

INTRODUCTION TO MANUFACTURING TECHNOLOGY

Lecture-1 Manufacturing Process

❖ MANUFACTURING

- Manufacturing is derived from the Latin word **manufactus**, means made by hand. In modern context it involves making products from raw material by using various processes, by making use of hand tools, machinery or even computers. It is therefore a study of the processes required to make parts and to assemble them in machines.
- The study of manufacturing reveals those parameters which can be most efficiently being influenced to increase production and raise its accuracy.
- Advance manufacturing engineering involves the following concepts—
 1. Process planning.
 2. Process sheets.
 3. Route sheets.
 4. Tooling.
 5. Cutting tools, machine tools (traditional, numerical control (NC), and computerized numerical control (CNC).
 6. Jigs and Fixtures.
 7. Dies and Moulds.
 8. Manufacturing Information Generation.
 9. CNC part programs.
 10. Robot programmers.
 11. Flexible Manufacturing Systems (FMS), Group Technology (GT) and Computer integrated manufacturing (CIM).

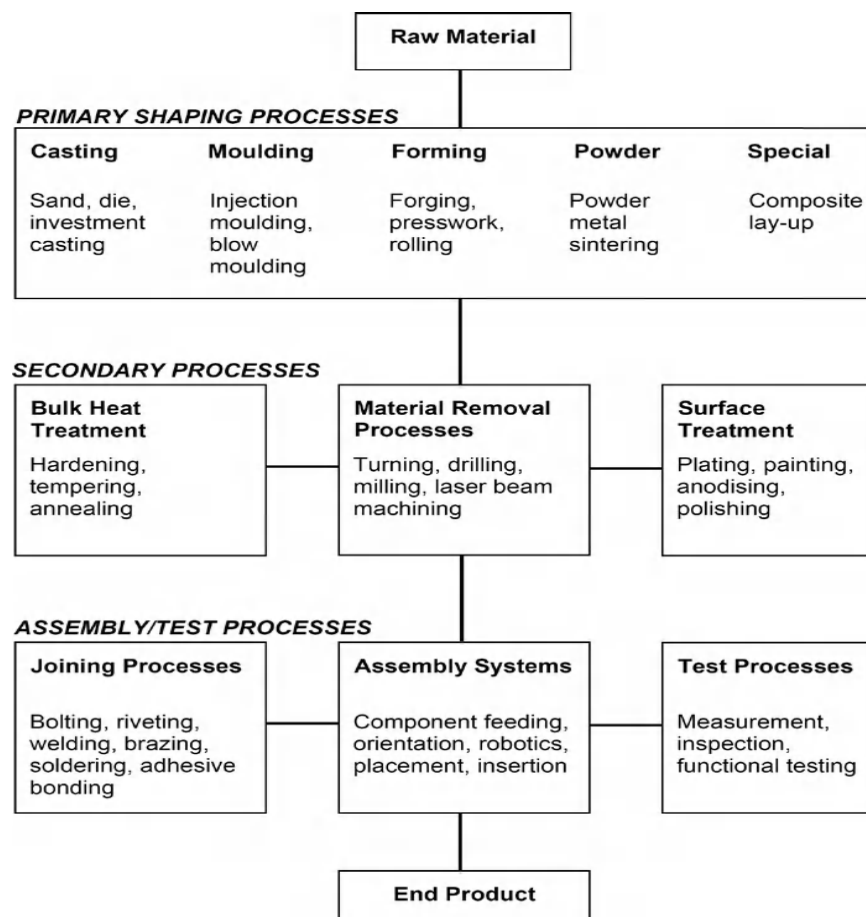
❖ IMPORTANCE OF MANUFACTURING

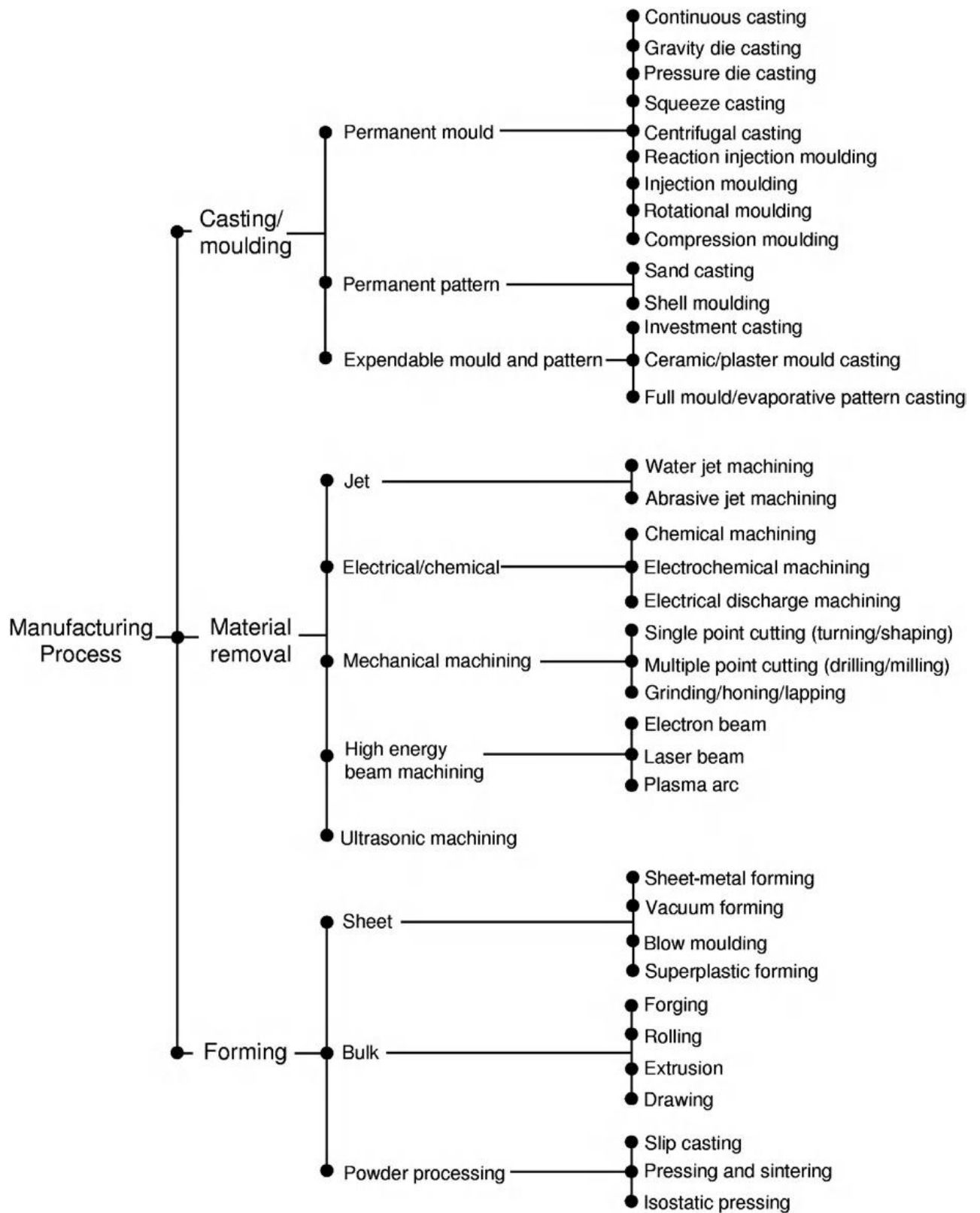
- Manufacturing may produce discrete products, meaning individual parts or pieces of parts or it may produce continuous products.
- Nails, gears, steel balls, beverage cans and engine blocks are example of discrete products.
- Metal or plastic sheet, wire, hose and pipe are continuous products that may be cut into individual pieces and thereby become discrete products.
- A manufactured item has undergone a number of changes during which raw material has become a useful product, it has added value, defined as monetary worth in terms of price.
- For example, clay has a certain value when mined. The clay is used to make a ceramic dinner plate, cutting tool, or electrical insulator, value is added to the clay; similarly, a wire coat hanger or a nail has added value over and above the cost of a piece of wire.

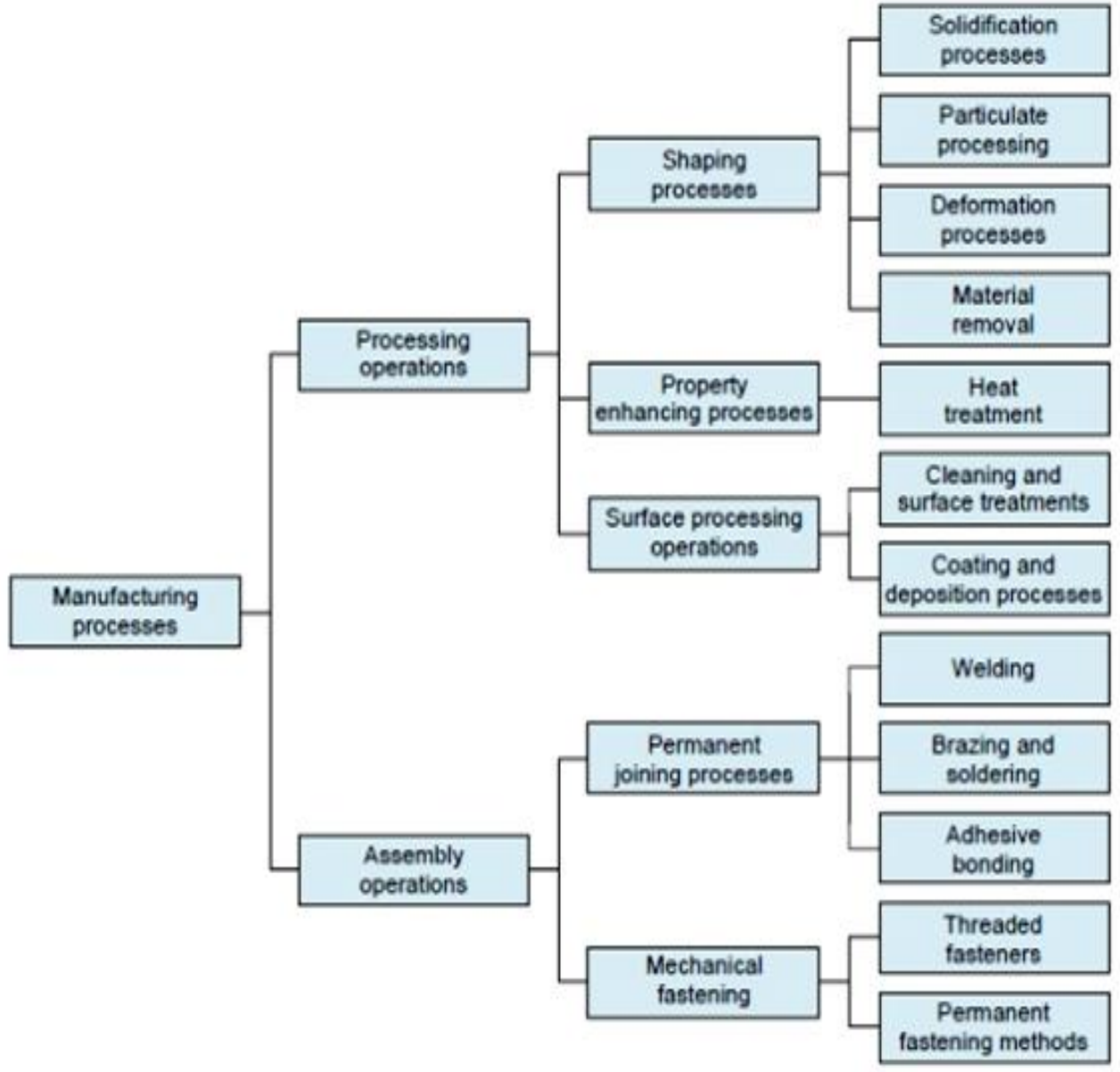
❖ CLASSIFICATION OF MANUFACTURING PROCESSES

Most of the metals used in industry are obtained as ores. These ores are subjected to a suitable reducing process which gives the metal in a molten form. This molten metal is poured into moulds to give commercial casting, called **ingots**.

The ingots are further subjected to one or more processes to obtain usable metal products of different shapes and sizes.







Lecture-2

Casting & Forming Processes

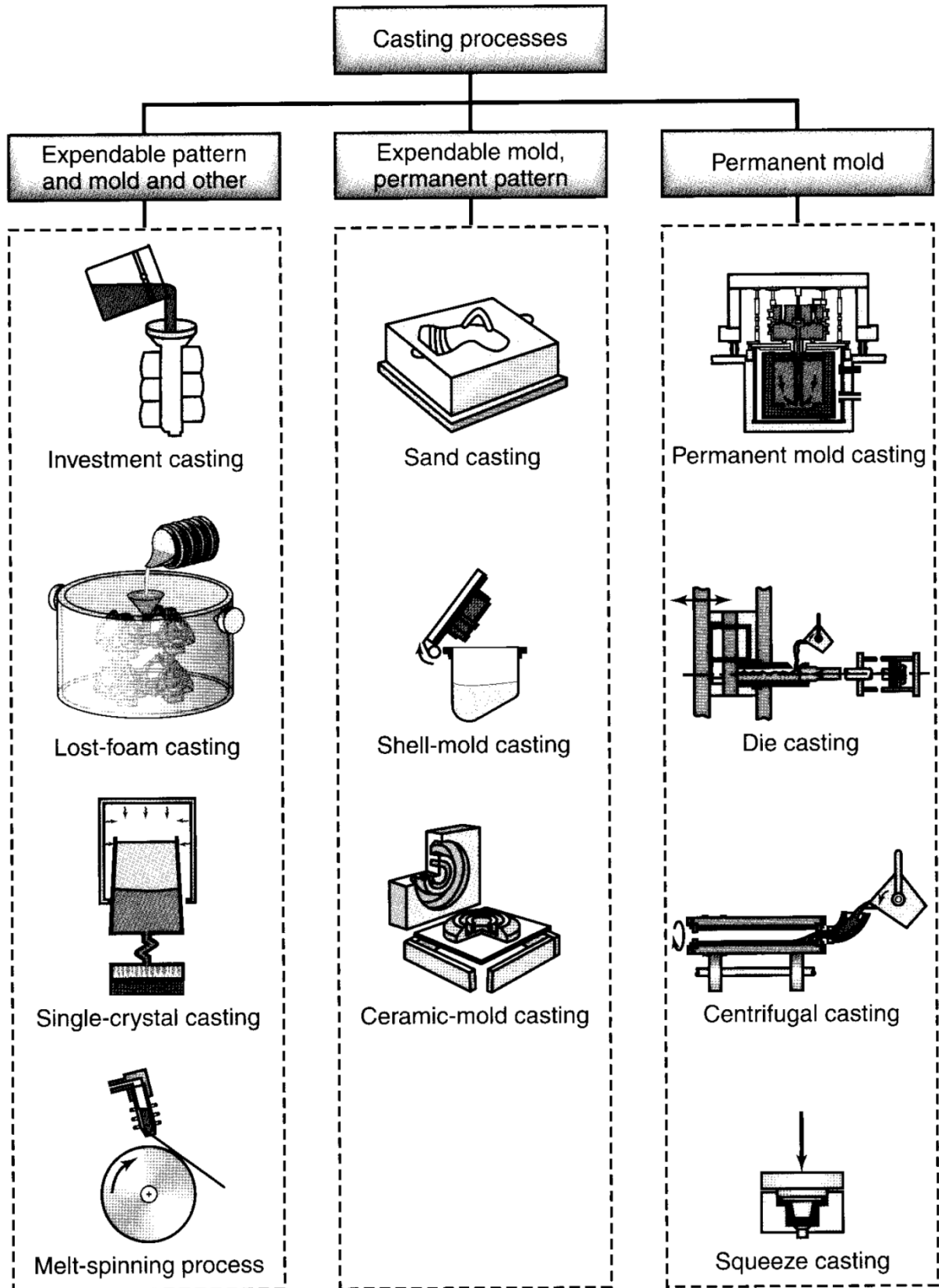
❖ METAL CASTING

- Casting is also one of the oldest known manufacturing processes.
- These are the only processes where liquid metal is used.
- Most of the metals used in industry are obtained as ores.
- These ores are subjected to suitable reducing processes which give the metal in a molten form.
- Molten metal is poured into this refractory mould cavity and is allowed to solidify.
- The object after solidification is known as ingots.
- Casting processes are universally used for manufacture of a wide variety of products from metal ingots and/or recycled scrap.

- | | |
|---------------------------------|------------------------|
| 1. Sand Casting | 2. Centrifugal Casting |
| 3. Shell Mould Casting | 4. Continuous Casting |
| 5. Precision Investment Casting | 6. Squeeze Casting |
| 7. Plaster Mould Casting | 8. Slush Casting |
| 9. Permanent Mould Casting | 10. Vacuum Casting |
| 11. Die Casting | 12. Thixo casting |

🔧 APPLICATIONS:

- | | |
|--|----------------------------|
| ▪ Engine blocks. | ▪ Gear housings. |
| ▪ Manifolds. | ▪ Cylinder heads. |
| ▪ Machine tool bases. | ▪ Connecting rods. |
| ▪ Pump housings. | ▪ Transmission components. |
| ▪ Cylinder heads | ▪ Cylinder heads. |
| ▪ Small mechanical parts requiring high precision. | ▪ Engine connecting rods |
| ▪ .Pistons. | |
| ▪ Gear and die blanks. | |
| ▪ Kitchen utensils. | |
| ▪ Gear blanks. | |
| ▪ Gear housings. | |
| ▪ Pipe fittings | |



(a)

❖ METAL FORMING PROCESS

- These are solid state manufacturing processes involving minimum amount of material wastage and faster production.
- In a forming process, metal may be heated to a temperature which is slightly below the solidus temperature and then a large force is applied such that the material flows and takes the desired shape.
- The desired shape is controlled by means of a set of tools called dies which may be completely or partially closed during manufacturing.
- These processes are normally used for large-scale production rates.
- These are generally economical and in many cases improve the mechanical properties too.

1. Rolling

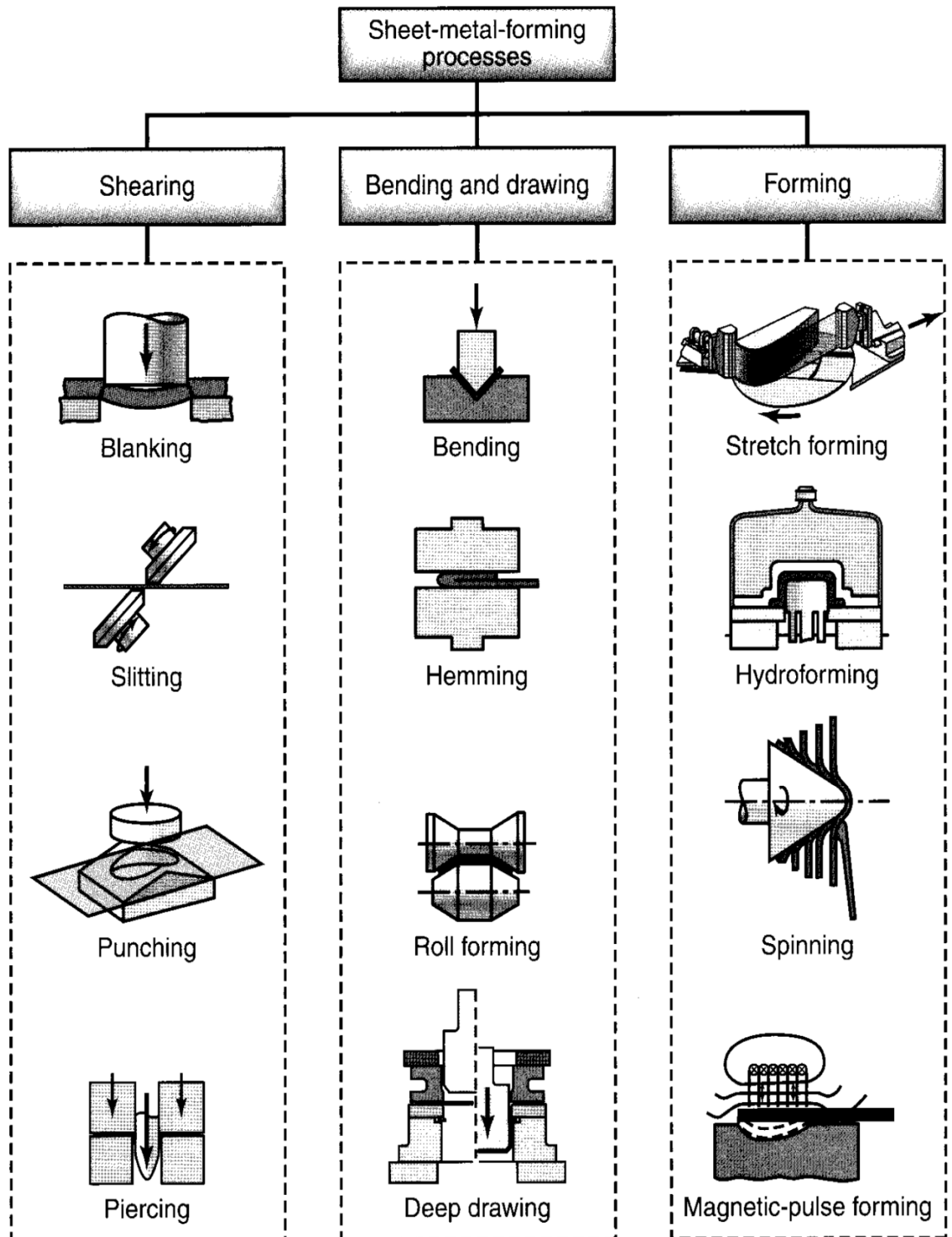
1. Drop Forging
2. Press Forging
3. Upset Forging
4. Extrusion
5. Wire Drawing

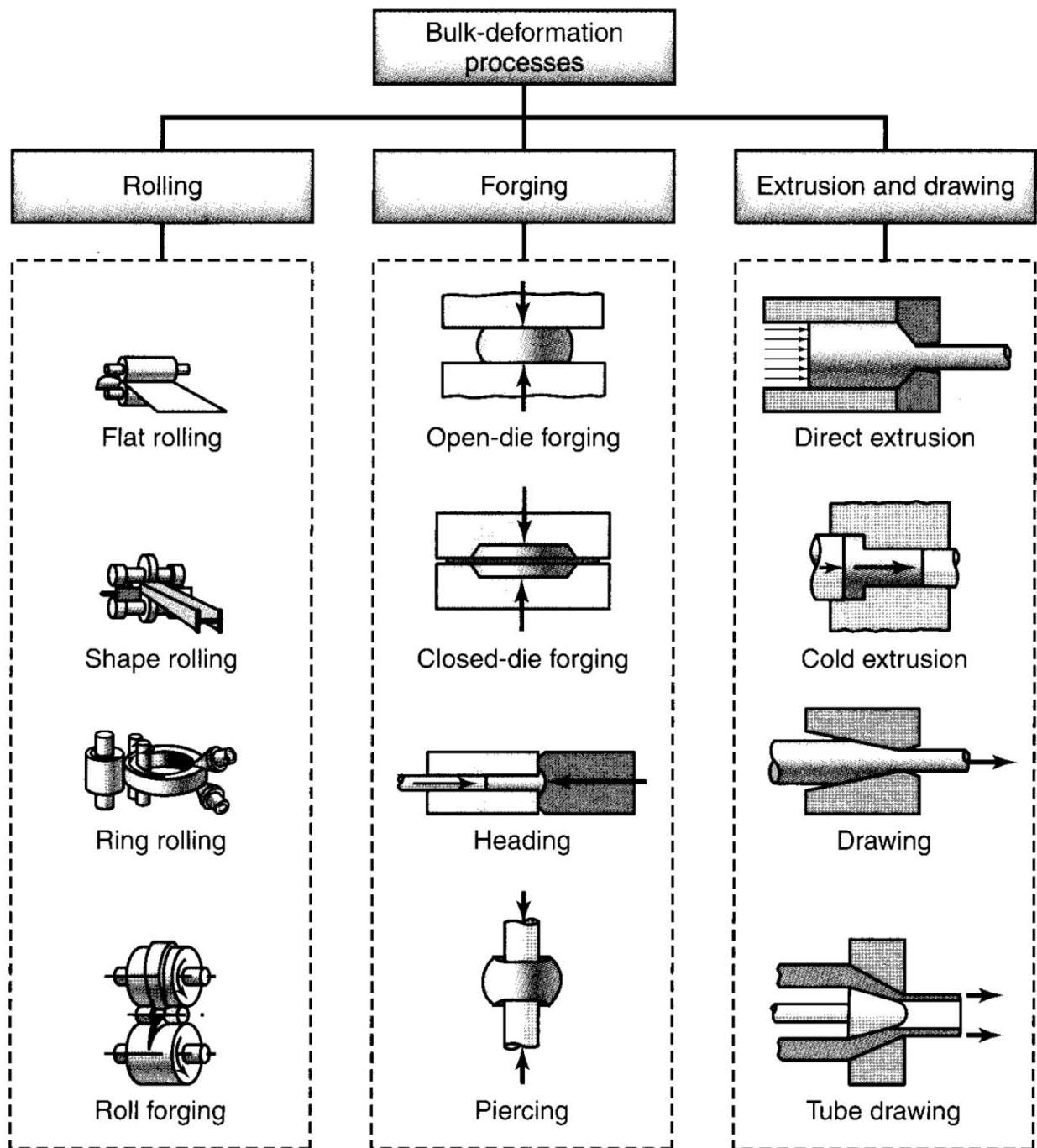
6. Sheet Metal Operations

- Bending
- Shearing
- Deep drawing
- Embossing
- Piercing and blanking

🚦 APPLICATIONS:

- Engine components (connecting rods, crankshafts, cam shafts).
- Transmission components (gears, shafts, hubs, axles).
- Aircraft components (landing gear, airframe parts).
- Tool bodies.
- Levers.
- Upset forging: for bolt heads, valve stems.
- Open die forging: for die blocks, large shafts, pressure vessels.
- Flat, square, rectangular and polygonal sections.
- Structural sections, e.g. I-beams, H-beams, T-sections, channels, rails, angles and plate.
- Strip, foil and sheet.
- Sheet for shipbuilding.
- Tube forming.
- Automotive trim
- Fasteners.
- Tool sockets.
- Spark plug bodies.
- Gear blanks.
- Bearing races.
- Valve seats.
- Tool shafts and handles.
- Punches.
- Chisels.
- Exhaust pipes.
- Cable assemblies.
- Washers.
- Kitchen utensils.
- Cans.





Lecture-3

Machining, Joining & Surface Finishing Processes

❖ MACHINING PROCESS

- These are secondary manufacturing processes where the additional unwanted material is removed in form of chips from the blank material by a harder tool to obtain the final desired shape.
- Material removal is normally the most expensive manufacturing process because more energy is consumed and also a lot of waste material is generated in the process.
- It is widely used because it delivers very good dimensional accuracy and good surface finish.
- It also generates accurate contours.
- Material removal processes are also called machining processes.

General Machining Processes

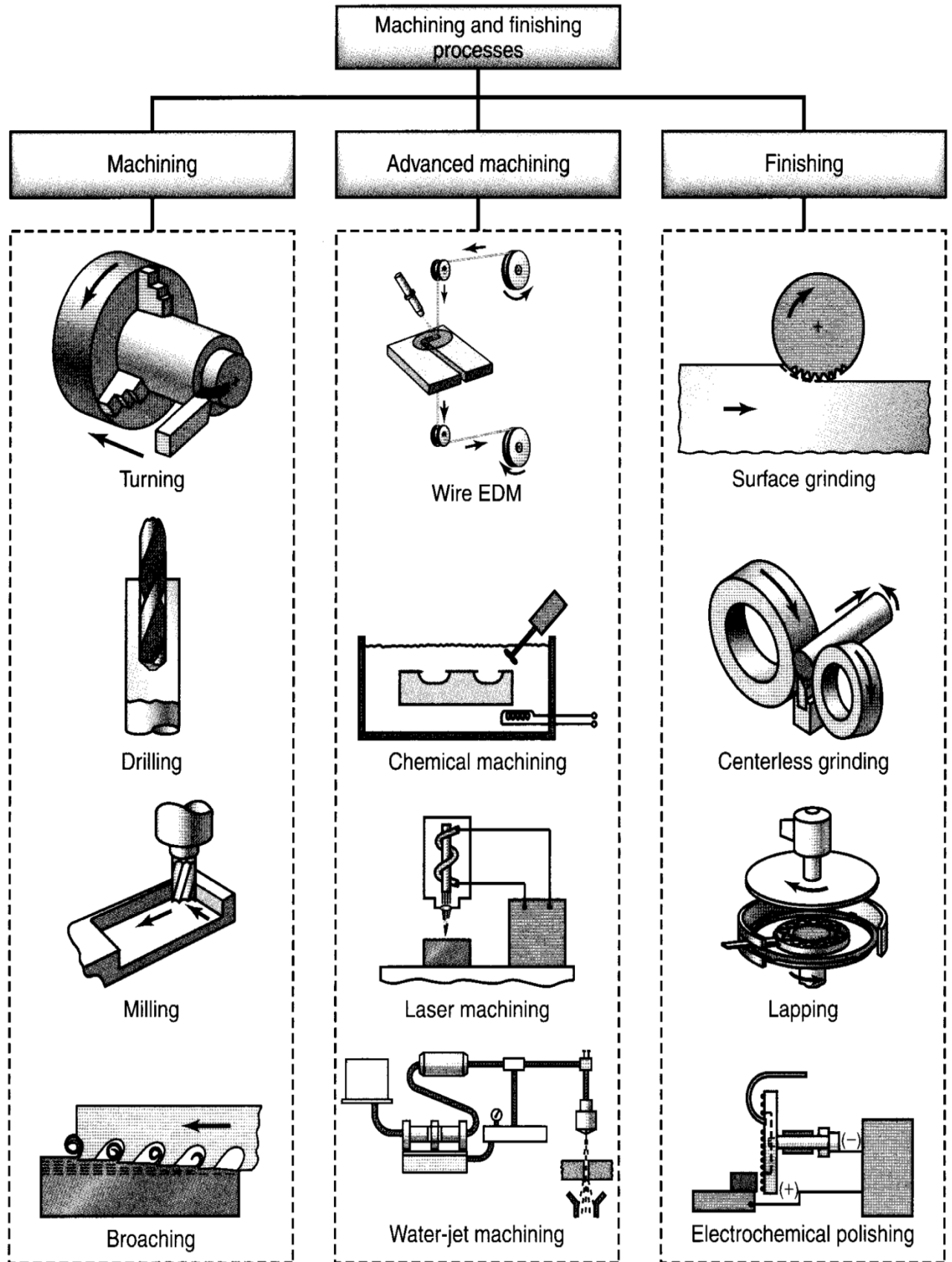
- Turning
- Drilling
- Shaping
- Planning
- Milling
- Grinding
- Broaching

Special Machining Processes

- Electric Discharge Machining
- Electro Chemical Machining
- Electron Beam Machining
- Ultrasonic Machining
- Laser Beam Machining
- Abrasive Jet Machining

✚ APPLICATIONS:

- Shafts with various diameters & tapers
- Screws and fasteners.
- Transmission components.
- Engine parts.
- Aircraft wing spars.
- Engine blocks.
- Pump components.
- Machine components.
- Gears.
- Machine tools beds.
- Large castings.
- Die blocks.
- Key seats, slots and notches.
- Large gear teeth.
- Engine blocks.
- Pump components.
- Machine components.
- Turbine blade root forms.
- Connecting rod ends.
- Rifling on gun barrels.
- Flat surfaces.
- Key seats and slots.
- Splines, both straight and helical.
- Gear teeth.



❖ METAL JOINING PORCESS

- These are secondary manufacturing processes where the starting raw materials are processed by any of the previous manufacturing processes.
- It essentially involves joining pieces either permanently or temporarily to perform the necessary function.
- The joining can be achieved by either or both of heat and pressure and/or a joining material.
- Many of the steel structural constructions are first rolled and then joined together by a fabrication process.

Permanent Joining Process

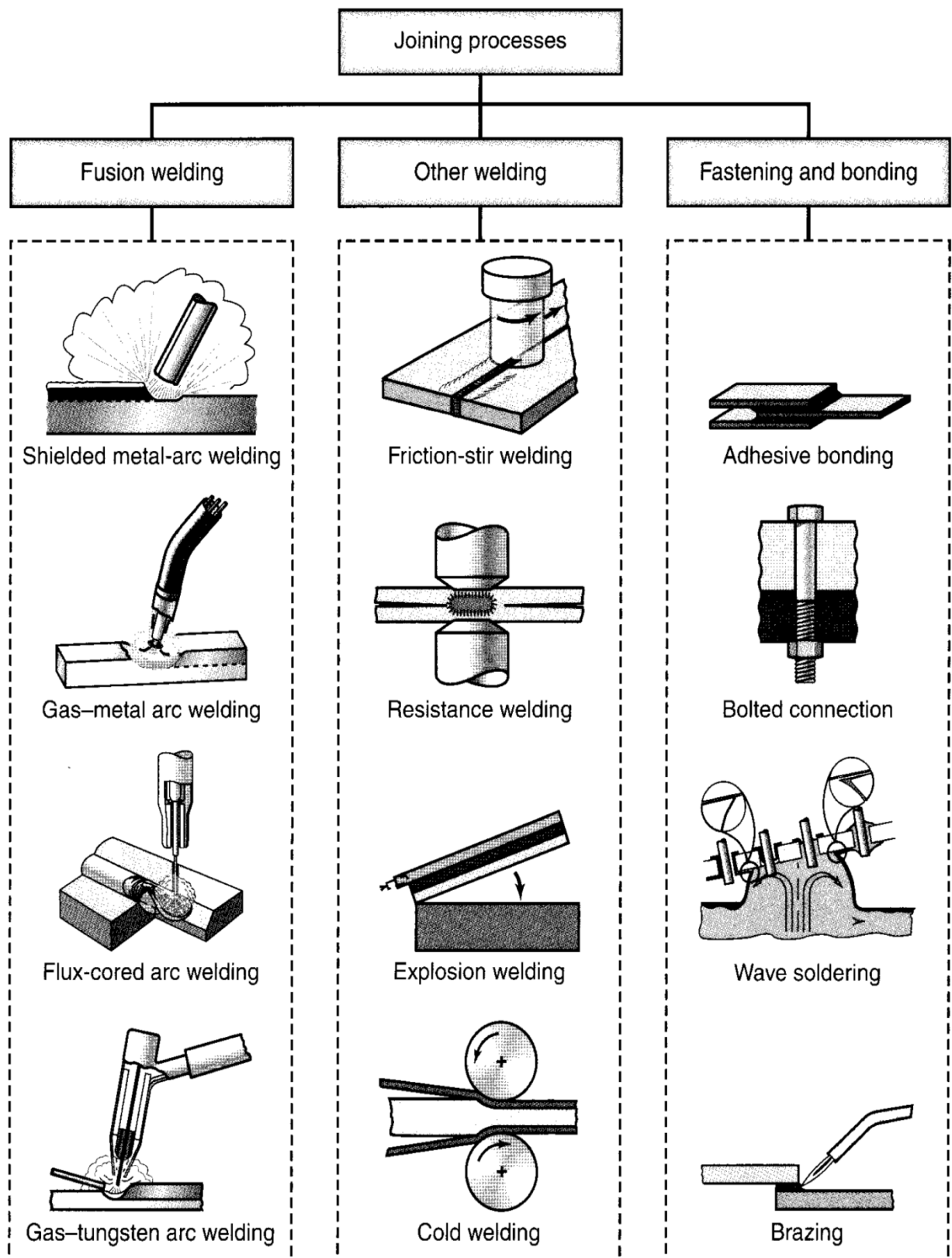
- Gas Welding
- Electric Arc Welding
- Electric Resistance Welding
- Thermit Welding
- Friction Welding
- Brazing
- Soldering

Temporary Joining Process

- Screwing
- Riveting
- Nut and Bolt
- Keys and Couplings

🌈 APPLICATIONS:

- Chemical plant pipe work.
- Nuclear plant fabrications.
- Aerospace structures.
- Sheet-metal fabrication.
- Hard facing.
- General fabrication.
- Structural steelwork.
- Automobile bodywork.
- Pressure vessels.
- Structural steelwork.
- Shipbuilding.
- Pipe work.
- Machine frame fabrication.
- Repair work.
- Ships.
- Bridges.
- fuel tanks, cans and radiators
- reinforcing rings,
- captive nuts,
- pins and studs to sheet metal,
- Site welding of rails to form continuous lengths.
- Joining heavy structural sections and low-loaded structural joints.
- Machine frame fabrication.
- Shipbuilding.
- Joining thick cables.
- Concrete reinforcement steel bars.



❖ SURFACE FINISHING PROCESSES

- These processes are not considered as metal removing processes,
- These processes are primarily intended to provide a good surface finish to the metal surface.
- In these processes although a very negligible amount of metal removal or addition does take place.
- These processes are not affecting any appreciable variation in dimensions
 - Grinding
 - Buffing
 - Polishing
 - Honing
 - Lapping
 - Super finishing
 - Sanding
 - Electroplating
 - Belt Grinding
 - Metal Spraying

✚ APPLICATIONS:

- Parts requiring fine surface roughness and/or close tolerances.
- Bearing surfaces.
- Valve seats.
- Gears.
- Cams.
- Keys and key seats.
- Mould and die cavities.
- Cutting teeth.
- Bearing surfaces.
- Pin and dowel holes.
- Engine cylinder bores.
- Rifle bores.
- Bearing surfaces.
- Gauge blocks.
- Piston rings.
- Balls for ball bearings.
- Piston pins.
- Valve seats.
- Glass lenses.
- Pump gears.

Lecture-4

Production Methods

❖ PRODUCTION PROCESS

It is the process followed in a plant for converting semi-finished products or raw materials into finished products. The art of converting raw material into finished goods with application of different types of tools, equipments, machine tools, manufacturing set ups and manufacturing processes, is known as production.

Generally there are three basic types of production system that are given as under.

1. Job production
2. Batch production
3. Mass production

[1] JOB PRODUCTION:

- Job production comprises of an operator or group of operators to work upon a single job and complete it before proceeding to the next similar or different job.
- The production requirement in the job production system is extremely low.
- It requires fixed type of layout for developing same products. This type of production system is characterized by the low production volume.
- This is usually concerned with special projects, special equipment or machinery to perform specialized and specific tasks.
- Examples: large turbo generators, boilers, processing equipment, material handling equipment and ship buildings etc.
- Job order production can be of following types:
 - (1) Small number of products produced once only.
 - (2) Small number of pieces produced intermittently when the need arises.
 - (3) Small number of pieces produced periodically at known time intervals.

[2] BATCH PRODUCTION:

- This type of production is suited for medium volume lot of the same variety either to meet a specific order or to satisfy the demand of the market.
- When the production of a specific batch is terminated, the plant facilities are available for the production of other similar products as per market demand.
- Batch order production can be of the following types:
 - (1) A batch produced only once.

(2) A batch produced repeatedly at irregular intervals when the need arises.

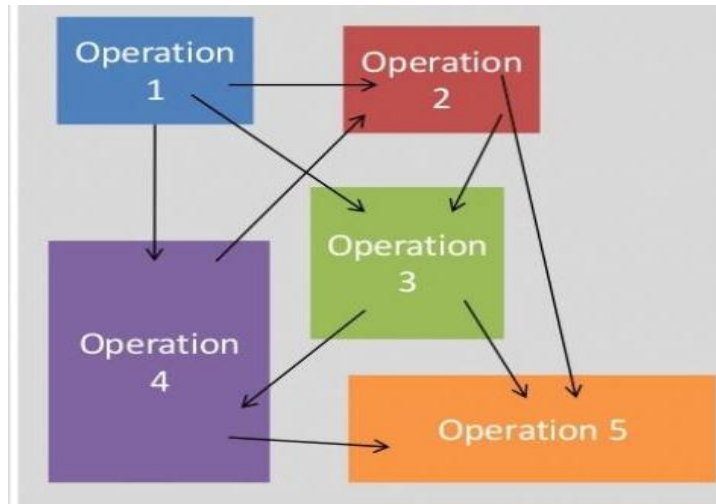
(3) A batch produced periodically at known intervals to satisfy continuous demand.

[3] MASS PRODUCTION:

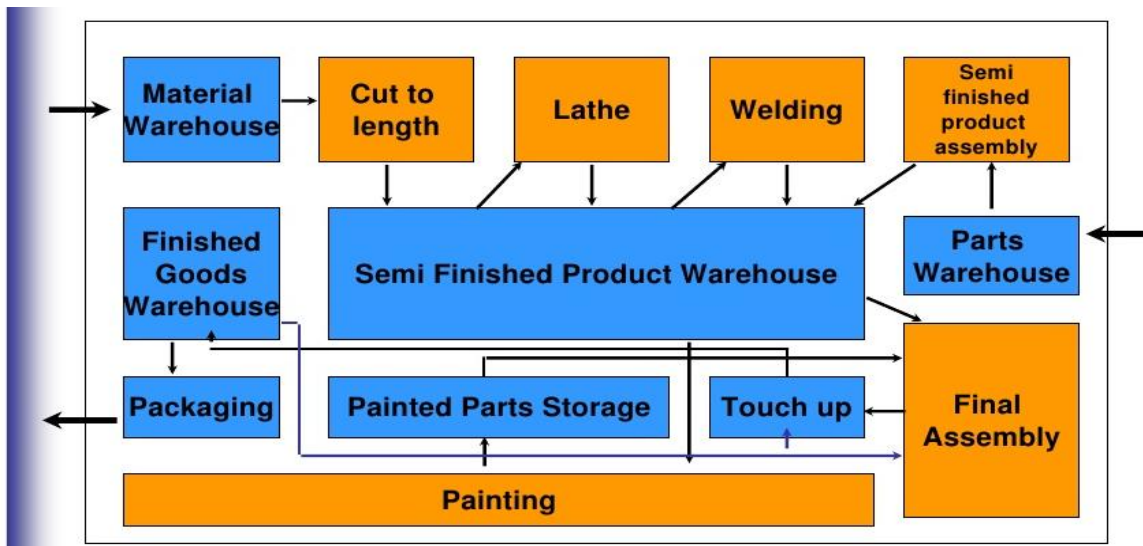
- This type of production is the specialized manufacturing of identical products/goods for which the equipment/ machinery is fully engaged.
- Production rate is generally very high.
- Continuous production is justified only when the production rate can be sustained by the market.
- In this type of production takes full advantage of repetitive operations in the design of production aids such as special tools, fixtures, positioners, material handling system and - inspection devices etc.

Criteria	Job Production	Batch Production	Mass Production
Set up time	Long set-up time as there is a new set up for every new job.	Can be reasonably fast as set up is usually a modification of an existing process. Otherwise as for mass production.	Very long set up as it takes time to synchronize the whole process.
Cost per unit	High	Medium	Low
Capital (machinery)	Can be flexible as it depends on specific use	A mixture of machines used, but this method is based on general purpose machines	Can involve large numbers of general purpose machines designed for a specific function
Labour	Highly skilled may be craft workers.	Semi-skilled and need to be flexible.	Unskilled & need medium training
Production time	Likely to be long	Once set up, production can be swift	Production is swift.
Stock	Low raw materials and finished stock, but high work in progress.	High raw materials-buffer stocks. Medium work in progress & finished stock	High raw materials & finished stock – low work in progress

Job Production



Batch Production



Mass Production

