

3D Printing

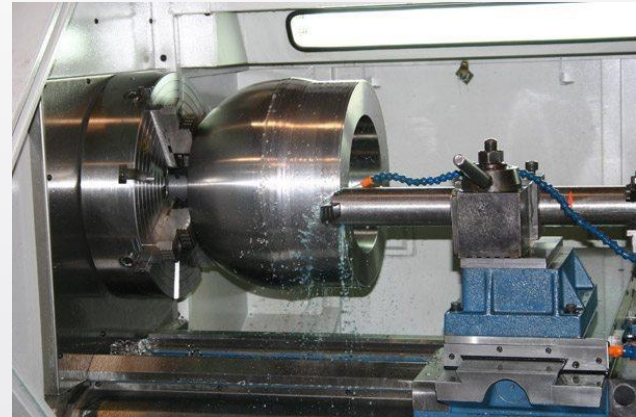
COMPUTER LITERACY



How it differs from traditional manufacturing



- Traditional methods involve subtractive methods or moulding/casting processes
 - Can result in waste
- For example, CNC Machining
 - Remove layer by layer



- 3D Printing is **additive manufacturing**
 - Production is carried out layer by layer in an additive process



A Brief History



1980s

- First patent for rapid prototyping technology

1990s

- Manufacturing split into two sections
 - High end section is very expensive and geared for high value and complex parts.
 - Concept modeler section keeps improving concepts of prototyping.

Late 2000s

- Attempt to reach a wider audience
 - First system under \$10,000
 - RepRap: a self replicating system
 - First system under \$5,000

How does 3D Printing Affect the world?



- Medical procedures
- Advances in research
- Product prototyping
- Historic Preservation
- Architectural Engineering / Construction
- Advanced Manufacturing
- Food Industries
- Automotive
- Accessories

Medical Procedures



- Custom hearing aids, braces, splints
- Drugs: [Spritam](#) is the first FDA approved 3D printed drug
- Body parts, including ears, hips and even organs, in exact proportions to fit the patient.
 - 2012: Surgeons successfully [implanted an entire titanium jaw](#), made with 3D printing, in an elderly woman.
 - 2014: Surgeons [replaced the entire top of a woman's skull](#) with a customized print implant
- Low cost prosthetics
 - <https://www.youtube.com/watch?v=WoZ2BgPVtA0>



Other Biomaterials



- Blood vessels: <https://www.youtube.com/watch?v=9VHFlwJQIkE>
- Bones
- Heart Valve
- Ears
- Skin
- Synthetic organs



Advanced Manufacturing



- Airbus would like to make a 3D printer that is large enough to make planes from the ground up – [a hangar-size printer](#) as large as 80m x 80m.
- [Made In Space](#) is a US company experimenting with zero-gravity 3D printing.
 - Print objects as needed in space
 - Save valuable weight at launch
- [NASA has been looking at 3D printing](#) for some time now, and considering the technology for long missions.
 - Astronauts could create their own equipment during the trip.

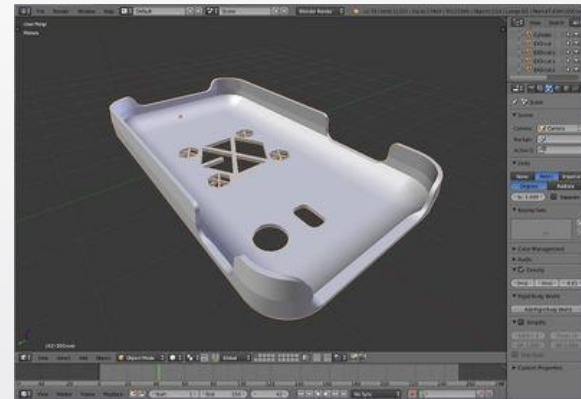
Accessories



How it works



- Start with a 3D digital model
 - 3D CAD
 - Blender
 - TinkerCAD
 - 3D Scanner
- Model is sliced into layers
- 3D printer processes material and layers it, binding layers based on the type of material and process used
 - Functional plastics
 - Metals
 - Ceramics
 - Sand
 - Bio materials
 - Food



3D Printing Technologies



- Fused Deposition Modeling (FDM)
- Stereo lithography (SL)
- Selective Laser Sintering (LS)
- Selective Laser Melting (LM)
- Binder Jetting (BJ)
- Material Jetting / Wax Casting (MJ)
- Electron Beam Melting (EBM)
- Laminated Object Manufacturing (LOM)

| Materials | Technologies | | |
|-----------|------------------------------------|-----------------------------------|-----------------------------|
| | Parts built through polymerization | Parts built through bonding agent | Parts built through melting |
| Ceramic | | BJ | LM |
| Metal | | | EBM |
| Sand | | | |
| Plastic | SL PJ | | FDM LS |
| Wax | | | MJ * |

| | | |
|---------------------------------|----------------|------------------|
| Lower | Durability | Higher |
| Smoother | Surface finish | Rougher |
| Higher | Detail | Lower |
| Prototypes Indirect processes | Application | Functional parts |

Fused Deposition Modeling (FDM)



- Most common 3D printing method used in desktop 3D printing
- A plastic filament is melted and extruded through a nozzle
- Parts are built by laying down layer-by-layer
- <https://youtu.be/cyXHHEfOAaA>

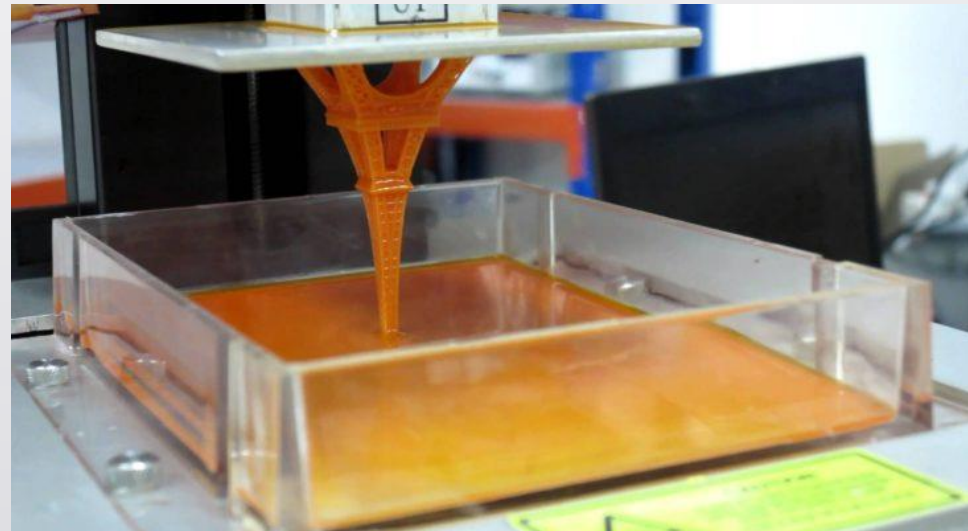


Stereolithography (SLA)



- A UV laser is curing a liquid photopolymer in a vat
- The part is built by lowering the build platform into the vat

• <https://youtu.be/yW4EbCWaJHE>



Selective Laser Sintering (SL)



- A thin layer of plastic powder is selectively melted by a laser
- Parts are built up layer by layer in the powder bed.
- High durability, rough finish, less detailed

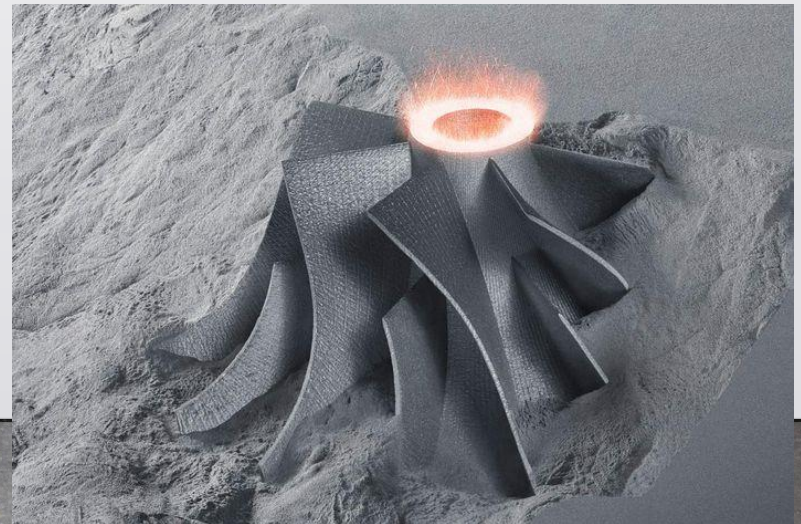
- <https://youtu.be/wdRswasftfl>



Selective Laser Melting (LM)



- A thin layer of metal powder is selectively melted by a laser
- Parts are built up layer by layer in the powder bed.
- <https://www.youtube.com/watch?v=te9OaS0kf8>



Binder Jetting



- Inkjet print heads apply a liquid bonding agent onto thin layers of powder
- Part is build up layer by layer by gluing the particles together
- <https://www.youtube.com/watch?v=eX8sv9gXpqc>



Laminated Object Manufacturing (LOM)



- A standard 2D inkjet printer is used for each paper layer.
- Layers are pressed together via a heat plate.
- <https://www.youtube.com/watch?v=Nkj6yrqfnSs>

