TOPIC OUTLINE

- What is manufacturing?
- Historical development of manufacturing technology
- Economic role of manufacturing
- Manufacturing as a technical activity
- Manufacturing organization and enterprise
- Standard measurement and measurement inspection

LESSON OUTCOMES

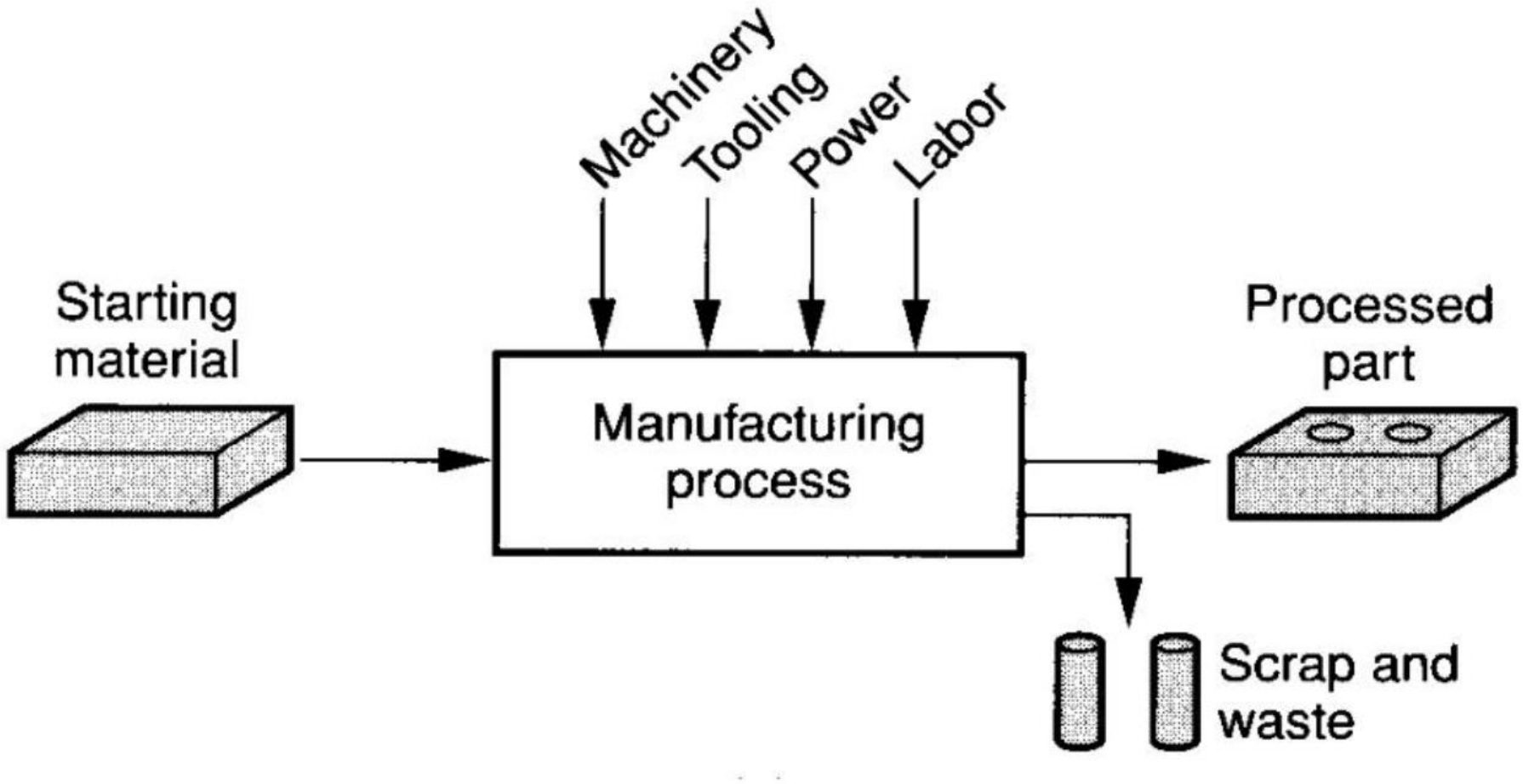
1. Able to describe what the manufacturing technology is and its role in a country economy
2. Able to explain the interconnected activities involved in product realization
3. Able to identify the use and method to take reading of basic measuring instruments

What is manufacturing?

- Literal: Manufacture = Manus (hand) + Factus (make) → Made by hand
- Technological: Application of physical and chemical processes to make parts or products, including assembly of products.
- Economical: Transformation of materials into items of greater value by means of processing and/or assembly operations.
- CIRP definition: Design + production + assembly

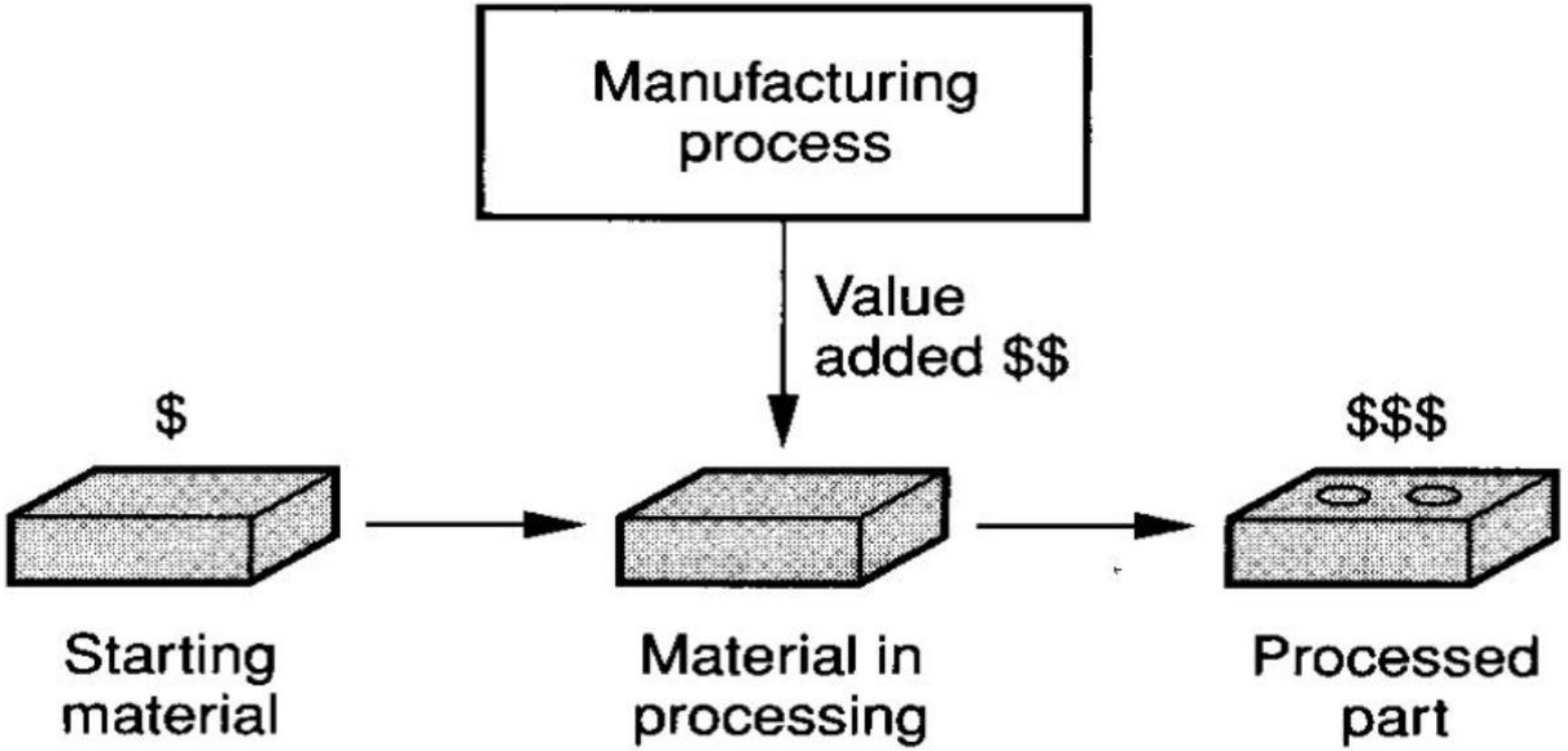
(CIRP = International Academy for Production Eng.)

What is manufacturing?



Representation of ‘manufacturing’ in a technological way

What is manufacturing?



Representation of 'manufacturing' in a economical way

Importance of Manufacturing

- Manufacturing is an important mean to create material wealth!!!
- One job in a manufacturing plant generates about four other jobs else!!! Question: How?
- Data from the USA:
  - Manufacturing : ~ 20% of the GNP
  - Agriculture, mining : < 5% of the GNP
  - Construction, public utilities : ~ 5% of the GNP
  - Service sector : ~ 70% of the GNP

(GNP = Gross National Product)

Question: What are the figures for MALAYSIA?

Historical Perspective (1)

In broad outlines:

- Man's discovery and invention of materials and processes to make things, since 6000 years ago
- Principle of division of labour → Adam Smith (~1750) Industrial Revolution (1770 – 1850), steam engine, machine tools, machinery for textile industry Factory system, UK
- American system, interchangeable parts → Whitney (~1800), guns (muskets), USA
- Second Industrial revolution → mass production, scientific management, assembly lines, Ford (~1915), cars, USA

Historical Perspective (2)

Manufacturing materials and processes:

- Neolithic period (~8000 - 3000 B.C.) in Mesopotamia Mediterranean, Asia; hammering, gold
- Bronze age (3500 - 1500 B.C.), extracting copper from ores, casting, hammering.
- Iron age (since 1000 B.C.), heating, quenching
- Industrial Revolution (1770 - 1850), machining like boring, turning, drilling, milling, shaping.
- Assembly methods (since ancient cultures), ships, weapons, tools, farming equipment
  Fusion welding (around 1900)
- Rubber and polymer shaping, vulcanization (1939)

Industries and Products

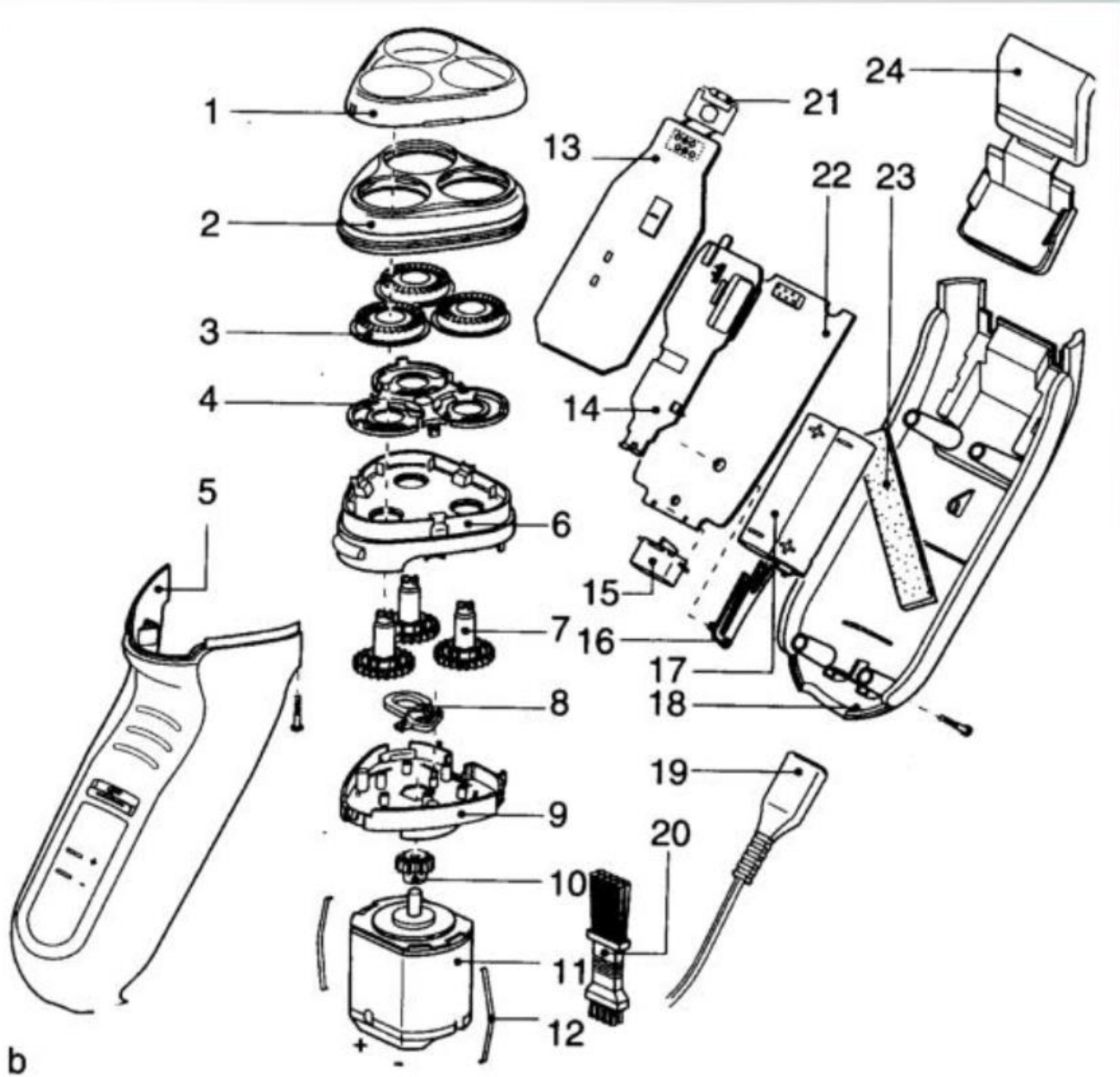
Manufacturing industries

- Primary industries: natural resources as mining, fishing, agriculture, petroleum
- Secondary industries: automotive, computers, electronics
- Tertiary industries (service): banking, tourism, education

Manufactured products

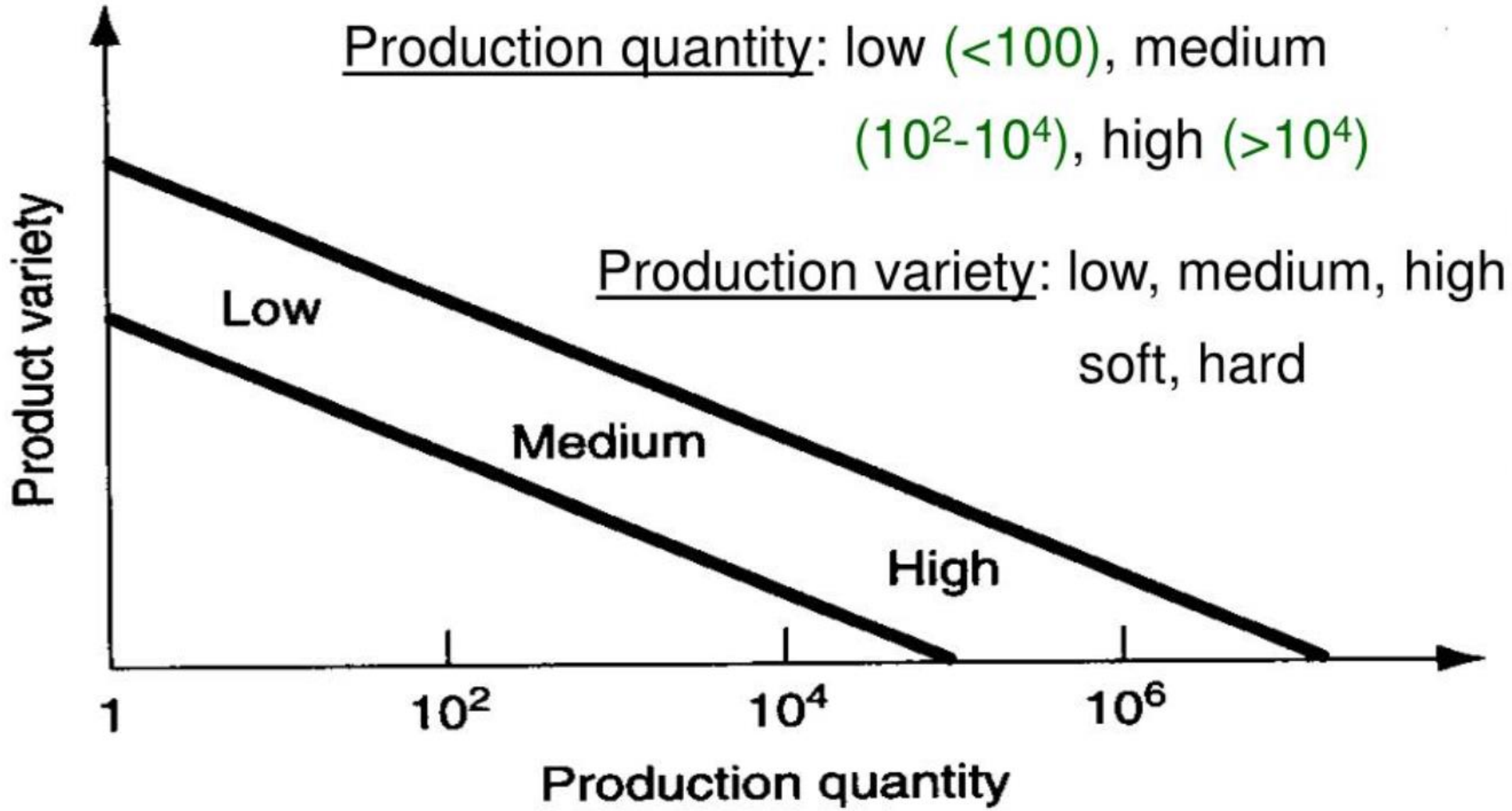
- Consumer goods: cars, TV's, tires, tennis rackets
- Capital goods: aircraft, machine tools, machinery
- Discrete products: pumps, shavers, coffee makers
- Continuous produced products: sheet-metal coils

Product Example



Electric shaver

Production Quantity & Variety



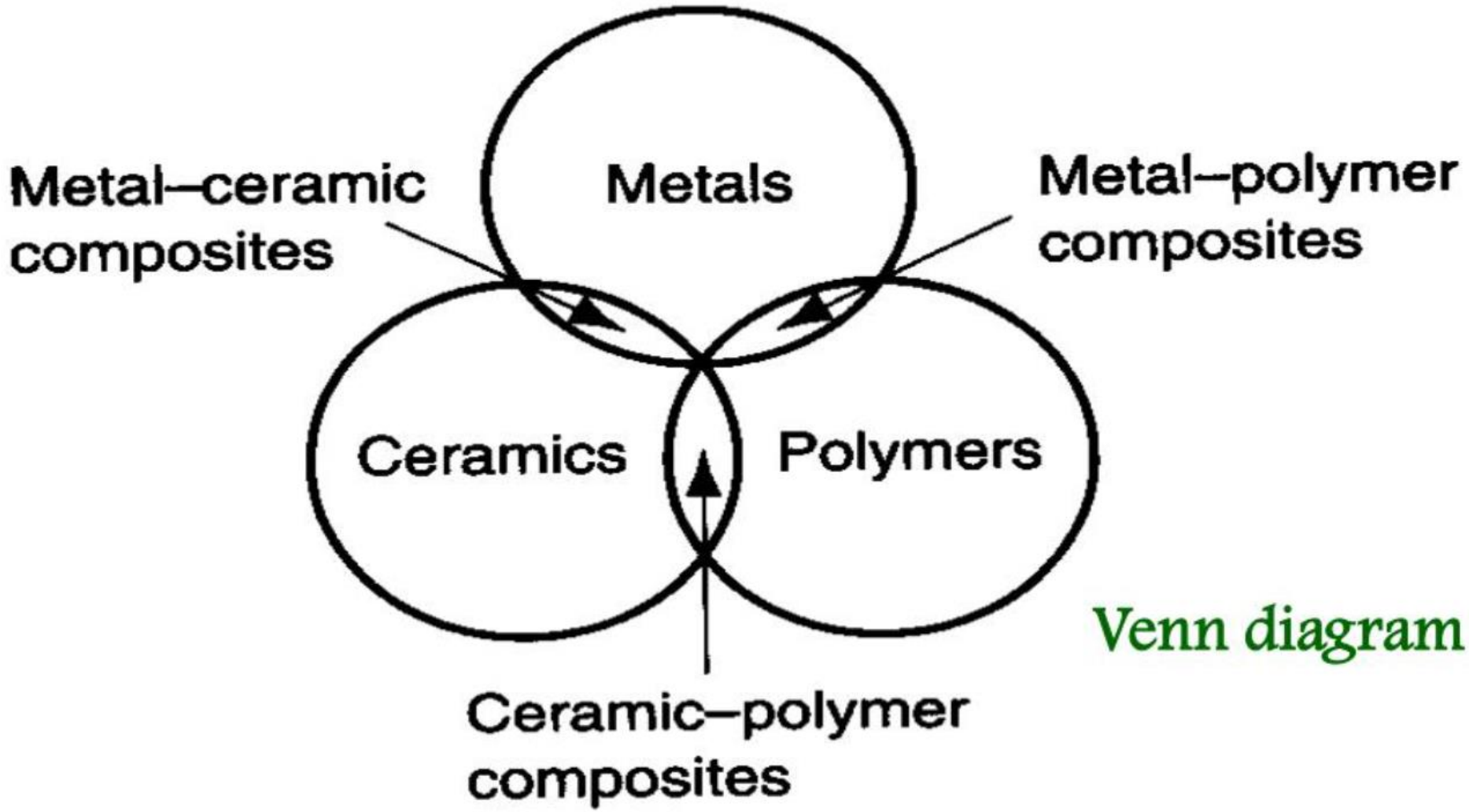
Manufacturing Capability

- Technological Processing capability
  - Available processes and machines
  - Outsourcing of some operations (casting, heat treatment, etc.)
- Physical product limitations
  - Size, weight
  - Machine dimensions, handling
- Production capacity (Plant capacity)
  - Production quantity in a given time, output

Materials in Manufacturing

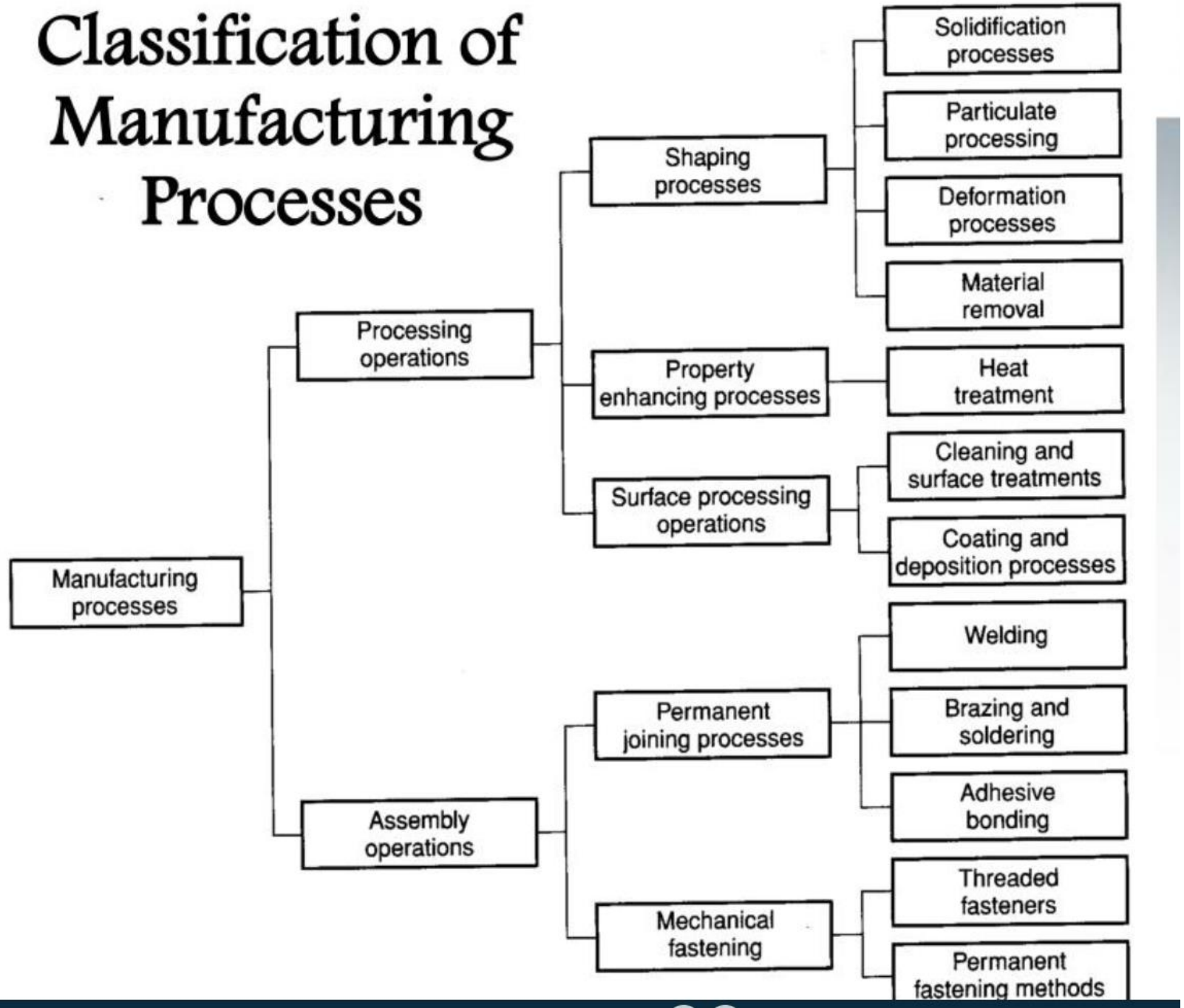
- Metals
  - Ferrous: Steel (iron-carbon, 0,02% - 2,11% C)
    Cast iron (iron + 2% - 4% C + silicon)
  - Nonferrous: copper, aluminium, nickel, alloys
- Ceramics: clay, silica, carbides (Al, Si), nitrides (Ti)
- Polymers
  - Thermoplastic polymers: PE, PP, PS, PVC
  - Thermosetting polymers: phenolics, epoxies
  - Elastomers: rubber, neoprene, silicone, PU
- Composites: more phases, particles/fibres + matrix
  glass reinforced plastic, Kevlar, WC in cobalt

Materials in Manufacturing



Venn diagram

Classification of Manufacturing Processes



Processing Operations

1) Shaping operations
   - Solidification processes → casting of metals, moulding of plastics
   - Particulate processing → powder metallurgy
   - Deformation processes → forging, extrusion
   - Material removal processes → machining, non-traditional, grinding
2) Property enhancing processes
   - Heat treatments, sintering
3) Surface processing
   - Cleaning, coating, plating

Manufacturing Processes

1) Processing operations
2) Assembly operations
   - Permanent joining: welding, brazing, adhesives
   - Mechanical assembly: bolts, screws, rivets, etc.
3) Production machines and tooling
   - Machine tools: lathe, milling machine, etc.
   - Presses, forge hammers, rolling mills
   - Welding machines and equipment
   - General and special purpose equipment
   - Tooling

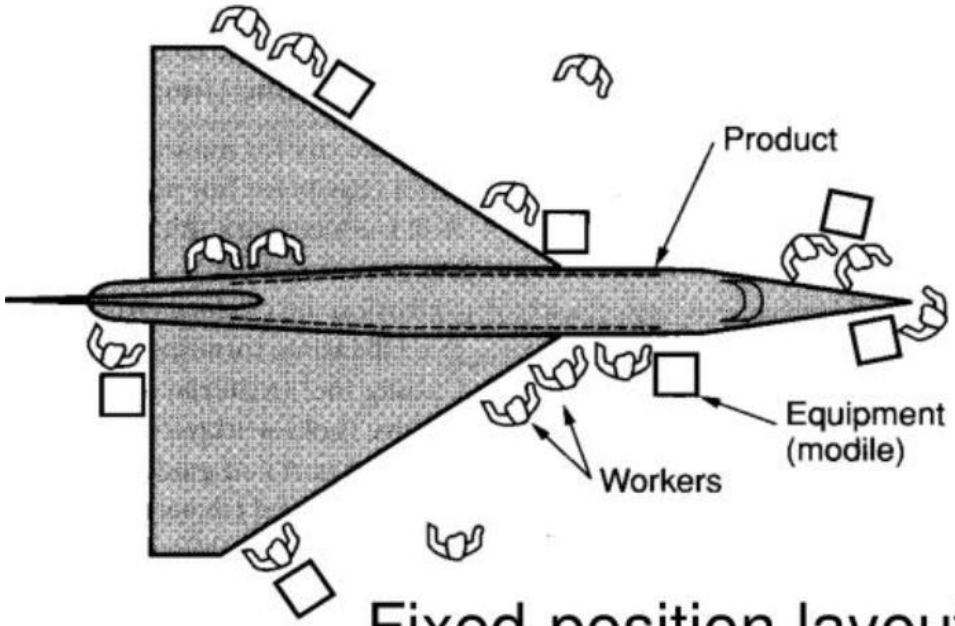
Production Systems

- Consist of people, equipment and procedures
- Production facilities: factory, production equipment material handling equipment
  - → Plant layout + Manufacturing systems
  - → Influence of production quantity (low, medium, high)
- Manufacturing support systems
  - Manufacturing engineering → process planning
  - Production planning and control → logistics, ordering materials and parts, scheduling
  - Quality control

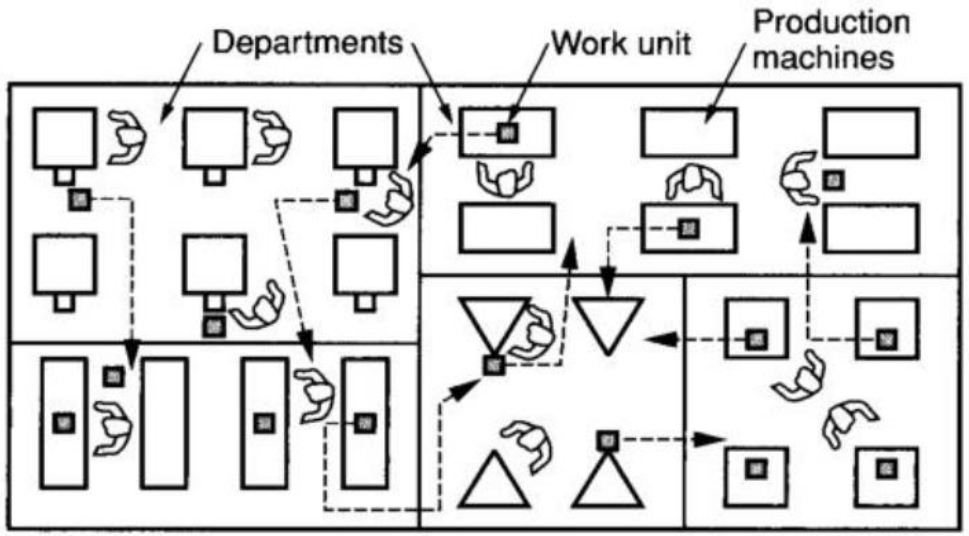
Influence of Production Quantity

- Low quantity production (1 – 100 units/year)
  - Job shop → maximum flexibility, fixed-position layout and often also process layout
  - Examples: aircraft, ships, heavy machinery
- Medium quantity production (10^2 – 10^4 units/year)
  - Batch production → process layout or cellular layout, usually make-to-stock
  - Examples: pumps, lathes, gear drives
- High quantity production (> 10.000 units/year)
  - Flow line production → product layout
  - Examples: cars, household appliances

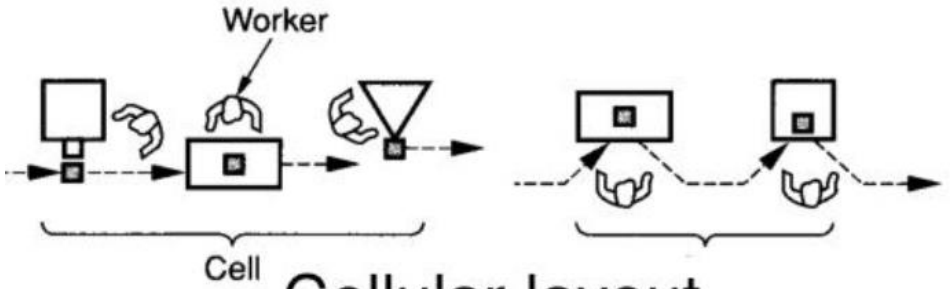
Plant Layouts



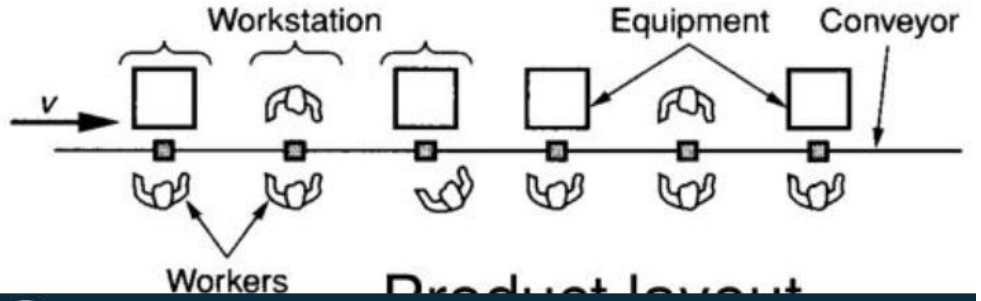
Fixed-position layout



Process layout

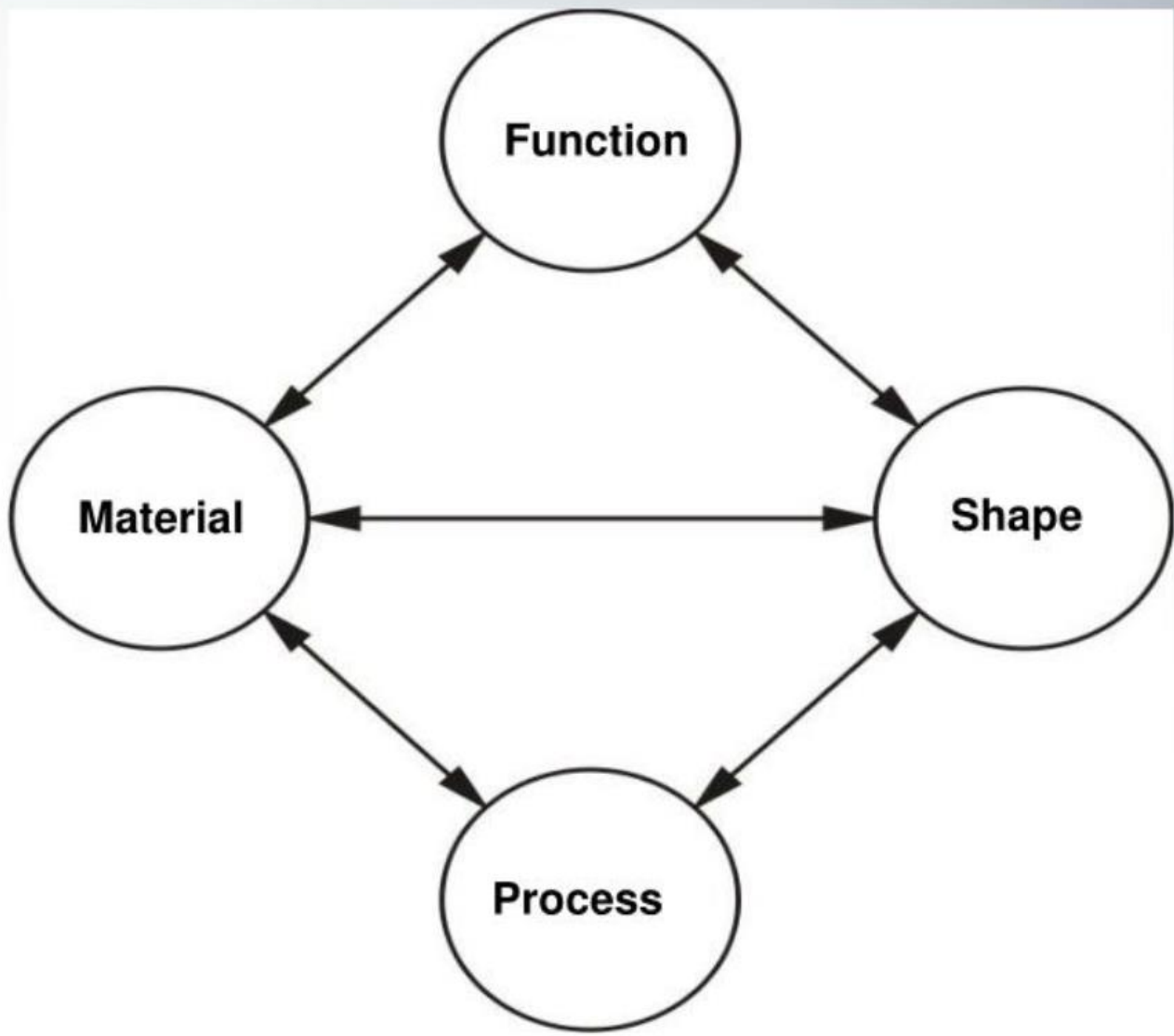


Cellular layout



Product layout

Mutual Relationships



Product Attributes

- Mechanical properties, e.g. tensile strength
- Physical properties, e.g. thermal expansion
- Dimensions, e.g. mm
- Tolerances: bilateral, unilateral tolerances
  limit dimensions
- Geometric attributes: angularity, circularity, concentricity, cylindricity, flatness, parallellism, perpendicularity, roundness, squareness and straightness
- Surface quality, e.g. roughness

Manufacturing Process Selection

Aspects:

- Batch size: Single product, medium size or mass production
- Geometric requirements: Shape and tolerances
- Manufacturing phase: Primary or secondary
- Tools: General purpose or product specific
- Assembly: Pay attention to assembly aspects during process selection for part manufacturing
- Minimize costs: Costs per product + Costs per batch + Once only costs

Production System