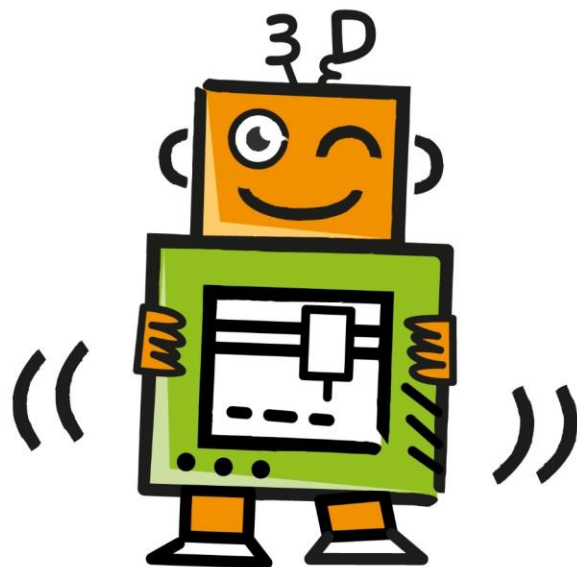




EMPOWER3D

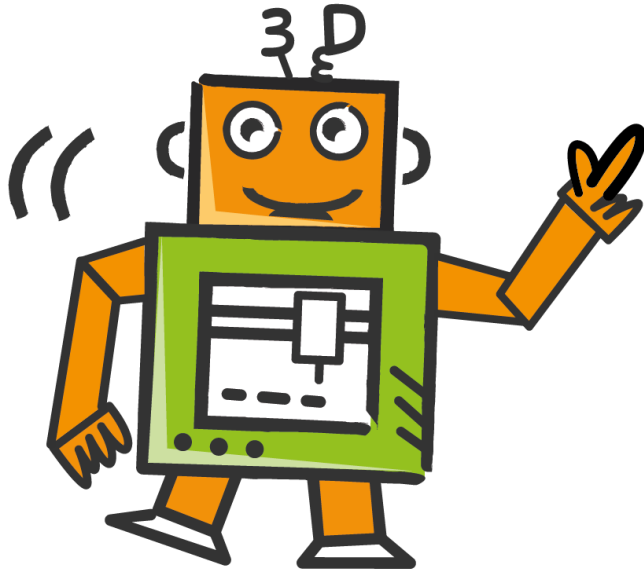
Empowering the engineers of
tomorrow through 3D printing



MUNI



Co-funded by the
European Union



1 – An Introduction to 3D Printing

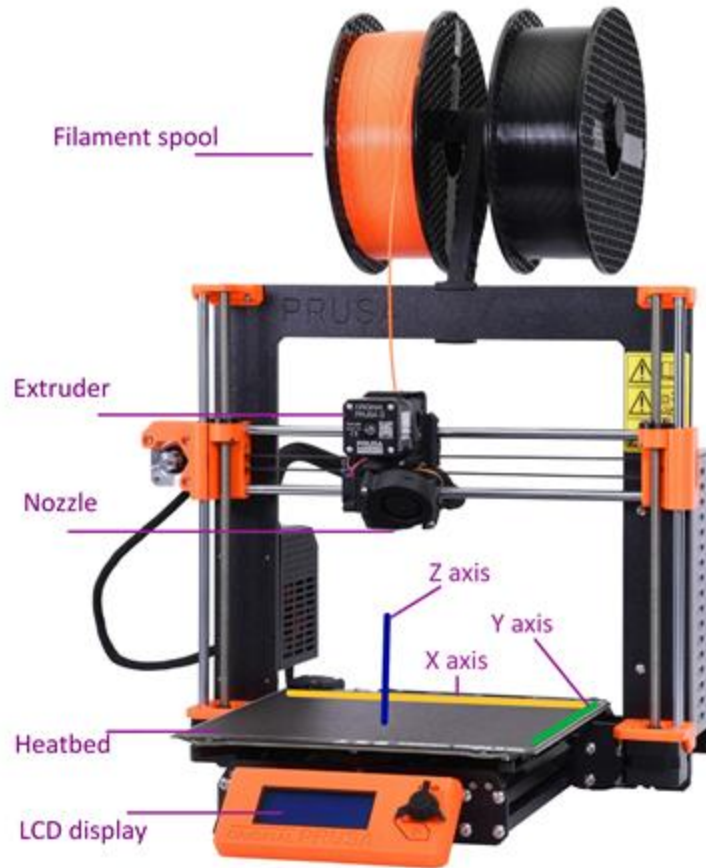
1.0 Introductions

- Intro from partners
- Interest / experience in 3D printing
- Training programme expectations
- Programme overview

1.1 What is 3D printing?

- Construction of a 3 dimensional object from a digital model
- Additive manufacturing - laying down layers of material until the object is completed
- Produce complex 3D objects that can be impossible to make by hand
- Timelapse of 3D print

Printer X, Y, Z axis



Subtractive modelling process



3D Printing used in industry



Aerospace



Automotive



Healthcare



Construction



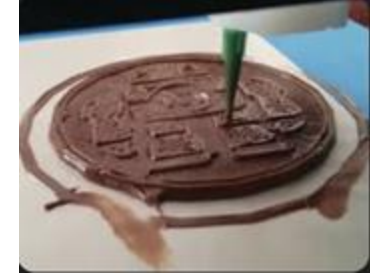
Consumer Goods



Education



Art & Design



Food

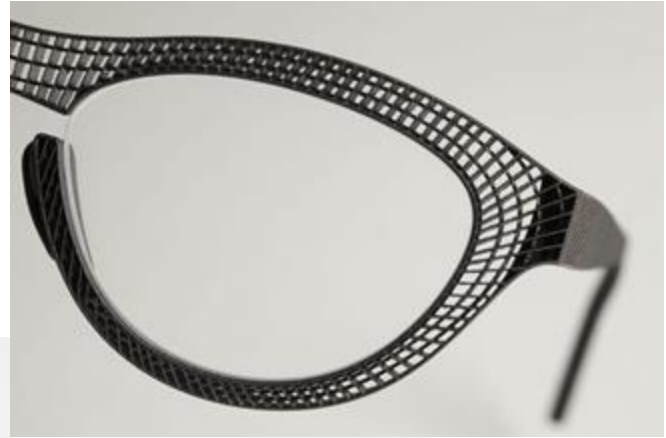
3D printed jewellery



3D printed footwear



3D printed eyewear



3D printed orthopaedics



3D printed prosthetics



Women in STEM in the EU

- Represent 33% of STEM graduates
- Represent 41% scientists and engineers
- 12% engineering, 21% ICT specialists, majority life and social sciences
- Represent 26% in leadership roles in STEM, earn 81% of male counterparts
- Minority women represent 10% of STEM workforce

Benefits of 3D printing in the primary curriculum

- Fosters creativity, innovation, problem-solving skills
- Supports STEAM learning:
 - Science: materials, structures, forces
 - Maths: geometry, shapes, special reasoning
 - Technology & Engineering: Hands-on experience designing, building testing prototypes
 - Arts: Creation of unique designs

1.2 3D printing during a global pandemic

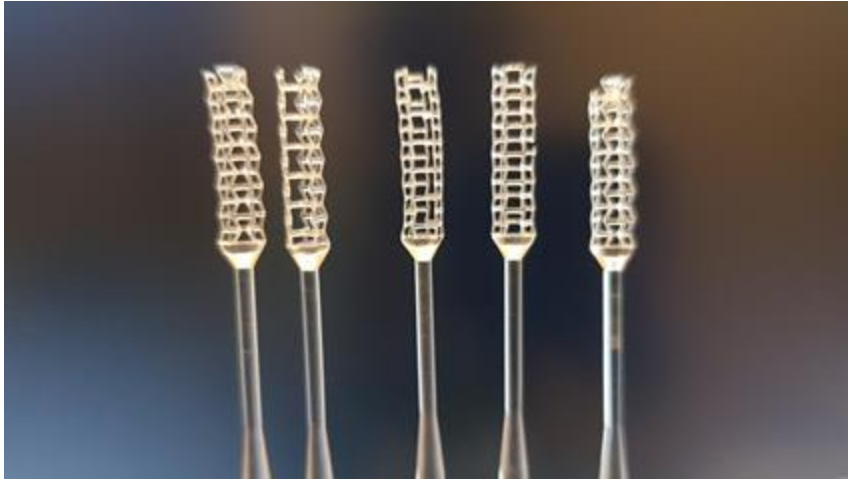
Charlotte valve



Face mask



Nasopharyngeal swabs



Training aids



Make 3D Company - Gambia's first 3D printing company 2019

3D printed housing



3D printed body parts



1.3 Main components of a 3D printer

- **Printer bed:** The surface of a 3D printer where the material is placed in layers to form a printed object.
- **Motors:** The parts that allow the print head to move along the X Y and Z axis
- **Extruder:** The part that ejects the semi liquid filament through a nozzle onto each print layer
- **Filament:** A continuous plastic thread which comes in a spool. It is fed into the extruder where it is melted before being ejected through the nozzle to form each layer of the print object.

Health & safety

- Nozzle is heated to over 200 degrees celsius. Keep away from skin and clothing when in operation.
- Printer is connected to mains electricity supply. Do not carry out maintenance while printer is plugged in.
- Motors move while printer is in use. Keep body and clothing away from motors when in operation.
- Some plastic filaments release ultrafine particles when heated. Ensure good ventilation while printer is in operation.
- **It's important that schools include 3D printer and associated activities along with other school equipment and activities on their insurance policy.**



Activity: Label 3D Printer Diagram

Using the given handout, please label the parts that you have learned about so far.

1.4 3D Printing Materials

- Plastics
- Powders
- Resins
- Metals
- Carbon Fiber
- Graphite and Graphene
- Nitinol
- Paper
- Wood



PLA



ABS



PETG



Flexible





PLA

PLA (Polylactic Acid) is a biodegradable, plant-based material derived from renewable resources like corn starch or sugarcane. It's one of the easiest materials to print. It is inexpensive and suitable for beginners and quick prototypes that don't require high mechanical, chemical, or temperature resistance. PLA has a lower printing temperature and releases fewer ultrafine particles (UFPs) and volatile organic compounds (VOCs) compared to other filaments, making it a popular choice for use in schools and homes.



ABS

ABS (Acrylonitrile Butadiene Styrene) is a petroleum-based, non-biodegradable plastic with a higher printing temperature than PLA. It is known for its strength and durability, making it suitable for various applications. However, it emits more UFPs and VOCs, such as styrene, which can be harmful when inhaled. It is advised to use ABS in well-ventilated areas and with an air filtration system to minimize exposure to potentially harmful emissions.



PETG

PETG (Polyethylene Terephthalate Glycol): PETG is a copolymer of PET, modified for better printability. It combines the best of both PLA and ABS, offering strength, durability, and flexibility. PETG is considered safe to use, as it releases fewer particles and VOCs than ABS. However, it is still recommended to use PETG in a well-ventilated area and with proper air filtration.

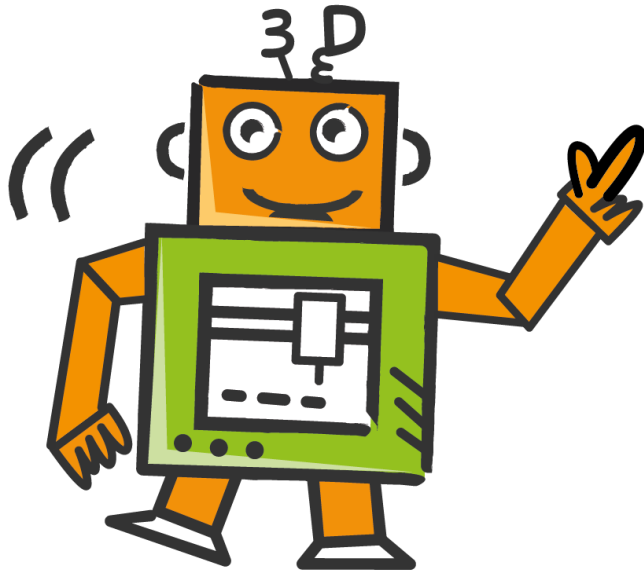


FLEXIBLE MATERIALS

TPU (Thermoplastic Polyurethane): TPU is a flexible, rubber-like material that is resistant to abrasion, wear, and chemicals. It is generally considered safe to use, but it is essential to ensure proper ventilation and air filtration when printing with TPU.

1.5 Popular 3D printing types

- **Fused Deposition Modelling (FDM)** - plastic filament is extruded layer by layer onto a build platform
- **Stereolithography (SLA)** - UV light is applied which hardens liquid resin layer by layer
- **Selective Laser Sintering (SLS)** - melts powders (nylon or a polyamide) into solid plastic (and other materials like metals)



2 – 3D Printing and Sustainability

2.1 3D Printing and Sustainability

Additive vs Subtractive manufacturing

The carbon footprint of additive manufacturing versus conventional manufacturing is highly dependent on the specific application, production scale, and materials involved. Some of the potential benefits:

- Material efficiency
- Lightweight designs
- Reduced transportation emissions
- Lower production energy consumption
- Use of sustainable materials

The Circular Economy

The circular economy is a sustainable model that minimizes waste, reduces resource consumption, and maximizes product value throughout their life cycles. It contrasts the traditional linear "take-make-waste" economy.

The circular economy focuses on three principles:

- Designing out waste and pollution
- Keeping products and materials in use through durability, repair, and reuse
- Regenerating natural systems using renewable resources and regenerative practices

Ellen MacArthur Foundation's [Circular Economy](#) project



dezeen.com



- Speed & efficiency
- Customisation
- Materials optimisation
- Affordable housing solutions
- Disaster relief in remote locations
- Eco friendly materials
- Energy efficiency
- Integration of services
- 3D printed homes



inhabitat.com



manufacturingtomorrow.com

- Printing furniture on demand reducing inventory, space and waste
- Printing close to customer cuts down on transportation, uses source materials closer to the site, eliminating supply chain and logistical issues and delays, localising manufacturing



Each stage of a product's life cycle has its own environmental, social, and economic impacts which need to be considered when assessing the overall sustainability of a product.

1. Raw material extraction
2. Material processing
3. Manufacturing and production
4. Packaging and distribution
5. Retail and consumption
6. Maintenance and repair
7. End of life management
8. Product recycling and reuse

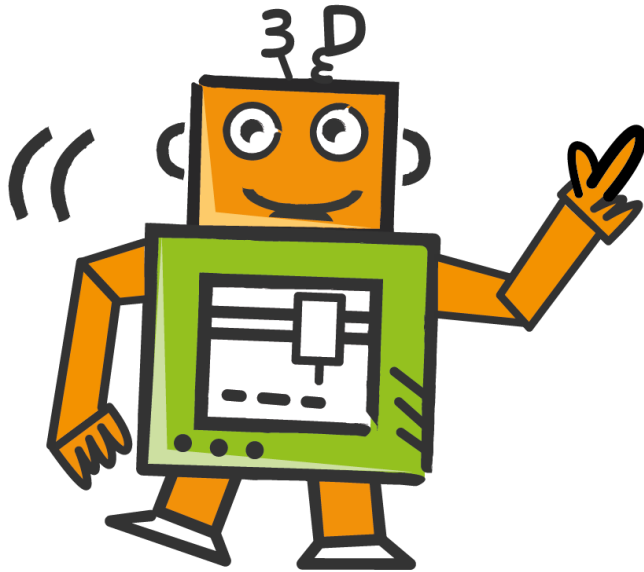


3Dprint.com

- Consumer level 3D printers have fairly low energy consumption (50 – 100 watts per hour of printing)
- Plastic packaging waste for use as raw materials for 3D printing is becoming more possible
- PLA Recycling is possible through organisation link Precious Plastics
- Some other 3D printed materials (ABS, resin, metal powders) require specific disposal methods
- 3D printed wood

How 3D printing supports a more sustainable world

1. More Efficient Designs
2. Less Raw Material – progress on more sustainable raw material
3. Repair Culture Development ([EU Right to Repair](#))
4. Localised Making
5. Inventory Elimination
6. Manufacturing Streamlined
7. Smaller factories



3 – An Introduction to 3D Design Software

3.1 What is 3D design software

- Digital version of a 3 dimensional object
- Allows users to visualise, design and control objects
- TinkerCad is a free browser-based software
- Introduction to TinkerCad
 - [Video 1](#)
 - [Video 2](#)

3.2 First 3D printed design



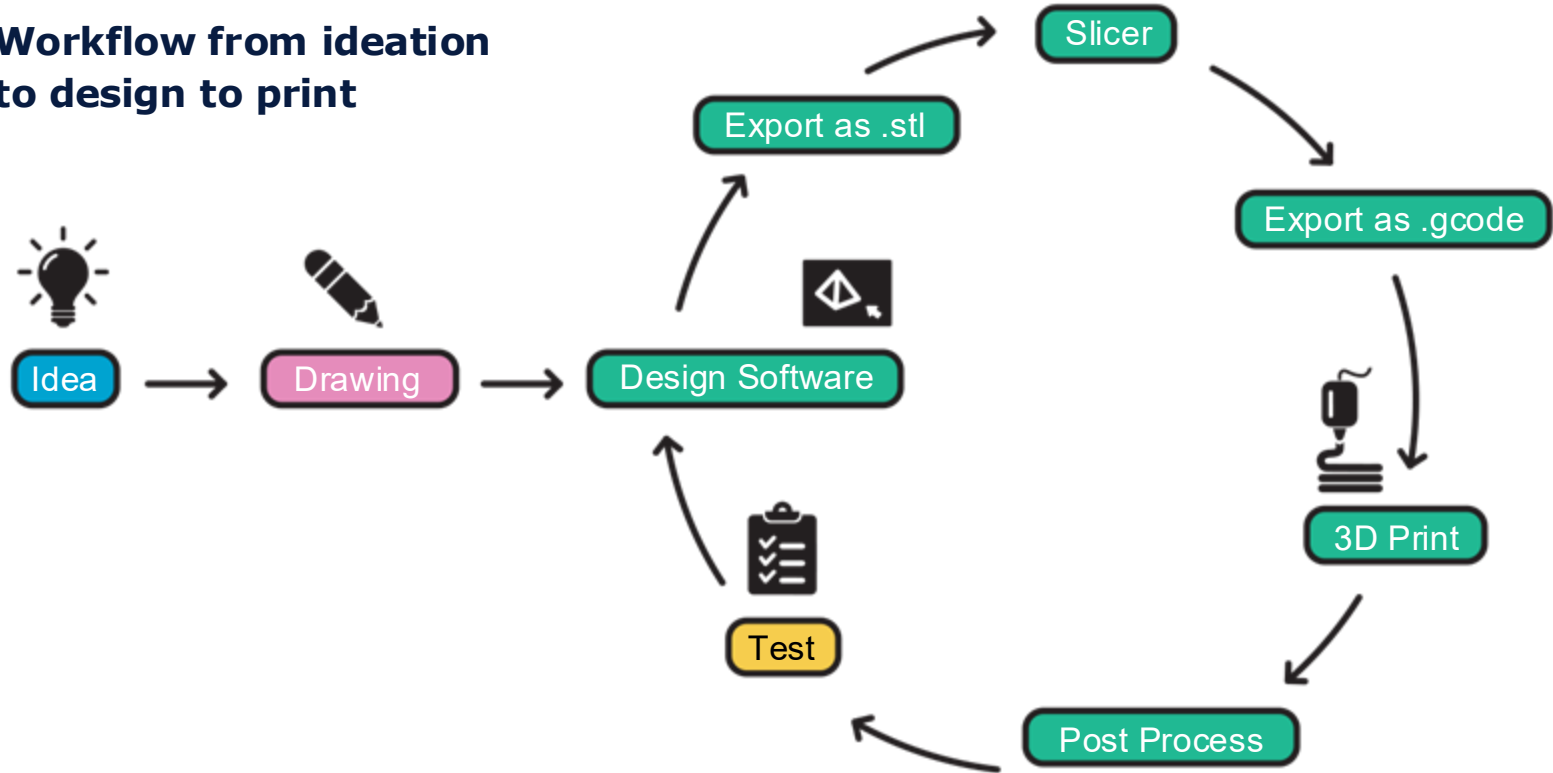
Activity: Design & Print a Basic Shape

Design a simple child's toy which teaches understanding of basic shapes

Design parameters:

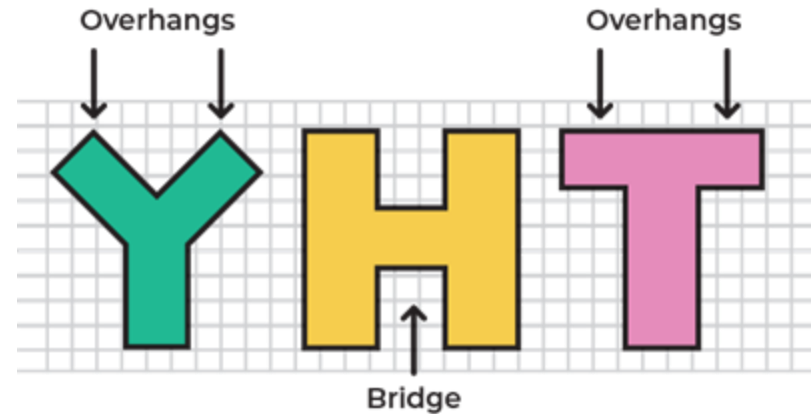
- 100mm x 100mm x 100mm max

Workflow from ideation to design to print



3.3 A closer look at 3D design

- When are supports needed
- [3d printing tips 1+2](#)
- Tip #1: Design parts with a flat base
- Tip #2: Avoid steep overhangs



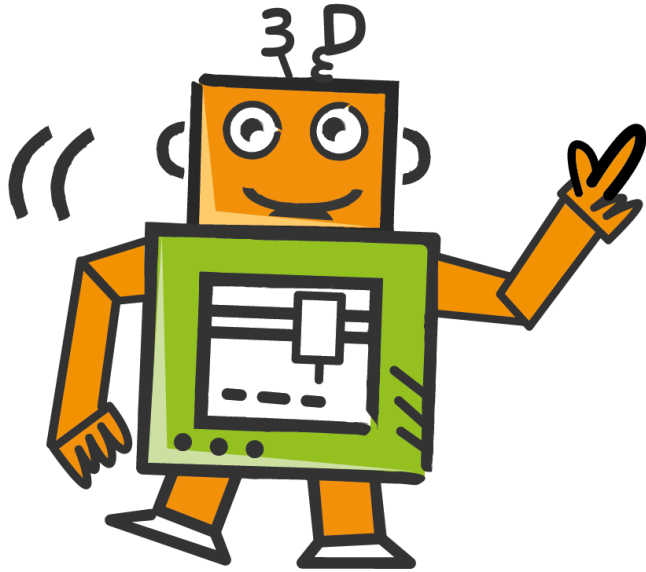
3.4 Further work with TinkerCad

Video 3

Cruise, Snap Grid, Patterns, Lock

Video 4

Snap Parameters, Shape Generator

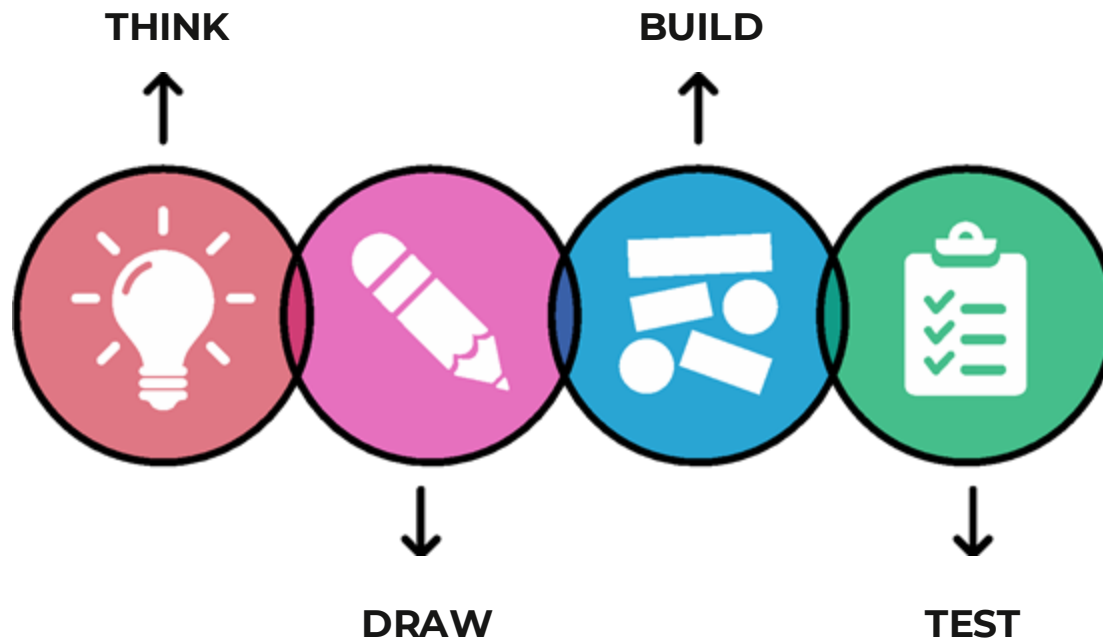


4 – Design Thinking

4.1 An introduction to Design Thinking

- Process used by many innovators in many fields, including art, music, science, engineering, software development, education, manufacturing and retail
- Human-centred technique used to solve problems using an iterative process
- Importance of understanding of the user - empathy
- Asking questions, challenging assumptions, and testing designs

Design Thinking



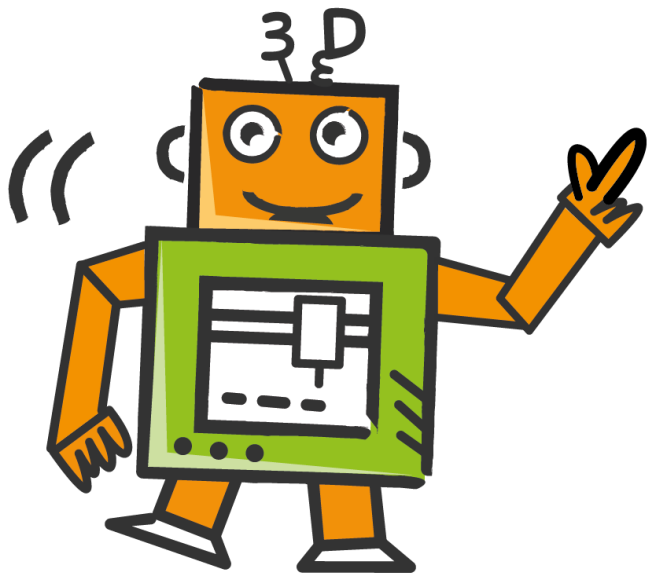
Description of the Design Thinking process

-  **THINK:** What problem are you trying to solve?
-  **DRAW:** Sketch a possible solution to the problem
-  **BUILD:** Quickly make a rough version of your solution
-  **TEST:** Test the prototype and see what tweaks are needed

4.2 Classroom Tool mini-challenge



Activity: Using the design thinking process, design a tool that solves a problem that a teacher has in the classroom



5 – A Further Look at 3D Design Software

5.1 A closer look at slicer software

- Middleman between the 3D design software and the 3D printer
- Print size, filament, shell thickness, layer height, infill, supports, etc
- In-built profile settings produce good results
- [Prusa Slicer Essentials](#) video resources

5.2 Tips for successful 3D designing and printing

- [3D printing tips 3, 4, 5](#)
- Tip #3: Layer line direction dictates strength
- Tip #4: Pay close attention to size
- Tip #5: Be patient and iterate

5.3 Review TinkerCad Resources

Projects

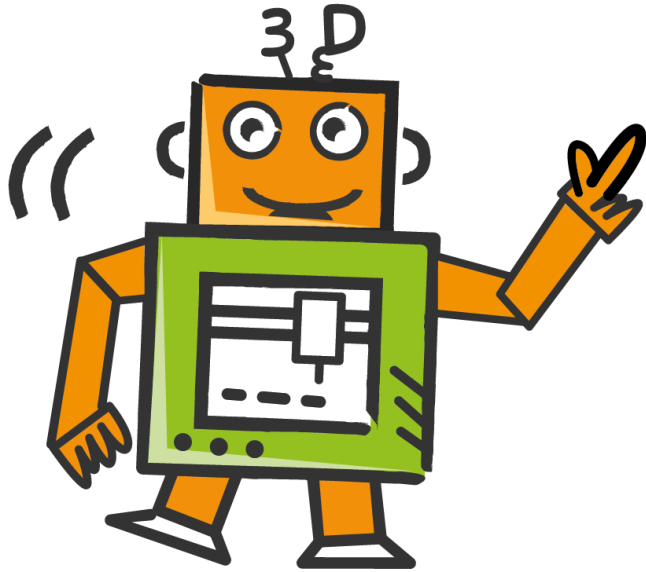
- Review TinkerCad and practice your skills!

Lesson plans

- Discuss possible challenges around introducing 3D printing activities to your classroom

5.4 TinkerCad in the Classroom

- Creating lessons and sharing with students
- Viewing and managing students' work
- TinkerCad in the classroom



6 – 3D Printer Maintenance

6.1 3D printer maintenance

General cleaning

- Wipe down each part of the printer with a microfibre cloth
- Compressed air for hard to reach components

Cleaning bed & nozzle

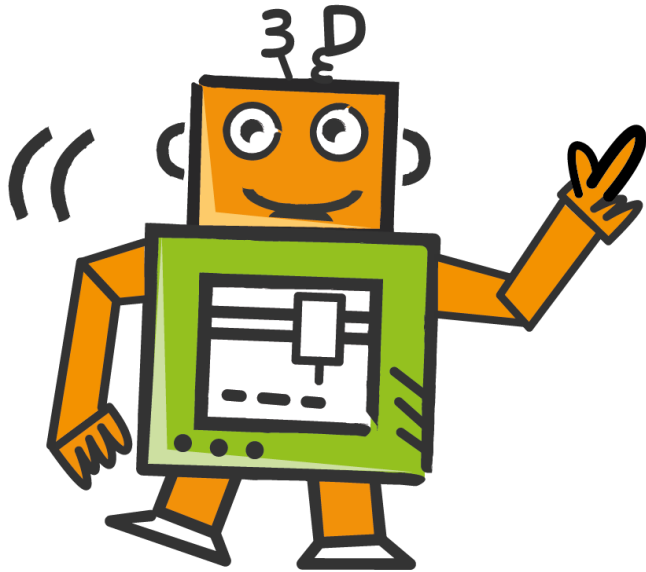
- A clean bed helps with print adhesion. Wipe down your printer bed using the recommended cleaning product for your bed

Lubrication

- Check your axis rods, if dry, apply a small amount of grease

Firmware updates, calibration

- Each printer will have its own diagnostic and calibration procedure – see printer documentation for details



7 – Conclusion

7.1 Industry talk

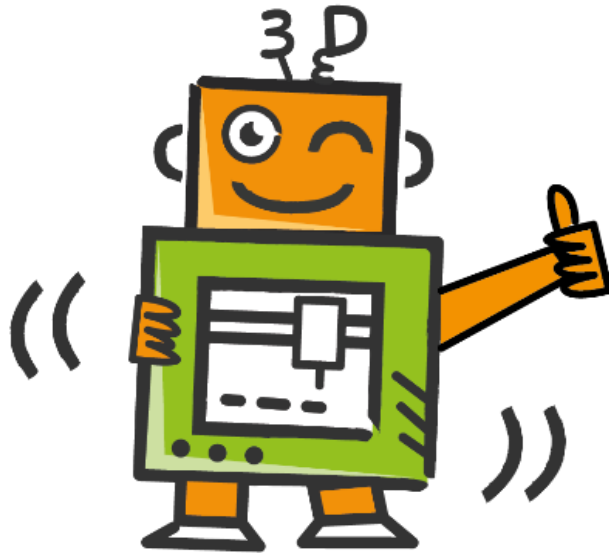
- Presentation from Project Partner or Industry Partner

7.2 Classroom Challenge

- Details of the challenge competition for primary schools
- Examples of previous participants

7.3 Next Steps

- Course reflection + feedback (Please complete the surveys!)
- Content, additional skills & supports needed, etc.
- Dates for challenge competition



END

Slide References

Slide 5: Prusa.com

Slide 6: Shy Greek Sculpture by cogdogblog

Slide 8: MeerschamDigital
3ders.org
Formlabs 2021

Slide 9: The Bit Shoe by Earl Stewart
The Bridge Shoe, London School of
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The Nike 3D Printed
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Slide 10: 3d printing industry
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Slide 23: Prusa.com

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