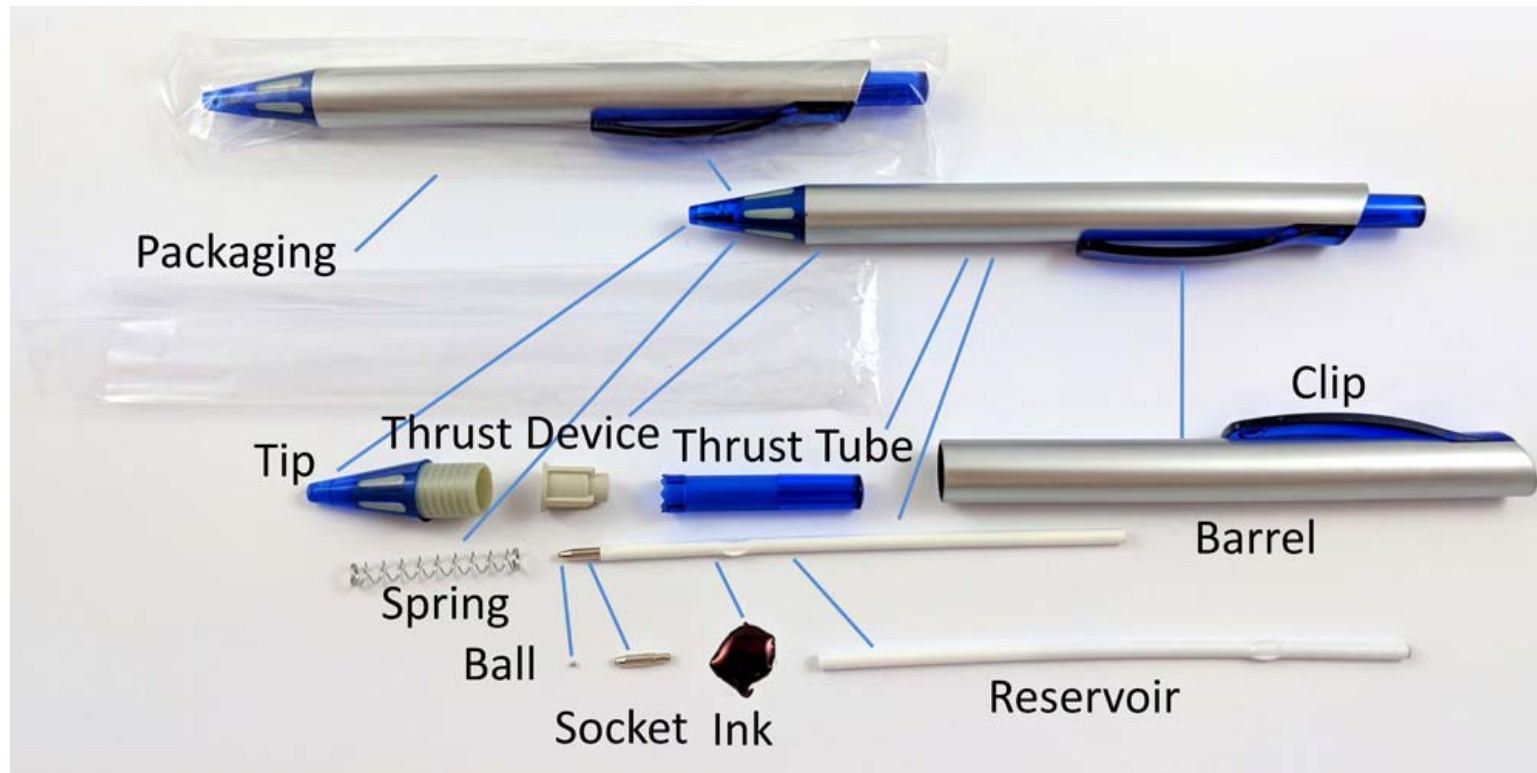


Manufacturing Technologies- II



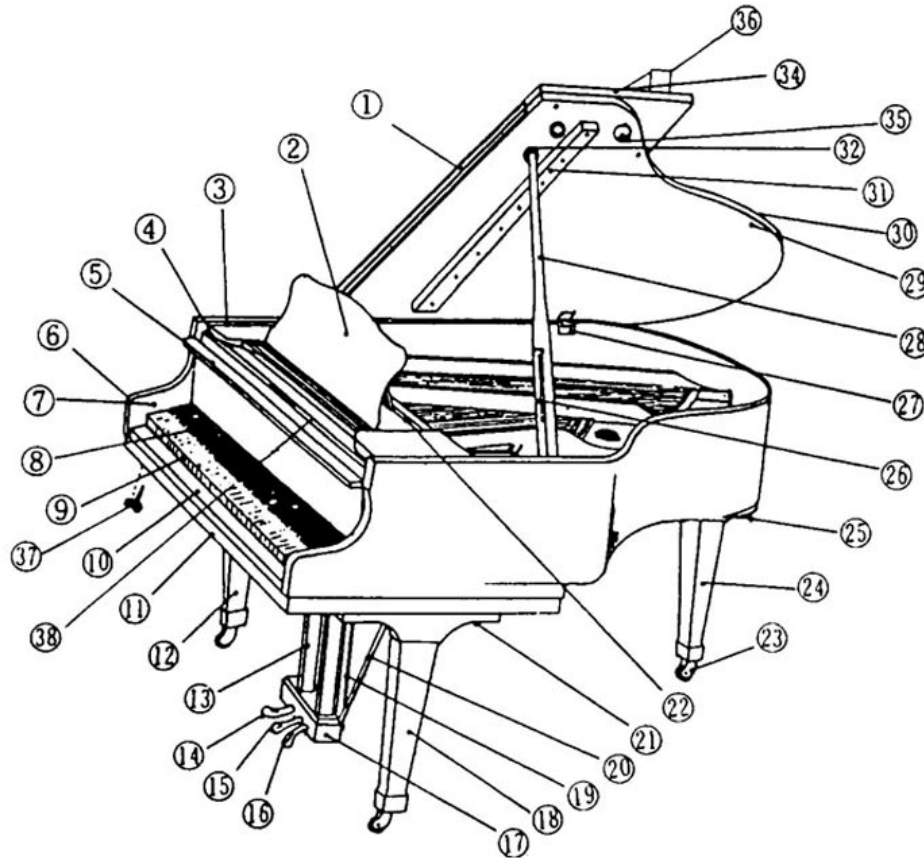
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Ball Point Pen Components



Source: Guanxin machinery

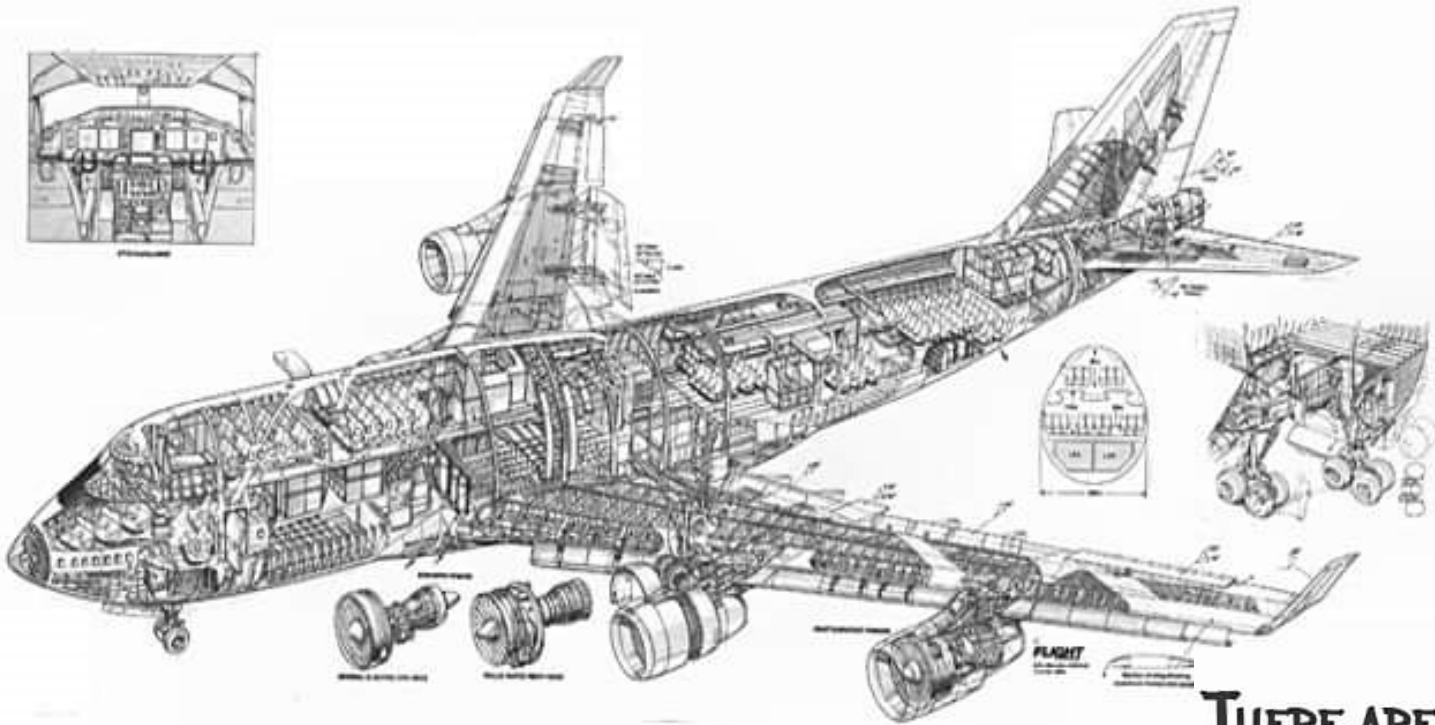
Piano Components



GRAND PIANO CABINET

- | | |
|---------------------------|----------------------------|
| 1. Top Board Long Hinge | 20. Lyre Brace |
| 2. Music Rack | 21. Leg Bolt |
| 3. Music Shelf Guide Rail | 22. Music Rack Prop |
| 4. Music Shelf | 23. Caster |
| 5. Fallboard | 24. Leg (Rear #3) |
| 6. Side Arm | 25. Leg Base |
| 7. Key Block | 26. Top Board Prop (Short) |
| 8. Logo | 27. Top Board Butt Hinge |
| 9. Keys | 28. Top Board Prop (Long) |
| 10. Key Slip | 29. Top Board Rubber Tack |
| 11. Key Bed | 30. Top Board (Rear) |
| 12. Leg (Bass #1) | 31. Top Bar |
| 13. Lyre Post | 32. Top Board Prop Cup |
| 14. Soft Pedal | 34. Top Board (Front) |
| 15. Sostenuto Pedal | 35. Brass Lid Catch |
| 16. Sustaining Pedal | 36. Lid Lock Bar |
| 17. Pedal Box | 37. Key Block Wing Bolt |
| 18. Leg (Treble #2) | 38. Stretcher Bar |
| 19. Pedal Rod | |

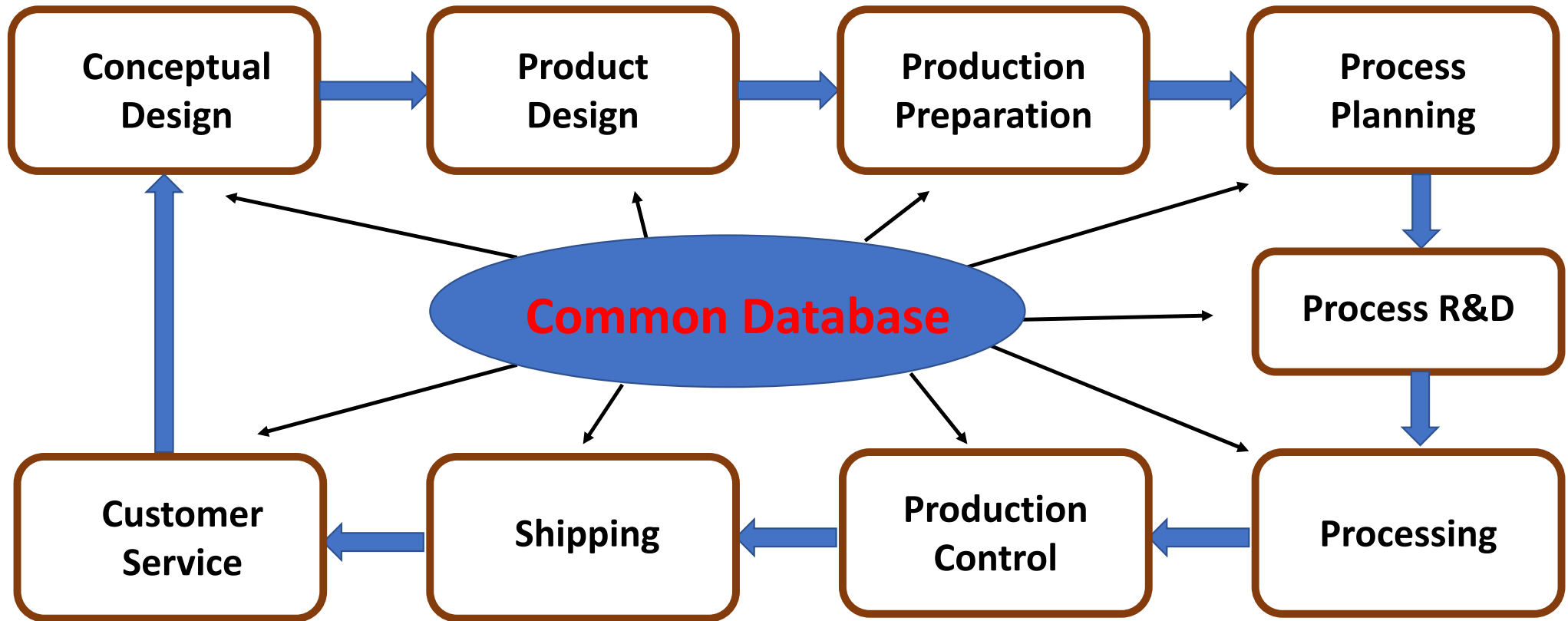
Boeing 747-400



**THERE ARE SIX MILLION PARTS IN THE
BOEING 747-400.**



Production Cycle





Manufacturing

- A ball point pen: around dozen parts/components
- A lawn mover: around 300 parts/components
- A piano: 12000 parts/components
- Boeing 747-400: about 6 million parts/components

All are produced by a combination of various processes called manufacturing



Properties of Component

Geometry: Shape, size (dimensions), surface finish, tolerances etc.

Optical properties: Color, transparency, reflectivity

Thermal properties

Electrical and magnetic properties

Material Properties: Hardness, Strength, Toughness etc

Weight

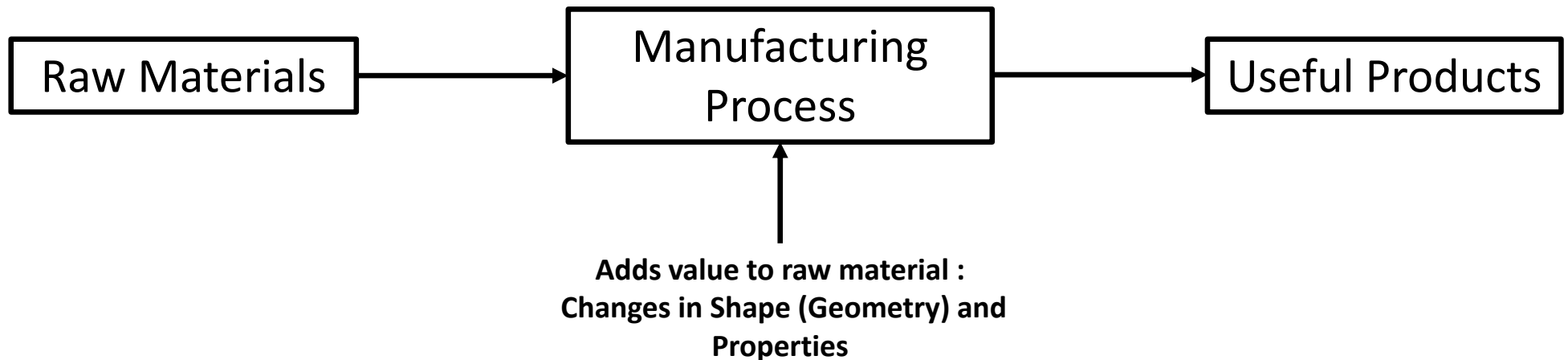
Geometry influences most of these other properties significantly

Physical Realization of Geometry

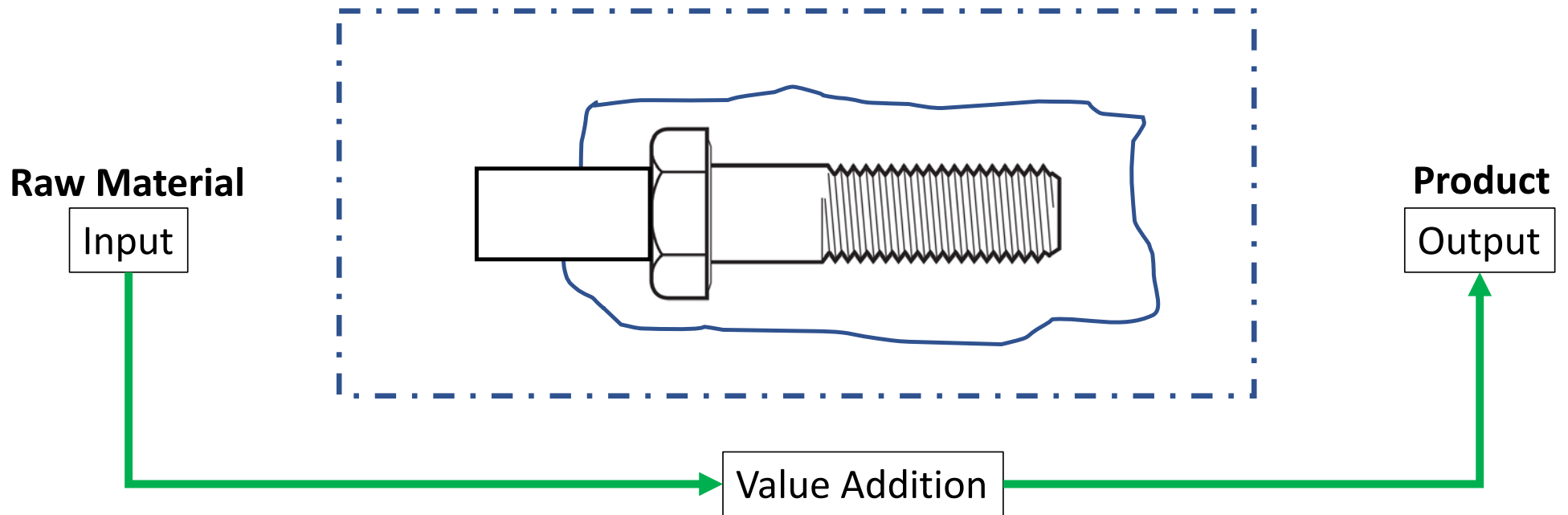


What is Manufacturing?

- Derived from the Latin word manufactus
- manus = hand, factus = made
- Practical definition: process of converting or processing raw materials into usable products



Manufacturing Processes





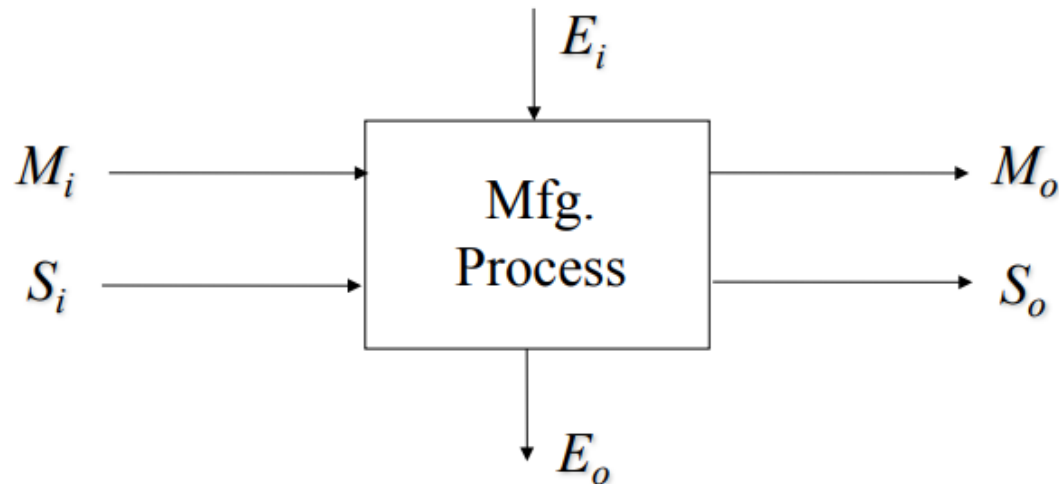
Systems-Oriented Definition

- Manufacturing as a system or enterprise
 - “A series of interrelated activities and operations involving design, materials selection, planning, production, quality assurance, management, and marketing of discrete consumer and durable goods” (CAM-I)
 - A highly complex, interdependent activity that is **dynamic in nature**



Classification of Manufacturing Processes

- Based on:
 - process type e.g., shaping vs. non-shaping
 - state of workpiece material e.g., solid or liquid
 - processing energy e.g., mechanical, electrical,...



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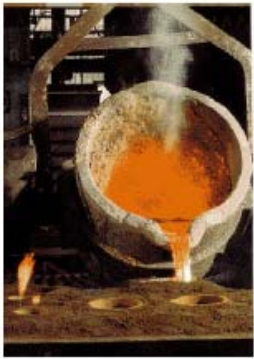


Classification of Manufacturing Processes

- Shaping process classification
 - Mass conserving, $dM \sim 0$
examples: casting, bulk forming, powder processing
 - Mass reducing, $dM < 0$
examples: conventional and unconventional machining
 - Mass adding, $dM > 0$
examples: joining processes

Further sub-classification is possible based on processing energy and workpiece state considerations

Classification of Manufacturing Processes



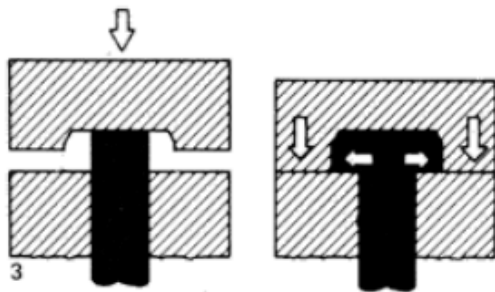
Casting ($dM \sim 0$)



Cutting ($dM < 0$)



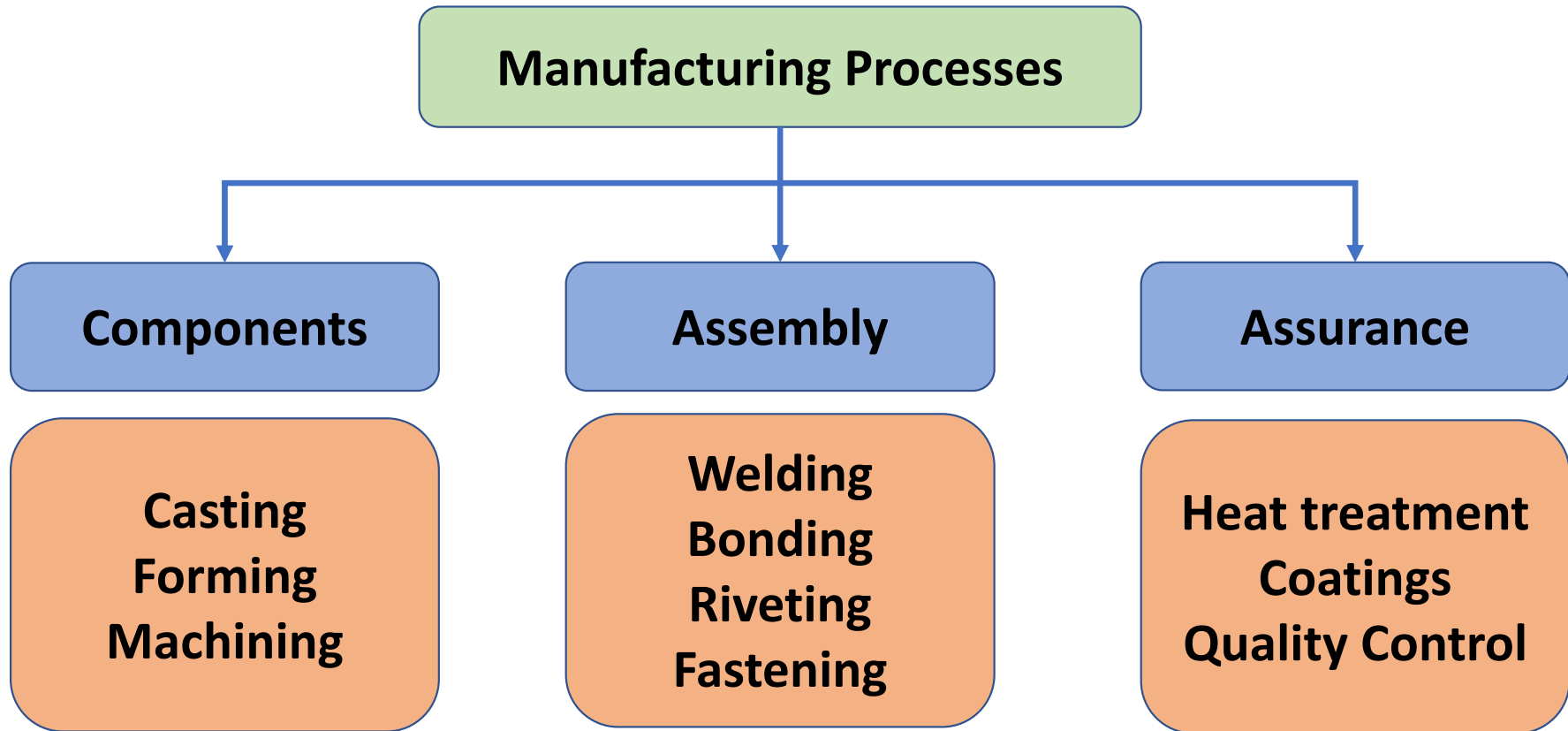
Welding ($dM > 0$)



Forging ($dM \sim 0$)

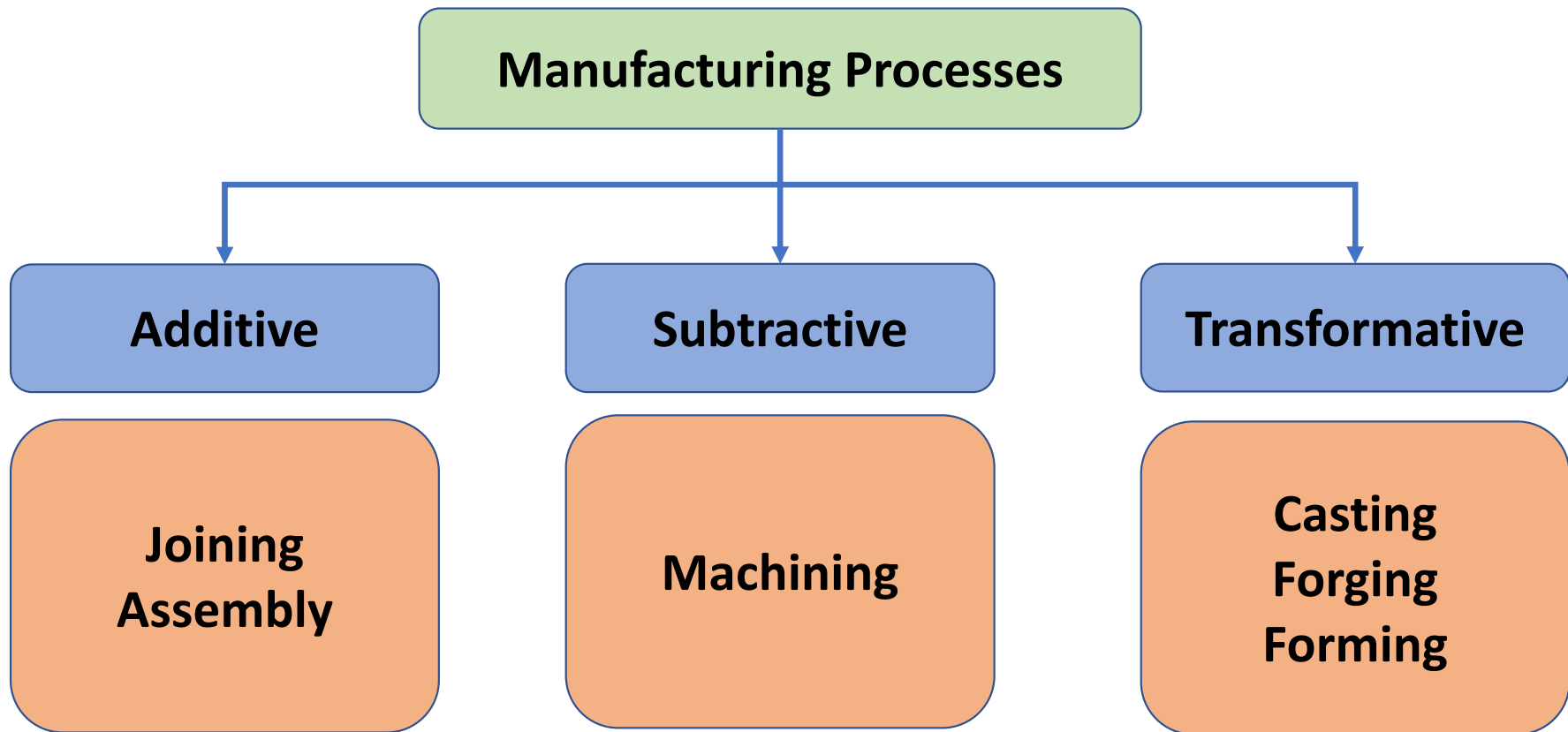


Classification



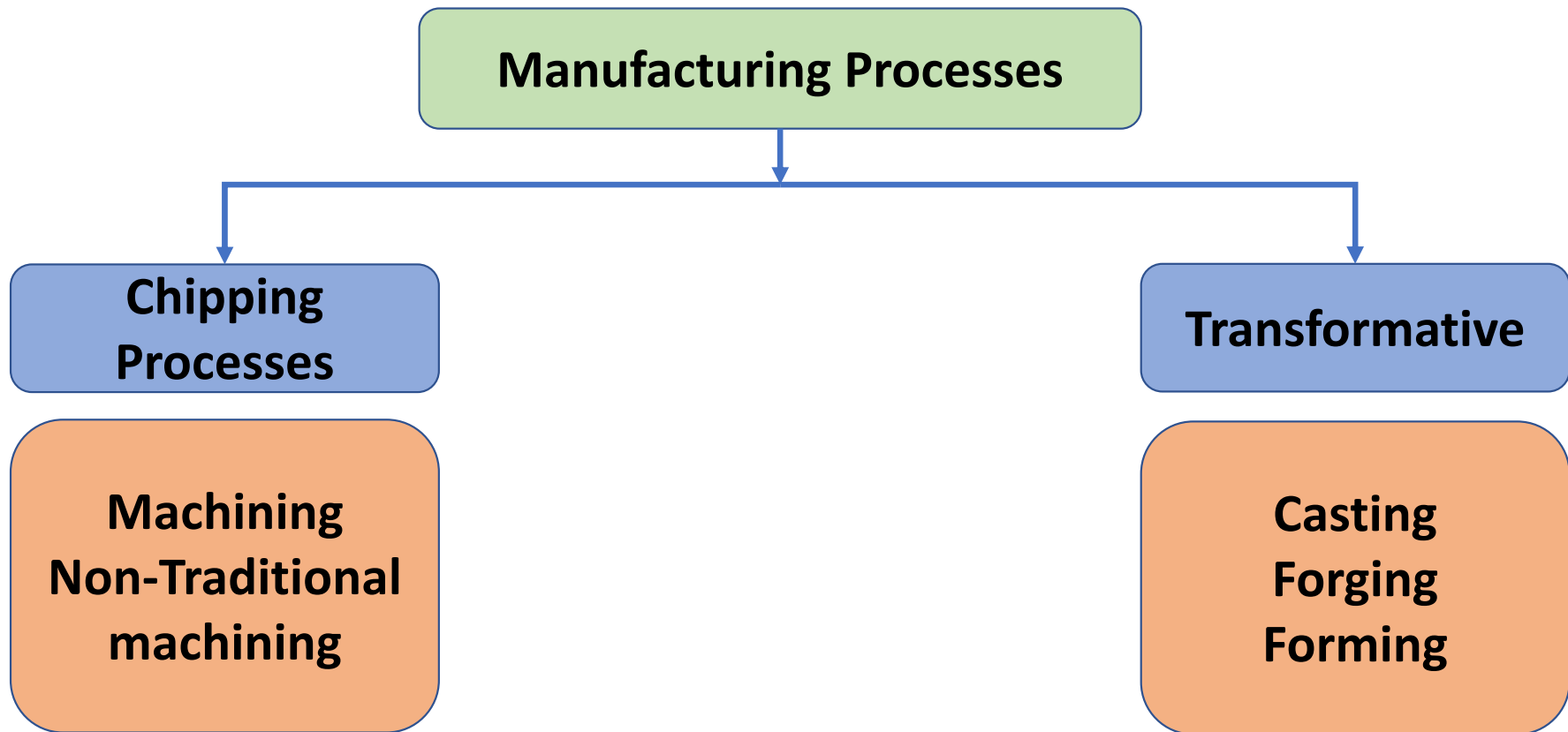


Classification



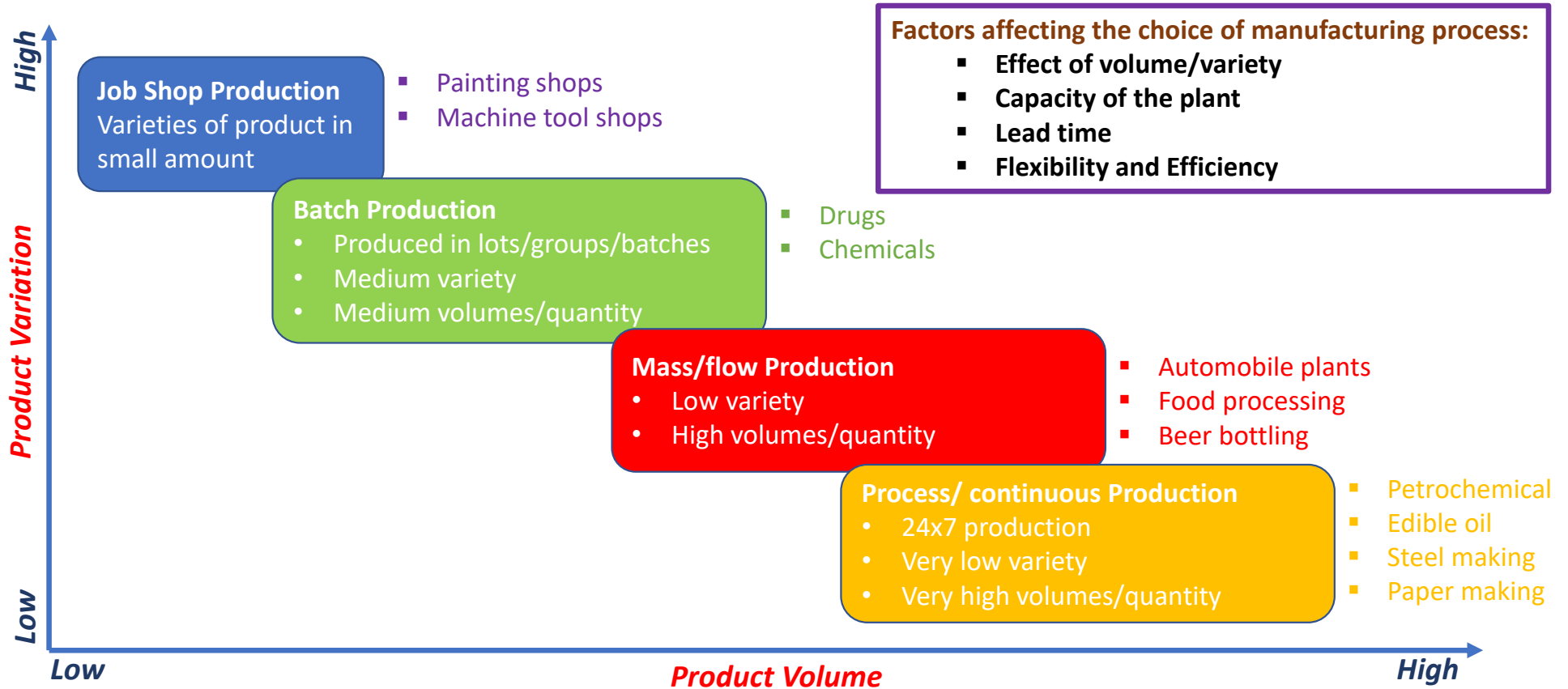


Classification



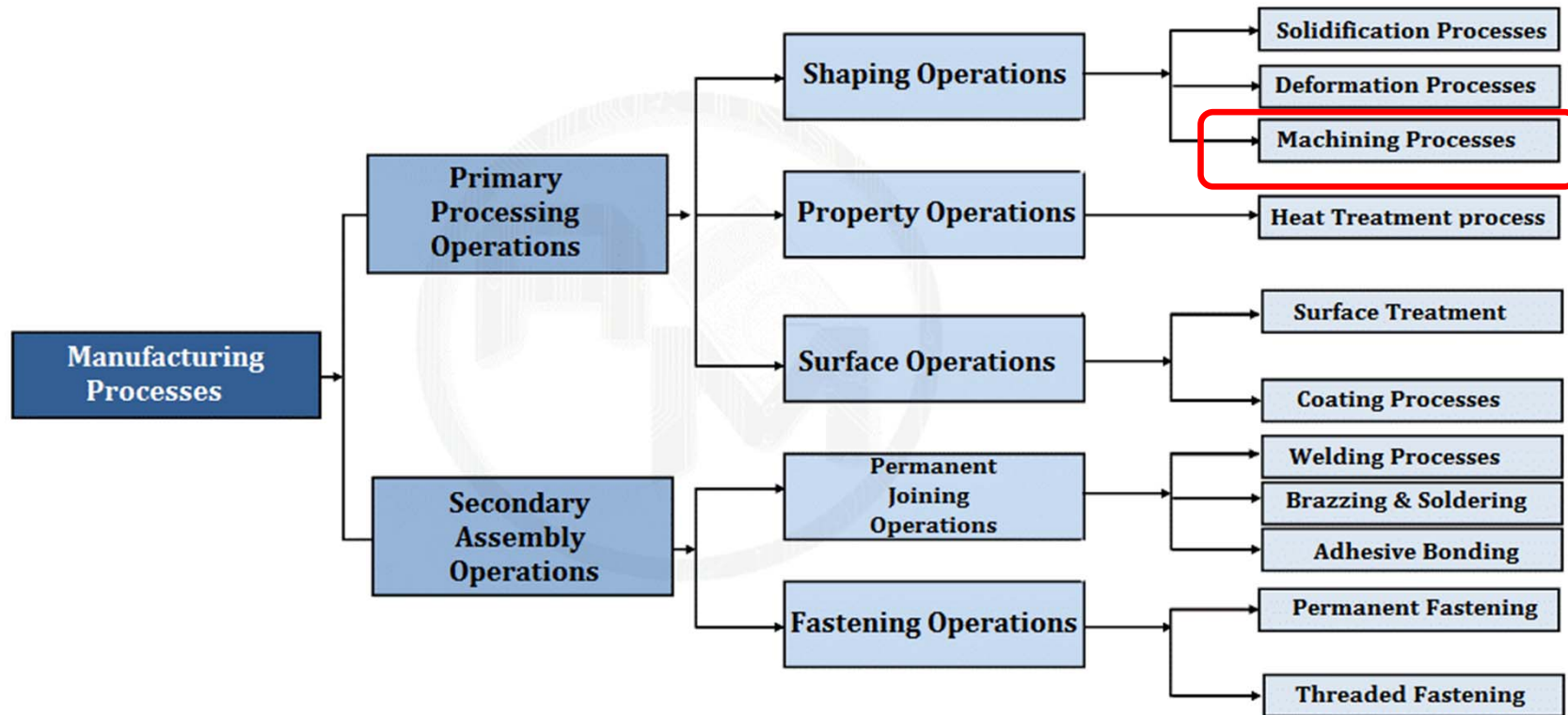


Classification





Manufacturing Processes





Machining Processes

*“Machining involves the removal of some material from the workpiece (machining allowance) in order to produce a **specific geometry** at a definite degree of accuracy and surface quality”*



Turning



Drilling



Milling



Why Machining?

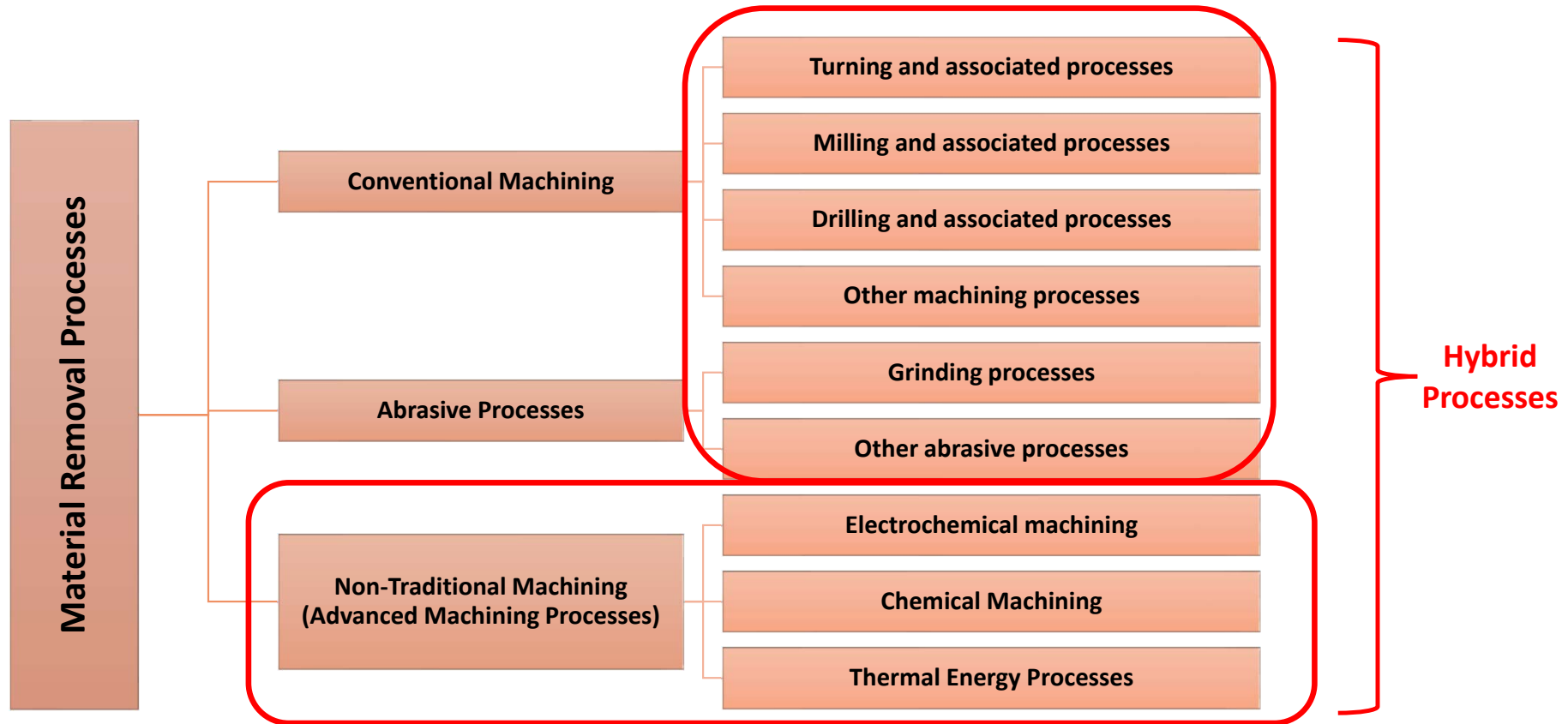
- Closer Dimensional and form accuracy
- Good surface finish
- External or Internal geometric features
- Requirement of additional finishing processes
- Economic viability

Machining to high accuracy and finish essentially enables a product

- Fulfill its functional requirements
- Improve its performance
- Prolong its service



Material Removal Processes





Conventional Machining

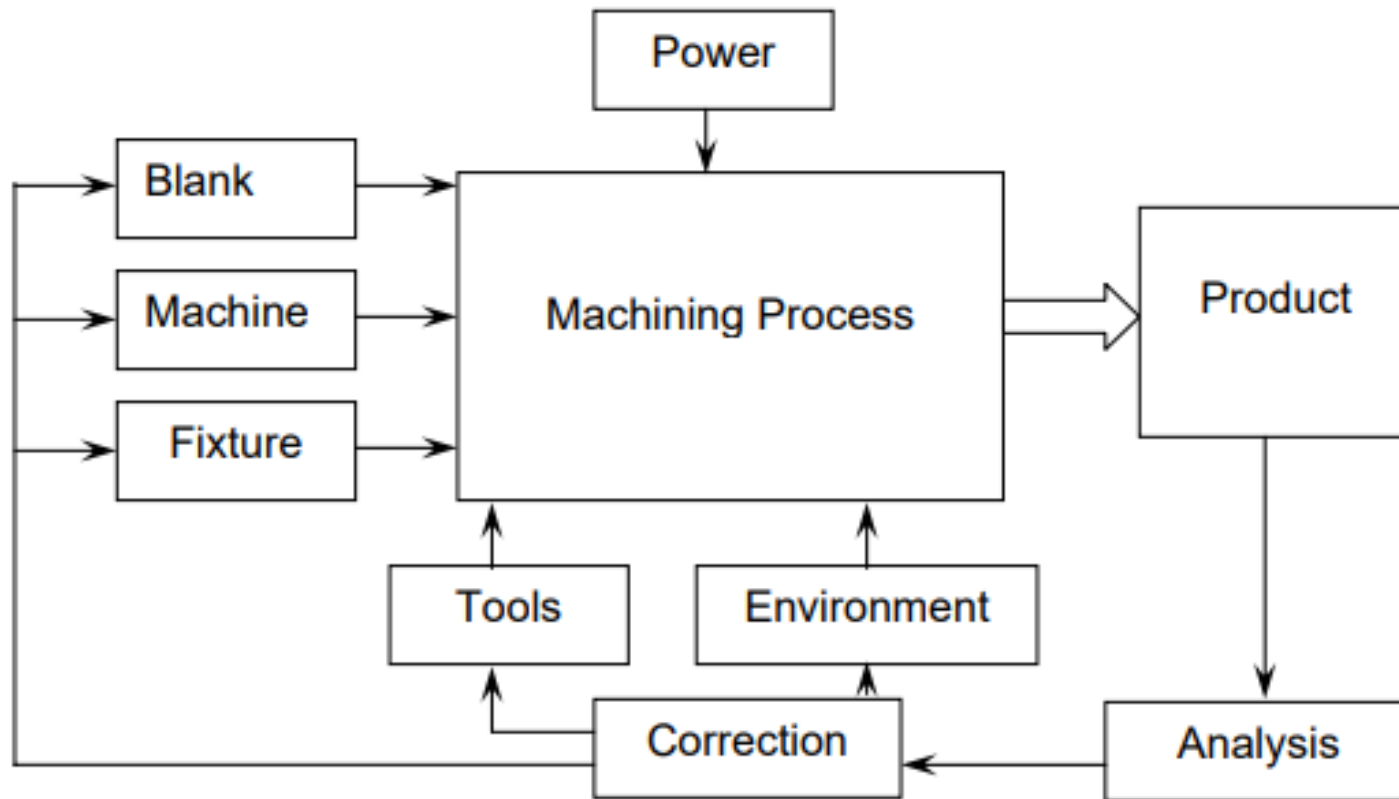
Chip formation by Tool

- **Workpiece**
- **Cutting Tool**
- **Chip**





Machining Requirement

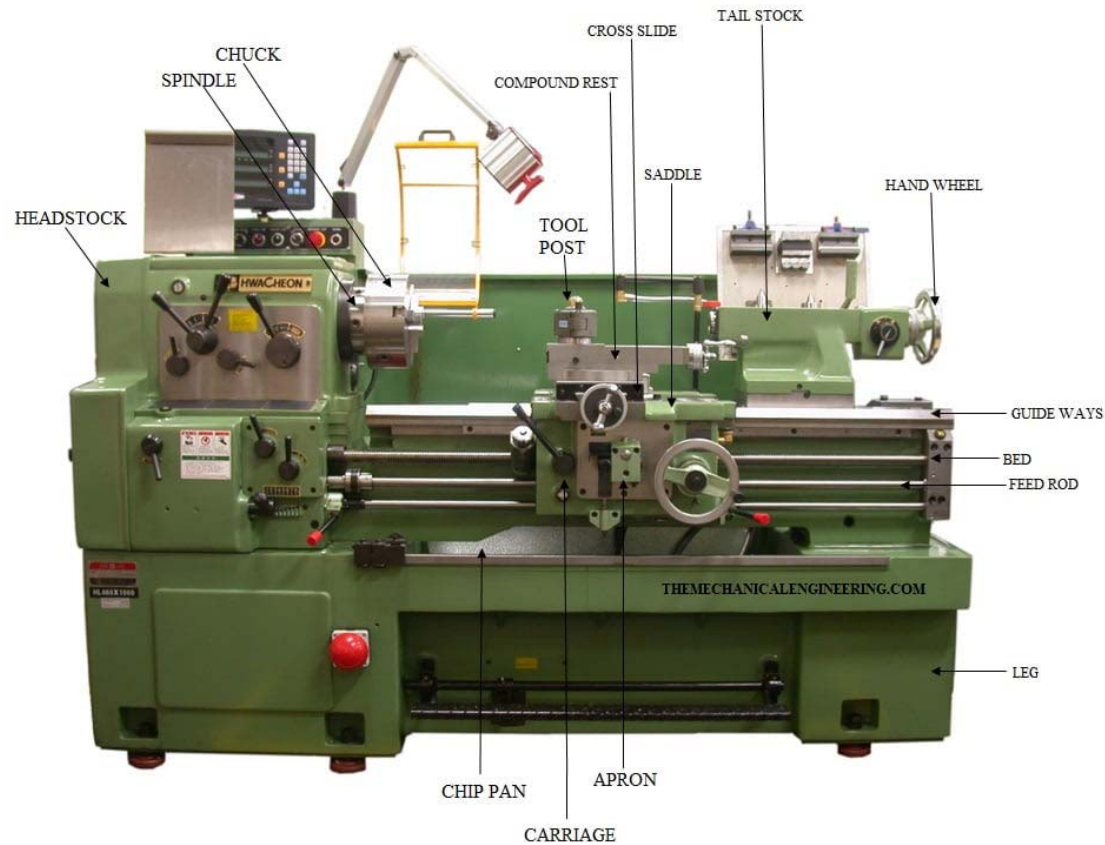




Machine Tools and Processes

- **Turning**
- **Drilling**
- **Milling**
- **Planing**
- **Shaping**
- **Broaching**
- **Filing**
- **Sawing**
- **Grinding**
- **Reaming**
- **Honing**
- **Tapping**
- **Boring**

Lathe Machine

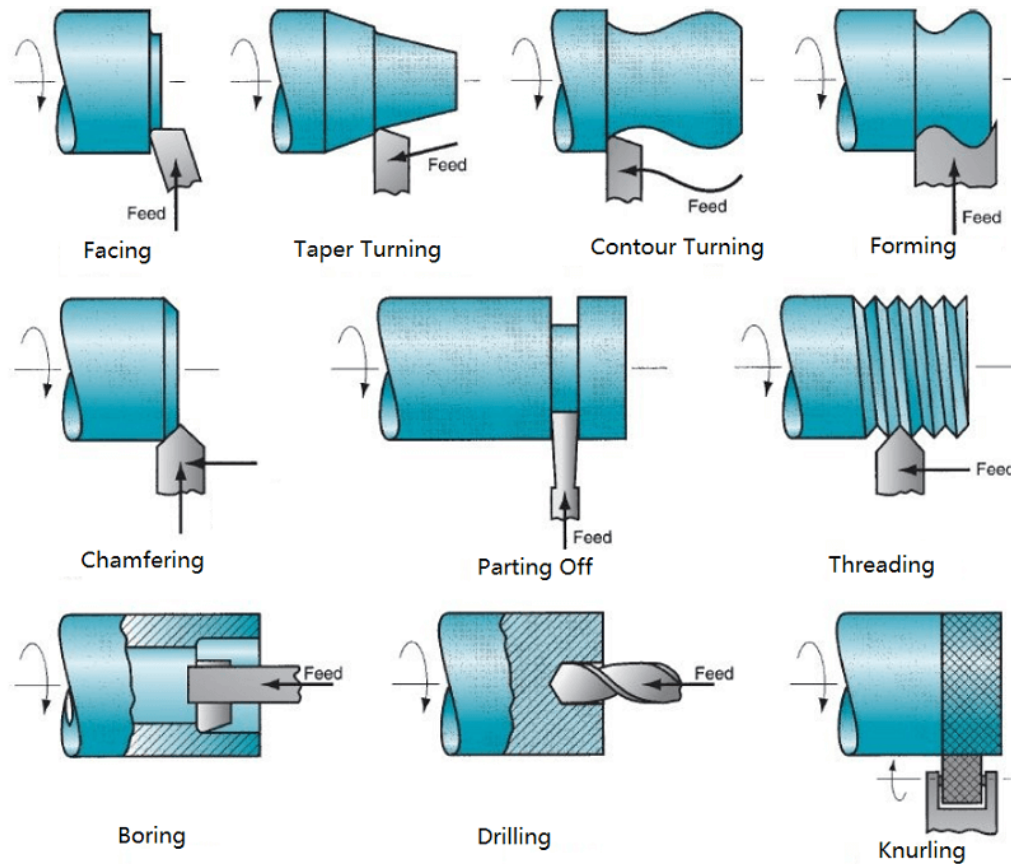


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Lathe Operation

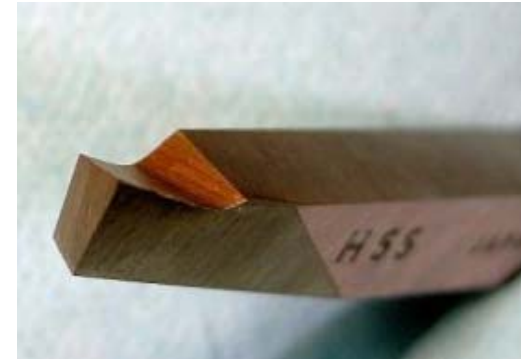
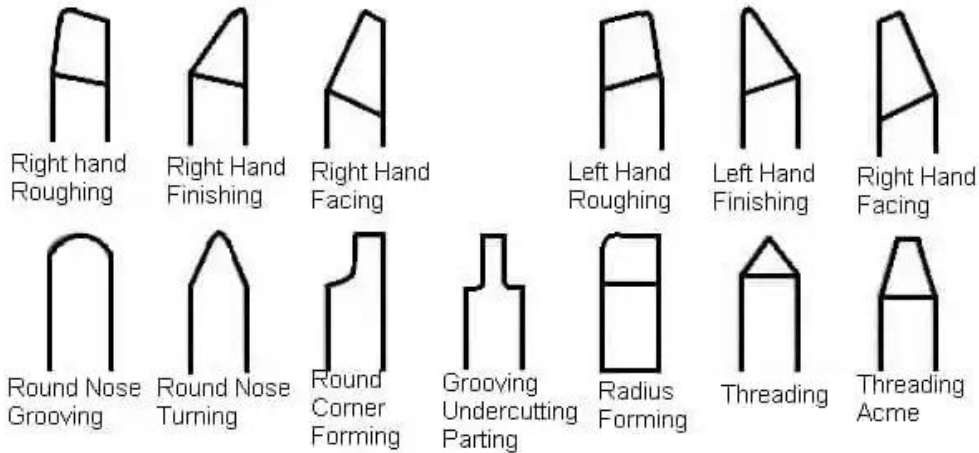
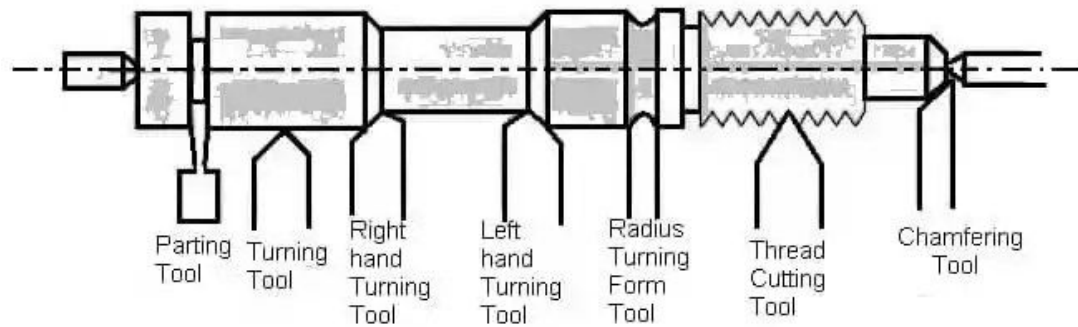
	turning	facing	grooving	forming	threadin
External					
Internal					

Lathe Operation



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Cutting Tools for Lathe



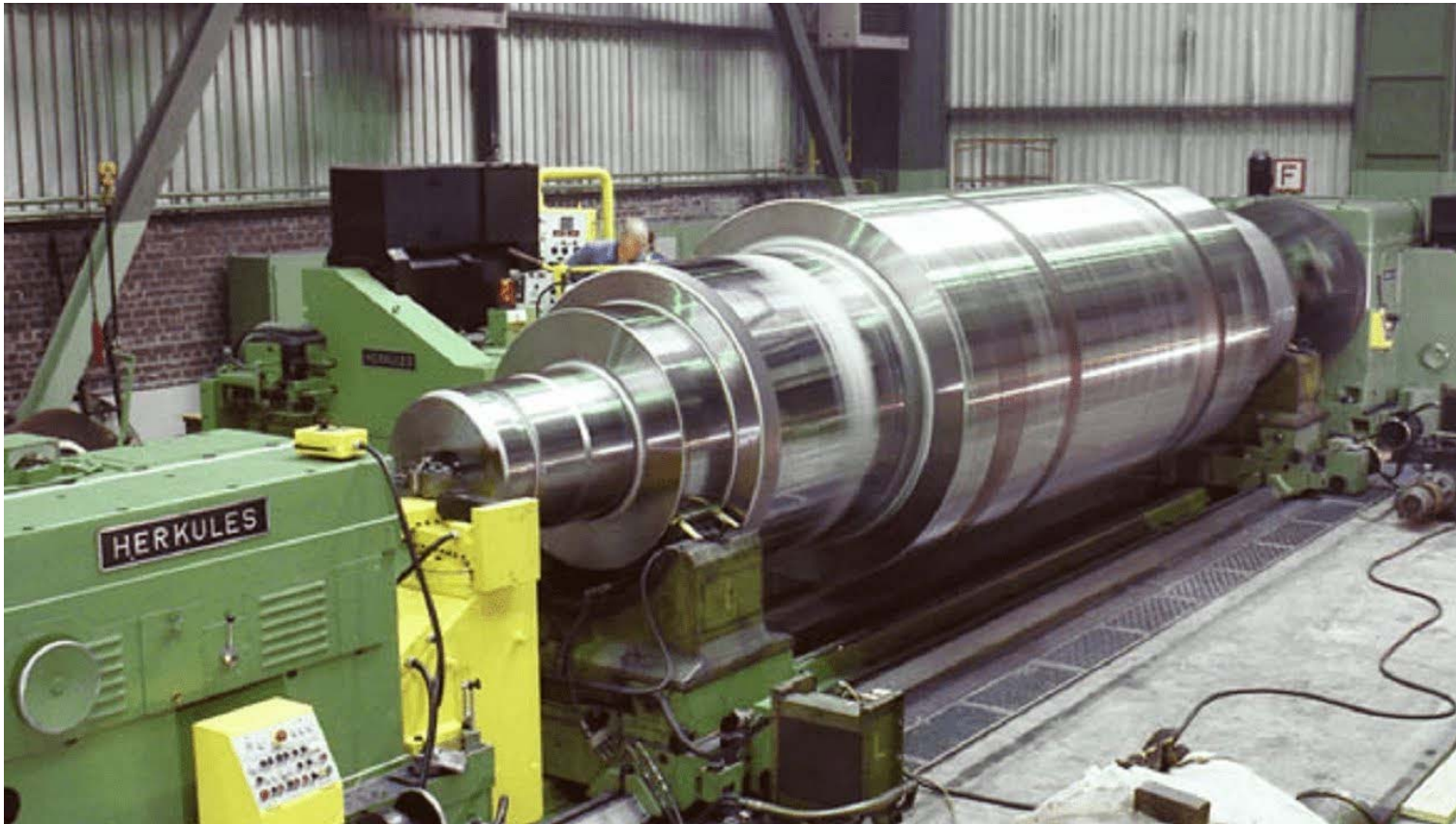
Single point cutting tool



Insert cutting tool

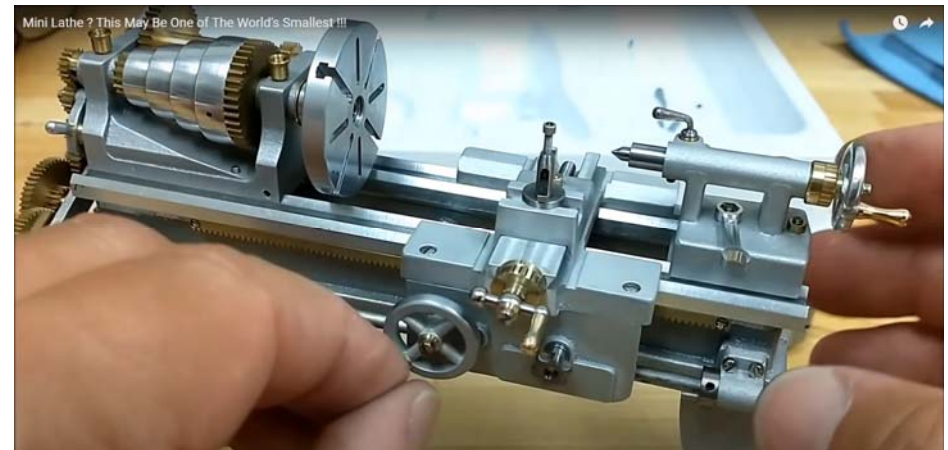
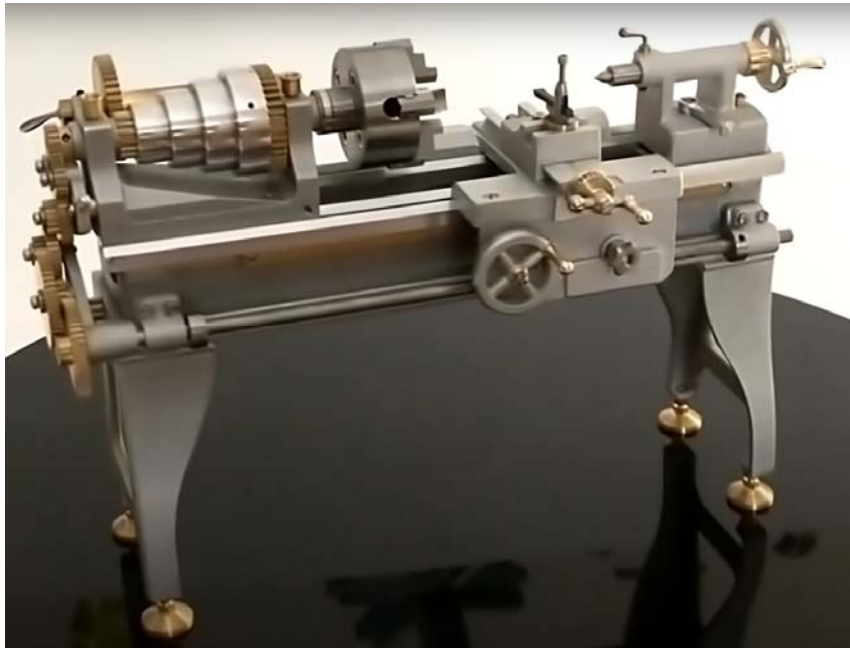


Lathe Machine



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Mini Lathe Machine



Lathe Operation

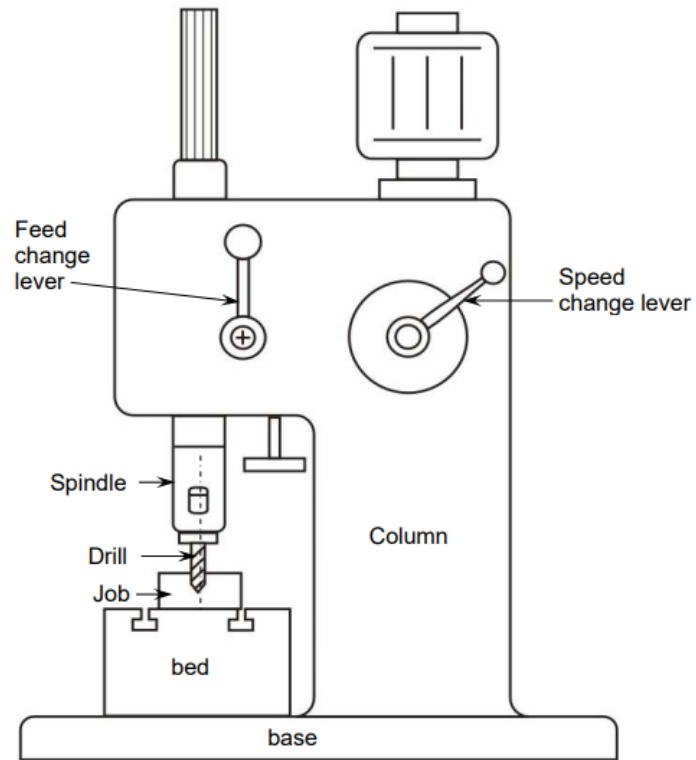


Stone Pillar



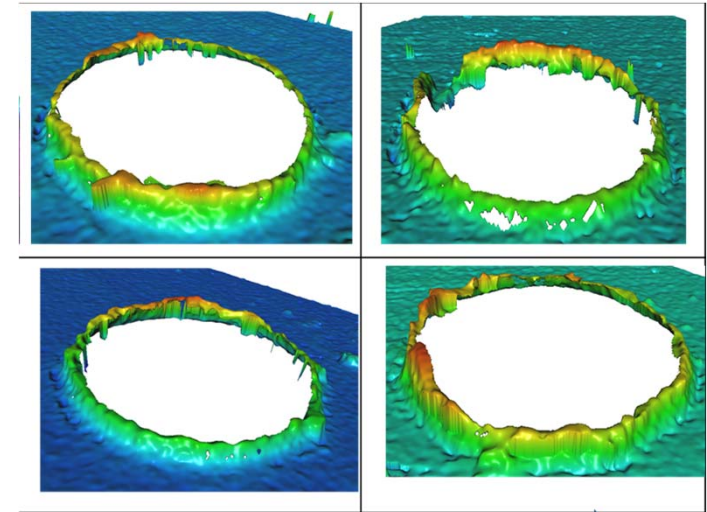
Wood Turning

Drilling Machine



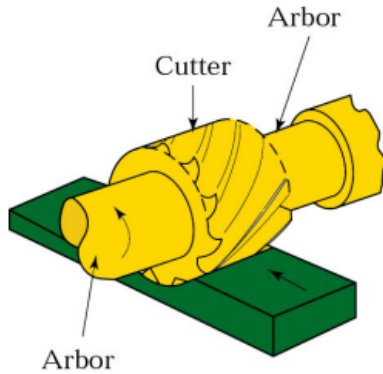
Drill Bits

Drilling Operation

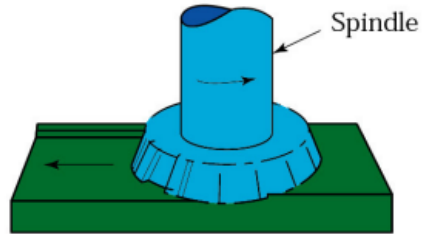


Microholes

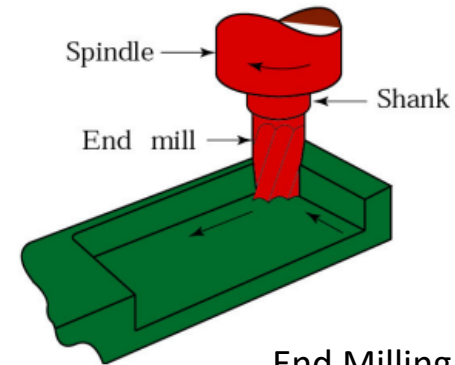
Milling Operations



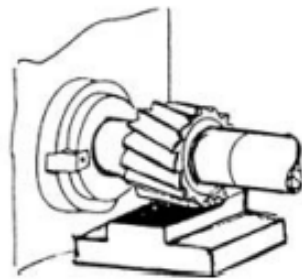
Slab Milling



Face Milling



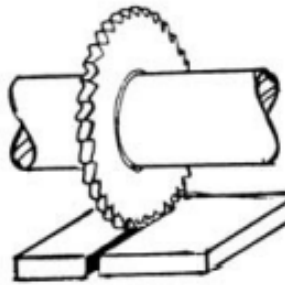
End Milling



surfacing



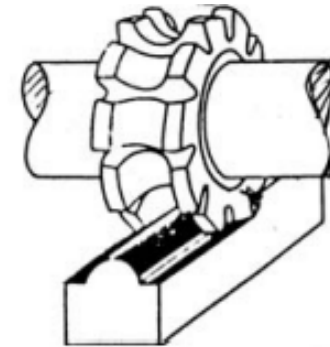
slotting



slitting

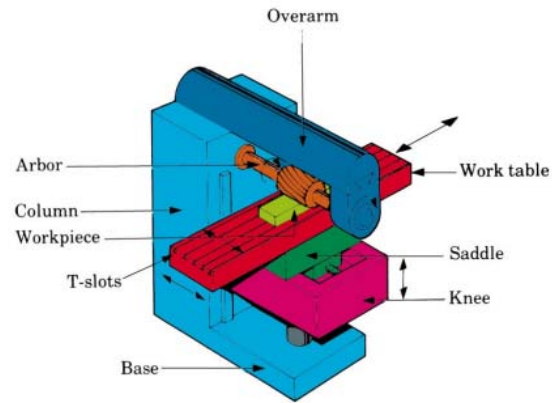


grooving

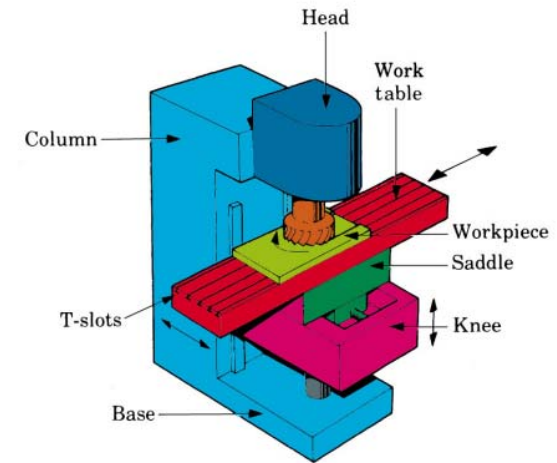


forming

Milling Machine

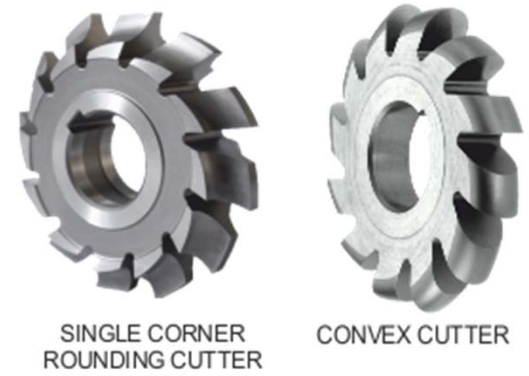
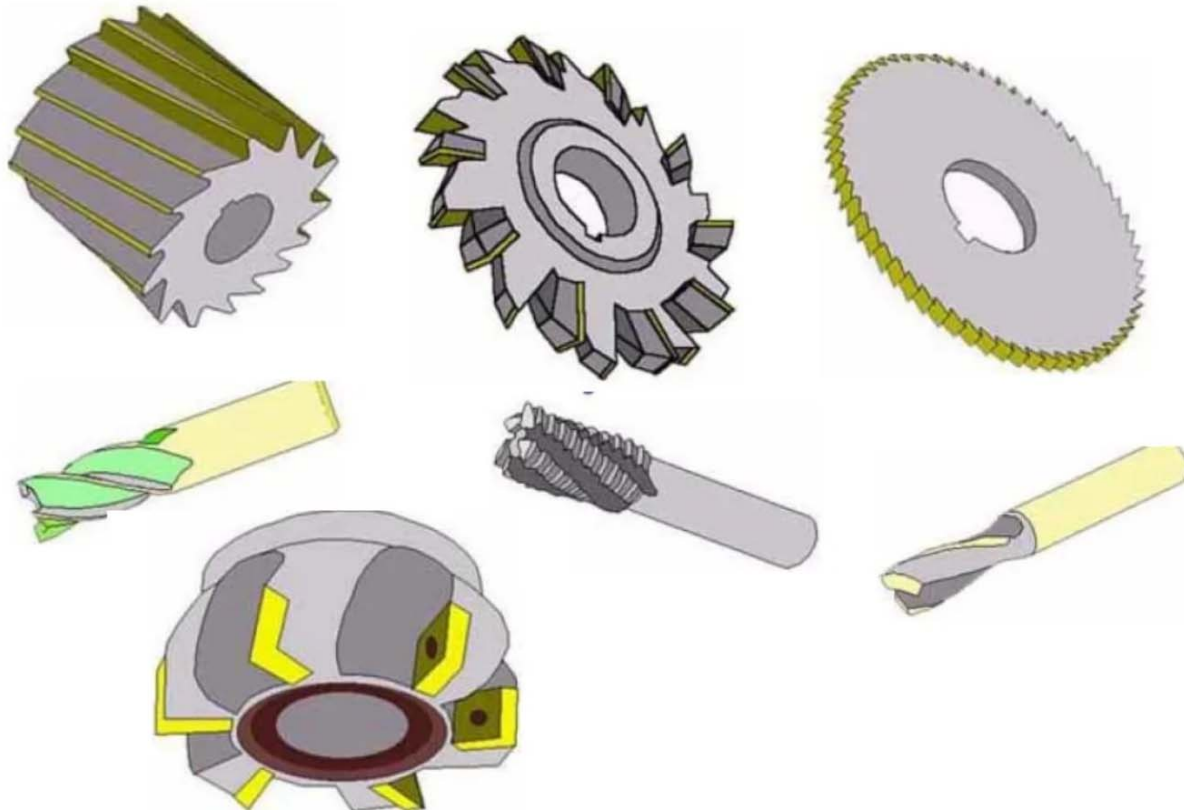


Horizontal Mill

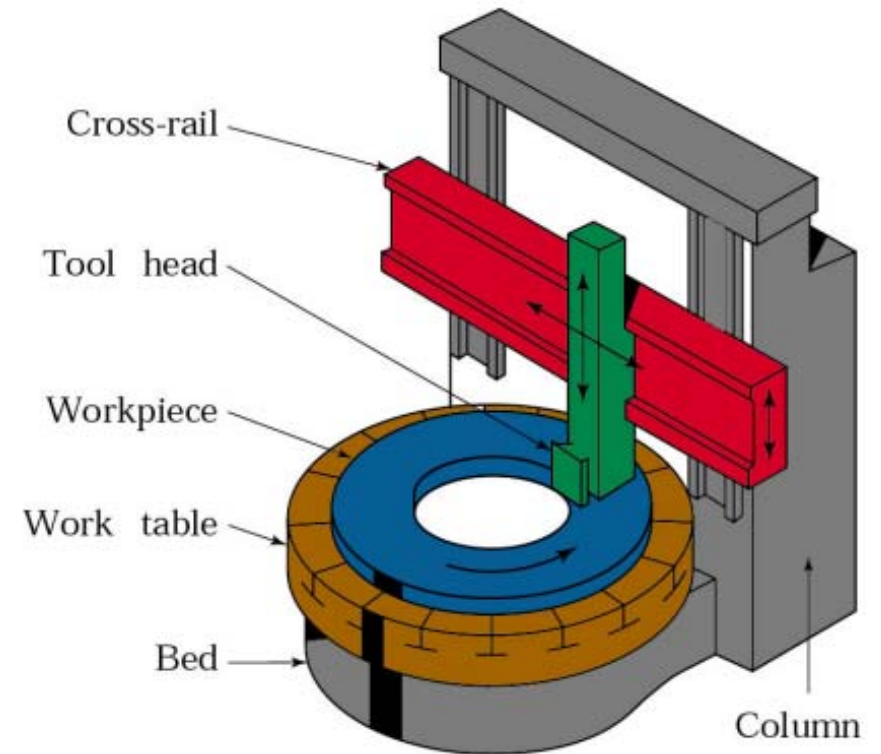
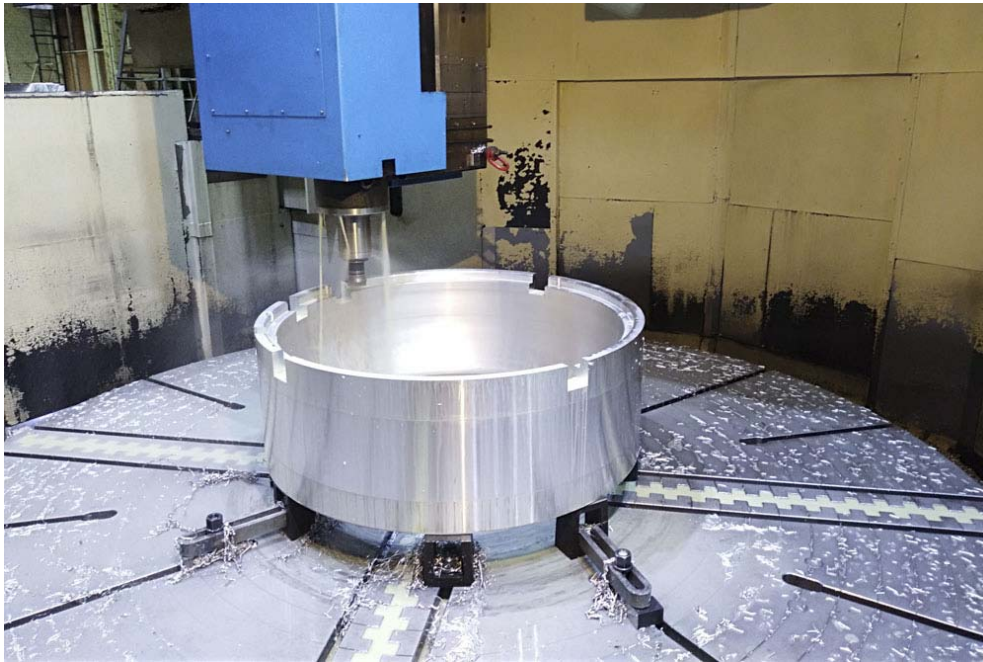


Vertical Mill

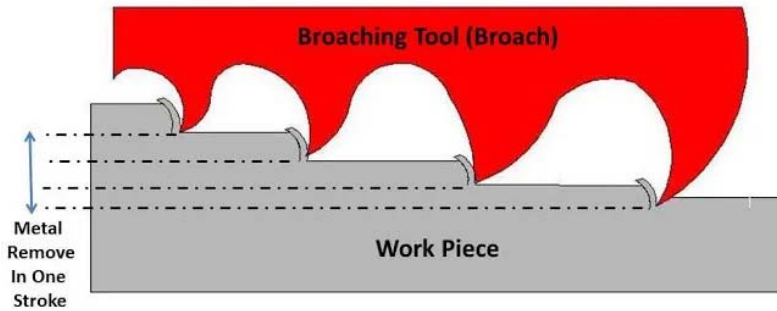
Milling Cutters



Boring



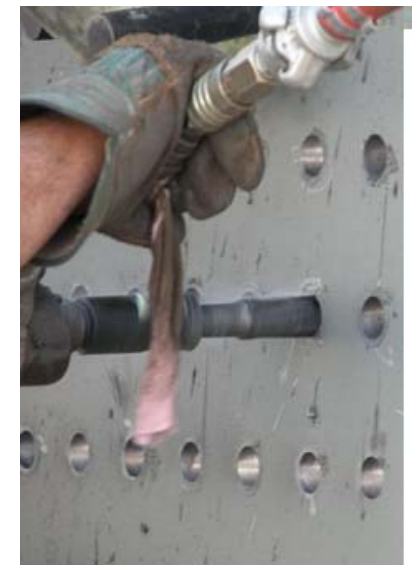
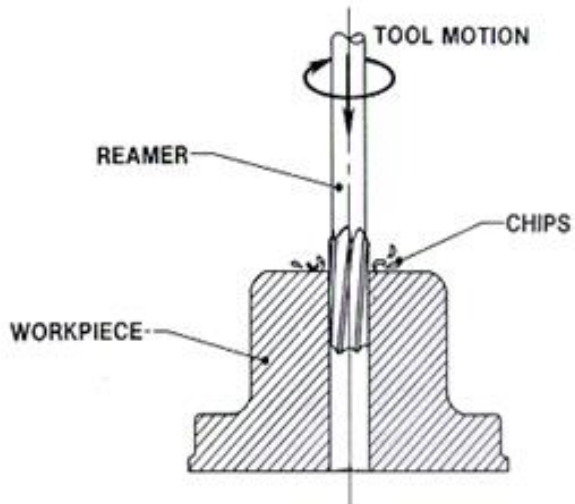
Broaching



Broaching Operation

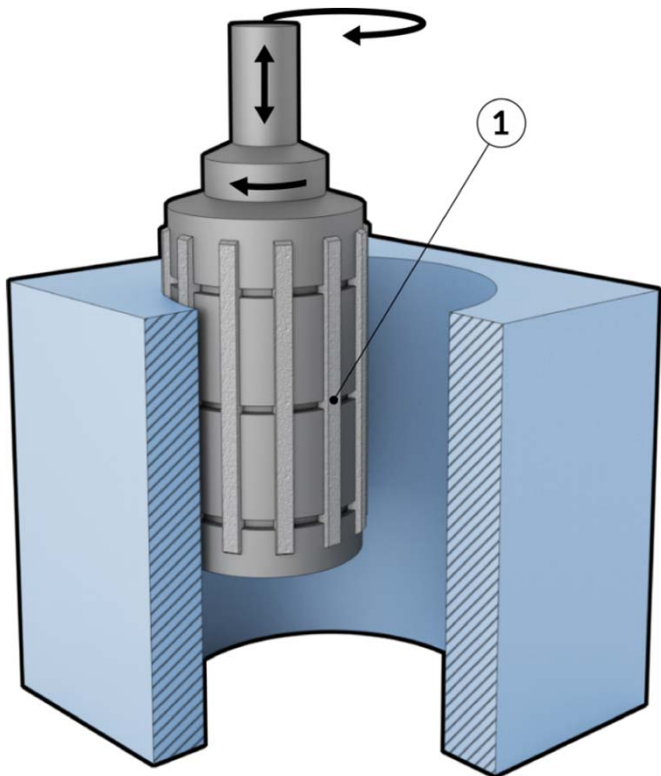


Reaming

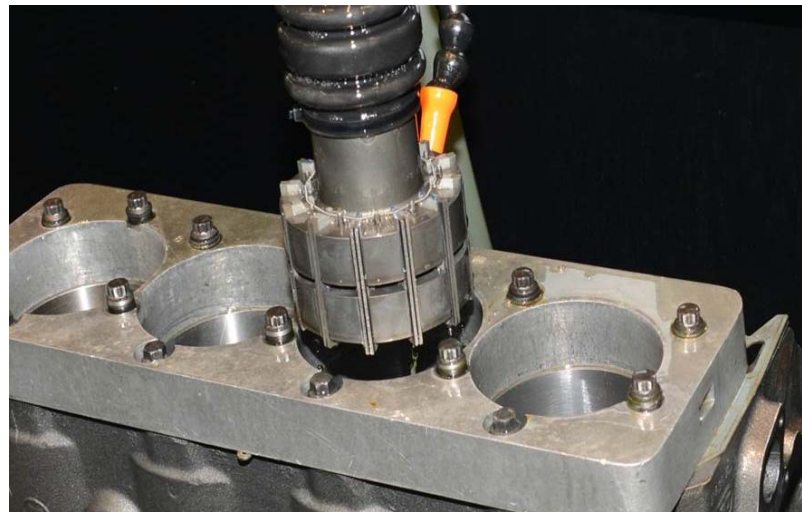
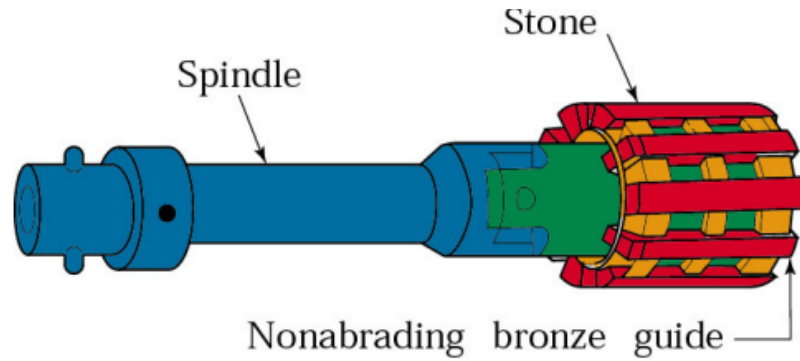


bridge reamer

Honing

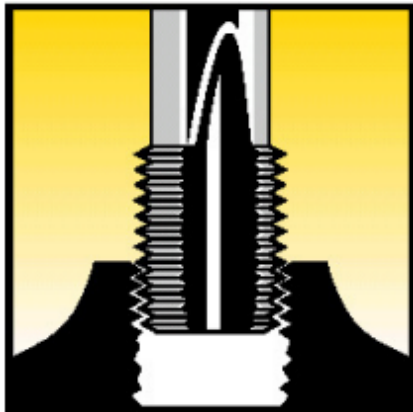


MANUFACTURINGGUIDE



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Threading Tap and Dies



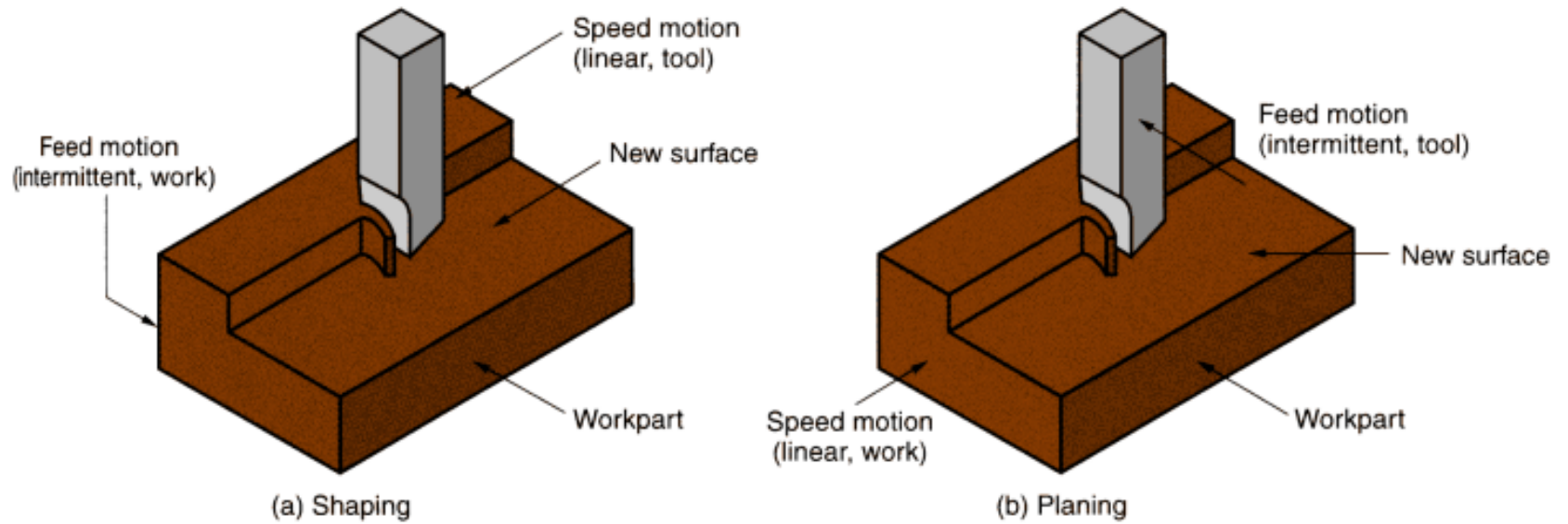
internal



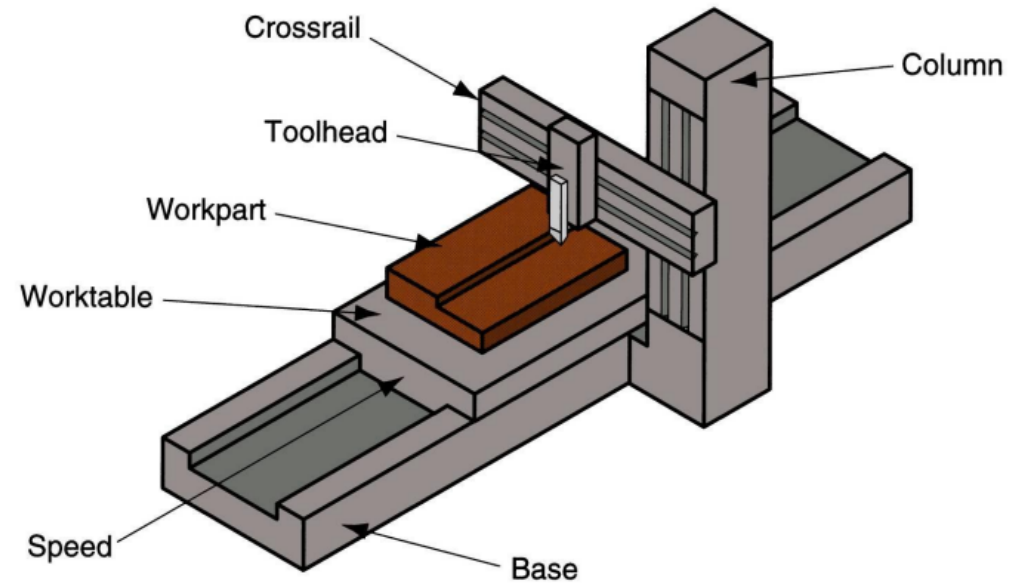
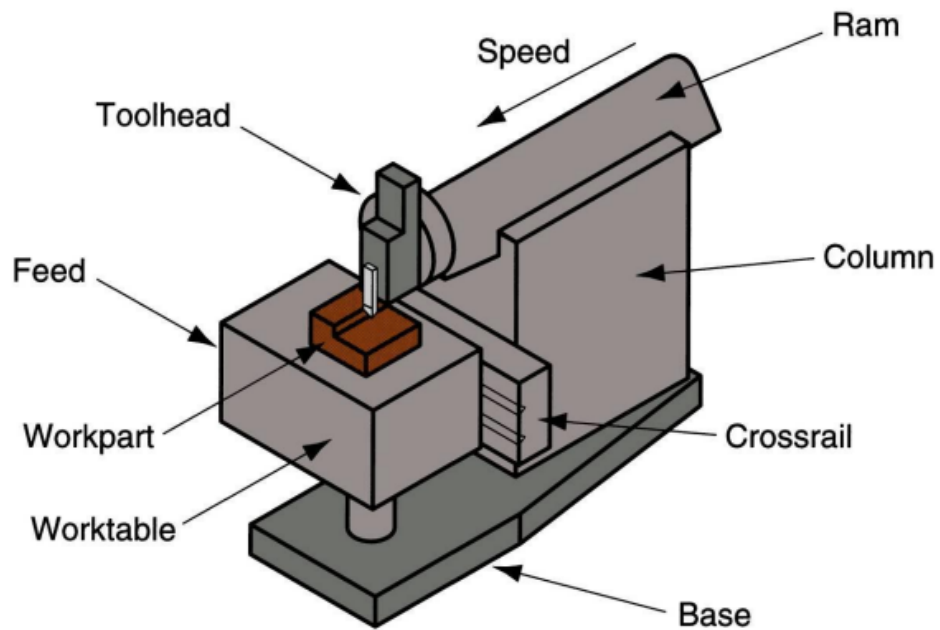
external



Shaping/Planing



Shaping/Planing





Nontraditional Machining

- A machining process is called non-traditional if its material removal mechanism is basically different than those in the traditional processes
- Processes that remove excess material by various techniques involving **mechanical, thermal, electrical or chemical energy or combinations of these energies**
- These processes **do not use a sharp cutting tools** as those need to be used for traditional manufacturing processes
- Also called **advanced machining processes**



Why Nontraditional Machining?

- **Engineering Materials**

- Metals and Alloys
- Plastics and Composites
- Ceramics



Getting more popularity and have advantages over others

- Demand of materials with ultrahigh strength, hardness, very high temperature resistance in industries
- The greatly improved thermal, chemical, and mechanical properties
- The high cost of machining of ceramics and composites and the damage generated during machining are major obstacles

Solution: Advanced Machining Process (AMP)

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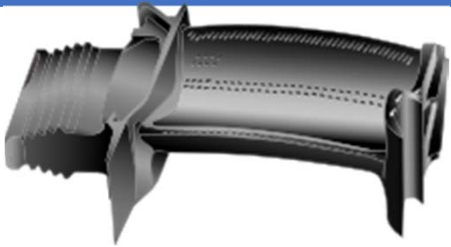


Why Nontraditional Machining?

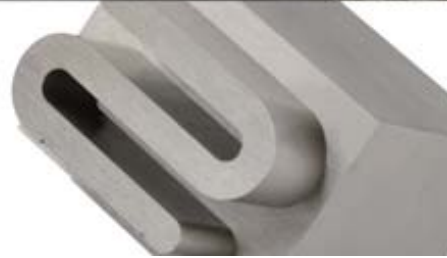
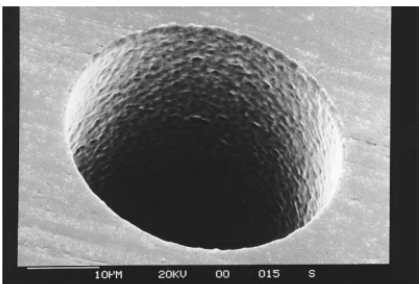
- **Product Requirement**

- Complex shapes
- Machining in inaccessible areas
- Low tolerances (less than 10 microns)
- Better surface quality (no defects such as microcracks)
- Increase demand of miniaturization of components

Solution: Advanced Machining Process (AMP)



Ceramics (bullentech.com)



High Tolerance Fitting



Taper cutting



Holes in Glass (swiftglass.com)