Standard Operating Procedure for 3D printing using:

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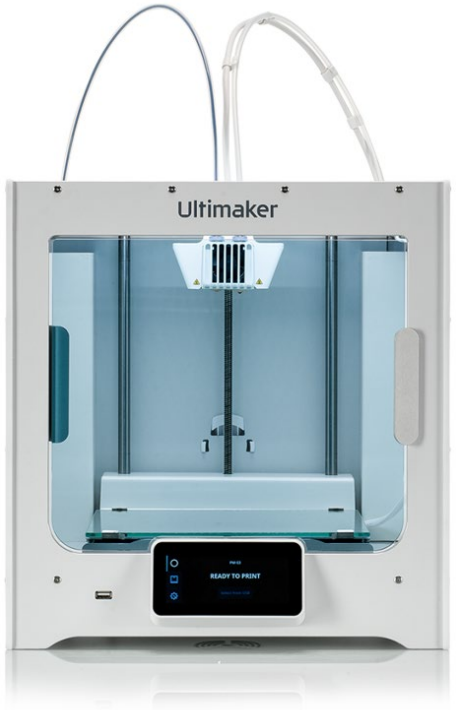
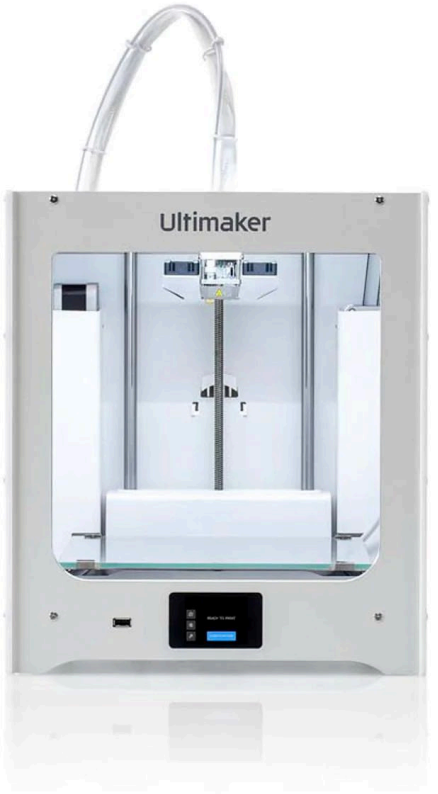


Ultimaker S3

Ultimaker S5



Ultimaker 2+ Connect

CAD graphics

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What you need to bring:

- A laptop with Ultimaker Cura slicing software installed: https://ultimaker.com/software/ultimaker-cura/
- Your CAD model exported as an STL, SMF, or OBJ file. (Note: OBJ files may lose their scale. Check size before printing).

What you need know:

- The 3D Printer Farm consists of communal access machines for James Watt School of Engineering student work.
- You must understand how to set up and operate the 3D printers safely and effectively before use.
- You must adhere to the Standard Operating Procedure that follows, and the read the 3D Printer Farm Policy.
- If you are interested in using a larger machine or a material other than PLA, speak to the Technician present, or contact cadgraphics@glasgow.ac.uk. See the 3D Printing page for further details on other machines.
- If you are interested in using the Bambu or Prusa machines, see their Standard Operating Procedures.

3D Printing in the School of Engineering

Cura: Add printer

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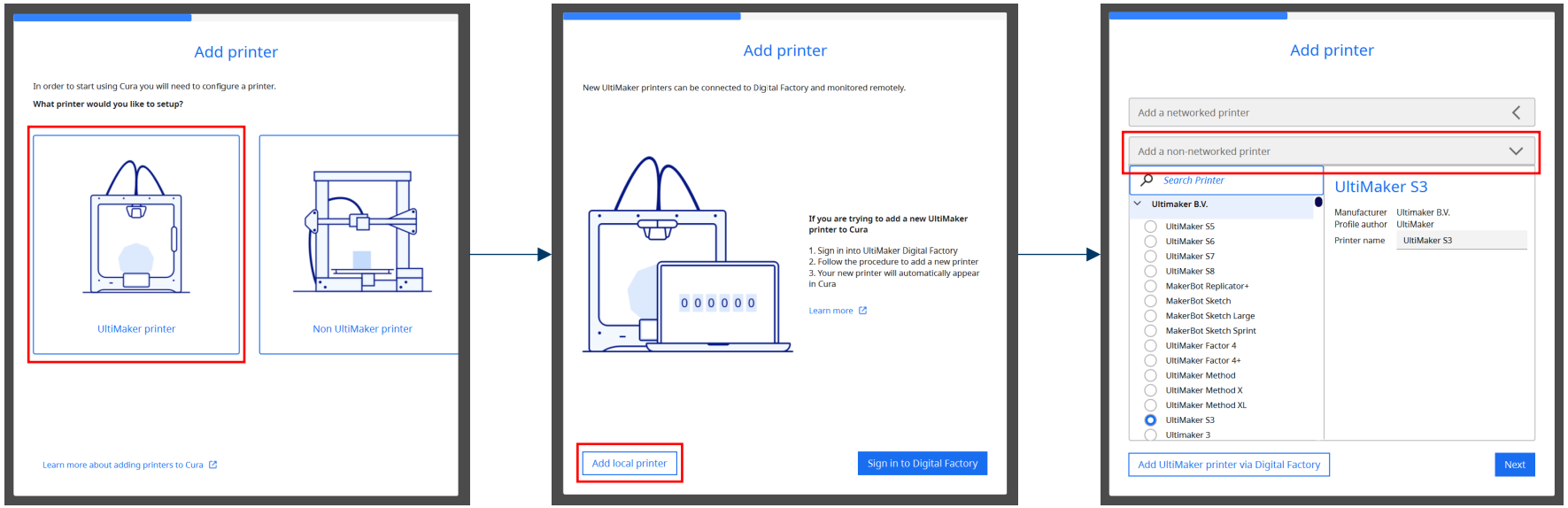

To add a printer, select: Ultimaker printer → Add local printer → Under the dropdown “Add a non-networked printer”, select the printer you will use

Cura: Prepare setup

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User interface – how to navigate

1. Import your model

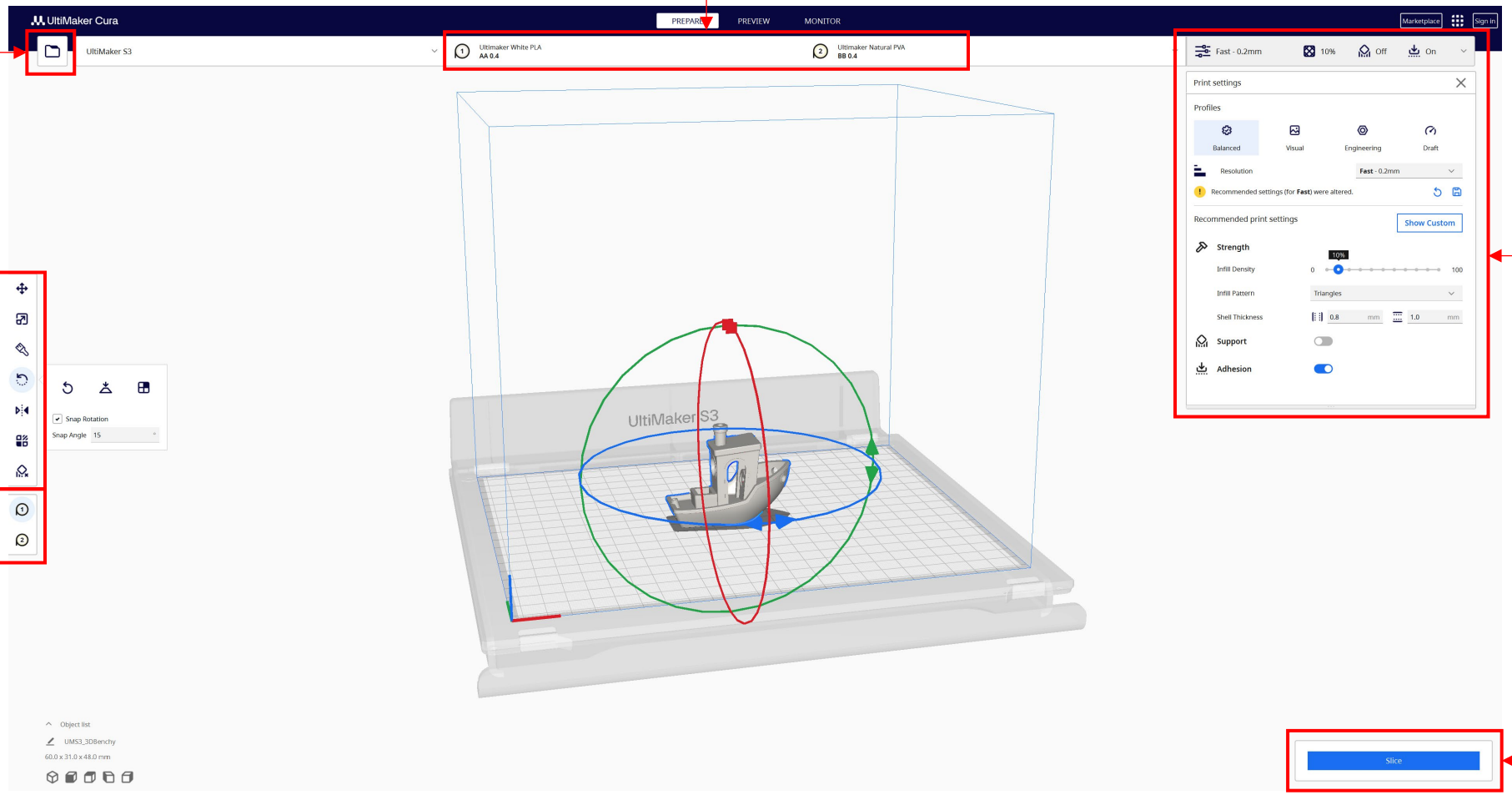
2. Setting materials and nozzles – see next page

3. Model manipulation tools – select your models to use

4. Choose the nozzle to build with

5. Print settings – see next page

6. Select “Slice” to preview the generated file



Cura: Print settings

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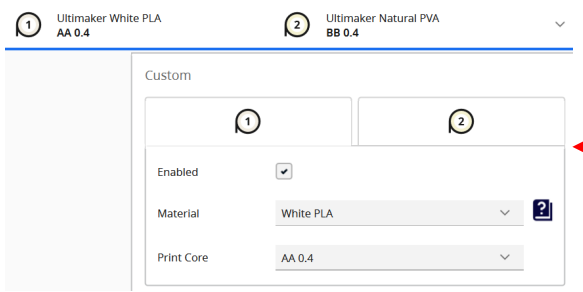
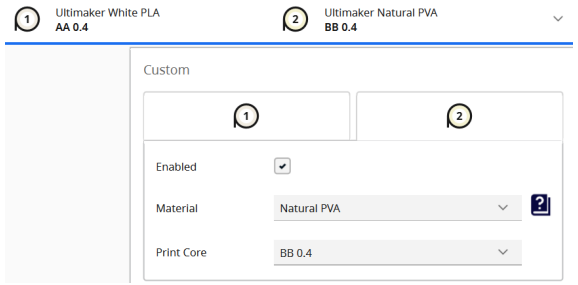
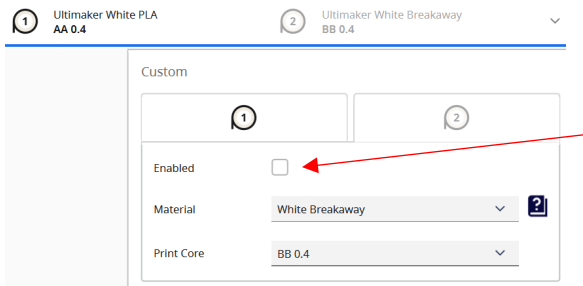
How you should set up the software for the 3D Printer Farm



Click on the material settings and:

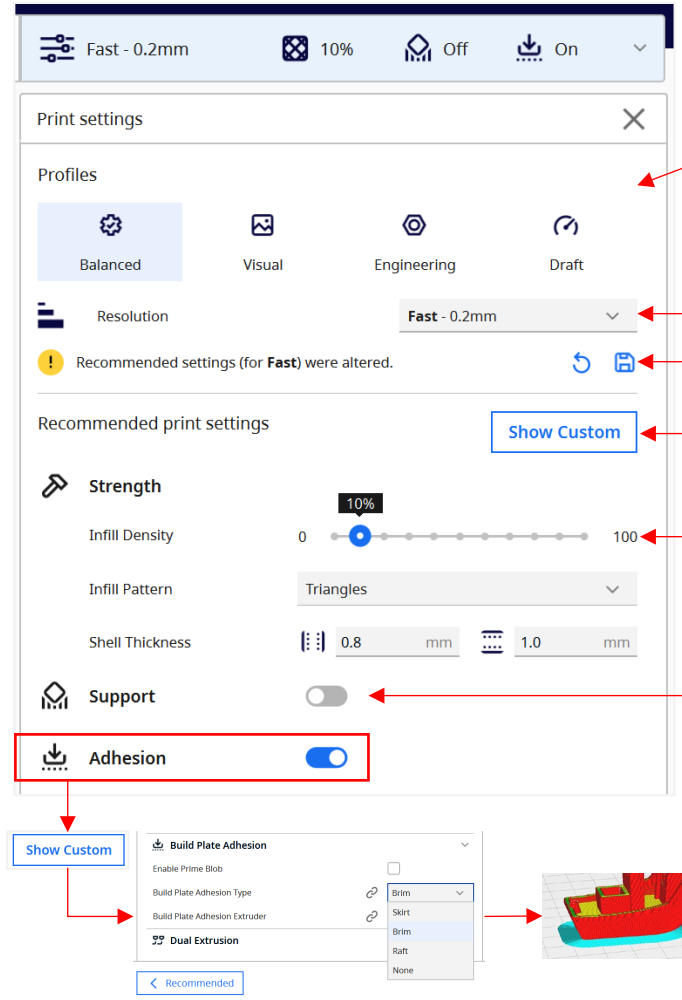
- Set the model material in nozzle 1 to Ultimaker PLA (set as generic PLA, if another brand is used)
- Set the Print Core to AA 0.4





<u>If</u> a separate support material is being used:

- Set the support material in nozzle 2. This will usually be either be Ultimaker Natural PLA or Ultimaker Breakaway (set generic PVA or Breakaway if another brand is used)
- Set the Print Core to BB 0.4
- **<u>If a separate support material isn't being used, uncheck "enabled"</u>**



- Different profiles adapt the settings for different outcomes
  - **Balanced is suitable for the majority of prints**
- Set layer height here:
  - **0.2mm is suitable for most prints**
- You can save changes you make to settings, creating a new "profile"
- Clicking "Show Custom" will reveal more in-depth settings
- **Infill density in most cases can be set at 10%**
- **Toggle support on and off – see next page**

Adhesion:

- Turning on adhesion can help prints stick to the glass bed and prevent warping
  - In custom settings, select **brim** for extra adhesion. If no extra adhesion is required, select **skirt**

Cura: Support settings

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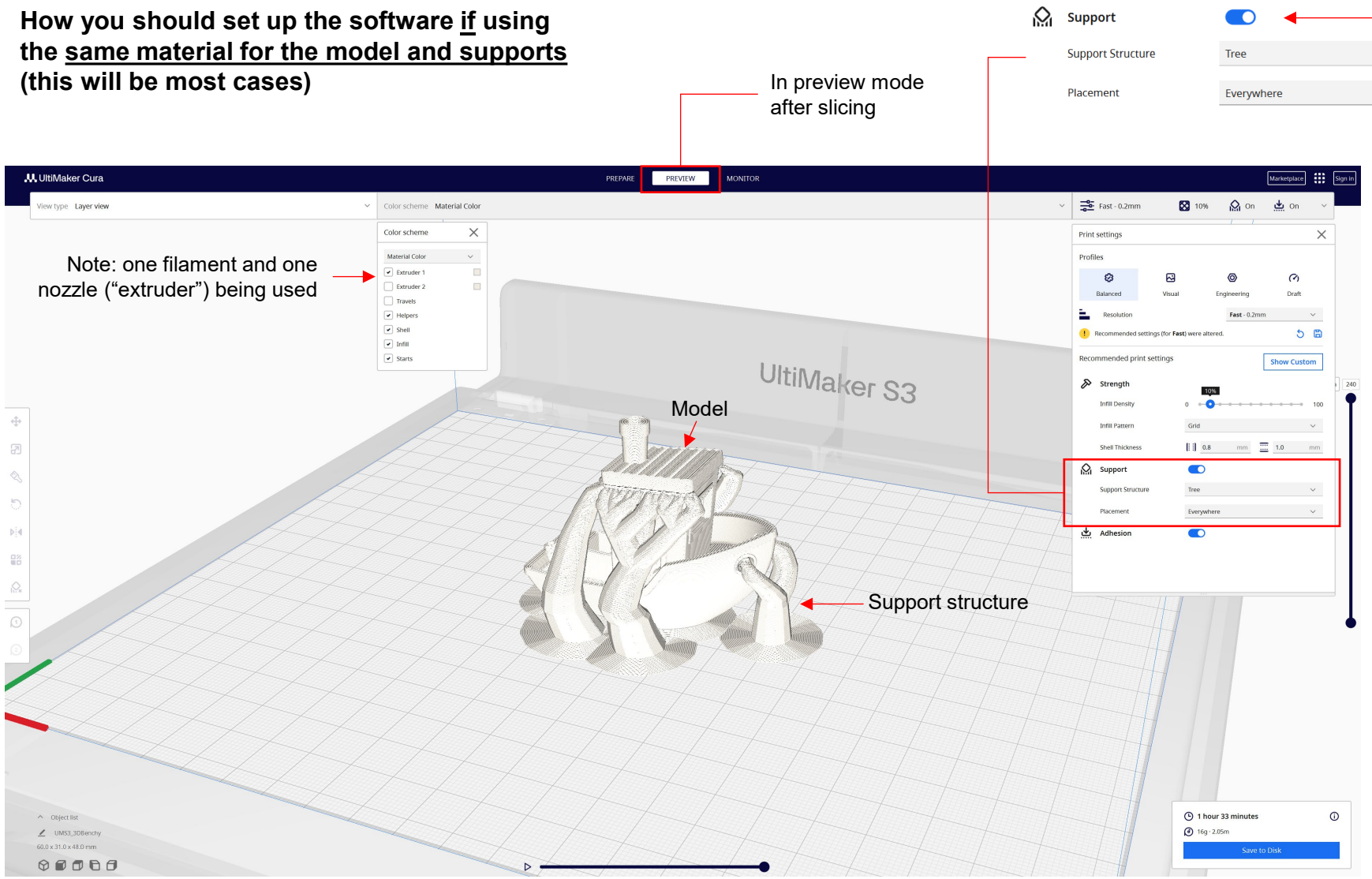
How you should set up the software <u>if</u> using the <u>same material for the model and supports</u> (this will be most cases)



- If support material is necessary, turn on “Support”
  - Choose tree or normal. Tree is often more efficient, especially for complex geometries. Normal is better for flat areas and simple geometry.
  - Placement relates to where support structure can be placed: “everywhere” allows structure to be built on your model, “touching build plate” means structure is only started from the glass bed.

Design and orientate your model to minimise overhangs, which reduces the amount of support structure needed.

Cura: Support settings

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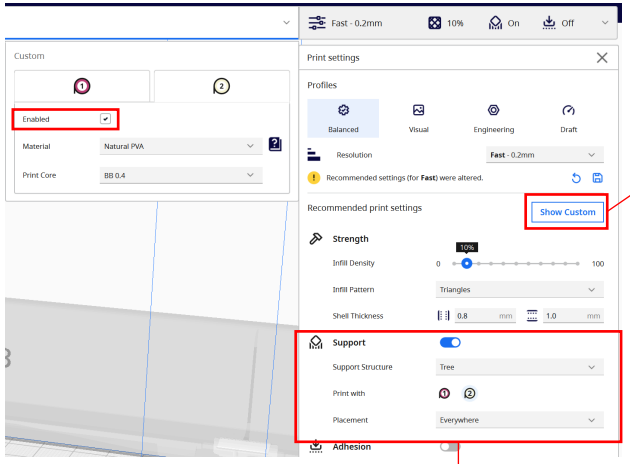
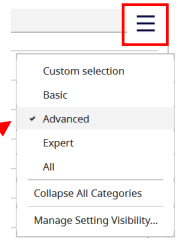
How you should set up the software <u>if</u> using <u>different materials for the model build material and the support structure</u>.

Ultimaker S3 & S5 printers have two nozzles, meaning the use of two materials can be accommodated. This can be used to print support structures using a different material to the model, allowing for easier, cleaner removal.

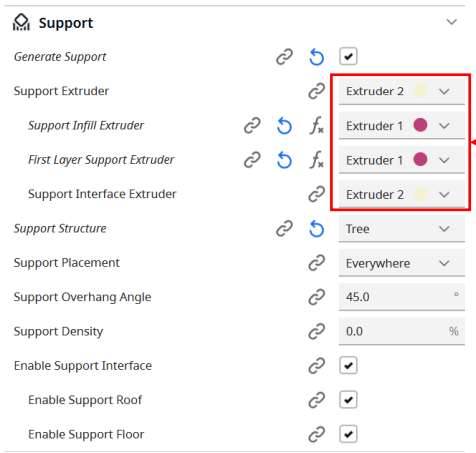


2



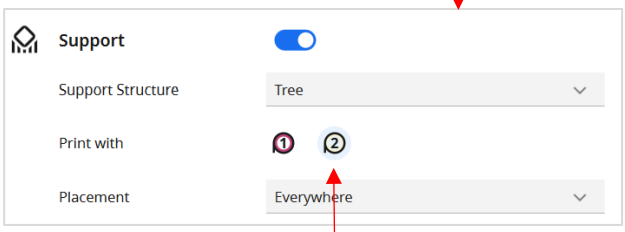
Under the Custom menu's hamburger icon, select "Advanced" to show more options

3



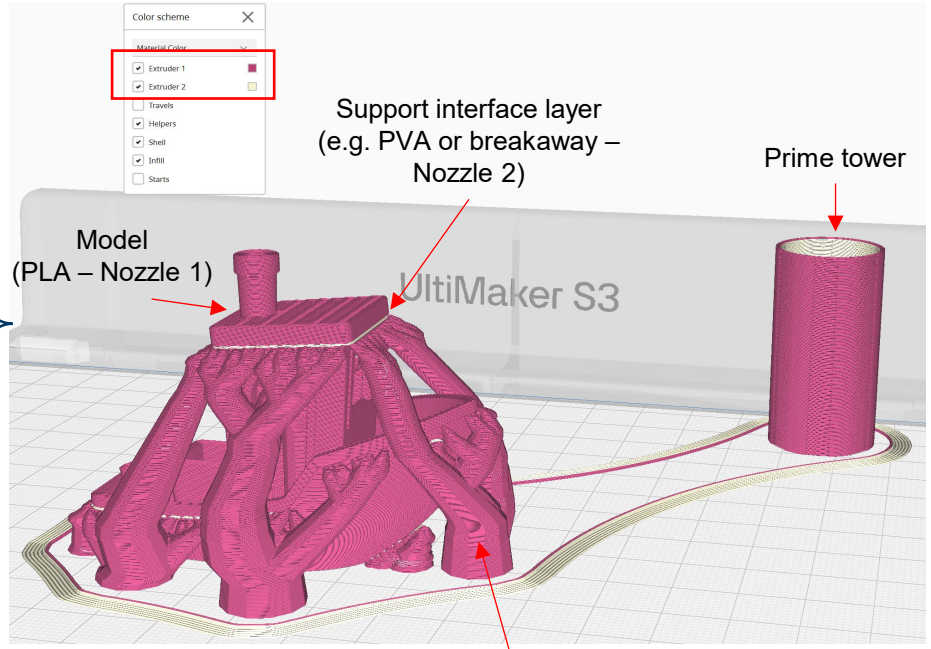
In the Custom menu's Support settings, ensure the nozzles are set as shown here

- With these settings, time and material savings will be made



1 Set support as nozzle 2

In preview mode, you can see and check the result of your settings:



Cura: Preview & export

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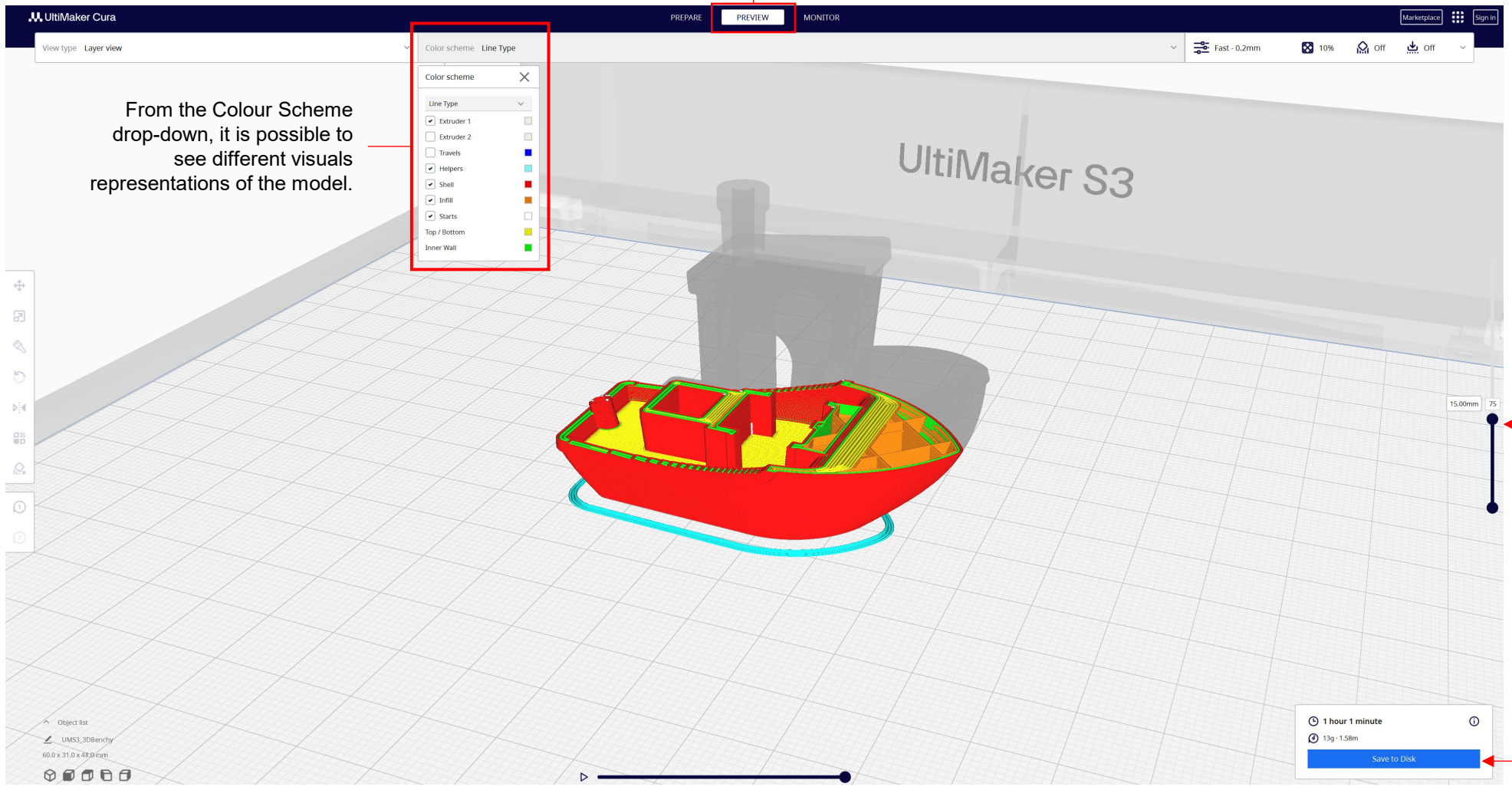
In preview mode after slicing



From the Colour Scheme drop-down, it is possible to see different visuals representations of the model.

Drag this bar up and down to see a layer-by-layer sliced view of the build.

When you are satisfied with the project's settings, model orientations and times, you can export a sliced file on to the Ultimaker 3D printer's USB.

It is also good practice to save your whole "project":
File → Save Project

Step 1

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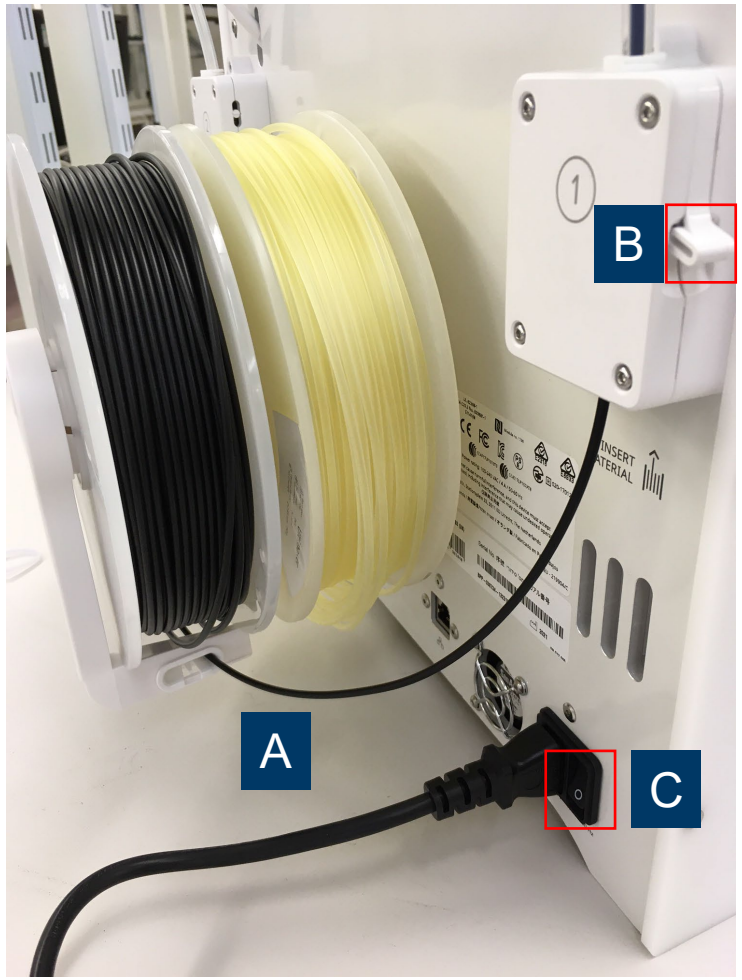

A – Check that the filament is untangled and feeds continuously from the spool into the feeders. Check whether the spools are empty or near empty. If there doesn't appear to be enough material for your model, first try to use another printer.

B – Check that the clamp(s) are in a down position on the feeders.

C – Switch on the printer, and wait until "ready to print" appears on the touch screen.

Do not attempt any maintenance or material changes unless you have discussed this with technical staff. For assistance, training, or troubleshooting → Speak to the Technician present, or contact cadgraphics@glasgow.ac.uk

Step 2

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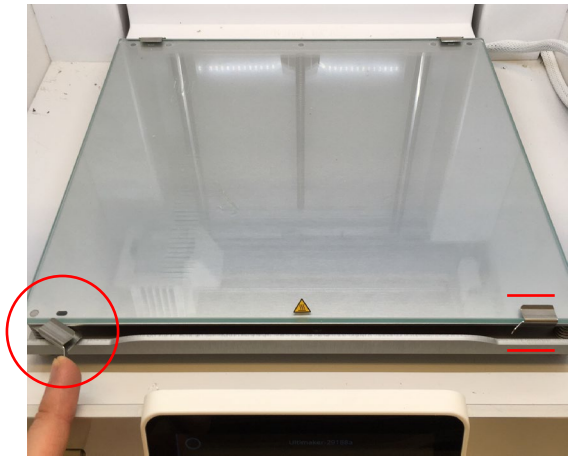
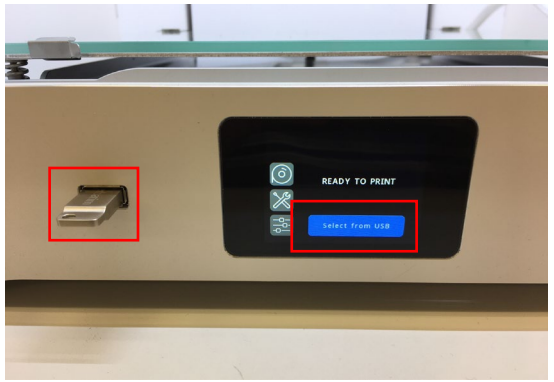
A



(B)

C



A – The bed is fully secured if the clips close parallel with the glass bed. Check that the glass bed is secured and clear of debris (if not clean, see step 4B). A clean build plate is vital for preventing print failures.

(B) – If you continue to experience warping after adding a brim and cleaning the bed, apply a light, single layer of glue to the bed, only on areas where you have placed models in the slicing software. Glue is found in the communal tools box.

C – Your sliced .ufp or equivalent gcode file should by now be on the printer's shared USB or a personal USB. Plug this into the port left side of the touch screen. Press "select from USB".

Do not change any settings or attempt to perform mechanical maintenance. Report issues to the Technician present or contact cadgraphics@glasgow.ac.uk

Checklist: Before you start

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- Printing a large box or plate? → Consider redesigning for laser cutting and submit your DXF file to
- Does your file take >24 hours to print? → It is not suitable for these printers. Adjust infill and layer height settings to reduce time, or submit your STL/3MF file to be printed on our industrial machines

Service Request System

Technical Services Request System

- Do your settings match the printer, material and nozzle specified in the settings?
- Have you checked that the spool on the back of machine has enough filament for your print?
- Do not use more than two printers at one time if your models take more than 2 hours to print.
- Ensure the glass build plate is secured by closing the clips fully.
- Wait for the first layer of filament to print before leaving. Put your details on the labels provided.

Step 3

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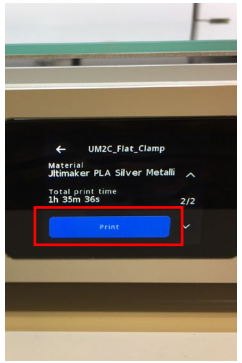
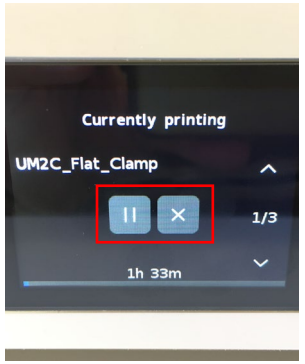
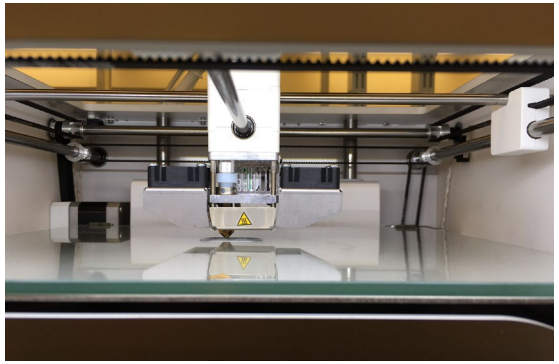
A





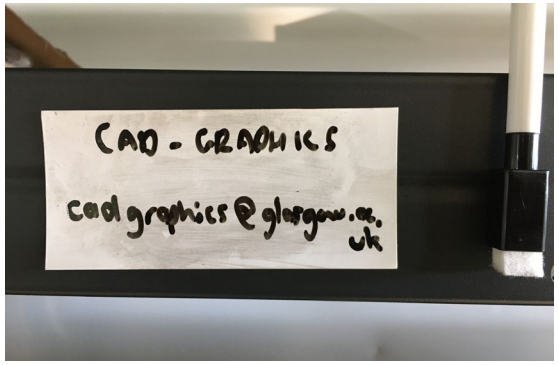
A – Select your file from the list. Scroll to page 2 once the file is selected to see and check an image of the file. Select Print.

B



B – Wait at the machine until the **first layer of material has successfully printed.** This takes a few minutes. **Do not place your hands inside the printer once printing has commenced, as the printer head is in motion.** Options to pause/abort the print must be used if problems are noticed or wanting to interact with a model mid-print.

C



C – Leave a note with your name and student email address using the labels and pens provided, so you can be contacted if necessary.

If you have used the printer's USB, clear your file off the stick. If you've used your own USB, remember to reclaim it and return the printer's USB to the machine.

Notice any on-screen warnings that arise during the printer's start up procedure. Do not attempt to perform any mechanical maintenance. Move to another printer and report issues to the Technician present or contact cadgraphics@glasgow.ac.uk.

Step 4

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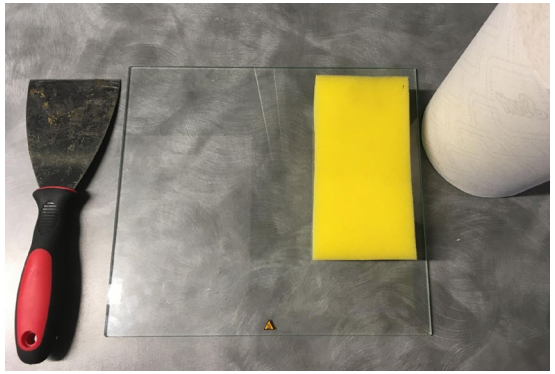
A

A – When the print is complete, carefully remove the glass bed from the printer. Peel away the model from the bed or carefully use a provided scraper to assist. Do not excessively finish or remove build material from your model in the lab – take your model away and do this elsewhere.

Caution: Removing supports or models from the build plate may create sharp breaks in the material. Perform these operations with care.

B



B – Use warm water, scraper/sponge, and paper provided to clean the bed of glue and build material. **Do not return the bed to the printer covered in glue** or wet. Put any waste or support material into the bin.

C

C – Follow the onscreen instructions until the printer is returned to its “ready to print” screen. When clean and dry, return the bed to the printer, with clips secured.

The printer and surrounding area should be left in the same condition as you would like to find it.

Dissolvable support material removal

If your model supports were printed using a dissolvable PVA material, this can be removed either by breaking it away, placing the model in warm water, or using the **support removal bath** provided.

To use the support removal bath, speak to the Technician present or contact cadgraphics@glasgow.ac.uk.

Checklist: When you are finished

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- Leave the machine and work area in the condition you would like to find it.
- Take the glass build plate out of the machine when removing your prints. Do not remove printed objects from the plate when it is in the machine. This disrupts the printer's calibration.
- Clean all glue from the glass build plate with water using the sink, scraper/sponge, and paper provided. **Do not leave build plates covered in glue.**
- Place the build plate back in the machine with clips secured.
- Put any tools used back in the boxes. Put any remaining waste the bin using the dustpan and brushes provided.
- Do not store private materials at the 3D Printer Farm. Unattended materials may be deemed fair use. Remove private spools from the facility after use.

Useful Information

University of Glasgow
James Watt School of Engineering

Service Request System	3D Printer Standard Operating Procedures, Videos and guidance	For enquiries, training, or troubleshooting
Technical Services Request System	3D Printing in the School of Engineering	1. Speak to the Technician present 2. Contact: cadgraphics@glasgow.ac.uk

- Ultimaker troubleshooting: https://support.makerbot.com/s/
- Ultimaker material table: https://core-electronics.com.au/guides/ultimaker-printing-material-comparison/
- Ultimaker marketplace – material profiles: https://marketplace.ultimaker.com/app/cura/materials
- Print quality guide: https://www.simplify3d.com/resources/print-quality-troubleshooting/