Lectures on mechanics

(lesson #4)

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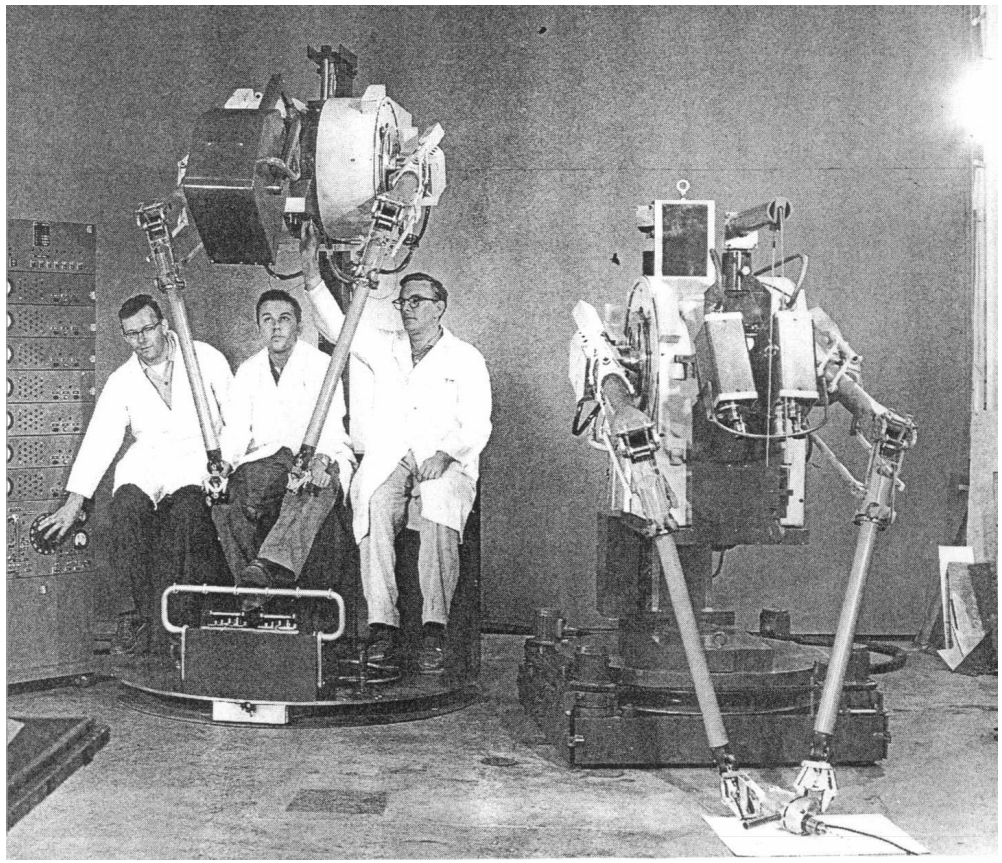
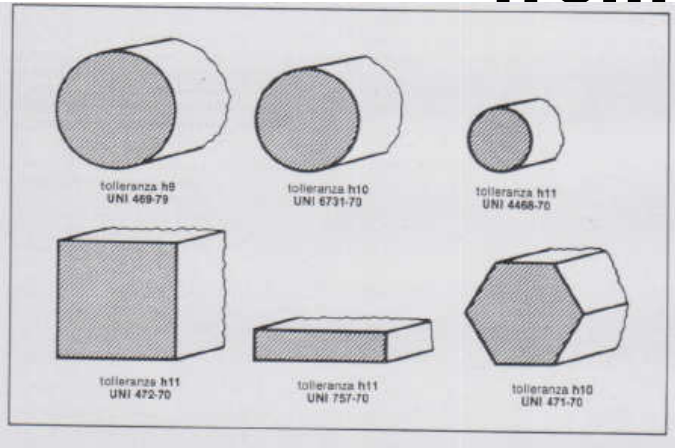
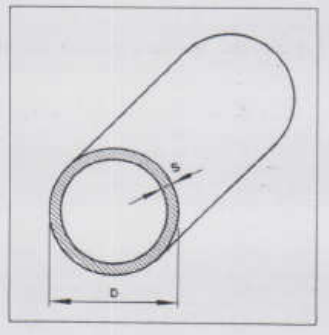
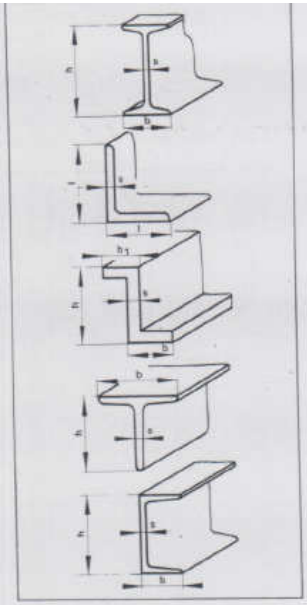


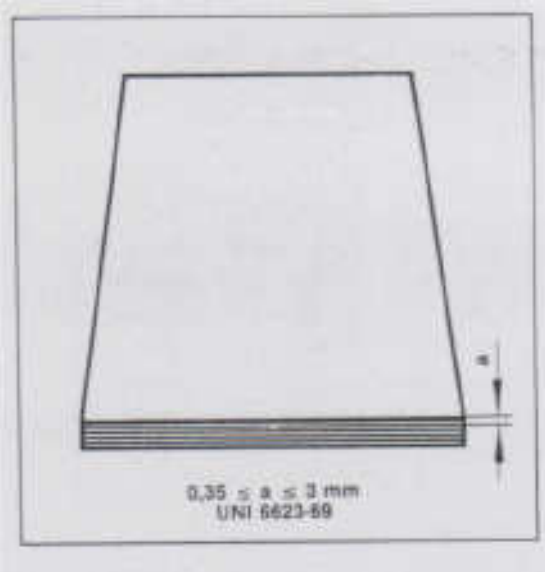
mechanical technology:from what we start from in designing part

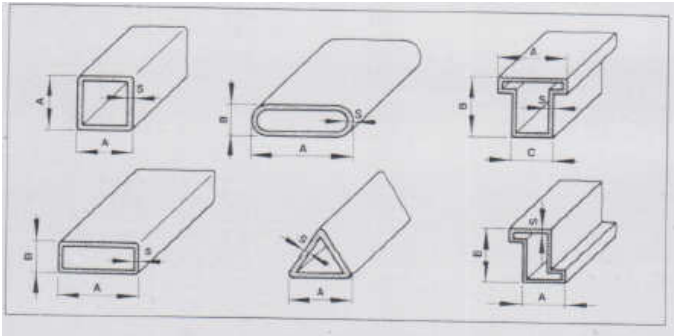






Semifinshed:
Blooms
Slabs
Billets (square /rect.)
Rounds
Structural shapes
Plates
Sheets





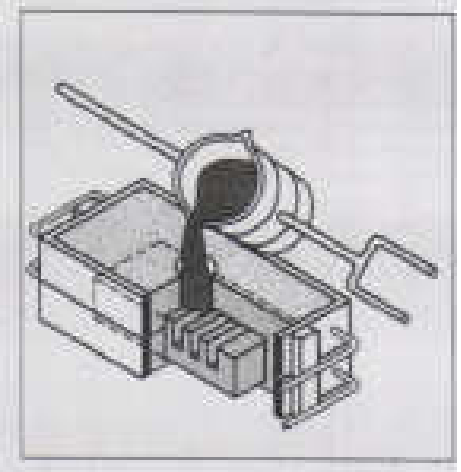
To realize a mechanical part we generally start from rough material or a semi finished part.

Generally not all shapes exists for all materials..

In designing a new part the staring point must be always known

How things are made

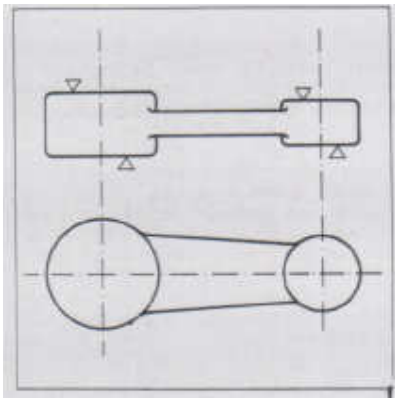
casting



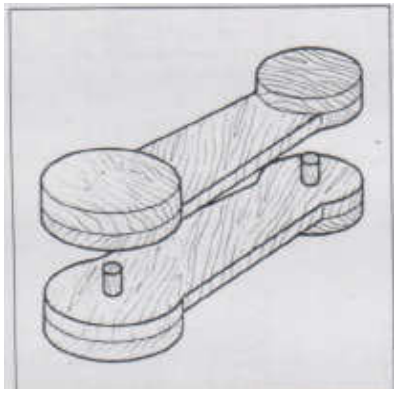
High fluid and omogeneous metals at liquid state:

cast iron
aluminium
bronze
steel

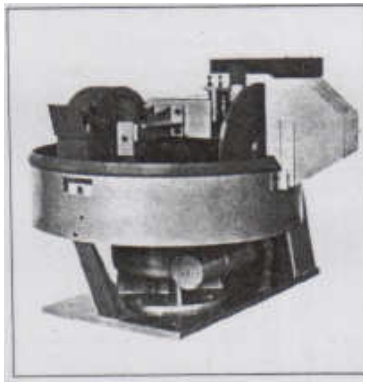
casting: SAND MOLD



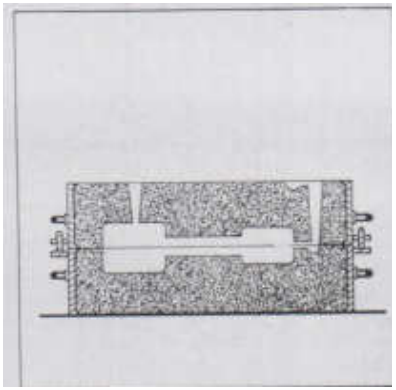
Part design



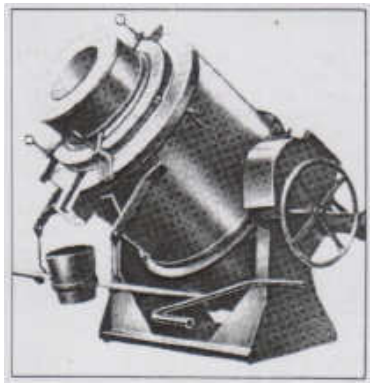
Pattern



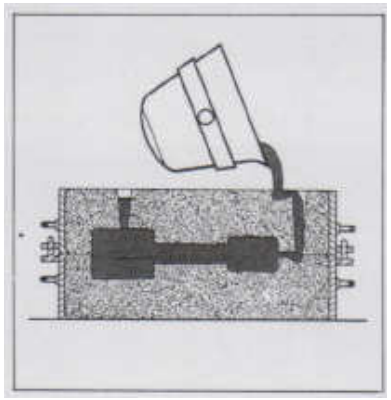
Foundry sand & mixing mill



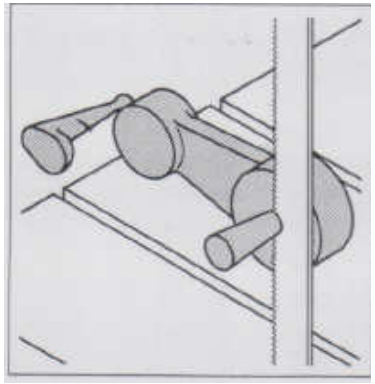
molding



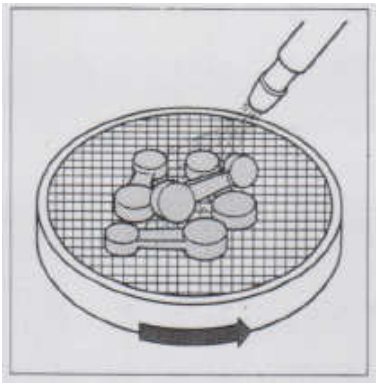
Fusion (crucible /air furnace)



casting



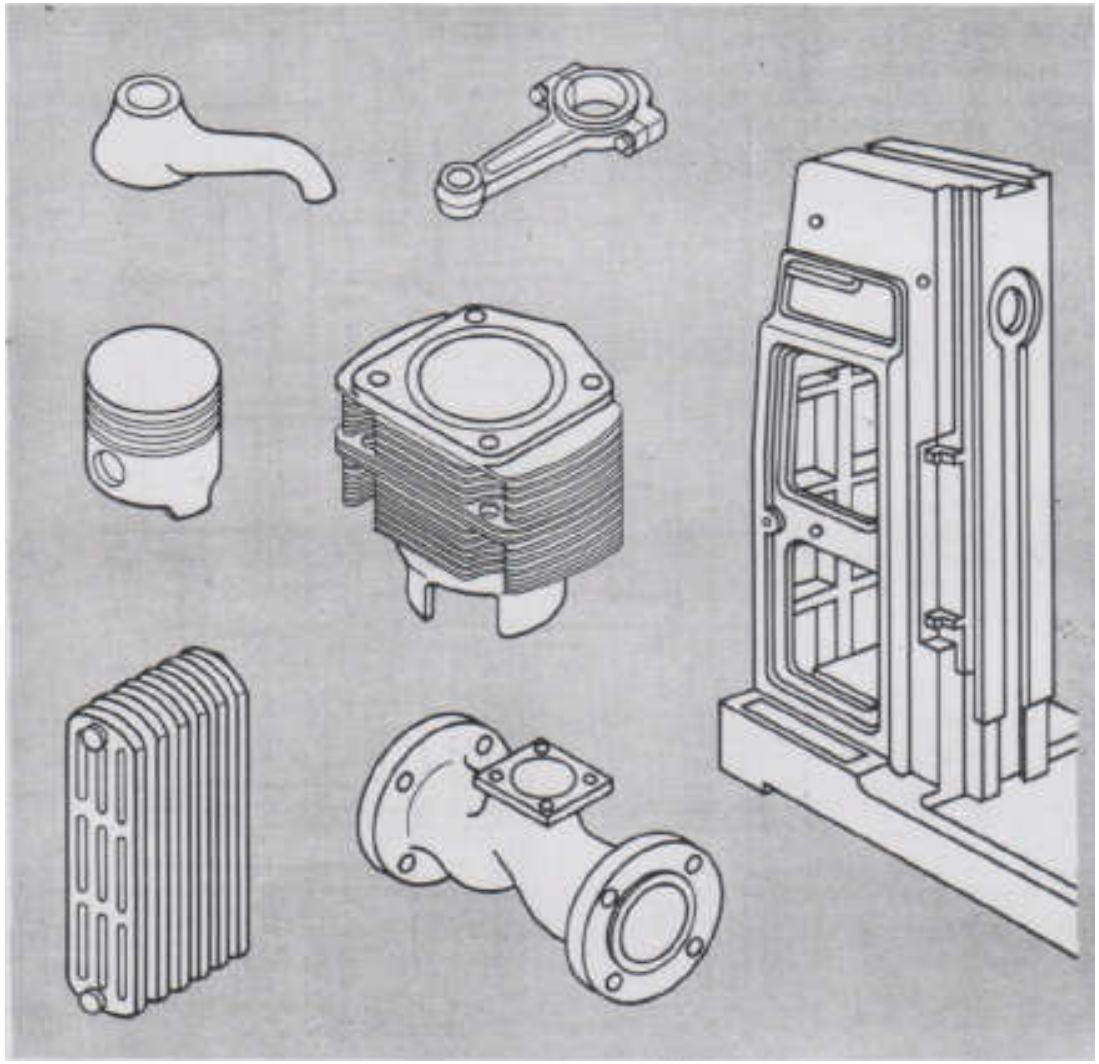
Snap-flasks opening, sand and risers removal



sandblasting

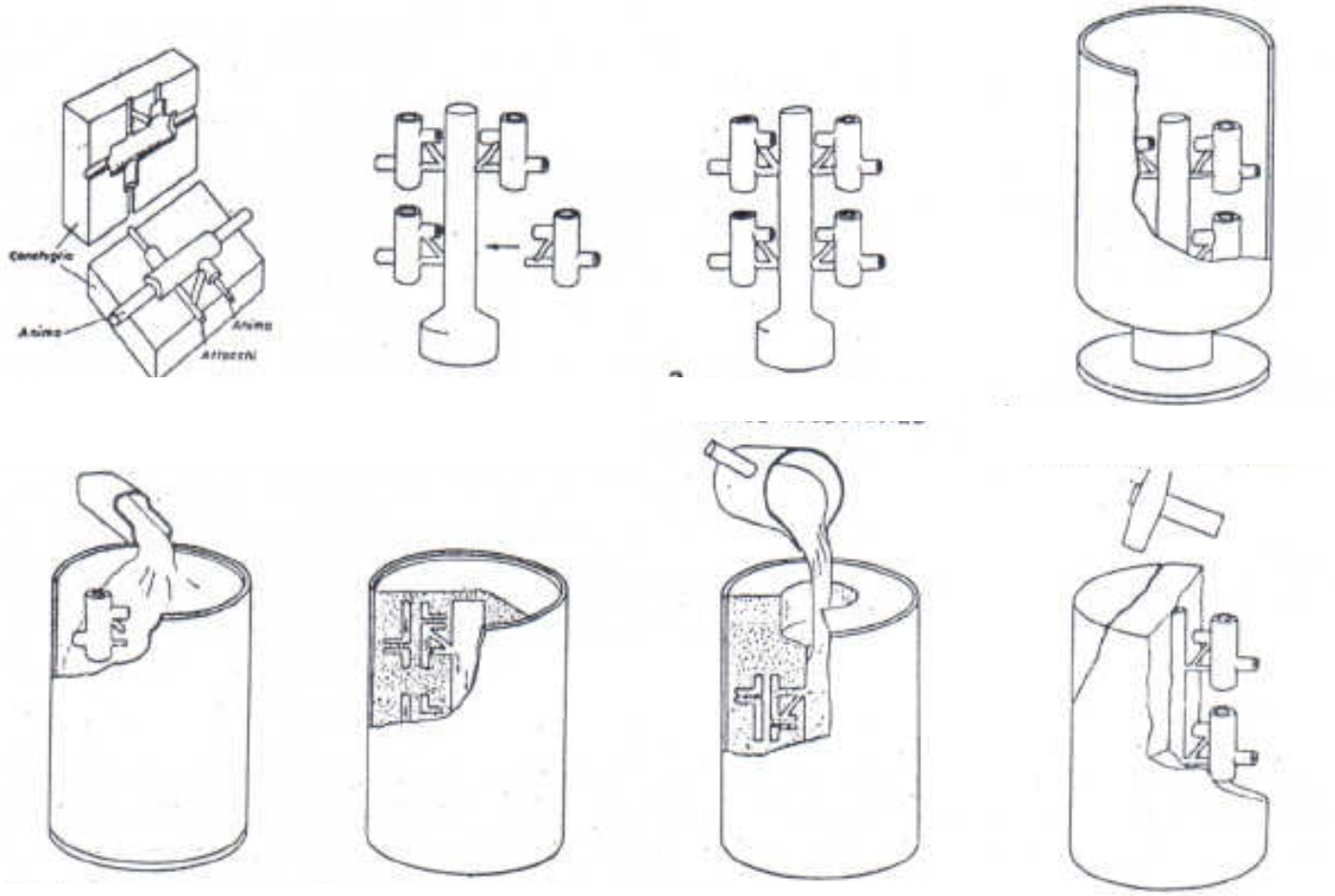
Big molds poor finish,thick walls generally poor precision

casting: SAND MOLD



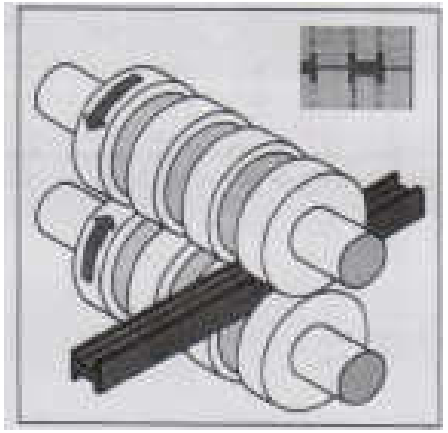
Examples of sand molded parts

Casting: WAX MOLD

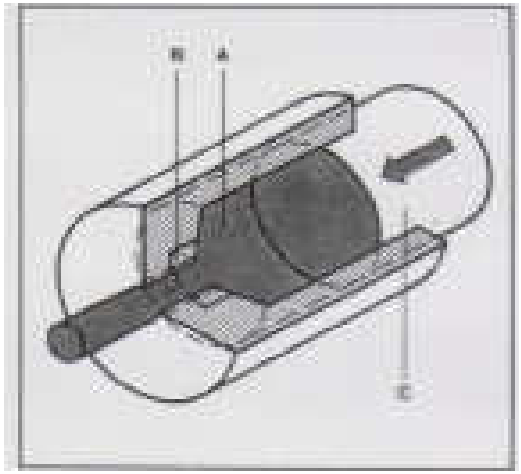


Smaller mold, thin wall, higher precision (cluster molds)

mechanical technology



steel,iron



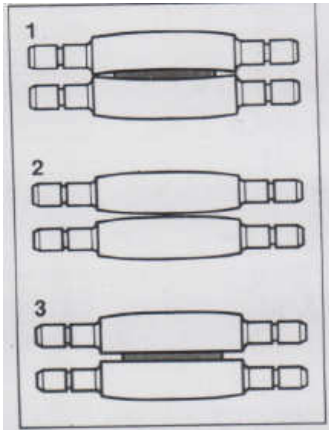
non-ferrous metals:
- copper
- zinc
- Brass
- aluminium
- light alloys
- Also for non metal (plastic)!

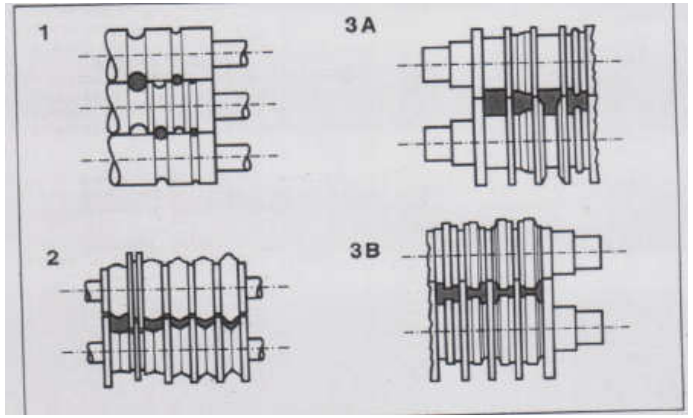
rolling

extrusion

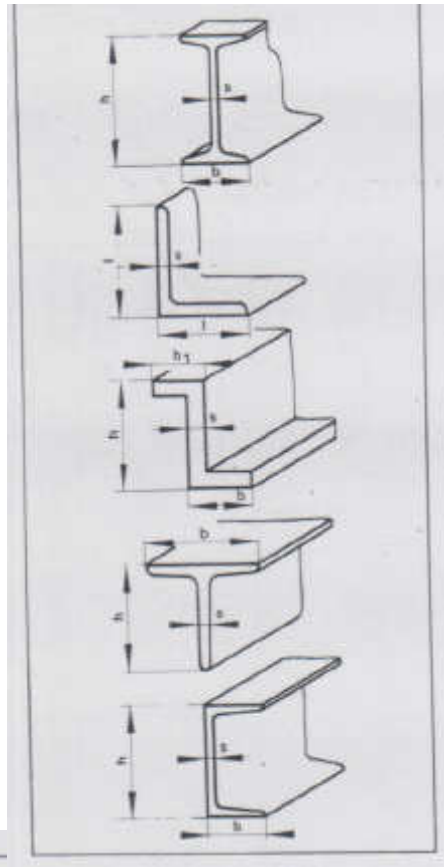
High stenght material are rolled
Low stenght material are extruded

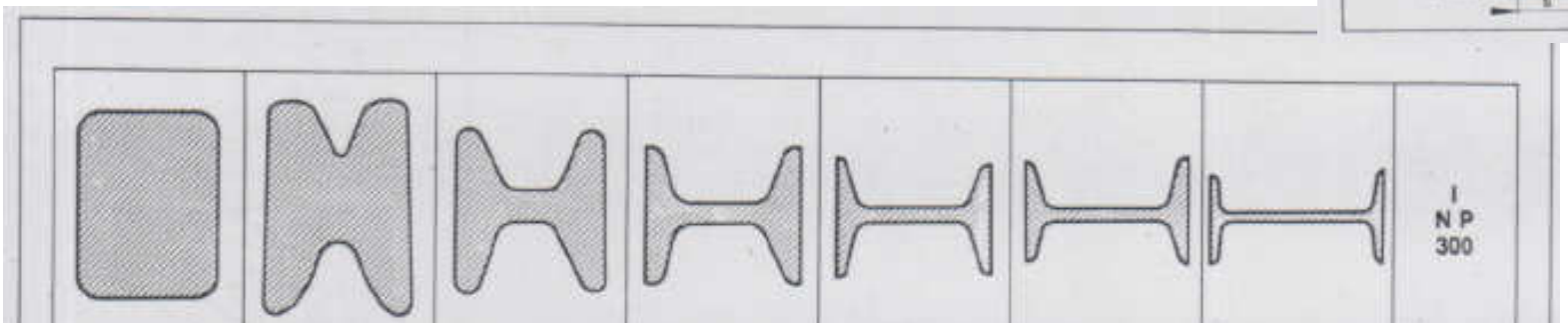
rolling





Shaped cylinders

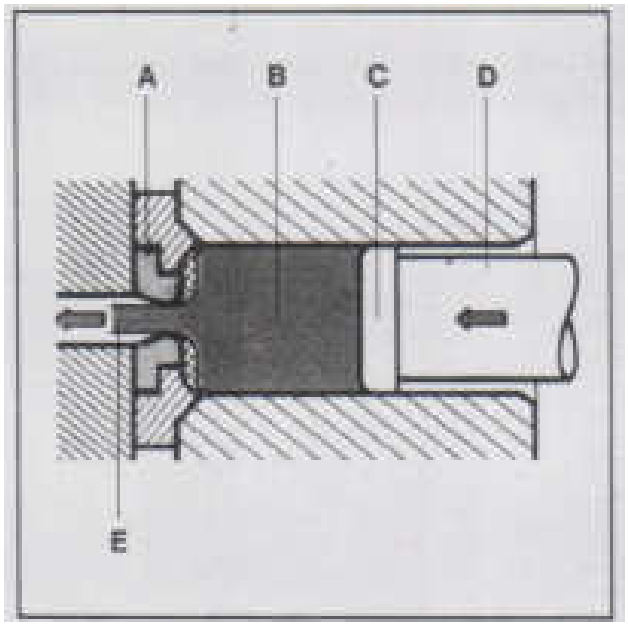




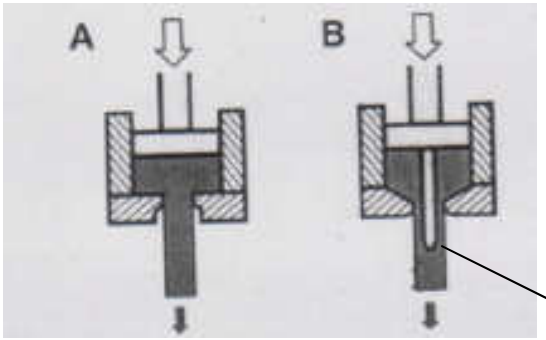
Shaped cylinders

High stenght material are rolled

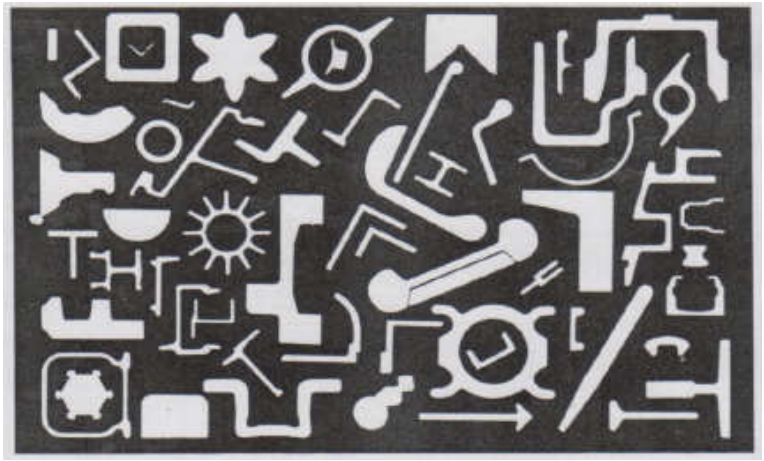
extrusion

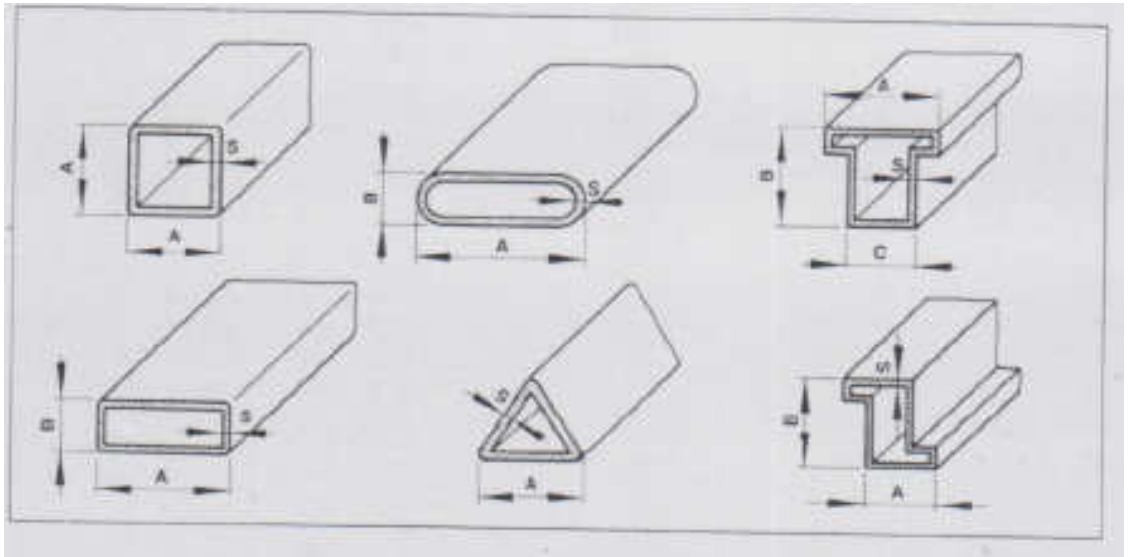


A die
B steel block
C cylinder
D mandrel
E extruded element



sizing mandrel

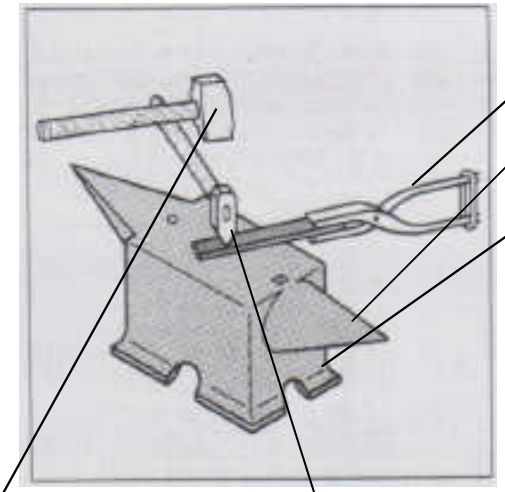


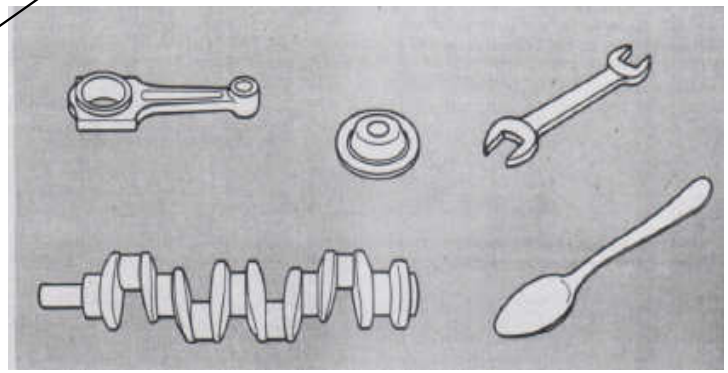


Extruded shapes can be hollow

mechanical technology

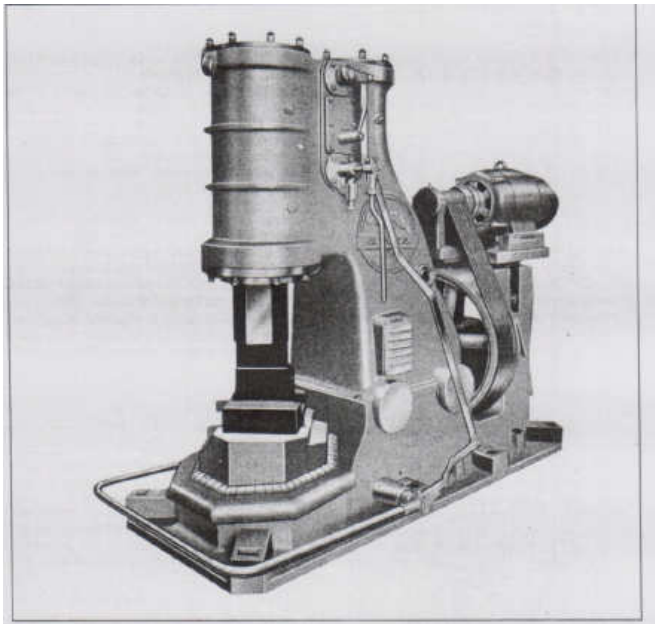
forging



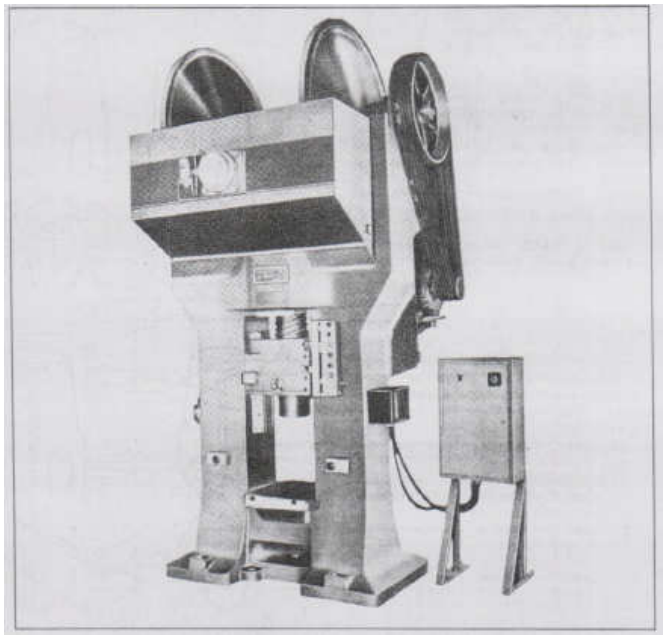


Finished or semifinished parts

Plastic deformation

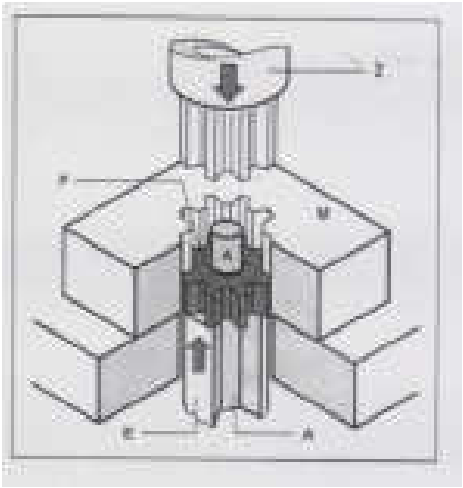


hammer forging



press forging
(hot pressing)

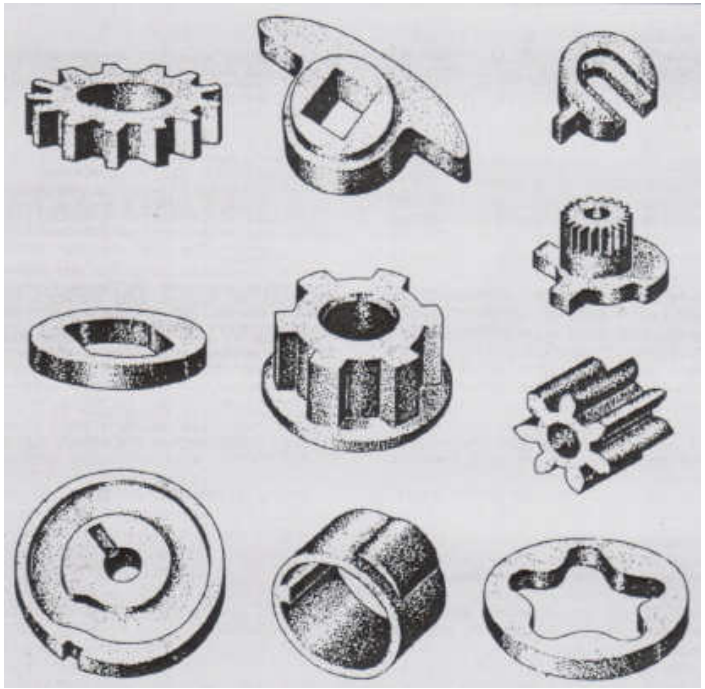
Forging can be an option to change the shape of the material e start from to realize a part

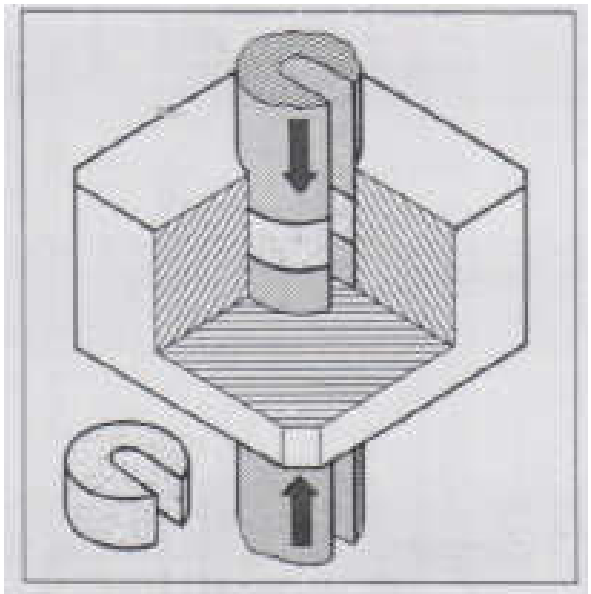


sintering

metal powders:
•stellite (cobalt, chromium alloys)
•tungsten carbides

sintering



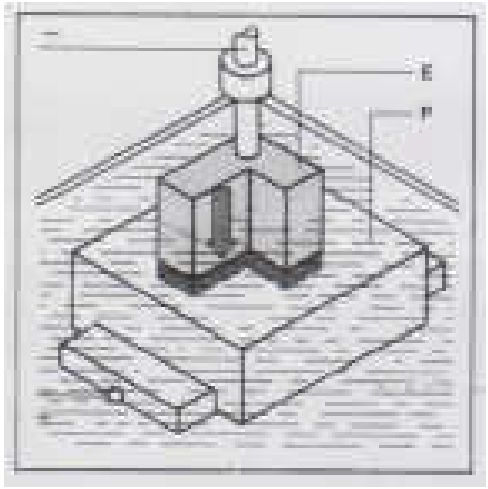


Powder metallurgy: sintering

Low-forging and/or high melting point metals; very hard metals; metal – non metal alloys;
(born for tungsten filament manufacturing)

0.5 micron up to 30/40 micron
1000 (98 Mpa) to 10.000 (980 Mpa) kg/cm2
2/3 reduction in volume
inert atmosphere (argon) or vacuum

Metal injection molding:in between molding and sintering for high complexity shapes



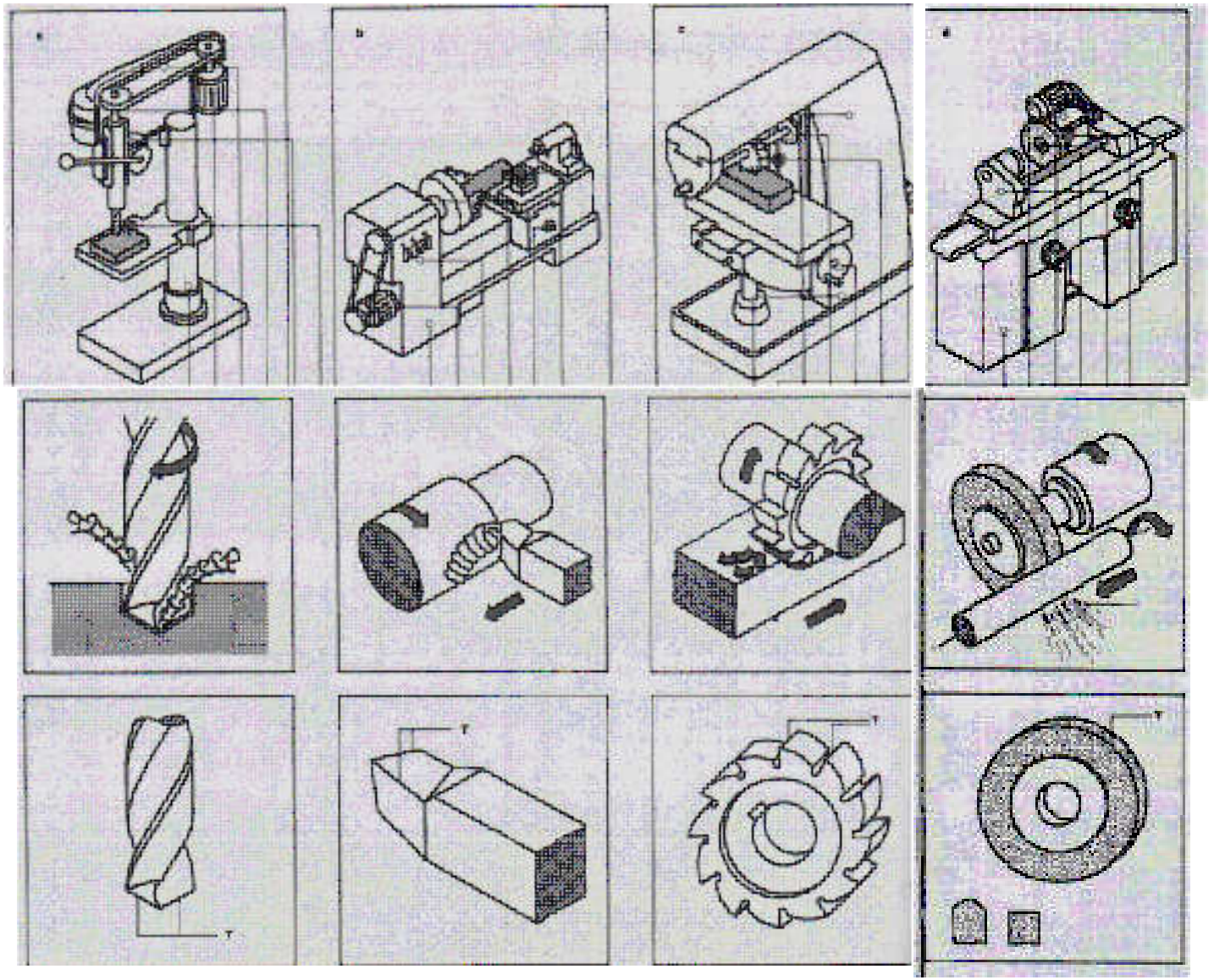
very hard metal carbides, hardened steel usual metals and alloys

EDM electron discharge machining

Very small features or complex shapes, blind holes with unusual shape.

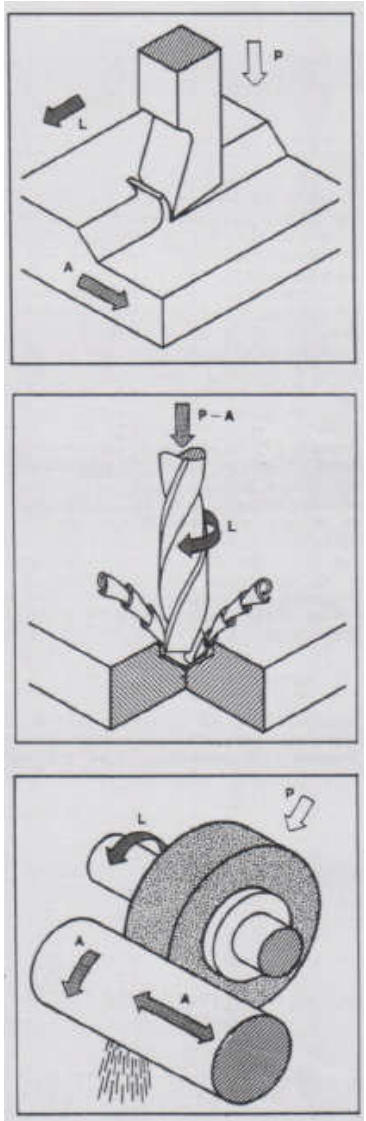
Shape EDM and Wire EDM

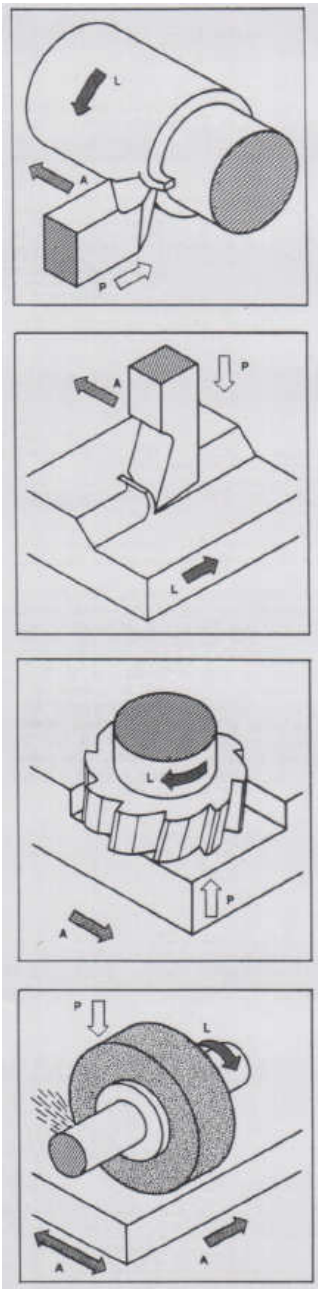
Machining



DRILL LATHE MILL GRINDING

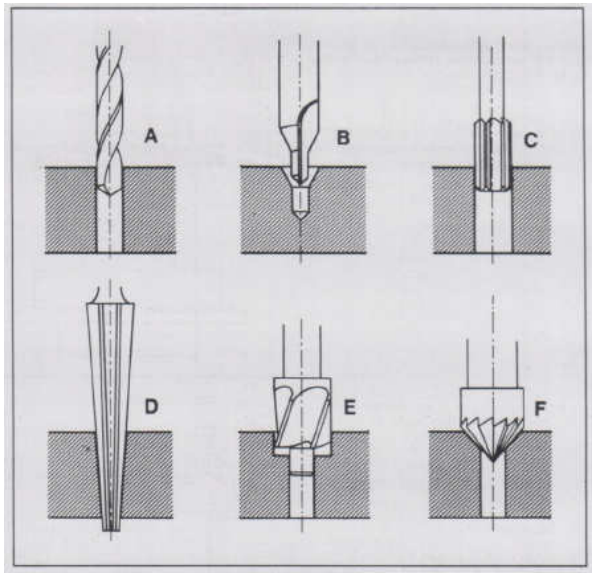
part – tool relative motion

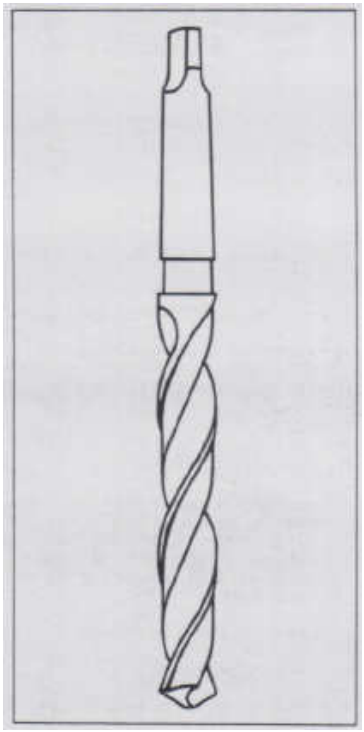


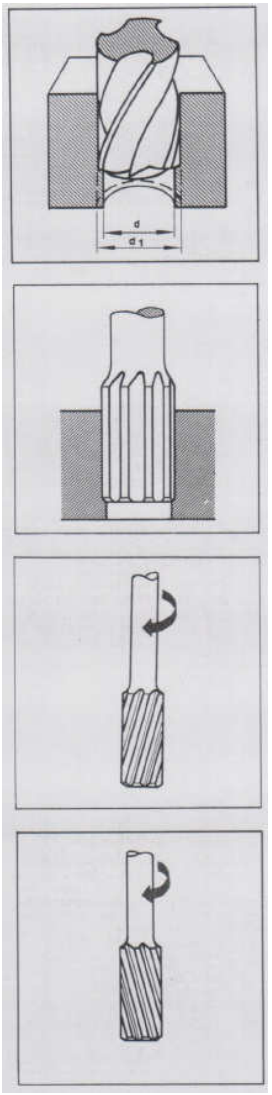


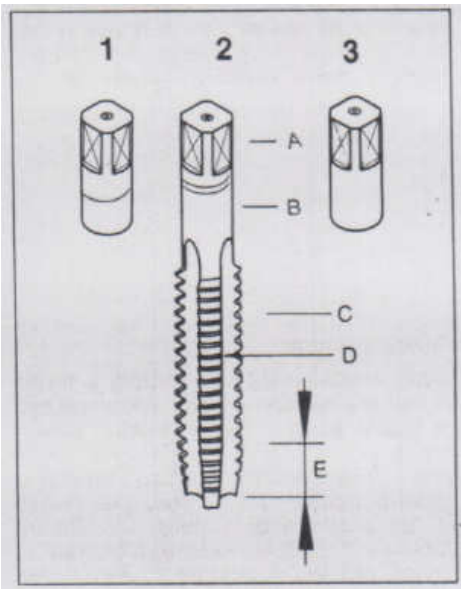
chip forming machining

drilling & boring





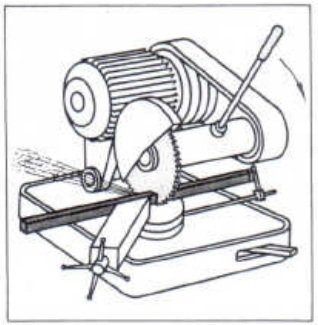




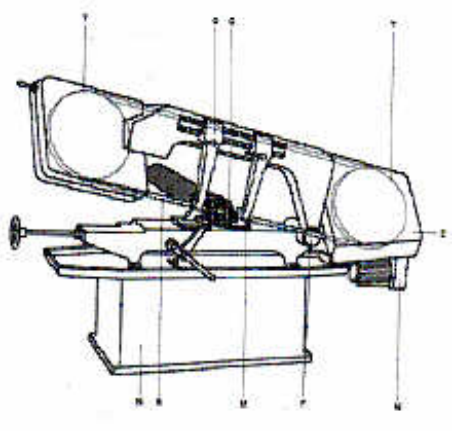
Taps:

1) Taper tap
2) Middle tap
3) Finishing tap

saw

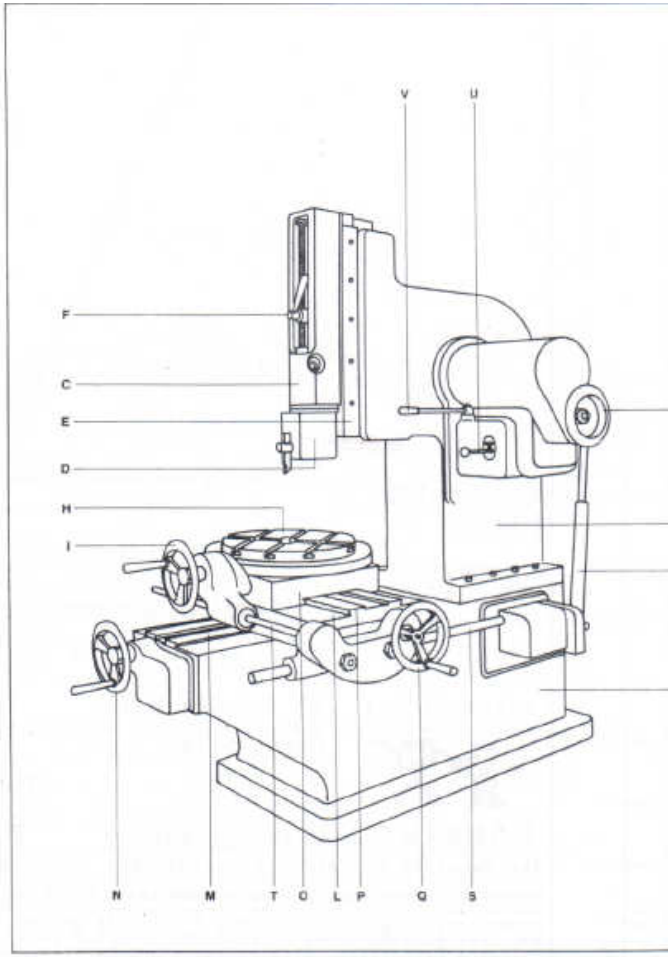


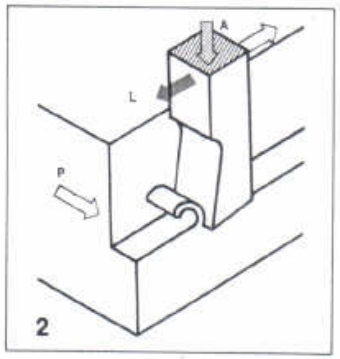
disc saw

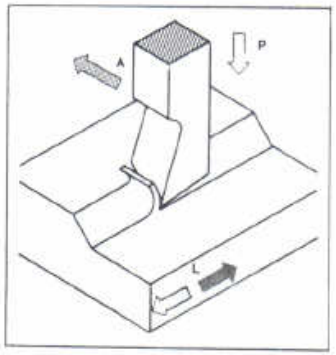


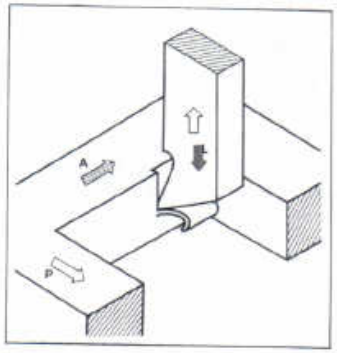
arm saw

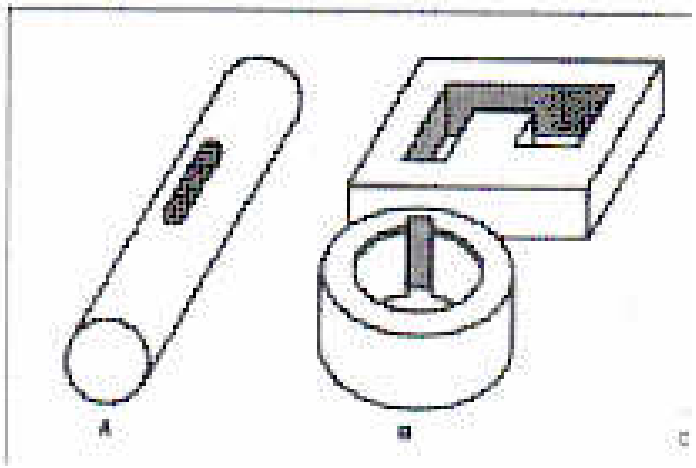
Slotting:internal straight keys

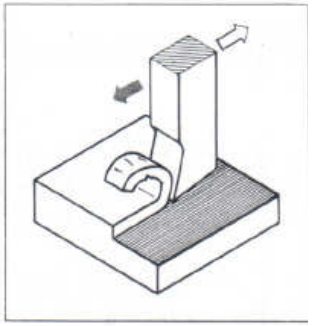




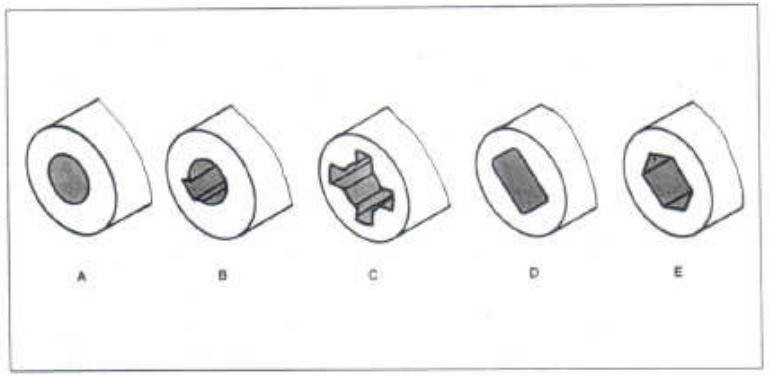


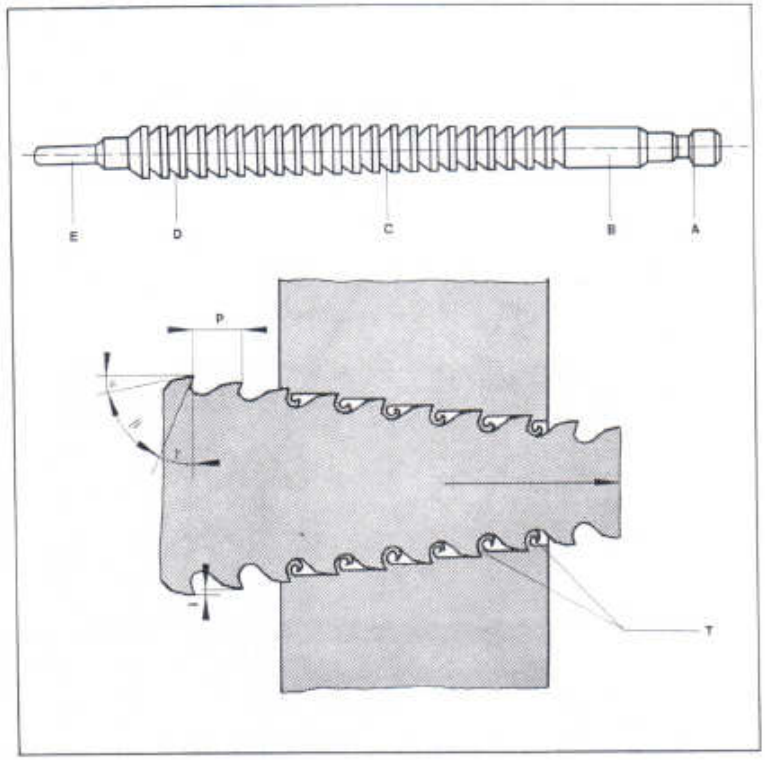


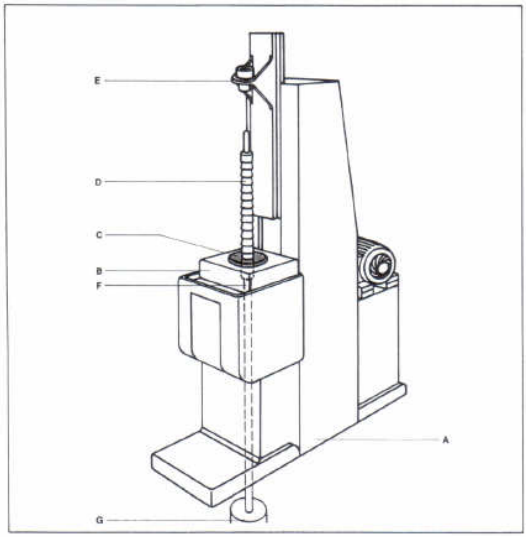


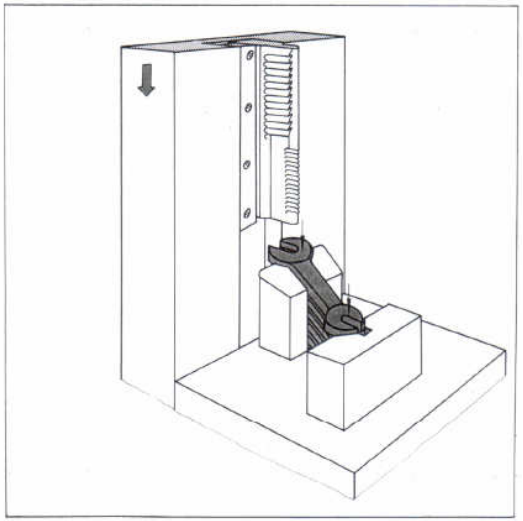


mechanical technology



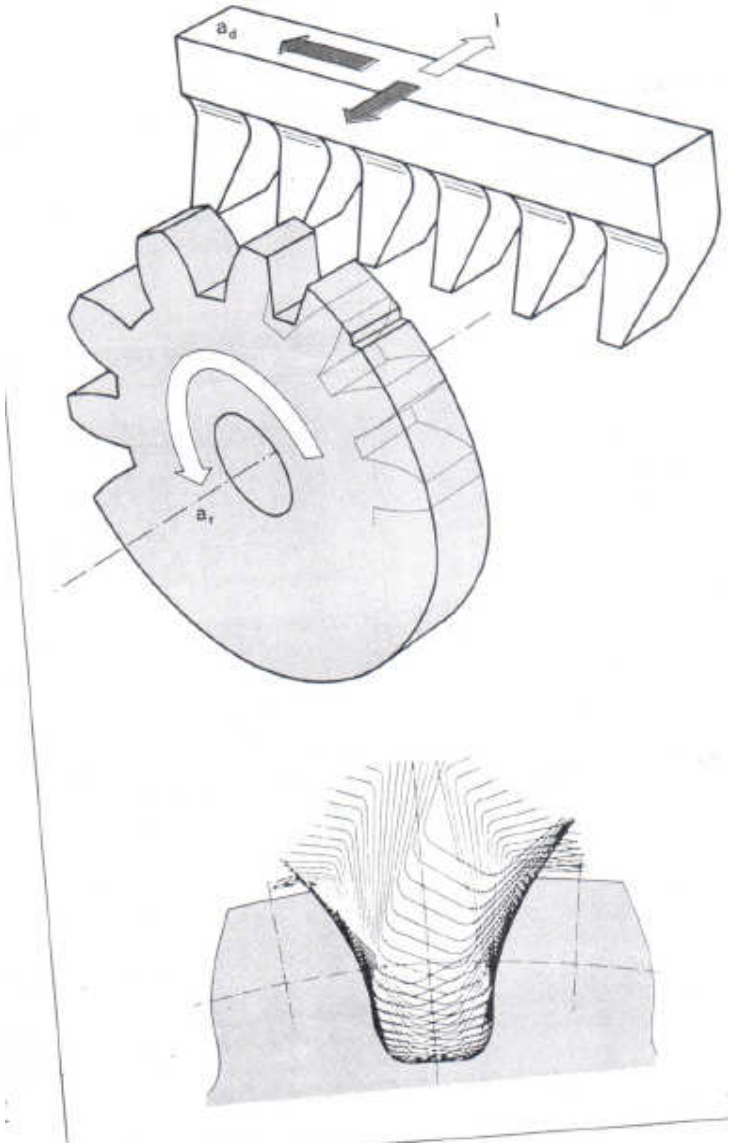


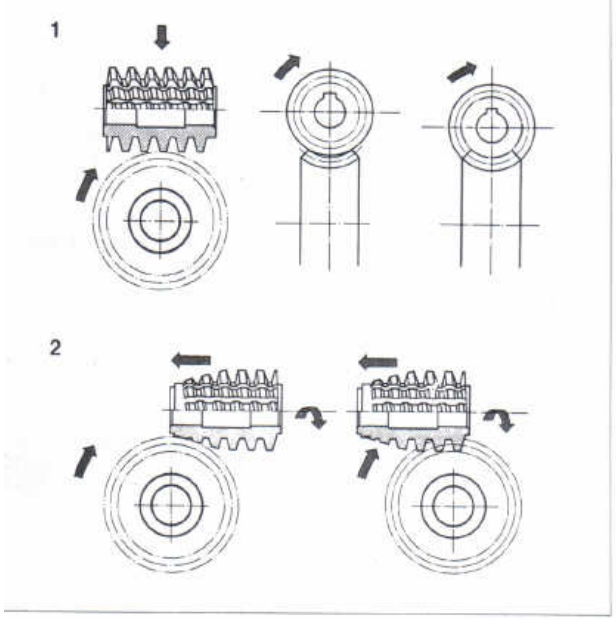


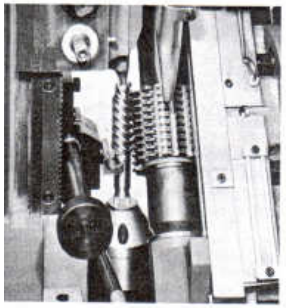


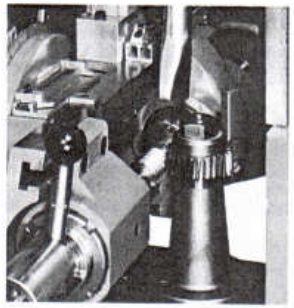
broaching

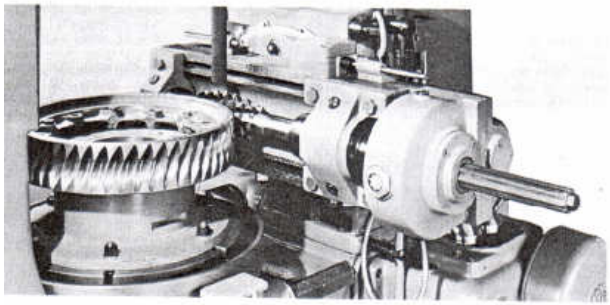
gear cutting (toothing)



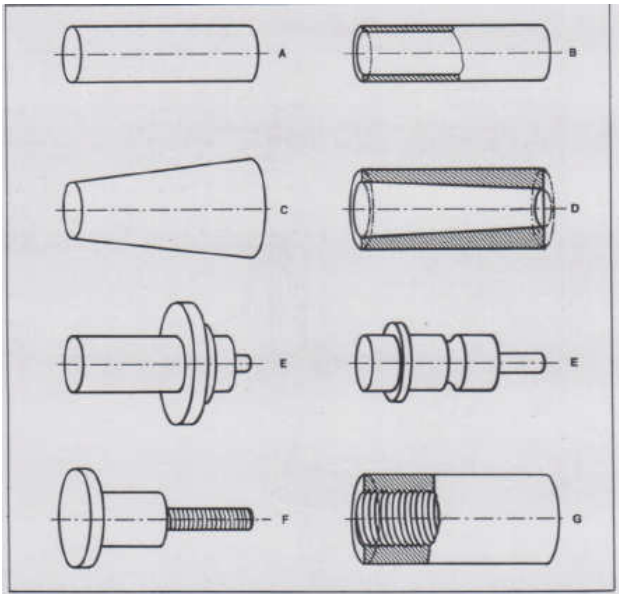


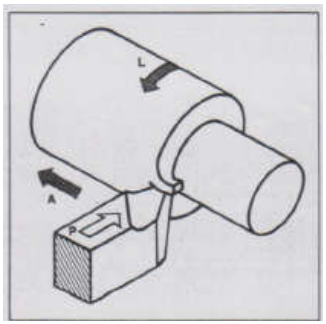


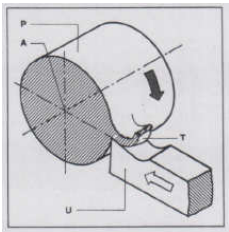


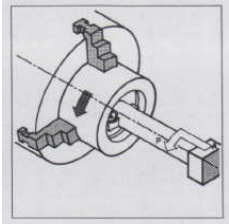


lathe

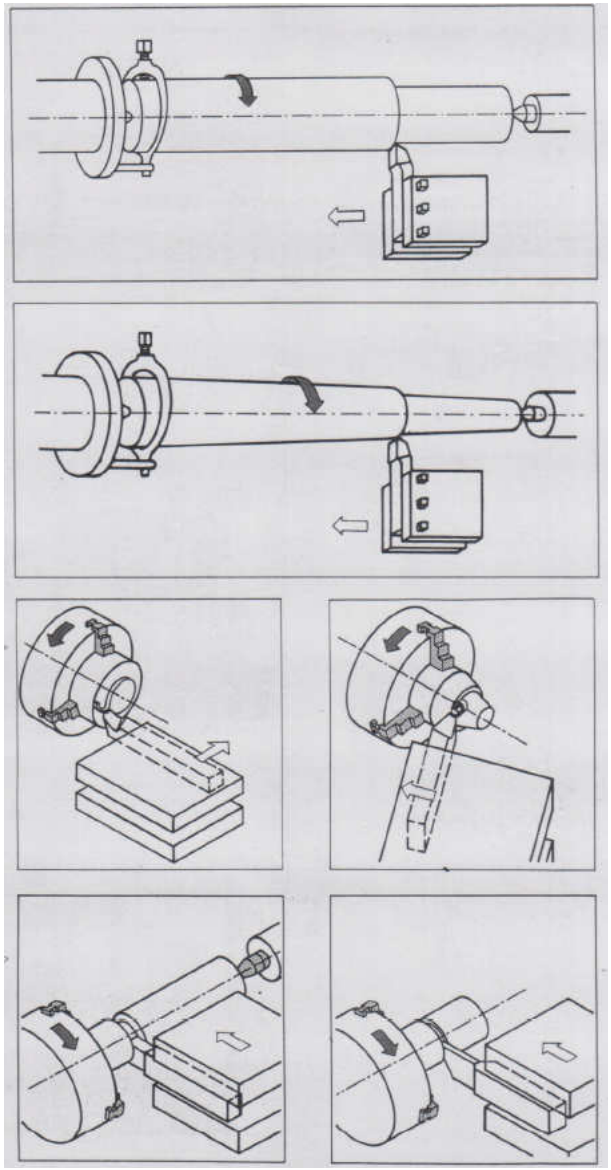


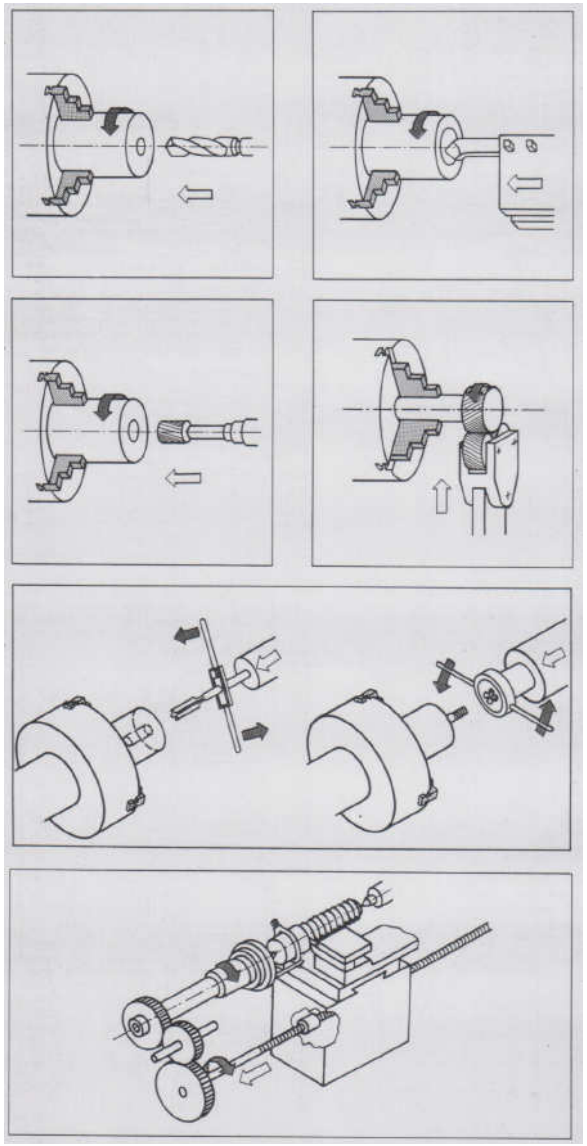




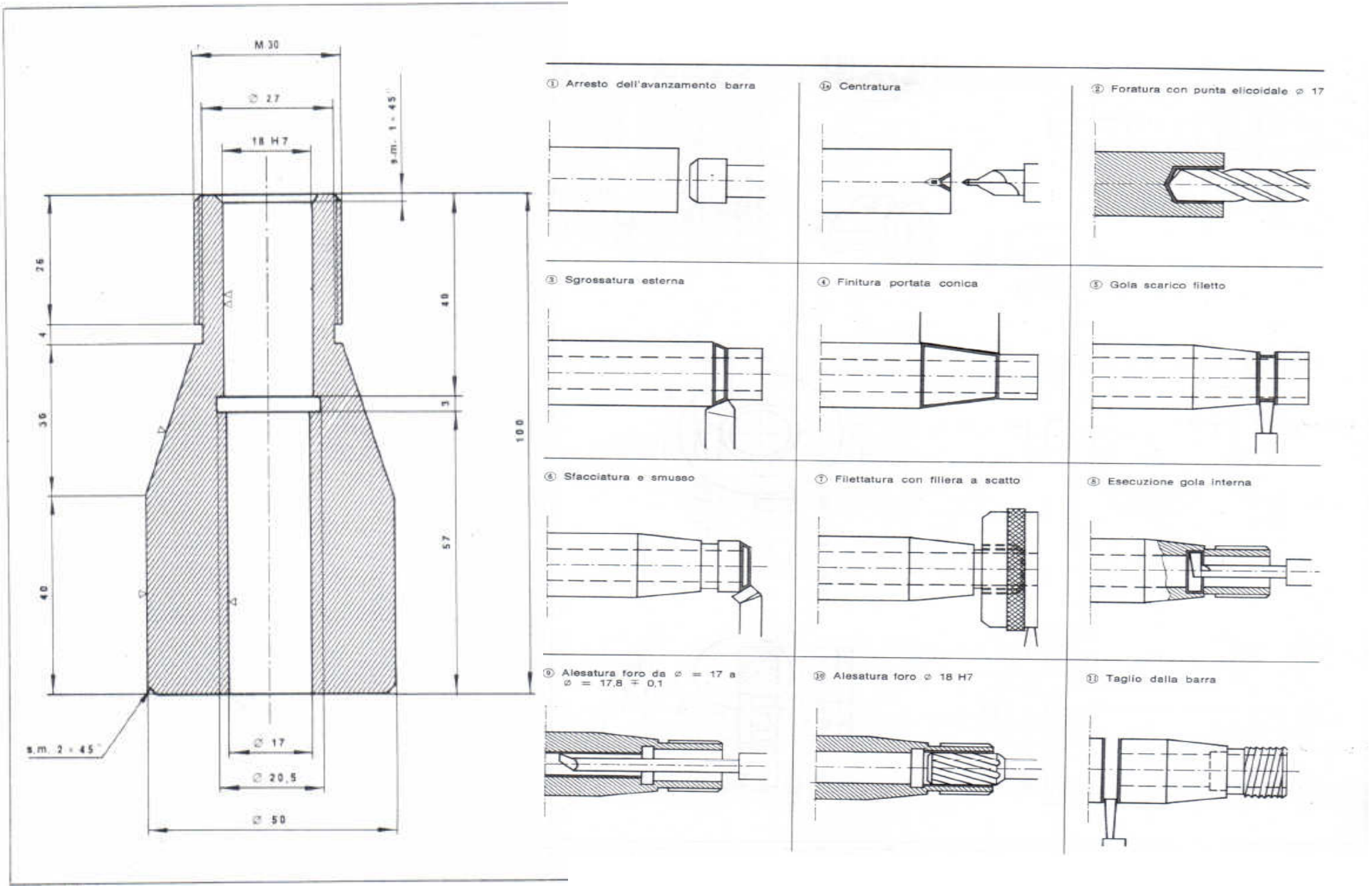


turning

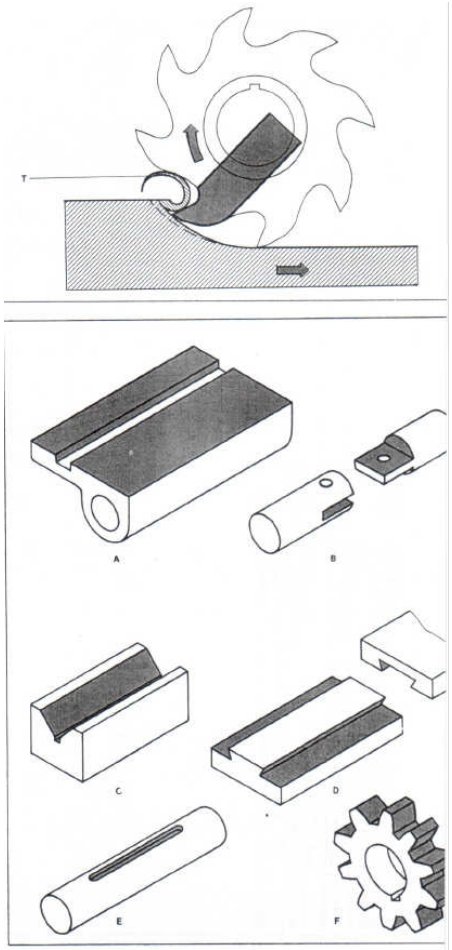


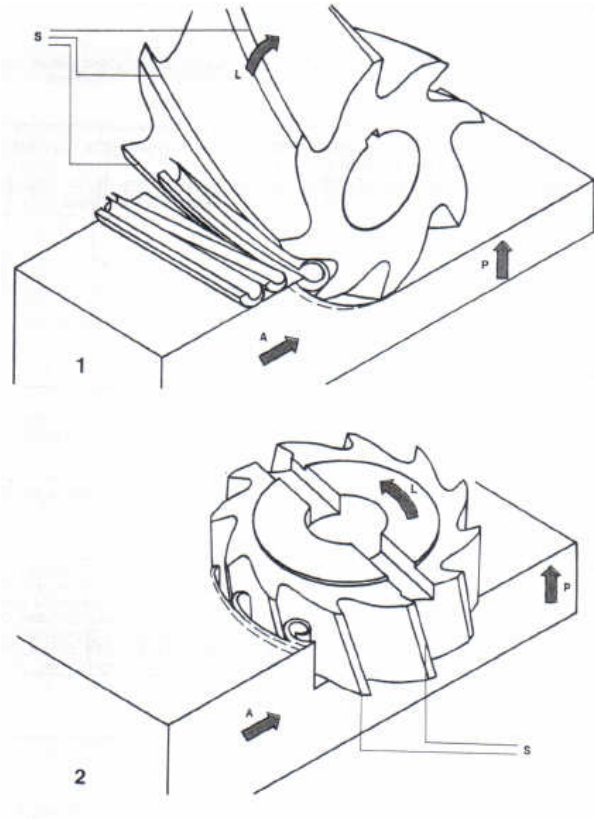


From drawing to finished part



milling



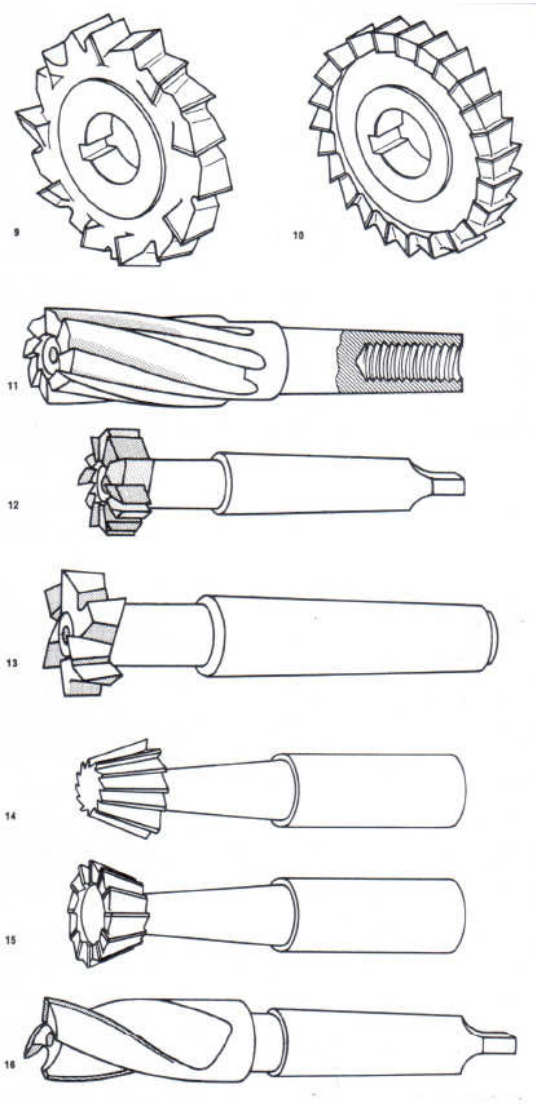


The tool axis can be horizontal or verical

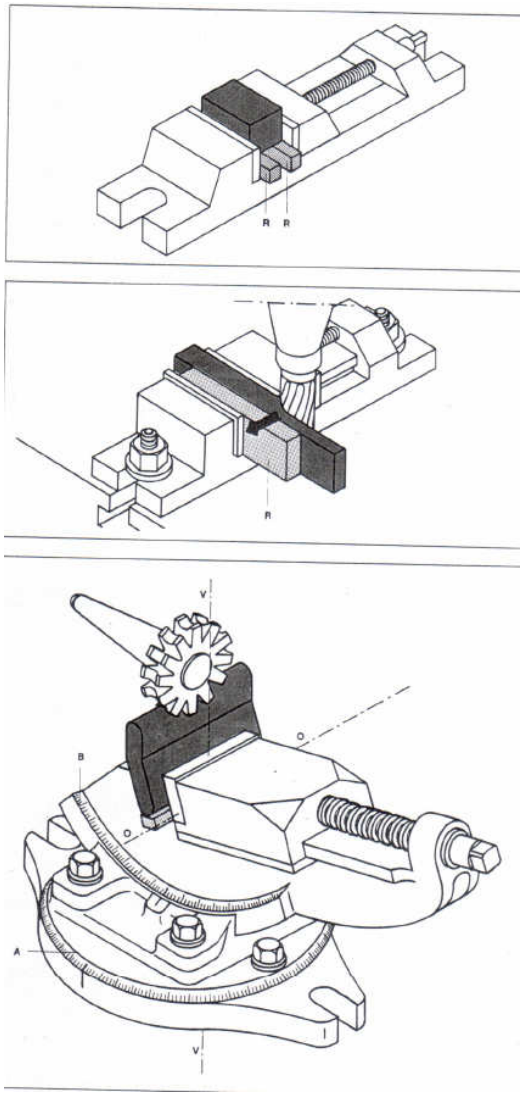
milling

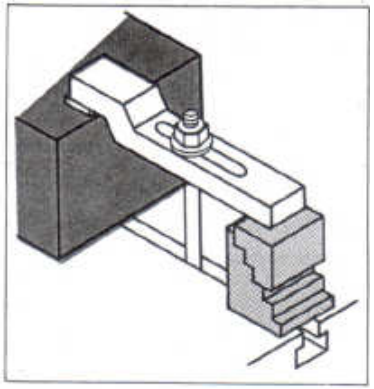
Relevant tool parameters:
Mill diameter
Mill cut lenght
Mill cut directions

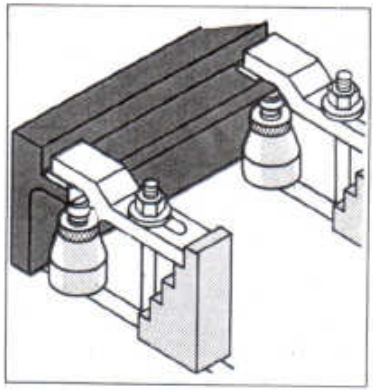
Proper tool must be identified to be sure that a feature is feasible

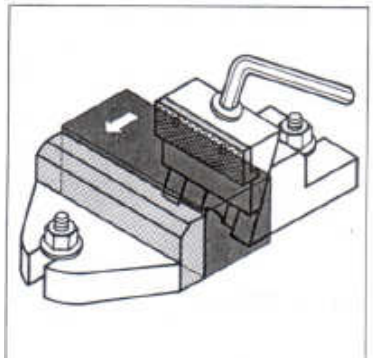


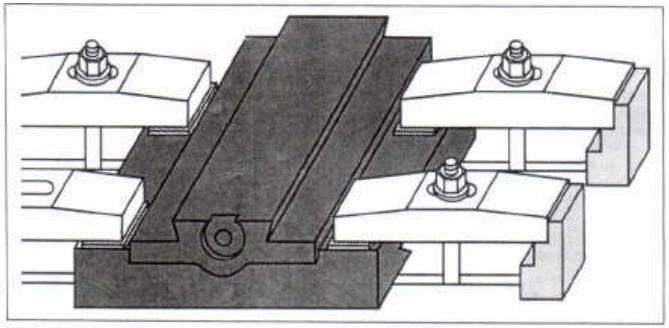
Once found the tool the part positioning inside the machine must be defined

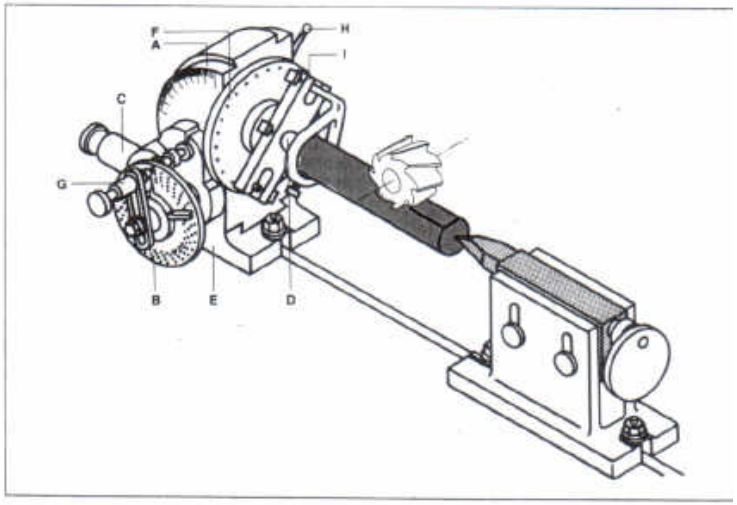


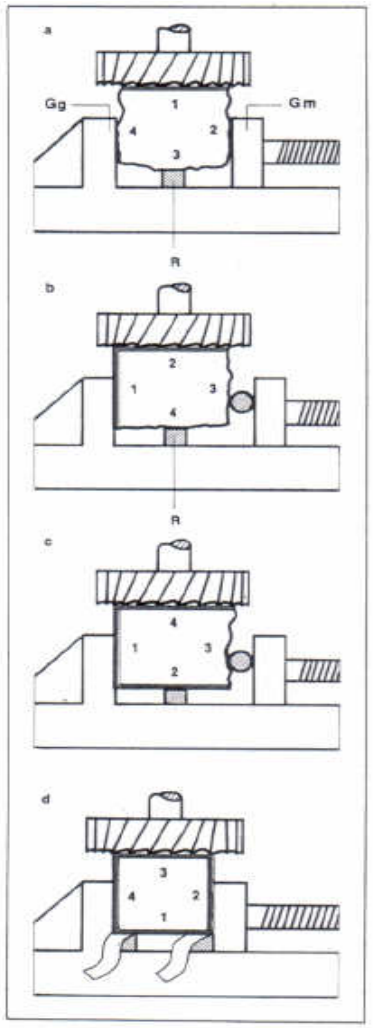


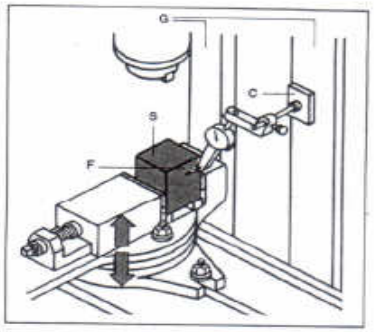


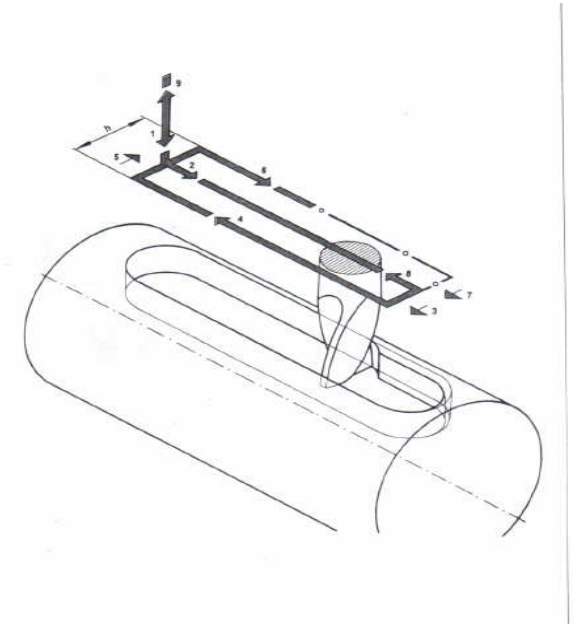


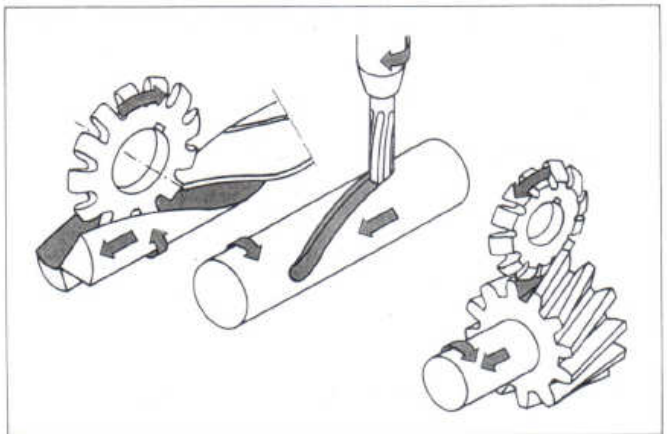






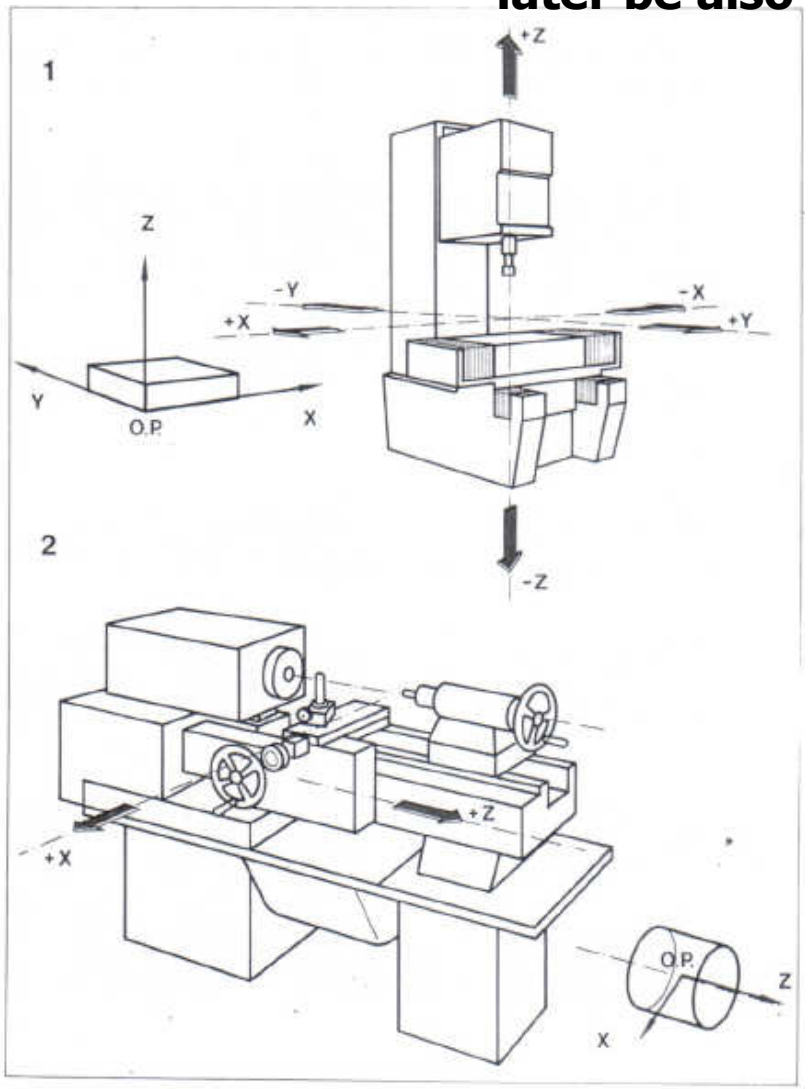


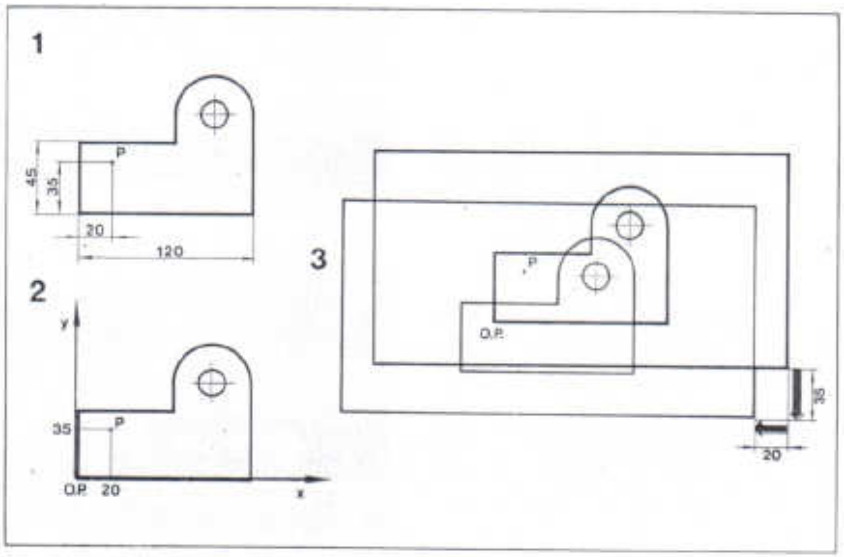




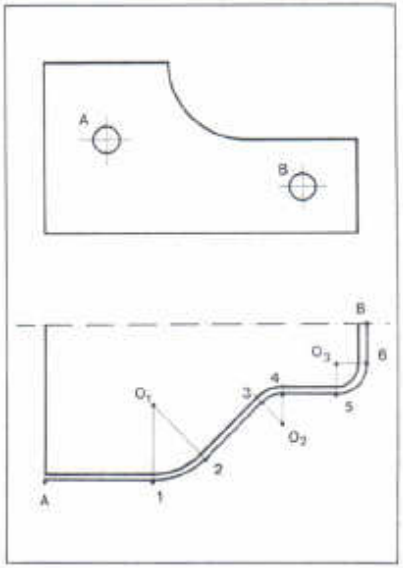
Finally once the tool is found and the part is placed in the mill the tool path needs to be defined (machining sequence)

According to the allowed motion of the tool respect to the part and to the kind of machine used a preliminary machining cycle is always a good check to assure that what we are thinking can later be also realized

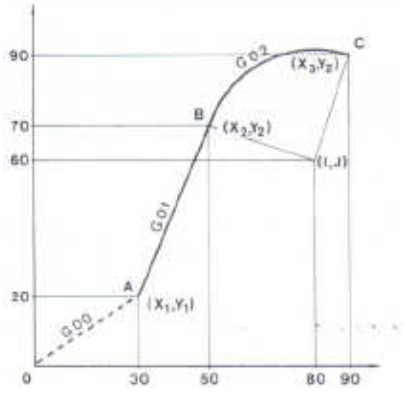


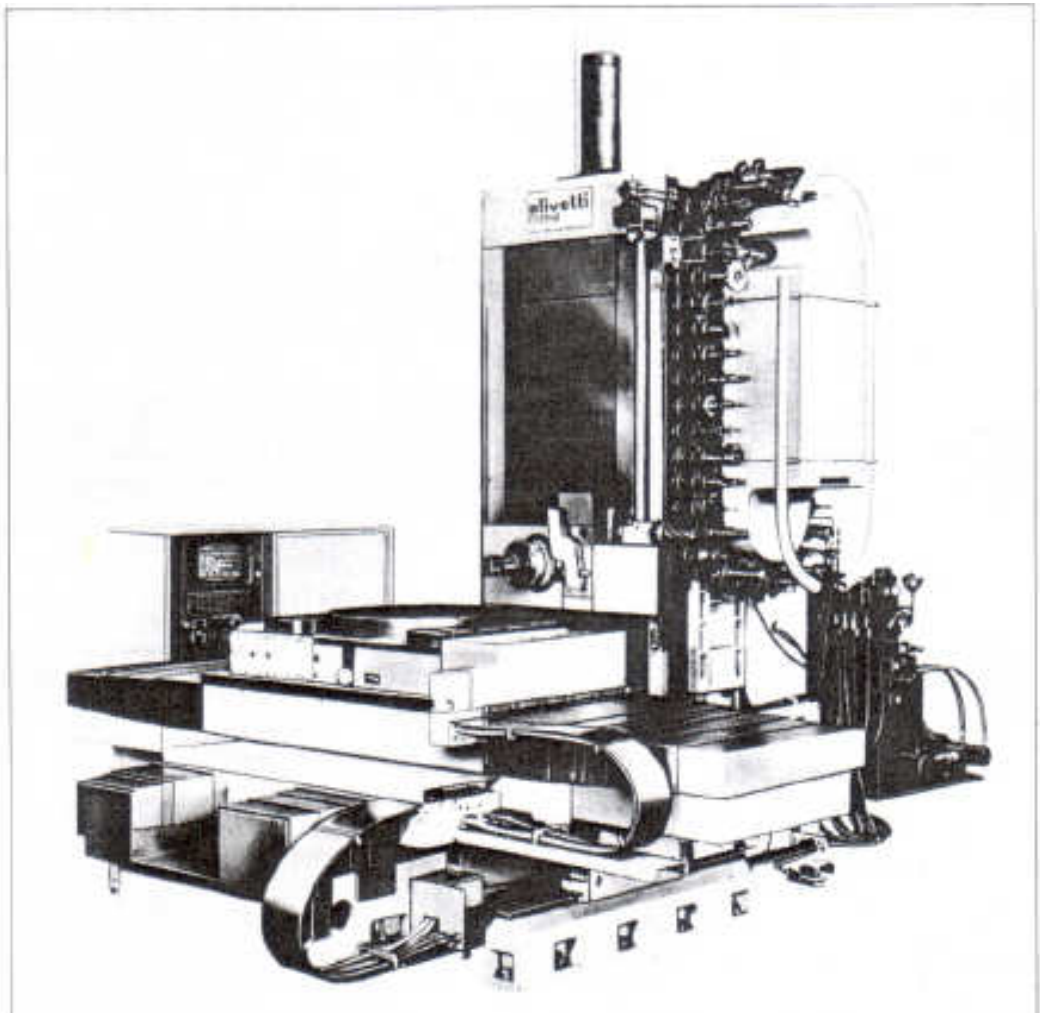


Cnc: numerical controlled machining, the big difference is only that the machining is programmed..



N	G	X	Y
N01	G00	X + 03000	Y + 02000
N02	G01	X + 05000	Y + 07000
N03	G02	X + 09000 I + 08000	Y + 09000 J + 06000





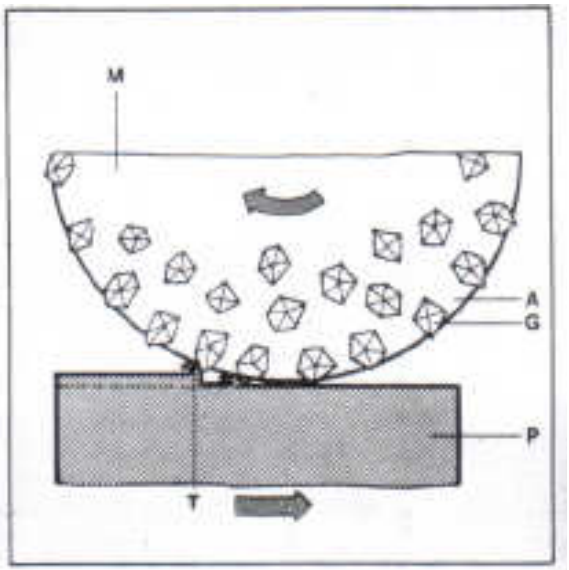
CAD/CAM sw bring the informations in the 3D cad to the CNC

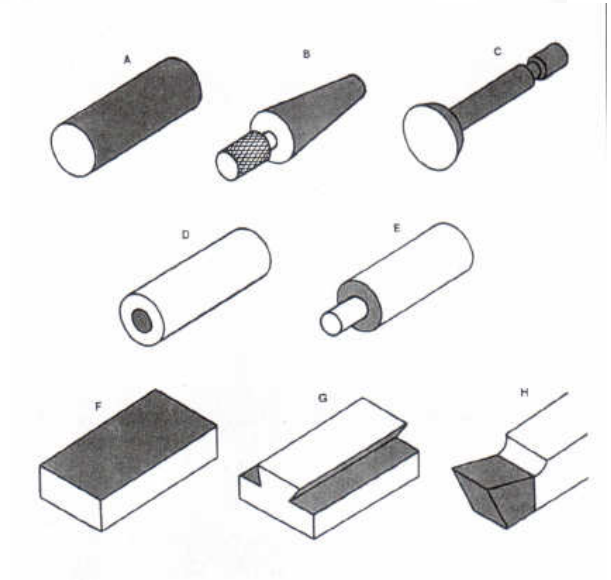
grinding

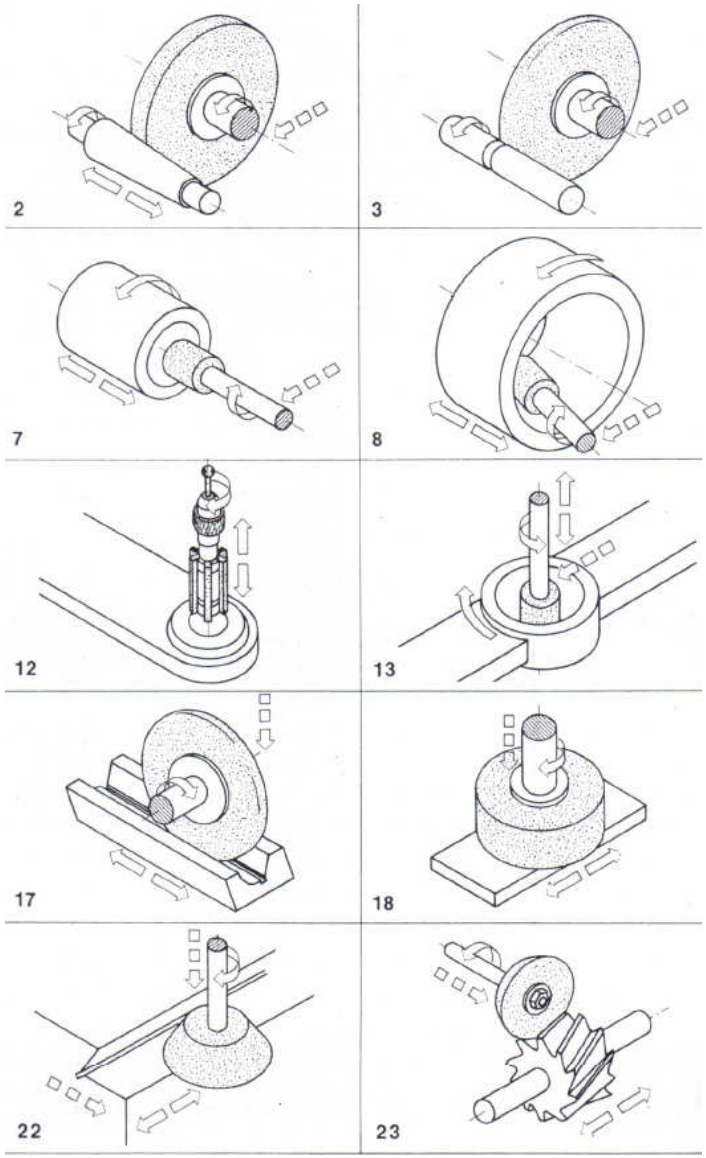
Decrease surface roughness

Thighter tolerances

Decrease friction

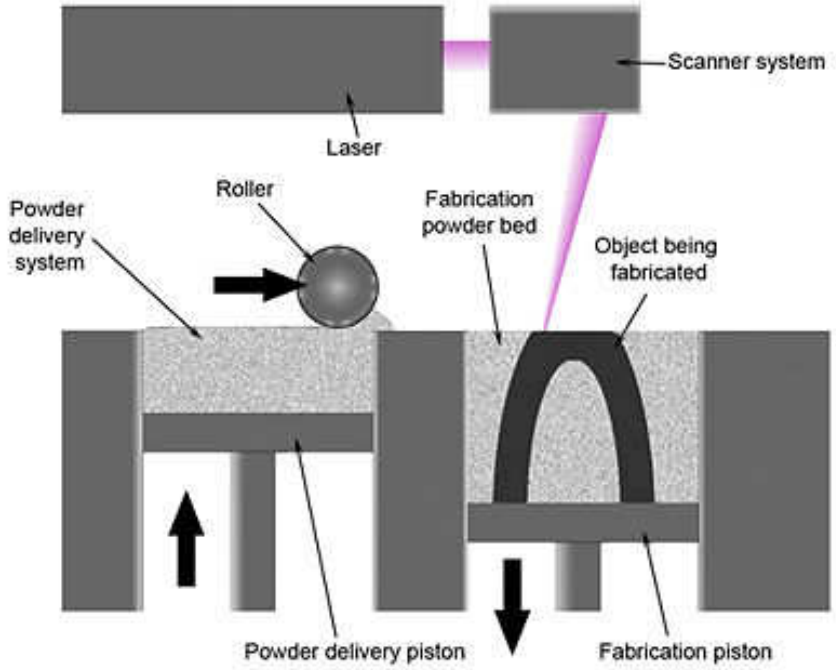


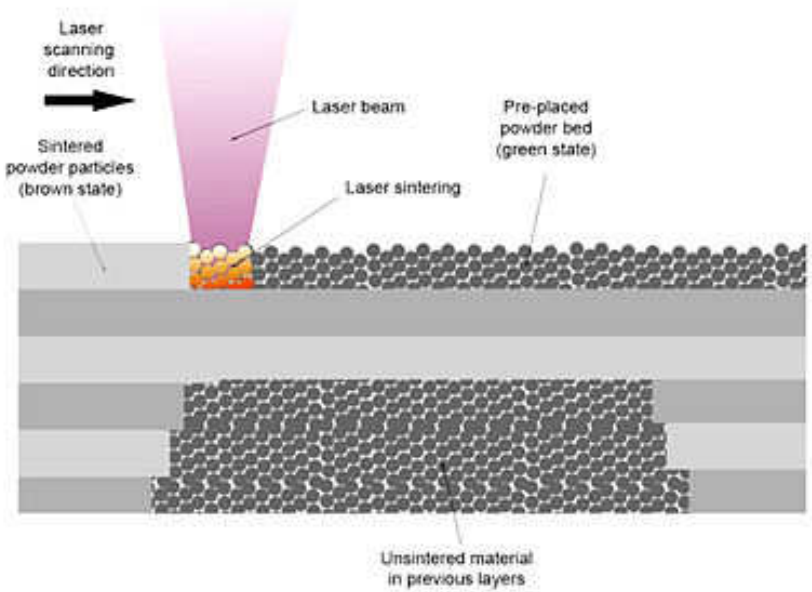




RAPID PROTOTYPE TECNIQUES

3D printer
SLA-stereolytography
SLS- selective laser sintering
SLM- selective laser melting





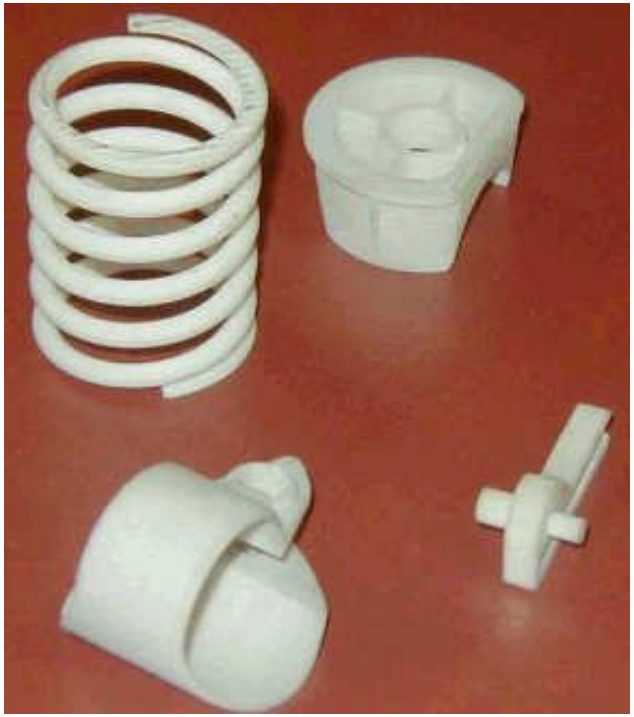
3-D Modeling takes digital input from three-dimensional data and creates solid, three-dimensional parts through an additive, layer-by-layer process. Easy to use, affordably priced and compact for the office, 3-D Modeling is used extensively by designers, engineers and hobbyists for concept development and product design to accelerate the design process and reduce the time to market.

What is Stereolithography?

Stereolithography or SLA® Systems use 3-D CAD data to convert liquid plastic materials and composites into solid cross-sections, layer by layer, to build highly accurate three-dimensional parts. An ultraviolet laser cures a liquid resin into very thin layers, including interior and exterior cavities, to closely mimic injection-molded parts. SLA Systems rapidly manufacture parts of different geometries at the same time and are designed to produce prototypes, patterns or end-use parts of versatile sizes and applications.

SLS

SLS® (selective laser
sintering) system directly produces end-use plastic or
metal parts, tooling inserts, or casting patterns from
your 3-D CAD data files

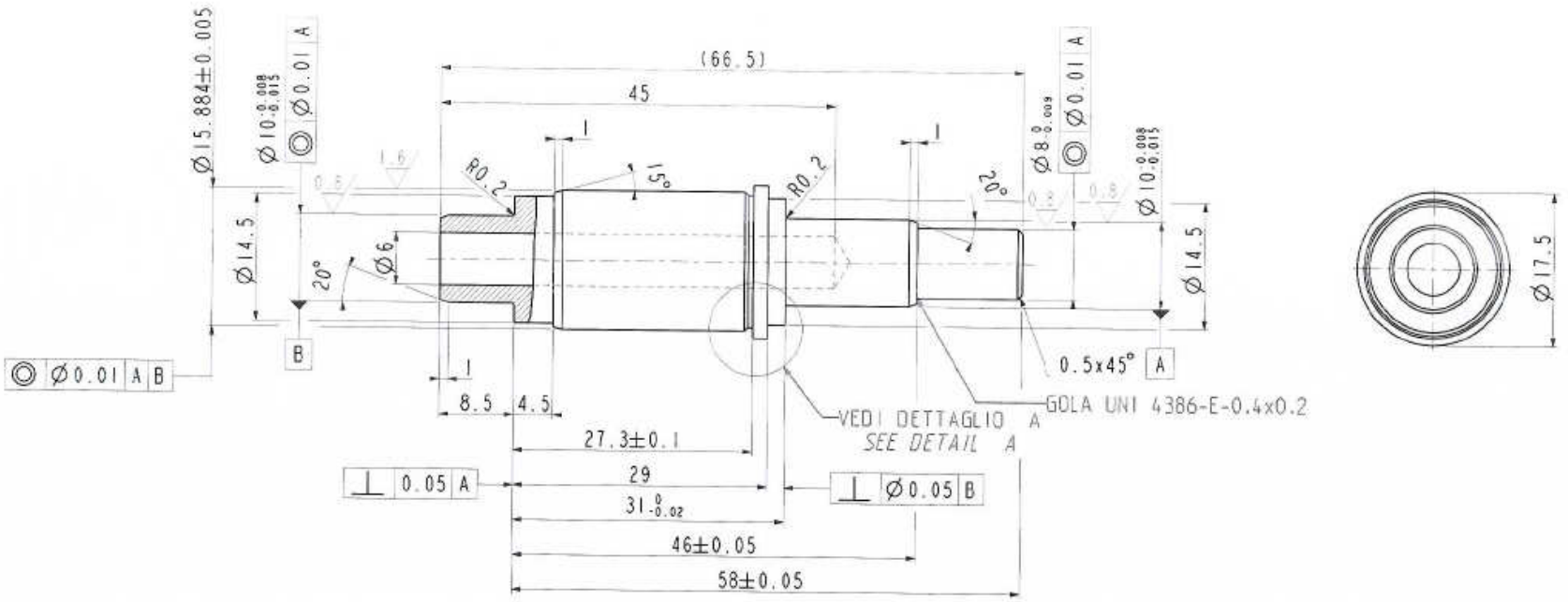


SLM

Rapidly manufacture fully dense end-use metal parts with excellent surface finish, feature detail and tolerances. Choose from the largest range of metal alloys, including Aluminum and Titanium

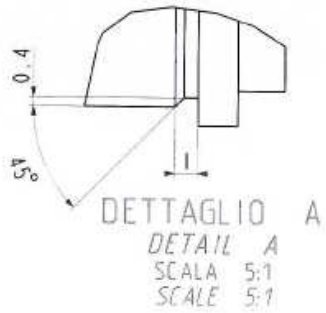
Functional testing of production-quality prototypes
Economical manufacturing of organic or highly complex geometries
Rapid low-volume manufacturing of metal parts
Examples:

- Custom medical implants
- Lightweight aerospace and motorsports parts
- Efficient heat sinks
- Injection mold inserts with conformal cooling channels
- Dental caps, crowns and bridges

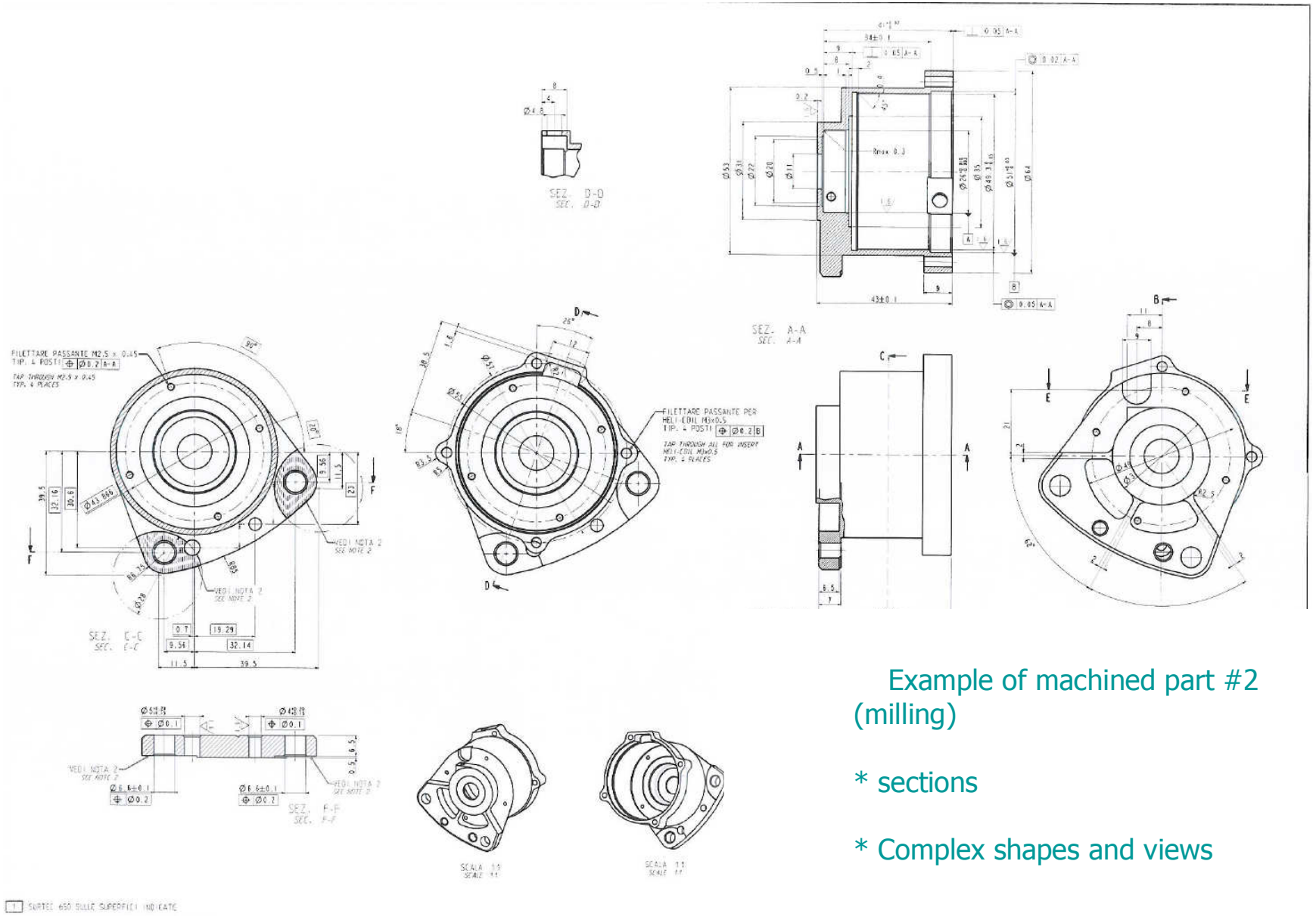


Example of machined part #1

Only turning



- Dimensional and geometric tolerances
- Roughness
- Projection views



Example of machined part #2 (milling)

* sections

* Complex shapes and views