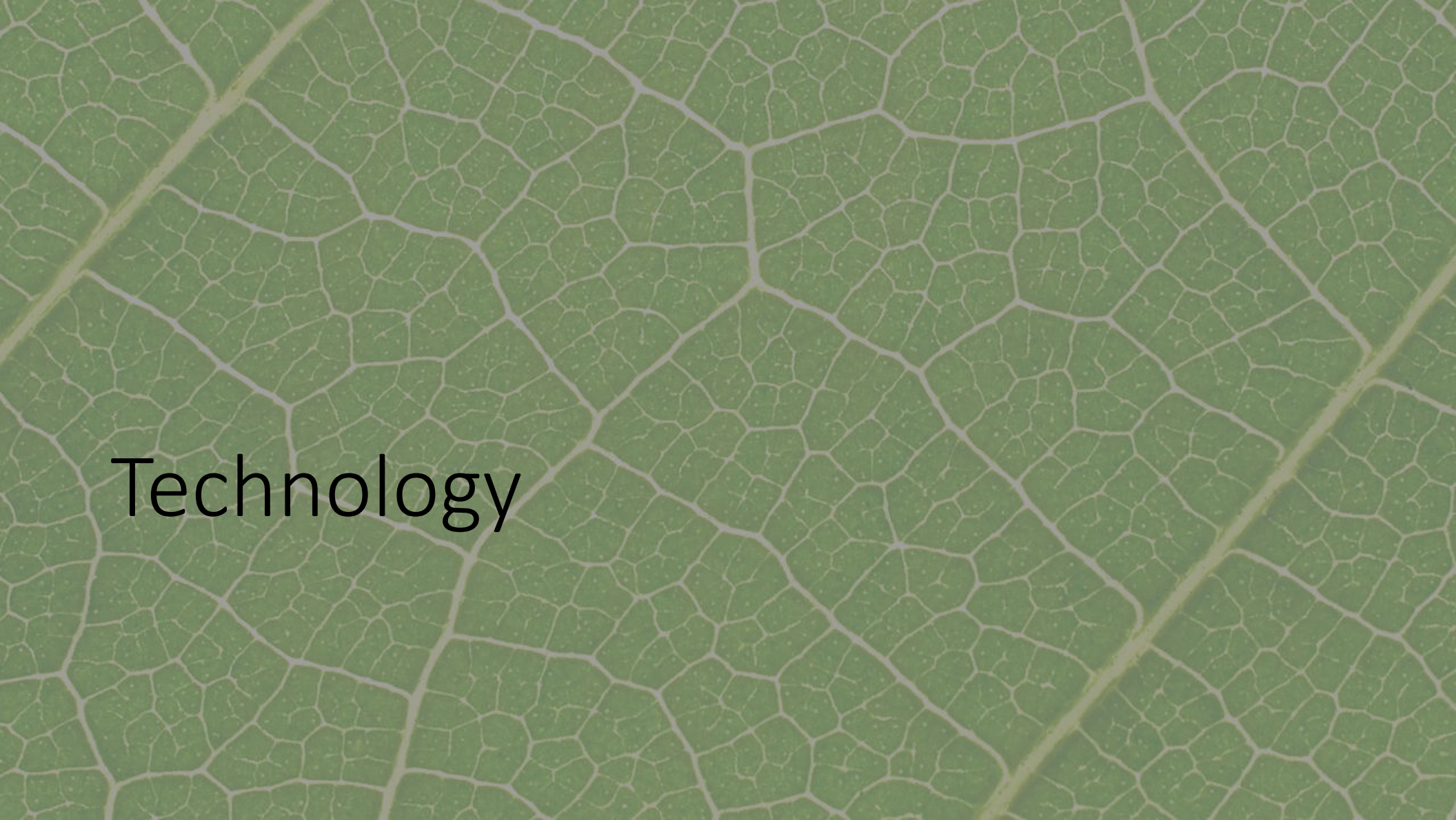

3D Printing
Technology & Impacts
TRAILS 2.0


Technology

Definitions

- Additive Manufacturing (AM)
  - the process of adding material(s) to produce a part
- 3D Printing
  - Form of additive manufacturing (AM) that creates physical 3-dimensional objects directly from a digital file
- This definition is in contrast with the process of subtractive manufacturing, which removes material to produce a finished part
  - whittling something from wood
  - CNC milling, turning

AM LEADING TECHNOLOGIES

American Society for Testing Materials (ASTM) defines seven key processes under which Additive Manufacturing technologies exist:

Material Extrusion	
FDM	Fused Deposition Modeling
FFF	Fused Filament Fabrication
Vat Photopolymerization	
SLA	Stereolithography
DLP	Digital Light Processing
3SP	Scan, Spin, & Selectively Photocure
Sheet Lamination	
UC	Ultrasonic Consolidation
LOM	Laminated Object Manufacturing
Powder Bed Fusion	
SLS	Selective Laser Sintering
DMLS	Direct Metal Laser Sintering
EBM	Electron Beam Melting
SHS	Selective Heat Sintering
Binder Jetting	
CJP	ColorJet Printing
PP	Plaster-based 3D Printing
Material Jetting	
MJP	MultiJet Printing
PJ	PolyJet
Directed Energy Deposition	
LMD	Laser Metal Deposition

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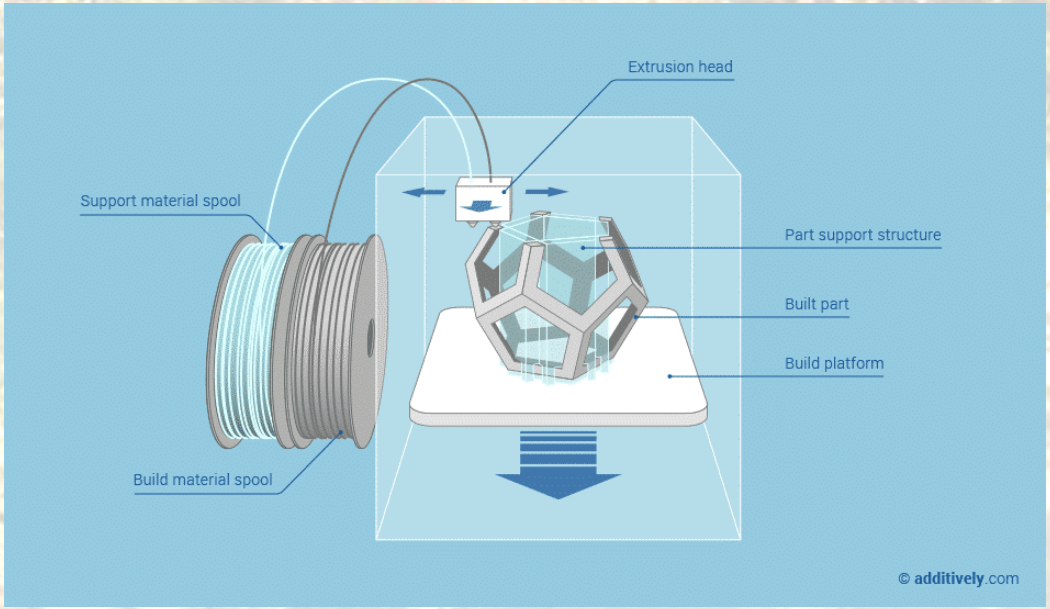
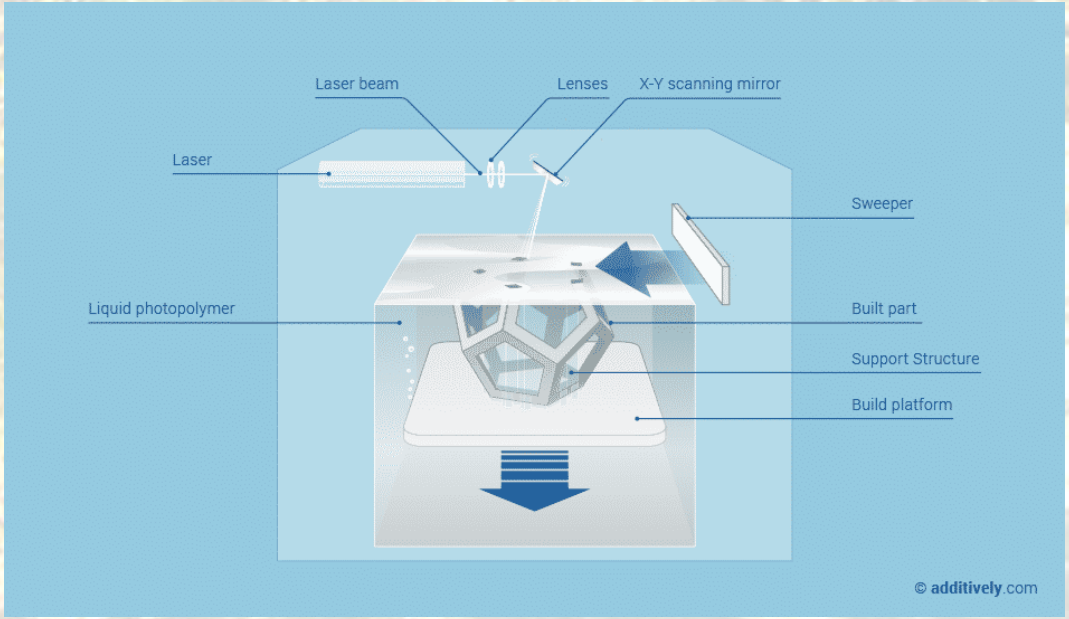
Material Extrusion

- Melting a material, squeezing it out of a nozzle, and selectively depositing it
- Many filament types
- https://www.youtube.com/watch?v=WHO6G67GJbM



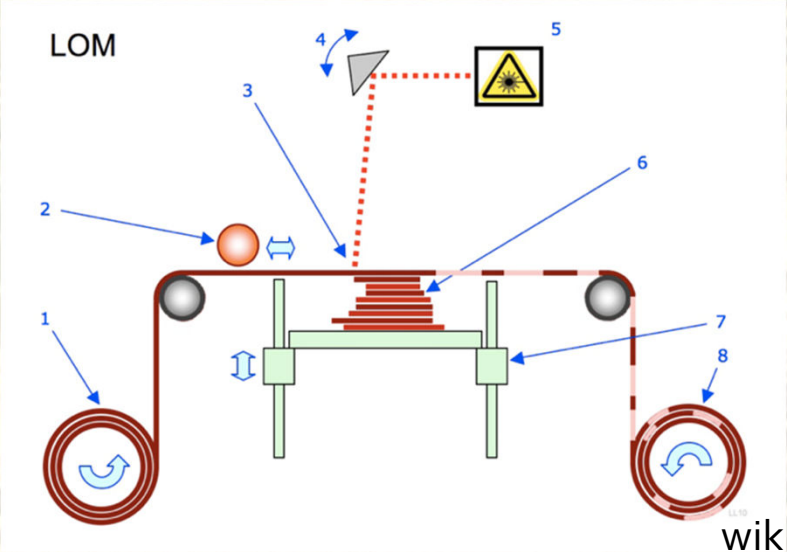
Vat Photopolymerization

- A highly-controlled light source is directed at a light-curing material such as a photopolymer
- More material is added as the part is moved in the Z axis
- https://www.youtube.com/watch?v=8a2xNaAkvLo



Sheet Lamination

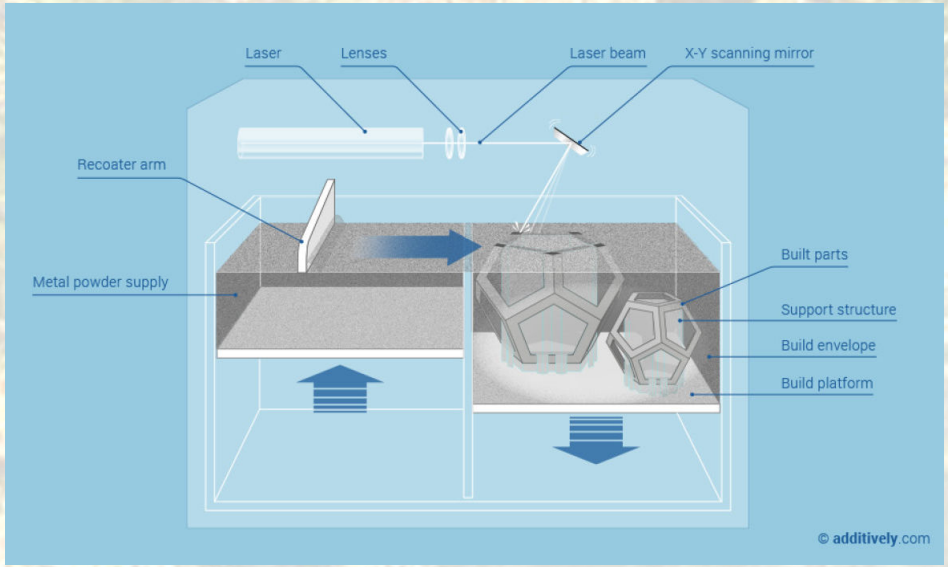
- A material such as paper is laid down
- A print head then applies an adhesive
- A laser or knife then cuts out a pattern
- https://www.youtube.com/watch?v=Aarsp7bEr9c



wikipedia.org

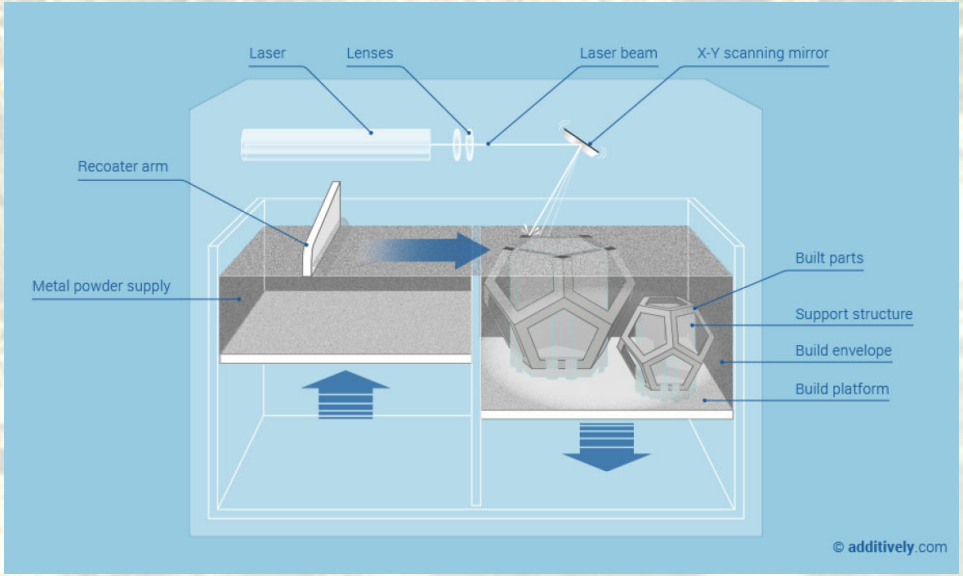
Powder Bed Fusion

- This process uses a laser directed at a powder bed
- The laser sinters the material (ceramic, metal, or polymer)
- The bed then moves down and another layer of material is added
- https://www.youtube.com/watch?v=yiUUZxp7bLQ



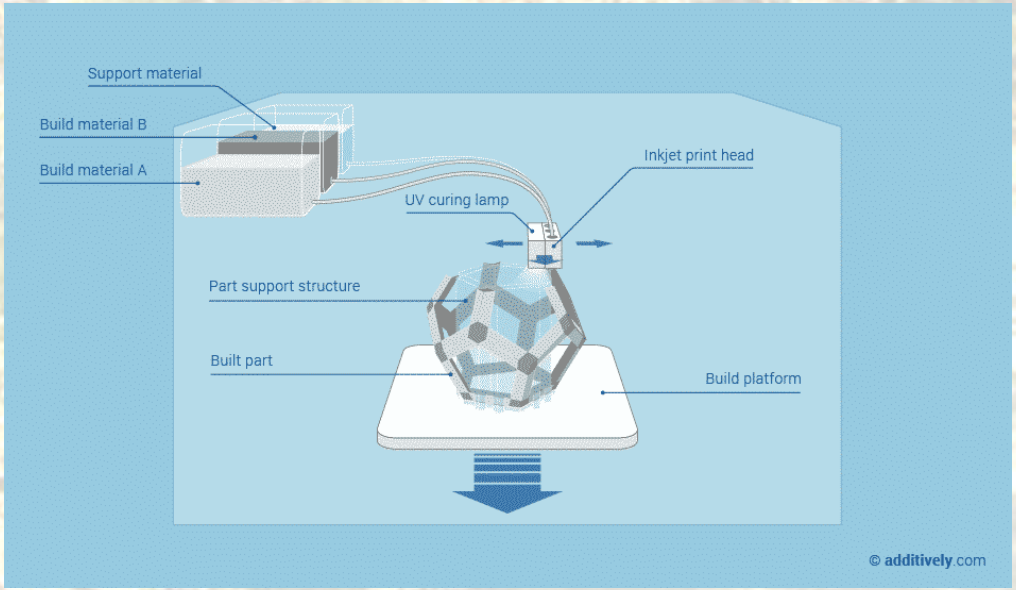
Binder Jetting

- A print head selectively drops a binder onto a bed of powdered material
- More powder is then added
- Can be done with metals, ceramics, and polymers
- https://www.youtube.com/watch?v=Igq8gQuXfR4



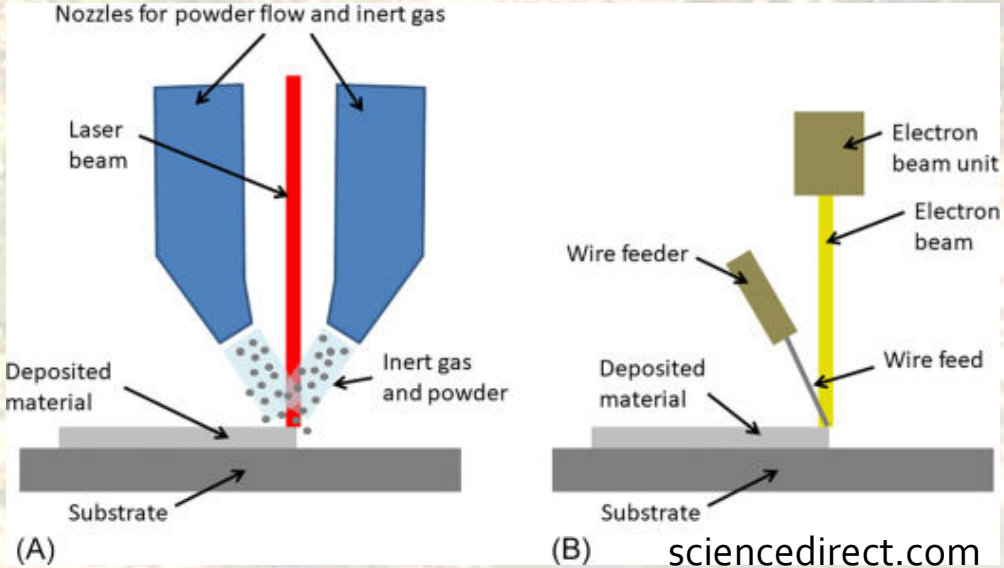
Material Jetting

- A print head selectively prints a photopolymer
- This is then cured
- Multiple materials can be used
- https://www.youtube.com/watch?v=Cz7pKRcuTgs

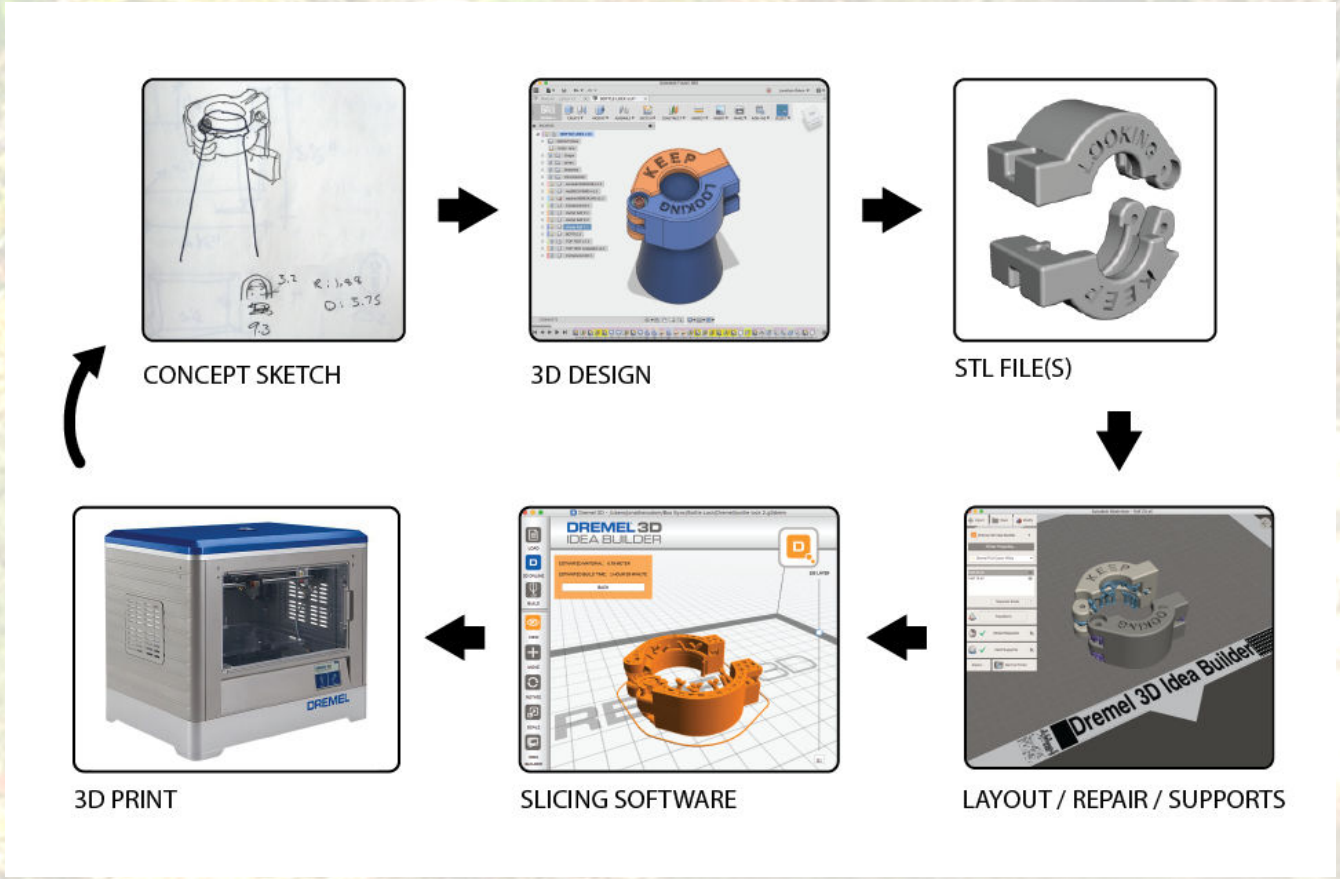


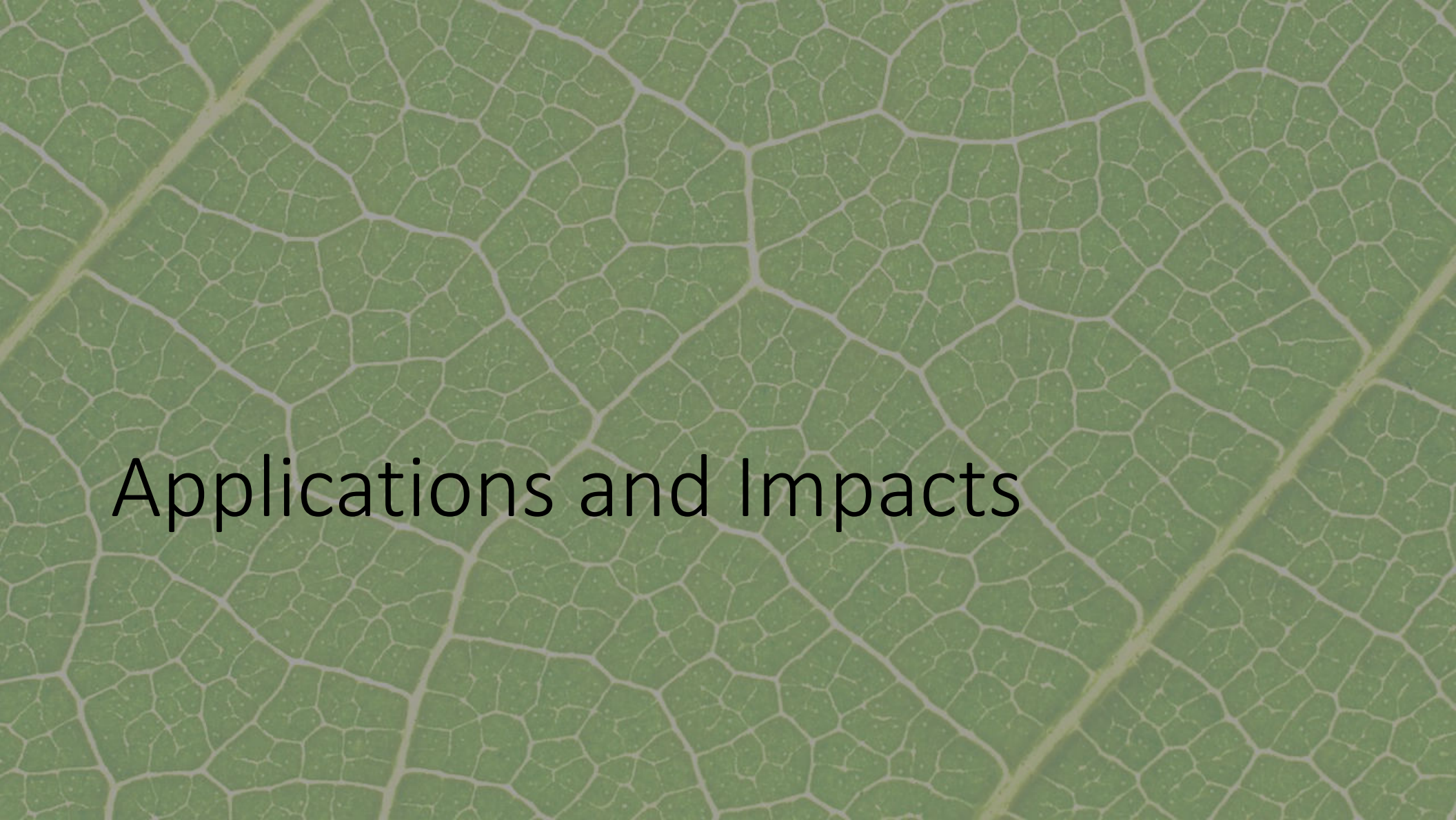
Direct Energy Deposition

- A laser fuses material as it is being added to the part
- https://www.youtube.com/watch?v=oL7bMhPTtDI



General Workflow





Applications and Impacts

Motorsports

CASE STUDY 4 – 2012 ENGINE AIR INTAKE

PRODRIVE WRC TEAM

- Flexible airbox duct required
- Fastest and cheapest route was additive manufacturing
- FDM masters: 60 hours + 6 hours finishing
  - Traditional method: 2 weeks

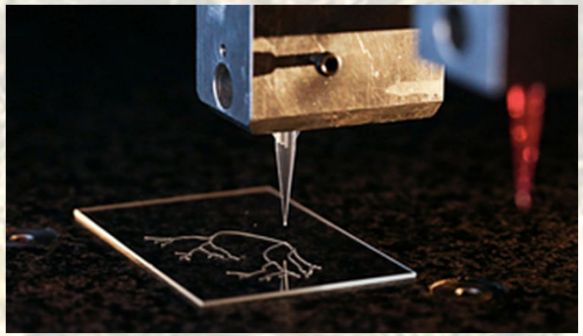
Fashion

- Jewelry - Hot Pop Factory
- Shoes – New Balance
- Sunglasses – Ron Arab

- “With 3D printing we are able to pursue performance customization at a new level to help our elite NB athletes and eventually all athletes, “New Balance President and CEO Robert DeMartin said in 2013.” We believe this is the future of performance footwear and we are excited to bring this to consumers.”
- Reduce financial costs for small designers

- Edision Fashion Design
- https://www.youtube.com/watch?v=oZPEaPSSMKY

Medicine



- 3D printing – life saving technology
- University of Michigan
- A baby had tracheobrochomalacia, the tissue of one portion of his airway was so weak that it persistently collapsed. Doctors printed a splint that goes into the sutures that would fit over the the weakened section of an airway.
- Makerbot Bio Printing
- https://www.youtube.com/watch?v=Zfl_tFdt2D4

Food

- Foodini – 3D-printed invention
- Users first select a recipe, then the machine make the individual components of the dish from scratch and put the components into Foodini's stainless steel ingredient capsules.
- Practical examples: edible wedding cake toppers, easily eaten vegetables for seniors with problem chewing
- https://www.youtube.com/watch?v=UKEdQD0numQ

Socio-economic Transformation: Era of User Manufacturing

Paradigmatic shift in manufacturing

- From factory manufacturing of patented and standardized goods to user manufacturing of patent free and customized goods
- Active user manufacturing through empowered user innovation
- Huge impacts on retailing and logistics as well as manufacturing
- Leadership of the market will be given to individuals
- https://www.youtube.com/watch?v=o7eutklRhMU

(Bogue, 2013)