

3D Printing





3D Printing

**What and How
Categories**

3D Model Creation

File Formats

Printers

Applications

Services

Challenges

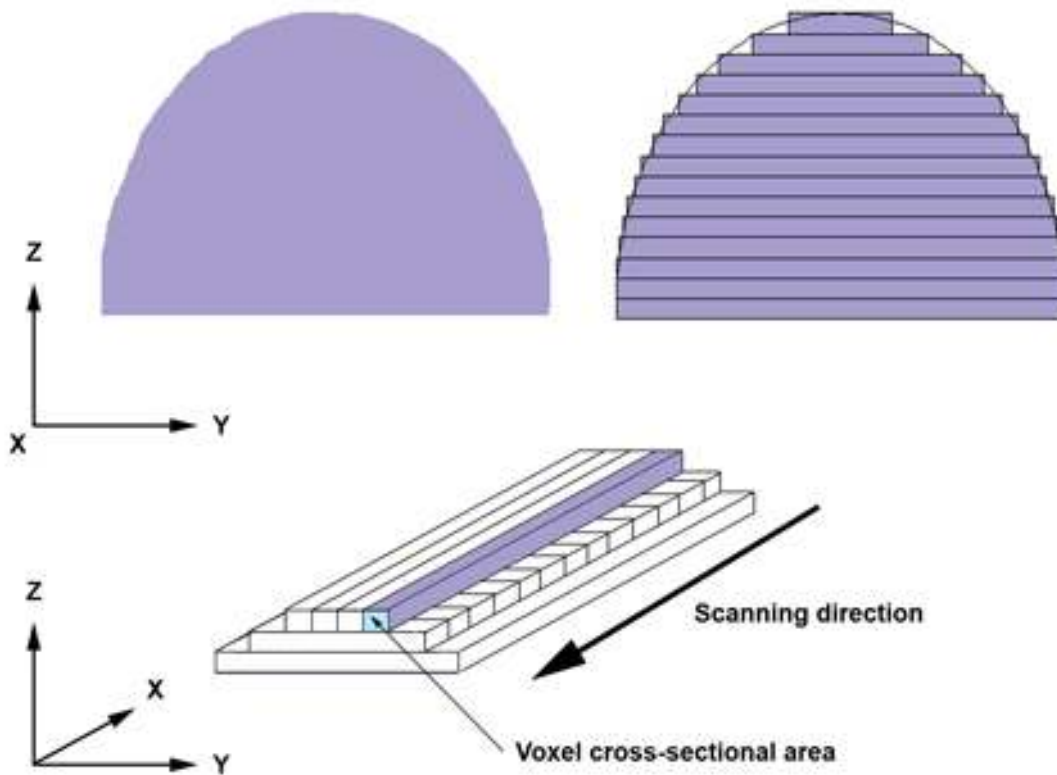


What is 3D Printing?

- **A manufacturing process**
- **3D objects**
- **Additive (one layer at a time)**
- **According to 3D models**

<http://3dprinting.com/what-is-3d-printing/#whatitis>

What is 3D Printing?



"Rapid prototyping slicing"
by Materialgeeza - Own
work. Licensed under CC
BY-SA 3.0 via Commons -
https://commons.wikimedia.org/wiki/File:Rapid_prototyping_slicing.jpg#/media/File:Rapid_prototyping_slicing.jpg



How does it work?

- **Additive: one layer at a time**
- **Common methods for producing layers:
FDM, SLS, SLA**
- **FDM: fused deposition modeling**
- **SLS: selective laser sintering**
- **SLA: stereolithography**

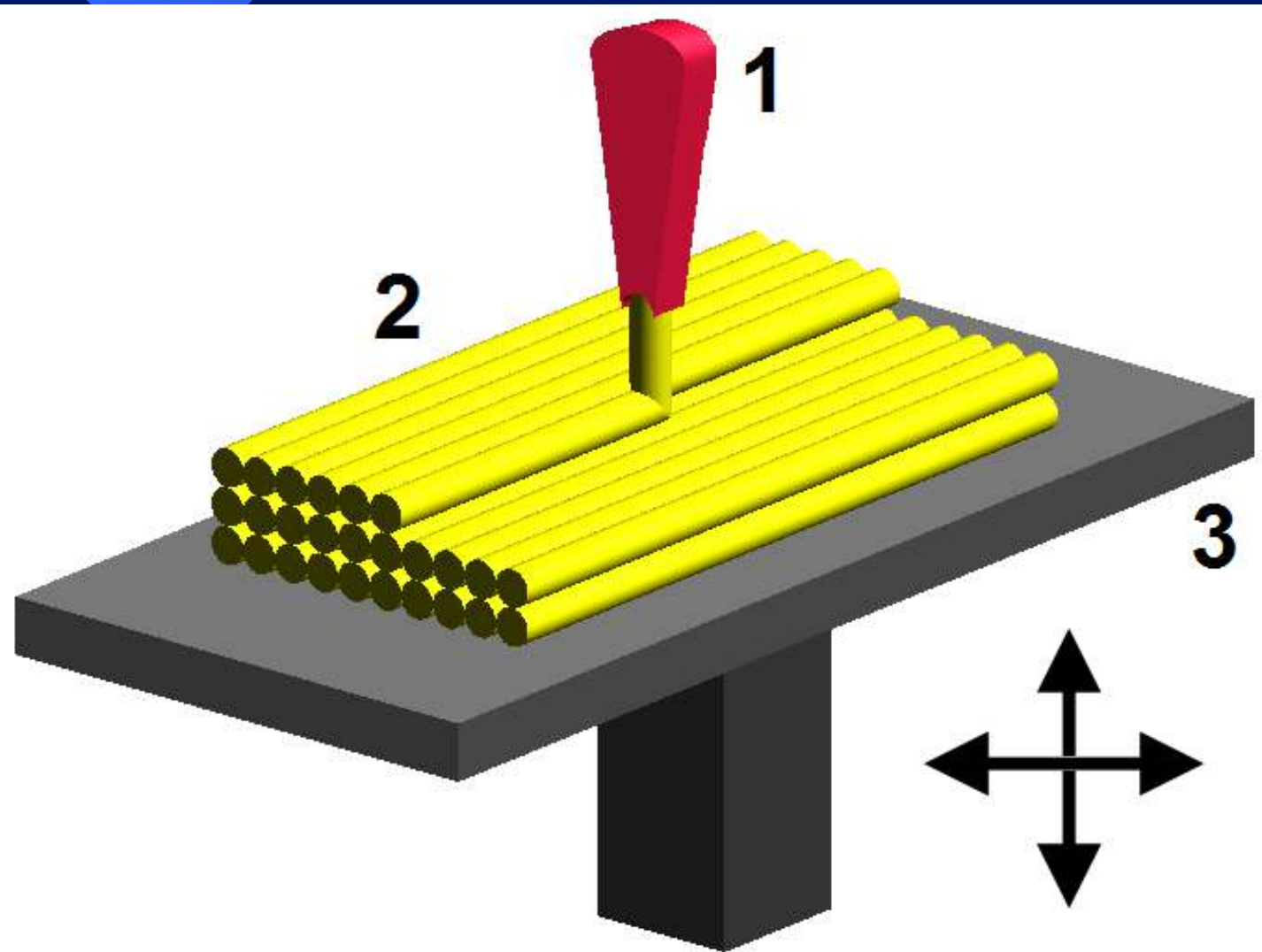


Categories of Additive Manufacturing

(American Society for Testing and Materials)

- **Extrusion Deposit**
- **Vat Photopolymerisation**
- **Material Jetting**
- **Binder Jetting**
- **Powder Bed Fusion**
- **Sheet Lamination**
- **Directed Energy Deposition**

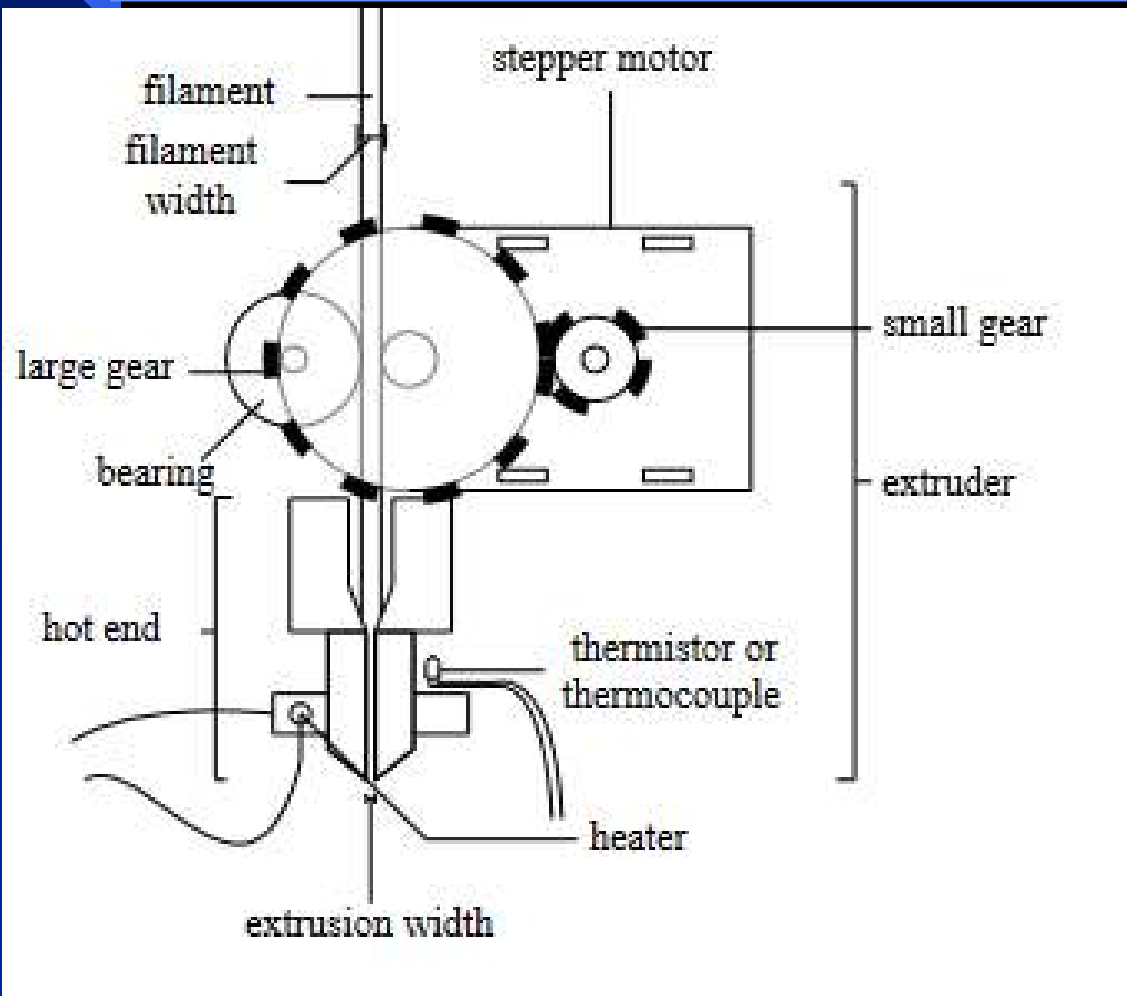
Extrusion Deposit



- A.k.a: fused deposition modeling (FDM)
- Most commonly used
- Prototyping
- Inexpensive

"FDM by Zureks" by Zureks - Own work. Licensed under GFDL via Commons - https://commons.wikimedia.org/wiki/File:FDM_by_Zureks.png#/media/File:FDM_by_Zureks.png

Extrusion Deposit



- Structure of an Extruder
 - Demo of FDM
- <https://youtu.be/WHO6G67GJbM>

"Extruder lemio" by Lemio - http://reprap.org/wiki/File:Extruder_lemio.svg. Licensed under GFDL via Commons - https://commons.wikimedia.org/wiki/File:Extruder_lemio.svg#/media/File:Extruder_lemio.svg

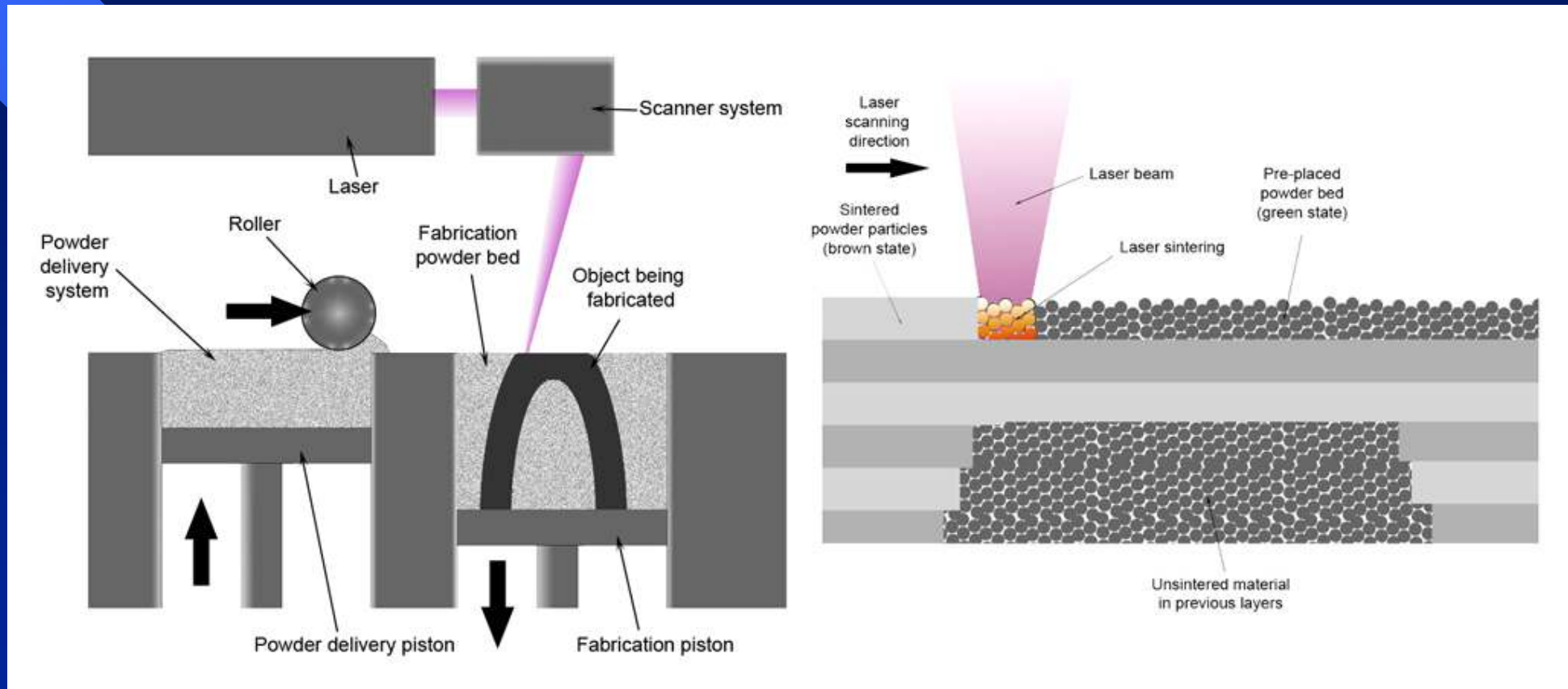


Extrusion Deposit

Extrusion Materials

- *acrylonitrile butadiene styrene (ABS)*
- *polylactic acid (PLA)*
- *high-impact polystyrene (HIPS)*
- *thermoplastic polyurethane (TPU)*
- *aliphatic polyamides (nylon),*
- **Polyether ether ketone (PEEK)**
- **paste-like materials (ceramic, chocolate, ...)**

Powder Bed Fusion




- **E.g.: Selective laser sintering (SLS)**

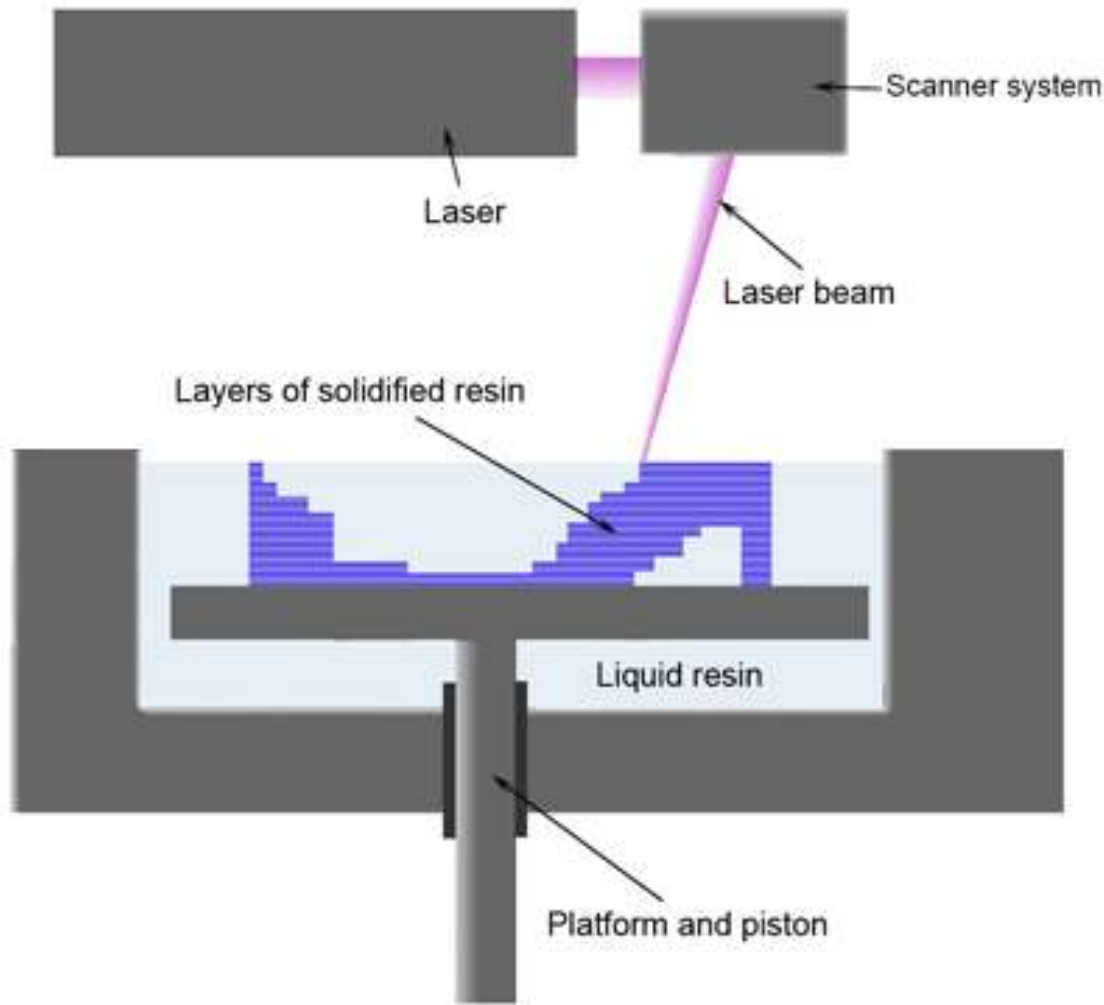
"Selective laser melting system schematic" by Materialgeeza - Own work. Licensed under CC BY-SA 3.0 via Commons -

https://commons.wikimedia.org/wiki/File:Selective_laser_melting_system_schematic.jpg#/media/File:Selective_laser_melting_system_schematic.jpg

Powder Bed Fusion

- 
- **Selective laser sintering (SLS)**
 - **Developed in 1980s at UT Austin**
 - **Patent expired 2014**
 - **Materials: metals, polymers, nylon**
 - **In powder form.**
 - **Un-melted powder becomes supporting material.**

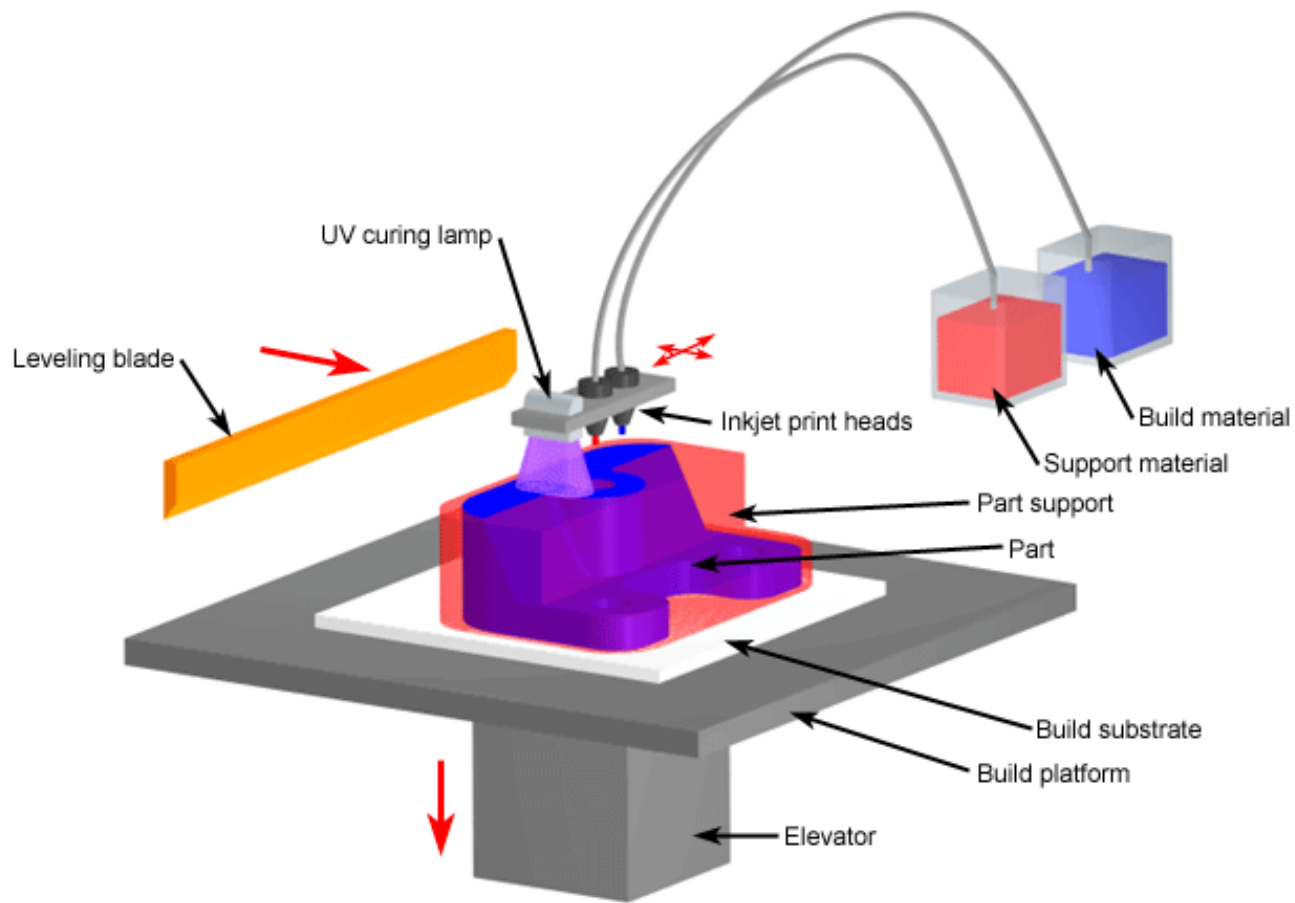
Vat Photopolymerisation



Examples:
SLA (stereolithography)
CLIP (Continuous Liquid Interface Production)

"Stereolithography apparatus" by Materialgeeza - Own work. Licensed under CC BY-SA 3.0 via Commons - https://commons.wikimedia.org/wiki/File:Stereolithography_apparatus.jpg#/media/File:Stereolithography_apparatus.jpg

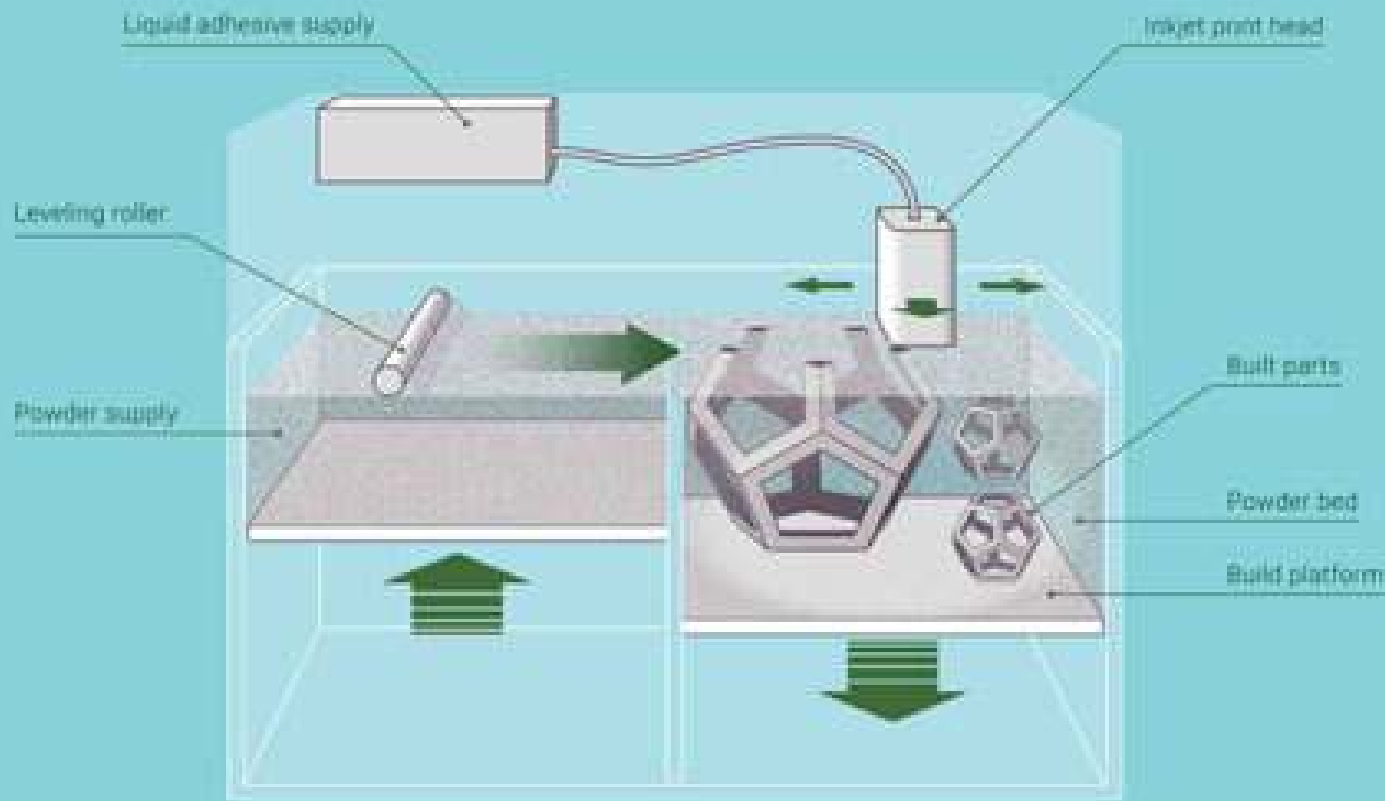
Material Jetting



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Image source:
CustomPartNet

Binder Jetting



© additively.com

Image source:
additively.com



3D Model Creation

- **3D Scanners**
e.g.: Kinect
- **CAD (Computer-Aided Design) software**
e.g.: AutoCAD (free for students)
<http://www.autodesk.com/education/free-software/all>
- **Visualization software**
e.g. VTK
<http://www.vtk.org/>



3D Print File Format

STL: STereoLithography

https://en.wikipedia.org/wiki/STL_%28file_format%29

- By 3D Systems
- Triangulated surface meshes
- ASCII or binary
- No unit
- No color



3D Print File Format

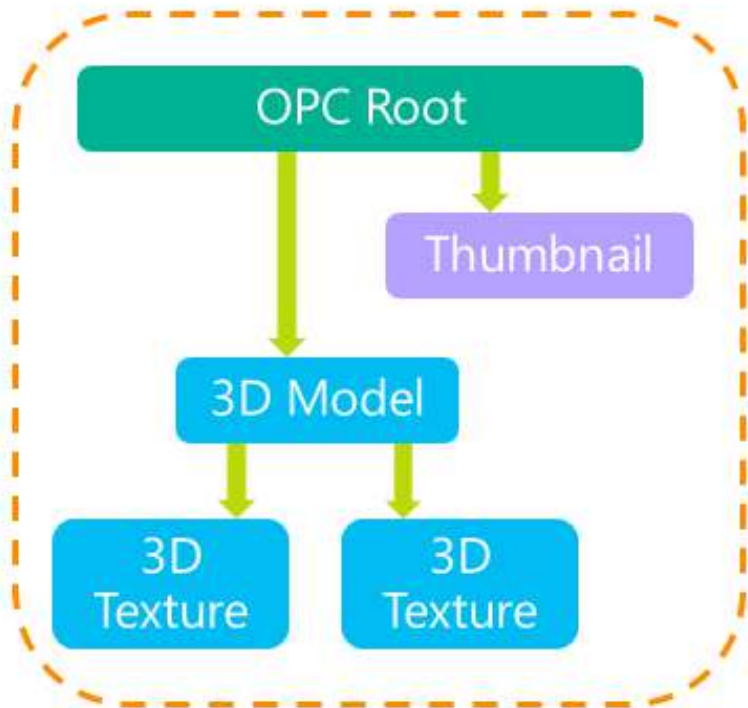
3MF: 3D Manufacturing Format

www.3mf.io

- Geometries (Triangulated, NURBs, ...)
- Materials (Color, Texture, Composite)
- Open source

3D Print File Format

3MF design considerations



Complete

- Open Packaging Conventions (OPC)

Compact

- ZIP package
- References avoid duplication

Human-readable

- XML
- Well-known binary formats (e.g. PNG, JPEG)



3D Print File Format

3MF: 3D Manufacturing Format www.3mf.io

- **Microsoft**
- **Consortium**
- <https://github.com/3mfconsortium>
- **Microsoft donated code reads STL/OBJ/3MF, writes 3MF**
- <http://www.3mf.io/what-is-3mf/3mf-specification/>

3D Print File Format

**3MF Example created by
Kinect**

Supported in Windows 10





3D Printers

- Prusa (RepRap.org)
- MakerBot Replicator
- LulzBot TAZ
- MakerGear
- Formlabs
- Ultimaker
- Polymaker (printing materials)



Applications

- Prototyping
- Manufacturing
(cars, houses,...)
- Arts
- Entertainment
- Medicine
- Food
- Personal

https://www.google.com/search?q=3D+printing&biw=1280&bih=689&source=lnms&tbn=isch&sa=X&ved=0CAgQ_AUoA2oVChMI3rKu4IWLyAIVi0mSCh1NwQpL



3D Printing Services

Printing Services:

- [Sculpteo](#)
- [Ponoko](#)
- [Shapeways](#)



3D Printing Services

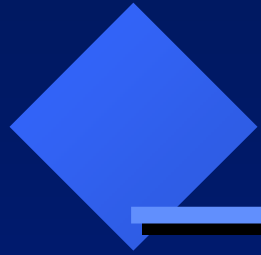
Model Services:

- [Pinshape](#)
- CGTrader
- MyMiniFactory
- Thingiverse
- Yeggi



Challenges in 3D Printing

- True color objects
- Supporting curved objects in FDM
- **Voxelization (non smooth surface and internal fracture)**



Summary

Infographics by Sculpteo

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<http://3dprint.com>