3D Printing Course for Beginners (Lecture-1)

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SCOPES OF THIS LECTURE

A — Course Curriculum & Materials

- Course Syllabus
- Course materials
- Marks Distribution
- Reference
- Output from this course
- Fusion 360
- Ultimaker CURA

B — Introduction

- Additive Manufacturing
- How 3D printer works
- Application of 3D printing
- Benefits of 3D printing

C — Additive Manufacturing

- Classification of Additive Manufacturing
- Material Extrusion
- VET polymerization

D — 3D printing Operation Process

- 3D printer parts introduction
- Producing a 3D file
- Printing

E — Summery

- Class Summery
- Discussion about next Class
- Q/A

Course Curriculum

Section 1: Introduction

1. What is Additive manufacturing
2. History of 3D printing
3. Overview of 3D printing process

1) Producing a 3D file
2) Stl creation and file manipulation
3) Printing
4) Removal of Prints
5) Post Processing

Section 2: 3D printing technology & Materials

1. Classification of 3D printing technologies
2. 3D Printing Material Groups
3. Material extrusion — FFF
    1. Fused Filament Fabrication (FFF)
4. Vat polymerization technologies
    1. Stereolithography (SLA)

Section 3: Designing for 3D printing

a. General design considerations for 3D printing
b. Description of 3D printed features
c. Designing for Material Extrusion/FDM
d. Designing for SLA/DLP

Section 4: Application of 3D Printing

a. Tools for producing 3D designs
b. Applications of Material Extrusion/FDM
c. Applications of SLA/DLP

After Passing/Finishing the course, you will be able to do the followings-

1. You'll be able to understand the methods of Additive manufacturing
2. Different methods of 3D printing
3. Different methods of 3D printing operations
4. Operate and print by your own
5. Design and slice complex geometries
6. Able to do basic troubleshoot out and maintenance
7. Certificate from CARL

Course Materials & Marks Distribution

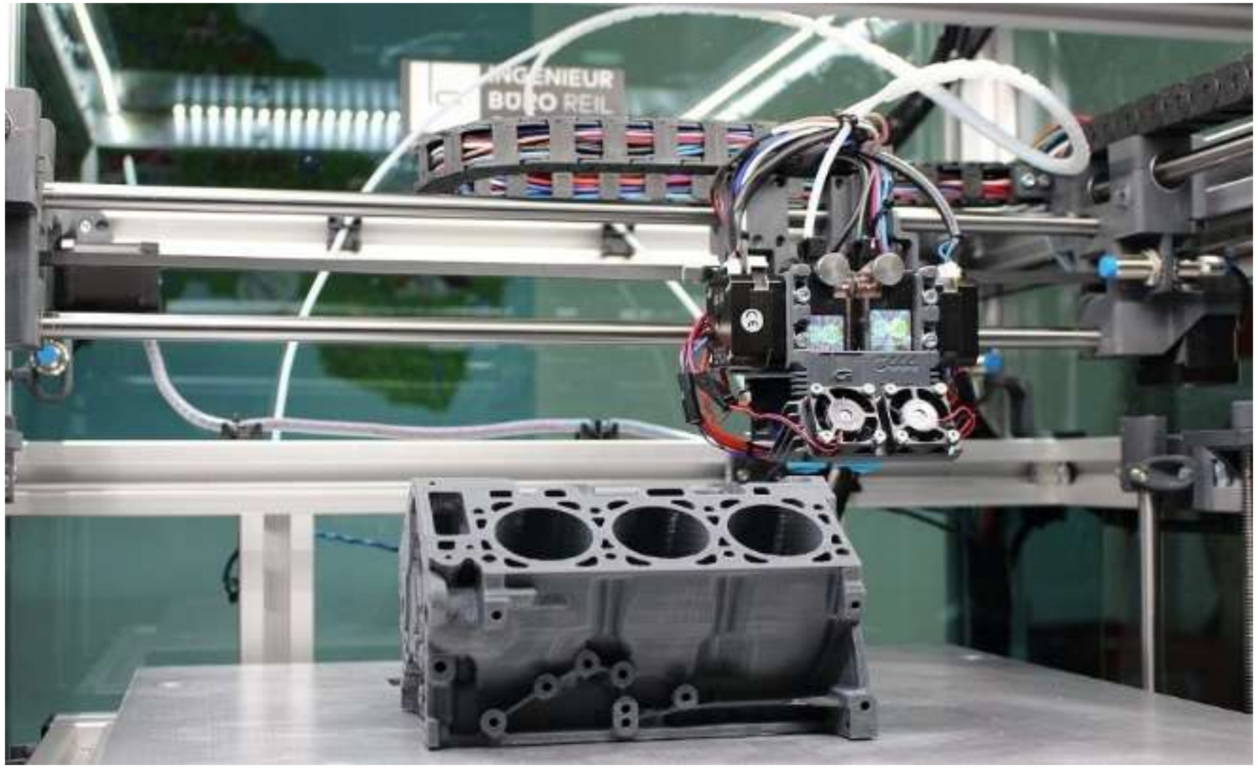
Course Title: 3D Printing course for Beginners
Course Duration: 16hrs (8 Days, 2 hours per class)
Course Fee: 5000tk (proposed)
Mark Distribution: 100 { 30(quiz)+30(written)+40(sessional) }
Course Instructor: Shihab Hasan Sarwar (Kambaii, CDRL)
Reference book: Printed handbook will be provided by CARL
Evaluation process:

a. Class 1-3 – First quiz(10), Sessional(5, viva)
b. Class 4-6 – Practical (15)
c. Class 7-8 – Third Quiz (10), Sessional(5, viva)
d. Final – Written-30 (Class 1-8)
e. Final – Sessional (lab test)- 25 (Class 1-8)

INTRODUCTION

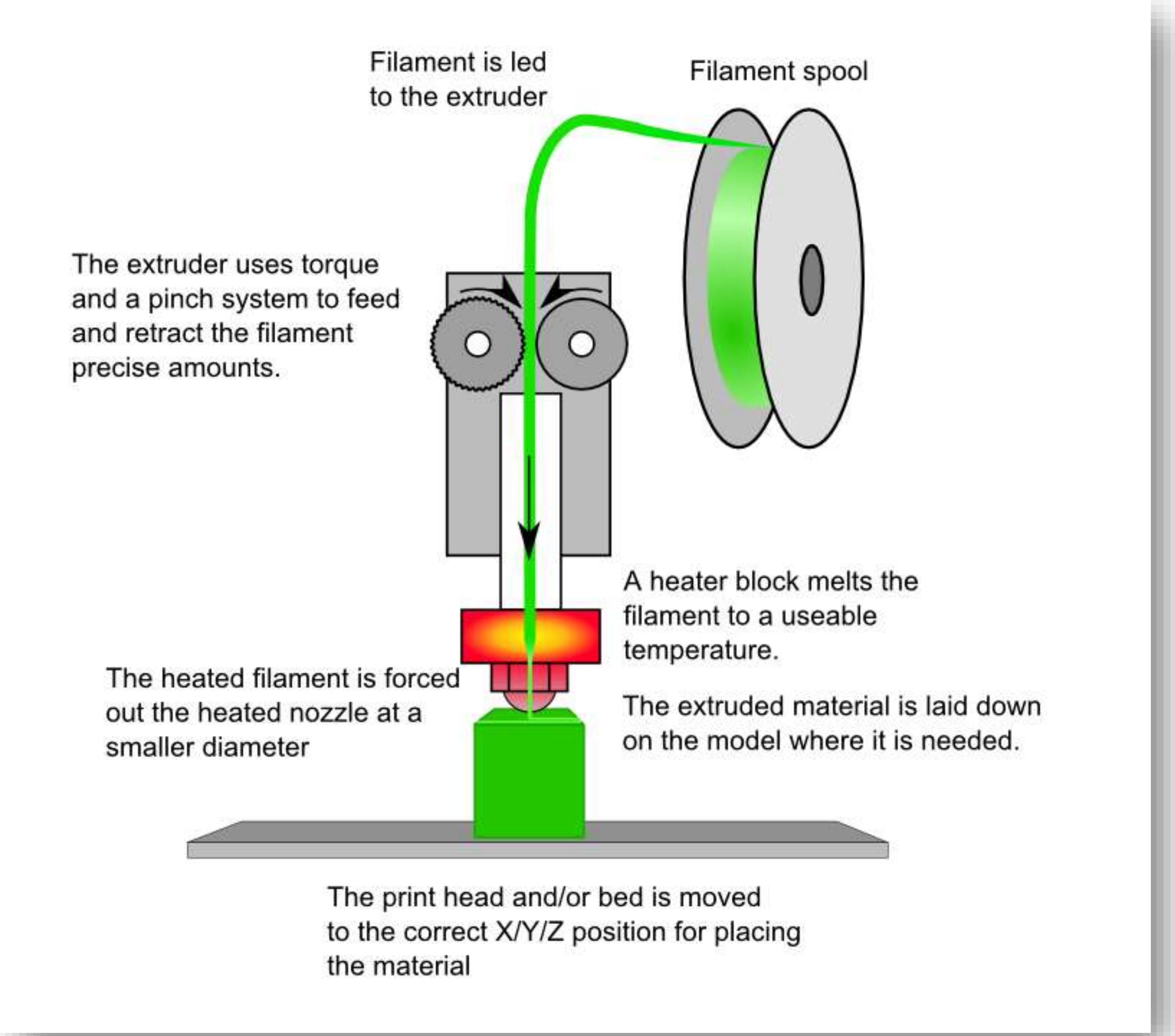
What is Additive manufacturing

Additive manufacturing is the process of building physical objects by layering materials like metal, plastic, or concrete. It is a process that uses special software and equipment.



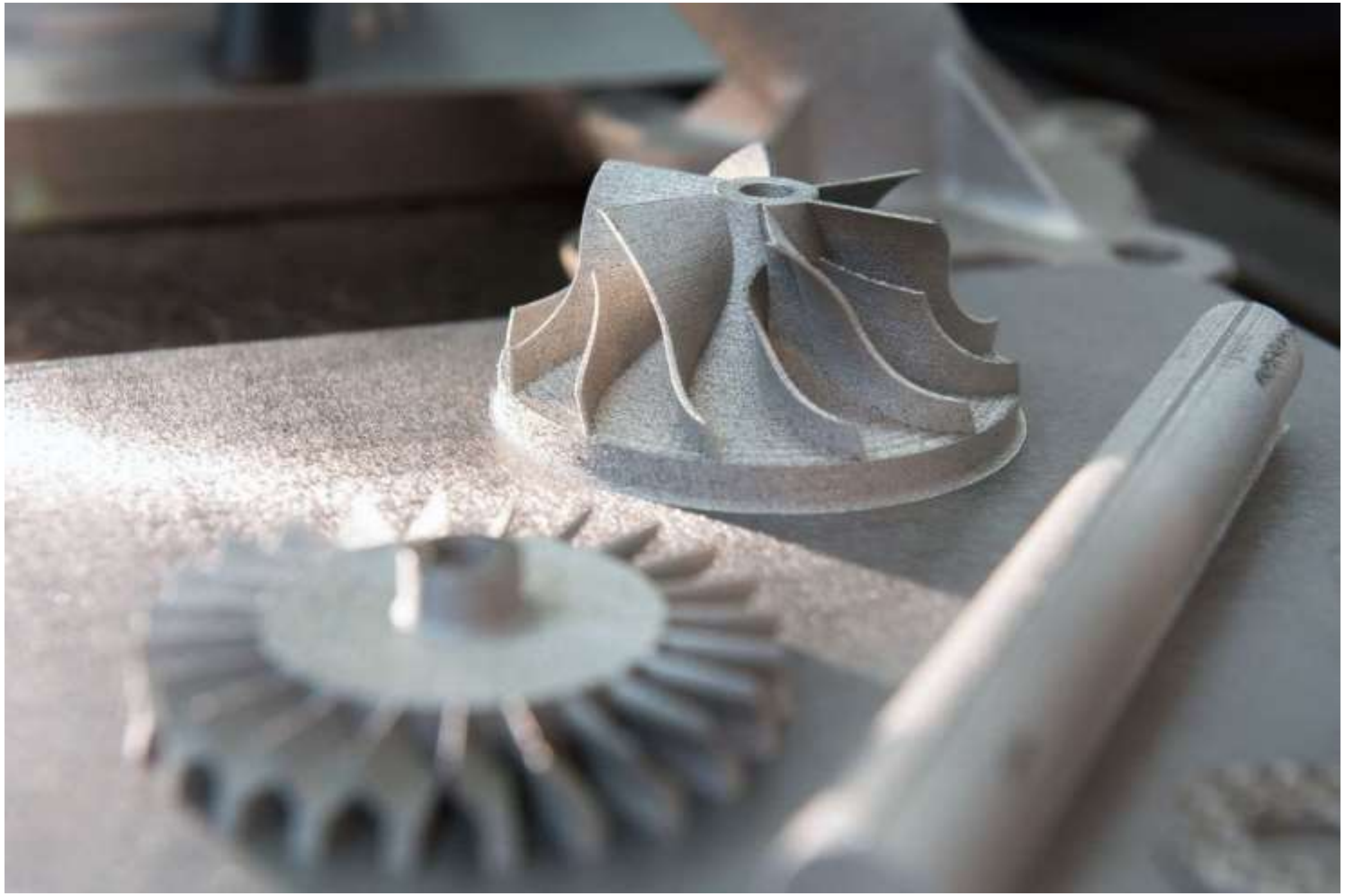
How 3D printer Works

The 3D printing process turns a whole object into thousands of tiny little slices, then makes it from the bottom-up, slice by slice. Those tiny layers stick together to form a solid object. Each layer can be very complex, meaning 3D printers can create moving parts like hinges and wheels as part of the same object.



Application of 3D printing

- Manufacturing applications
  - Cloud-based additive manufacturing
  - Mass customization
  - Rapid manufacturing
  - Rapid prototyping
  - Research
  - Food
  - Agile tooling
- Medical applications
  - Bio-printing
  - Medical devices
  - Pharmaceutical Formulations
- Industrial applications
  - Apparel
  - Industrial art and jewelry
  - Automotive industry
  - Construction, home development
  - Firearms
  - Computers and robots
  - Soft sensors and actuators
  - Space
- Sociocultural applications
  - Art and jewelry
  - 3D selfies
  - Communication
  - Domestic use
  - Education and research
  - Environmental use
  - Cultural heritage



Benefits of 3D printing

Low-volume production

For industries like aerospace and defense, where highly complex parts are produced in low volumes, 3D printing is ideal. Using the technology, complex geometries can be created without having to invest in expensive tooling equipment. This offers aerospace OEMs and suppliers a cost-effective way to produce small batches of parts cost-effectively.

Weight reduction

Alongside aerodynamics and engine performance, weight is one of the most important factors to consider when it comes to aircraft design. Reducing the weight of an aircraft can significantly reduce its carbon dioxide emissions, fuel consumption and payload.

This is where 3D printing comes in: the technology is an ideal solution for creating lightweight parts, resulting in considerable fuel savings.

Enhanced medical devices

3D printing is an ideal technology for creating or optimizing designs for medical devices. Thanks to low-cost rapid prototyping, medical device manufacturers have greater freedom in designing new products, helping to bring new medical devices to the market much faster.

Greater design flexibility

The ability to produce designs quickly gives designers greater flexibility when testing multiple design options. 3D printing enables designers to make quick design changes and modifications in a fraction of the time.

Customization

3D printing offers automakers a cost-effective and flexible way to produce customized parts. Within the luxury and motorsports segment of the industry, companies are already using the technology to produce personalized parts for both the interior and exterior parts of a vehicle.

Create complex geometries

With the majority of car components requiring complex geometries like internal channels (for conformal cooling), thin walls and fine meshes, AM enables highly complex parts to be produced that are still lightweight and durable.

ADDTIVE MANUFACTURING

CLASSIFICATION

There are 7 types of Additive manufacturing

- MATERIAL EXTRUSION
- VAT PHOTOPOLYMERISATION
- MATERIAL JETTING
- BINDER JETTING
- POWDER BED FUSION
- SHEET LAMINATION
- DIRECTED ENERGY DEPOSITION

ADDTIVE MANUFACTURING

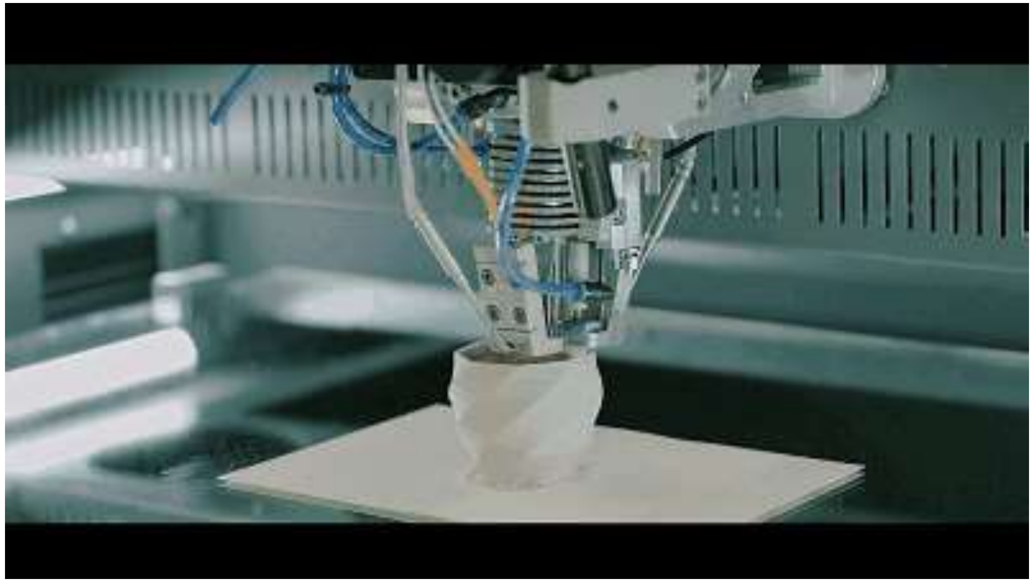
MATERIAL EXTRUSION

Material extrusion is a type of additive manufacturing process often used in inexpensive at-home 3D printers where the material is drawn through a nozzle, heated, and then deposited in a continuous stream. This nozzle moves along horizontally and the platform moves up, down, and vertically. This is how the layers are created. Because the material is heated (melted) when it is applied, it fuses to the previous layer. The bonding between layers can also be controlled through temperature and chemical agents.

Although material extrusion is often seen in inexpensive models, it has many capabilities. Polymers and plastics can be used, which provide strong structural support. However, there are also limitations to this additive manufacturing process.

- Accuracy is reduced because of the nozzle thickness.
- Material extrusion is also one of the slower types of additive manufacturing.

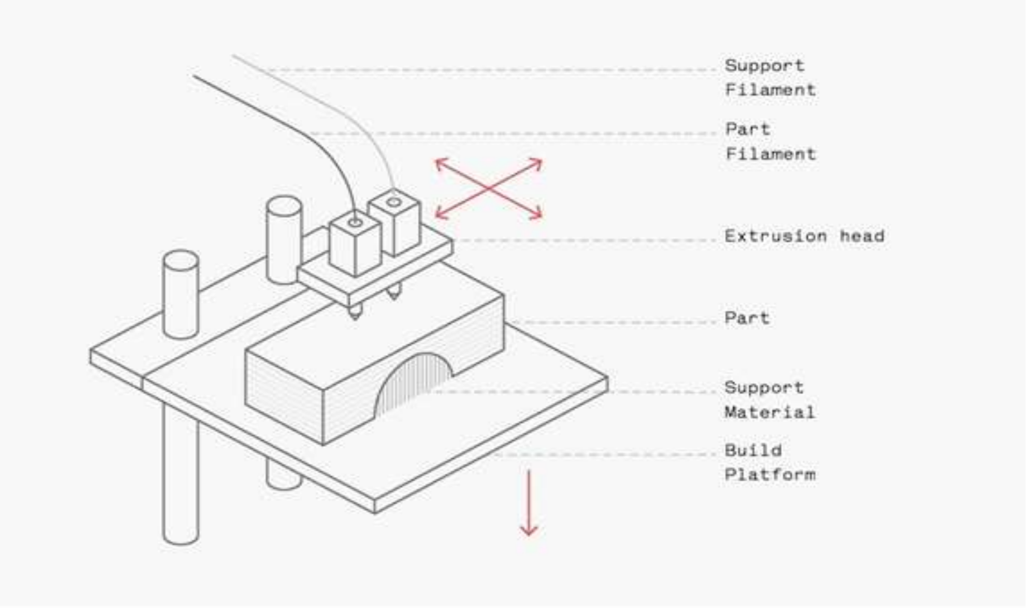
Many automotive companies use material jetting to create manufacturing devices used in assembly lines.



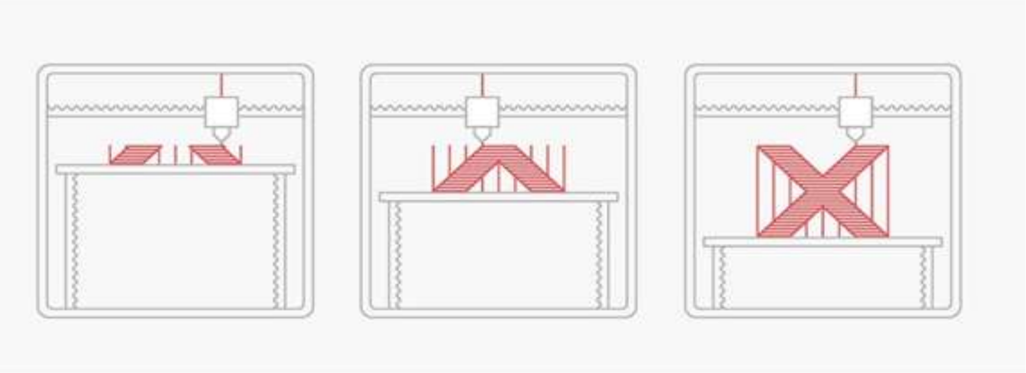
Fused filament fabrication (FFF)

The most common material extrusion technology is Fused Filament Fabrication or FFF (more commonly referred to as Fused DepositionModeling or FDM, a term trademarked by Stratus's).

A spool of filament is loaded into the printer and fed through to the extrusion head. Once the printer nozzle has reached the desired temperature, a motor drives the filament through the heated nozzle melting it. The printer then moves the extrusion head around, laying down melted material at a precise location, where it cools down and solidifies. Once a layer is complete, the build platform moves down and the process repeats building up the part layer-by-layer (essentially resembling a very precise hot-glue gun).



- Schematic of a FFF printer

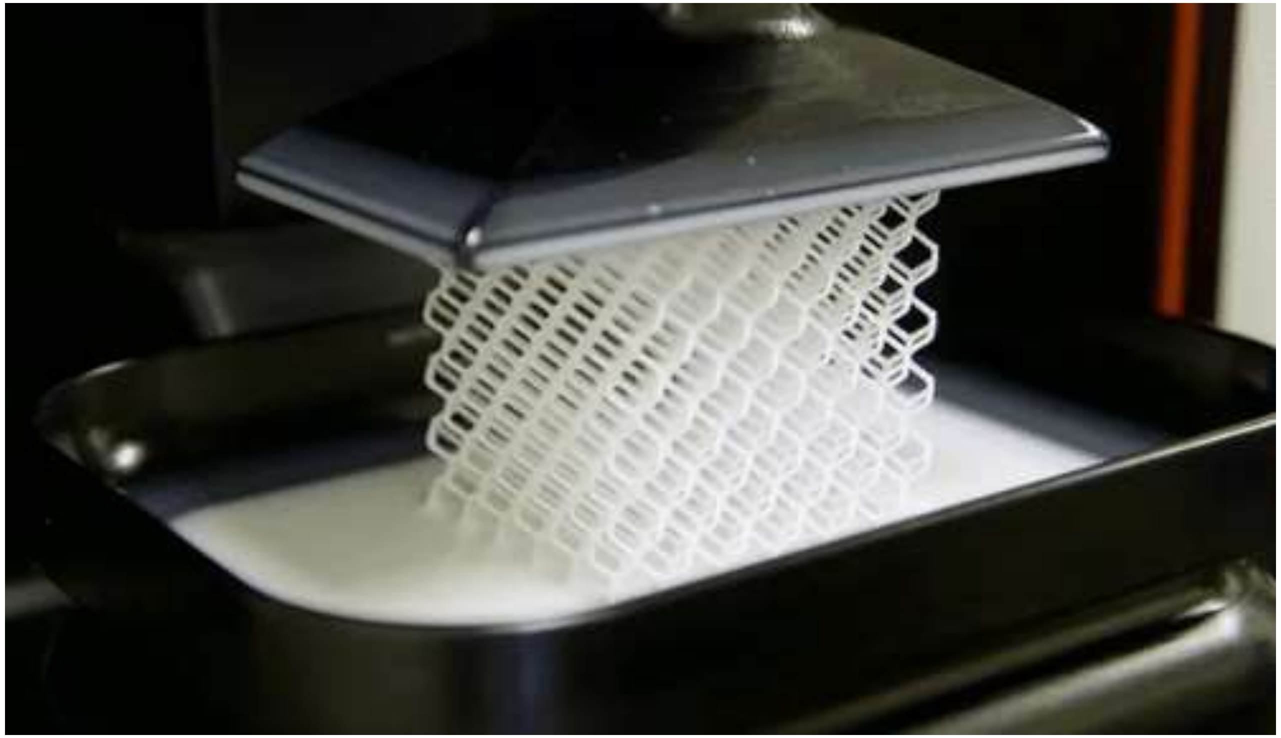


- The FFF printing process

ADDTIVE MANUFACTURING

VAT POLYMERIZATION

- VAT Photopolymerisation is also known as stereo lithography. This type of additive manufacturing uses a vat of liquid photopolymer resin—which is how VAT photo polymerization received its name.
- A build platform is lowered from the resin's top, moving downward, and a laser beam draws a shape in the resin, creating a layer. The average thickness of one layer is between 0.025 and 0.5mm. After each layer of resin, it must then be cured using ultraviolet (UV) light.
- This process of photo polymerization uses motor controlled mirrors to direct the UV across the resin surface, causing it to harden. These steps are repeated to add layers.
- For increased accuracy and finish, most equipment uses blades that go over each layer to remove defects before applying and curing the next layer. Using a liquid creates a great deal of accuracy and detail in the finished project; however, it lacks the structural support provided by other types of additive manufacturing. This is corrected by adding support structures. Although the VAT photo polymerization process is quick to complete, the clean-up and post-processing time is lengthy.

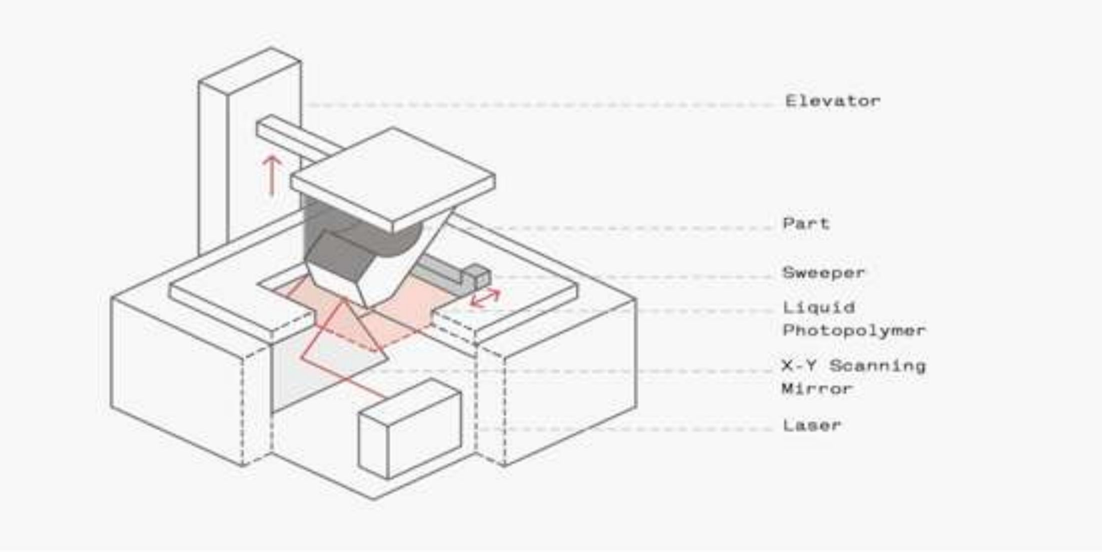


VAT POLYMERIZATION

Stereolithography (SLA)

SLA is famous for being the original 3D printing technology. The termStereolithography itself was coined by Charles W. Hull, who patentedthe technology in 1986 and founded the company 3D Systems to commercialize it.

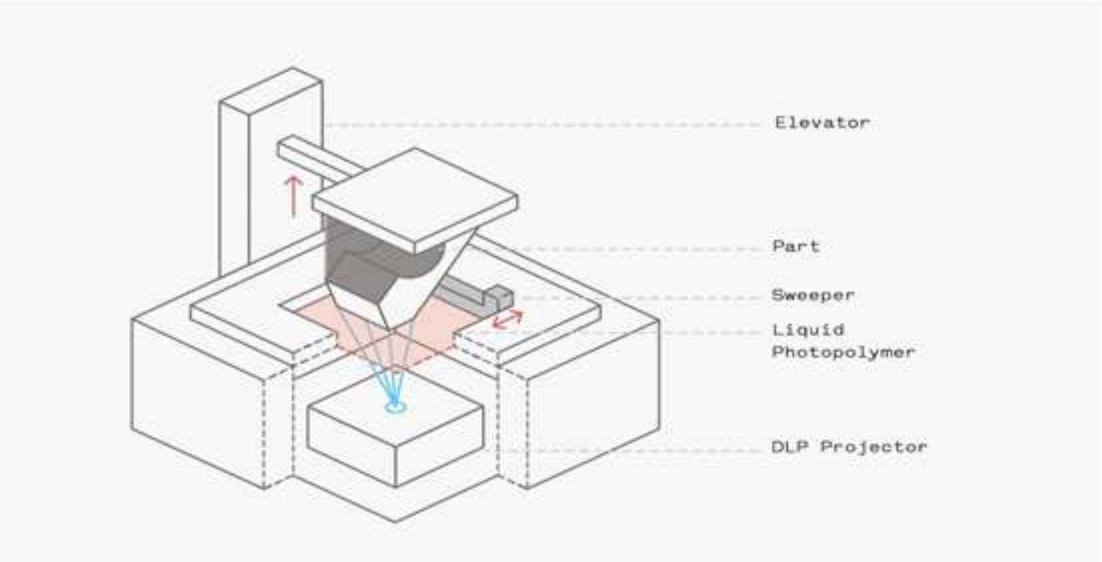
The process uses mirrors, known as galvanometers or galvos, (one onthe x-axis and one on the y-axis) to rapidly aim a laser beam across a vat, the print area, curing and solidifying resin as it goes along. This process breaks down the design, layer by layer, into a series of points and lines that are given to the galvos as a set of coordinates. Most SLA machines use a solid state laser to cure parts.



Schematic of a SLA printer

Direct Light Processing (DLP)

DLP follows a near identical method of producing parts when compared to SLA. The main difference is that DLP uses a digital light projector screen to flash a single image of each layer all at once (or multiple flashes for larger parts). Because the projector is a digital screen, the image of each layer is composed of square pixels, resulting in a layer formed from small rectangular bricks called voxels.



Schematic of a DLP printer

VAT POLYMERIZATION

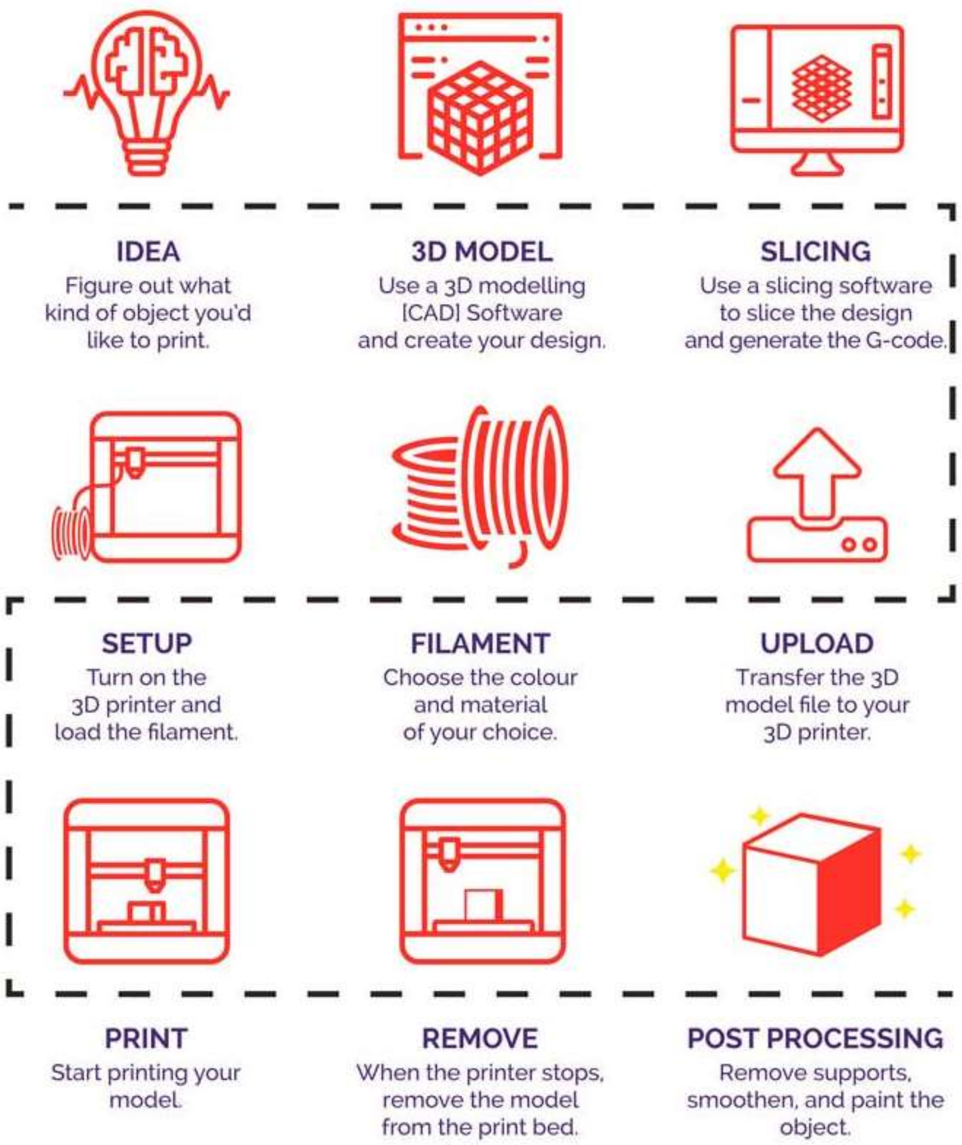
SLA vs DLP

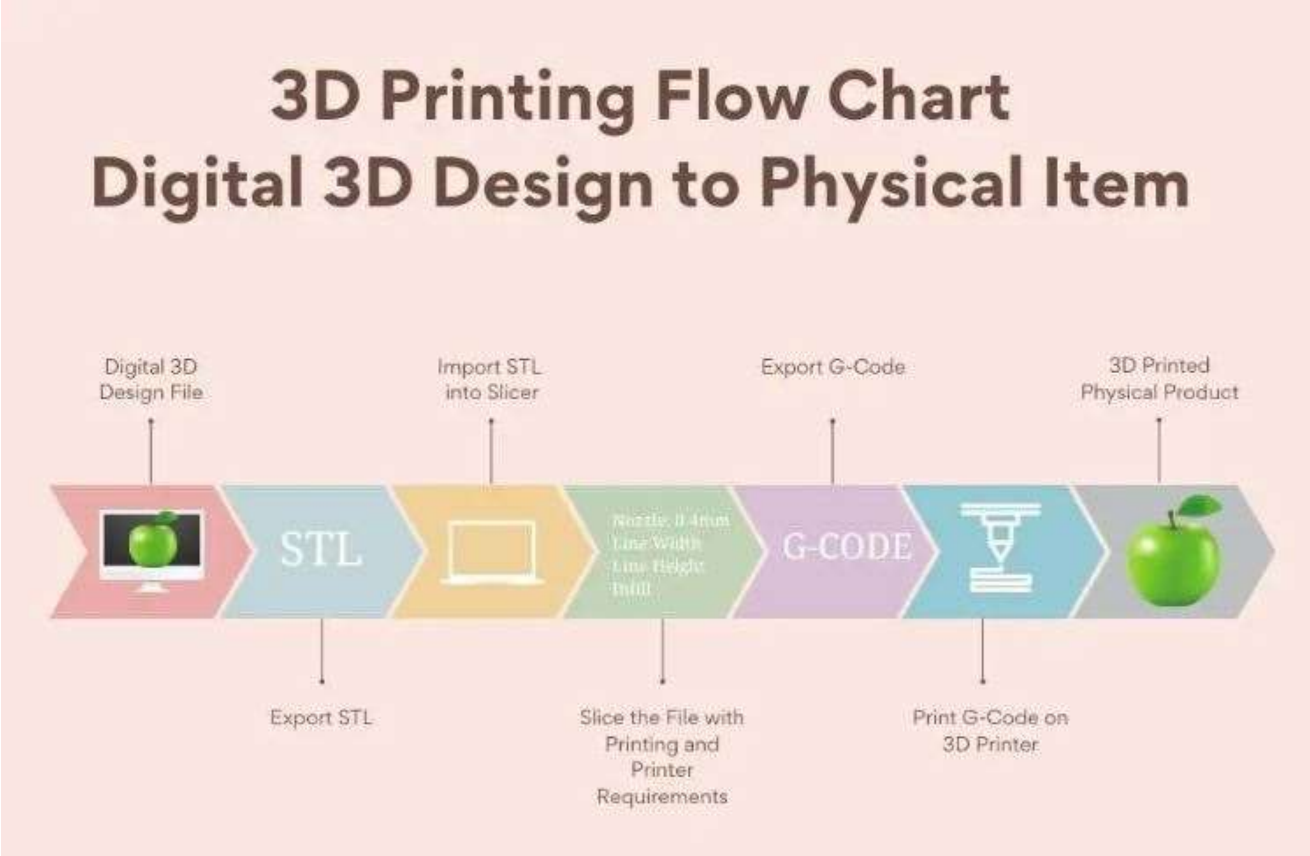
- The fundamental difference between SLA and DLP is the light source each technology uses to cure the resin. SLA printers use a point laser compared to the voxel approach that DLP printers use. In terms of theresolution of each method, standard DMDs have a resolution of 1024
-

x 780, while standard SLA printers use a laser with a 130 - 150 micronspot size (this can vary depending on the size of the machine).

- The downside to SLA using a point laser is that it takes longer to tracethe cross section of a part compared to DLP printers which are capable of exposing the cross section in a single flash (depending on part size). This makes DLP faster than SLA when printing an identical part.

3D PRINTING OPERATION

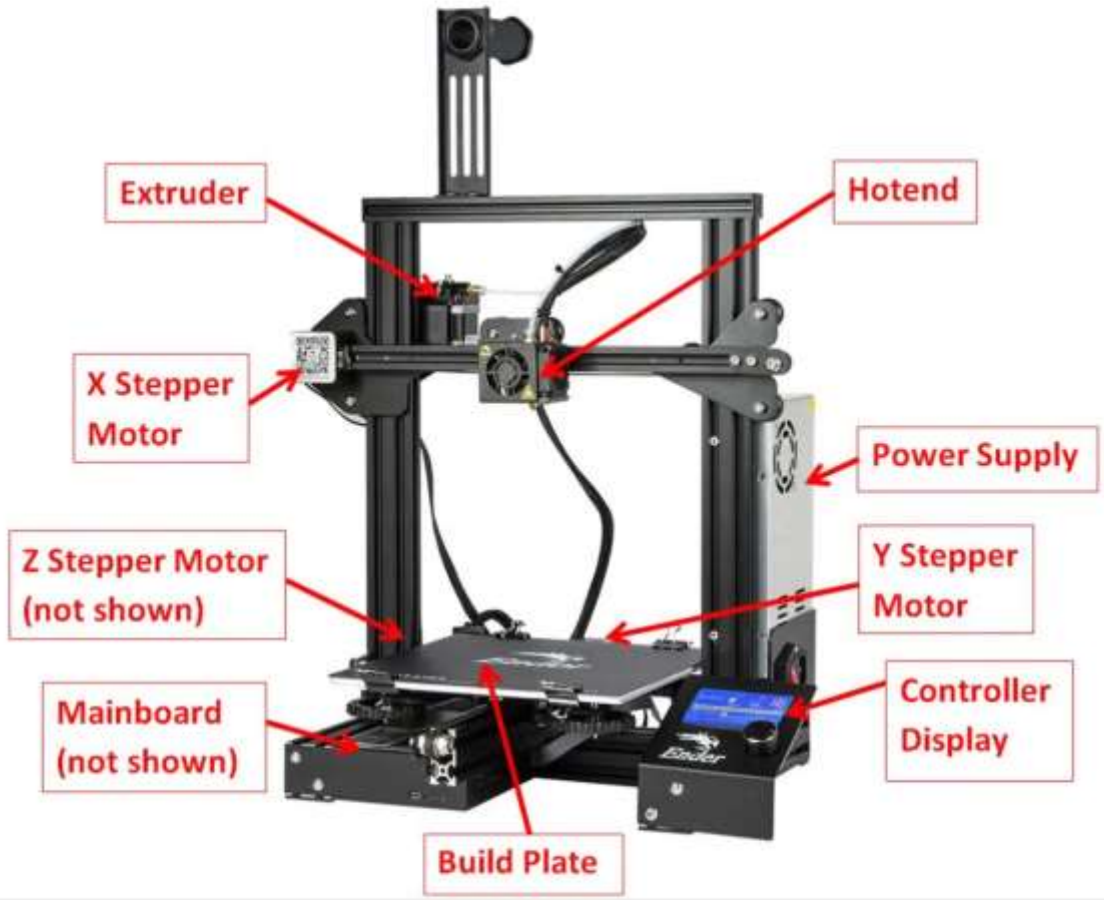




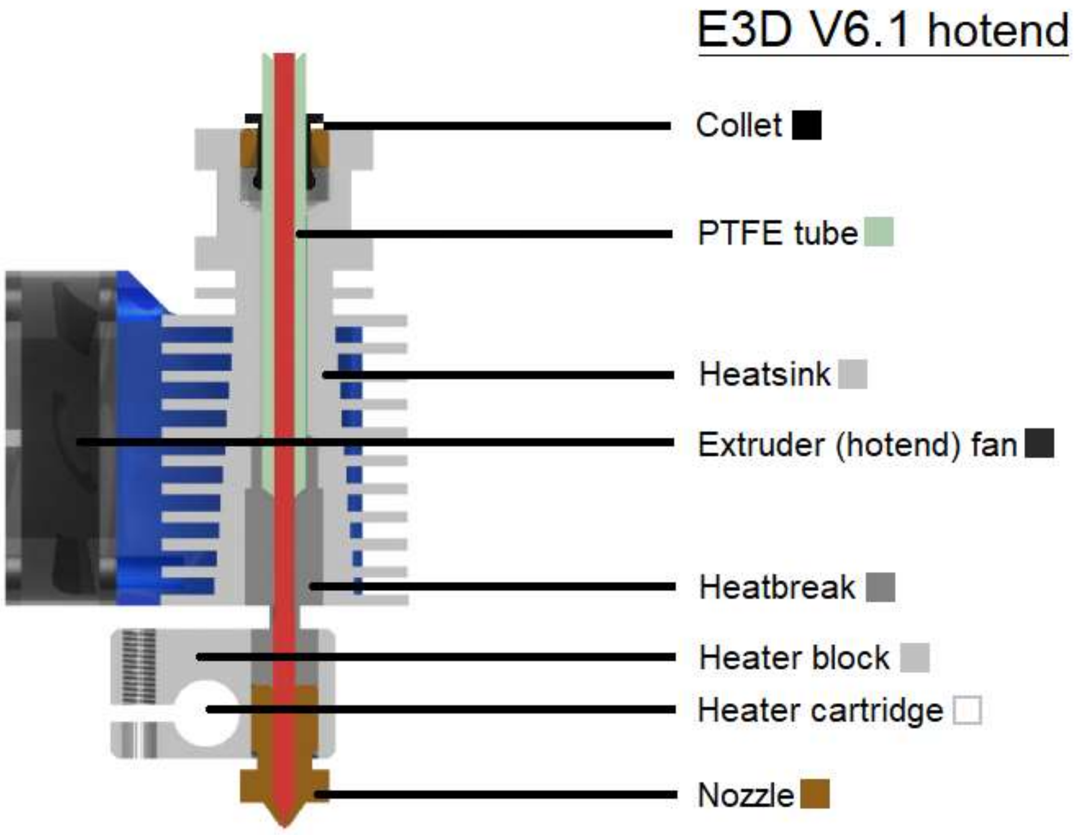
3D PRINTING OPERATION

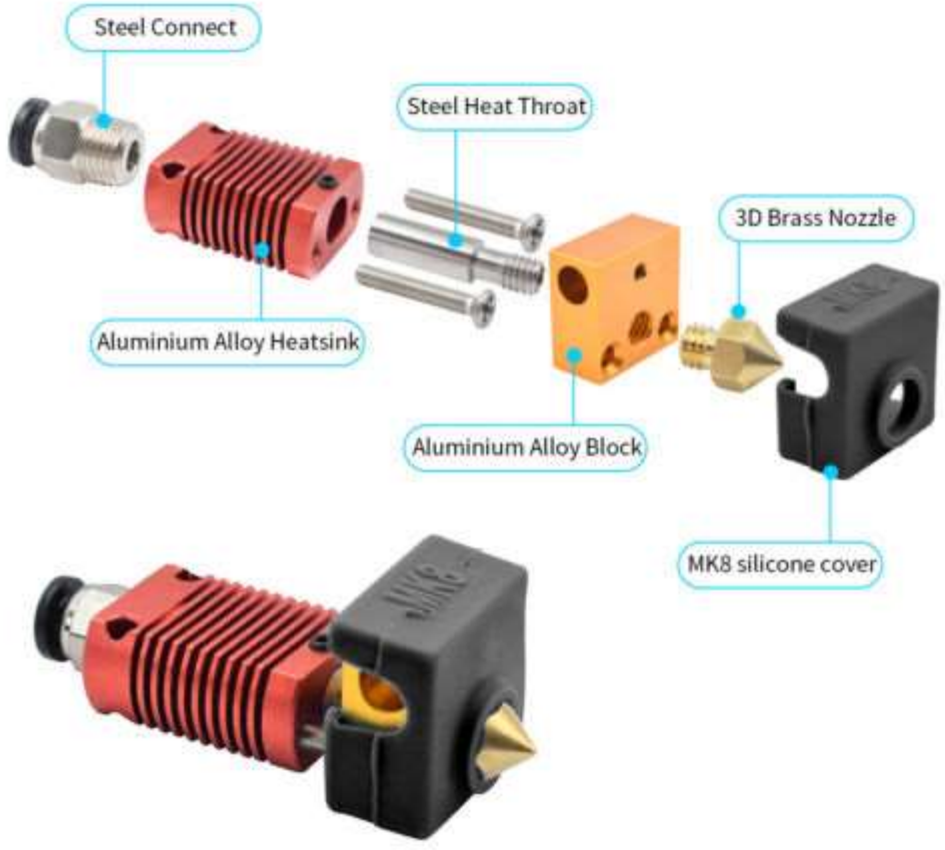
3D Printers (FFF) consist of the following major systems:

1. Hotend - this is the nozzle that melts the plastic filament
2.Extruder - electric motor and gear assembly used to push filament through the hot end
3.Print Bed - the surface where the 3D printed part is built on
4.XYZ Stepper Motors - In order to print a desired shape, the hot end must move while extruding plastic. Most machines come with 3 or 4 stepper motors to handle the motion
5.Controller Board - a small computer that reads the print file (G-Code) and controls the machine's components to print the desired object
6.Controller Display - small LCD display used to show information from the Controller board
7.Power Supply - this system is responsible for taking your household power, converting it, and making it suitable for the various components on the 3D printer



3D PRINTING OPERATION





Q/A

THANK YOU