

Lecture # 3.1

Manufacturing Considerations in Design

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Manufacturing Considerations in Design

The following are the various manufacturing processes used in Mechanical Engineering.

1. Primary shaping processes.

The processes used for the preliminary shaping of the machine component are known as primary shaping processes.

The common operations used for this process are

Casting:

Molten metal is poured into a mold cavity that has the negative shape of the desired part. It is then allowed to cool and solidify.

Example: Engine blocks, car wheels, door handles, and jewelry.

Forging:

The workpiece is compressed between two dies using impact or gradual pressure to impart the die's shape.

This process improves the metal's grain structure and strength.

Example: Crankshafts, connecting rods, gears, and hand tools like hammers.

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Extruding:

A metal billet is forced through a die opening to create a part with a fixed cross-sectional profile, similar to squeezing toothpaste from a tube.

Example: Aluminum window frames, curtain rails, and seamless tubes.

Rolling:

A slab or plate is passed through two rotating rolls. The compressive forces reduce the material's thickness and increase its length.

Example: Steel sheets, plates for ship hulls, and I-beams for construction.

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Drawing:

A workpiece (wire, rod, or tube) is pulled through a die to reduce its diameter and increase its length using tensile forces.

Example: Electrical wiring, copper tubing, and paperclips.

Bending:

Sheet metal is strained along a straight axis by a punch to create a specific angle or shape.

Example: Brackets, car body panels, and metal enclosures.

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Shearing:

A cutting operation that uses two blades or a punch and die to separate a metal sheet along a straight line.

Example: Cutting large sheets of steel into smaller blanks for stamping.

Spinning:

A rotating circular metal blank is gradually shaped over a mandrel using a rounded tool or roller.

Example: Cookware (bowls, pans), rocket nose cones, and satellite dishes.

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Powder Metal Forming:

Fine metal powders are compacted into a die under high pressure and then heated (sintered) in a controlled atmosphere to bond the particles without melting them.

Example: Self-lubricating bearings, oil-pump gears, and cutting tools.

Squeezing:

A broad category of compressive operations, such as coining or hubbing, where the metal is forced to flow into a die to produce fine surface details or small changes in geometry.

Example: Coins, medals, and intricate jewelry.

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Manufacturing Considerations in Design

2. Machining processes

The processes used for giving final shape to the machine component, according to planned dimensions are known as machining processes.

The common operations used for this process are

Turning:

A cutting tool removes material from a rotating workpiece (usually cylindrical).

Example: Shafts, bolts, and machine spindles are produced on a lathe.

Shaping:

A single-point cutting tool moves linearly across the workpiece to cut flat surfaces.

Example: Key slots and grooves in machine components.

Planning:

Similar to shaping, but here the workpiece moves against a stationary cutting tool.

Example: Large flat surfaces of machine beds are finished using planing.

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The processes used for giving final shape to the machine component, according to planned dimensions are known as machining processes.

The common operations used for this process are

Drilling:

A rotating drill bit creates round holes in a workpiece.

Example: Holes in furniture fittings, automotive parts, and construction beams.

Boring:

Enlarging or finishing an existing hole with a single-point cutting tool.

Example: Cylinder bores in engines are finished by boring.

Reaming:

A precision finishing process to slightly enlarge drilled holes and improve accuracy.

Example: High-precision holes for dowel pins in machine assemblies.

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The common operations used for this process are

Sawing:

Cutting material into pieces using a saw blade (circular or band).

Example: Cutting steel rods or aluminum sheets into required lengths.

Broaching:

A toothed tool (broach) removes material in a single pass to create complex shapes.

Example: Internal keyways, splines, and gear teeth.

Milling:

A rotating multi-point cutter removes material from a stationary workpiece.

Example: Gear blanks, slots, and complex profiles in automotive and aerospace parts.

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2. Machining processes (Contonue...)

The processes used for giving final shape to the machine component, according to planned dimensions are known as machining processes.

The common operations used for this process are

Grinding:

An abrasive wheel removes very fine material for high precision and surface finish.

Example: Finishing of bearing surfaces and cutting tools.

Hobbing:

A gear-cutting process using a hob (specialized cutter) to generate gear teeth.

Example: Spur gears, helical gears, and sprockets.

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3. Surface finishing processes

The processes used to provide a good surface finish for the machine component are known as surface finishing processes.

Mechanical methods (Polishing, Buffing, Honing, Lapping, Abrasive Belt Grinding, Barrel Tumbling) – [appearance-focused]

Chemical methods (Electroplating, Sheradizing) – [corrosion-protection]

Electrochemical/Advanced precision methods (Superfinishing) – [precision-enhancement]

The common operations used for this process are

Polishing:

Mechanical process using fine abrasives to smoothen surfaces and remove scratches.

Example: Polishing stainless steel utensils or automotive body panels for a glossy finish.

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Electrochemical/Advanced precision methods (Superfinishing) – [precision-enhancement]

The common operations used for this process are

Buffing:

Similar to polishing but uses a soft cloth wheel with fine abrasive compounds for mirror-like finish.

Example: Buffing of jewelry, decorative parts, and car accessories.

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The processes used to provide a good surface finish for the machine component are known as surface finishing processes.

The common operations used for this process are

Honing:

Abrasive stones are pressed against the surface while oscillating to improve dimensional accuracy.

Example: Engine cylinder bores honed for smooth piston movement.

Lapping:

Loose abrasive slurry is rubbed between two surfaces to achieve extreme precision.

Example: Lapping of gauge blocks and optical lenses.

Abrasive Belt Grinding:

Uses a continuous abrasive belt to remove material and improve surface finish.

Example: Finishing of sheet metal panels and furniture components.

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The common operations used for this process are

Barrel Tumbling:

Small parts are placed in a rotating barrel with abrasives to remove burrs and polish.

Example: Tumbling of nuts, bolts, and coins for smooth edges.

Electroplating:

Depositing a thin metal layer on a component using electric current.

Example: Chrome plating on bike parts, gold plating on jewelry.

Superfinishing:

High-precision finishing using fine abrasive stones with oscillatory motion under light pressure.

Example: Superfinishing of crankshafts and roller bearings.

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The common operations used for this process are

Sheradizing:

Diffusion process where steel parts are heated in zinc dust to form a corrosion-resistant coating.

Example: Sheradized fasteners and gears used in automotive and marine industries.

- Polishing & Buffing → Appearance enhancement.
- Honing & Lapping → Precision and dimensional accuracy.
- Electroplating & Sheradizing → Corrosion resistance.
- Superfinishing → High-performance machine parts.
- Barrel Tumbling & Belt Grinding → Economical finishing for bulk parts.

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4. Joining processes

The processes used for joining machine components are known as joining processes.

The common operations used for this process are

Welding:

Fusion of two materials (usually metals) by applying heat, pressure, or both.

Types: Arc welding, MIG, TIG, gas welding.

Example: Steel frames in buildings, automobile chassis, pipeline joints.

Riveting:

Joining two plates by inserting a metal pin (rivet) and deforming its ends.

Example: Aircraft fuselage panels, bridge structures, railway coaches.

Soldering:

Joining metals using a filler metal (solder) with a melting point below 450°C.

Example: Electronic circuit boards, copper plumbing, jewelry.

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4. Joining processes (Contonue...)

The processes used for joining machine components are known as joining processes.

The common operations used for this process are

Brazing:

Similar to soldering but uses filler metal with a melting point above 450°C.

Example: Heat exchangers, cutting tools, bicycle frames.

Screw Fastening:

Temporary joining using threaded fasteners like screws, bolts, and nuts.

Example: Furniture assembly, machine covers, automotive parts.

Pressing:

Joining by force-fitting one component into another with a slight size difference.

Example: Gears on shafts, bearings in housings.

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4. Joining processes (Contonue...)

The processes used for joining machine components are known as joining processes.

The common operations used for this process are

Sintering:

Powder metallurgy process where metal powders are compacted and heated below melting point to bond.

Example: Porous filters, gears, bushings, cutting tools.

- Welding and brazing are preferred for high-strength permanent joints.
- Soldering and riveting are ideal for precision or lightweight assemblies.
- Screw fastening and pressing offer modularity and ease of maintenance.
- Sintering enables mass production of precision parts with minimal waste.

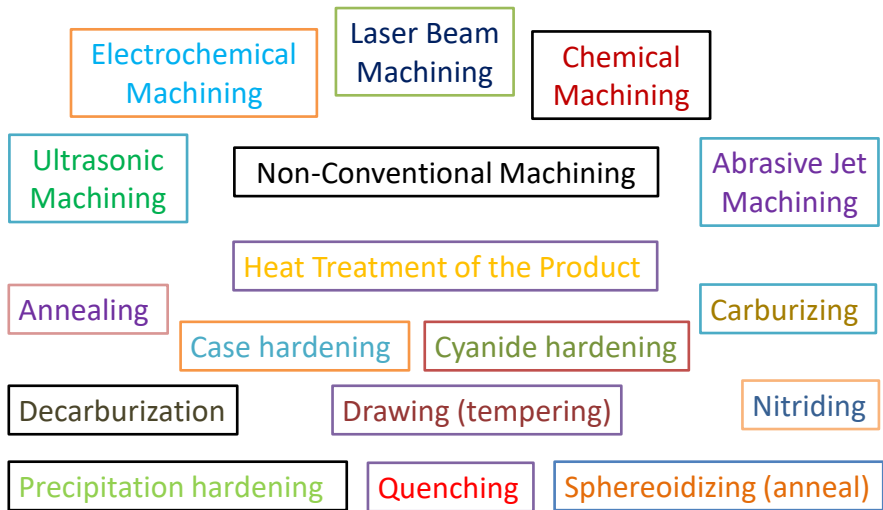
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Other Manufacturing Processes.



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