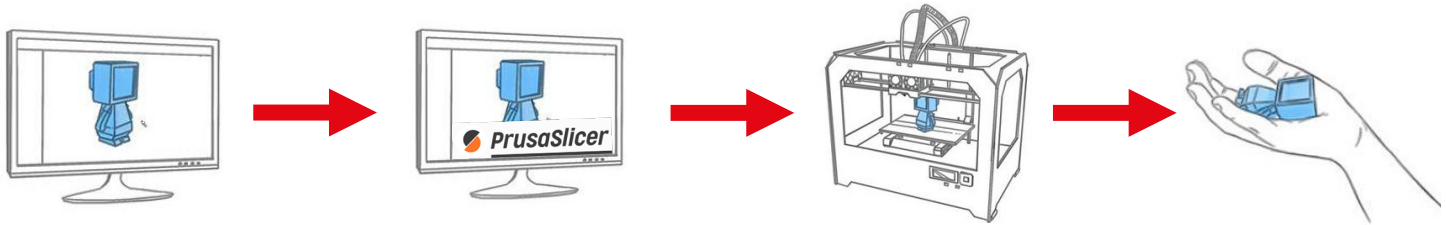
# STEPS FOR SUCCESSFUL 3D PRINTING




DESIGN
(for manufacturing)

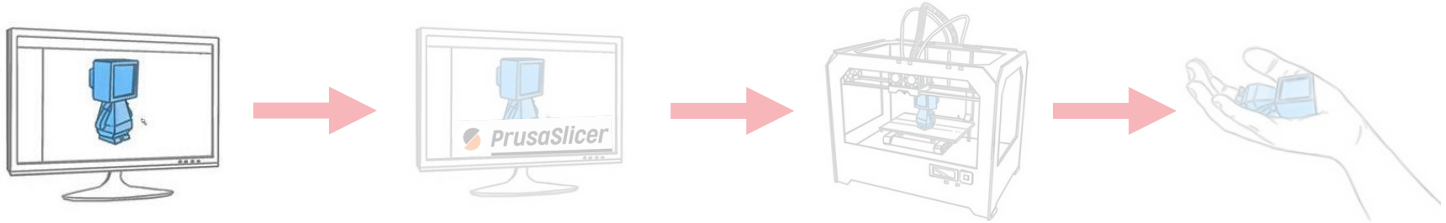
PREPARE
(aka slice)

3D PRINT

FINISH

- Each step is important, takes time and determines the others.
- Don't waste time and materials. A good design and a good slice reduce the number of iterations, failures and breakdowns.
- Schedule your prints in advance and take some margin.
- Some manual finishing work is part of the job.
- Asking for help is always OK.

# STEPS FOR SUCCESSFUL 3D PRINTING




DESIGN
(for manufacturing)

PREPARE
(aka slice)

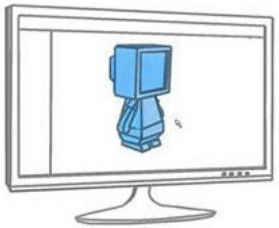
3D PRINT

FINISH

- Consider functions, working conditions, constraints, assemblies…
- Anticipate the following steps:
  - How will you print the parts, in which orientation, which material?
  - On which type of printer will you print? What is it capable of?
  - Can you reduce the amount of material, printing time and manual finishing?

> Export each part in a STEP or STL file

# STEPS FOR SUCCESSFUL 3D PRINTING

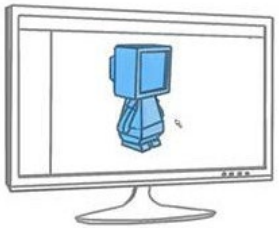


DESIGN
(for manufacturing)

- Using your favorite **CAD software**
- Determine how your prototype **will work**
  - Functions
  - Assemblies
  - Working conditions, constraints…
- **Anticipate** what's coming next:
  - How will you manufacture/print the parts, in which orientation, in which material?
  - On which type of printer will you print? What is it capable of (size, precision, etc.) ?
  - Can you improve strength and reduce the amount of material, printing time and manual finishing?
- **Think Additive**, not machining nor injection molding.
- Export each part in **.STEP (or .STL) format**

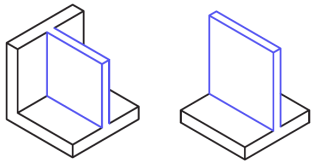
SPOT / Sébastien Martinerie

# STEPS FOR SUCCESSFUL 3D PRINTING



## DESIGN
(for manufacturing)

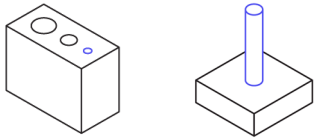
### Wall thickness



Min. 0.8 mm

Min. 1.2 mm

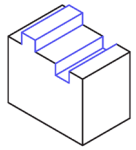
### Hole and pin diameter



Min. 2 mm

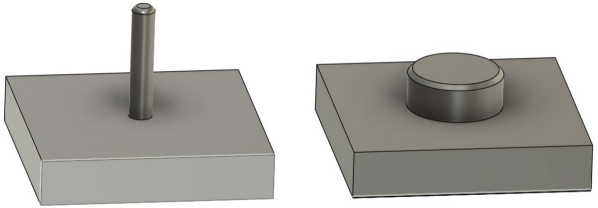
Min. 4 mm

### Embossed and engraved details



Min. 0.8 mm wide and high

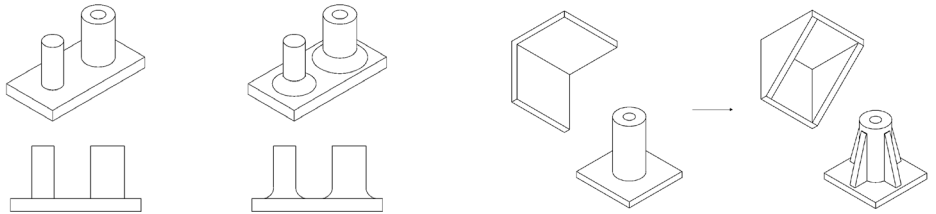
### Avoid fragile elements



X

V

### Add filets and ribs



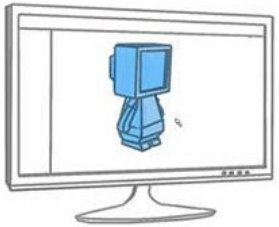
X

V

X

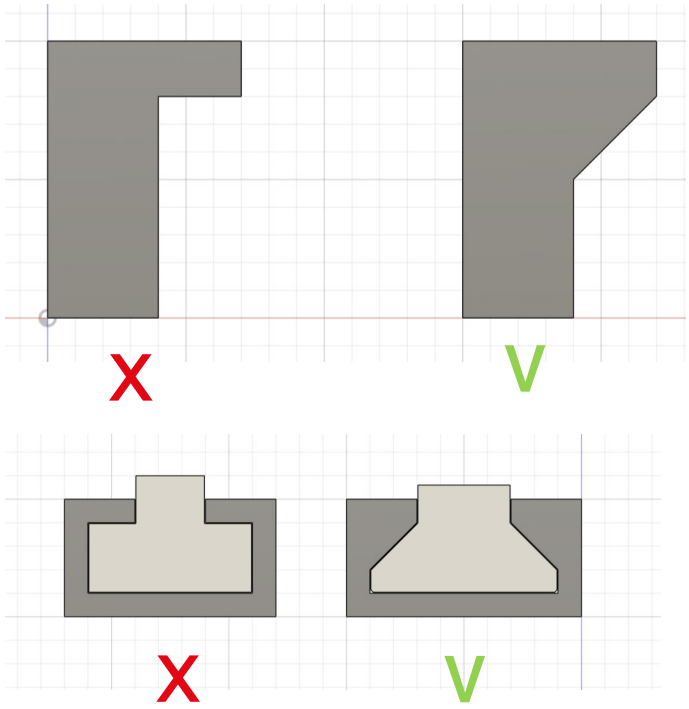
V

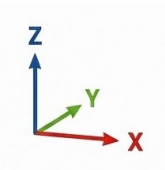
# STEPS FOR SUCCESSFUL 3D PRINTING



DESIGN
(for manufacturing)

Avoid useless overhangs and supports



# STEPS FOR SUCCESSFUL 3D PRINTING

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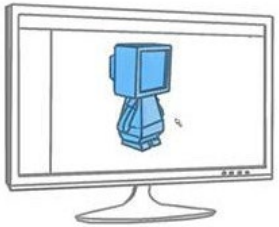
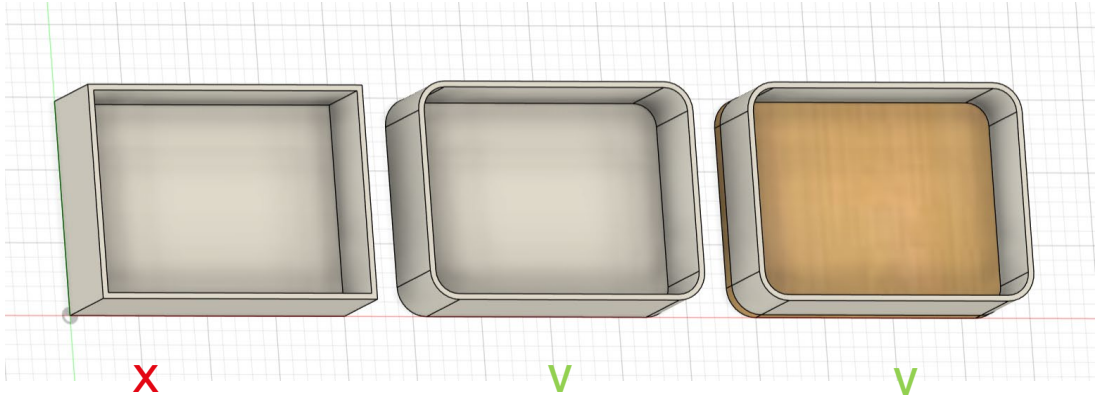


DESIGN
(for manufacturing)

Avoid large rectangular bases



X

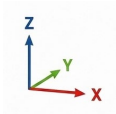
V
Rounded corners

V
Laser cut base

Avoid downward facing filet

X

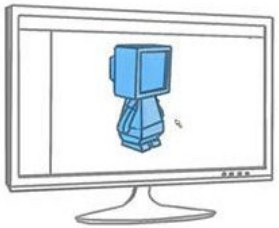
V





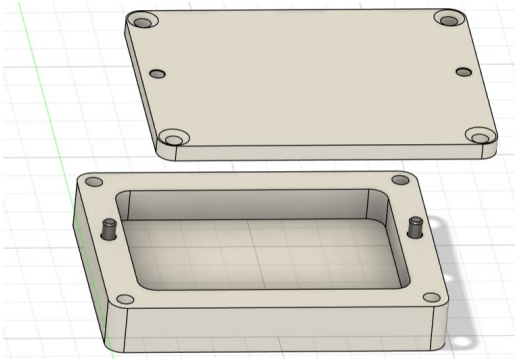

SPOT

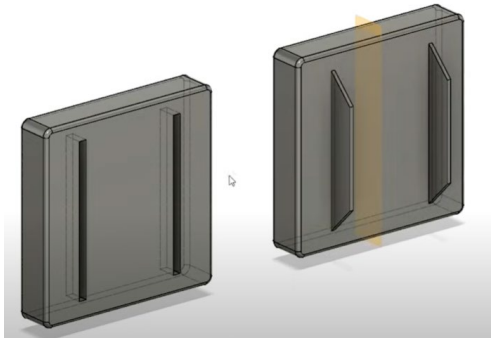
# STEPS FOR SUCCESSFUL 3D PRINTING



DESIGN
(for manufacturing)

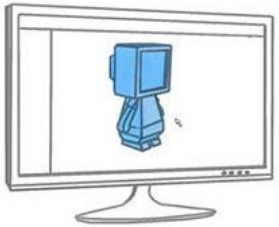
- **Designing assemblies > Positioning elements**
  - If you need to assemble parts together, you should not forget to ensure a good positioning by designing positioning elements such as:
  - Pins and holes of any shape (prefer standard pins when possible)
  - Any other positioning element.
  - Don't forget the tolerance consideration of next slide.





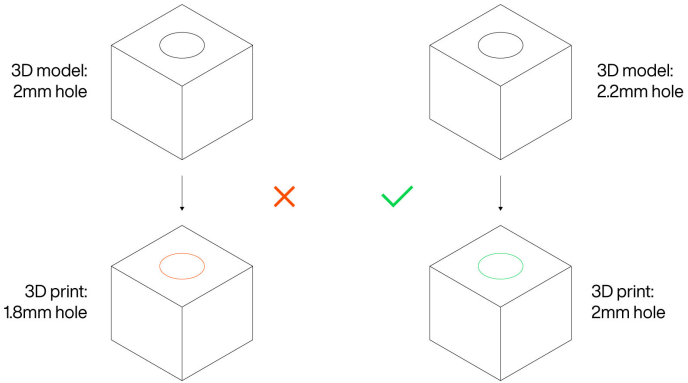
# STEPS FOR SUCCESSFUL 3D PRINTING

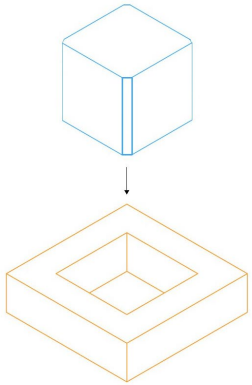


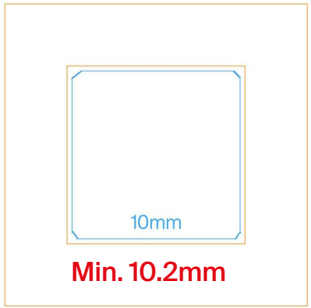


DESIGN
(for manufacturing)

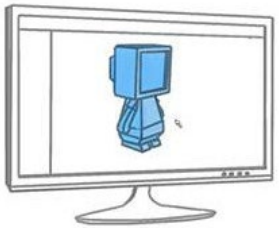
- **Designing assemblies > Tolerances**
  - The printed dimensions are generally larger than the 3D model (about 0.1 mm everywhere).
  - Leave a distance between parts for easy assembly. Typical value for FDM 3D printing: **0.1 – 0.2 mm**
  - Use chamfers for easy insertion.
  - See the tolerance test parts in the room, or print your own to determine precise tolerances





# STEPS FOR SUCCESSFUL 3D PRINTING



DESIGN
(for manufacturing)

- **Designing assemblies > Fixing parts together**
  - There are many options to secure parts together.
  - You can use:
    - Glue (strong but not reversible)
    - Magnets (reversible but not strong)
    - Screws (strong and reversible) > See next slide
    - Other options like snap fits, zip ties, etc.
    - Tips and samples coming soon > Ask your coach

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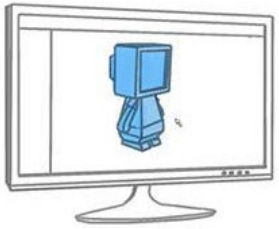
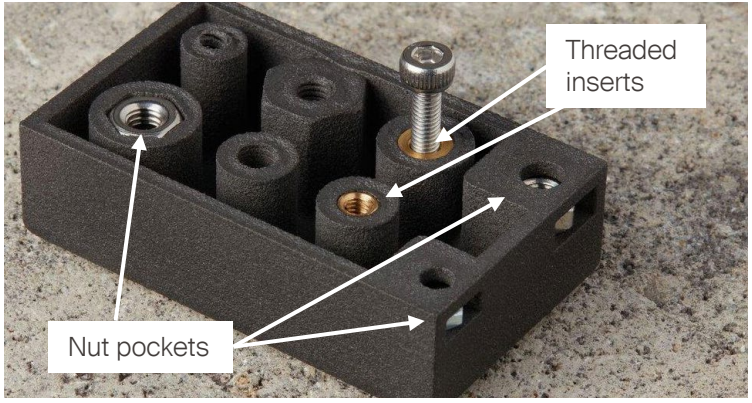
# STEPS FOR SUCCESSFUL 3D PRINTING



DESIGN
(for manufacturing)

- **Designing assemblies > Screwing parts together**
  - 3D printing threads or threading 3d printed parts is generally not a good idea (not precise and strong enough). Use standard elements such as:
  - **Nut pockets > BEST OPTION !**
  - **Threaded inserts >** Check the hole dimensions before printing
  - Tips and tutorial > Wiki





https://make.epfl.ch/wiki/public/spot_-_3d_printing/how_to_use_threaded_inserts

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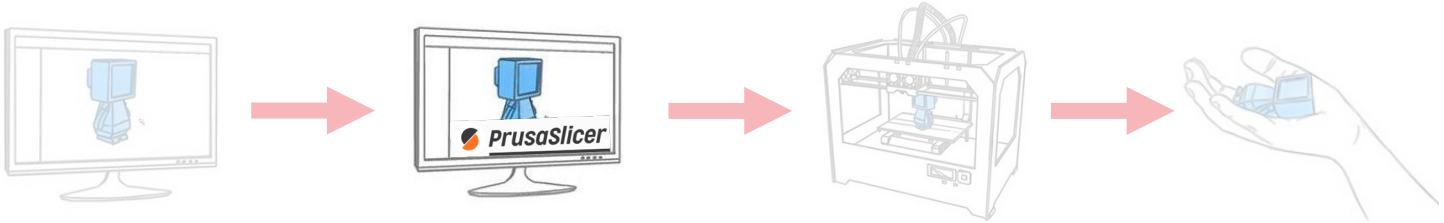
# STEPS FOR SUCCESSFUL 3D PRINTING




DESIGN
(for manufacturing)

PREPARE
(aka slice)

3D PRINT

FINISH

- Transform geometry (STL, STEP) into instructions for the printer (G-code)
- Printer model, material, advanced settings
- Part orientation, support structure (if necessary)
- A bad slicing can ruin your print and even the printer > Double check before printing!

> Export G-code on a USB stick

# STEPS FOR SUCCESSFUL 3D PRINTING


PREPARE
(aka slice)

- **Configure PrusaSlicer**
  - Use only UpToDate **PrusaSlicer**
  - Configure the right printers and filament profiles

https://make.epfl.ch/wiki/public/spot_-_3d_printing/prusaslicer_configuration

➢ **Prusa MK4S** with **0.4 mm High Flow nozzle**
  ➢ **SPOT PETG_2026**

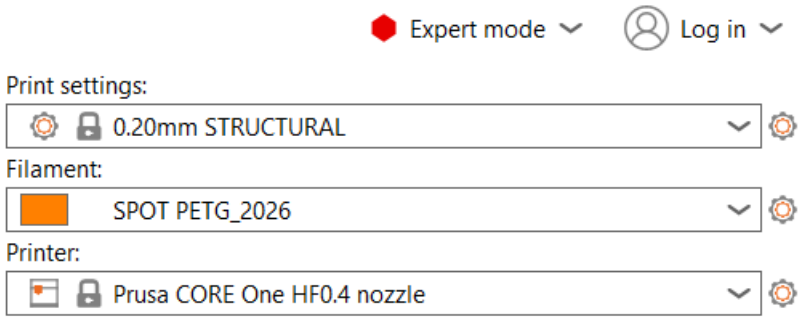
➢ **Prusa Core One+** with **0.4 mm High Flow nozzle**
  ➢ **SPOT PETG_2026**

- For other printers and materials, ask your coach or refer to documentation

# STEPS FOR SUCCESSFUL 3D PRINTING


PREPARE
(aka slice)

- **Start slicing**
  - Work in Expert mode
  - Import your STEP or STL files
  - Choose your printer type and filament
  - Choose your print settings
    - **0.2 mm** layer height
    - **Structural** settings are always better than Speed!



# STEPS FOR SUCCESSFUL 3D PRINTING



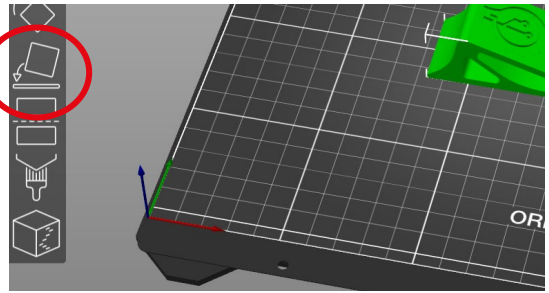

PREPARE
(aka slice)

- **Orient your part:**

  A good part orientation is decisive for a successful print.
  Keep in mind the following factors

  - **Tensile strength** is lower along the Z axis (layers separation)
  - The **best precision/resolution** is on XY plan
  - **Supports** affect the surface quality once removed

  If you don't find the good orientation, try to change your design.

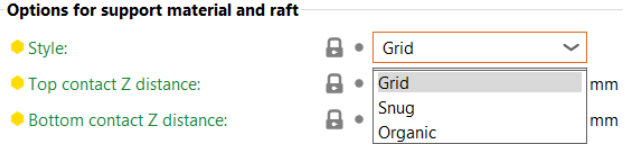


**Place on face tool:**
Choose which surface will face the printbed.
**Preferably use this tool!**

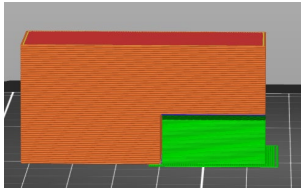
# STEPS FOR SUCCESSFUL 3D PRINTING


PREPARE
(aka slice)

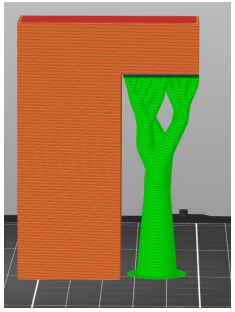
- **Generate supports:**
  - **You can't print in the air!**
  - Surfaces that are not supported enough **can ruin your print.**
  - In case of doubt, place supports **everywhere.**
  - Remember you will have to access the support for removal.
  - And that supported surfaces are altered.
  - You can find different support styles here:
    - Print settings > Support material > Style
    - Snug and Organic are particularly easy to remove




For large and low supported areas



For small and high supported areas

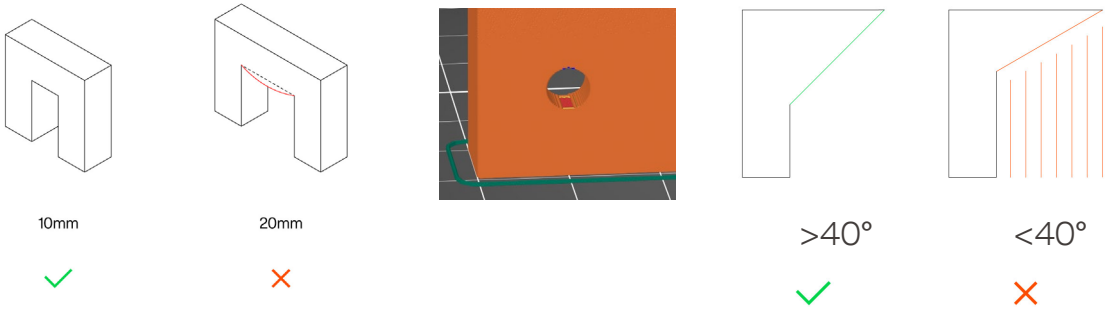


# STEPS FOR SUCCESSFUL 3D PRINTING

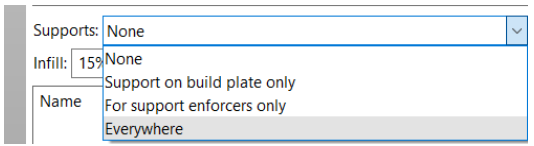



PREPARE
(aka slice)

- **Generate supports:**
  - Small bridges are fine. Short horizontal holes don't need to be supported
  - Overhangs above 40° are ok



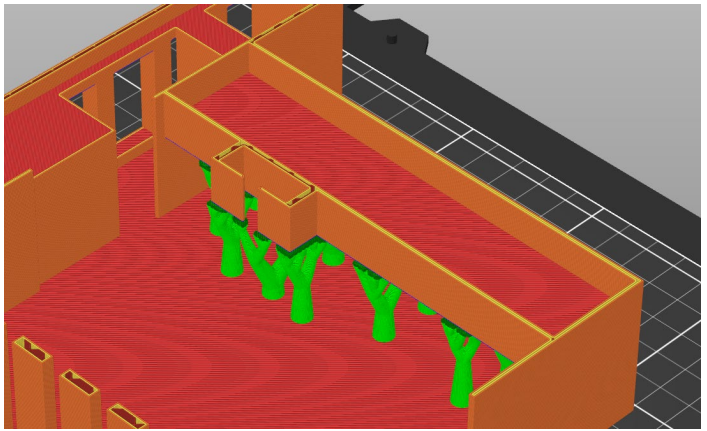

- You can also place supports selectively using the **paint-on supports tool** and the **"For support enforcers only"** option.



# STEPS FOR SUCCESSFUL 3D PRINTING


PREPARE
(aka slice)

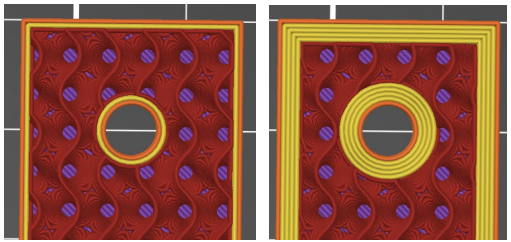
- **Generate supports:**
- **Warning**: avoid supports printed on top of a flat printed surface.



- The need for supports can be optimized by changing:
  - your **design** (splitting parts, adding chamfers, etc.)
  - and/or your part **orientation**

# STEPS FOR SUCCESSFUL 3D PRINTING


PREPARE
(aka slice)



- **TIP: Increase strength**
  - **Part design**
    - Avoid stress concentrations
  - **Part orientation**
    - Avoid layers delamination
  - **Infill**
    - Big time and filament usage increase > Slight strength increase
  - **Perimeters**
    - **Big strength increase**
    - Also increases print time
    - Allows you to mechanically correct the part afterward (increase a hole diameter)
    - Improves sealing as well as compliance capability

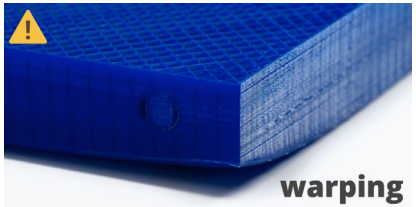
➢ Print settings > Layer and perimeters > perimeters

> 2 (default) -> **4 to 6**

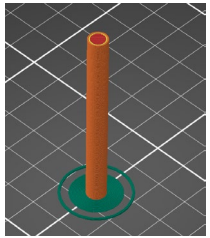
# STEPS FOR SUCCESSFUL 3D PRINTING


PREPARE
(aka slice)

- **TIP: Prevent warping or bad adhesion to the bed**

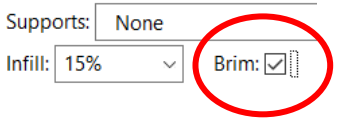


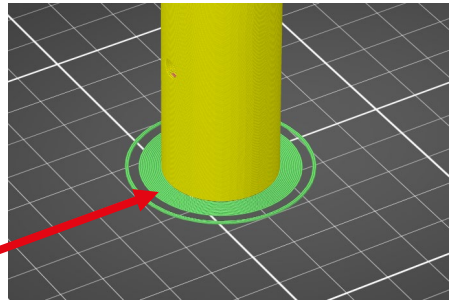

Large rectangular base



Thin and high parts

1) **Avoid that kind of parts**
2) **Take a smooth printbed**
3) **Add a brim**



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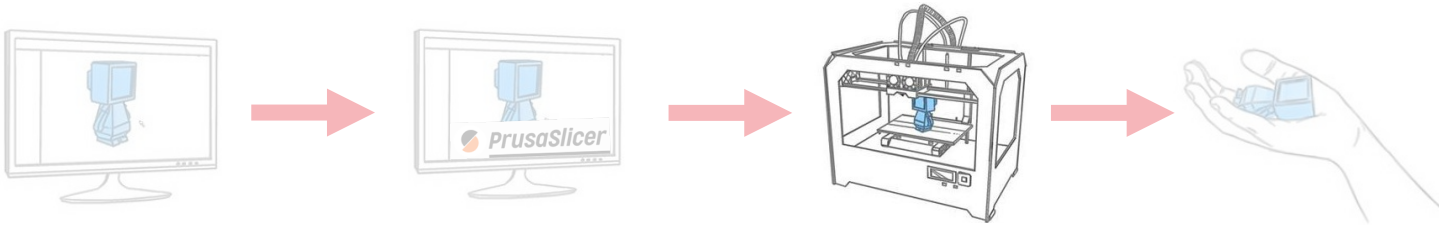
# STEPS FOR SUCCESSFUL 3D PRINTING




DESIGN
(for manufacturing)

PREPARE
(aka slice)

3D PRINT

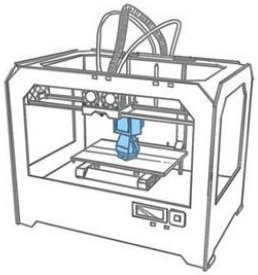
FINISH

- Unlock the printer on **make.epfl.ch/3dprint** and choose your budget
- If your project's list is wrong > update it on make.epfl.ch/training
- Do the different checks (printbed, filament, nozzle)
- Insert your USB stick
- Start printing and stay for at least one layer

*Wiki*

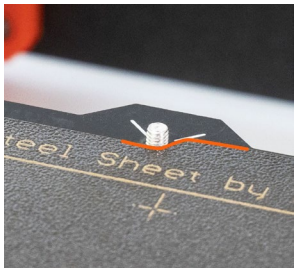
https://make.epfl.ch/wiki/public/spot_-_3d_printing/how_to_unlock_a_printer_using_internet

# STEPS FOR SUCCESSFUL 3D PRINTING



3D PRINT

- **Respect** the tools and the rules
- Put the previous user's printbed on the table
- Take any **new clean printbed** and place it properly.
  - Textured printbed for easy part removal
  - Smooth printbed for stronger adhesion



- Check the filament (type and amount)
  > Tutorial for filament change →

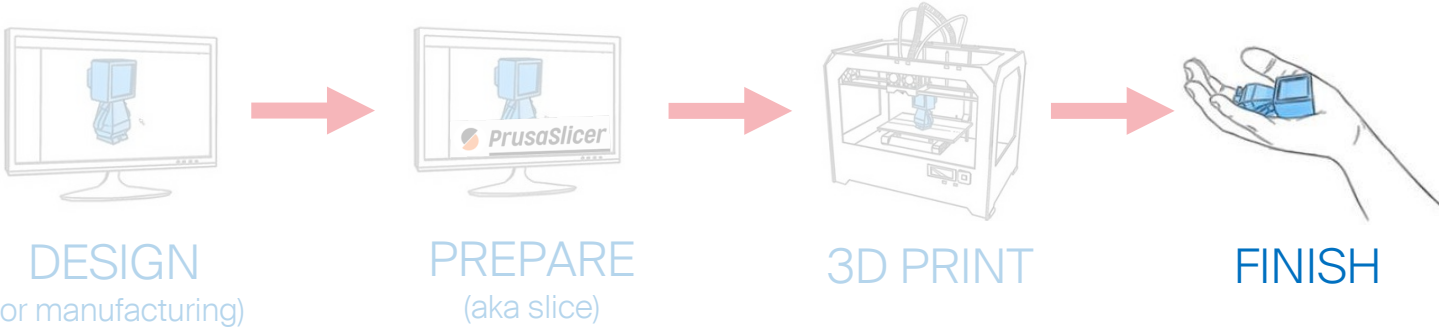
- Check if the nozzle is clean

  If not, preheat the printer and remove excess filament with a plier or ask for help

https://make.epfl.ch/wiki/public/spot_-_3d_printing/load_filament

- **Start** your print and **stay for the first layers** and eventually come back from time to time

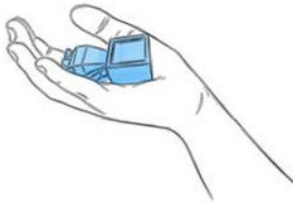
# STEPS FOR SUCCESSFUL 3D PRINTING




- Remove the printbed from the printer
- Remove carefully your parts from the printbed and the supports from your part
- Clean your workplace and printbed, manage your wastes
- Sanding, drilling, assembling > In the atrium

# STEPS FOR SUCCESSFUL 3D PRINTING





## FINISH / ASSEMBLE

- **After printing**

- Unload filament and store it properly
- Remove the printbed from the printer
- **Wear safety glasses!**
- Remove your part from the printbed
  Please, avoid scratching the surface
- Remove the **supports** > use pliers

- **Clean** the workplace
- **Clean** the printbed (soap and water)

- Use the **PETG bin!**
  - Only for dust-free PETG parts and supports
  - No screws, inserts, glue, dust

- Sanding, drilling, assembling, etc. **> In the atrium**