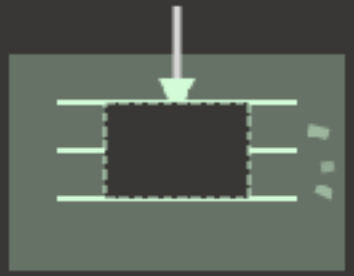
3D Printing

Introduction to Additive Manufacturing

Overview

- Digital Fabrication Concepts
- Materials & Print Parameters
- Slicer Software & Troubleshooting
- Tools, Generators & Libraries
- 3D Printing Technologies (FDM, SLA, SLS)
- Workflow: Design to Print
- Advanced Techniques

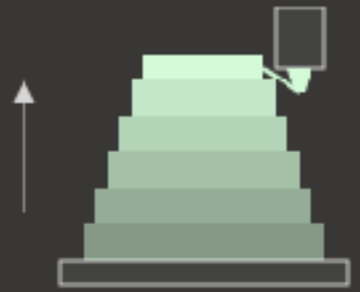
Digital Fabrication



Subtractive

CNC milling, laser cutting

Material is removed from a solid block



Additive

3D printing, layer by layer

Material is added to build the object

3D Printing Methods

FDM

Fused Deposition Modeling

Melted filament extruded layer by layer

Best for: Prototypes, functional parts

SLA

Stereolithography

UV light cures liquid resin

Best for: High detail, smooth surfaces

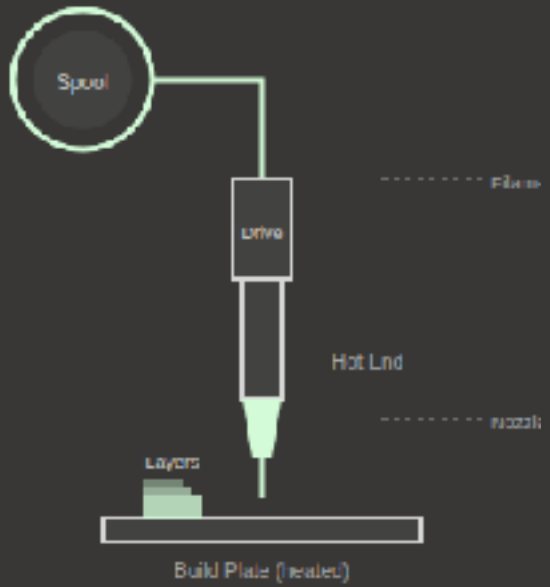
SLS

Selective Laser Sintering

Laser fuses powder particles

Best for: Strong parts, no supports

FDM: How It Works



1. Feed

Filament pulled from spool by extruder motor

2. Heat

Hot end melts plastic (180-260°C)

3. Extrude

Molten material pushed through nozzle

4. Build

Layers deposited on heated bed, z-axis rises

FDM Materials

PLA

190-220°C • Bed 20-60°C

Biodegradable, easy to print

Best for prototypes, visual models

PETG

220-250°C • Bed 70-80°C

Good strength, chemical resistant

Great for functional parts

ABS

220-250°C • Bed 90-110°C

Durable, heat resistant

Needs enclosure

TPU

210-230°C • Bed 20-60°C

Flexible rubber-like

For gaskets, grips, wearables

Tip: Start with PLA and the recommended settings by the filament manufacturers

Key Print Parameters

Layer Height
0.1mm (fine) – 0.3mm (draft). Smaller = smoother but slower.

Infill Density
10-20% decorative, 30-50% functional, (80-100% structural.)

Print Speed
40-60mm/s typical. Slower for detail, faster for drafts.

Supports
Needed for overhangs >45°. Tree supports save material.

Wall Thickness
2-4 perimeters (0.8-1.6mm). More walls = stronger shell.

Bed Adhesion
Brim for stability, raft for difficult materials.

Workflow: Design to Print

1. Design

CAD software or download model

2. Export

STL, OBJ, or 3MF file

3. Slice

Generate G-code toolpath

4. Transfer

SD card, USB, or WiFi

5. Print

Monitor first layers!

Slicer Software

Cura

By Ultimaker • Free & open source

Beginner-friendly, wide printer support, marketplace for plugins

PrusaSlicer

By Prusa • Free & open source

Advanced features, excellent defaults, works with any printer

OrcaSlicer

Community fork • Free & open source

Modern UI, calibration tools, Bambu Lab support

Tip: Start with the slicer by the manufacturer of the printer. Move to different slicers if more special features are needed.

Troubleshooting

Warping

Increase bed temp, use brim, check for drafts

Stringing

Increase retraction, lower temp, dry filament

Layer Shift

Check belt tension, reduce speed, secure cables

Under-extrusion

Check nozzle clog, increase temp, calibrate e-steps

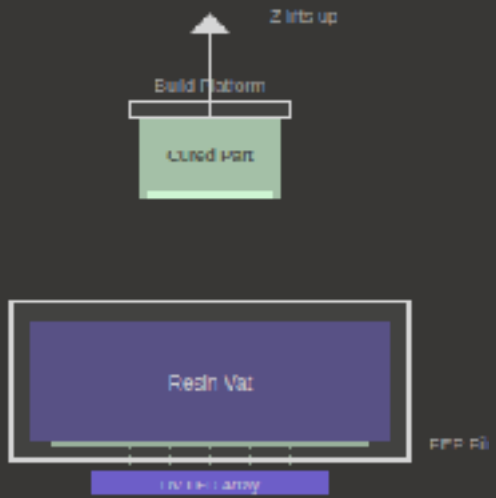
Poor Adhesion

Level bed, clean surface, use glue stick

Elephant Foot

Lower bed temp, reduce first layer squish

SLA: How It Works



1. Expose

UV light shines through transparent FEP film

2. Cure

Photopolymer resin hardens where light hits

3. Peel

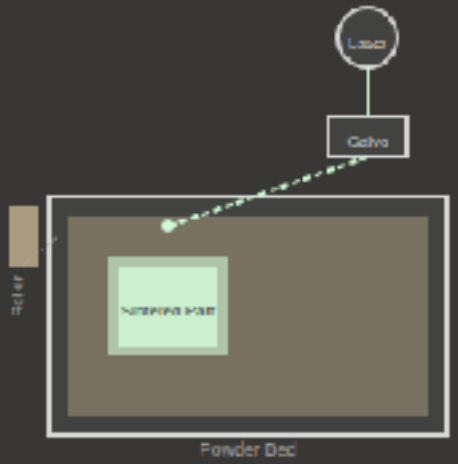
Platform lifts, layer separates from FEP

4. Repeat

Part builds upside-down, layer by layer

Note: Requires post-processing: wash (IPA) + UV cure

SLS: How It Works



1. Spread

Roller spreads thin layer of nylon powder

2. Scan

CO_2 laser traces cross-section via galvo mirrors

3. Sinter

Powder particles fuse together (not fully melt)

4. Lower

Bed drops, new powder layer added

Advantage: No supports needed—powder supports the part!

Advanced Techniques

Pause & Insert

Stop print mid-way to embed objects

- Magnets for snap-fit closures
- Nuts for threaded inserts
- Bearings, LEDs, weights

Use slicer's "pause at layer" feature

Print-in-Place

Moving parts printed assembled

- Hinges that flex immediately
- Chain links, ball joints
- Captive gears & mechanisms

Requires precise tolerances (0.2-0.4mm gap)

Multi-Material

Combine different filaments

- Color changes (M600 command)
- Dissolvable supports (PVA)
- Flexible + rigid combos

Needs dual extruder or AMS system

Software & Tools

CAD Software

Fusion 360

Professional parametric CAD, free for hobbyists

FreeCAD

Open source parametric CAD

Blender

Organic modeling, sculpting, mesh editing

TinkerCAD

Browser-based, great for beginners

Online Generators

boxes.py

festi.info/boxes.py • Parametric boxes & enclosures

Gridfinity Generator

gridfinitygenerator.com • Modular storage bins

Thread Generators

MakerWorld customizers • Screws & nuts

Gear Generator

geargenerator.com • Spur & planetary gears

Libraries & Services

Model Libraries

Printables

printables.com • Curated, high quality

Thingiverse

thingiverse.com • Largest collection

MakerWorld

makerworld.com • Bambu Lab ecosystem

Thangs

thangs.com • AI-powered search

Print Services

JLCPCB / PCBWay

Low-cost SLA/SLS, fast shipping

Shapeways

Wide material selection, metals

Craftcloud (All3DP)

Price comparison across services

Local Makerspaces

ZHdK Lab, FabLab Zürich

Key Takeaways

- Start with PLA on FDM for learning—it's forgiving and requires minimal setup.
- Design for 3D printing: consider overhangs, tolerances, and print orientation.
- Use online generators for common parts: boxes, threads, gears, storage.
- Start with presets and slicers from manufacturers you use (Filament - Presets / Printer - Slicer). Tweak if needed
- Watch the first layer—most failures happen at the start.
- Consider print services for SLS/metal or when you need more special (material) requirements