UNIVERSITAT POLITÈCNICA DE VALÈNCIA

CAMPUS D'ALCOI

INNO3D+

Co-funded by the Erasmus+ Programme of the European Union

3D printing support service for innovative citizens

Servicio de apoyo a la impresión 3D para ciudadanos innovadores (INNO3D)

Dr. Santiago Ferrandiz
Dr. Juan López
Dr. Octavio Fenollar
Dra. Mº Dolores Samper

UPV – Team/equipo

13 de octubre del 2022

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- Instalaciones disponibles
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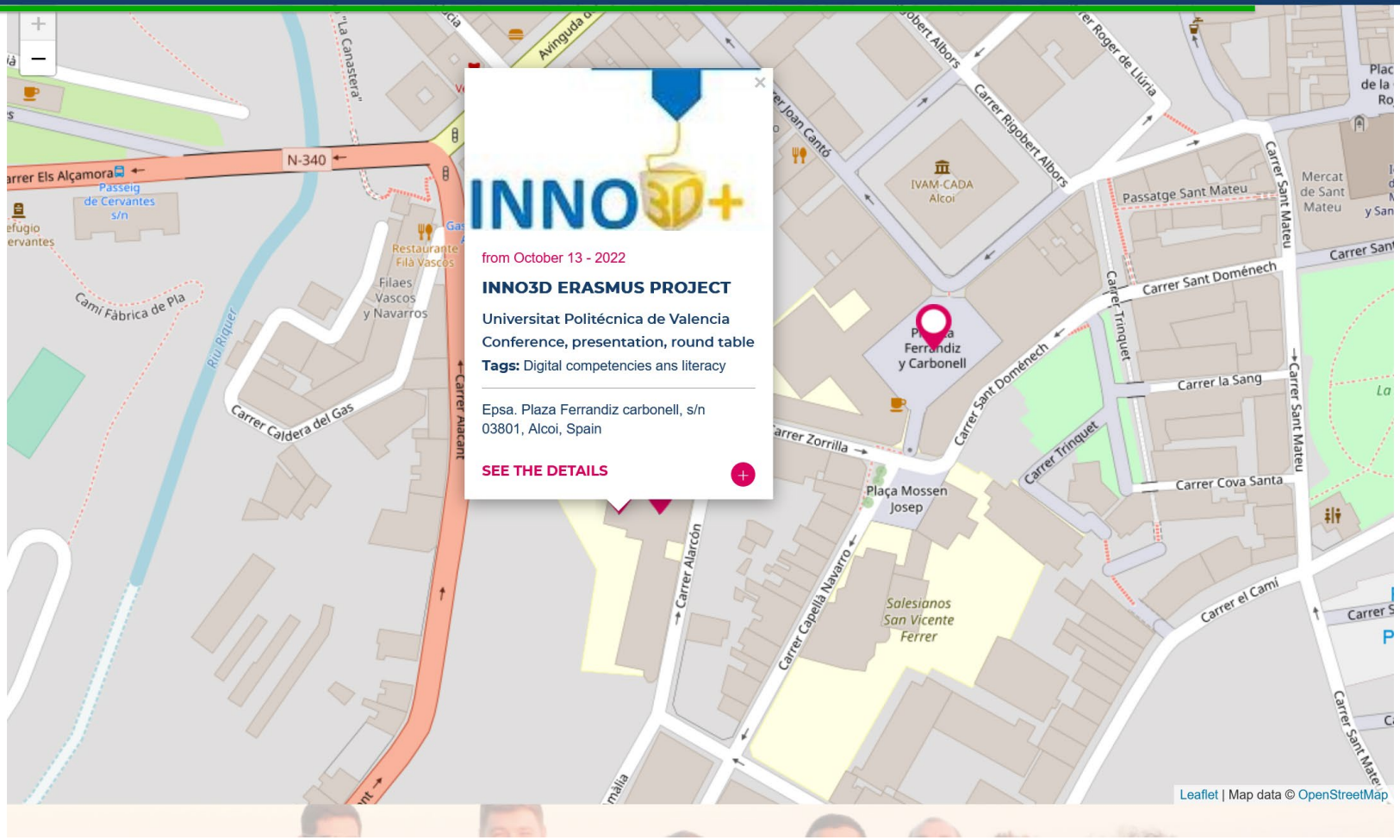
#ERASMUSDAYS

INNO3D+



SOCIAL WALL

https://www.erasmusdays.eu/

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The 3D printing support service for innovative citizens (INNO3D) project

El proyecto mejorará la calidad y relevancia de los conocimientos y habilidades de los bibliotecarios en el área de la impresión 3D.

Objetivos del Proyecto: El proyecto está diseñado para mejorar y diversificar los servicios ofrecidos a los usuarios de las bibliotecas universitarias y de otro tipo al ofrecer a estos usuarios de bibliotecas habilidades clave y la oportunidad de desarrollar competencias de impresión 3D. Esto se logrará capacitando a los bibliotecarios que luego capacitarán a los usuarios de la biblioteca, estudiantes, personal y ciudadanos en general en el uso de los servicios de impresión 3D.

The project will improve the quality and relevance of librarians' knowledge and skills in the area of 3D printing.

Project Objectives: The project is designed to improve and diversify the services offered to users of academic and other libraries by offering these library users key skills and the opportunity to develop 3D printing competencies. This will be achieved by training librarians who will then train library users, students, staff and general citizens in the use of 3D printing services.

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INNO3D Project Partners:

Technological University of the Shannon: Midlands Midwest (TUS) (formerly LIT), Limerick, IRELAND (Grant-holder)

Translivania University of Brasov (UTBV), Brasov, ROMANIA

University of Crete (UOC), Rethymno, Crete, GREECE

Constantine the Philosopher University of Nitra (UKF), Nitra, SLOVAKIA

Polytechnic University of Timisoara, Timisoara (UPT), ROMANIA

Polytechnic University of Valencia (UPV), Valencia, SPAIN

MBTHINKTANK SRL, Brasov, ROMANIA

Universidade NOVA de Lisboa, Lisbon (UNL), PORTUGAL

University of Piraeus Research Centre (UPRC), Piraeus, GREECE

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INNO3D Project Budget and duration:

Project Duration:

The duration is three years (36 months)

Grant Awarded

€439,560

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Intellectual Outputs in INNO3D

Intellectual Output (IO)	Leader
1. Framework for 3D Printing in each EU Partner institution	Universitat Politecnica de Valencia
2. Situation analysis on 3D Printing education in each EU partner institution and Library	Universidade Nova de Lisboa
3, Blended Curriculum	Limerick Institute of Technology
4. Develop web Portal with Innovative content that will provide up-to-date information on 3D Printing technology as well as an e-learning platform addressed to the project target Group.	MBTHINKTANK SRL, with University of Piraeus Research Center
5. 3D Printing simulation videos	Transilvania University of Brasov
6. Guide for 3D Printing- Best Practice and Policy	University of Crete
7. 3D Printing Trainers Toolkit for theoretical program	Universitatea Politehnica Timisoara
8. Research study on impact of the 3D Printing Training curriculum and teaching materials	Constantine the Philosopher University of Nitra

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Project Progress to Date

Intellectual Outputs in INNO3D

Intellectual Output (IO)	Progress
1. Framework for 3D Printing in each EU Partner institution	****The Framework has been Published on the project website
2. Situation analysis on 3D Printing education in each EU partner institution and Library	****Publshed on the project website
3, Blended Curriculum	****Published on the project website
4. Develop web Portal with Innovative content that will provide up-to-date information on 3D Printing technology as well as an e-learning platform addressed to the project target Group.	****Web Portal has been created https://www.inno3d.eu/
5. 3D Printing simulation videos	****Published on the project website
6. Guide for 3D Printing- Best Practice and Policy	****Published on the project website
7. 3D Printing Trainers Toolkit for theoretical program	*****Published on the project website
8. Research study on impact of the 3D Printing Training curriculum and teaching materials	***Onging Due for delivery in 2022

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BLENDED CURRICULUM (Intellectual Output 03)
8 Modules

Module 1: Introduction to 3D Printing Technologies in Libraries (UPT)

Module 2: Types of Additive Manufacturing Technologies (UTBV)

Module 3: Industrial and Personal 3D Printers (UOC)

Module 4: Design and Materials used for Personal 3D Printers (UNL)

Module 5: 3D Printing Workflow for Trainers (UPV)

Module 6: Basic Maintenance (UKF)

Module 7: Application areas of 3D Printing (UPRC)

Module 8: Relevant Intellectual Property Rights in the Context of 3D Printing (MBTT/TUS)

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skills to be acquired	PBL14	PBL15	PBL16	PBL17	PBL18	PBL19	PBL20	PBL21	PBL22	PBL23	PBL24	PBL25	PBL26	PBL27	PBL28	PBL29	PBL30	PBL31	PBL32
																			
	ches_horse	Albert_Einstein_highres	Castle	Base movil 3.0	fish_fossilz_fob	Maxillary_Denture_Bas	Micro_Catapult	anatomical_heart	Jewelry_Tree	not_Vortex2	wind-up+car+gift	dvorak	Adalinda	Mega_Mew Two_Y	Mega_Mew Two_Y_sup	Mega_Mew Two_X	Mega_Mew Two_X_sup	Traction_Engine	Treasure_Chest_Remix
Skill to recognize mechanical properties like Impact resistance, layer adhesion (isotropy), Heat resistance						X					X							X	
Ability to select Part accuracy				X	X	X					X	X			X		X		
Skill to select Surface finish															X		X		X
Skill to select material post processing				X	X														
Ability to select cold welding procedures				X								X							
About the 3D printing process data																			
Demonstrated ability to recognice STL, AMF, 3MF, PLY, OBJ input files	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ability to recognize technologies estimation built time				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ability to use STL repairing software, Netfabb, Cura, Simplify3D, Slic3r prusa, Pronterface, Repetier Host, Meshmixer, Meshlab, Magics, Deskartes.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Skill to use slicing software Netfabb, Cura, Simplify3D, Slic3r prusa, Pronterface, Repetier Host, Meshmixer, Meshlab, Magics, Deskartes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Skill to manage Print Quality Troubleshooting Guide	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ability to recognize 3d printing glossary and terminology	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Skill to manage closed surfaces/solids																			
Ability to use platform built simulators																			
Skill to manage booleans operations, symmetry, scaled, duplicated parts with dedicated software	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ability to programming printing parameters (Hotend diameter, slicing layer, skirt, dual printing,	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Competencias

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Competencias

Skills about the 3D printing technologies

- Ability to select 3d printing technologies
- Ability to recognize technologies build size
- Skills to recognize dimensional Accuracy on 3D printing technologies
- Capacity to select between conceptual design

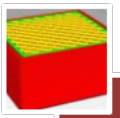
Skills about the 3D printing materials

- Ability to select 3d printing materials
- Skill to recognize mechanical properties
- Ability to select Part accuracy
- Skill to select Surface finish
- Skill to select material post processing
- Ability to select cold welding procedure

Skill about the 3D printing process data

- Demonstrated ability to recognice STL, AMF, 3MF, PLY, OBJ input file
- Ability to recognize technologies estimation built time
- Ability to use STL repairing software,.
- Skill to use slicing software
- Skill to manage Print Quality Troubleshooting Guide
- Ability to recognize 3d printing glossary and terminology

Skills about the 3D printing desktop layout



- Ability to recognize technologies build size
- Ability to recognize dimensional
- Accuracy on 3D printing technologies
- Ability to work with network printers or standalone 3d printer
- Skill to make 3d printer configurations
- Skill to make 3d printer calibration

Skills sbout the 3D printing post- Processing

- Ability to remove supports on printed parts
- Ability to clean printed parts
- Skill to use electric cutting, cleaning parts
- Skill to use soluble supports filaments (PVA, HIPS)
- Ability to use sanding post Processing
- Ability to use painting technique
- Ability to use welding technique
- Ability to use gluing technique

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Syllabus

1. Information about the **Module 1**

1.1 University	Politehnica University of Timişoara
1.2 Team	UPT_Team
1.3 Trainer_Name	Associate Professor Anca Drăghici Associate Professor Carmen Sticlaru
1.3 Degree level	Postuniversitary degree

2. Information about the course

Module title	**Introduction to 3D Printing Technologies in Libraries**

3. Time budget

3.1 Number of hours	**3 h**	divided in:	Lecture	**100 mins**	Laboratory/ Project	**80 mins**

3.2 Time budget distribution (hours) for individual activity:	
(a) Individual study (course, obligatory bibliography, etc.)	1
(b) Additional documentation (recommended bibliography, etc.)	0.5
(c) Preparation for seminary/laboratory/project activities	0.5
(d) Peer learning	0
(e) Exam preparation	0
(f) Other activities	0

3.3 Total individual study (sum (3.7(a)...3.7(f)))	**2 h**
3.4 ECTS credits	**0.2**

4. Preconditions

4.1 curriculum	Librarian
4.2 competences	Space vision, technical skills, computer using knowledge

En proceso de traducción al castellano

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Module 1: Introduction to 3D Printing Technologies in Libraries

Content

Module 2: Types of Additive Manufacturing Technologies

Contents

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Contents

INNO3D Blended Curriculum – Module 3: Industrial and Personal 3D Printers

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Modulo 4

Design and Materials used for Personal 3D Printers

Contents

Modulo 5 - PBL

Problem definition_1.pdf. Student Work Sheet logo.stl
Problem definition_2.pdf. Student Work Sheet Nefertitti.stl
Problem definition_2 - help.pdf
Problem definition_3.pdf. Student Work Sheet Vase.stl
Problem definition_4.pdf. Student Work Sheet treefog.stl
Problem definition_5.pdf. Student Work Sheet Spinner.stl
Problem definition_6.pdf. Student Work Sheet buddy.stl
Problem definition_7.pdf. Student Work Sheet santi.stl
Problem definition_8.pdf. Student Work Sheet Yoda.stl
Problem definition_8 - help.pdf
Problem definition_9.pdf. Student Work Sheet pingu80.stl
Problem definition_10.pdf. Student Work Sheet Sw_ship.stl
Problem definition_11.pdf. Student Work Sheet nutcracker.stl
Problem definition_12.pdf. Student Work Sheet Scull_geant.stl
Problem definition_12 - help.pdf
Problem definition_13.pdf. Student Work Sheet squizzer.stl
Problem definition_14.pdf. Student Work Sheet chess_horse.stl
Problem definition_15.pdf. Student Work Sheet Albert_Einstein.stl
Problem definition_15 - help.pdf
Problem definition_16.pdf. Student Work Sheet Castle.stl
Problem definition_17.pdf. Student Work Sheet Base_movil.stl
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Problem definition_19.pdf. Student Work maxillary.stl
Problem definition_20.pdf. Student Work micro catapult.stl
Problem definition_20 - help.pdf
Problem definition_21.pdf. Student Work anatomical_heart.stl
Problem definition_22.pdf. Student Work Jewelry_Tree.stl
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Problem definition_27.pdf. Student Work Mega_MewTwo_Y.stl
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Problem definition_29.pdf. Student Work Mega_MewTwo_X.stl
Problem definition_30.pdf. Student Work Mega_MewTwo_X_supports.stl
Problem definition_31.pdf. Student Work Traction_Engine.stl
Problem definition_32.pdf. Student Work Treasure_Chest_Remix.stl
Problem definition_33.pdf. Student Work calibration xyz
skills inno3d

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Modulo 6: Basic Maintenance

1.1 Regular maintenance of i3 printers, Nozzle replacement or replacement, Belt tension adjustment
1.2 Disassembly of hotend & heatbreak stuck in cooler,
Manual removal of fibre from the extruder, Checking / aligning the feed wheels
1.3How to shorten a PTFE tube - Original Prusa printer, Replacement of PEI foil

1.4 How to replace a hot end thermistor, How to replace a heatbreak / heating block/cooler 1.5 Firmware update, Safety testing,
Printer maintenance tips

Modulo 7: Campos de aplicación

Contents

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INSTALACIONES ASOCIADAS EPSA- UPV
EPSA-UPV LABS FACILITIES

FabLab (Design Factory)
Granja DIMM

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UPV Farm 3d printer labs DIMM

5 colors 3D printer, FFF and DLP printers

3devo filament extruder

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Dental scanner
UV furnace
RTM vacuum machine for composite materials

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HP laser scan
Sense scan
Ms Kinect
Revoscan

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Fff printer
SLA printer
Pellet printer tumaker
Filabot filament extruder

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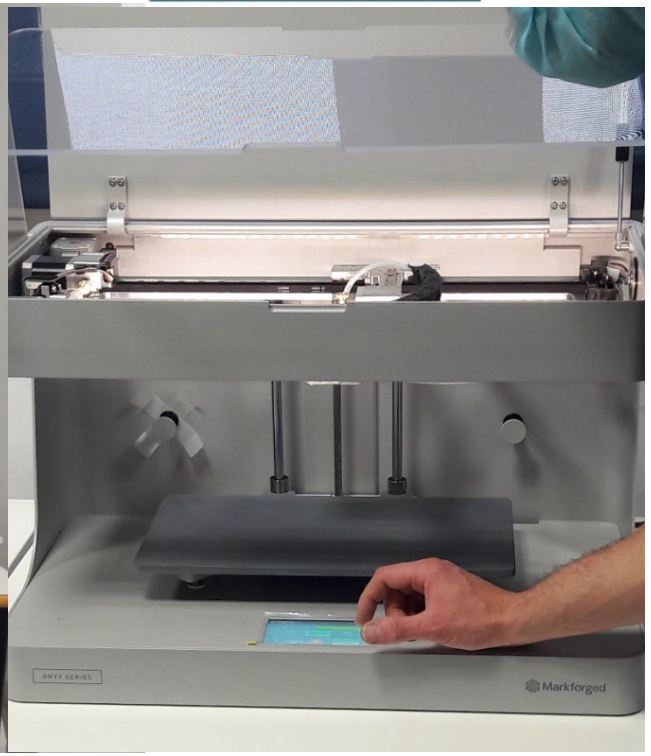

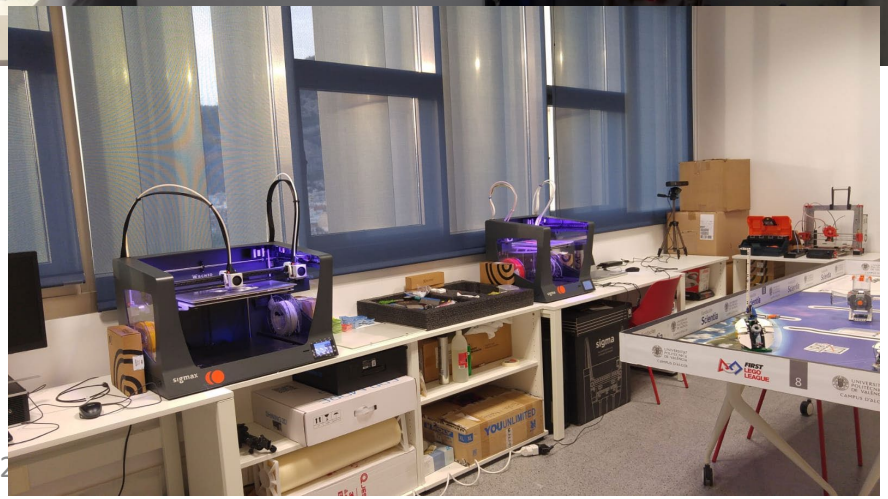

Stratasys™ Dimensión 1200 (ABS&HIPS)
SCA-1200 support removal system
Marketforget GF
BCN Sigma and sigmax

FabLab EPSA

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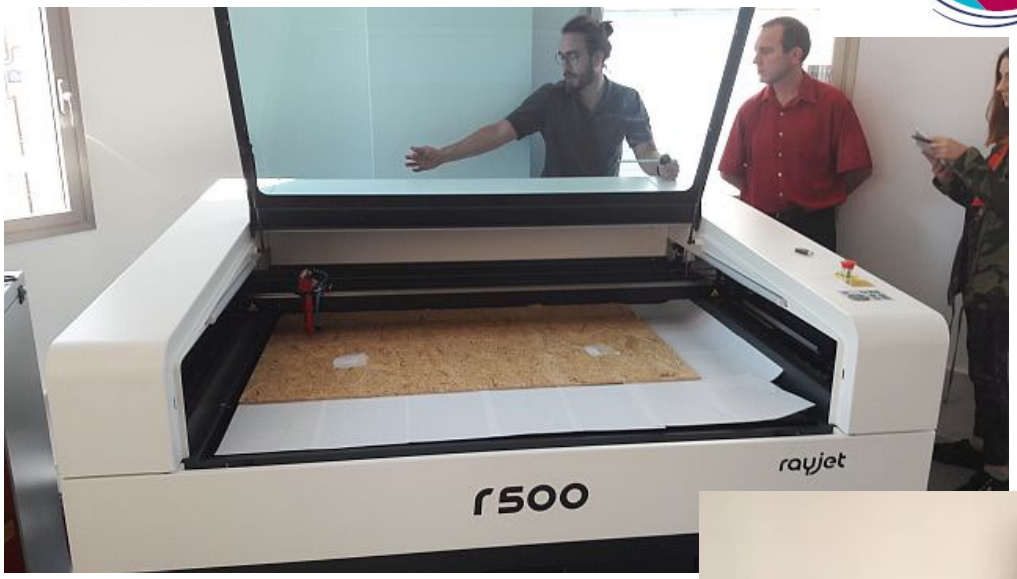

Laser cutting
CNC cutting
Vinyl cutting

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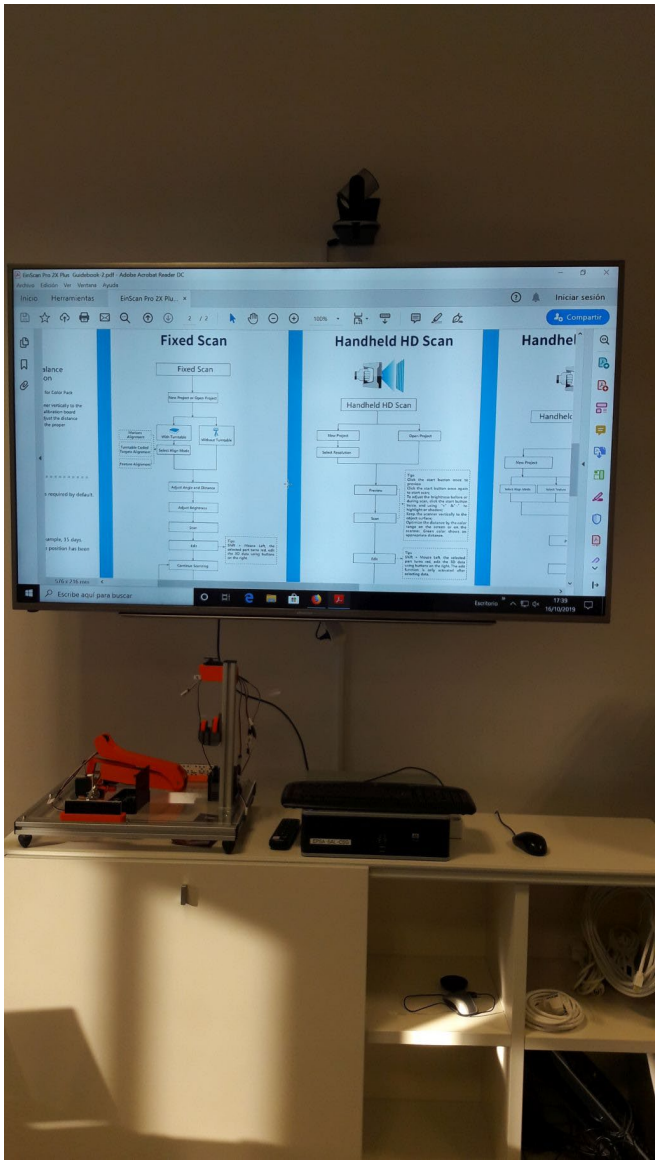
EinScan Pro 2X

FabLab EPSA



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MATERIAL DE FORMACIÓN
TRAINING MATERIALS

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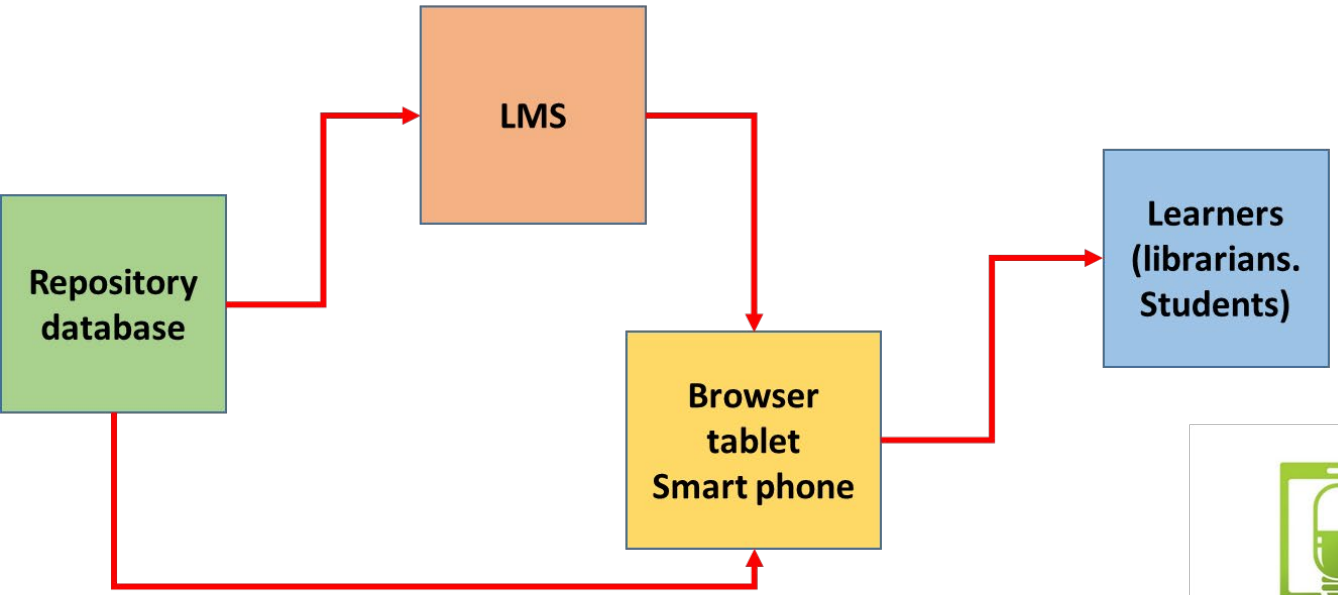
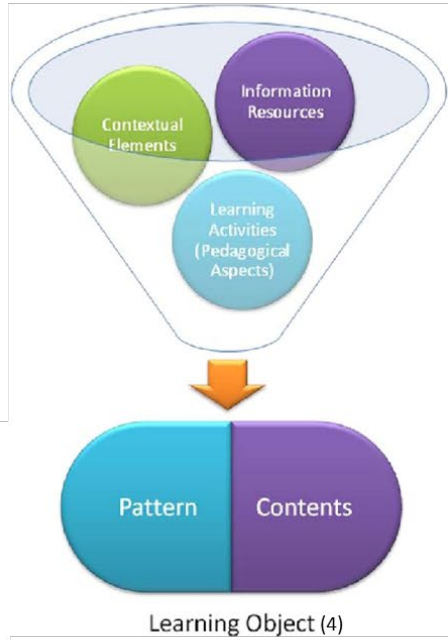
WORKFLOW LEARNING PILLS – LEARNING OBJECTS



learningpills
life changing apps



Learning Object (4)

(3) Learning Object Systems and Strategy: A Description and Discussion. 2010. Interdisciplinary Journal of E-Learning and Learning Objects (IJELLO) 6(1):217-238. License CC BY-NC 4.0. Albert D. Ritzhaupt

(4) Developing Large Scale Learning Objects for Software Engineering Process Model. A. Saavedra, J. M. Arteaga, G. MaríaE.García. Published in ENC 2009. Computer Science, DOI:10.1109/ENC.2009.46Corpus ID: 5523503

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Knowledge Pill is a piece of knowledge packed in multimedia format and made available to everybody that needs it, but some key elements should be respected:

- The use of multimedia format.
- Simplicity, easy to create and to distribute.
- Short, the average Knowledge Pill should not take more **than 3 minutes** to watch.

There are various possible formats for Knowledge Pills:

- Audio.
- Video.
- Multimedia Presentation

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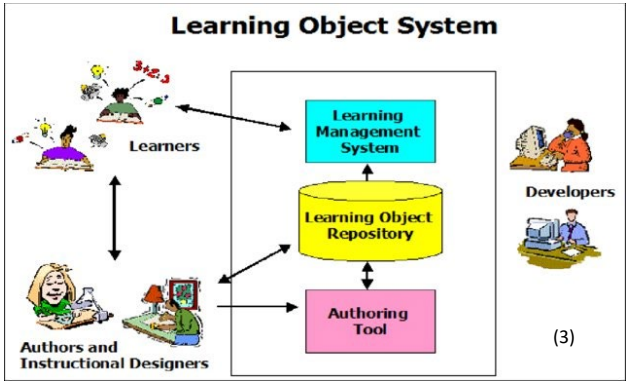
A **learning object** is "a collection of content items, practice items, and assessment items that are combined based on a single learning objective".[2]

- Learning objects are a new way of thinking about learning content. Traditionally, content comes in a several hour chunk. Learning objects are much smaller units of learning, typically ranging from **2 minutes to 15 minutes**.
- Are self-contained – each learning object can be taken independently
- Are reusable – a single learning object may be used in multiple contexts for multiple purposes
- Can be aggregated – learning objects can be grouped into larger collections of content, including traditional course structures
- Are tagged with metadata – every learning object has descriptive information allowing it to be easily found by a search



(2) Wikipedia.es
(3) Learning Object Systems and Strategy: A Description and Discussion. 2010. Interdisciplinary Journal of E-Learning and Learning Objects (IJELLO) 6(1):217-238. License CC BY-NC 4.0. Albert D. Ritzhaupt

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Training pills 3 Printing multicolor parts

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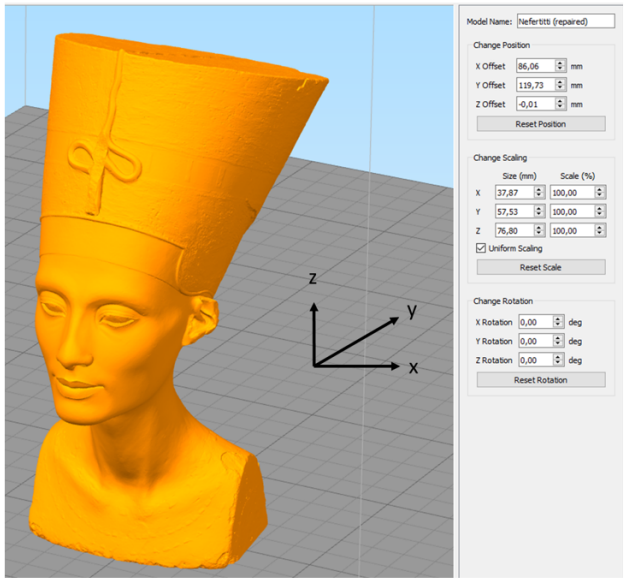
Objectives:

Explain how select 3D printing materials and how orient the part. Explain if necessary to scale the part. Explain how select Part accuracy and how use slicing software (PrusaSlicer) to scale, move the part.

Problem definition:

Some people ask us about the following 3D print part. Material specification will be PLA. In addition, quality request 0.15 mm.

Part dimension



X=37,87 mm; y= 57,53 mm: z = 76,80 mm

Download file at: http://personales.upv.es/sferrand/Nefertitti.stl

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Student Work Sheet Nefertitti.stl

Questions to be solved:

1.- How do you orient the part?

2.- It's necessary use supports?. Study different part orientations

3.- What is the printing time?

4.- How decrease the printing time to 2,5 hours?

5.- How do you generate g-code?

References:

https://manual.prusa3d.com/c/English_manuals

https://www.thingiverse.com/thing:1376105

https://www.prusaprinters.org/prints/3112#_ga=2.50931626.2065968544.1609843932-42545626.1609843932

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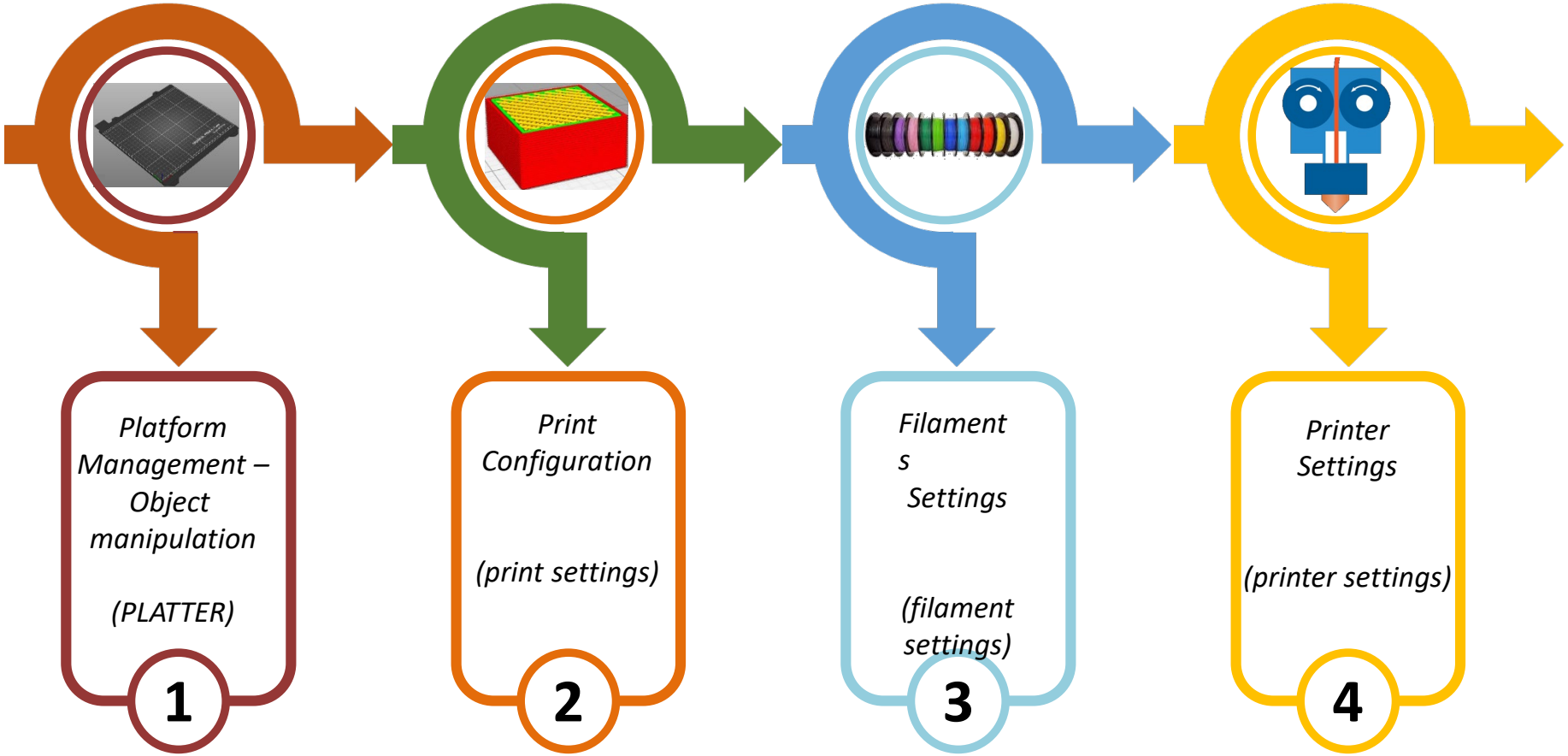
Preparing, optimizing & Slicing 3D Models workflow



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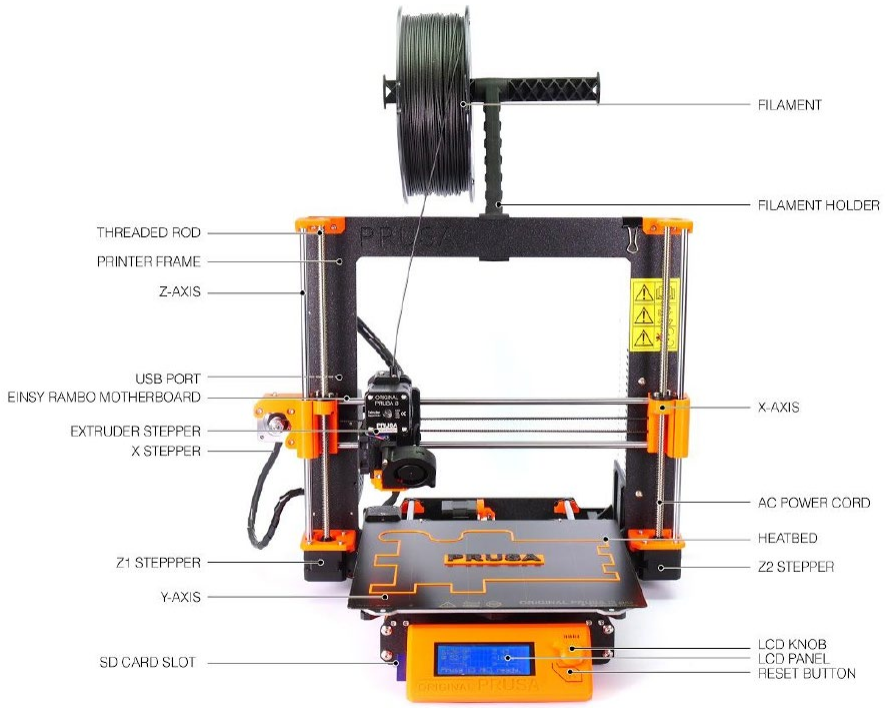
Platform Management



Prusa components

(1) 3D printing handbook. J. Prusa. 2019

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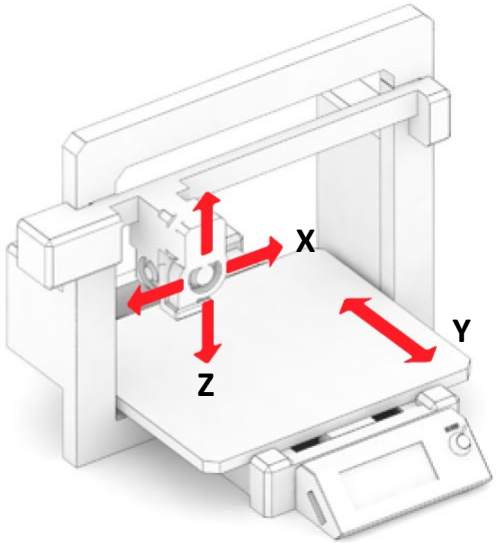
Platform Management



Prusa movements

"***Cartesian*** *3D printer is named after the XYZ dimensional coordinate system. The extruder moves in two directions (X and Z), while the print bed moves along the Y-axis. It also means that the print bed is usually square- or rectangle-shaped. Original Prusa i3 MK3S is a cartesian printer*." (1)

(1) 3D printing handbook. J. Prusa. 2019

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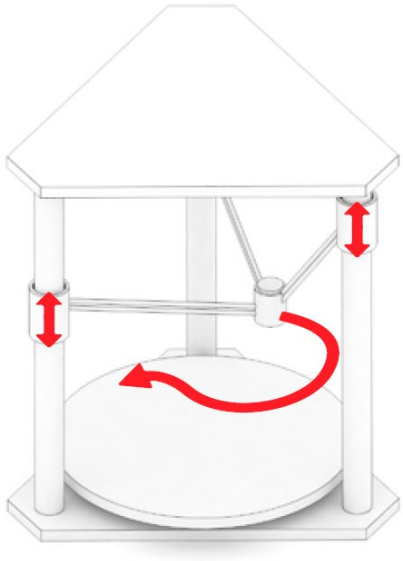
Platform Management



Delta movements

*"**Delta** 3D printers have their extruder movements controlled by three moving arms, which meet in the extruder. Two of the biggest advantages are the speed of printing and large printing volumes. However, the printer requires extremely precise assembly and calibration. The printer's geometry requires complex calculations for movements of stepper motors in each of the arms*". (1)

(1) 3D printing handbook. J. Prusa. 2019

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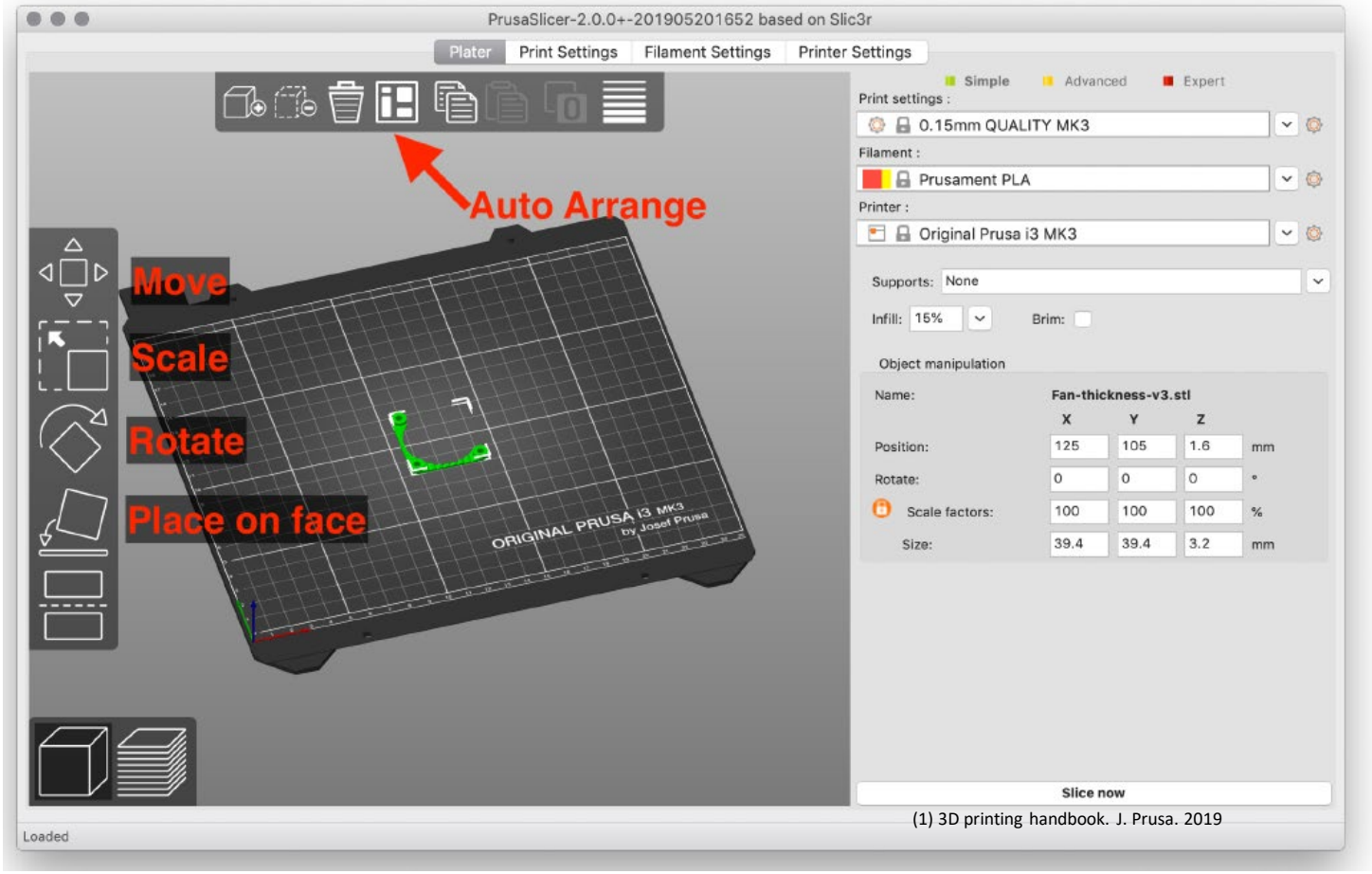
Platform Management – object manipulation



(1) 3D printing handbook. J. Prusa. 2019

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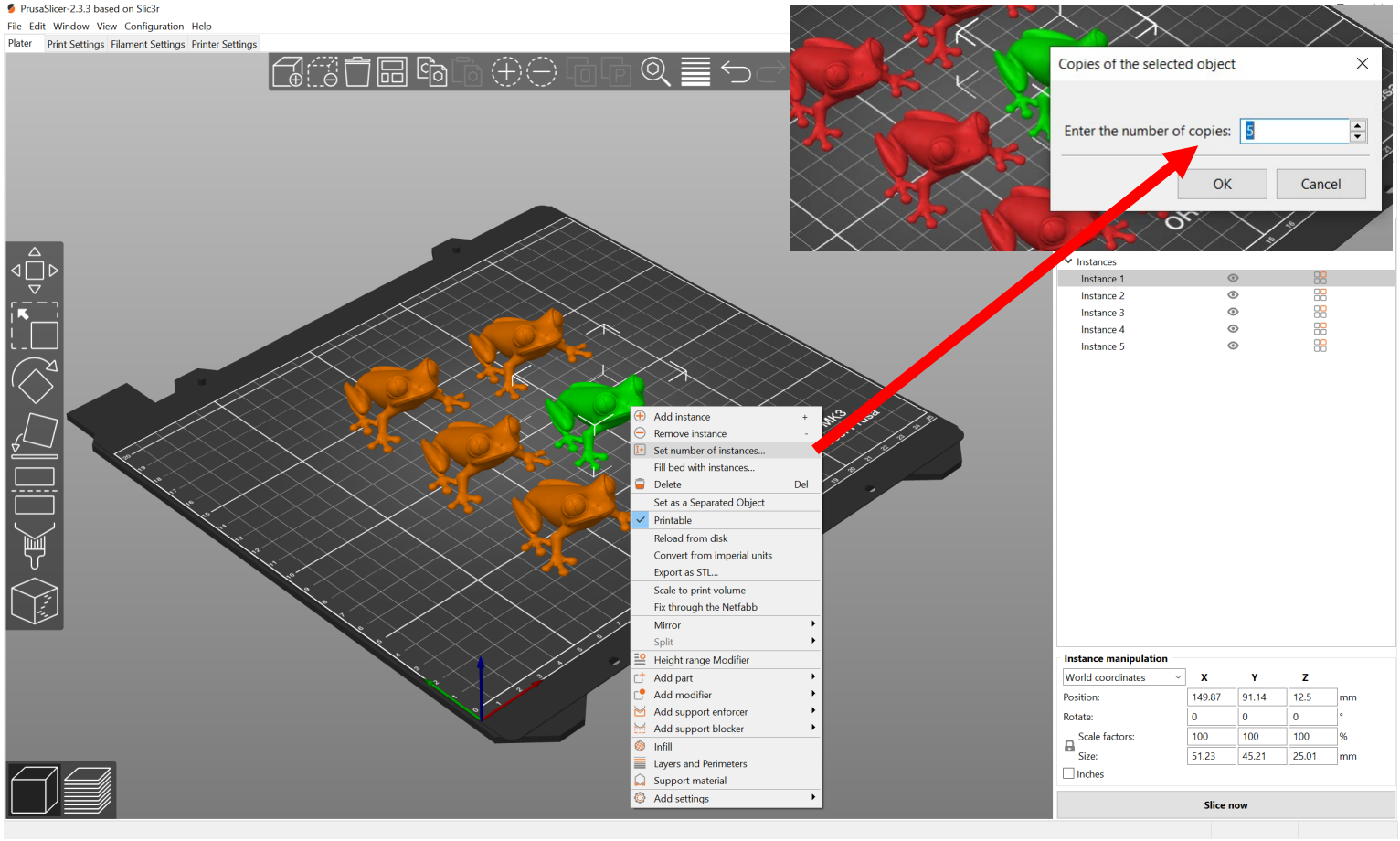
Platform Management



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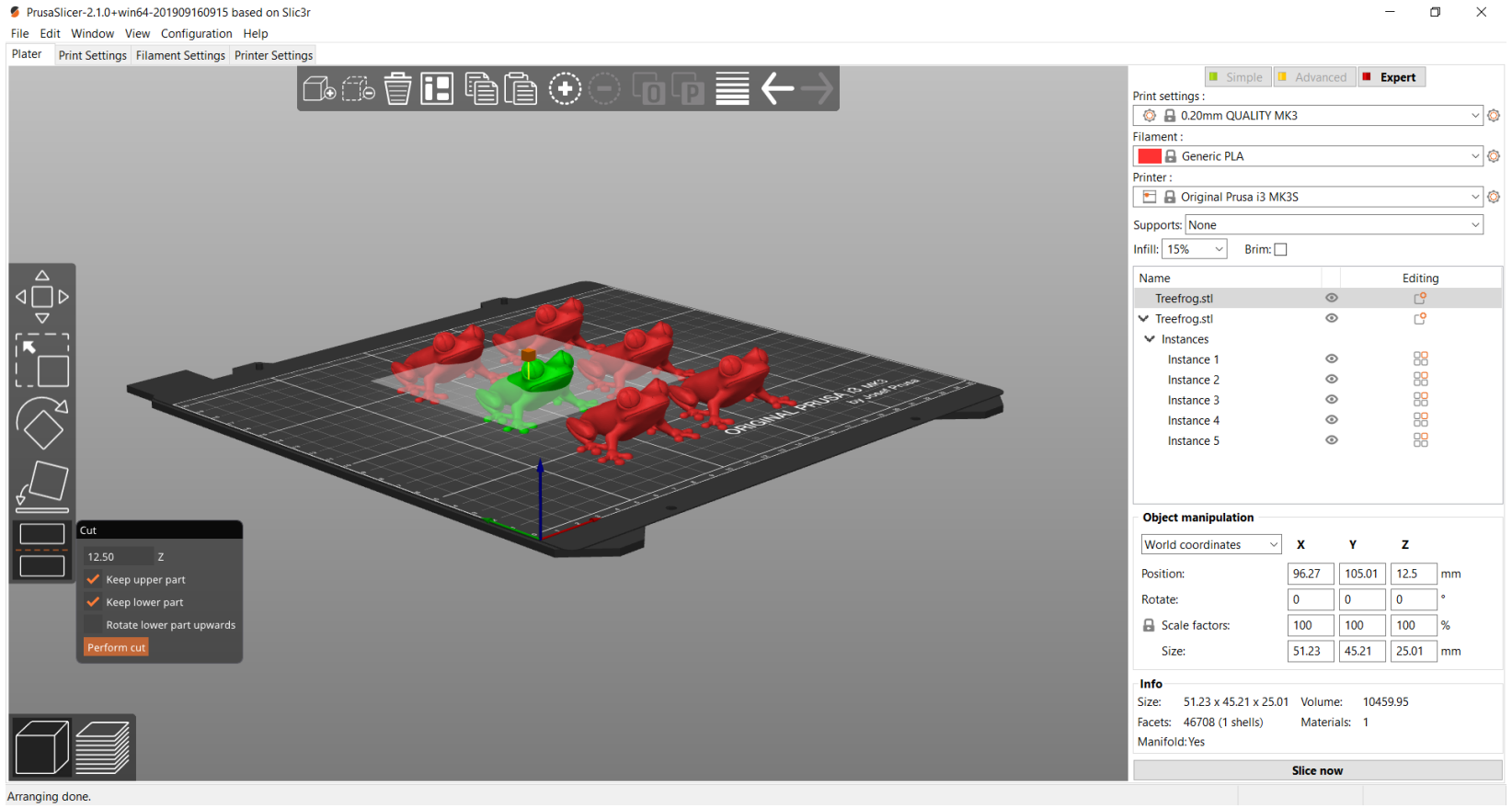
Platform Management



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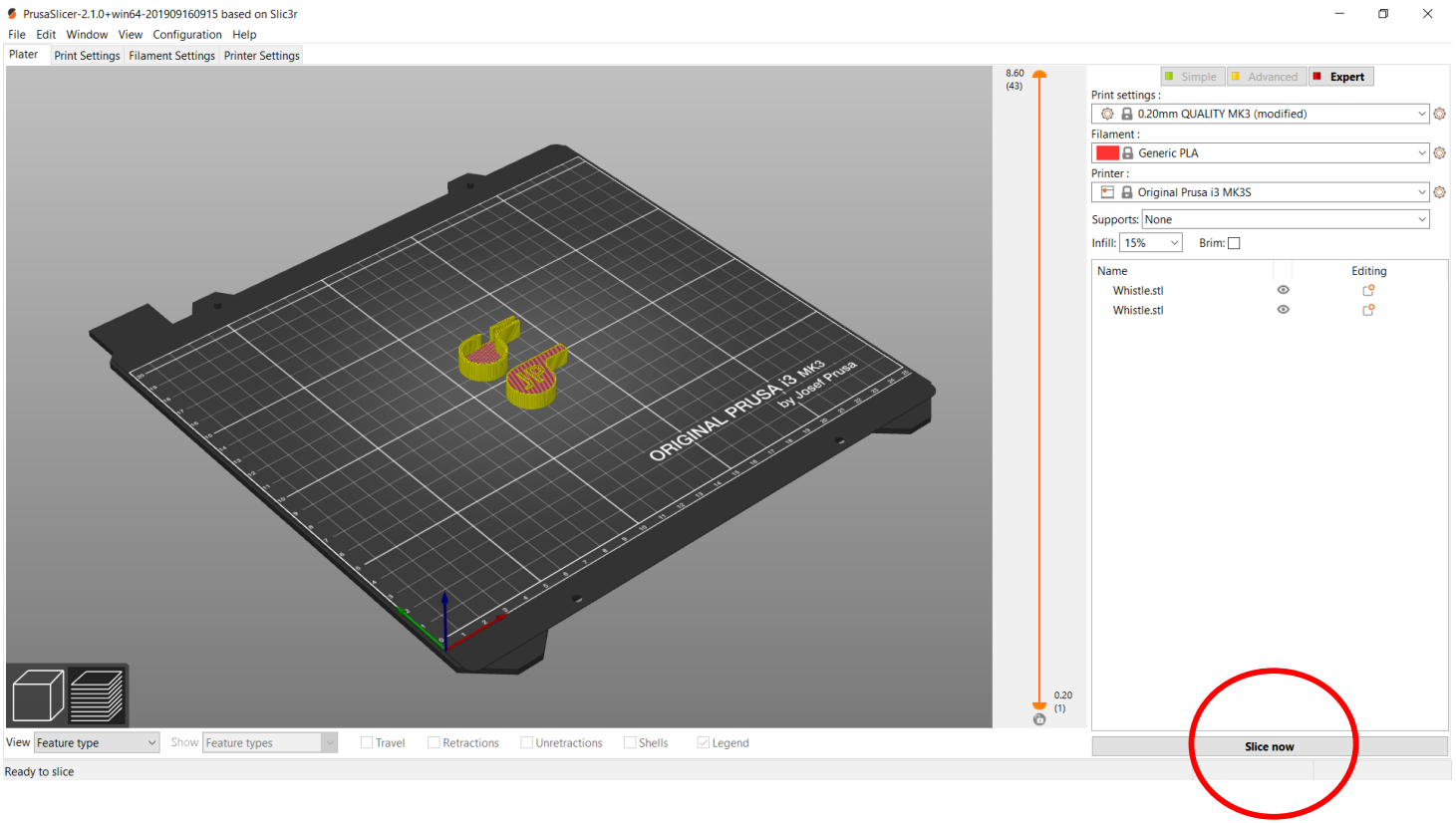
Platform Management



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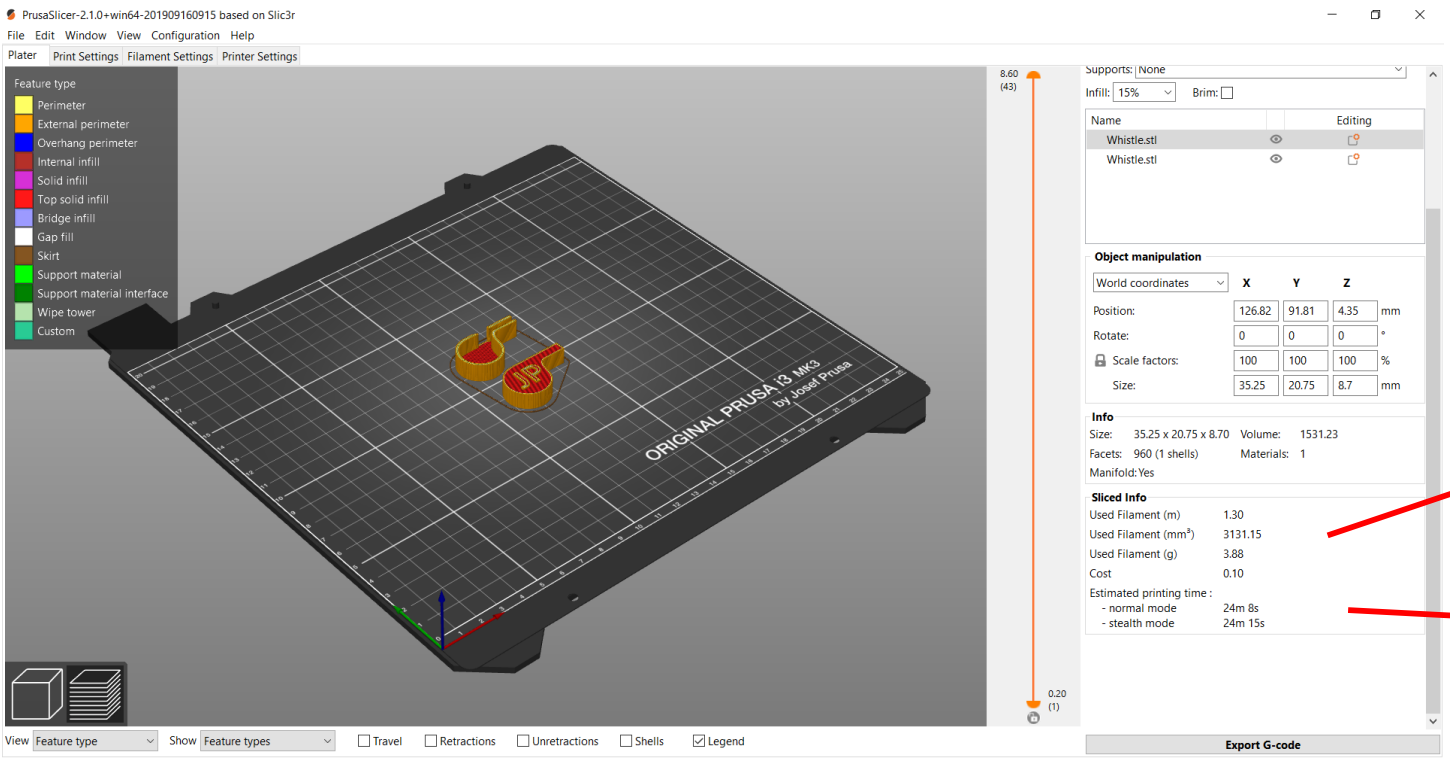
Platform Management



weight, length and cost info

Print Time Info

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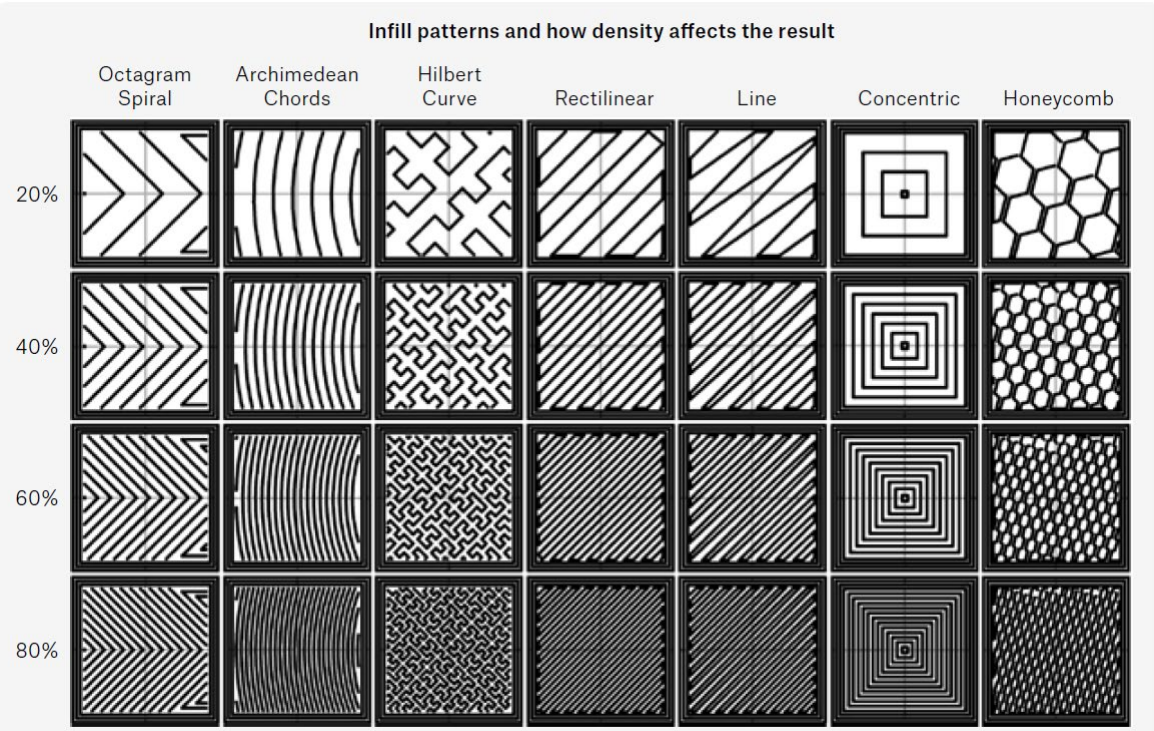
Print configuration



(3) Basis of 3D printing by Josef Průša 2019

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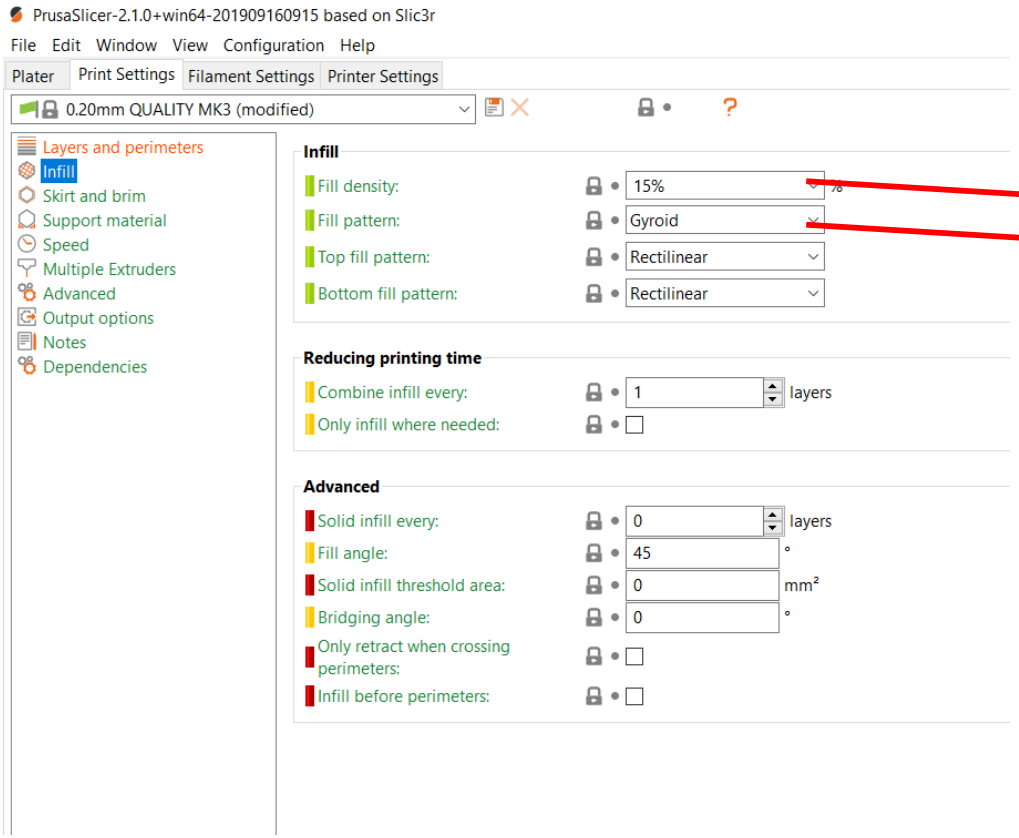
Print configuration



Fill density selection

Fill pattern selection

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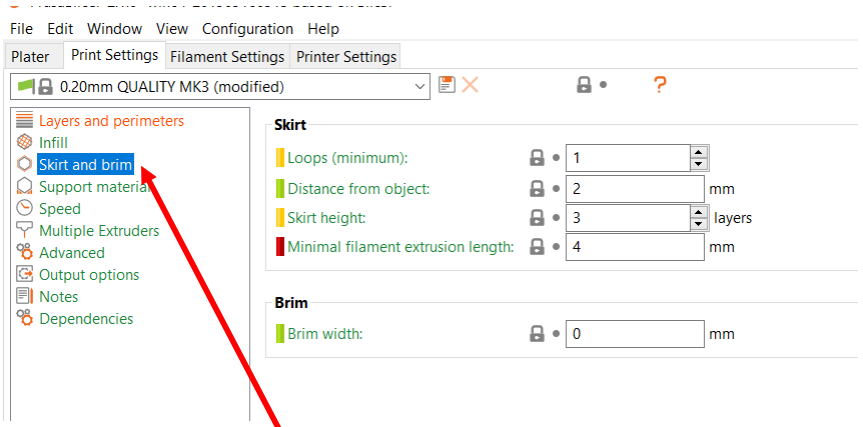
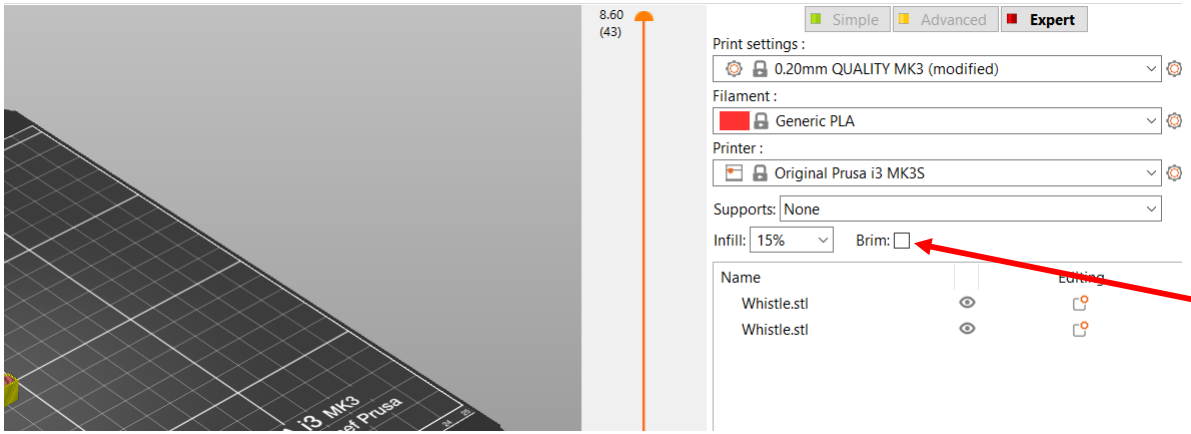
Print configuration





Brim selection

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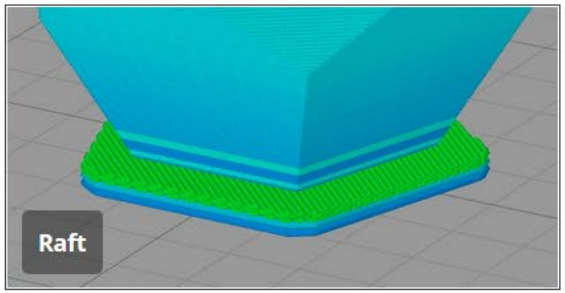
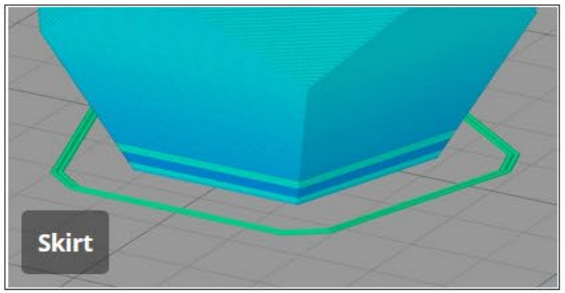
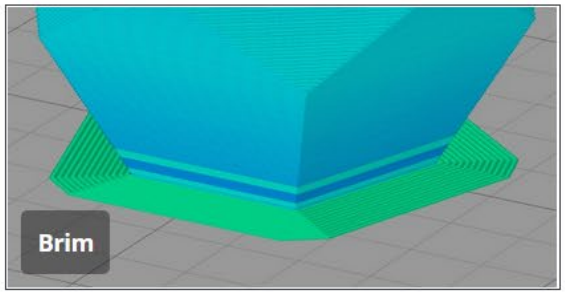
Print configuration

Rafts, Skirts and Brims!







(4) https://www.simplify3d.com/support/articles/rafts-skirts-and-brims/ , 2019

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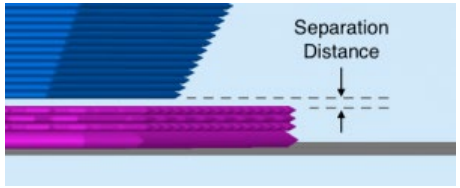
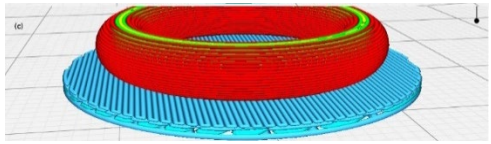
Print configuration

Rafts

A Raft is a horizontal latticework of filament that is located underneath your part. Your 3D printed part will be printed on top of this raft, instead of directly on the build platform surface. **Rafts are primarily used with ABS to help with warping and bed adhesion, but they can also be used to help stabilize models with small footprints, or to create a strong foundation on which to build the upper layers of your part.**

- **Raft Top Layers** – The number of interface layers that are printed at the top of the raft. Your model will be printed on top of these layers, so you usually want at least 2-3 layers to ensure a smooth surface.
- **Raft Base Layers** – The number of extra-thick layers at the very bottom of the raft. These layers are printed slow and thick to ensure a strong bond to the build platform.





(4) https://www.simplify3d.com/support/articles/rafts-skirts-and-brims/ , 2019
(5) https://ca.wikipedia.org/wiki/Fitxer:Skirts,_Brims,_Rafts.jpg

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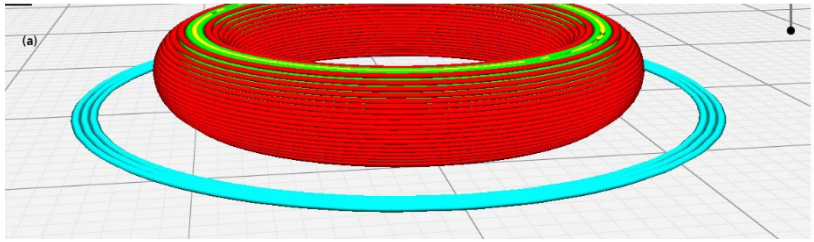
Print configuration

Skirts

A skirt is an outline that surrounds your part but does not touch the part. The skirt is extruded on the print bed before starting to print your model. **Skirts serve a useful purpose because they help prime your extruder and establish a smooth flow of filament.** Observing the skirt also allows you to detect and adjust any leveling or adhesion issues before the actual model begins printing.



(4) https://www.simplify3d.com/support/articles/rafts-skirts-and-brims/ , 2019
(5) https://ca.wikipedia.org/wiki/Fitxer:Skirts,_Brims,_Rafts.jpg

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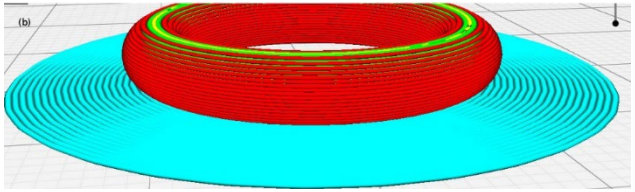
Print configuration

Brims

A Brim is a special type of skirt that is actually attached to the edges of your model. Typically, the brim is printed with a increased number of outlines to create a large ring around your part, similar to the brim of a hat. Brims are often used to hold down the edges of your part, which can prevent warping and help with bed adhesion. The Brim may be a preferred option to the raft (which also helps with adhesion), as the brim can typically be printed much faster and uses far less filament. Once the print is complete, the thin brim can be separated from the solid model and discarded.



(4) https://www.simplify3d.com/support/articles/rafts-skirts-and-brims/ , 2019
(5) https://ca.wikipedia.org/wiki/Fitxer:Skirts,_Brims,_Rafts.jpg

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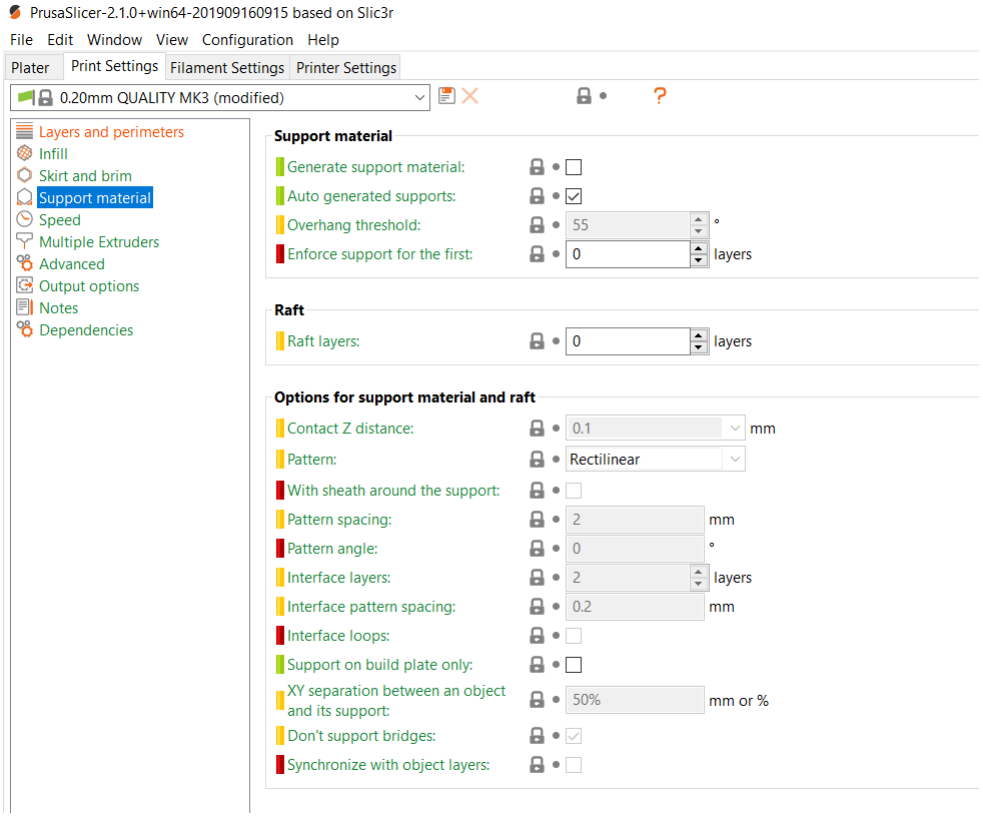
Print configuration



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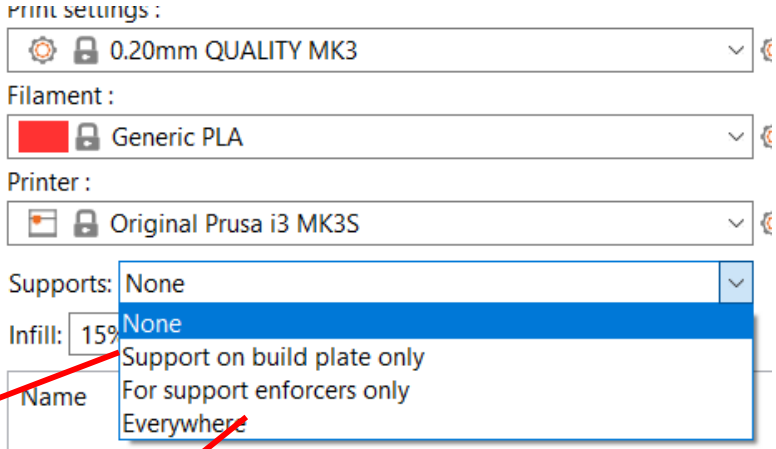
Print configuration



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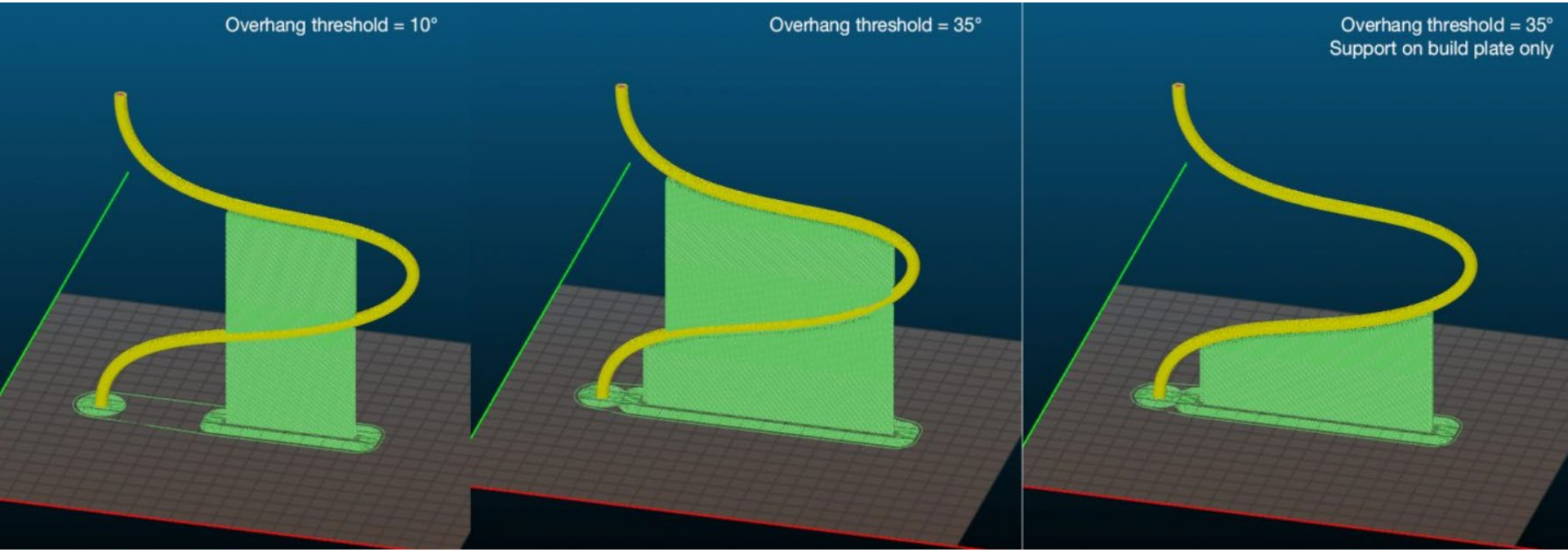
Print configuration



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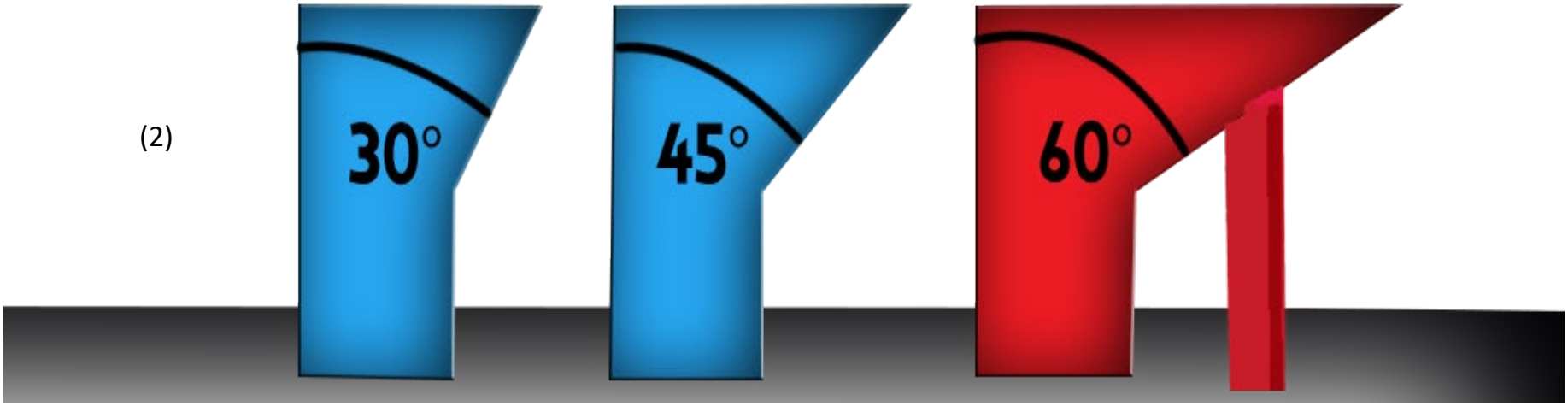
Print configuration

(1)(2) https://www.sd3d.com/3d-printing/quality/

(2)



"Overhang angles are extremely important to take into consideration when designing a part to be 3D printed. Without understanding how support structures work, it is easy to think that any structure can be easily printed with a clean surface quality.
As mentioned above, a fine quality print will not result in any better surface quality over a draft quality print when in reference to the scarring resulting in support for extreme overhangs.
This scarring is just about impossible to get rid of 100%, even on our specialty printer. This scarring is worse on some unique materials, especially on the flexible options. That is why complex flexible models are very difficult to print, and you should be warned of such before moving forward printing with a unique material.
If you have a part with angles roughly 45° or more, then you will require support. This support will leave scarring such as you can see from the image on the right. The more extreme the angle and the closer to the build plate that angle is, the more difficult this support material gets to remove cleanly." (1)

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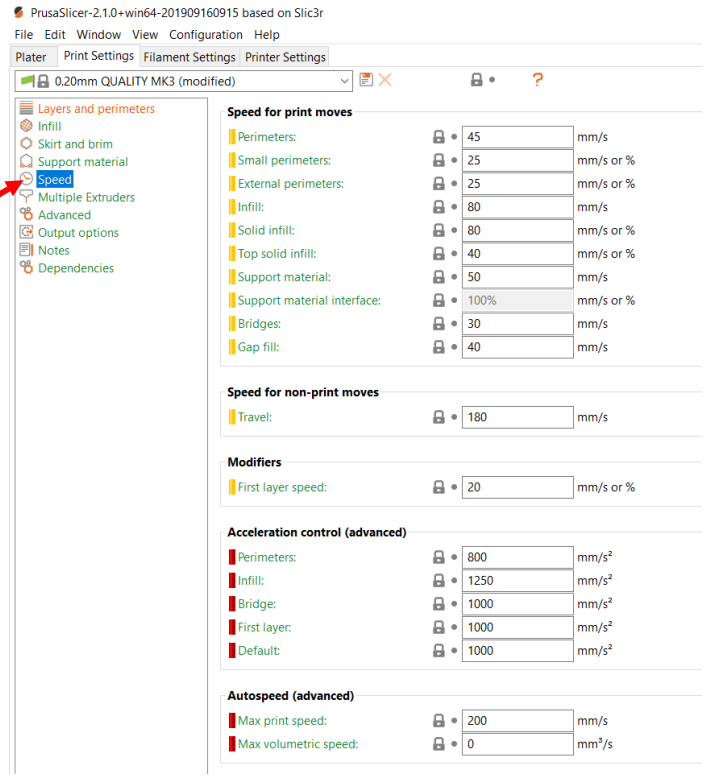
Print configuration

Speed selector



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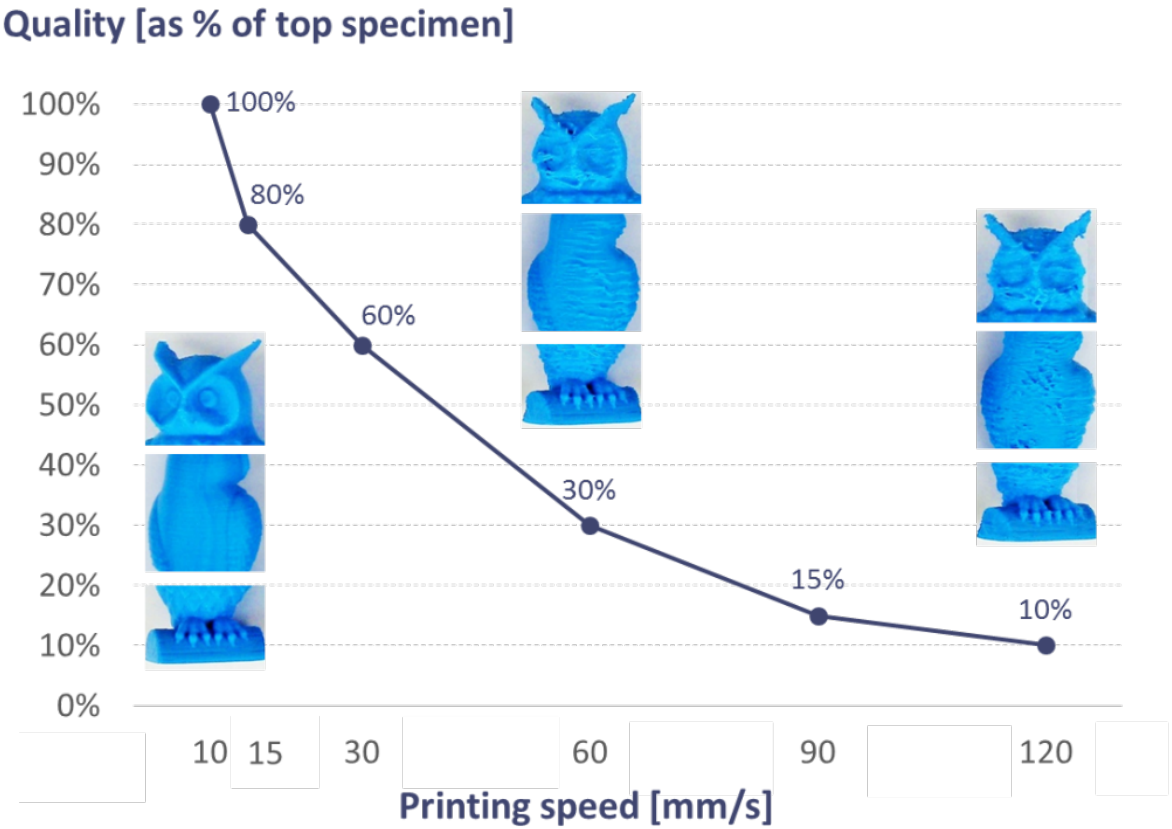
Print configuration



Print speed vs quality

(6) https://my3dmatter.com/what-is-the-influence-of-color-printing-speed-extrusion-temperature-and-ageing-on-my-3d-prints/, 2019

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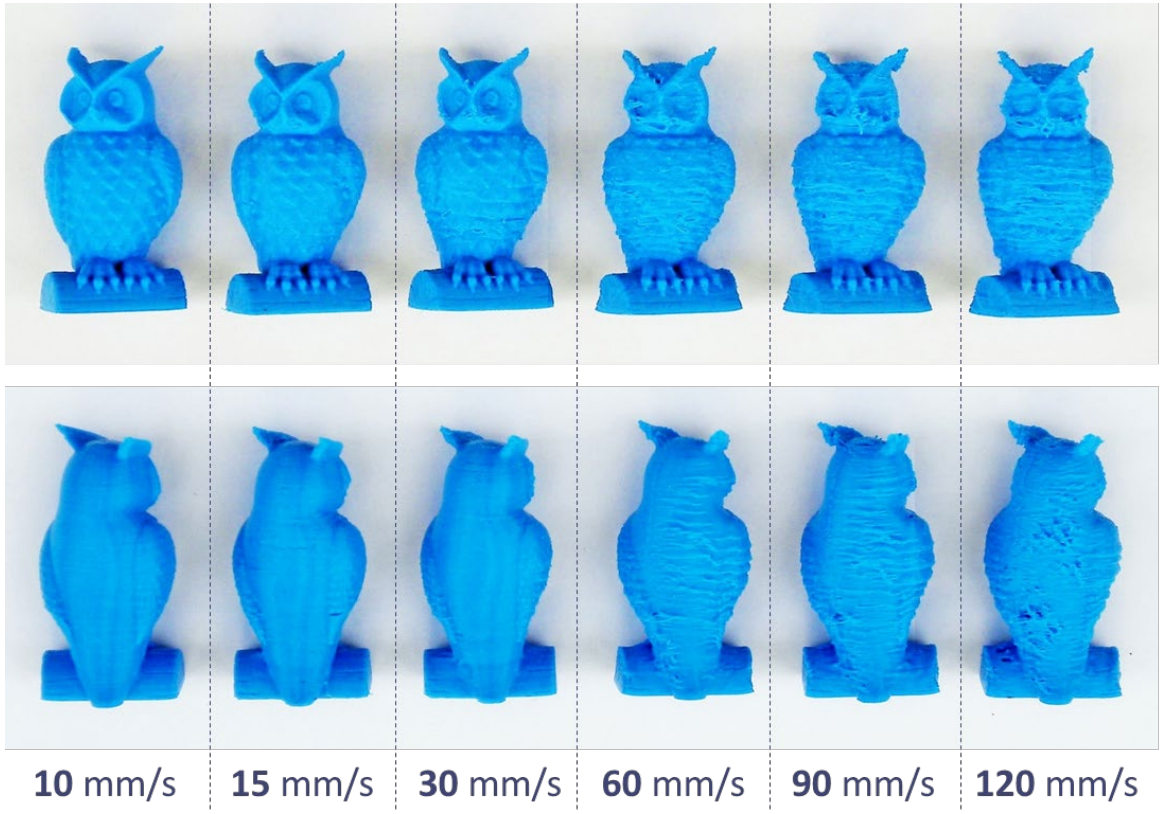
Print configuration



Print speed vs quality

(6) https://my3dmatter.com/what-is-the-influence-of-color-printing-speed-extrusion-temperature-and-ageing-on-my-3d-prints/, 2019

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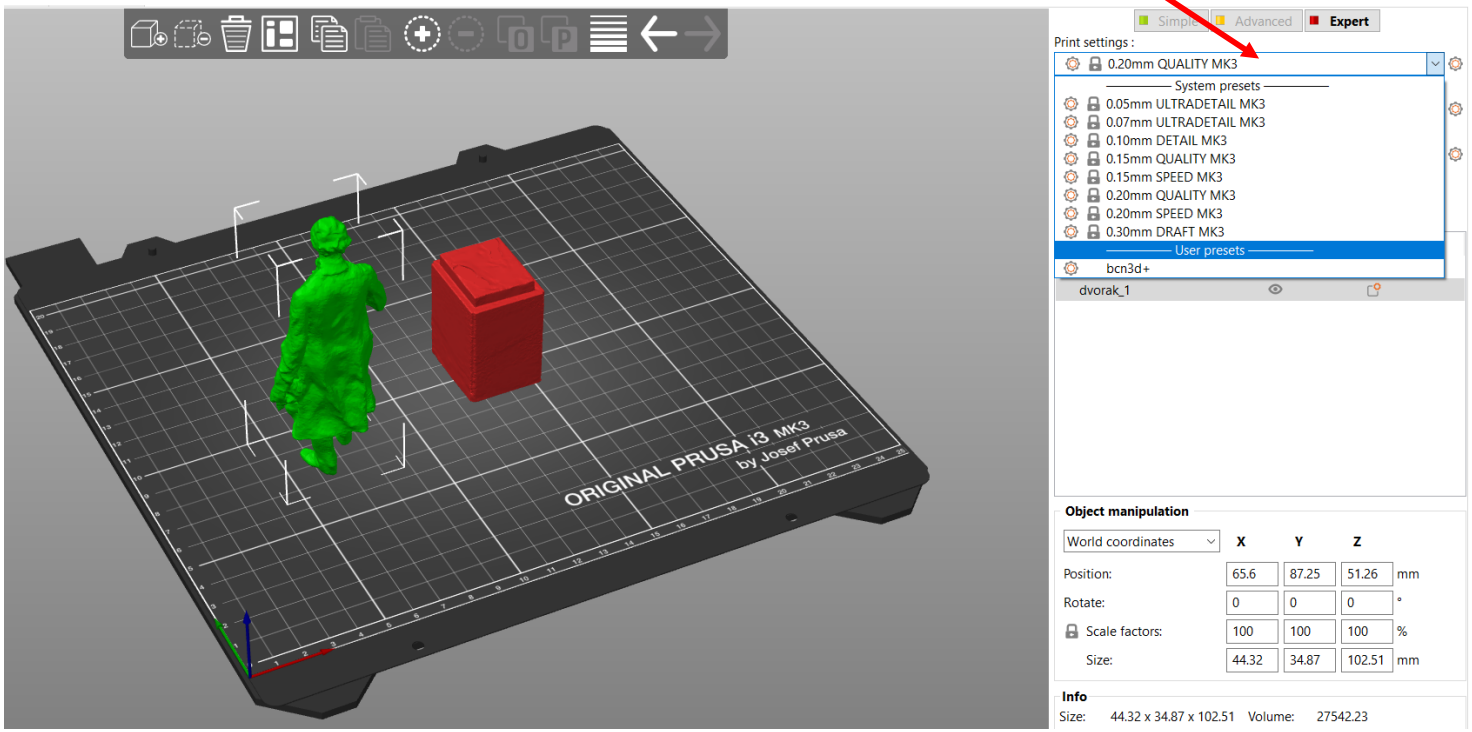
Print configuration

Layer height selection



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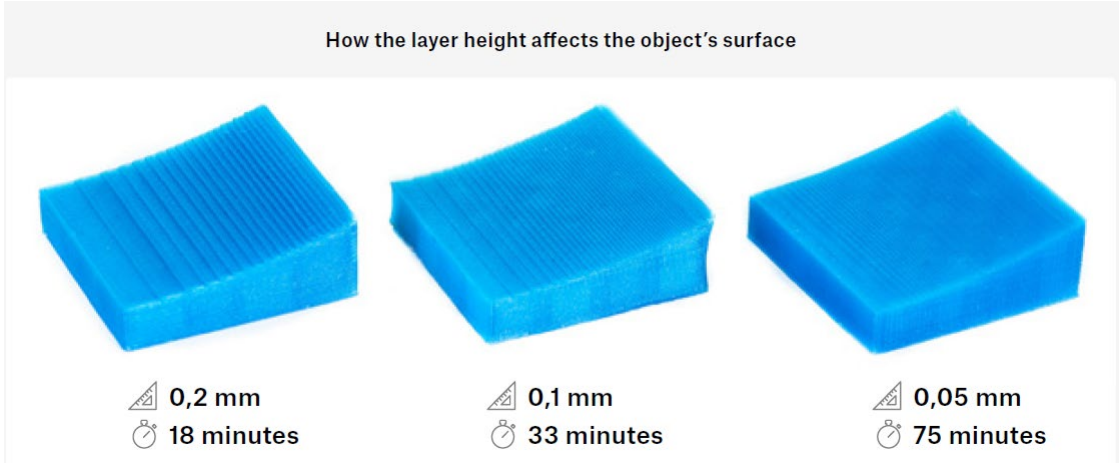
Print configuration



"***Layer height*** *– sometimes also called the "Z-axis resolution" has a major impact on both print times and overall surface finish of the printed object. Higher values lead to faster prints and more visible layers on the surface of the object. This effect is especially prominent on surfaces that are nearly parallel to the print bed. Most of the time, layer heights of 0.15mm - 0.20 mm are preferred.*"(1)

(1) 3D printing handbook. J. Prusa. 2019

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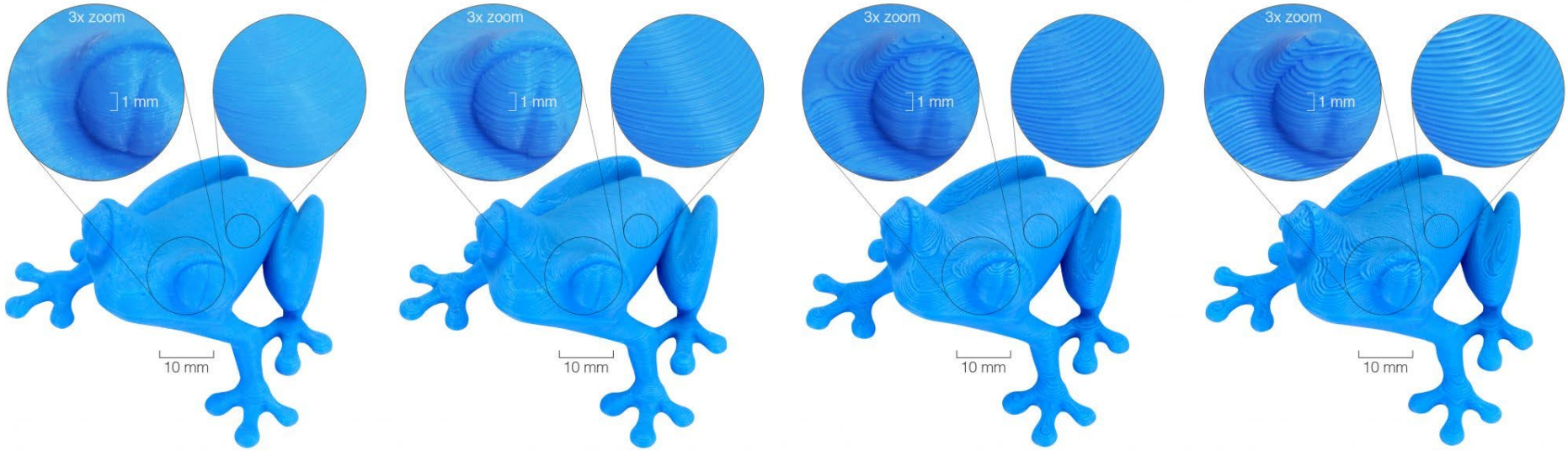
Print configuration



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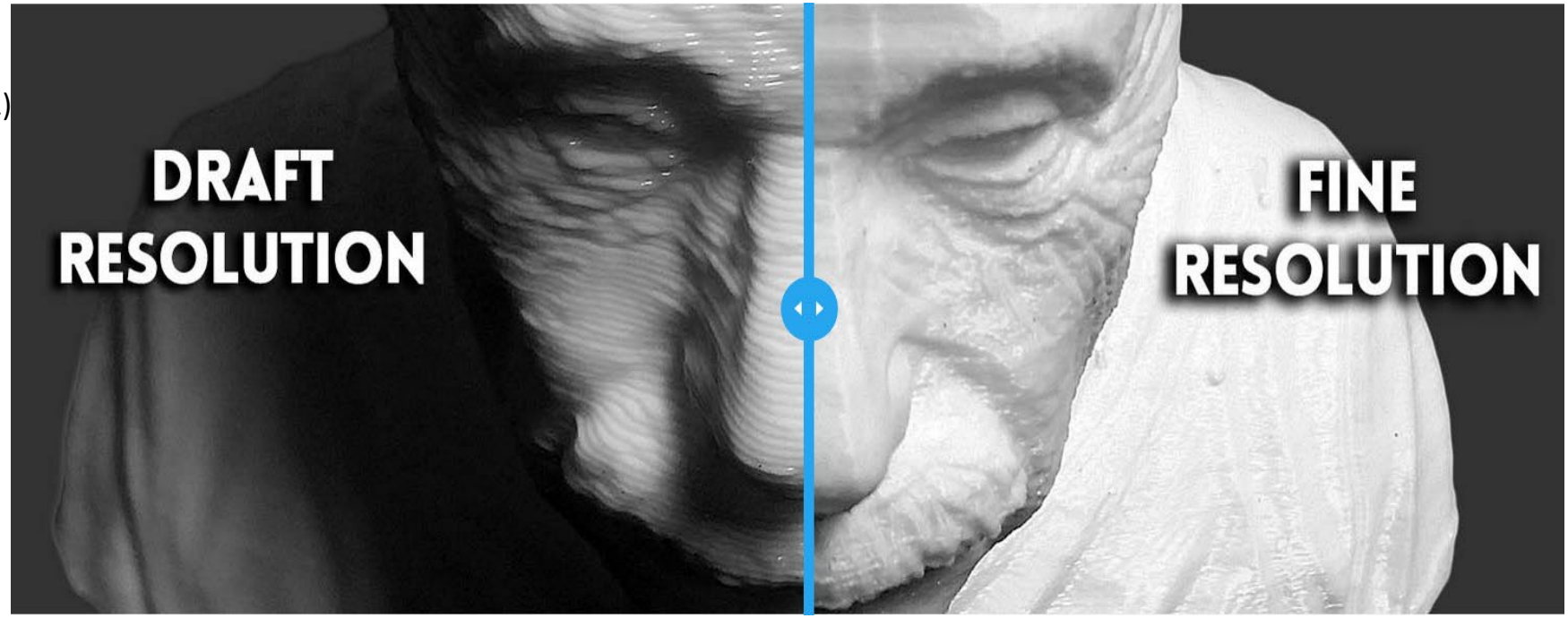
Print configuration

(2)



(2) https://www.sd3d.com/

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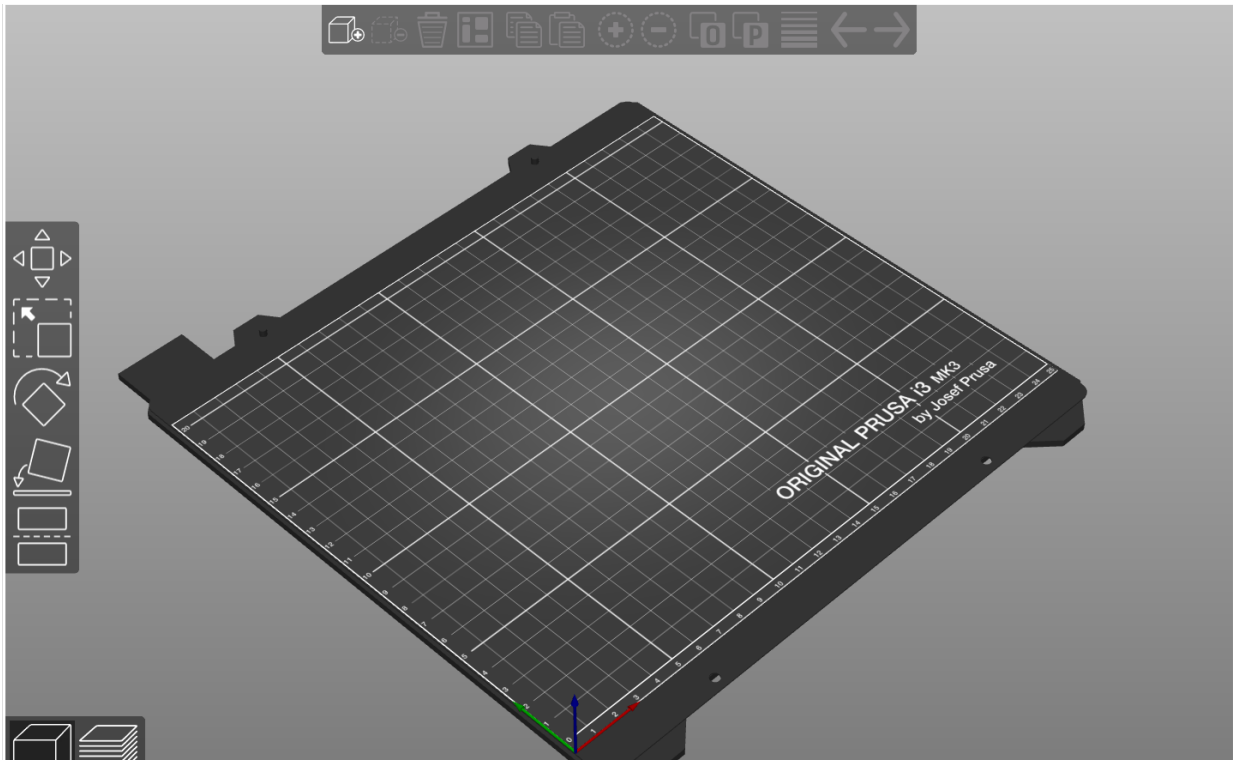
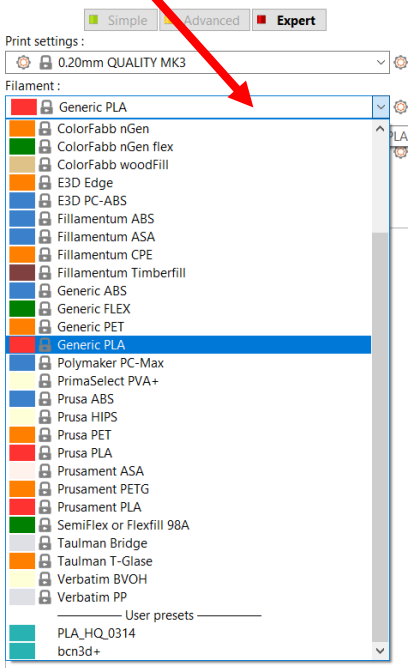
Filaments Settings

Material selector





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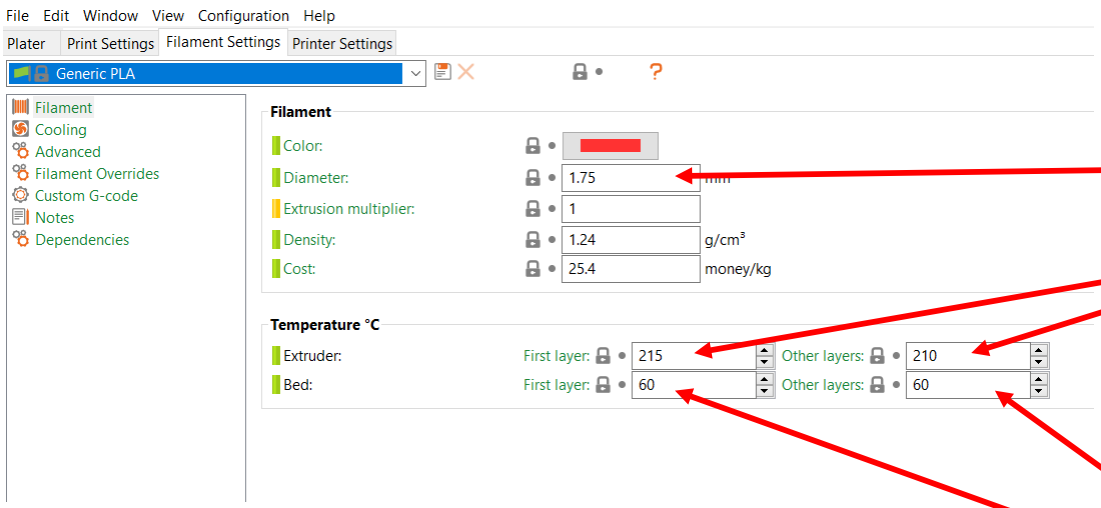
Filaments Settings



Filament diameter

Material processing temperature

Bed temperature selector

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Filaments Settings

ABOUT PLA

PLA melts at a relatively low temperature of about 175 degrees Celsius. Unlike so-called thermoset materials, PLA can be heated past its melting point multiple times with very little degradation. It's a hard material, but that also means it's somewhat brittle, and once it breaks, it likes to shatter. **Only this material is proven for 50 microns layer height.**

However, PLA is not a perfect material and, just like every other plastic, has some disadvantages. The low melting temperature also means **low-temperature resistance**. Parts start to lose mechanical strength at temperatures **over 60 °C**.

The combination of being both biodegradable and having low-temperature resistance means that it's **not ideal for outdoor use**, not to mention low UV-resistance. Also, PLA is only soluble in chemicals like chloroform or hot benzene. So when connecting multiple pieces, you're better off using just glue.

Even though PLA is biodegradable, and the material on its own is food safe, we do not suggest to repeatedly **drink or eat from your 3D prints**. Because of the small fractures on the print surface, bacteria can build up in there over time. You can prevent this by applying a food-safe coating. When **post-processing PLA**, it's better to use wet sanding. Without water you'll quickly start heating the plastic by friction, it will melt locally and make it hard to keep sanding.

PRINTING SETUP

Nozzle	215 °C	Heatbed	50-60 °C

BASIC ATTRIBUTES

+	Easy to print	−	Brittle
+	Can print tiny parts	−	Low temperature resistance
+	Can print huge objects	−	Difficult post-processing
+	Hard and tough		
+	Low warping		

https://shop.prusa3d.com/en/prusament/715-prusament-pla-lipstick-red-1kg.html

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Filaments Settings

	ABS	Flexible	PLA	HIPS	PETG	Nylon	Carbon Fiber Filled	ASA	Polycarbonate	Polypropylene	Metal Filled	Wood Filled	PVA
	Learn More	Learn More	Learn More	Learn More	Learn More	Learn More	Learn More	Learn More	Learn More	Learn More	Learn More	Learn More	Learn More
Compare Selected	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ultimate Strength	40 MPa	26 - 43 MPa	65 MPa	32 MPa	53 MPa	40 - 85 MPa	45 - 48 MPa	55 MPa	72 MPa	32 MPa	20 - 30 MPa	46 MPa	78 MPa
Stiffness	5 / 10	1 / 10	7.5 / 10	10 / 10	5 / 10	5 / 10	10 / 10	5 / 10	6 / 10	4 / 10	10 / 10	8 / 10	3 / 10
Durability	8 / 10	9 / 10	4 / 10	7 / 10	8 / 10	10 / 10	3 / 10	10 / 10	10 / 10	9 / 10	4 / 10	3 / 10	7 / 10
Maximum Service Temperature	98 °C	60 - 74 °C	52 °C	100 °C	73 °C	80 - 95 °C	52 °C	95 °C	121 °C	100 °C	52 °C	52 °C	75 °C
Coefficient of Thermal Expansion	90 µm/m-°C	157 µm/m-°C	68 µm/m-°C	80 µm/m-°C	60 µm/m-°C	95 µm/m-°C	57.5 µm/m-°C	98 µm/m-°C	69 µm/m-°C	150 µm/m-°C	33.75 µm/m-°C	30.5 µm/m-°C	85 µm/m-°C
Density	1.04 g/cm³	1.19 - 1.23 g/cm³	1.24 g/cm³	1.03 - 1.04 g/cm³	1.23 g/cm³	1.06 - 1.14 g/cm³	1.3 g/cm³	1.07 g/cm³	1.2 g/cm³	0.9 g/cm³	2 - 4 g/cm³	1.15 - 1.25 g/cm³	1.23 g/cm³
Price (per kg)	$10 - $40	$30 - $70	$10 - $40	$24 - $32	$20 - $60	$25 - $65	$30 - $80	$38 - $40	$40 - $75	$60 - $120	$50 - $120	$25 - $55	$40 - $110
Printability	8 / 10	6 / 10	9 / 10	6 / 10	9 / 10	8 / 10	8 / 10	7 / 10	6 / 10	4 / 10	7 / 10	8 / 10	5 / 10
Extruder Temperature	220 - 250 °C	225 - 245 °C	190 - 220 °C	230 - 245 °C	230 - 250 °C	220 - 270 °C	200 - 230 °C	235 - 255 °C	260 - 310 °C	220 - 250 °C	190 - 220 °C	190 - 220 °C	185 - 200 °C
Bed temperature	95 - 110 °C	45 - 60 °C	45 - 60 °C	100 - 115 °C	75 - 90 °C	70 - 90 °C	45 - 60 °C	90 - 110 °C	80 - 120 °C	85 - 100 °C	45 - 60 °C	45 - 60 °C	45 - 60 °C
Heated Bed	Required	Optional	Optional	Required	Required	Required	Optional	Required	Required	Required	Optional	Optional	Required

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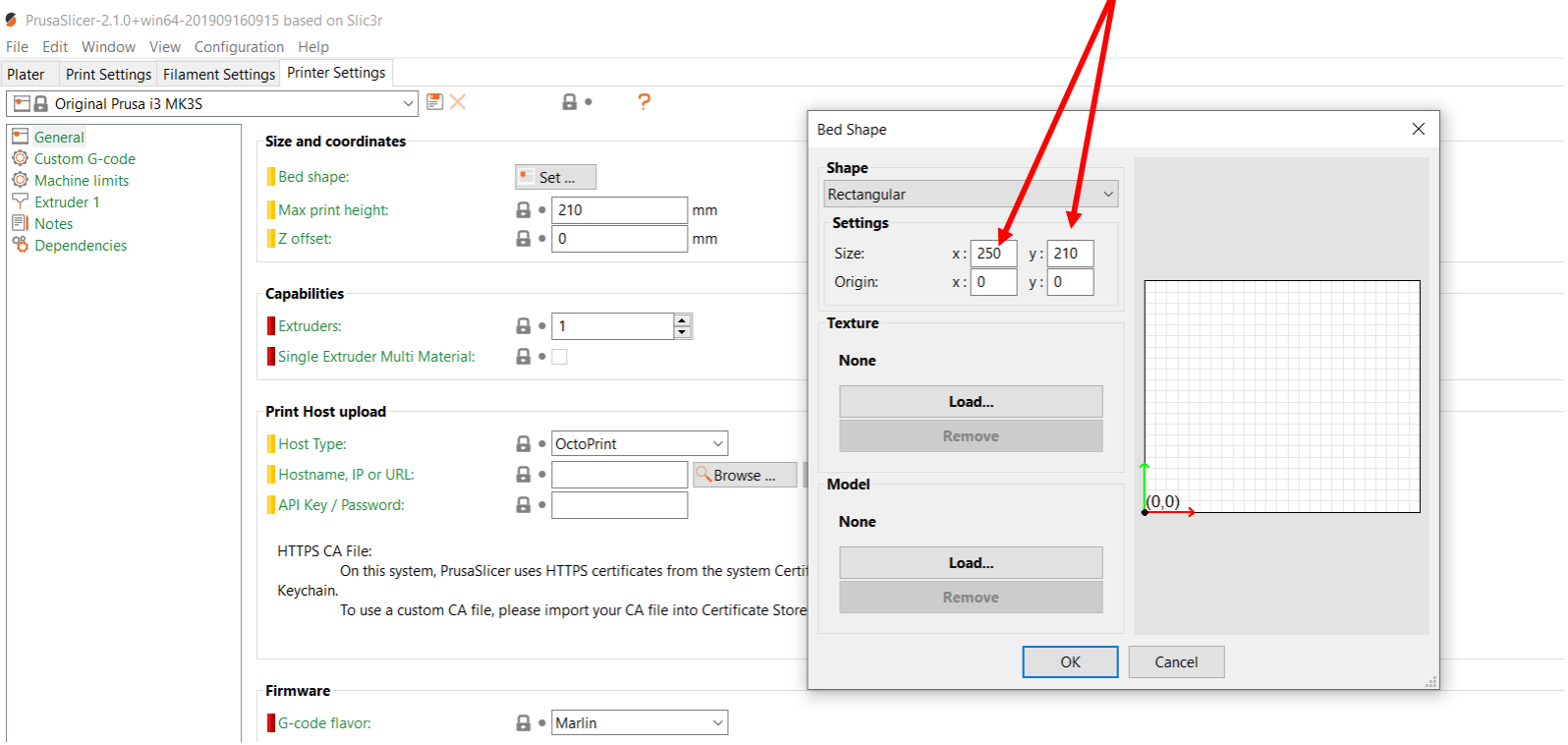
Printer Settings



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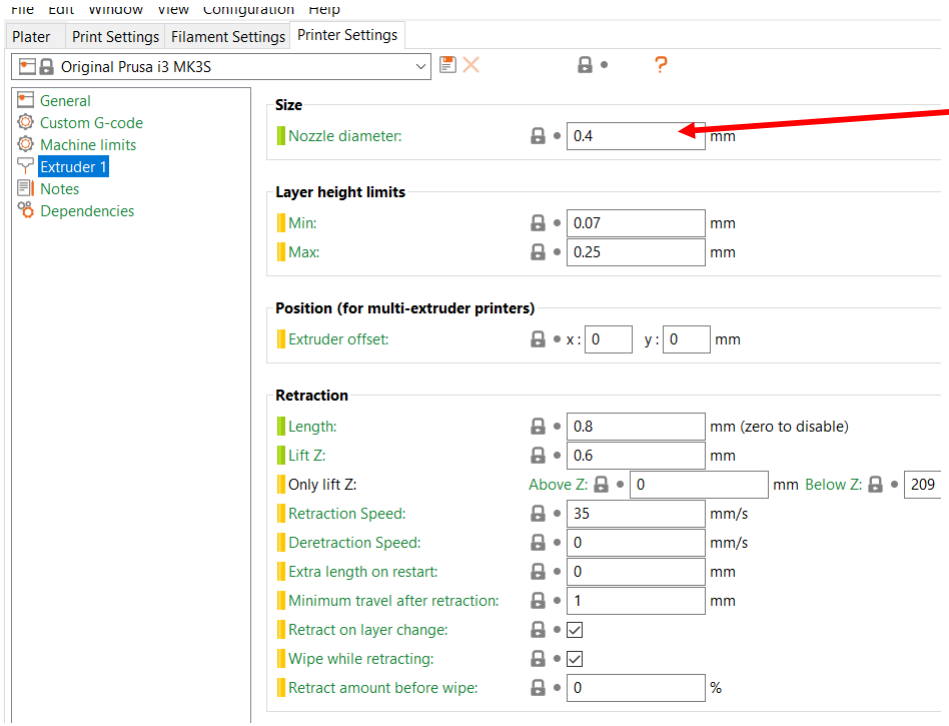
Printer Settings



Nozzle diameter

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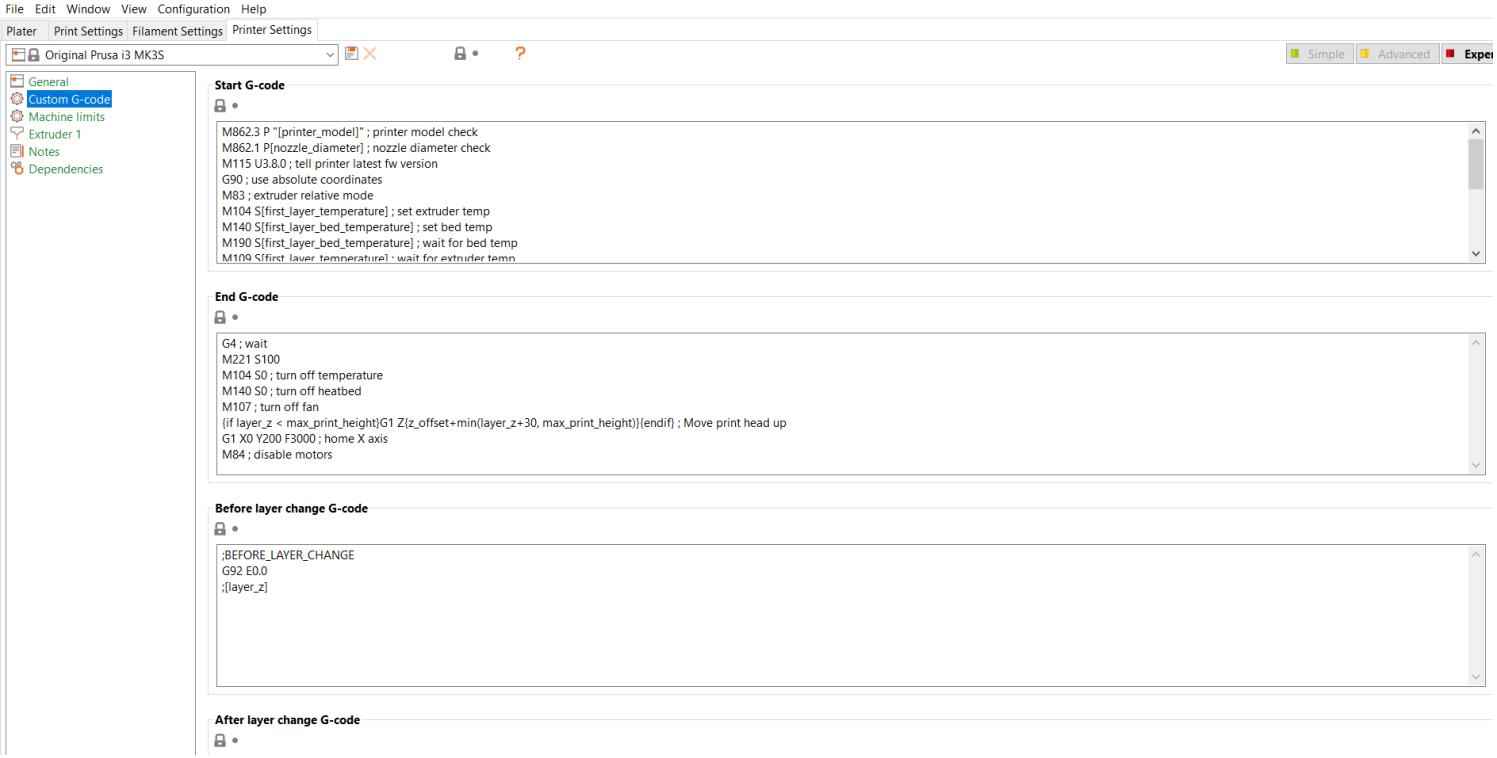
Printer Settings



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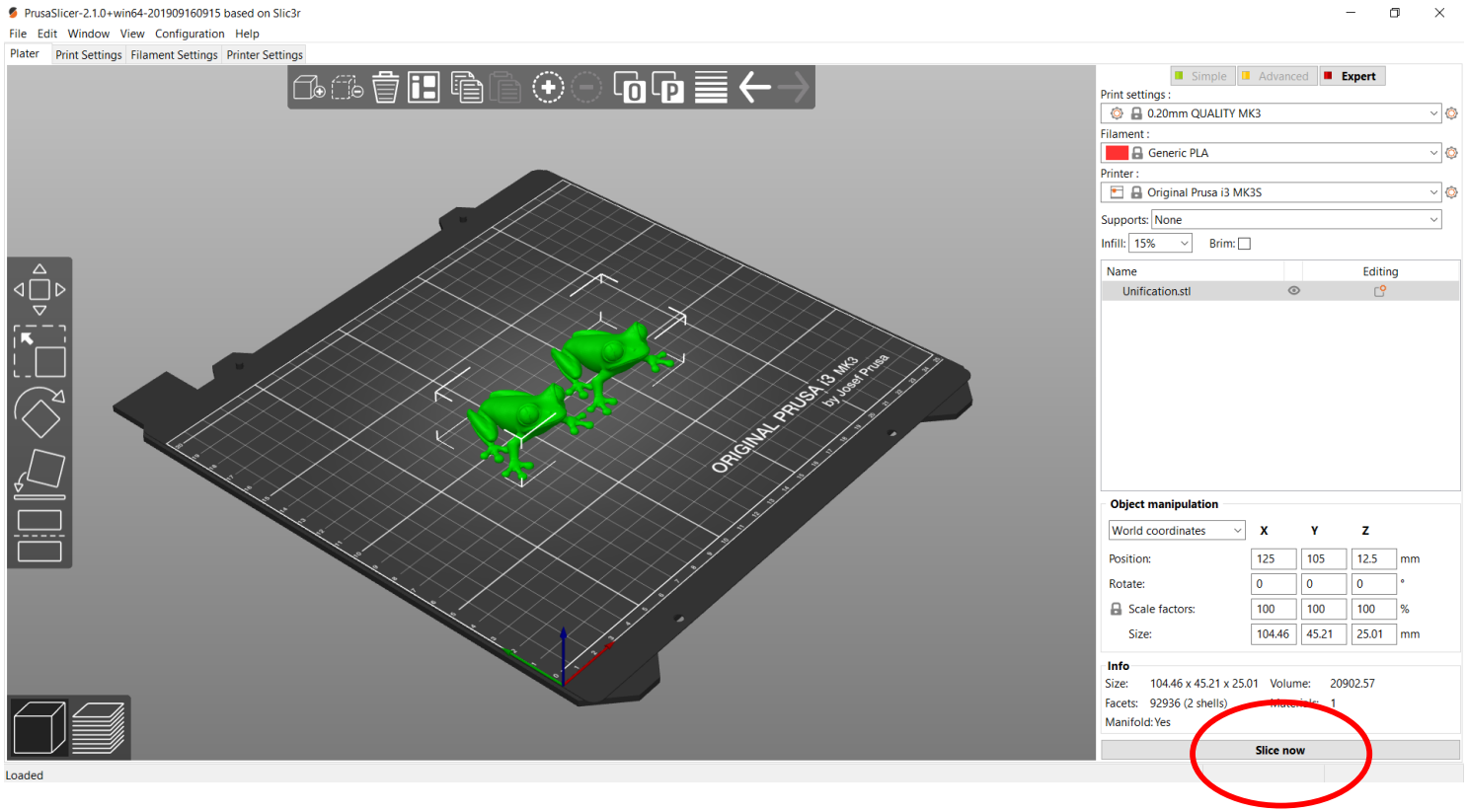
Slicing

slicing



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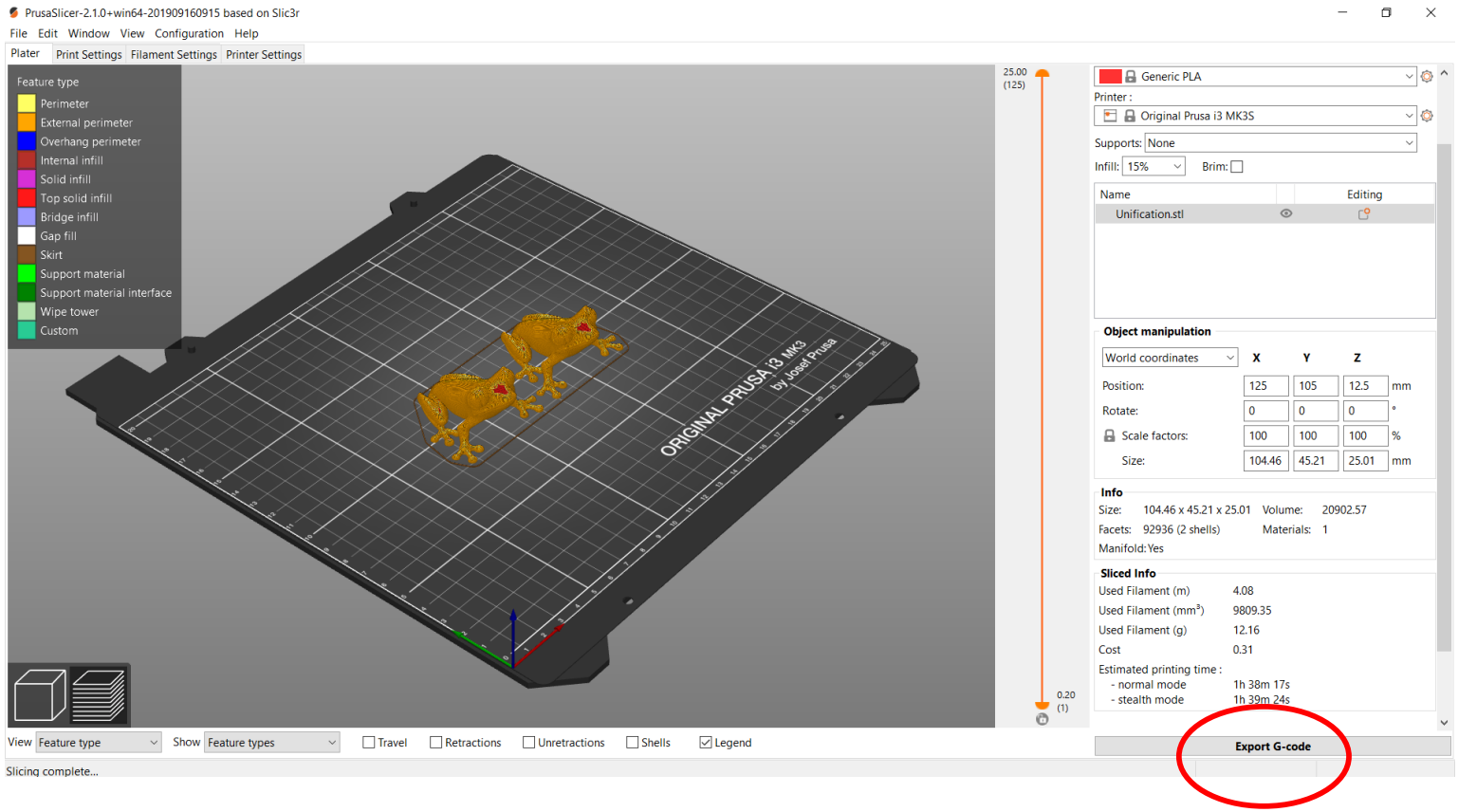
Slicing

Export g-code



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KEEP CALM AND THANKS FOR WATCHING

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