Lectures on mechanics

(lesson #4)

francesco.becchi@telerobot.it
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 homogeneous 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)
extrusion

• copper
• zinc
• Brass
• aluminium
• light alloys

Also for non metal (plastic)!

High strength material are rolled
Low strength material are extruded

mechanical technology

rolling

steel, iron

extrusion

non-ferrous metals:
rolling

Shaped cylinders

High strength material are rolled
Extrusion

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

Extruded shapes can be hollow
Forging can be an option to change the shape of the material and start from to realize a part.

**Forging**

- Finished or semifinished parts
- Plastic deformation

**Mechanical Technology**

- **Hammer Forging**
- **Press Forging** (hot pressing)

**Tools**

- Sledge hammer & hammer
- Tongs
- Cone & pyramid
- Anvil
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
EDM electron discharge machining

very hard metal carbides, hardened steel, usual metals and alloys

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 (tooothing)
lathe
turning
From drawing to finished part
The tool axis can be horizontal or vertical.
milling

Relevant tool parameters:
  Mill diameter
  Mill cut length
  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.

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

Decrease surface roughness

Thighter tolerances

Decrease friction
RAPID PROTOTYPE TECHNIQUES

3D printer
SLA-stereolithography
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