

# **ROCO222: Intro to sensors and actuators**

## Lecture 10 Mechanical fabrication technologies

# Fundamentals of fabrication

- Clamping (vice, C-clamps)
- Cutting (hack saw, band saw, table saw)
- Drilling (drill press, milling machine)
- Grinding (grinding wheel)
- Bending (press brakes)
- Milling (milling machine)
- Turning (lathe)
- Punching (punch press)
- Laser cutting (CNC laser cutter)



Press brake



Lathe



Hacksaw



Band saw



Vice



Drill press



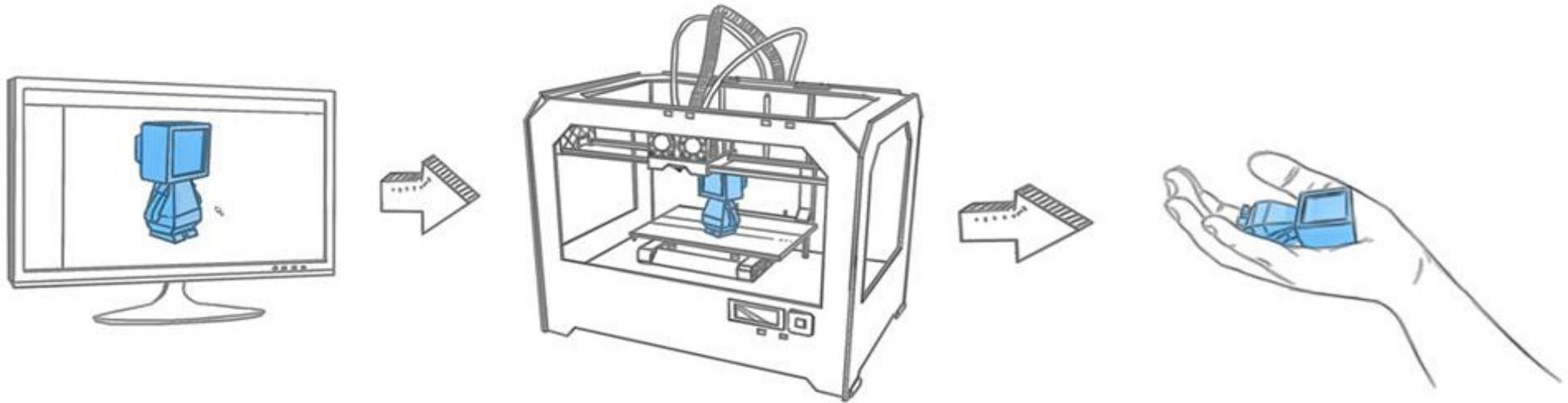
Milling machine

# Construction using hand tools

- Requires much traditional skill
- Limits what can be achieved
- May be fine for quick prototypes



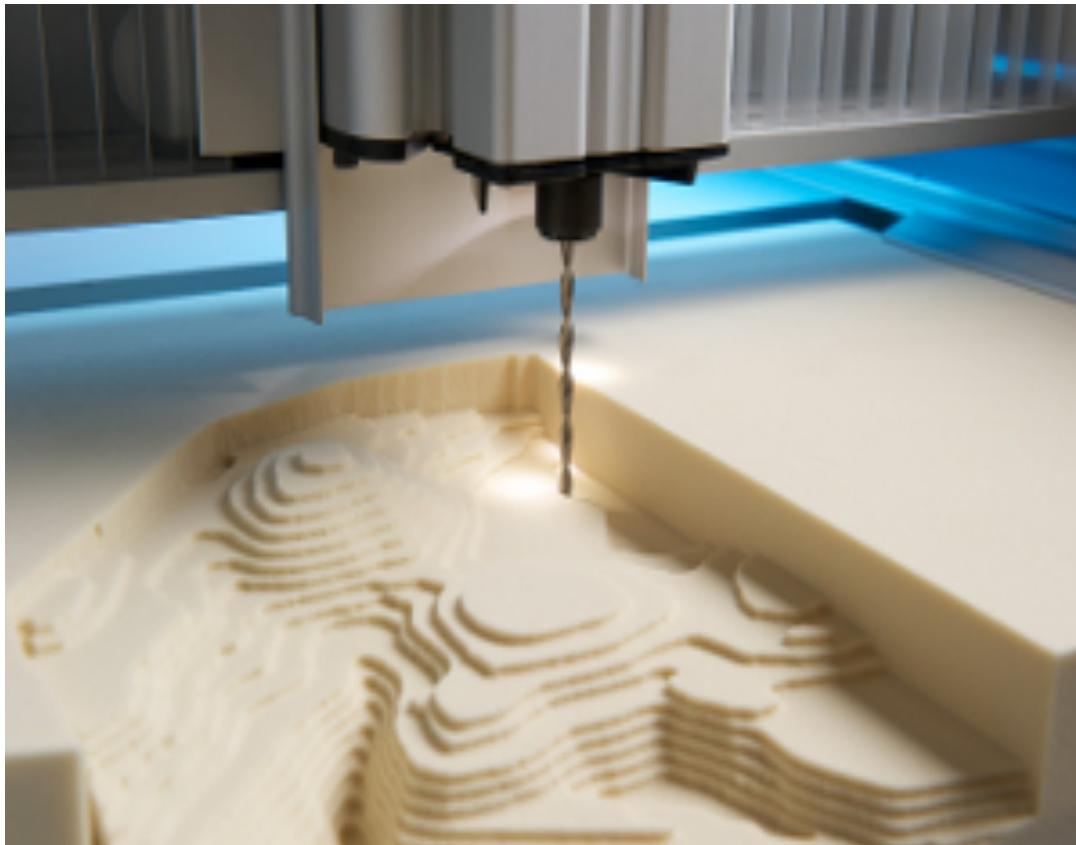
# Overview of 3D manufacturing



- 3D machines may use a subtractive manufacturing process (CNC, milling)
- Using them is often referred to as “**machining**”
- **3D printing** is an additive manufacturing process
- Creates 3D objects from 3 dimensional digital information.
- 3D digital models are “sliced” into many 2 dimensional cross-sections that are then “printed” one on top of the other

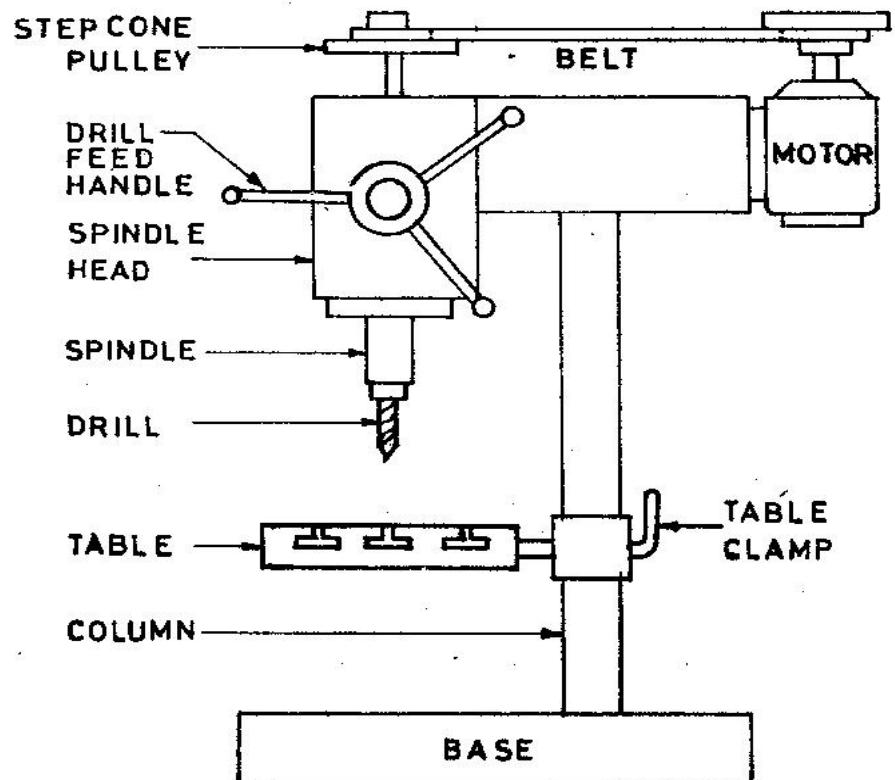
# Subtractive manufacturing

- Remove material from work piece using cutting tools
- Like a sculpture
- Remove the bits that you don't want in the finished component
- Includes: Milling, Turning, Drilling Computer Numerical Control (CNC) Machines

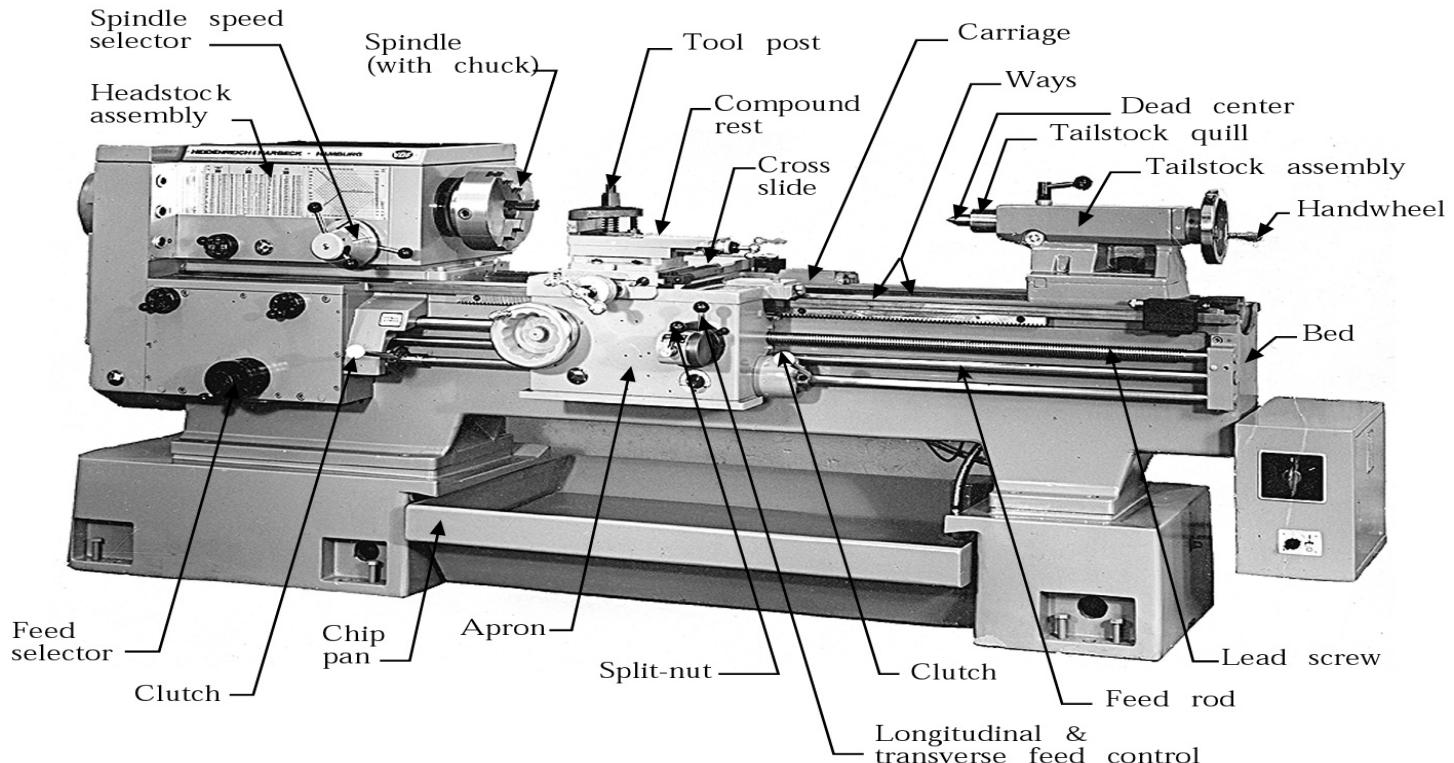


# Pillar drilling machine

- Drill holes from 1.5 to 15mm
- Operator senses the cutting action so sensitive drilling machine

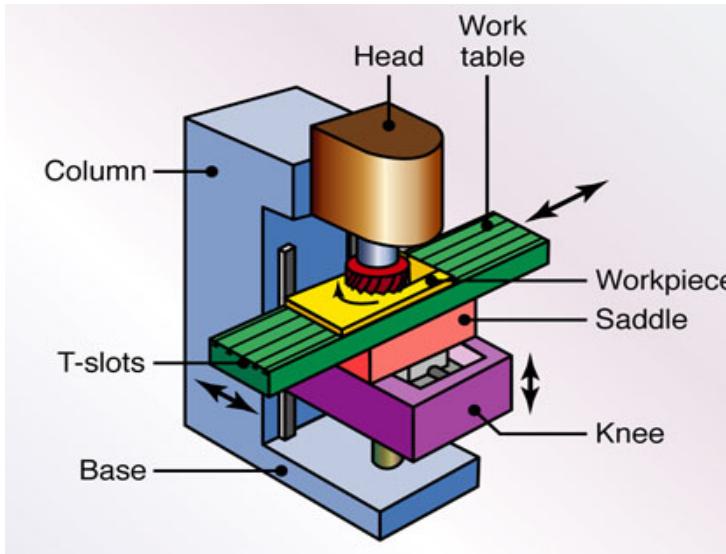


# Lathe

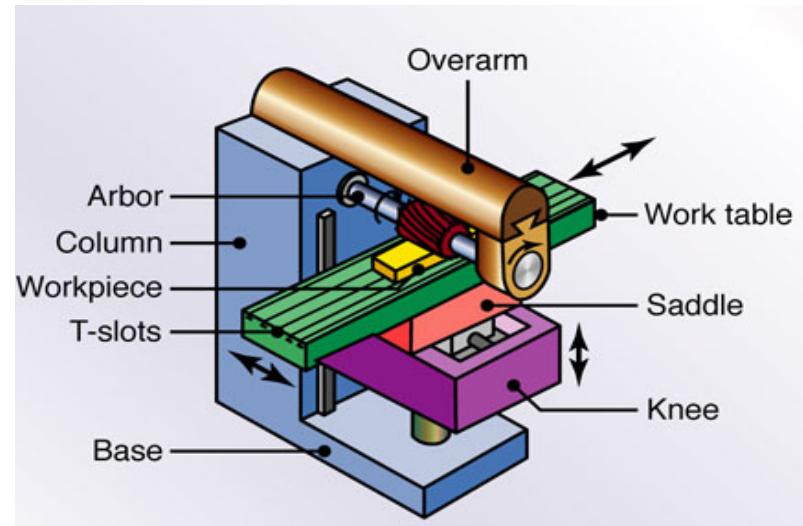


- Turning: produce straight, conical, curved, or grooved work pieces
- Facing: to produce a flat surface at the end of the part or for making face grooves
- Boring: to enlarge a hole or cylindrical cavity made by a previous process or to produce circular internal grooves
- Drilling: to produce a hole by fixing a drill in the tailstock
- Threading: to produce external or internal threads
- Knurling: to produce a regularly shaped roughness on cylindrical surfaces

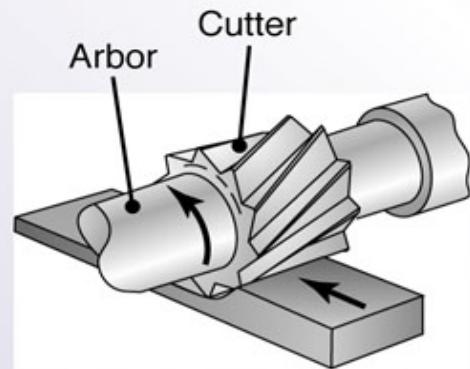
# Milling machines



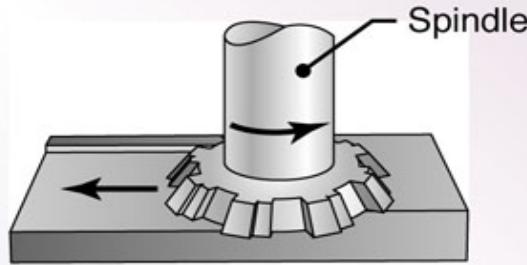
Vertical-spindle milling machine



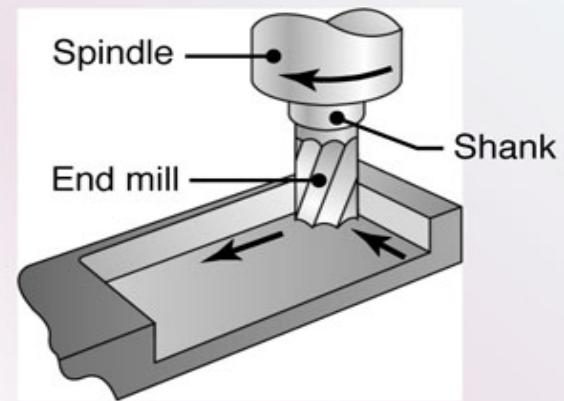
Horizontal-spindle milling machine



(a) Peripheral milling



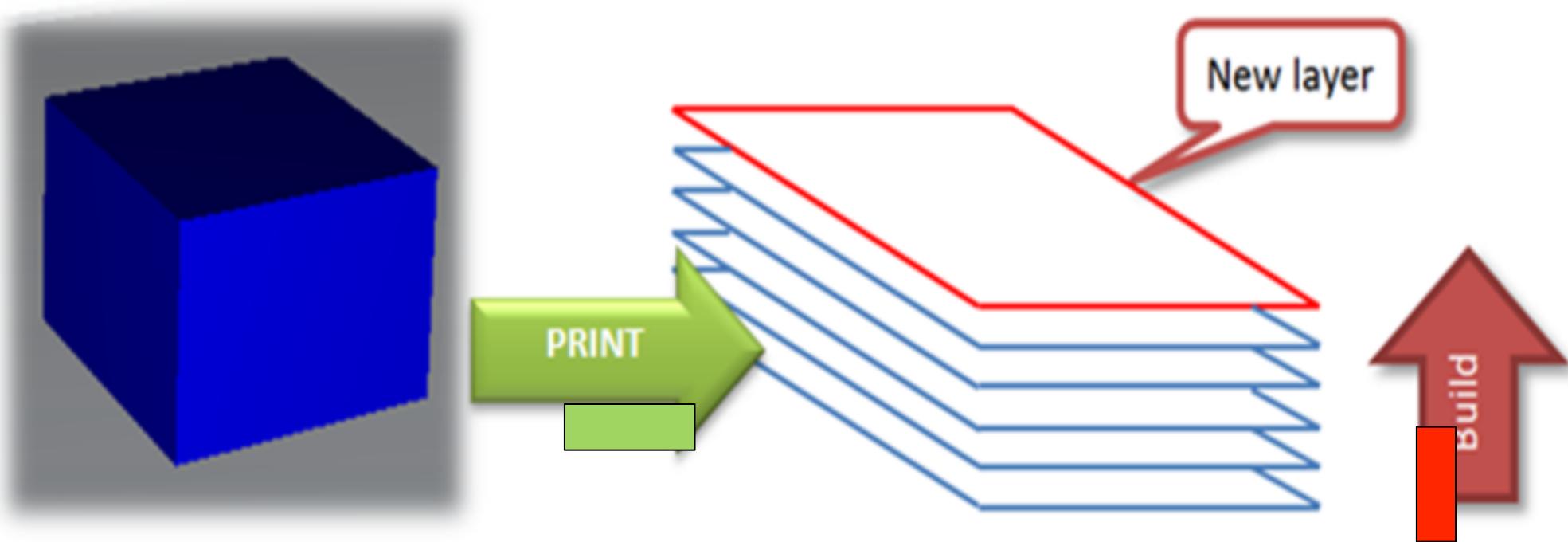
(b) Face milling



(c) End milling

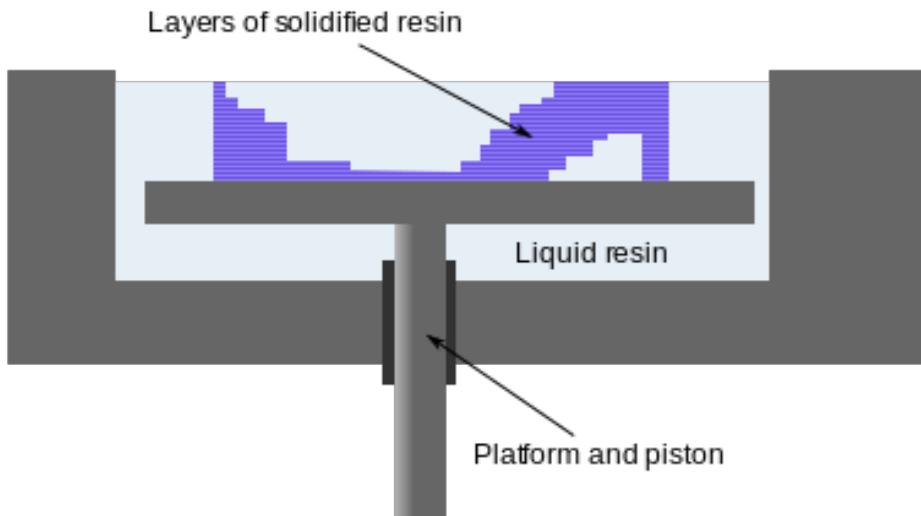
# 3D printing

- A form of additive manufacturing
- Process of joining materials to make an object from 3D model
- This is a layer-by-layer process



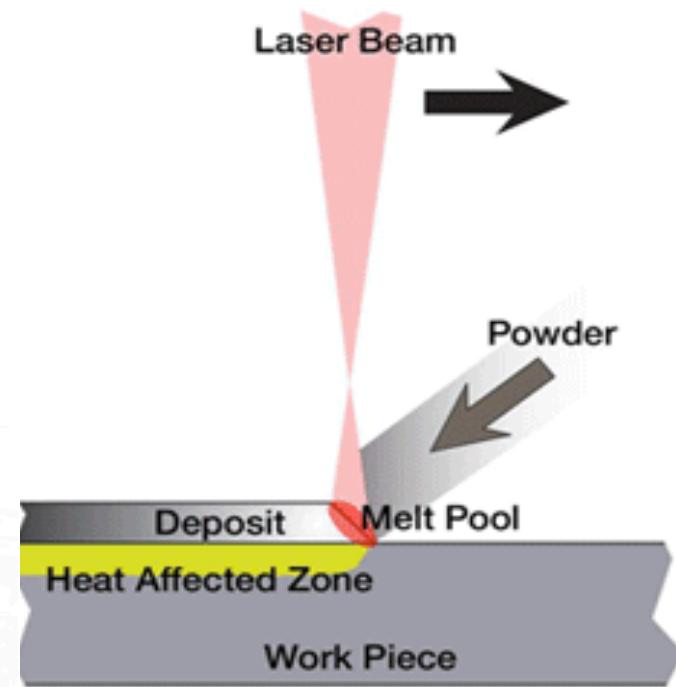
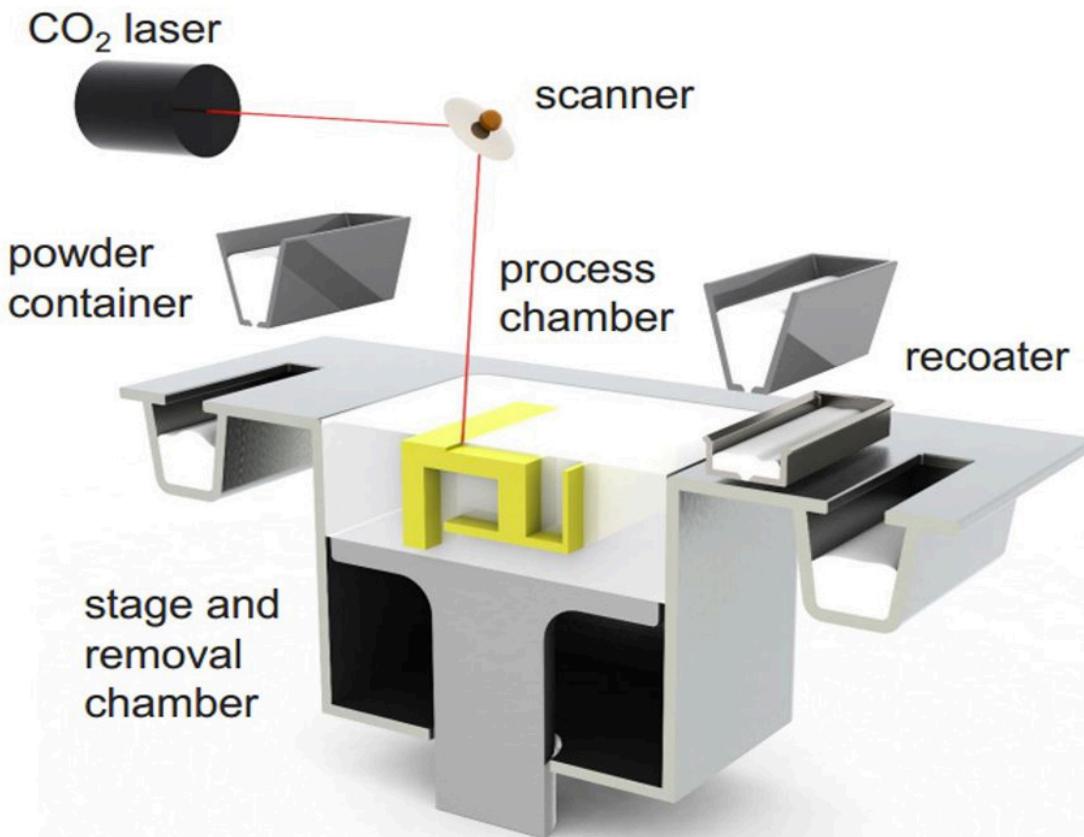
# Stereo lithography

- SLA - Stereo lithography
- UV light used to “cure” photosensitive resin
- Relatively fast process



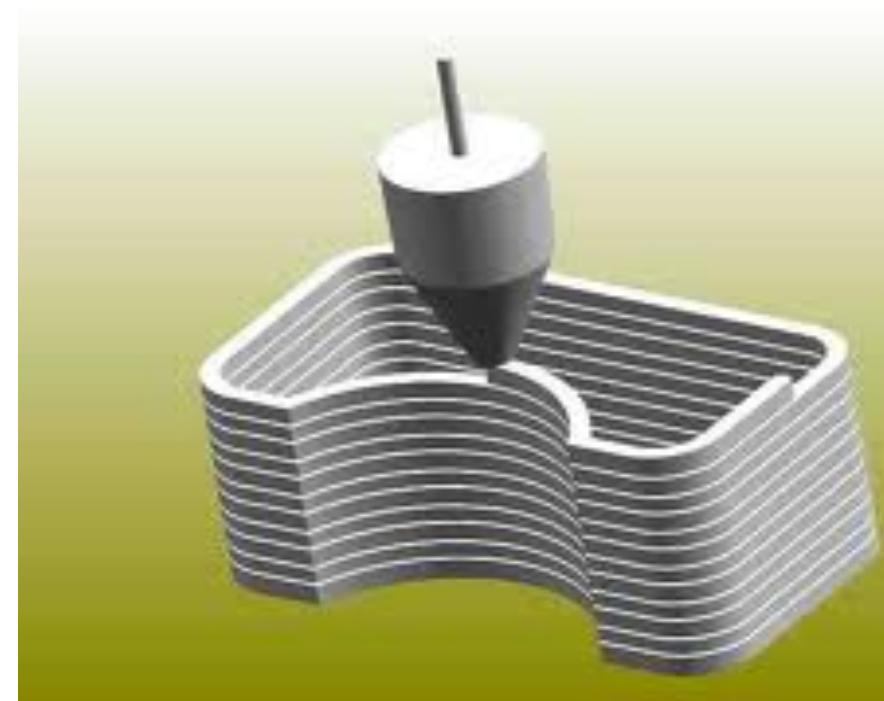
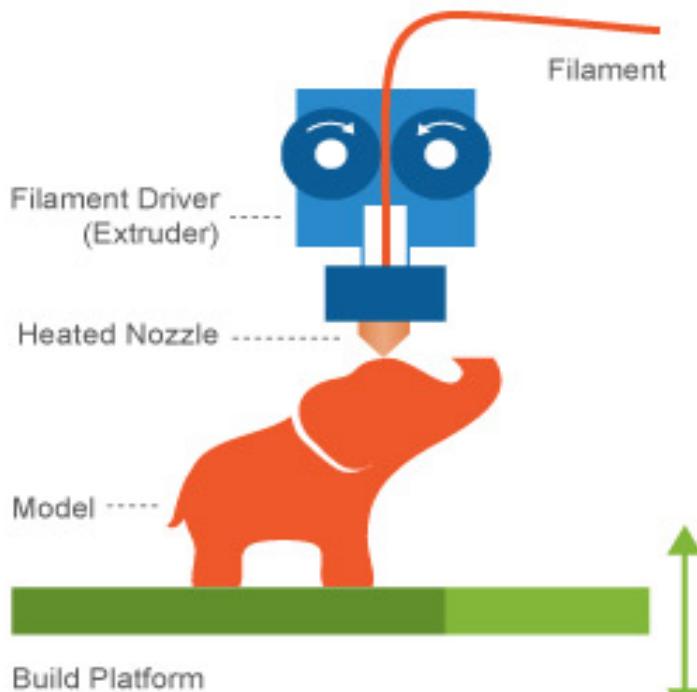
# Powder bed

- SLS or Selective laser sintering is most common
- A granular bed of materials are selectively fused together by a laser.
- Various materials:
- Metal alloys, metal powders, thermoplastics, ceramic powders



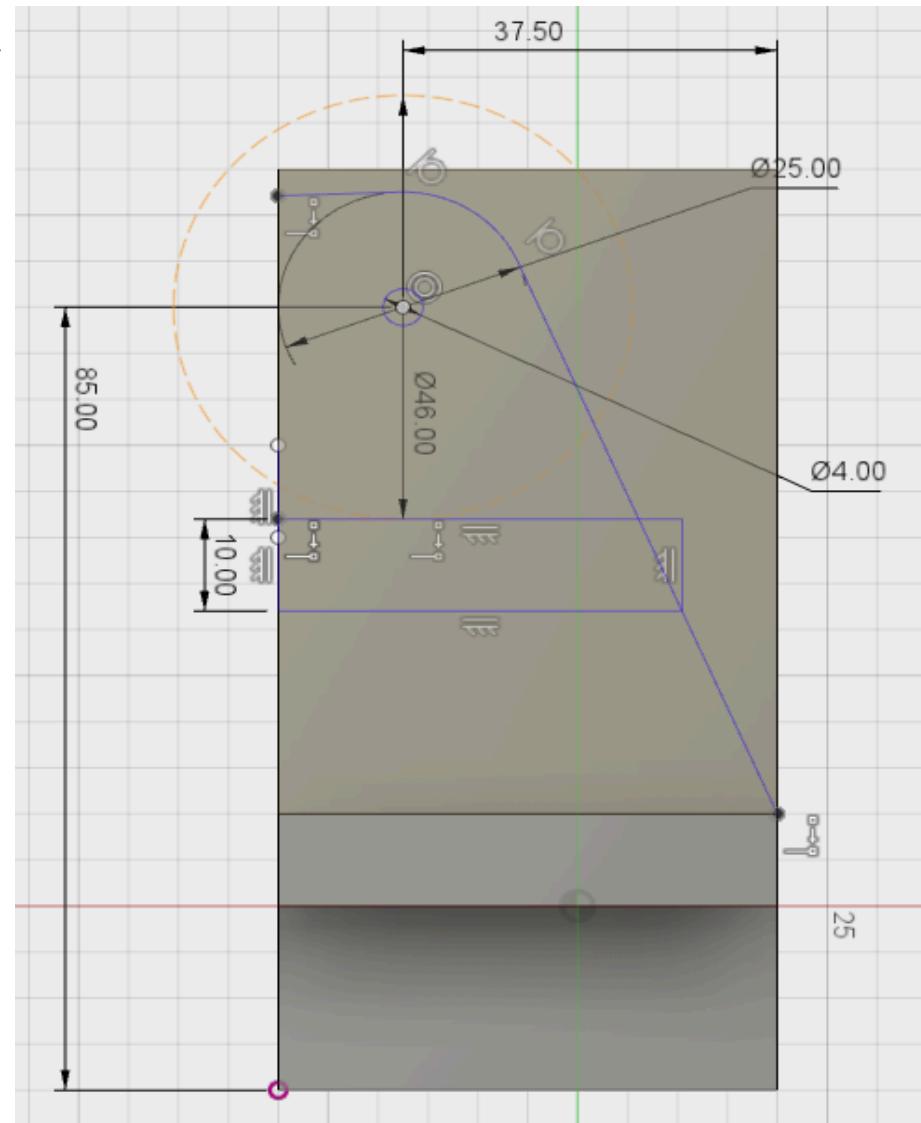
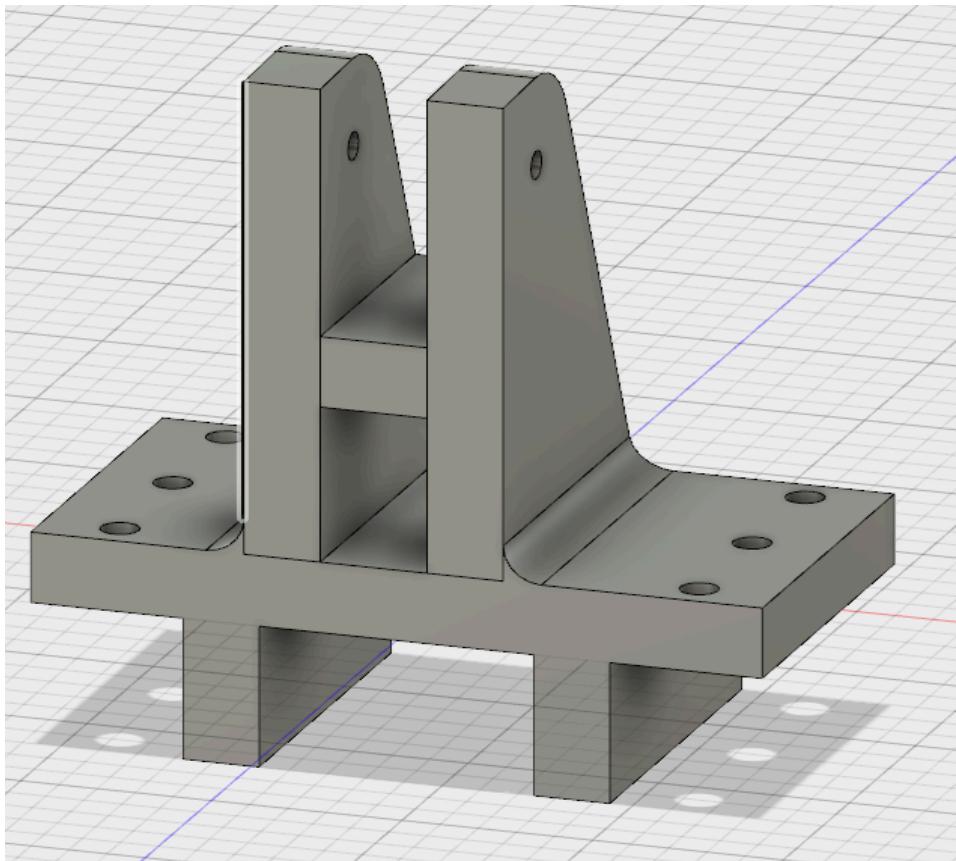
# Fused deposition modeling

- FDM Fused Deposition Modeling is now widespread
- This is the technology in most hobby machines
- Melted plastic filament is pushed through a nozzle or “extruder”
- It then builds up model layer by layer
- Commonly use plastics are:
  - ABS (acrylonitrile butadiene styrene; used to build Lego bricks)
  - PLA (polylactic acid; commonly used for hobby 3D printers)
  - Can also use nylon, Ninjaflex, and even carbon fiber reinforced materials!



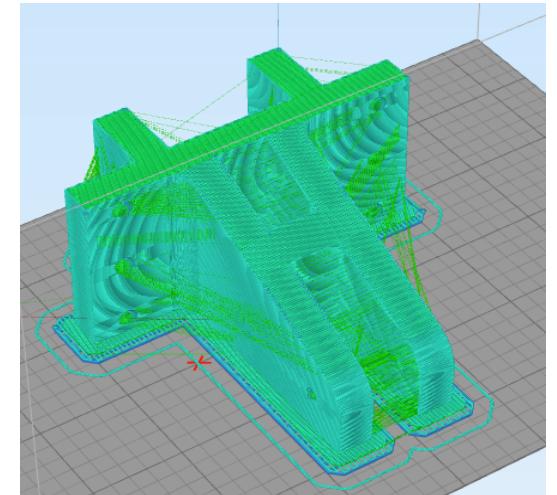
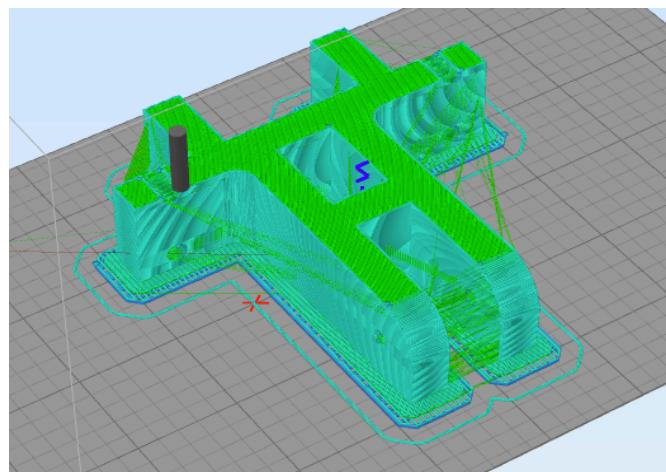
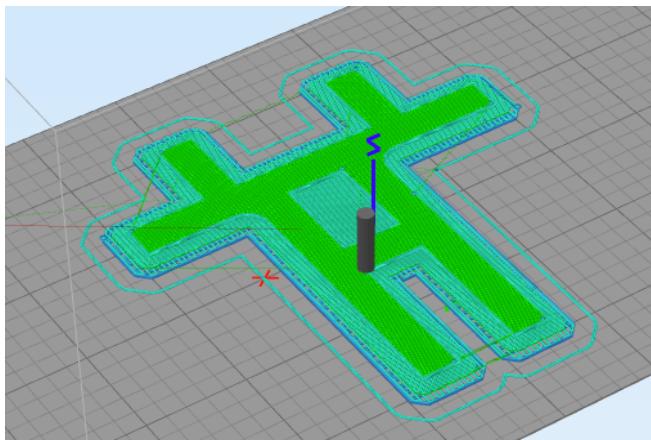
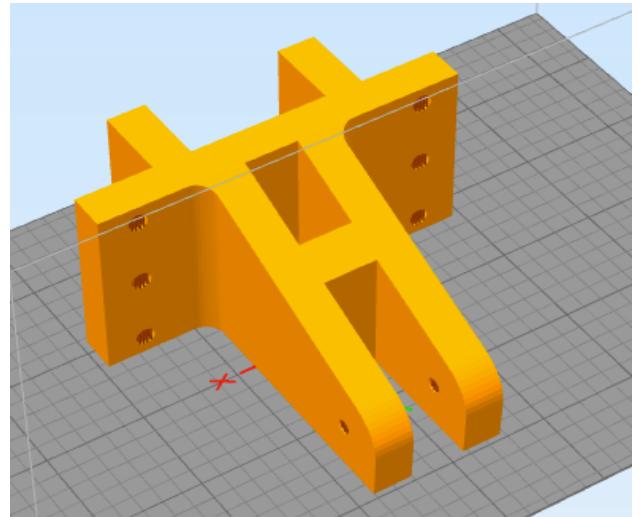
# 3D modeling

- First you start with a 3D model
- Build it in 3D AutoCAD software
- Or scan an object with a 3D scanner
- Or download an existing part file



# Slicer software

- Next 3D use software that “slices” the model into many cross-sections
- Eg can use Simplify 3D
- Generates g-code to drive a 3D printer



# Print the model

- Once the 3D model is sliced the data is sent to a 3D printer
- Printer recreates the object one layer at a time
- Stacks consecutive layers atop one another

FDM 3D printers move along their 3 axis and eject hot plastic as required

- X-axis: left-right
- Y-axis: forward-backward
- Z-axis: up-down

