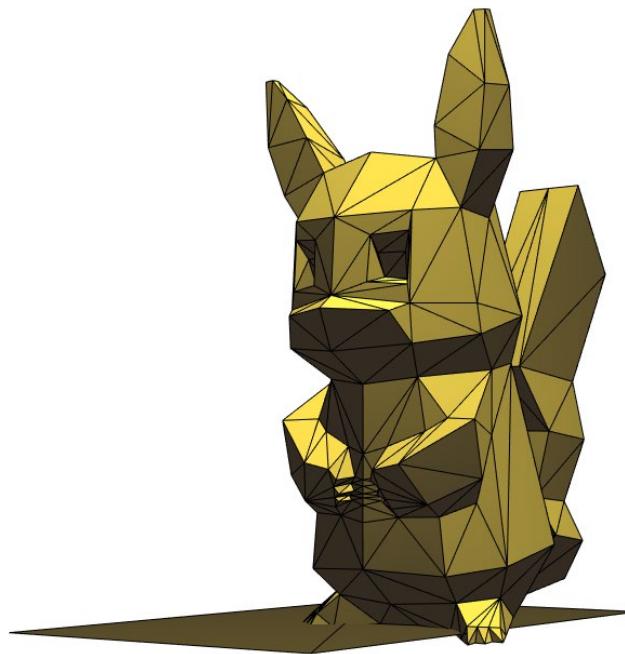
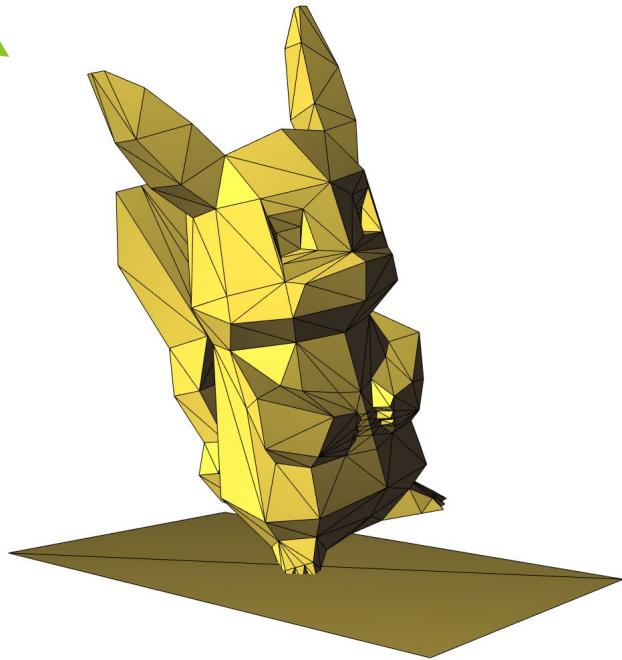
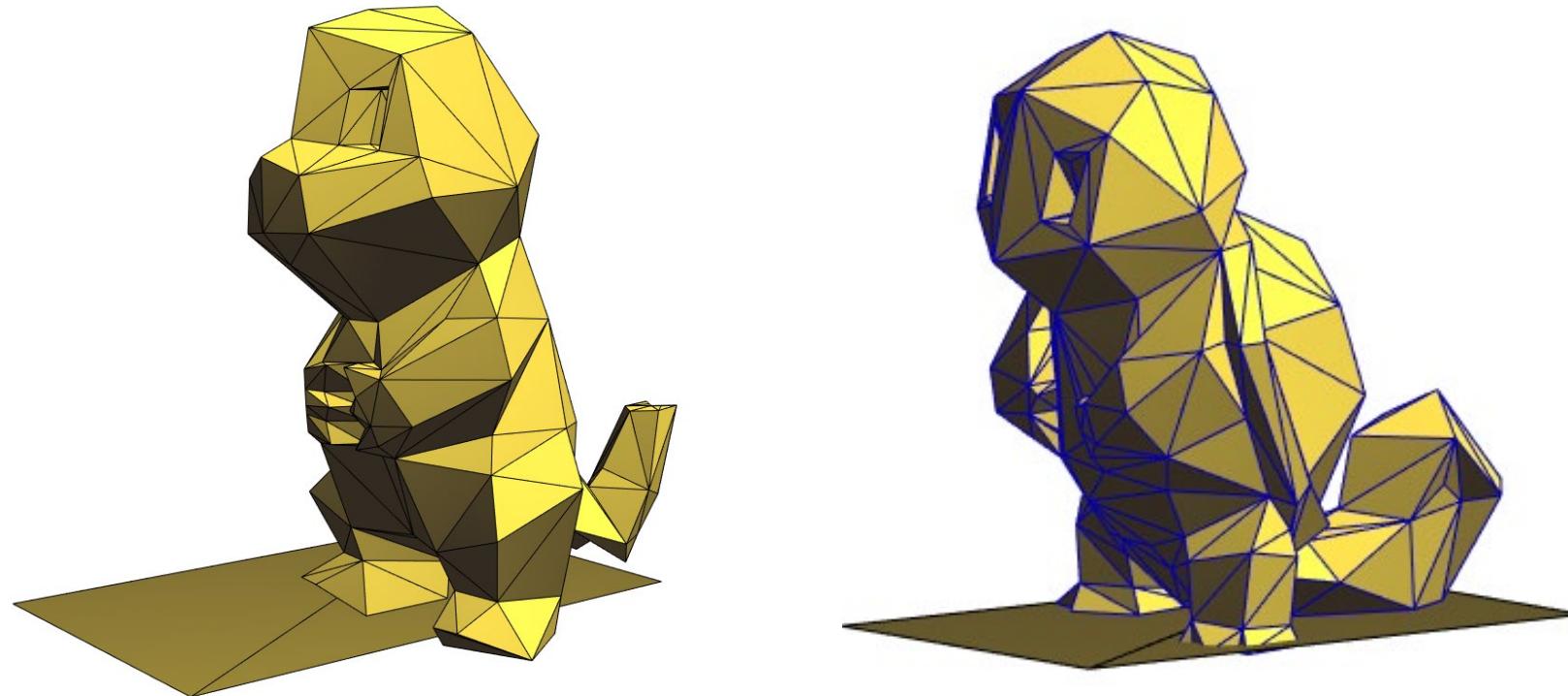


Photo for contest



Make it Stand



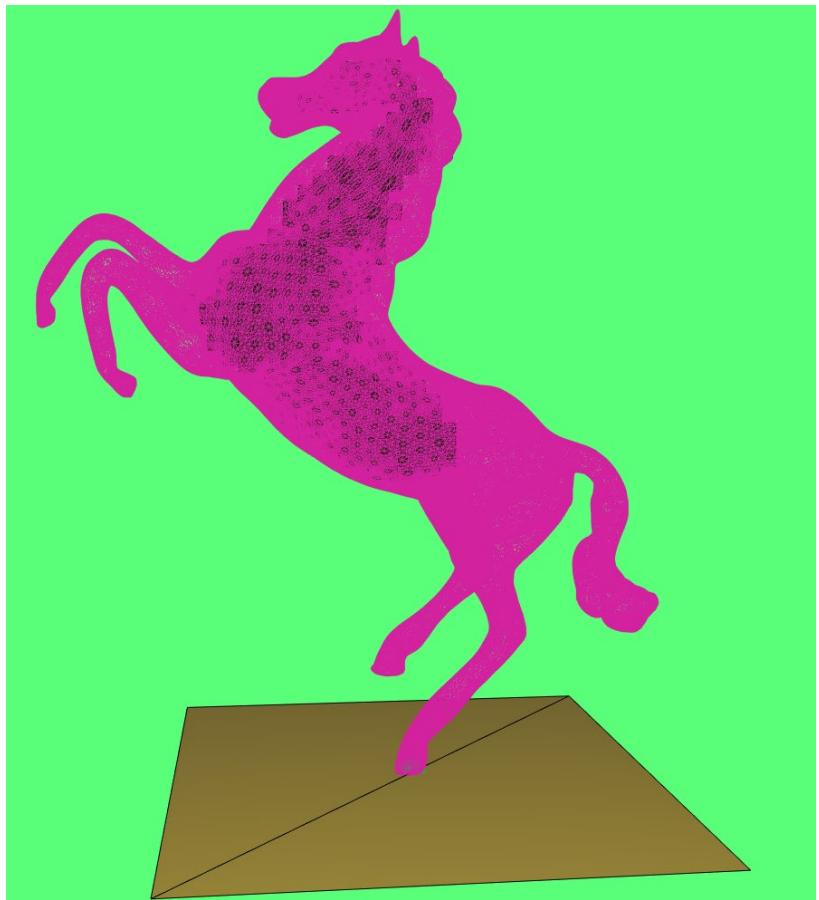
Make it Stand Balancing Shapes for 3D Fabrication

Barak Levy

Make it Stand - Into



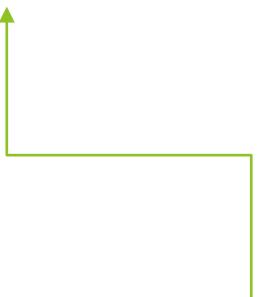
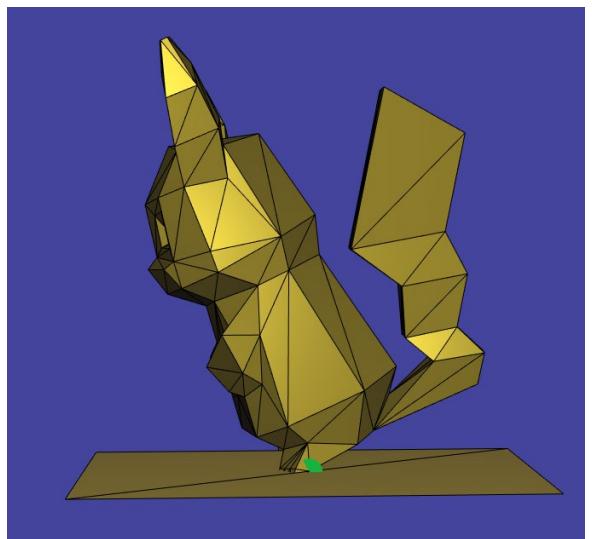
- ▶ The motivation to balance solid objects are varied.
- ▶ Artists, designers and architects can produce surprising designs that seem to defy gravity using intelligent software's.
- ▶ Unintuitive to change the weight distribution of figures in order to implement balance



Make it Stand - Into

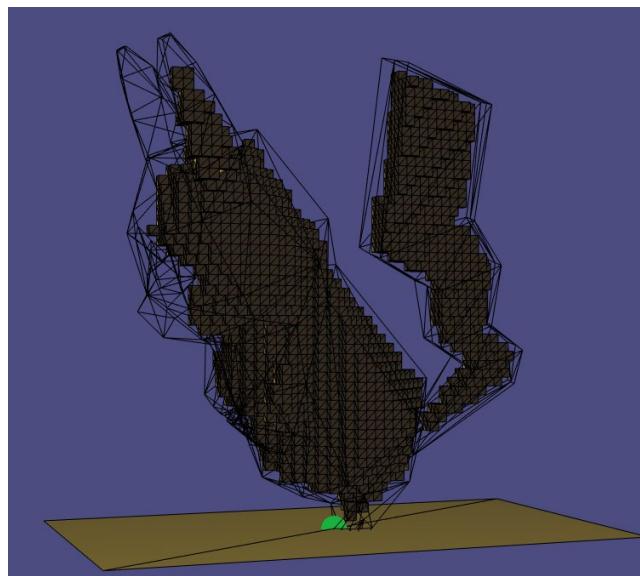
- ▶ This paper propose a novel method for balancing 3D models.
- ▶ As a result, a potential user can print a 3D balanced figures.
- ▶ The method is well suited for the modeling of surprising balance configurations.

Make it Stand - My Implementation Method



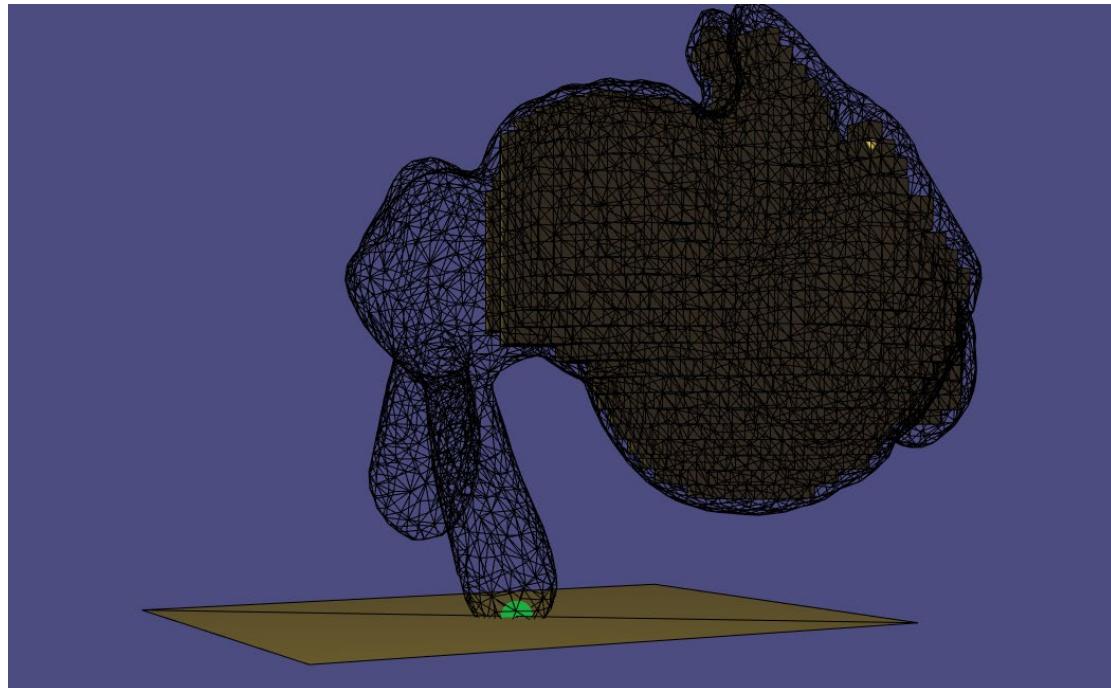
Input Model

Inner-Carving



Balanced Model

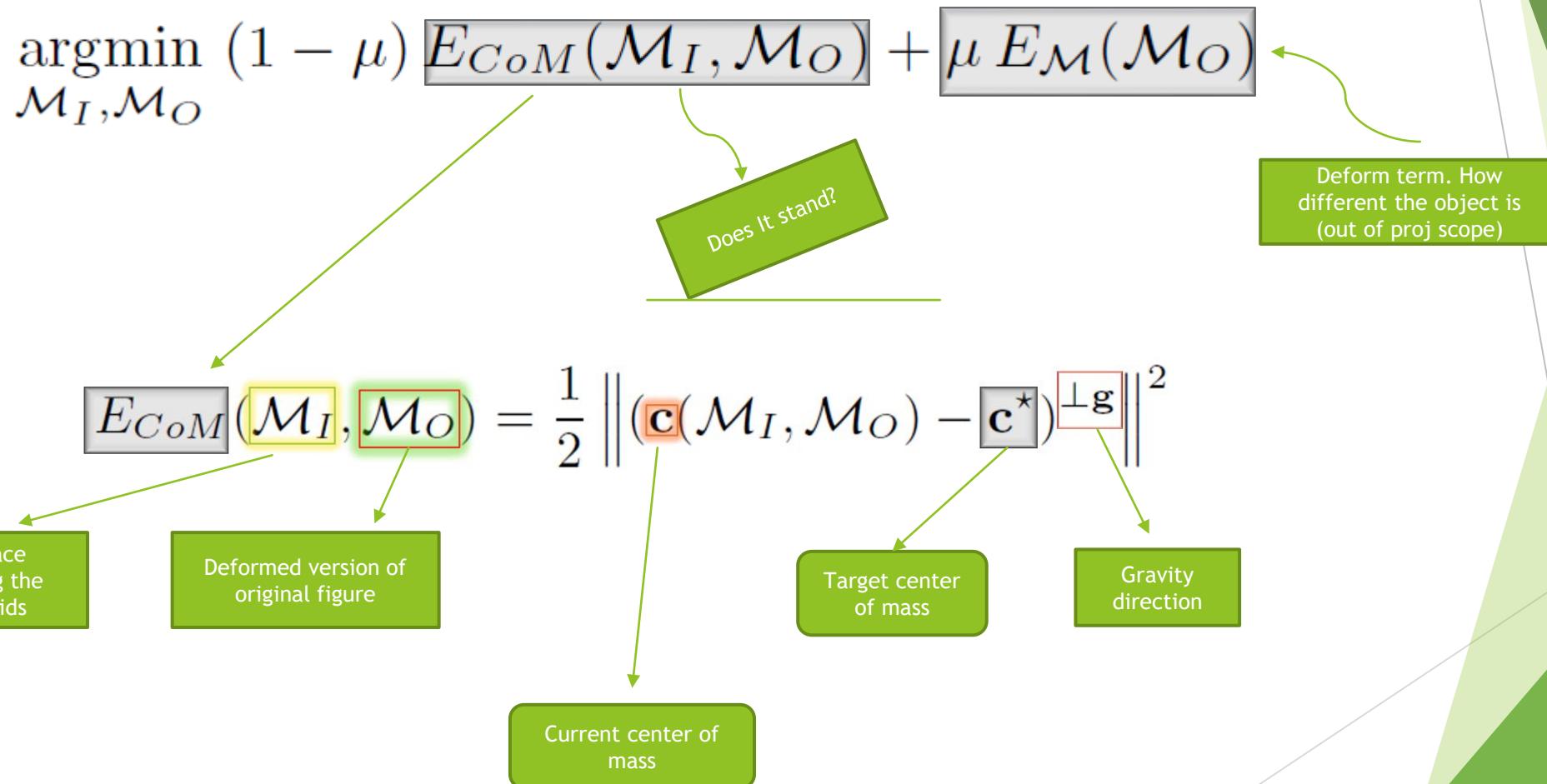
Make it Stand



- ▶ The input represents solid model.
- ▶ The objective is to make the model stand
- ▶ Two degrees of freedom:
 1. Carving inside the model to create inner voids. (Implemented in this project)
 2. Deforming the model (not implemented)

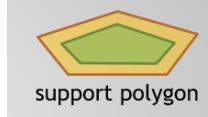
Make it Stand - Minimization Problem

- One can formulate the main objective as an Energy function to minimized.

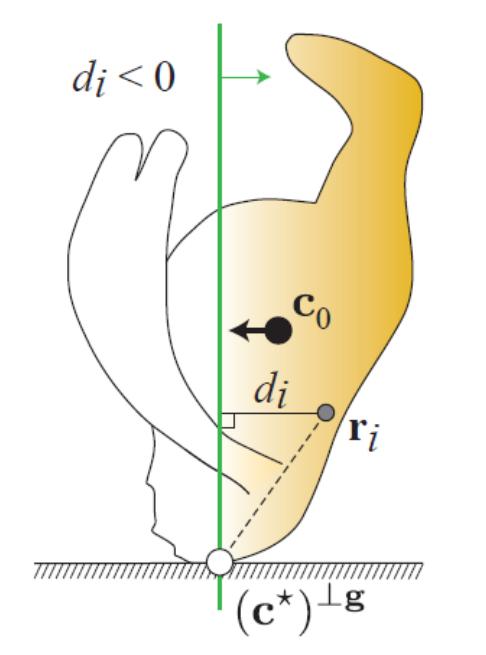
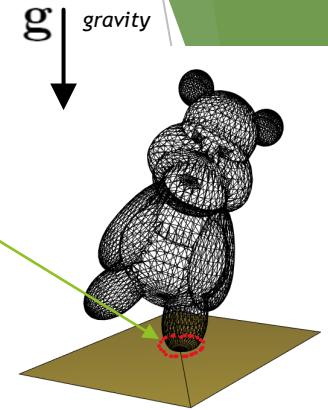


More Terminology

- ▶ The center of mass (com) are key factor by determining balance.
- ▶ Base of support - Points of the mesh that touching the ground (plane)
 - Also called - support polygon.

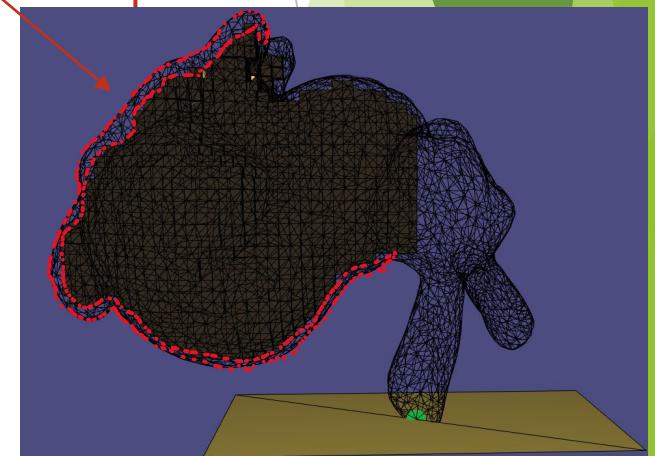


- ▶ Using heuristic for updating the com.
- ▶ In order to minimize the energy, we simply need the squared distance between the current com and its target c^* (after projection on the ground plane).
- ▶ Assuming a constant density - using the divergence theorem to reduce the integrals into 2D



Make it Stand Difficulties

- ▶ Using the method, arbitrary inner surfaces not in use, instead we are using voxel grid.
- ▶ Our main object is to carve the interior part of the volume, in order to do that we compute voxel grid. That is, a discretized representation of the interior volume.
- ▶ Determined the boundaries and the voxels next to them.
- ▶ Determined the thickness layer of voxels nearby the boundary (t_{min}).

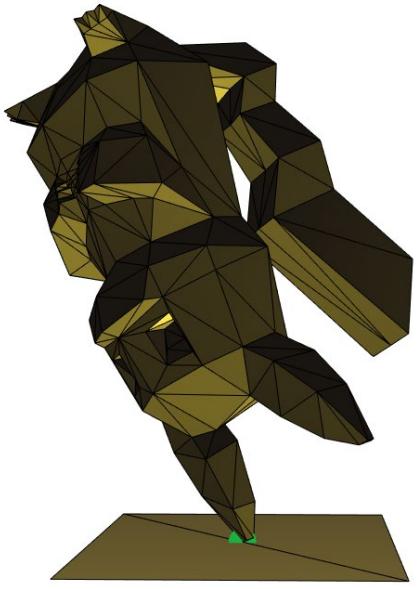


Make it Stand Difficulties cont

- ▶ Set the halting condition.
- ▶ The halting conditions that given in the paper dealing with two degrees of freedom - carving and deforming.
- ▶ In my implementation there is only one degree of freedom - carving inner mass.
- ▶ Therefore, I find it difficult to find a right stopping conditions.
- ▶ At long last and after: trial and error, heuristics and logics I set these three carving stop conditions:
 1. Too many iteration implemented upon the mesh (set as 22, T&E), OR
 2. Too many voxels already removed (82% from all the interior voxels), OR
 3. The reached center of mass is one voxel from the point of balance,

Results



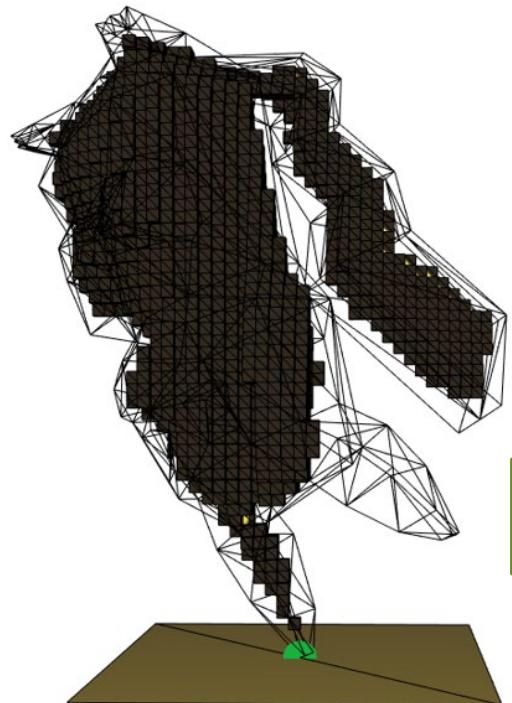


Input - not balanced

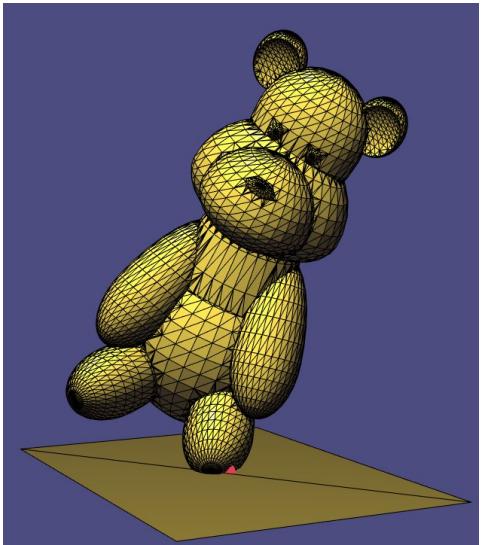
Carving



Carved voxels

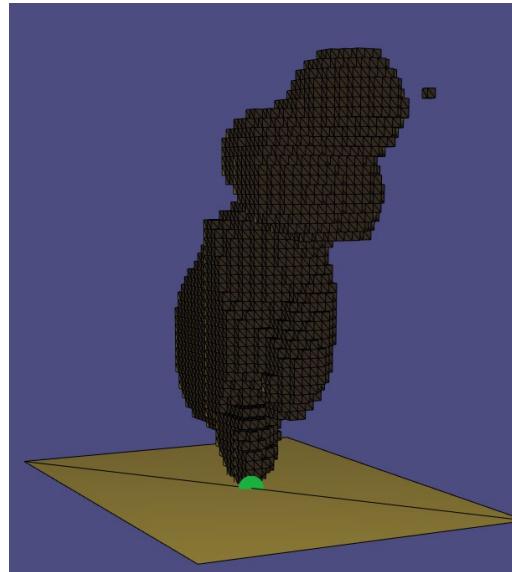


Balanced
Model

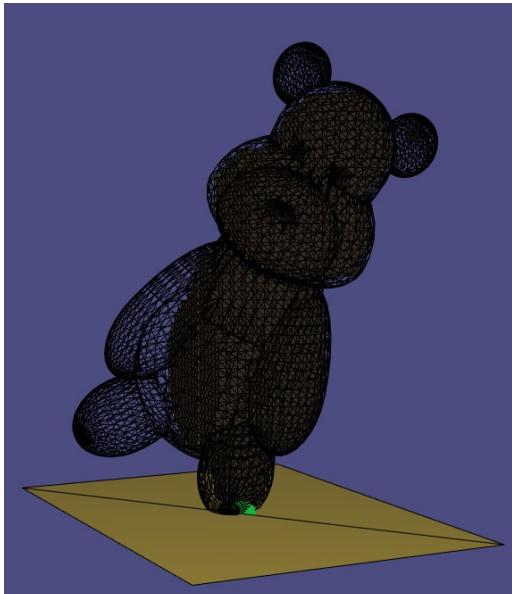


Input - not balanced

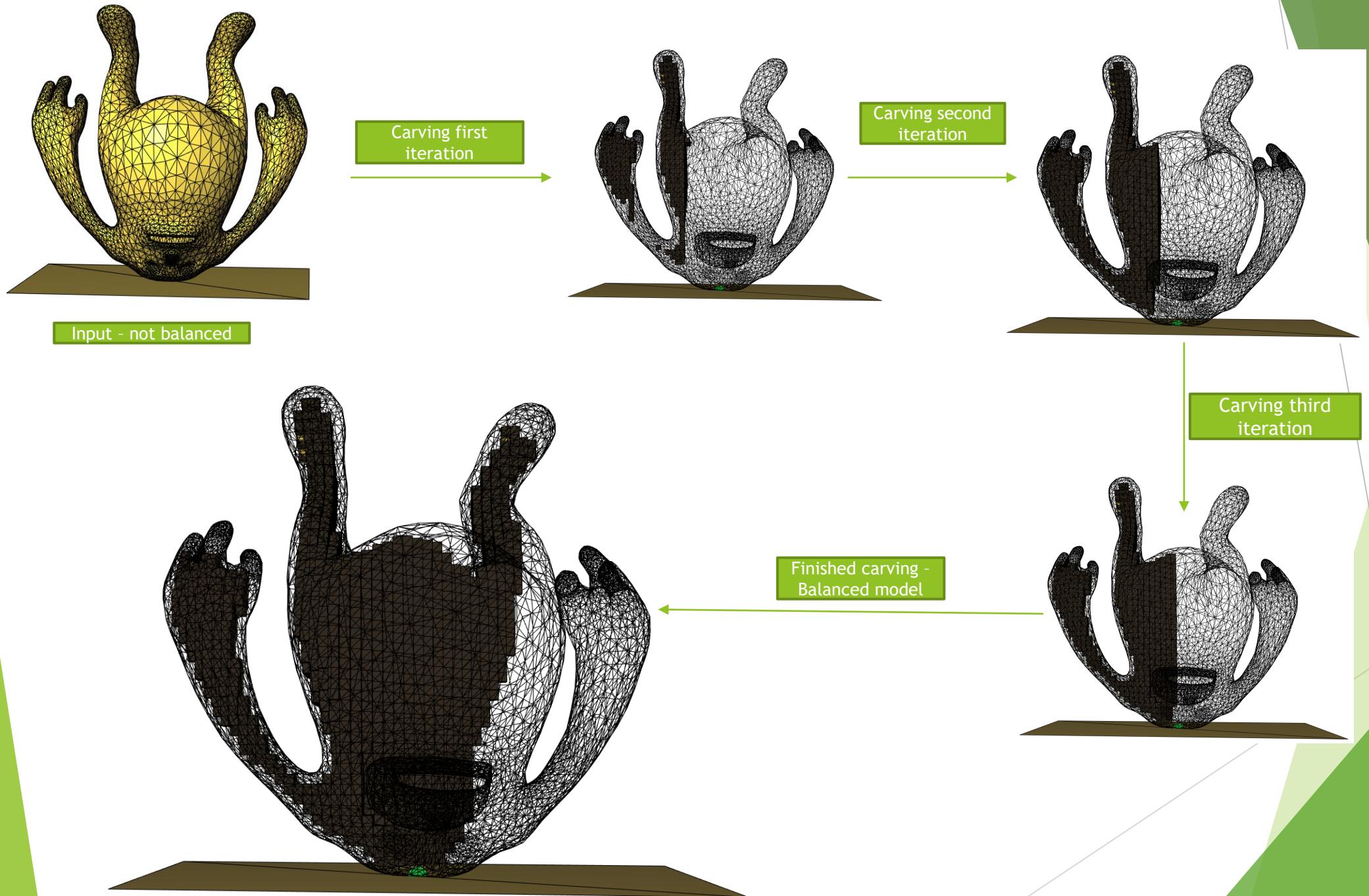
Carving

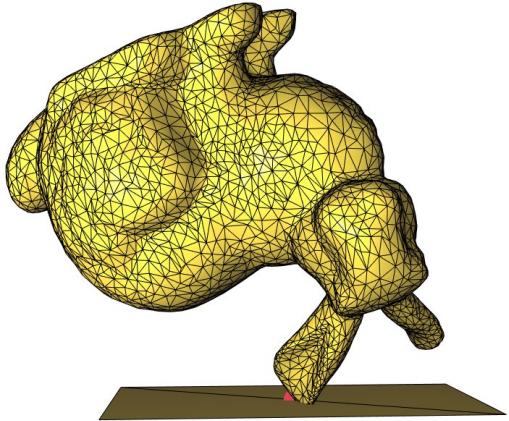


Carved voxels



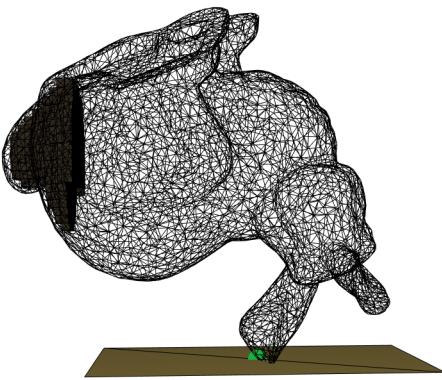
Balanced
Model



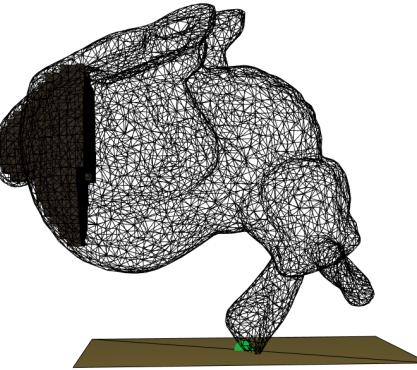


Input - not balanced

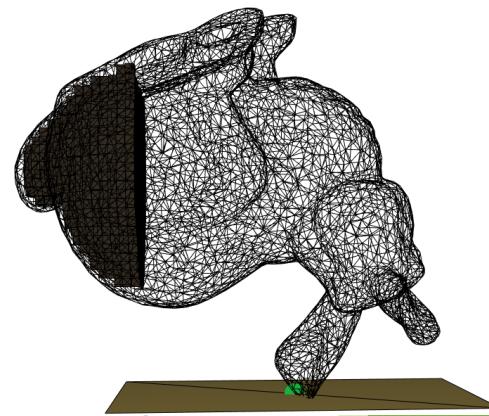
Carving first iteration



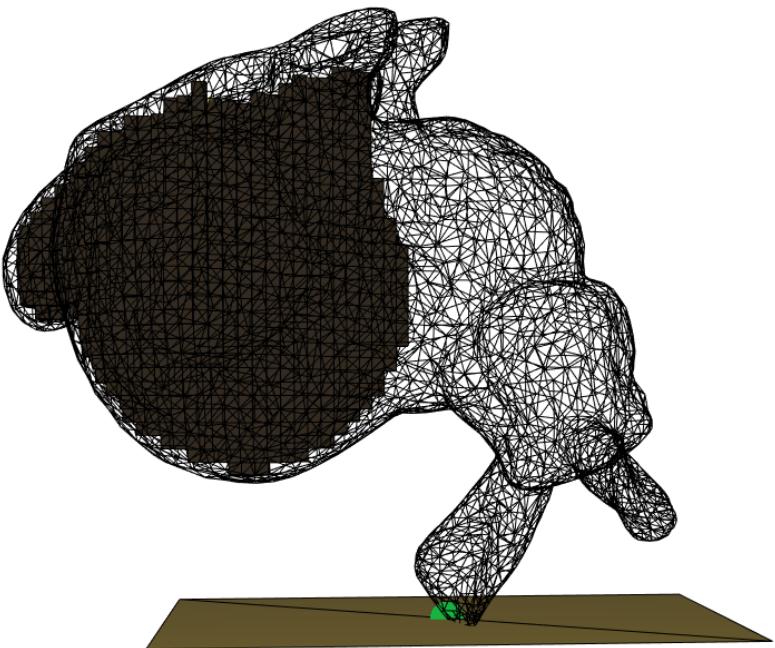
Carving second iteration

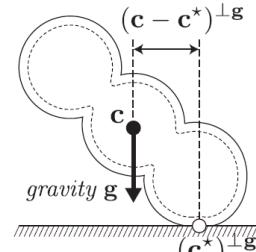
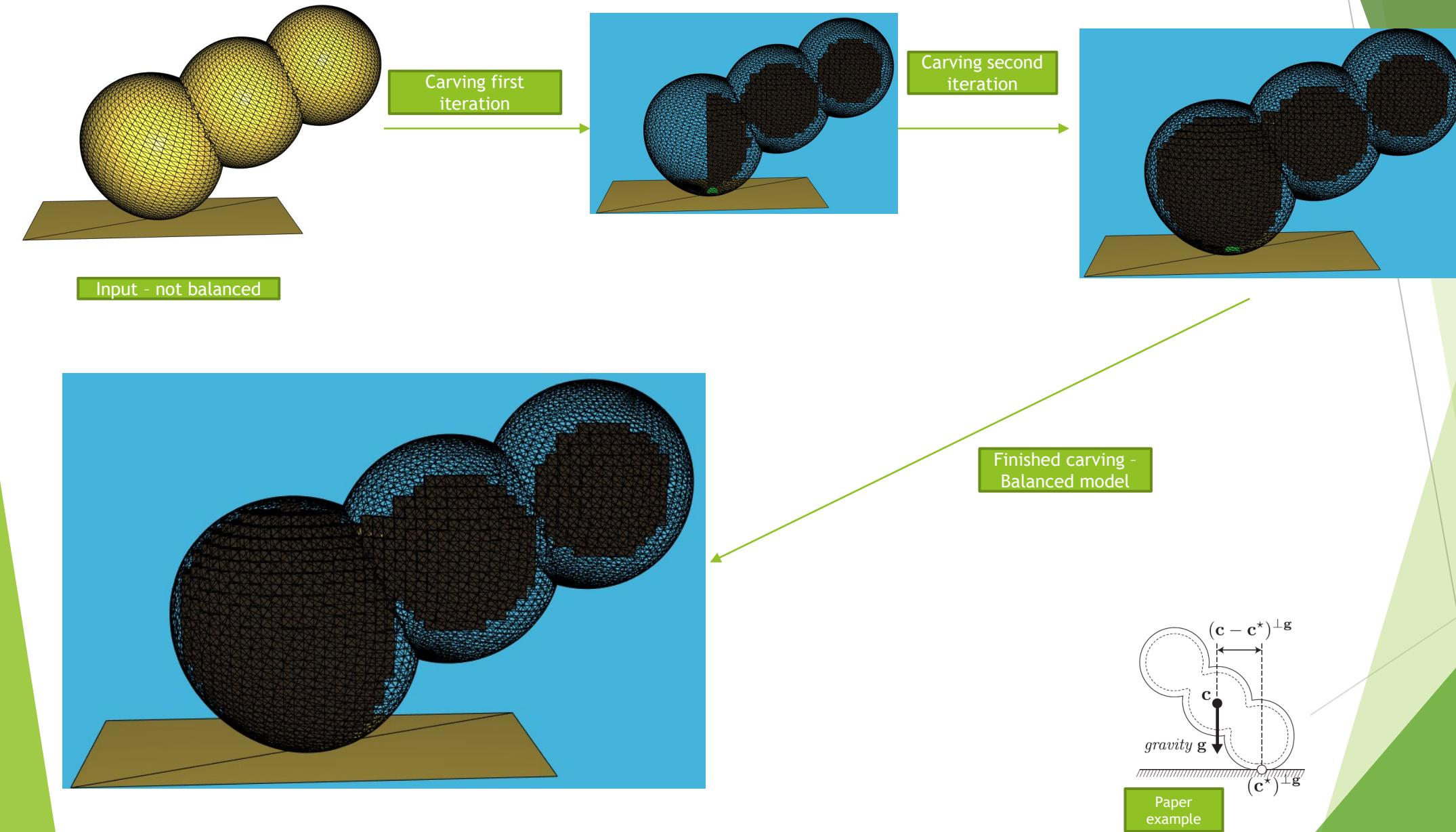


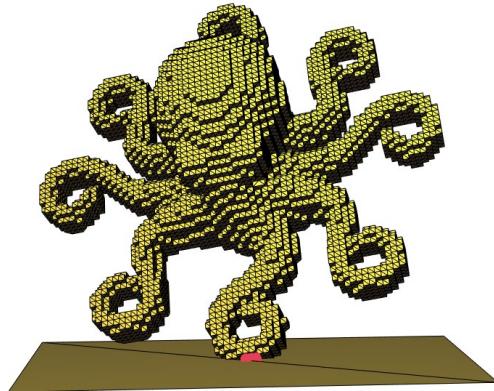
Carving third iteration



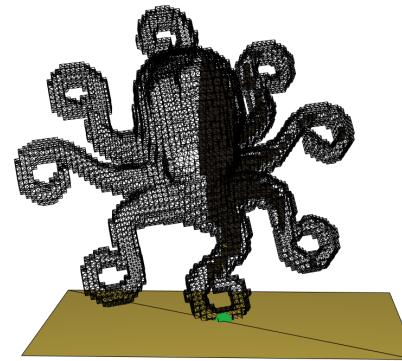
Finished carving -
Balanced model



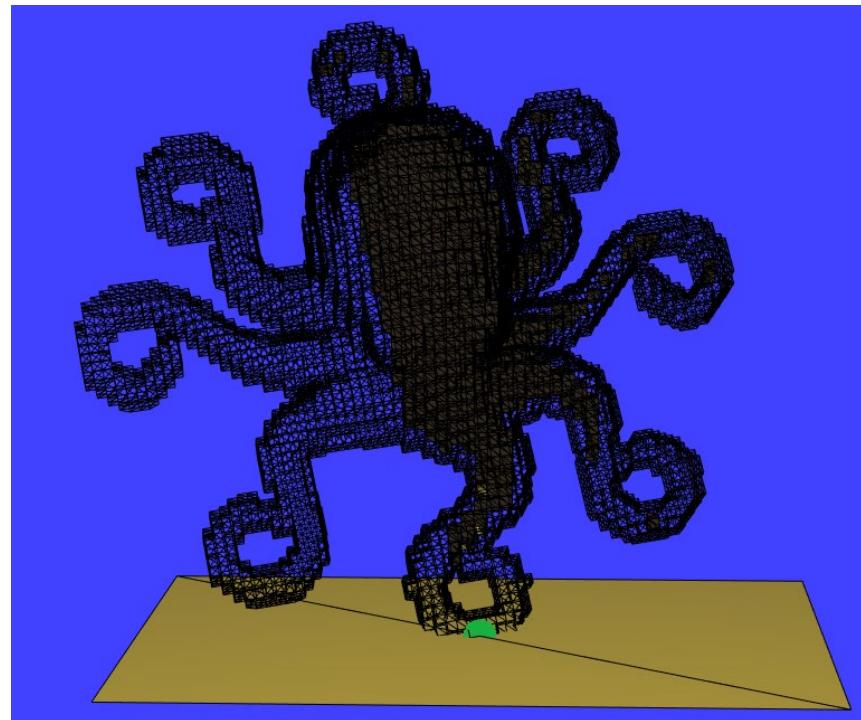
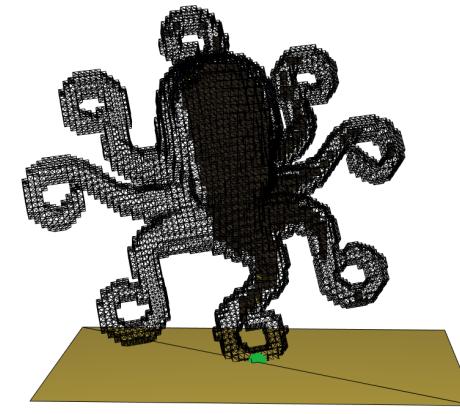




Carving first iteration

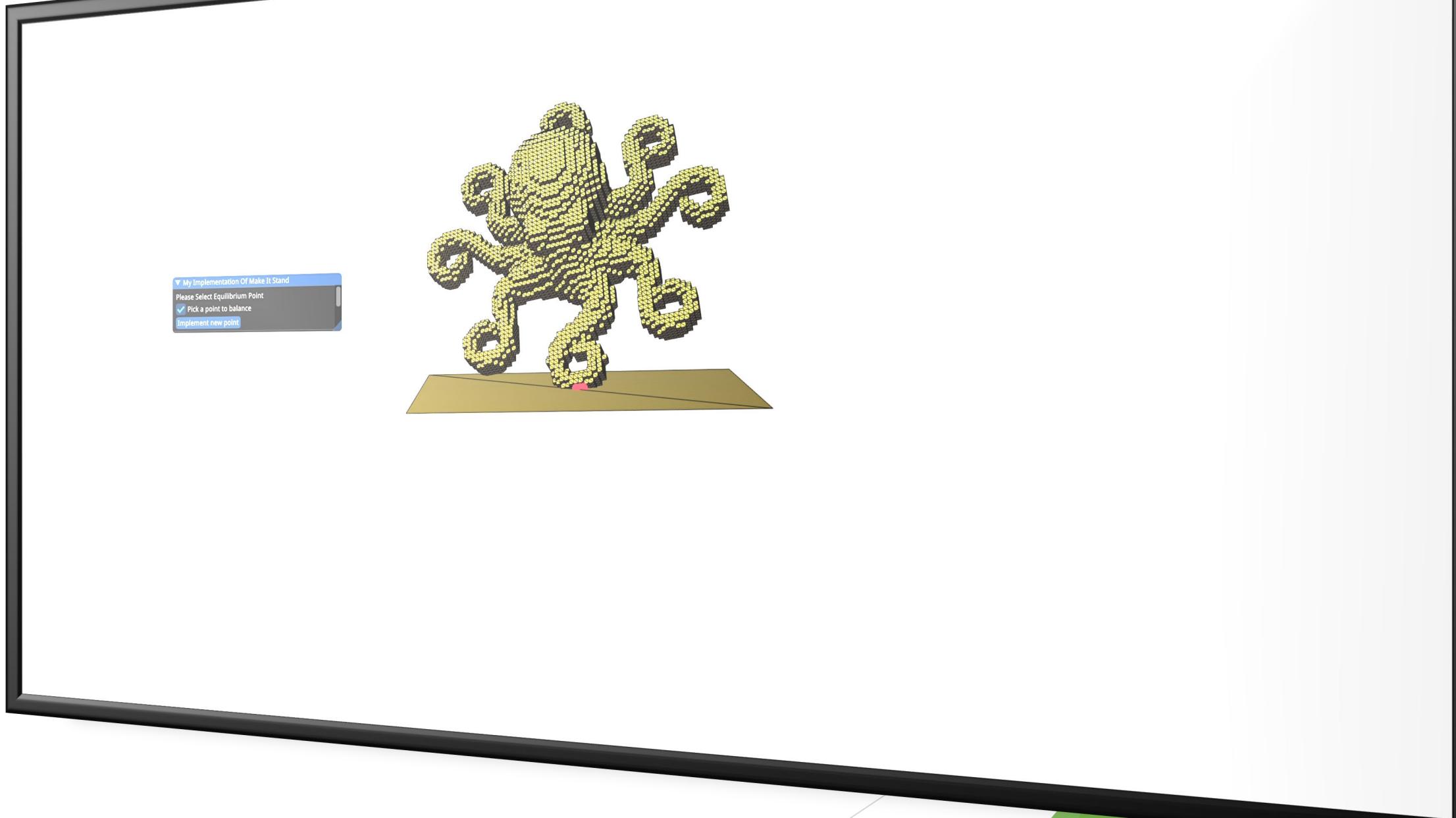


Carving second iteration



Finished carving -
Balanced model

► Setting new balance point



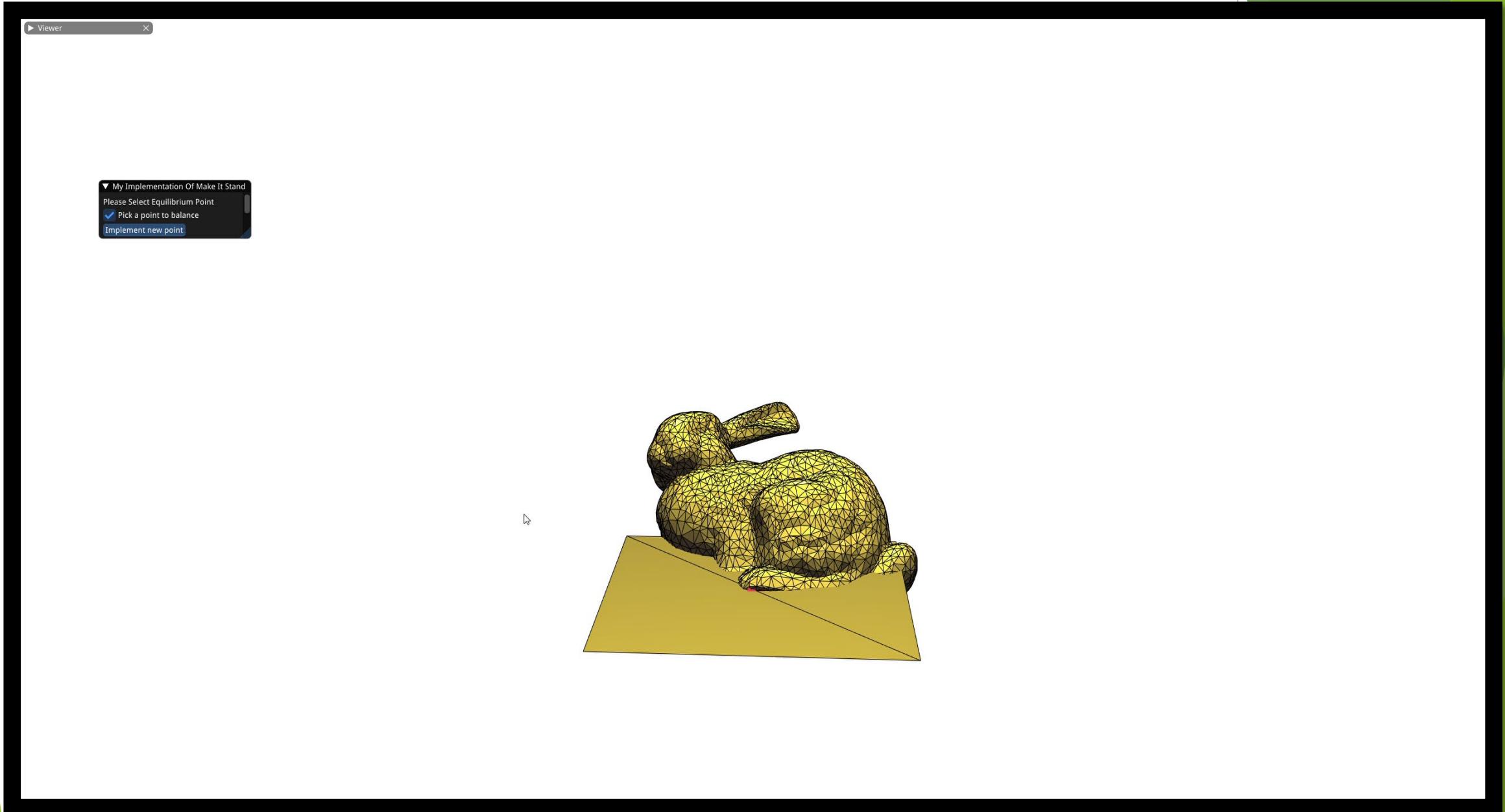
Program

- ▶ The program is very simple and user friendly therefore I'll demonstrate it by videos:
- ▶ Overview of carved model:

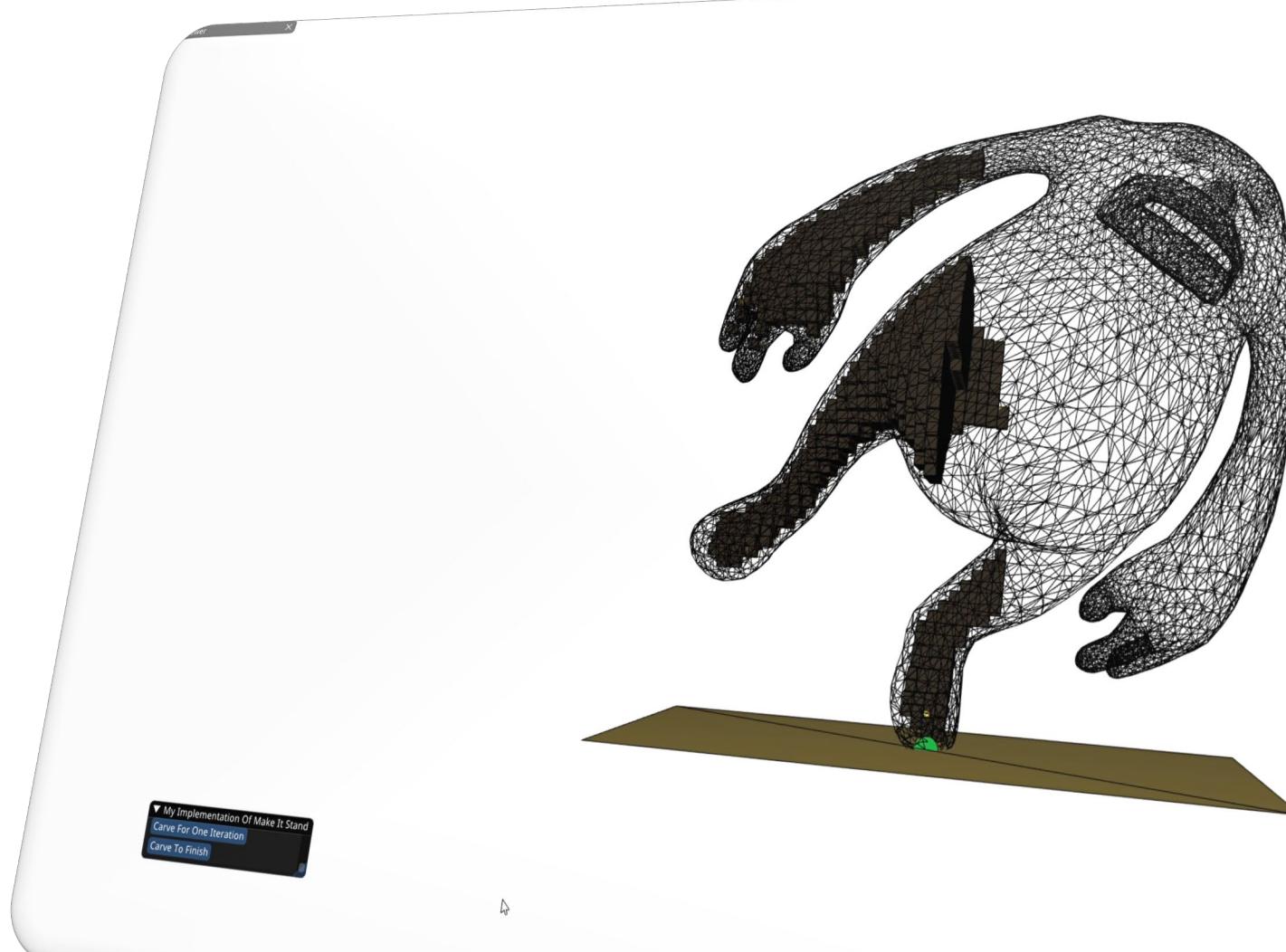
 My Implementation Of Make



► End-to-end usage



► End-to-end usage



▼ Viewer X

▼ Workspace

Load Save

▼ Mesh

Load Save

▼ Viewing Options

Center object Snap canonical view 0.318 Zoom Two Axes Camera Type Orthographic view

▼ Draw Options

Face-based Show texture Invert normals Show overlay Show overlay depth Background Line color 35.000 Shininess

▼ Overlays

Wireframe Fill Show vertex labels Show faces labels Show extra labels

▼ My Implementation Of Make It Stand

Please Select Equilibrium Point Pick a point to balance

Please Select Figure Angle Change figure angle

Carve The Figure

Start Carving Carve For One Iteration Carve To Finish

Process of Carving Complete

