

3D-printing Education



What is a 3D-printer

Additive manufacturing –
depositing layer by layer to form
a three-dimensional object.

FDM - thermoplastics deposited
as thin strands, layer by layer

Filament led to the Extruder

Gears control the feed movement of filament

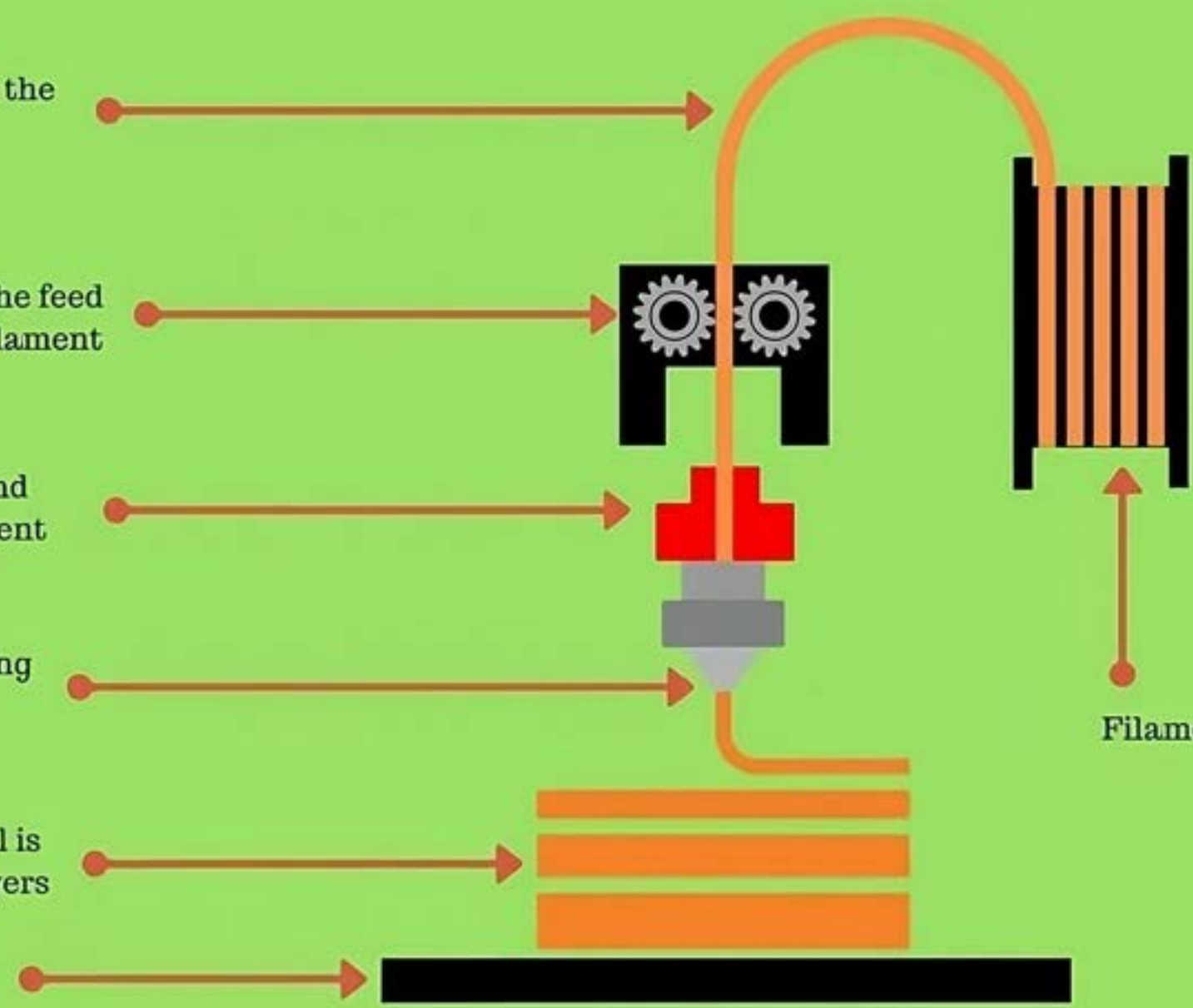
Heater heats and melts the filament

Nozzle extruding the material

Melted material is deposited in layers

FDM Print Bed

Filament Spool



Material/filament

Material	Build plate	UV	Strength	Heat	Moisture	Support
PLA (bioplastic)	Smooth	UV breakdown	Less Elastic	Low heat resistance	Becomes Brittle and takes damage	Easy to remove
PETG (PET same as bottles)	Powder coated	-	Elastic	High Heat resistance	Resists water damage but can become stringy	Hard to remove

Common material use cases

PLA

- Prototypes
- Figurines

PETG

- Mechanical Parts
- Outdoor

Prusa

- Two types
- Print-volume - 25×21×21 cm

Prusa MK4



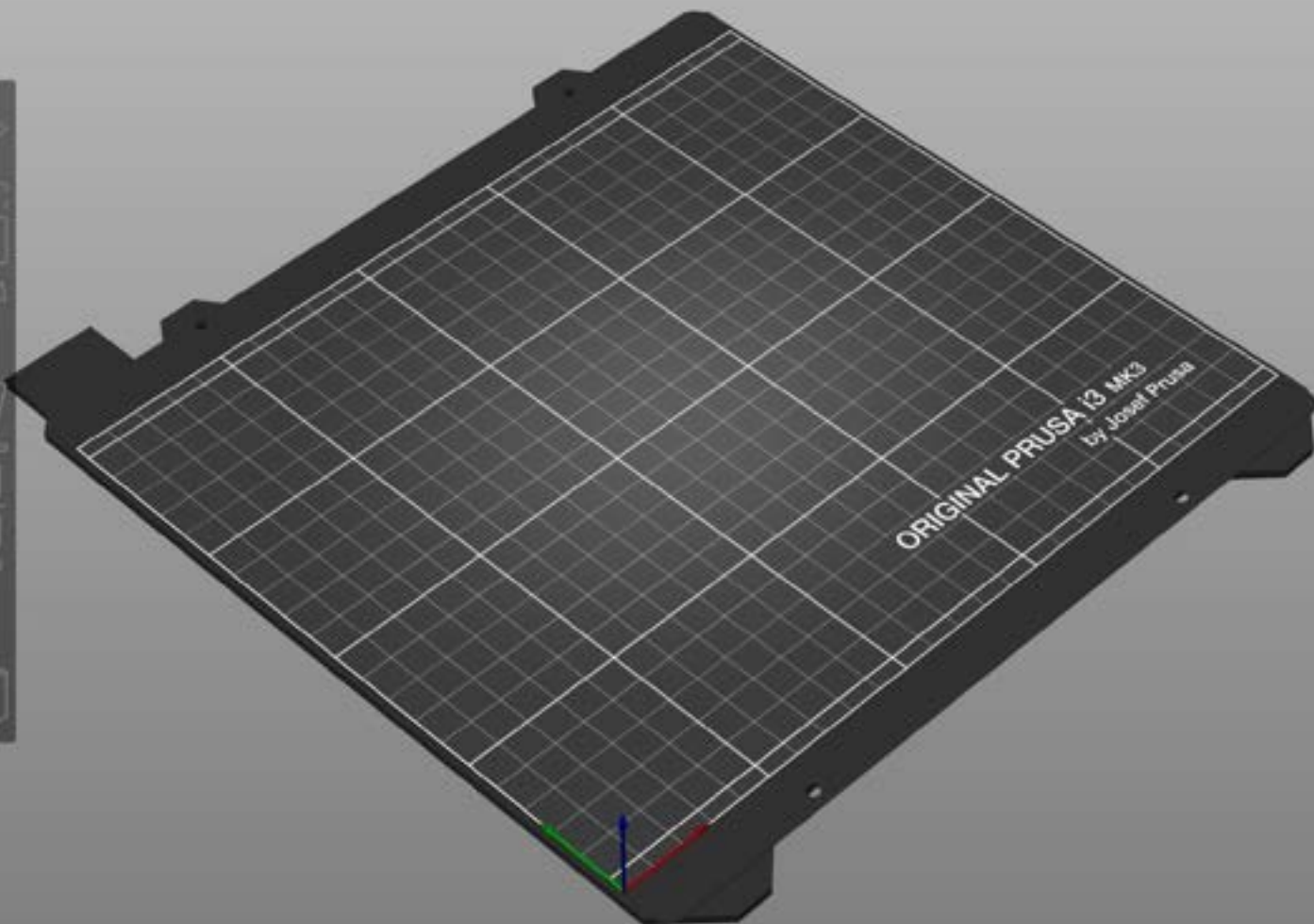
Prusa MK3S+



What is a Slicer?

Takes a model file (STL/3MF) and transforms it to GCODE - instructions for the printer.

There are many parameters and settings, the default settings are recommended and work in most cases.



Print settings:

0.30mm DRAFT

Filament: Prusament PLA

Printer: Original Prusa i3 MK3

Supports: None

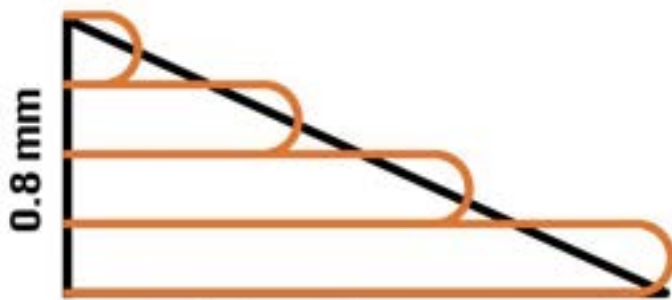
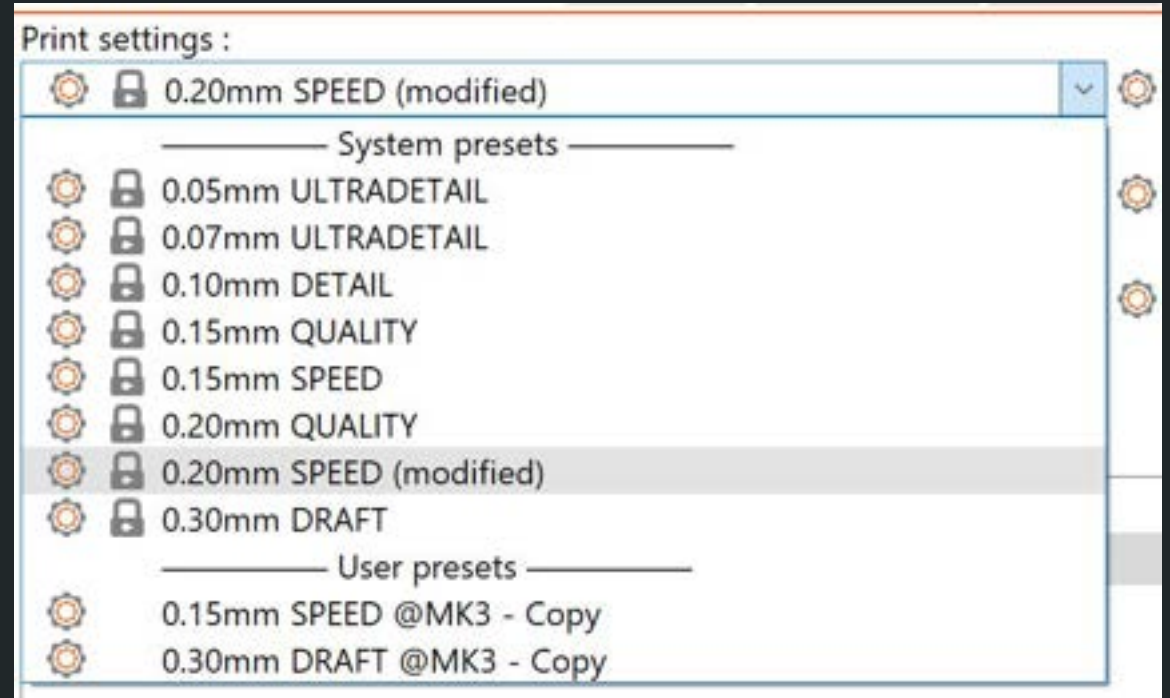
Infill: 20% Brim:

Name	Editing
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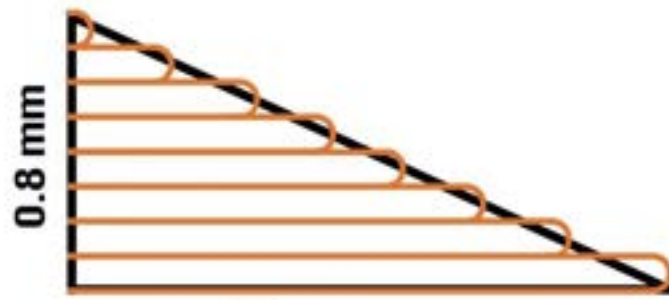


PrusaSlicer

Layer height



0.2 mm layers



0.1 mm layers

Infill

- Higher infill = higher strength
- Infill between 15-25% or 100% (mechanical)
- Different patterns – Different properties

INFILL DENSITY



Decoration: 0-15%

Objects that are only supposed to look nice don't have to be stable. Here you can save time and money with a low density.



Standard: 15-50%

The most commonly used infill density is 20-25%. A compromise between stability, speed and filament consumption.



Robust: 50-100%

Objects with a mechanical purpose must be sturdy. A density of 100% means a solid part.

INFILL PATTERN

Low Strength

Application: Figures, decorative objects.

Density: 0-15%

Patterns:



Lines



Zig Zag

Medium Strength

Application: Standard objects

Density: 15-50%

Patterns:



Grid



Triangles



Tri-Hexagonal



Honeycomb

High Strength

Application: Robust objects

Density: 50-100%

Patterns:



Cubic



Cubic
Subdivision



Octet



Gyroid

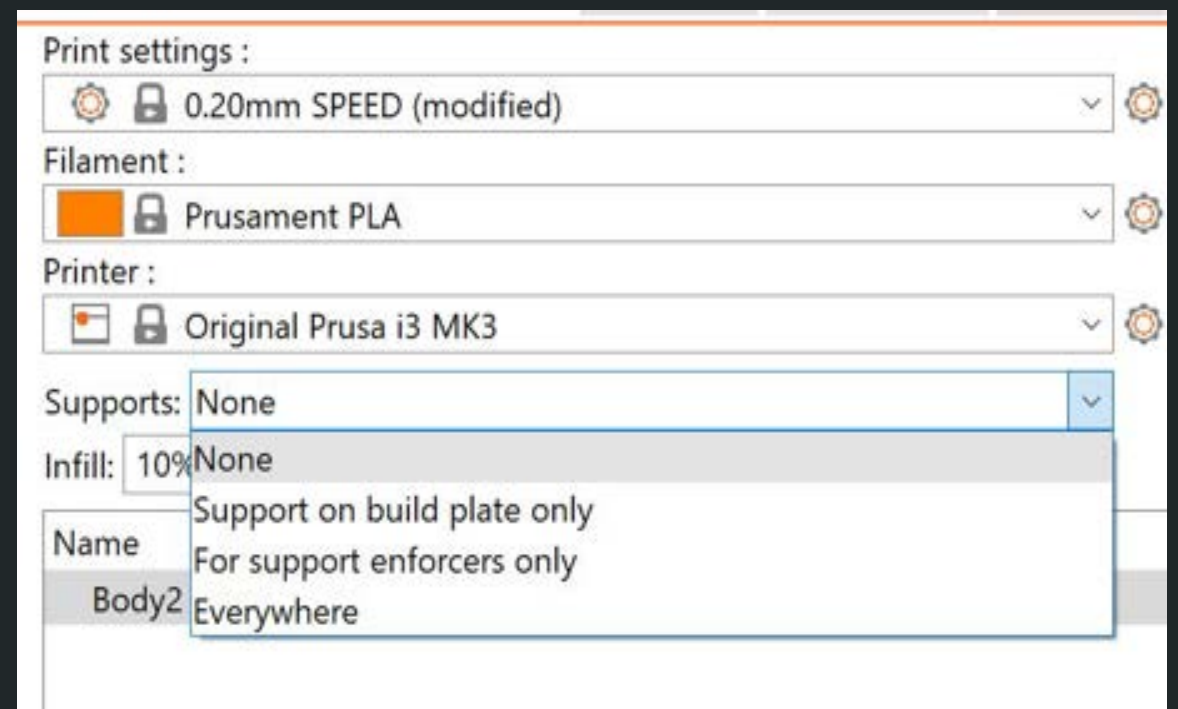
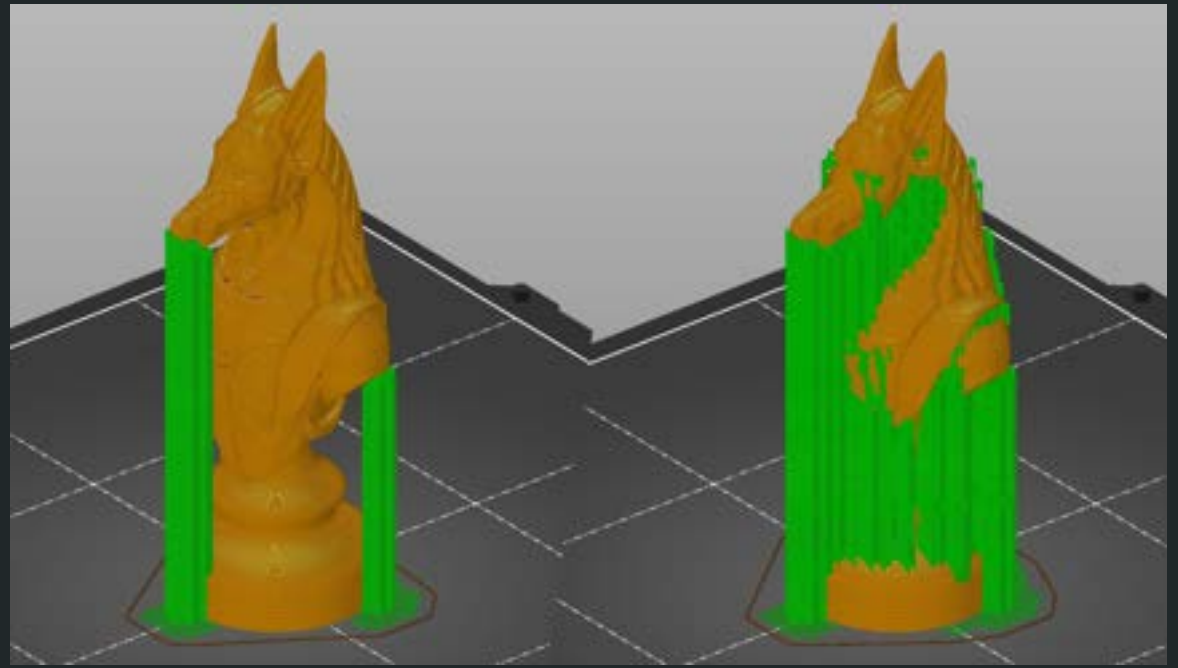
Bridging



- Possible to print in air. (Between points)
- Can create deformations
- Avoid bridging if possible (orientate model in slicer)

Supports

- Supports which are later removed
- Used when overhangs are unavoidable in the model
- Automatically generated by the slicer



Preview

- A breakdown of the print
- Analysing before printing
- Each feature represented as a color
- Time and filament used per feature

Feature type	Time	Percentage	Used filament
Perimeter	10m	8.3%	1.04 m 3.11 g
External perimeter	16m	13.5%	1.43 m 4.27 g
Overhang perimeter	6s	0.1%	0.01 m 0.02 g
Internal infill	5m	4.4%	0.61 m 1.82 g
Solid infill	8m	6.9%	0.80 m 2.40 g
Top solid infill	4m	3.1%	0.30 m 0.91 g
Bridge infill	4m	3.0%	0.25 m 0.75 g
Gap fill	3m	2.8%	0.06 m 0.17 g
Skirt/Brim	21s	0.3%	0.02 m 0.07 g
Support material	59m	50.7%	2.04 m 6.09 g
Support material interface	8m	6.7%	0.16 m 0.47 g
Custom	12s	0.2%	0.02 m 0.06 g

Estimated printing times [Normal mode]:

First layer: 5m
Total: 1h57m

Show stealth mode

Warping

Symptoms

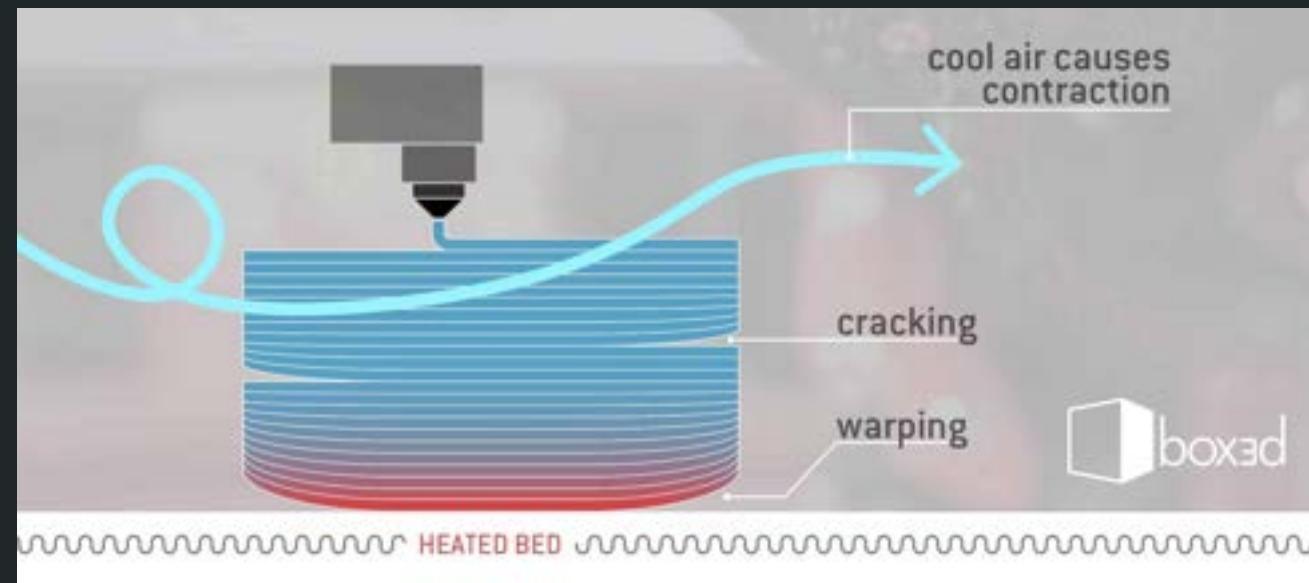
- Corners lift from bed
- Best Case: bottom is twisted
- Worst Case: Print detaches from plate

Cause

- The plastic expands and contracts with temperature changes.
- If adhesion between bed and print is bad the print will detach

Solutions

- Clean build plate with IPA (denatured alcohol)
- Rounded corners



To think about when designing and orienting model in software

- Avoid bridging over large gaps
- Complex shapes may need support
- Design with the printing process in mind
- Layer orientation
- You need less infill and support than you think

Export G-CODE

- Export to SD-card (or USB). There is one per printer.
- The filename contains print information. Double-check before starting print.