptimal solution

Information and analysis for the design of fixed-position layouts

In fixed-position arrangements the location of resources is determined on the convenience of transforming resources

Objective of detailed design of fixed-position layouts is to achieve a layout for the operation that allows all the transforming resources to maximise their contribution to the transformation process by allowing them to provide an effective service to the transformed resources.

Information and analysis for the design of functional layout

Information that the designer needs before the process of detailed design in functional layout is:

- **Area** required by each work centre
- **Constraints** on the shape of the area allocated to each work centre
 - **Degree and direction of flow** between each work centre
- **Desirability** of work centres being close together or close to some fixed point in the layout

Minimizing distance travelled

The prime objective of functional layout is usually to minimize the costs to the operation that are associated with flow through the operation, and usually means minimizing the total distance travelled in the operation.

$$\text{Effectiveness of layout} = \sum F_{ij} D_{ij} \text{ for all } i \neq j$$

where

F_{ij} = the flow in loads or journeys per period of time from work centre i to work centre j

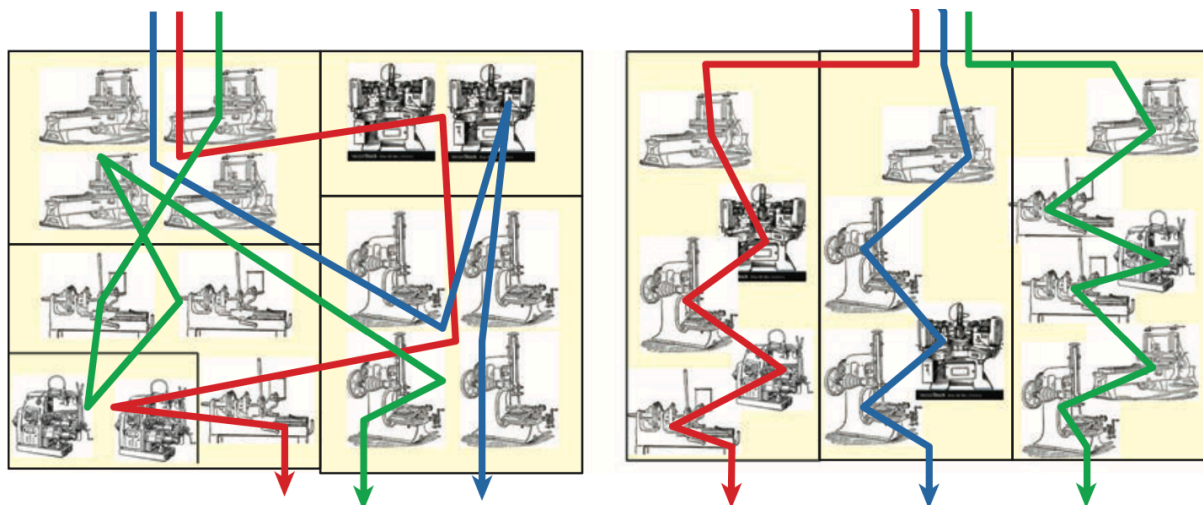
D_{ij} = the distance between work centre i and work centre j .

The lower the effectiveness score the better the layout

Information and analysis for the design of cell layout

When dividing a functional layout into cells, operations management takes 2 interrelated decisions regarding:

- **Extent and nature** of the cells it has chosen to adopt
 - Which **resources** to allocate to which cells



7.14 Cell layout groups the processes together that are necessary for a family of products/services

Production flow analysis

It is difficult to make a detailed design of cellular layouts because of the idea that a cell is a compromise between process and product layout. It is simplified by concentrating on either the process or product aspects of the cell.

Cluster analysis = examining each type of process and asking which other types of processes a product or part using that process is also likely to need

Production flow analysis = approach to allocating tasks and machines to cells, examines both product requirements and process grouping simultaneously

Information and analysis for the design of line layout

Locations are frequently decided upon and then work tasks are allocated to each location. The main product layout decisions are:

- What **cycle time is needed**?
- How many **stages** are needed?
- How should the **task-time variation** be dealt with?
 - How should the layout be **balanced**?
- How should the stages be **arranged**? (long thin or short fat)