

MANUFACTURING PROCESSES (SME 2713)

Introduction 2

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1. Methods of Production

1. Job shop production
2. Batch production, Cellular Manufacturing
3. Mass Production

2. Plant layout

1. Fixed position
2. Process Layout, Cellular Layout
3. Product Layout

3. Manufacturing capability

1. Methods of Production

- ❑ **Manufacturing** is the application of physical and chemical processes to alter the geometry, properties, and/or appearance of a given starting material to make parts or products; **manufacturing** also includes assembly of multiple parts to make products.
- ❑ **Manufacturing** is the **transformation** of materials into items of greater value by means of one or more processing and/or assembly operation.
- ❑ **Manufacturing system** in which the input is processed or transformed into output is implemented in a **manufacturing facility** using a certain **method of production**.

1. Methods of Production

- The **manufacturing facilities** consist of the factory, the equipment in the factory, and the way in which the equipment is organized (the plant layout).
- The facilities "touch" the product.
- The equipment is usually organized into logical groupings, examples: *automated production line, machine cell consisting of an industrial robot and two machine tools.*
- A company designs its manufacturing systems and organizes its factory to serve the particular mission of each plant.

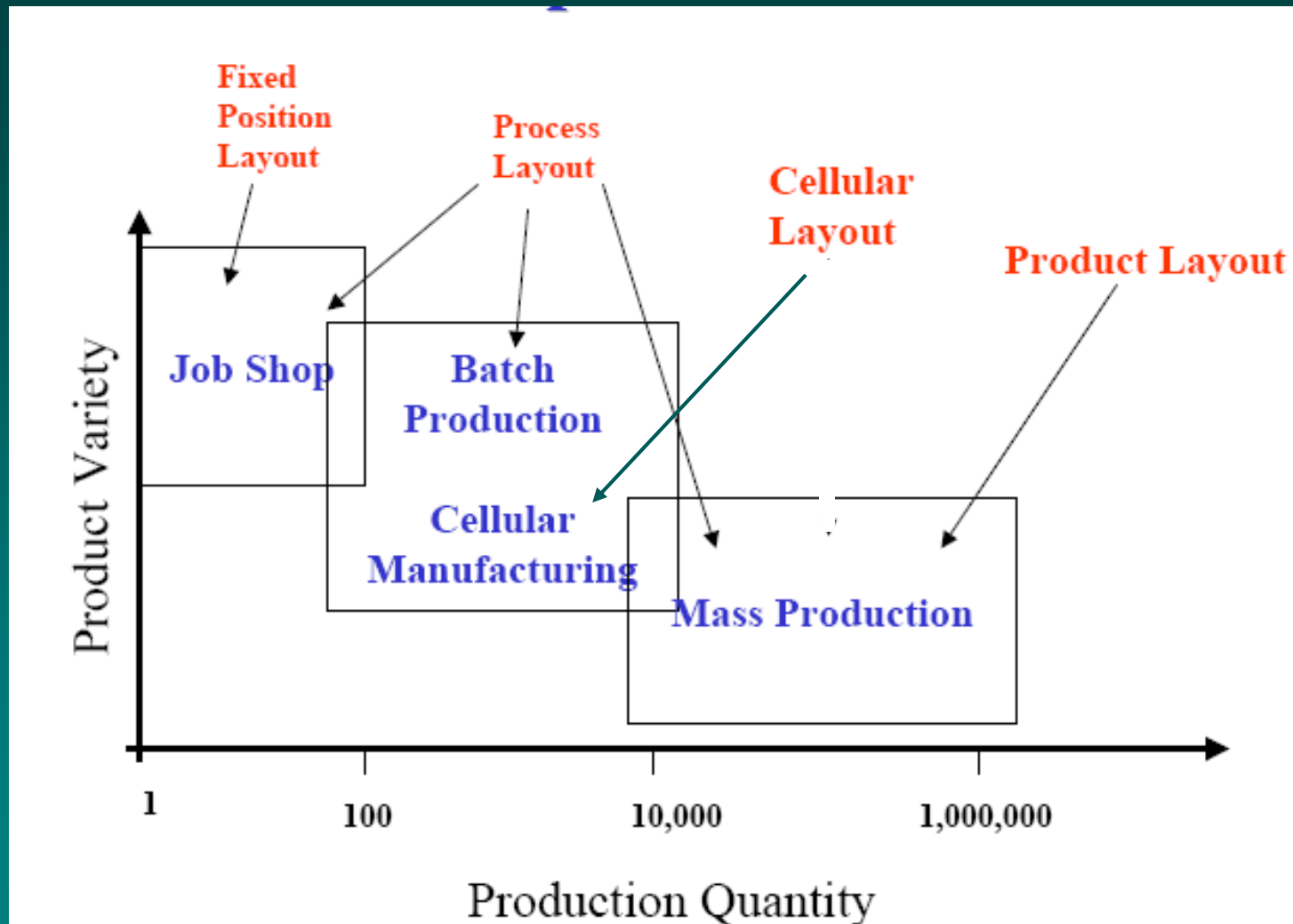
1. Methods of Production

- Certain types of production facilities are recognized as **the most appropriate** for a given type of manufacturing (normally a combination of product variety and production quantity relationship).
- Production quantity is normally classified into **three quantity ranges – low, medium and high.**
- Different production methods and different facilities are required for each of the *three quantity ranges* and also *different product types*.

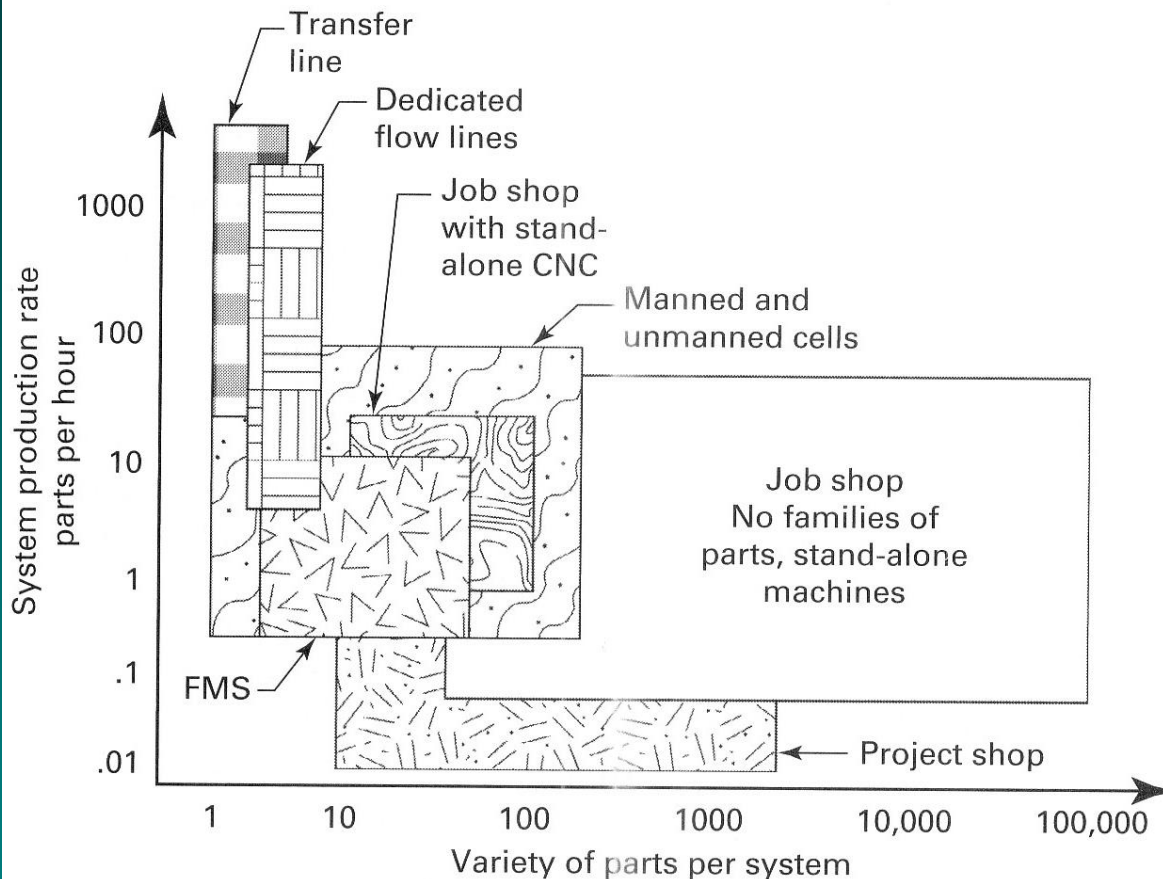
1. Methods of Production

- The methods of production are normally known as
 - Job production (one-off, custom)
 - Batch production & cellular manufacturing
 - Mass production (flow line, continuous)
- Manufacturing facilities are also associated with the methods of production, respectively
 - Fixed position layout
 - Process/functional layout
 - Product layout

1. Methods of Production



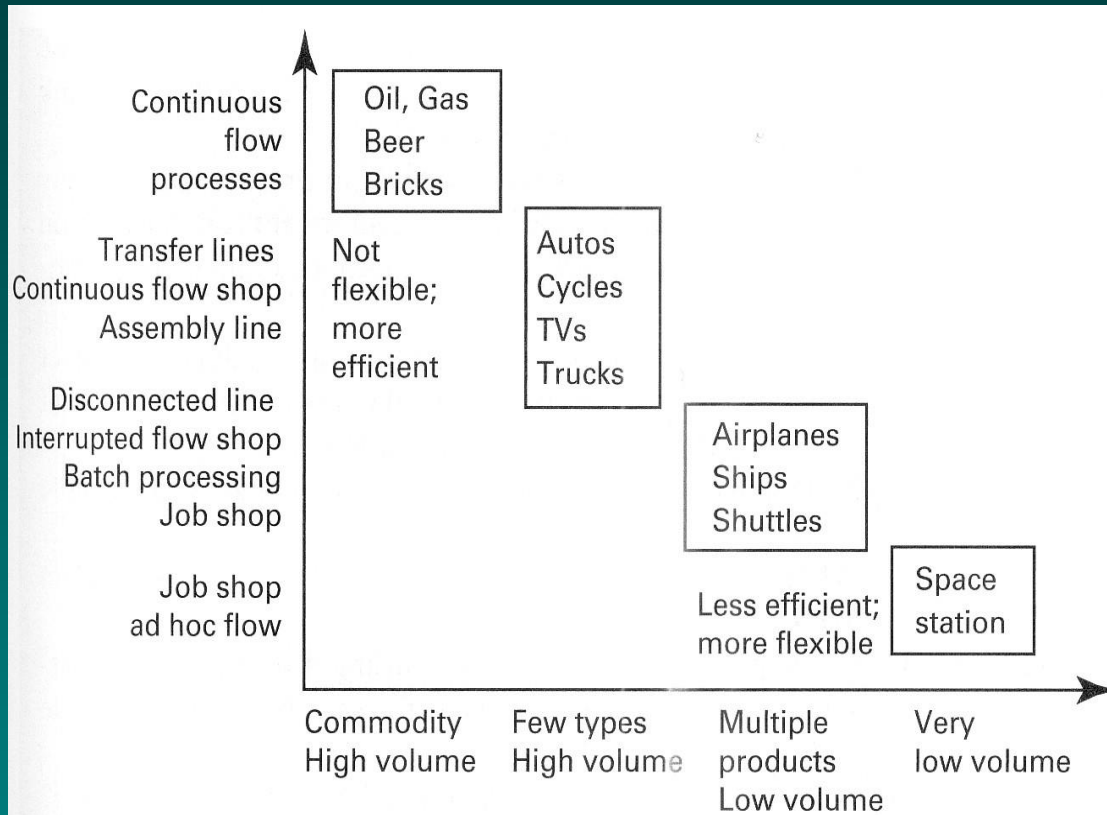
1. Methods of Production



This part variety-production rate matrix shows examples of particular manufacturing system designs. This matrix was developed by Black based on real factory data. Notice there is a large amount of overlap in the middle of the matrix, so the manufacturing engineer has many choices regarding which method or system to use to make the goods. This book will show the connection between the process and the manufacturing system used to produce the products, turning raw materials into finished goods.

FIGURE 1-15 Different manufacturing system designs produce goods at different production rates.

1. Methods of Production



The figure shows in a general way the relationship between manufacturing systems and production volumes. The upper left represents systems with low flexibility but high efficiency compared to the lower right, where volumes are low and so is efficiency. Where a particular company lies in this matrix is determined by many forces, not all of which are controllable. The job of manufacturing and industrial engineers is to design and implement a system which can achieve low unit cost, superior quality, with on-time delivery in a flexible way.

FIGURE 1-16 This figure shows in a general way the relationship between manufacturing systems and production volumes.

Job shop / One-off Production

SINGLE ITEM PRODUCTION



SAMPLE PRODUCTS

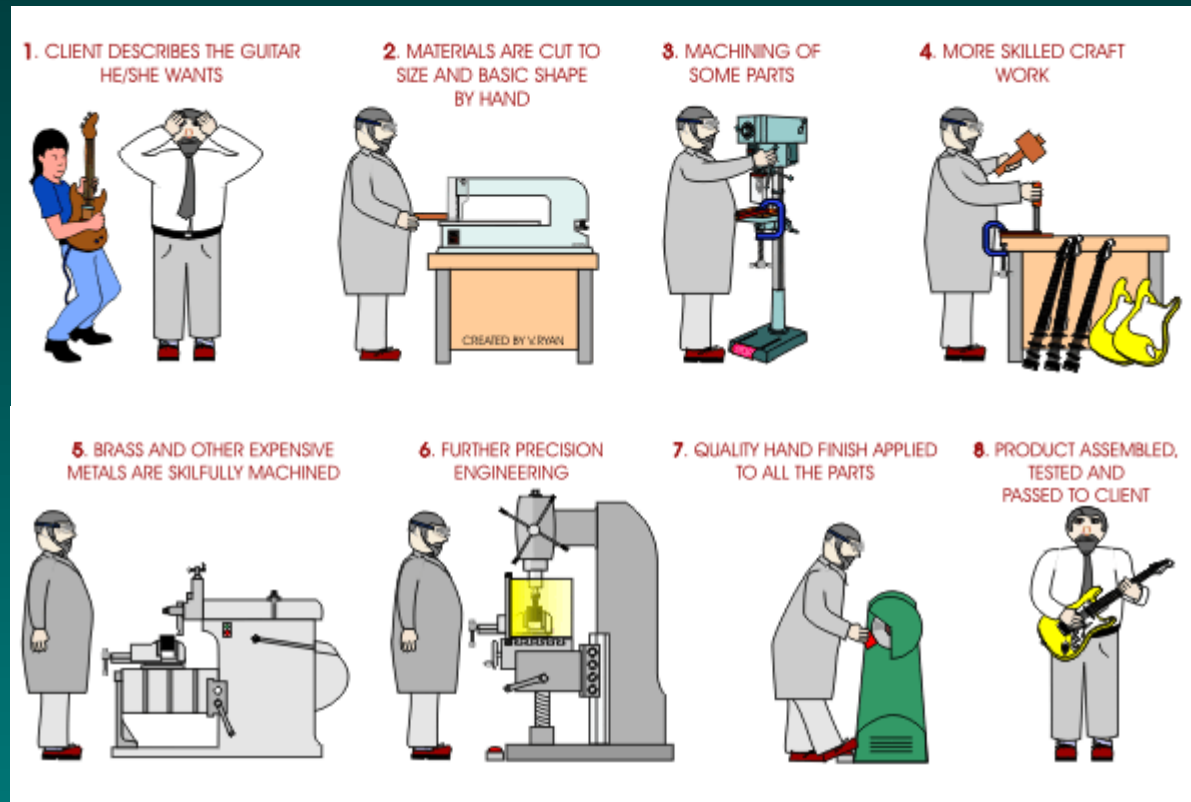
PROTOTYPES

SPECIALIST MODELS

HANDMADE ITEMS

SPECIALIST ENGINEERING

ONE OFFS



A highly specialised company. A small highly skilled workforce, possibly one or two workers, sometimes more. Constant communication with the client, constant discussion regarding the design.

Company specialises in particular areas such as engineering or musical instruments etc...

Specialist materials are often required e.g.. specialist woods or modelling materials

The final product is expensive due to the level of skill needed to manufacture the product and the cost of specialist materials and equipment. A high standard of quality control

Products are manufactured for a specialist market / clientele eg. musicians, medical profession, aerospace

Job shop / One-off Production

- Low quantity range = 1 to 100 units/year
- A job shop makes low quantities or small volumes of specialized and customized products (often craft products), client-based article or a prototype for larger scale production.
- Products are typically complex, e.g., space capsules, prototype aircraft, special machinery, ship making
- Equipment in a job shop is general purpose and flexible enough to meet a variety of needs
- Labor force is highly skilled

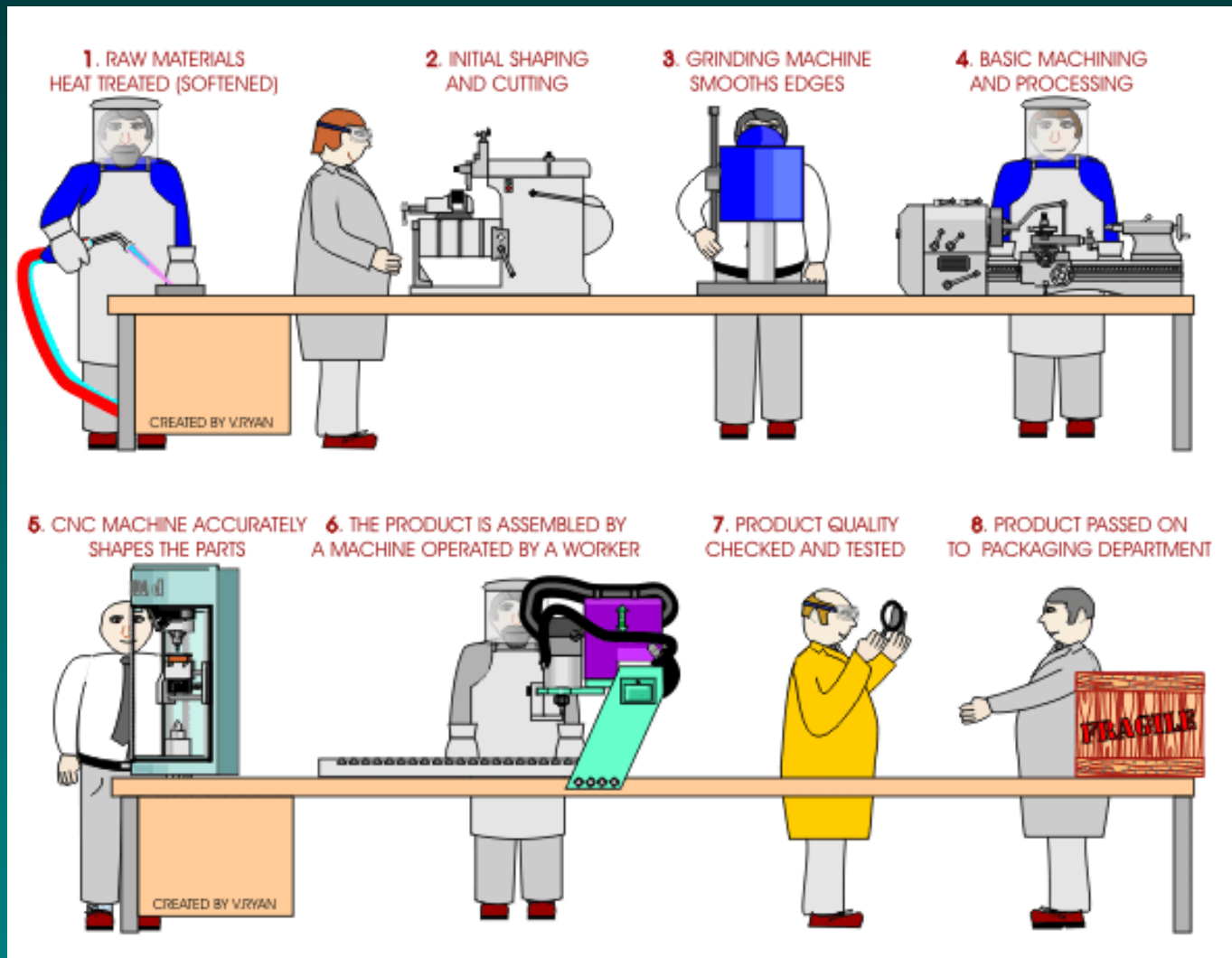
Batch Production

BATCH PRODUCTION



SAMPLE PRODUCTS

FURNITURE
ELECTRICAL
GOODS
CLOTHING
NEWSPAPERS
BOOKS
SAMPLE PRODUCTS



A production line is set up. Each worker completes one task and passes work down the production line to the next worker. The workers are semi skilled or unskilled. The workers must be able to switch from one part of the production line to another

Batch Production

- Medium quantity range = 100 to 10,000 units annually
- Two different types of facility, depending on product variety:
 - Hard product variety: *batch production*
 - Soft product variety: *cellular manufacturing*
- Batch Production Characteristics
 - Functional layout
 - Components manufactured in batches and stored
 - Complicated scheduling / routing

Batch Production

- A batch of one product is made, after which the manufacturing system is **changed over** to produce a batch of the next product, and so on.
- The production rate of the equipment is greater than the demand rate for any single product type, and so the same equipment can be shared among multiple products.
- The changeover between production runs takes time - time to change tooling and set up the machinery.

Batch Production

- This setup time is lost production time, and this is a disadvantage of batch manufacturing.
- Batch production is commonly used for make-to-stock situations, in which items are manufactured to replenish inventory that has been gradually depleted by demand

Batch Production/Cellular Mfg

- *Batch production*
 - *Hard product variety* - products differ substantially, and there are few, if any, common parts, e.g., the difference between a small car and a large truck
- *Cellular Manufacturing*
 - *Soft product variety* - small differences between products, e.g., differences between car models made on the same production line, in which there is a high proportion of common parts among models

Batch Production/Cellular Mfg

- If product variety is soft, extensive **changeovers** between one product style and the next may **not** be necessary. It is often possible to configure the manufacturing system so that **groups of similar products can be made on the same equipment without significant lost time due to setup.**
- The processing or assembly of different parts or products is accomplished in cells consisting of several workstations or machines.

Batch Production/Cellular Mfg

- The term *cellular manufacturing* is often associated with this type of production. Each cell is designed to produce a limited variety of part configurations; that is, the cell specializes in the production of a given set of similar parts, according to the principles of *group technology*. The layout is called *a cellular layout* (the term *group technology layout* is also common)

Batch Production

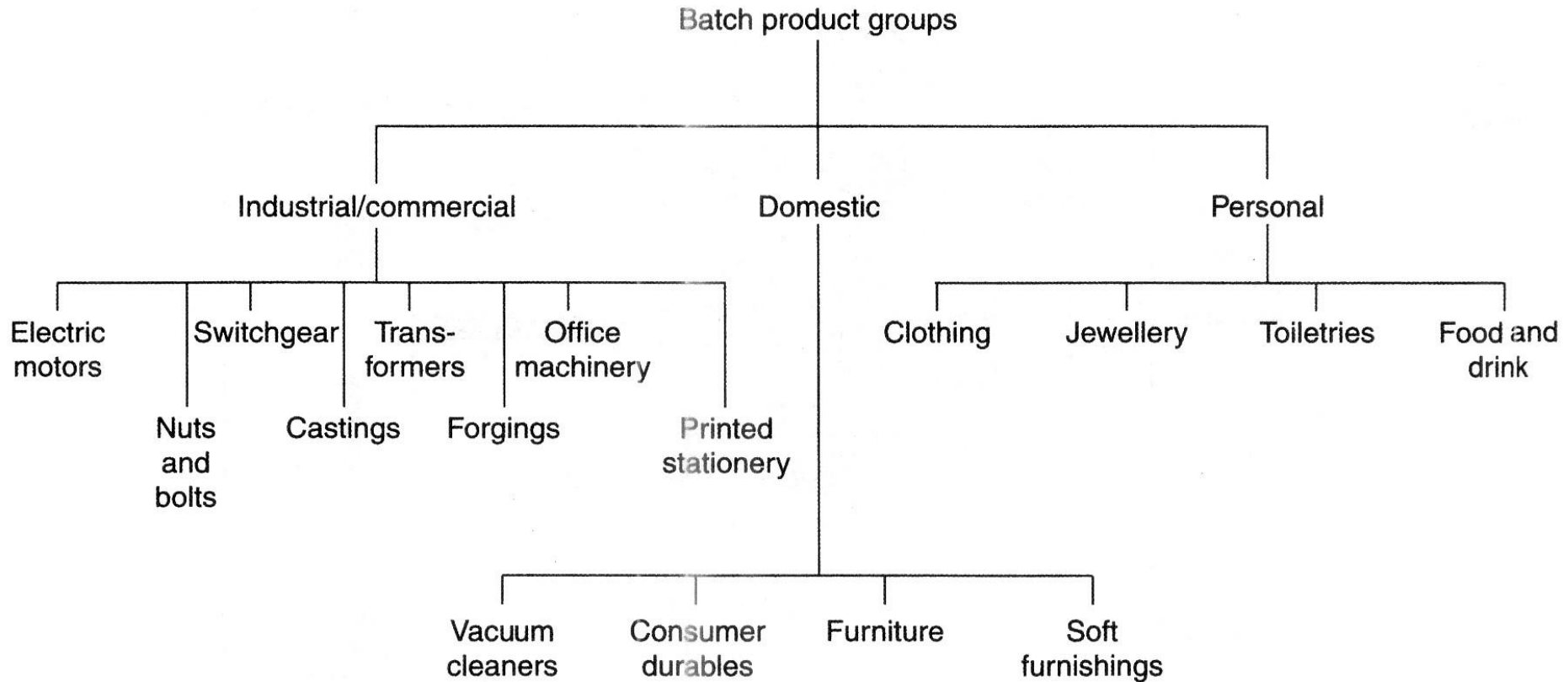


Figure 1.30 Some typical batch product groups.

Continuous Production

CONTINUOUS PRODUCTION



SAMPLE PRODUCTS

CARS
PETROL / OIL PRODUCTS
BRICKS
MANY FOOD PRODUCTS
WASHING POWDER
WASHING-UP LIQUID
CARS
CHEMICALS
ELECTRONIC COMPONENTS
PAPER / PULP PRODUCTS

An semi-automated production line is normally set up. Relying on computer control as well as human labour. Workforce comprised of skilled and unskilled workers.

The pine trees are cut down using equipment such as chain saws



Controlled lifting gear lifts the tree trunks on to trucks for transport to the pulp processing factory.



Tree trunks are removed from the trucks by lifting equipment. The trucks are stockpiled for use 24 hours a day.



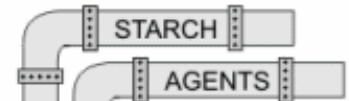
Each trunk is fed into a chipping machine where it is cut into very small pieces. Mechanised equipment controlled by workers is used at this stage.



The wood chips are boiled in water to form a thick wood pulp



Chemicals / ingredients such as starch and bonding agents are added. The pulp is poured over a fine mesh and the water escapes leaving the cellulose fibres behind. This forms the paper.



Mass Production

- High quantity range = 10,000 to millions of units per year
- Referred to as *mass production*
 - High demand for product
 - Manufacturing system dedicated to the production of that product
- Two categories of mass production:
 1. Quantity production
 2. Flow line production

Large volume production

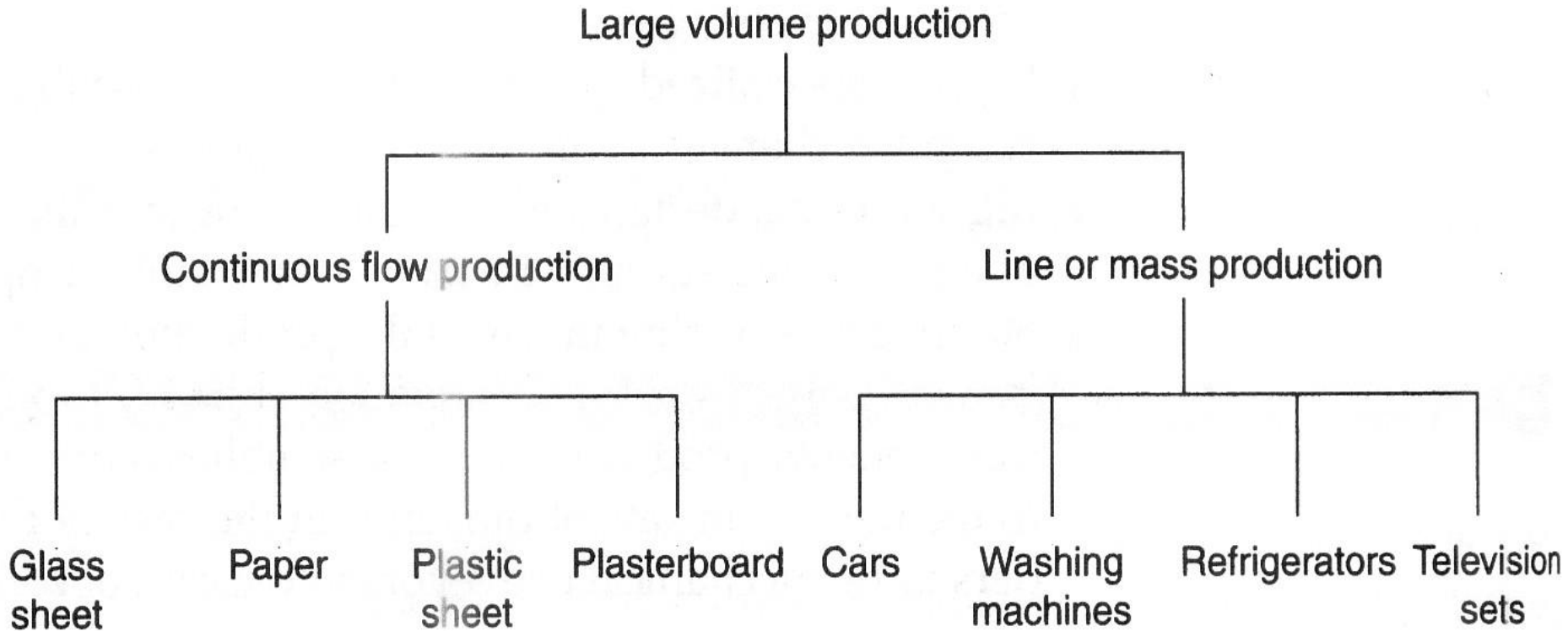


Figure 1.28 Large volume production.

Quantity Production

Mass production of single parts on single machine or small numbers of machines

- Typically involves standard machines equipped with special tooling
- Equipment is dedicated full-time to the production of one part type
- Typical layouts used in quantity production is **product layout**

Flow Line Production

Multiple machines or workstations arranged in sequence, e.g., production lines

- Product is complex and requires multiple processing and/or assembly operations
- Work units are physically moved through the sequence to complete the product
- Workstations and equipment are designed specifically for the product to maximize efficiency

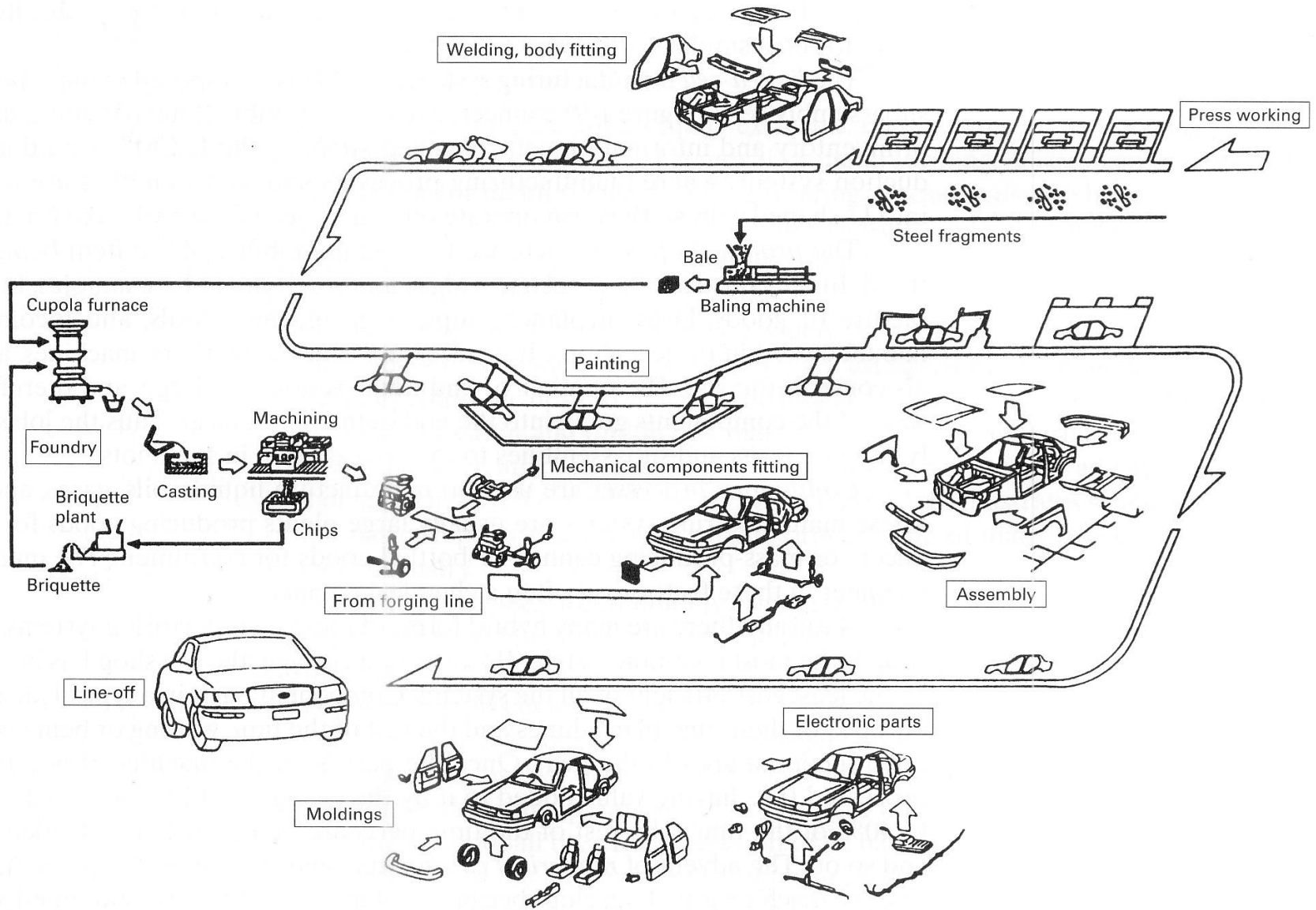


FIGURE 1-8 The moving assembly line for cars is an example of the flow shop.

Mass Production

- Manufacturing or processing of uniform products in large quantities using interchangeable parts and machinery. Mass production is either a wholly automated process or a series of short, repetitive procedures.
- Application of the principles of specialization, ***division of labour***, and standardization of parts to the manufacturing of goods on a large scale.

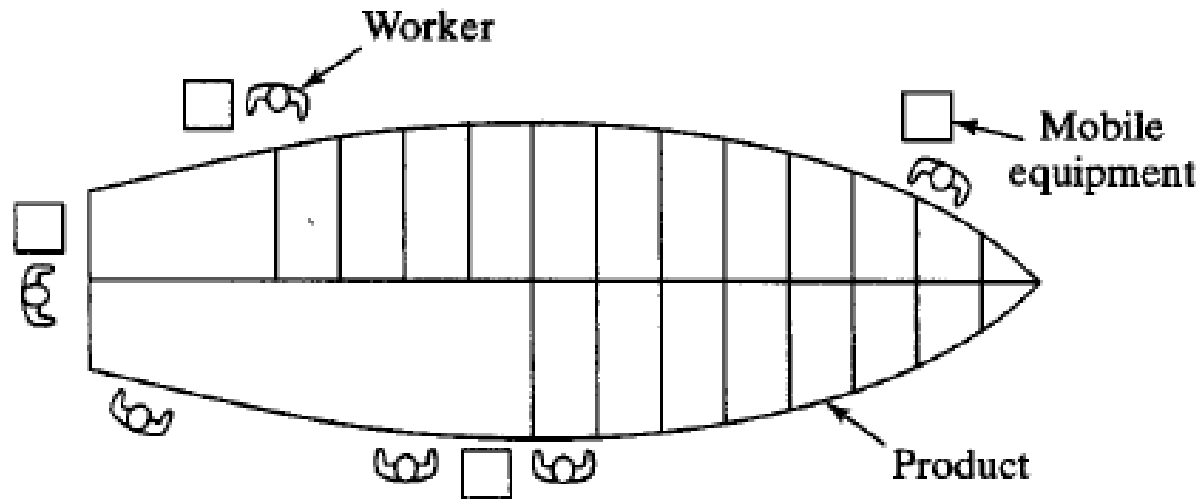
Mass Production

- Modern mass-production methods have led to such improvements in the cost, quality, quantity, and variety of goods available that the largest global population in history is now sustained at the highest general standard of living ever.
- The requirements for mass production of a particular product include the existence of a market large enough to justify a large investment; a product design that can use standardized parts and processes; *a physical layout that minimizes materials handling; division of labour into simple, short, repetitive steps; continuous flow of work; and tools designed specifically for the tasks to be performed.*

2. Plant Layout

- There is a very close relationship between the types of production and the arrangement of facilities in the factory.
- The basic plant layout can be classified into three types namely
 - Fixed position layout
 - Process layout, cellular layout
 - Product layout
- The physical size, quantity, and variety of products being manufactured often dictate the way in which a plant is organized.

Fixed position layout



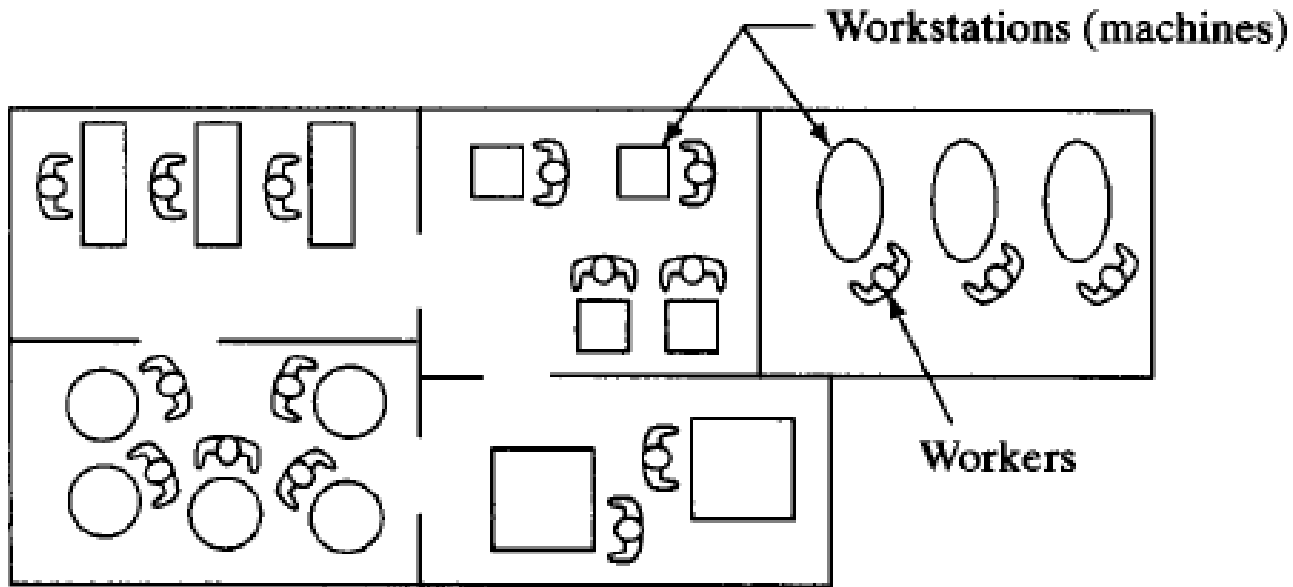
Workers and equipment move around product.

Fixed position layout

Boeing 767-400 Assembly line



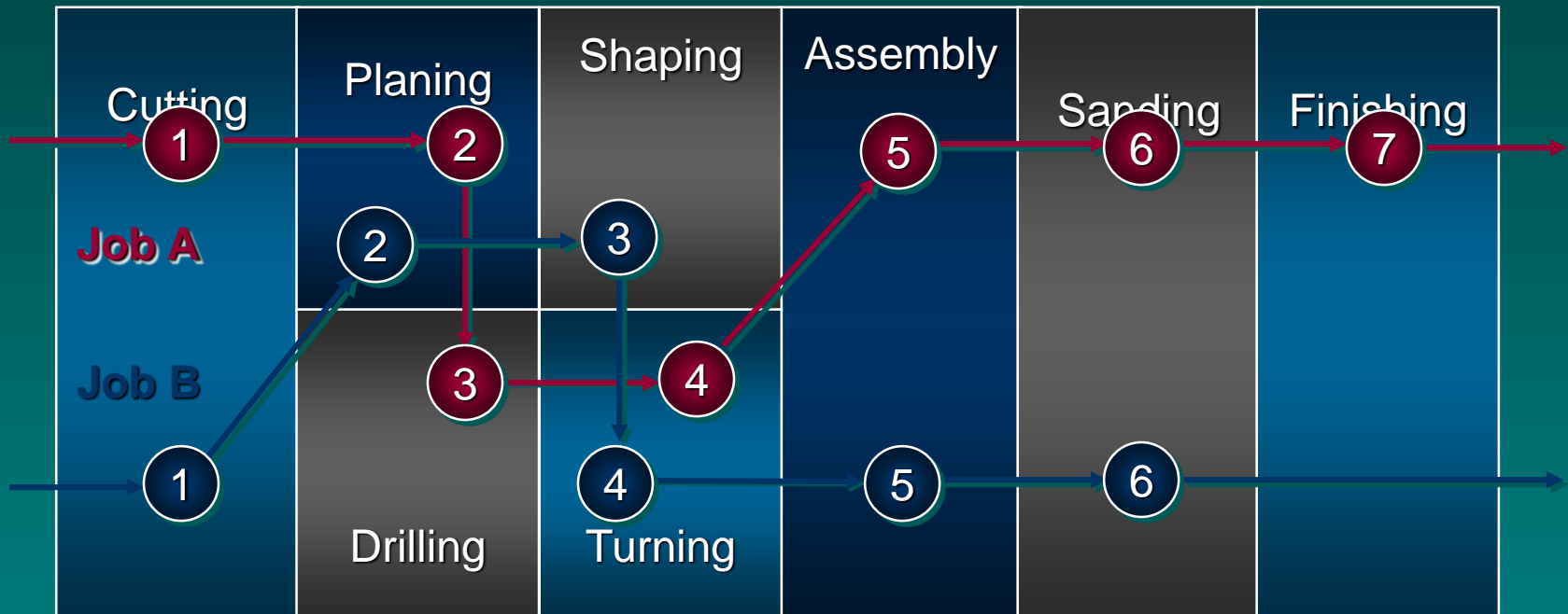
Process layout



Common operations or processes are grouped together.

Process-Focused

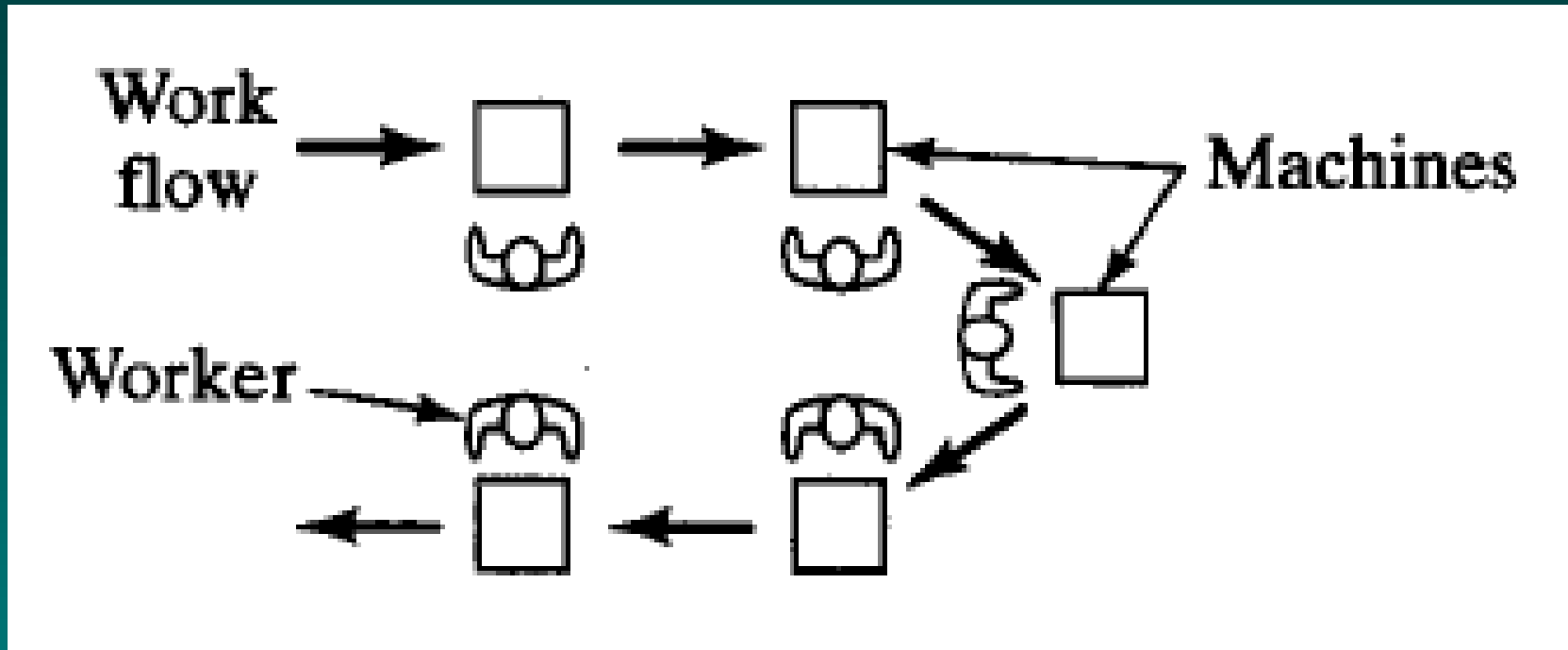
Custom Woodworking Shop



Process layout

- Different parts, each requiring a different operation sequence, are routed through the departments in the particular order needed for their processing, usually in batches.
- The process layout is noted for its flexibility: it can accommodate a great variety of operation sequences for different part configurations.
- Its disadvantage is that the machinery and methods to produce a part are not designed for high efficiency

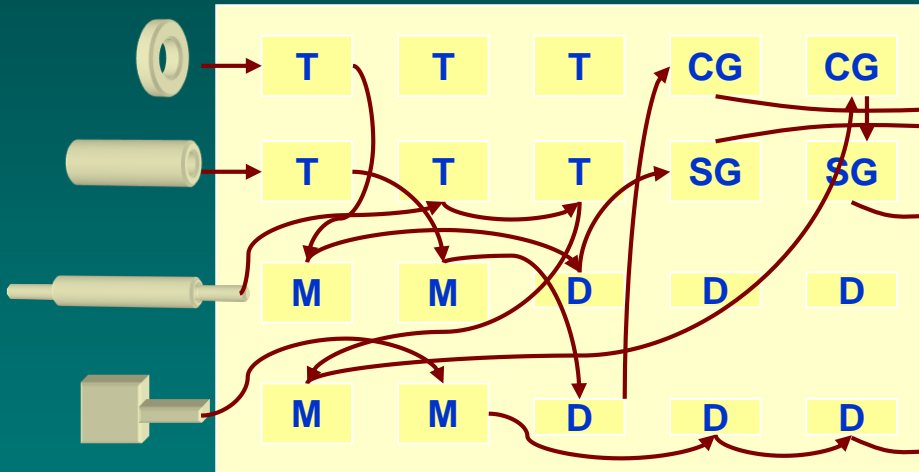
Cellular layout



Each manufacturing cell specializes in the production of a given set of similar products

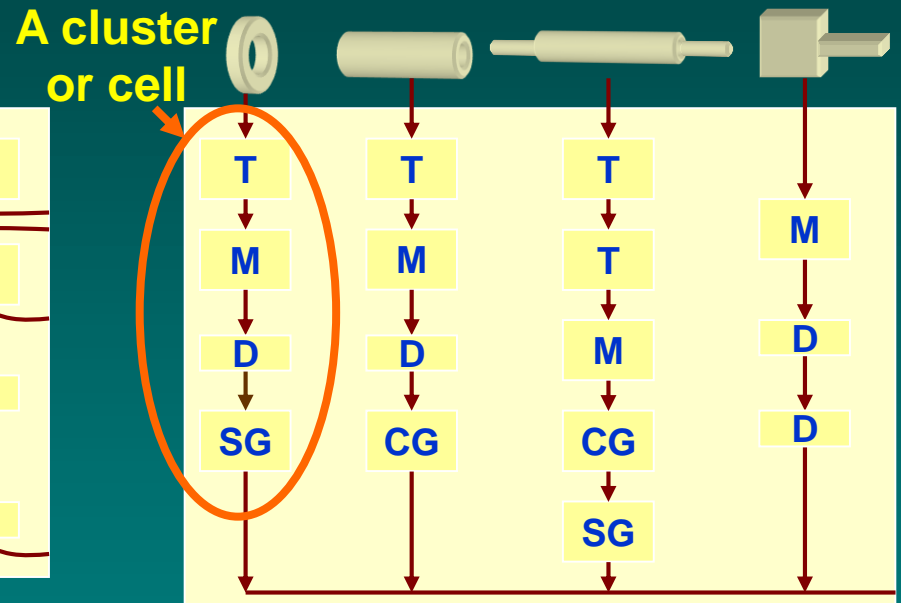
Manufacturing Layout

Process (Functional) Layout



Like resources placed together

Group (Cellular) Layout

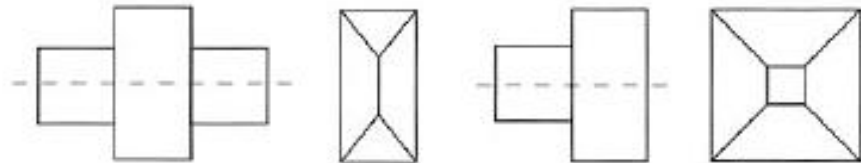
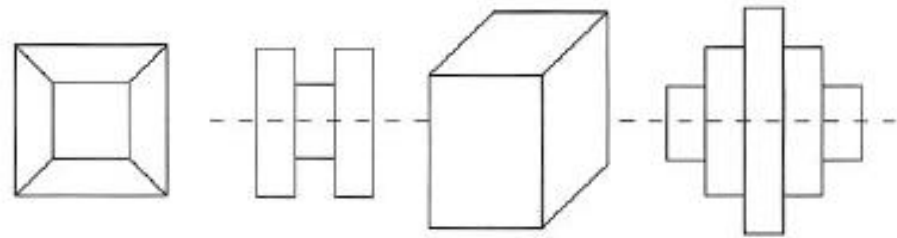


Resources to produce like products placed together

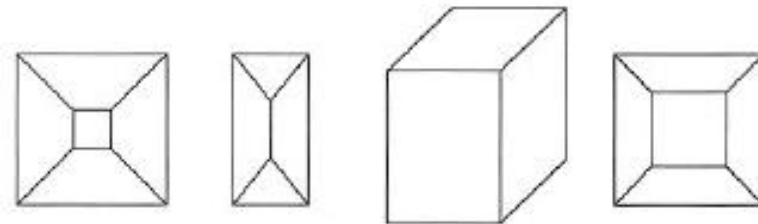
Part Family

- A Part Family is a collection of parts which are similar either because they possess similarities in geometric shape and size, or because similar processing steps are used in their manufacture.
- Part families are a central feature of group technology.
- There are always differences among parts in a family (Fig. 12.1).
- But the similarities are close enough that the parts can be grouped into the same family

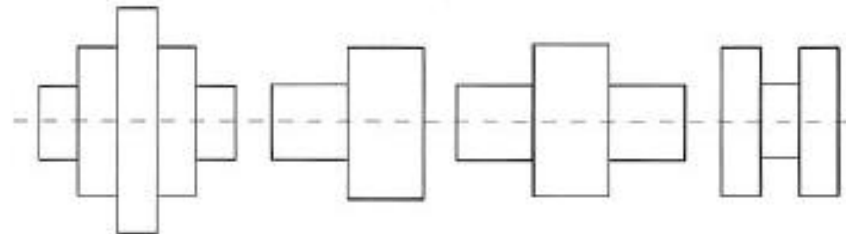
Rearrange- ment of parts



(a)



Part family 1: Prismatic parts



Part family 2: Rotational parts

(b)

Part family

Part Families

PF : A collection of parts that are similar either because of geometric shape and similar processing steps are required in their manufacture.

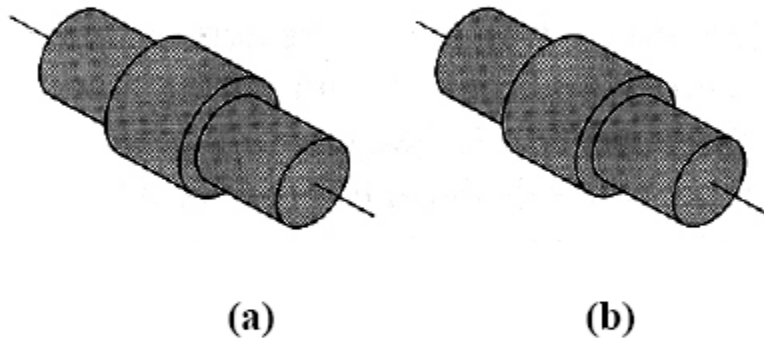


Figure 15.1 Two parts of identical shape and size but different manufacturing requirements: (a) 1,000,000 pc/yr, tolerance = ± 0.010 in, material = 1015 CR steel, nickel plate; and (b) 100 pc/yr, tolerance = ± 0.001 in, material = 18-8 stainless steel.

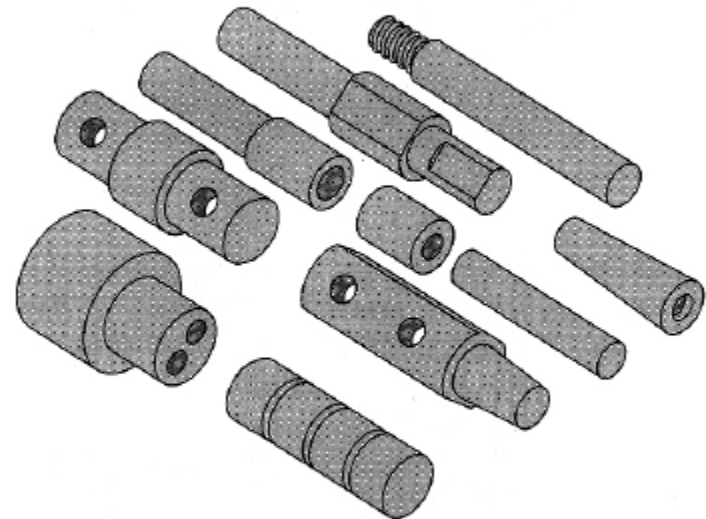
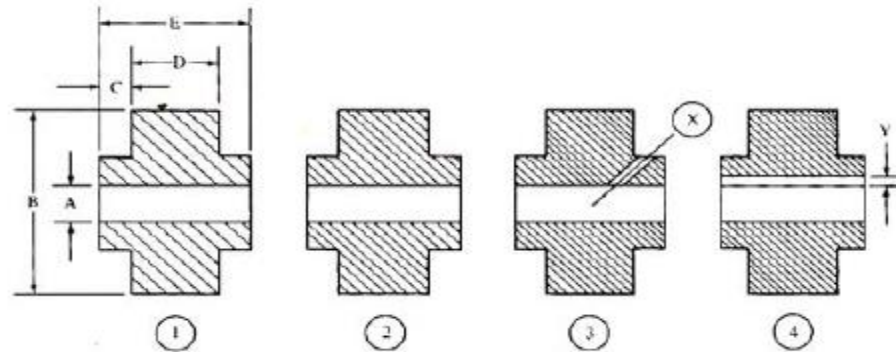


Figure 15.2 A family of parts with similar manufacturing process requirements but different design attributes. All parts are machined from cylindrical stock by turning; some parts require drilling and/or milling.

Part family

■ Parts grouped by geometric shape

FIGURE 5.3 Parts grouped by geometric shape. (Reprinted with permission from Ref. 15.)



■ Parts grouped by manufacturing process

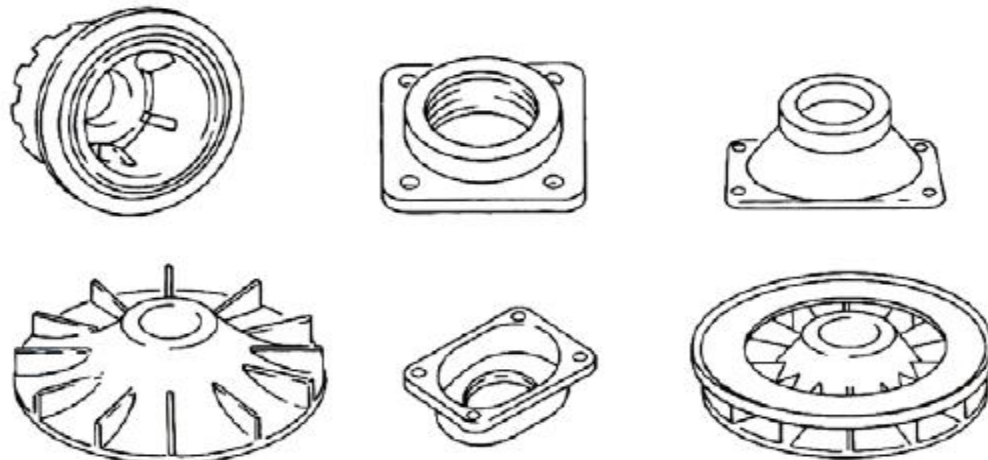
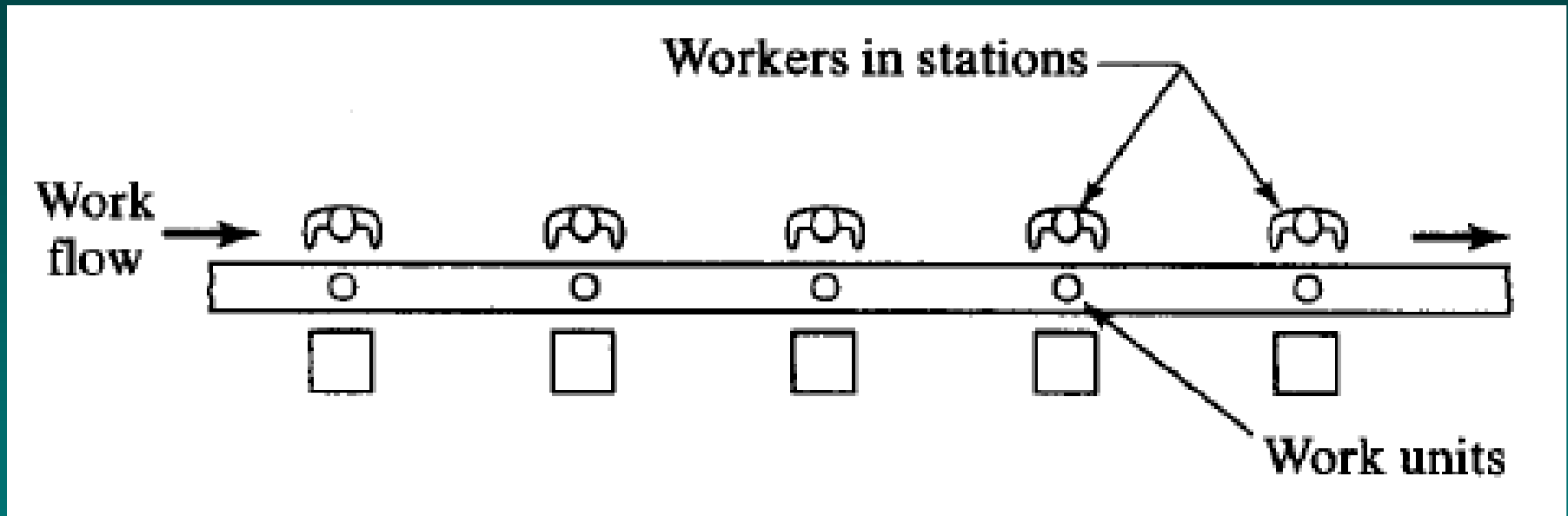


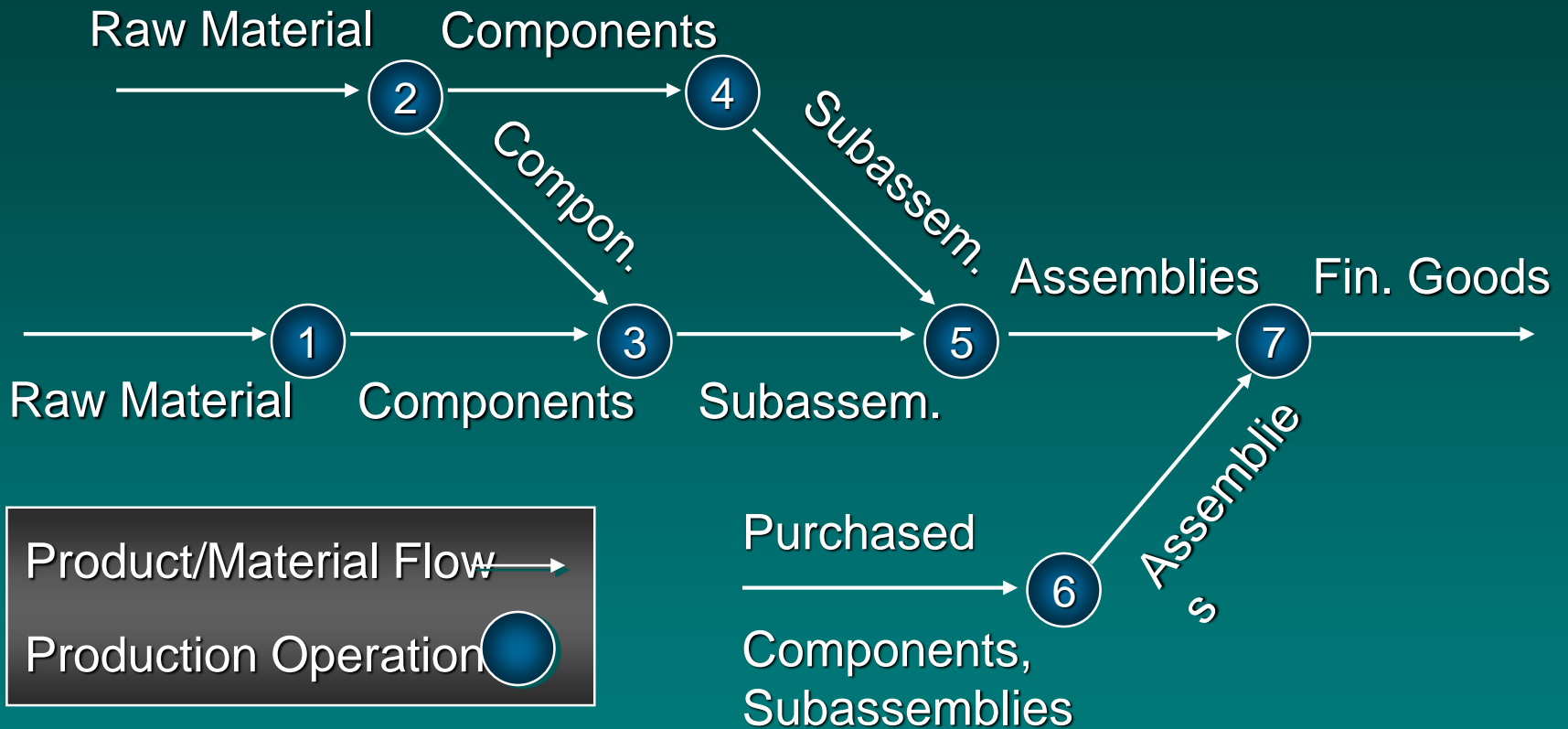
FIGURE 5.4 Parts grouped by manufacturing process. (Reprinted with permission from Ref. 15.)

Product layout



Collection of workers and stations are designed specifically for the product being produced

Product-Focused





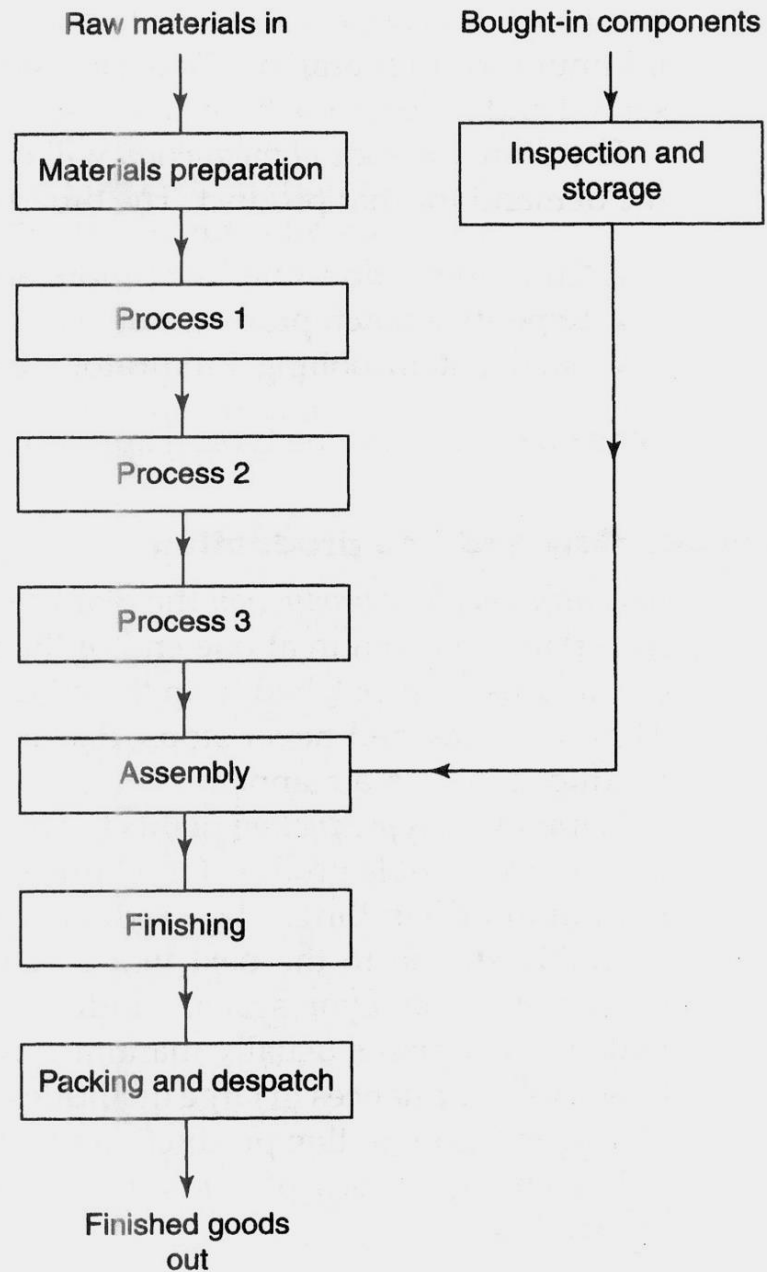


Figure 1.27 Layout for a flow production plant.