PROFORMA ENGINEERING

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Module 1 – What is 3D Printing?

Additive Manufacturing in the Tool Room Seminar

Winnipeg, October 19th, 2022

Overview

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1. Introduction
2. Application Success
3. Types of Printing Processes
4. General Workflow
5. Common Terms

Introduction

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What is 3D Printing?

- 3D printing or additive manufacturing (AM) is the construction of a three-dimensional object from a CAD model or a digital 3D model.
- It can be done in a variety of processes in which material is deposited, joined or solidified under computer control, with material being **added** together, typically layer by layer.

Introduction

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Why 3D Printing?

- Material efficiency
- Complexity is “free” (consolidation)
- Speed to answer questions or solve problems
  - Iterations
- In-house
  - No minimums
  - Schedule control

Application

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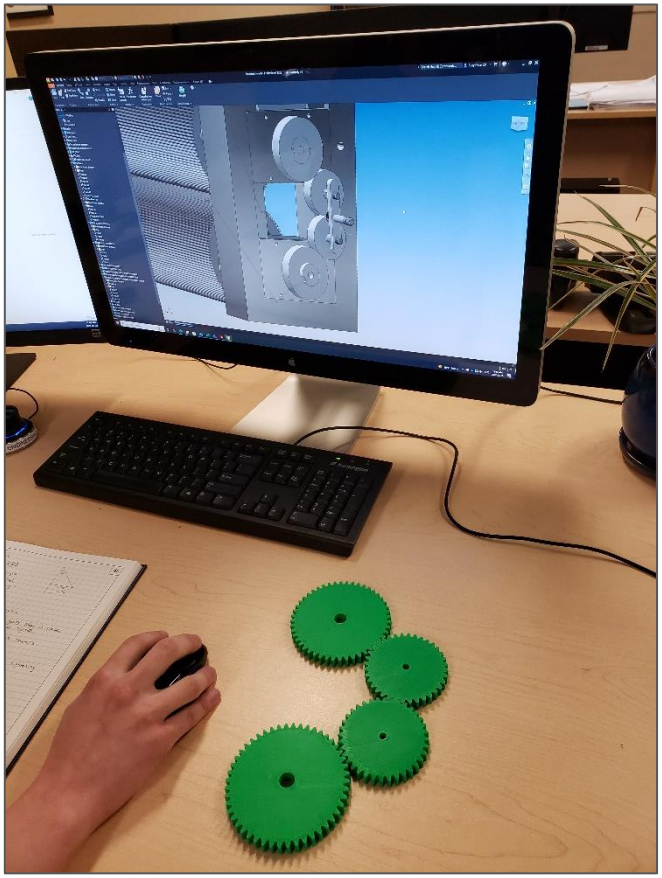
Design Aid



Goal

- Evaluate engagement during travel for a roller drive system gearing and tensioning

Purchased Parts

- Cost: $160
- Leadtime: 5 days
- Risk: High

Printed Parts

- Cost: $3.20 (~100g at $32/kg)
- Print Time: 4hrs 19mins
- Risk: Low

90% Reduction in Time

Types of Processes

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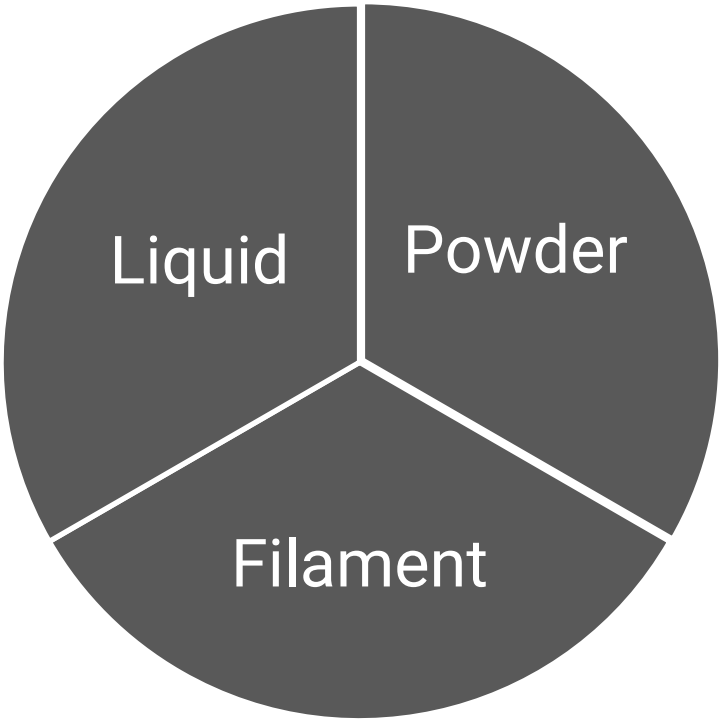
Materials

- The materials come in a few mediums (Powder, Liquid, Filament).
- Different processes are required to build with these materials
- In general, many materials are available in one or more feedstock types including:
  - Metals
  - Plastics
  - Reinforced Plastics
  - Ceramics
  - Biomaterials
  - Food



Types of Processes

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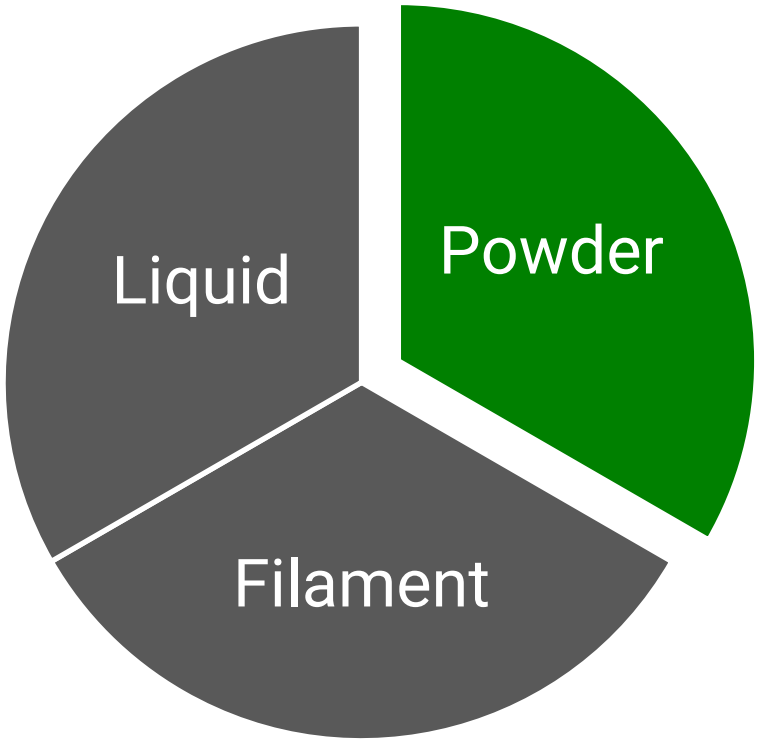
Powder Processes

- Selective Laser Sintering (SLS)
- Multi Jet Fusion (MJF)
- Direct Metal Laser Sintering (DMLS)
- Electron Beam Melting (EBM)

- Companies:
  - Stratasys
  - 3D Systems
  - HP
  - EOS
  - Desktop Metal
  - EXOne



Types of Processes

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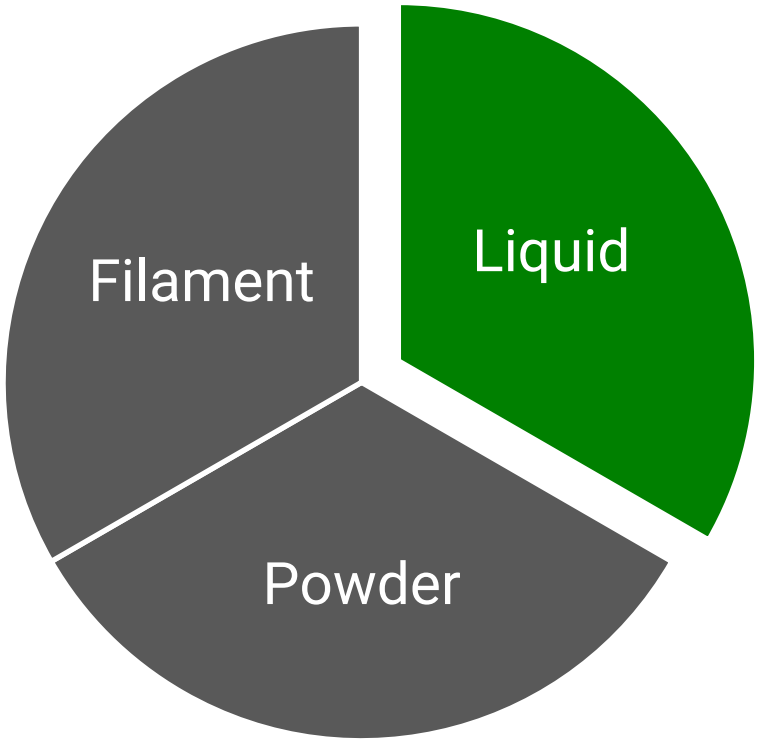
Liquid Processes

- Digital Light Process (DLP)
- Stereolithography (SLA)
- Polyjet

- Companies:
  - Stratasys
  - 3D Systems
  - FormLabs
  - Carbon
  - Creality
  - Anycubic



Types of Processes

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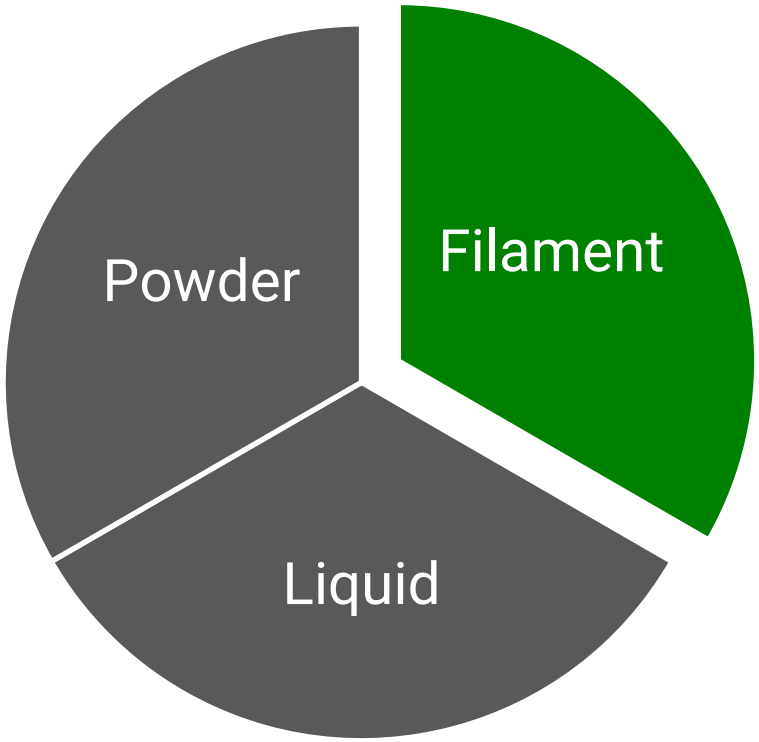
Filament Processes

- Fused Deposition Modeling (FDM)
- Fused Filament Fabrication (FFF)
- Wire Arc Additive Manufacturing (WAAM)
- Continuous Fiber 3D Printing (CF3D)

- Companies:
  - Stratasys
  - 3D Systems
  - Markforged
  - Creality
  - Anycubic
  - Lincoln Electric
  - Desktop Metal
  - Ultimaker/MakerBot



Workflow

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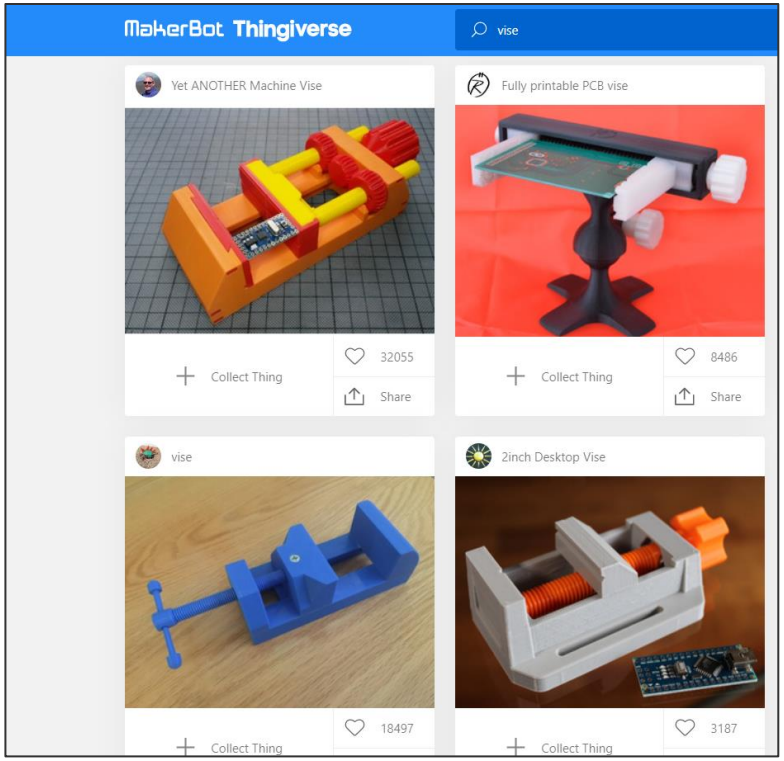
CAD Model

- Since AM is digital first, everything starts from a computer aided design (CAD) model.
- File formats are typically .STL

- Locations to find models
  - Thingiverse
  - Cult3D
  - Thangs
  - Misumi
  - McMaster Carr



Workflow

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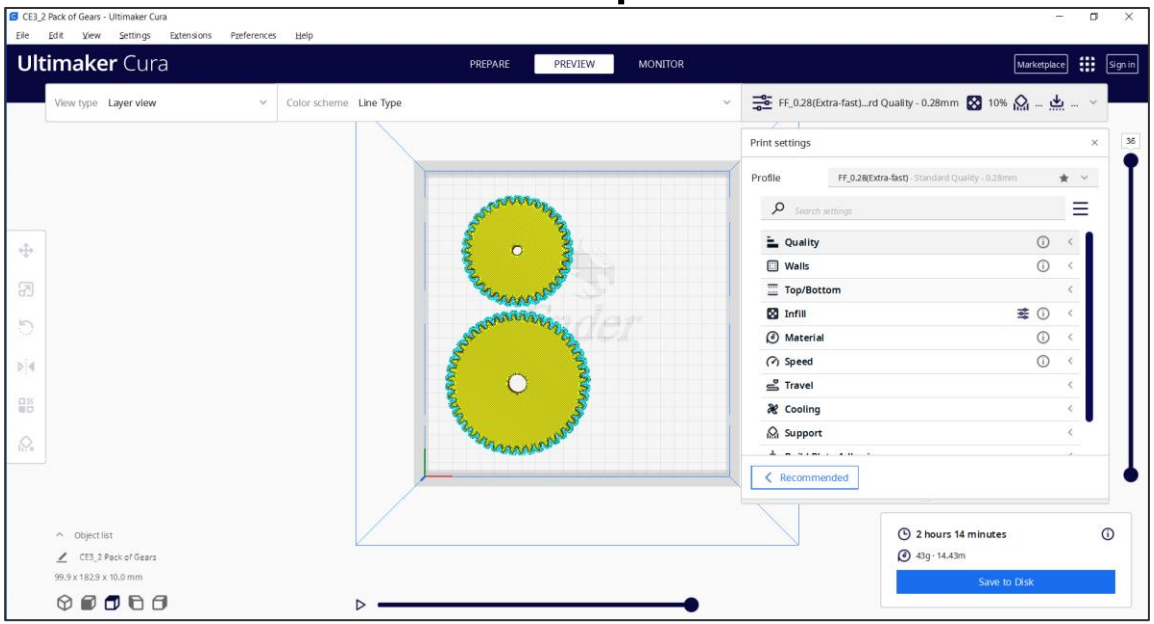
Slicer

- Once you have a model, the next step is into a **slicer**. This is a specialized Computer Aided Manufacturing (CAM) that “slices” the 3D model layer by layer and creates instructions for the printer.



Workflow

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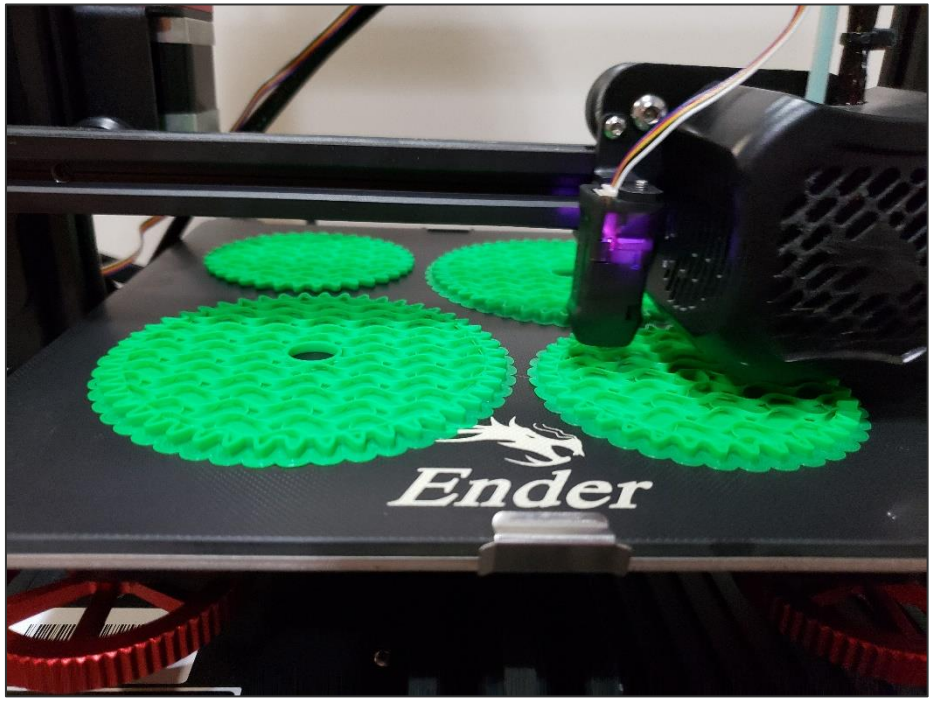
Printing

- Material is loaded into the machine.
- Initializing the machine.
- Running the program.



FDM/FFF Printing

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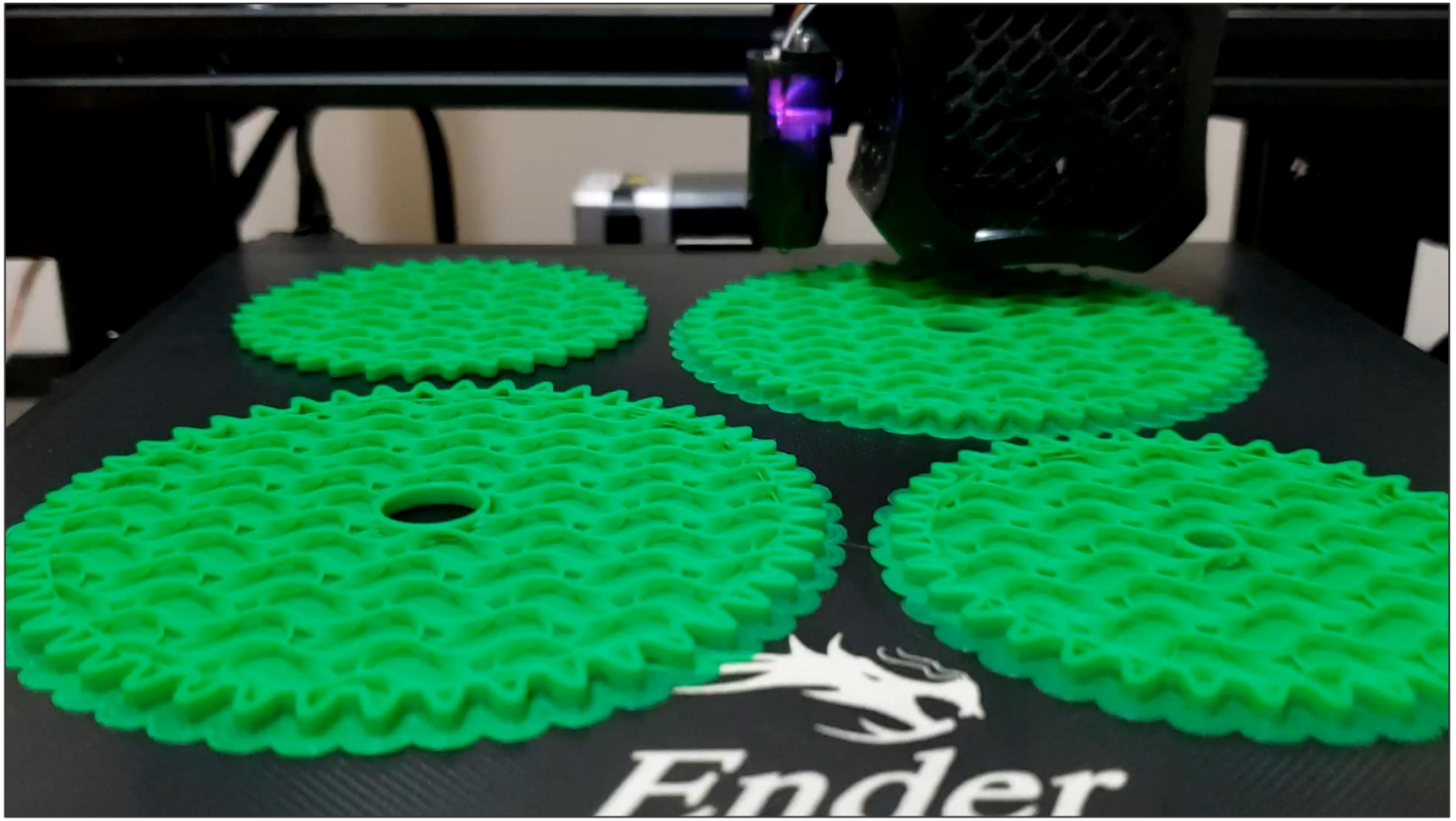

Workflow

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Post-Processing

- Support material removal
- Homogenizing
  - Debinding, Sintering, UV Curing, Vapor Smoothing

Terms

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- **Layer** – Slice of part
- **Wall** – Perimeter of continuous section on a layer
- **Infill** – Density of part and pattern (lattice)
- **Supports** – Material deposited to prevent deformation in void spaces
- **Topology Optimization** – Process of removing non-stressed (loaded) material sections
- **Self-Supporting** – Design that does not need supports for processing
- **Bed/Platform** – Zero plane surface for the parts to be built from in the machine
- **First Layer Adhesion**
  - Brims – material around the first layer wall
  - Rafts – platform underneath first layer
- **Delamination** – Separation of layers
- **Green Parts** – Printed but not prepared (binder not removed)
- **Brown Parts** – Prepared but not final (debinded)