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3D printing as an inspiring technology for challenges in 21st century

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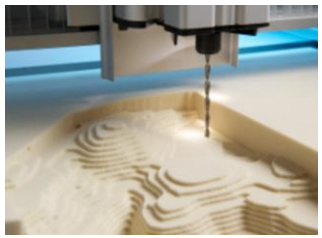
Outline

1. Basics of additive manufacturing
2. General steps in the process of 3D printing
3. Different 3DP technologies
4. Some sample applications

Basics of additive manufacturing (AM)

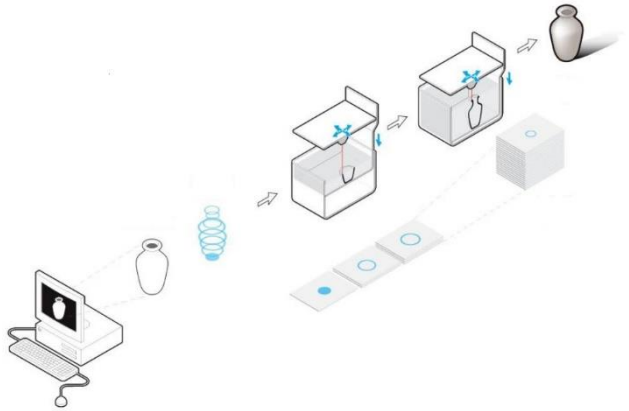
- Building 3D objects by adding layer-upon-layer of material, whether the material is plastic, metal, concrete or one day…..human tissue
- Additive ↔ subtractive
  - build
  - almost no waste
  - layering material
  - e.g. 3D printing
  - remove needless parts
  - significant waste
  - a solid by carving
  - e.g. CNC milling

AM application is limitless.



General steps in the process of 3D printing

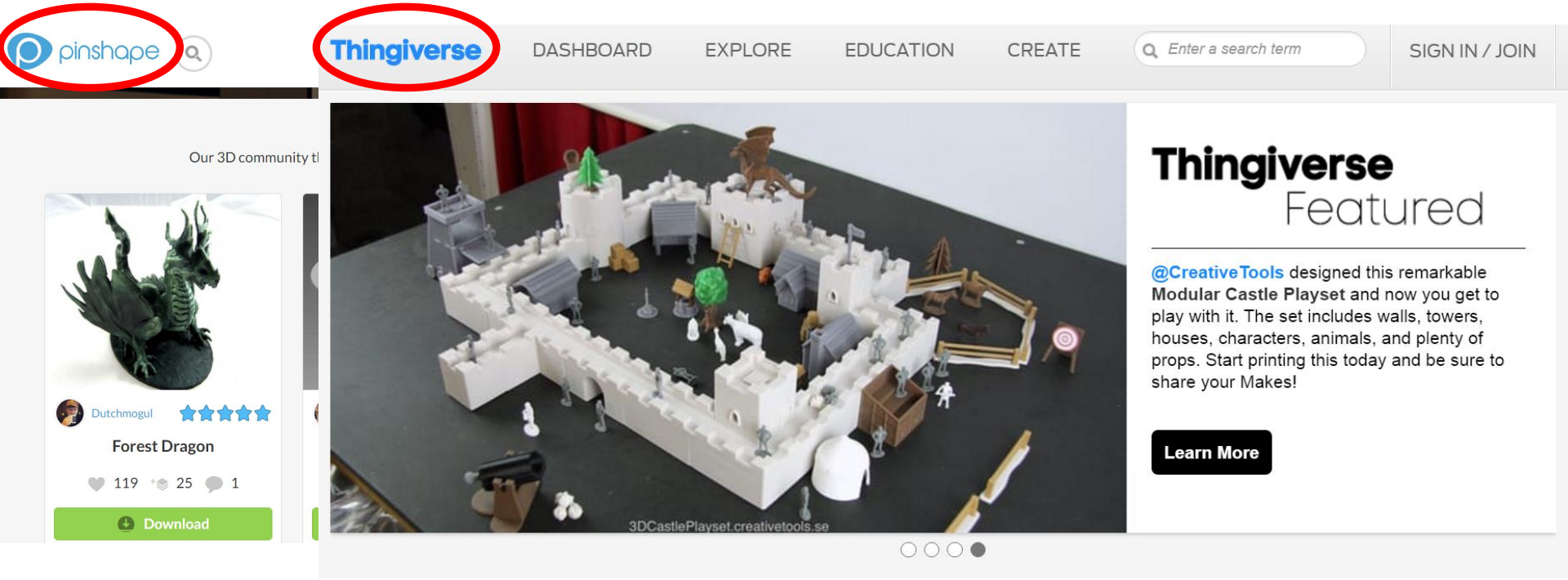
1. Get a 3D model
2. Convert it into .stl (or .obj) file
3. Use a slicer program to create layer-by-layer information
   - lots of settings have to be done
4. 3D print the model
   - post processing may be required



How to get a 3D model?

1; Download it!

Several webpages offer various 3D models for free.



How to get a 3D model?

2; Let's 3D scan the object to be printed!

But how without a 3D scanner?

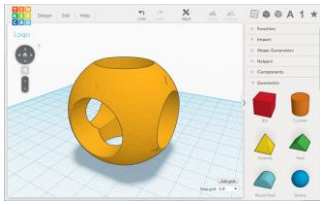
- Autodesk Recap 360
free application to convert
photos into 3D models

- Xbox, Kinect

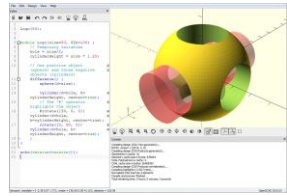
How to get a 3D model?

3; Let’s design the model by ourselves!

- TinkerCAD



- Blender
- 123D
- FreeCAD
- OpenSCAD



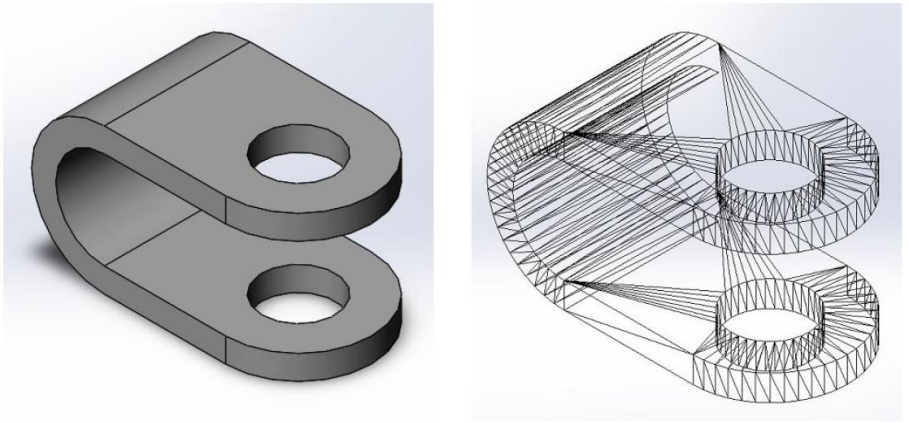
- SketchUp

3D model → .stl

- Depending on the method used to create the 3D model its geometry is stored in different format.
- Design software products support converting a model into an .stl file
- Check Hull, the inventor of stereolithography and founder of company 3D Systems reports that file extension originated from the word stereolithography.

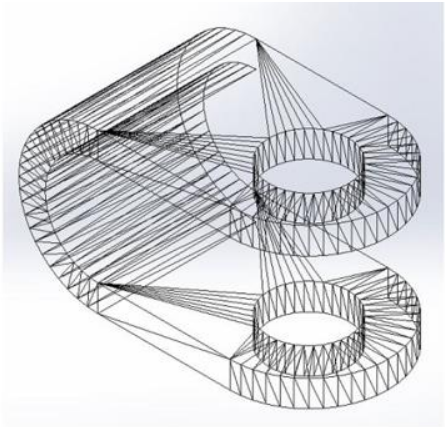
Structure of an .stl file

- STL native files describe only the surface geometry of a 3D object without any representation of color, texture or other common CAD model attributes.
- A series of x, y and z coordinate triplets describing connecting triangular facets and the surface unit normal.
- ASCII or
  binary representation



Why do we need a slicer?

- Description of the surface



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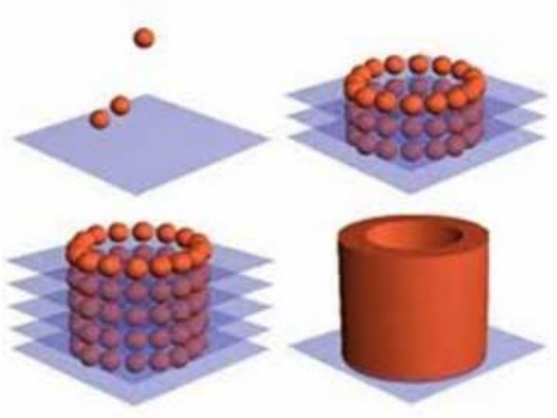
- Information about each layer



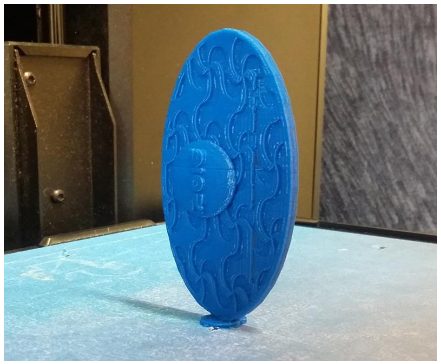
Settings influencing the printing

1; Layer thickness

- depends on the technology and the printer itself
- FDM: 0.1 mm SLA: 0.025 mm
- Influences the vertical resolution (along Z axis)

↓

- Orientation of the object counts



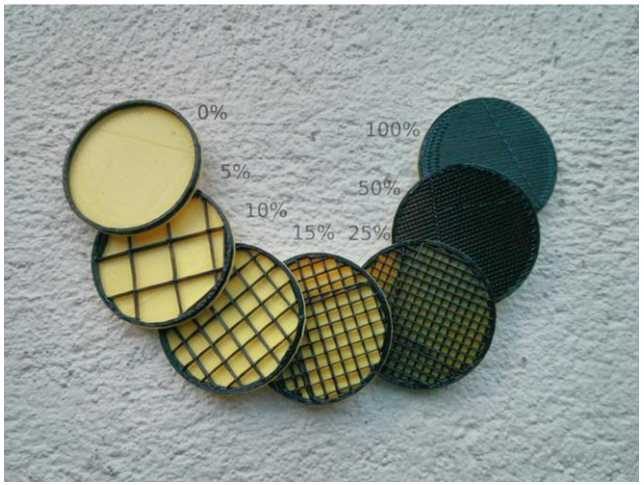
Settings influencing the printing

2; Infill

Affects the mechanical strength.

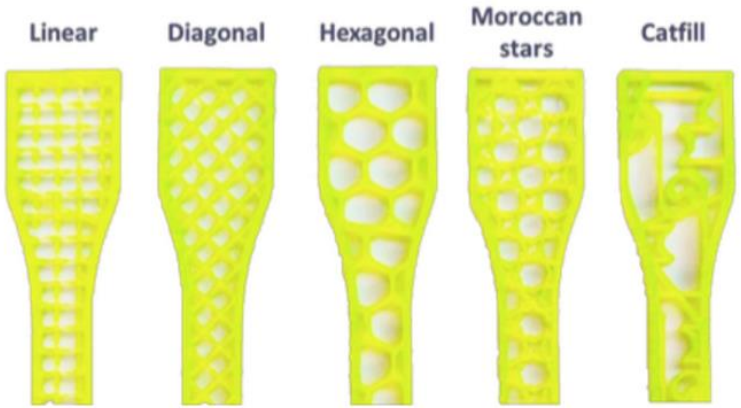
Rate

- 0% - 100%



Geometry

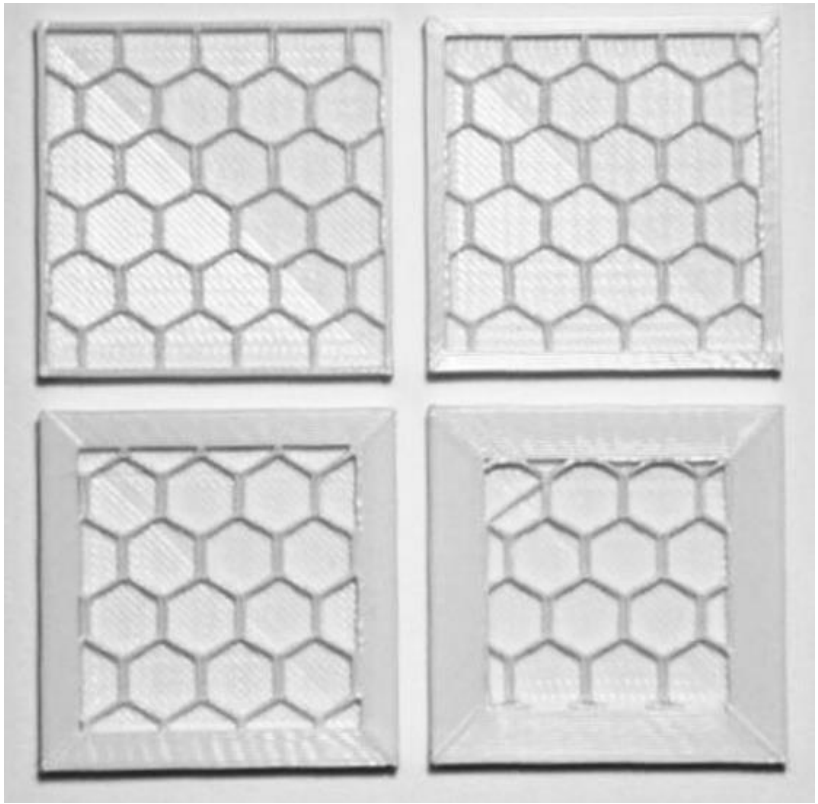
- Linear
- Diagonal
- Hexagonal
- Etc.



Settings influencing the printing

3; Number of shells

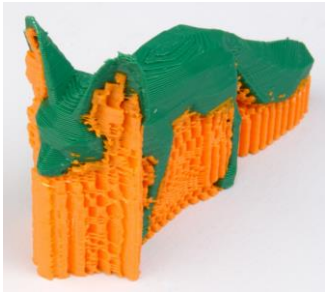
- 2, 5, 10, 15
- affects the mechanical strength
- Limited by the slicer



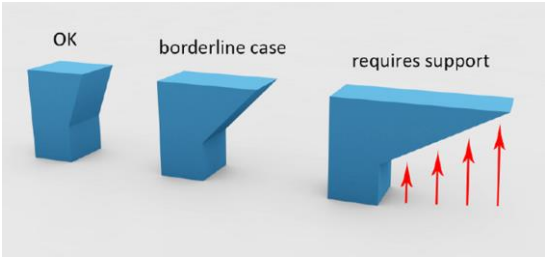
Settings influencing the printing

4; Need of support PLA

- Overhangs have to be handled
- Removable material → possible waste
  - Special material can be used
    e.g. water dissoluble filament
  - Unused row material has a role of support



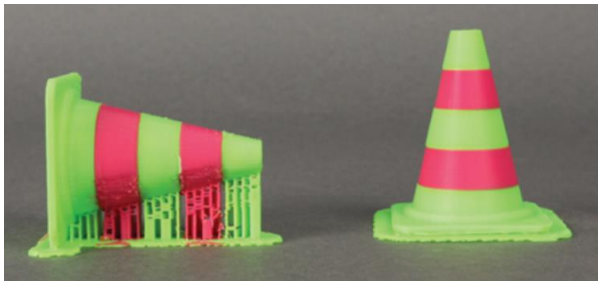
- Slope, bridges and overhangs



Settings influencing the printing

4; Need of support – Is it avoidable?

- Change the orientation



- Split the objects into several parts

Settings influencing the printing

Orientation

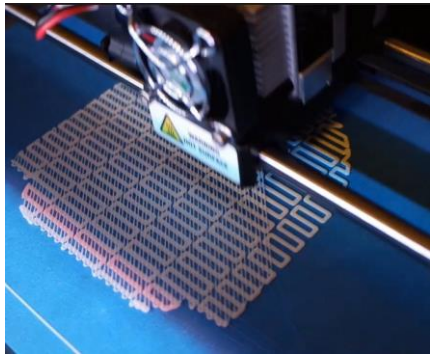
Technology	Importance of part orientation
FDM	Very important
SLA	Very important
SLS	Not important
Polyjet	Important
Binderjet	Not important
Metal printing (SLM or DLSM)	Very important

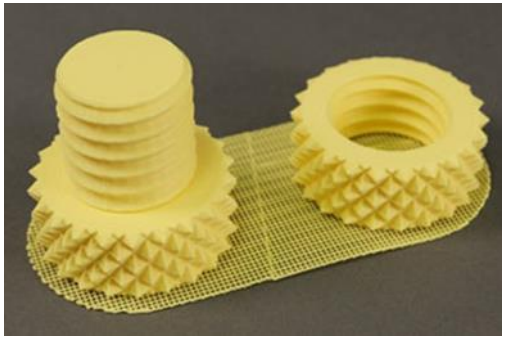
Settings influencing the printing

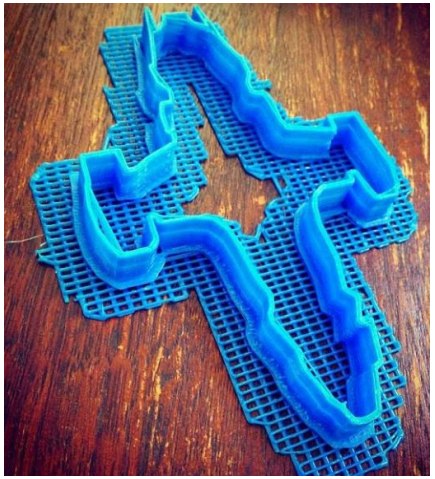
5; Raft

A few layers of material set down to the plate.

- Eliminate bad leveling of the plate
- Get an object to stick to the plate
- Fix the object in a special orientation

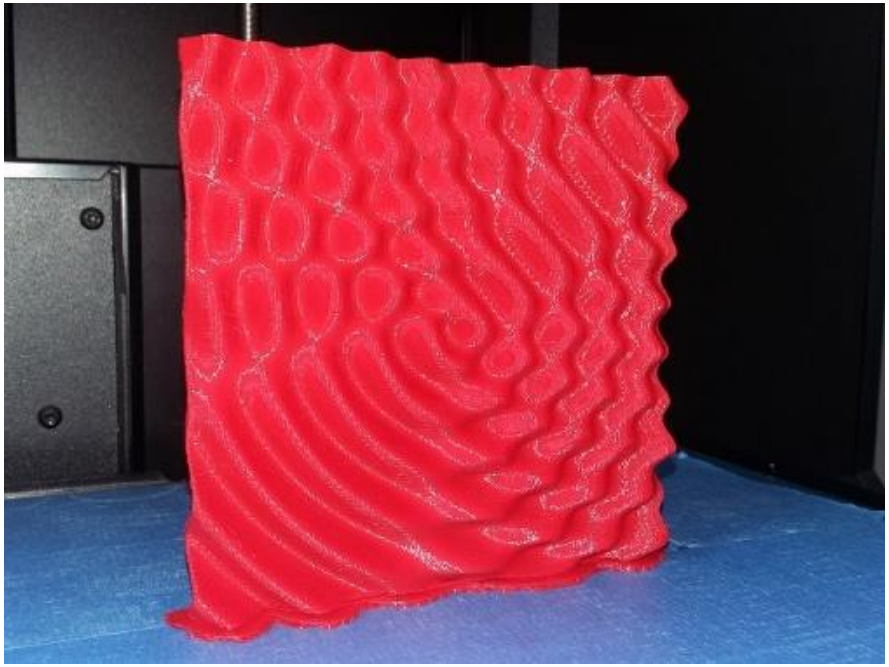


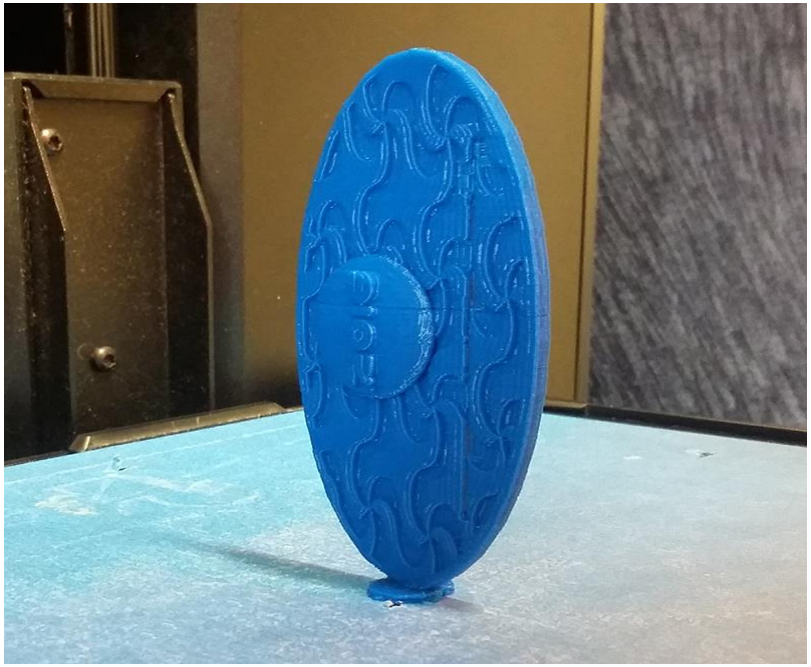




Settings influencing the printing

6; Orientation

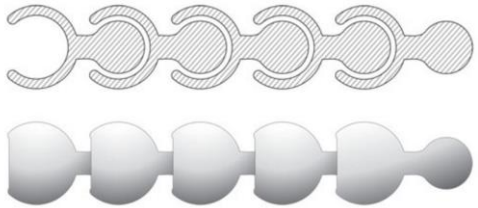




Uniqueness of 3D printing

- Printing real ”chain”
  series of interlinking closed links

- Print in place
  various type of joints, moving parts, hinges



- Affinity to accommodate custom needs

- Raw material & printer

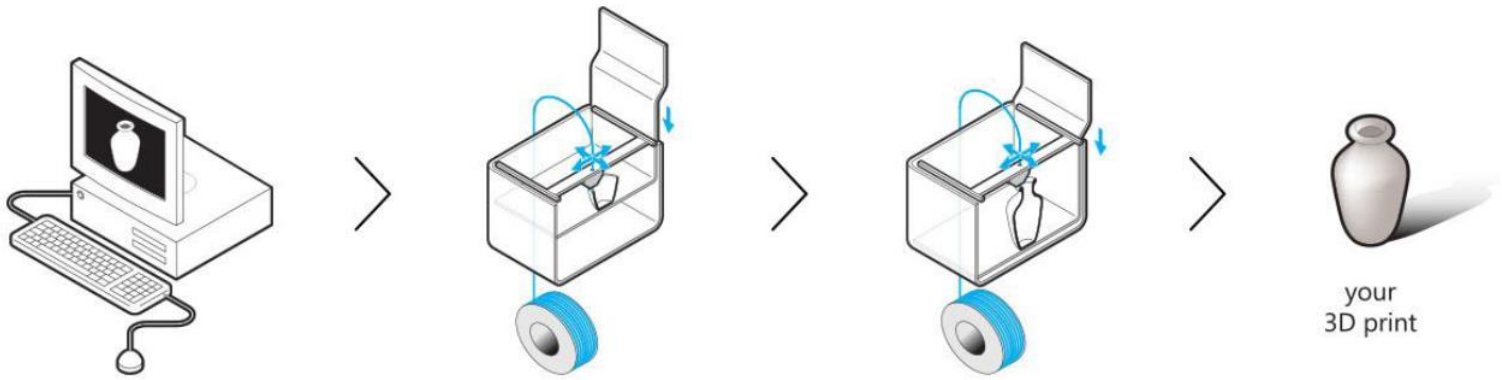
Most essential 3DP technologies

- Filament-based 3D printing
- Stereolithography
- Selective Laser Sintering

Further details in the presentation of Case Study 1.

Filament-based 3DP

- Fused Deposition Modeling (FDM)
  - a long plastic filament is fed through a spool to a nozzle where the material is liquefied and 'drawn' on the platform, where it immediately hardens again.
  - Material: PLA, ABS
  - video



Stereolithography (SLA)

- Focusing a UV laser onto the **transparent bottom of a tank** of liquid photopolymer resin.
- The light cures or hardens the top layer of the resin, building the object from the top down.
- Mainly used to create prototypes for products and in medical modeling.
- video

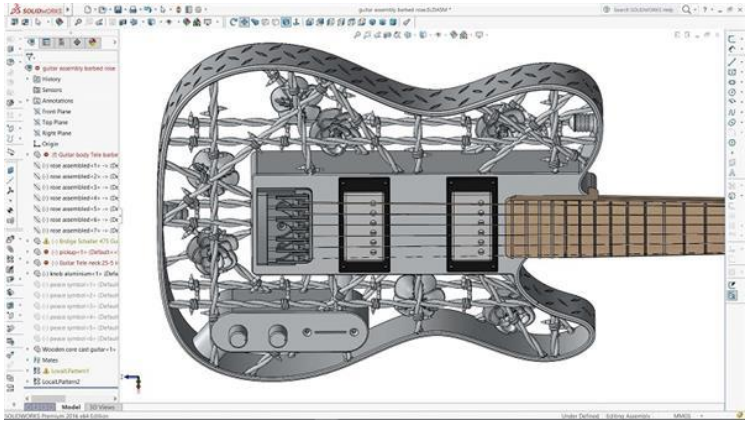
Selective Laser Sintering (SLS)

- Laser is used to sinter the powdered material plastic, metal, ceramic, glass.
- Unused powder serves as support.
- video

Some applications (not related to H2020)

Musical instrument

- Aluminum steampunk guitar
- Designed with SolidWorks based on Sweden ideas
- Printed by a Dutch company
- One piece of 0,1mm layer height
- Its sound is of high quality
- Postprocessing: 4 days



Some applications (not related to H2020)

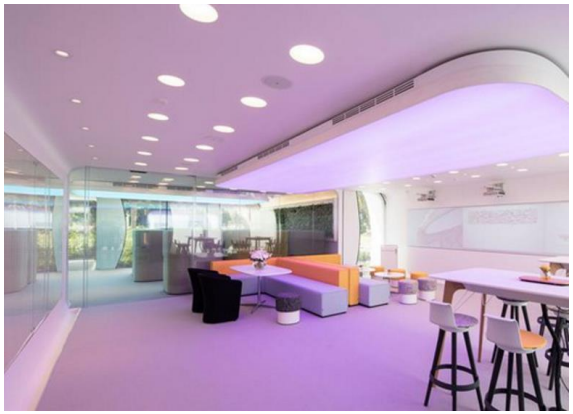
Trainer

- Goal: lightweight, highly stable, and cushioning shoes to support athletes during the most intense workouts.
- Generative design
- Autodesk Fusion 360 and 3ds Max were used as well.
- The first commercially available 3D printed performance trainer.

Some applications (not related to H2020)

Building in Dubai

- Built in the frame of project *Museum of the Future*
- Material: special mixture of cement
- Area: 250 m^2
- Volume of printer: 6,5m high, 47m length, 13m width
- 17 days, ≈ 130.000 EUR (including design elements)
- Expense of human labor is halved
- not the first one



Some applications (not related to H2020)

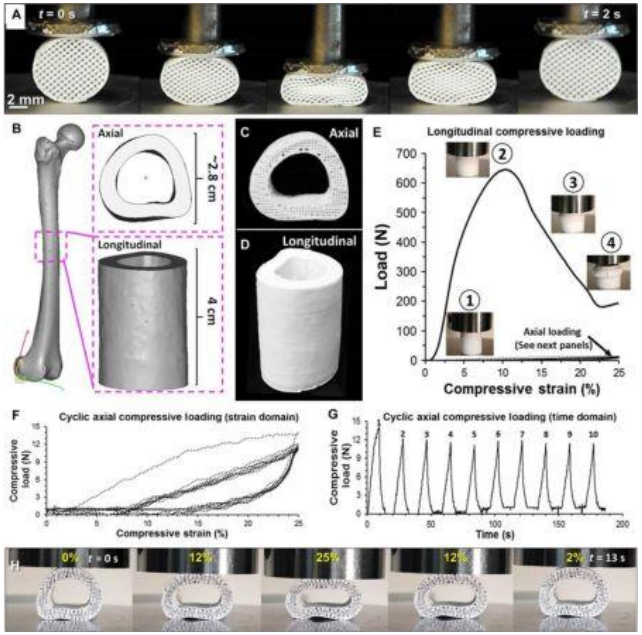
First Japanese 3D printed car

- Collaboration of Kabuku and Honda.
- Small volume to carry confectionery products.

Some applications (not related to H2020)

Realistic bones

- Special material acting like real bone for custom-made implants.
- Tested on monkeys
  The implant had fully integrated, fully vascularized with the monkey's own skull.



Some applications related to H2020

In the presentation of Case Study Group 1

Thank you for your attention.

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