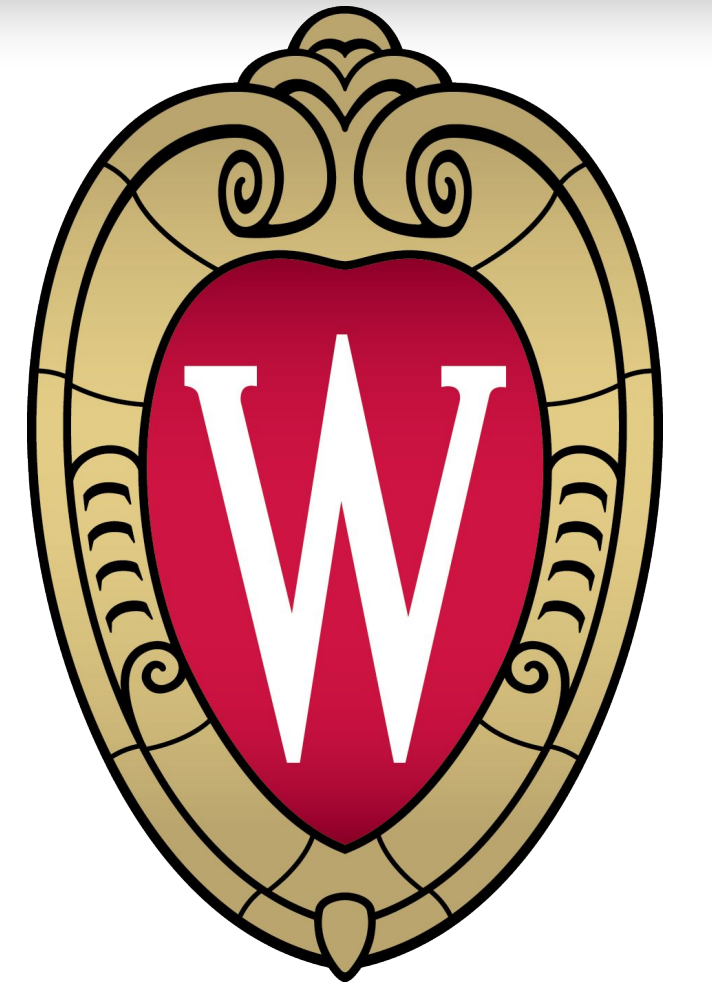


3D Printed Canine Dental Device



Parker Callender, Ethan Frohna, Sanam Jhaveri, Justin Grudem, Amy Cao, Sammie Gilarde
 Client: Dr. Graham Thatcher, University of Wisconsin-Madison, School of Veterinary Medicine
 Advisor: Dr. Walter Block, Department of Biomedical Engineering
 University of Wisconsin - Madison



Abstract

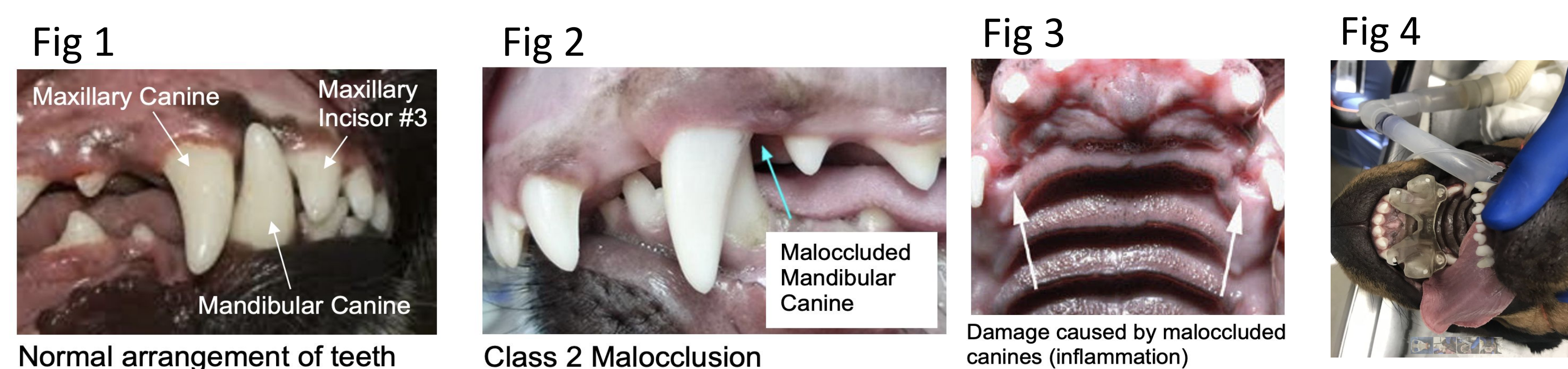
Class II malocclusions in dogs treated with orthodontic brace devices, called incline planes. Incline planes move teeth through passive force, and can be created through several different methods. A 3D printable incline plane can be constructed using scans of the patient's jaw, but the current design and workflow requires many prototypes and the help of a software engineer to produce a device. There is also a need for a more adjustable, flexible design that can fit patients of different sizes and allow for growth over time. The team devised an alternative design consisting of two 3D printed pieces on each side of the mouth, allowing for growth of the maxillae and decreasing risk of palatitis. The software Blender for Dental was used to fit the piece to the jaw and manipulate the teeth.

Motivation

- Malocclusions are heritable traits that can cause issues for dogs and cats if not treated [1].
- The treatment process involves many possible complications:
 - Adjustments may be needed throughout the process
 - Gingivitis and palatitis are common side effects [2]
- 3D printing has been adopted into human dentistry, but is not as common in veterinary dentistry.
- The project's goals are to improve treatment for the patients and streamline the fabrication and treatment process for veterinarians and veterinary orthodontists alike.

Background

- Class 2 Malocclusion in dogs is the misalignment of the mandibular (lower) and maxillary (upper) jaw
- Causes damage to the upper palate and gums which results in pain
- Current treatments include extracting the teeth, shortening the teeth, and applying orthodontics (dog braces)



Figures 1, 2, and 3: Show the normal arrangement of teeth, the arrangement of teeth in a dog with a class 2 malocclusion, and the damage to the upper palate as a result of the class 2 malocclusion, respectively.
 Figure 4: Shows the original dog braces used by the client in the patient's mouth

Design Criteria

- | | |
|--|--|
| Inclined Plane <ul style="list-style-type: none"> Withstand up to 400 lb (1390 N) of pressure Last 6-8 weeks in patient's mouth over treatment period | Software <ul style="list-style-type: none"> Easy to understand interface Ability to manipulate models of the teeth and inclined plane |
|--|--|

Software and Blender

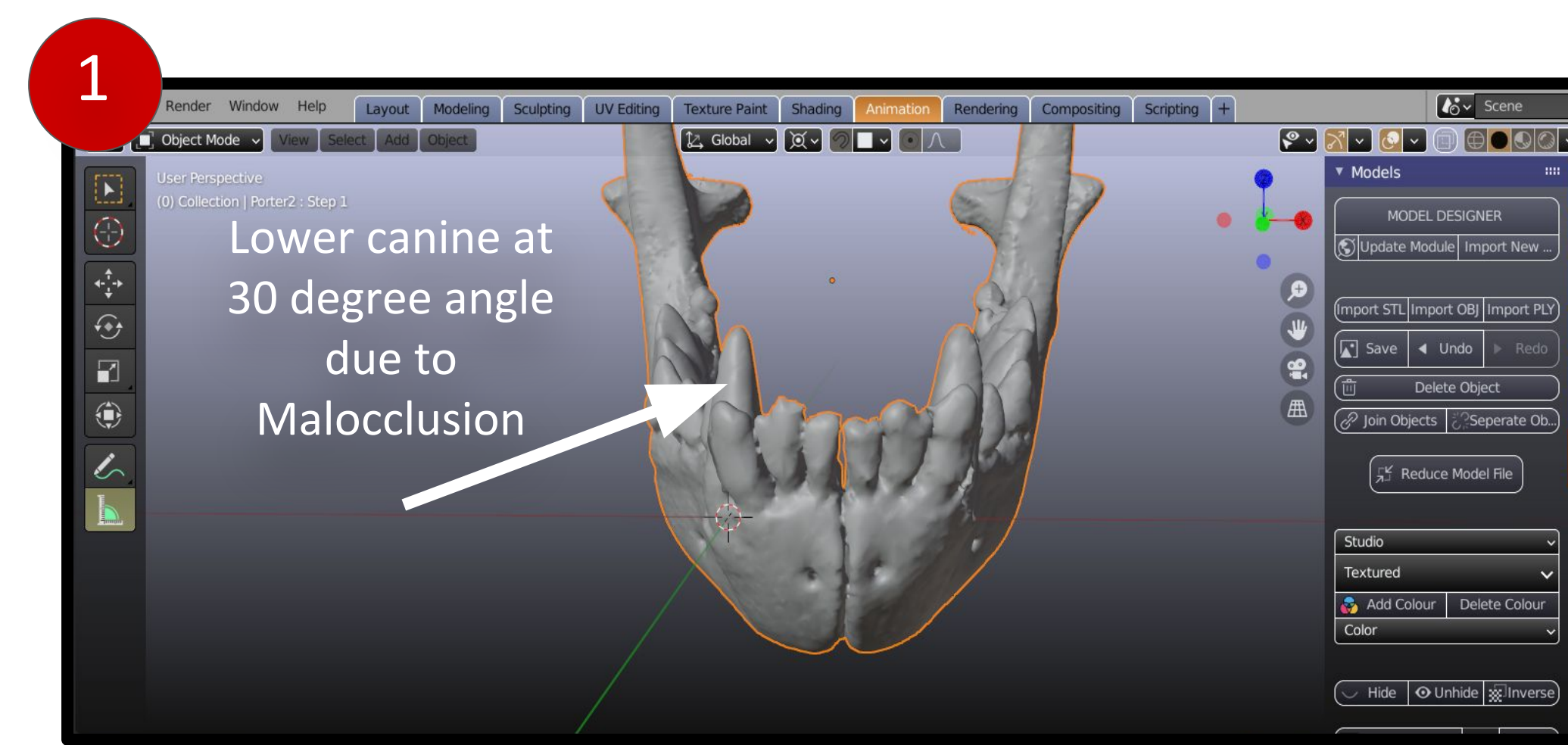


Figure 5: Tooth at Malocclusion (0° angle)

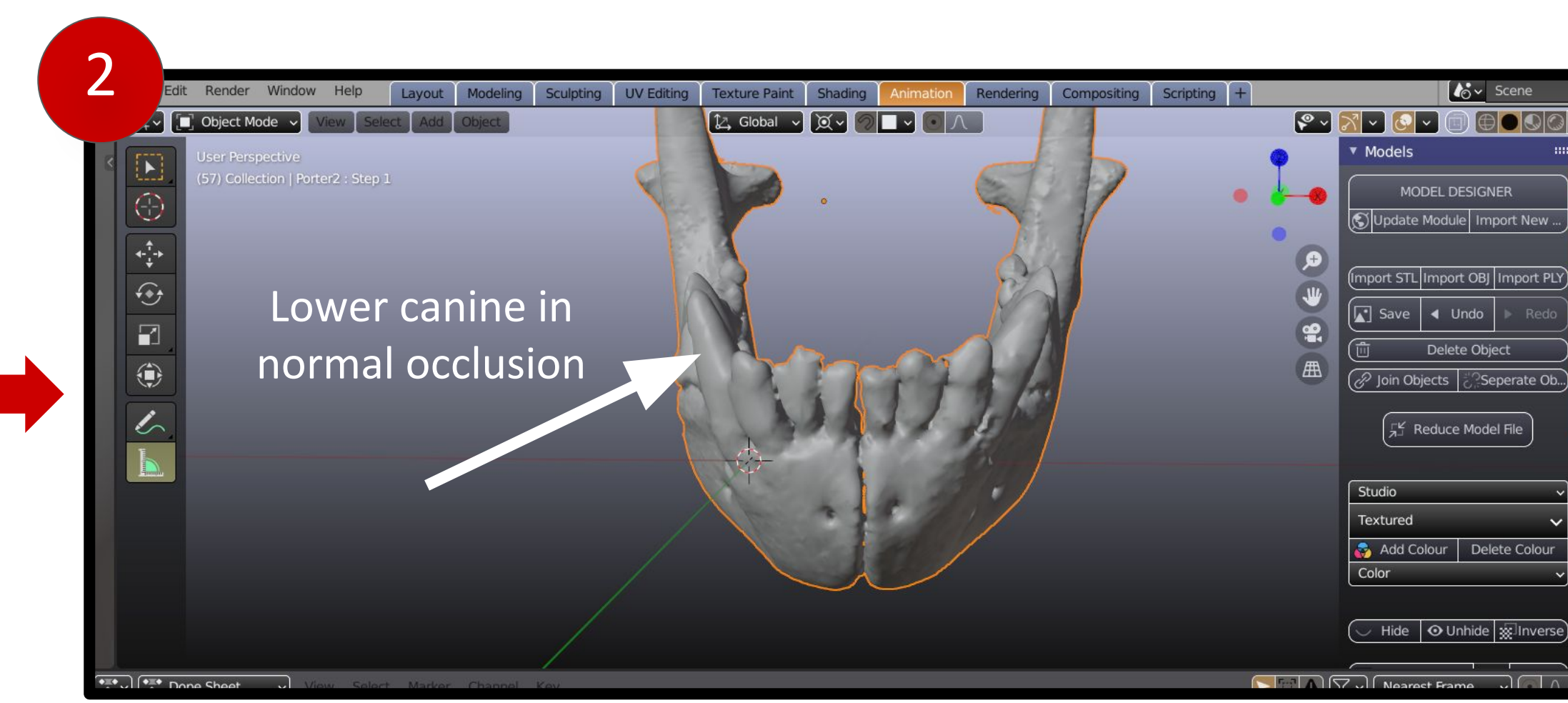


Figure 6: Teeth at 30° angle

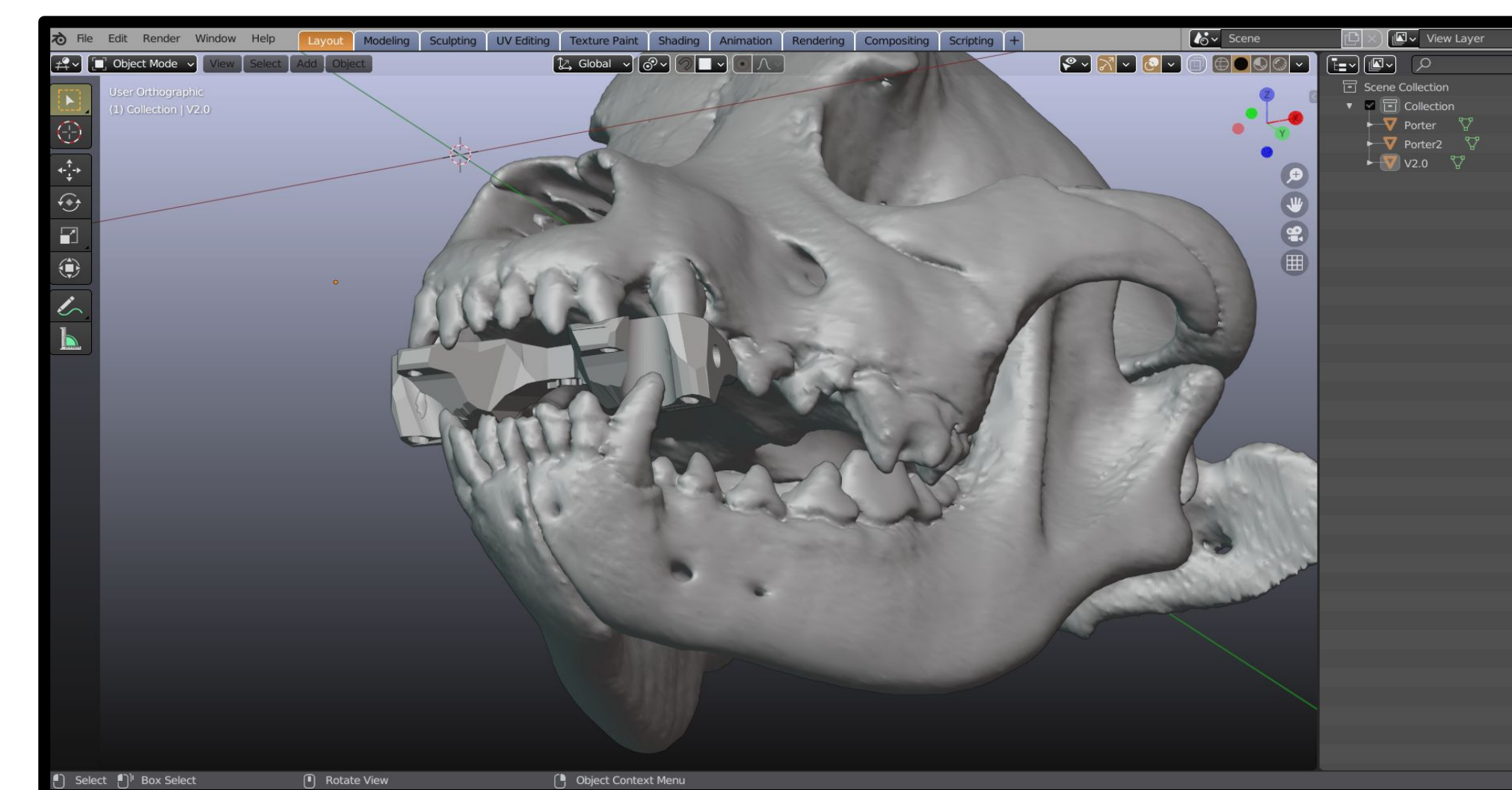


Figure 7: Alignment of piece and jaws

- Software: Seeing how components align**
- Alignment of top jaw, bottom jaw, incline plane
 - Movement of teeth at necessary angle – checks how teeth align with planes
- Blender: Manipulating variables**
- Changing dimensions of pieces (for example, diameter of hole)
 - Splicing tool: cutting away pieces that team wanted to cut – used for making two-piece design

Final Design

- Features:**
- Separated inclined plane
 - 3 teeth holes (Upper Maxillary, Upper Canine, and Upper Incisor)
 - Separates each side of malocclusion into own unique situation
- No Bridge:**
- Eliminates variability of bridge size
 - Dogs experience no irritation of the palette
- Prototype was 3D printed using Dental LT Resin

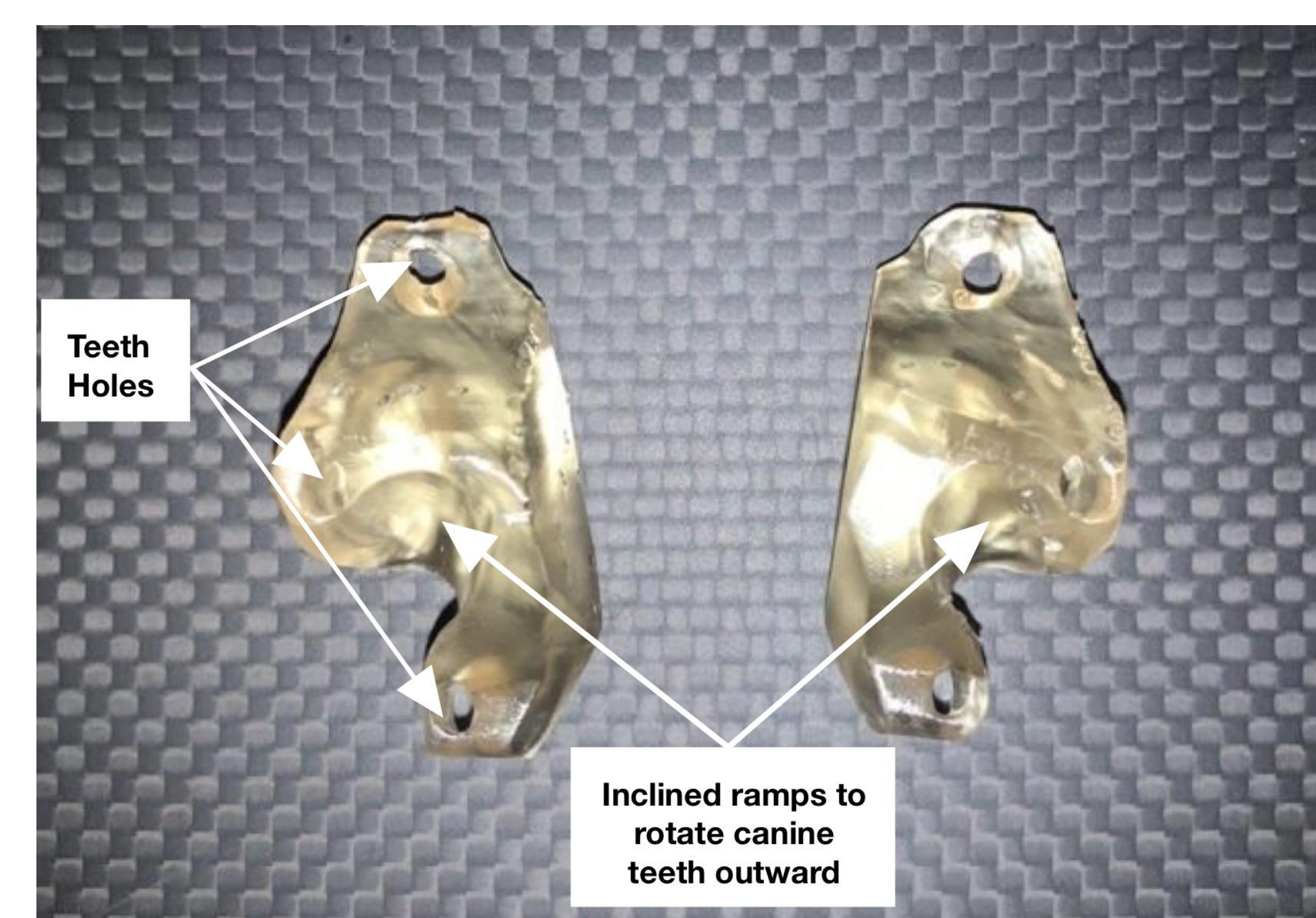


Figure 8: Separate Inclined Planes from Mandibular Jaw Perspective

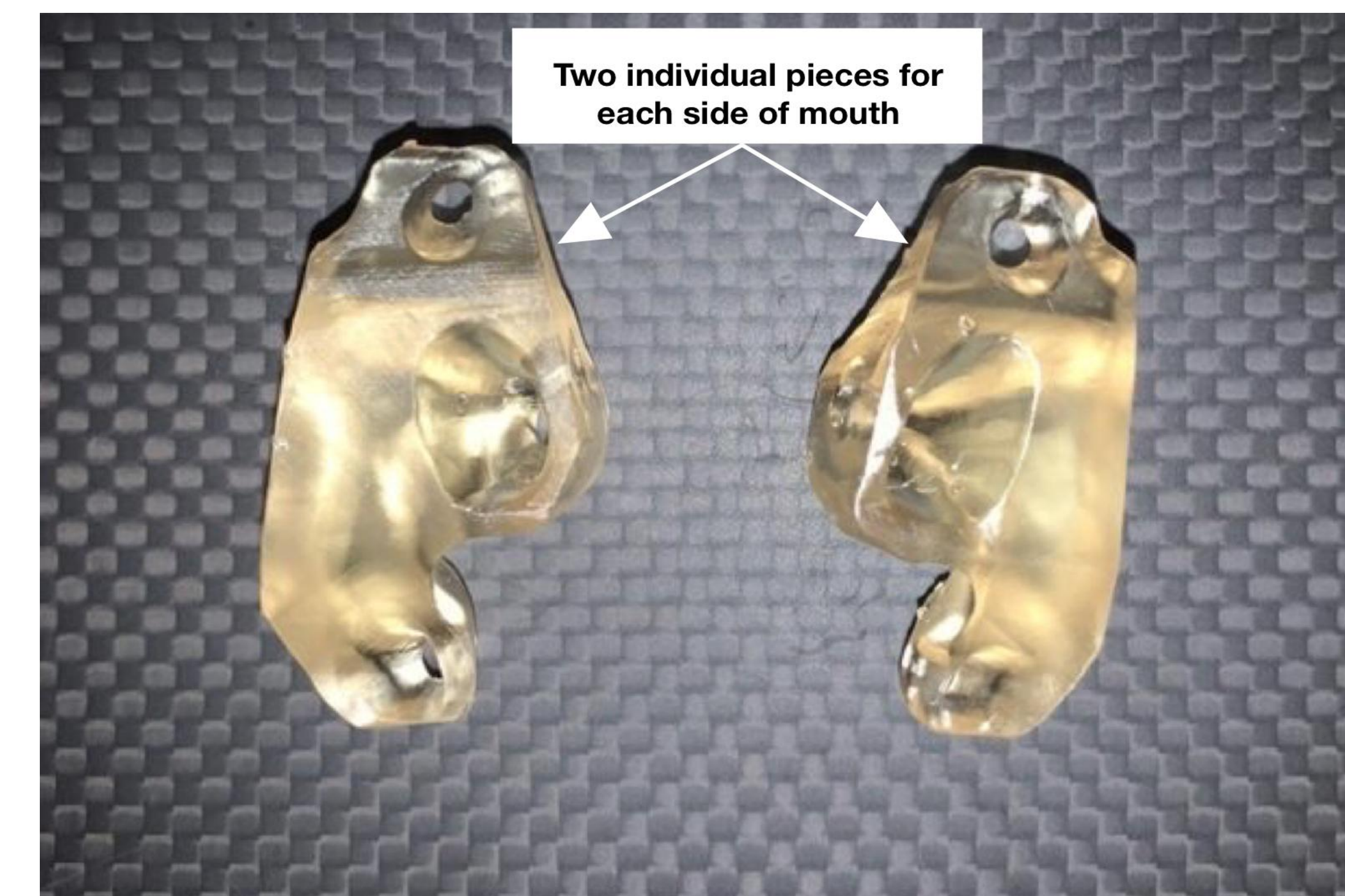


Figure 9: Separate Inclined Planes from Maxillary Jaw Perspective

Testing

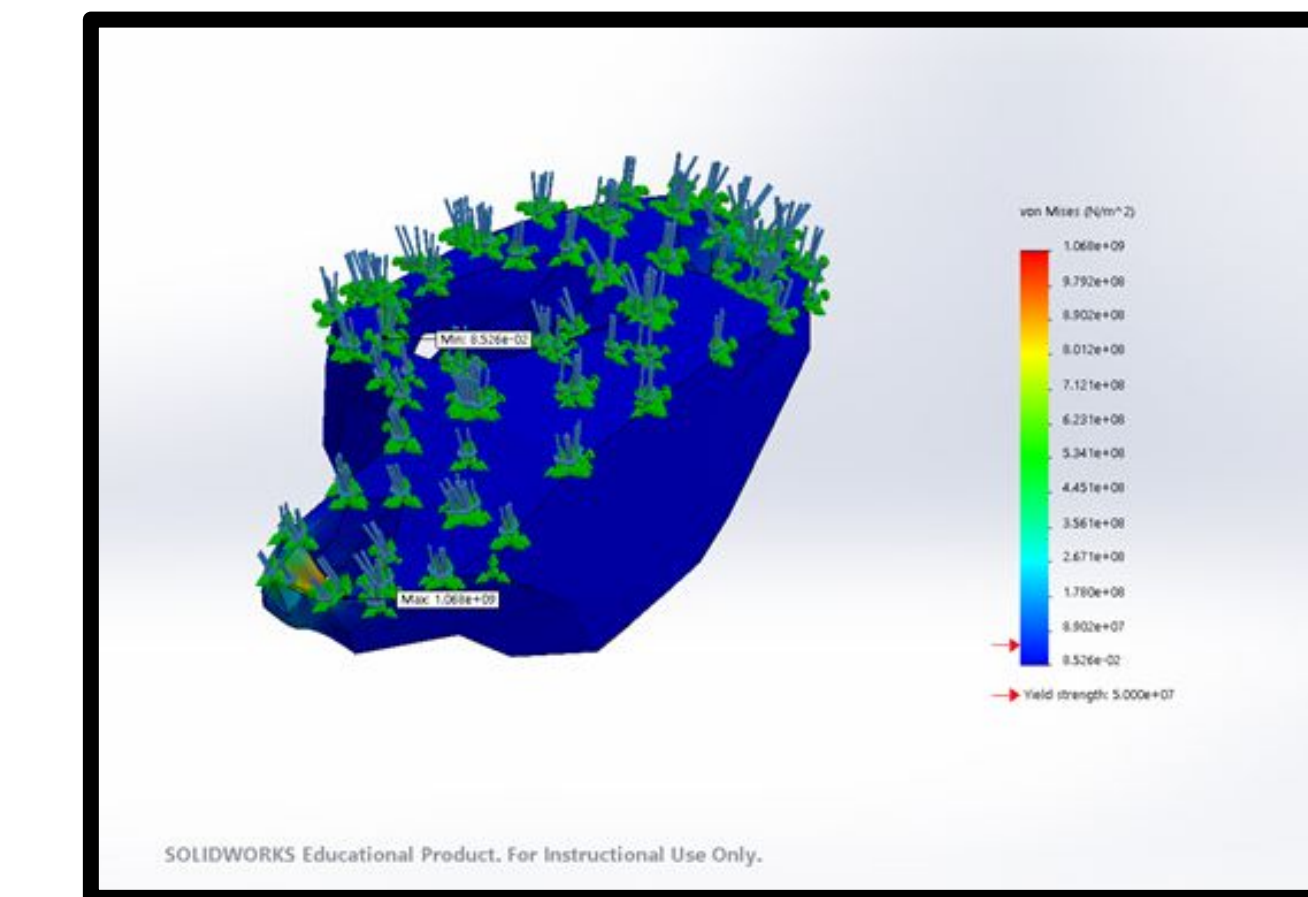


Figure 10: Design after undergoing force testing through Solidworks' Simulation Wizard. Force points of 1350 N used.

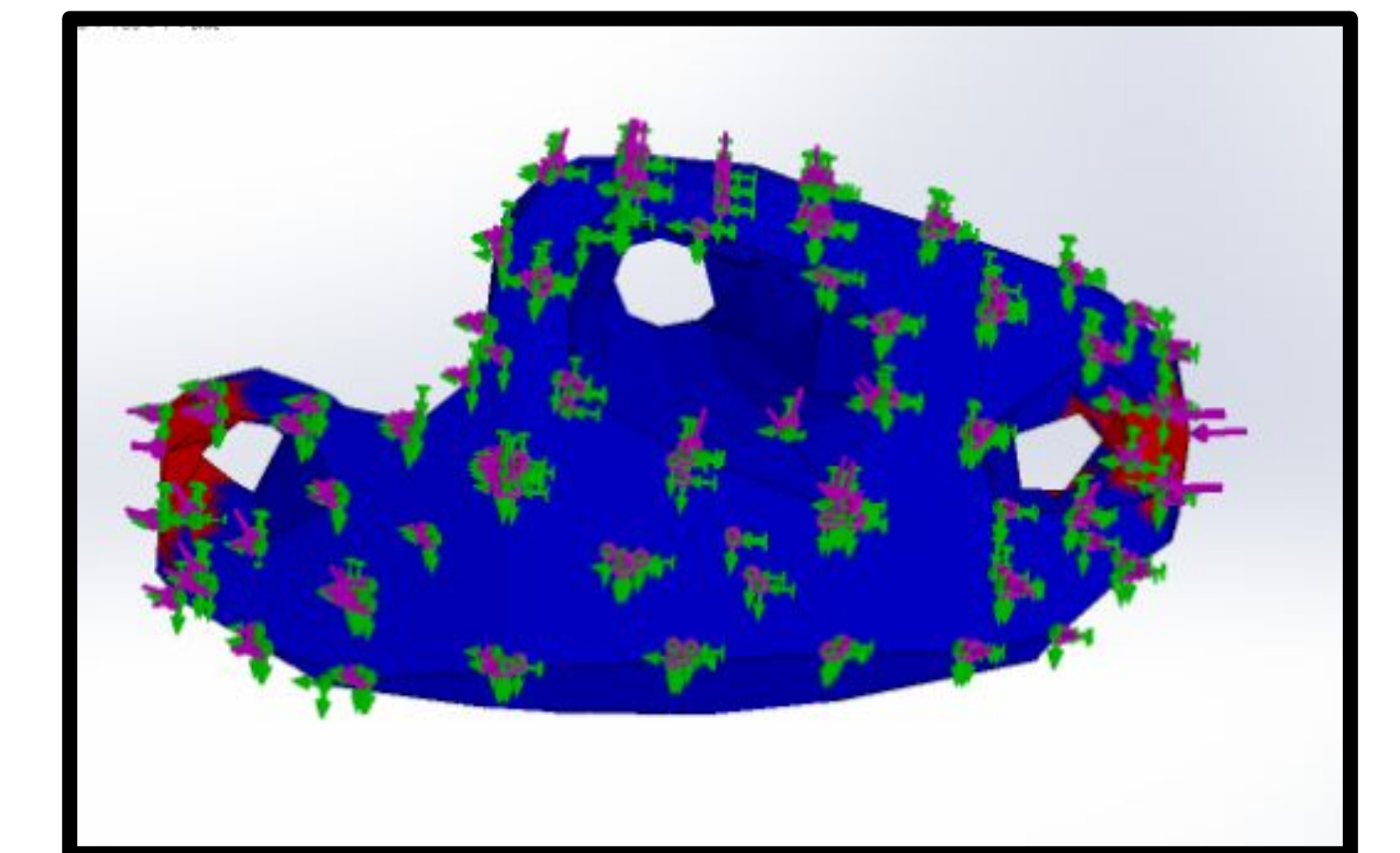


Figure 11: Red areas of the design are known weak points. These areas would likely deform under the 1390 N force.

Future Work

- This medical treatment is in early stages (i.e. doctor does have many patients)
- The team hopes to implement discovered workflow on new patients
 - Developing a particular "incline plane" to fit the mouth and specifications of new dogs
 - Testing these braces as the patient progresses through therapy
 - Using blender to manipulate current design or creating completely new with CT scan manipulations

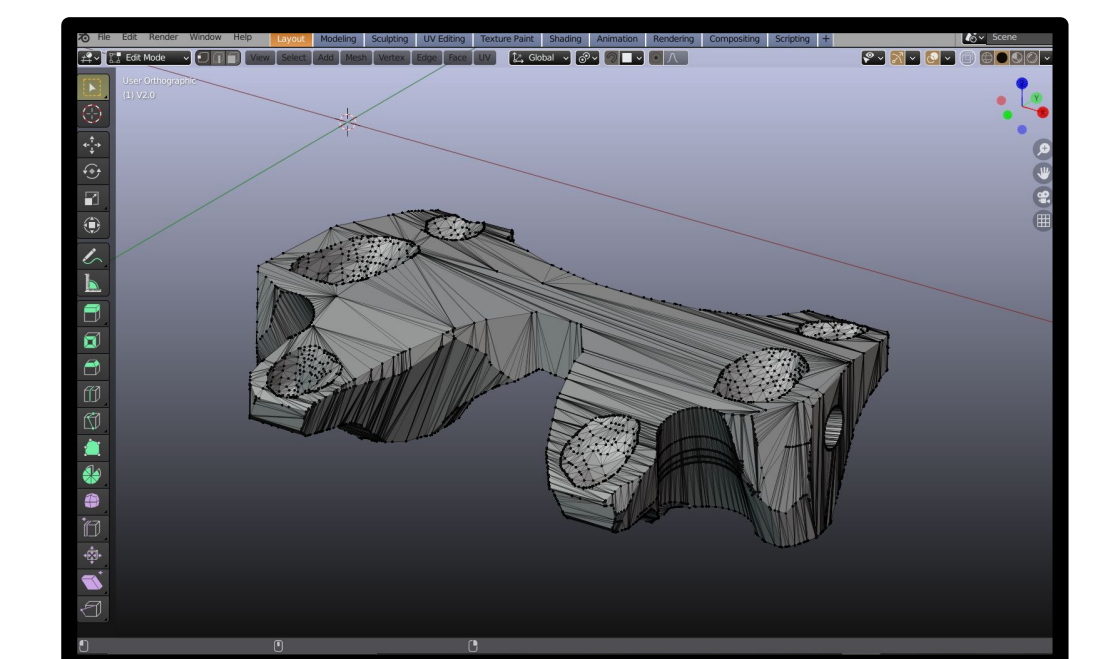


Figure 12: Edit Mode in Blender

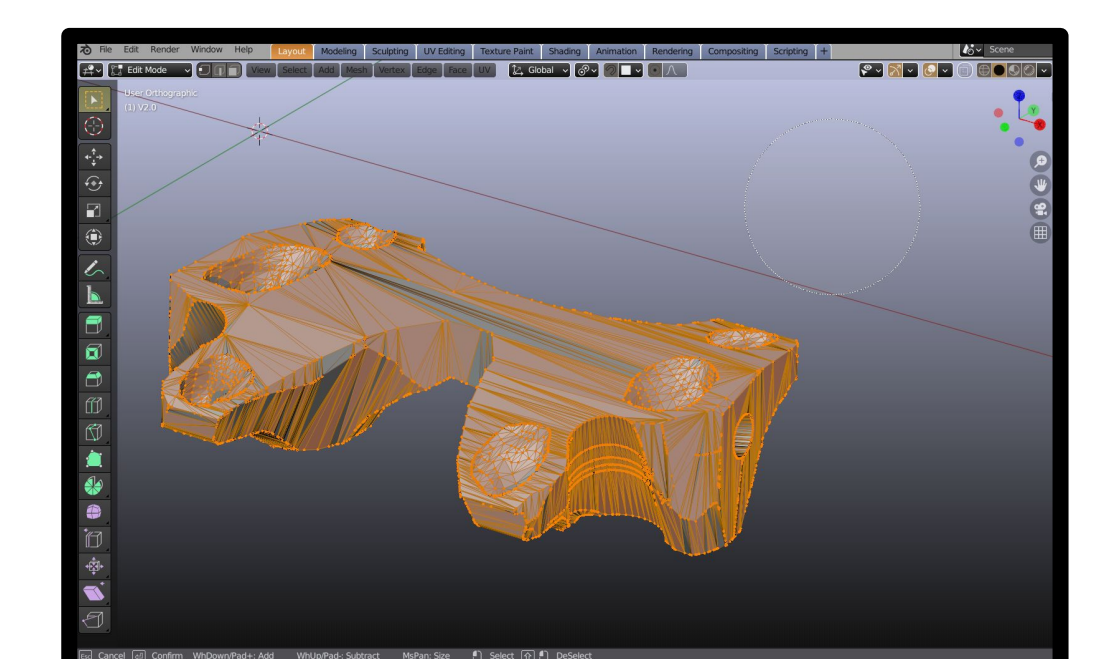


Figure 13: Highlighted part enables edits

Acknowledgements

We would like to thank our client, Dr. Graham Thatcher, as well as our advisor, Dr. Walter Block for guiding us through the design process, providing valuable advice, and overall creating a positive experience.

References

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Abstract

Class II malocclusions in dogs treated with orthodontic brace devices, called incline planes. Incline planes move teeth through passive force, and can be created through several different methods. A 3D printable incline plane can be constructed using scans of the patient's jaw, but the current design and workflow requires many prototypes and the help of a software engineer to produce a device. There is also a need for a more adjustable, flexible design that can fit patients of different sizes and allow for growth over time. The team devised an alternative design consisting of two 3D printed pieces on each side of the mouth, allowing for growth of the maxillae and decreasing risk of palatitis. The software Blender for Dental was used to fit the piece to the jaw and manipulate the teeth.

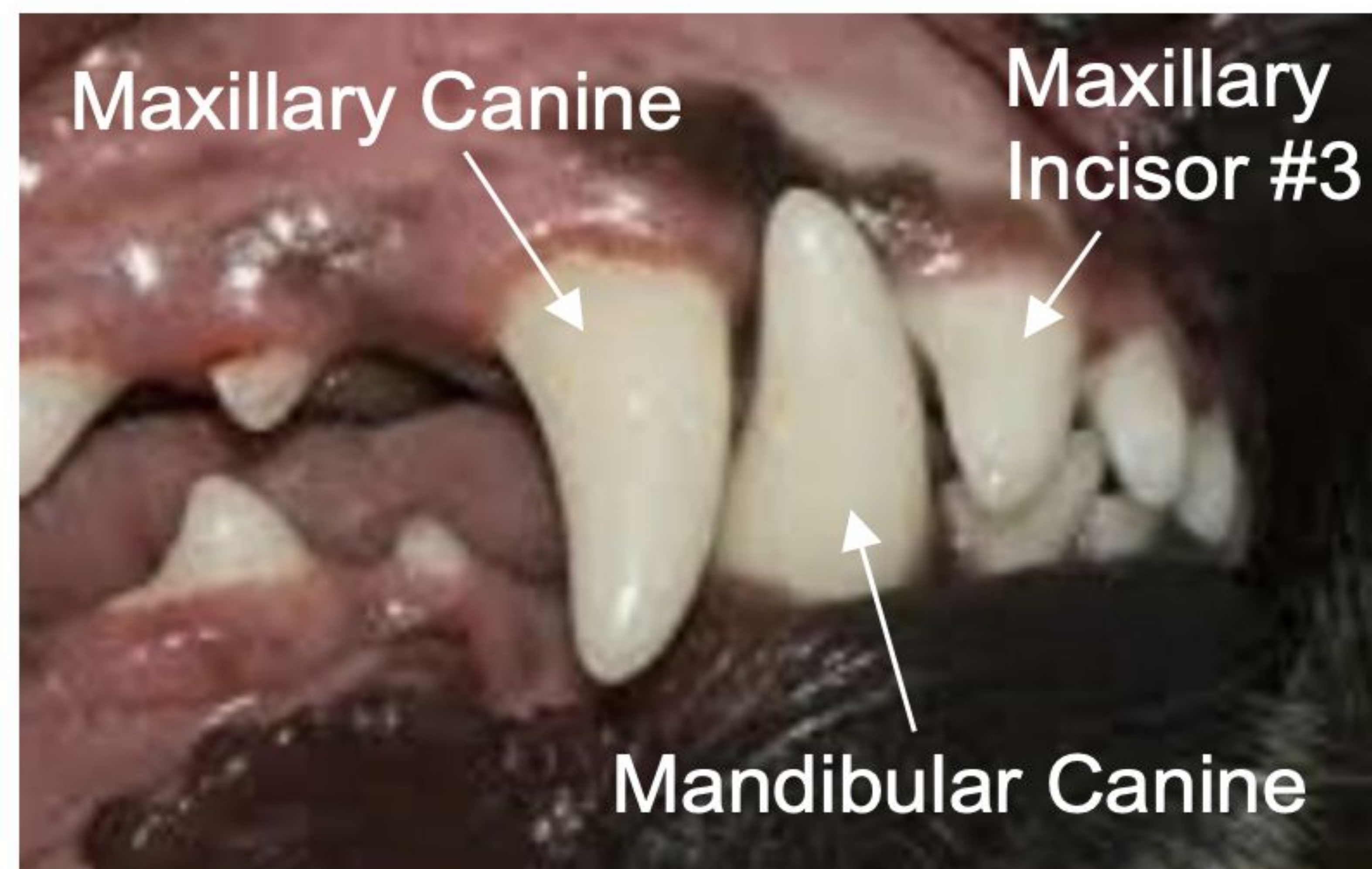
Motivation

- Malocclusions are heritable traits that can cause issues for dogs and cats if not treated.
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- 3D printing has been adopted into human dentistry, but is not as common in veterinary dentistry.
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- Class 2 Malocclusion in dogs is the misalignment of the mandibular (lower) and maxillary (upper) jaw
- Causes damage to the upper palate and gums which results in pain
- Current treatments include extracting the teeth, shortening the teeth, and applying orthodontics (dog braces)

[1]



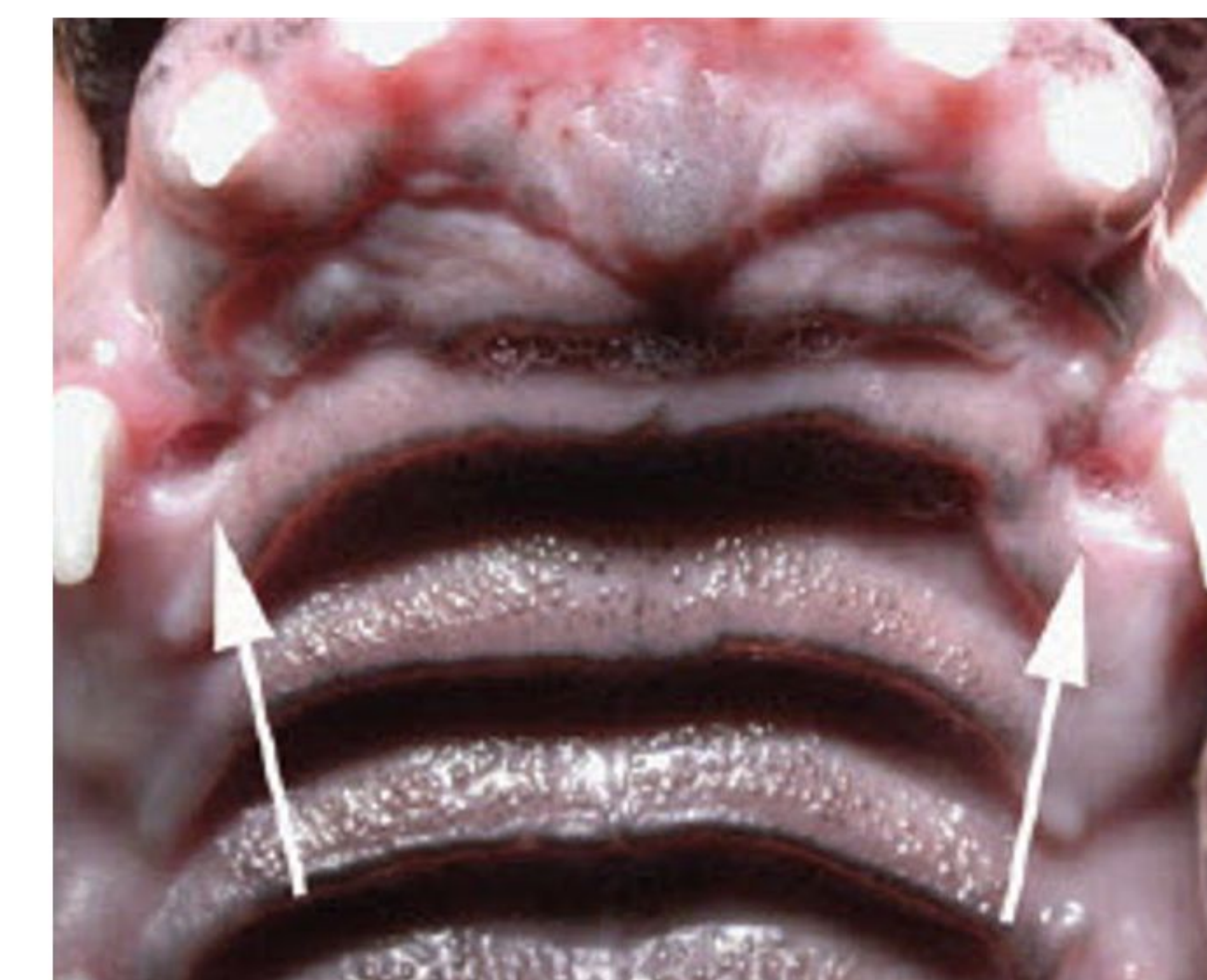
Normal arrangement of teeth

[2]



Class 2 Malocclusion

[3]



Damage caused by maloccluded canines (inflammation)

[4]



Figures 1, 2, and 3: Show the normal arrangement of teeth, the arrangement of teeth in a dog with a class 2 malocclusion, and the damage to the upper palate as a result of the class 2 malocclusion, respectively.

Figure 4: Shows the original dog braces used by the client in the patient's mouth

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Inclined Plane

- Withstand up to 1350 N of pressure
- Last 6-8 weeks in patient's mouth over treatment period

Software

- Easy to understand interface
- Ability to manipulate models of the teeth and inclined plane

Software and Blender

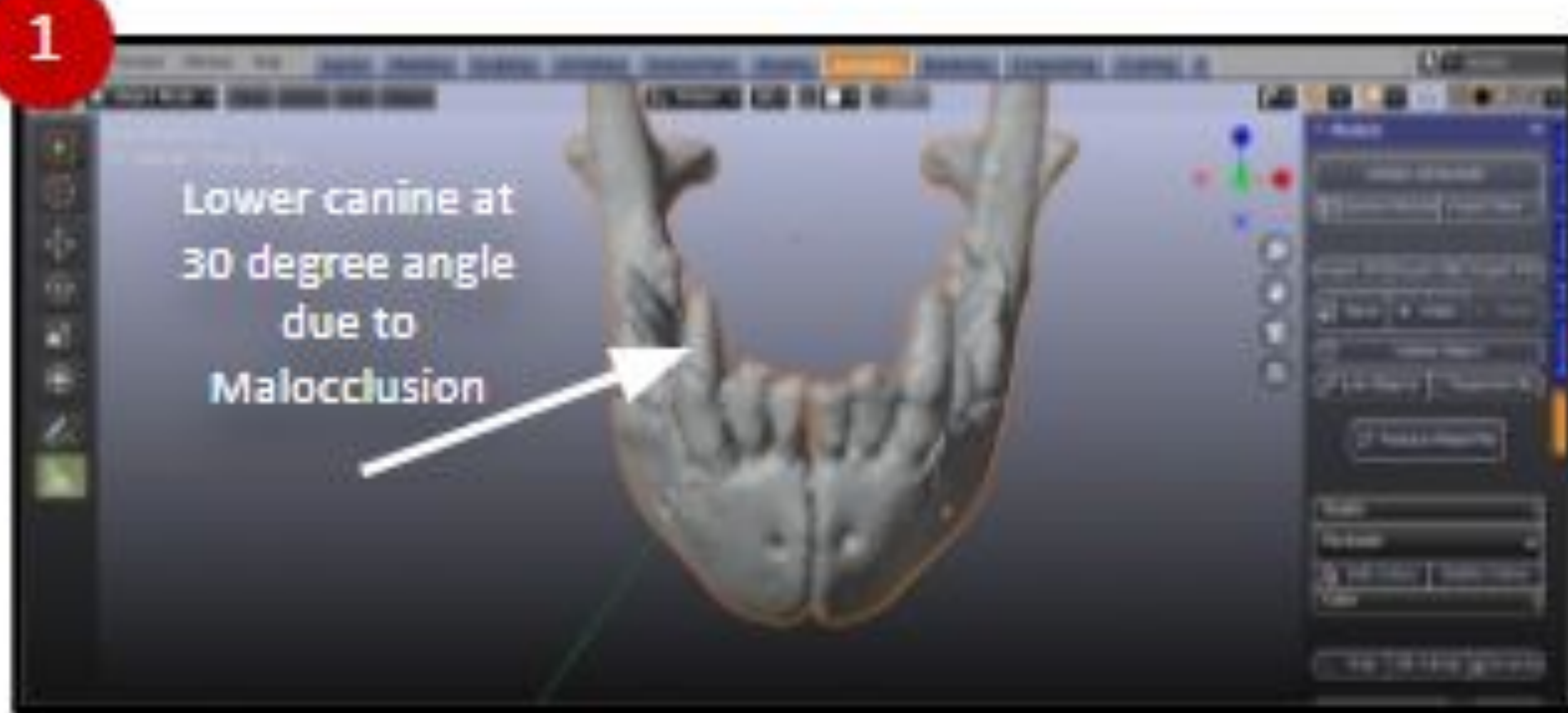


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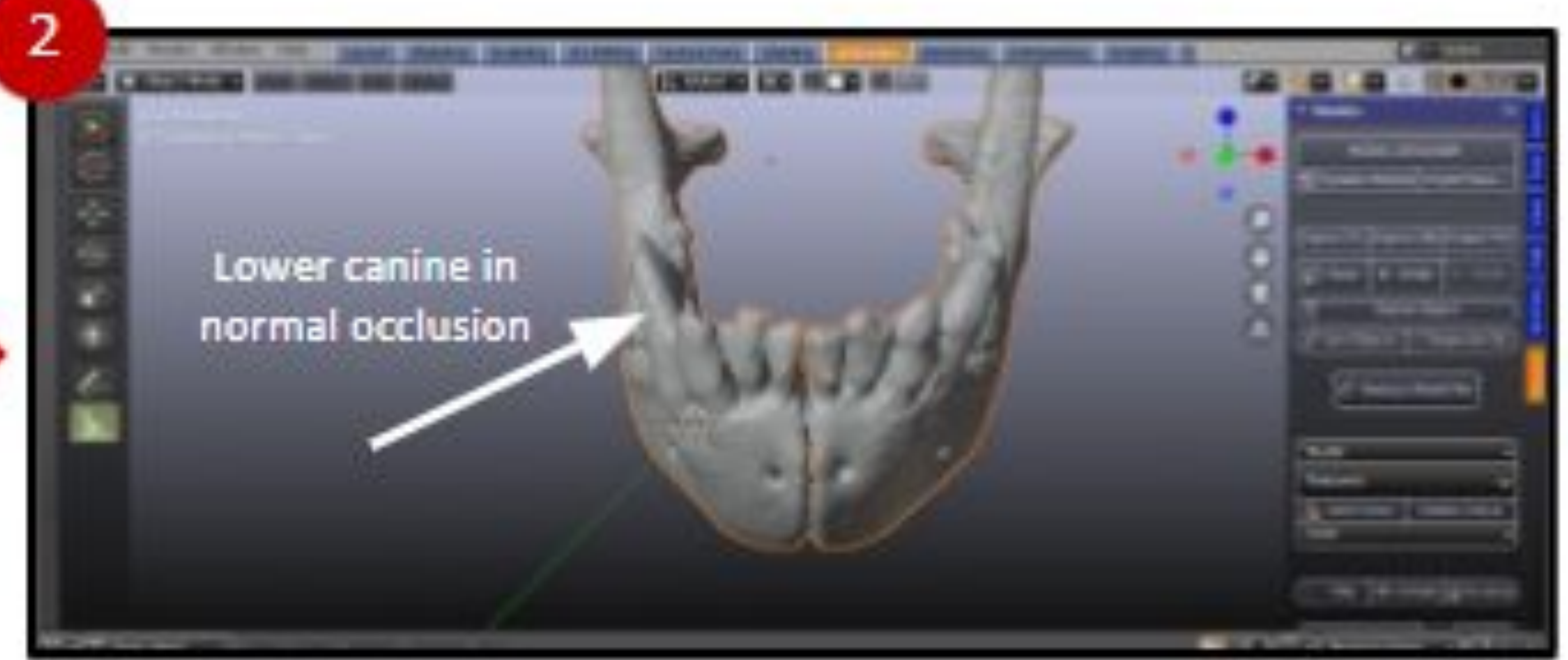


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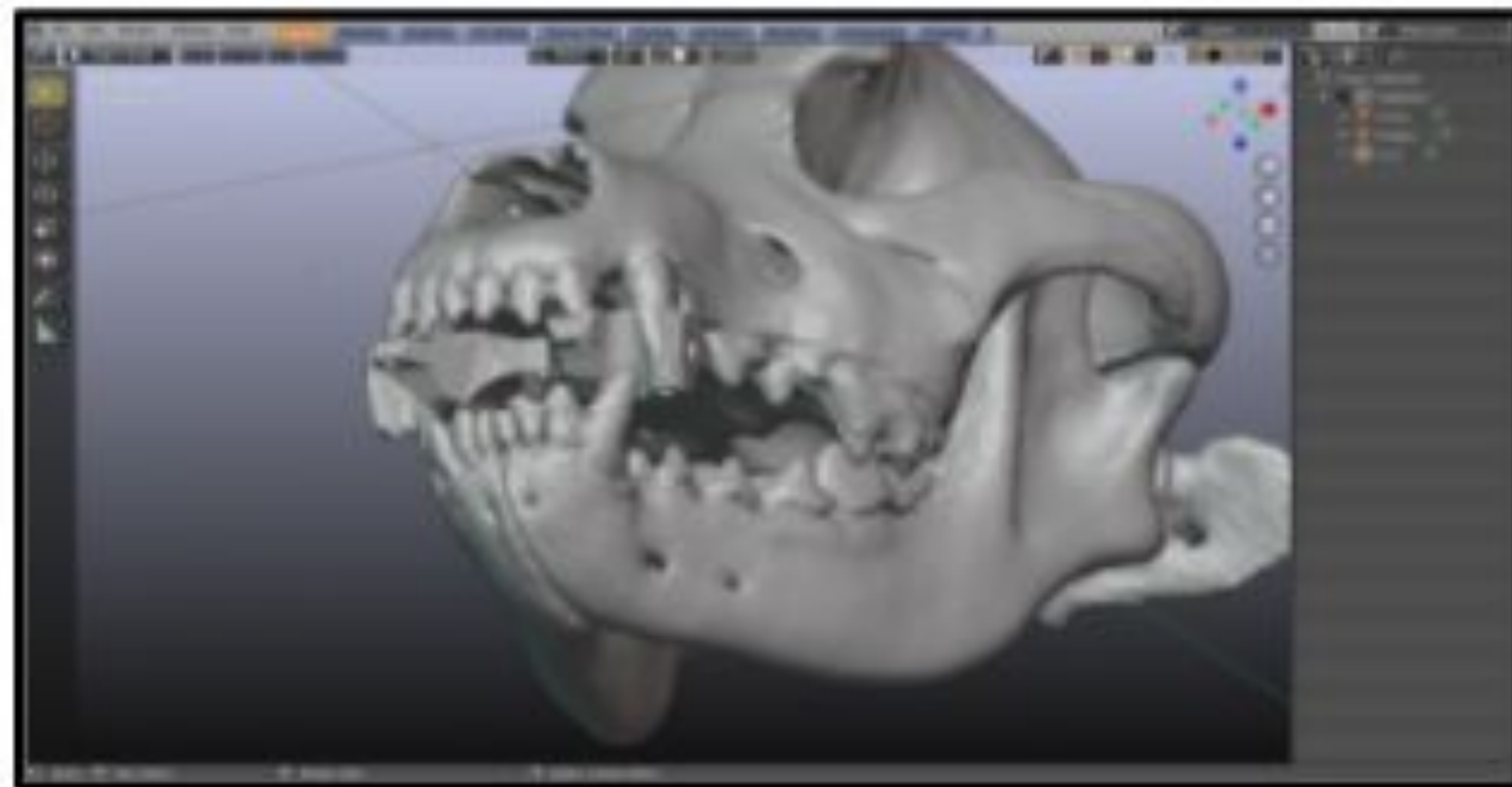


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Object Mode View Select Add Object

www.BANDICAM.COM

fps: 23.32

(70) Collection | Porter2 : Step 1



Final Design

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- 3 teeth holes (Upper Maxillary, Upper Canine, and Upper Incisor)
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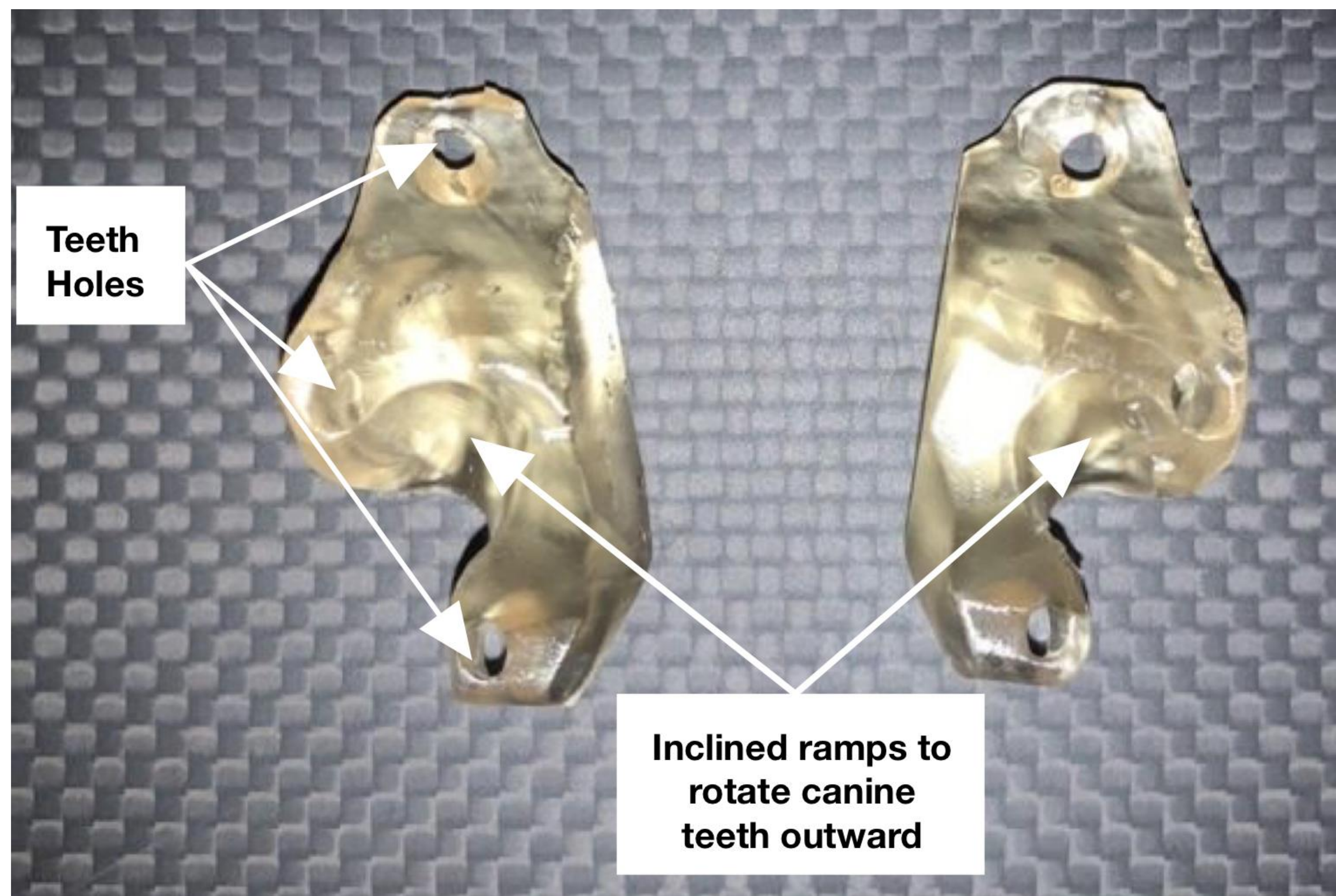


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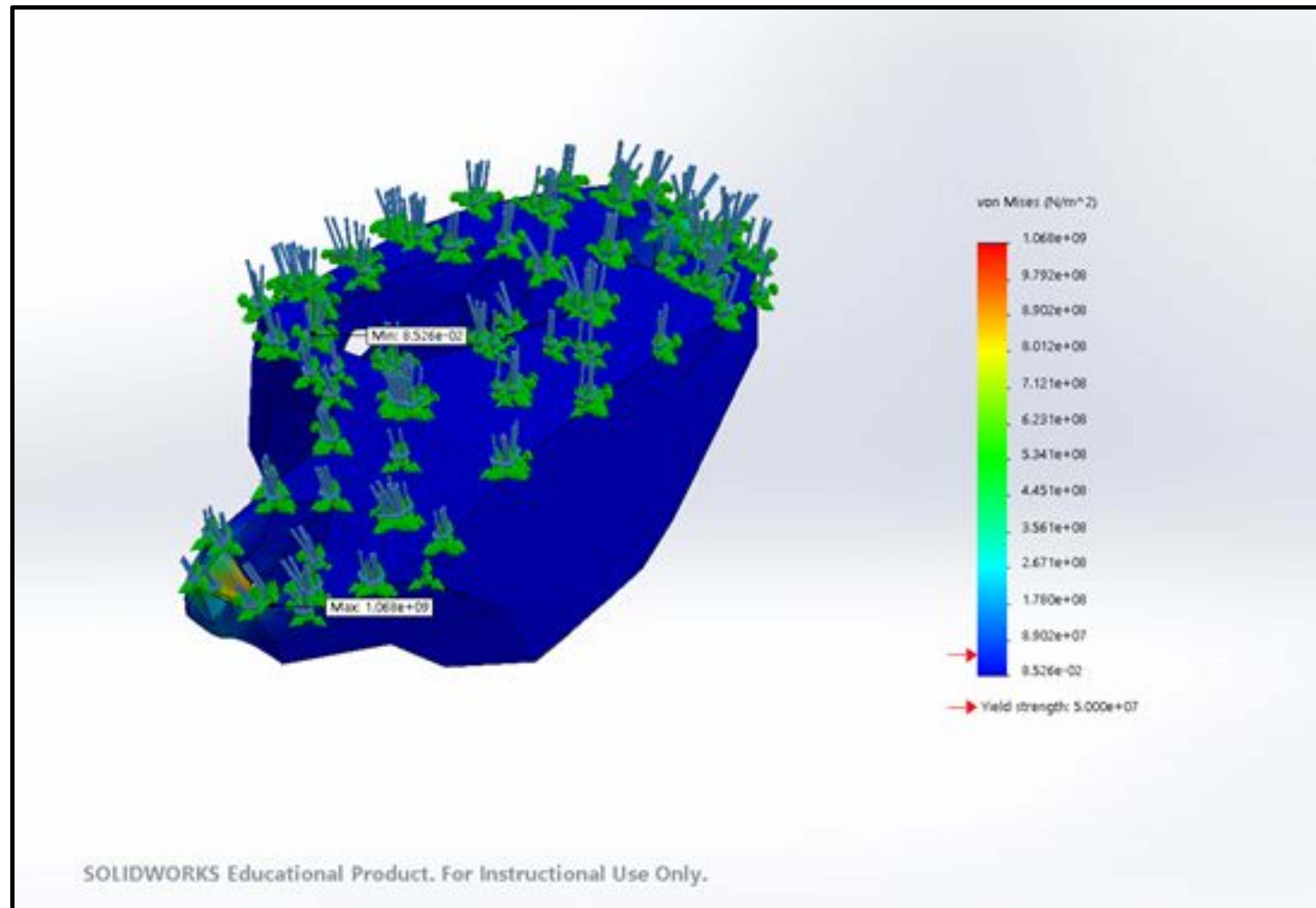


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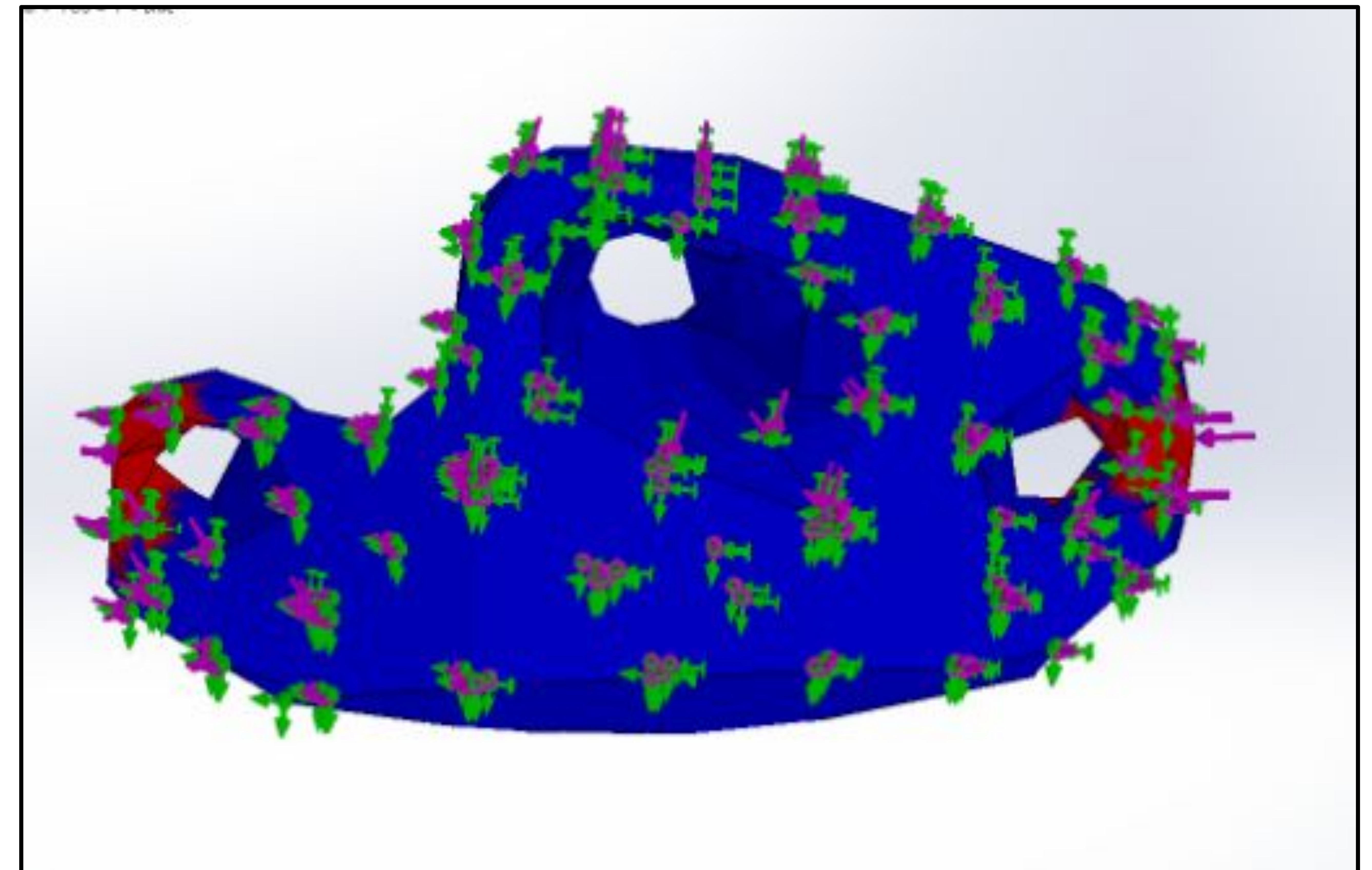


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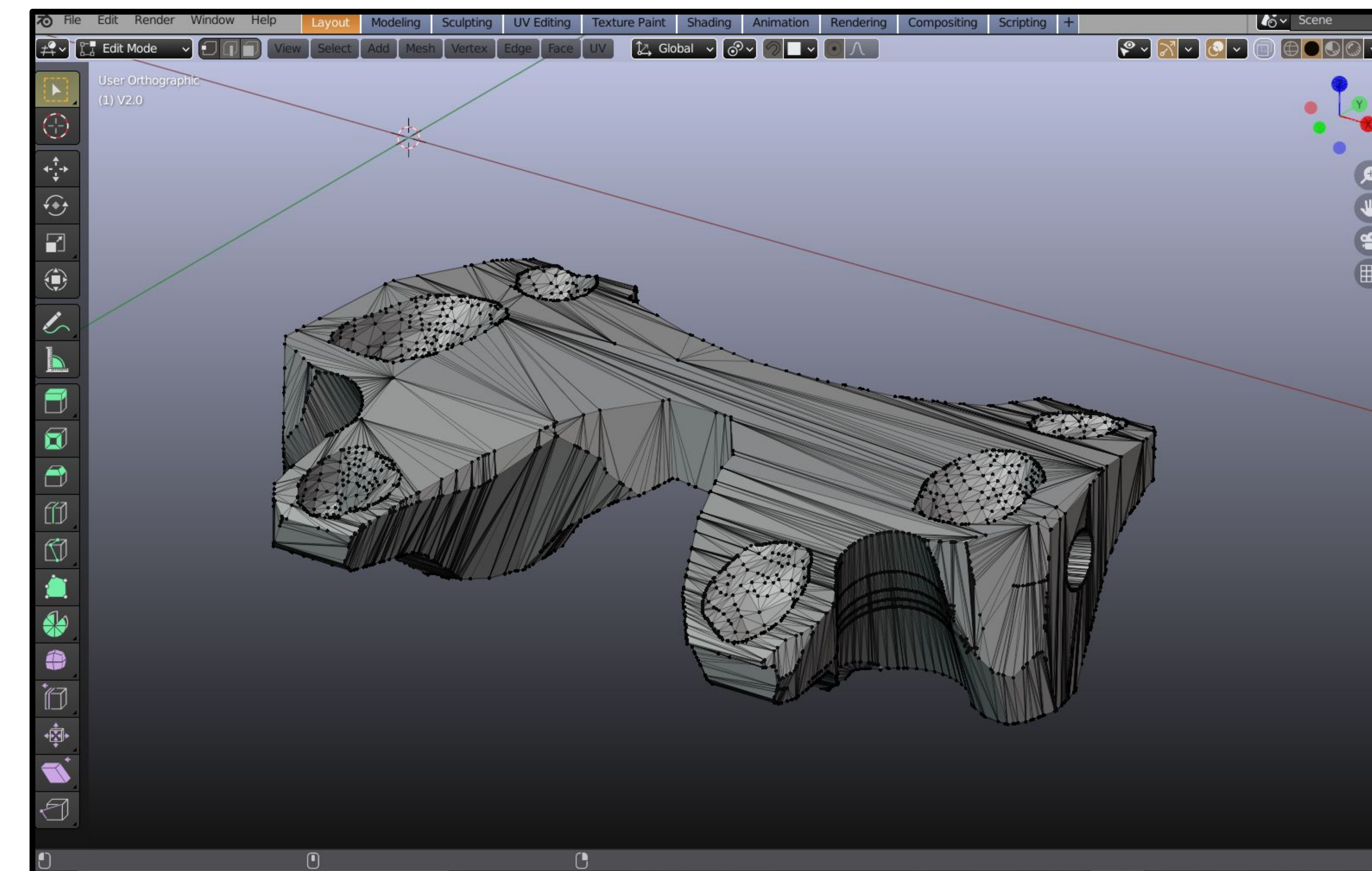


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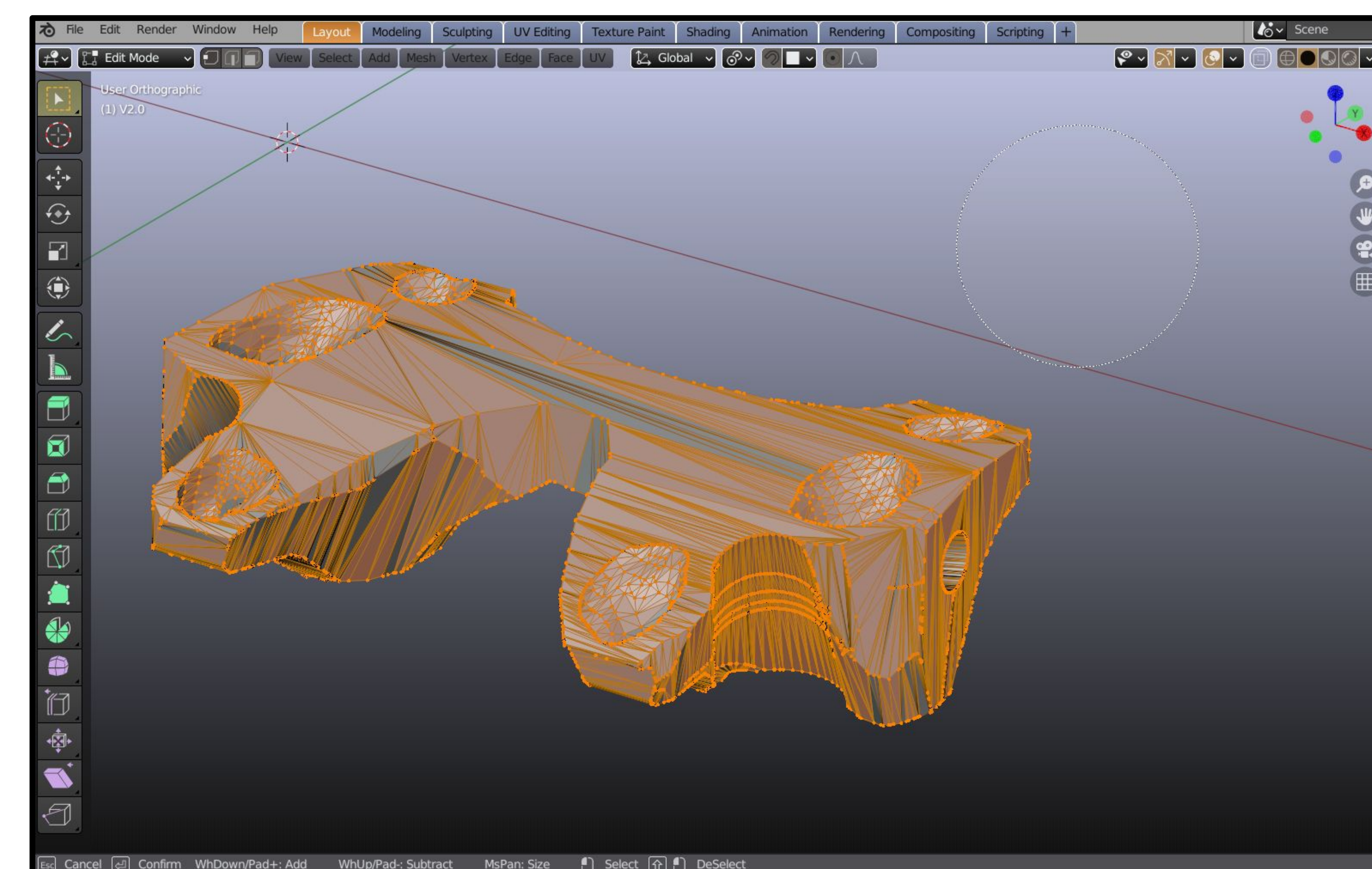


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