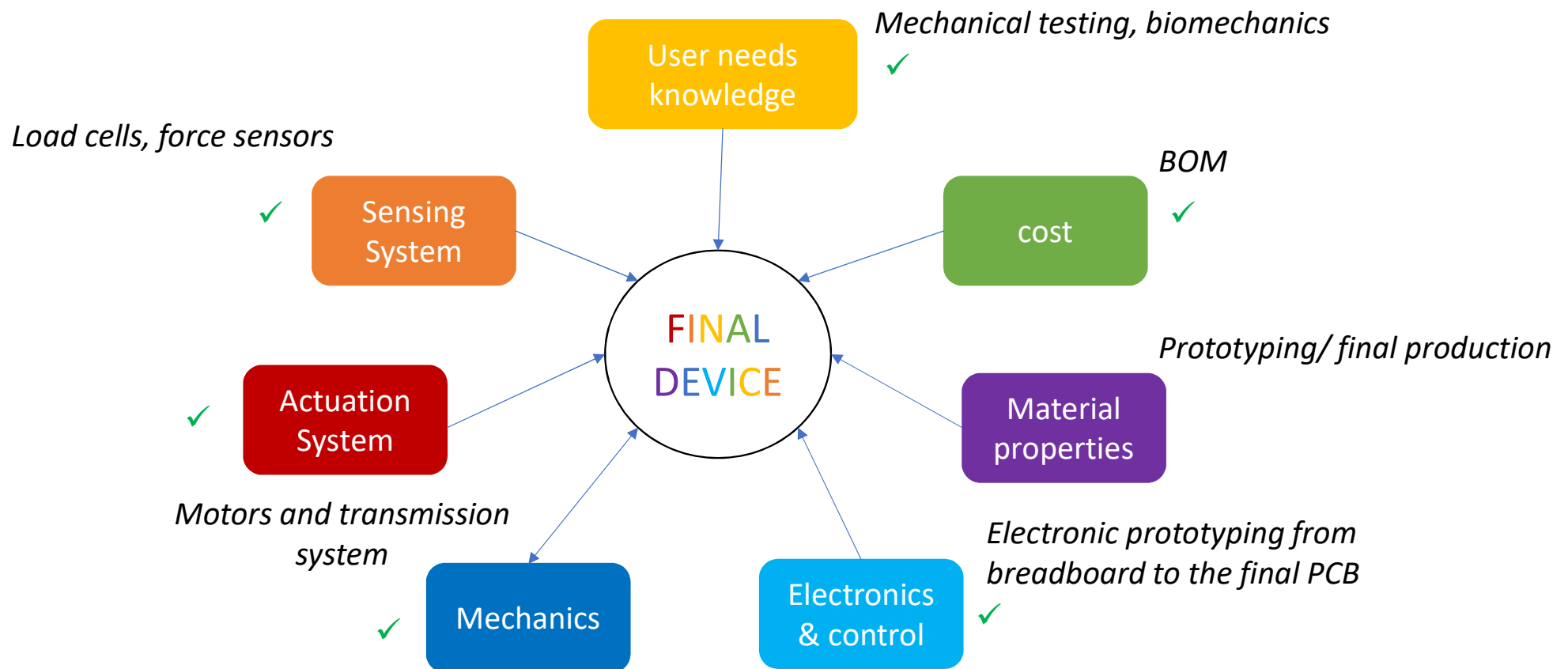


Design Lab: Materials and Manufacturing

Corso Materiali intelligenti e Biomimetici
12/04/2018

ludovica.cacopardo@ing.unipi.it

Design of innovative testing systems



LAB LESSONS:

1. Sensing
2. Attuazione
3. Meccanismo trasmissione
4. Elettronica e controllo
5. Materiali & Manufacturing 12 Aprile
6. Design CAD (SW) 19 Aprile
7. Design elettronico & controllo (fritzing & arduino) 26 Aprile
8. Letture sensori e implementazione motori 3 Maggio
9. " " 10 Maggio
10. realizzazione struttura esterna (stampa 3D) 17 Maggio
11. assemblaggio e testing 24 Maggio

Come presentare il progetto di classe - multitester

Slides - 6 sezioni:

1. Sensing
2. Attuazione (motore e meccanismo)
3. Design CAD (SW)
4. Design elettronico & controllo (fritzing&arduino)
5. Materiale e tecniche produzione prototipo/dispositivo finale
6. Riassunto prove motore/lettura sensori e testing

*per l'esame portare anche i file sw e fritzing

Come presentare i progetti di gruppo

Goal: sfruttare le proprietà di un materiale intelligente per realizzare un sistema di testing meccanico (il materiale può fungere sia da elemento di sensing che attuazione)

Slides - 5 sezioni:

1. Sensing
2. Attuazione
3. Design CAD (SW)
4. Design elettronico (fritzing)
5. Materiale e tecniche produzione prototipo/dispositivo finale

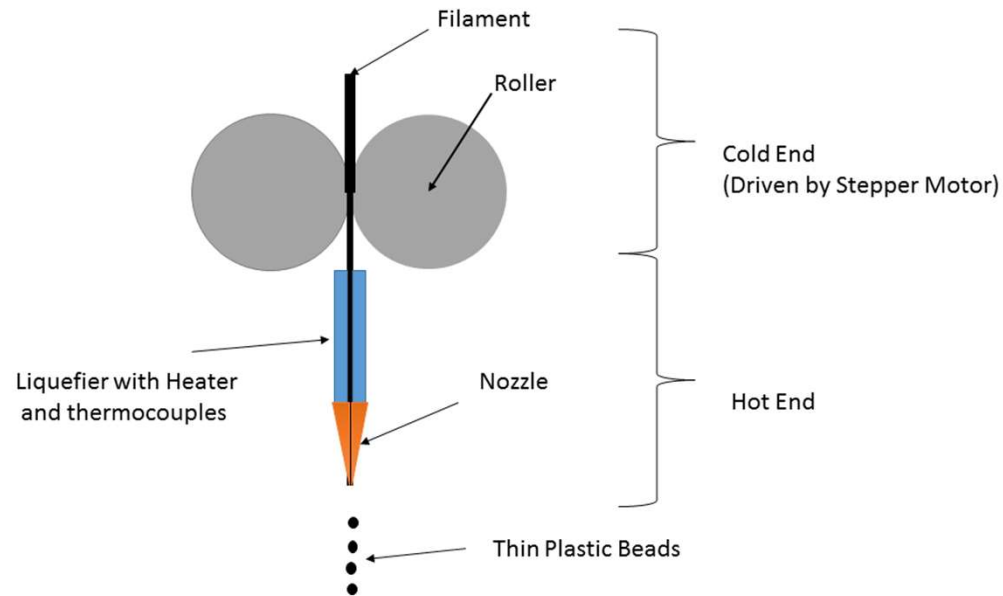
*per l'esame portare anche i file sw e fritzing

Rapid Prototyping

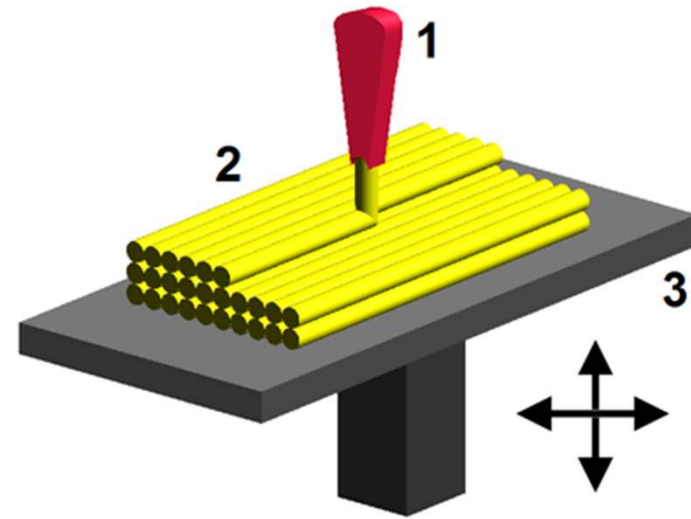
Rapid prototyping is a group of techniques used to quickly fabricate a scale model of a physical part or assembly using three-dimensional computer aided design (CAD) data. Construction of the part or assembly is usually done using 3D printing or "**additive layer manufacturing**" technology.

- 3D printing (3DP) -> printing of a binder material onto a powder bed with **inkjet printer** heads
- Fused deposition modeling (FDM)
- Laminated object manufacturing (LOM)
- Stereo lithography (STL)
- Selective laser sintering (SLS)

FDM

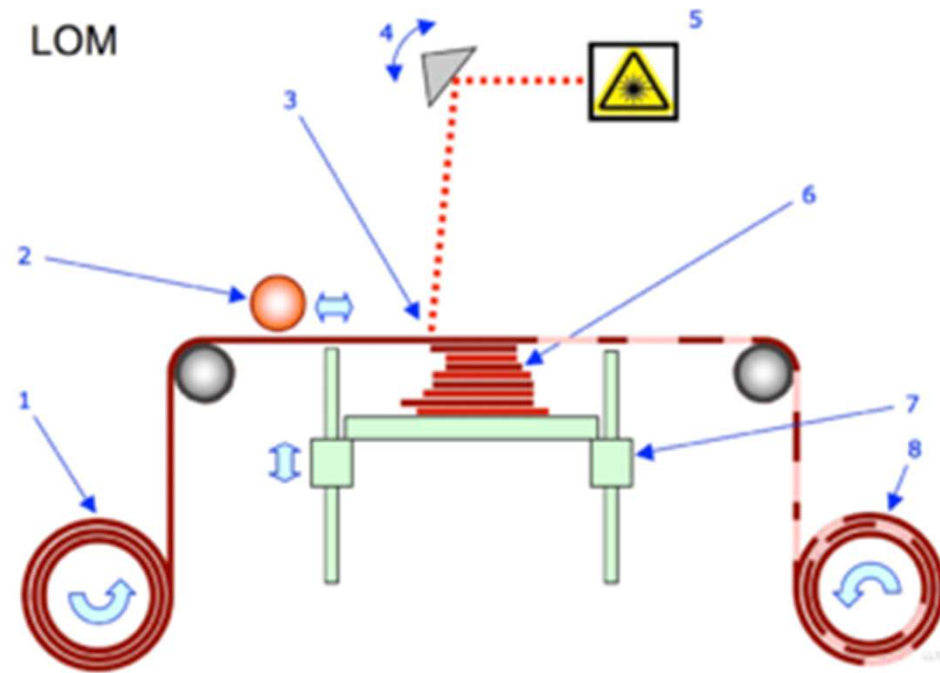


3-D Printer Extruder



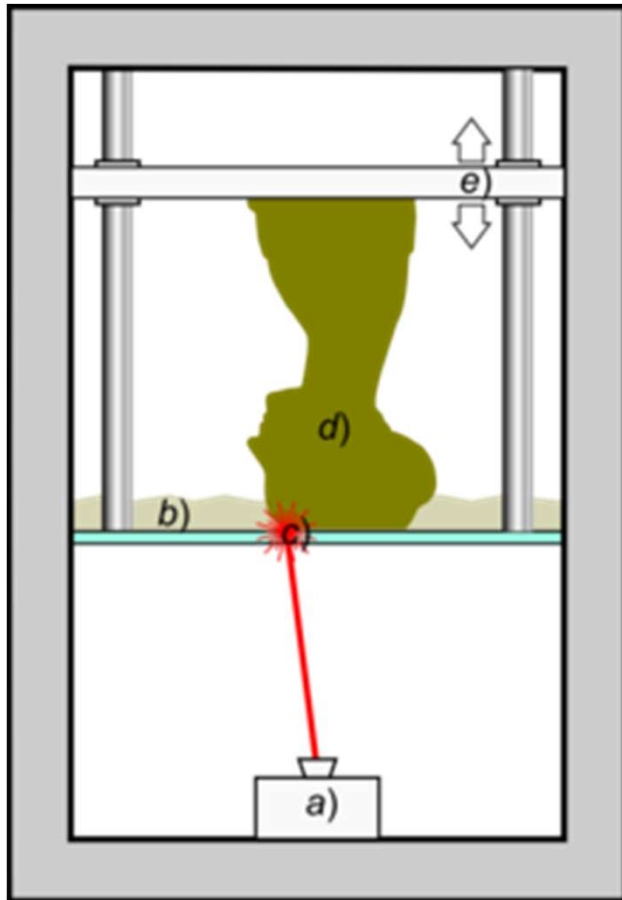
thermoplastics such as *acrylonitrile butadiene styrene* (ABS), *polylactic acid* (PLA), *high-impact polystyrene* (HIPS), *thermoplastic polyurethane* (TPU), *aliphatic polyamides* (nylon)

LOM



layers of adhesive-coated paper, plastic, or metal laminates are successively glued together and cut to shape with a knife or laser cutter

STL

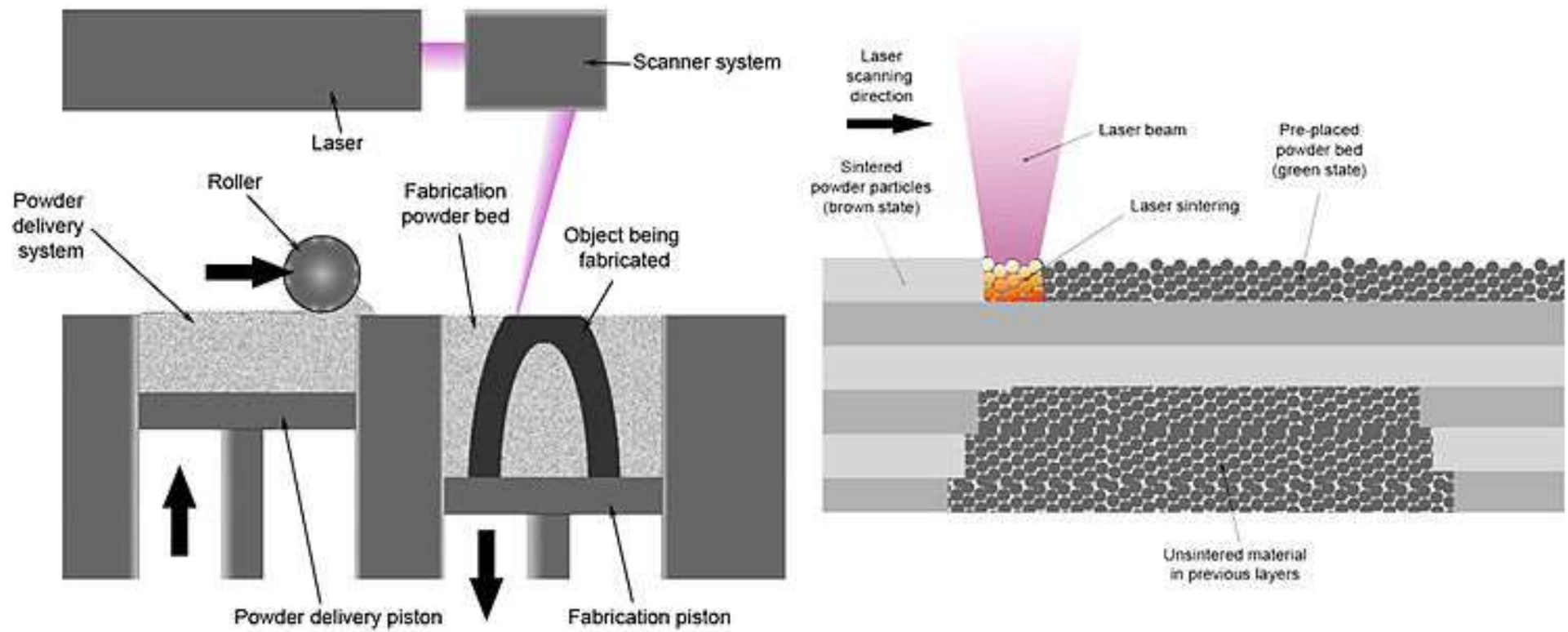


Stereolithography works by focusing an **UV laser** on to a vat of **photopolymer resin**. The UV laser is used to draw a pre-programmed design or shape on to the surface of the photopolymer vat.

Then, the build platform lowers one layer and a blade recoats the top of the tank with resin.

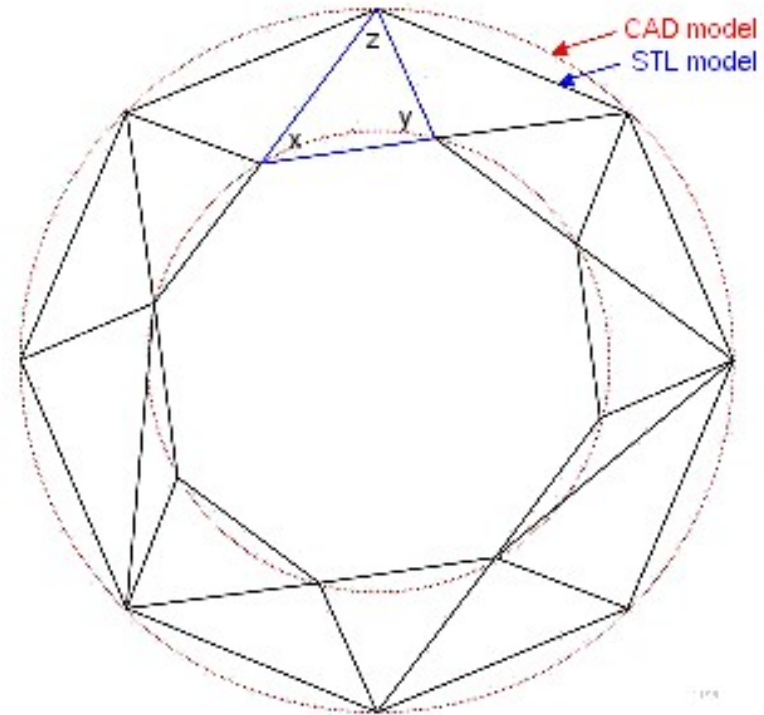
This process is repeated for each layer of the design until the 3D object is complete. Completed parts must be washed with a solvent to clean wet resin off their surfaces.

SLS



Work Flow

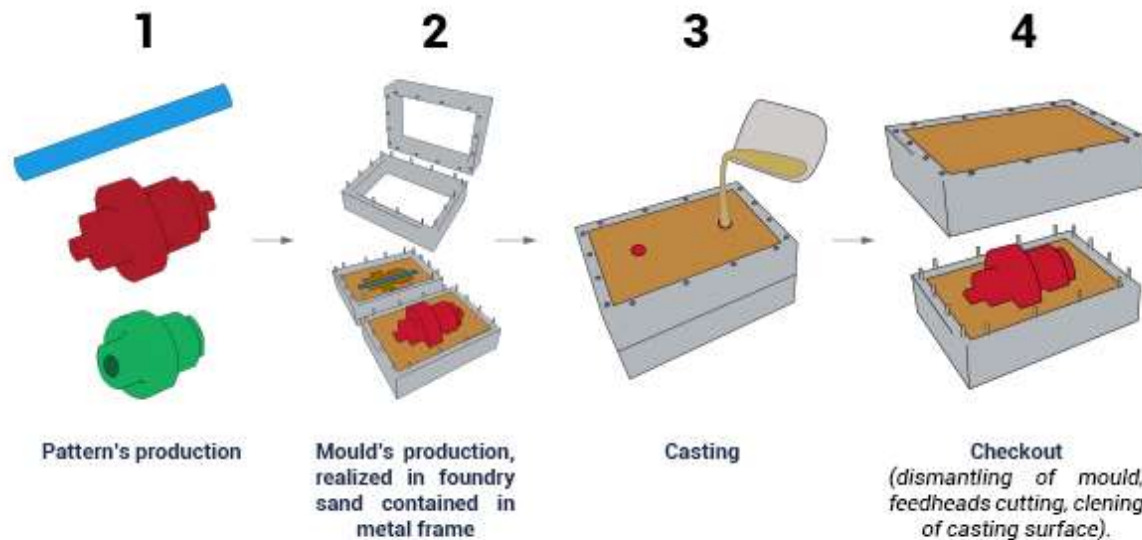
1. File CAD
 2. File STL
 3. G-code
- Slic3r



STL: Standard Triangle Language -> STL file describes a raw, *unstructured triangulated surface* by the unit normal and vertices;

G-code is a language in which people tell computerized machine tools how to make something. The "how" is defined by g-code *instructions provided to a machine controller* (industrial computer) that tells the motors where to move, how fast to move, and what path to follow

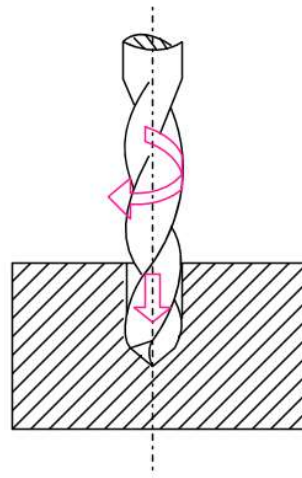
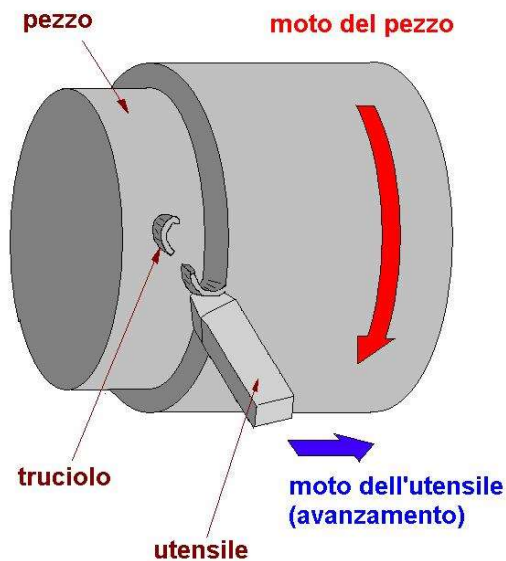
Manufacturing techniques



- **Casting** : Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify.
- **Additive manufacturing**
- **Subtractive manufacturing** : Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process.

Subtractive manufacturing

- **Turning** (tornitura): a cutting tool with a single cutting edge is used to remove material from a rotating workpiece to generate a cylindrical shape.
- **Drilling** (foratura) is used to create a round hole. It is accomplished by a rotating tool that typically has two or four helical cutting edges
- In **milling** (fresatura), a rotating tool with multiple cutting edges is moved slowly relative to the material to generate a plane or straight surface. The direction of the feed motion is perpendicular to the tool's axis of rotation. The speed motion is provided by the rotating milling cutter.



CNC Machining

Computer numerical control (CNC) is the **automation of machine tools** by means of computers executing pre-programmed sequences of machine control commands. This is in contrast to machines that are manually controlled by hand wheels or levers.

The parts are defined using computer-aided design (CAD) software, and then translated into manufacturing directives by computer-aided manufacturing (CAM) software. The resulting directives are transformed (by "post processor" software) into the specific commands necessary for a particular machine to produce the component, and then are loaded into the CNC machine.





Material Classes

- Metals: aluminum, steel -> sintering, casting, machining
corrosion, mechanical strength, magnetic properties
- Polymers: ABS, PVA, PLA, PC (thermoplastic) -> FDM, casting, machining
Teflon, Delrin -> machining
mechanical strength, transparency
- Ceramics and glass -> sintering, casting
mechanical strength, transparency

Others: sterilisability, biocompatibility, weight, machinability, cost

Esercitazione

Scegliere materiali e tecniche di produzione per le principali componenti del dispositivo (motivando le scelte), sia per la realizzazione di un prototipo che per una versione finale del dispositivo