

BML 300: INTRODUCTION TO HEALTHCARE ENGINEERING

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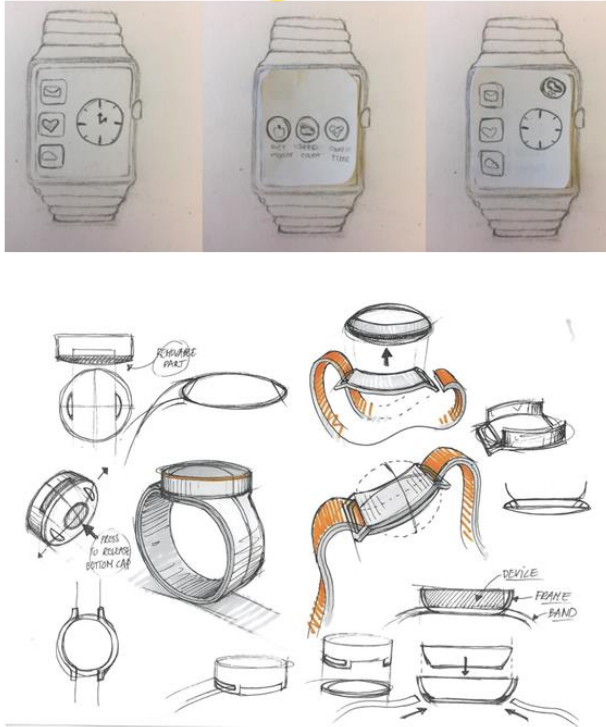
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WHAT IS A PROTOTYPE

Wireframe



A two-dimensional illustration of a product. A low fidelity MVP

3D Design



A three-dimensional illustration of a product. A low fidelity MVP

Prototype



A full-scale and functional form of a design. A high fidelity MVP

NEED FOR A PROTOTYPE: **SHOWCASE TO CUSTOMERS**



Additive Manufacturing

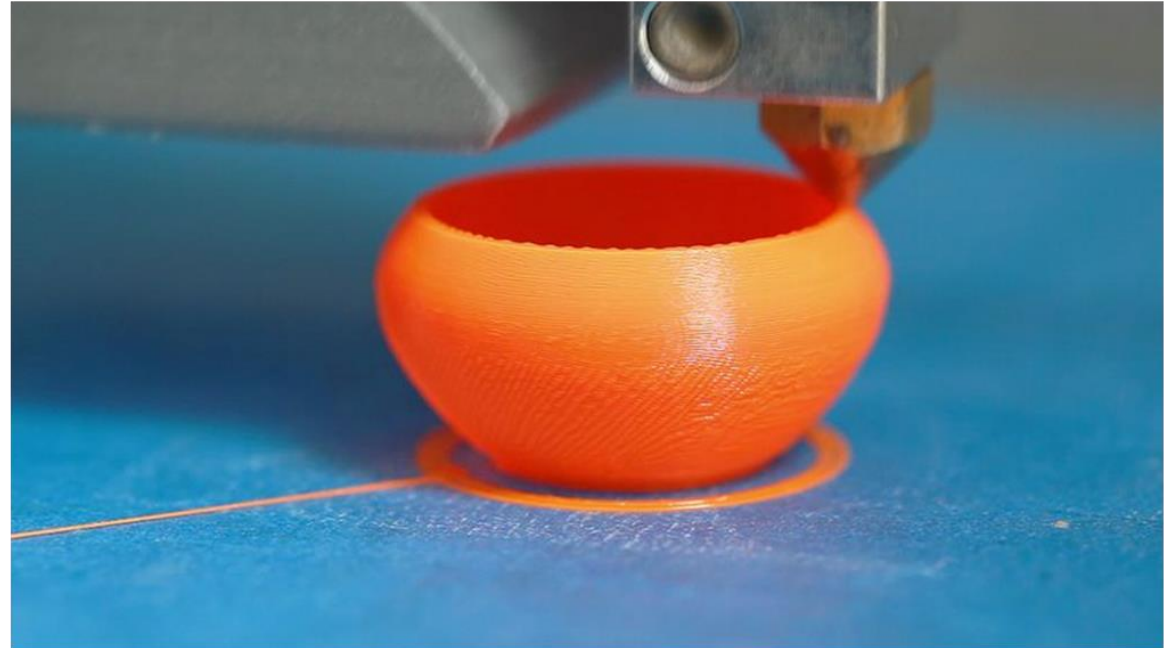
ADDITIVE MANUFACTURING

3D Printing

Overview of 3D Printing Technologies

3D printing, also known as additive manufacturing, is a method of creating a 3D product layer-by-layer using a computer created design

- **Fused deposition modeling (FDM)**
- **Stereolithography (SLA)**
- DLP 3D printing
- Photopolymer Phase Change Inkjets (PolyJet)
- Selective laser sintering (SLS)
 - Direct metal laser sintering (DMLS)
- Plaster-based 3D printing (PP)
 - Powder bed and inkjet head 3D printing
- Thermal Phase Change Inkjets
- Laminated object manufacturing (LOM)



https://www.youtube.com/watch?v=m_QhY1aABsE

FUSED DEPOSITION MODELING

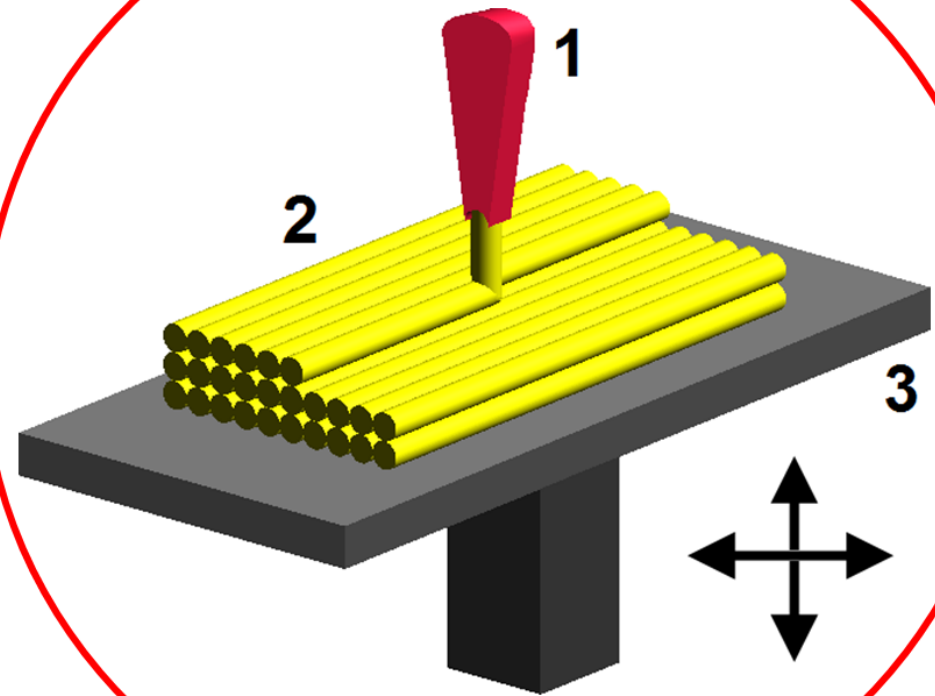
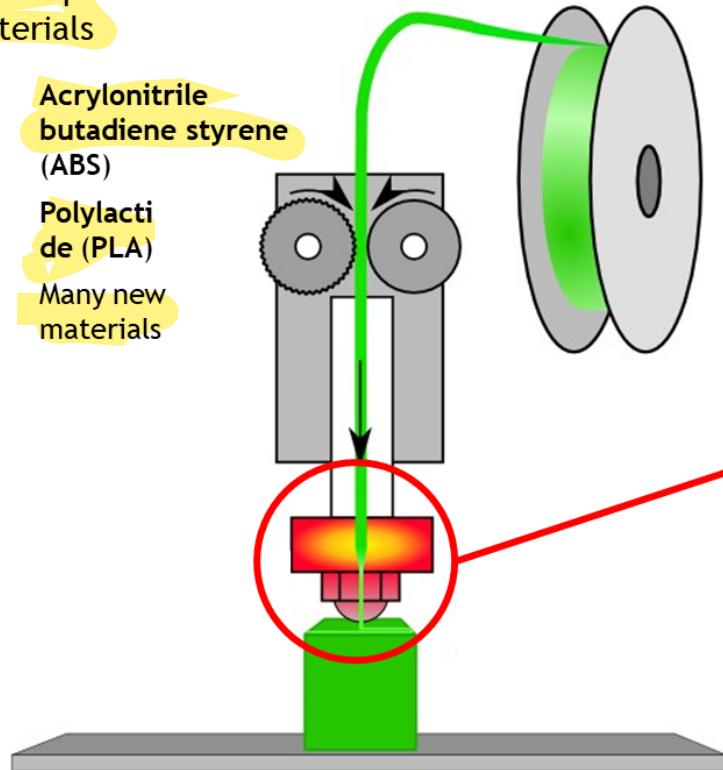
Filament is made of thermoplastic materials

Acrylonitrile butadiene styrene (ABS)

Poly lactide (PLA)

Many new materials

Filament spool



FUSED DEPOSITION MODELING

Several 3D printer variants

1. Make

- Commercial
- General and DIY

2. Build Area

- Micro to 2m x 2m

3. Layer thickness

- >0.1mm

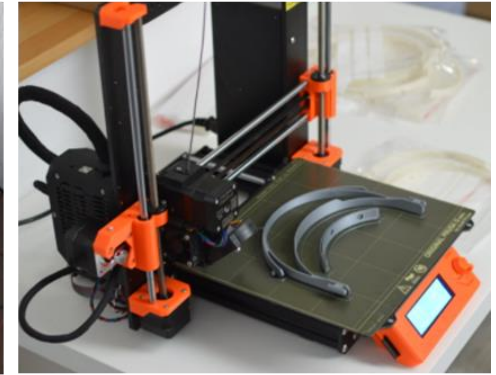
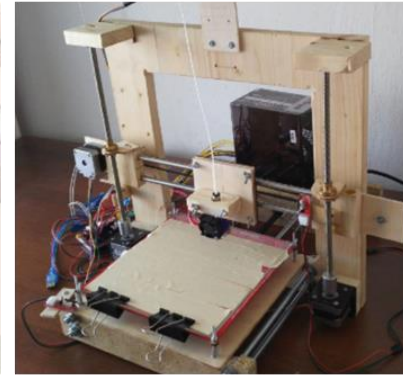
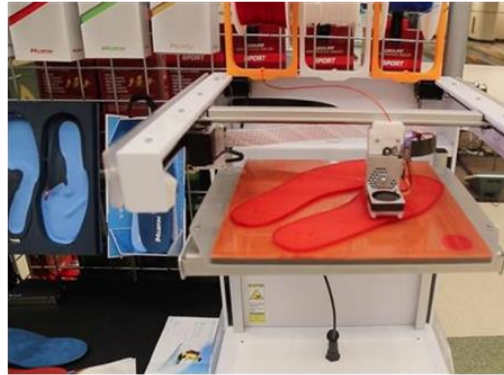
4. Nozzle Diameter

- >0.1mm

5. Print Speed

- 10-150 mm/s

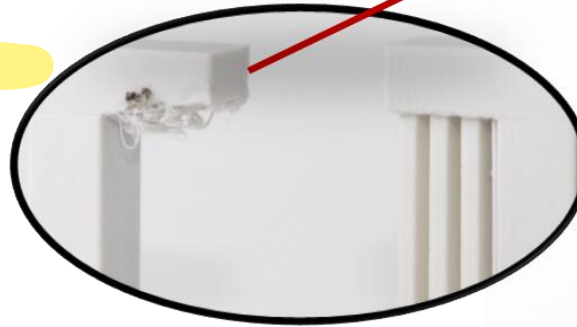
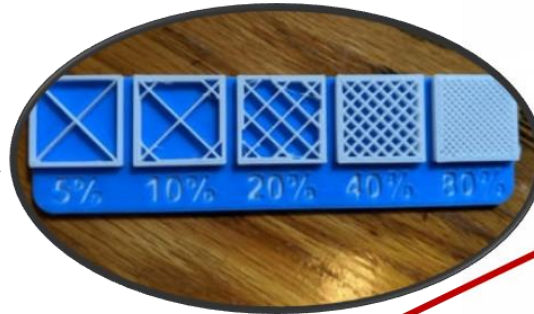
6. Extrusion Speed



FUSED DEPOSITION MODELING

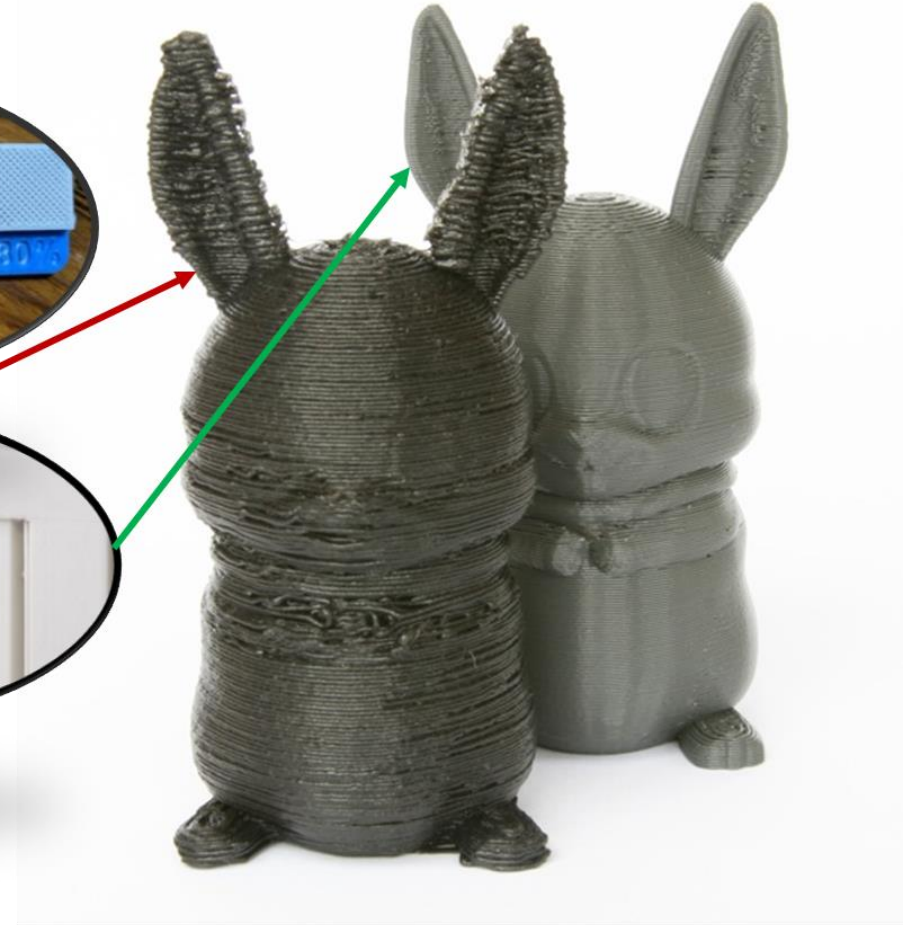
Good Quality 3D Prints

1. Make, build area does not matter
2. Low layer thickness
3. Med-high infill
4. Low-medium print-ext speed
5. Material-nozzle temperature
6. Presence of supports-dissolve



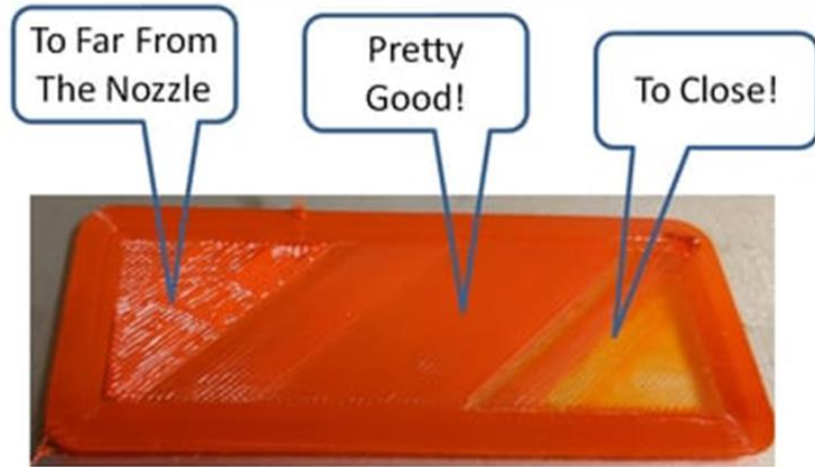
Poor Quality 3D Prints

1. High layer thickness
2. Low infill
3. High print-ext speed
4. Wrong nozzle temperature
5. No supports



FUSED DEPOSITION MODELING

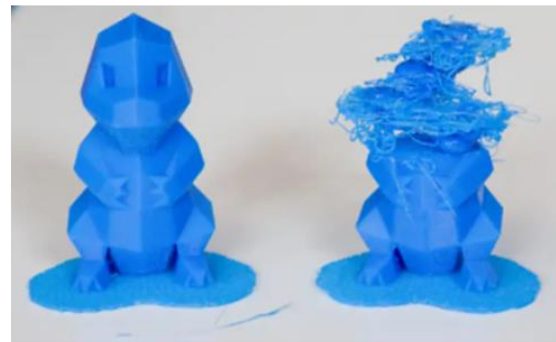
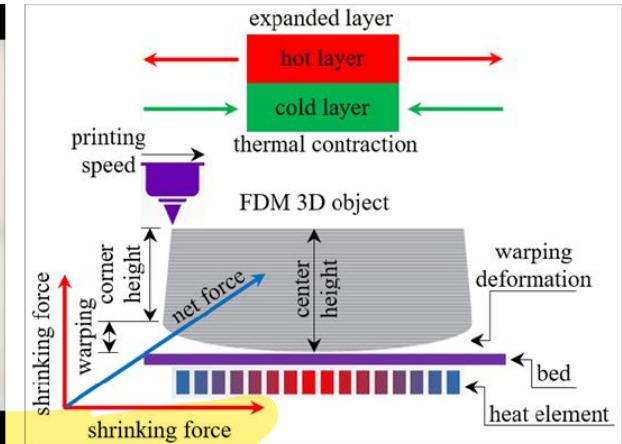
Other Print Quality Issues



Bed leveling Issue



Product warping Issue



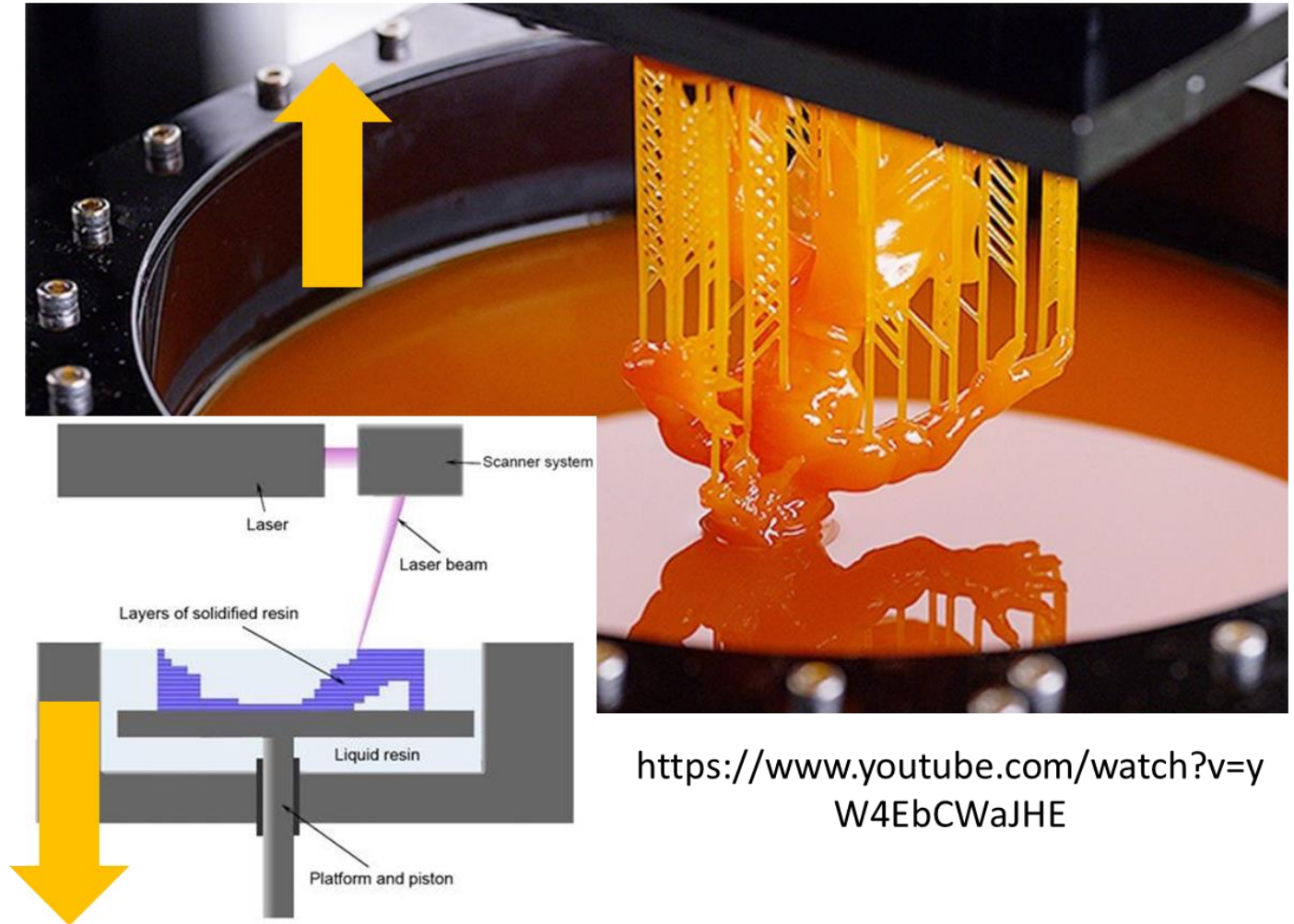
Filament break issue



Layer shift issue

STEREOLITHOGRAPHY (SLA)

- SLA uses liquid photoreactive resin
- Laser beam traces one layer on the surface of the resin
- Laser light cures and solidifies parts it hits
- The platform descends or ascends by one layer



<https://www.youtube.com/watch?v=yW4EbCWaJHE>

STEREOLITHOGRAPHY (SLA)

A few 3D printer variants

1. High Resolution and Accuracy

-Better solution for complex jigs, highly accurate tooling, and molds-General and DIY

-FDM is better for large, simple parts

2. More choice of Materials

-Wide range of compositions-hard to soft

-FDM uses standard thermoplastics only (PLA/ABS)

3. Performance and ease of use

-High repeatability, not very easy to use

-FDM encounter recurrent issues, easy to use

4. Cost and Build Volume

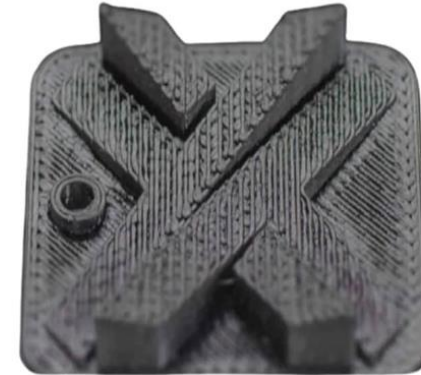
-High cost (1 lakh-crores), low build volume

-FDMs are low cost (10k>), high build volume

6. Extrusion Speed



SLA



FDM



High Res Image 300dpi



Low Res Image 72dpi

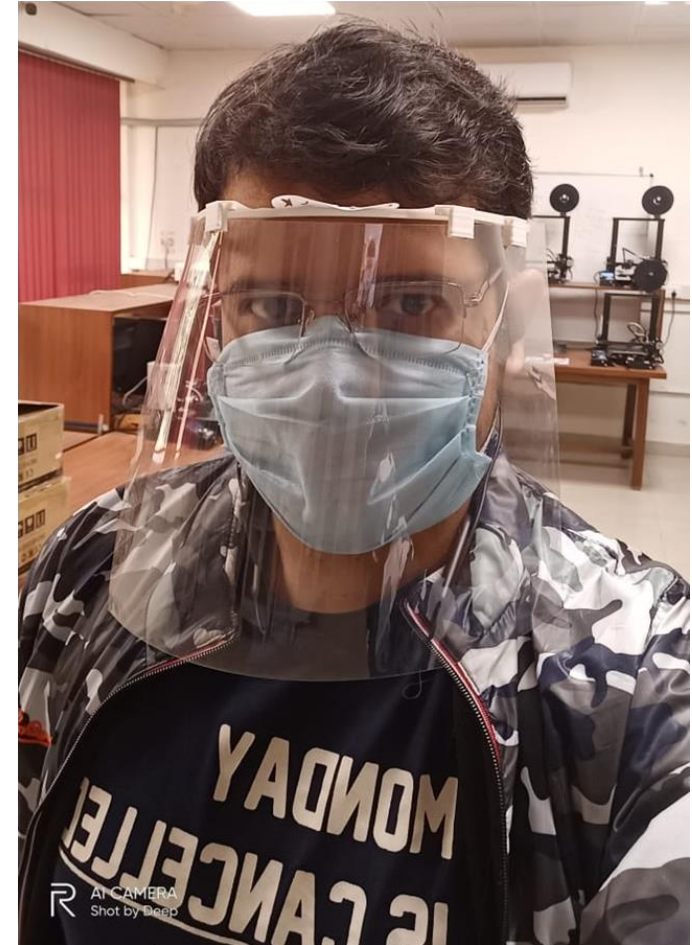
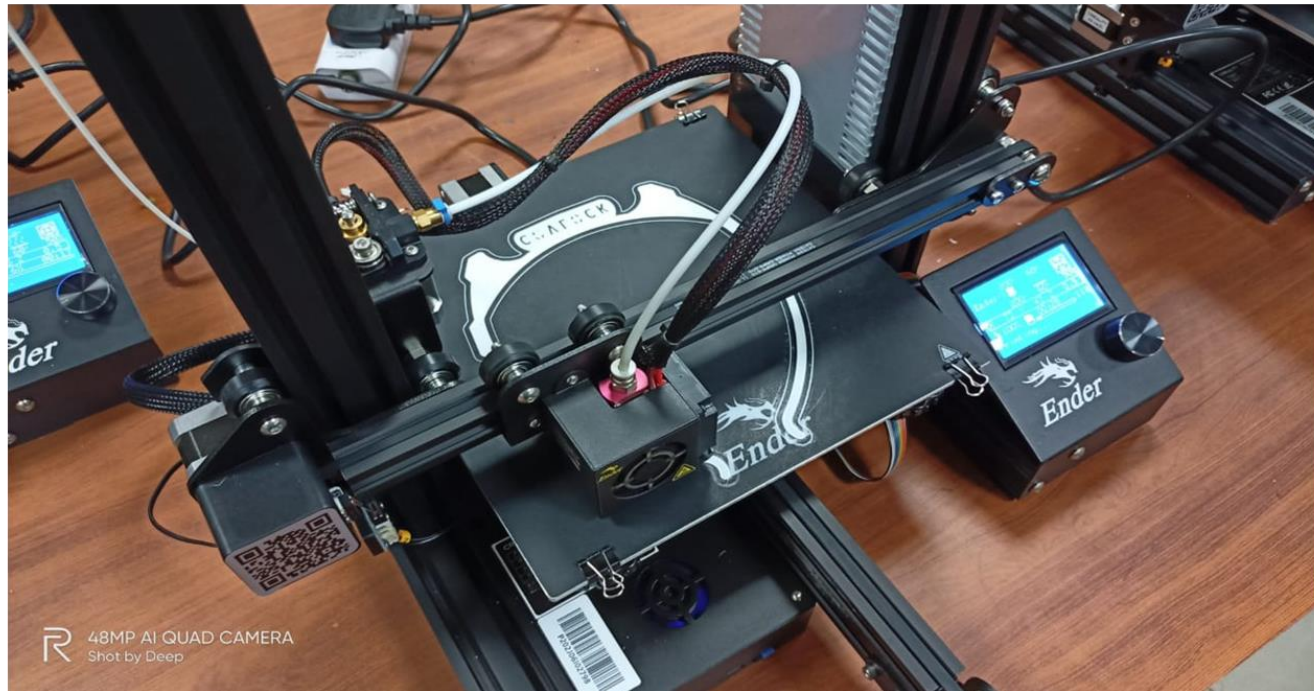
COVLOCK

The Ergonomic 3D Printed Face Shield

IIT Delhi

Prototype Development

- Design optimized (10+ iterations)
- 3D printing and assembly
- Short term and long term testing



Beta Testing

- Volunteer recruitment
- Two weeks of full day testing
- Feedback collection for product improvisation



Production Planning



Production Planning-Volume

- 200+ Printed
- 1st week of production
- Goal of 300-500/week



Production Planning-Package & Ship



Production Planning-Delivery

