CSC293 CS Improves 3D Printed Manufacturing
Getting Started with 3D Printed Manufacturing

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URCS
Outline

The Process

3D Printing Parts
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The Process

3D Printing Parts
Pre-3DPM Building Process

- Obtain all parts
  - Buy off the shelf parts
  - Make custom parts
- Obtain required tools
- Assemble!
- Test
- Deploy
Post-3DPM Building Process

- Obtain all parts
  - Buy off the shelf parts
  - Make custom parts [rare]
  - 3D print required parts
- Obtain required tools
  - 3D print some required tools
- Assemble!
- Test
- Deploy
The Process

3D Printing Parts
How it is supposed to work

- Download STL
- Print it!
Printing

- Obtain STL files
- Use slicer to produce G-code files
- Set print parameters
  - Layer height
  - Line width (depends on nozzle width)
  - Infill
  - Support
- Choose material: color, type, etc.
- Make sure printer can meet quality expectations
- Print it!
Print Parameters: Layer height and Line Width

- Closely related to and limited by nozzle diameter
- Layer height is the height of each plastic layer
  - 3D model is sliced into layers
  - Smaller layer heights, finer detail
- Line width is the width of the extrusion
  - The “round” extruded plastic is “squished” to form line width
  - Affects speed, detail, strength

Area = rectangle + circle = \( h \times (\text{width} - h) + \pi \left(\frac{h}{2}\right)^2 \)

Picture from PRUSA Layers and Perimeters
Print Parameters: Infill

- A 3D model has solid portions
- But its 3D printed object is usually not solid
  - Less plastic
  - Faster printing
  - May affect strength
- Solid portions of the model are replaced with *infill*
FDM 3D printers cannot print in air

Structural features that are affected
- Bridges
- Overhangs

These features require "support"
- Slicer-inserted structures that must be removed after printing
- Support bridges and overhangs during printing

Sophisticated printers use two materials
- Support material is designed to be dissolvable
Avoiding Support

- Limit overhang angle
- Use built-in supports
  - E.g. Voron Stealthburner
- Design for 3D printing
  - Required reading: Ultimate Guide: How to design for 3D printing
Quality Assurance

- 3D printers are not standardized
- Can produce objects of wildly varying quality
  - Affects expected tolerances
- One solution: test parts
  - Voron test prints
  - ERCF calibration
  - Stealthburner guidler
TOLERANCES, EXTRUSION MULTIPLIERS AND YOU
The part has tight tolerances. If it doesn’t fit together well the printed parts are likely over-extruded.
Part Orientation

- STLs parts should be oriented correctly for printing
  - Placed on the bed as supplied
- But not all projects handle this correctly:
  - Haxophone Octave Rest
  - Haxophone Hook Rest
Plating Multiple Objects

- Small volume printers can print one object at a time
- Large volume printers can handle many more
  - But STL files usually contain a single object
- Slicers allow placing multiple objects on the plate
  - Increases throughput slightly (cooling/heating)
  - May increase failure rate
Technology to the rescue?

Can we make building easier?
Platers

- Given:
  - a set of objects
  - print settings/print profile
  - printer description
- Plates objects automatically
- Generates g-code using slicer command line
- Many platers available
  - Some now incorporated with slicers (e.g. BambuSlicer)
- I wrote one too:
  https://github.com/sree314/pj3d
What about other kinds of users?

- I discussed the end user’s workflow
  - aka the builder
- What about:
  - modelers
  - modders
  - documentation producers
  - testers
  - kit makers
  - ...