

Introduction to 3-D Printing

Table of Contents

- Introductions
- 3-D Print Overview
- Printing
- Slicer
- Post-Processing
- Modeling

Introductions

- Me
 - Ian Vogt – pronouns are he/him
 - Retired computer software developer
 - 3-D printing for 6 years
- You ?
 - Do you have any previous 3-D printing experience?
 - What are your expectations for this workshop?

Overview -- What is 3-D Printing?

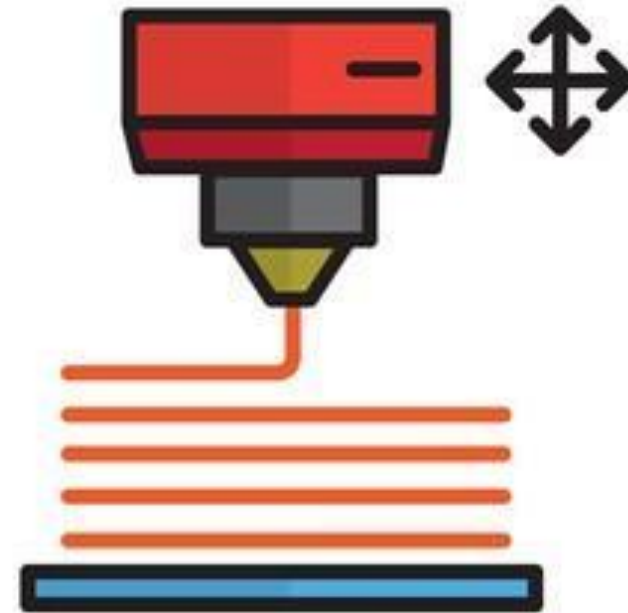
In general terms, 3-D printing takes a virtual model of an object and creates it out of some physical material.

3-D Print Overview - Technologies

- FDM (Fusion Deposition Modeling) ← This is our focus
 - Deposits melted material layer by layer
- SLA (Stereolithography)
 - Solidifies a liquid resin with laser layer by layer
- SLM (Selective Laser Melting)
 - Melts powdered material layer by layer
- CNC (Computer Numerical Control)
 - Uses a computer-controlled milling machine to carve a block of material
 - Not strictly “printing”

FDM Overview

- The printer is like a robotic hot-glue gun nozzle.
- It deposits melted plastic, layer-by-layer, to build up the object.
- Each layer is a 2-D vertical “slice” of the object.



shutterstock.com · 1084048451

FDM Materials

- PLA (Polylactic Acid)
 - Most common for home use
 - Low cost (\$25-40 per kg.)
 - Reasonable strength
- ABS (Acrylonitrile Butadiene Styrene)
 - More expensive (\$25-80 per kg.)
 - More odour – ventilation recommended
 - Stronger, harder, and more heat resistant
- Others
 - Nylon, flexible (e.g. TPU), food-safe (e.g. PETG), etc.
 - Not all are compatible with the studio printer

3D Model Files

- File Formats
 - STL most common
 - OBJ also good
 - Others
- Many Downloads
 - thingiverse.com
 - Others -- find by Internet search
- Create you own
 - 3-D Scanner
 - Modeling tools
 - More later

Steps to Print a Model

- Load the model in a slicer app
- Configure settings and run the slicer
 - Note the amount of filament and time to print
- Copy the sliced file (.gcode) to the printer
- Print the file
- Remove the print and post-process

Parts of the Printer

- Filament
- Extruder
- Hot End
- Build Plate
 - Theoretical maximum build volume 22 cm. x 22 cm. x 25 cm. but practically slightly less
- X, Y, and Z Axes
 - X and Y are horizontal
 - Z is vertical
- User Interface

Printing

- Copy the .gcode file (slicer output) to a micro SD card
- Insert micro SD card in the printer
- Turn on the printer
- Start the printer preheating (nozzle and bed)
- Select and load filament
- Level the build plate
- Start the print
- Wait until print completes
- Let the build plate cool a bit before removing the print

Print Leveling

- Place a sheet of copier/laser print paper on the build plate
- From the main menu select Prepare → Auto Home
- When the print head has stopped moving, select Prepare → Disable Steppers
- Move the print head near to each corner of the build plate (keeping the paper under the print head) and adjust the build plate height until you can slide the paper back and forth but still feel the paper texture.
- Repeat with the print head in the center
- Repeat until the feel is consistent with no further adjustment

Slicer

- Converts the model file into vertical slices and outputs the print file (.gcode)
- Ultimaker Cura
 - Free to download and use
 - <https://ultimaker.com/software/ultimaker-cura/>
 - For the studio printer, start with the defaults for Creality Ender-3
- Others
 - Some free and some paid
 - All have similar capabilities
- Settings customize details of how the model will be printed
- Automatically adds supports as necessary

Slicer Settings

- Size
- Rotation
 - FDM prints are stronger in the horizontal and weaker in the vertical
 - Sides are smoother than tops and bottoms
 - Bottom layers are rougher than top layers
- Side/top/bottom thickness
- Infill style and density
- Layer height
- Support style
- Brim or no brim

Final Slicer Steps

- Settings are satisfactory and you've performed the final slice
- Note the amount of filament required and the time to print
- Save the .gcode file to your computer or removeable media to be loaded on the printer

Printing at Eastern Edge

- Slice model to .gcode file and save
- Contact Eastern Edge to schedule print time
 - Using own filament? If not, how much filament do you need?
 - Type of filament?
 - How long is the print?
- Bring the .gcode file to the studio
- Assist staff to set up the print
- Wait a bit to ensure all looks OK
- When complete, collect the print

Commercial Printing Sites

- For example: <https://www.hubs.com/>
- Upload the model file and they print and ship the model to you
- Expensive but may be worth considering for volume production

Post-Processing

- Remove supports
 - Tools: pocketknife, needle-nose pliers, clippers, small carving tools, eye protection
- Glue parts together, if necessary
- Fill seams/holes
 - I use ordinary wall spackle
- Sand rough spots
 - 200-600 grit sandpaper
 - Rotary tool (e.g. Dremel)
 - For extensive sanding, print with thicker walls/top/bottom
- Painting
 - I use regular acrylic paint and varnish

More Post-Processing

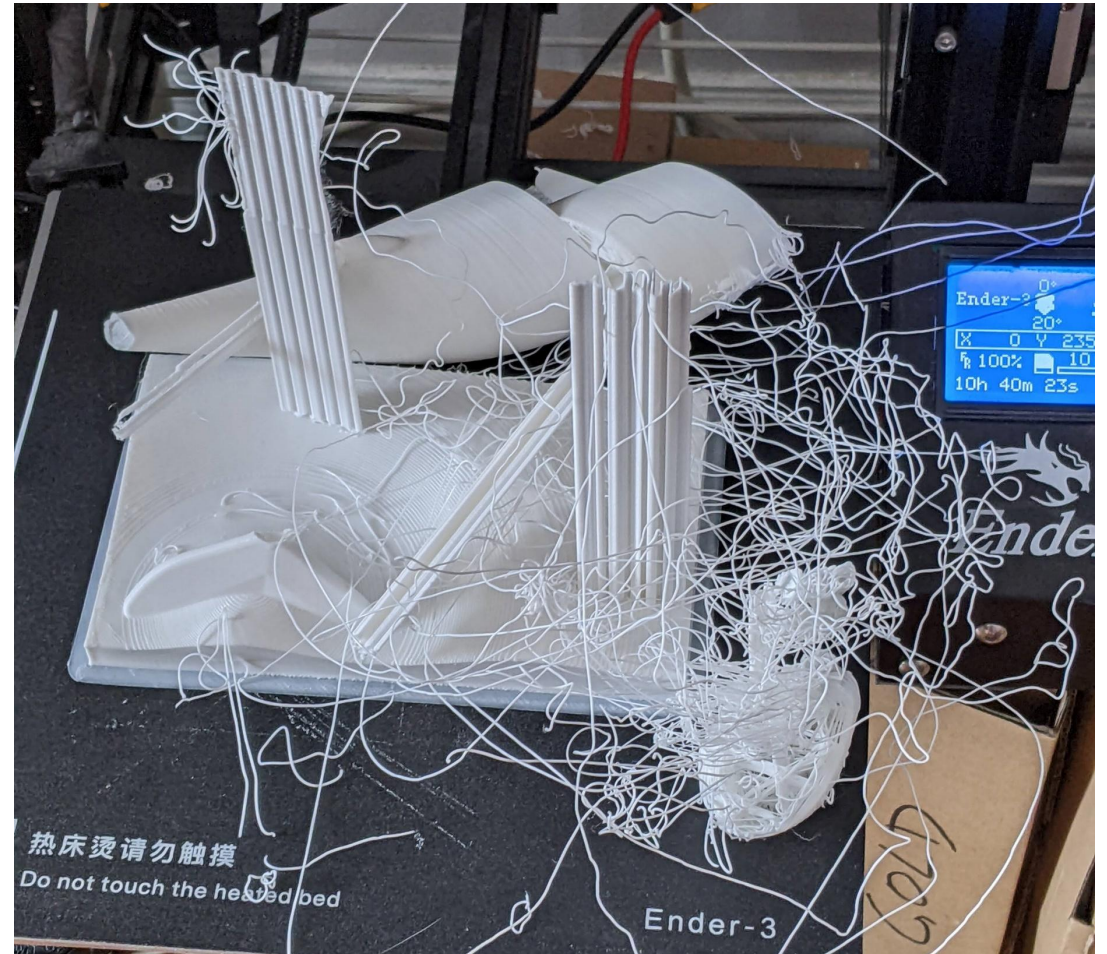
- Annealing
 - Heat and cool the print
 - Makes it stronger
 - But it shrinks (and may warp)
 - 100% infill recommended
- Plastic Deformation
 - Heat the print and shape it
 - For example: oven, heat gun, hair dryer, torch

Recommendations

- Print a smaller maquette first
 - At half size the model prints in $\frac{1}{4}$ of the time and uses $\frac{1}{4}$ of the filament
 - Detect composition and print issues before committing to the full-size
 - See if supports are easy enough to remove without breaking the model
- Consider printing the model in multiple parts
 - If removing the supports is difficult/impossible
 - If the model contains delicate parts that break off easily – especially while removing supports
 - If not possible to paint interior details without printing in pieces

When Prints Go Wrong

- Filament breaks or runs out
- Filament tangles
- Nozzle jams
- Power failure
- Build plate adhesion
- Print or print head shifts
- Model breaks or falls over
- Details/Walls too fine



Creating Models

- A printable model is like any sculpture
- It has to stand up and be strong enough to support itself
- Every element has to be supported
- You have to model all sides

Virtual Modeling Tools

- Tinkercad (<https://www.tinkercad.com/>)
 - Web-based
 - Good for beginners
- OpenSCAD (<https://openscad.org/>)
 - Free download
 - Good if you have some coding experience
- Blender (<https://www.blender.org/>)
 - Free download
 - 3-D Animation app with 3-D print support
- Others – some free and some paid
- Many resources (e.g YouTube) to learn how to use these tools

Questions?