

Basic Mesh Modeling Sustainability

By Friend

Pre-workshop

- For part 1, read and do stuff assigned in sections up to and including “Install and open Blender”
- For part 2, do this questionnaire and put your results on Slack <https://footprint.wwf.org.uk/#/>
 - It’s a UK quiz, so try to match to you the best you can; for example:
 - Green tariff ≈ carbon tax
 - Use Google Maps to check your flight distance
- I’m at 154% because I flew 4 times last year

Part 1: Basic Mesh Modeling

If there's a word you don't understand in
the slide, let me know and I'll add it here

-

Note

- If it's a keyboard shortcut, I'll use []
- If it's a mouse click, I'll use “ ”

Agenda

- We'll walk through the process of making something similar to this pencil cup
 - <https://www.thingiverse.com/thing:2143549>
 - <https://www.thingiverse.com/thing:933001>
- You'll learn some Blender basics along the way
- Enough to get you through 90% of 3D printing prototyping



Why Blender is better than Solidworks (sometimes)

#1: Save time (and money)

- For most basic, first iteration prototypes, most likely someone's already made something similar that you can adapt to your project
- And they've put it up for free, online
- Adapting it to your ideas is less time, compared to CAD something from zero
- Popular 3d-print-able format for 3D models is STL (mesh, not CAD files, unfortunately), so Blender is better suited than Solidworks

#2: You can do everything Meshmixer does with Blender, and more

- Some examples:
 - Closing hole:
<https://blender.stackexchange.com/questions/52661/how-can-i-close-a-big-hole-in-a-mesh>
 - Plane cut:
<https://blender.stackexchange.com/questions/88578/how-do-i-bisect-along-an-axis>
- Much larger user community than Meshmixer
 - Someone's already answered any question to anything you need to fix in Blender
 - Many useful Blender plugins people write and put up for free
- You can do animation, video editing, modeling, etc. (and even CAD if you want to)

Find models

- The main elements of this project are:
 - A model
 - A hole
 - A bottom plate if the hole cuts through the model, or
model doesn't stand on itself
- We can make the hole and the bottom plate in
Blender, so for now, find a nice model on
thingiverse.com you want to put a hole through
 - Good if it's solid block that stands on its own
 - Ideas: dogs, cats, skull, moon, globe, turtle, bunny,
R2D2, mushroom cloud

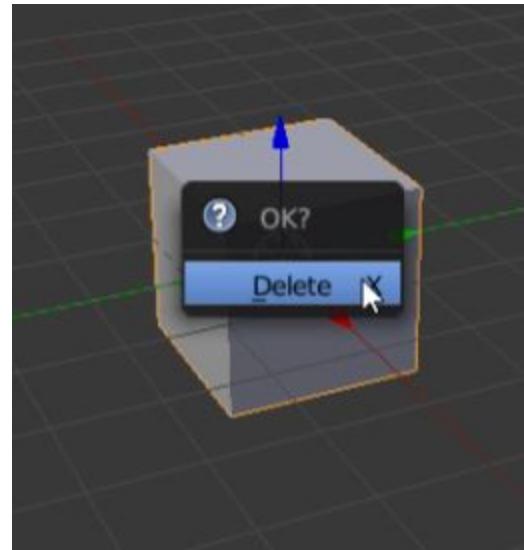
Install and open Blender

- Go to blender.org, download, and install
 - It's a fairly clean website unlike Lulzbot's so I won't go into detail
 - I'll use Blender 2.79 in this workshop
 - Blender 2.80's new UI is easier to use, but there isn't as much resources on it online yet, so I'll stick with Blender 2.79
- Open it once you're done, click anywhere outside the center to make the middle pop up go away



Install and open Blender

- Get rid of the default cube by pressing [X] and click “Delete”



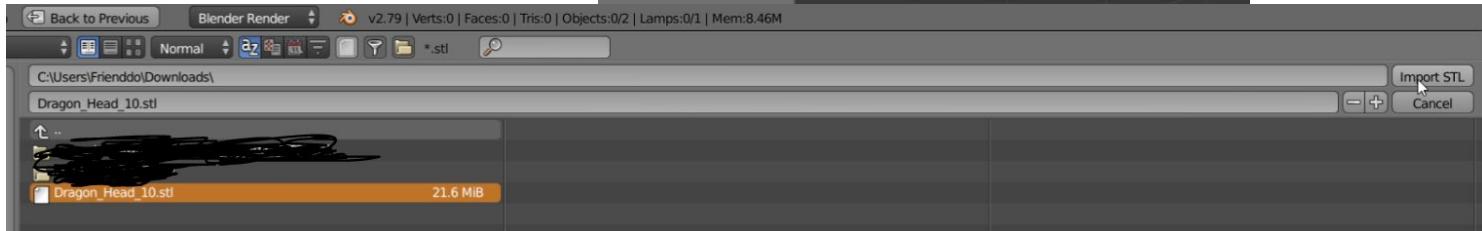
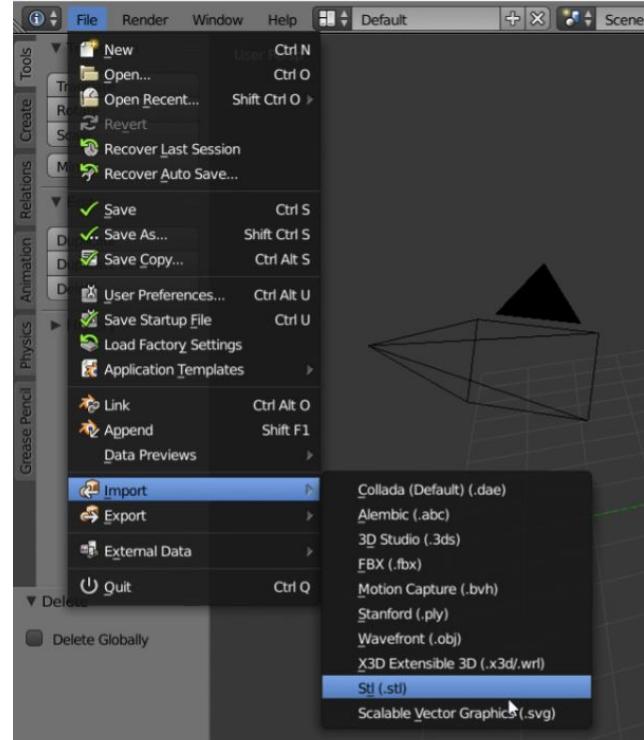
Manipulate your view

- To rotate view, hold middle mouse button, and drag your mouse
- To move view, hold [Shift] and middle mouse button, and drag your mouse

Import and center your model

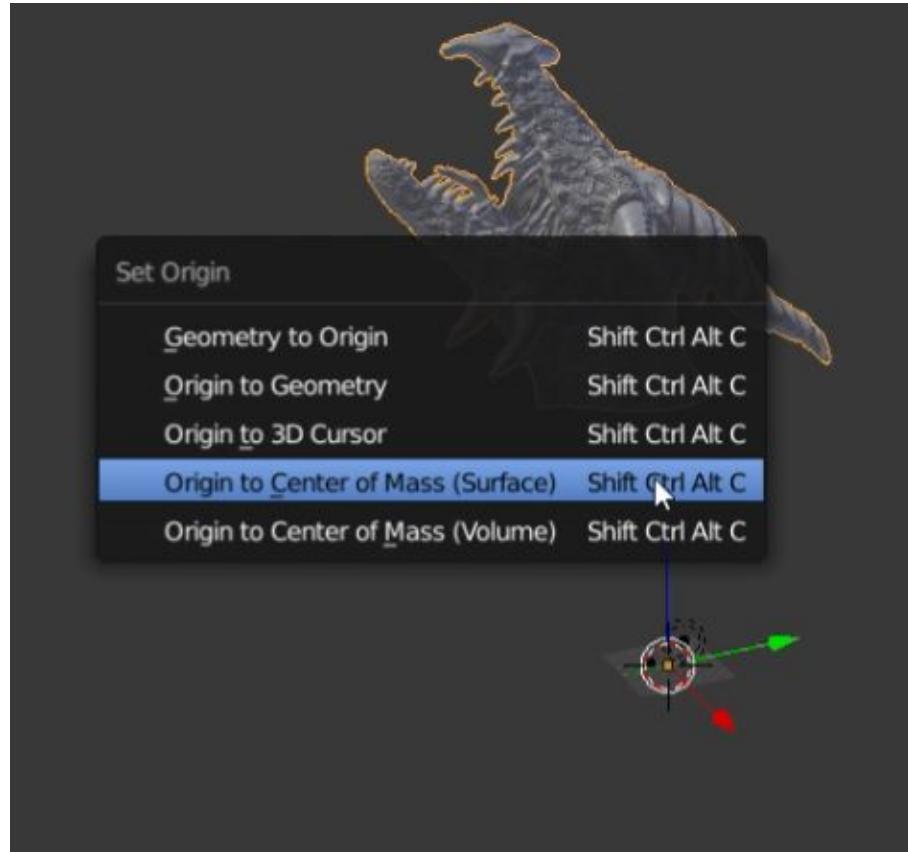
- To import, click “File” (top left corner) -> “Import” -> “Stl (.stl)”
- Go to the folder, click on the file, then click “Import STL”
- I picked this

<https://www.thingiverse.com/thing:478774>



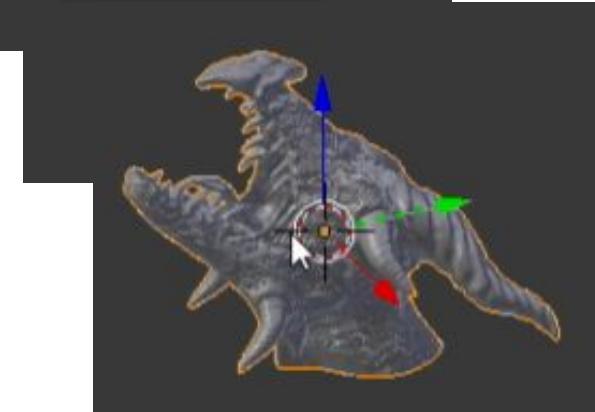
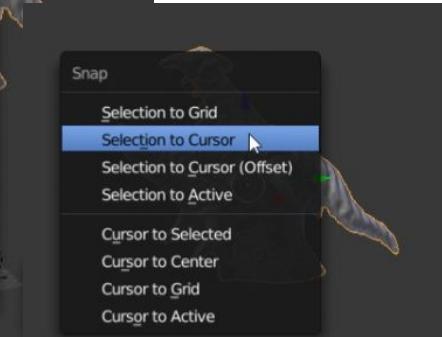
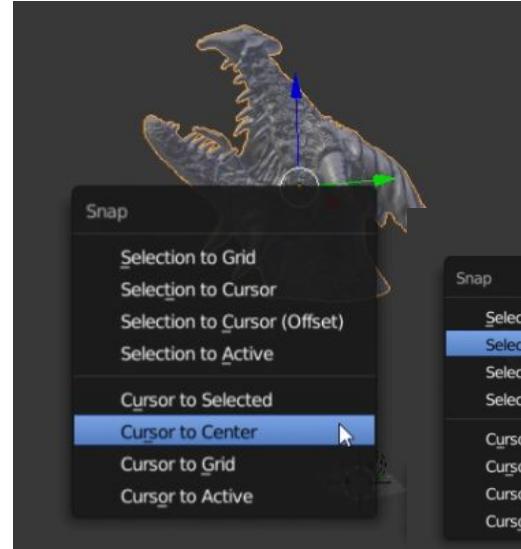
Import and center your model

- STL files are sometimes not centered to origin
- If you don't see it, use the middle mouse scroll, and zoom out until you see it
- Press [Shift]+[Ctrl]+[Alt]+[C], then click "Origin to Center of Mass (Surface)"
 - You can use Volume as well; they're approximately the same



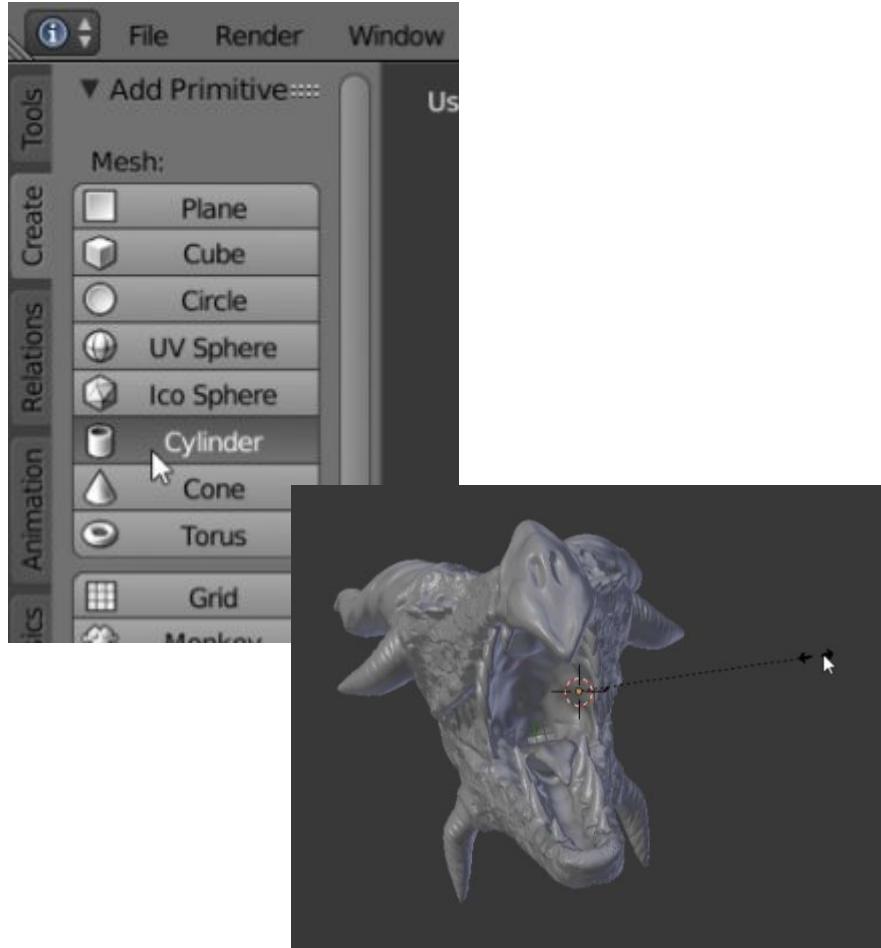
Import and center your model

- Press [Shift]+[S], click “Cursor to Center”
- Click “Selection to Cursor”
- Your model should snap to center of the world now



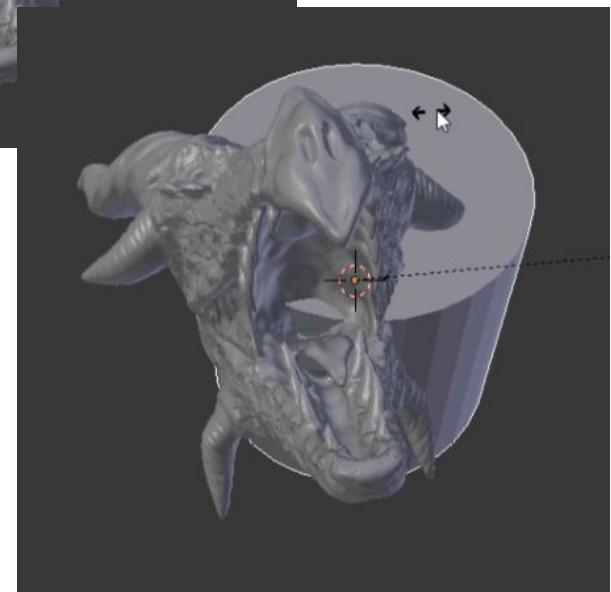
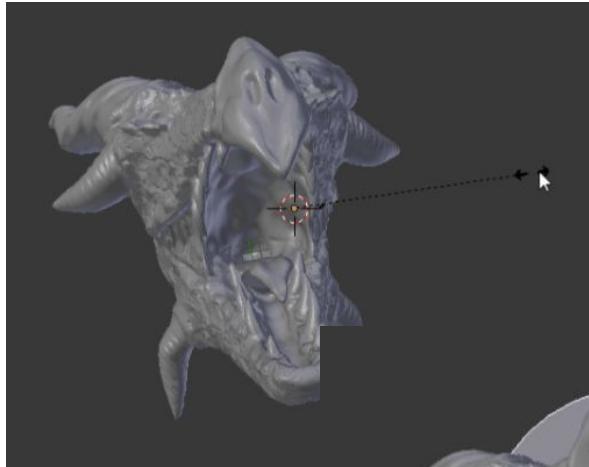
Make a hole

- Click “Create” -> “Cylinder”
- We’ll use this model to as the hole
- You can make a square, or a cone hole too if you want
- Before you click anything else, press [S] and drag your mouse outwards
- This will scale up your cylinder



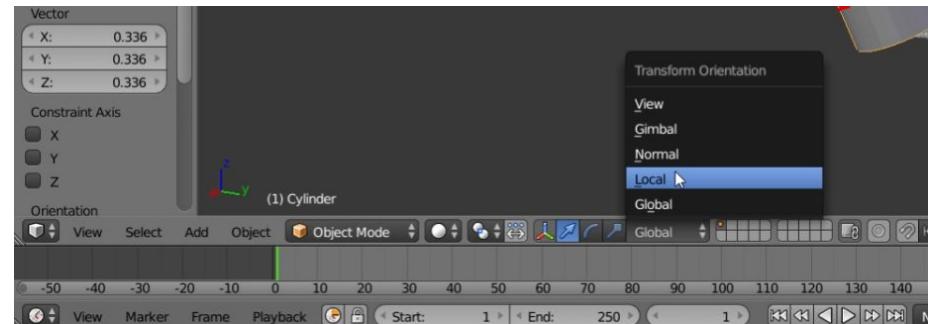
Make a hole

- Once it's to a scale that you can see, stop
- To move the model, click [G]+[x/y/z]
 - To move along the local axis, rather than global axis, click [G]+[x/y/z]+[x/y/z]
- To rotate the model, click [R]+[x/y/z]
 - To rotate along the local axis, rather than global axis, click [R]+[x/y/z]+[x/y/z]
- To scale the model, click [S]+[x/y/z]
 - To scale along the local axis, rather than global axis, click [S]+[x/y/z]+[x/y/z]



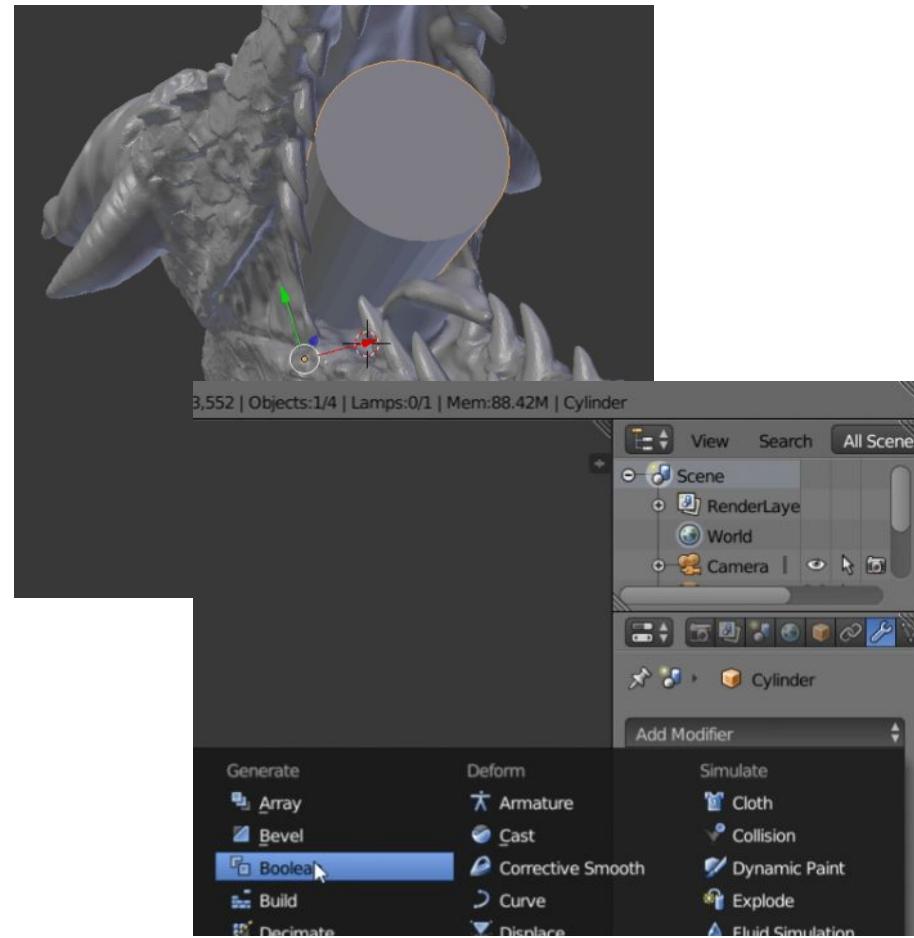
Make a hole

- It might be hard to visualize rotating or scaling along local axis without seeing local axis, so you can change that on the bottom toolbar



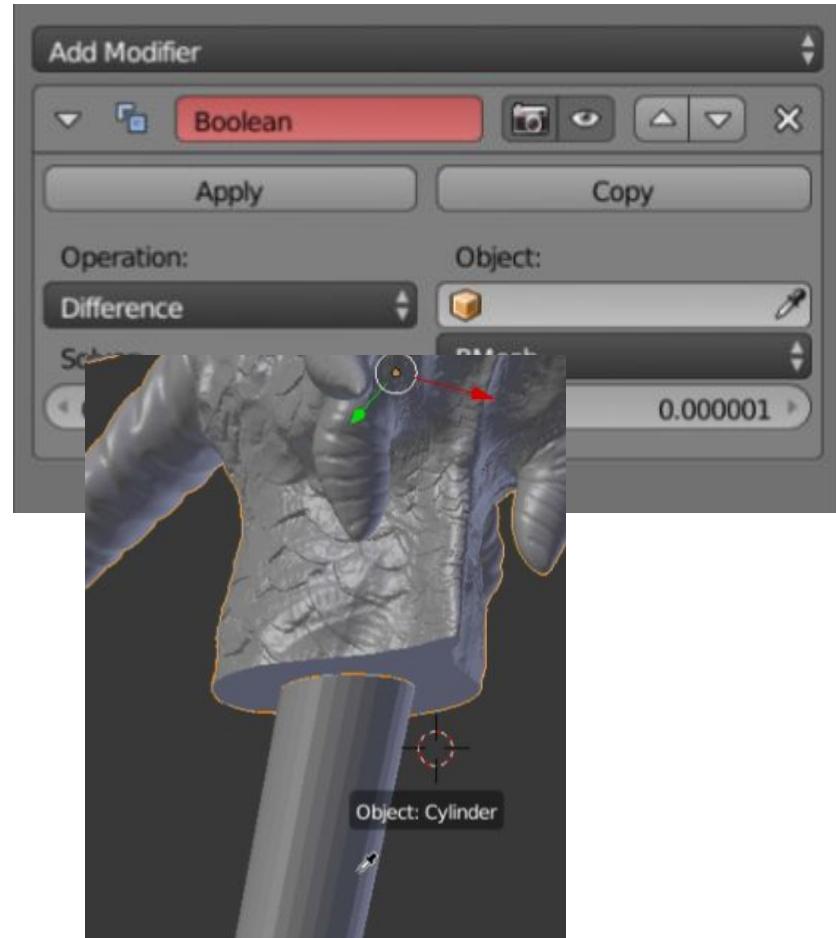
Make a hole

- Once you have put it in the right position, go to the right toolbar, click on the wrench icon -> “Add Modifier” -> “Boolean”
- THE IMAGE IS WRONG! You should select the main object, not the cylinder when applying boolean
 - You want to cut the hole in the dragon, not cut a dragon-shape hole in the cylinder



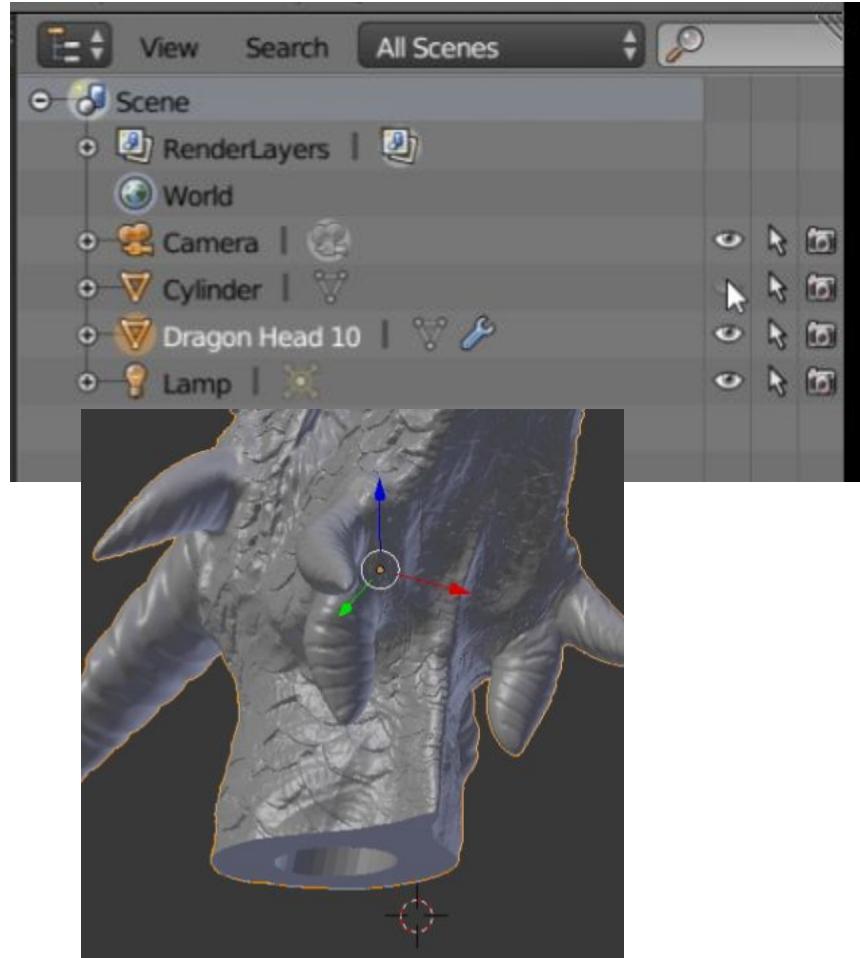
Make a hole

- Change Operation to “Difference” (it’s a drop down menu)
- Use the eyedrop icon near Object to select your cylinder



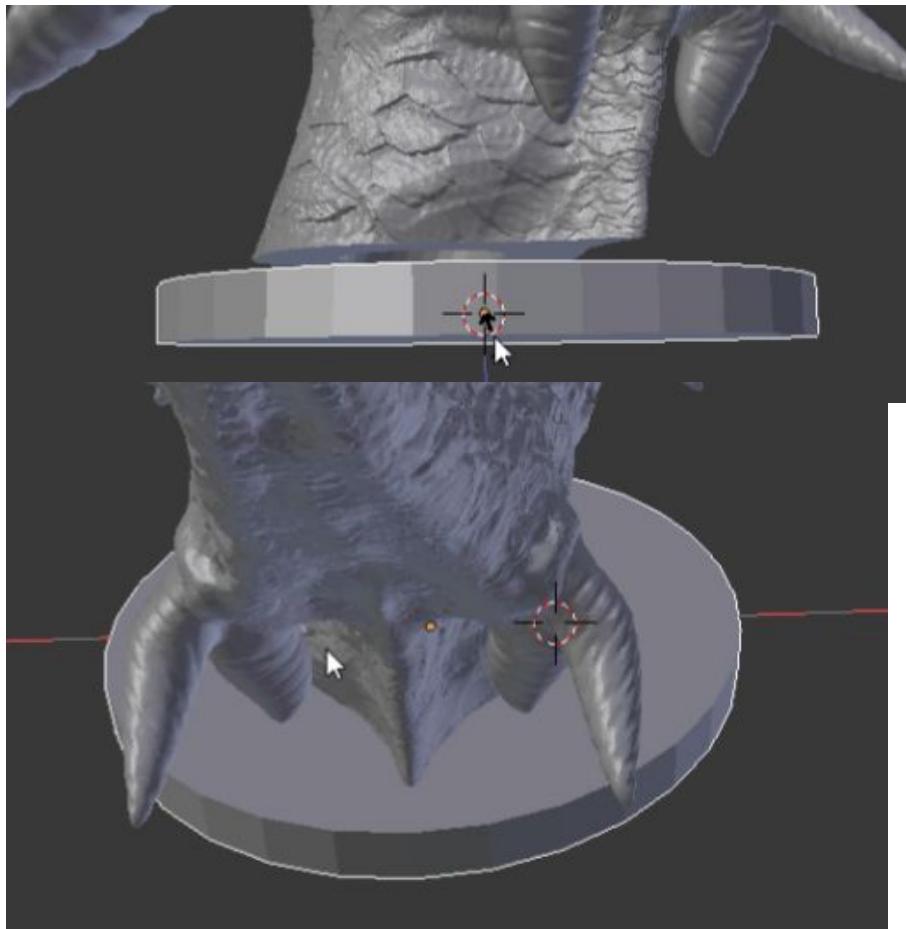
Make a hole

- Click on the eye icon next to the cylinder's name to not see it
- You should be able to see the hole you've made very clearly



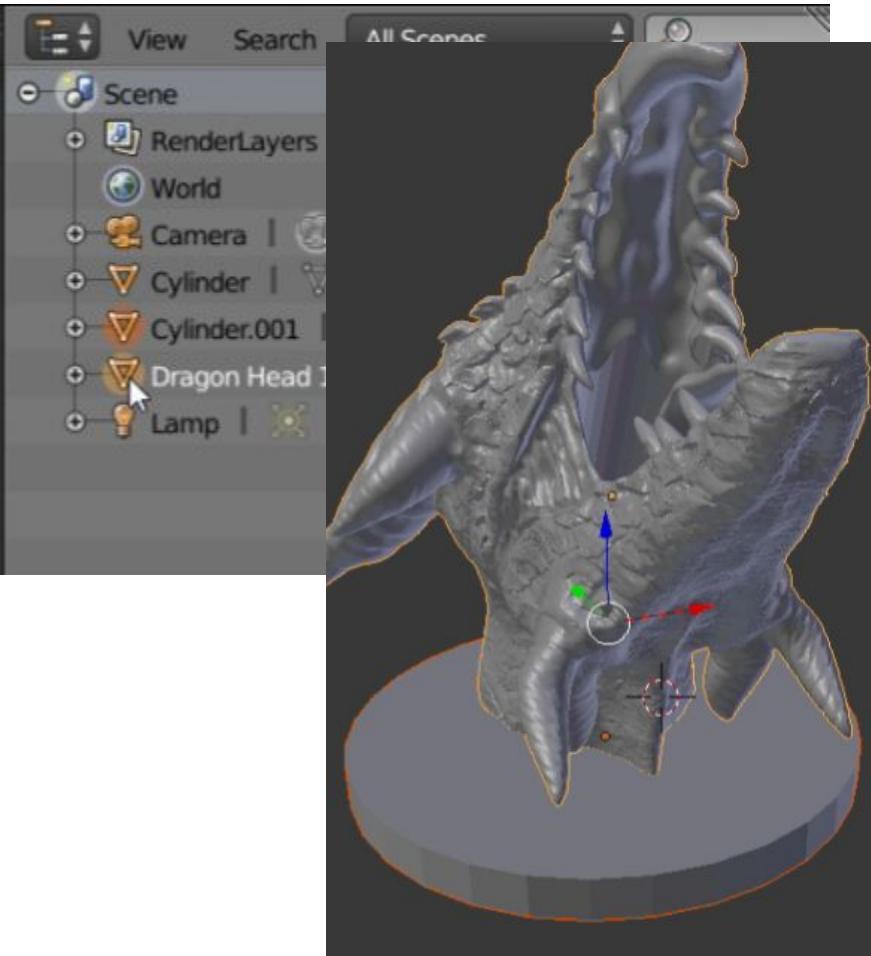
Make a base

- Use the skills you learned when moving, rotating, and scaling a model to make the base
- Make another cylinder and manipulate it into a base
- Make sure the main model (ex: dragon) overlaps a bit with the base so it can become a single solid model



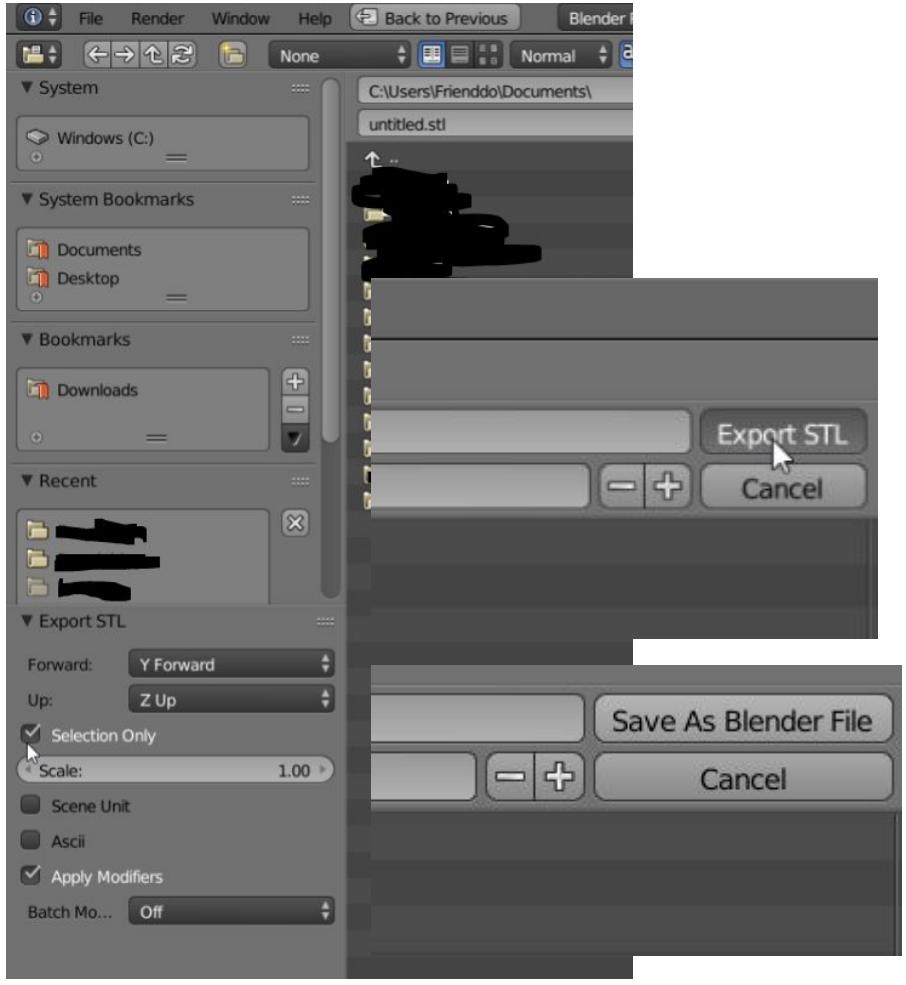
Exporting

- Select only the model you want to export
(hold [Shift] to select multiple things at once)
- If you haven't noticed by now, a model that is selected has an orange highlight around it



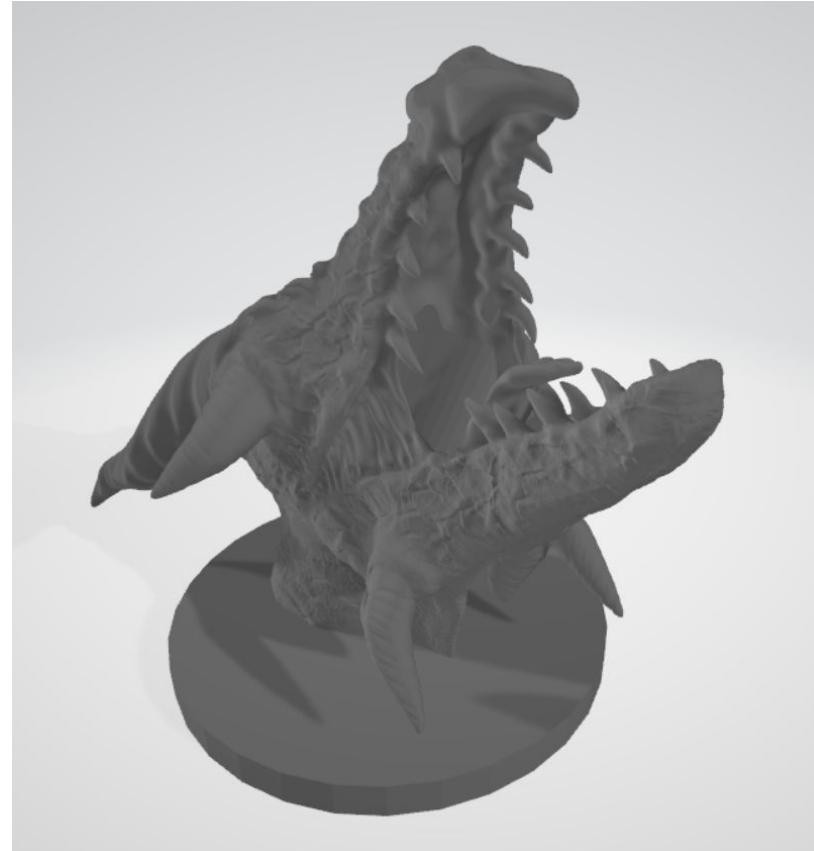
Exporting

- Tick yes on “Selection Only” and “Apply Modifiers”
 - This will make sure only the stuff we’ve selected is exported (so the hole model doesn’t get exported), and the hole is actually cut into the main model
- Save it anywhere you’d like by clicking “Export STL”
- Save the whole Blender project by pressing [Ctrl]+[S], find a good directory, then click “Save As Blender File”
 - It’ll say “Save As” the first time you save



Final product

- Nice
- You can open it with 3D viewer (Windows) or Preview (Mac)
- Import it to Cura to print

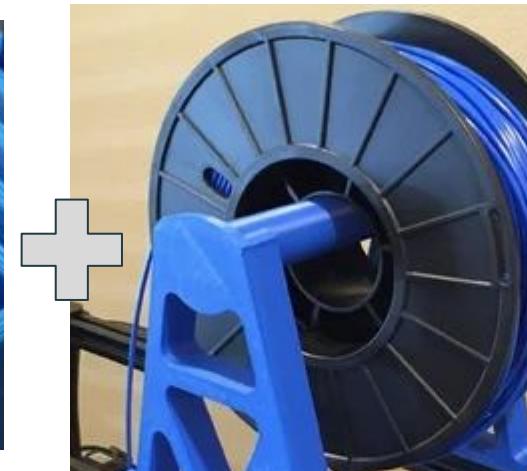


Other useful/cool stuff I didn't mention

- In edit mode, [Alt]+[S] to shrink/fatten
 - Good for clearances
- In object mode, there's Decimate as one of the boolean operations
 - Use to make low-poly toys

An example of what I've made using this method: SD card holder attached to 3D printer

- SD card holder with boolean difference to cut it to have only one SD card slot
 - <https://www.thingiverse.com/thing:56074>
- Spool holder with boolean difference to cut out for only the section to slot into aluminum extrusion
 - <https://www.thingiverse.com/thing:1608830>
- Export them together



Some further readings

- Modeling organic shapes
<https://blender.stackexchange.com/questions/45925/whats-the-best-way-to-model-organic-shapes>
- Physics simulation
<https://github.com/jonbruner/blender/tree/master/Cloth>

Part 2: Sustainability

Note

- This is going to be a straight-up lecture
- I don't like lecturing either (notice that most of the previous workshops are activities where you do, and I moderate)
- But this is extremely important, and someone has to do it, so I might as well
- Please pay attention
- Sustainability is also good for you, not just the planet; for example:
 - Reducing plastic use saves you plastic and money
 - Shipping from a nearer seller saves you shipping costs
 - Disposing wastes properly saves you waste disposal fees
 - List goes on...

You use a lot of resources

- Look at how much plastic waste we've printed during the workshop, and how much more you'll generate with more failed prints, printing the wrong model, etc.
- It's not just plastics, it's the energy 3D printer used, parts that are worn down, emissions from shipping, etc.
- Extrapolate that to a lifetime of you doing 3D printing, extrapolate that to everyone who has a 3D printer...
- Let's take a look at your survey results on Slack

You use a lot of resources

- As a person with all this rapid prototyping knowledge, you're going to use them to make products much more than a regular person
- With great power, comes great responsibilities
 - Kinda like how I'm responsible to tell you guys this, with my power as a workshop leader (ha!)
- Sustainability is something to consider during the whole process (conception, design, printing, usage, iteration)

Sustainability

The three pillars are:

1. Social
2. Environmental
3. Economic

I'm going to focus mainly on environmental since it's the most obviously related to 3D printing. However, you should also consider the other two just as much.

Environmental sustainability

In terms of ease and impact, methods to tackle waste are generally ranked as:

1. Reduce
2. Reuse
3. Recycle

Reduce

When designing, some questions to ask yourself:

- Can I design this object so it can be made with more sustainable materials? Ex: cardboard, wood vs. plastic
- If I need to 3D print it, can I design this so it can print without support?
- If the design change reduces strength, do I actually need that much strength for this?
- Has someone already designed this, in a more sustainable way?

When printing, some questions to ask yourself:

- Do I need to print this at all?
- Can I print this smaller?
- Can I find an orientation that prints with minimal support?
- Can I reduce infill?
- Can I reduce print temperature?
- Do I need to keep bed heating after print is done?

Reduce

Other things to consider:

- Filaments are heavy to transit, so there's obviously more emissions from shipping from other countries vs. shipping from Canada. Is there a Canadian manufacturer you can buy from?
- For example, Filaments.ca is guaranteed to source and store in Canada
- <https://filaments.ca/pages/about-us>
- High quality parts lasts longer so there's less wastes generated. Is there a quality difference in the parts you're looking to buy?

Reuse

- Do I have to buy this part new? Can I buy it second-hand?
- Facebook Marketplace, Craigslists are decent
- FreeGeek Vancouver has a store that sells refurbished laptops and electronic parts
- <https://www.freegeekvancouver.org/shop.html#thrift-store>
- Can I reuse parts from other retired projects for my current project?
- Can I reuse failed prints as simple things like pencil container, door stopper, paper weight, etc.?

Recycle

- PLA is advertised as compostable, but only under specific conditions. Will your waste collector accept PLA? Check with them first
- <https://www.cbc.ca/news/canada/british-columbia/compostable-items-confusion-more-infrastructure-needed-1.4665757>
- https://www.creativebc.com/database/files/library/Okay_Whats_up_with_Compostable_Plastics_min.pdf
- UBC WasteNauts are a collective on campus that recycles 3D printer wastes into filament and other things
 - This method is very finicky
- If you are a part of an on-campus research lab or a club, contact them and they can take your plastics from your lab to recycle
- <https://ubcwastenauts.com>

Recycle

- FreeGeek also accepts electronics for recycling
- Dropping off stuff with them is super easy
- <https://www.freegeekvancouver.org/recycle.html#what-we-take>

Non-3D-printing related ways

Some everyday things:

- Turn off the lights when you leave a room
- Bring your own container to a take-out
- Bring reusable bags to groceries
- Bike or bus instead of private transport
- Compost your food waste
- Eat less meat
- Take vacations at a nearer place

Some bigger scale things:

- Vote for officials with sustainable agendas
- Attend town halls to make this issue heard
- Donate money to environmental groups
- Attend local events, join local clubs about sustainability
- Argue with online strangers
 - That person won't change their mind, but everyone else who reads that argument later can hear the sustainable arguments

Some further readings

Videos on 3D printing sustainability stuff:

- CNCKitchen on plastic recycling at home
https://www.youtube.com/watch?v=vqWwUx8l_lo
- Maker's Muse on designing without support
<https://www.youtube.com/watch?v=SBHHwid7DWM>

Some local orgs about sustainability to join and/or donate to:

- CommonEnergy
<https://commonenergyubc.com>
- Sprouts <http://www.ubcsprouts.ca>