Introduction to 3D modelling and fabrication

Johdatus 3D-mallinnukseen

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OULUN YLIOPISTO

Euroopan unioni
Euroopan sosiaalirahasto

Vipuvoimaa EU:lta 2014–2020

TehdäänMuutos
Digitaalisella pienvalmistuksella uusille urille

TERVETULOA!

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Digitaalisella pienvalmistuksella uusille urille

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Suunnittele ja tee oma pieni huonekalu tai sisustusesine

Create your own small piece of furniture

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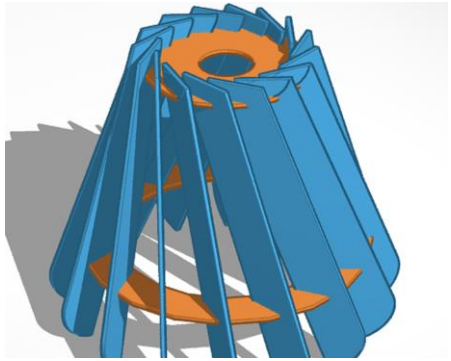
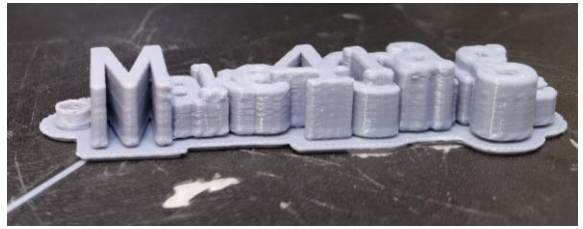
Mitä opit?

WHAT ARE YOU LEARNING?

- Ymmärrät, mitä 3D-mallinnus on
  Understand what 3D modeling is
- 3D-mallinnus osana digitaalista pienvalmistusta
  Uses of 3D modeling for digital fabrication
- Opit 3D-mallinnuksen perusteet
  Basics of 3D printing
- Valmistat 3D-mallin laserleikattavaksi
  Create a 3D model for laser cutting
- Design constraints





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Ohjelma 1. päivä

Johdatus 3D-mallinnukseen käyttäen Tinkercadia ja 3D-tulostukseen

Introduction to 3D design with Tinkercad and to 3D printer

- Mitä 3D-mallinnus on?
  What is 3D design?
- **Projekti 1: Valmistele avaimenperä, jossa on sana**
  - Tinkercad-harjoitus: 3D-suunnittele avaimenperä
    Tinkercad tutorial: 3d-design a keyring
  - 3D tulostin: Valmistele malli 3D-tulostinta varten
    3D printer: Prepare a model for the 3D printer
- 3D-mallinnuksen käyttötavat digitaalisessa pienvalmistuksessa
  Uses of 3D modelling in digital fabrication
- 3D-mallinnuksen suunnittelumallit
  3D modelling design paradigms

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Ohjelma 2. päivä

"Making" eli varsinainen valmistaminen

- **PROJEKTI 2: Luo 3D-malli pienelle sisustusesineelle, valmistele malli laserleikkurilla leikattavaan muotoon**

  Create a design in 3D to be cut with the laser cutter.

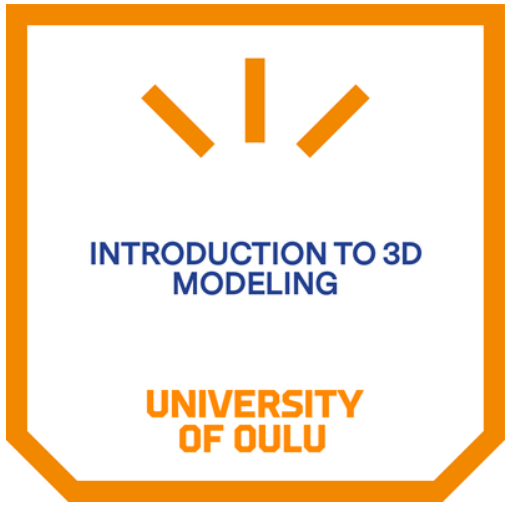
  - **Luo 3D-malli** sisustusesinettä varten
    >> Apuna harjoitusvideo -> kuulokkeet!
    Create a 3D model of a small piece of furniture
    >> Youtube tutorial -> headphones!)

  - **Leikkaa** mallin osat laserleikkurilla
    Cut with the laser cutter

- REFLEKTOI JA ANNA PALAUTETTA

OSAAMISMERKKI
DIGITAL BADGE

- **HUOM!** Those that create their own design will have the “Intro to 3D modeling” badge

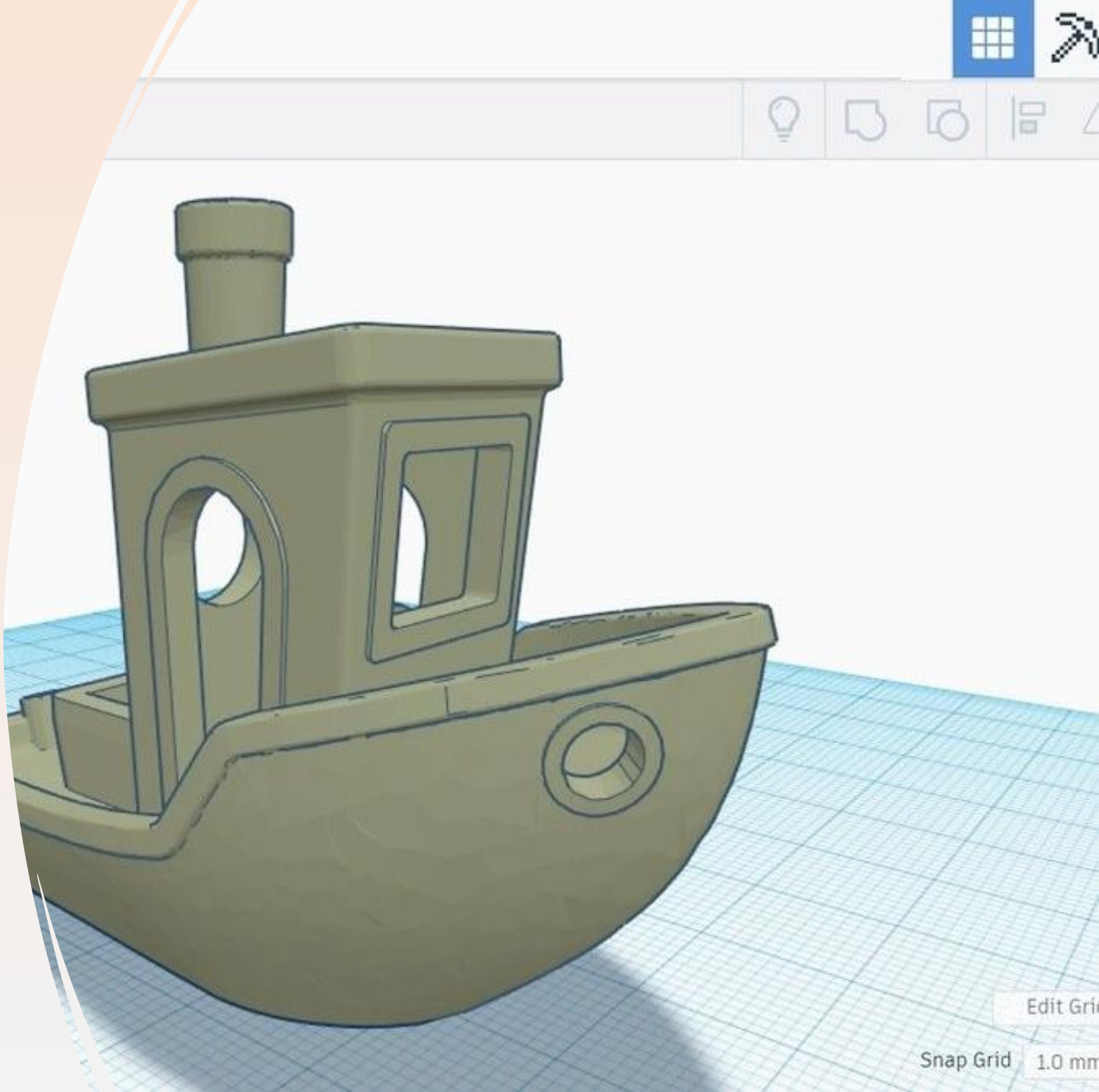


- **Send** the link to your TinkerCad design as well as a picture of the final product to marta.cortes@oulu.fi
  - To get the link: Click on  ***“Invite people design with you”*** and copy the link

- It should contain a model that can be 3D printed
  - STL file can be generated
  - It contains different shapes
  - Align / Group must be used
  - One or more of your shapes must be *holes*
  - The result should be a combined part

Mitä 3D-mallinnus on?

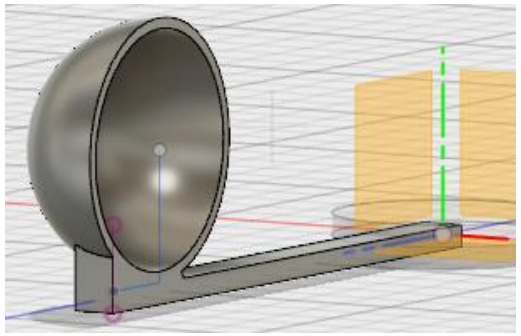
What is 3D modelling?



3D Malli
3D Model

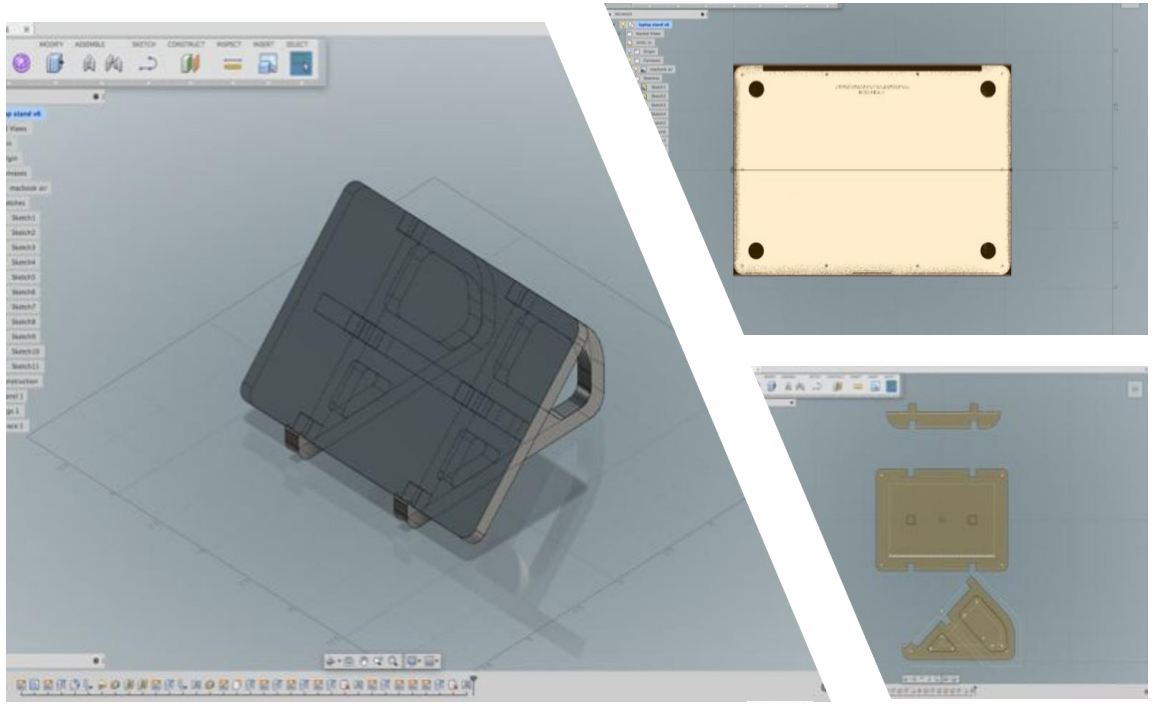
❖ Esineen minkä tahansa pinnan 3-ulotteinen (3D) malli
Representation of any surface of an object in 3 dimensions

- Leveys (width)
- Pituus (Length)
- Korkeus (Height)



❖ 3D-mallinnus ohjelman avulla voi
With 3D modeling software (CAD software)

- Luoda 3D-mallin
  Create a 3D model
- Muokata olemassa olevaa mallia
  Modify an existing one
- Tarkastella mallia eri kulmista
  Visualize it from different perspectives



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Projekti 1
3D print a nametag

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3D-suunnittele avaimenperä, jossa on sana ja 3D-tulosta se

3D model and 3D print a name tag

- **TEHTÄVÄ 1: Luo 3D-malli** sanasta/nimestä tms. Tinkercadilla
  Create a 3D model of a word with Tinkercad
- **TEHTÄVÄ 2: 3D-tulosta malli**
  3D print the model

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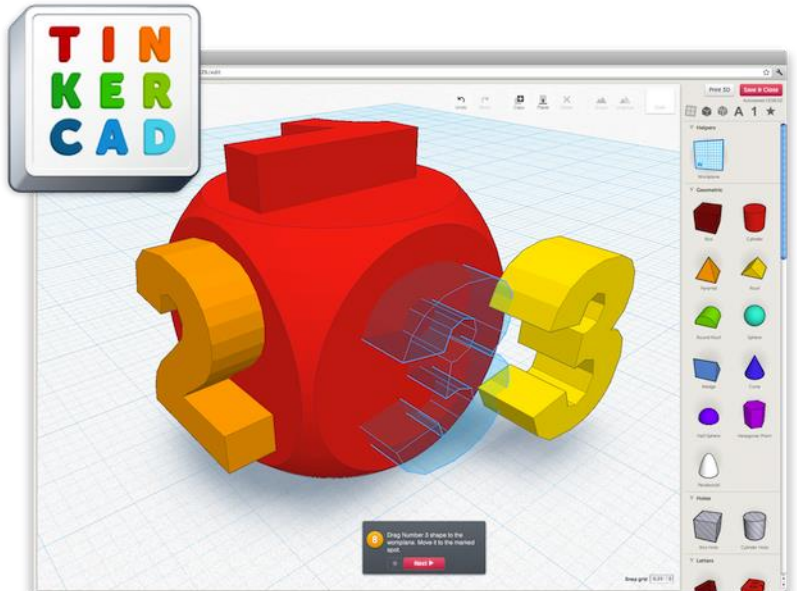
TEHTÄVÄ1: Tinkercad tutorial



http://blogs.dickinson.edu/mediacenter/2014/07/07/tinkercad-and-intuitive-design/ @seltzerb

- **AVAA/OPEN TINKERCAD:**
  https://www.tinkercad.com/

- Kaksi vaihtoehtoa Tinkercadin käyttöön:
  Two options for using tinkercad:

1. Luo oma Autodesk-tili (**voit käyttää tiliä myös myöhemmin**)
   Create your own Autodesk account (**You can use the account also later**)

2. Liity Make4Change -”luokkaan” (**Voit käyttää vain tämän työpajan aikana**)
   Join to Make4change class **(You can use only in this workshop)**
   Sign in > Students, “Join your class”
   - Käytä annettua koodia
     Use the code we give you
   - Käytä etunimeäsi pienin kirjaimin käyttäjänimenä
     Use your firstname (lowercase) as nickname

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TASK1:
Tinkercad tutorial

Step-by-step tutorial:
https://wikifab.org/wiki/Design_your_personal_logo_with_Tinkercad

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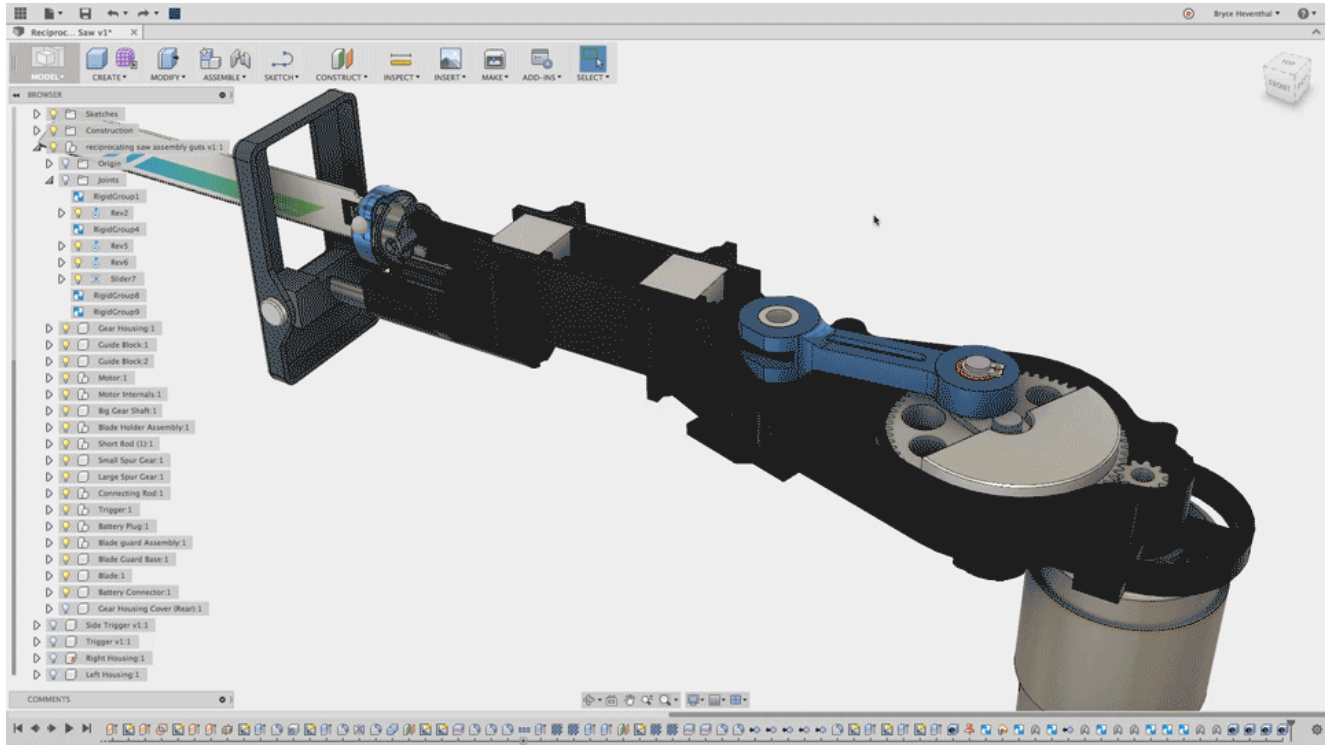
3D-mallinnuksen käyttötavat digitaalisessa pienvalmistuksessa

Uses of 3D modelling in digital fabrication

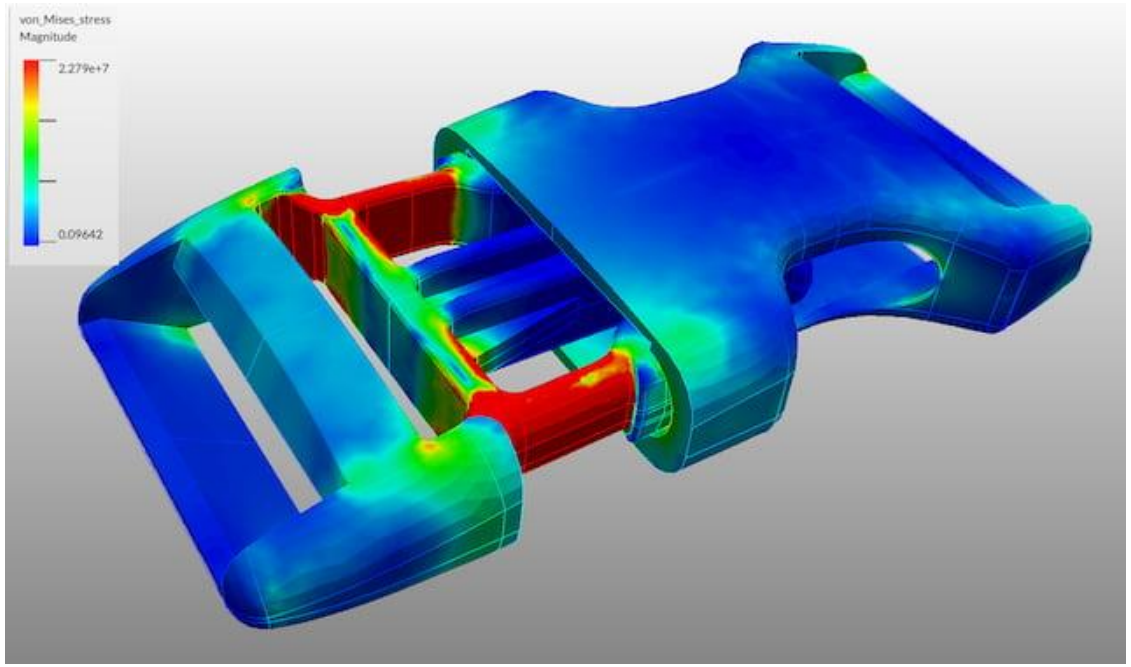
https://twitter.com/tmg_makerspace/status/1336590721156050944

Mekaanisten ominaisuuksien simulointi ja analysoiminen

Simulation and analysis of mechanical properties



http://archive.fabacademy.org/2018/labs/fablabreykjavik/students/jonthor-sigurdsson/week3.html



https://fractory.com/finite-element-analysis-software/

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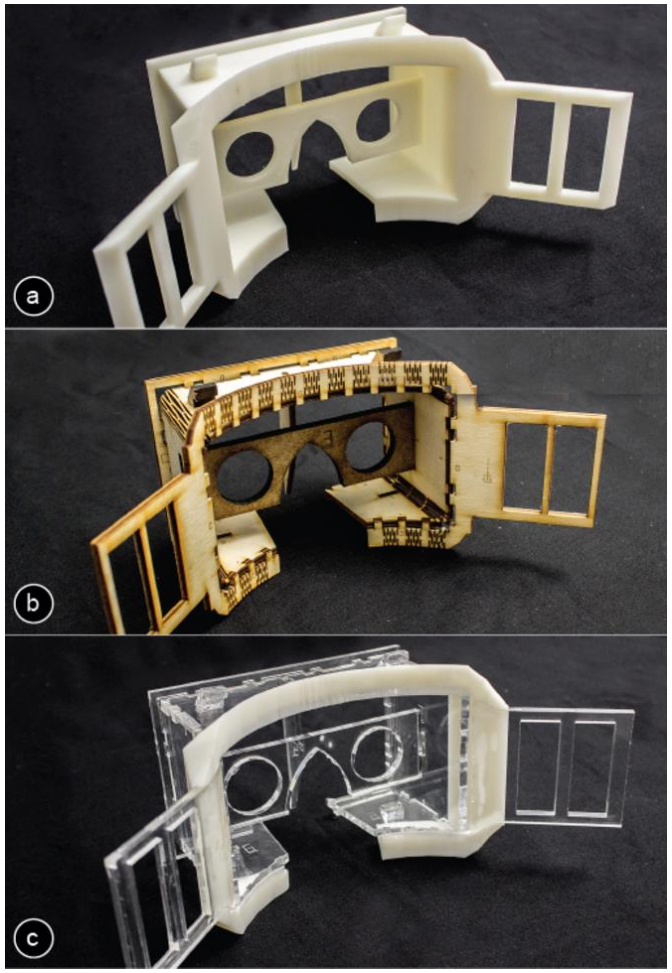
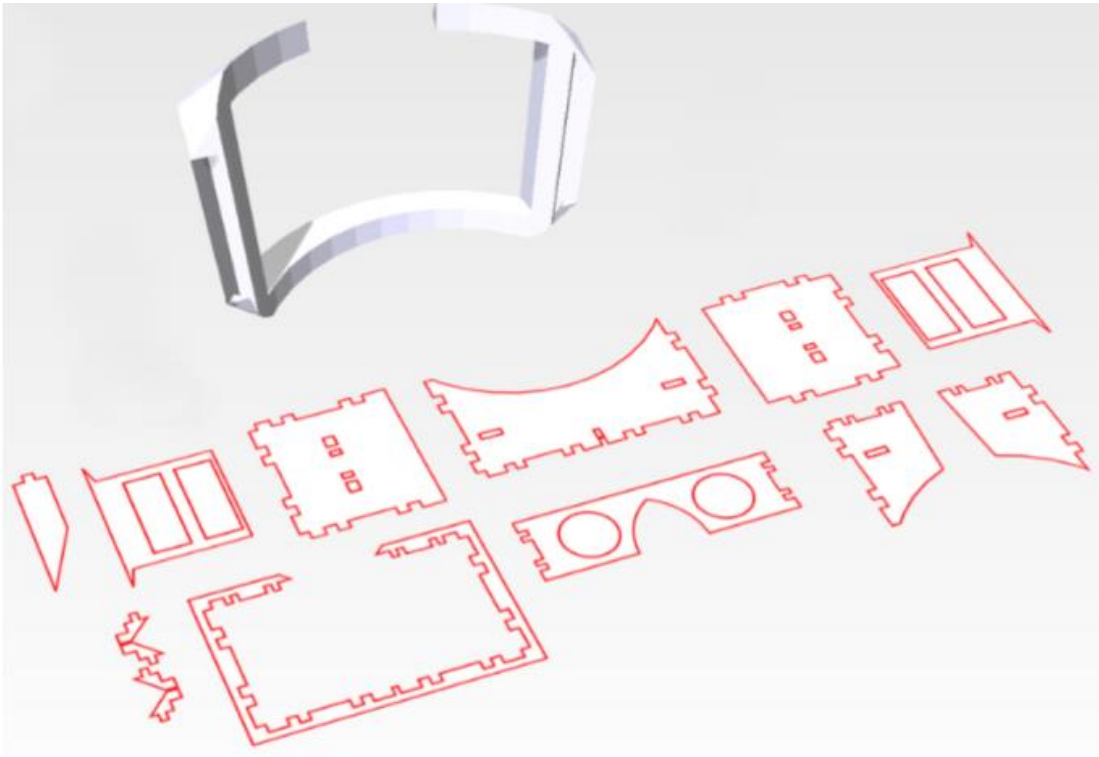
Laser- ja vinyylileikkaus

Laser cutting / vinyl cutting

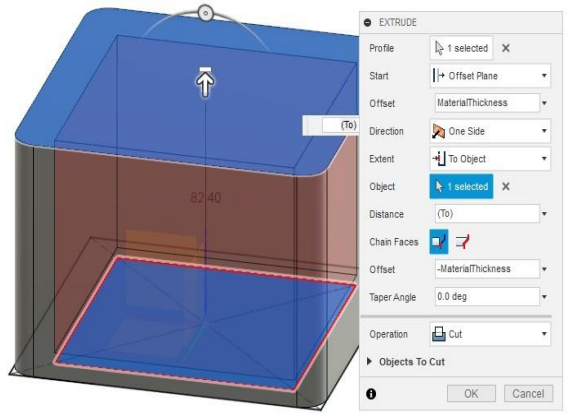


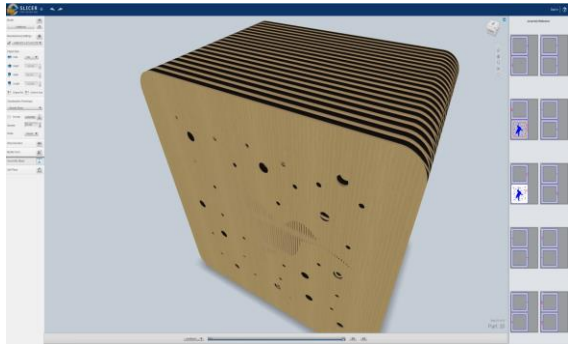


https://api.semanticscholar.org/CorpusID:7103007

3D-objektien laserleikkaus

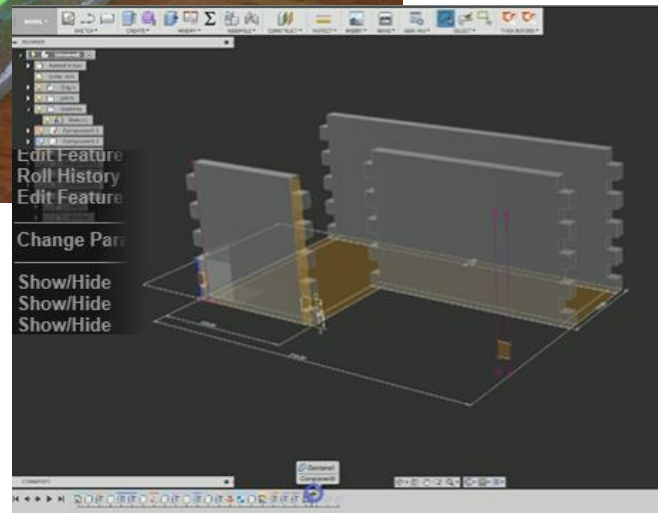
Laser cutting 3D objects





http://fab.academany.org/2020/labs/oulu/students/noora-nyberg/projects/final-project/

https://forums.autodesk.com/t5/fusion-360-design-validate/designing-finger-joint-tabs-for-complex-geometries/td-p/8512187



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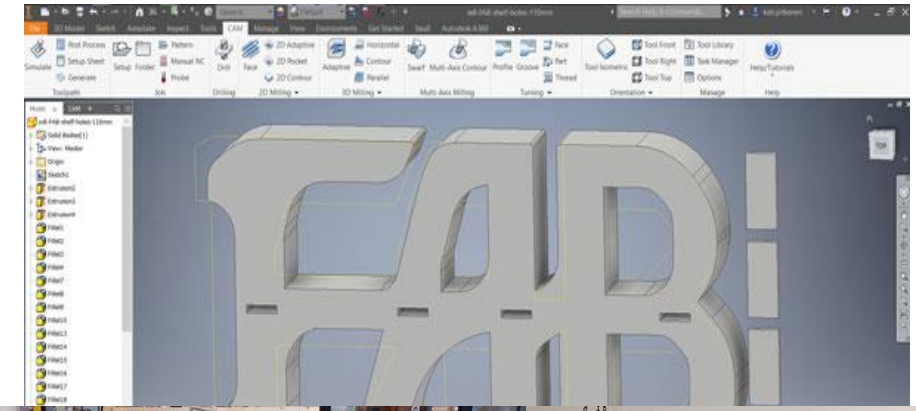
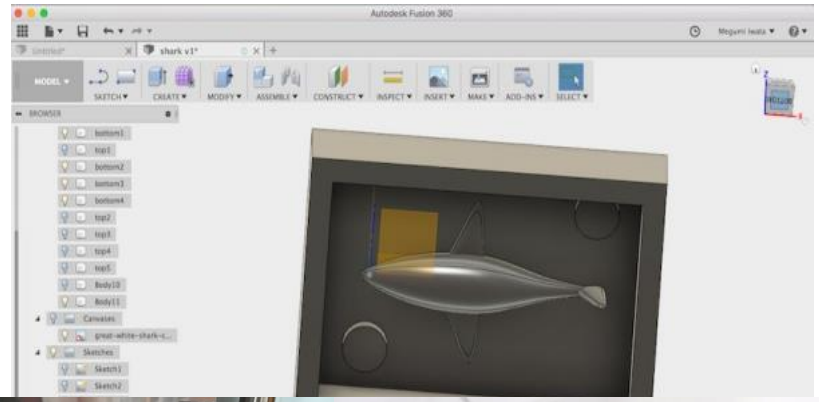
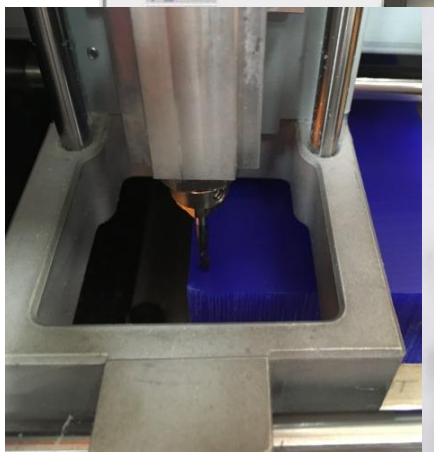
Kaivertaminen / Muottien tekeminen / Huonekalut
CNC-tarkkuusjyrsin & CNC-reititin

Carving / Creating molds / Furniture
CNC precision milling machine & CNC router







http://archive.fabacademy.org/2018/labs/fablaboulu/students/kati-pitkanen/week8.html

http://archive.fabacademy.org/2018/labs/fablaboulu/students/megumi-iwata/index_w10.html

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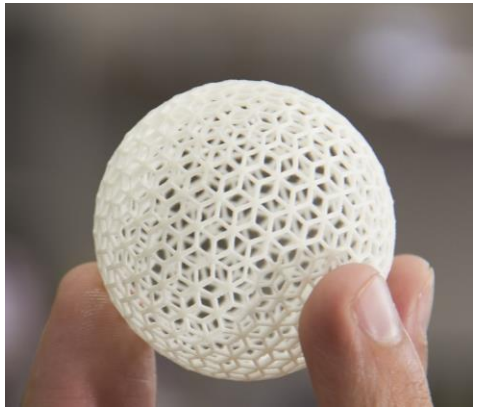
3D-tulostus
3D-printing

http://fab.academany.org/2020/labs/oulu/students/xinhui-hu/Week5_3D_printing_and_scanning.html



https://formlabs.com/blog/3d-printing-transparent-parts-techniques-for-finishing-clear-resin/ ©Formlabs

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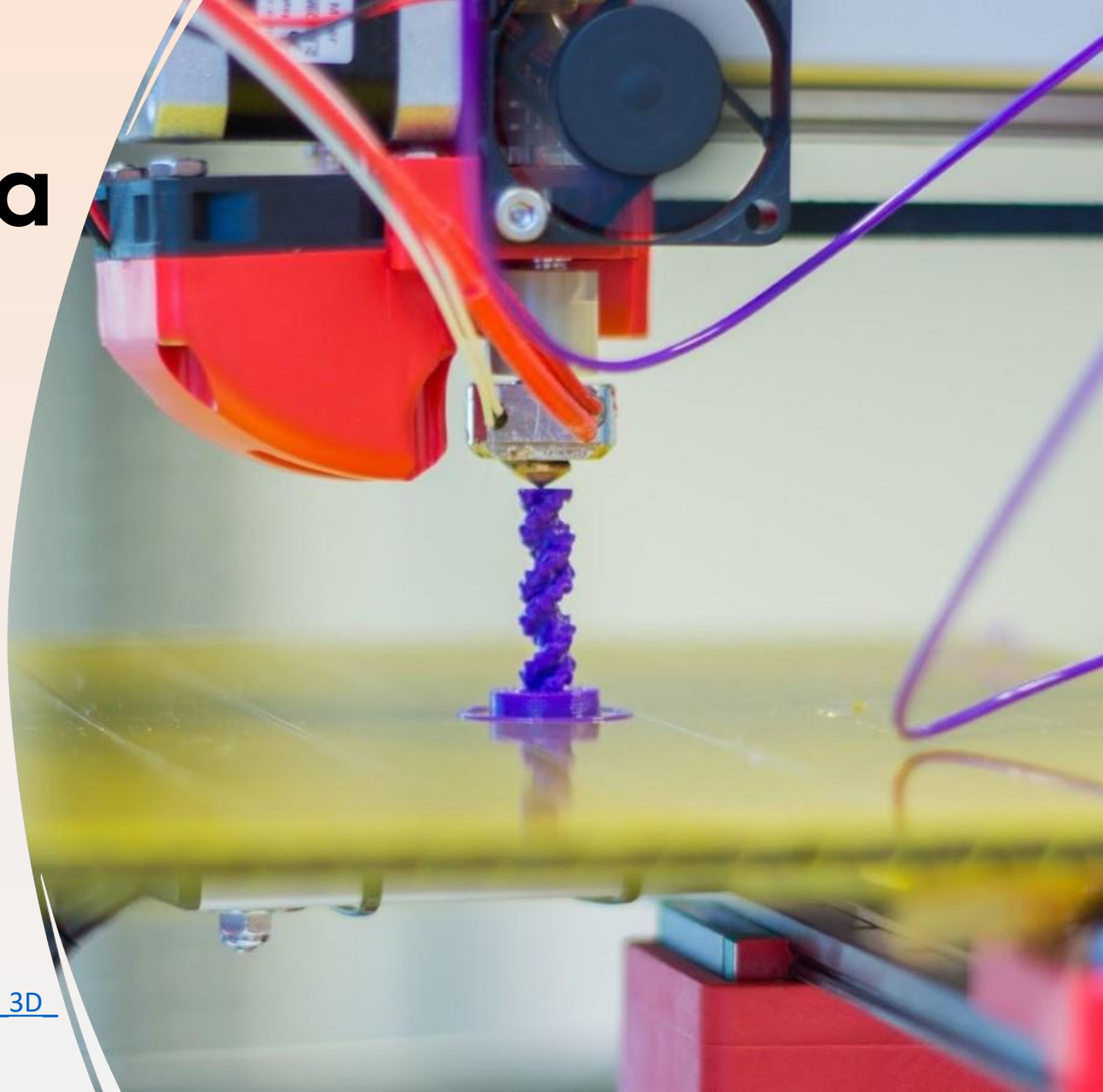
3D-mallinnuksesta 3D-tulostukseen

From 3D modelling to 3D printing

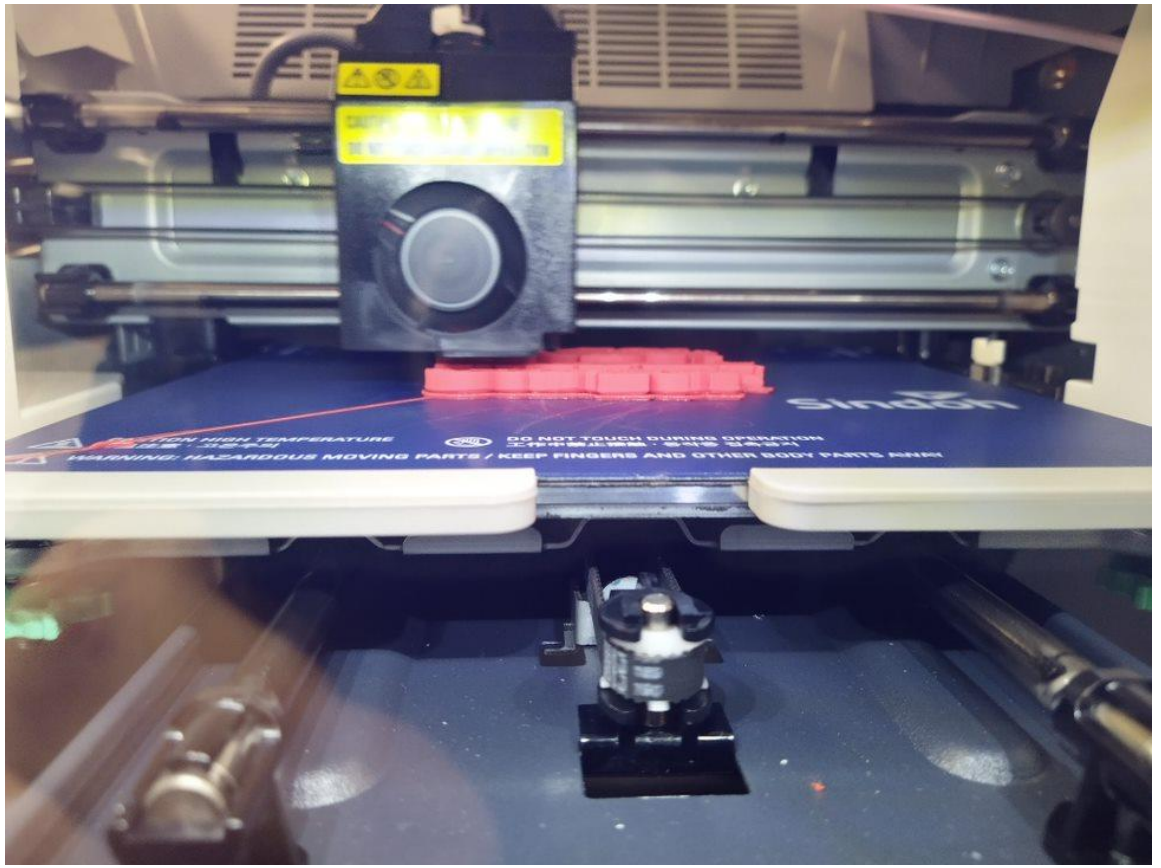
LISÄTIETOA:
https://peda.net/joensuu/jm/oio/alakoulu/3d-tulostus



https://commons.wikimedia.org/wiki/File:Felix_3D_Printer_-_Printing_Head_Cropped.JPG
Author: Jonathan Juursema

TASK 2.

3D print the model



3D-Tulostus

3D printing

- https://twitter.com/i/status/1057034744381222913

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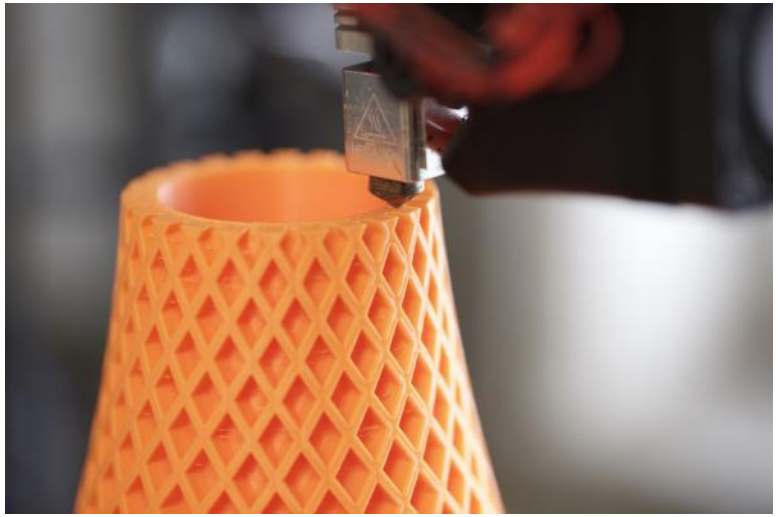
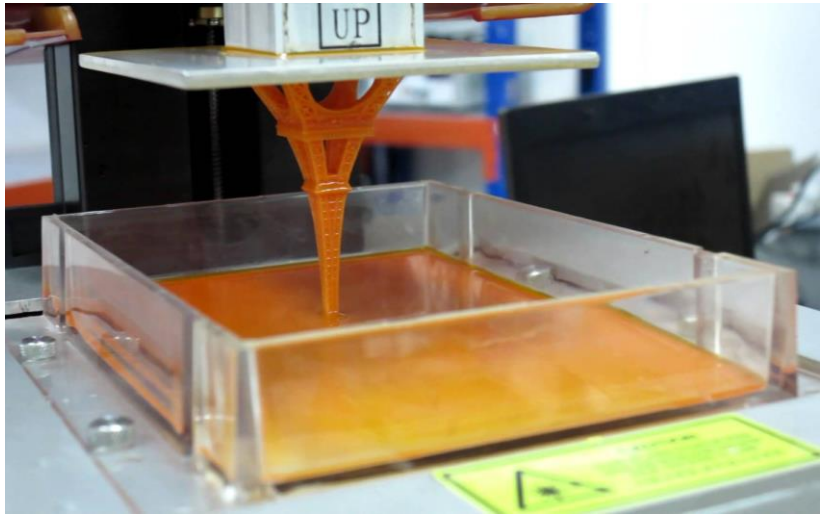
3D-tulostustekniika

3D printer technologies

Fused deposition modelling (FDM)



Stereolithography(SLA)



Selective Laser Melting(SLM) / Direct Metal Laser Melting(DMLS)

Lisätietoa: https://www.3d-tulostus.fi/uutiset/Vertailussa-FDM-SLA-ja-SLS-teknologiat

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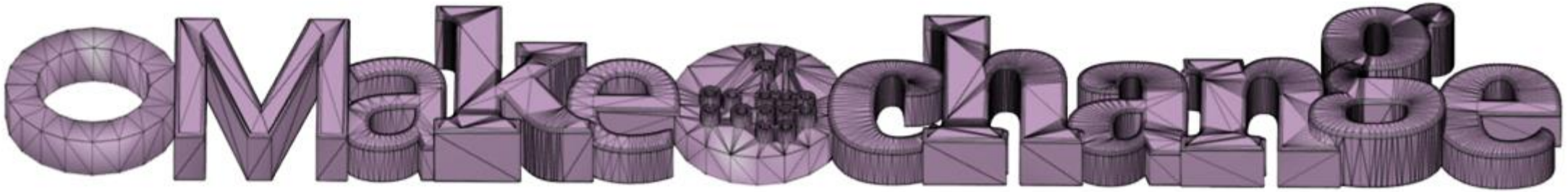
STL-Tiedosto

STL File

Kolmioista koostuva verkko

Mesh of triangles



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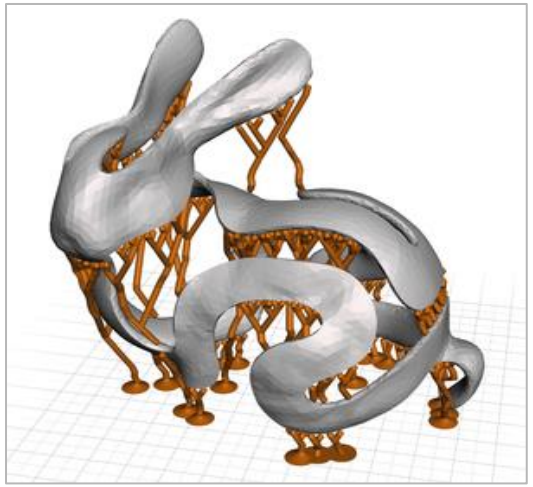
Jälkiprosessointi

Post-processing

Problems

- Holes: Not “water-tight”
- Non-mainfold geometry: 2 identical edges on top of each other
- Intersecting faces



Meshmixer

http://www.meshmixer.com/

AUTODESK® NETFABB®

Netfab

https://www.autodesk.com/products/netfabb/overview

Viipalointi

Slicing

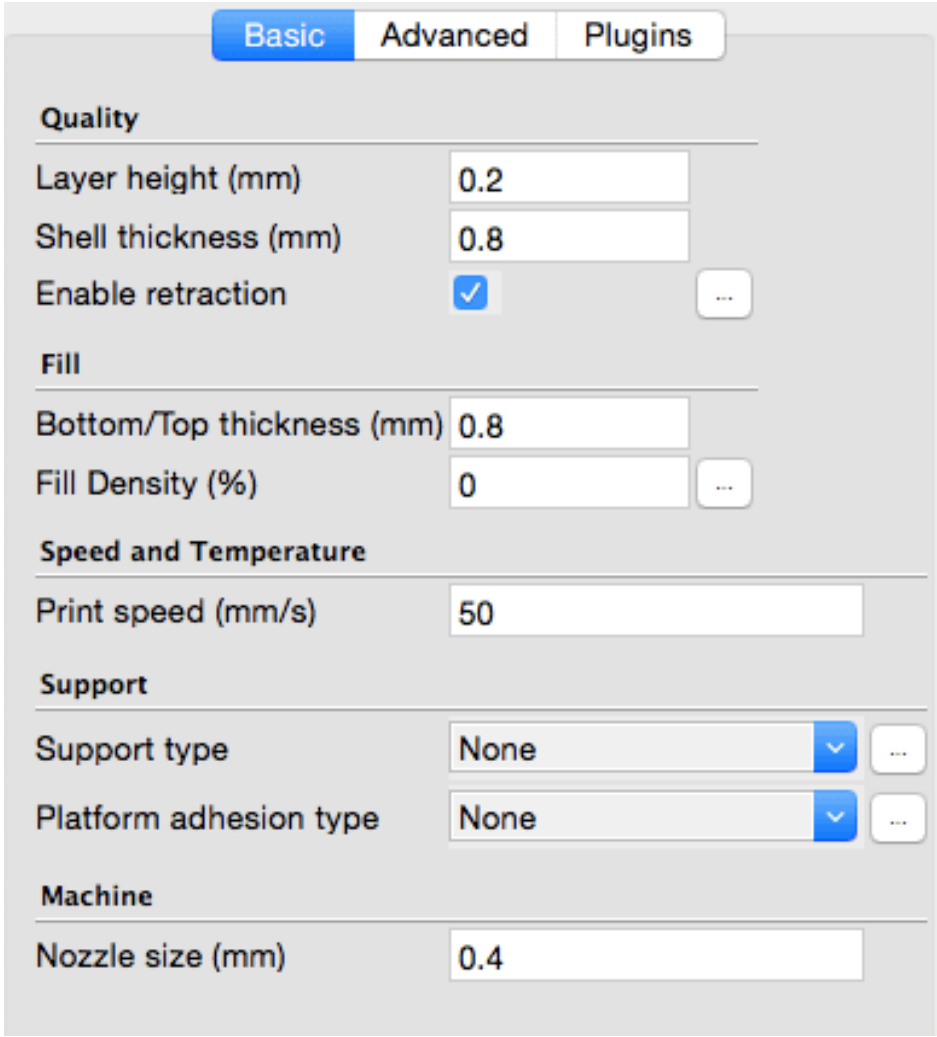
- STL-tiedosto jakautuu tasoihin
  STL file is divided into layers
- Jokainen taso määrittää koneen reitin
  Each layer defines the machine path

HUOM: ILMAAN EI VOI TULOSTAA

ATTENTION: YOU CANNOT PRINT ON THE AIR !

3D-tulostimen ASETUKSET

3D printer SETTINGS



https://all3dp.com/3d-slicer-settings-beginners-8-things-need-know/

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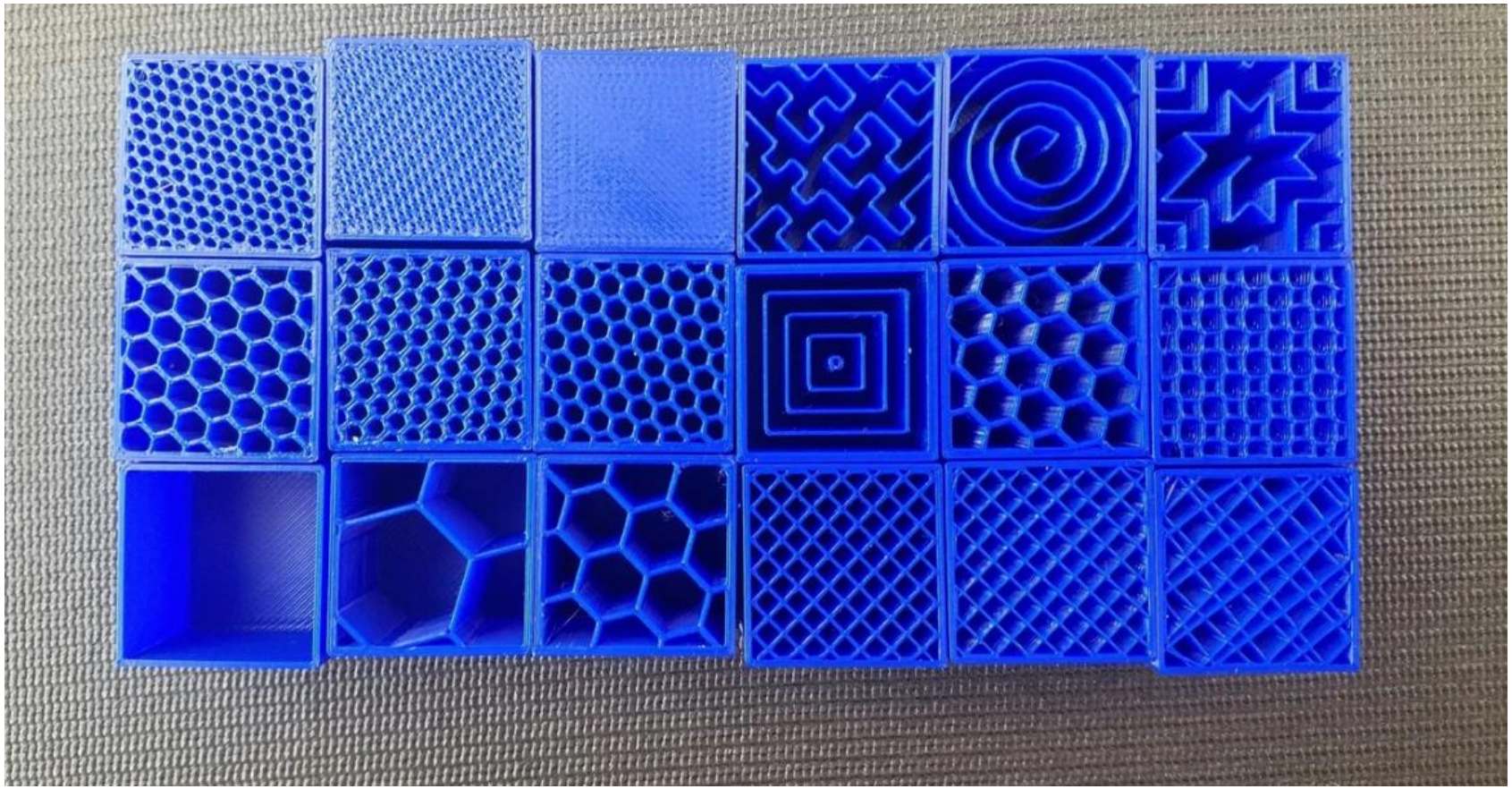
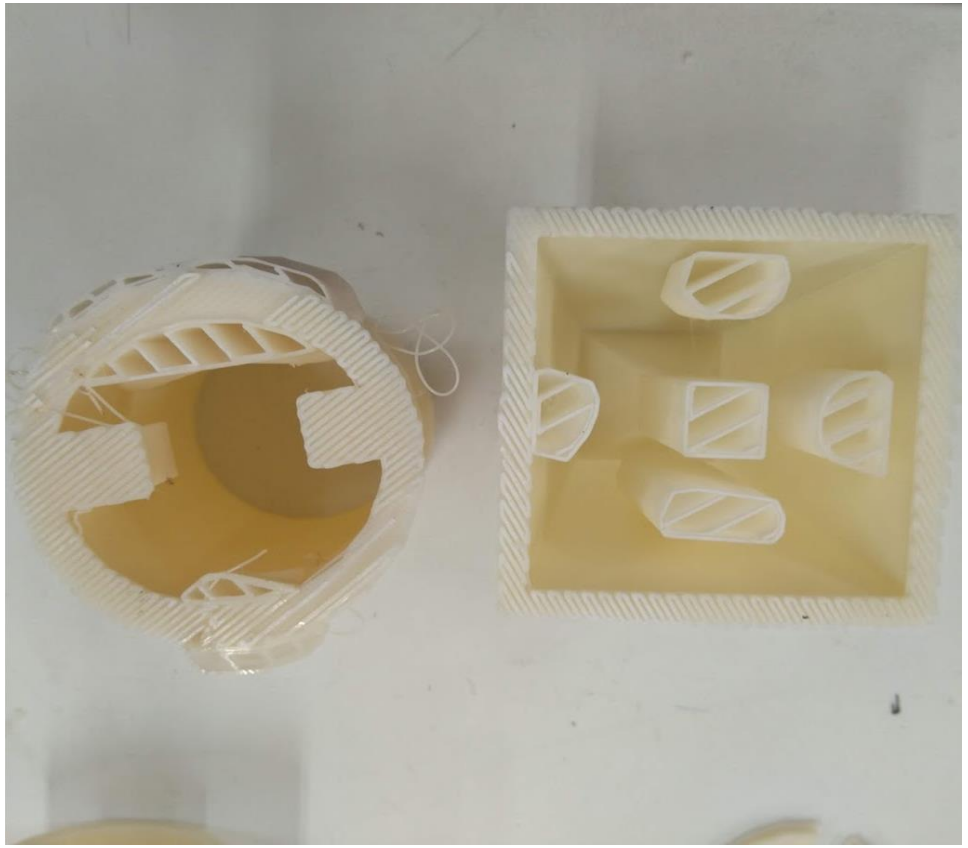
INFILL



https://all3dp.com/2/infill-3d-printing-what-it-means-and-how-to-use-it/

SUPPORT



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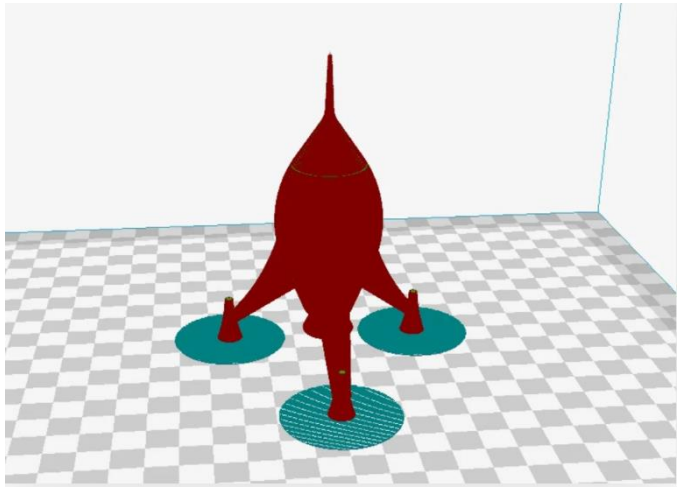
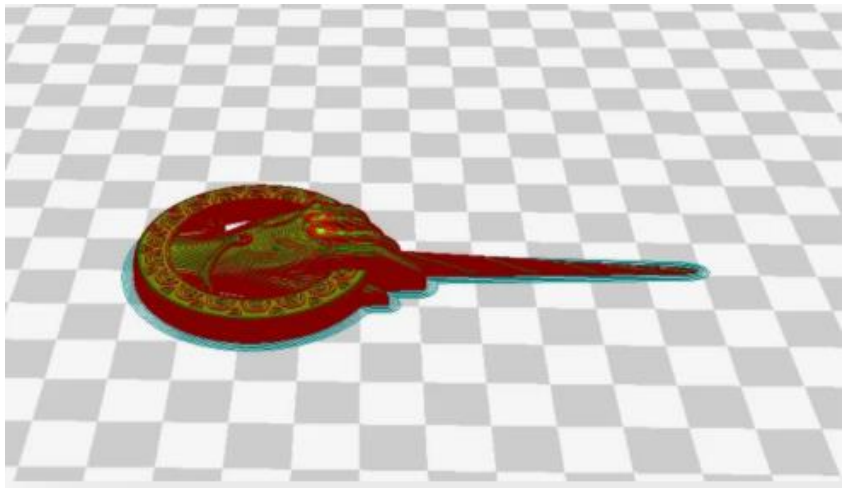
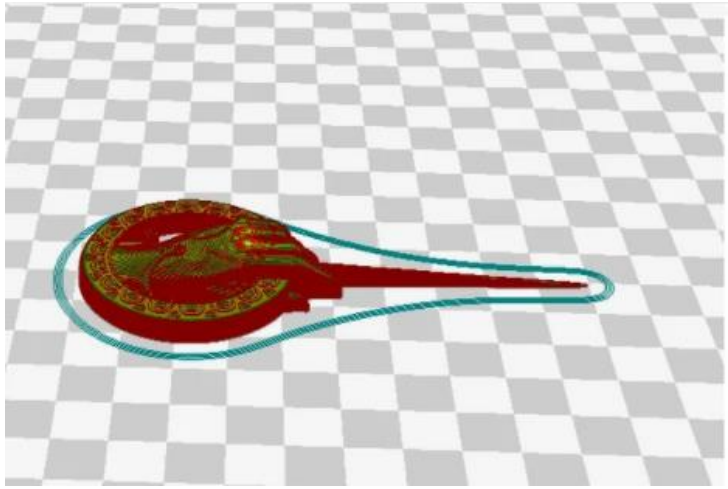
BED ADHESION



Raft



Brim



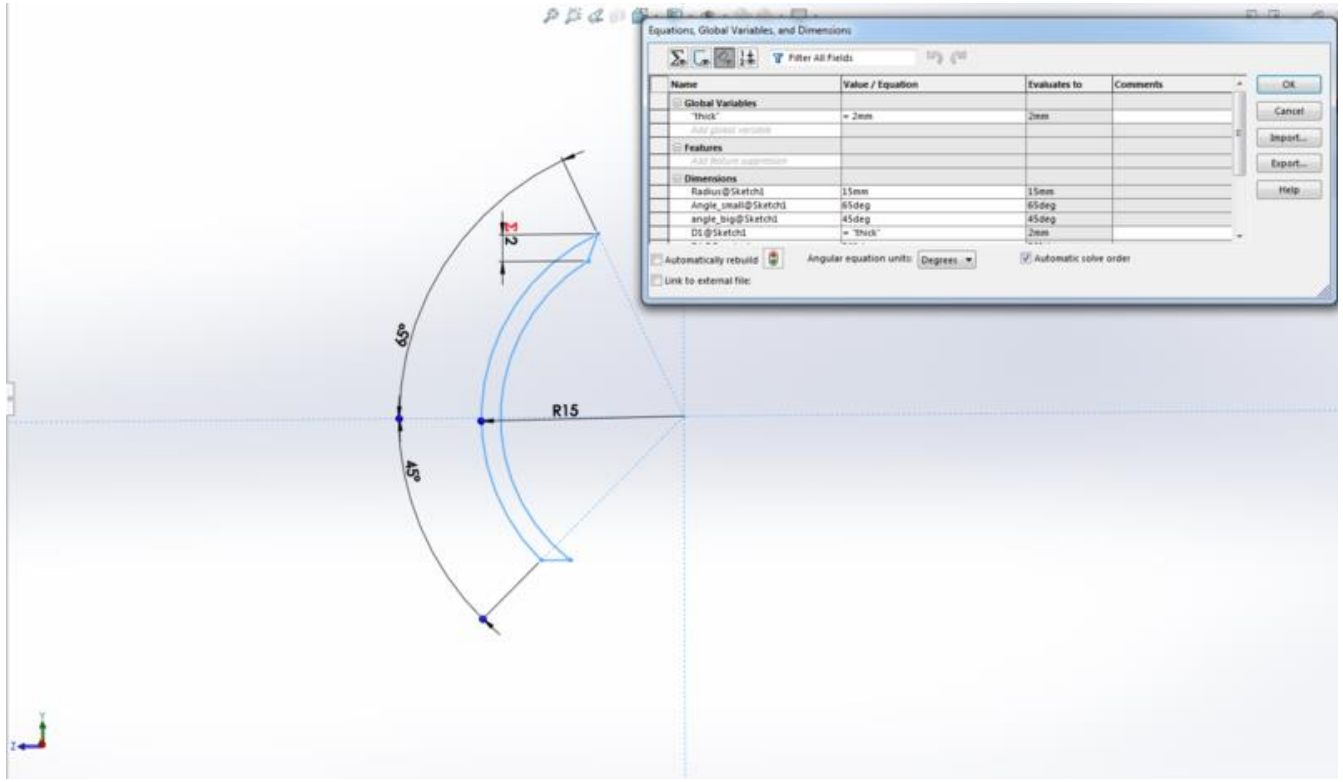
Skirt

https://all3dp.com/2/3d-printing-raft-brim-and-skirt-all-you-need-to-know/

3D modelling design paradigms

https://www.arch.tamu.edu/vi

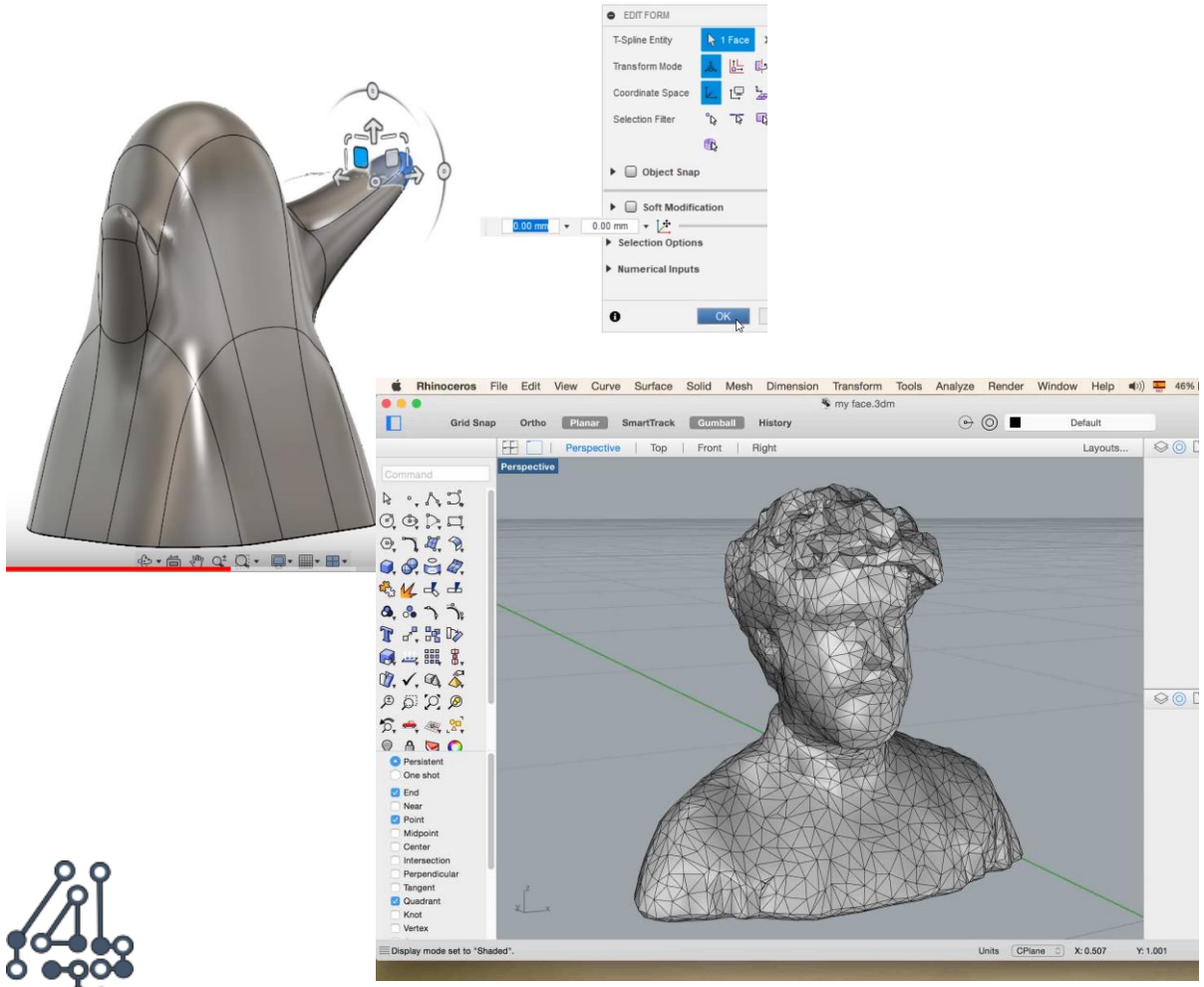
Solid modeling vs. surface modeling / wireframe modeling



Solid modeling

- Involves working with primitive shapes (spheres, cubes, planes …) and operations among them (e.g. cut, combine, join …)
  - Some programs need to start with a 2D design (sketch) that is later ***extruded*** to generate a 3D shape
- Useful for mechanical design and simple object shapes that does not containing an organic shape.
  - Highly precise measures, angles…

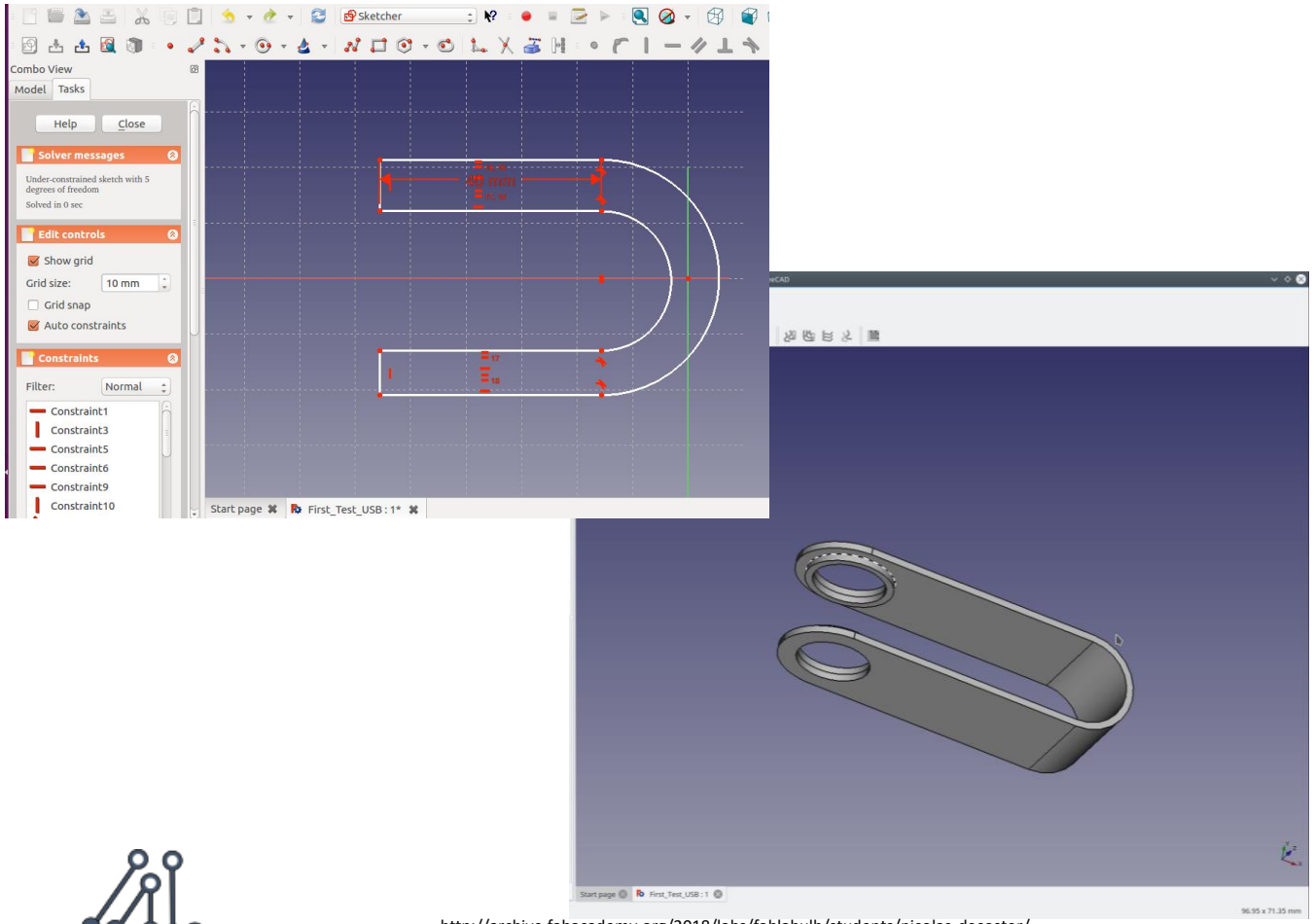
Solid modeling vs.
surface modeling / wireframe modeling



Surface modeling / Wireframe modeling

- ***Wireframe:*** Represents shapes (surfaces) as a mesh of polygons (mainly triangles or four-side forms)
- ***Surface*****:** Represents shapes (surfaces) using guiding lines (curves such as spline). Guiding lines are basically the skeleton of the 3D objects.
- Allows for instance, sculpting the 3D shape out of a primitive
- Used in modeling of organic shapes or when the silhouette is of vital importance (e.g. aerodynamics).
  - Use in design of cars, planes …
  - For modeling organic shapes: artisans, artists…

Parametric modeling vs. Direct modeling

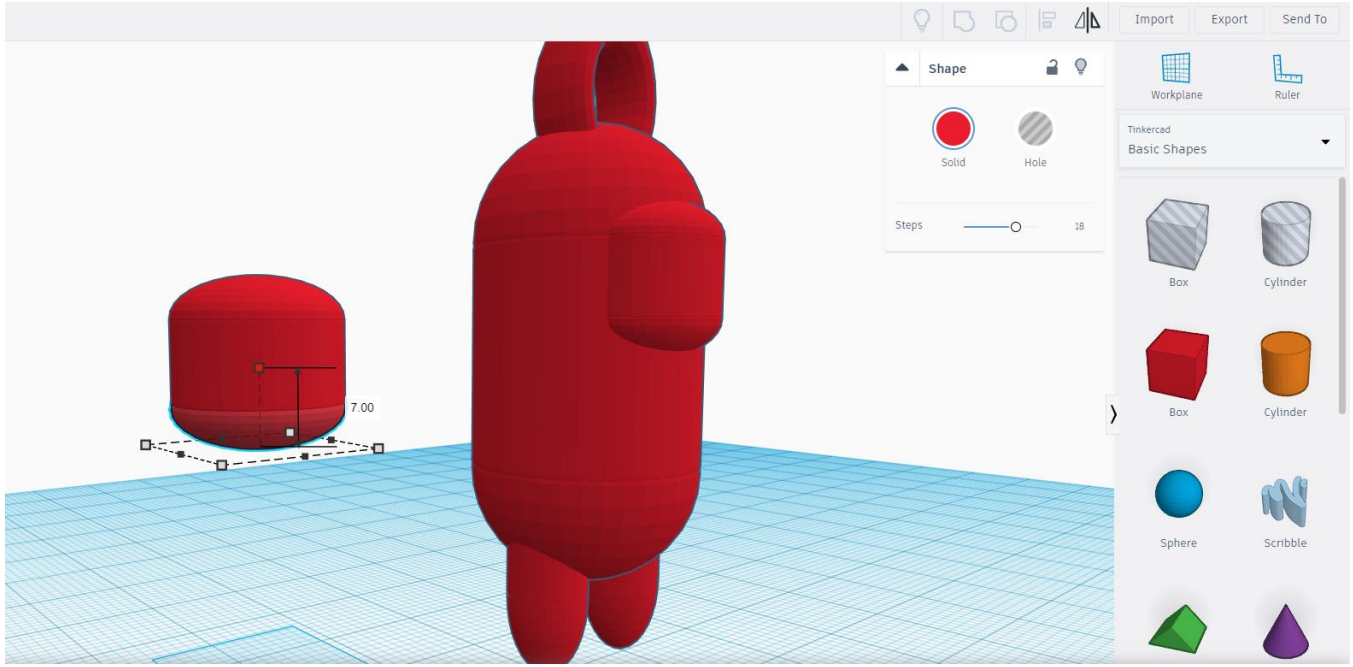


http://archive.fabacademy.org/2018/labs/fablabulb/students/nicolas-decoster/

Parametric modeling

- Build the 3D geometry piece by piece.
  - Generally working in **2D sketches** that are extruded into 3D pieces.
  - 2D sketches does not need to define exact dimensions but relation among them (constraints)
    - E.g. perpendicular, tangent, collinear …
  - Additional features and operations can be applied to the shape: chamfer, fillets, rotations, matrix…
- Order in which operations are executed is important.

Parametric modeling vs. **Direct modeling**



Direct modeling

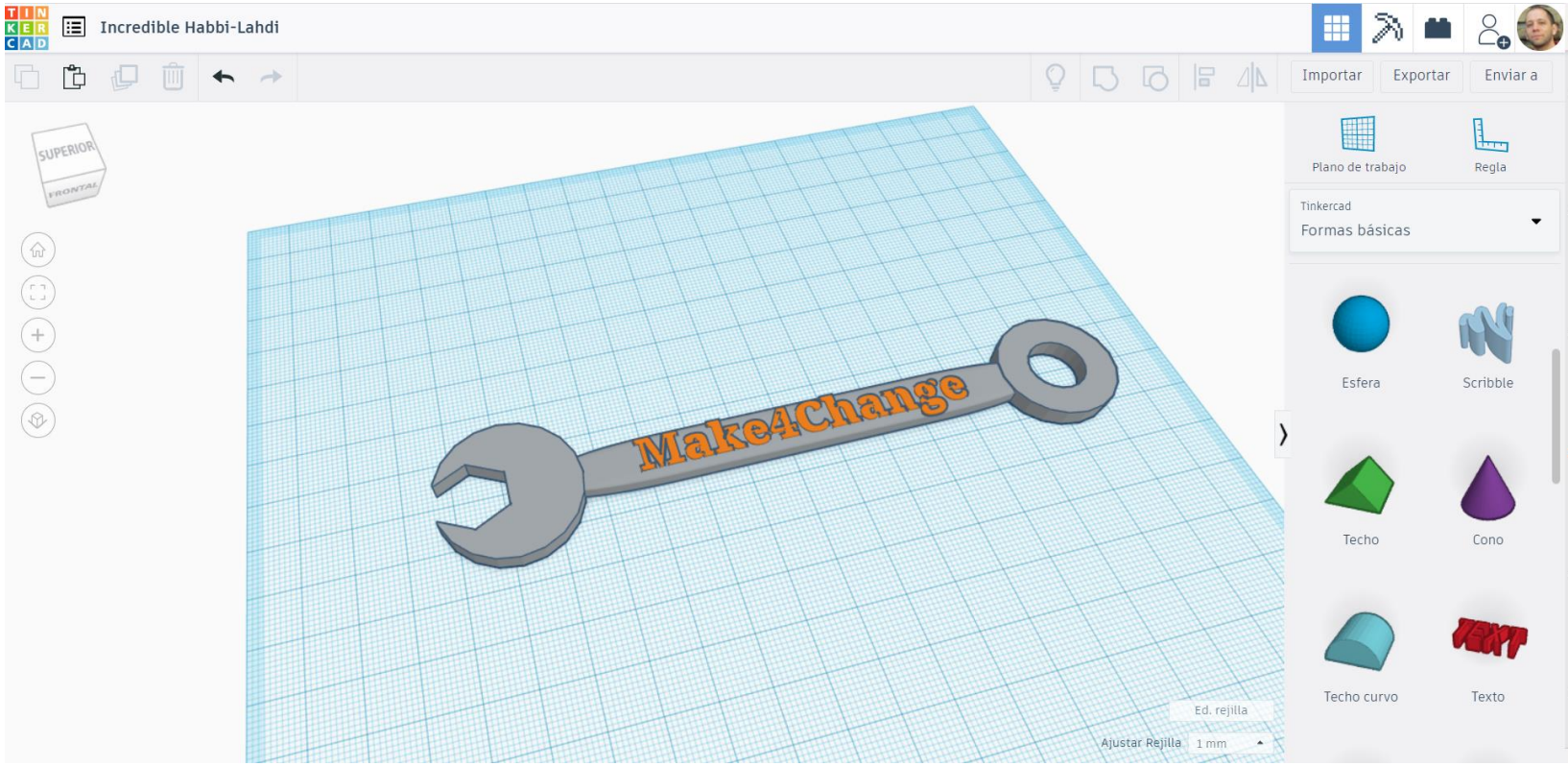
- The designer acts directly on the 3D shape (usually a primitive) by pulling, pushing or combining primitives.
- What you see is what you get (WYSIWYG)
- Geometry is the most important aspect, not relation among objects.
- History is not important. You are always modifying the last version of the model.

3D modelling software

3D-mallinnus ohjelmistot

TINKERCAD

- Online
- Free



https://www.tinkercad.com/

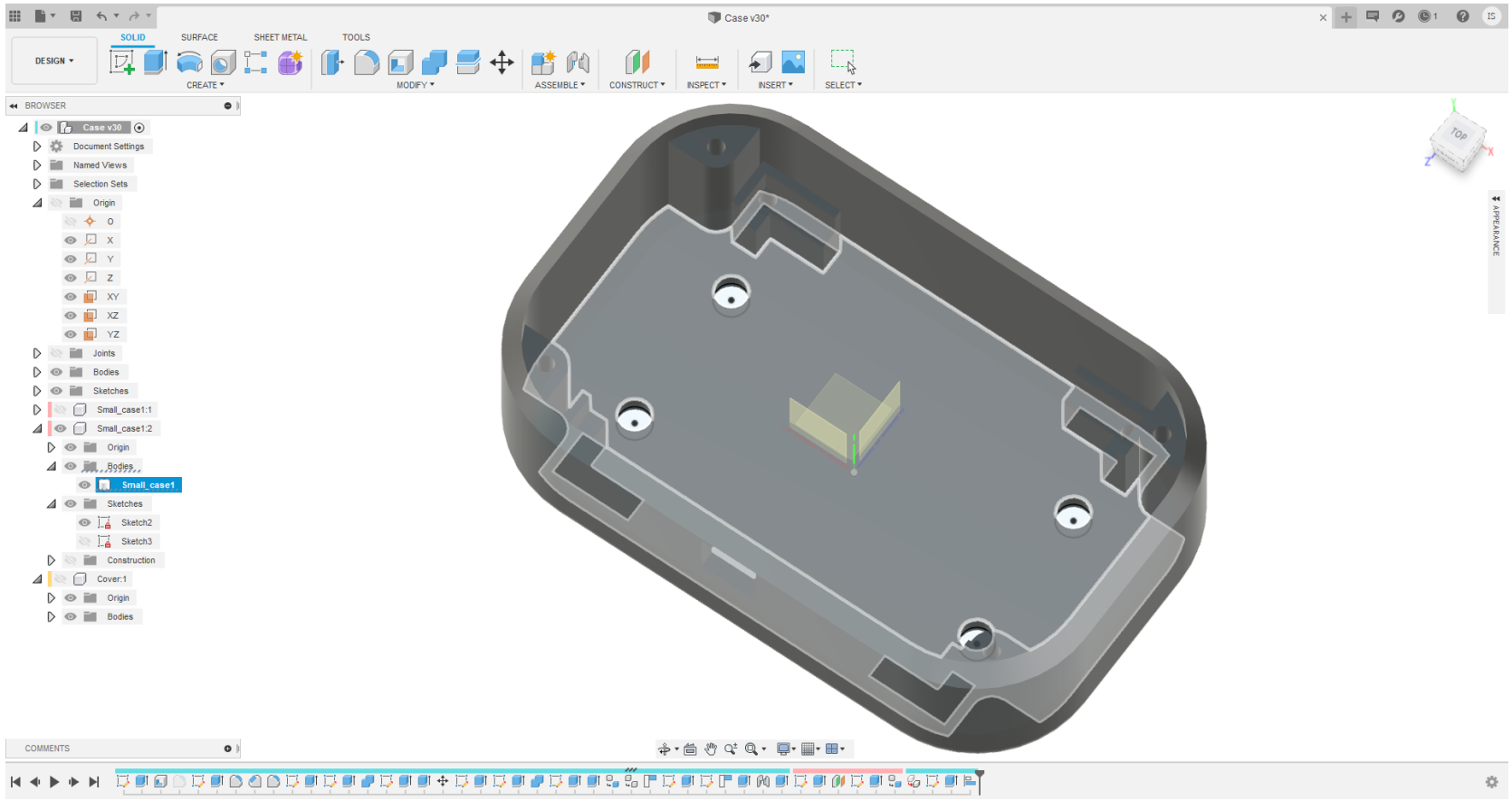
Sketchup

- Online
- Free plan available

https://www.sketchup.com

Fusion 360

- Windows software
- Free with limitations for students and hobbyist



https://www.autodesk.com/products/fusion-360/

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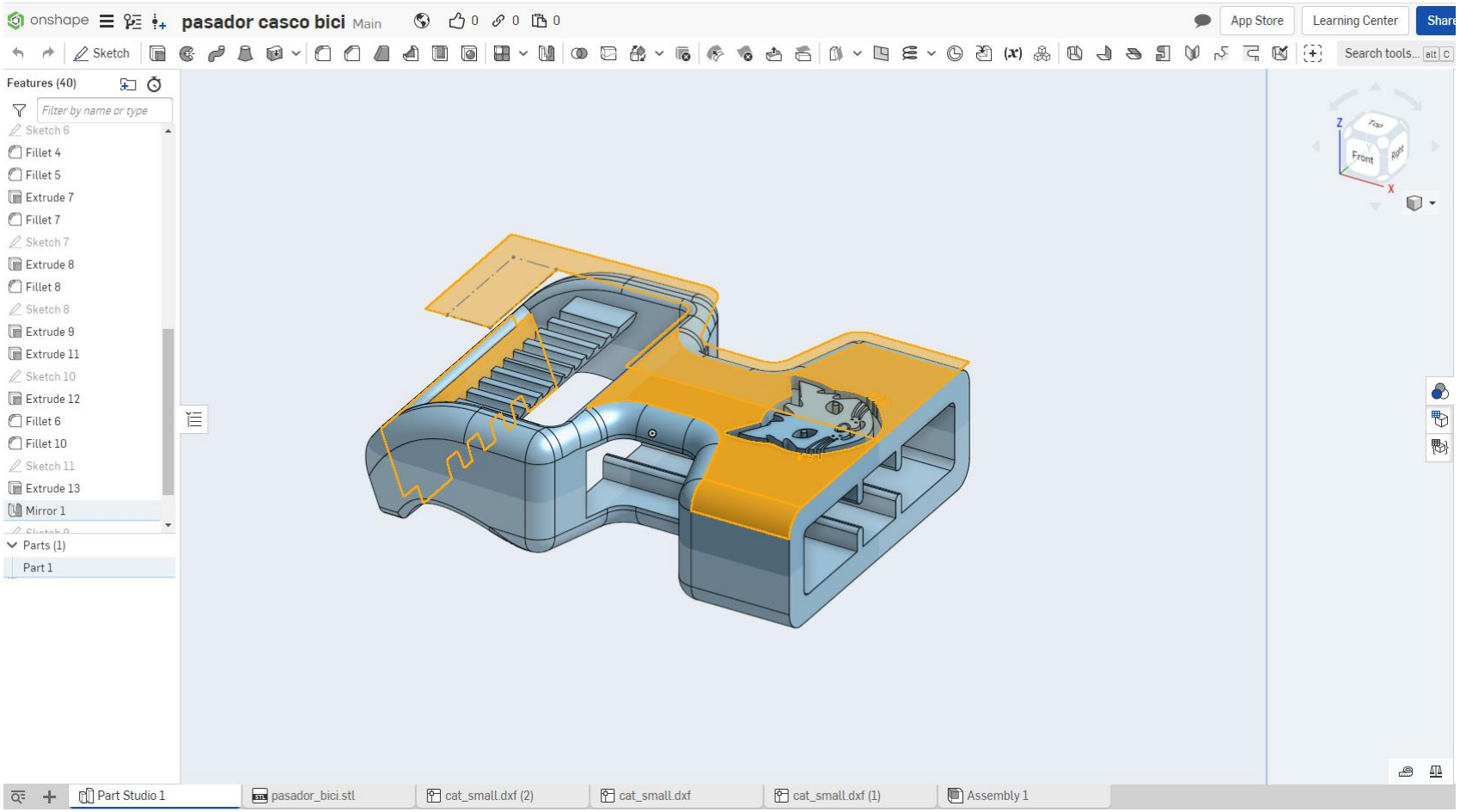
OnShape

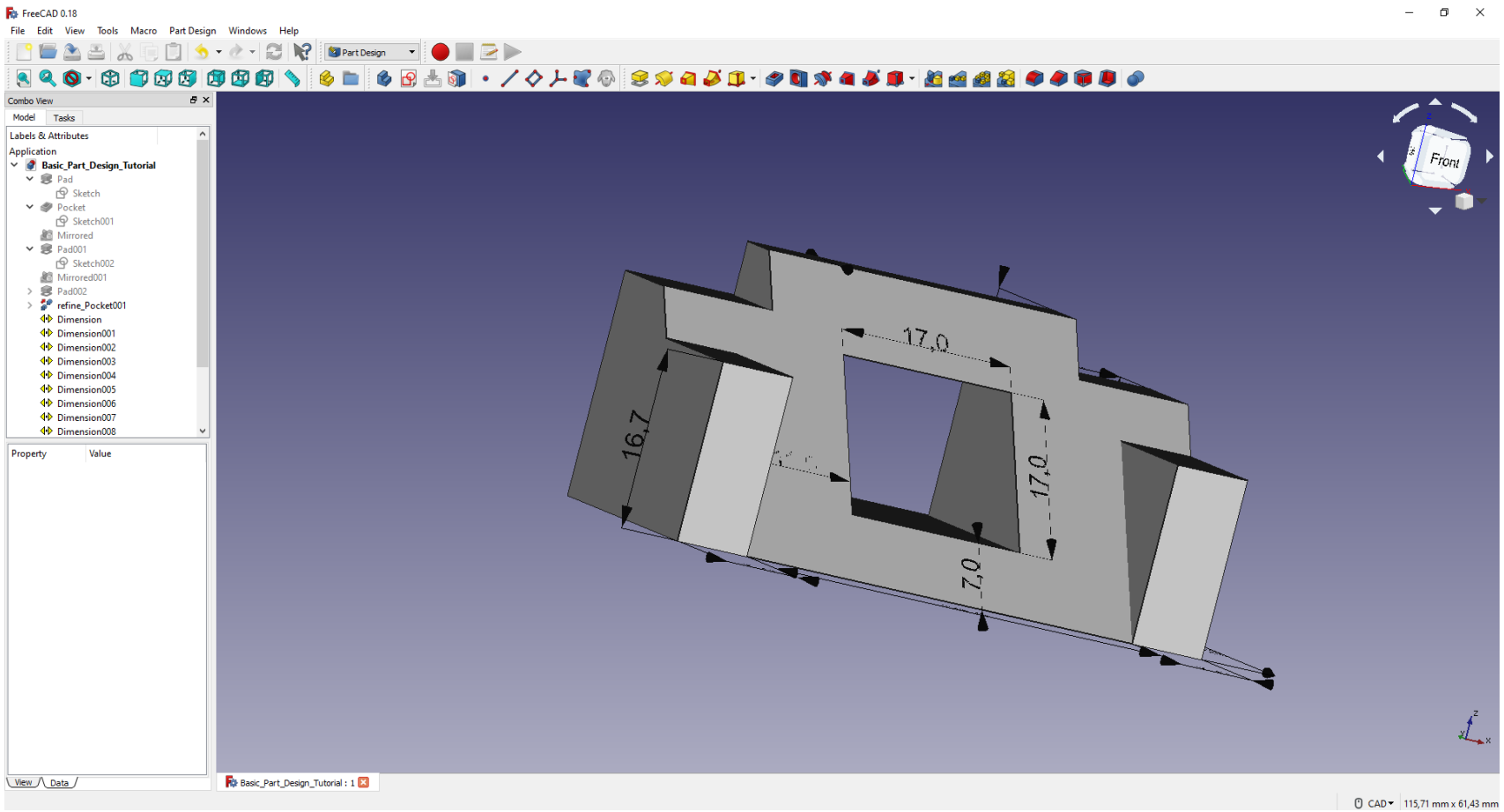
- Online
- Free (models available for everybody)



https://www.onshape.com

Freecad

- Multiplatform
- Free



https://www.freecadweb.org/

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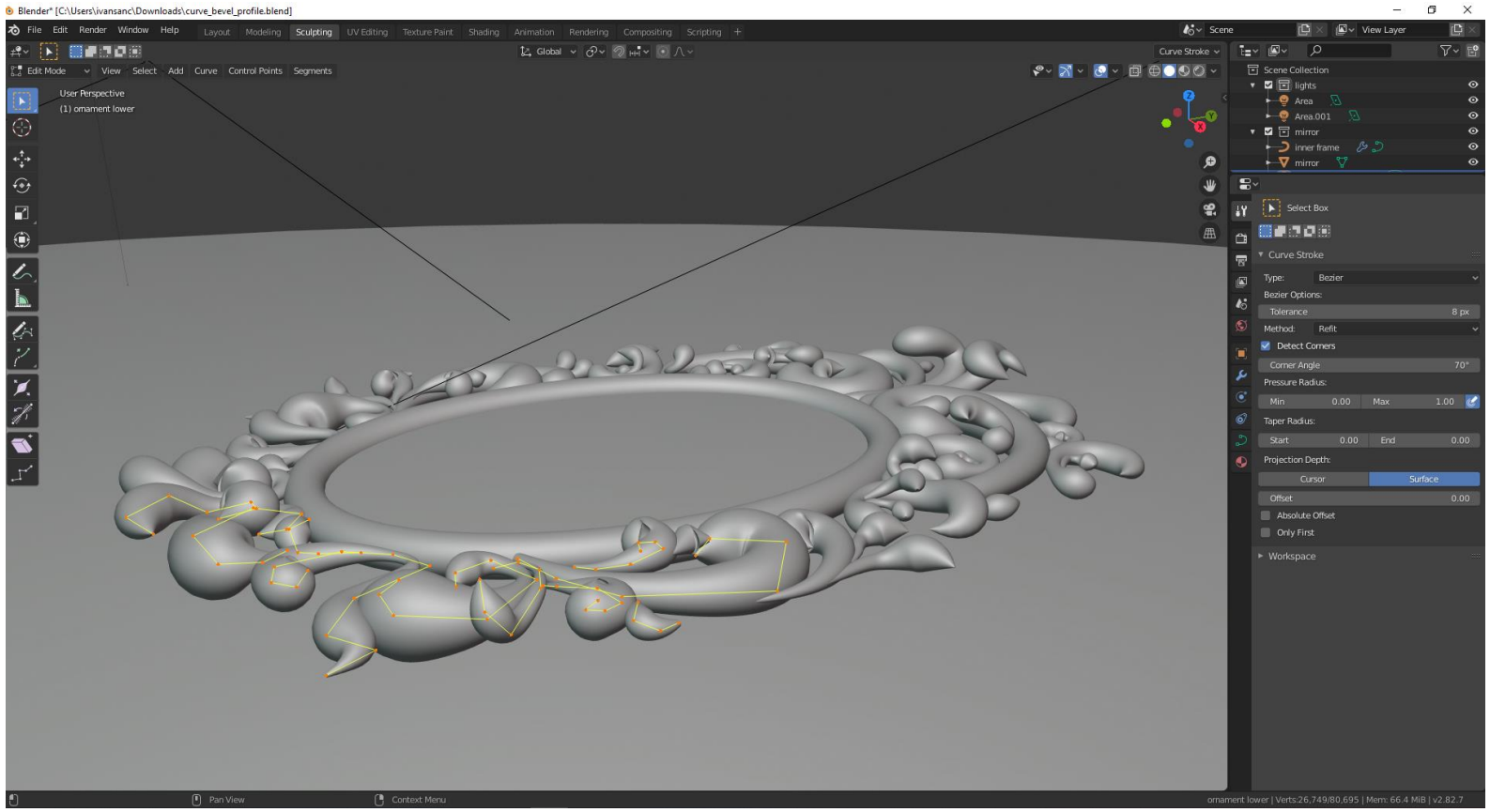
Blender

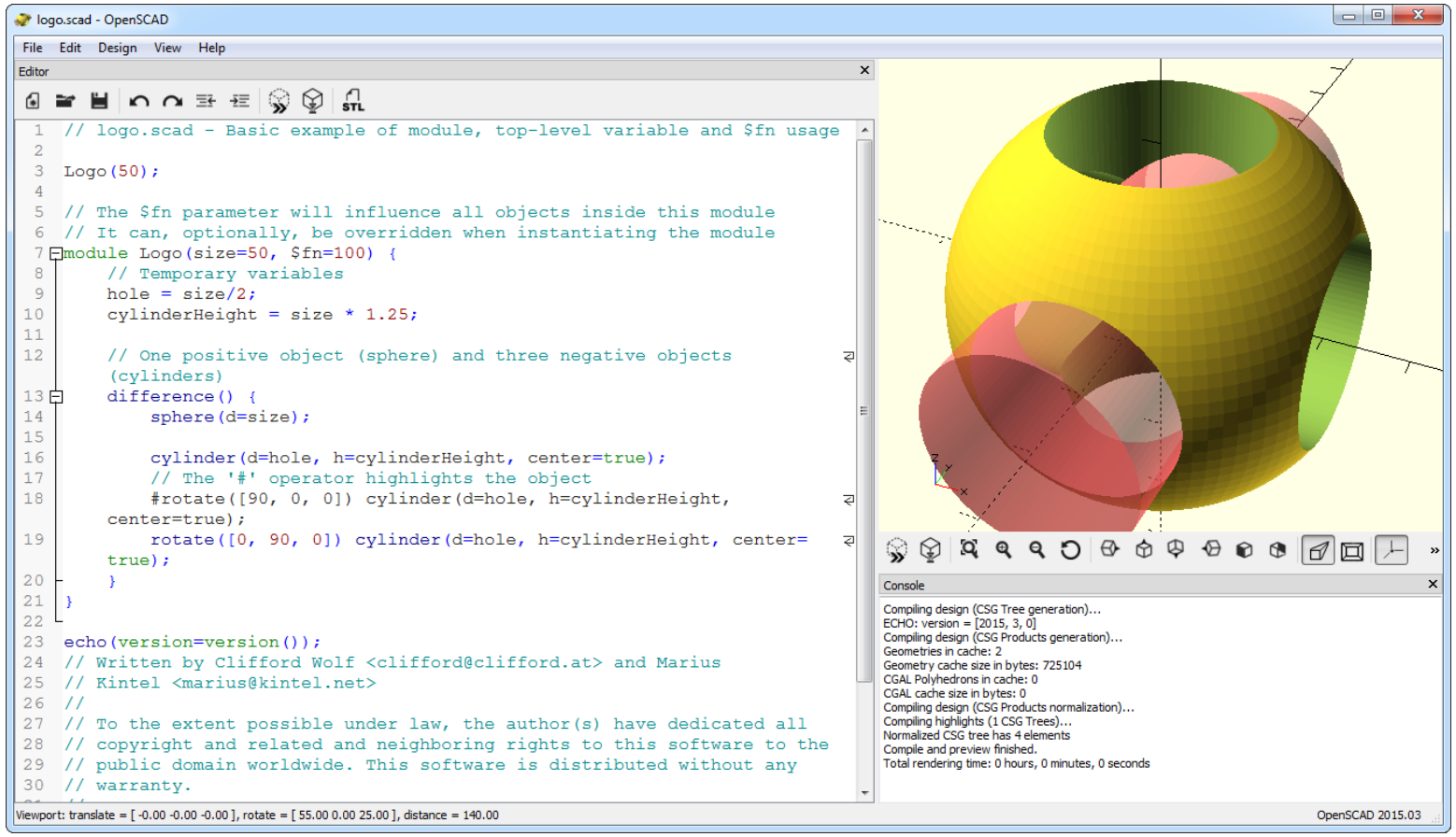
- Multiplatform
- Free



https://www.blender.org/

Openscad

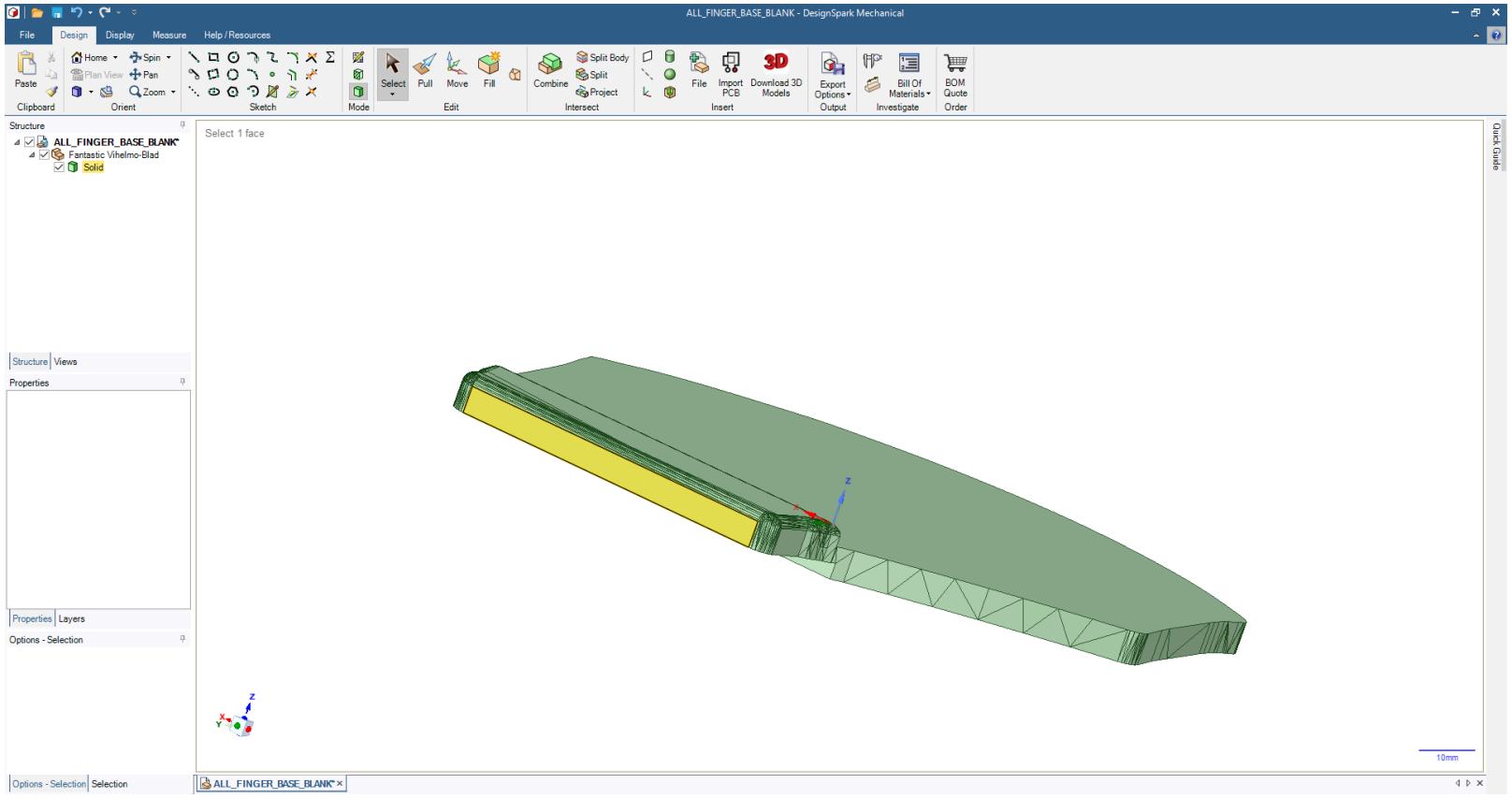
- Multiplatform
- Free



https://www.openscad.org

Design Spark

- Windows
- Free version available



https://www.rs-online.com/designspark/home

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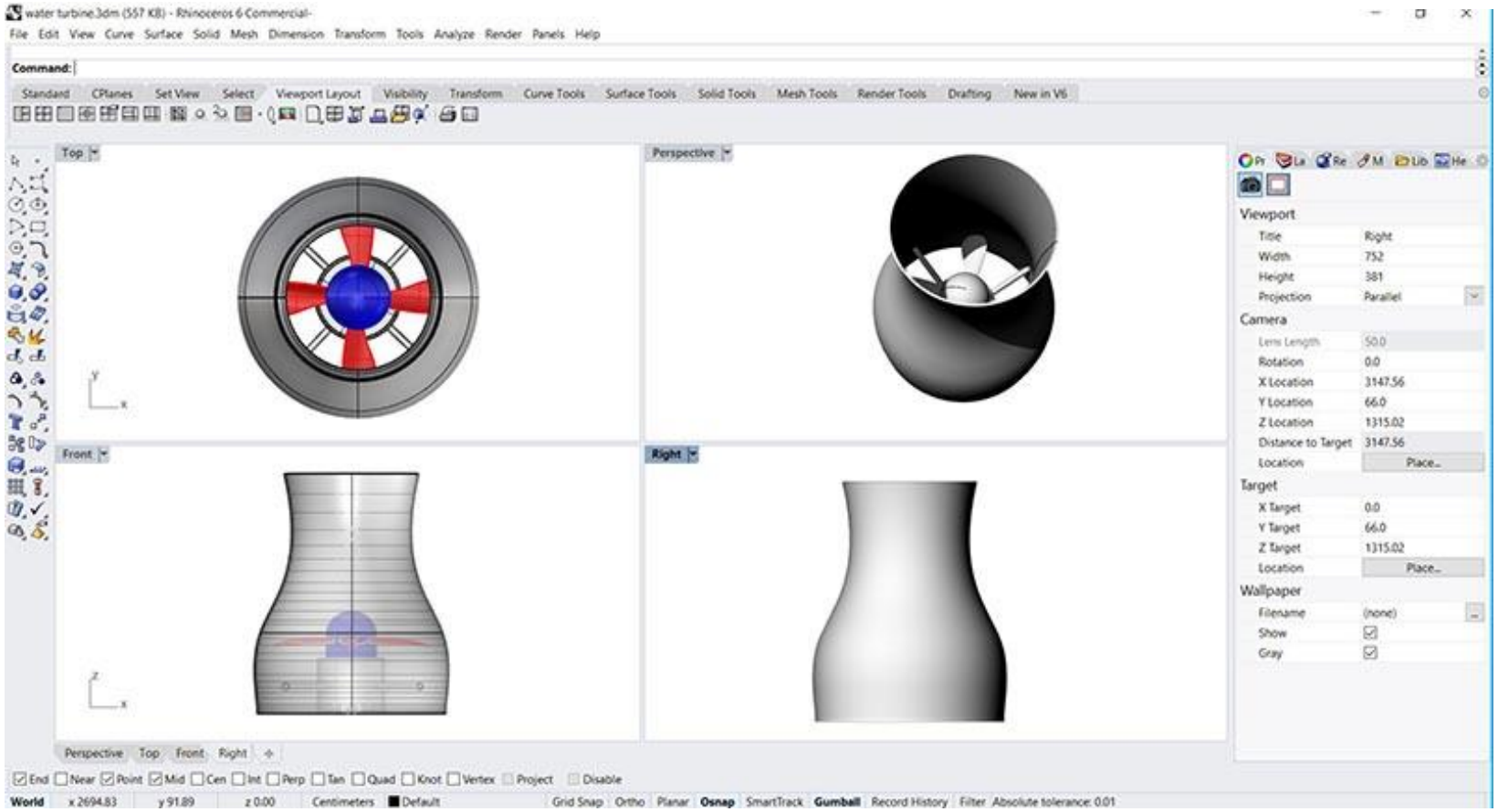
Rhino

- Windows / Mac
- License

http://fab.academany.org/2020/labs/vestmannaeyjar/students/magnus-magnusson/pages/week2.html



https://www.rhino3d.com

Autodesk Inventor

https://www.autodesk.com/products/inventor

SolidWorks

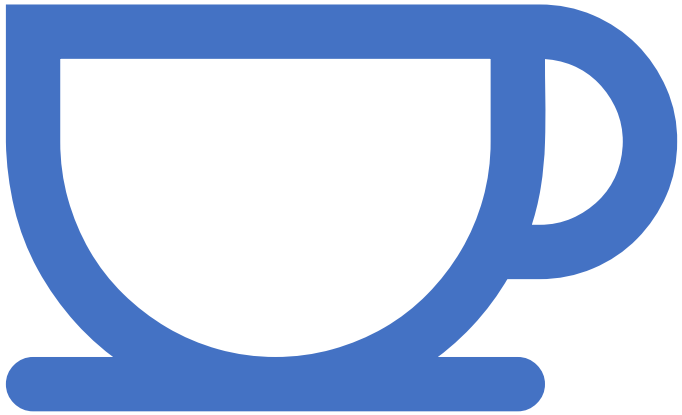
https://www.solidworks.com/

NX

https://www.plm.automation.siemens.com/global/en/products/nx/nx-for-design.html

Catia

https://www.3ds.com/products-services/catia/



HUOMENTA!!!

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PROJECT2:
Tee oma pieni huonekalu

Make your own piece of furniture

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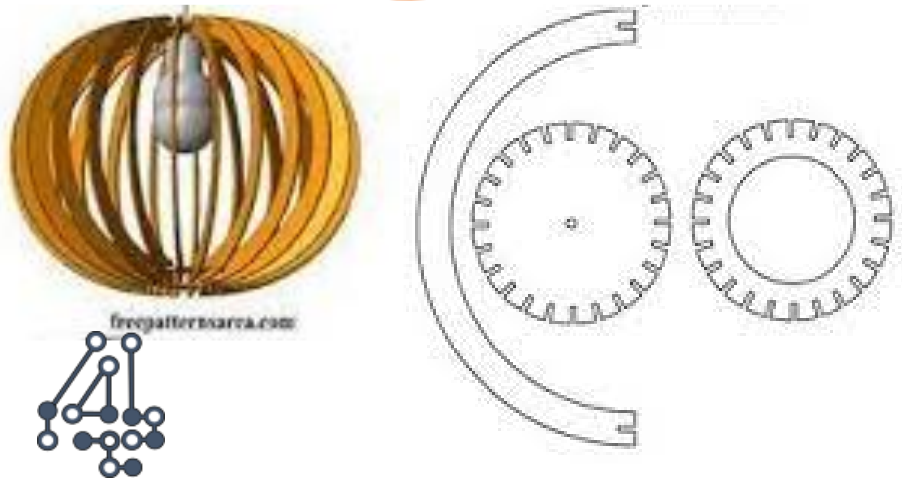
PROJEKTI2: Suunnittele ja tee oma lampu/pieni huonekalu

Create your own piece of furniture



- Valitse toinen ehdotetuista Tinkercad-harjoituksista (seuraava dia)
  Choose one of the Tinkercad tutorials (next slides)
- Rakenna 3D-malli haluamastasi esineestä ja leikkaa se laserleikkurilla
  Build a 3D model of the selected piece
- Voit etsiä oman mallin netistä, mutta sinun TÄYTYY MALLINTAA SE UUDELLEEN Tinkercadissa. Pelkkä mallin tuominen Tinkercadiin ei riitä!
  You can look for a design from internet BUT you HAVE TO replicate it in Tinkercad. It is not enough to import the model

RAJOITUKSET: Mallin osien pitää mahtua 520x700mm -kokoiselle levylle

LIMITATIONS: The model should fit in a sheet of 520x700mm

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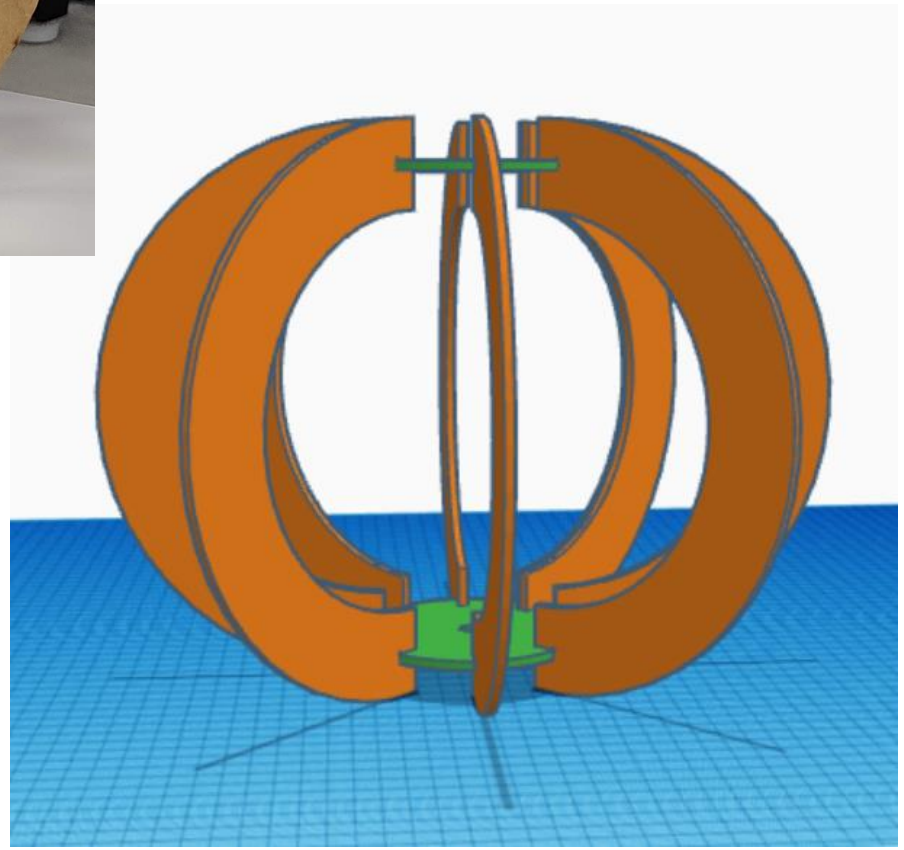
Lampun-varjostin

3D lamp



Video tutorial:

https://youtu.be/_uynfmtSnD4

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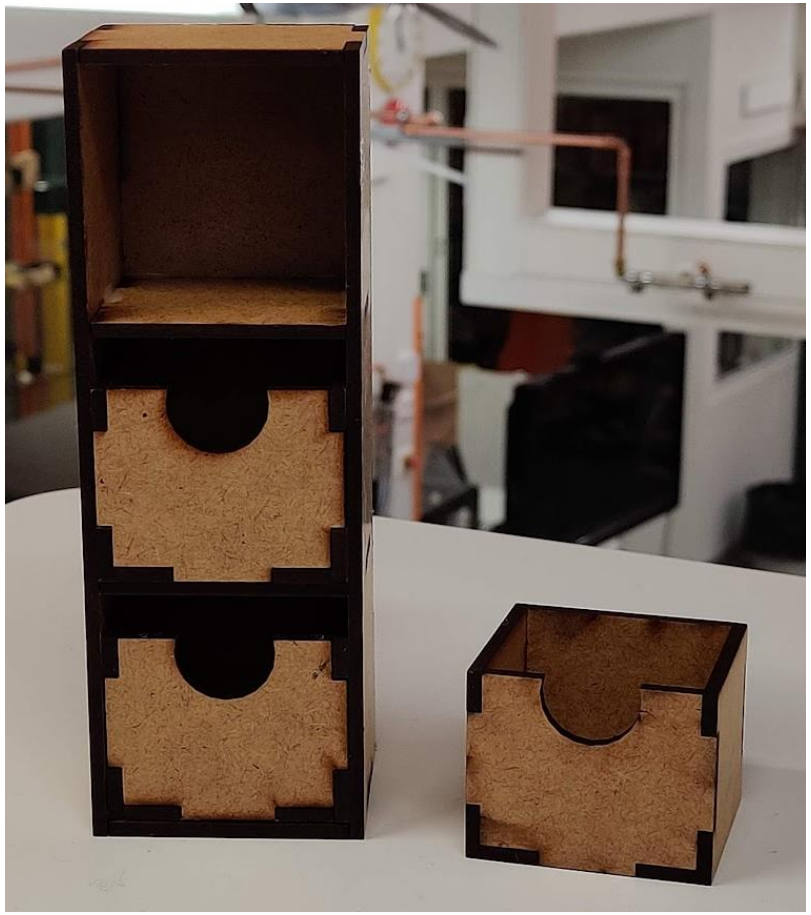
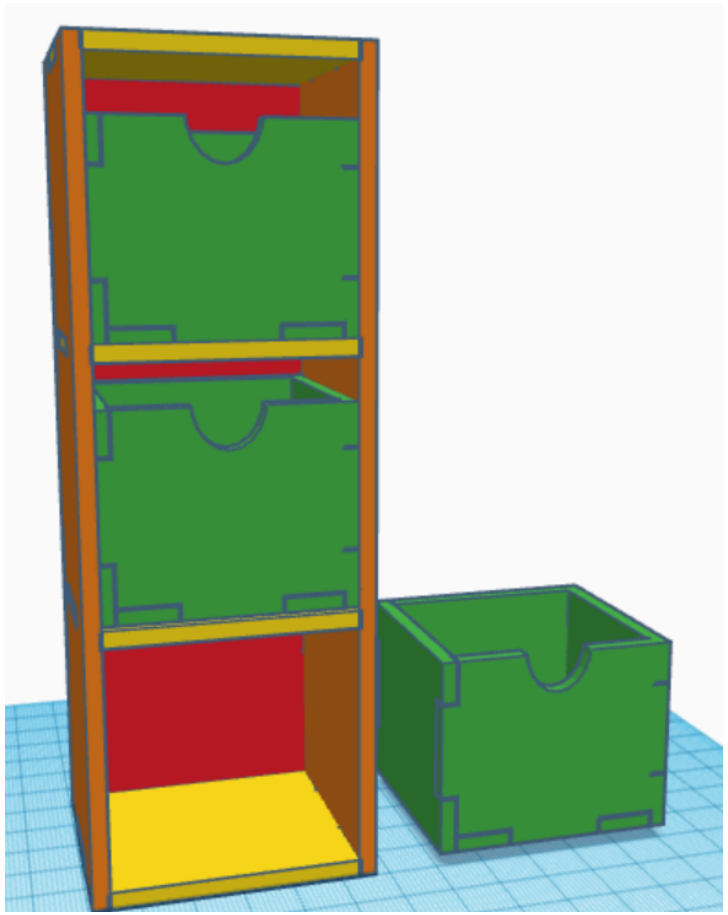
Lokerikko

Mini-Shelf with drawers





Video tutorials:

Part 1: Main structure https://youtu.be/Hf9qpPWgguA

Part 2: Reinforcing https://youtu.be/jCjnoDAozqk

Part 3: Drawers https://youtu.be/cNIzUdWeCg0

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Tutorials

Shelf:

Part 1: Main structure
https://tinyurl.com/make4change3dvid1

Part 2: Reinforcing
https://tinyurl.com/make4change3dvid2

Part 3: Drawers
https://tinyurl.com/make4change3dvid3

Lamp:

Tutorial
https://tinyurl.com/make4change3dvid4

PLAYLIST WITH ALL VIDEOS:
https://tinyurl.com/make4change3dvid

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3D MODEL BANK AND IDEAS

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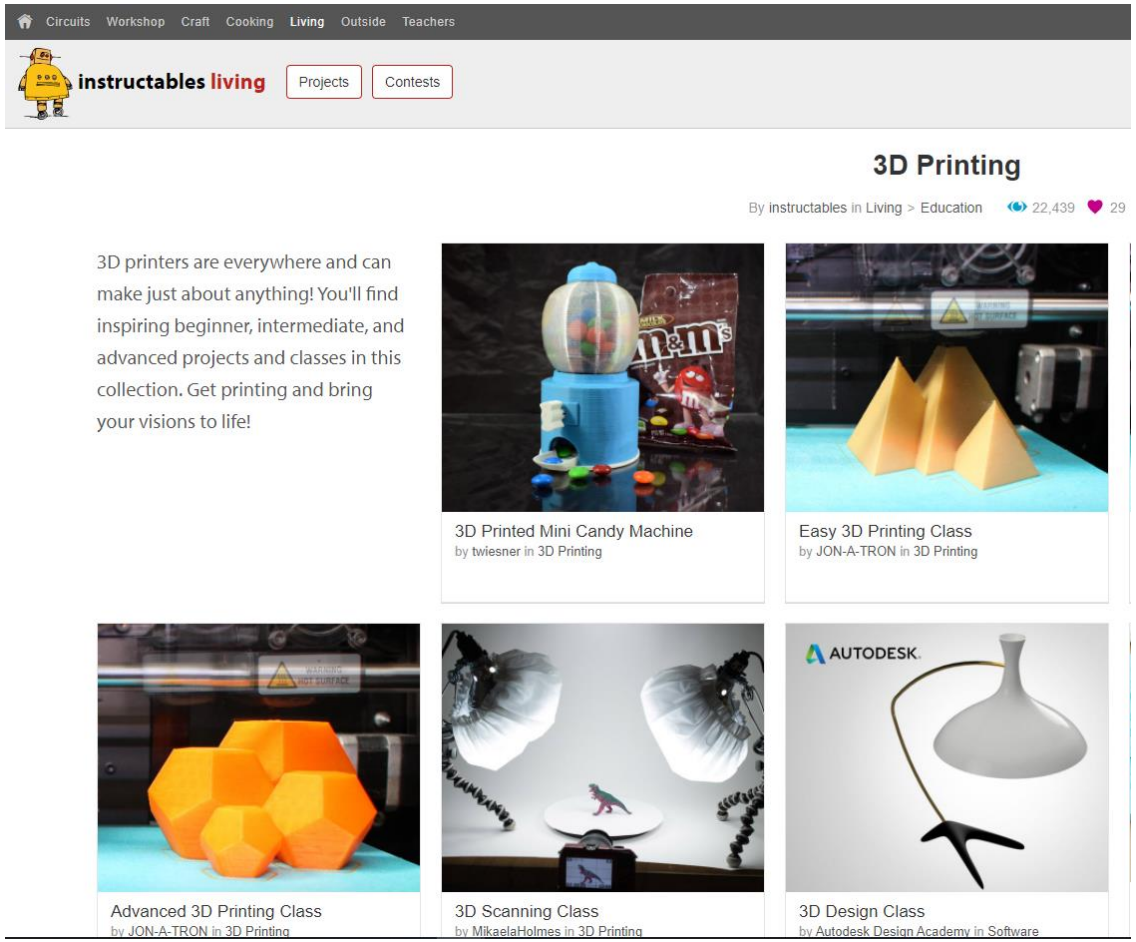
Instructables

https://www.instructables.com/



- Language: English
- Collection of all kind of DIY tutorials
- Topics cover from recipes, to furniture construction, electronics principles, customes ...
- Tutorials are sent by Makers all around the world

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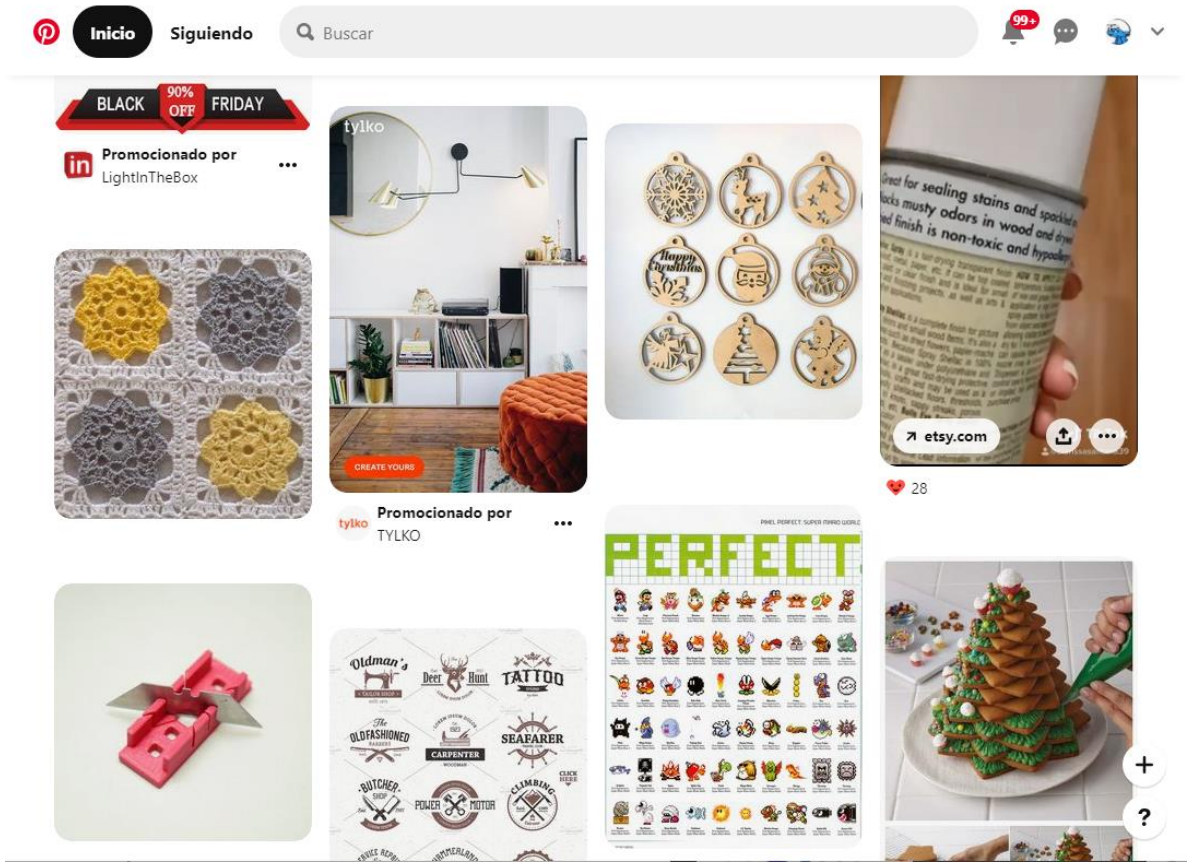
Pinterest

https://fi.pinterest.com/



- Language: All
- Social network with link to small projects and ideas. People share their bookmarks.
- Great variety of topics. Not only focus in digital fabrication.
- Does not have a content by itself, but links to other resources

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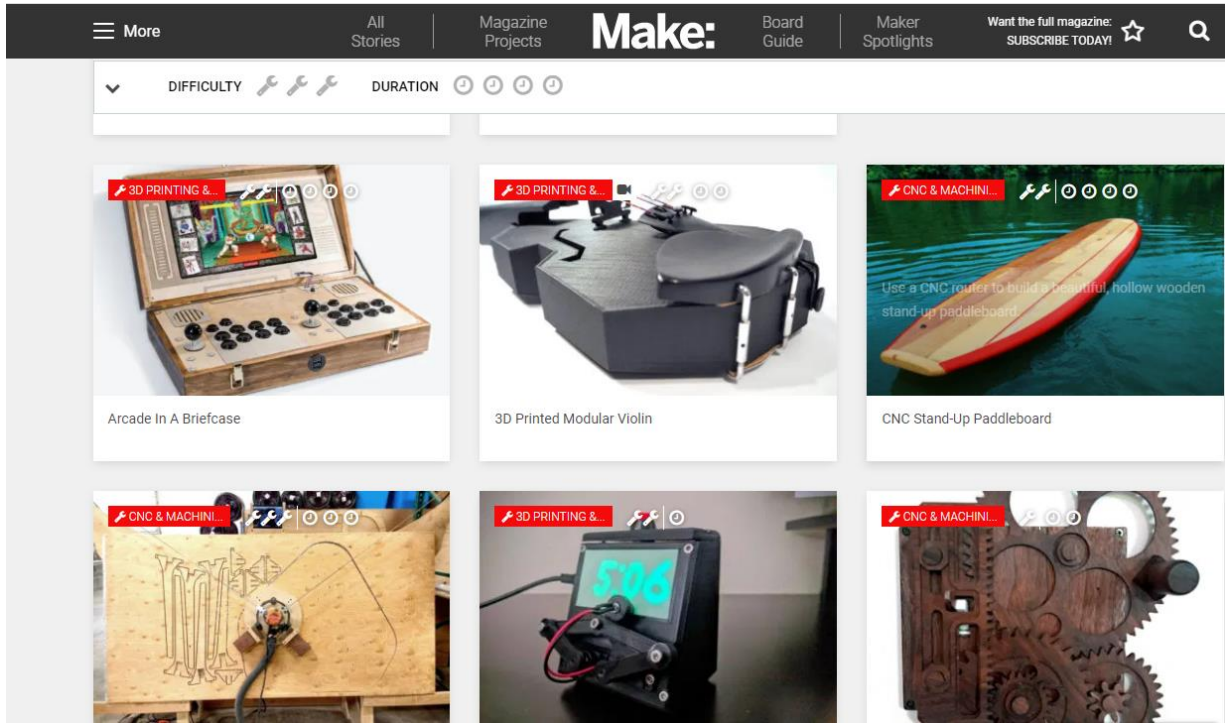
Make Magazine

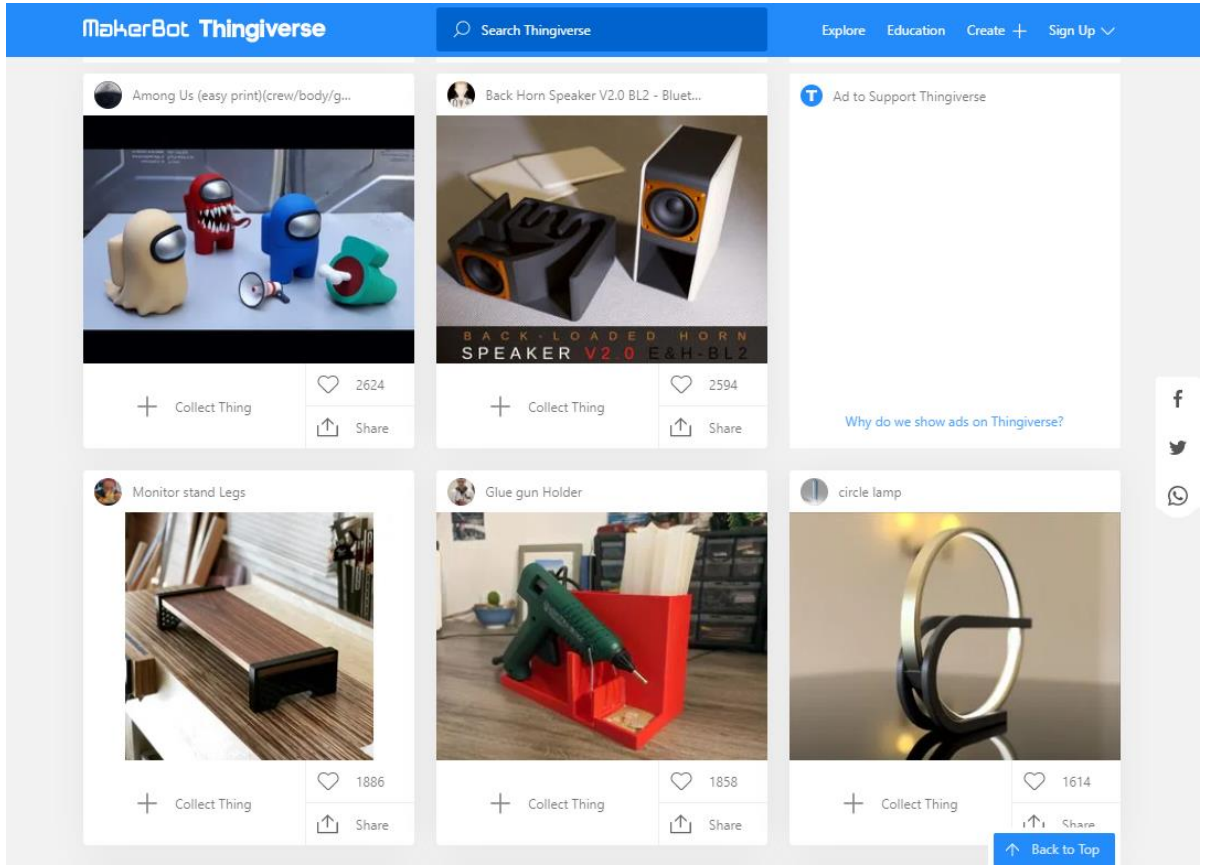
https://makezine.com/



- Language: English
- The magazine that brought the Make community
- Lots of projects, ideas, blog, reports, instructions…

Thingiverse

https://www.thingiverse.com/



- Language: English
- Collection of 2D and 3D models for all kind of projects
- Generally, each project includes all necessary files (including STL files) and some instructions
- It includes feedback from other users

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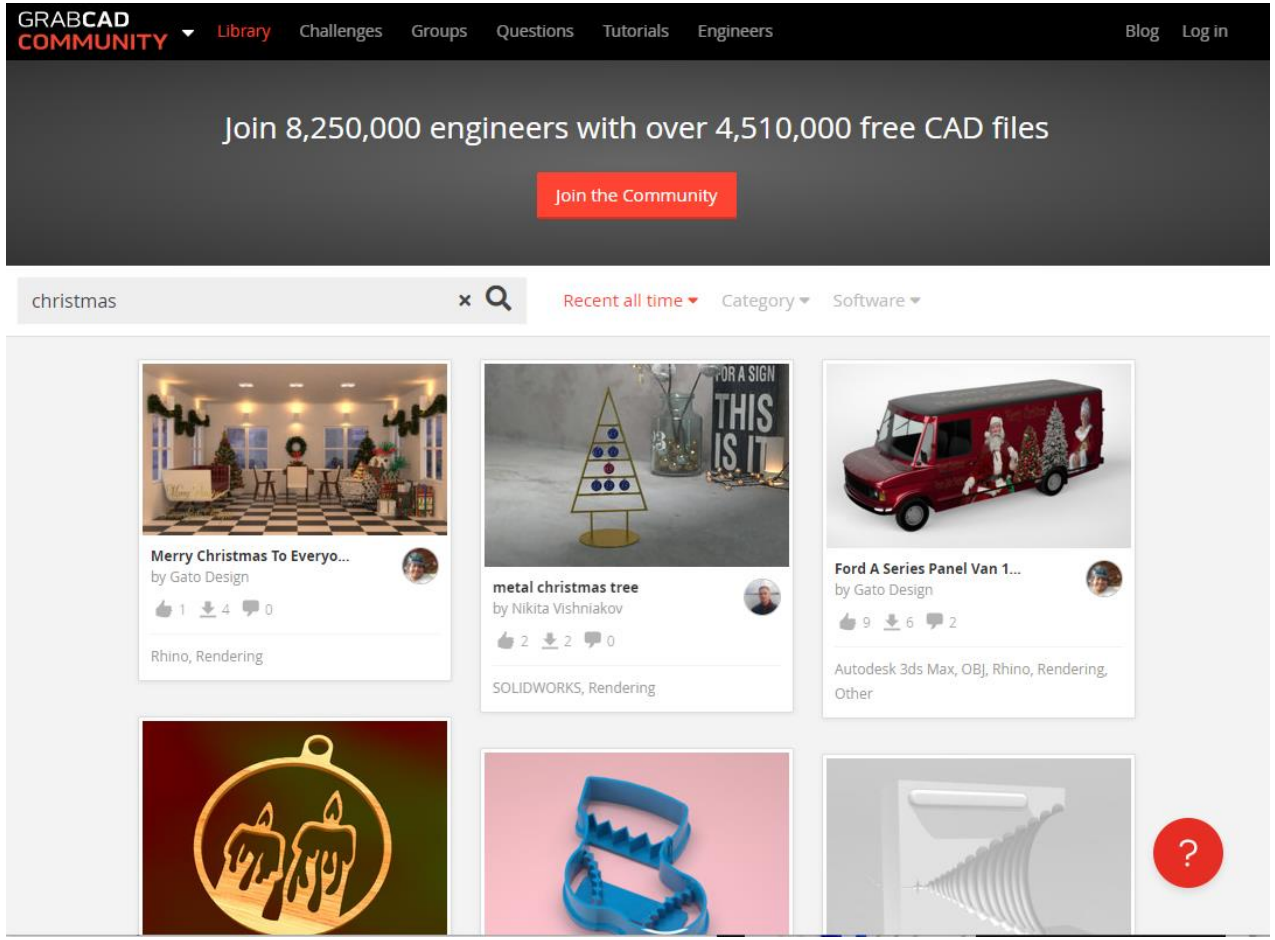
Grab CAD library

https://grabcad.com/library



- Language: English
- Collection of 2D and 3D models including cars, buildings …
- Generally, each project includes all necessary files (including STL files)
- It includes feedback from other users

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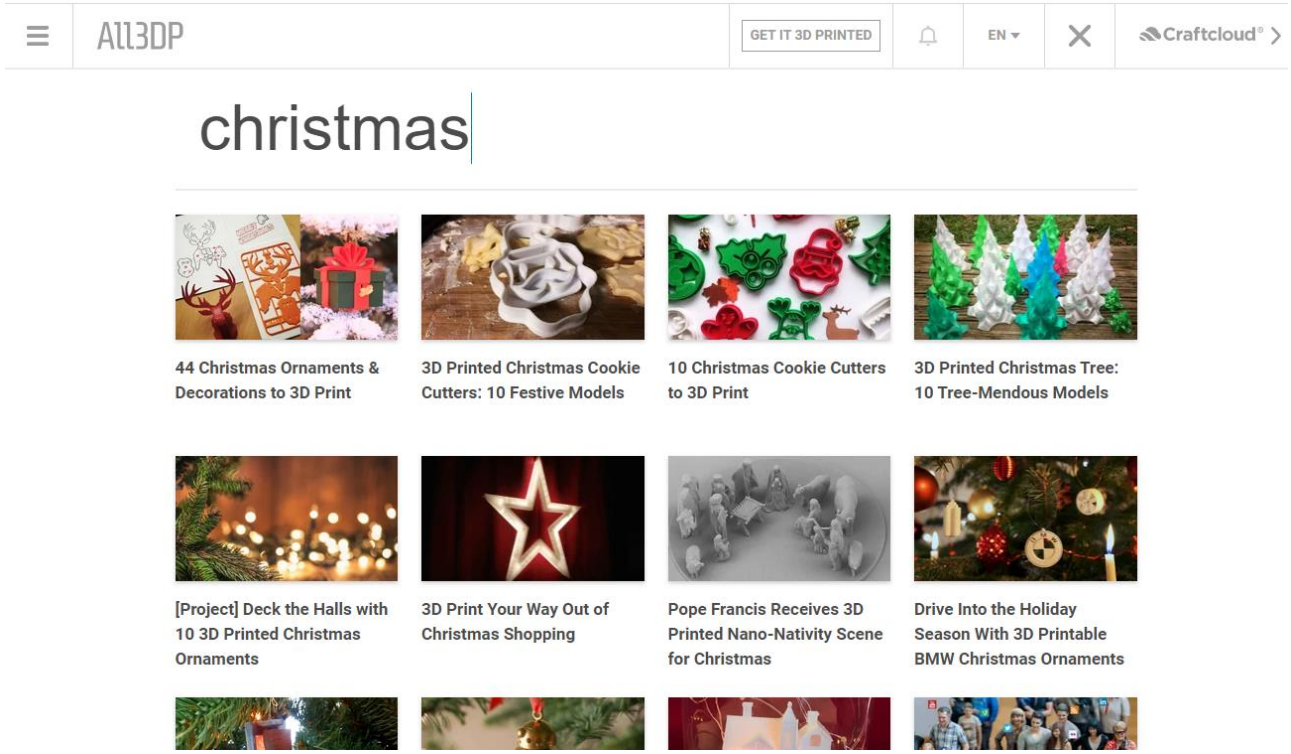
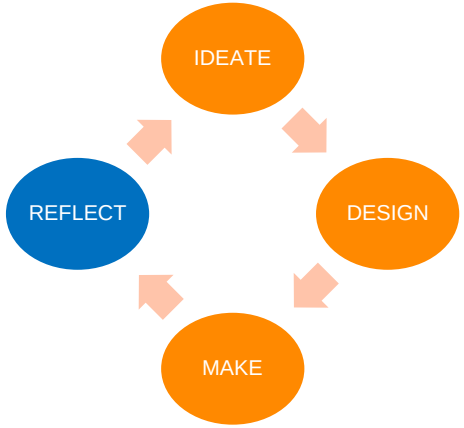
All3DP

https://all3dp.com/



- Language: English
- Website dedicate to 3D printing
- Includes multiple projects, tutorials and advanced concepts on 3D printing

REFLECT

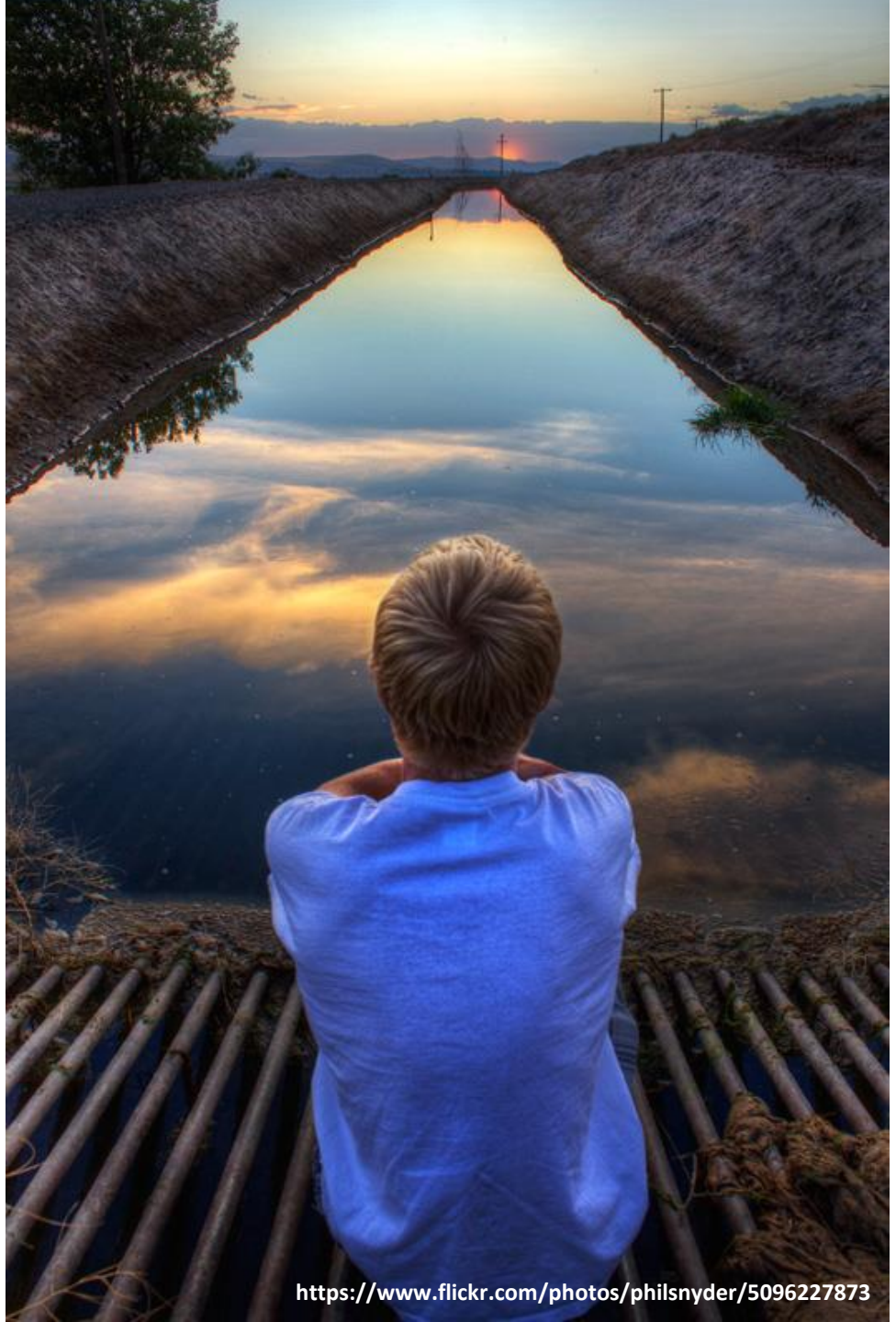


Mitä olet oppinut? **What have you learnt?**

Mikä oli helppoa? **What was easy?**

Mikä oli vaikeaa? **What was difficult?**

Mitä tekisit toisin? **What would you do differently?**



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