



## USER GUIDE

*Integrating 3D printing into an eCraft2Learn project*







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# Overview

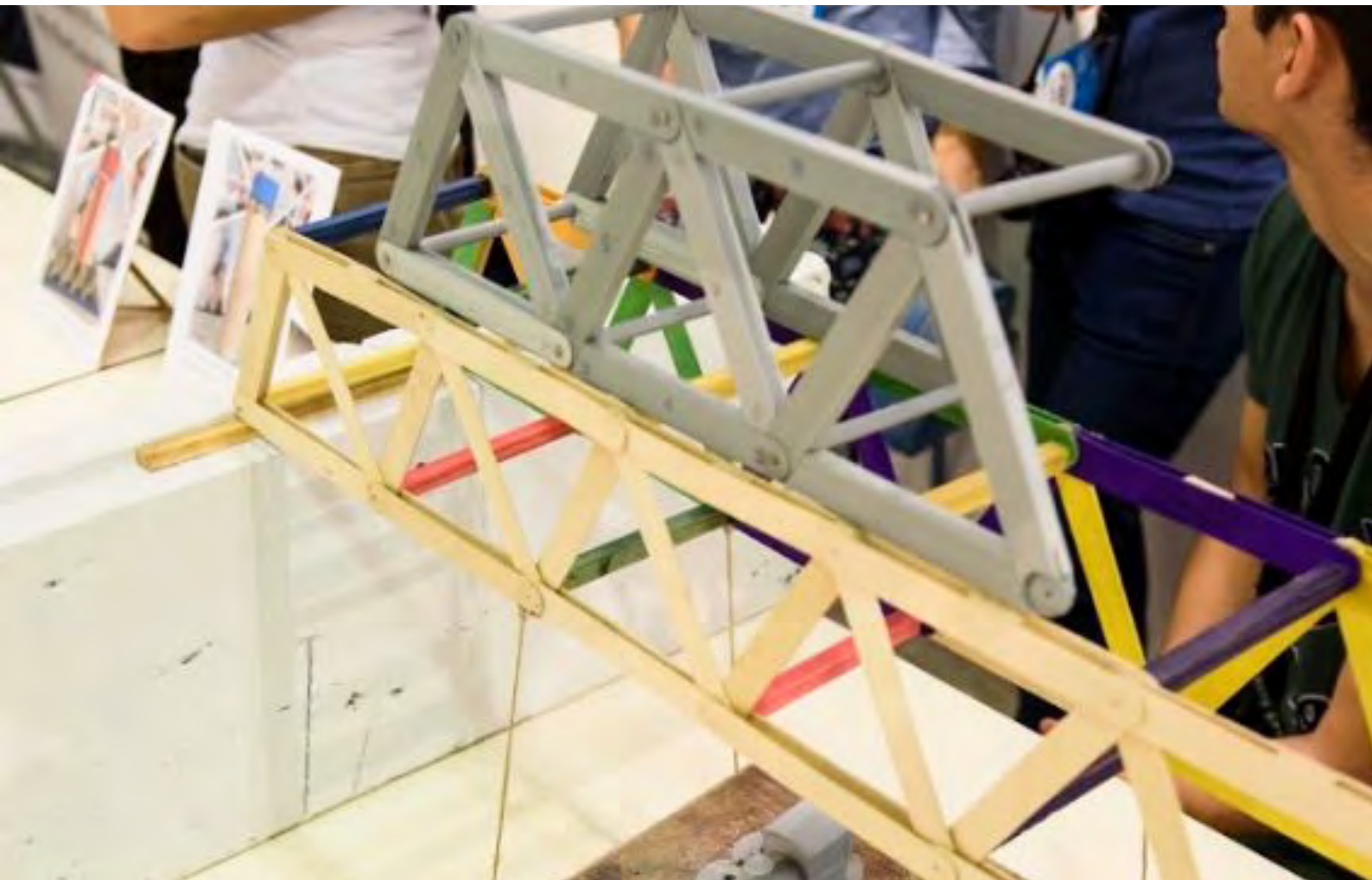
eCraft2Learn is an EU funded project centred around researching, designing, piloting and validating an ecosystem based on digital fabrication and making technologies for creating computer-supported artefacts.

You can learn more about the eCraft2Learn Project in Teacher Guide 1 Introducing eCraft2Learn which can be downloaded at: <https://project.ecraft2learn.eu/introducing-ecraft2learn/>

This guide has been created to assist you in integrating 3D printing into an eCraft2Learn project. The guide will take you through the following:

- Why integrate 3D printing
- Tools for 3D printing in the eCraft2Learn ecosystem
- Learning about 3D printing
- Planning for 3D printing
- Setting up the 3D printing workstation
- Managing 3D printing

Throughout the guide, you will be signposted to other more detailed documentation from the eCraft2Learn academic research and project pilots. These documents provide a more detailed information and support for 3D printing.





## Why integrate 3D printing?

The addition of 3D printing in the eCraft2Learn ecosystem allows students to design and manufacture components to complement their DIY electronics. Examples include casings for the Arduino, housing units for the electronic components and structural or moving parts e.g. robotic arms, vehicle chassis, wheels, gears etc.

Although eCraft2Learn projects can be run successfully without incorporating any 3D printing, there are a number of benefits to using 3D printing as an integral part of the project.

1. 3D printing is a manufacturing technology now being widely implemented across many industries. Consequently students interested in pursuing a STEAM related career have a high likelihood of being involved with the technology at some point. Having experience in 3D design and 3D printing will provide them with many of the skills that employers in these industries require, boosting their chances of future employment and progression in STEAM industries.
2. The 3D design process allows students to develop a range of new 3D modelling and design skills and the process also requires them to practically apply a range of mathematical knowledge and skills.
3. 3D printing allows students to make more complex artifacts that they may not be able to model using traditional craft materials, tools and techniques, or that they do not have the practical skills to model in more traditional ways.
4. 3D printing allows students to design and make robust, professional quality artifacts and final products that they are proud of.
5. 3D printing is an immersive and engaging experience for students, inspiring even the most reluctant of learners.

# TOOLS FOR 3D PRINTING IN THE ECRAFT2LEARN ECOSYSTEM

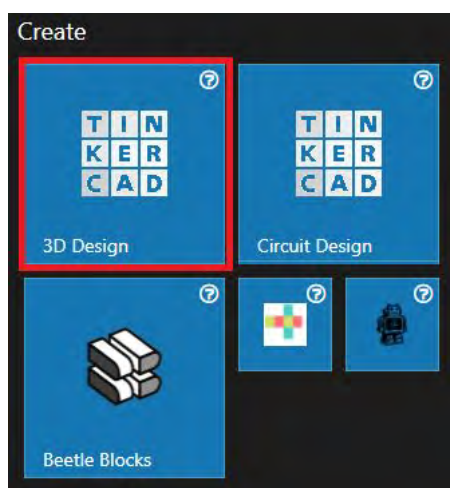
eCraft2Learn provides a range of tools for 3D printing through its Unified User Interface (UI). These include Tinkercad and Beetleblocks for 3D modelling and Cura for slicing.

## TINKERCAD

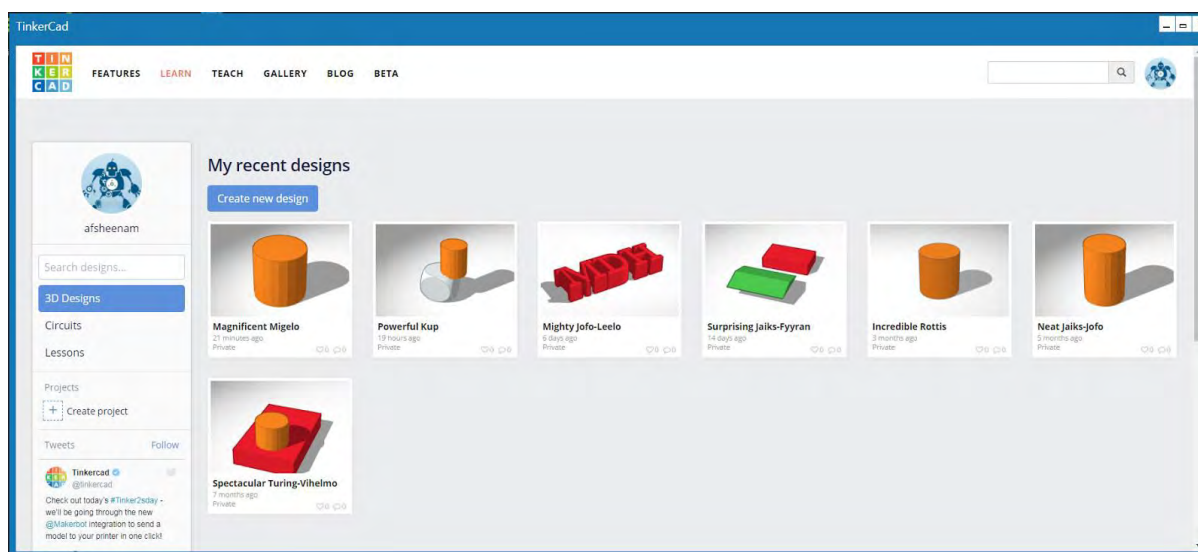
Tinkercad is a simple 3D CAD program to use and is based around building up a design by using 3D shapes from a library and combining them (by adding or subtracting shapes) to build your model.

### Launching Tinkercad

It is recommended that the students login to Tinkercad before they launch the application in the UI. Click on the Tinkercad tile which is located under the “Create” tile group.



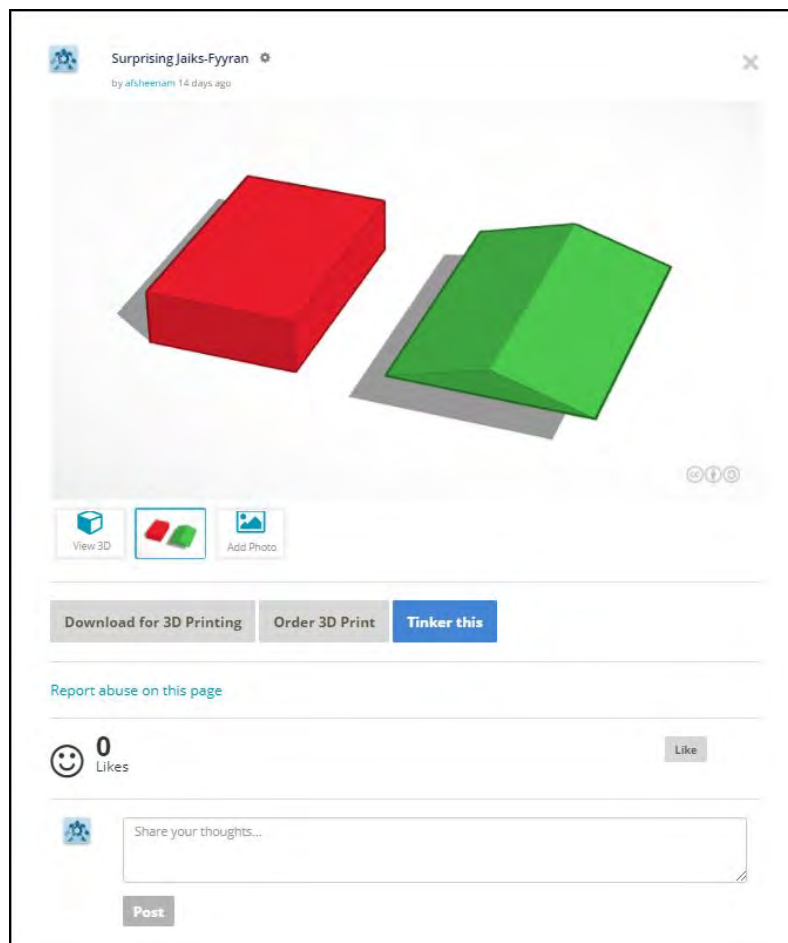
This launches Tinkercad inside a window in UI. If you are already logged in to Tinkercad, you will directly be forwarded to your project space and list of 3D designs.





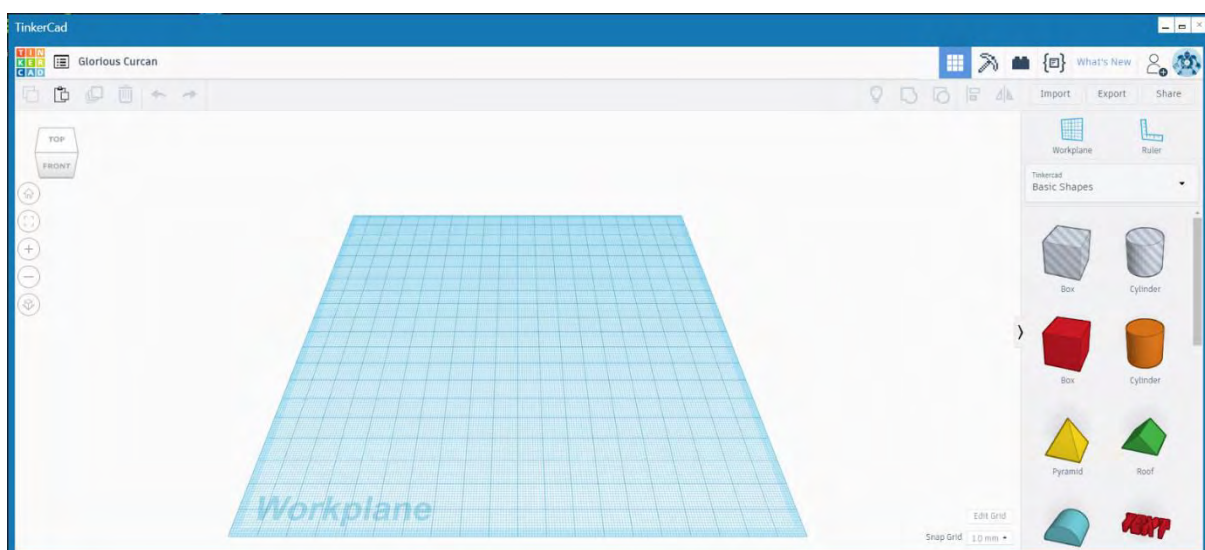
## Loading a previous design

Tinkercad lists all of your design thumbnails in a tile view. Click on the design that you want to continue working on. This will open up a dialog showing your design (Figure 20). Choose “Tinker this” in the dialog. This will take you to Tinkercad editor.



## Creating a new 3D model

In the recent designs view click on the “create new design” button. This will take you to Tinkercad editor.



## Editing a 3D model

Using Tinkercad's toolbox (on the left of the editor), you can create/modify different shapes.

You can learn more about the editor at: <https://www.tinkercad.com/learn/>

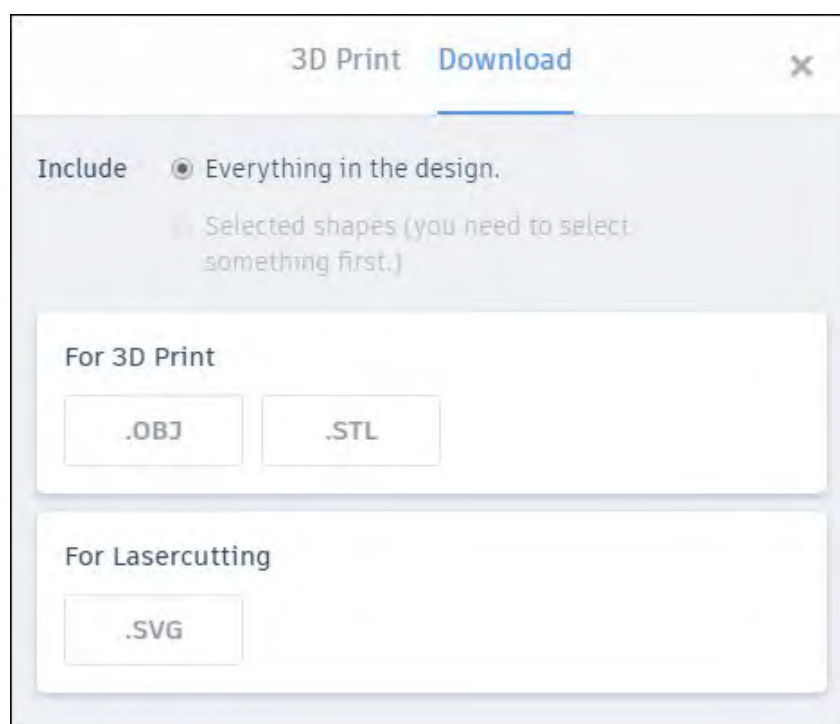
## Sharing 3D models

Press the "Share" button on the top-right corner of the Tinkercad window. This allows you to share your design through "Thingiverse" or "My Mini Factory". Thingiverse is integrated to eCraft2Learn environment and is the recommended option.

## Downloading a printable 3D model

There are two ways to achieve this in Tinkercad:

1. From the item view dialog click the "Download for 3D Printing" button. In the next dialog choose ".STL" as the file format.
2. From the Tinkercad editor click the "Export" button (top-right corner). In the new dialog choose the "Download" tab and then ".STL" as file type.



You can learn more about how to use Tinkercad and access some practical Tinkercad activities to get you started in Project Report D3.4 Section 3.7.4 at: [https://project.ecraft2learn.eu/wp-content/uploads/2018/05/eCraft2Learn\\_D3.4\\_M16\\_Manual-of-Craft-and-Project-based-Learning-STEAM-Training-for-Teachers.pdf](https://project.ecraft2learn.eu/wp-content/uploads/2018/05/eCraft2Learn_D3.4_M16_Manual-of-Craft-and-Project-based-Learning-STEAM-Training-for-Teachers.pdf)

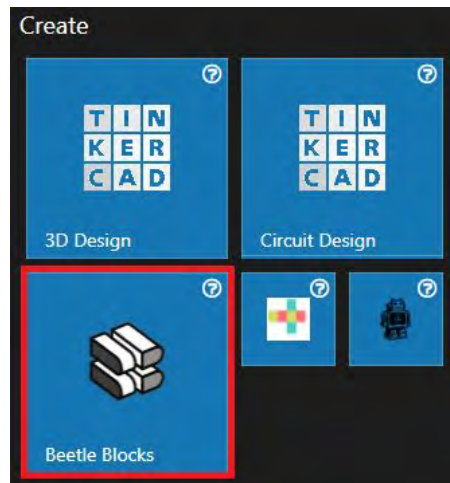


## BEETLEBLOCKS

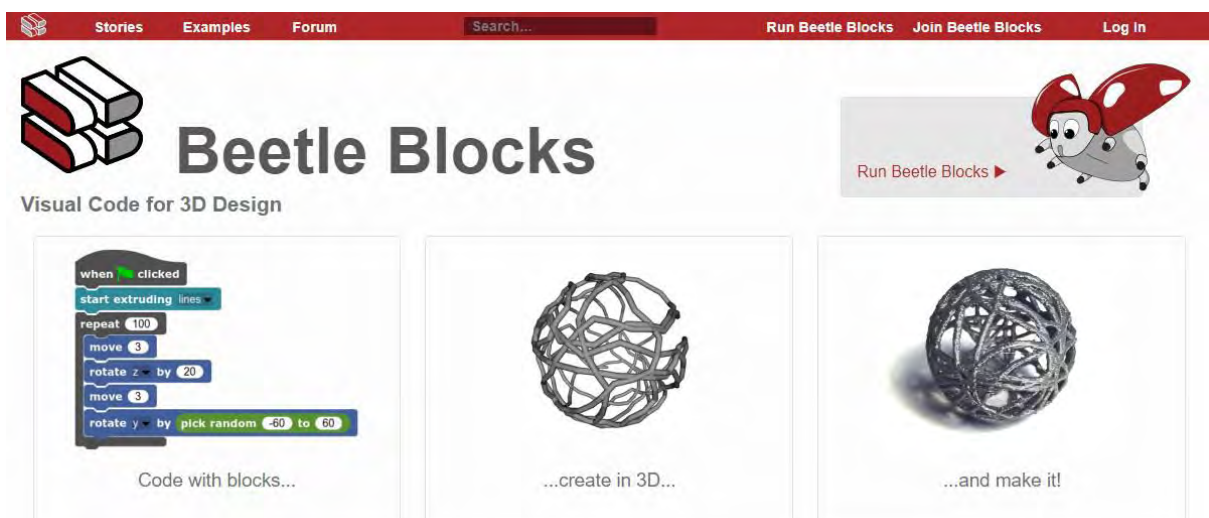
Beetle Blocks is a graphical blocks-based programming environment for 3D design and fabrication. It allows students to program a design in 3D using Snap! programming blocks.

### Launching Beetleblocks

Click on the “Beetle Blocks” UI tile to launch Beetle Blocks in a new browser tab.

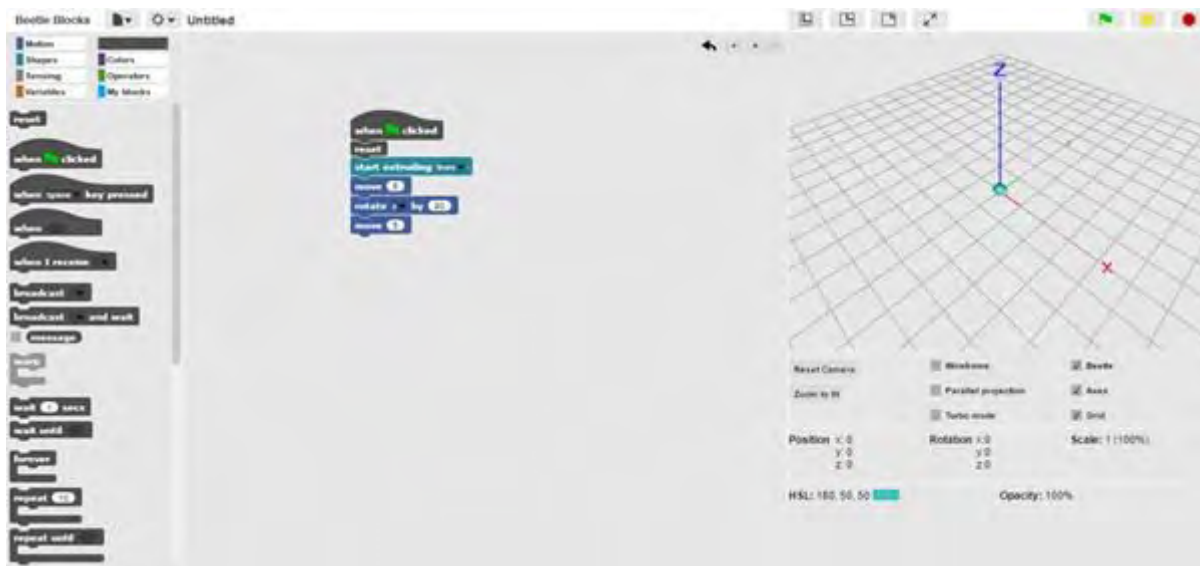


From here students can create an account and log into Beetle Blocks to create, save and access their designs.



## Creating a 3D model

To create a 3D model in Beetleblocks click on the Run Beetleblocks button in the top left corner of the screen. This will launch the programming window.



The left part of the interface contains the programming blocks, these are simply dragged into the coding area in the centre of the interface and stacked together. When the program is run, the beetle, which is shown in the X,Y,Z plane on the right of the interface responds to the code.

You can learn more about how to use Beetleblocks and access some practical Beetleblocks activities to get you started in Project Report D3.4 Section 3.7.5 at: [https://project.ecraft2learn.eu/wp-content/uploads/2018/05/eCraft2Learn\\_D3.4\\_M16\\_Manual-of-Craft-and-Project-based-Learning-STEAM-Training-for-Teachers.pdf](https://project.ecraft2learn.eu/wp-content/uploads/2018/05/eCraft2Learn_D3.4_M16_Manual-of-Craft-and-Project-based-Learning-STEAM-Training-for-Teachers.pdf)

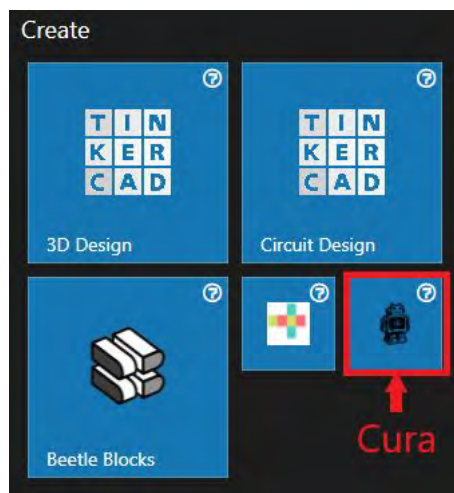


## SLICING AND CURA TOOLS

The UUI includes an embedded 3D modelling and slicing application, however Cura is the recommended slicing software for eCraft2Learn as it is developed by Ultimaker and optimised for the Ultimaker 3D printers. It is simple to use and eCraft2Learn have provided comprehensive open education resources and teacher training materials to support its use.

### Launching Cura

Cura needs to be downloaded and installed onto a desktop or laptop computer as it is not web based application. In the UUI “Create” area, click on the small “Cura” tile. Click on the link in the information window to download and install the Cura slicing software.



### Using Cura to slice 3D models

To learn how to use Cura to slice 3D models, click on the question mark icon in the top left corner of the Cura tile in the UUI. This will open a window where you can access a series of thirteen short video tutorials.

## Cura

Cura is a program that reads in 3D models and prepares them for printing. If it is not installed on your computer it can be [downloaded for free](#). While there are Windows, Mac, and Linux versions there are problems running it on Raspberry Pis. A Raspberry Pi can be configured to access Cura running on another computer in the local area network. Contact your local tech support if you have any questions or problems.

Below is a collection of short videos explaining how to use Cura. [Full documentation is available here](#).

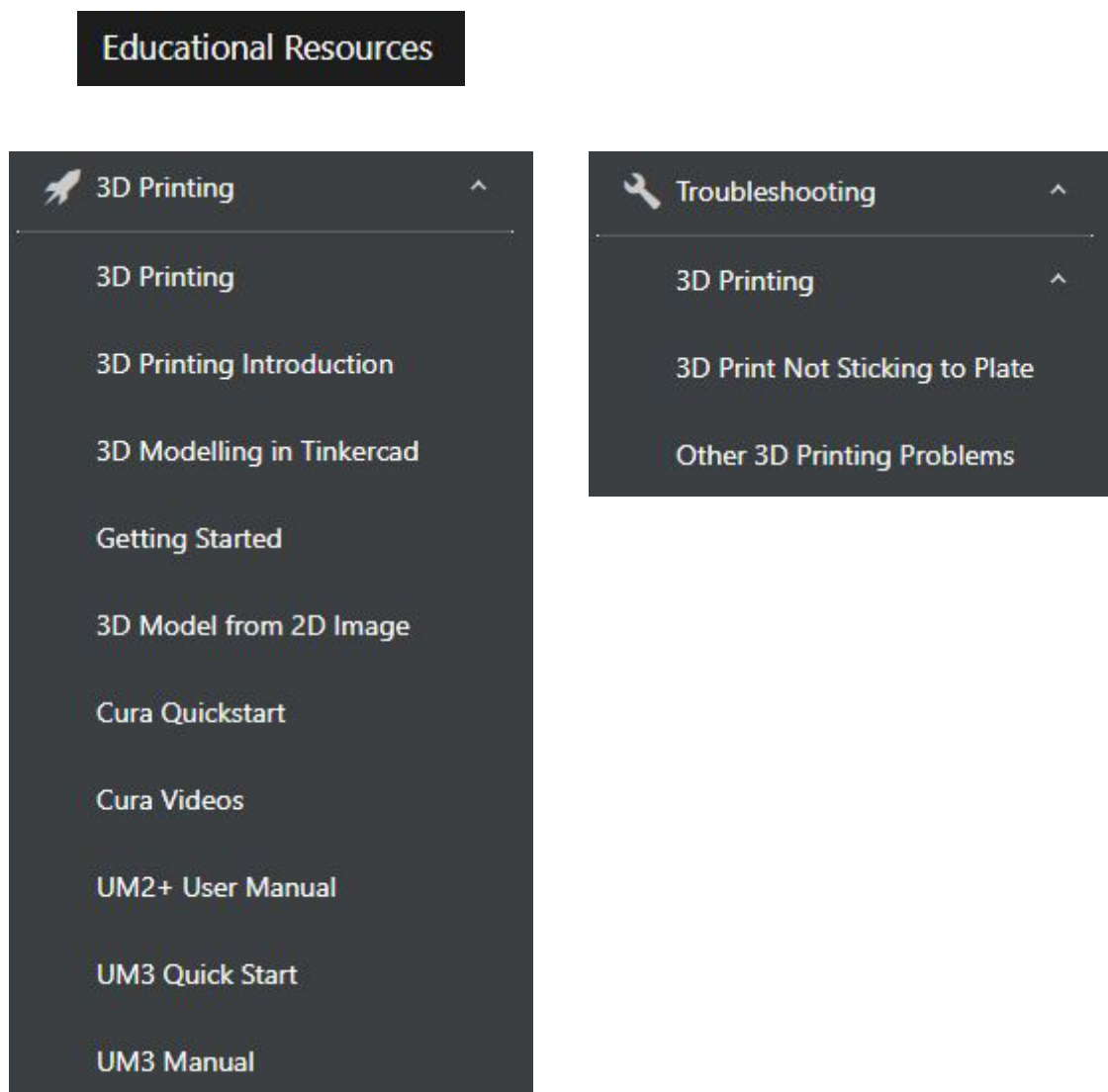
1. [Introduction to Cura \(2 minutes 32 seconds\)](#)
2. [View Manipulation \(53 seconds\)](#)
3. [Print Preparation \(5 minutes 52 seconds\)](#)
4. [Multiple Models \(1 minute 34 seconds\)](#)
5. [Layers View \(3 minutes 38 seconds\)](#)
6. [Infill \(2 minutes 28 seconds\)](#)
7. [Layer Heights \(3 minutes 24 seconds\)](#)
8. [Build Plate Adhesion \(5 minutes 22 seconds\)](#)
9. [Custom Options \(1 minute 51 seconds\)](#)
10. [Support 1 \(3 minutes 5 seconds\)](#)
11. [Support 2 \(4 minutes 47 seconds\)](#)
12. [Support 3 \(3 minutes 11 seconds\)](#)
13. [2D to 3D \(3 minutes 11 seconds\)](#)

# LEARNING ABOUT 3D PRINTING

The eCraft2Learn ecosystem provides a range of documentation and open education resources to help educators and students to learn about 3D printing.

## EDUCATION RESOURCES

In the UII students can access 3D printing education resources. Click on the Educational Resources Link in the top right of the interface, then click on 3D Printing and the Troubleshooting links in the menu to access these resources.





## PROJECT DOCUMENTATION FOR TEACHERS

In addition to the open education resources available in the UII. The eCraft2Learn project has produced various research reports including a Teacher Training Manual which includes a series of 3D printing activities to get you started and a User Manual for the UII.

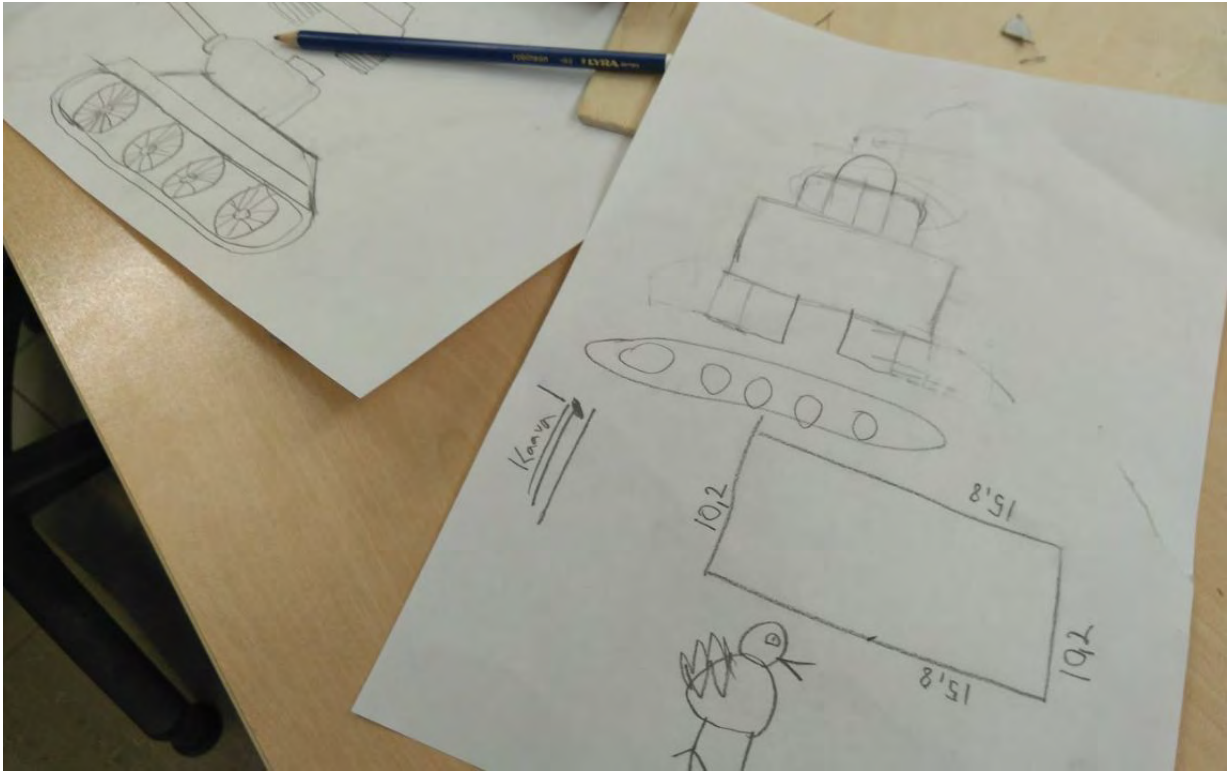


You can access technical training documentation and activities for 3D printing in Project Report D3.4 Section 3.7 at: [https://project.ecraft2learn.eu/wp-content/uploads/2018/05/eCraft2Learn\\_D3.4\\_M16\\_Manual-of-Craft-and-Project-based-Learning-STEAM-Training-for-Teachers.pdf](https://project.ecraft2learn.eu/wp-content/uploads/2018/05/eCraft2Learn_D3.4_M16_Manual-of-Craft-and-Project-based-Learning-STEAM-Training-for-Teachers.pdf)

You can access further support for 3D printing in the UII user manual in Project Report D4.5 Section 5 (for 3D modelling) and Section 8 (for 3D printing) at: <https://project.ecraft2learn.eu/wp-content/uploads/2019/01/D4.5-User-manual-for-programming-of-computer-supported-artefacts-with-integrated-debugger-and-3d-modelling-simulation-and-printing-%E2%80%93-the-unified-user-interface-approach.pdf>

# PLANNING FOR 3D PRINTING

It is important that if 3D printing is going to be used that students plan for the use of 3D printing in the planning stage of their project, either at the beginning of the project or by revisiting the planning stage later.



In the planning stage students should be encouraged to sketch their artifacts and consider what the best materials and construction methods best suit different elements of their design. It may be that only part of the artifact requires 3D printing.

During the planning stage students should consider the following:

- Design of the artifact, can it be successfully 3D printed? For example with no large overhangs otherwise supports will have to be added.
- Is 3D printing the best way of producing the part? Thin flat parts are best produced from sheet material as 3D printing is time consuming.
- Size of the artifact and relative print time. The larger the model is the longer it will take to print, some prints can take days!
- Dimensions - If the part is to be joined to other parts it is important that students plan specific dimensions for the artifact, particularly at connection points.
- How the artifact will be modelled - what shapes will be used in Tinkercad to produce the final design? Will they need to be assembled in a particular order?



# SETTING UP THE 3D PRINTING WORKSTATION

The 3D printing workstation will be a shared space for all groups to use. For this a 3D printer and a desktop or laptop computer are required. If you are using desktop or laptop computers for the student workstations instead of Raspberry Pi's. You will not require a separate computer for the 3D printing workstation, instead you can set up each of the workstation computers up for 3D printing.

Please note, Ultimaker 2+ and Ultimaker 3 are the recommended 3D printers for eCraft2Learn. All of the 3D printing open education resources, information, instructions and support are based around these specific 3D printer models. However if you have a different 3D printer, this can be used but you will need to refer to the manufacturer documentation for further information, help and support.

## SETTING UP THE 3D PRINTER

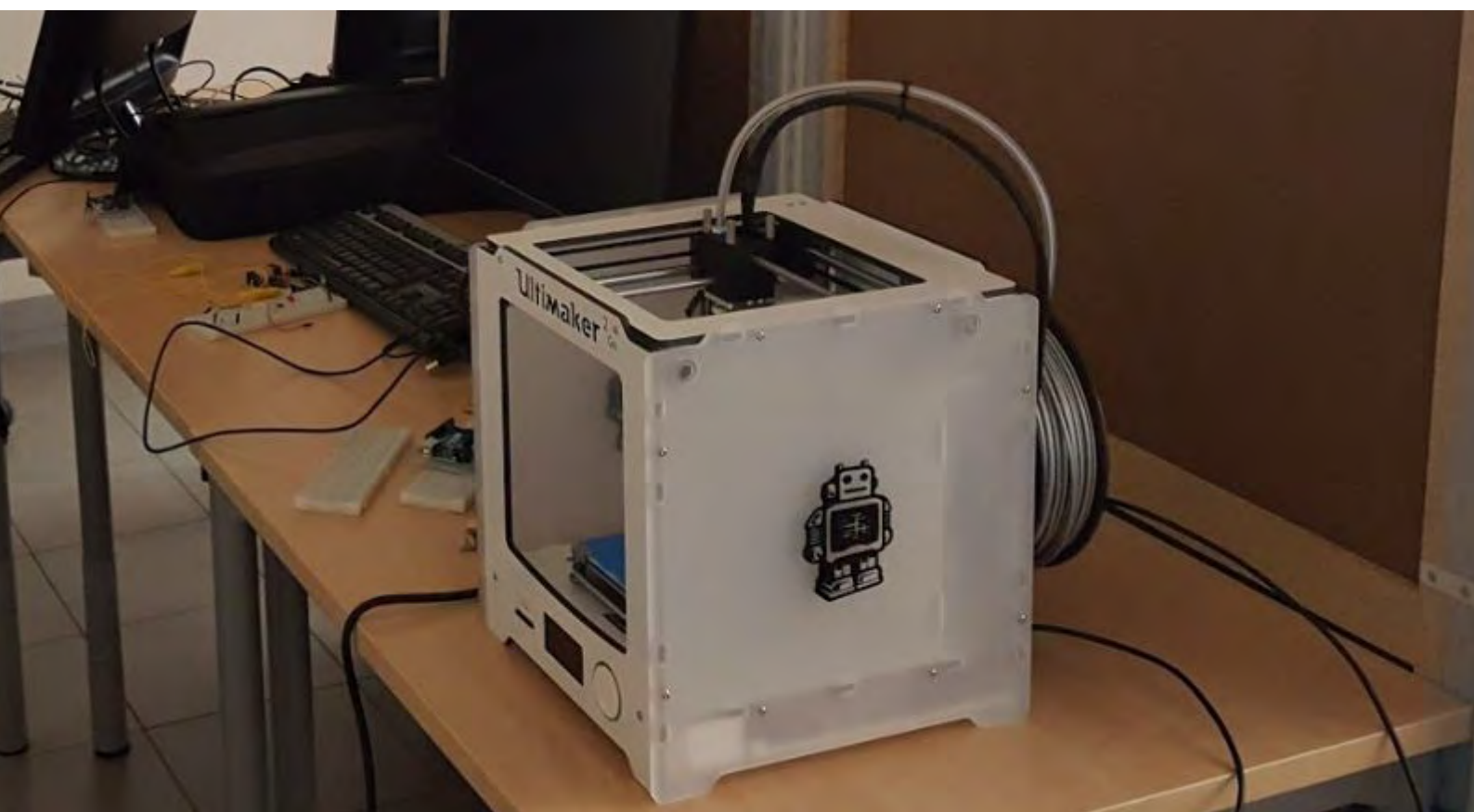
The 3D printer needs to be unpackaged and placed on a sturdy, flat, level surface where it will not be disturbed whilst in operation. Usually this is on a desk or furniture unit at the side of the room. Ideally it should also be positioned away from doors and open windows as drafts can affect the quality of the prints.

Before using the 3D printer, it will need to be calibrated to ensure that the build plate is level and in the correct position. Then filament will need to be inserted. Please follow the detailed step-by-step instructions that are on the quickstart guide which is in the printer packaging. When the printer has been set-up you are ready to run a test print.

If you experience any problems with setting up the printer or running the test print, refer to the Troubleshooting Guide. This is available in the UUI at:

<https://ecraft2learn.github.io/uui>

Education Resources>Troubleshooting>3D Printing>Other 3D Printing Problems



## SETTING UP THE DESKTOP/LAPTOP COMPUTER(S)

In order to 3D print, you need to download and install the “Cura” slicing software. You can download it at:

<https://ultimaker.com/en/products/ultimaker-cura-software>

If you are using an Ultimaker 3, to allow it to print wirelessly over the network directly via Cura, you will need to install Wi-Fi and update the firmware on the printer. Full instruction for how to do this are available at:

<https://ultimaker.com/en/resources/23115-installing-wi-fi-and-firmware>

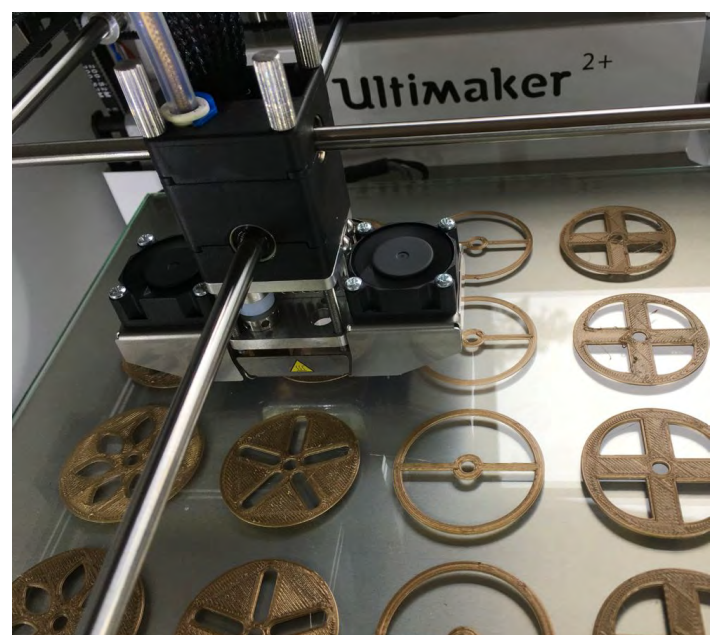
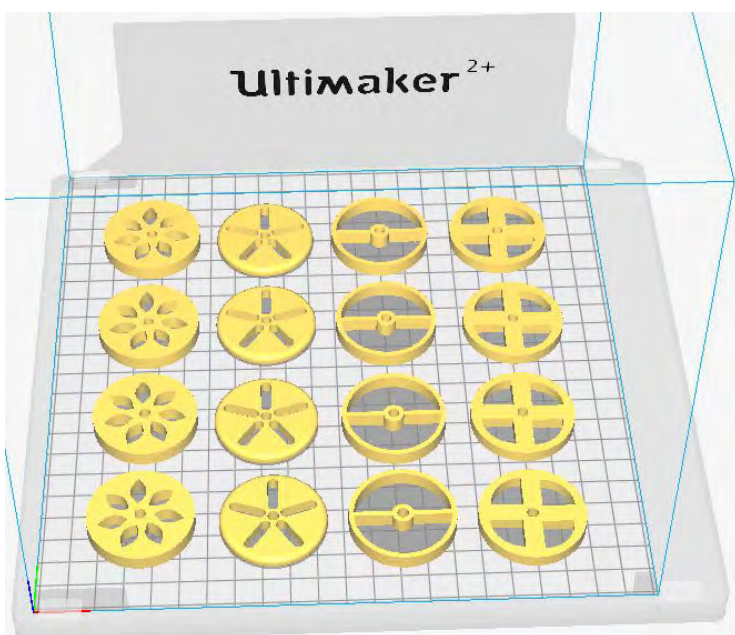
At the beginning of each session, you will need to login to Tinkercad in a browser. You can access Tinkercad to login at [www.tinkercad.com](http://www.tinkercad.com)

After login in to Tinkercad, open the UI and launch Tinkercad from here. The 3D printing workstation is now set up and ready for designing, slicing and 3D printing models.

# MANAGING 3D PRINTING

When you have a large group of students working on projects that all require 3D printing, it can be difficult to manage the 3D printing process. To make it easier to manage the 3D printing of students work, use the following tips:

- Cura will tell you how long a sliced print will take to print, use this information to adjust print settings such as size, layer height and infill if required to allow prints to print quicker. Bear in mind that there is always a speed vs quality trade off.
- Unless you are printing models with very intricate surface details, use a layer height of 0.2 or even 0.3mm this will produce quicker prints and the students are still delighted with the quality.
- For larger prints and quick prototypes where students will be developing multiple iterations of a design, consider using a larger nozzle diameter, swapping from a 0.4mm nozzle to a 0.8mm nozzle will significantly speed up the printing.
- Where possible develop projects where the 3D prints are small or print miniature scale models of students work so that the prints are produced quicker (this also conserves filament). You can always resize models directly in the slicing software to adjust the print time.
- Place several students prints on a single print bed. Older students can work in groups to do this in Cura themselves.
- For printing a whole class of prints, keep a class list next to the printer and tick off the students names as their work has been printed.
- Keep a roll of masking tape next to the printer, when removing prints from the printer, write the students name on the masking tape and stick it to the print so you know whose print it is.







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01/2017 – 12/2018



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ARDUINO

Ultimaker  
It's in the making



This project has received funding from the European Union's Horizon 2020 Coordination & Research and Innovation Action under Grant Agreement No 731345.