Unit 3: 3D design

Autor: Guillermo Gómez

Contents

Textos Marea Verde

Prior knowledge

***Activity:** Summarize your general knowledge on this topic.

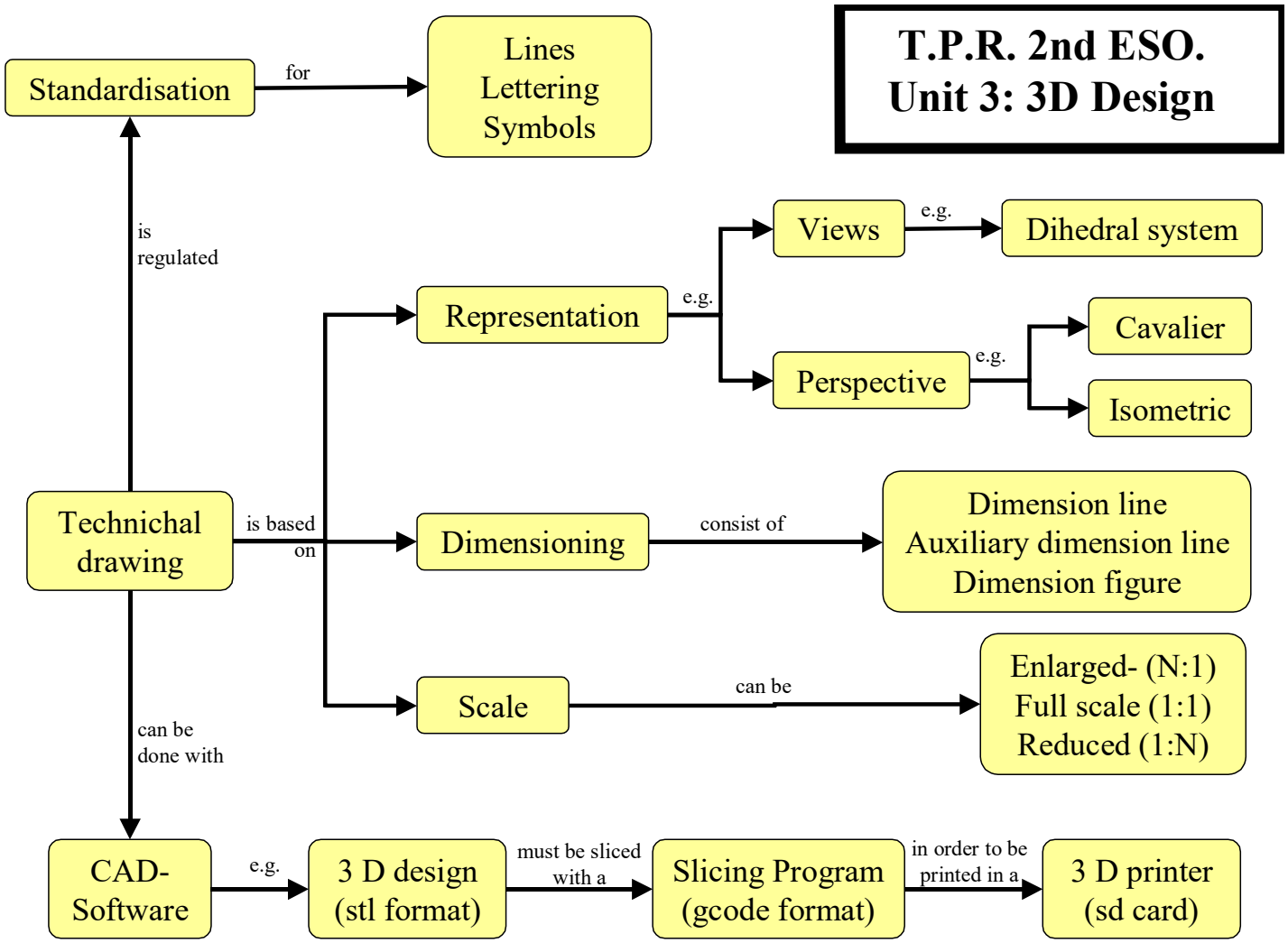
Keywords

Activity: Copy following keywords, understand their meaning and translate them into English.

Auxiliary dimension line	Front elevation	Isometric perspective
Dimension line	Plan	Slicing
dimension	Left or right elevation	Extruder
Standardisation	Cavalier perspective	GCODE

Mindmap of the unit

Activity: Analize and try to understand following mindmap

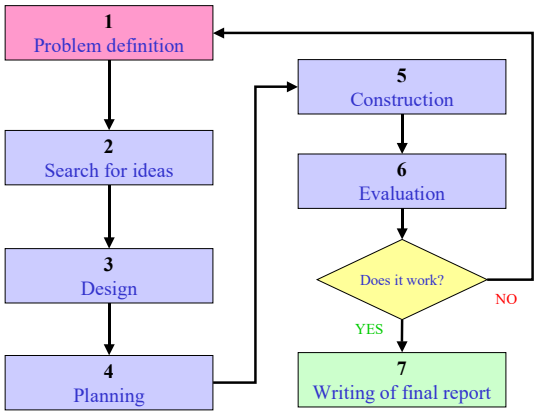


3.1. 3D design

In the stage of design of the technological process, we use the technical drawing for communicating our ideas, which is essential in industry and engineering.

A three dimensional (3D) object can be represented by its views or in perspective.

The stages of technological processes



Activity: Copy following exercises and solve them in your notebook

1) Represent your desk in three dimensions. Measure it and write the dimensions on your drawing.
2) Draw the three primary views of the desk and dimension it as best as you can.

3.1.1. Basics of technical drawing

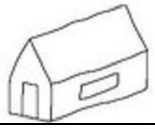
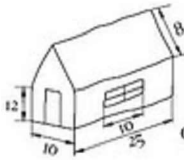
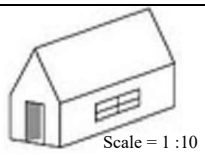
Activity: *Copy the text, look for information and fill in with following words: freehand proportion, scale, fine-line pen, drawing tools, unit, DIN, H, B, ISO, dam, hm, dm, cm, standards, language, object, plan, information, measurements, diagram, rough draft, Organization, clarity, submultiples, ruler, formats, symbols, Norma, decimetre, decametre*

- Technical drawing is an universal conventional_____, bound by specific rules, which makes it possible to transmit all the _____ needed to manufacture an object.

- Scale is the _____ (relationship) between the size of the drawings and the size of the real_____.

$$\text{Scale} = \frac{\text{Size of the drawing}}{\text{Size of the real object}}$$

- Graphic systems are the different ways of representing an object, depending on the _____ and instruments used.

Graphic System	Characteristics	Example
_____ (or sketch) (boceto)	✓ Freehand ✓ _____ and imagination	
Sketch (or _____) (croquis)	✓ _____ ✓ Incorporates all data / scale	
_____(or technical drawing) (plano)	✓ With _____, compass... ✓ Use of a _____.	

- Rule for drawing: First draw using a hard lead (i.e. F or___) and once you are sure, go over tracing darker lines with soft lead (i.e. HB or___) or _____.

- Standardisation is the set of _____ (technical specifications) that regulates every element of technical drawing: _____(sizes), lettering, dimensioning and _____.

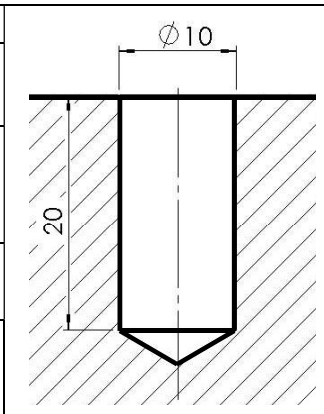
Country	Standard	Standard acronym
Spain[1]	Una _____ Española	UNE
Germany	Deutsches Institut für Normung	_____
International	International _____for Standardization	_____

- Dimensions of the drawing show the real _____ of an object. They help us understand the drawing. The ISO standard _____is the metre (m). Multiples and _____ are:

Multiples / Sub-multiples	kilometre	hectometre	_____	metre	_____	centimetre	milimetre
Symbol	km	____	_____	m	____	____	mm
Equivalence	1000m	100m	10m	1m	0,1m	0,01m	0,001m

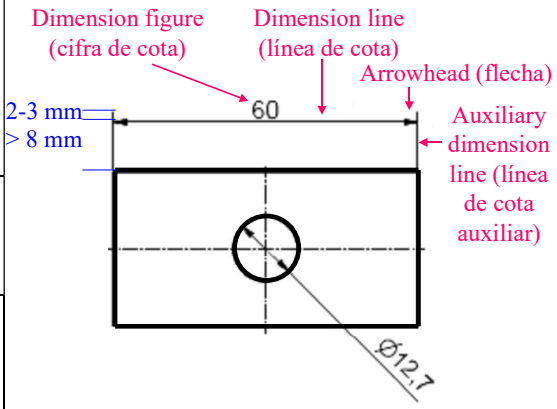
- Types of lines

Type of line	Name	Application
▬▬▬	Heavy line (0,7)	• Visible outlines (contornos vistos) • Visible edges (aristas vistas)
———	Fine line (0,3)	• Dimension lines, auxiliary dimension lines (líneas de cota, líneas auxiliares de cota) • Hatching (sombreado)
- · - · - · -	Fine dash-dotted line (0,3)	• Axis lines (líneas de ejes: simetría o revolución)
- - - - - -	Fine dashed line (0,5)	• Hidden edges (aristas ocultas)



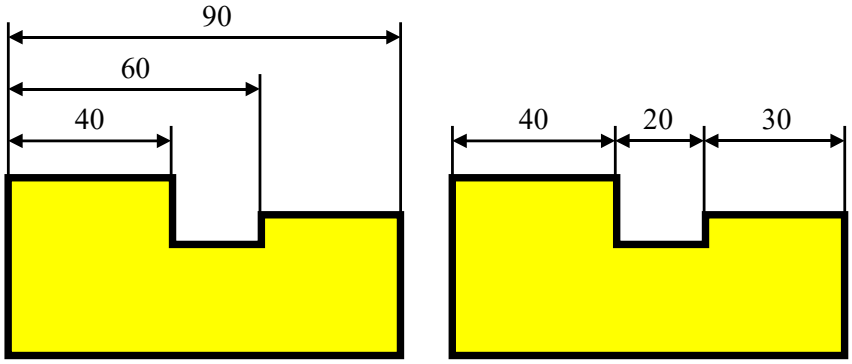
- Dimensioning

Element	Application	Drawing instructions
Dimension line	Indicates the measurement	• Parallel to the measured edge • > 8 mm from the edge of the figure or other dimension line • Avoid crossing between them • Avoid duplicate information
Auxiliary dimension line	Delimits the dimension lines accurately	• Extension of the outlines • Avoid crossing between them • Protrude 2-3 mm
Dimension figure	Expresses the real measurement in mm	• Over the dimension line • 5-8 mm height • No unit expressed (unless ≠ mm) • Readable from bottom or right



[1] Spanish standards are agreed by AENOR (Asociación Española de NORmalización y certificación)

The two most common dimensionig standars are parallel and chain.

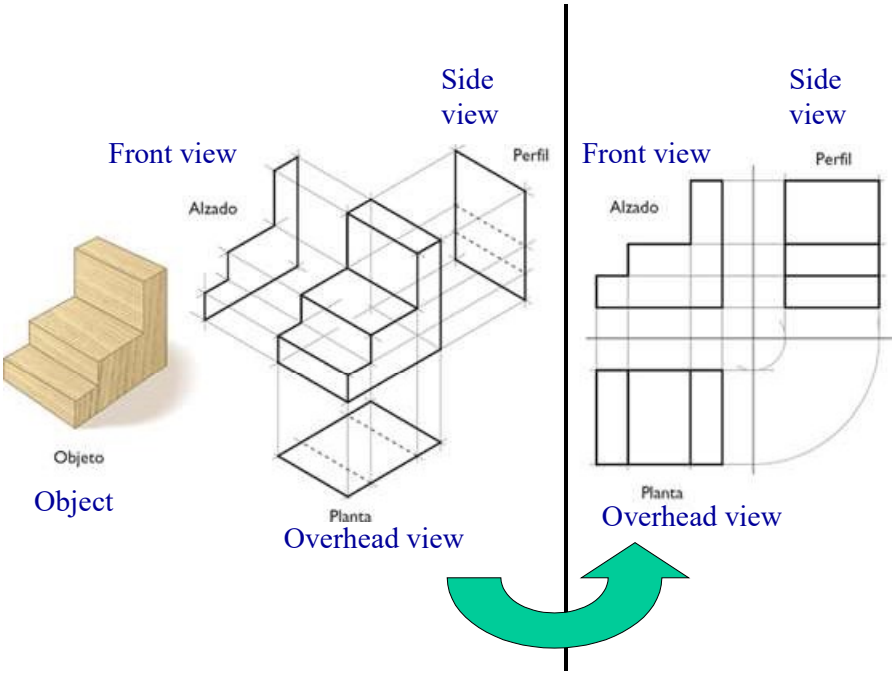


Parallel dimensioning Chain dimensioning

3.1.2. Views

The most common system for representing objects is the dihedral projection system (or **dihedral system**).

The different views of an object are the images produced when we look at it from different positions. The effect is like placing the object suspended between three planes perpendicular to one another and project the object on them.



View of the object	We look at the object from	We say the object is projected perpendicularly onto
Front view (front elevation) (alzado)	the front	Vertical Plane
Side view (side elevation) (perfil)	one side	Profile Plane
Overhead view (plan) (planta)	above	Horizontal plane

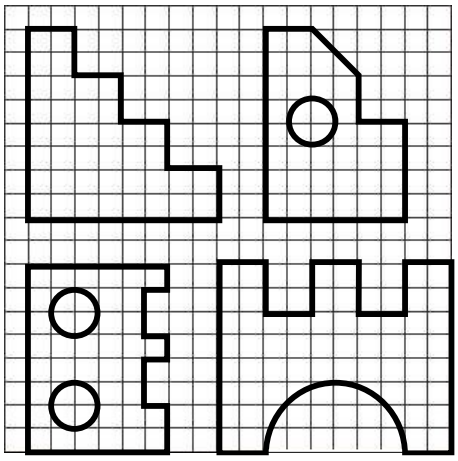
According to the European standard, the overhead view is always drawn **below** the front view, and the **left** side view is drawn to the **right** of the front view (see image).

Activity: Copy following exercises and solve them in your notebook

3) Copy these tables in your notebook and convert the measurements to the units indicated:

13 cm	mm	1,2 km	dam	110 cm	hm	0,24 m	mm
0,55 mm	m	2,7 m	mm	3,3 dam	km	245 cm	mm

4) Copy the four next figures following the squares of your notebook and leaving enough space between them to dimension them correctly. Each square represents 10 mm.



5) Calculate the scale of the previous exercise.

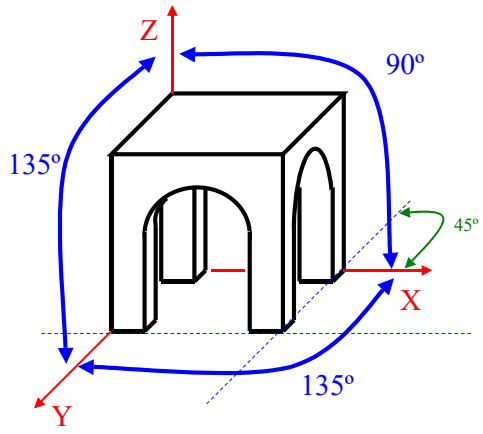
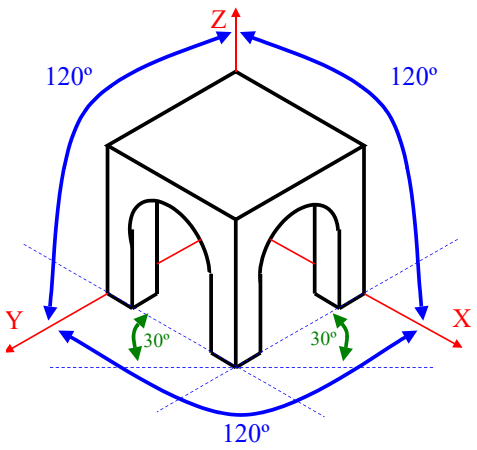
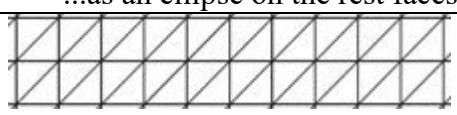
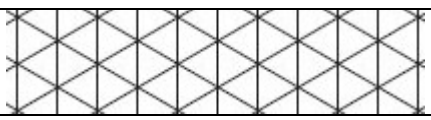
6) Work with the computer to solve the view-exercises proposed by your teacher:
View exercises (website) http://www.educacionplastica.net/zirkel/vistas13.html

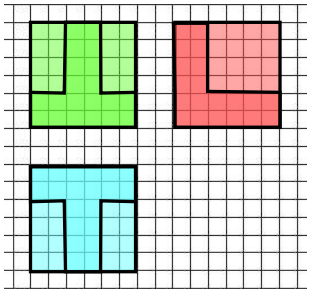
7) Represent full scale in your notebook the three views of some of the figures of the previous exercise (consider that each square in the computer represents 20 mm), and dimension it (be careful to avoid repeating information).

3.1.3. Perspective.

We us perspective to view an object in three dimensions (3D). The most common perspectives are cavalier and isometric. Both are are parallel projections; therefore:

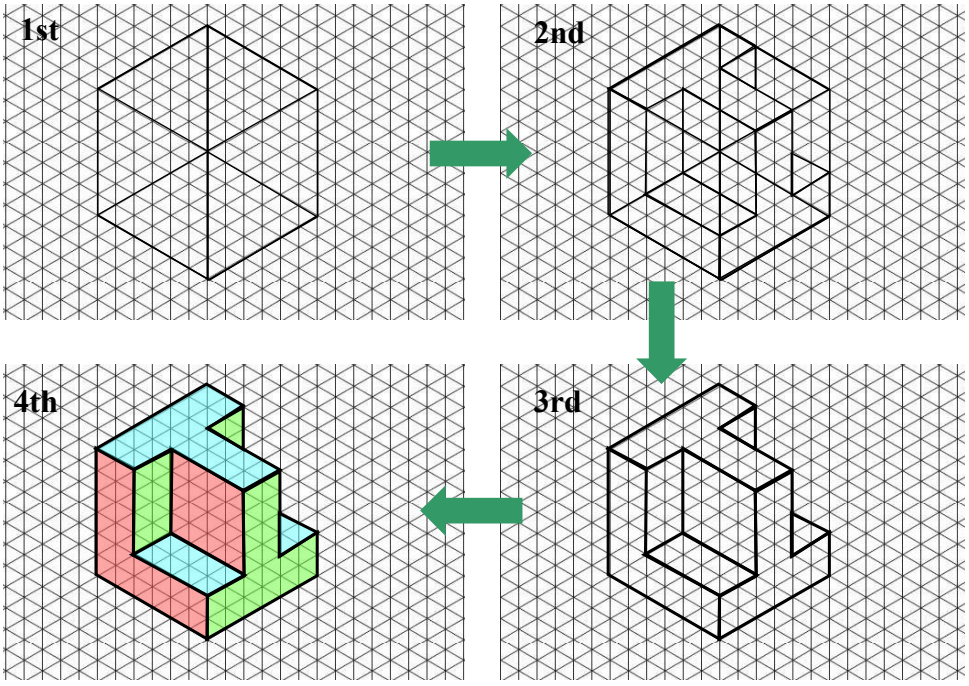
- parallel edges and surfaces of an object are also drawn parallel
- the vertical edges are always drawn vertically.

	Cavalier perspective	**Isometric perspective**
		
Angle between axes	90º between X and Z axes; rest 135º	120º
Reduction on the axes	Only on Y axis: usually half the size	No; all axes have the same scale
A circle is represented	... as a circle on the front (X-Z plane) ...as an ellipse on the rest faces	...as an ellipse on all the faces
Graph paper		



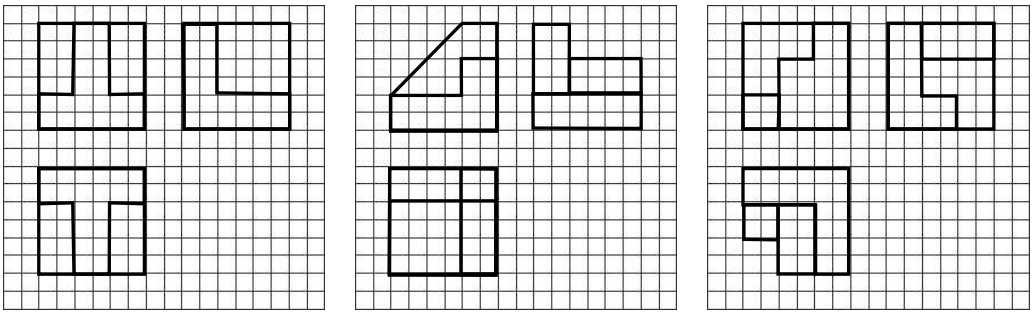
Drawing in perspective a figure on graph paper using views:

1. Draw with fine lines a box in perspective as big as the figure.
2. Include the details with fine line, paying attention to the measurements.
3. Profile the not hidden edges with heavy lines and erase unnecessary lines.
4. You can colour the faces to identify them with the views.



Activity: Copy following exercises and solve them in your notebook

8) Draw the isometric and cavalier perspectives of the following figures, imagining that they are inside a cube of 3 cm side.



3.2. 3D printing

3D printing refers to a revolutionary[2] manufacturing process of three-dimensional objects, in which successive layers of material are added under computer control.

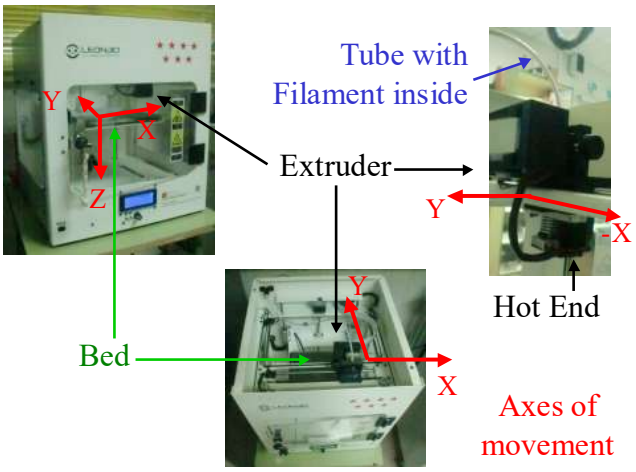
In a broad industrial context, it does not compete, but complements traditional manufacturing methods as e.g. that of machining (mecanizado).

Method	Type	Industrial revolution	Main materials	Advantages
Machining	substractive	1st and 2nd	Metal, Wood,...	strength
3D Printing	additive	3rd ?	Plastic, Food,...	very intricate designs

[2] 3D printing is also known as additive manufacturing (AM), a "material-friendly" method accessible to anyone ("manufacturing democratization").

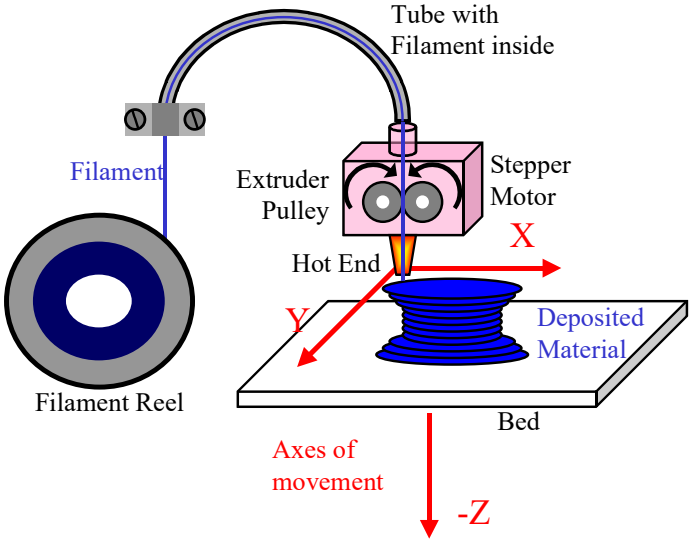
3.2.1. Printer

A 3D printer works like a hot glue gun, whose movements are controlled by a computer.



The LEON3D printer consist of:

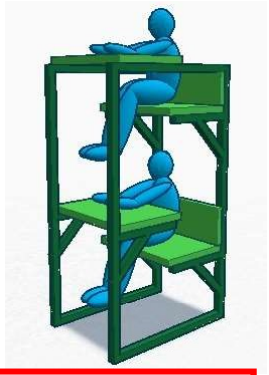
- **Hot End**: melts the plastic filament, which is pushed through a small nozzle to expel a thread that builds the layers of the object.
- **Extruder**: feeds the filament to the hot end and moves along the X-Y plane according to the shape of the different layers.
- **Bed**: moves down along the Z axis each time a layer is finished to allow the next layer to be added on top.

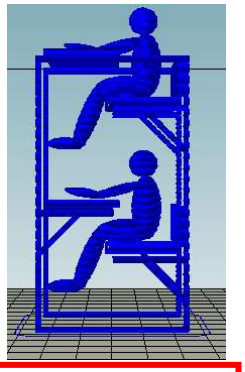


3.2.2. Process

The process consist of:

- **3D Design**: Graphic design programs are used and the file must be saved in STL format.
- **Slicing**: Slicing programs determine the number and order of plastic layers of the design and translate the file into GCODE format, which is understood by the printer.
- **Printing**: The GCODE file is copied to a memory card that is read by the printer.





3D DESIGN (stl format) → SLICING (gcode format) → PRINTING (sd card)

How to load the filamential (video): http://tecnorobot.educa2.madrid.org/tecnologia/-/visor/video-impresora-lion-3d-carga-de-material
How to calibrate the bed (video): http://tecnorobot.educa2.madrid.org/tecnologia/-/visor/video-impresora-lion-3d-calibracion-
How to print with the SD card (video): http://tecnorobot.educa2.madrid.org/tecnologia/-/visor/video-impresora-lion-3d-imprimir-desde-tarjeta-microsd

3.2.3. Programs

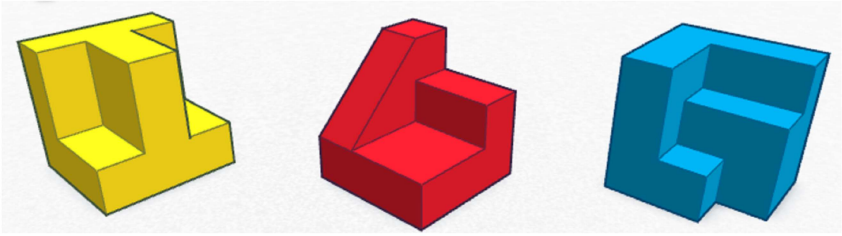
Program	Type	Remarks / link
Tinkercad	3D design	Online. Ideal for beginners. https://www.tinkercad.com/
SketchUp	3D design	Offline. Easy to use. http://www.sketchup.com/es
Slic3r	Slicing	http://slic3r.org/
Repetier-Host	Printer control	https://www.repetier.com/

Activity: Copy following exercises and solve them in your notebook

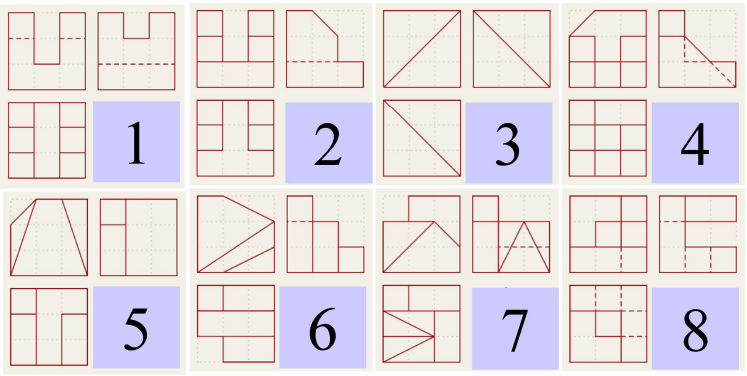
9) Do you think that 3D printing can be considered the 3rd industrial revolution? Why / why not?

10) In a 3D printer there is a stepper motor in the extruder. What for? How many other stepper motors do you think are in the 3D printer? What for?

11) Designing in Tinkercad: Create a account in Tinkercad and design the three pieces of exercise 8.



12) Designing in Tinkercad: Design following 8 figures, imagining that they are inside a cube of 3 cm side. Tell your teacher to help you printing them.



13) Repeat exercise 12, but using SketchUp. (To learn how to use this program, click on http://www.sketchup.com/es/learn; clue: to create a rectangle instead of the '2nd clicking' on the diagonal, you can type the measurements directly (e.g. "30;20").

14) Design your ideal classroom using SketchUp.