BIOPRINTING

3D bioprinting is the process of creating cell patterns using 3D printing technologies, where cell function is preserved within the printed construct.

You will simulate the bioprinting process by:

1. Estimating the dimensions (l, w, h) and volume of an organ

2. Estimating how much filament (print material) you need

3. Designing a model of the organ in a 3D drawing program

4. Printing your model on a 3D printer in the Startup Incubator

Example – Brain

1. Estimate the dimensions (l, w, h) and volume of the organ

Average brain length = 167 mm = 16.7 cm

Average brain width = 140 mm = 14 cm

Average brain height = 93 mm = 9.3 cm

Source: https://faculty.washington.edu/chudler/facts.html

Average brain volume =   l   x   w   x   h

= 16.7 cm x 14 cm x 9.3 cm

= <u>2174 cubic centimeters</u>

2. Estimate how much filament is needed

To do this, we must first figure out how much filament is used to print a unit cube. A *unit cube* is a cube with volume 1 cubic centimeter. This is a cube that is 1 cm (or 10 mm) on each side. Here is the unit cube in TinkerCad.
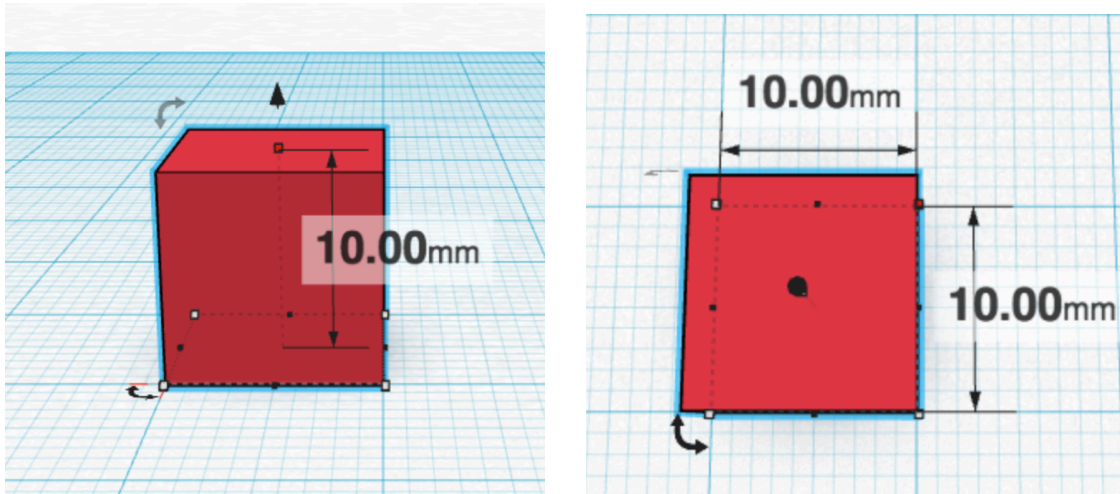

Here is the unit cube ready to print in FlashPrint. With the settings you will use to print (30% fill and other attributes), it will use 0.34 m of filament.
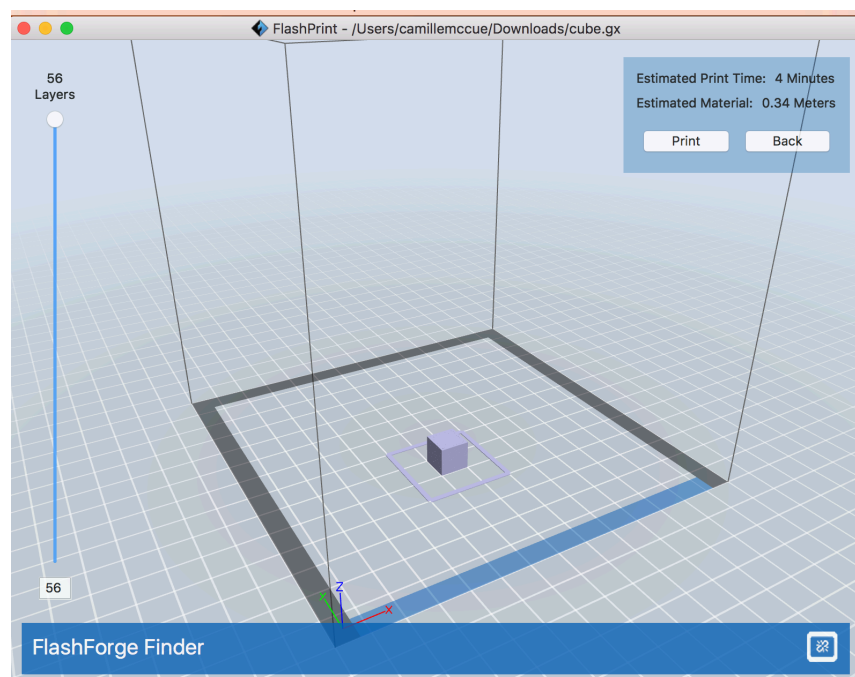
Filament used for the brain = volume of brain x filament per unit cube

                                    = 2174 cubic cm x .34 m filament per cubic cm

                                    = <u>739 m filament needed</u>

*** NOTE: This is an overestimation. Sides require a lot of filament, and interior fill requires less.   By computing the filling of the volume with lots of unit cubes, you are including many sides that will not actually exist in your print. Therefore, your real print will not require this much filament. It's better to overestimate filament needs than underestimate. But could you devise a more accurate method of estimating actual filament needs? ***
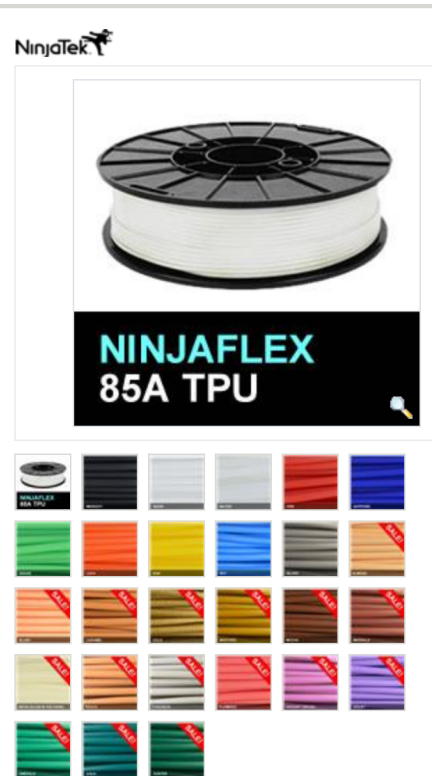
You will you Ninjaflex filament, a nice squishy filament in lots of colors, to print your organ. You can select a color for your organ here:

http://www.fennerdrives.com/product-lines/_/3d/

Each spool of Ninjaflex has 195m of filament…
…that's around 2 football fields in length!

To figure out how many spools of filament are needed:

# of spools =   filament needed   / quantity of filament per spool

           = 739 m filament needed / 195m of filament per spool

           = 3.8 spools

                 <u>buy 4 spools</u>

Now for the organ on which you are working, compute:
- The dimensions and volume
- The quantity of filament you'll need, and the number of Ninjaflex spools

Question: What are the potential sources of error in your calculations?

Step 3. Design a model of the organ in a 3D drawing program

It is recommended that you use Sculptris, a free program that is especially well suited to creating organic shapes. Download Sculptris from

http://pixologic.com/sculptris/   and then install the program on your computer.

- Design according to the dimensions you researched and computed in class.
- Tutorials are available on the Sculptris website and on YouTube.
- For symmetrical organs, turn on the line of symmetry and design on half the organ; the mirror image will form at the same time.
- Save your work often.

Step 4. Print your model on a 3D printer in the Startup Incubator

- Output your model to .STL format
- Open your model in FlashPrint, then scale it for small-size printing to examine the overall proportion and appearance of the organ prior to printing it to scale. Scale to approximately 20-30 mm per dimension. Save this version and output it to .GX format for printing on the FlashForge Finder 3D printer. Ensure the Ninjaflex filament, in the appropriate color for your organ, is loaded into the printer. You will be able to keep this print!
- Full scale designs for most organs will be printed on the Gigabot printer (since they are large and require the larger print bed). Your instructor will provide additional instructions in executing these prints. (Smaller organs such may still be printed at full scale on the Finder printers. Note that small, two-color prints – for example, the eye – may be printed on the FlashForge Creator. Your instructor will provide additional instructions for this.)