

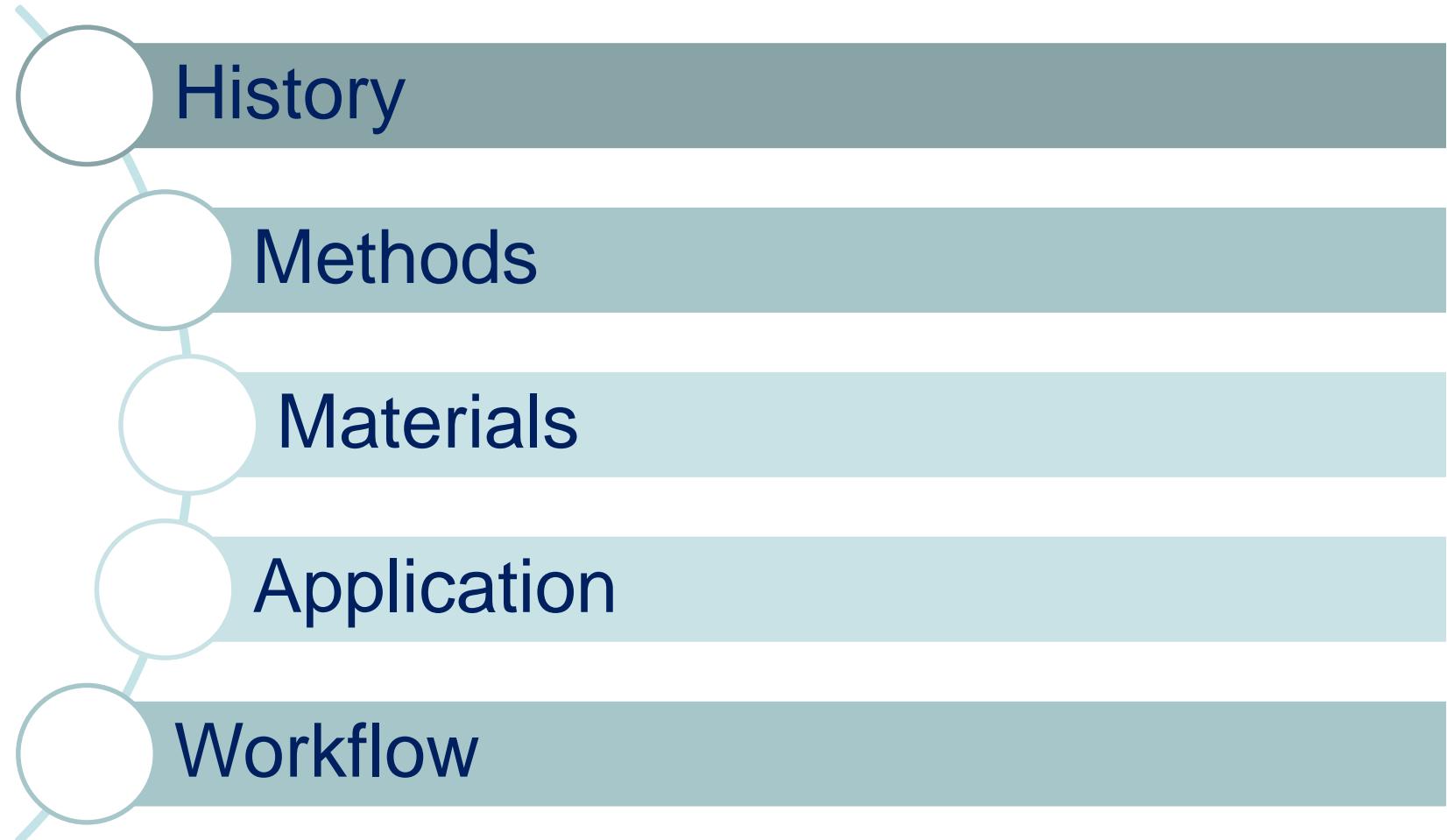


universität
wien

3D Printing

[Introduction to the Basics]







Rise of the 3D printers

early 80's

- rapid prototyping using the **stereolithography method**

1987

- **selective laser sintering**

1989

- **fused deposition modeling**

up to 2000

- new technologies for industrial application

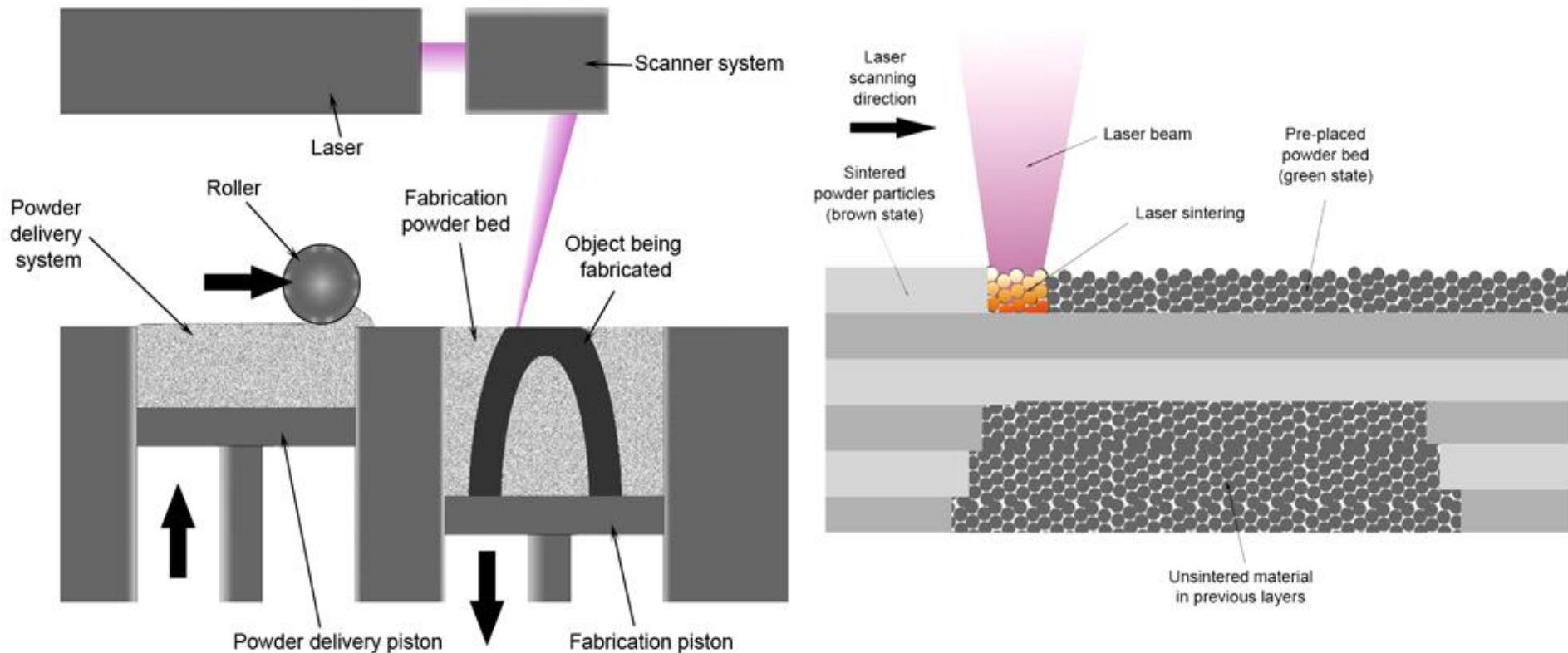
2004

- Open Source conceptual printer '**RepRap**'

2009

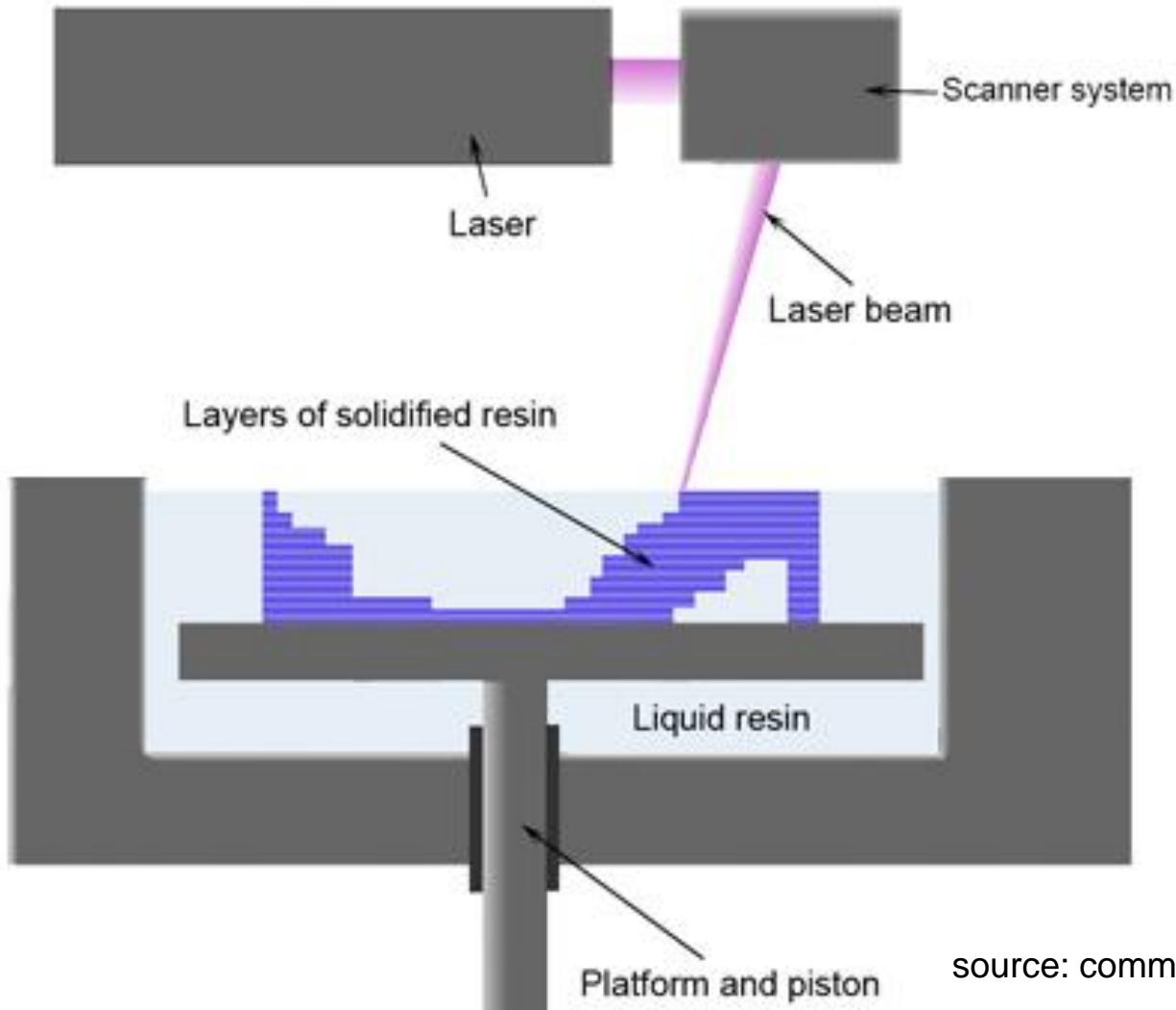
- first printers based on the '**RepRap**' (Makerbot, RapMan), Open Source community (Thingiverse)

Selective laser sintering/melting



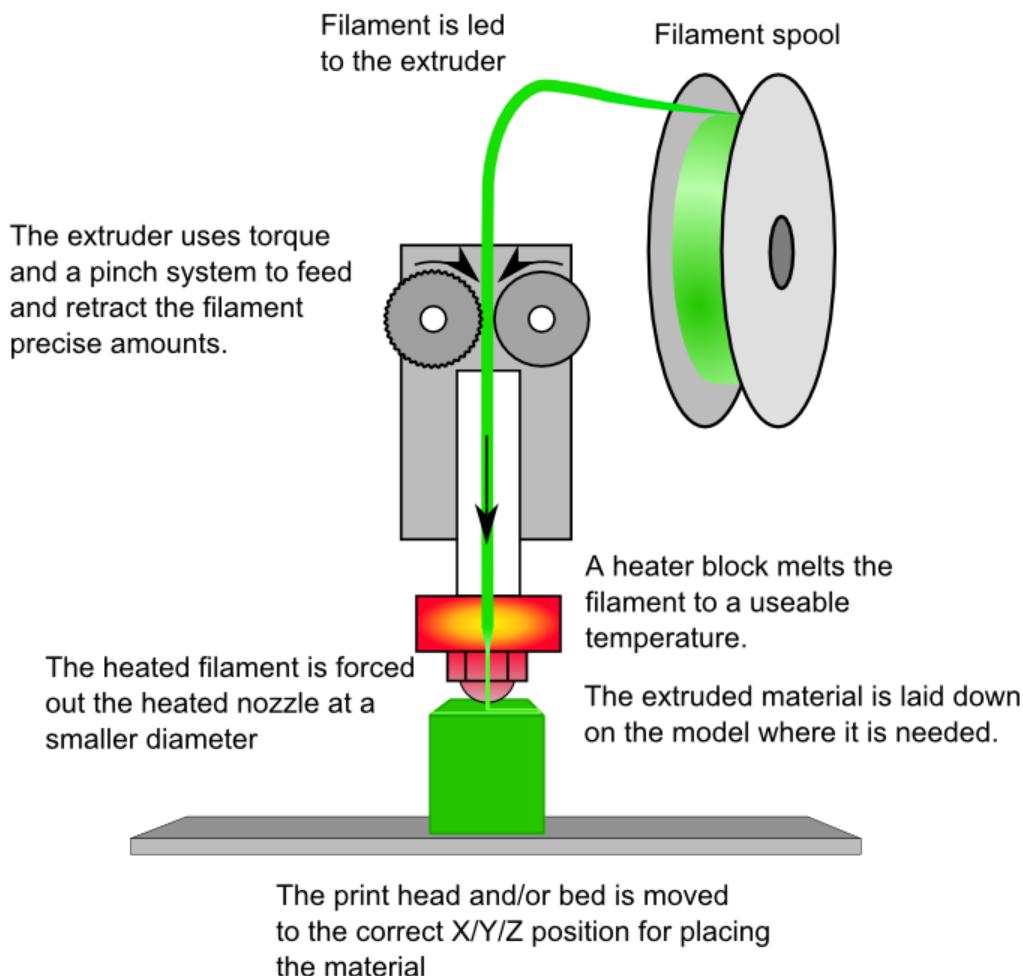


Stereolithography



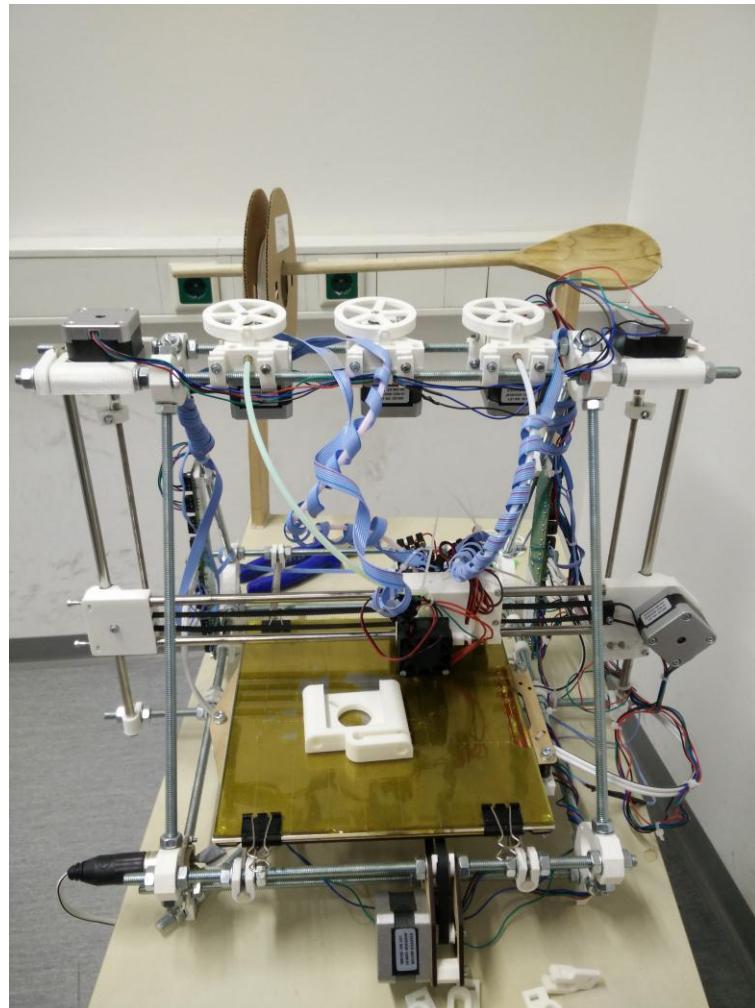
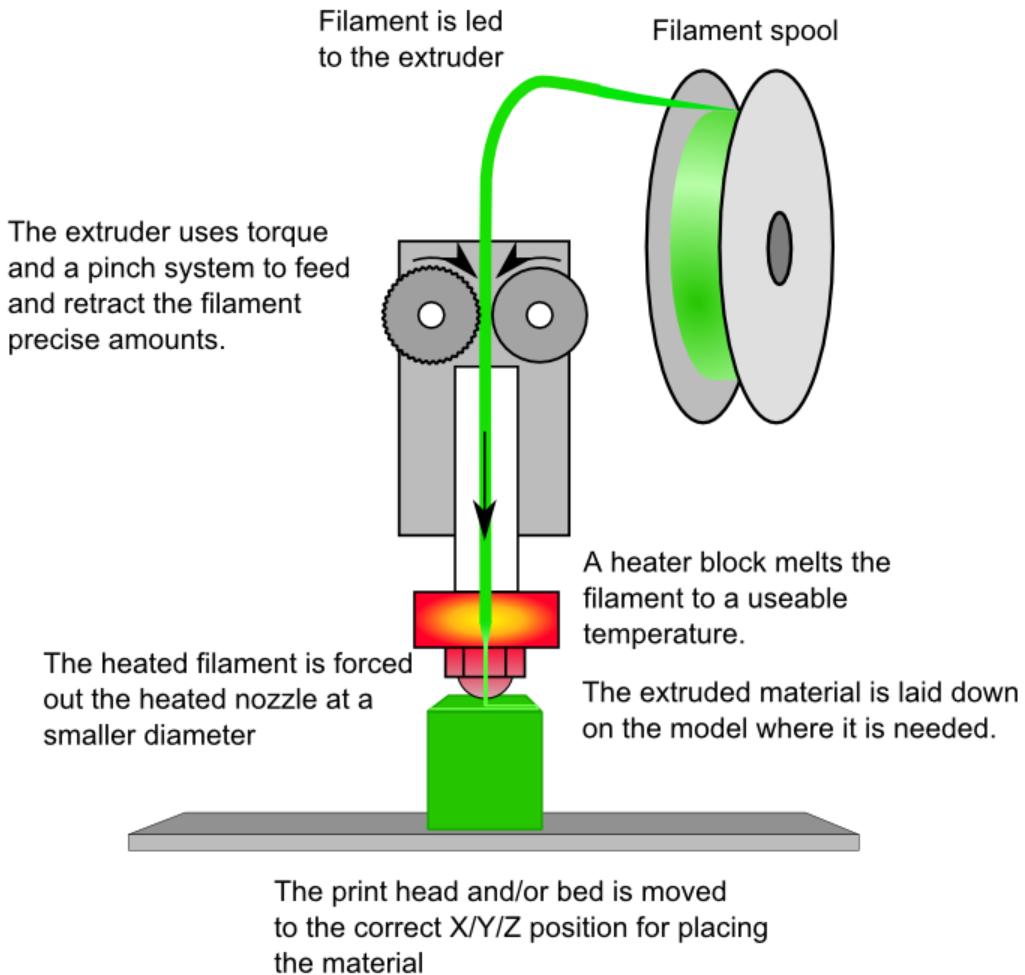


Fused deposition modeling





Fused deposition modeling



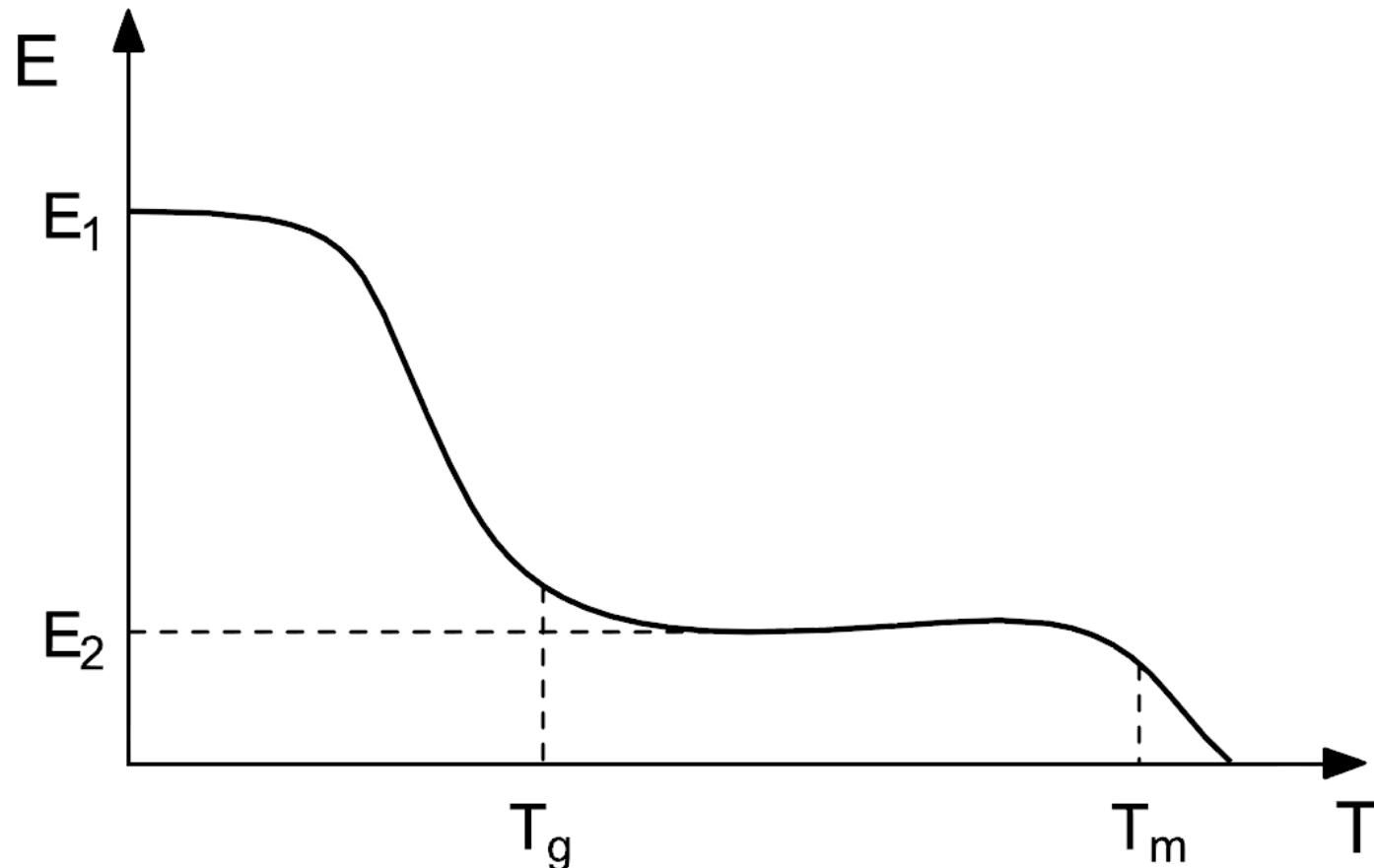


Materials

- Glass transition
- PLA (polylactic acid)
- ABS (acrylonitrile butadiene styrene)



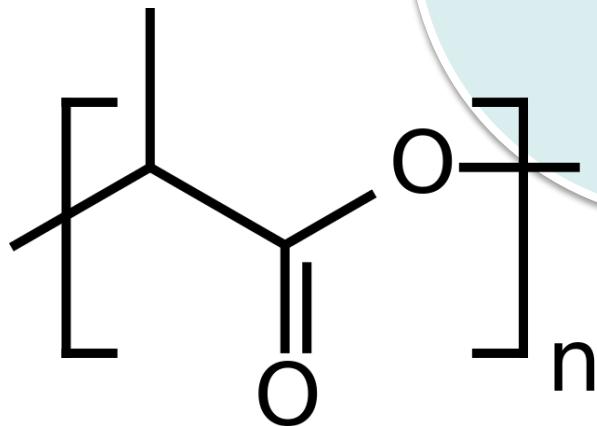
Glass transition





PLA (polylactic acid)

$T_g = 60 - 65 \text{ } ^\circ\text{C}$



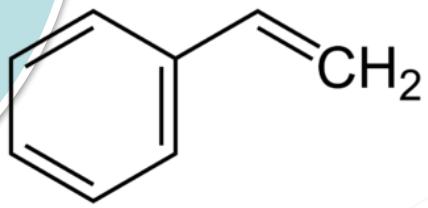
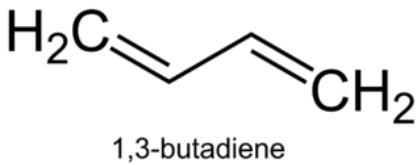
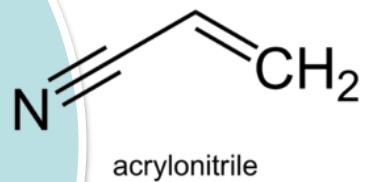
$T_m = 173-178 \text{ } ^\circ\text{C}$

biodegradeable



ABS (acrylonitrile butadiene styrene)

Resistant to acids,
alcohols and alkaline
solutions



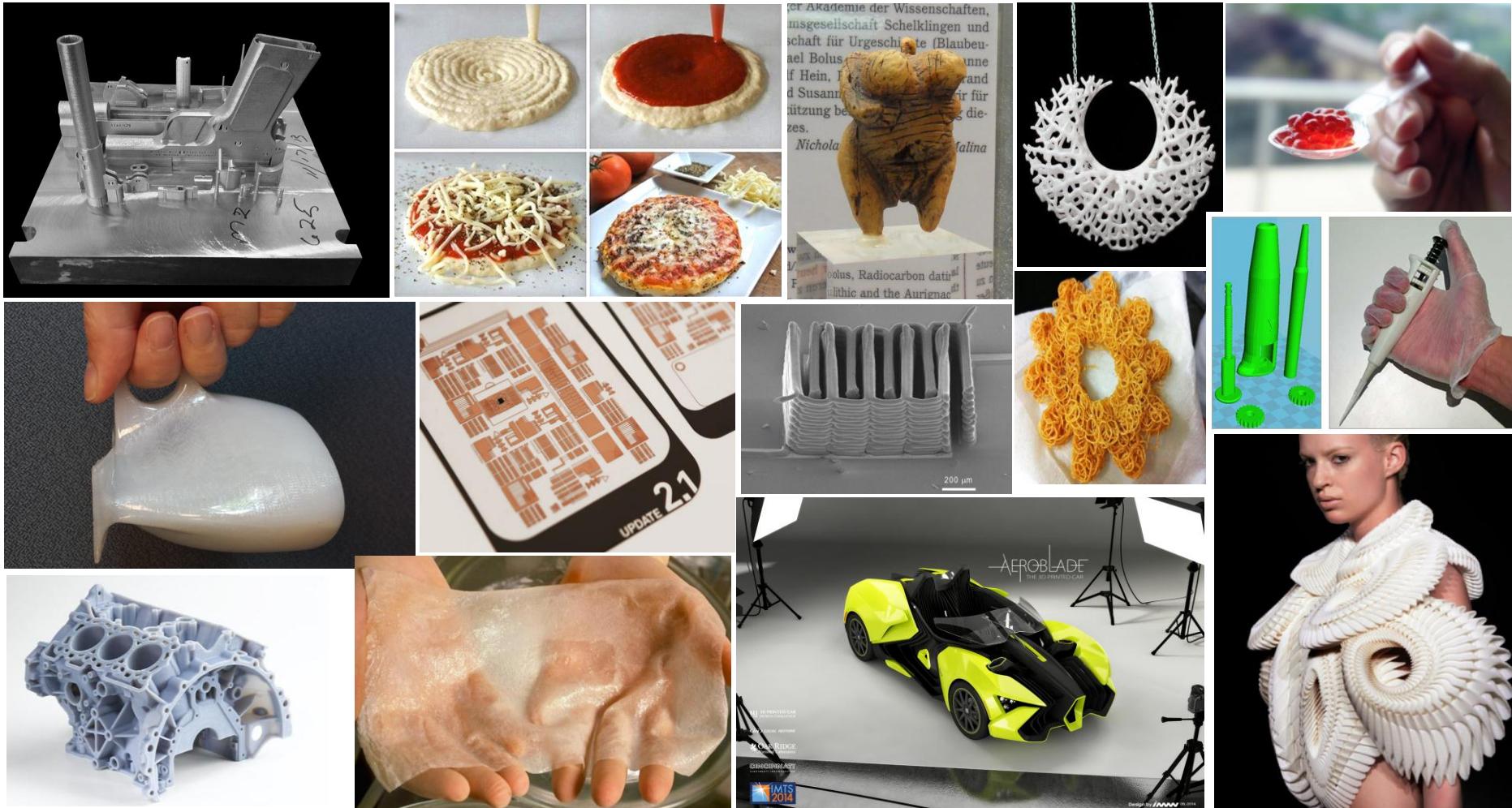
$T_m = \text{none}$
(amorphous)

Soluble in
ketones

$T_g = \sim 105 \text{ }^\circ\text{C}$

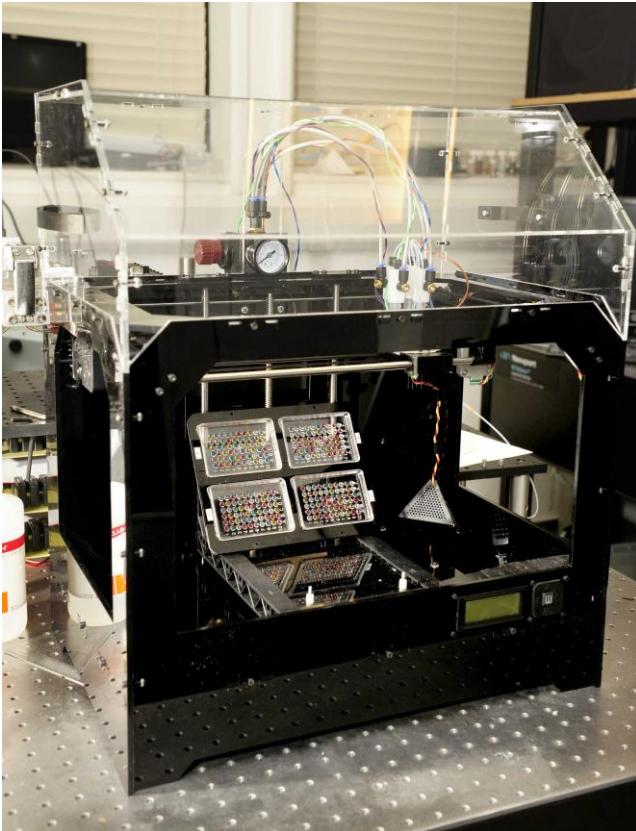


Applications





Applications



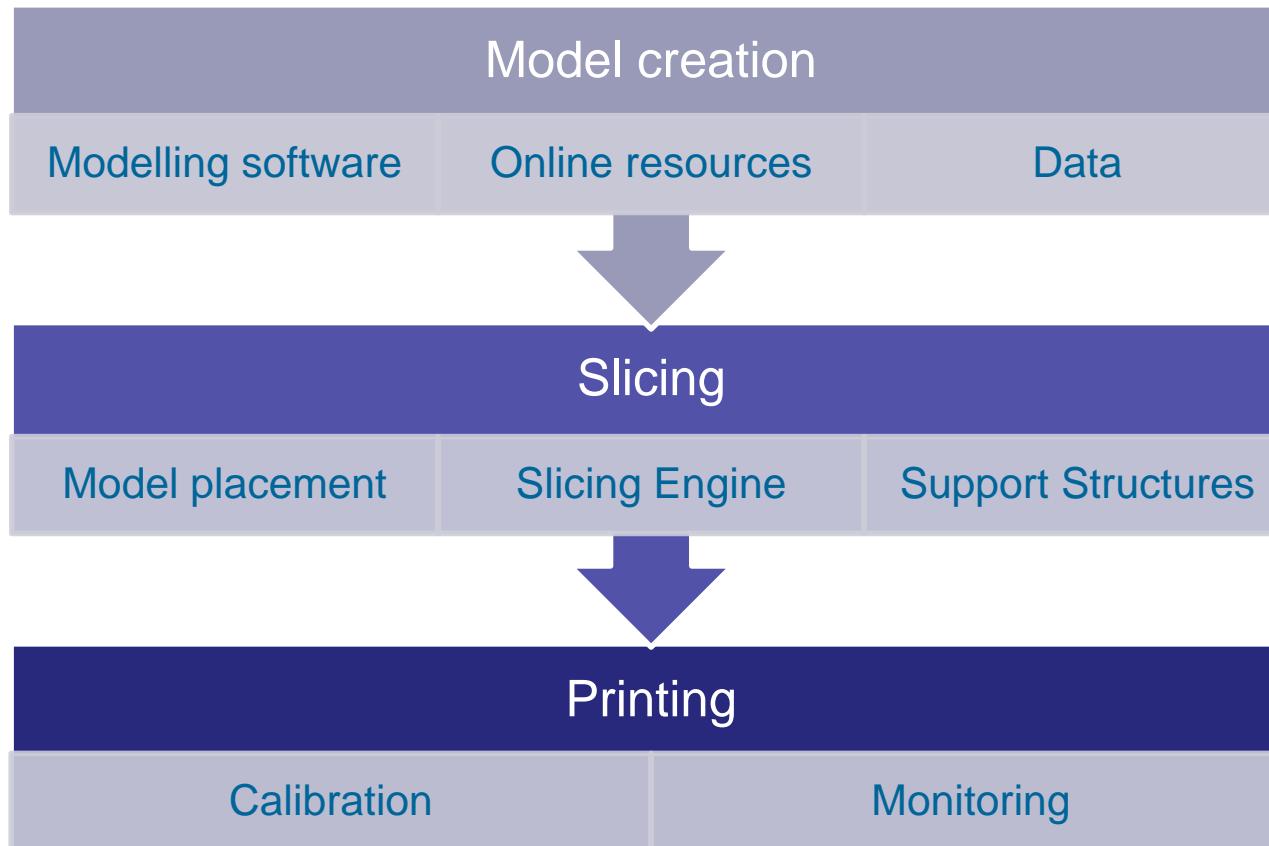
3D printed ear implant
(*National Geographic*)

hESC printer
(*Alan Faulkner-Jones et al*)





Project workflow



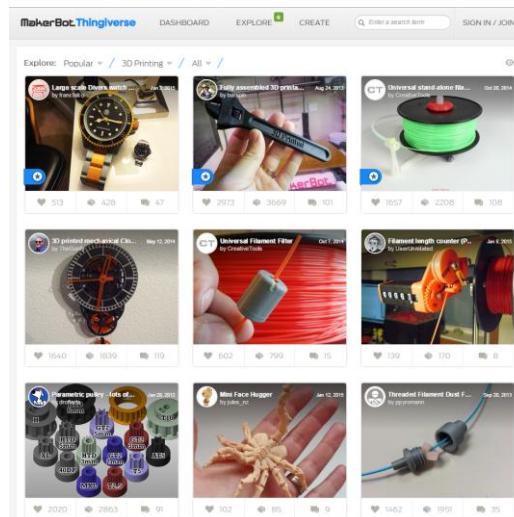


Model Creation



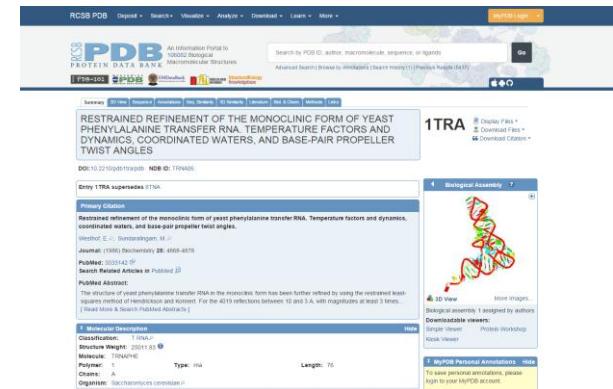
Modelling Software

file.STL



Online Resources

file.STL



Data

file.*



Slicing

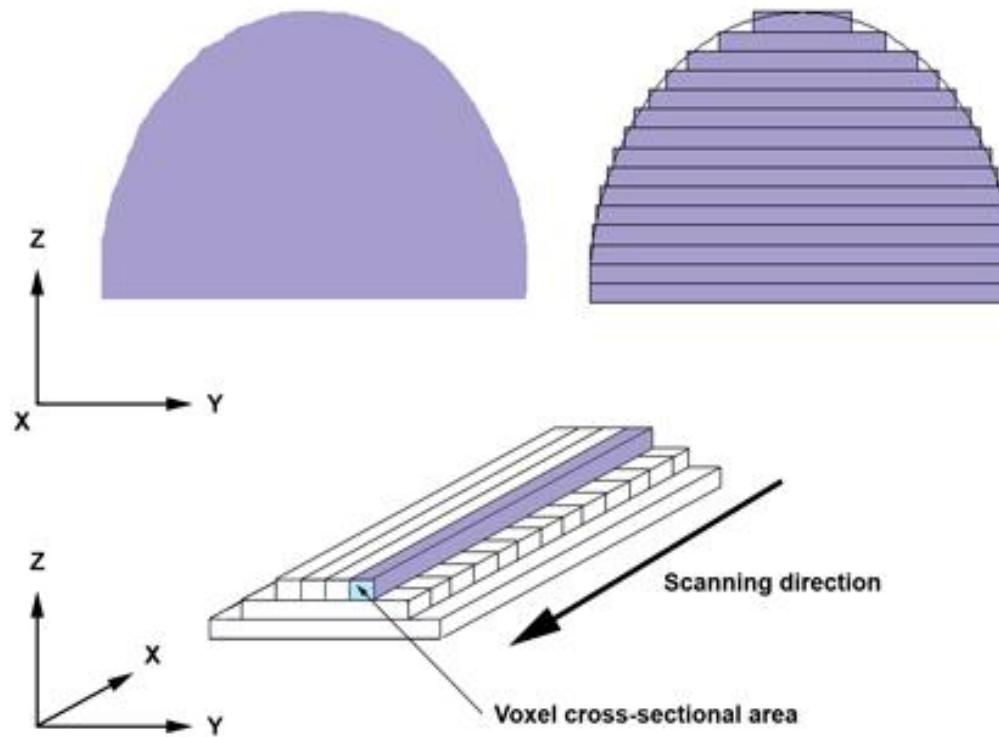
STL

Slicing

G-code

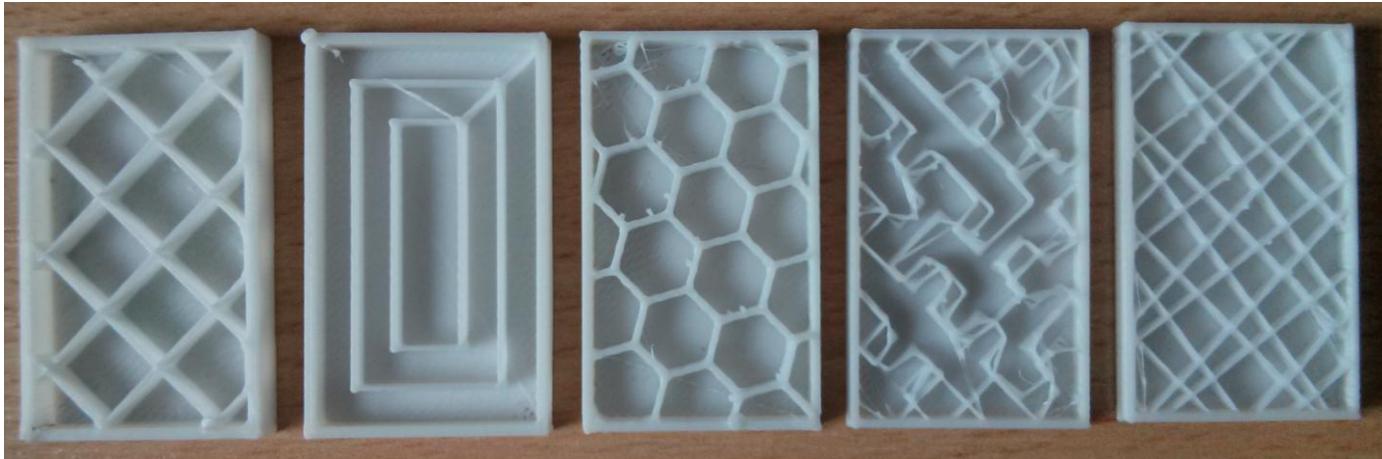


Slicing





Fill Structure



Rectilinear

Concentric

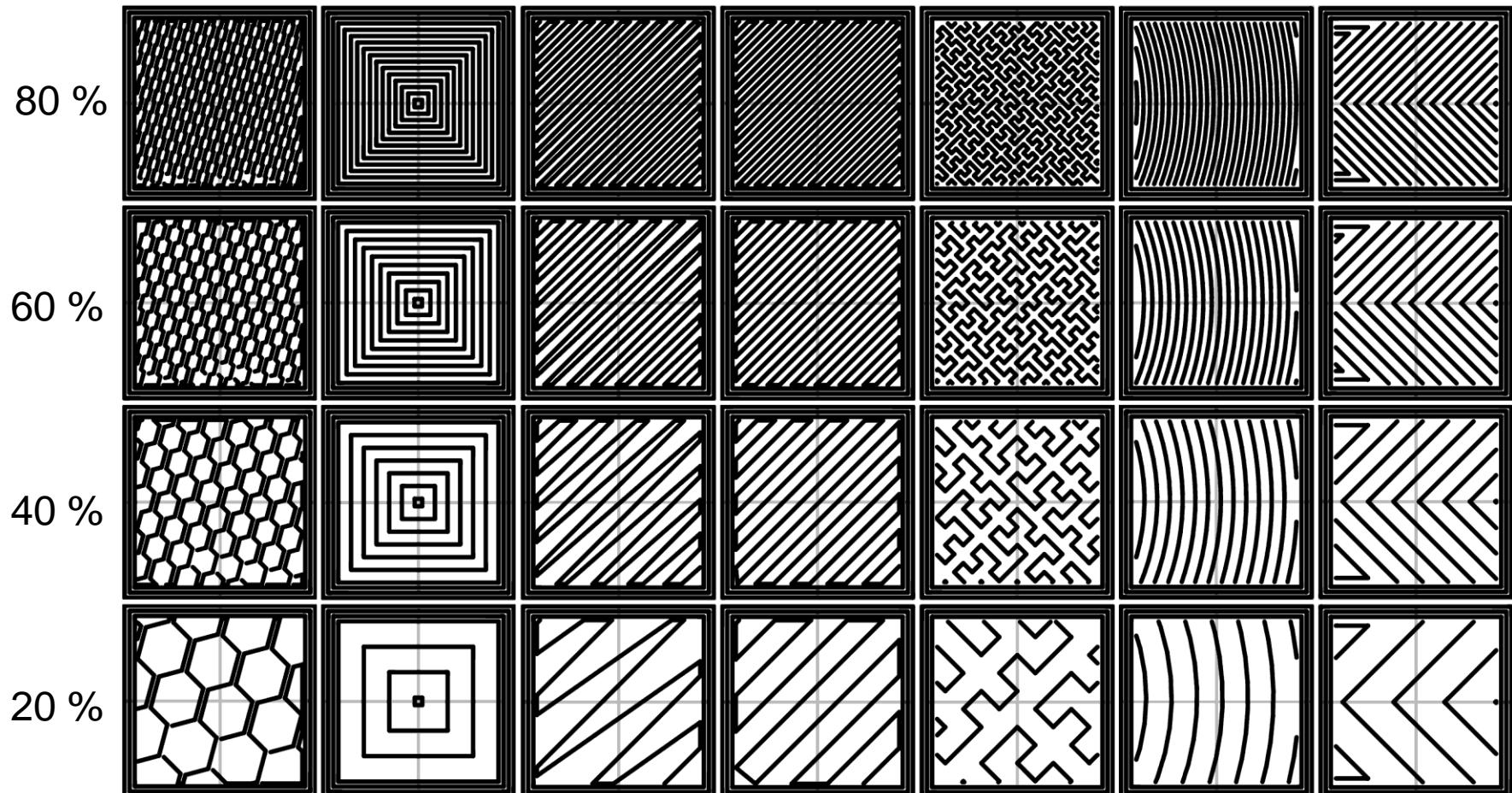
Honeycomb

Hilbert Curve

Line

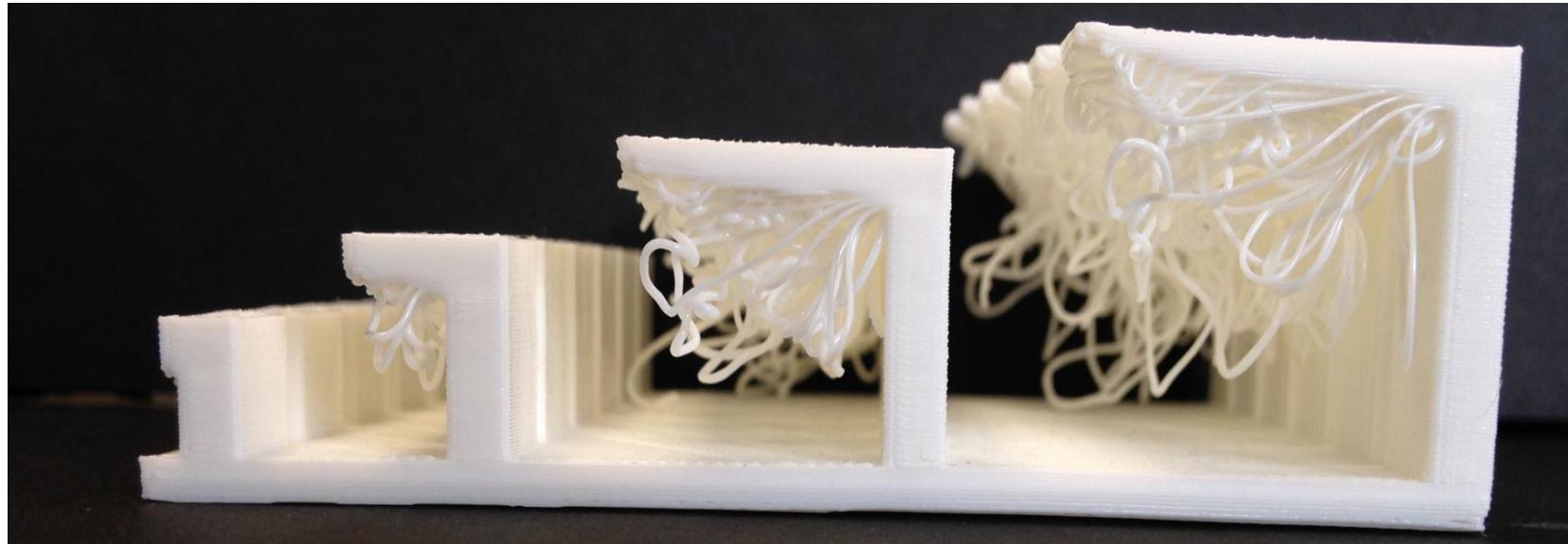


Fill Structure





Support Structures

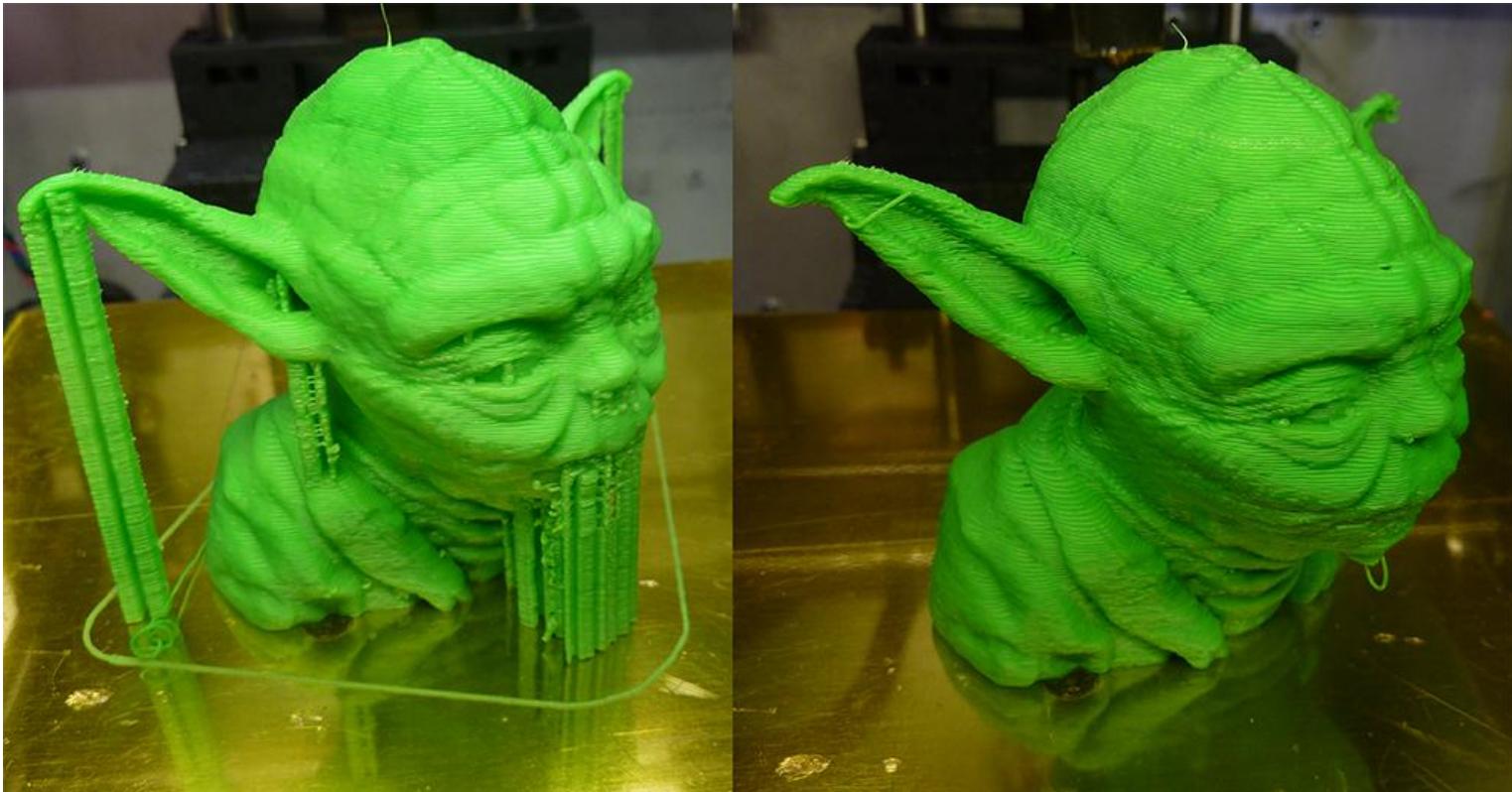


Failed Horizontal Overhangs



universität
wien

Support Structures





G – Code - Startup

M107	#	Fan off
M117 Warming up	#	Get Zero Position
M104 T0 S192	#	Set Extruder Temperature
M140 S55	#	Set Bed Temperature
M109 T0 S192	#	Wait for Extruder to reach Temperature
M190 S55	#	Wait for Bed to reach Temperature
G91	#	Moves are relative to this position
G1 Z1 F300	#	Move 1 in Z-direction with Feedrate F
G90	#	Position is absolute
G28	#	Move to Origin
T0	#	Use Extruder 0
G92 E0	#	Set Position



G – Code - Printing

```
G1 Z0.4
G1 E0.04366 F3600
G1 X105.856 Y111.983 E0.04664 F720
G1 X105.795 Y112.023 E0.04881
G1 X105.709 Y112.012 E0.0514
G1 X105.552 Y111.833 E0.05851
G1 X105.497 Y111.741 E0.06171
```

G1 ... Move

X, Y, Z ... Target Position

E ... Amount to extrude

F ... Feedrate per minute



Printing

[Video]



Specific Workflow for Biomolecules

Structure

- Crystal or NMR Structure from PDB

Visualization

- PyMOL – visualization options
- Export as *.wrl

Modelling

- Blender
- Preparing for print



universität
wien

Printer Workshop

[TBA]