

FINAL PRESENTATION

3D PRINTED HAIR

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NIGEL LEONG

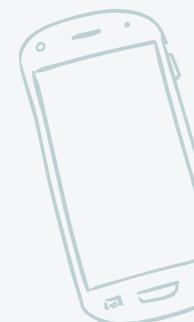
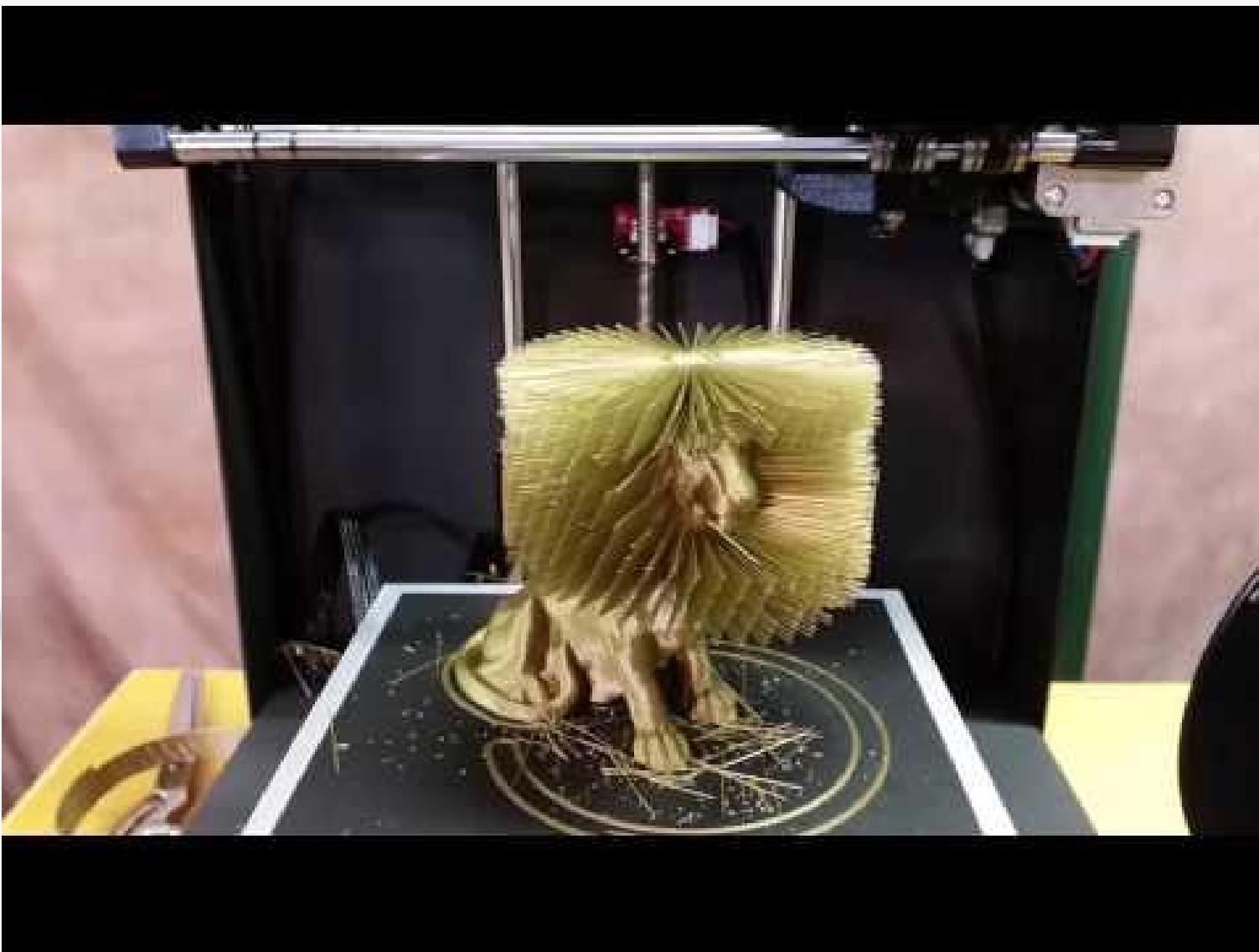
TAN SHUN YU

BACKGROUND

Automatic generation of 3D
printable hair fibers



HAIRY LION VIDEO

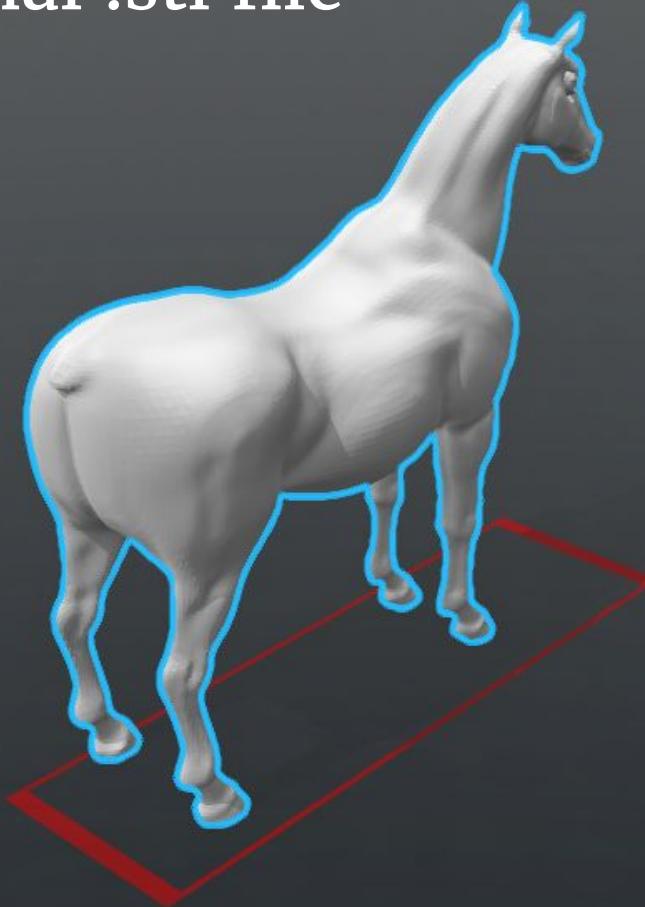


WORKFLOW OVERVIEW



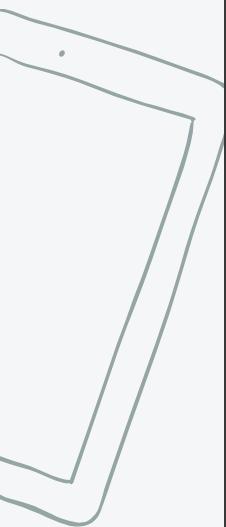


The original .stl file

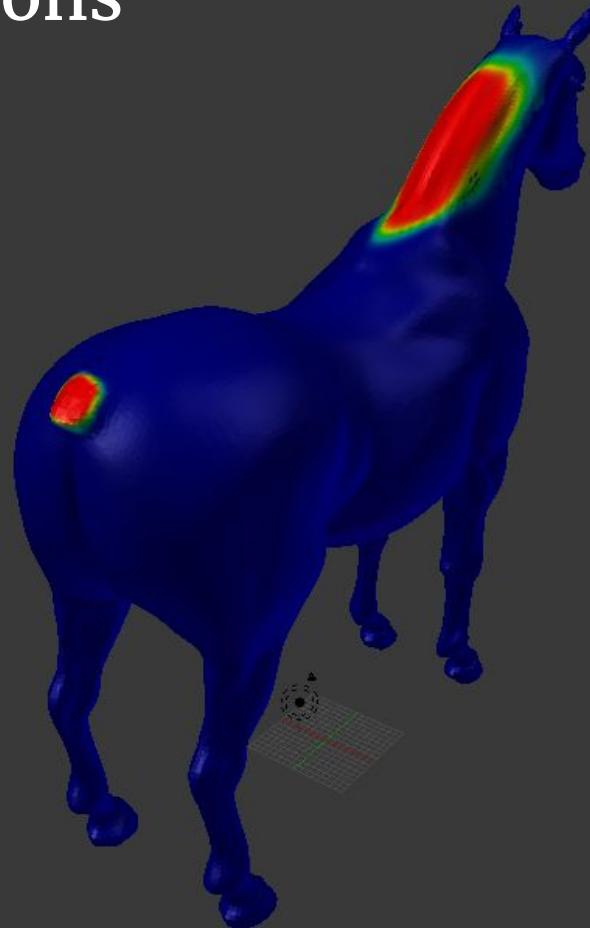




Import .stl file to Blender

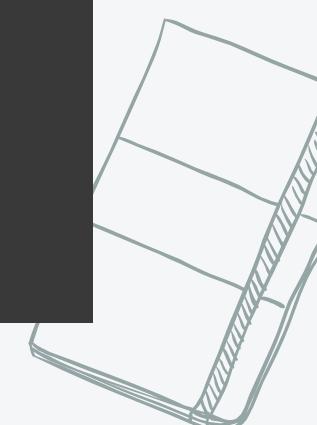
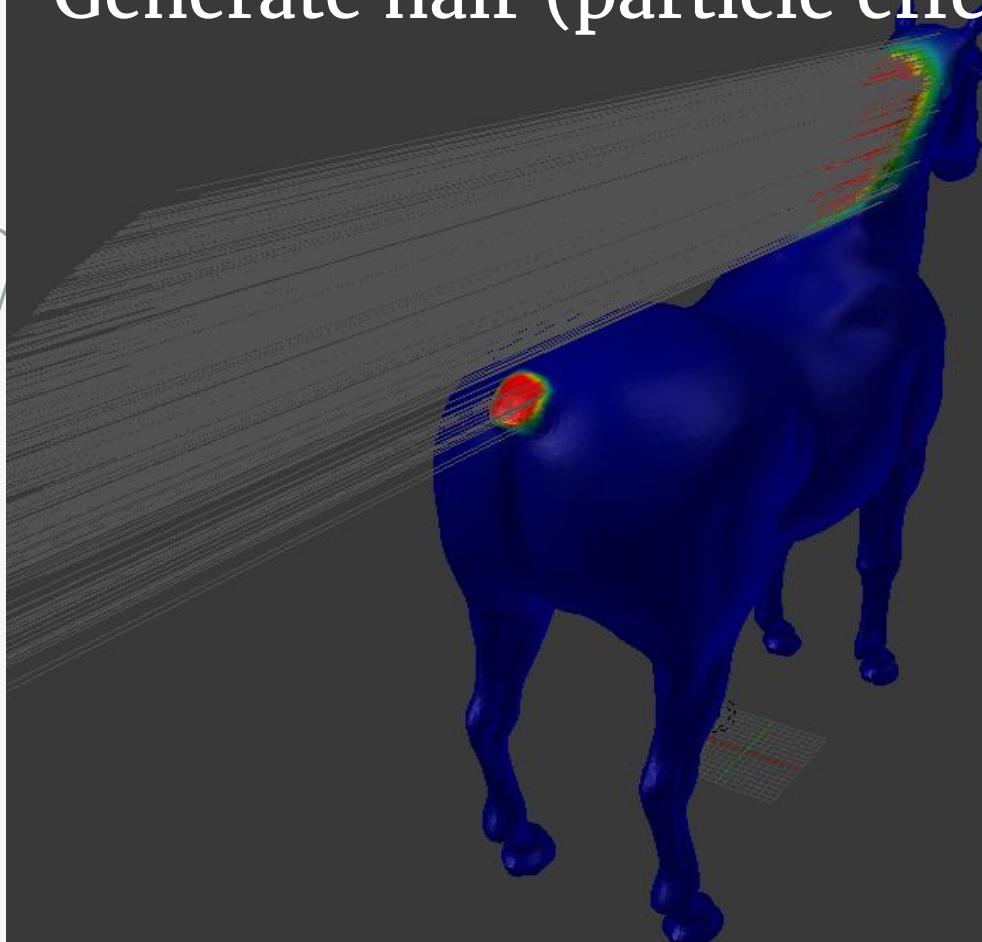


Select regions



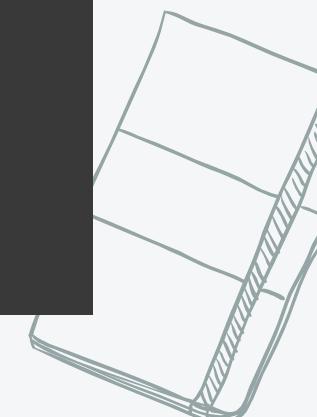
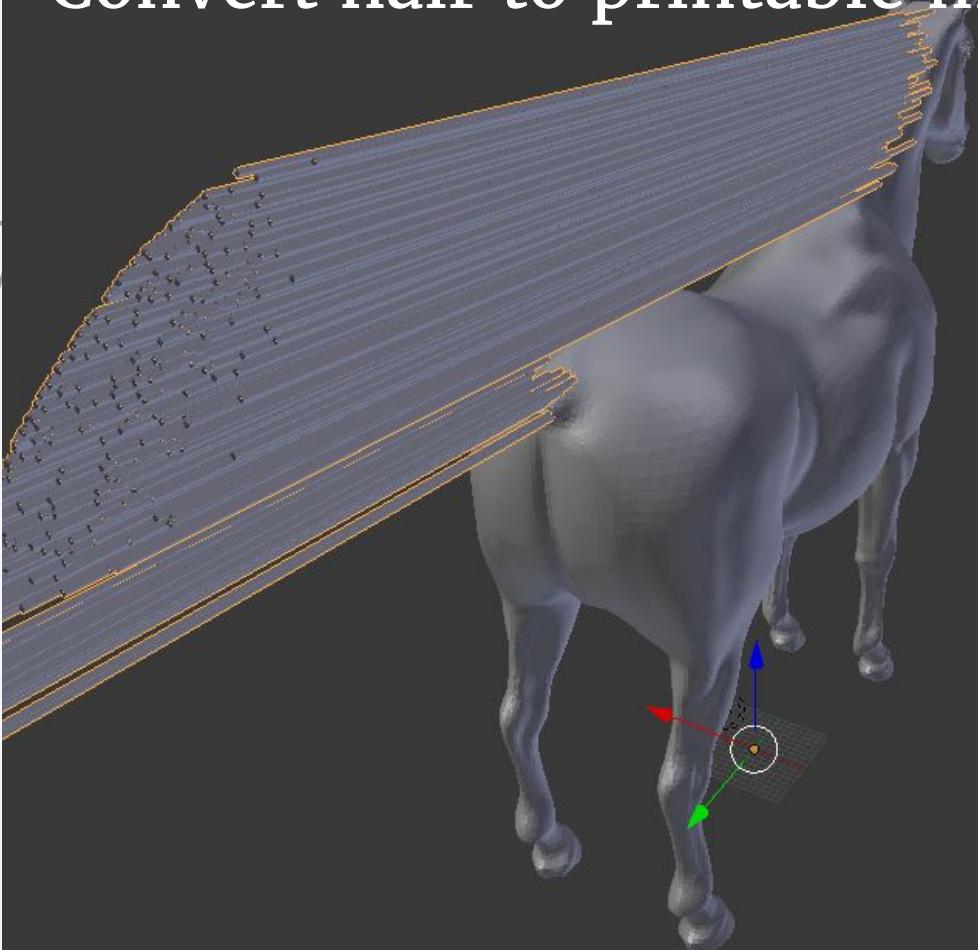


Generate hair (particle effect)



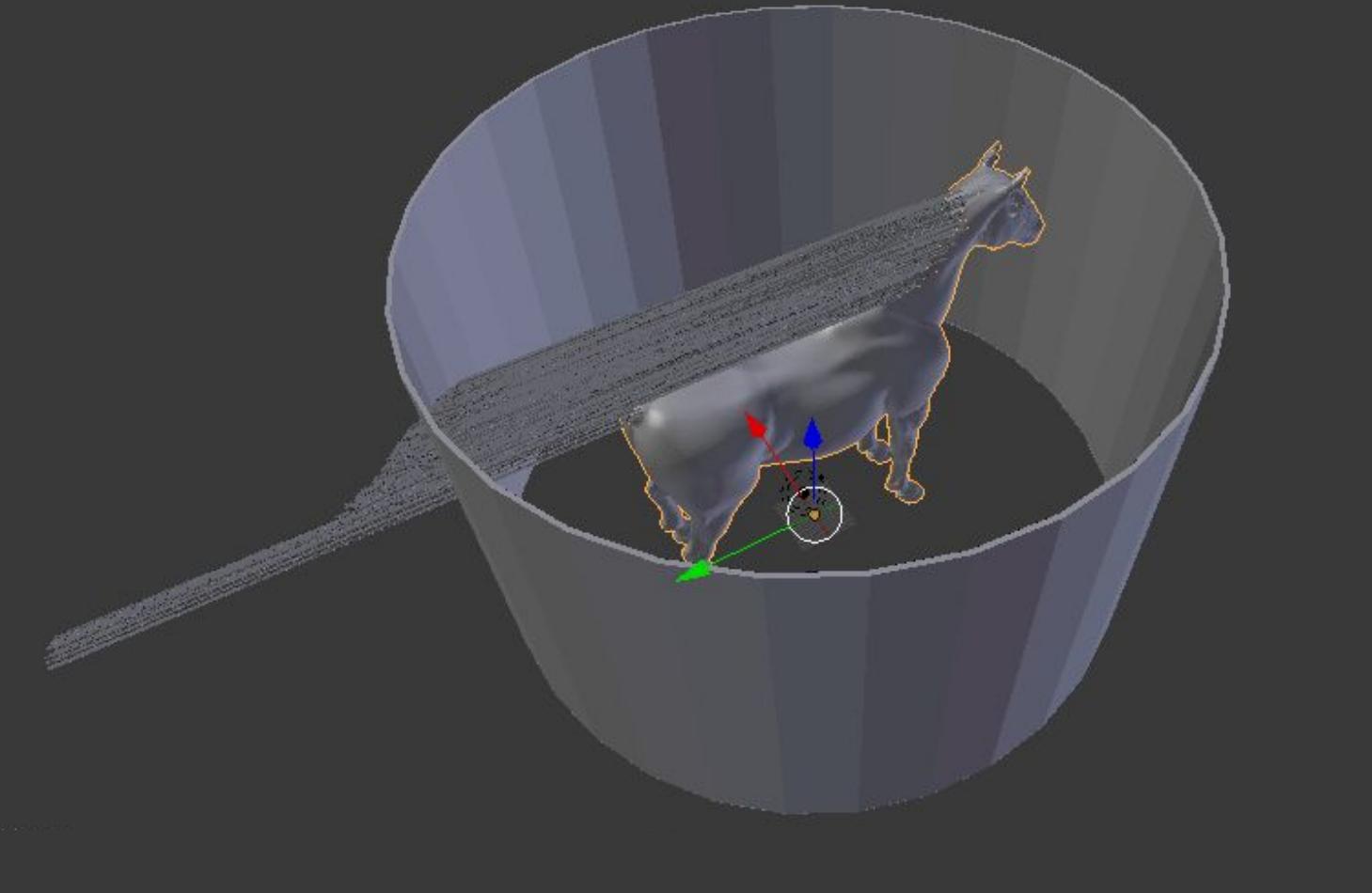


Convert hair to printable mesh



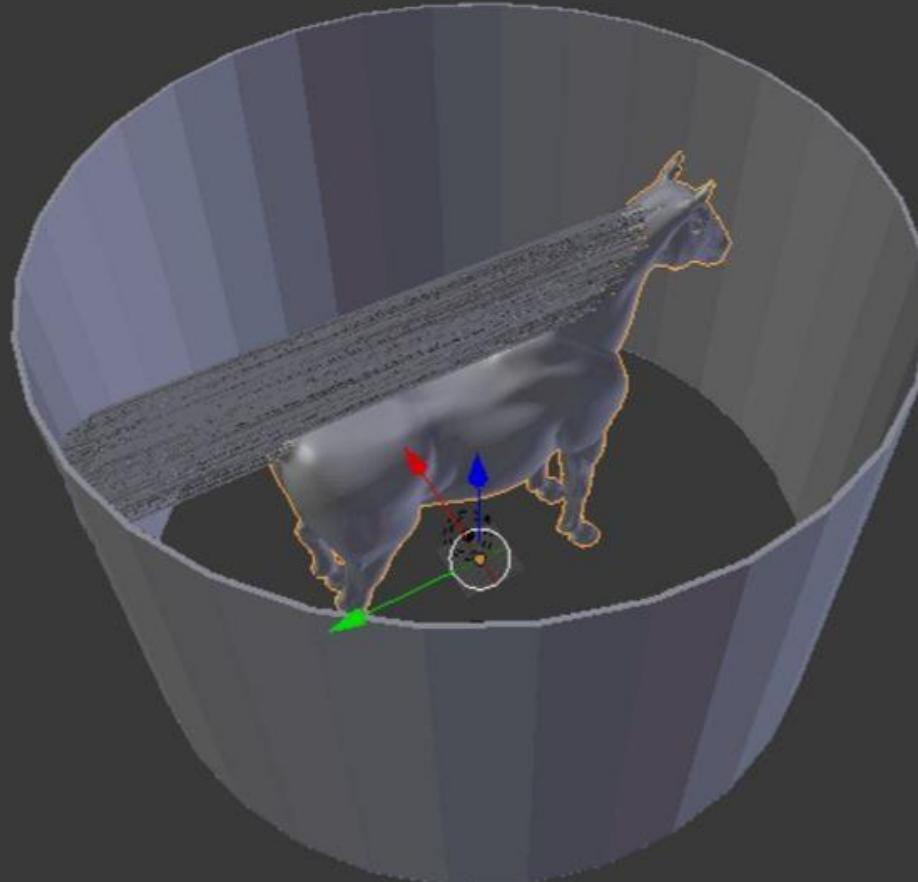


Generate support cylinder



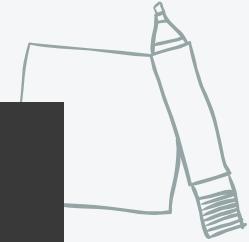
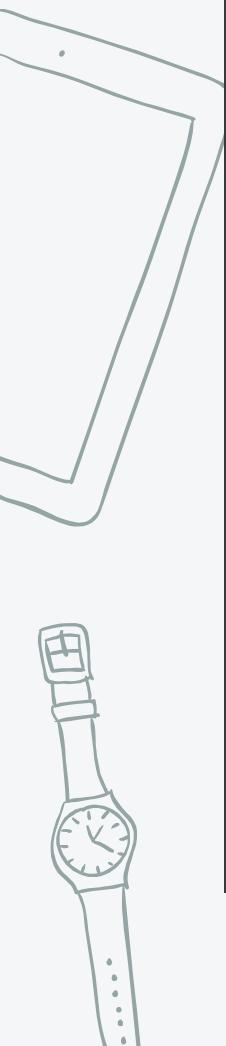


Clean extra hair



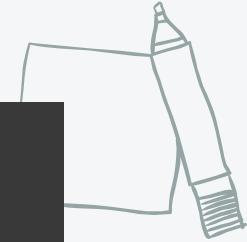
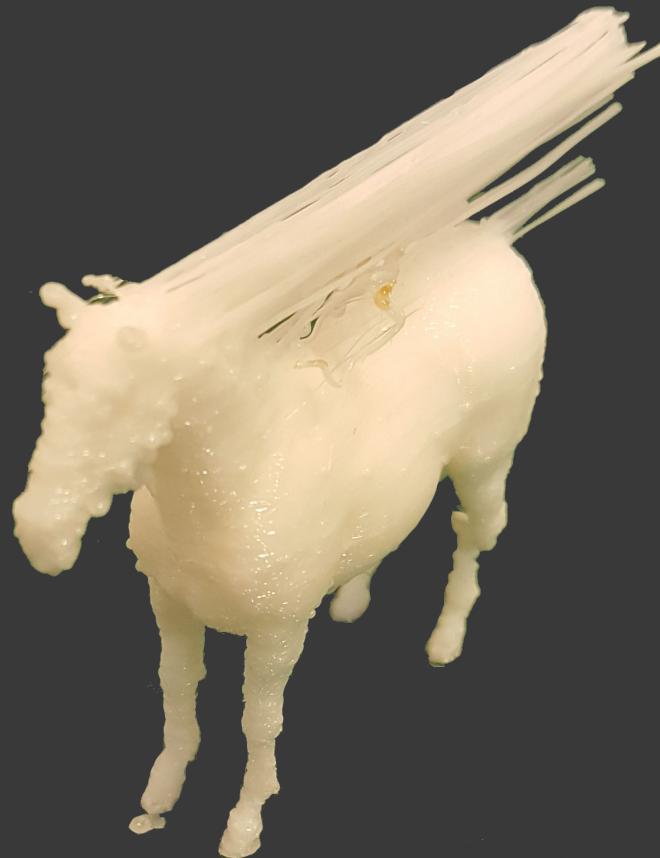


3D printing



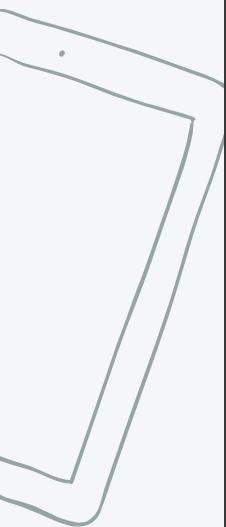


Remove support structure



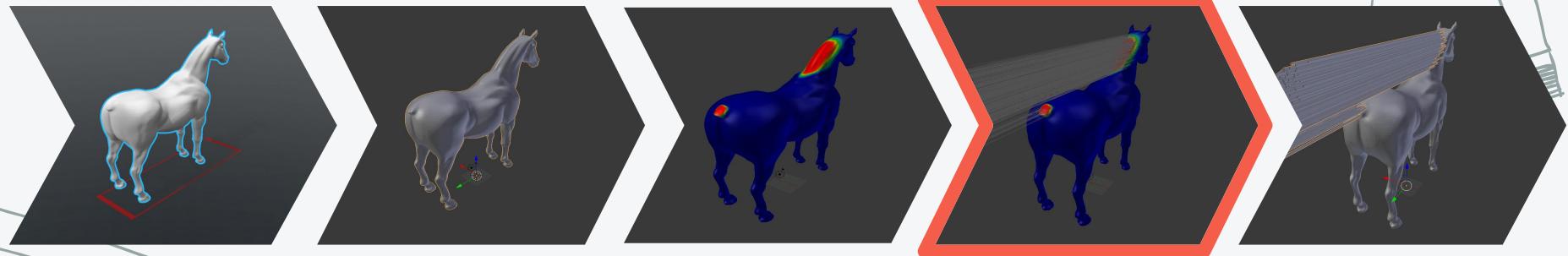


Hair shaping



DEVELOPMENT PROCESS





HAIR GENERATION

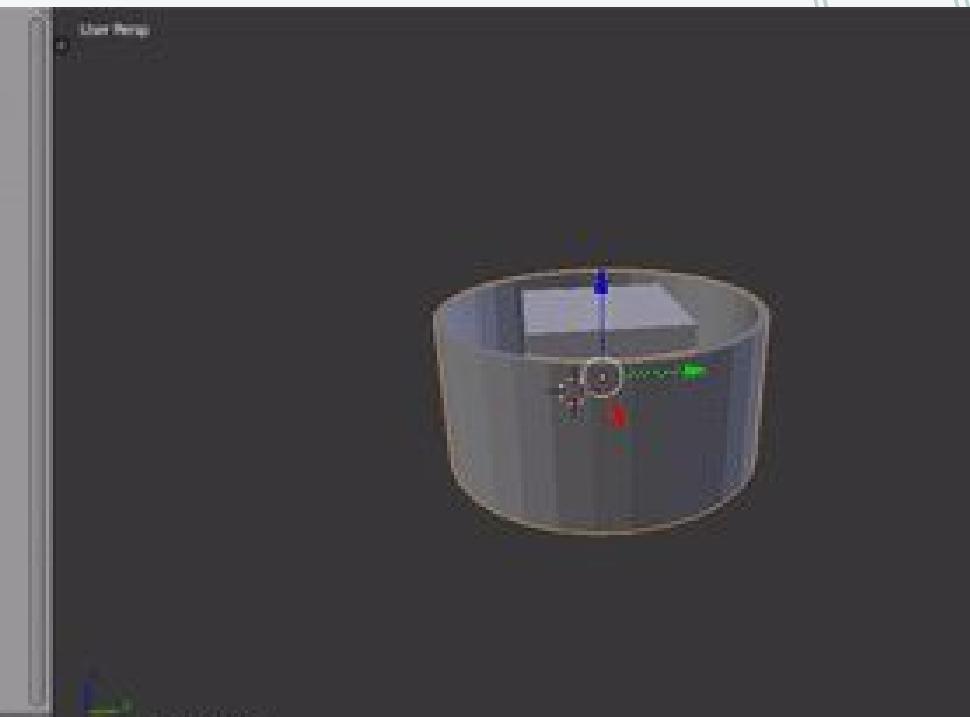




AUTOMATIC HAIR GENERATION

- Hair particle effect
- Use modifier to convert to mesh
- Customisable length, thickness and number of hairs

```
import bpy  
  
object = bpy.context.object  
object_radius = 0.3 * max(object.bound_box.dimensions) + object.bound_box.dimensions[0]  
  
bpy.ops.object.particle_system_add()  
bpy.data.particles["ParticleSettings"].type = "HAIR"  
bpy.data.particles["ParticleSettings"].count = 1000  
bpy.data.particles["ParticleSettings"].hair_length = object_radius  
bpy.ops.object.modifier_add(type='ParticleSystem')  
bpy.ops.object.convert(target='MESH')  
bpy.context.object.data.fill_mode = "FULL"  
bpy.context.object.data.bevel_depth = 0.2  
bpy.ops.object.convert(target='MESH')
```

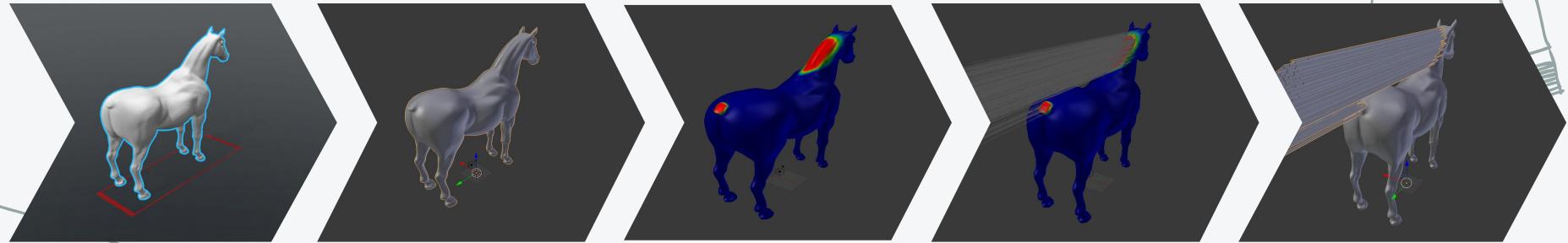




MANUAL HAIR GENERATION

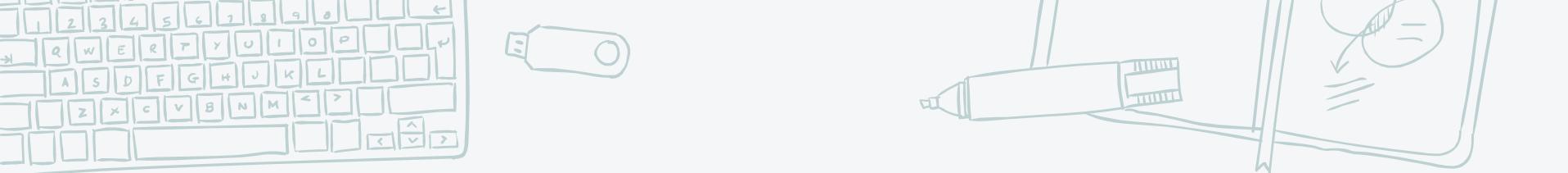
- Particle edit mode brush
- Brush mode: add, cut etc
- Hair normal, deflection, and z-axis values are set to zero to make the hair 3D print-ready (horizontal)





CYLINDER GENERATION





CYLINDER GENERATION

- Inspired from the hairy lion
- Used for hair bridging
- Dynamic based on object position and size (using bounding box method)

```
#include <ray.h>
#include<iostream>
#include<math.h>
#include<vector>

// Get parameters of object
object = ray_context.object;
object_location = object.location;
object_radius = 0.3 * max(object.bounding_box.data.dimensions.x, object.bounding_box.data.dimensions.y);
object_height = object.bounding_box.data.dimensions.z;

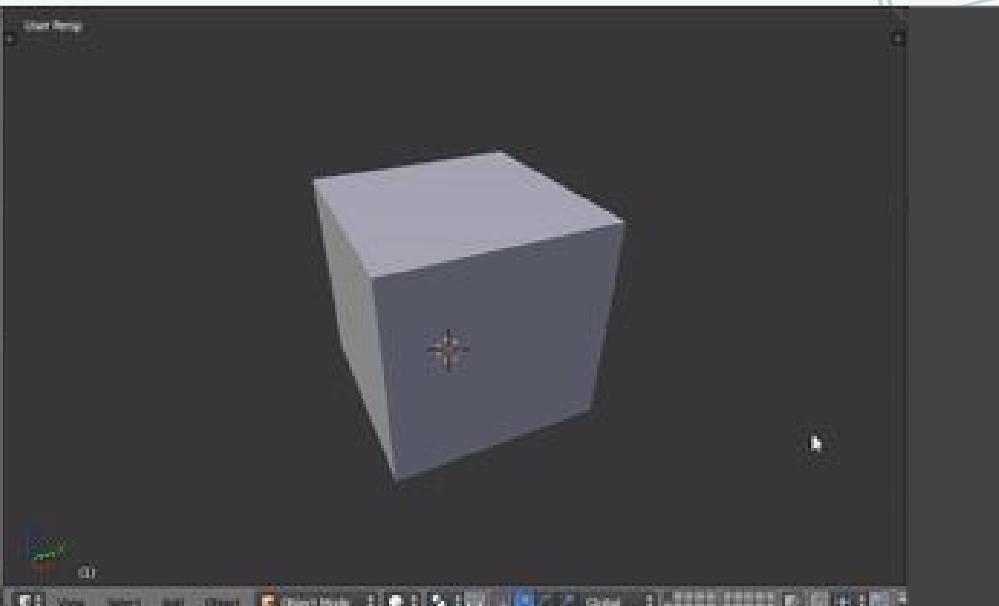
// Parameters
cylinder_radius = object_radius * 2.0f;
cylinder_thickness = 2.0f;
cylinder_height = object.height * 0.05;
cylinder_position = object_location + (0, 0, 0);

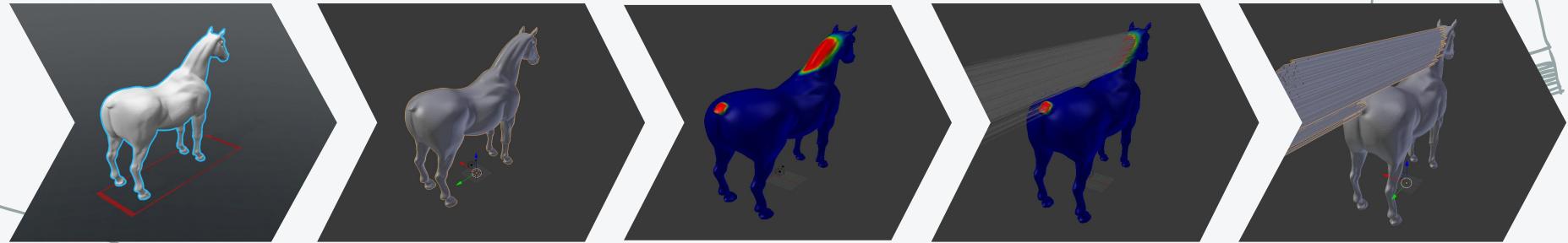
// Create an outer cylinder.
ray_tracer.mesh.primitive_cylinder.add(radius=cylinder_radius,cylinder_thickness,depth=cylinder_height);
cylinder_outer = ray_context.object;
cylinder_outer.name = "cylinder_outer";
cylinder_outer.location = cylinder_position;

// Create an inner cylinder.
ray_tracer.mesh.primitive_cylinder.add(radius=cylinder_radius,depth=cylinder_height / 2.0);
cylinder_inner = ray_context.object;
cylinder_inner.name = "cylinder_inner";
cylinder_inner.location = cylinder_position;

// Create a boolean modifier named "ray_bool_mod" for the cube.
mod_bool = cylinder_outer.modifiers.new("ray_bool_mod", "BOOLEAN");
if(mod_bool.type == "BOOLEAN")
    mod_bool.operation = "DIFFERENCE";
else
    mod_bool.operation = "UNION";
cylinder_outer.modifiers["ray_bool_mod"].object = cylinder_inner;

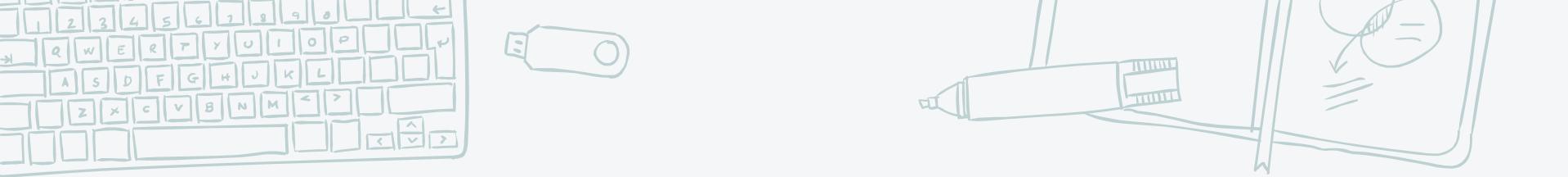
// The modifier apply function only works on the active object.
cylinder_outer.modifiers["ray_bool_mod"].apply()
```





MESH CLEANUP

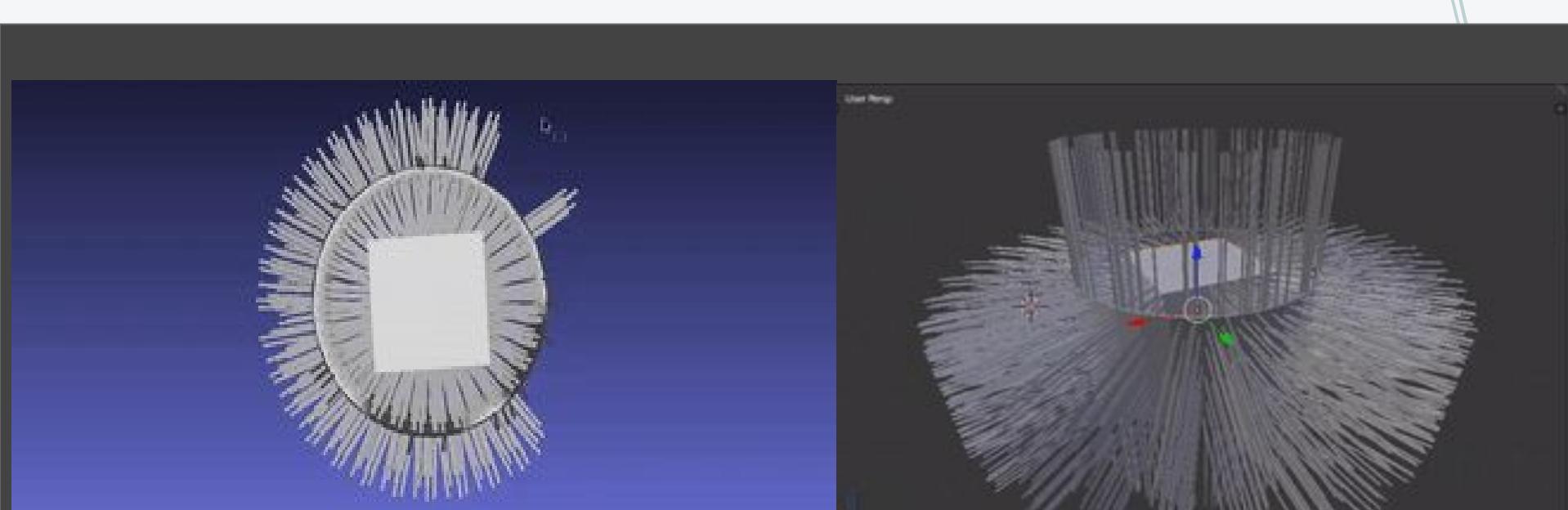




MESHLAB CLEANUP: MANUAL VS AUTO

Manual:
Meshmixer

Auto:
Run Blender script





ONE-CLICK HAIR GENERATION BLENDER ADDONS

FROM SCRIPT TO ADDON

1. Addon metadata (`bl_info` variable)
2. Convert script into class
3. Register and unregister classes
4. Include in addon directory
5. Activate addon

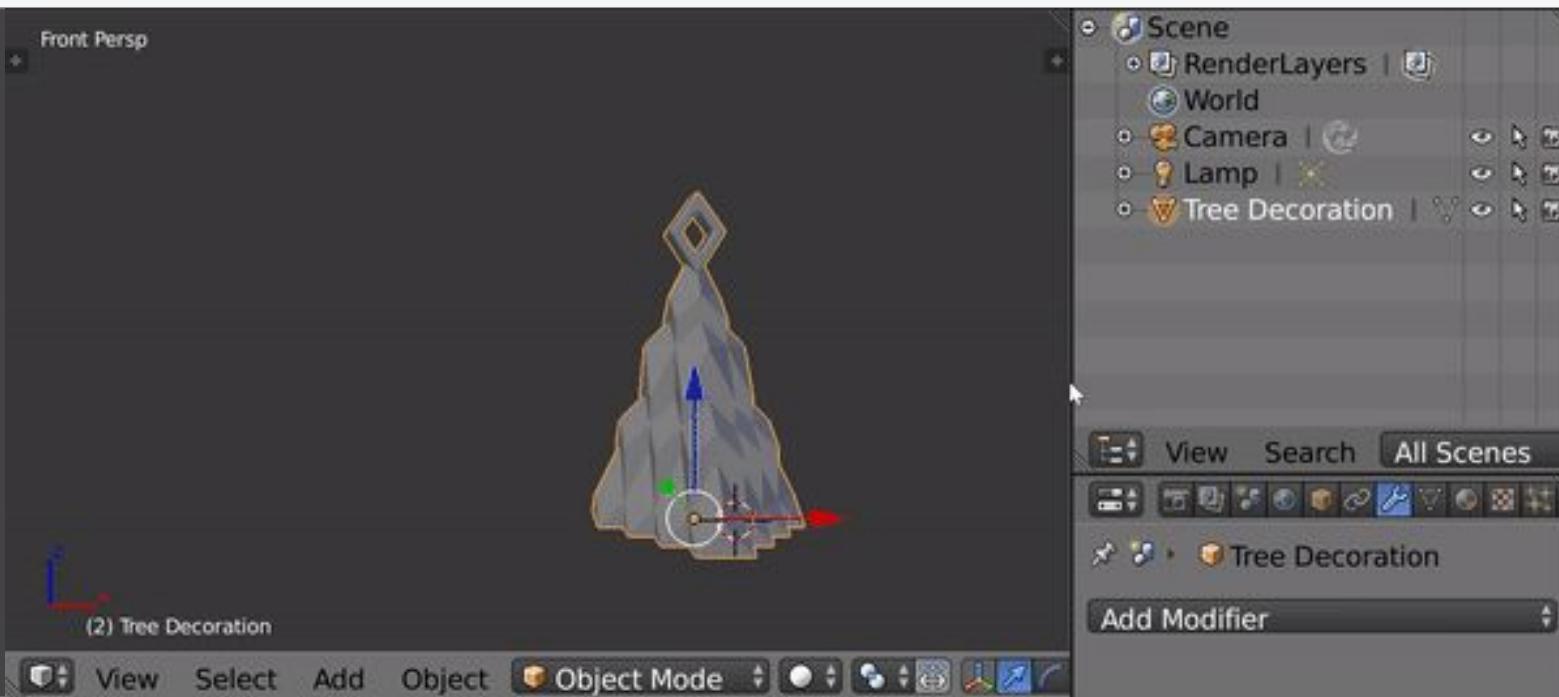


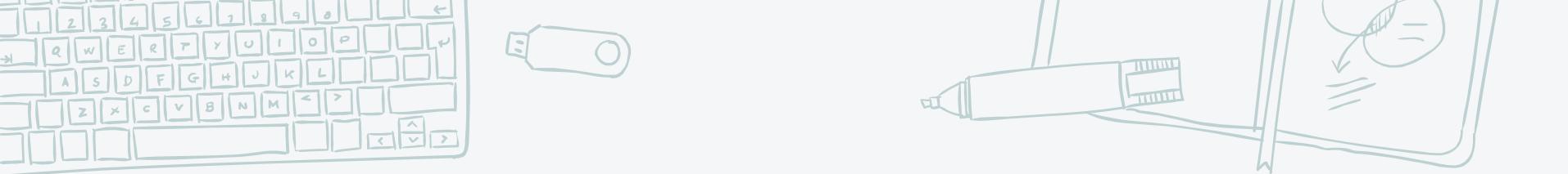
ADDON: AUTOMATIC MODE

Load model

One button press to generate hair
and support cylinder

Export model





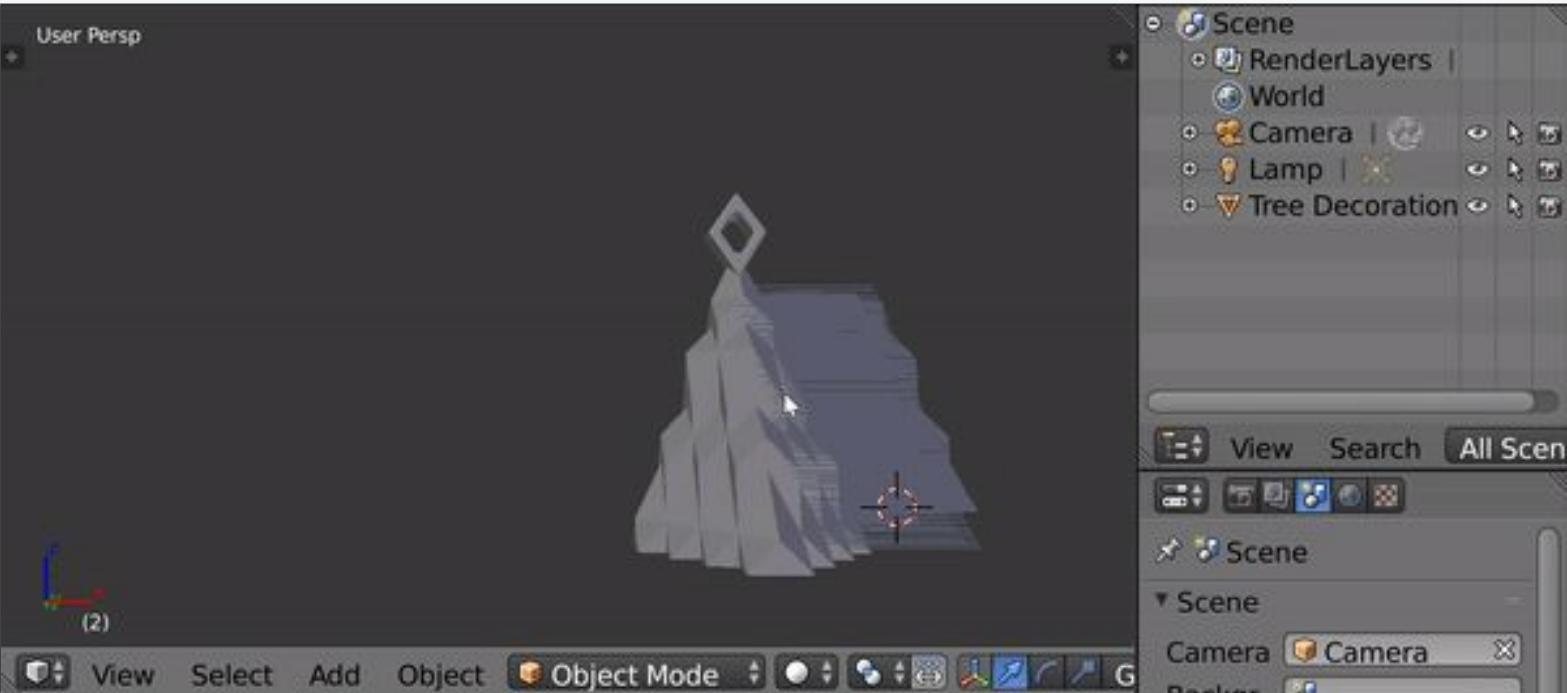
ADDON: MANUAL MODE (SEMI-AUTOMATIC)

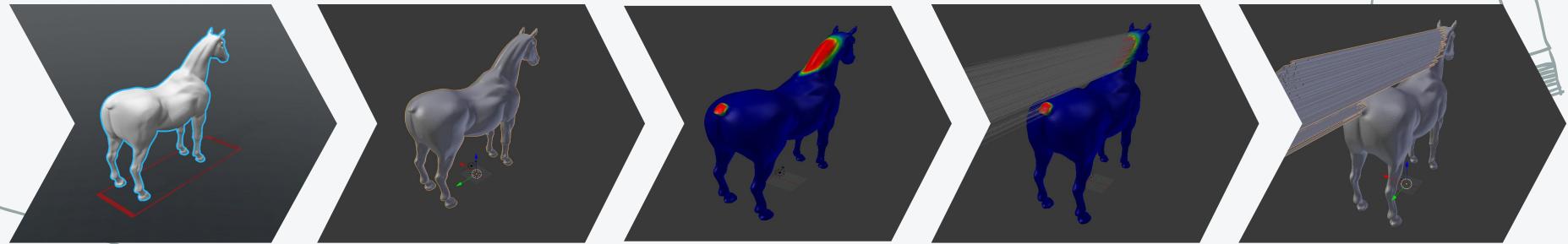
Load model
&
Hair particle
effect brush

Button press to
convert hair to
printable mesh

Optional:
button press to
generate
support
cylinder

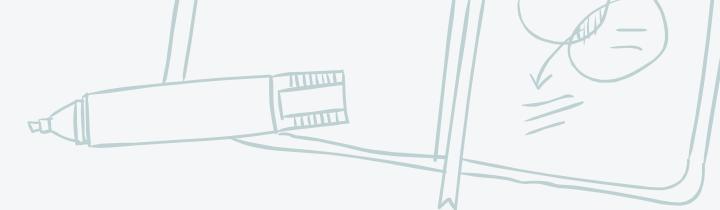
Export Model





HAIR SHAPING



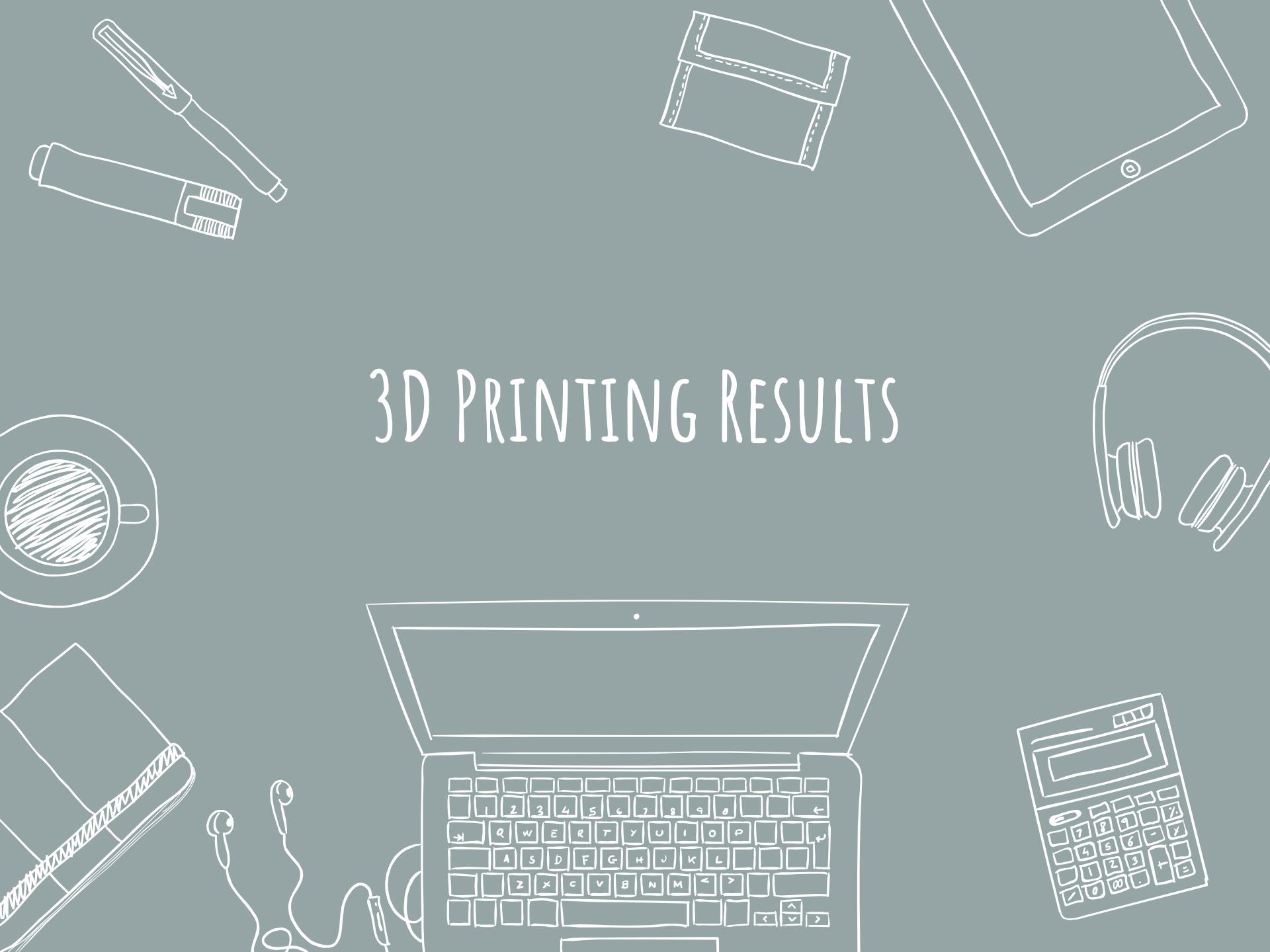


HAIR SHAPING

- Hair fibres are softened using heat gun
- Once softened, the fibres can be moulded



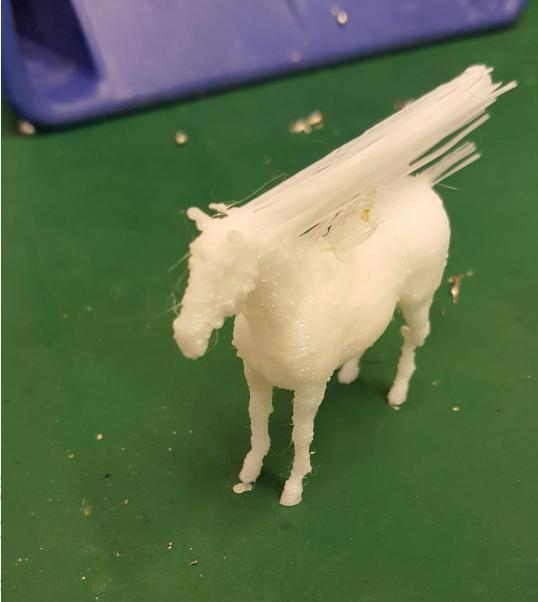
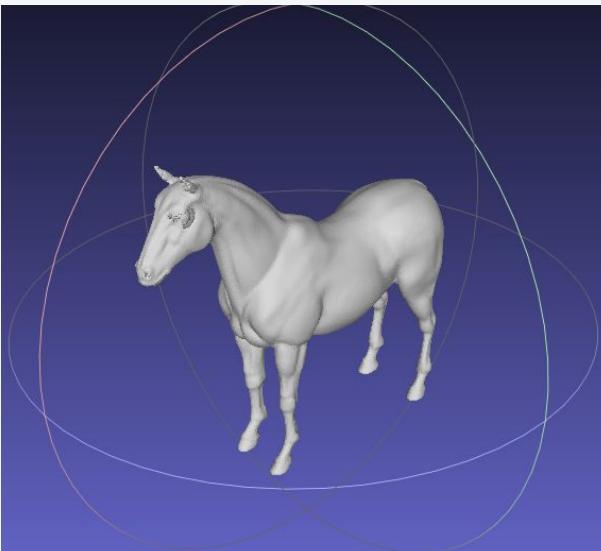
3D PRINTING RESULTS



RESULT SUMMARY

- Automatic mode
 - Cat
 - Bunny
- Manual mode with cylinder
 - Christmas Tree
 - Horse
- Manual mode without cylinder
 - Christmas Tree
 - Bust (3 different hair styles)

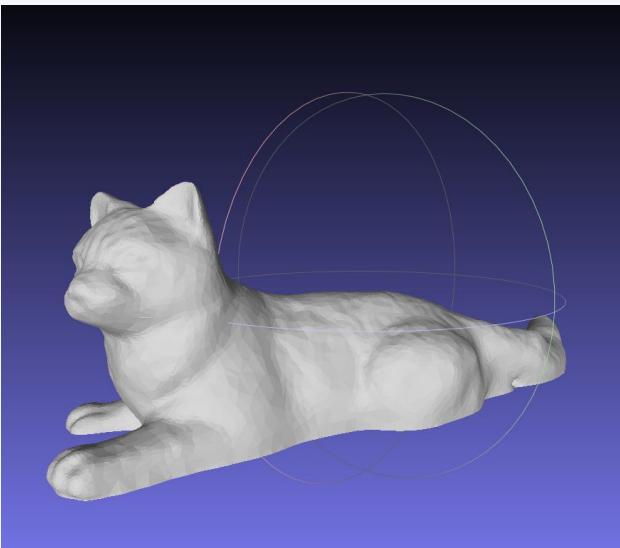
RESULTS - HORSE (MANUAL W/ SUPPORT)



RESULTS - BUNNY (AUTOMATIC W/ SUPPORT)



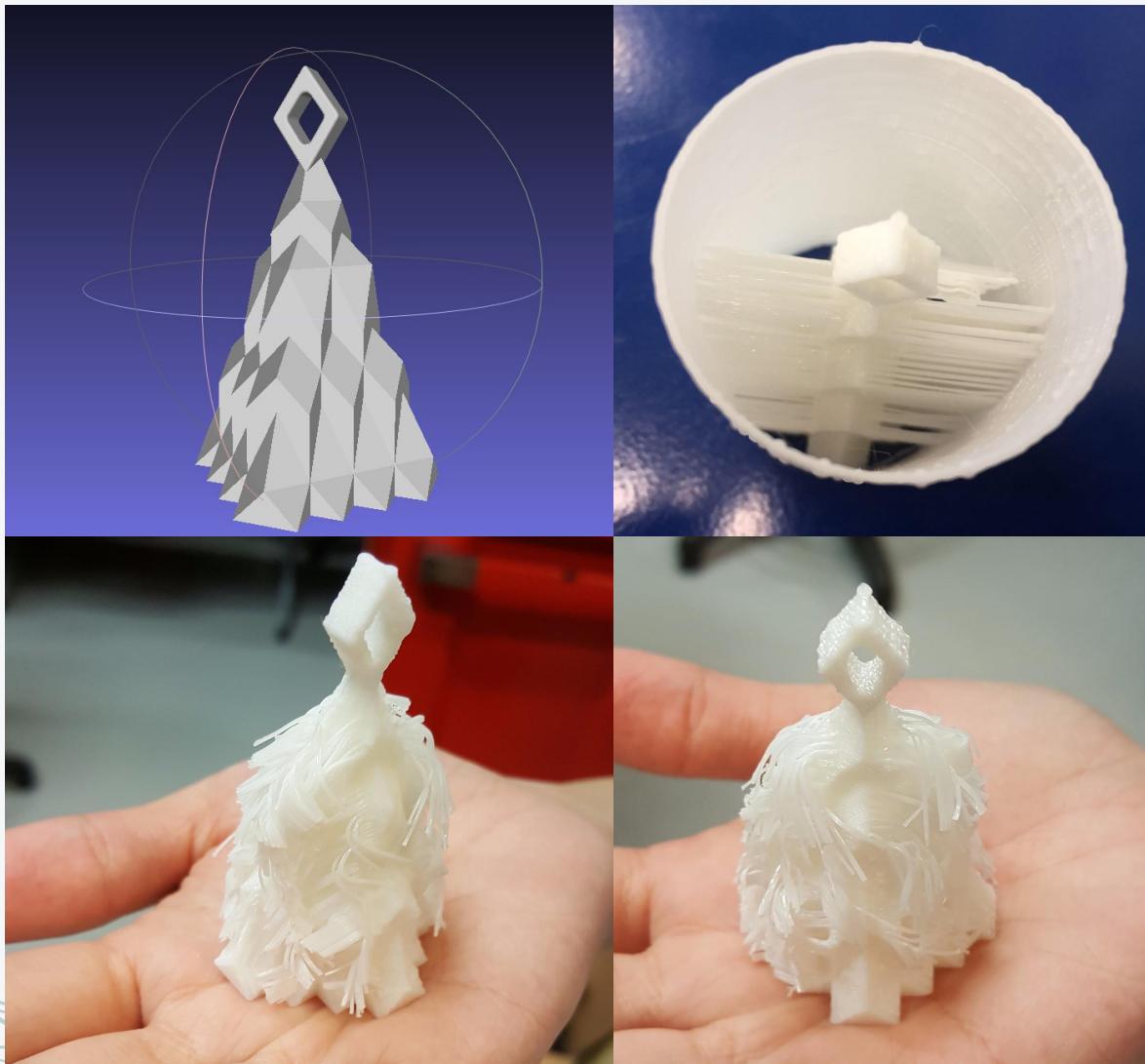
RESULTS - CAT (AUTOMATIC W/ SUPPORT)



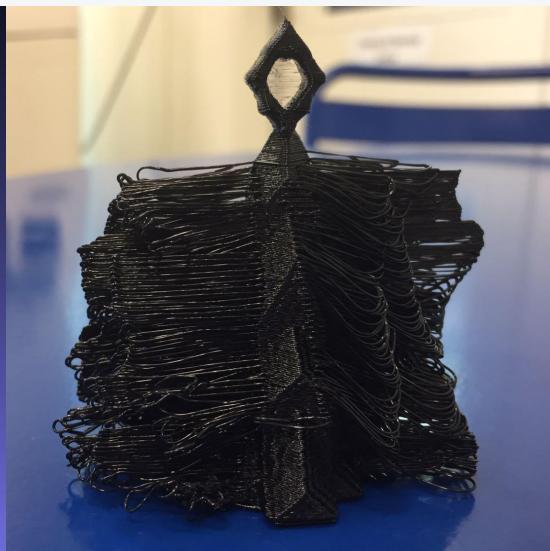
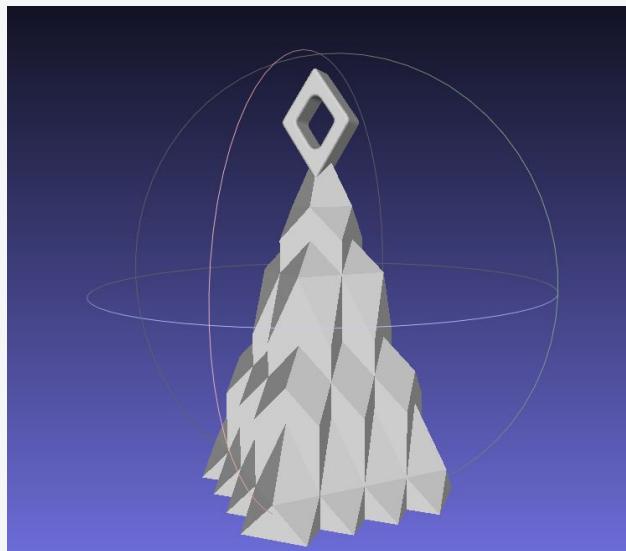
RESULTS - BUST (MANUAL WITHOUT SUPPORT)



RESULTS - CHRISTMAS TREE (MANUAL W/ SUPPORT)



RESULTS - CHRISTMAS TREE (MANUAL WITHOUT SUPPORT)



PROBLEMS AND SOLUTIONS

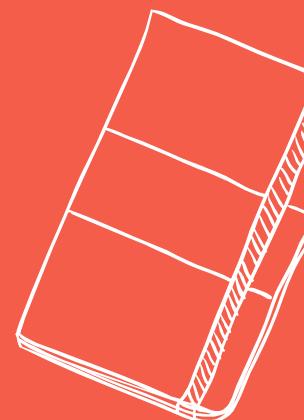


PROBLEMS FACED & SOLUTIONS

Problem Faced	Solution
Determining support structure thickness	Trial and error – tried different thicknesses, slice in Mankati and check if cylinder is detected correctly
Determining hair fibre thickness	Trial and error – tried different thicknesses, slice in Mankati and check if hair fibres are detected correctly
Separating individual hair fibres in slicing software	Found an optimal hair fibre thickness that will prevent hair fibres from joining together with other hair fibres
Printing hair near sharp corners	Regard the action of hair generation near object corners as invalid to the user, the user can choose to generate hair near those areas and comb the 3D printed hair towards those areas
Removing 3D print from printer bed	Optimally aligned cylinder base with object base



THANKS!
ANY QUESTIONS?



REFERENCES

- <https://stackoverflow.com/questions/25437171/edit-a-stl-file-using-python-blender-library>
- http://www.mertl-research.at/ceonwiki/doku.php?id=software:kicad:3d_package_with_blander
- <https://blenderartists.org/forum/archive/index.php/t-227726.html>
- <https://blender.stackexchange.com/questions/40247/extrude-a-mesh-by-region-using-python-script>
- <http://blenderscripting.blogspot.com/2016/04/getting-index-indices-of-selected-faces.html>
- <https://vimeo.com/20963790>
- <https://docs.blender.org/api/2.78b/>
- <https://blender.stackexchange.com/questions/8459/get-blender-x-y-z-and-bounding-box-with-script>
- <https://blender.stackexchange.com/questions/70373/how-to-convert-hair-particles>
- <https://blender.stackexchange.com/questions/539/snap-object-on-top-of-surface-of-other-object>
- <https://cgi.tutsplus.com/tutorials/modeling-a-modern-interior-scene-in-blender--cg-15294>