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TRAINING

HOW TO USE CUTTING-EDGE TECHNOLOGICAL EQUIPMENT IN THE CLASSROOM



1ο Επαγγελματικό
Λύκειο Πάτρας

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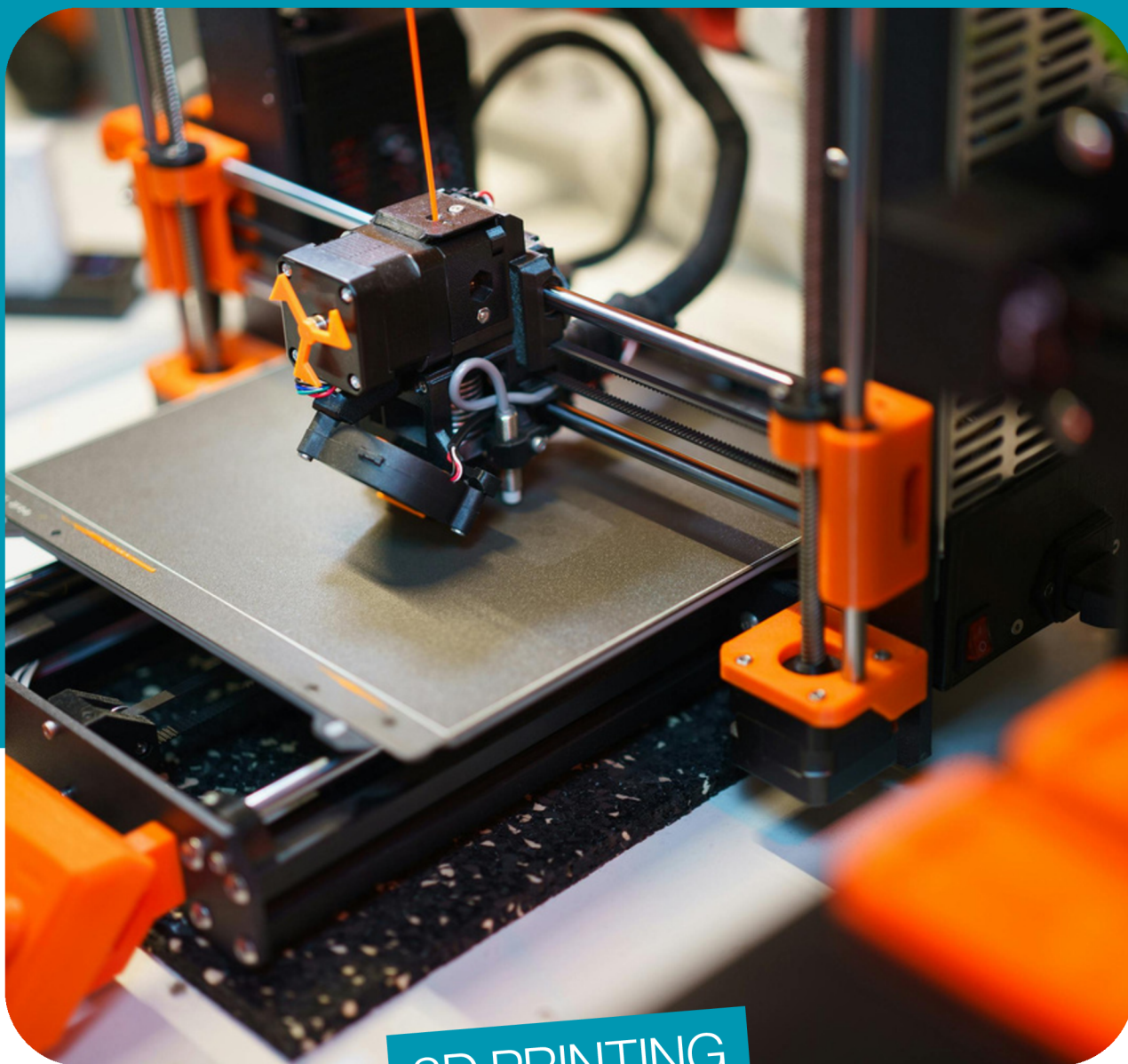
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3D PRINTING

3D PRINTING

Timing

Part of the session	Description	Duration
Block 1. What is 3D printing?	Concept of additive manufacturing and uses of 3D printing	20 min
Block 2. 3D Printing Process	General explanation of the process: design, lamination and printing	20 min

Goals

- Understand what 3D printing is and how it works.
- Learn about the 3D printing process.
- Identify 3D printing files and software

Methodology

The session will be conducted using an expository and participatory methodology. Theoretical explanations will be combined with the observation of printed parts and a 3D printer.

Content development

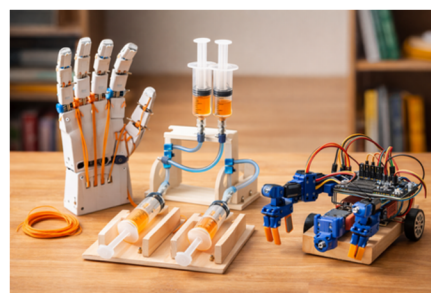
Block 1. What is 3D printing?

3D printing is an additive manufacturing technique. This process involves creating an object by layering material.

In this sense, unlike other traditional manufacturing methods where material is cut, drilled, or removed (such as subtractive methods, milling, etc.), in 3D printing the object is built progressively. Thanks to this, we can create more complex shapes more easily, reduce the amount of material we use, and facilitate the creation of customized materials adapted to educational settings.

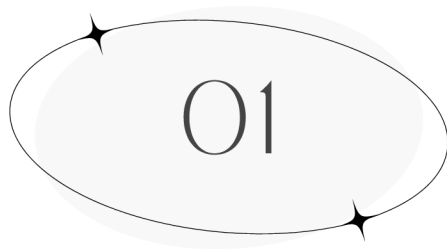
Currently, the use of 3D printing has expanded into very diverse fields such as medicine (for the creation of prostheses, dental implants...), architecture (models...) or education (Techlab, more dynamic training...).

In the Erasmus Plus project “Didactech,” we developed the Techlab methodology, an educational strategy to promote science and technology in secondary education. This strategy is implemented through the creation of Techlabs, 3D printing technology labs where students learn by doing. In these labs, students work on real-world projects—such as 3D design and printing—to develop STEM skills in a practical way, while experimenting, collaborating, and applying knowledge to concrete situations. The initiative democratizes access to technological innovation and uses it as a tool for inclusion, motivation, and personal development. Furthermore, the Techlab functions as a cross-curricular axis for the school, integrating different subjects and activities, with support and training for teachers and collaboration from external experts. It also incorporates a social dimension, as the products created are shared with other schools, especially in disadvantaged contexts, fostering values of solidarity, equity, and commitment.



Block 2. The 3D printing process

The 3D printing process consists of several phases that allow you to go from design to printing a 3D object.



Design the 3D part

It all begins with the digital design of the part we want to print, for which we'll need to use 3D modeling software. In the educational field, there are intuitive and free programs that you can easily use. Below, we suggest several options:

- Tinkercad: especially recommended for beginners and high school students.
- Fusion 360 (educational license): more advanced, ideal for technical design.
- FreeCAD: free software based on parametric modeling.
- SketchUp Free: useful for simple designs and architectural environments.

However, we can "skip" this step, since nowadays there are online 3D model databases that are royalty-free and can be downloaded for free without needing to design the object from scratch.

Some of these pages are:

- Thingiverse
- Printables
- My Mini Factory
- Maker World



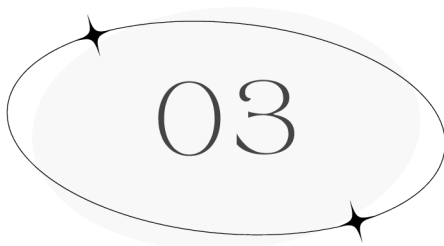
Export the STL file

Once we have designed the 3D model, we must export it in a format compatible with 3D printing: the .stl format. Note: if you decide to download pre-made 3D printing models, make sure they are in .stl format, as it is one of the most compatible with slicing programs.

What is an STL file?



This file represents the geometric shape of the 3D part through a mesh. In other words, it contains the visual information of what we want to print, regardless of the machine we're using. It's the universal format compatible with 3D slicing software (which we'll see in the next step).



Prepare the model in the laminator

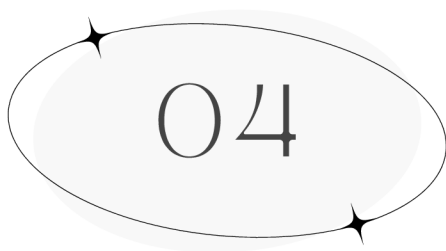
The printer cannot interpret the STL file. To print it, it must be converted into layers and the printing instructions generated. For this, we use a program called a slicer, which transforms the model into a file of instructions (G-code) that the printer can execute.

We suggest some laminating software programs that are free and easy to use:

- Ultimaker Cura
- PrusaSlicer
- Bamboo Studio
- IdeaMaker

In this phase, parameters such as print quality, part infill, and temperature are configured, although many programs include pre-configured profiles that facilitate their use in the classroom.

Session 6 details how to use Ultimaker Cura as an example. These software programs also have online tutorial databases that can facilitate their use.



Generate the G-code print file

Once we have set all the printing parameters, we will easily generate the G-code with the program.

What is a G-code?



This is the file that contains all the instructions the 3D printer will follow step by step to print the part. That is, how to move, when to deposit material, at what temperature to print, speed, etc.

In other words, it is the language that allows the machine to print the object.

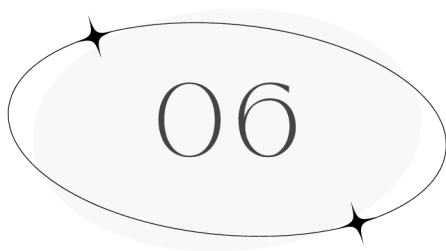
Important note: G-code is unique to each machine. This means that G-code generated for one printer will not work correctly for printing on a different printer, as each machine has its own parameters (such as print volume).



3D print the part

The final step is to send the G-code file to the 3D printer so it can begin printing. Some printers allow you to send these files via Wi-Fi, while others require you to do so through an SD card or USB cable connected directly to the printer.

Printing time can range from a few minutes to several hours, depending on the size of the object and the selected quality.



Post-processing (optional)

Once we have our 3D printed part, we may want to make small adjustments, such as removing supports or improving the finish of the part (by filing, for example).

During this process we recommend taking into account the environmental sustainability practices that are included in session 8.



3D PRINTING

OPERATION FROM A 3D PRINTER

Timing

Part of the session	Description	Duration
Block 1. How a 3D printer works	Parts, axes, movements and printing times	30 min
Block 2. Types of 3D printers	Main technologies and basic differences	15 min

Goals

- Understanding how a 3D printer works at a general level.
- Identify its main parts and their basic function.
- Understanding the system of movement in axes (X, Y, Z).
- Consider printing times as an educational factor.
- Learn about the main types of 3D printers and their differences.

Methodology

The session will be conducted using an expository and participatory methodology. The focus will be on providing a comprehensive understanding of how 3D printing works in a simple, practical, and dynamic way.

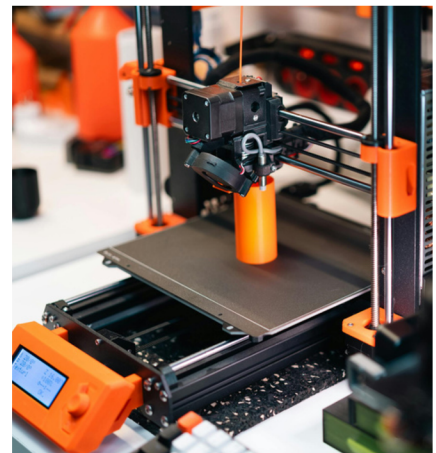
Content development

Block 1. How a 3D printer works

1. Machine parts

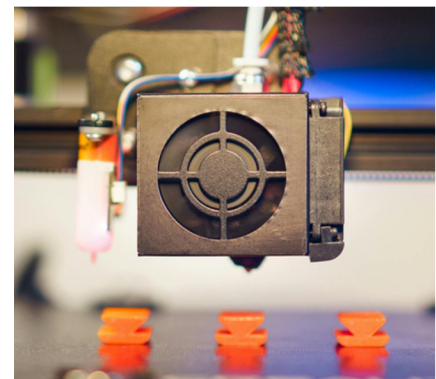
3D printers are made up of various elements/components that work together during the printing process. The design of each printer varies depending on the model, type, and manufacturer. However, they all have some common elements:

Structure: This is the printer's "chassis," responsible for maintaining the machine's stability. The more solid and stable the structure, the fewer vibrations there will be during printing, resulting in a more precise final piece. A solid structure doesn't necessarily mean it's larger, but rather that its components are well-assembled and provide stability during printing.

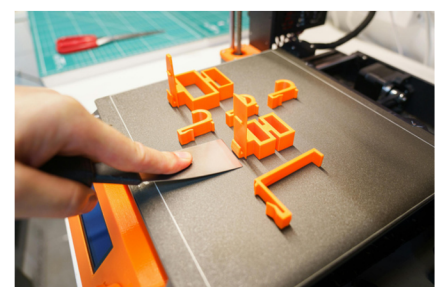


Print head: It is one of the most important parts of the machine and consists of the extruder (the component that extrudes the filament) and the hotend (the component that heats the filament so that it can be extruded).

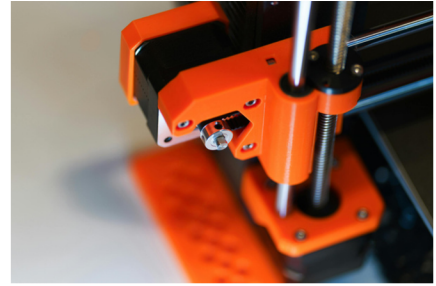
The print head deposits the molten filament following the G-code instructions to print the part layer by layer.



Print bed. This is the surface on which the part is printed. In most 3D printers, it can be heated to improve material adhesion and prevent warping during printing. Warping can occur because the material expands when heated and contracts when cooled. During printing, some areas of the part may cool faster than others, creating stresses that cause corners to lift, for example.



Motors and movement system. They allow the print head and/or bed to be moved on different axes (X, Y, Z) to build the piece layer by layer.



Control panel or display. Allows you to give instructions to the printer, such as starting printing, moving the axes, adjusting temperatures, or checking the printing status.



Control system. This includes all the electronic components and software that coordinate the operation of the machine.

2. Movements and axes of a 3D printer

To print a 3D part, the machine needs to move in different directions within the printing area (the bed). These movements are organized along three axes:

- X: the horizontal movement from left to right.
- Y: horizontal movement forwards and backwards.
- Z: the vertical movement.

3. Printing times

We must keep in mind that 3D printing, although it can be fast, is not instantaneous, and the printing time depends on various factors such as the size of the part, the amount of material and support we use, the height of the part, the printing speed, and the infill density.

In this sense, a print job can take anywhere from a few minutes to several hours. As we'll see later, when you generate the file to print the job (G-code), the slicer software indicates the print time, as well as the filament that will be needed.

Content development

Block 2. Types of 3D printers

Although there are various 3D printing technologies, in this context we will focus on those most common in educational centers due to their accessibility and ease of use.

1. FFF / FDM printers (the most common in education)

FFF (Fused Filament Fabrication) or FDM (Fused Deposition Modeling) printers are the most recommended in educational contexts because:

- They are cheaper.
- Easier to use.
- They use simpler materials.
- Relatively simple maintenance

These printers work by melting a thermoplastic filament (plastic material that can melt when heated and solidify again when cooled) which is deposited layer by layer until the piece is built.

2. Resin printers (SLA / MSLA)

Resin printers use a different technology. Instead of melting filament, they use a photosensitive liquid resin that solidifies under ultraviolet light.

These printers allow for the production of parts with much greater detail and more precise finishes, so they are commonly used for miniatures, precision prototyping, etc. Therefore, the main advantages of these printers are:

- Smoother finishes
- High precision and level of detail
- Useful for small and complex parts
- On the contrary, they have limitations such as:
- They require more maintenance and cleaning.
- The resin requires careful handling.
- It is almost always necessary to perform post-processing of the part.



3D PRINTING

TYPES OF MATERIALS

Timing

Part of the session	Description	Duration
Block 1. Types of filament	Characteristics, uses and differences between PLA, ABS, PETG	30 min

Goals

- Learn about the most common types of 3D printing filament
- Understand the characteristics, advantages, and limitations of each filament.

Methodology

The session will be conducted using an expository and participatory methodology. Theoretical explanations will be combined with the observation of physical filaments and printed pieces made from each filament to highlight the differences.

Content development

Block 1. Types of filament

In this session we will focus on PLA, PETG and ABS filaments:

PLA (POLYLACTIC ACID)

It is a thermoplastic polymer derived from renewable resources such as corn starch or sugarcane. In 3D printing, it is one of the most widely used filaments due to its ease of use and low environmental impact.

For optimal use, it should be printed at relatively low temperatures (between 205°C and 220°C) and a bed temperature between 50°C and 60°C. Therefore, it is easier to use on simpler printers. Furthermore, it has a rapid cooling process, allowing for detailed printing.

The main characteristics of this filament are:

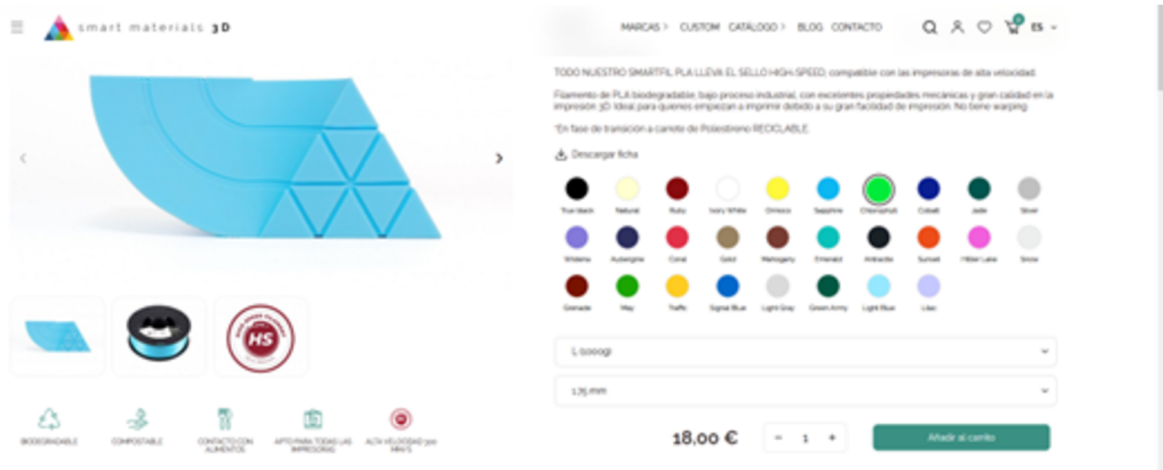
- Biodegradable.
- Rigid and relatively fragile.
- Low contraction, that is, it shrinks little.
- Glossy and smooth surface.

Among the main advantages we find:

- Ease of printing
- Low environmental impact.
- Low extrusion temperature.
- It generates a very low level of emissions and odors during printing, making it more suitable for education.

Among the main limitations we find:

- It has low heat resistance. It deforms at temperatures above 60°C.
- It has less resistance to impacts.
- It is not flexible, meaning it can break under tension.
- It is not suitable for prolonged exposure to sunlight or humid environments.



Fuente: Smart Materials

ABS (Acrylonitrile Butadiene Styrene)

ABS is a thermoplastic polymer (a plastic material that becomes flexible or malleable when heated and solidifies when cooled) derived from petroleum, offering a high level of durability and strength. It is widely used in industrial manufacturing and functional prototypes (casings, supports, etc.). Unlike PLA, it is printed at higher temperatures (between 240°C and 260°C) and with a heated bed between 90°C and 110°C to prevent warping and ensure proper adhesion of the material to the bed.

On the other hand, during printing it may release strong-smelling fumes that require ventilation.

As a fun fact, LEGO pieces are made with ABS.



The main characteristics of this filament are:

- Very tough, hard and rigid material.
- High heat resistance.
- More flexible; can withstand impacts without breaking
- It can deform and shrink when it cools.
- A more matte surface than PLA.
- You can get translucent pieces because it has 91% transparency in its natural state.

Among the main advantages we find:

- Very strong and durable.
- It withstands higher temperatures without deforming.
- Flexible.
- It allows sanding, gluing and post-processing (e.g., using acetone).

Among the main limitations we find:

- It emits vapors.
- Difficult to print for beginners.
- It may shrink when it cools
- It may be less accurate for fine details due to shrinkage.
- Higher cost.



Fuente: Smart Materials

PETG (Polyethylene Terephthalate Glycol)

PETG is a strong and durable thermoplastic filament that is printed at temperatures between 230°C and 250°C, with a heated bed between 70°C and 90°C. It deforms less than ABS and has greater impact resistance than PLA.

The main characteristics of this filament are:

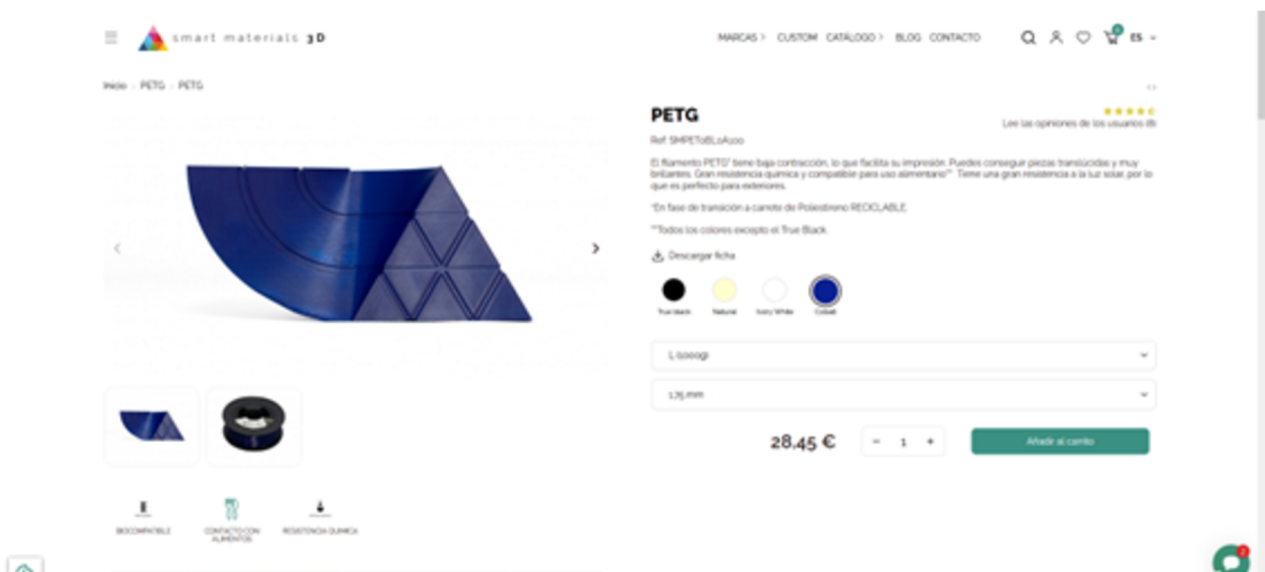
- Translucent, with a glossy finish
- Less ABS contraction
- Stable over time, it does not degrade easily.
- Impact resistant

Among the main advantages we find:

- Easier to print compared to ABS
- Flexible in the face of impacts
- Water and moisture resistant
- Smooth and glossy finish

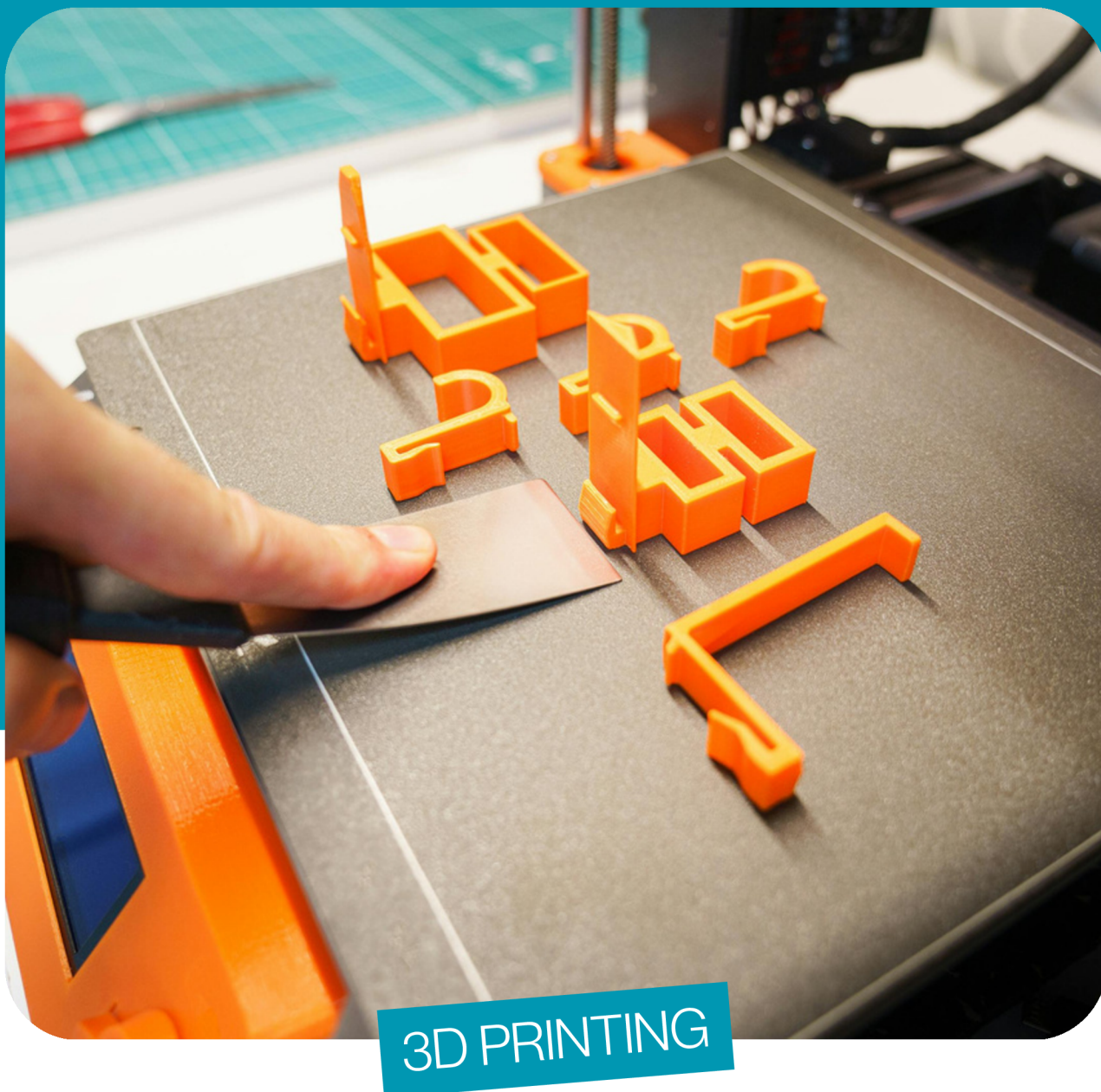
Among the main limitations we find:

- Bed adhesion is more complicated than with PLA
- It is neither biodegradable nor compostable
- Less rigid than PLA



Fuente: Smart Materials

Material	°C	Ease of use	Heat resistance	Emissions	Shrinkage	Sustainability
PLA	205–220	Very easy	Low	Very low	Very low	High
ABS	240–260	Difficult	High	High	High	Low
PETG	230–250	Medium-high	Medium	Low	Low	Medium



PREVENTION OF RISKS

Timing

Part of the session	Description	Duration
Block 1. Risk prevention in 3D printers	Identifying risks and guidelines for action in the classroom	40 min

Goals

- Understanding the importance of safety in the educational use of 3D printers.
- Identify the main risks associated with the use of 3D printers in the classroom.
- Learn about basic prevention measures applicable in a Techlab environment.
- Promote the responsible, safe and sustainable use of technology in the classroom.

Methodology

The session will be conducted using an expository methodology focused on real-world situations in the Techlab. It will combine simple explanations with case studies highlighting potential pitfalls when using an FFF 3D printer in the classroom.

Content development

Block 1. Risk prevention in the use of 3D printers

The use of 3D printers in Techlab technology labs offers many educational opportunities in the STEM field. However, it is important to be aware of the main risks that may arise and how to prevent them to ensure a safe environment for students and teachers.

This isn't about creating alarm or suggesting that 3D printers are dangerous or difficult to use; they won't explode or cause serious problems under normal conditions. It's simply important, as with any classroom tool, to know some basic usage rules to work safely and avoid minor risks that can be easily prevented.

On the other hand, we want you to keep in mind that the recommendations we make in this training session are of an indicative and preventive nature, based on the usual educational use of a 3D printer in the Techlab.



It is important that:

- Please review the technical data sheets and safety data sheets (SDS) of the materials used
- Follow the printer manufacturer's safety instructions
- Comply with current regulations regarding occupational risk prevention and center safety

The educational center and the teachers in charge of using the 3D equipment are responsible for implementing these measures.

What risks should we be aware of?



There are five risks we will focus on:

- Mechanical. Those related to the moving components of the printer, such as the print head, the bed, or the movements of the different axes.
- Thermal. Those associated with the temperatures of components such as the nozzle, filament, and bed.
- Electrical. Those related to the electrical and electronic connections of the printer.
- Chemicals. Those related to gas emissions or odors during printing due to the use of certain filaments.
- Environmental. Those derived from the generation of waste and plastic remains if they are not managed properly.

MECHANICAL RISKS

Possible risks:



- Head strike in motion.
- Printer will fall if accidentally pushed.
- Slight pinch when inserting the hand during printing.
- Put your finger on the extruder.
- Touch the moving fans.

How can we prevent them?



- It is important to explain to students that they should not touch the printer while it is running (for example, to prevent them from putting their hands in the printing area). This preventative measure, as we will see, applies to virtually all risks.
- When printing is complete, it is important to wait a few minutes before removing the part or touching the machine.
- Maintain a safe distance
- Always place the printer on a stable surface. In other words, avoid tables that are not sturdy or wobble.

THERMAL RISKS

Possible risks:



- Burns can occur when touching the nozzle. Depending on the filament used, the nozzle will be at a different temperature. This temperature can range between 180°C and 260°C.
- Burns from touching the heated bed. This surface is not as hot as the nozzle, but it can reach 50°C (in the case of PLA).
- Burns when touching the molten filament.

How can we prevent them?



- It is important to explain to the students that they should not touch the printer while it is running (prevent them from putting their hand, for example, in the printing area).
- When printing is complete, it is important to wait a few minutes before removing the part or touching the machine.
- Use tools such as tweezers to touch the filament or clean the nozzle
- Removal of pieces preferably by the teacher
- Inform students about the hot items and the importance of not touching them.

ELECTRICAL HAZARDS

Possible risks:



- Damaged cables
- Improper handling
- Liquid spill near the printer
- Cramps

How can we prevent them?



- If any of these things happen, the first thing we should do is immediately turn off the machine and notify the manufacturer.
- Unplug the machine from the power outlet
- Do not place liquids nearby, such as open glasses or bottles that may fall and cause electrical failures.
- Visually check the condition of the power cord.
- It is important to explain to the students that they should not tamper with the printer connections.

CHEMICAL RISKS

Here we find two main risks: from gas emissions and from particle emissions.

Due to gas emissions

We must bear in mind that, although it is not an immediate risk, there is no risk of sudden poisoning and using appropriate materials the risk is very low, when we print a 3D part, the filament heats up and can emit small gases and volatile compounds into the air.

Therefore, we recommend that you review the characteristics that the manufacturer indicates for the material.

In addition, we recommend using PLA, as it emits very low levels, generates fewer odors, and is safer in educational settings.

Possible risks:



- Discomfort caused by odors
- Stagnant air in enclosed spaces
- Prolonged exposure without ventilation

How can we prevent them?



- Use PLA as the main material
- Maintain natural ventilation of the classroom
- Avoid printing for many consecutive hours in unventilated spaces.
- Do not place multiple printers in small, unventilated spaces
- If using polymers such as ABS, place the machine in a secure chamber protected with filters that capture chemicals from the air.

Due to particle emission

The risk of particles arises during post-processing. That is, once the 3D printing is complete, we may need to make adjustments to the part, such as filing or sanding.

This process produces fine particles that can get into our eyes, we can transport them to other places (on our hands for example if we touch something else), or we can even ingest them without realizing it.

How can we prevent them?



- Use EPI
- Wear masks
- Wear glasses
- Wear gloves
- Pay attention to the cleanliness of the space. We recommend vacuuming.

ENVIRONMENTAL RISKS

The use of 3D printers can have an environmental impact if the materials and waste generated during the printing process are not properly managed. In addition, some plastic materials are not biodegradable and require proper waste management.

Possible risks:

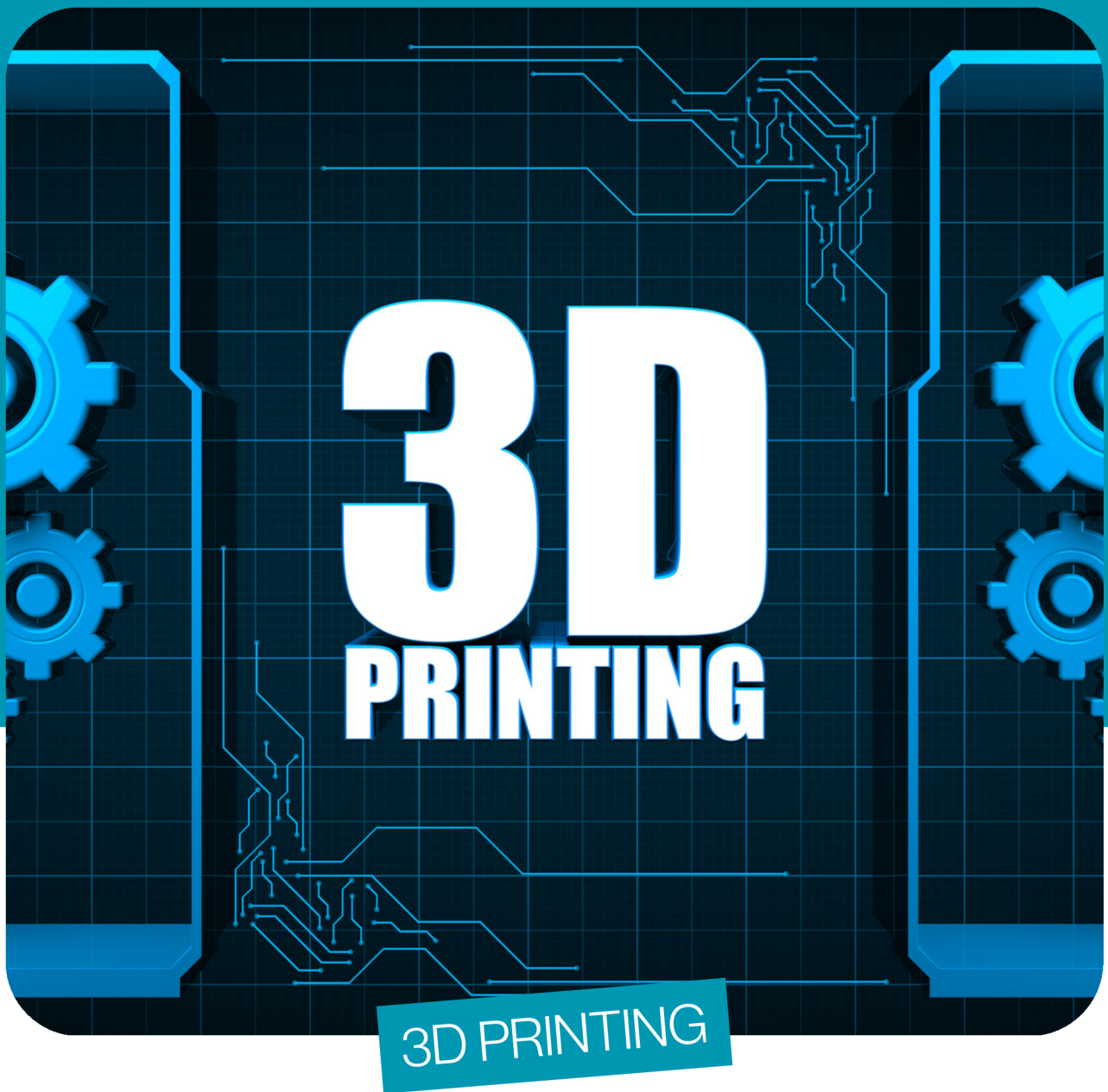


- Accumulation of plastic waste
- Environmental pollution due to poor waste management
- Classroom dirt
- Scattering of small pieces or fragments

How can we prevent them?



- Have a specific container for 3D printing waste
- Encourage the reuse of failed parts whenever possible
- Keep the workspace clean and tidy
- Clean the space by vacuuming to avoid the displacement of particles.
- Clean with a damp cloth/paper and store in a plastic bag to avoid polluting the air.
- Collect the remains after each session
- Use more sustainable materials whenever possible (such as PLA)
- Avoid printing unnecessary or non-educational materials
- Reuse materials whenever possible through material collection programs (see next section).



TOOLS

3D DESIGN

Timing

Part of the session	Description	Duration
Block 1. Free software and advantages for educational institutions	Explanation of what free software is, its characteristics and advantages for schools.	15 min
Block 2. How to use FreeCAD step by step	Practical and guided explanation on the use of FreeCAD	60 min

Goals

- Understanding what free software is.
- To understand the advantages for the educational center and the inclusion of students with disabilities.
- Learn to use FreeCAD software for 3D design focused on the implementation of Techlabs.

Methodology

The session will be conducted using an expository and participatory methodology. Theoretical explanations will be combined with step-by-step guided practice, enabling teachers to understand how to use the free software FreeCAD for 3D design.

During the session, active participation will be encouraged, promoting their acquisition of autonomy in the basic use of this software.

Content development

Block 1. Free software and advantages for educational institutions

Free software is software whose source code can be studied, modified, used, copied, and distributed freely for any purpose.

According to the Free Software Foundation (FSF), “Free software is software that gives the user the freedom to share, study, and modify it. We call it free software because it is free for the user.” [1]

According to Richard Stallman, founder of the Free Software Foundation (FSF) and the free software movement, software, to be considered free, must have four essential freedoms[2]:

- Purpose: The software can be used for any purpose without licensing restrictions or geographical limitations. Therefore, all users can use the software on any system and for any purpose without the obligation to notify an owner.
- Distribution: The software can be shared and copied at no cost, with or without modifications.
- Study: anyone can study how the software works.
- Modifications: The software can be modified by any user, as well as sharing the modified versions.

[1] Free Software Foundation. (n.d.). What is free software and why is it so important for society? Retrieved [fecha de consulta], from <https://www.fsf.org/about/what-is-free-software>

[2] Free Software Foundation. (n.d.). The Free Software Definition. GNU Project. Retrieved November 7, 2025, from <https://www.gnu.org/philosophy/free-sw.en.html>

If we're talking about open source... is it the same thing?

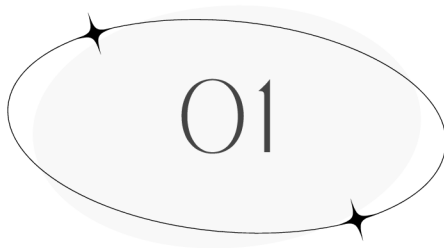
Although they are often used interchangeably, they don't mean exactly the same thing. The main difference lies in their philosophy and objectives. While free software is based on an ethical and social vision whose main goal is to guarantee the freedom to use, study, modify, and share the software, open source focuses on practical aspects and the advantages of having code available to improve software quality, innovation, and technical cooperation, leaving aside the ethical component.

What are the main advantages of using free software in Techlabs for educational centers?

- Free access. The primary advantage is that this software doesn't represent an extraordinary cost for educational institutions. Therefore, you can use it without depending on contracts or commercial plans from external companies.
- Inclusion. The use of this type of software allows everyone to use it inside and outside the classroom, eliminating economic and technological barriers and allowing all students to participate and learn on equal terms.
- Active learning. In line with the above advantages, the use of this type of software allows all students to explore, modify and create 3D designs, developing key and transversal skills.
- Collaboration. While not an exclusive advantage of free software, its use allows students to share and work as a team, promoting the acquisition of key skills.
- Creativity and Innovation. Like the previous advantage, this is not exclusive to free software, but it is a significant advantage, since being able to test new ideas and translate their creativity into tangible goals promotes their motivation and brings them closer to science and technology in a dynamic, practical way that is key to their learning.

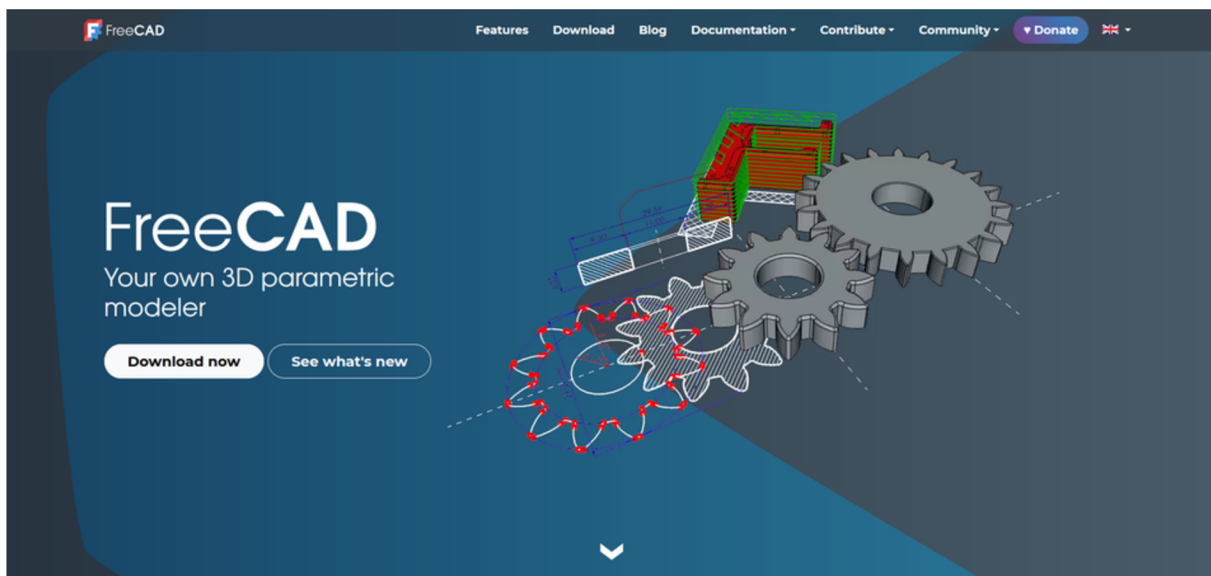
Block 2. How to use FreeCAD step by step

FreeCAD is a free and open-source 3D model design software that offers tools to produce, export, and edit fully accurate solid models, export them for 3D printing or CNC machining, create 2D drawings and views of your models, perform analyses such as finite element analysis, or export model data such as quantities or bills of materials.

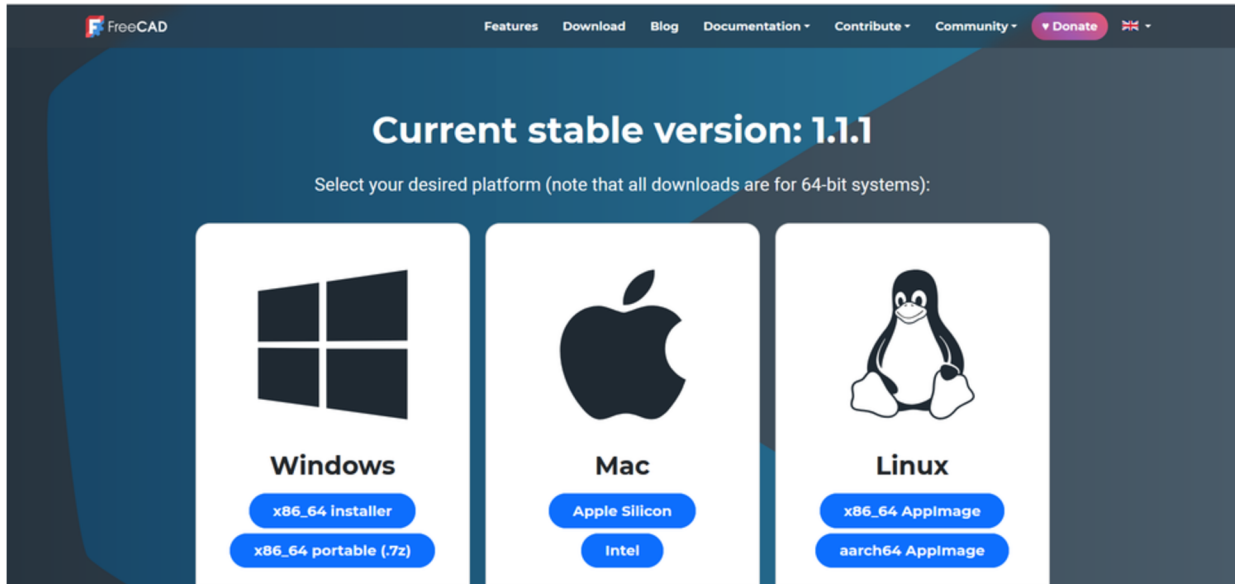


Install the software

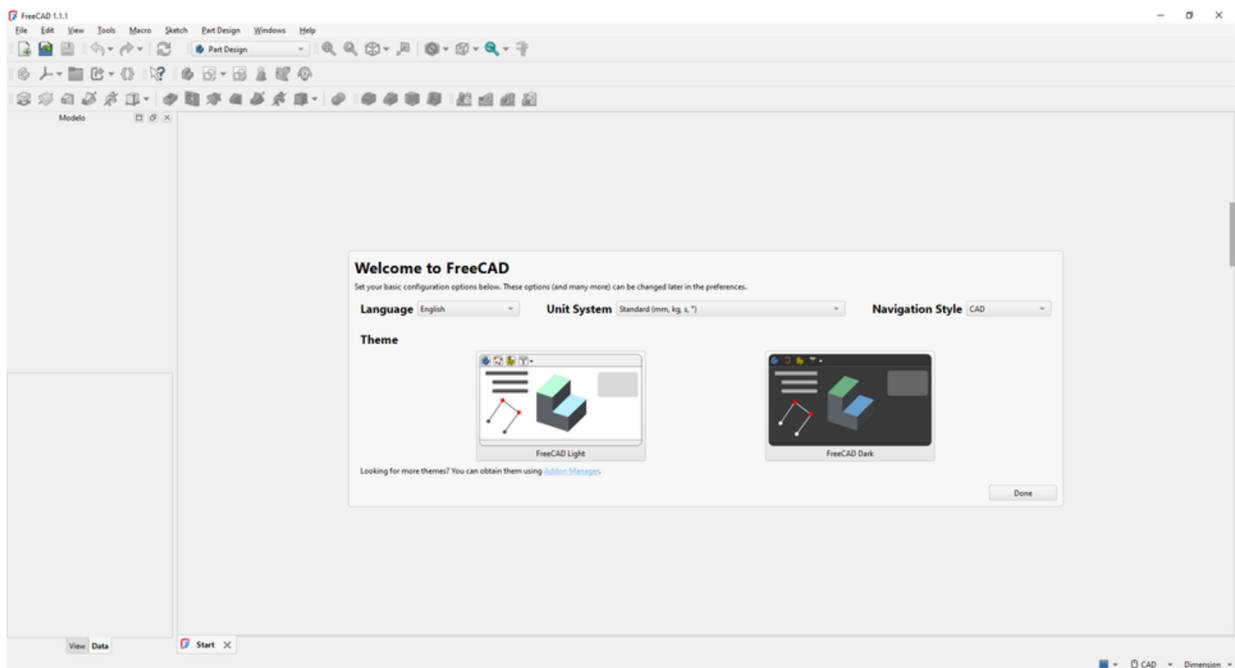
The first step will be to install the software on the computers at the center or on our laptop. To do this, we will need to access the official FreeCAD website, from where we can download the version most suitable for our computer (Windows, macOS, Linux).

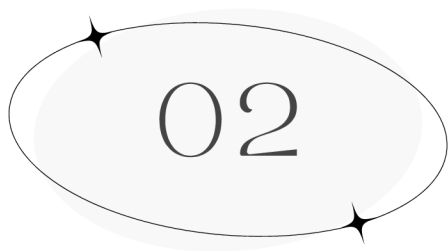


From the homepage, the first thing we see is the software download link. If we click on “Download now,” we will automatically be redirected to the download page where we can choose our operating system.



The download will start automatically. Once the download is complete, open the downloaded program and follow the installation steps. When finished, open the software directly and select the language:



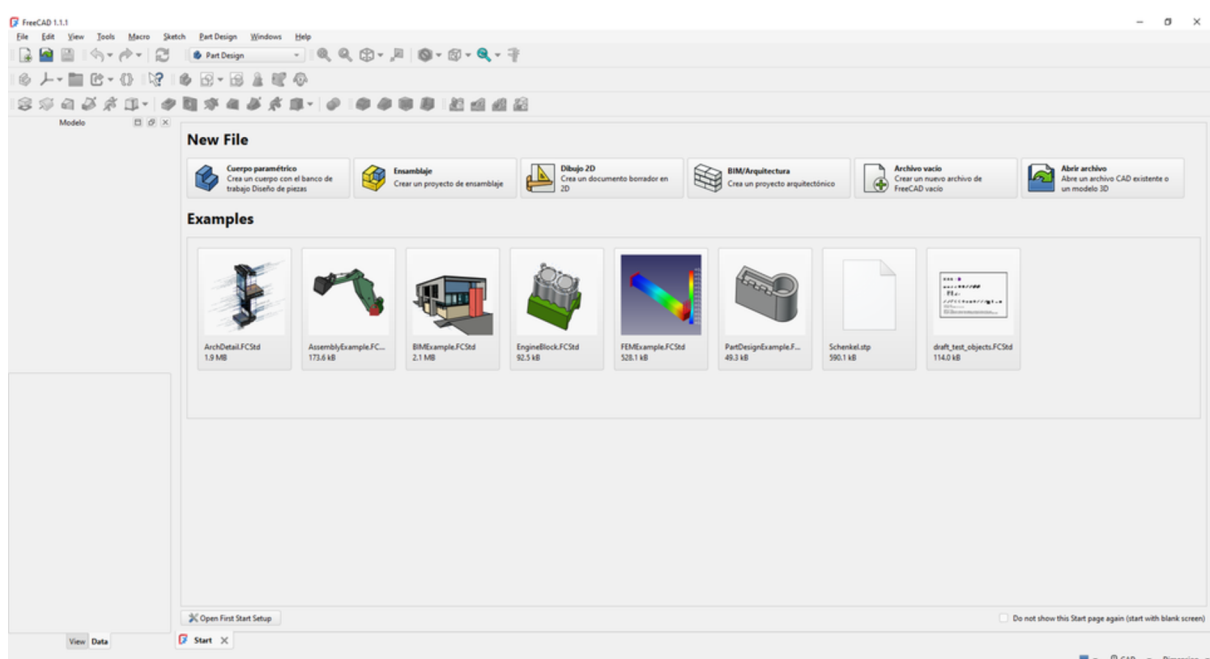


How to get started using the software

When you open the program, a window appears with several options for creating a new file:

- Parametric modeling. This is the most common option for 3D design. From here, you can create solid parts and modify them. It's the best option for creating parts for Techlab, as it's an environment designed for creating 3D parts step by step. Each part is built from measurements and rules without templates or predefined models.
- Assembly. This is used to put together several pieces and see how they fit together. It's useful when we have several parts of the same item and want to check that they work well together.
- 2D drawing. Allows you to create plans and diagrams. For example, to show exact measurements of a part in a PDF.
- BIM/Architecture. It allows the design of circuits or architectural structures.
- Empty file. You open a new, empty project, with no structure or active environment.
- Open file. Allows you to open a previously saved project.

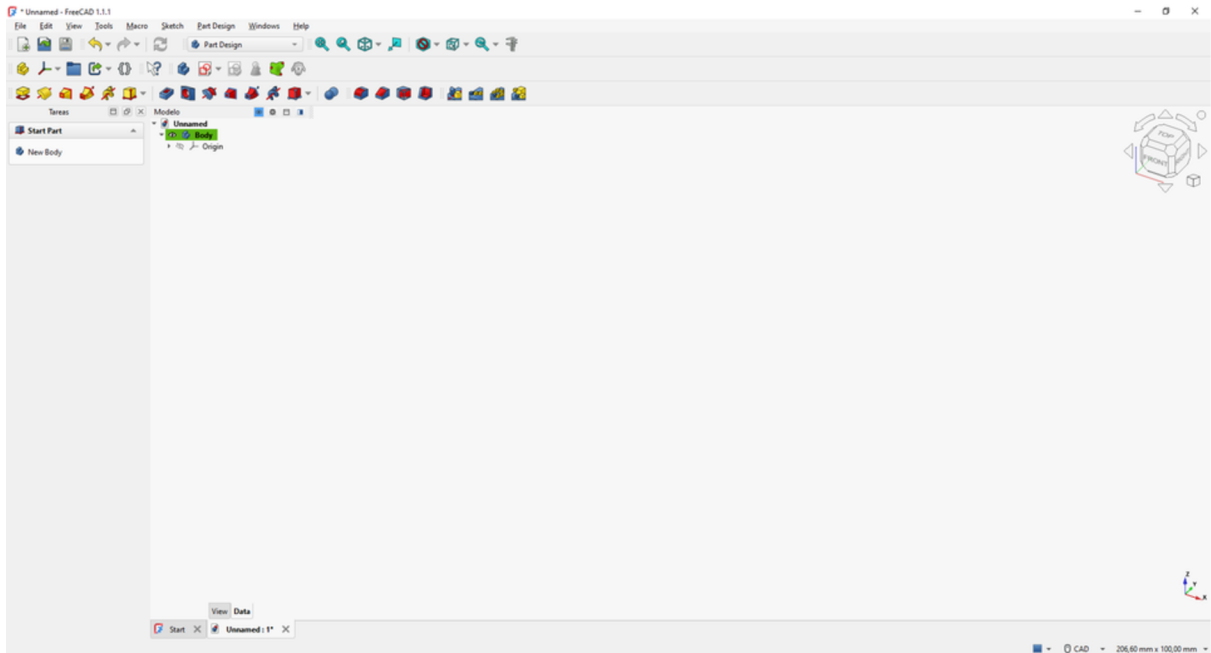
Below we can see examples offered by FreeCAD of various files that we can open to see how the models are made.





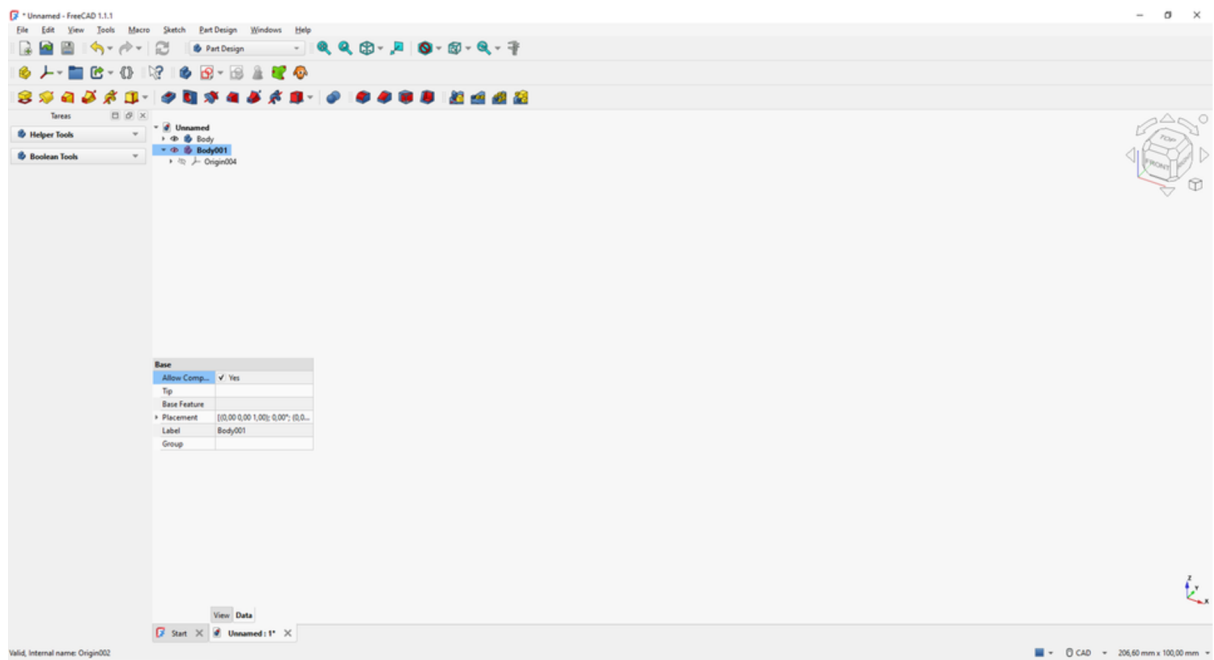
Creating our first 3D model

Let's begin by clicking on "Parametric Part", after which the following screen will appear:



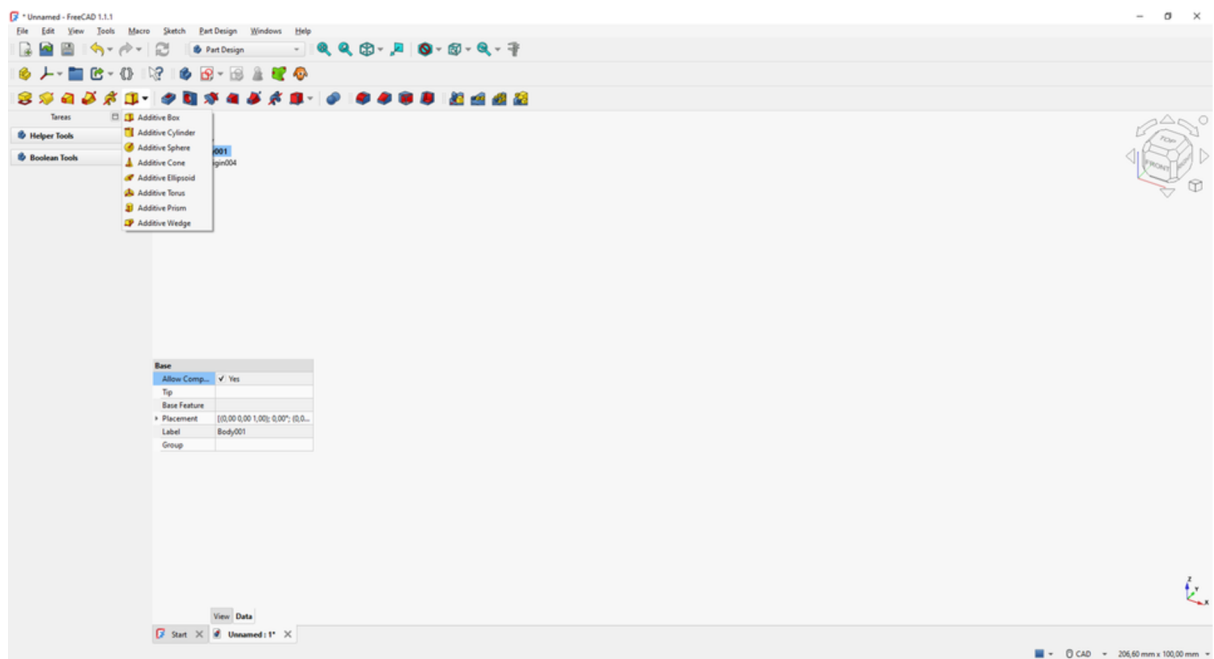
The first thing we see is an empty space with a toolbar at the back and a sidebar on the left where we find "Tasks" (shows the steps you can take) and "Template" (shows the goal tree of your project).

The first thing we're going to do is create a body. This will allow us to work on a new part. First, we'll select "new body." The body is the "part container" where sketches and modifications are saved.

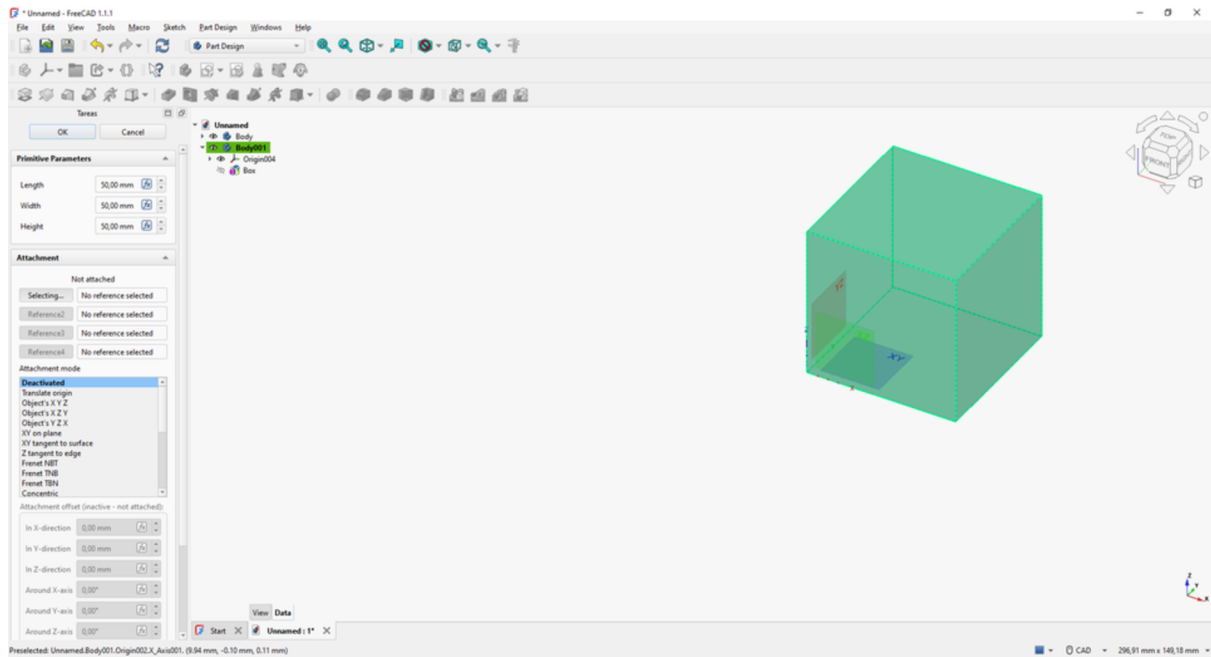


Now, within that body we have to create a sketch, which will then become our 3D piece.

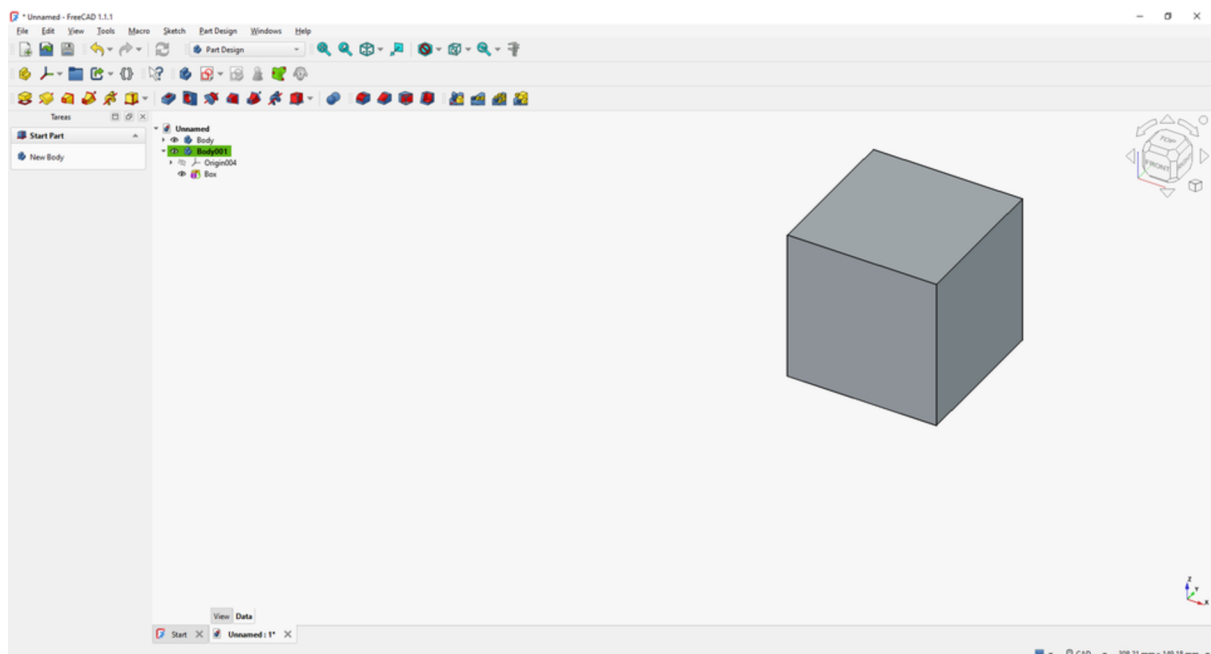
Next, we select the "Creates an additive primitive" button, that is, a predefined basic shape: cube, cylinder, sphere, cone...



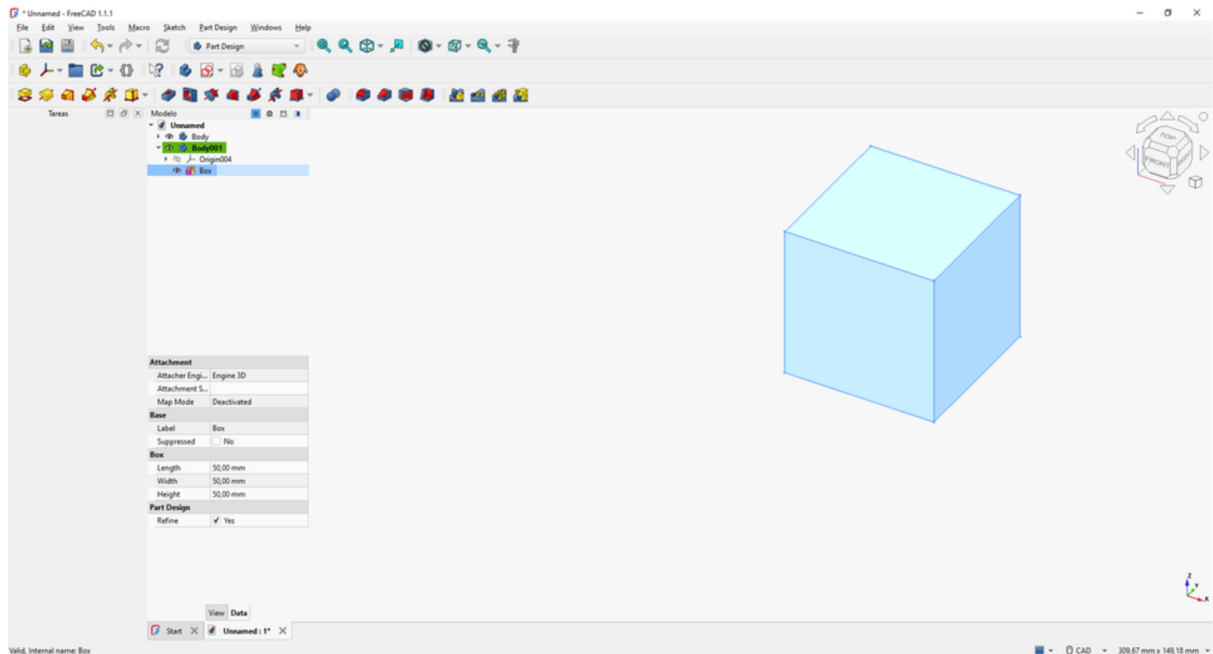
We select "cube" to begin and enter the desired dimensions (length, width, and height). For example: 50mm x 50mm x 50mm



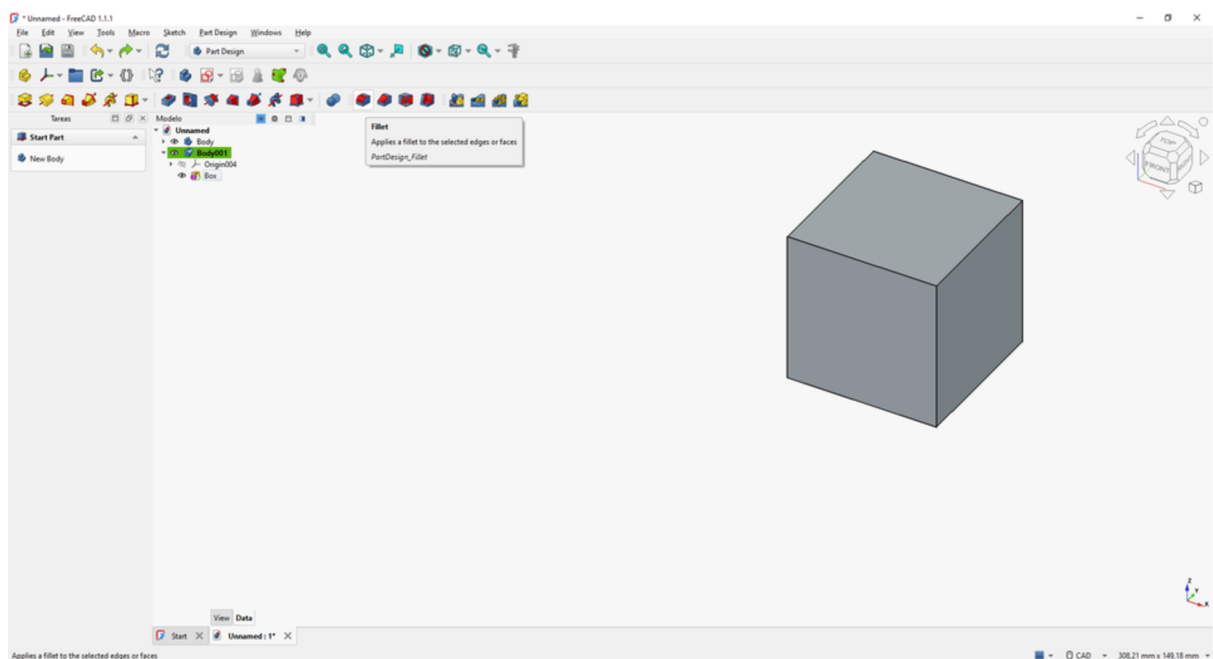
Clicking "ok" will display the 3D block in the main view and the "Model" sidebar will appear inside the body.



Once created, if we want to modify the dimensions we can do so by selecting “Box” in the sidebar and a properties tab will appear below where we can make the modifications we want.

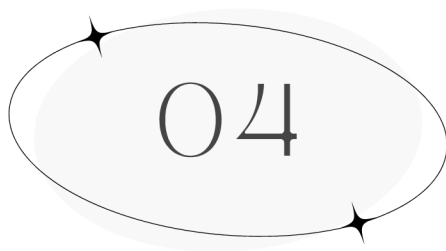


We can also make modifications such as rounding corners from the top toolbar:



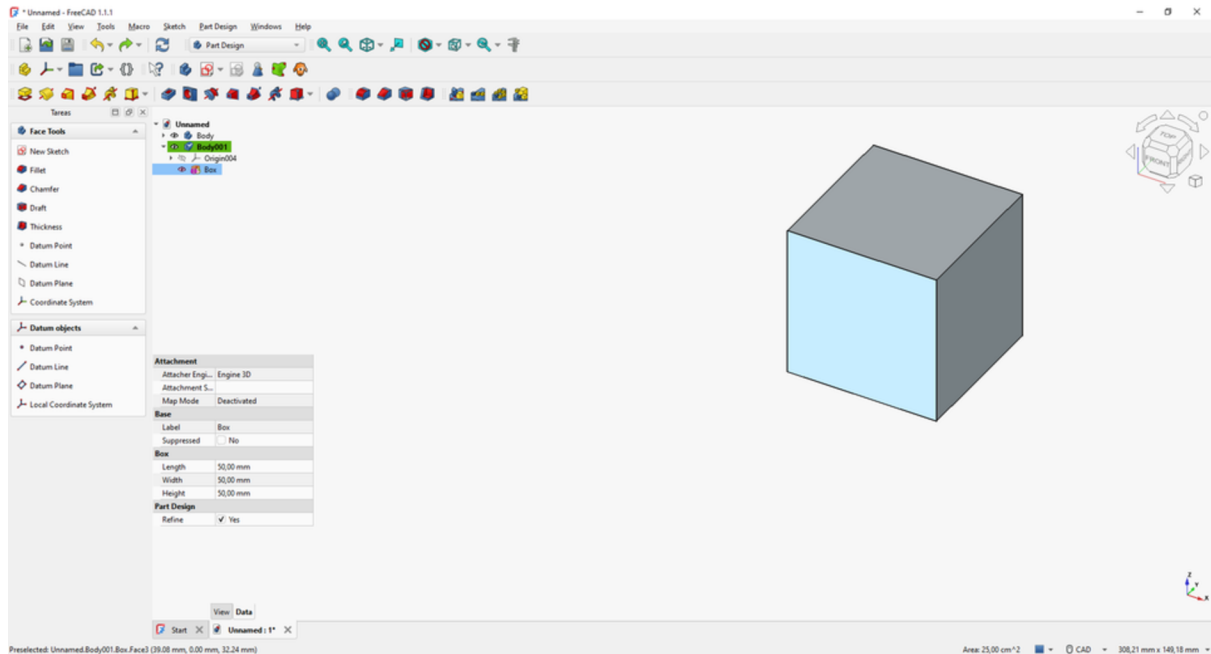
Make a hole or create another primitive shape (like a cylinder) inside our cube, change the thickness, etc.

Now is the time to explore and think about how we want our piece.



Check the part

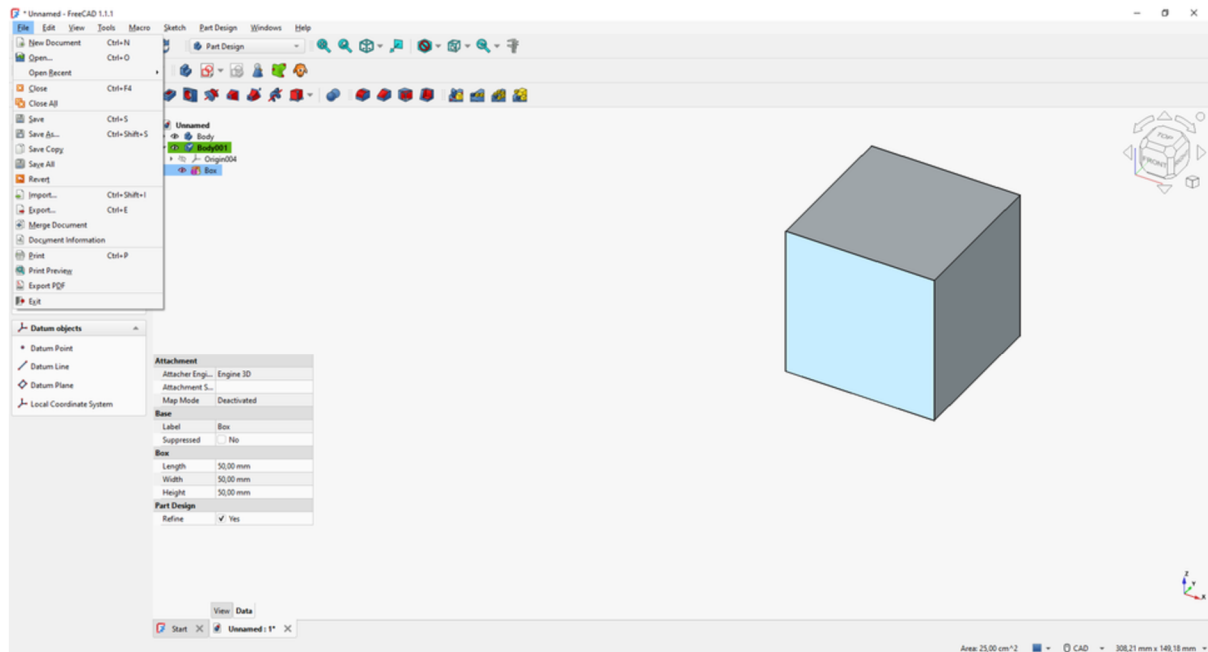
Rotate the piece in 3D view and make sure all the modifications look the way you want, as well as verifying that the measurements are correct.

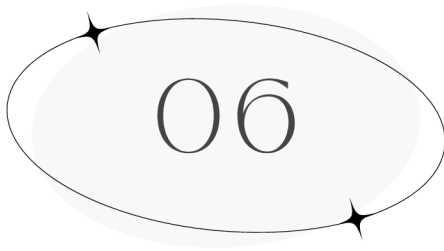




Save the FreeCAD project

Go to File – Save, and give your project a name. This way you can open it later and continue modifying it.

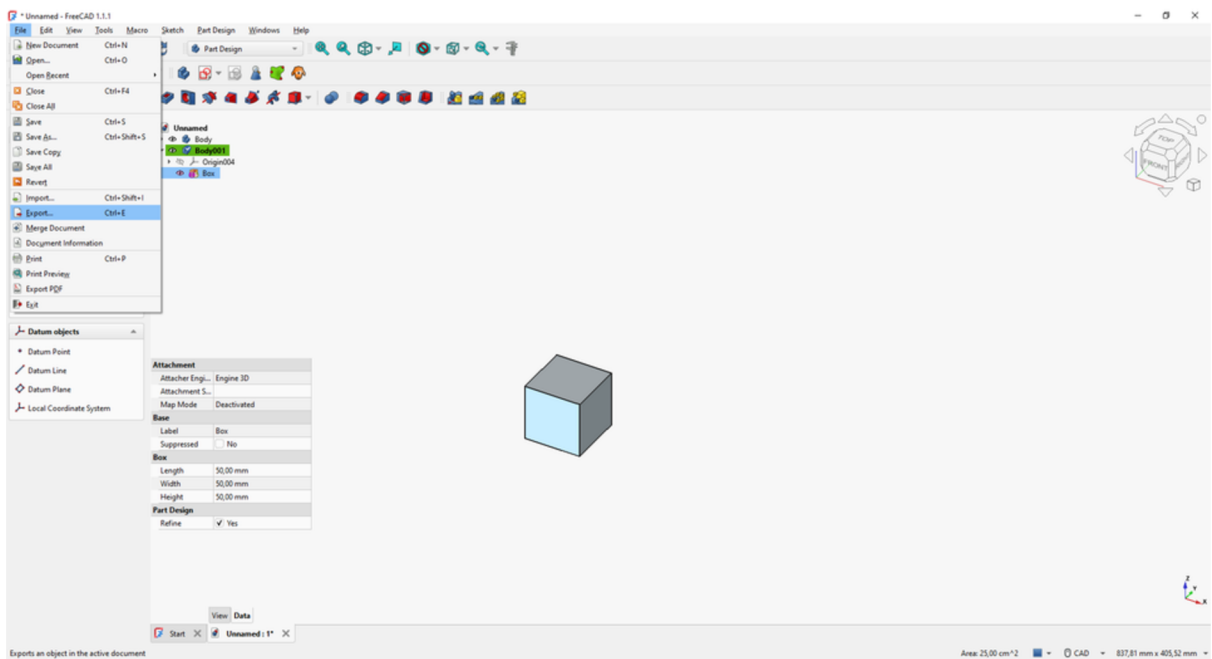




Export for 3D printing

If you already have the final part to print on the Techlab 3D printer:

- Select the final piece in the "Model" sidebar.
- Go to file – export
- Choose STL format
- Save the file





TOOLS

FOR 3D LAMINATION

Timing

Part of the session	Description	Duration
Block 1. How to use Ultimaker Cura	Practical and guided explanation on the use of CURA: installation, interface, slicing, G-code creation	60 min

Goals

- Learn to use Ultimaker Cura software for 3D slicing focused on the implementation of Techlabs.

Methodology

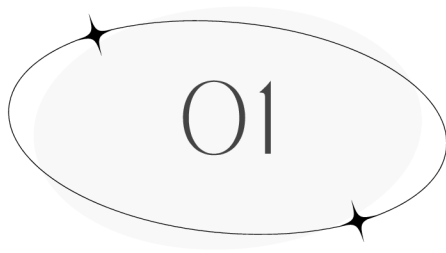
The session will be conducted using an expository and participatory methodology. Theoretical explanations will be combined with step-by-step guided practice, enabling teachers to understand how to use the ULTIMAKER CURA software for 3D slicing.

During the session, active participation will be encouraged, promoting their acquisition of autonomy in the basic use of this software.

Content development

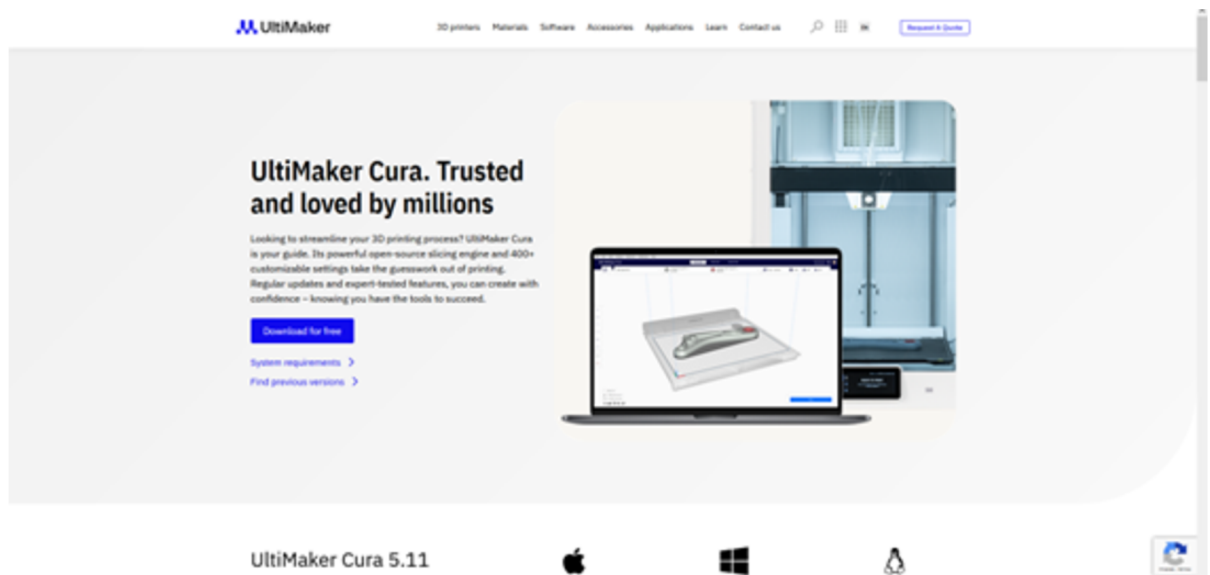
Block 1. How to use Ultimaker Cura

Ultimaker Cura is a free and open-source software designed for 3D printers, in which printing parameters can be modified to transform them into G-code and directly print three-dimensional objects on a 3D printer.

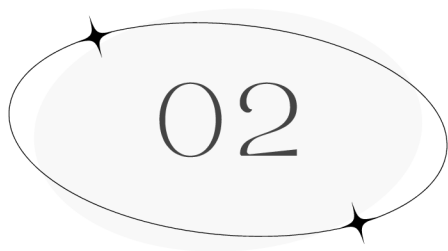


Install the software

The first step is to install Ultimaker® cura on your computer. To do this, go to the official website and download the installer, which is available for Windows, macOS, and Linux.



Once the installation file has been downloaded, we must run it and follow the steps it indicates.

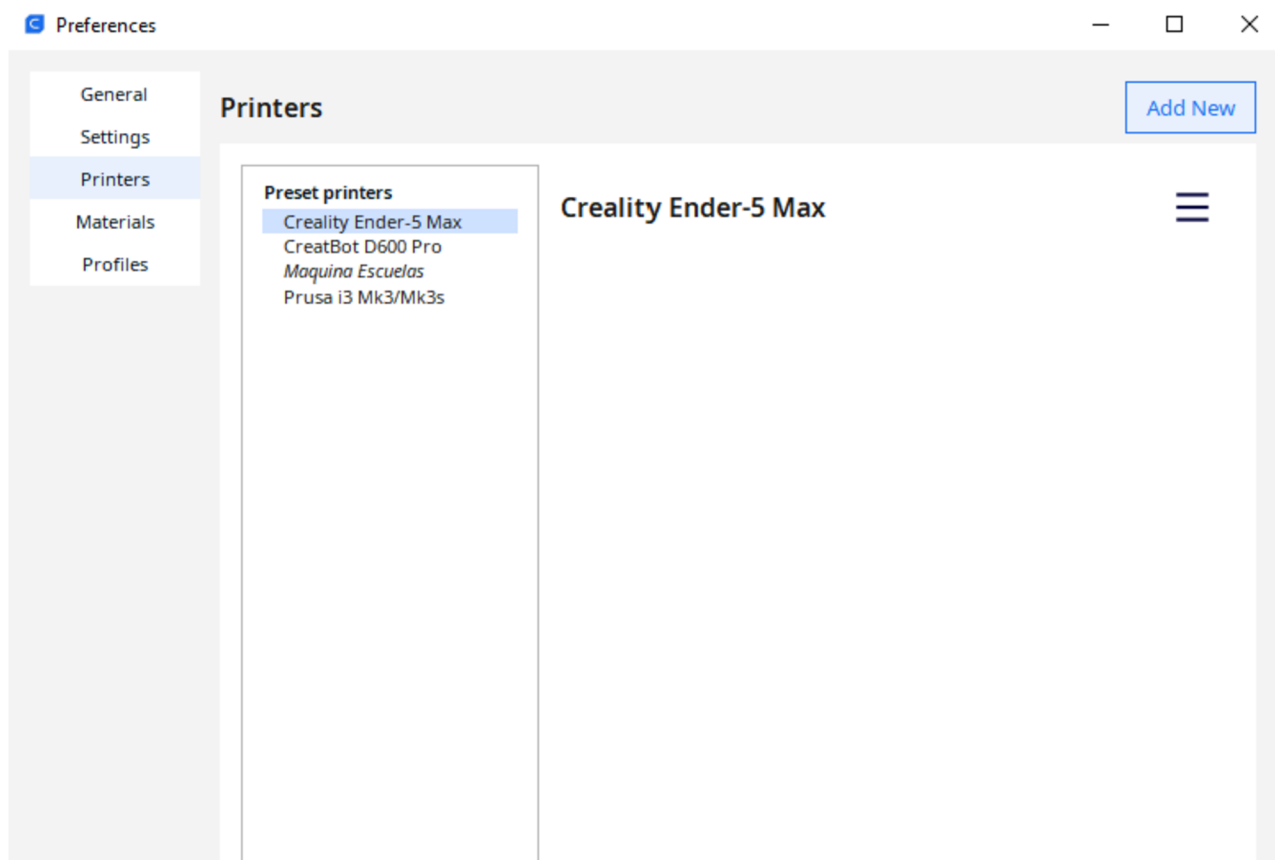


Initial setup

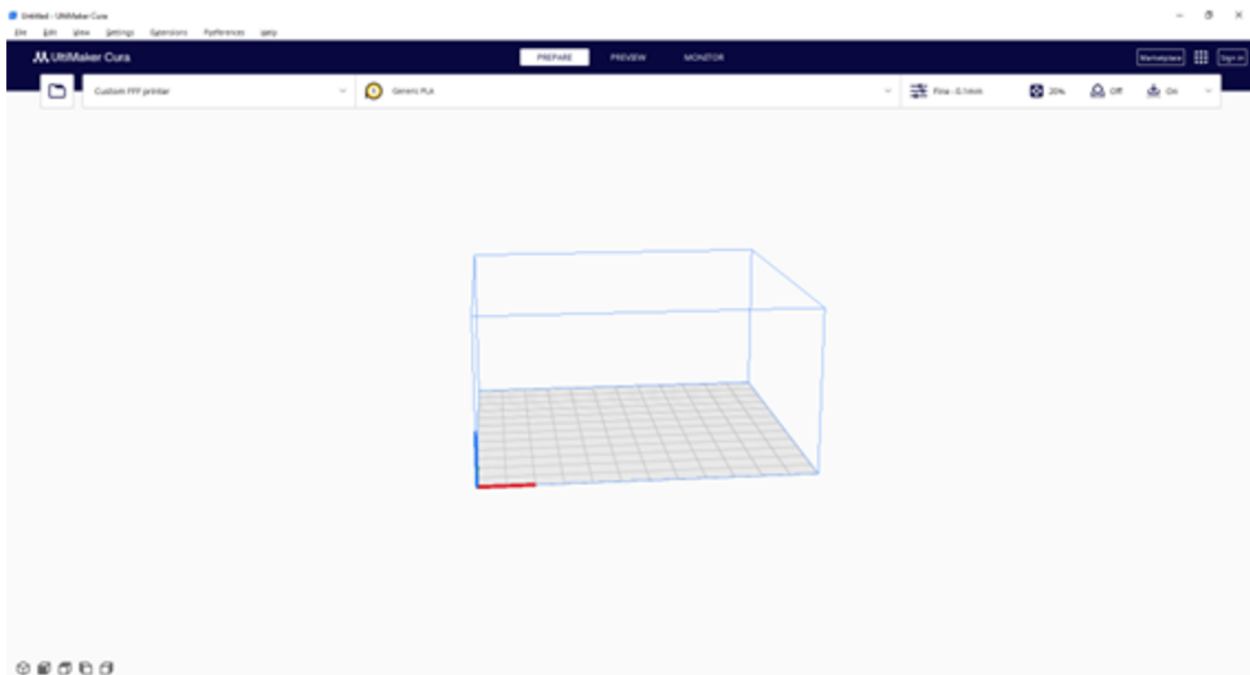
The first time you open the software it asks for basic information such as language or printer, allowing you to create the profile that controls the generation of a G-code.

G-code is the language that 3D printers read and has step-by-step instructions for the actions it will perform to print the desired part.

The most important part is selecting a printer.



The program shows us a representation of its printing surface

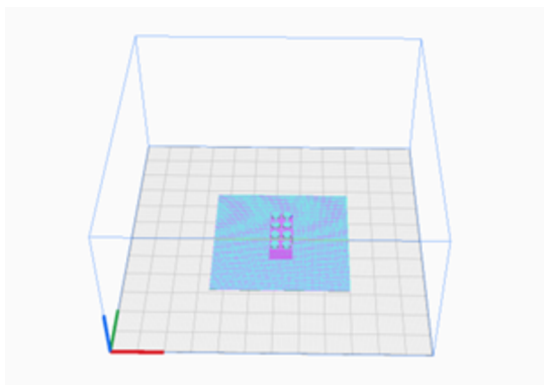




Understanding the interface

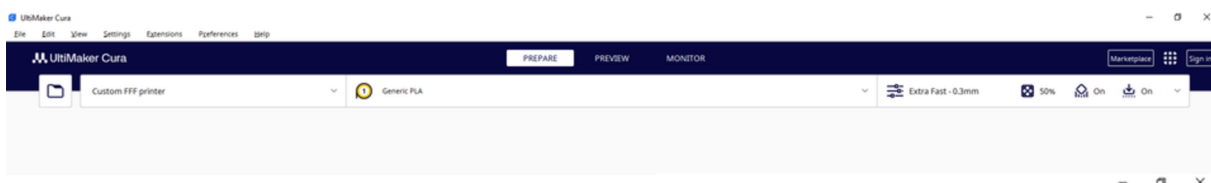
the

Central area: simulates the printer bed, where we place our part.

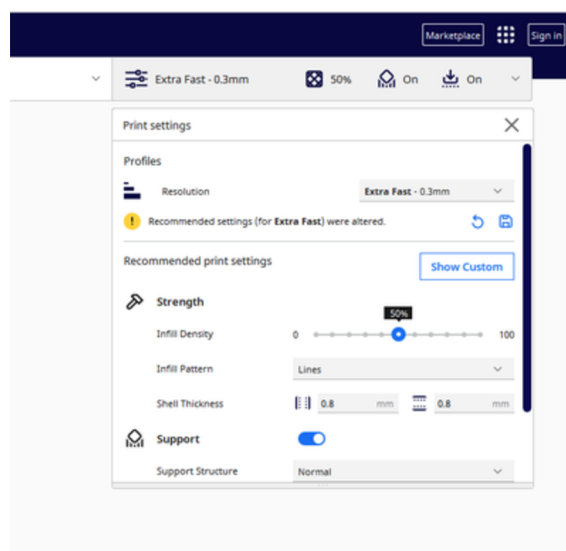


Toolbar: From here you can open new files, export them, set Cura preferences...

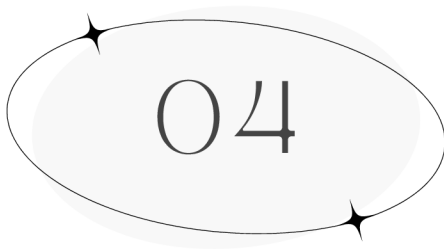
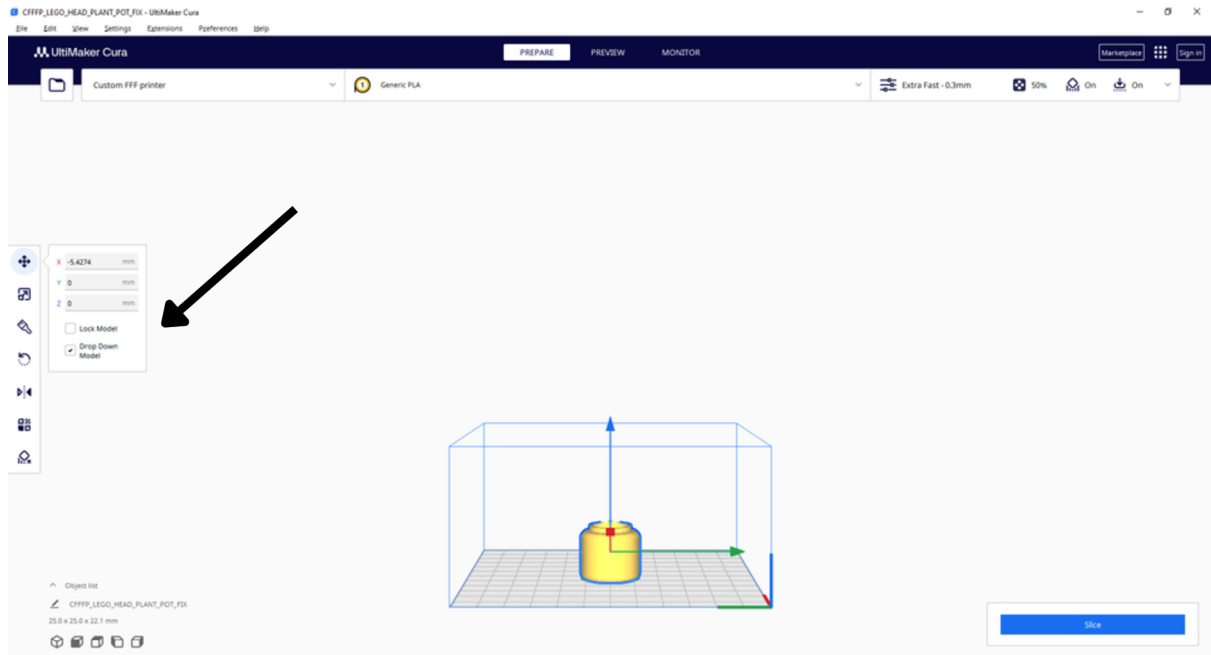
Top bar: From here you can prepare and preview the print target.



Top right panel: allows us to make printing adjustments (layer height, infill, support, adhesion...)



Left panel: These are the basic tools for the object we are going to print (move, scale, rotate, duplicate, etc.). They are only active when the object is selected.



Import the 3D model

Keep in mind that there are different formats, but the most common are STL or OBJ. First, we need to import the file. To do this, we can simply drag and drop the file into the central area, or we can use the toolbar:

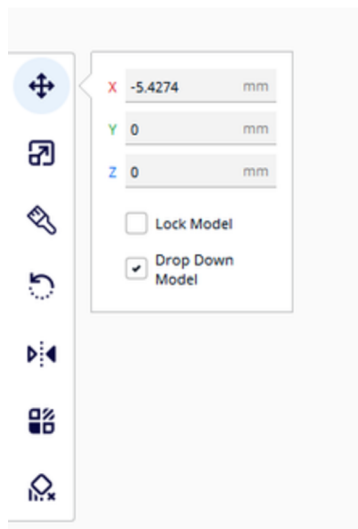
File > Open File > Select File



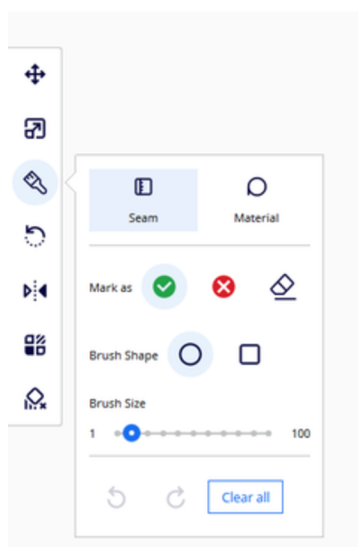
Object settings

In the left panel we can make adjustments to the object, such as moving, rotating, scaling it...

Move: The first icon allows you to move the target in X, Y, Z.



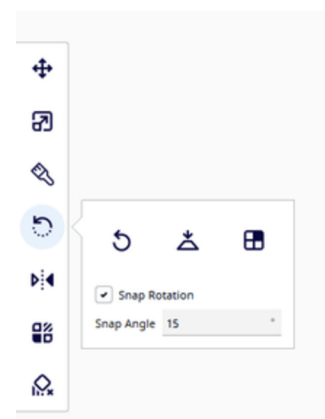
Paint: the third icon allows you to paint on the piece the areas where you want support and those where you don't.



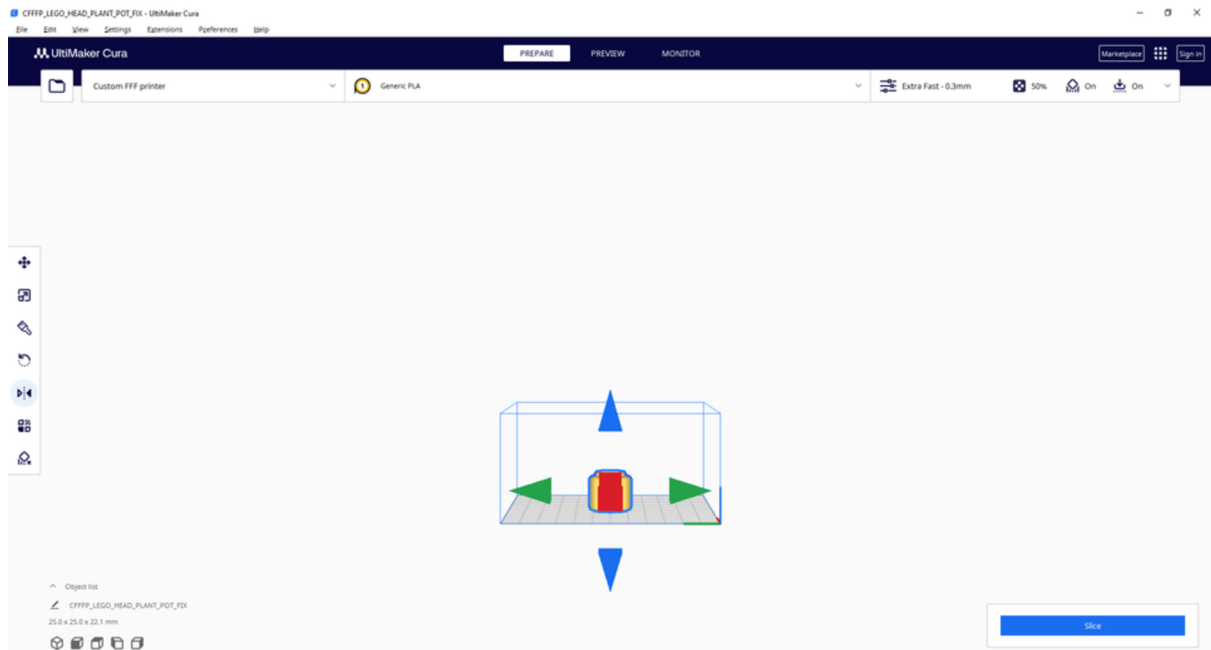
Scaling: allows you to change the size of the object. Keep in mind that if you scale a shape, any tolerances you have specifically designed will be altered when you scale the piece.



Rotate: allows you to rotate the part on its base. Positioning the part is very important to optimize printing. Imagine you want to print a T; if you print it vertically, you'll need a lot of support material. If you rotate it 180° or place it horizontally, you save on support material and time.

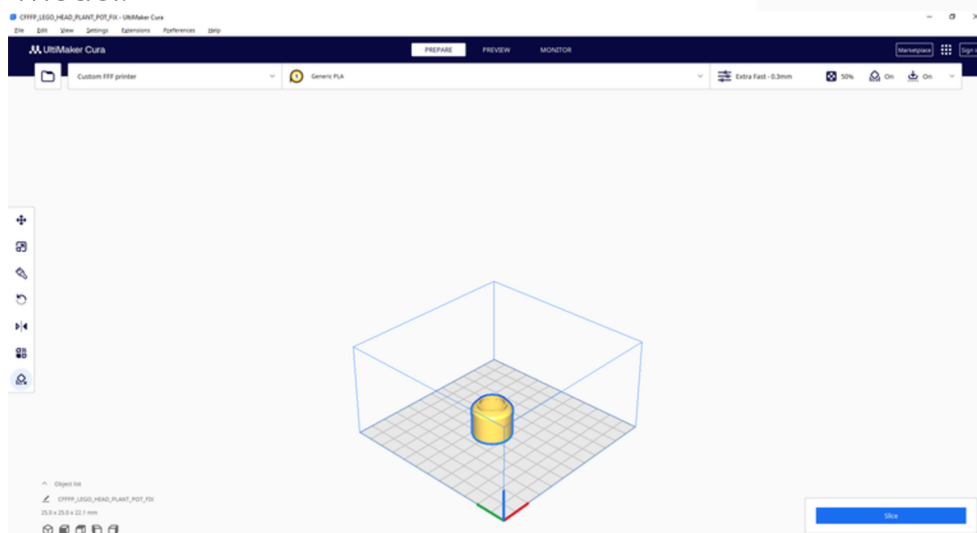


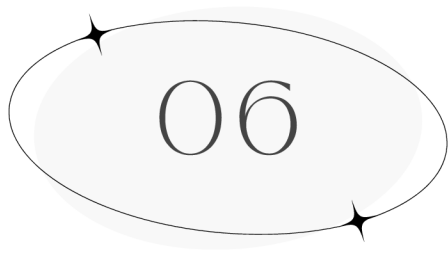
Mirror: The fifth icon is used to reflect the object across one or more axes. In other words, you can create a mirror image. This is very useful when you have one side of the object and want to generate a version of the other side.



Per model settings: the sixth icon allows you to configure different settings for each object within the same print bed without affecting the rest.

Support blocker: the seventh and final icon is used to prevent supports from being generated in specific areas of the model.





Print settings

- Quality / Layer height: This is the thickness of each layer (mm). Lower layer height results in more detail but longer printing times.
- Printing speed: mm/s.
- Infill: interior structure. There are various patterns, such as lines, grids...
- Supports: These are the structures that serve as support for cantilevered elements.
- Bed adhesion (Build plate adhesion): It has 3 options: Bri, (to prevent the part from deforming in parts with little support surface), Skirt (test extrusion before starting), Raft (adds a full base for difficult parts).
- Temperature: This refers to the temperature of the extruder and the bed. These values depend on the filament, as we've seen in previous sessions.

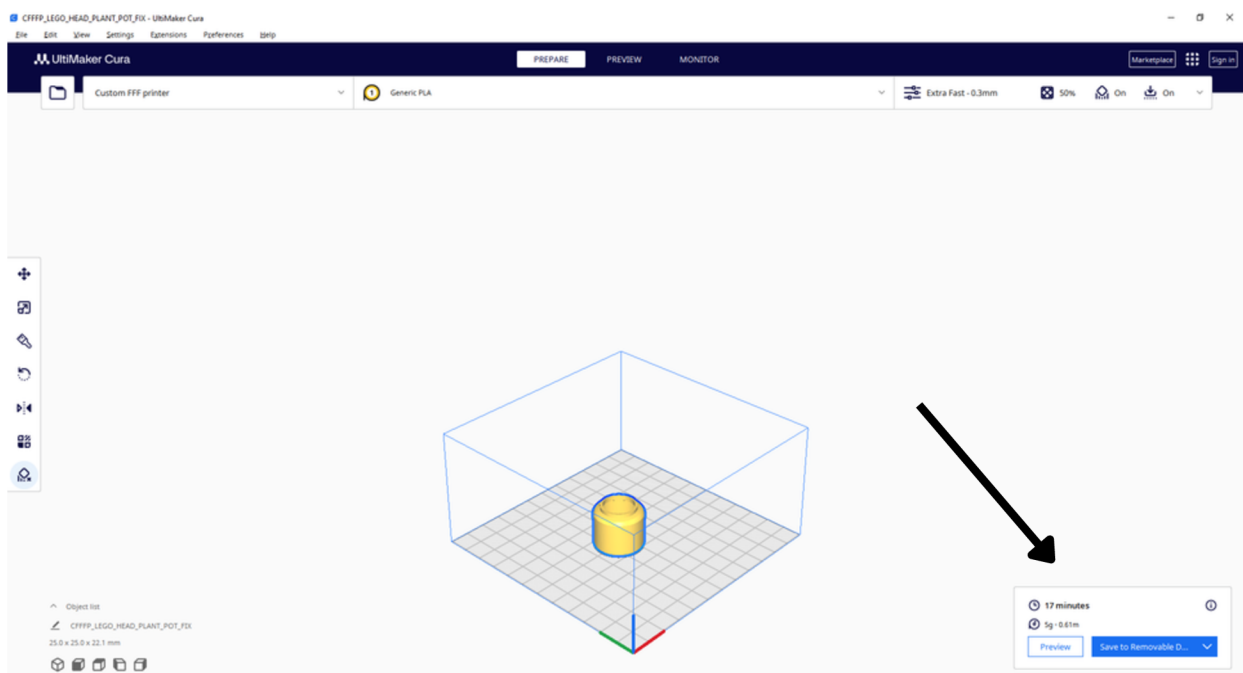


Preview and verification

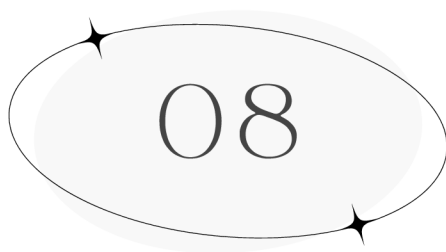
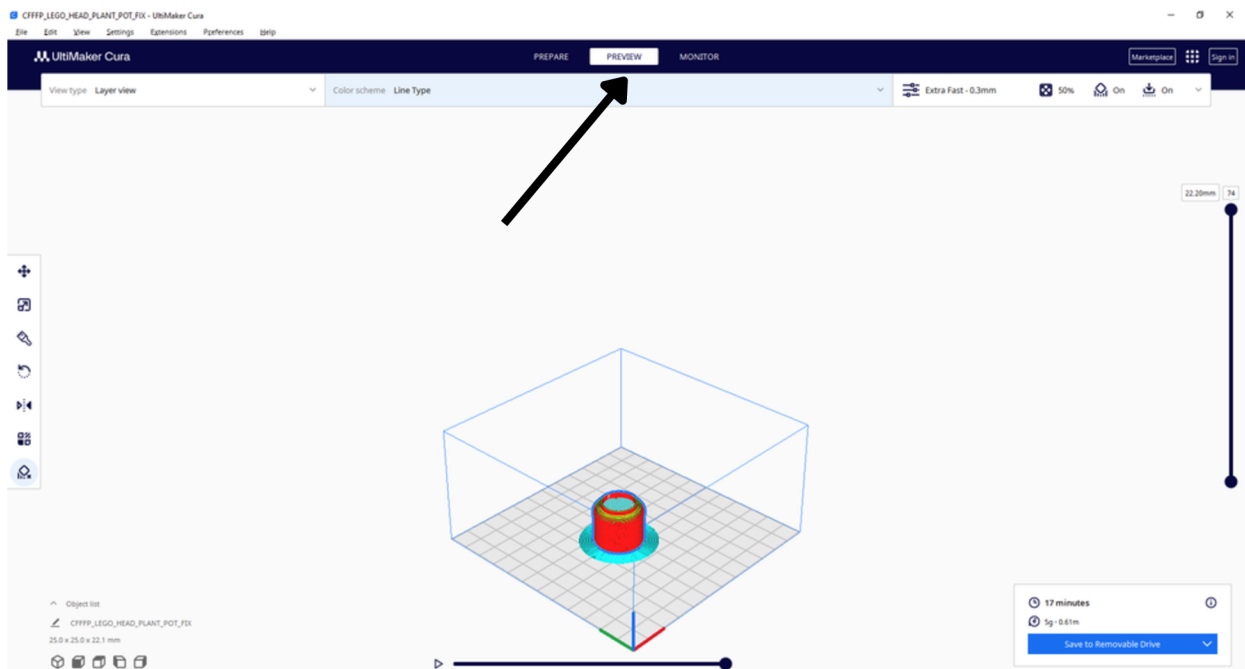
Before creating the G-code file, we must review the layers to avoid surprises, save time and filament, which will allow us to be more environmentally sustainable.

To do this:

- Click on “Slice”. This will allow you to calculate routes, time, and quantity of material.



- Preview. In the top bar, click "Preview" to preview all layers and check for errors. You can view each layer individually using the right sidebar.

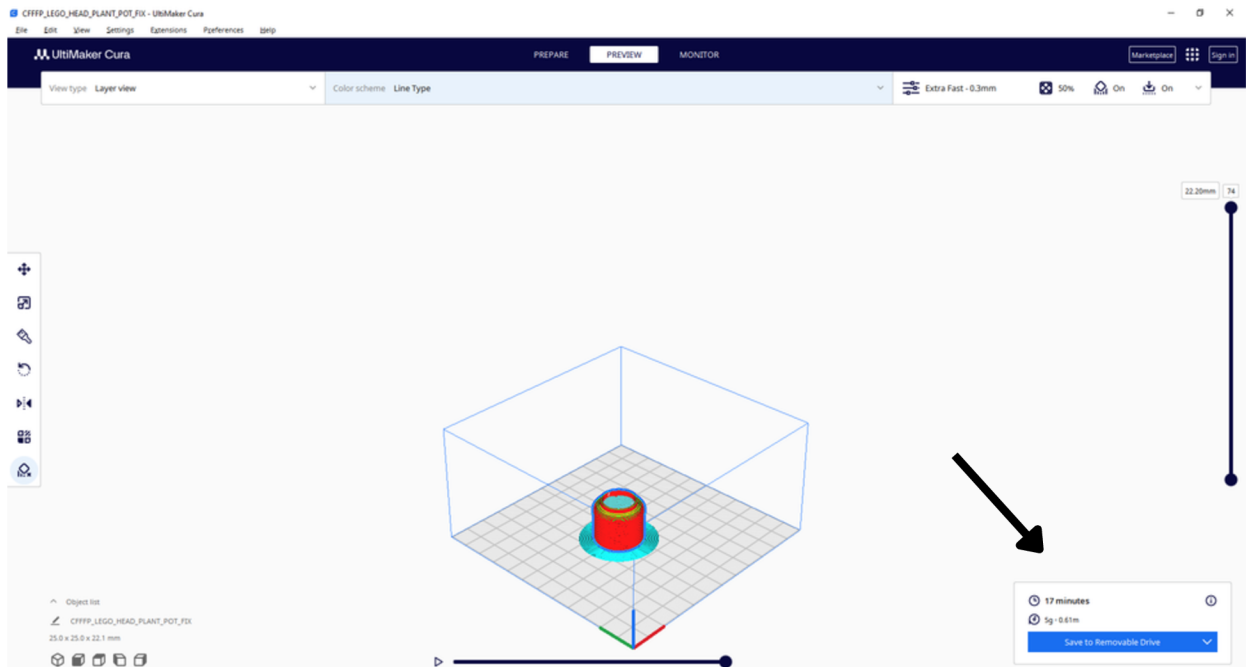


Export G-code

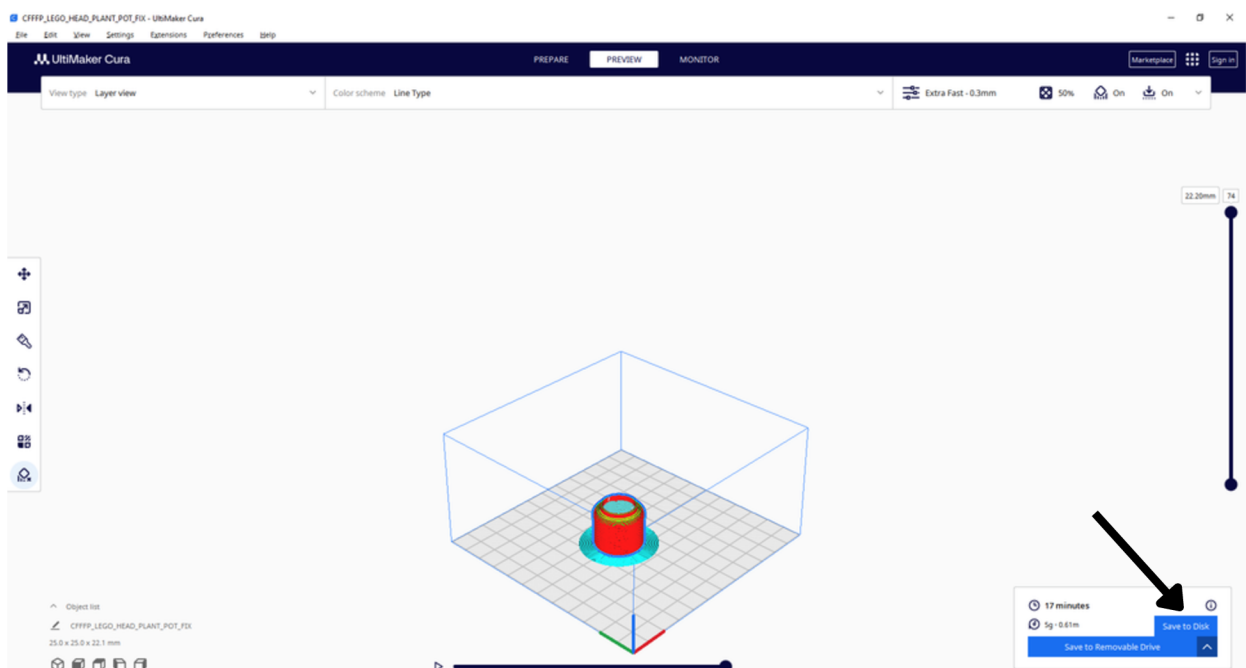
As we have discussed, G-code is the instruction language that 3D printers use to know exactly what to do: where to move, at what speed, how much material to deposit, at what temperature to work, etc.

To generate it, we must:

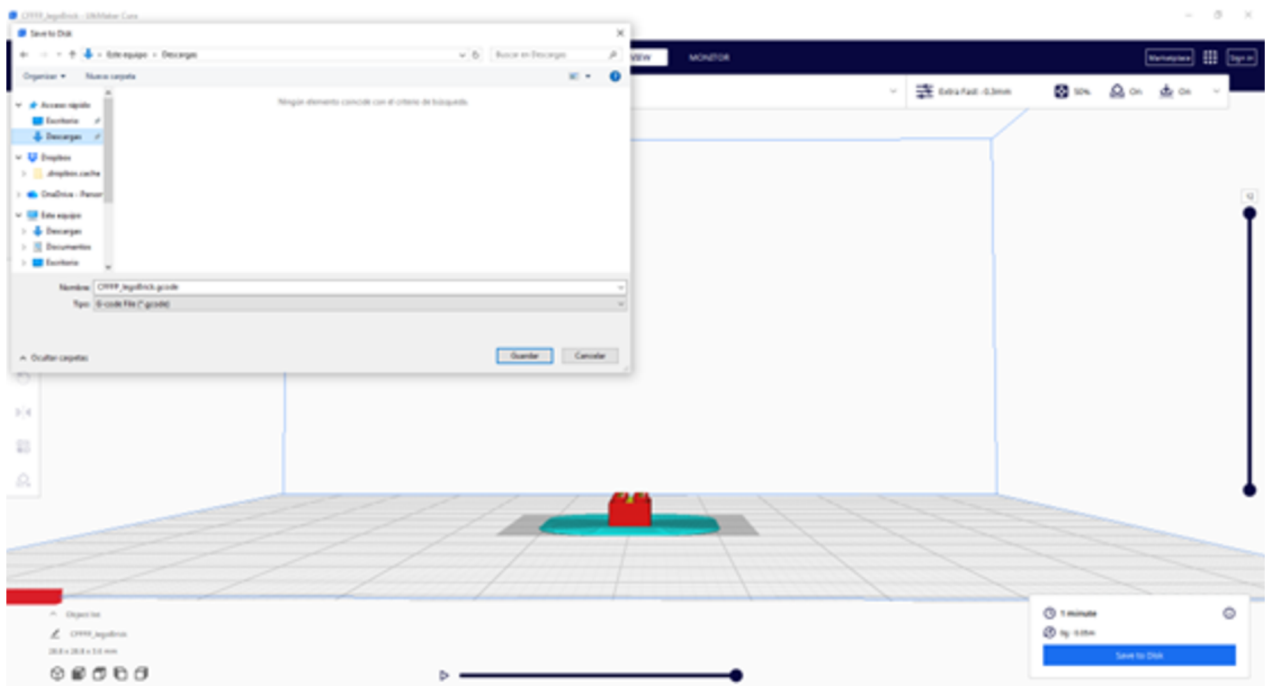
- Click on “Slice”. After completing the previous step, it will show you the printing time and the amount of filament you will use.



- Haz click en “save to disk”.

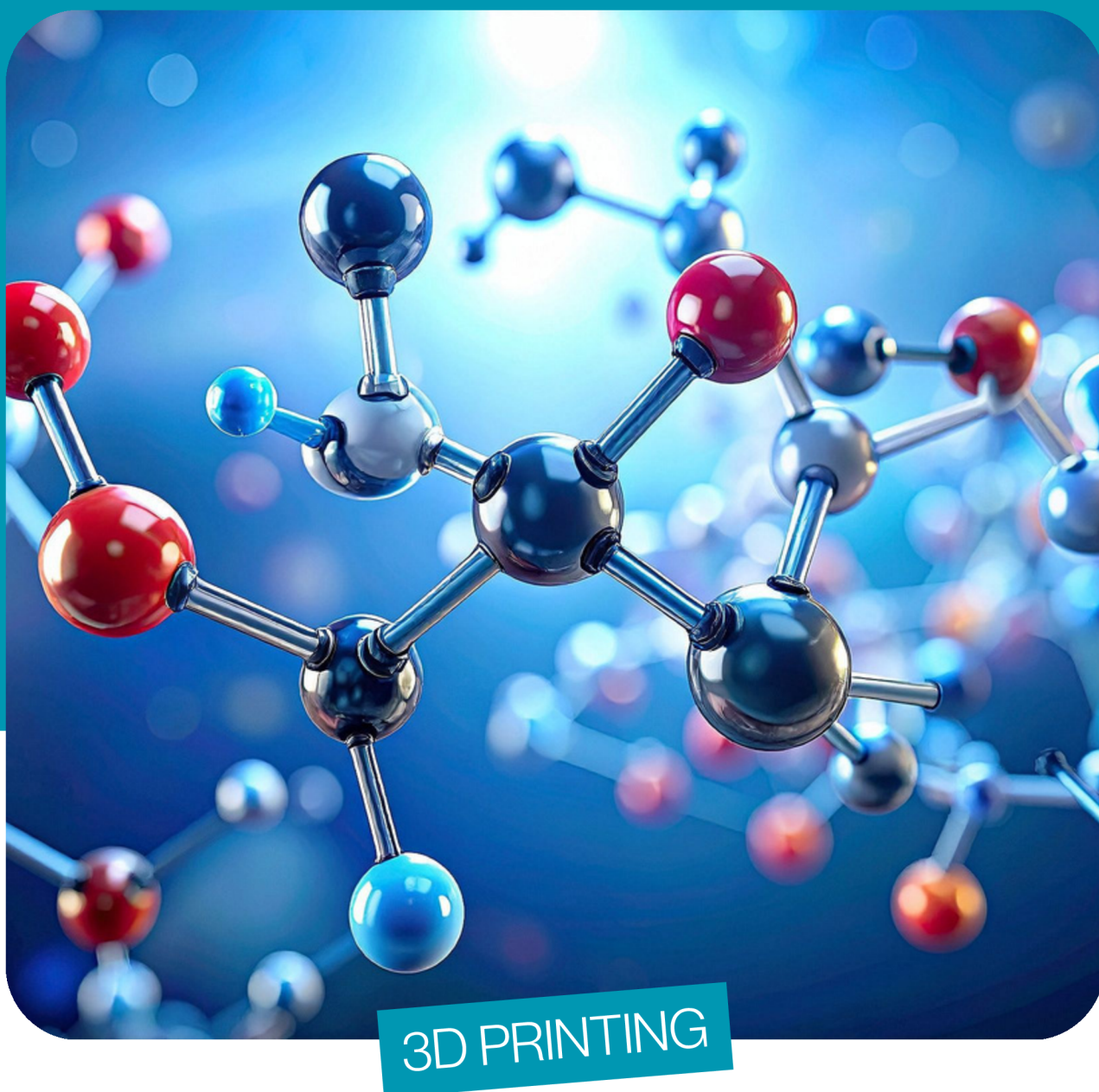


- Save the G-code file to your computer.



The file we've created already contains all the instructions for the printer to create the programmed part. The G-code is then placed in the 3D printer's memory, usually an SD card or USB drive.

This is opened through the machine's interface and selected to start printing.



HOW TO BUILD THE MODEL OF A CARBON ATOM

Timing

Part of the session	Description	Duration
Block 1. How to create a 3D carbon atom	Practical explanation for creating 3D carbon atoms for STEM subjects at Techlab	60 min

Goals

Apply the concepts learned in previous sessions to create a carbon atom model that can be used directly in the Techlab implementation for STEM subjects such as Physics and Chemistry.

Methodology

The session will be conducted using an expository and participatory methodology. Theoretical explanation will be combined with a step-by-step guided practice that will allow teachers to create models of carbon atoms.

During the session, active participation will be encouraged, promoting their acquisition of autonomy in the basic use of this software.

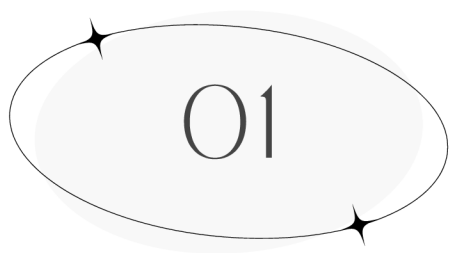
Content development

Block 1. How to create a 3D carbon atom

The atomic model will consist of a sphere with gaps at positions where other atoms can bond. Small axes will be fitted into these gaps, connecting them and allowing rotation around the bond, as shown in Figure 4b.



Figure 4 Model of the carbon atom, with the positions for the four single bonds (the model of methane CH₄ is also shown in which carbon is bonded to 4 hydrogen atoms) and the piece that we will use to join two atoms in a molecule.



Designing the part in a 3D design program

There are many 3D design programs that can be used, some free and others paid, each with its own peculiarities that need to be learned, but what we are going to explain below is surely general for all of them and if some of the tools we use are not in a particular program it is certain that it will have very similar alternatives.

First, we'll draw a sphere and mark the points where we want to insert the axes that form the single bonds. In the design program, you always start by drawing a sketch on a specific plane. We have an xyz coordinate system with an origin $x=0$, $y=0$, $z=0$. Three mutually perpendicular planes are also defined: the xy plane, which we'll call the plan view; the xz plane, which we'll call the elevation view; and the yz plane, which we'll call the profile view. This is the dihedral system of representation. We can start drawing on any of them, for example, the elevation view. First, I draw a semicircle centered at the origin of the coordinate system with a radius of 15 mm. This is our arbitrary scale. For the carbon atom model with a covalent radius of 77 pm, it will be 15 mm, as we've already mentioned. I position the atom so that one of the bonds points in the direction of the z-axis, upwards, and another bond lies in the plane where we're making the sketch. The links will be at the vertices of a tetrahedron inscribed in the circle. We can determine the edge length of this tetrahedron using a little trigonometry (or we can look it up directly on the internet). We will find that the edge length of the tetrahedron, a , is related to the radius of the sphere, R , by the equation:

$$a = \frac{4}{\sqrt{6}} R$$

In our case, $a=24.5\text{mm}$.

The geometric construction is simple. Just draw a line starting at point A, which will be one of the vertices of the tetrahedron, and ending at any point on the semicircle we have drawn. Set the constraint that this point must always lie on the semicircle if the program doesn't do so automatically, and assign it a dimension of 24.5 mm . The program will then position the end of the line, point B, correctly so that the edge length is the correct one.

We can now ask you to indicate the dimension of the angle formed by lines OA and OB, which would be the connecting angle. This angle is already determined by the position of point B; the dimension indicates it is 109.5° , and we cannot change this value. This is called a driven dimension, which is already determined by other dimensions in our drawing. We could have done it the other way around: draw line OB and force the angle between OA and OB to be 109.5° . Now, dimension AB is the driven dimension.

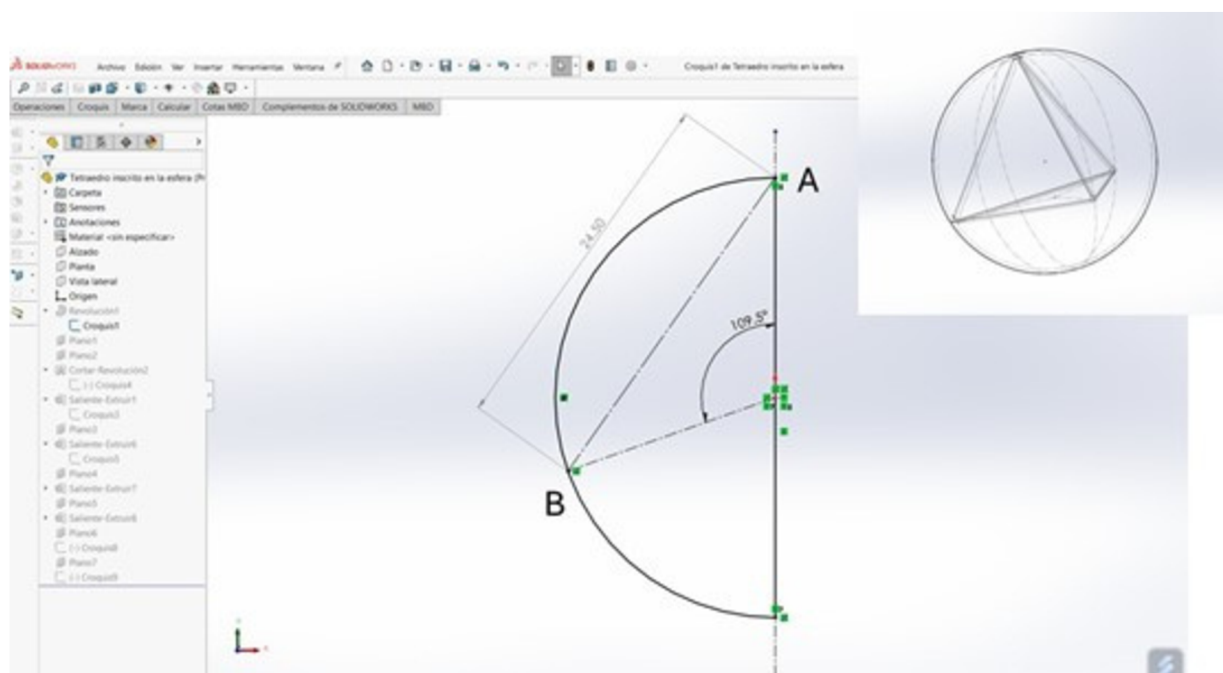


Figure 5. Sketch in which we draw, to the scale we have decided, the semicircle of radius 15mm that will generate the sphere of the carbon atom and an edge of the inscribed tetrahedron that will determine two of the possible bonds.



Generate the sphere

The next step is to convert the semicircle into a sphere. This involves rotating the semicircle around the OA axis. This generates the sphere shown in Figure 6. Now we have something three-dimensional. Note that we have left visible the sketch that indicates where to place two of the holes into which we will fit the pieces that link the different atoms.

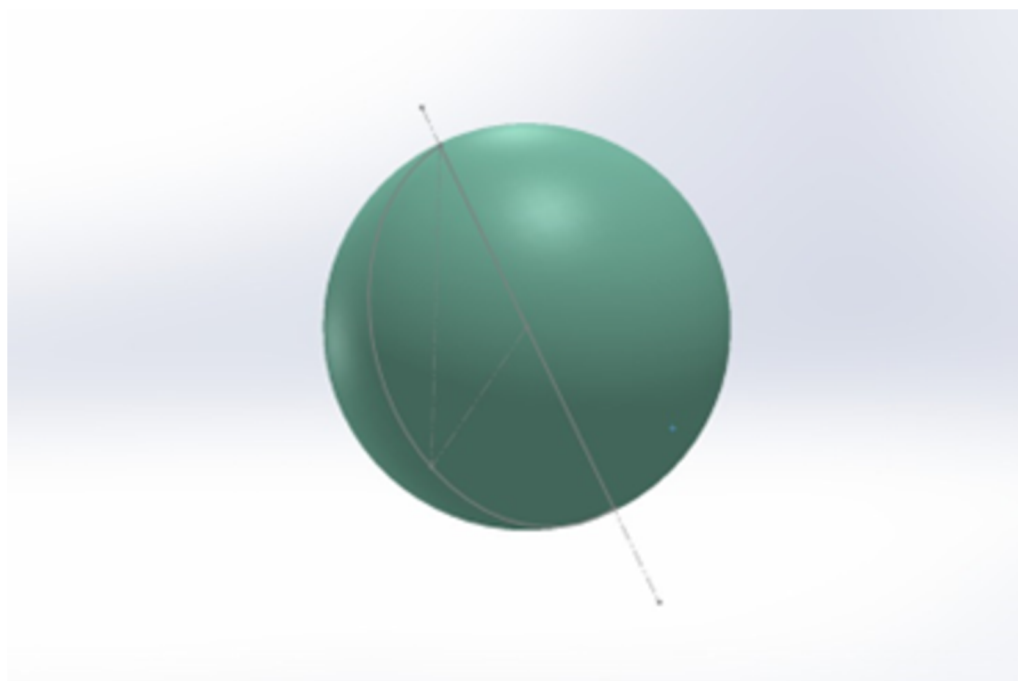


Figure 6. Sphere of radius 15 mm with the sketch showing two of the bonds that carbon can form.



Creating the first hole for the link

We're going to drill a hole at point B. We need to draw a circle centered at point B and perpendicular to line OB. A sketch must be drawn on a predefined plane; this is called a reference geometry.

In the tool that allows us to create this reference geometry, we choose a plane and set three constraints that define its position in space. We'll define it by stating that it must be tangent to the surface of the sphere and contain point B. We could also specify that it must contain point B and be perpendicular to line OB. Generally, in these 3D design programs, there are always several ways to achieve the desired result. The plane can be seen in Figure 7.

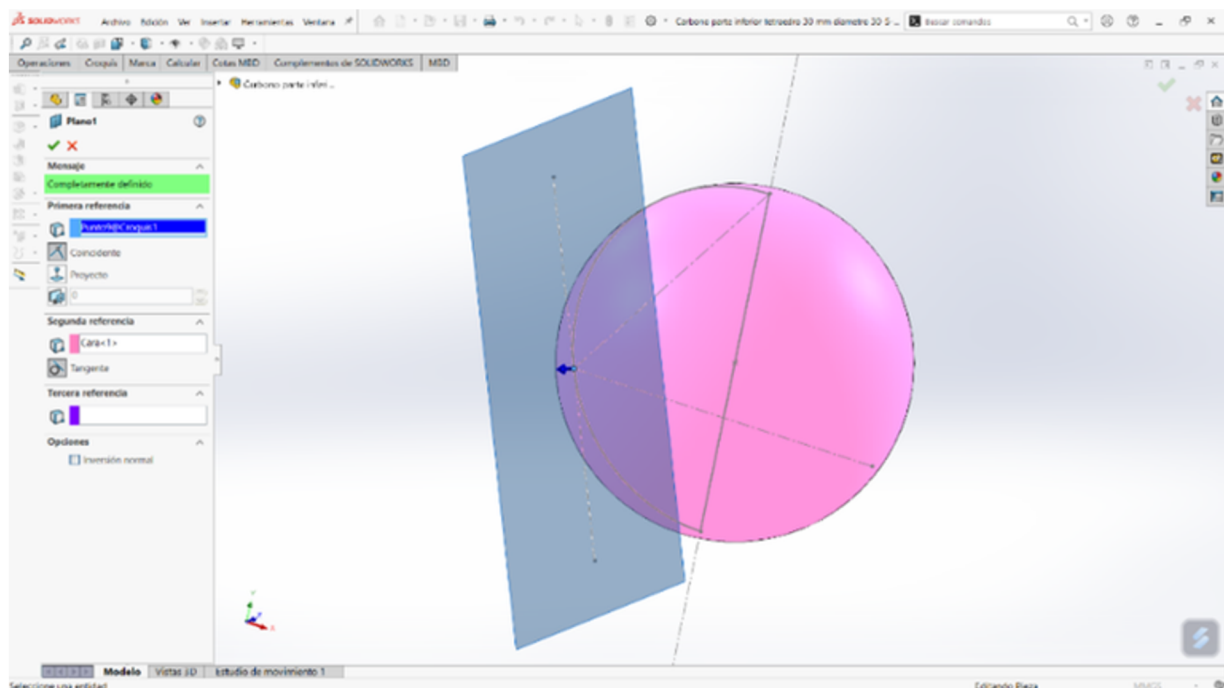


Figure 7. Plane tangent to the surface of the sphere at point B

Now, we position ourselves on that plane and draw a sketch consisting simply of a circle centered at B with a radius of 3.5 mm (Figure 8). We then perform an operation to generate a cylinder from that circle. This operation is called extruding a protrusion. The program will ask us for the direction; we'll select "towards the sphere." We'll also ask for the height; we can set it to 1 mm, it doesn't matter much, as the cylinder will integrate with the sphere as shown in Figure 8.

Next, we create the 3 mm diameter hole: we position ourselves again on the plane tangent to the sphere at point B, draw a sketch consisting of the 3 mm diameter circle, and now create a cylinder by cutting through the shape we have created. We give it a depth of 1 mm (Figure 9). This operation is called extruding a cut.

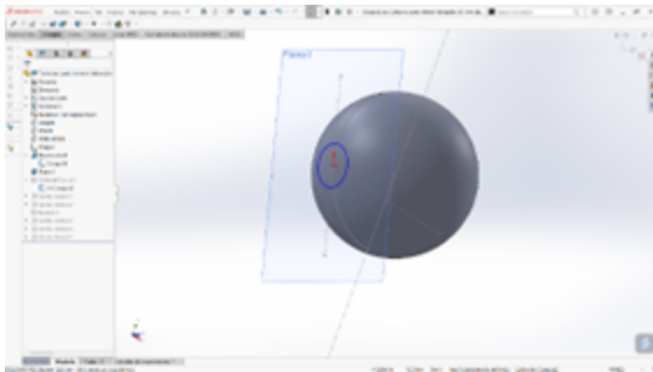


Figure 8. Sketch on the plane tangent to the surface of the sphere. On this, we draw a circle with a diameter of 3.5 mm. Then, we generate a cylinder from it that fills the space up to the surface of the sphere.

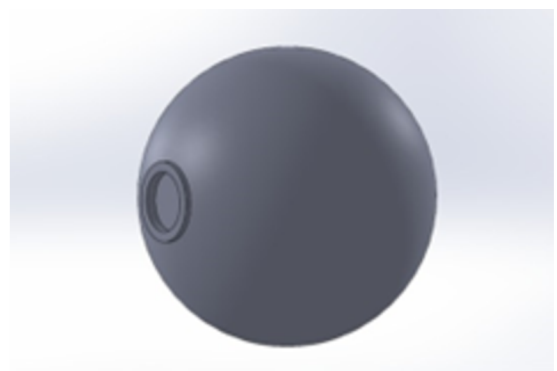
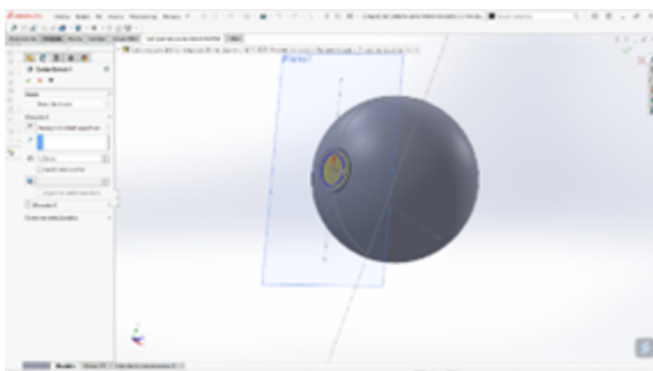


Figure 9. Cut in the shape of a circle with a radius of 3 mm and a depth of 1 mm. Extrude cut operation.

Notice that if we were to join the two atoms simply with a shaft inserted into the gaps of one and the other, even with some pressure, they would constantly be coming loose. The piece that creates the single bond is represented in Figure 4. It's a kind of clip that will pass through the 3 mm diameter hole we just made, deforming slightly. As it passes through that millimeter of wall, it expands and stays in place, although it can rotate. So, we're going to extend the hole inwards, but with a slightly larger diameter, 3.2 mm. We mark the bottom of the hole we made (Figure 9) and request a sketch on that plane. We draw the circle as before and perform the extrude cut operation, now with a depth of 4 mm, resulting in the shape shown in Figure 10.

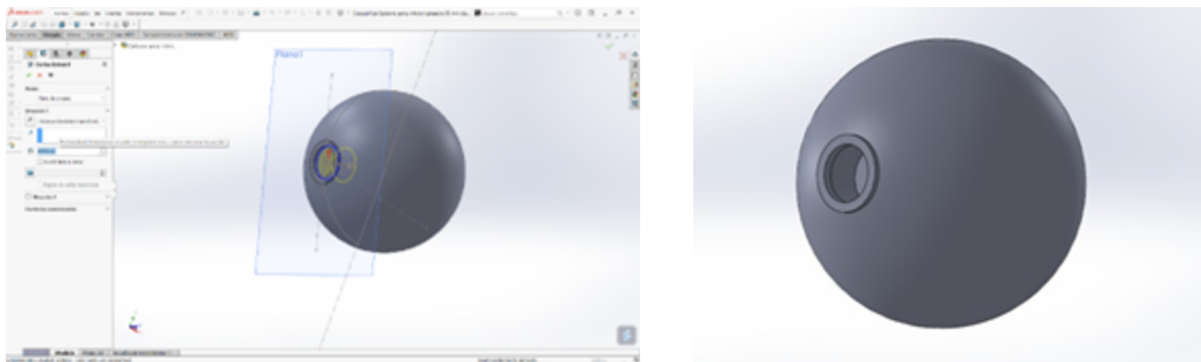
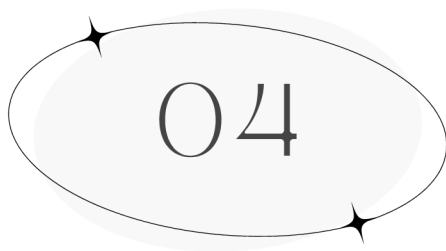


Figure 10. Housing for a single bond of the carbon atom.



Creation of the other link gaps

We need to create the slots for the other three possible links, but it's not necessary to repeat all the previous steps (although it can be done). There's an operation that simply copies a series of operations into a linear or cylindrical array. In this case, it will be a cylindrical array. We'll tell it to repeat all the steps we've done three times, rotating around the OA axis and positioning them every 120°. Figure 11 shows the result.

To make the missing link, centered at point A, we can copy one of the others only once, but rotating it 120° around the appropriate axis, or it might be faster to drill the hole again as we did the first time, thus recalling all the steps. The result is shown in Figure 12.

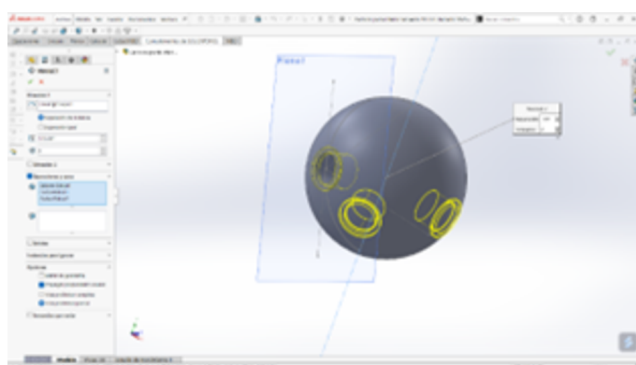


Figure 11. Copying the gap we created at point B to generate two more bonds on one of the faces of the tetrahedron.

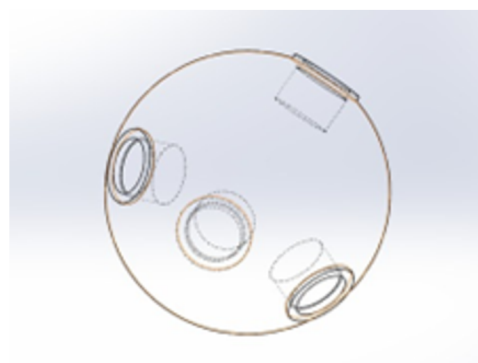
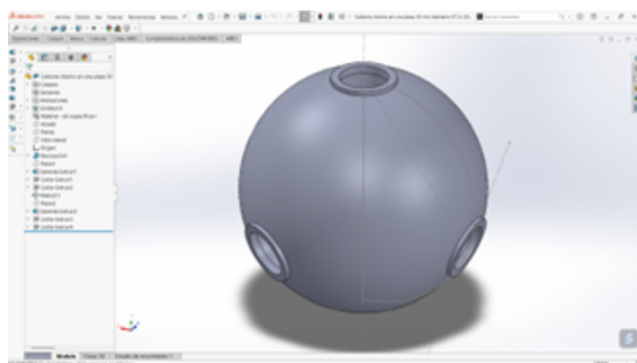


Figure 12. The model of the complete carbon atom.



Save the design

Once the design of the part we are going to print is finished, it must be saved in a format that other applications can recognize. The STL format (which stands for Standard Tessellation Language or Stereolithography) captures information about the outer surface of the object we have designed. It does this by breaking it down into a mesh of triangles and saving the position of the vertices of each triangle. This is a very large but finite number of points. Figure 13 shows how the 3D design program performs this conversion when we ask it to save our model in an .stl file.

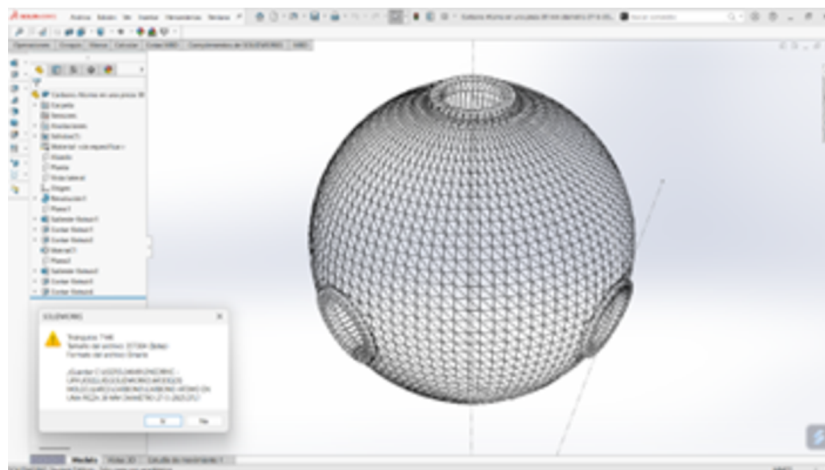
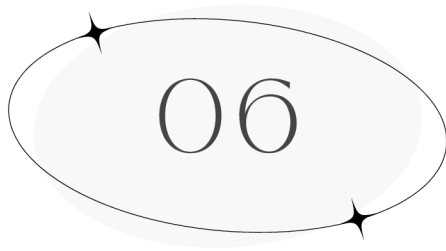


Figure 13. Decomposition of the outer surface of the designed object into a mesh of triangles to save it in .stl format.



Laminating and preparing the print file in G Code

3D printing is done layer by layer. The part is manufactured lying flat on one of its sides. In a fused filament printer, the machine pushes the filament through an extruder where its temperature increases until it melts and flows through a fine nozzle (typically 0.2 to 0.5 mm, although in certain applications it can be thicker). The nozzle moves from one point to another within each layer of the part, depositing the plastic onto the previous layer. When it finishes, it rises a certain height and begins printing the next layer.

The G-code file contains the information that tells the machine at each moment the position where the nozzle should be, what point it should move to next, at what speed and how much plastic it should deposit, and that point by point in each layer and layer by layer until the piece is complete.

The program called a slicer takes the information from an .stl file and uses it to build a G-code file. This is shown in Figure 14. Images 4a, 4b, and 4c show three layers at different heights on the part. Parts manufactured by 3D printing are generally not solid; they have an outer surface made up of a number of lines or walls that can be selected.

In detail, Figure 14g shows the outermost wall, the one visible from the outside, in red. It then has two more walls, shown in green and yellow. In this example, we have four external lines, which will form a wall with a thickness of 0.8 mm. The interior is filled with walls of varying geometries, which can be selected, as well as the fill density.

In this example, the infill occupies 20% of the part's internal volume and is constructed in the form of squares. This is more than enough to make the part rigid and strong, printed with polylactic acid (PLA) filament, one of the most widely used materials in fused filament 3D printing. We will also choose the layer thickness. For very small parts with a lot of detail, the layer thickness can be 0.06 mm; normally, with this polymer, it might be 0.15 or 0.20 mm. The nozzle has a thickness of 0.5 mm, printing a thinner layer because as it extrudes the molten polymer, it presses it against the material it has already built up. Depending on the part's geometry, this can cause a problem. As seen in Figure 14c, when the machine tries to print the outermost ring, the red one, it doesn't have enough material to press against, and the print will not be successful.

In that case, it's necessary to add a support material, shown in blue in images 14d, 14e, and 14f. If the printer has only one print head, this support will be made from the same material as the part. To make it easy to remove later, the bond points between the support and the outer surface of the part are very weak. However, it's somewhat cumbersome, and the surface isn't perfectly smooth. If the printer can change materials or has more than one print head, the support can be printed in a water-soluble polymer and then easily removed without leaving marks on the part.

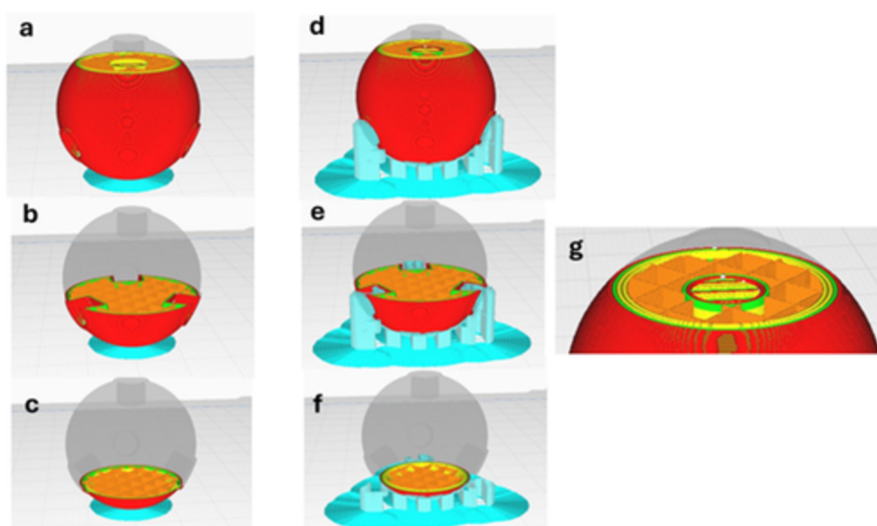


Figure 14. How the slicer program breaks down the piece into a series of layers that the 3D printer will then print consecutively, one on top of the other.



Prepare the piece for good adhesion

The adhesion of the first layer that is printed is essential for the construction of the part, as we have said the nozzle squeezes when printing and if we do not have the part solidly attached to the base it can drag it.

We need to return to the part design to resolve these problems. One possible solution is to split the sphere in two. To do this, we create a sketch in the elevation view consisting of a rectangle whose base is at the height at which we want to split the part, as shown in Figure 15. We then use the extrude cut operation in one direction and in another, a distance sufficient to cut the entire part, leaving us with the bottom portion. In this case, we must be careful to choose a height that does not cut the slots for the simple links we have prepared.

The 3D design program allows you to create complex parts with simple operations. With a little practice, you'll see that you can do anything you can imagine. With patience, of course.

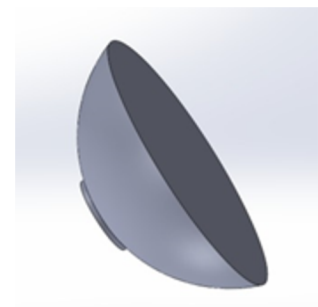
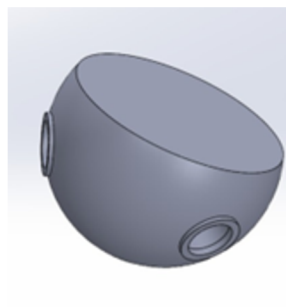
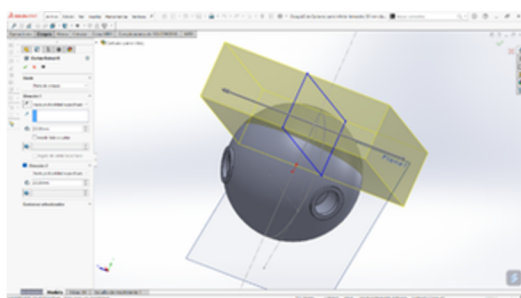
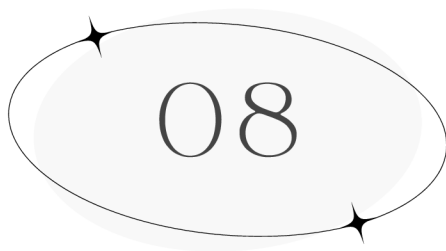


Figure 15. Cutting the piece into two parts.



Join the two halves of the model

To join the two parts, we used clips similar to those we made to link two atoms, except this time we don't want the two pieces we're joining to be able to rotate relative to each other. We'll make the pin housings rectangular and use more than one. To make, for example, four rectangular holes, we could follow the same steps we used earlier to make the housings for the single bonds. First, we make one and then copy it in other positions. To see another way to do this, let's draw the initial sketch with the four rectangles. As you can see in Figure 16, we first drew a reference square (for construction) centered on the circle that forms the base of our piece. We also drew a horizontal and a vertical reference axis.

At one of the vertices, for example the top left one, we draw a rectangle, in our case 2 x 4 mm. Now we ask the program to draw the rectangle symmetrical with respect to the vertical axis and then the symmetry of the two rectangles we already have with respect to the horizontal axis, and now we have all four. We extrude the sketch by cutting into the interior of the piece with a depth of 1 mm.

We position ourselves on the bottom plane of that recess and repeat the four rectangles slightly larger, measuring 2 x 4.2 mm. We extrude again in cut mode to another 4 mm deep, and that's it. Now the top and bottom parts will be joined with clips like the ones shown in Figure 17. The central groove of the clip has a cross-section of 2 x 4 mm, while on either side it widens to 2 x 4.2 mm. When inserted into their housing, they pass through the surface opening because the clip's shape allows it to deform slightly. Once the thickest part has passed, its elasticity causes it to open up again inside, making it more secure than if it had a constant cross-section and was held in place only by friction.

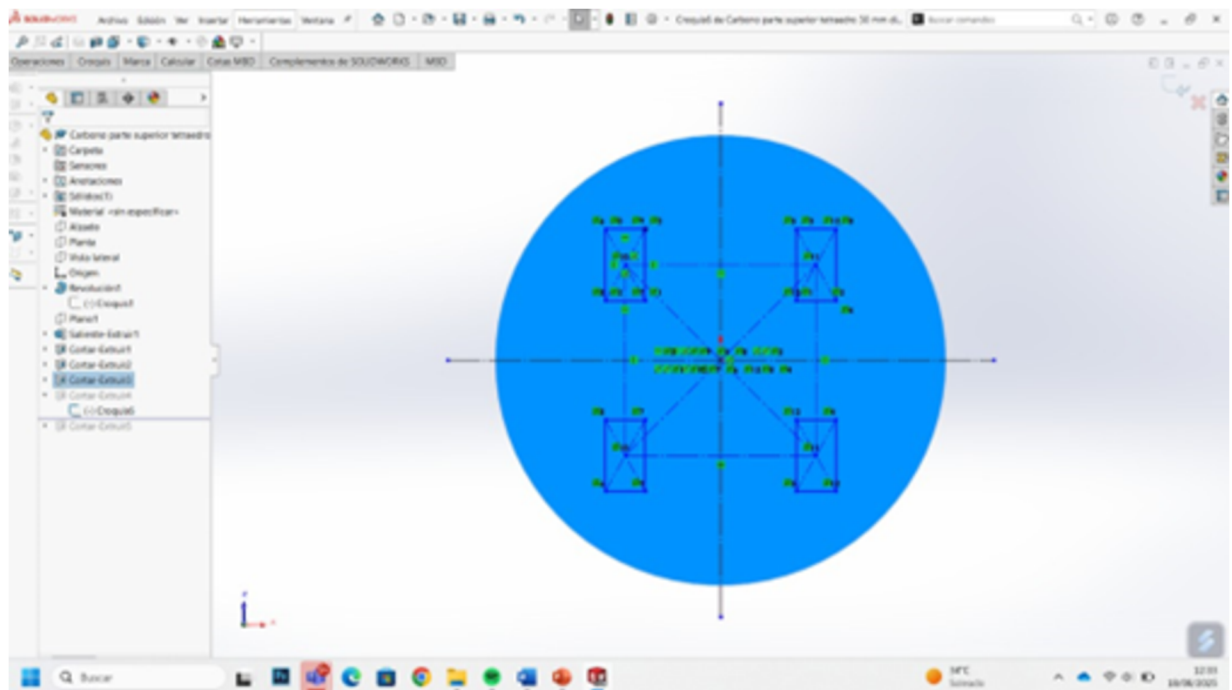


Figure 16. Sketch for making the housings for the clips that will join the two parts of the carbon atom model.

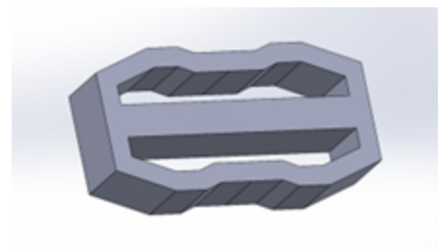
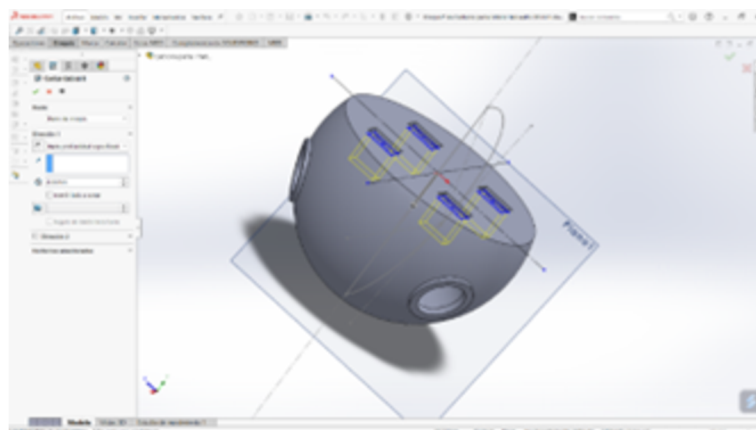


Figure 17. The lower part of the carbon atom model with the slots for the four clips that will attach it to the upper part. The clip we will use is shown on the right.



Preparing the parts in the rolling mill

We now have both parts designed, we save them as an STL file, and we take them to the slicer. We can print them together by placing their flat bases on the heated bed of the 3D printer, as shown in Figure 18. Now we have a solid bond between the part and the bed, and we don't need support material because each layer provides firm support on the previous ones. We can print the two parts together, but in reality, we can print many more. The slicer allows us to make multiple copies, as shown in Figure 19, which is set up to print 6 atoms at a time. Of course, this will take longer to print, but the machines are designed to operate very reliably without supervision. You can leave it working for several hours while you do other things or overnight and find the printed parts when you return.

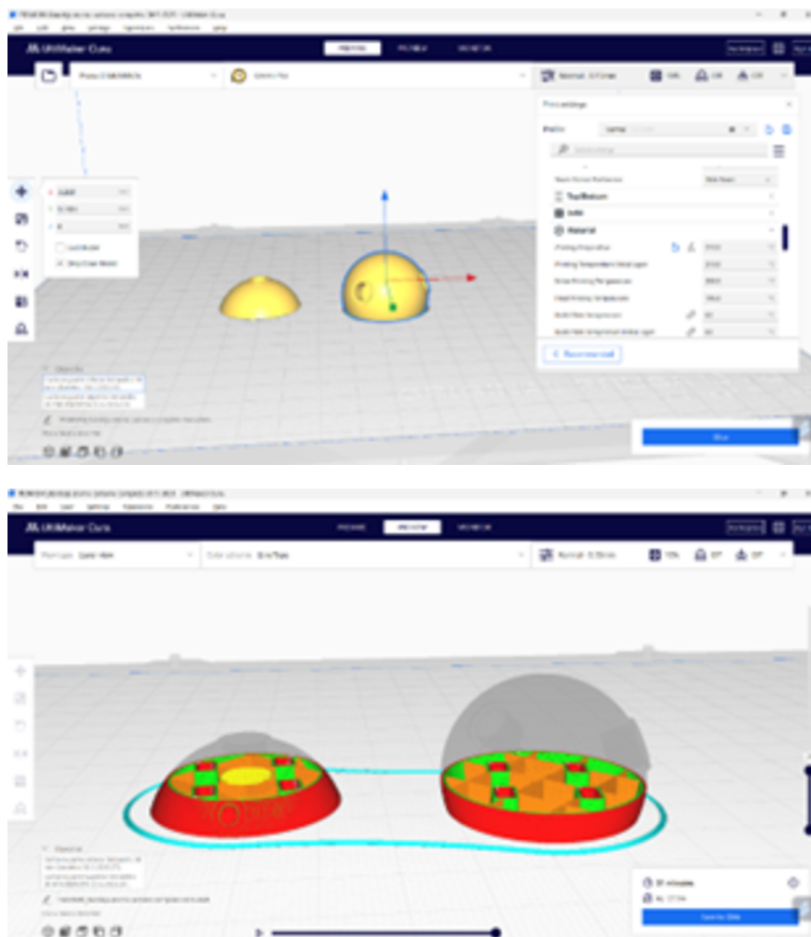


Figure 18. The two parts of the carbon atom model on the laminator screen.

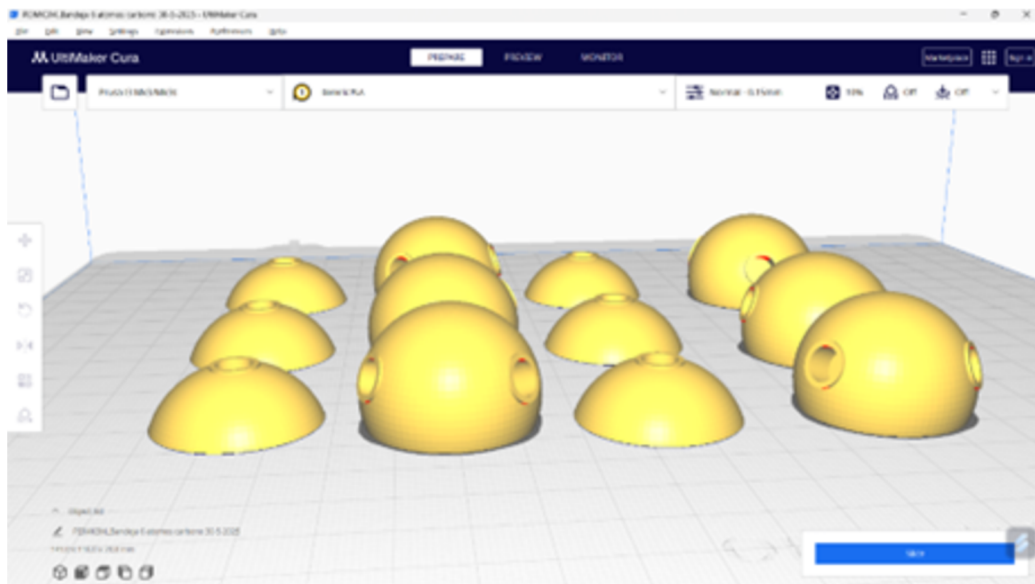
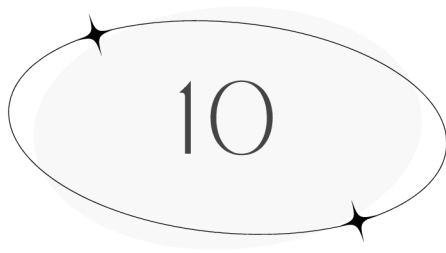


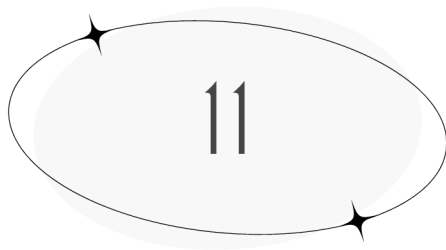
Figure 19. Image of the laminator screen prepared to print 6 models of the carbon atom.

Needless to say, there are many alternative designs to the one we have explained; I'm sure the teacher and the students themselves will come up with better solutions.



Save the result of the slicer to a file in G code.

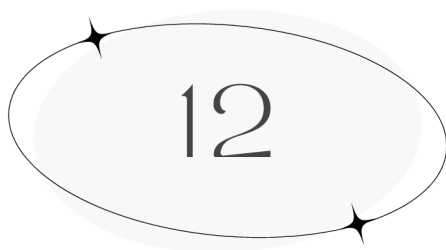
Now all that remains is to save the laminator's output to a G-code file. This is a text file. In the following lines, highlighted in blue, we've copied the beginning of this file and will briefly examine the meaning of these lines, which tell the machine what to do to print the part.



The filament

For the construction of our model, we suggest using PLA to build the spheres and the simple links that join them.

But how much filament is needed to print a model of an atom? The slicer provides this information when it prepares the G-code file. For example, printing a model of a carbon atom requires 8 grams of PLA filament. Considering the price of a 1-kilogram spool and the small lengths of filament lost at the start of printing or when changing filaments, the current cost would be around €0.10.



Print

The final step is to print our part on the 3D printer.



3D PRINTING

SUSTAINABILITY

ENVIRONMENTAL

Timing

Part of the session	Description	Duration
Block 1. Introduction	European framework, the role of teachers and the role of Techlabs.	30 min
Block 2. Sustainable practices in the use of 3D printing	Specific practices and how to implement them in Techlabs	55 min
Block 3. Linking with the SDGs in the Techlab	Pedagogical and curricular approach	30 min

Goals

- Understanding the importance of environmental sustainability in the implementation of Techlabs.
- Identify sustainable practices to implement in the Techlabs.
- Learn to apply sustainable practices in Techlabs.
- Understand and identify teaching strategies that link Techlabs with the Sustainable Development Goals (SDGs).
- To promote ecological awareness and critical thinking among students.

Methodology

The session will be conducted using an expository and participatory methodology. Theoretical explanations will be combined with practical examples to help participants understand how to apply the content in the classroom.

Throughout the session, dialogue and collective reflection will be encouraged, allowing teachers to share their experiences and perspectives. The aim is for teachers to understand the role of sustainability in Techlabs and to realistically apply what they have learned to their educational practice.

Content development

Block 1. Introduction

In recent years, the ecological transition and sustainable development have become fundamental pillars. The European Union is promoting measures and initiatives that contribute to the ecological transition and the implementation of sustainable practices. In this context, as explained in the Council Recommendation on learning for environmental sustainability,[i] it highlights the importance of creating and implementing short-term measures that not only support educational institutions and teachers, but also help students develop the skills and critical awareness necessary for the ecological transition.

In this context, we consider the incorporation of sustainable practices in Techlabs to be a priority in these laboratories; they are not only to reduce the ecological footprint, but also to teach students to be more environmentally responsible and to acquire critical awareness about it.

[i] European Commission. (2022). Proposal for a Council Recommendation on learning for environmental sustainability [COM(2022) 11 final]. Brussels: European Commission. Available from: <https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A52022DC0011>

3D printing is carried out through a layer-by-layer additive manufacturing process, reducing the amount of material used compared to more traditional manufacturing processes. However, environmental sustainability in a Techlab depends not only on this printing factor, but also on other factors such as the printing material chosen, the design of the parts to be printed, work routines, and more.

Therefore, following the European Commission's guidelines on learning for the ecological transition and sustainable development[ii], the Techlabs:

- Learning about sustainable development is a priority at Techlab.
- They provide students with the opportunity to learn about climate change, sustainable practices, and to develop critical awareness.
- They support teachers in implementing sustainable practices to combat climate change.
- They are learning environments that promote sustainability in all their activities.
- They actively involve the students.

[ii] European Commission. (n.d.). Learning for the green transition and sustainable development [Web page]. European Education Area. Retrieved from <https://education.ec.europa.eu/es/focus-topics/green-education/learning-for-the-green-transition>

Block 2. Sustainable practices in the use of Techlabs

Selection of printing materials

As we've seen in previous sessions, there are various printing materials available for 3D printing. However, some materials are more sustainable because they use recycled or biodegradable materials to reduce plastic waste. PLA is one example.

PLA (polylactic acid) filament is a biodegradable thermoplastic material derived from renewable natural resources such as corn or sugar cane.

PLA is characterized by its ease of use, low thermal contraction, and good surface finish, making it especially suitable for educational environments. It does not emit toxic gases during use and is safe for educational activities.

Efficient design of each piece

When designing a part for 3D printing, there are many factors to consider. However, there are some practices that will allow us to reduce the environmental impact without reducing the quality and usefulness of the part, such as:

- Group several pieces into a single print to optimize energy use.



Figure. Pieces grouped in a single print. Photograph by Minku Kang (unsplash)

- Review the 3D models to reduce unnecessary thickness or support without compromising the quality of the piece at an educational level.

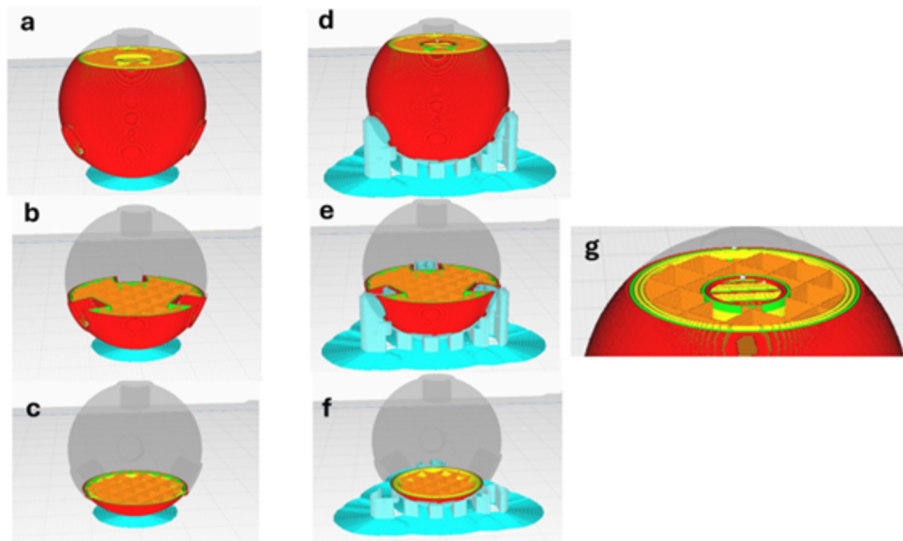


Figure. How the slicer program breaks down the piece into a series of layers that the 3D printer will then print consecutively, one on top of the other.

- Calculate the estimated filament consumption before printing. In software like Ultimaker Cura, the slicing process will be performed, generating the extruder paths. When finished, you'll see the print path layer by layer in the preview.
 - Look in the bottom right corner of the screen (just above the "Save to disk" or "Save to SD card" button). Cura will display an estimate like this:
 - Printing time: 2h 45min
 - Filament: 8.35 m – 25 g
 - Material: PLA

The time indicates the total duration of the print.

The length indicates how many meters of filament you will use.

The weight corresponds to the total weight of the material that will be used.

Recycling of printing materials

All 3D printing generates some waste, however small (supports, the initial extrusion line or purge line, defective parts, etc.). Therefore, it is important to know recycling practices for this material:

- Separate and store the scraps: Place a box or container in the classroom for students to dispose of leftover materials and defective pieces. If different types of materials are used (such as PLA, PETG, ABS, etc.), it is advisable to separate them by material type if known.
- Collection programs or recycling centers. If you accumulate a significant amount of material, you can take it to a recycling center or contact organizations that collect 3D printing plastics. First, you should find out if your center has an established recycling program with a recycling company. If not, there are several options:
 - CITY COUNCIL RECYCLING SERVICE. The easiest way is to contact the city council's waste management services or the local recycling centers to ask if they accept 3D printing filament waste.
 - UNIVERSITIES. Many universities have recycling centers for waste such as 3D printing filaments.

Efficient use of energy and responsible machine maintenance

- Group several pieces into a single print to take advantage of warm-up times and printing time.
- Turn off the printer when not in use.
- Analyze the estimated printing time.

Block 3. Linking with the SDGs in the Techlab

In September 2015, at the United Nations General Assembly, countries from around the world endorsed the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs).

These have the main objective of ending poverty, protecting the planet and ensuring that everyone lives in peace by 2030, balancing the social, economic and environmental dimensions of development.



Source: https://commission.europa.eu/strategy-and-policy/sustainable-development-goals/eu-and-united-nations-common-goals-sustainable-future_es

In this context, Techlabs are key learning spaces for working on the following SDGs from a practical approach:

Block 3. Linking with the SDGs in the Techlab

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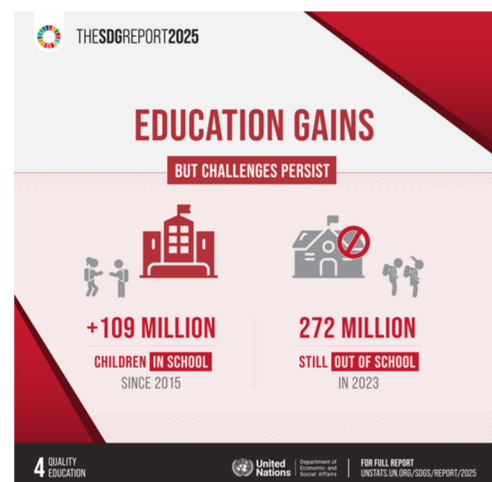
SDG 1. END POVERTY

While Techlabs won't eradicate poverty in all its forms, these technology labs have been designed inclusively to address the economic barriers that primary and secondary school students may face. Although secondary education is free, the availability of materials and resources for certain activities is not covered by the school. Therefore, Techlabs offer free materials and equipment so that all students can participate in the activities on equal terms.



SDG 4. QUALITY EDUCATION

To guarantee inclusive, equitable and quality education, promoting lifelong learning opportunities for all.



Techlabs transform the classroom into a technological laboratory with a quality learning environment in which students not only learn science and technology in a practical, dynamic and motivating way, but also from an inclusive perspective.

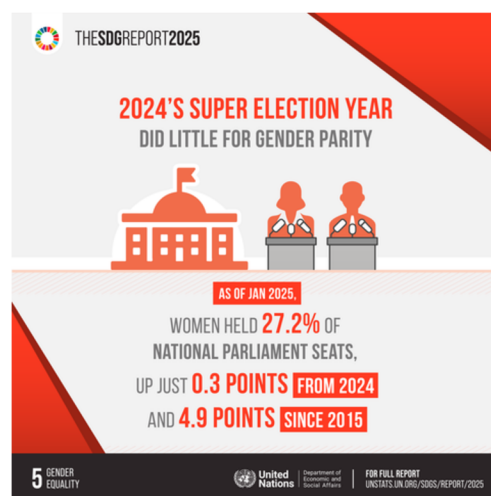
Hands-on learning is a key tool for motivating students in the classroom, especially those facing challenges, as they become more engaged and show greater interest when they are actively involved in the learning process. In STEM subjects at the secondary level, this methodology presents a significant opportunity to motivate students, since science and technology are best learned through doing rather than simply reading or memorizing.

In this sense, the implementation of a Techlab (technology laboratories) offers teachers the opportunity to bring science and technology closer to students, turning intangible concepts into tangible, dynamic and meaningful learning.

SDG 5. GENDER EQUALITY

Achieving gender equality and empowering all women and girls.

Learning in Techlabs encourages the participation of all students on equal terms, promoting the active presence of female students and showing them real and current role models of female scientists, so they naturally perceive that science is an area in which gender diversity is key to progress.

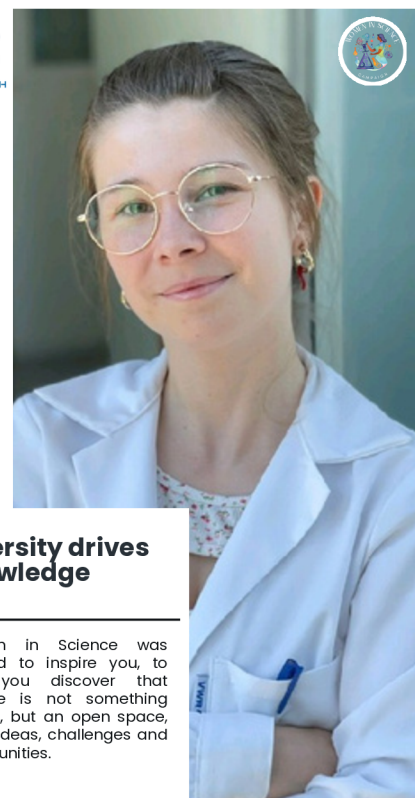


Showing students relatable role models is another strategy to motivate them, break down stereotypes, promote gender equality, foster aspirations, and demonstrate that science and technology careers are accessible to everyone. When we see ourselves reflected in a story or concrete example, our motivation and aspirations increase.

Within the framework of the Erasmus Plus “Didactech” project, the Women in Science Today campaign was developed. This innovative initiative presents secondary school students with real-life, current examples of women contributing to scientific advancements in various fields. The Women in Science campaign was created with a clear objective: to inspire secondary school students to discover the potential of women in science and technology. Unlike other initiatives focused on women throughout history, this campaign focuses on the present, showcasing the crucial role women play today, leading pioneering research centers and directing and working on research projects that will shape the future of Europe and the world.



Women in Science



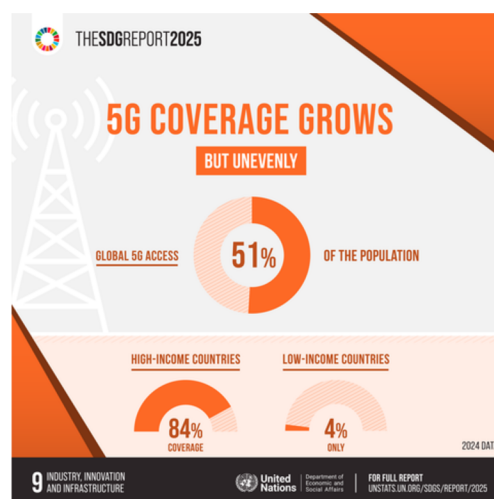
Diversity drives knowledge

Women in Science was created to inspire you, to help you discover that science is not something distant, but an open space, full of ideas, challenges and opportunities.

SDG 9. INDUSTRY, INNOVATION AND INFRASTRUCTURE

Building resilient infrastructure, promoting inclusive industrialization, and fostering innovation.

Innovation is one of the fundamental pillars of Techlabs. The integration of additive manufacturing and 3D printing in the classroom transforms how students learn and how teachers teach. Techlabs promote innovative learning based on experimentation, design, and problem-solving, in which students become the protagonists of their own learning process.



Developing projects at the Techlab fosters curiosity, creativity, and critical thinking, encouraging students to seek original solutions and apply science and technology responsibly. In this way, innovation is no longer understood solely as a technical advancement but becomes a way of learning that combines science, technology, and sustainability with a practical and motivating approach.

SDG 10. REDUCING INEQUALITIES.

Reduce inequality within and between countries.

While the technology workshops (Techlab) are aimed at all secondary school students, we place special emphasis on those students who face obstacles, as they are the ones who encounter the greatest barriers to inclusion. These are secondary school students, especially girls, from disadvantaged regions who face economic, social, and employment barriers.



who encounter serious difficulties in accessing the technological job market and higher scientific careers, losing interest in this field.

Equal participation of all students in technology projects is one of our main objectives. The main measures designed to promote inclusion in the Techlabs are:

- Technological support. This refers to the adaptation of resources and tools that allow all students to participate in learning activities on equal terms, eliminating barriers to access and promoting student autonomy.

- Digital accessibility. Ensure that all devices used in the classroom meet accessibility criteria such as screen readers, contrast options, adapted fonts, etc.
- Adapting the format and duration of activities is crucial. It's important to consider the diversity of the student body and their different learning paces, particularly those with learning difficulties. Therefore, we recommend designing activities flexibly, adjusting their length and difficulty to each student's learning rhythm. This will ensure that all students can participate and achieve the proposed objectives.
- Individual and group tutoring. Group tutoring allows for observation of general classroom questions and teamwork dynamics, but students don't always feel comfortable expressing themselves in a group setting. Therefore, personalized tutoring is invaluable, especially for students facing challenges, in order to identify difficulties early, boost their confidence, and guide their progress. In secondary education, the role of tutor exists; however, this role is not necessarily linked to STEM or to projects at the Techlab technology lab. Furthermore, the teaching load is heavy.
- Joint actions with school psychologists. One inclusion measure is to carry out joint actions with the guidance and psychology teams of the educational center with the aim of ensuring that the inclusion measures are adapted to the needs of the participating students, as well as to ensure effective support from support tutors, reducing inequalities among students.
- Motivational support. Implementing strategies to motivate students in STEM in secondary education not only allows them to acquire key and transversal skills, but also shows them that science and technology are accessible and inclusive paths to their future.

SDG 12. RESPONSIBLE PRODUCTION AND CONSUMPTION

Ensure sustainable consumption and production patterns.

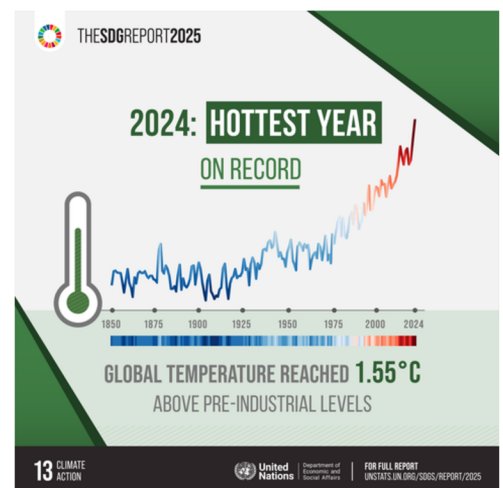
As we have seen in the previous section, there are various sustainable practices that we can carry out in Techlabs to promote responsible consumption.



SDG 13. CLIMATE ACTION

Take urgent action to combat climate change and its effects.

In the previous section we have seen how the implementation of Techlabs is carried out from an ecological perspective, fighting against climate change, as well as helping students to acquire a critical awareness of the need to get involved in this fight.





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