DOI²T: 3D Printing

Lesson Plan:
Print a Whistle

(Created 2018)

Activity Description:

- Learner uses computer software and a 3D printer to print a pre-designed whistle.

Goal Path:

- Employment, Independence, Postsecondary.

OALCF Competencies + Task Groups:

- A. Find and Use Information.
  - A1.1 Read brief texts to locate specific details.
- B. Communicate Ideas and Information.
  - B1.1 Participate in brief interactions to exchange information with one other person
  - B4. Express oneself creatively, such as by writing journal entries, telling a story and creating art.
- C. Understand and Use Numbers.
  - C2.1 Measure time and make simple comparisons and calculations
  - C3.1 Measure and make simple comparisons and calculations.
- D. Use Digital Technology.
  - D.2 Perform well-defined, multistep digital tasks.

Milestones:

- 55: Conduct an Internet search.
  - While this is a very popular milestone, it remains the only milestone decently relevant to this activity.

Learning Objectives:

- Understand more about computer software by using the 3D printing program.

- Demonstrate an understanding of numbers and measurement by using 3D printing software to coordinate/scale the design to fit the 3D printer itself (i.e. the build plate).
- Apply creativity by choosing a 3D design to create.
- Demonstrate understanding of instructions by completing all designated activity steps.

Physical Equipment and Supplies:

- 3D printer.
- Computer with 3D printing software specific to the 3D printer.
- PLA filament (i.e. the 3D printer ink).
- Needle-nose pliers.
- Other optional but useful tools:
    - Small knife.
    - Sandpaper or wood files.
    - Wire cutters.

General Notes to Practitioner:

- This activity requires a basic understanding of digital technology. The learner must have a general familiarity with the following to succeed in this activity:
    - Internet (i.e. how to use a search engine and how to find websites).
    - Websites' search functions (i.e. how to find the "Search" bar of a website and use it).
    - Digital files (i.e. know the difference between .doc .pdf .stl etc., and know how to download them).
    - Connectability (i.e. know that the internet or a cable can be used to connect the 3D printer to the computer).
- Class size and projected activity times:
    - This is a hands-on activity, therefore the class size is dependant on the number of 3D printers and practitioners available. One learner per 3D printer is recommended, though two learners per 3D printer can work.
        - The main issue with two learners per 3D printer is that one person will exit the lesson without a whistle in hand. This problem can be somewhat solved by printing extra whistles to reward the learners at the end of the lesson.
    - It is recommended to for facilitators to work with no more than three 3D printers and/or learners per lesson.
    - The overall activity takes between 45 and 75 minutes to complete. The software time takes approximately 30 minutes, the 3D printing approximately 30 minutes.
- Setup:
    - Computer:

        - Have the computer plugged in, or with enough battery power to last at least two hours.
        - Have two programs open on the computer: the 3D software, and a general search engine.
        - Have the computer connected to the 3D printer via USB or Wi-Fi.
    - 3D printer:
        - Have the 3D printer loaded with PLA filament.
        - Make sure the 3D printer is plugged into a reliable power source.
            - If the 3D printer loses power (i.e. the power cable is unplugged), the print will not be saved.
        - It is highly recommended to perform a test print just to make sure the 3D printer is working. The print can always be cancelled after a few minutes once it is clear that the 3D printer is operational.

Detailed Activity-Steps/Process:

Step 1 – Introduction

- Give an overview of the activity to learner.
    - Identify **3D printer**.
    - Identify **filament**.
    - Identify 3D printing **software**.
- Show learner a picture (or physical version) of the completed **whistle**.
- Provide overview of the 3D printer, its parts, and how it works.
- Then situate learner on the designated computer.

Step 2 – *Thingiverse*

- On the designated computer, have learner search and access the ***Thingiverse* website**.
- Explain to learner that this website is home to countless 3D designs.
    - Explain what an **STL file** is: it's a 3D design file.
    - Explain how it is not impossible to create custom 3D designs, it just takes much more time (if they are interested, suggest exploring *Tinkercad* on another date).
- On *Thingiverse*, have learner search for and locate the whistle design titled "Better Whistle" created by crkoolkid.
    - If time permits, this is a good moment for learner to explore *Thingiverse*, and this exploring and the discovery of other designs is usually the hook to future learner engagement.
- Have learner download the STL file version of "Better Whistle."
    - Note that because STL files are often quite large, all *Thingiverse* downloads happen in **zipped folder**s.

Step 3 – Upload and configure STL file

- Open the computer's 3D printing software.

    - i.e. For MakerBot, open the MakerBot Print software; for M3D, open the M3D software.
- The software's main screen/view should be of a blank **digital build plate**.
- Find the "Better_Whistle" download, and unzip the file.
    - This will create another identical file also called "Better_Whistle".
- Using the 3D printer software, upload the STL file of the whistle.
    - This STL file will be titled "whistle_fixed" and will be found in the unzipped "Better_Whistle" file.
- The 3D whistle design should appear on the digital build plate.
    - This design is a good design because it does not require resizing/scaling or repositioning of the design on the digital build plate.
- Configure the whistle so that it print's WITH a raft and WITHOUT supports.
    - Finding these options in the 3D printing software will take a little searching. They are likely found under a title/icon called "**Print Settings**."
    - **Supports** are extra braces, or scaffolding, that the 3D printer creates to help support overhanging sections of the 3D design. These **scaffolds/braces/supports** easily snap off when the print is finished. Specifically for the whistle design, if the print accidentally has supports, the supports/braces/scaffolding will be within the finished printed whistle, and they will be impossible to snap/remove from inside the whistle, and the whistle will not work.
    - A **raft** is a flat plastic base that the 3D printer creates on the **build plate** and under the 3D print. A raft can be useful because sometimes the first layer of PLA filament has difficulties adhering to the build plate. The raft, like the supports, easily snaps off when the print is finished.
        - If there is time to try test prints, try playing with raft settings. Some 3D printers only need rafts for the occasional design, and some 3D printers seem to need rafts for all prints.

<u>Step 4 – Prepare the 3D printer</u>

- Do the obvious: make sure the 3D printer is plugged in, turned on, and connected to the computer (via USB or Wi-Fi).
- Make sure that the build plate is empty.
- Make sure the 3D printer is properly loaded with PLA filament.

<u>Step 5 – Print</u>

- Using the 3D printing software, print the whistle.
    - Depending on the 3D printing software, the button will likely say "Print" or "Send to Printer."
- Depending on the 3D printer, the "Accept" or "Agree to Print" button on the 3D printer **control panel** itself (this is true for MakerBot 3D printers) may need to be pushed next.
- Depending on the printer, the print settings (i.e. raft and support settings) might only be manipulatable at this stage (this is true for M3D printers). Set them to the recommendations stated above (i.e. rafts on, supports off).

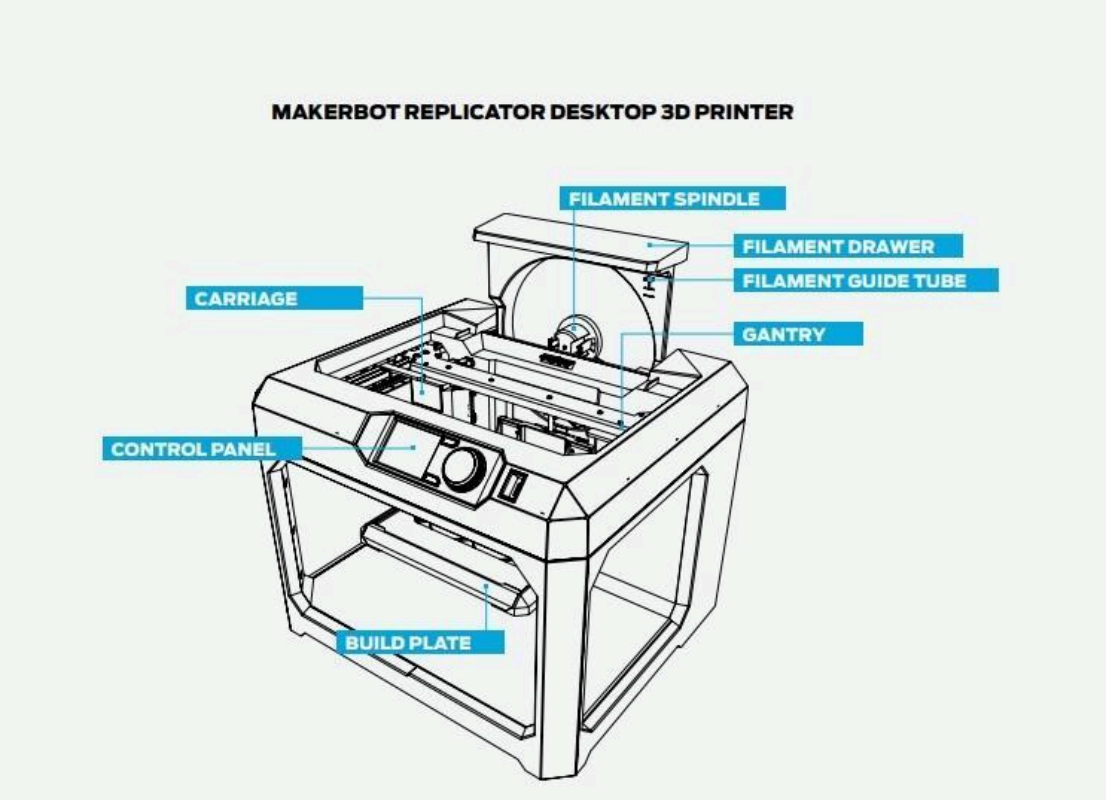
- Several preparation stages will now happen autonomously. These stages can take up to five minutes for this design, and often longer for larger or more complex designs (On MakerBot 3D printers, the control panel identifies each stage as it progresses):
    - The extruder will take time to preheat.
    - The software will transfer the STL file to the 3D printer.
    - The 3D printer will test distances, level, and then align itself.
    - Some 3D printers will extrude some filament to make sure it is not jammed/clogged.
- The 3D printer will begin printing. The print will take between 20 and 30 minutes.
    - If something goes wrong, cancel the print, remove the failed project/PLA filament material, fix the problem (remove support settings, add raft, etc.), and start again.
- The print will finish! Most 3D printers have a special noise to notify users when the project is complete.

<u>Step 6 – Remove and groom the whistle</u>

- Remove the whistle from the build plate. This might take some force/muscle/pliers.
    - If the whistle is really stuck to the build plate, use something really flat and sturdy, like **a thin knife**, to pry off the whistle.
    - Some 3D printers have a removable and flexible build plate (i.e. MakerBot and M3D). If a print is real stuck to the build plate, remove the build plate and then flex the build plate until the print pops off.
- Remove the raft and any extra material.
    - With some pressure, the raft should snap right off.
    - Sometimes the raft adheres completely to the whistle base, and when attempting to snap off the raft, parts of the raft crack and stay attached to the whistle, leaving one rough whistle edge. In this case, simply use **pliers**, **wire cutters**, and/or a **wood file** to remove and smooth the rough side of the whistle.
- Pry the whistle **pee (the little ball inside the whistle)** free from the inside wall of the whistle by using a knife, screwdriver, or something else thin and strong.
- Smooth the edges of the whistle with the wood file or **sandpaper**.
- Done! Watch out; it's really loud!

Extra Online Resources:

- *Thingiverse*
    - The foremost website for finding STL files. Website is owned by MakerBot, but STL files can be used on any 3D printer.
- *MakerBot* (website): makerbot.com/learn
    - The most comprehensive online resource hub for 3D printing. Most things are free, but you must have an account.
    - They provide the following 3D printer diagram:



- MakerBot's YouTube channel, *MakerBot for Educators*: https://www.youtube.com/playlist?list=PLvy119PeSK5icIT1tqIgthG49vxEn6F7w
    - MakerBot has a heavy YouTube presence, much of which is irrelevant to beginner-users. The *Educators* page is better curated to beginner/learner needs.
- *Tinkercad*
    - The foremost website for creating and personalizing 3D STL files from scratch (but code-writing skills are not needed; it's not that advanced of a program).
    - Note that this program can be quite difficult to use, even for most digitally attune learners. However, if a learner is keen to advance their 3D printing skills, using *Tinkercad* is an important next step.
- Ground 3d, "How does 3D Printing work?" a video introduction to 3D printing: https://www.youtube.com/watch?v=dnIVrLqrEI8