# Generative Design and Immersive Realities

# Multi-Materal VR Headset
*Powered by a Smartphone*
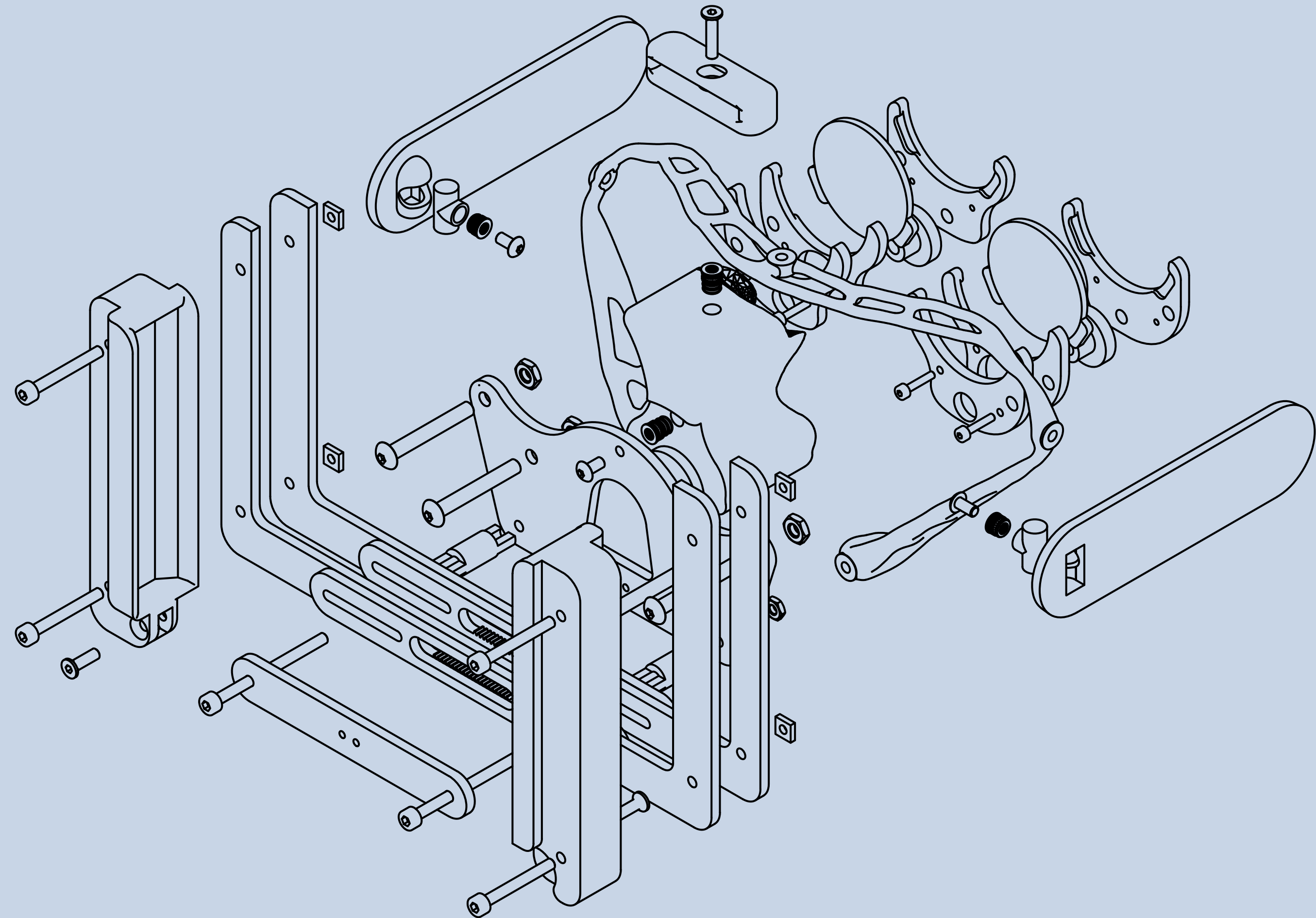
# Virtual Reality

Virtual reality immerses users in a simulated environment, utilising headsets and other peripherals to create the experience.

Here are some of its potential uses:

Visualisations

Gaming

Virtual meetings

Remote training

Simulations

Name: Timothy Laurence Weston    Unit Number:   6E7V0016_2324_O     Year: 2023/4

# Task

To design a bespoke VR headset to accommodate a smartphone and utilise generative design.



## Minimalist



## Open to ambient light



## Utilising 40 mm focal length lenses



## Generative design



Name: Timothy Laurence Weston    Unit Number:   6E7V0016_2324_O    Year: 2023/4
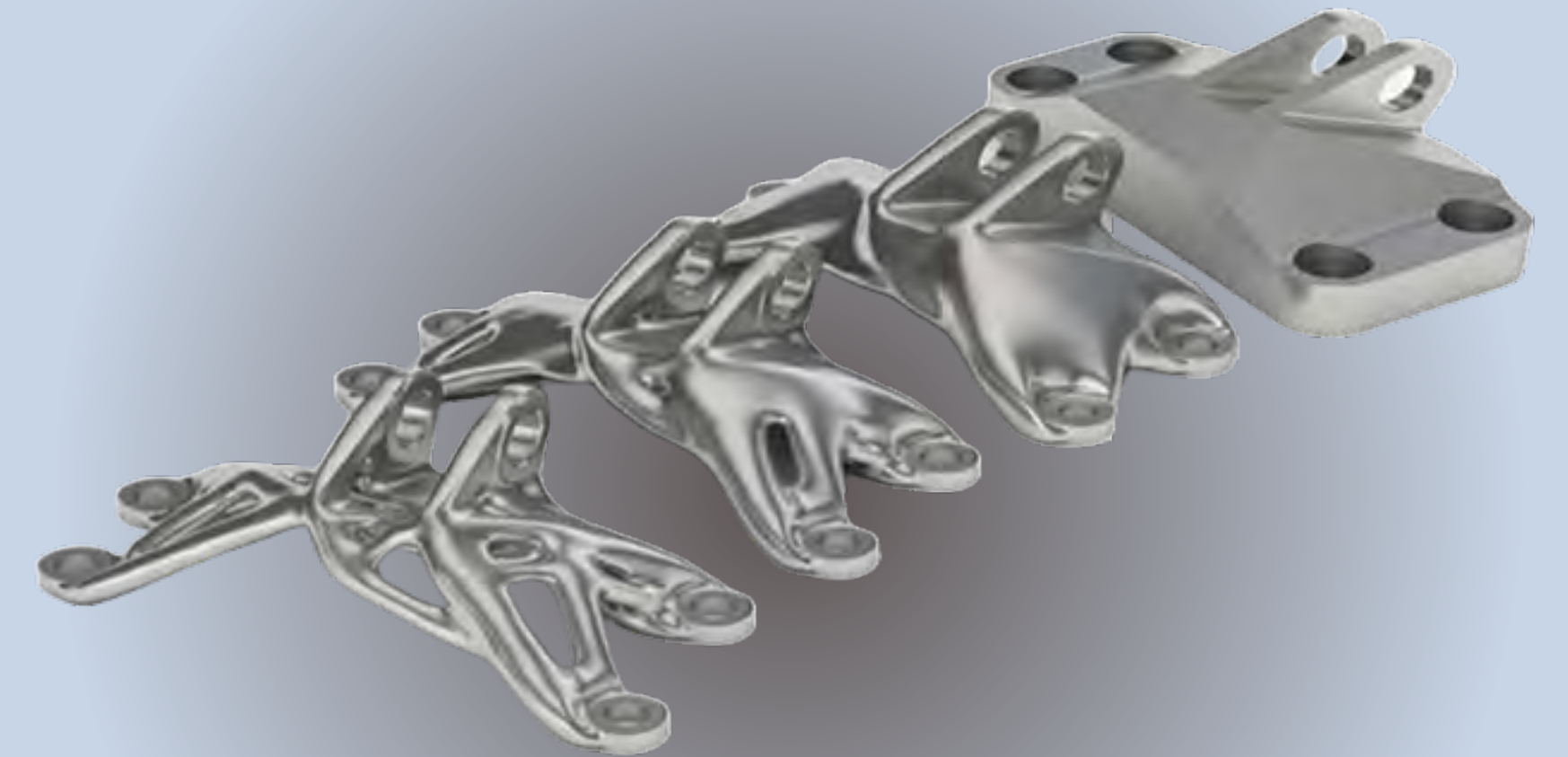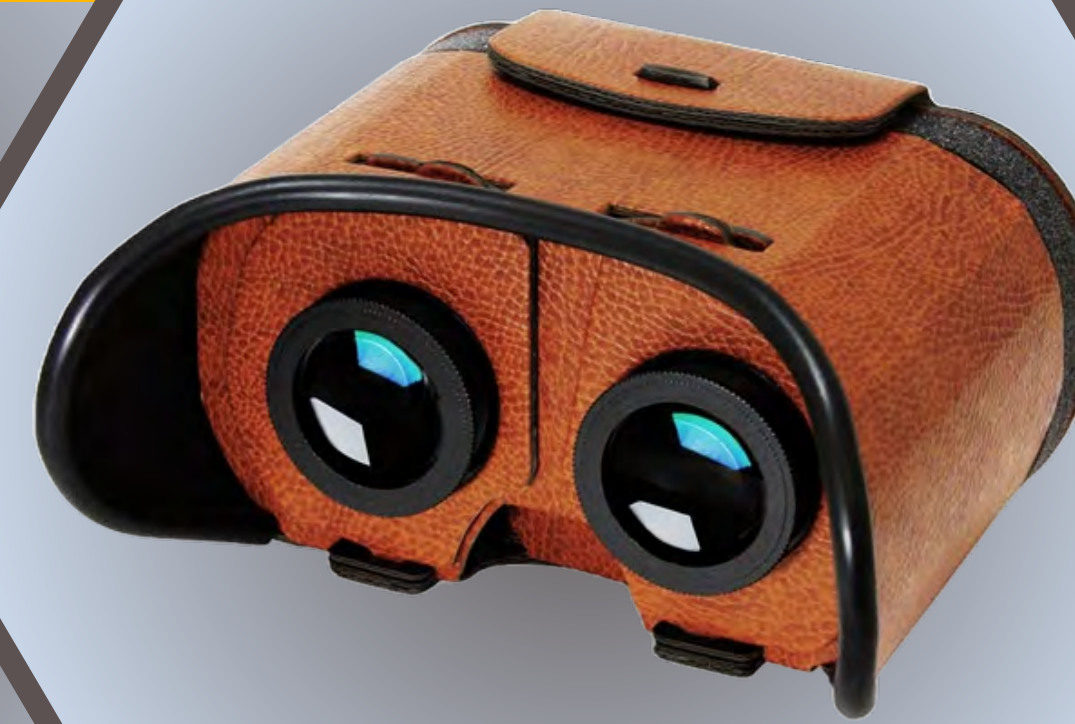
# Smartphone VR Viewer

The processing power and display capabilities of a smartphone can be utilised to deliver immersive virtual reality experiences at a low cost and in a variety of form factors.

Homido "Mini"
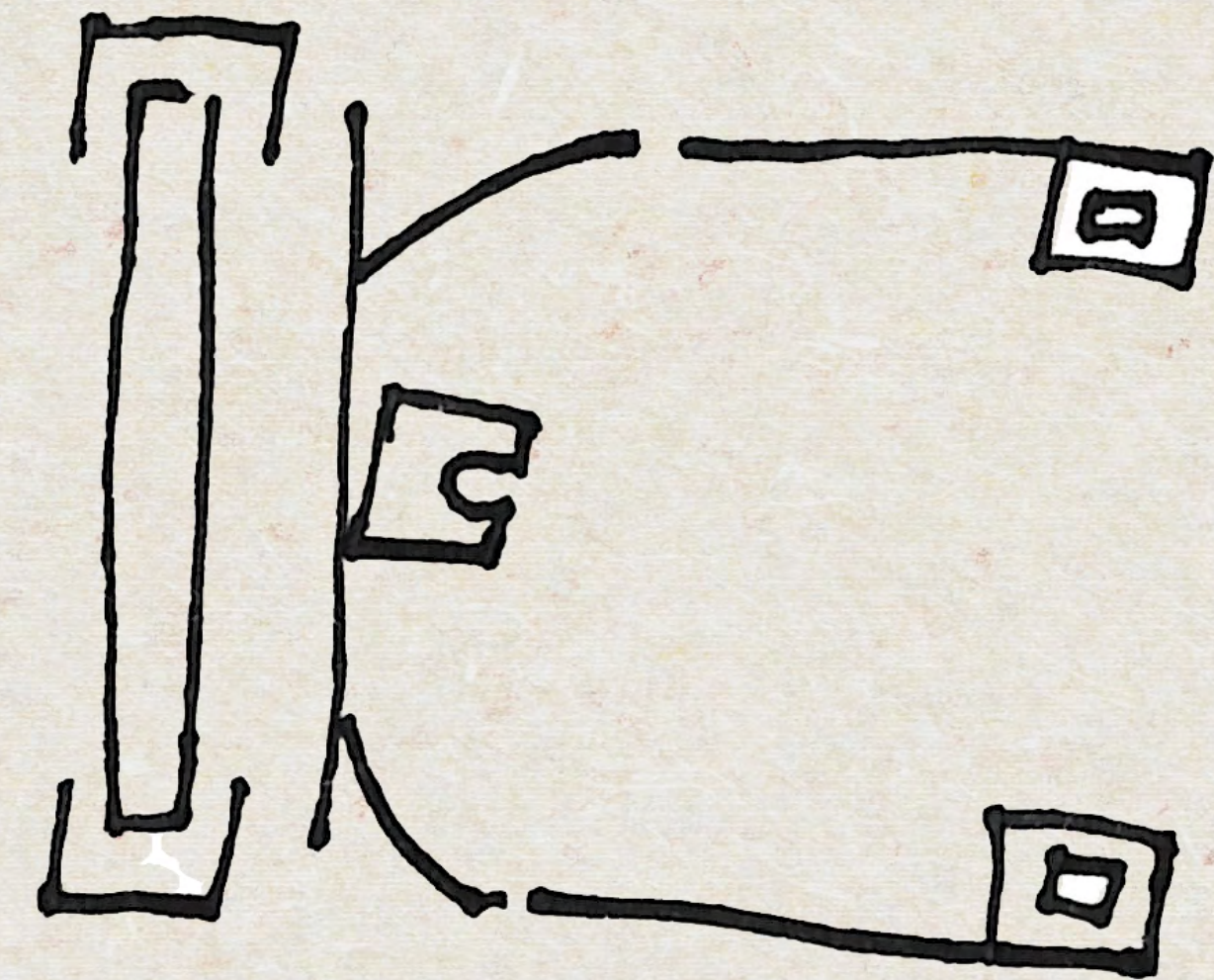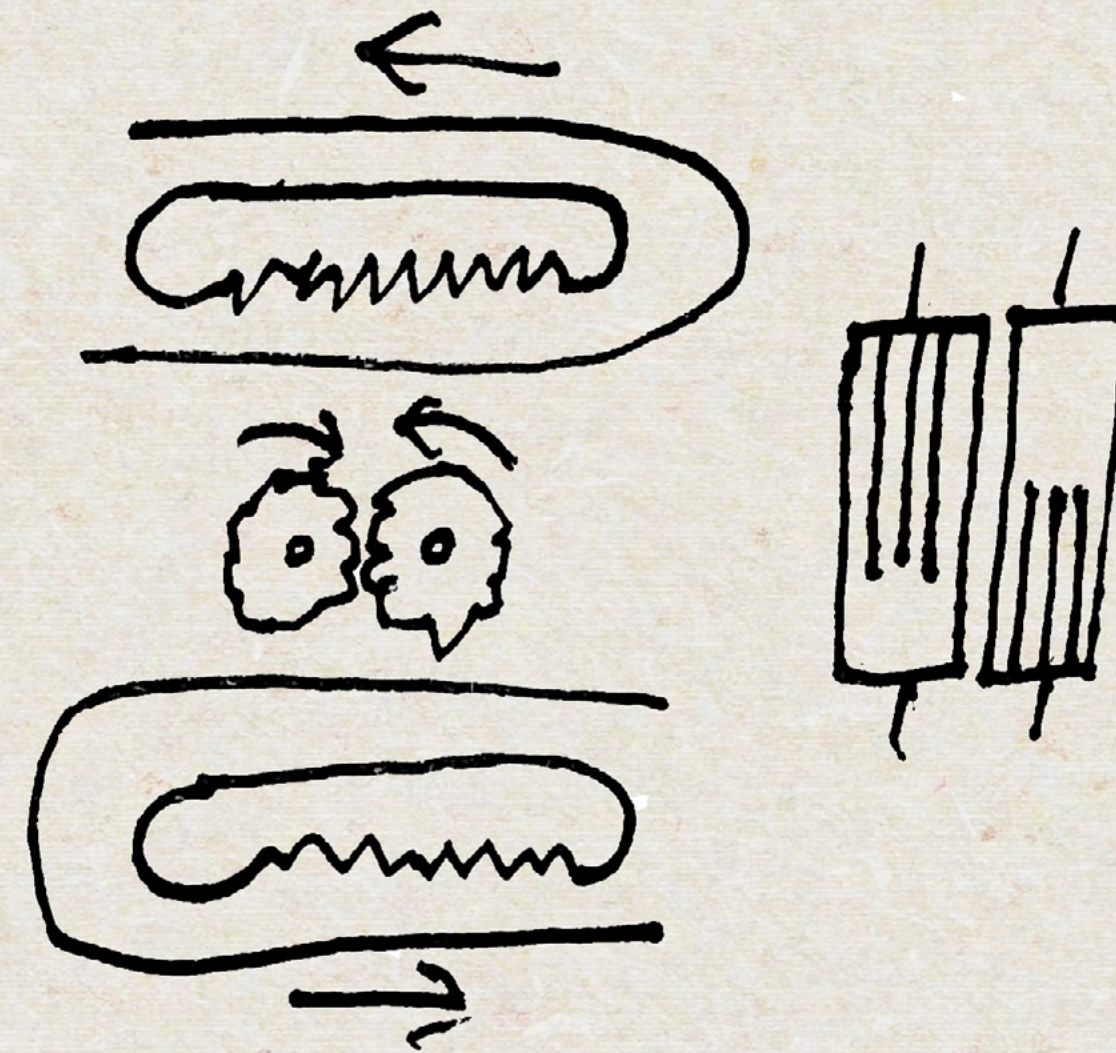


Optic VR



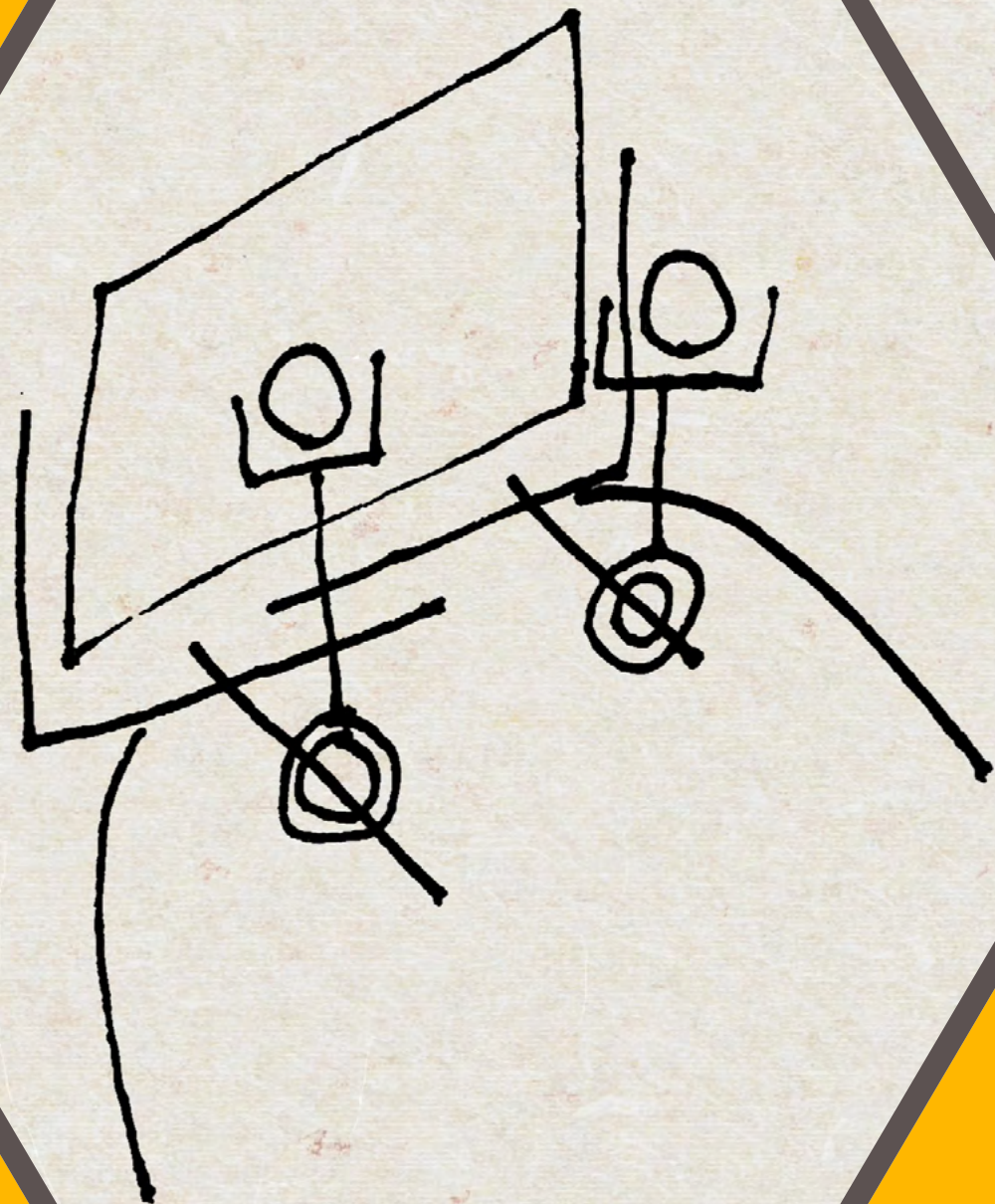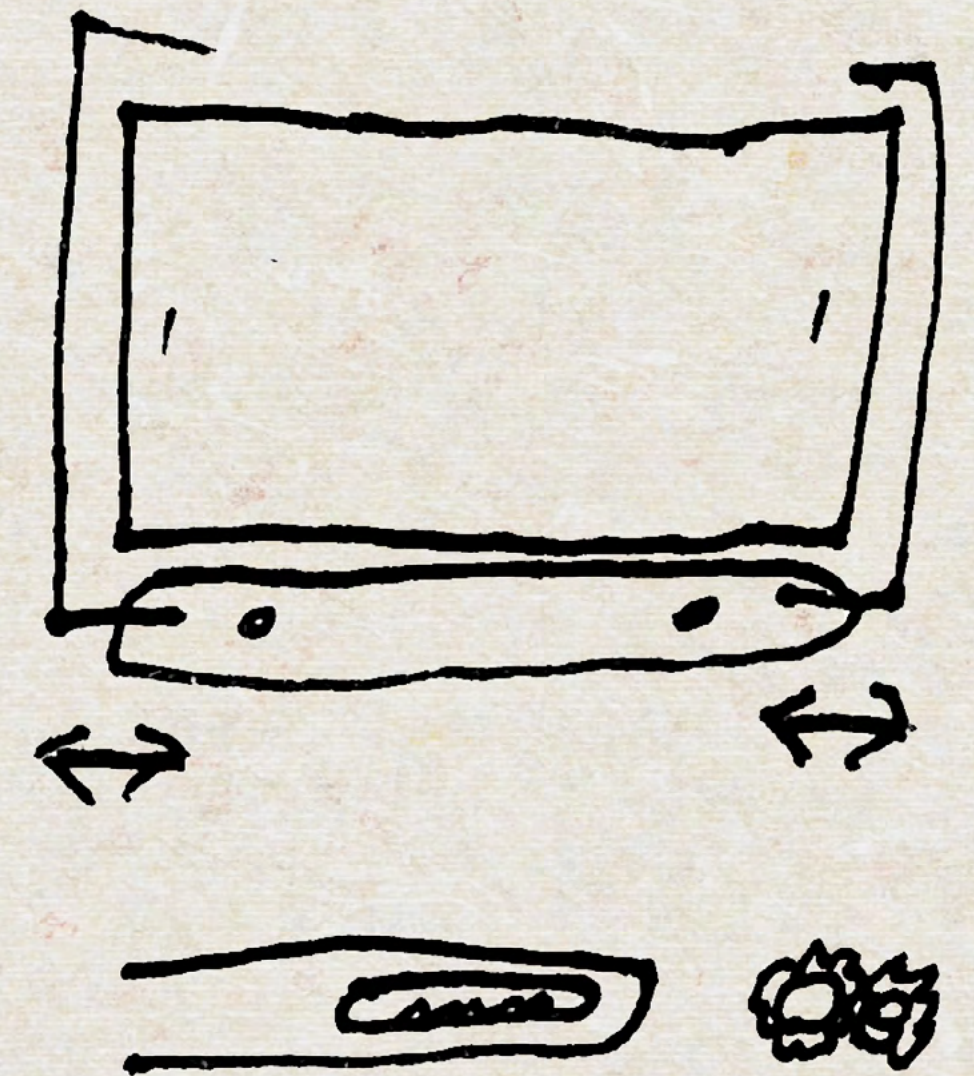Powis Viewer 3.0





Google Cardboard



Samsung Gear VR

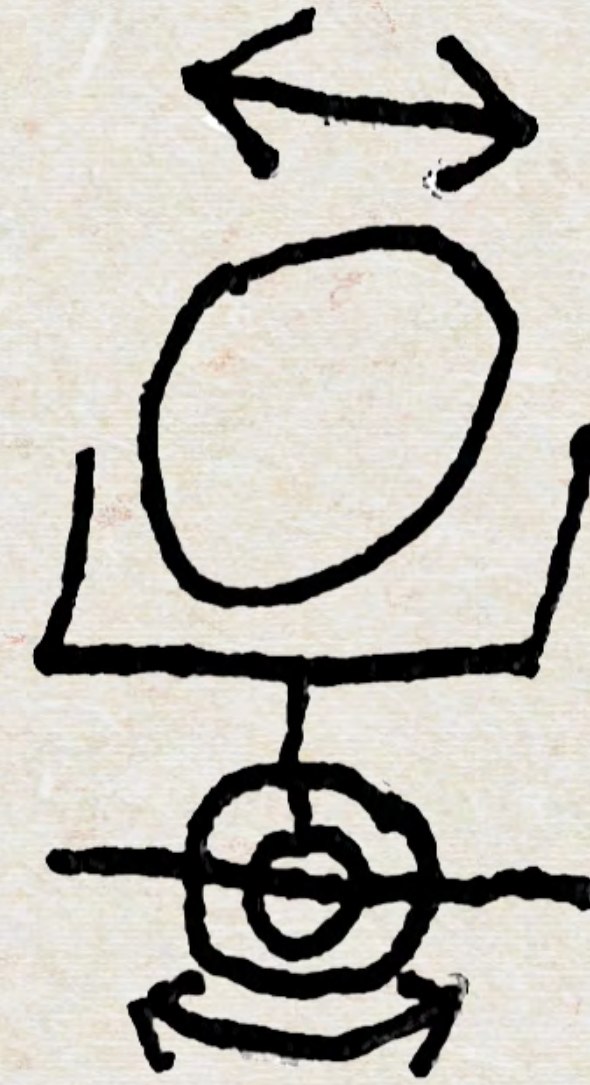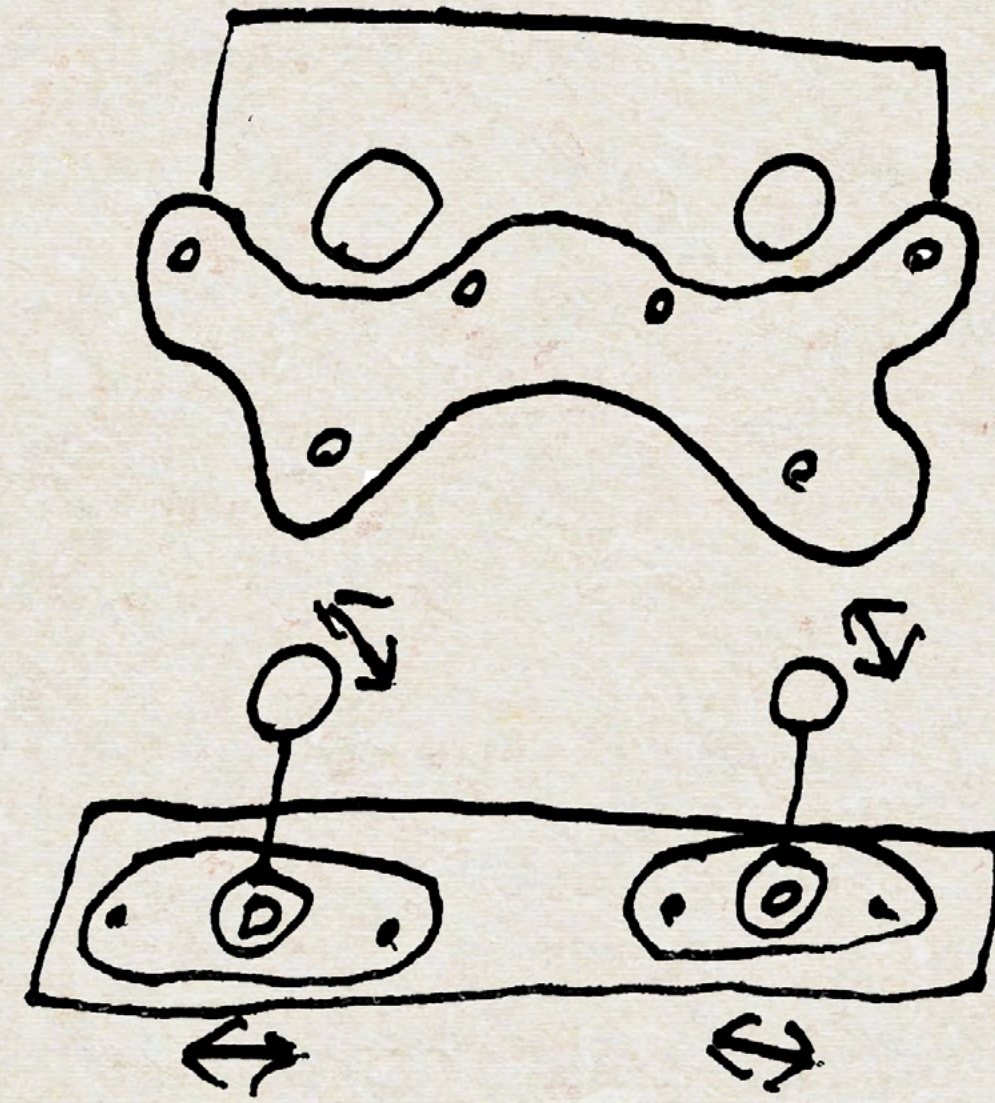Name: Timothy Laurence Weston     Unit Number:   6E7V0016_2324_O     Year: 2023/4

# Ideation

Whilst exploring ideas a number of criteria were settled upon:

- Multi-material
- Adjustable focal length
- Easy removal of phone
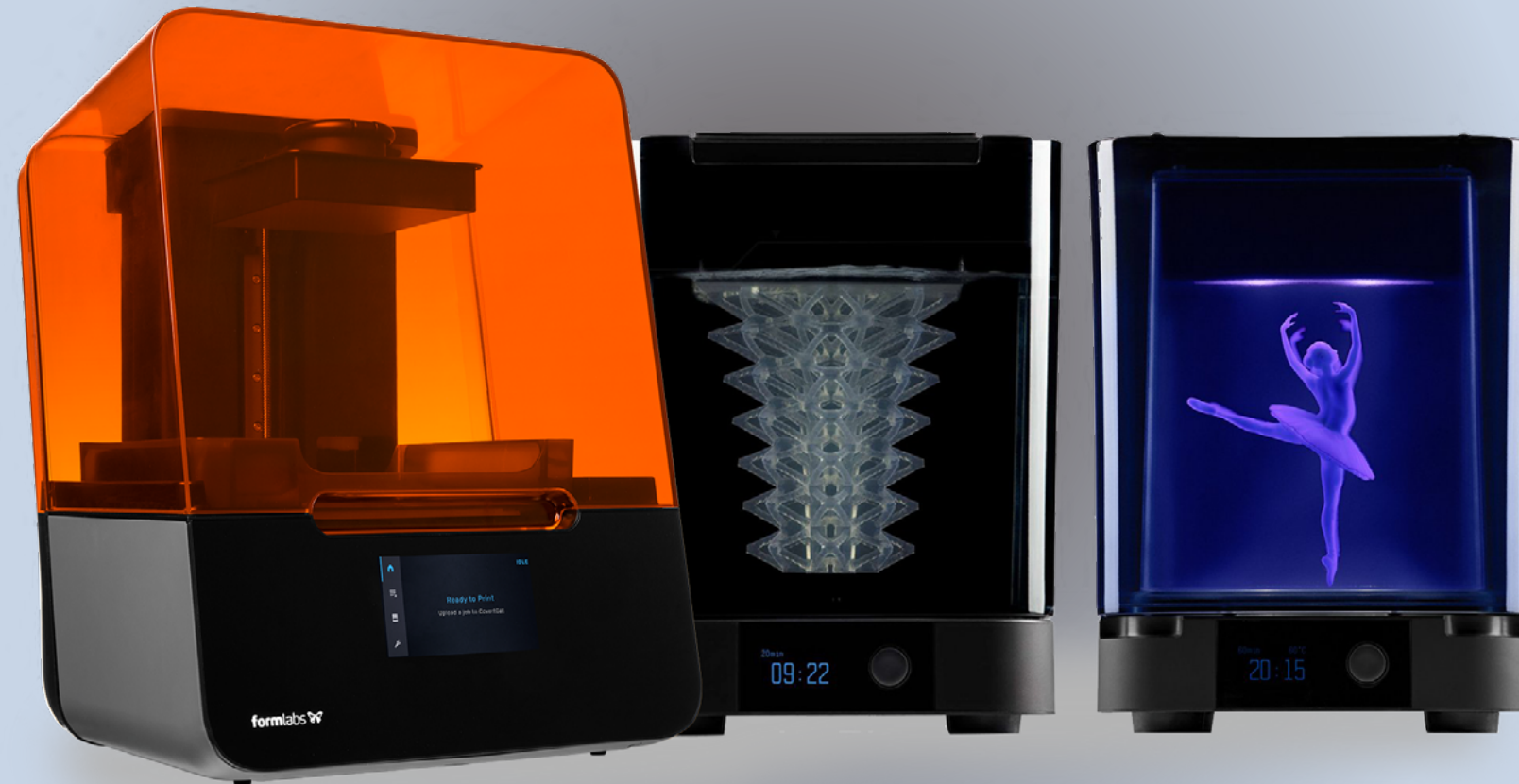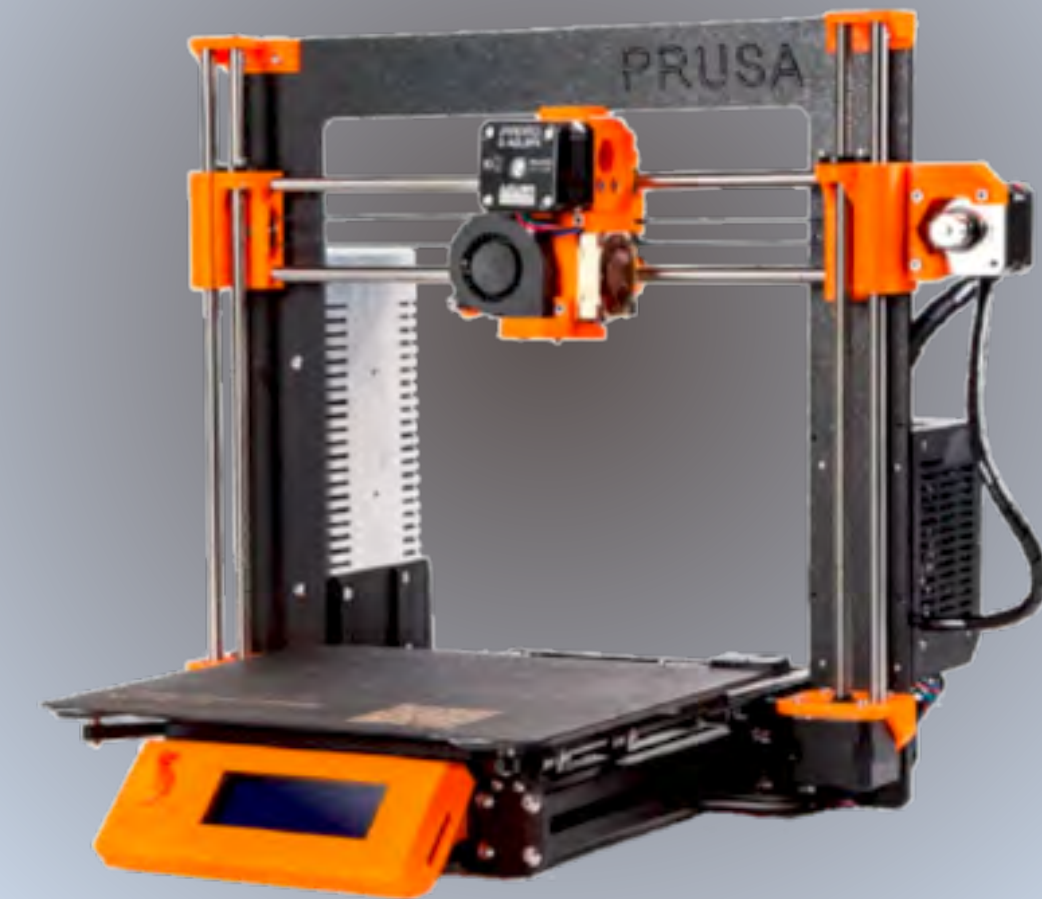- Easy to disassemble for recycling

# Multi-Material

Whilst the headset will be a usable VR device, it will also function as a demonstration unit for various methods of manufacturing.
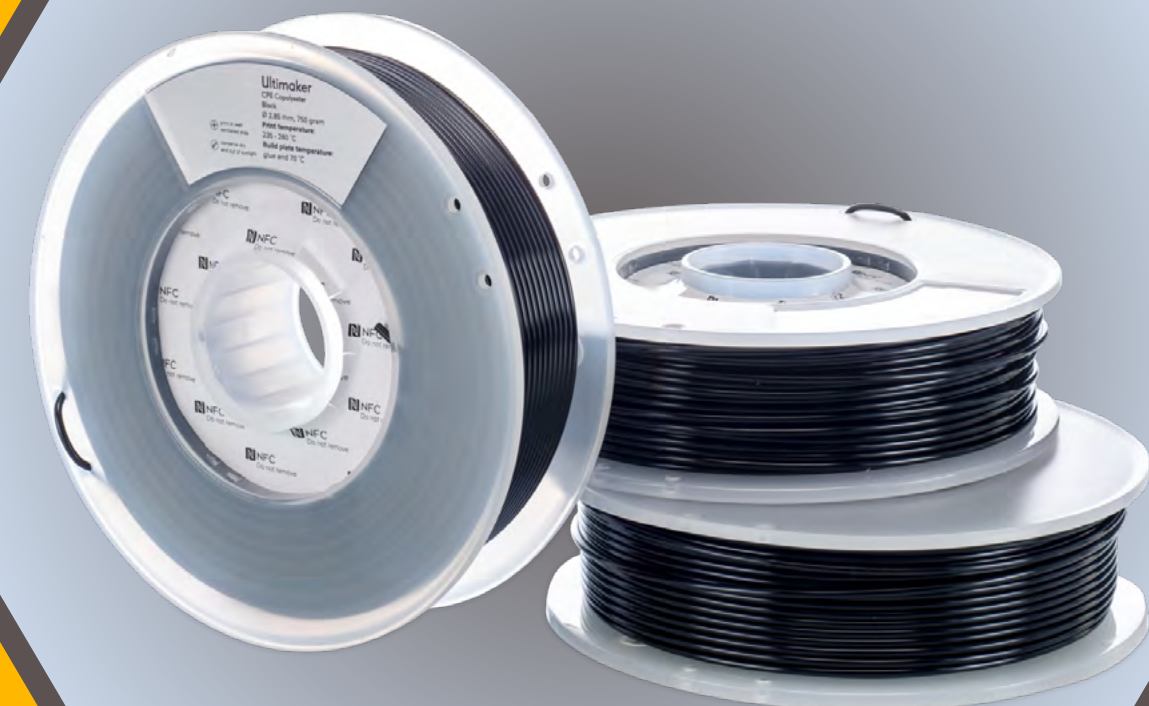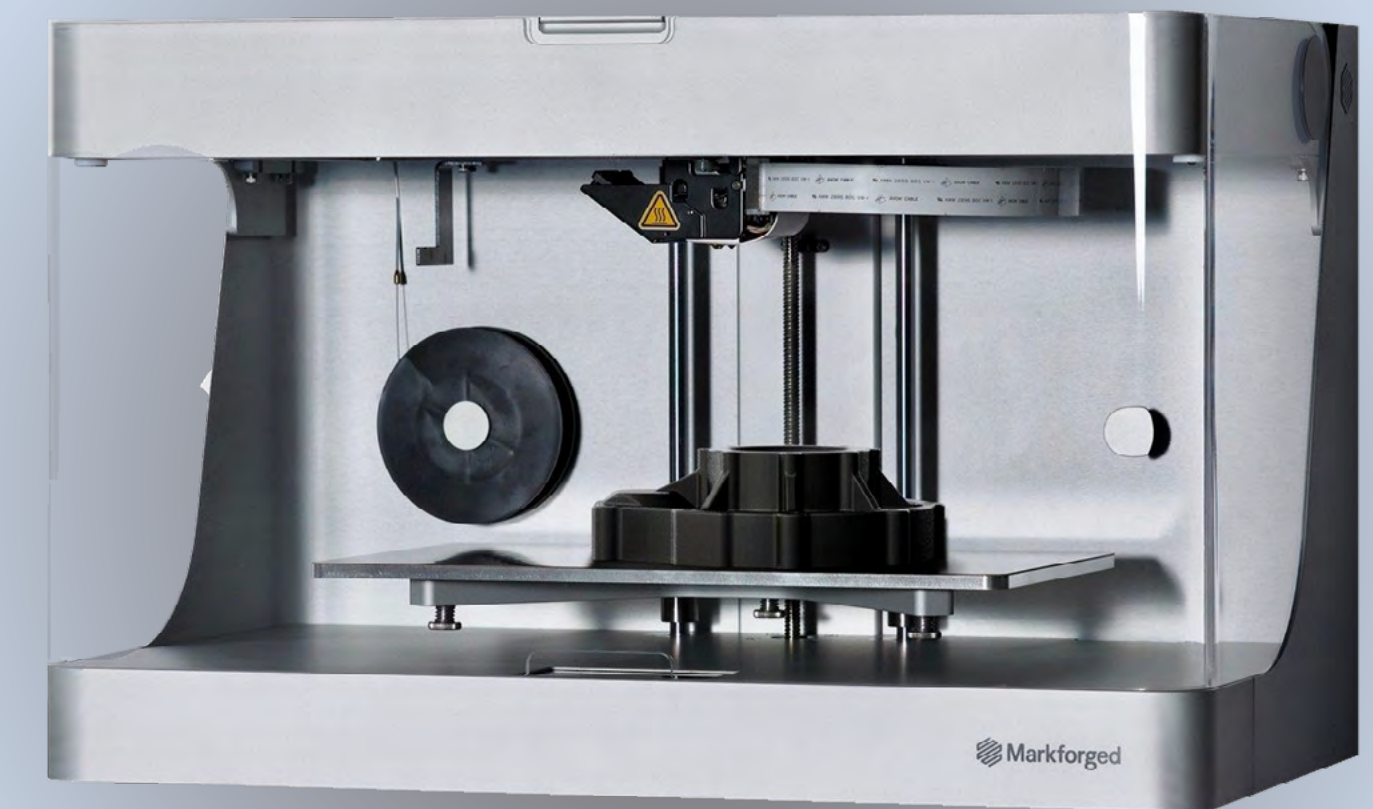
**Stereolithography 3D printing**

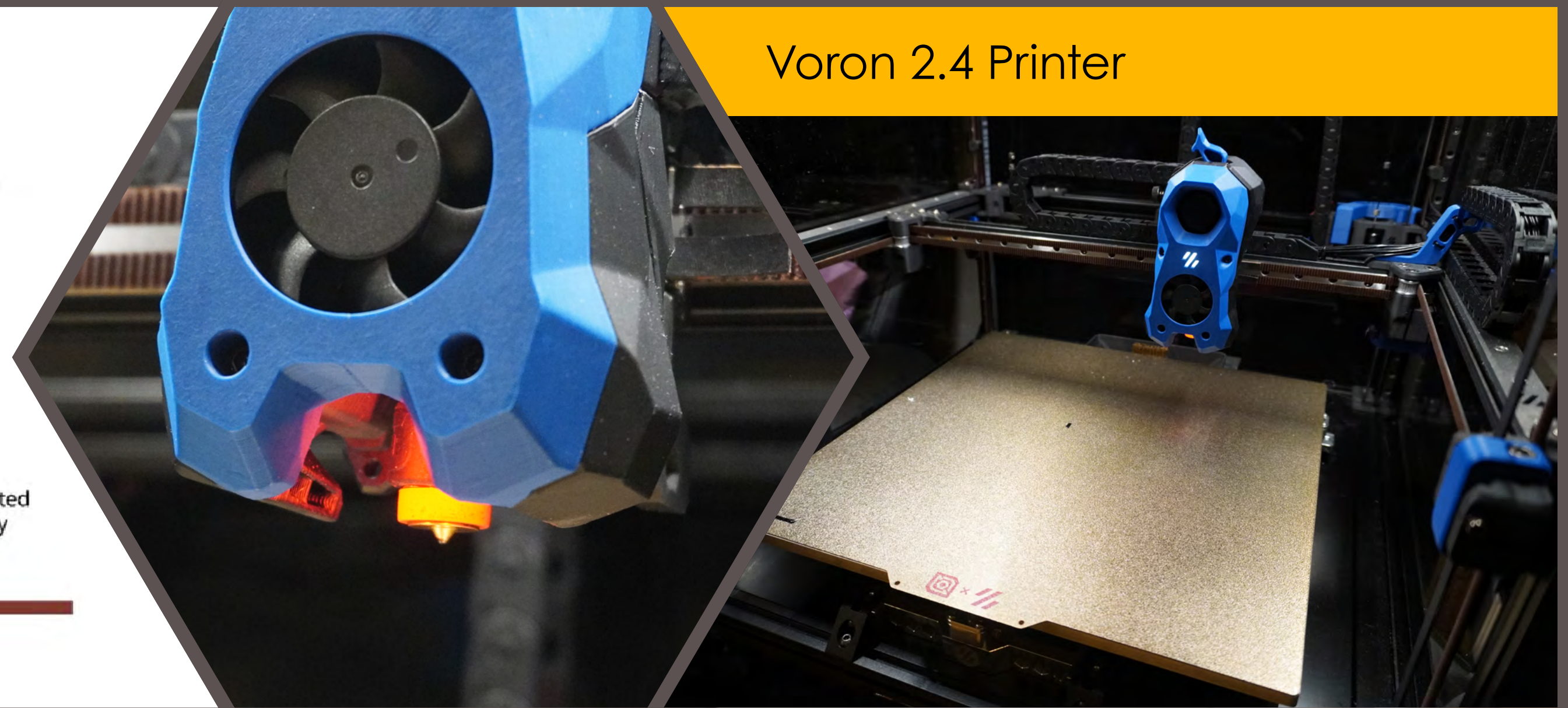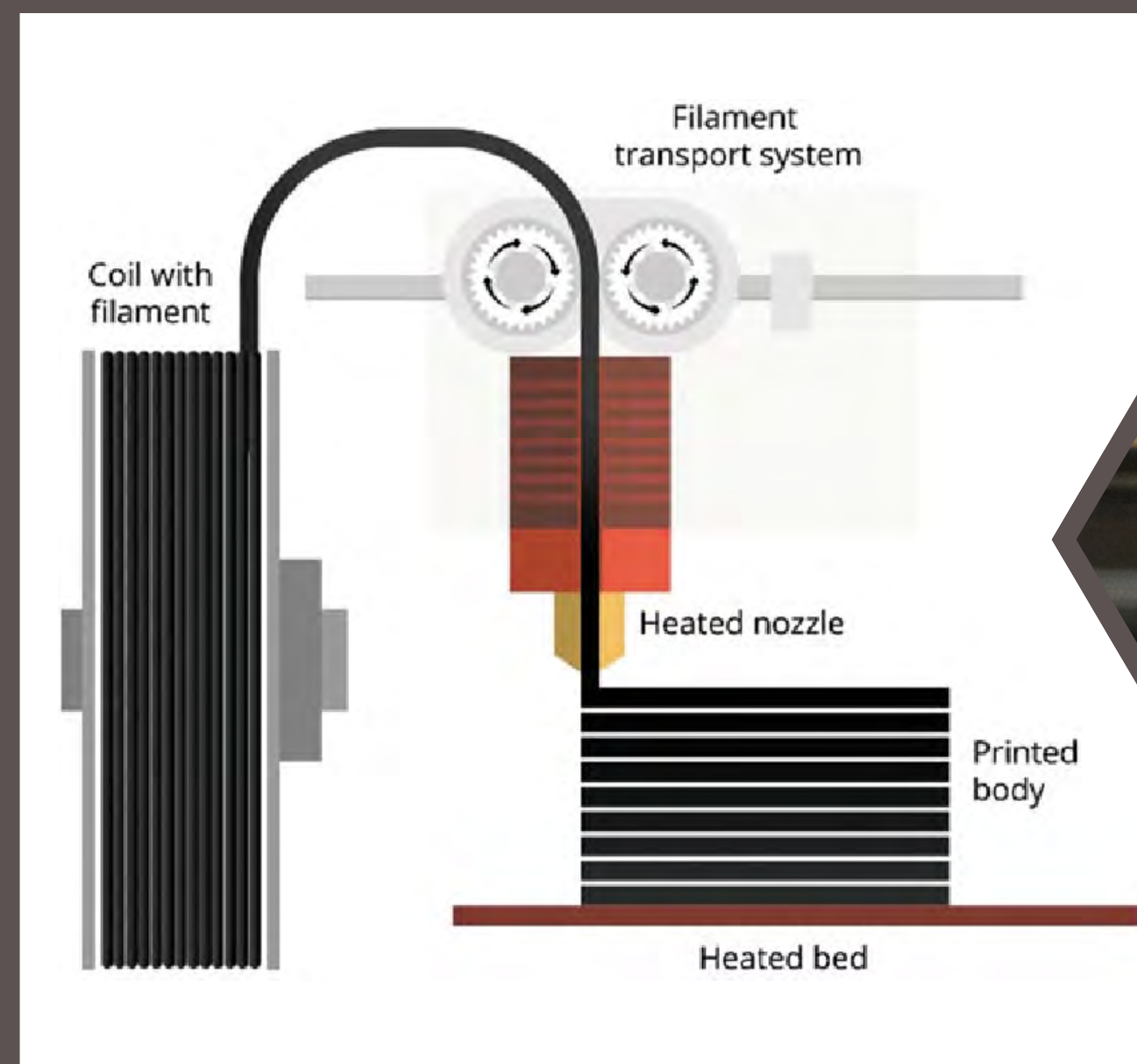**Fused Filament Fabrication 3D printing**

**Laser cutting**

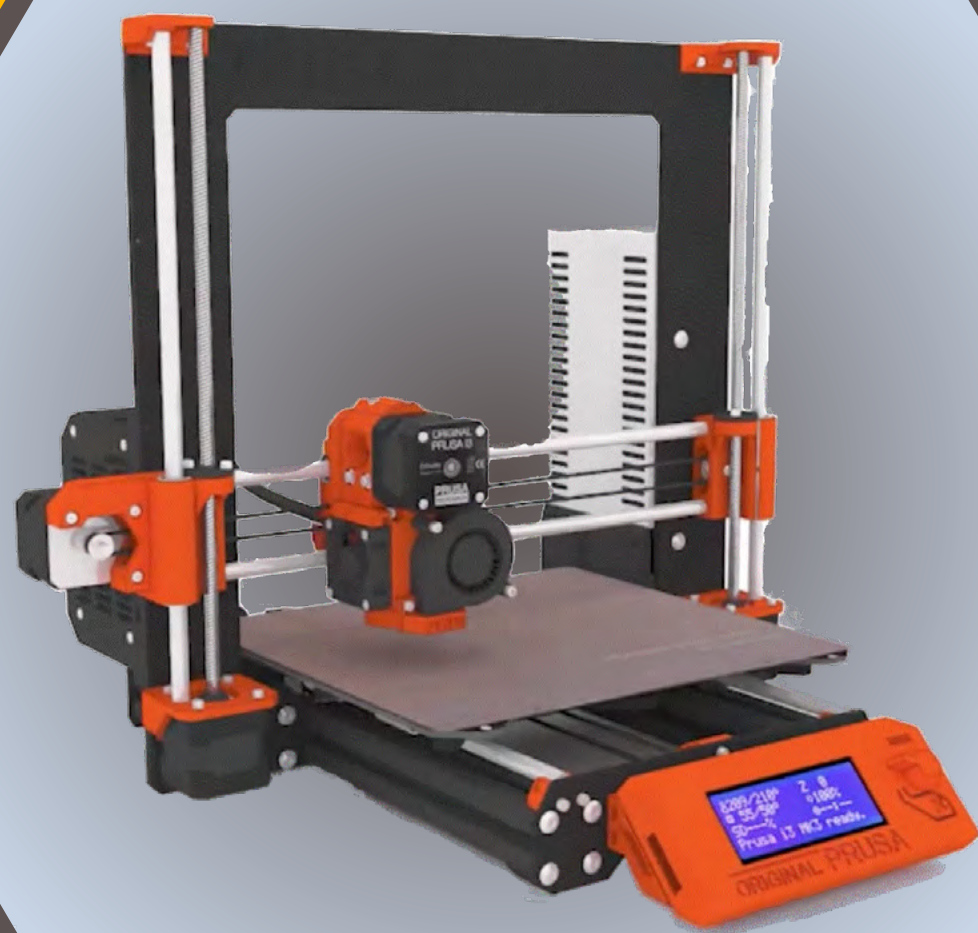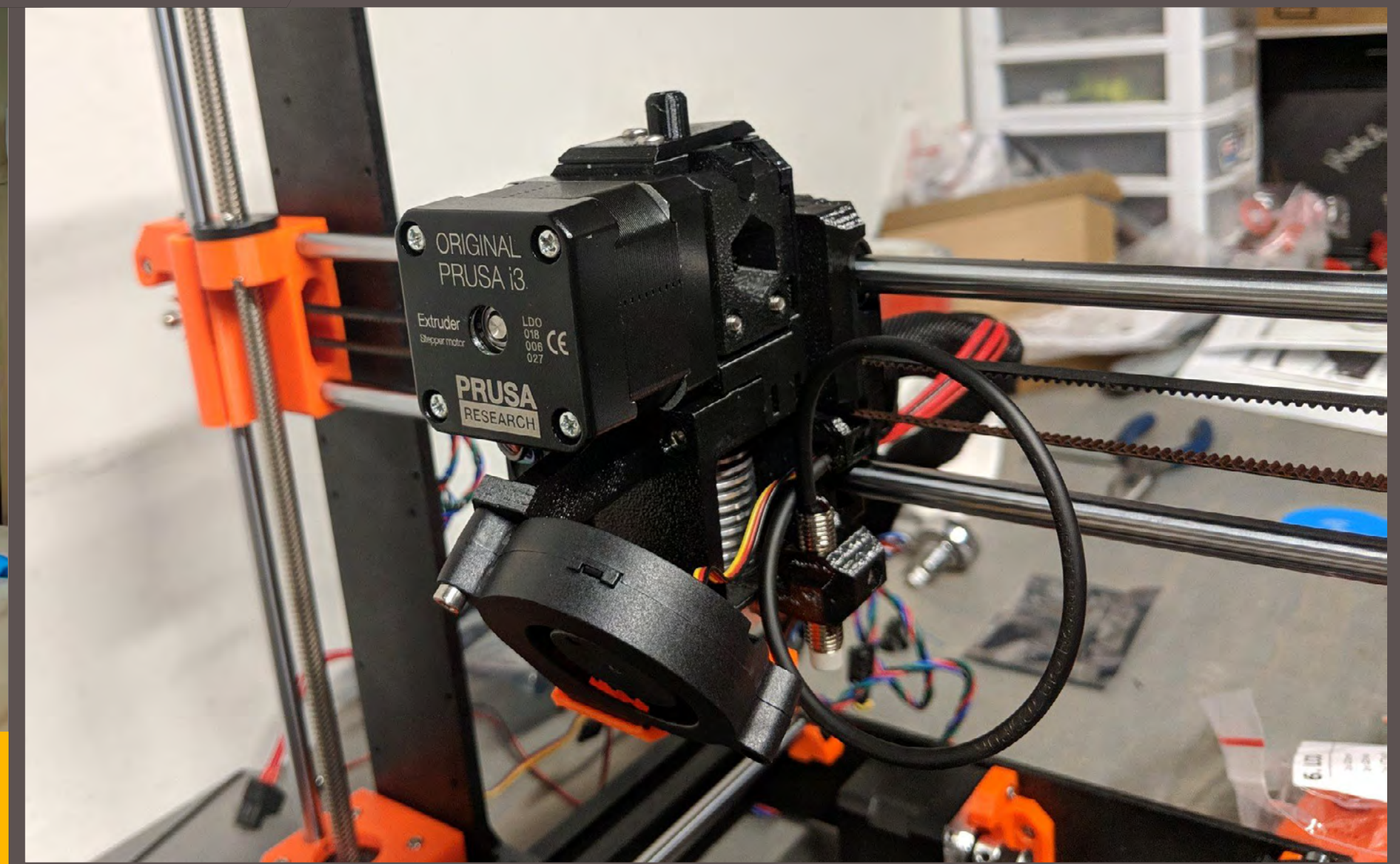**Continuous Fibre Reinforcement 3D printing**

# FFF 3D Printing

Some parts will be created using fused filament fabrication (FFF) 3D printers. This will allow for the rapid creation of prototype parts.

Filament transport system

Coil with filament

Heated nozzle

Printed body

Heated bed
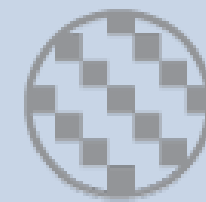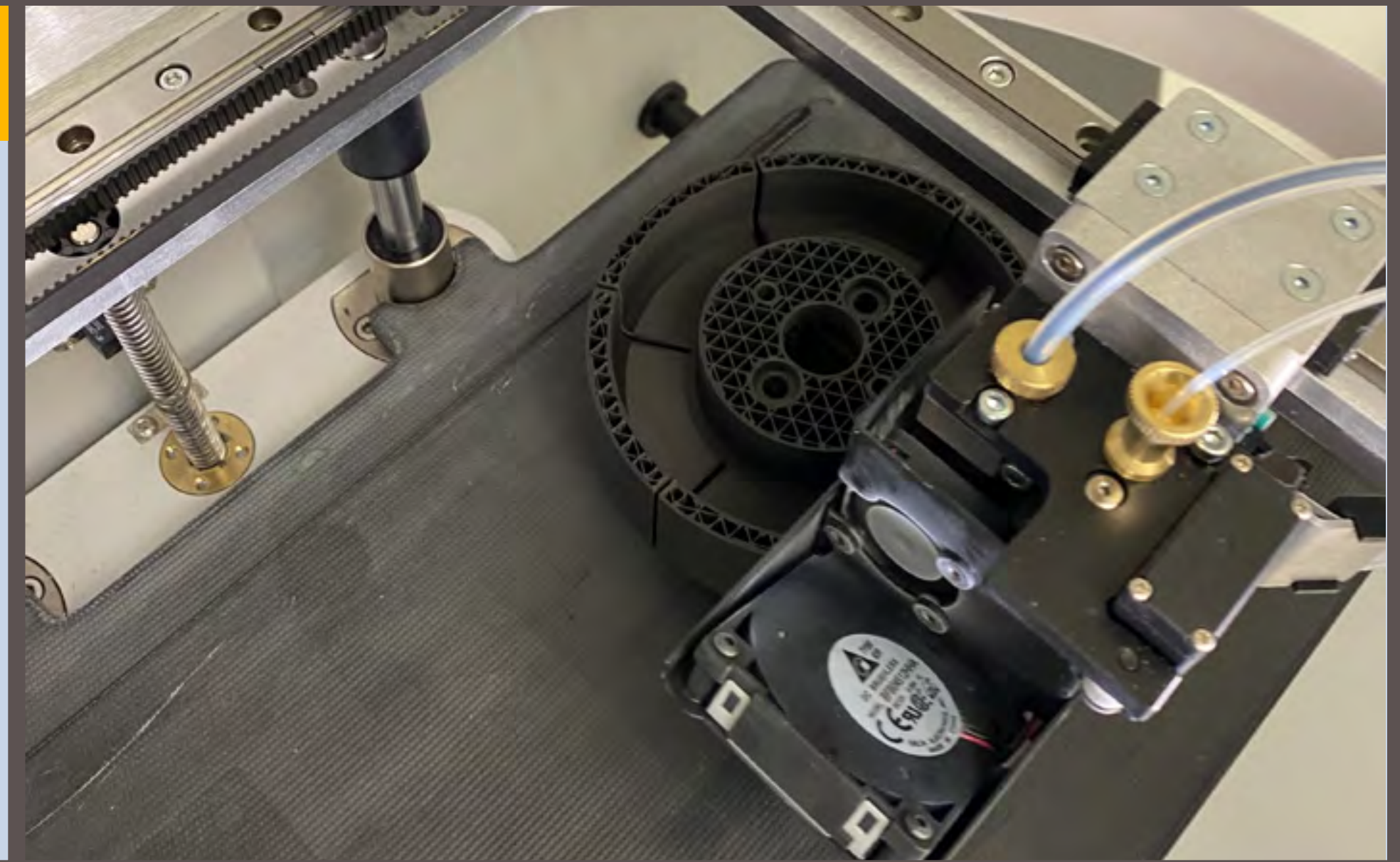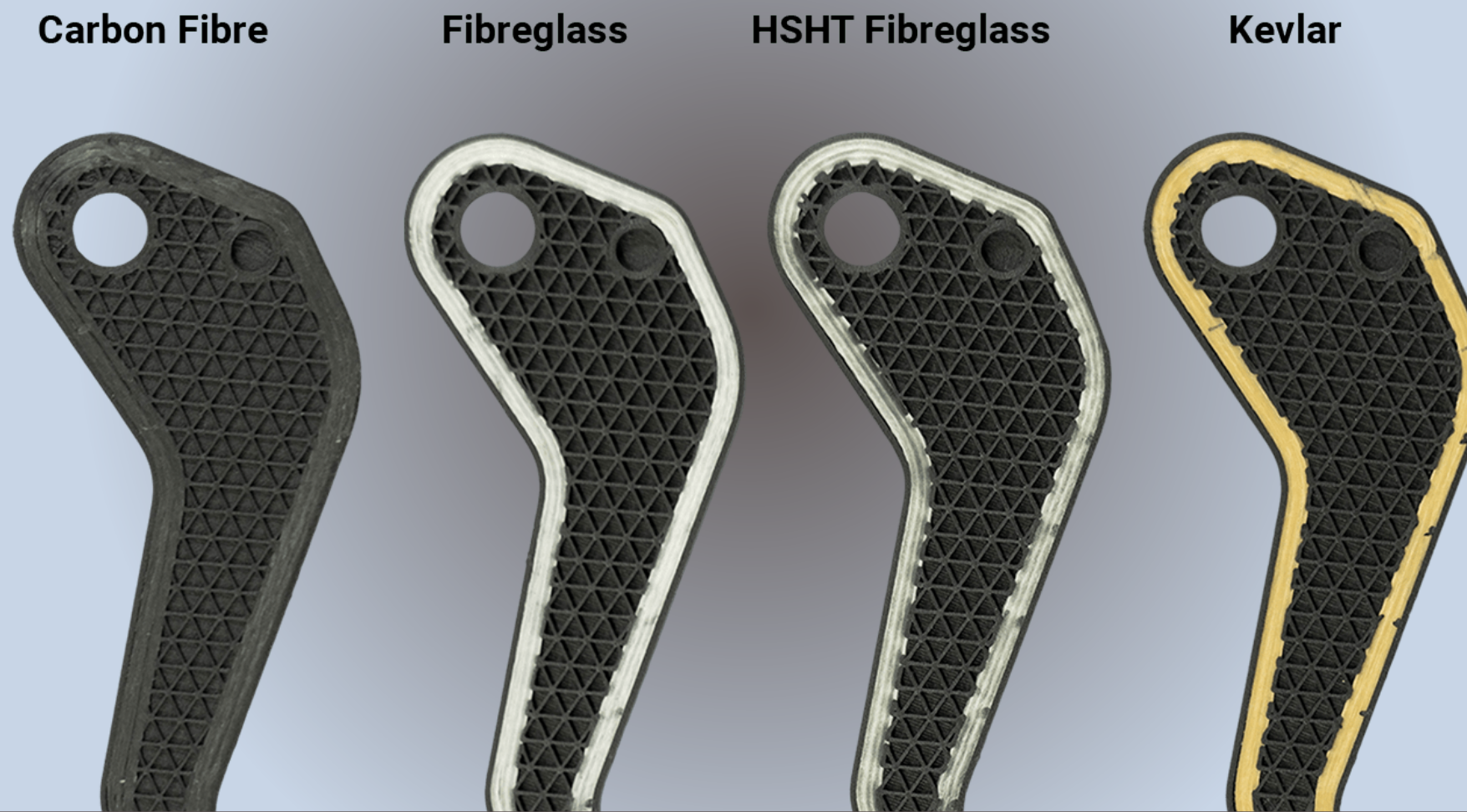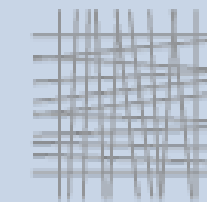
Voron 2.4 Printer

Prusa i3 Mk 3S

# CRF 3D Printing

One part will use Continuous Reinforced Fibre 3D printing.

This system embeds continuous fibres during the printing process to enhanced strength, stiffness, and durability.
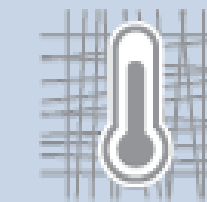
## A variety of different fibres can be embedded



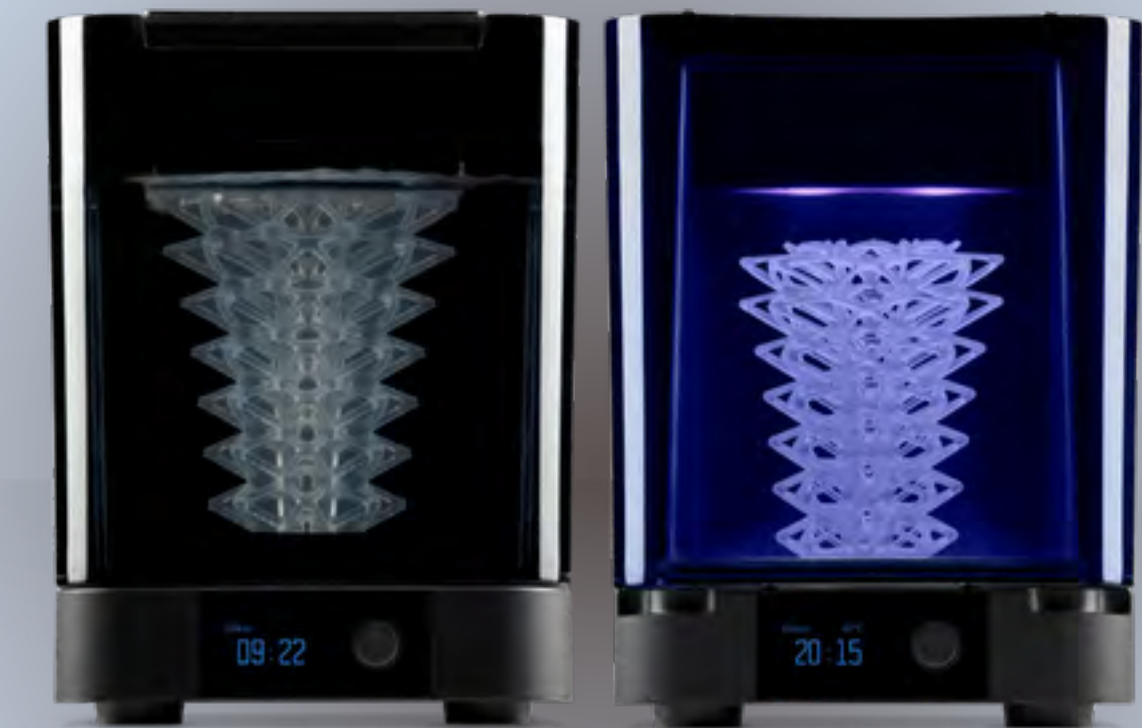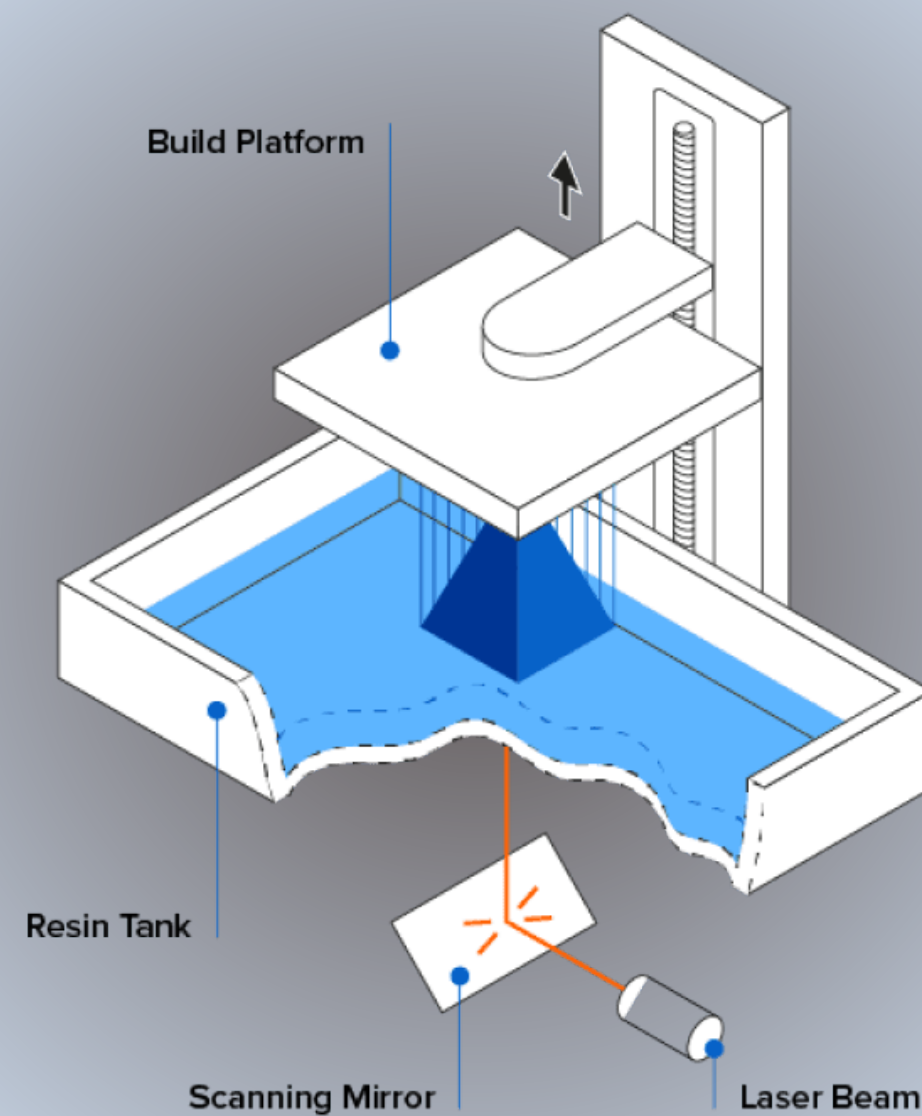Carbon Fibre    Fibreglass    HSHT Fibreglass    Kevlar

|  | Carbon Fiber | Fiberglass | HSHT Fiberglass | Kevlar® |
|---|---|---|---|---|
| Properties | High strength-to-weight ratio, stiff | Sturdy, cost-effective | Sturdy, high heat deflection | Tough, impact-resistant |
| Ideal loading type | Constant loading | Intermittent loading | Constant loading at high temperatures | Impact loading |
| Failure behavior | Stiff until fracture | Bends until fracture | High energy absorption until fracture | Bends until deformation |
| Characteristics and advantages | Metal stiffness and strength, lightweight | Economical starting point, general-use fiber | Keeps strength at high temperatures | High deflection and impact resistance |

# SLA 3D Printing

Stereolithography (SLA) 3D printing uses a laser to cure layers of liquid photopolymer resin. This creates highly detailed and smooth-surfaced prints.

The generatively designed part of the headset will use this method.







Build Platform

Resin Tank

Scanning Mirror
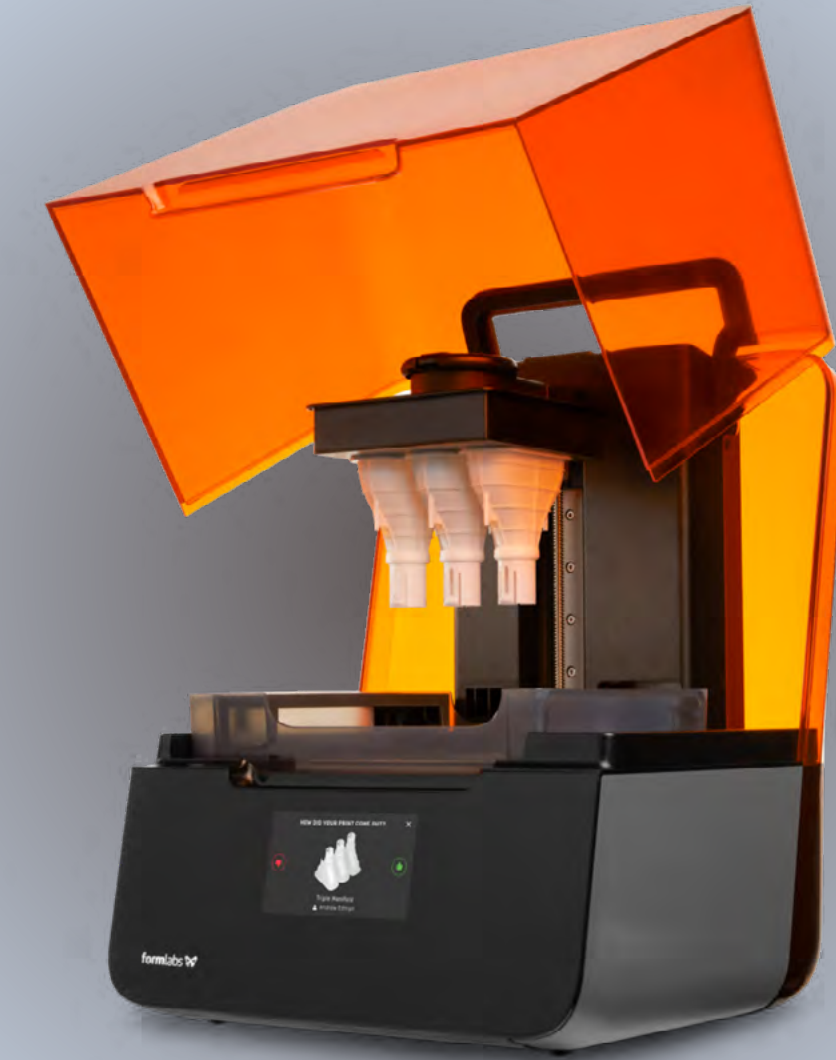
Laser Beam



After printing, parts need to be washed and cured under UV light

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# Laser Cutting

This process uses a high-powered laser beam to cut or engrave materials, producing clean and precise results.

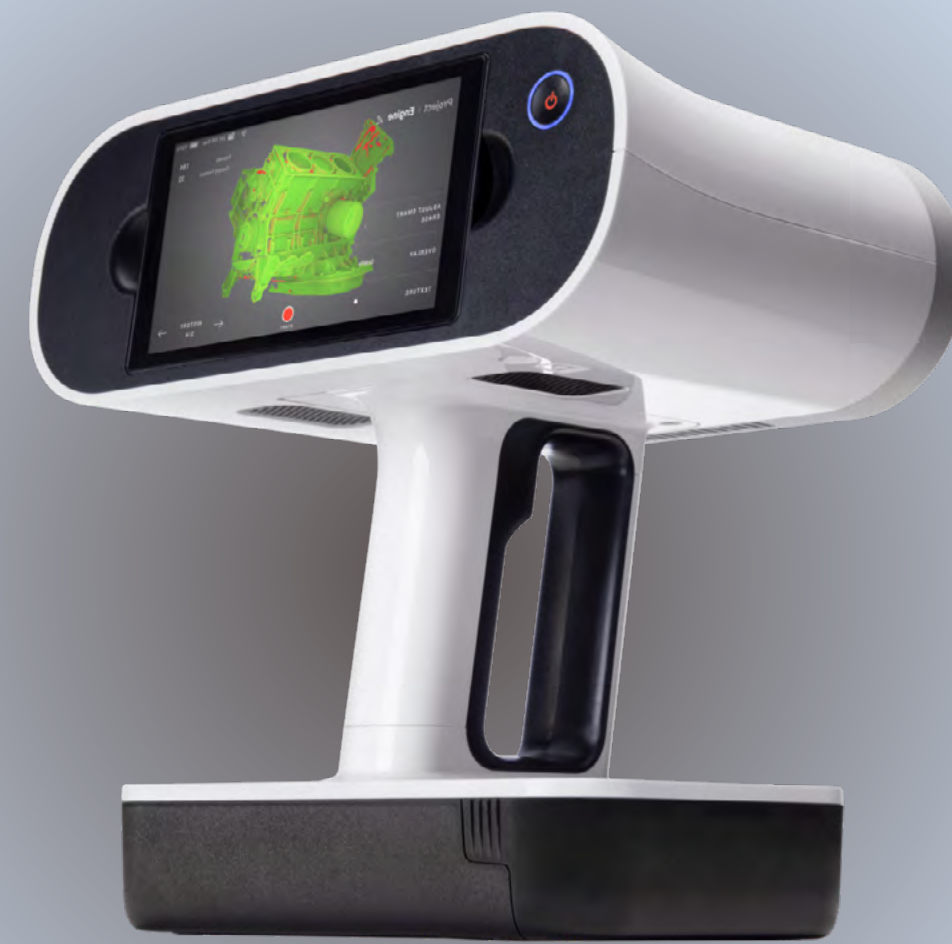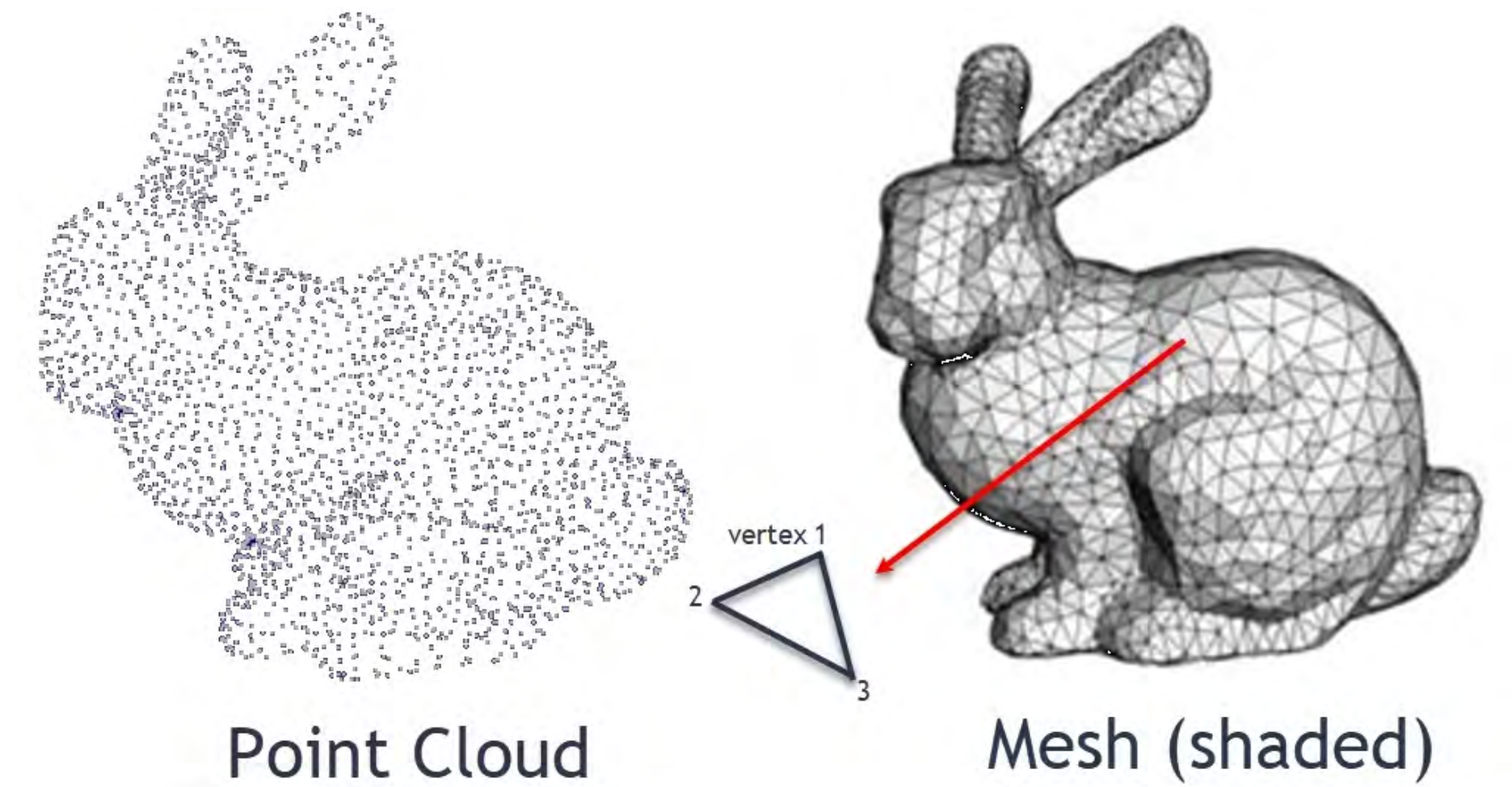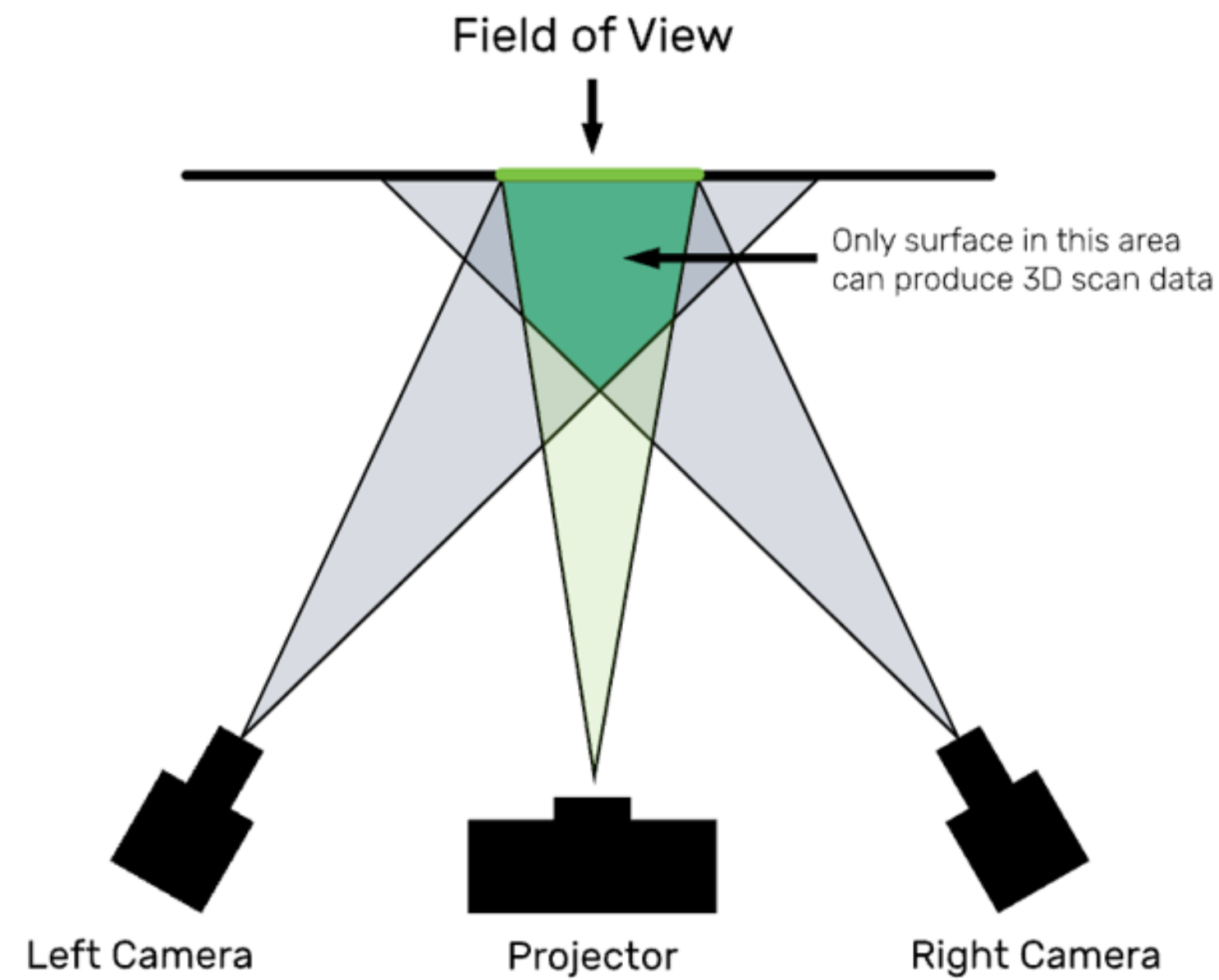Many parts on the headset will be cut from clear acrylic.

Google Cardboard

# 3D Scanning

Structured light scanners project a pattern onto an object. This pattern is deformed by the surface and captured by cameras. Software creates a point cloud and then converts this into a mesh.



Field of View

Only surface in this area can produce 3D scan data

Left Camera    Projector    Right Camera



Point Cloud

vertex 1

2

3

Mesh (shaded)



Artec Leo



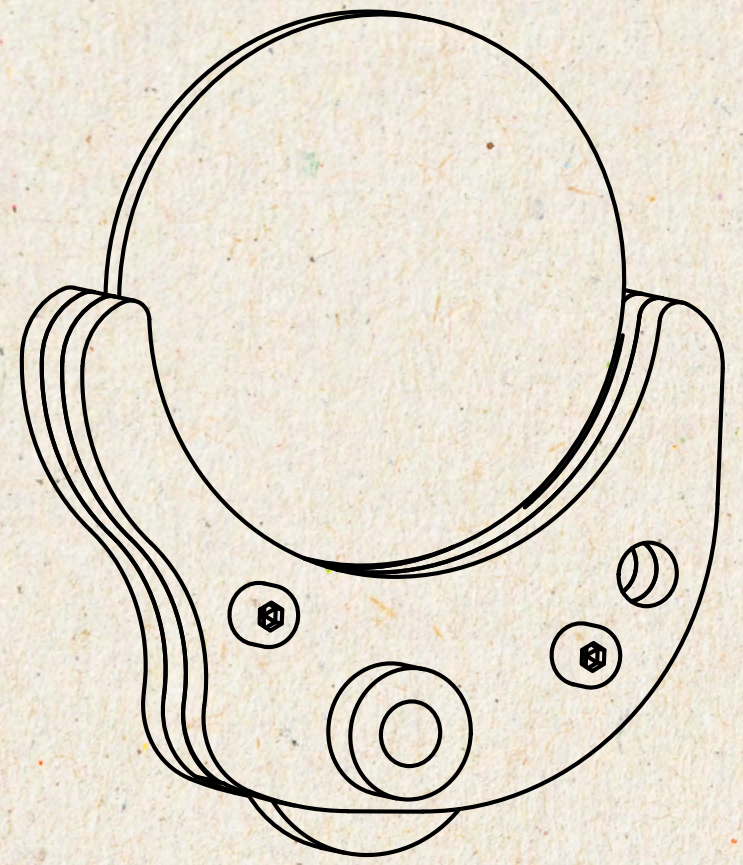Name: Timothy Laurence Weston    Unit Number:    6E7V0016_2324_O    Year: 2023/4
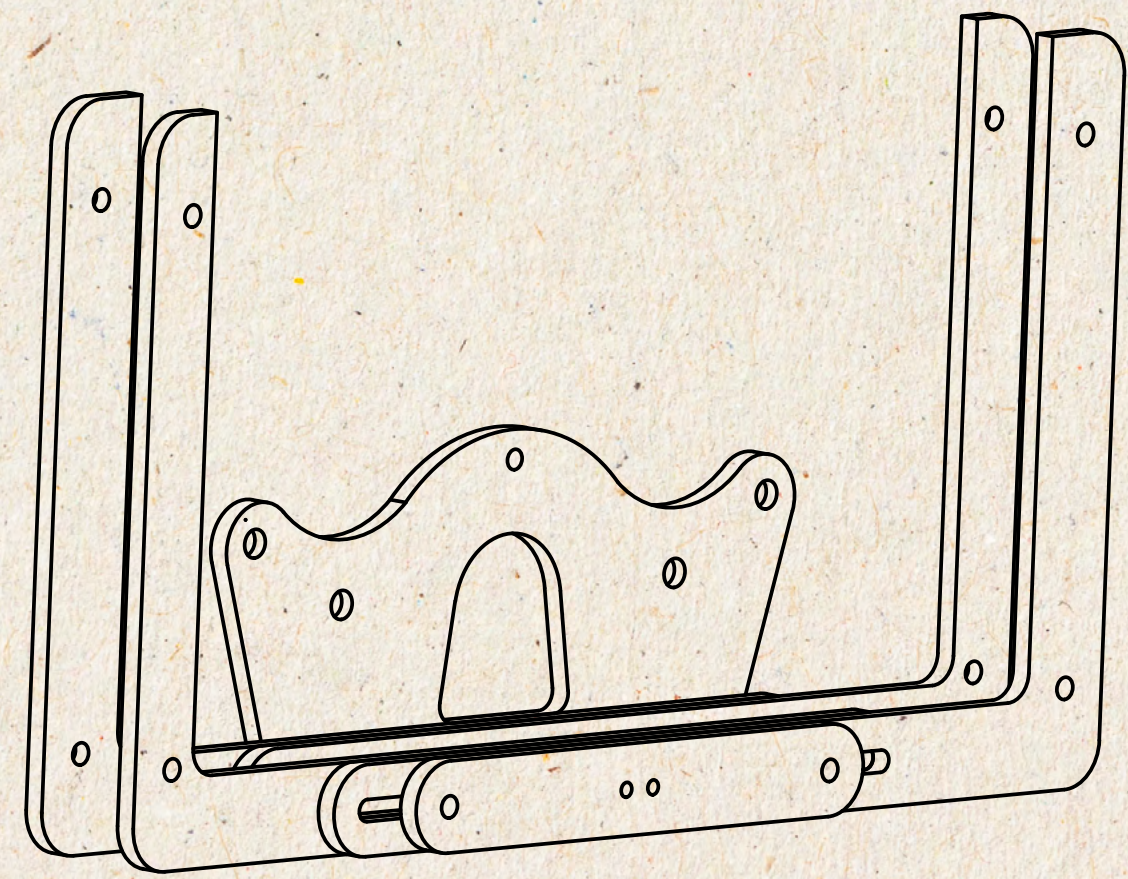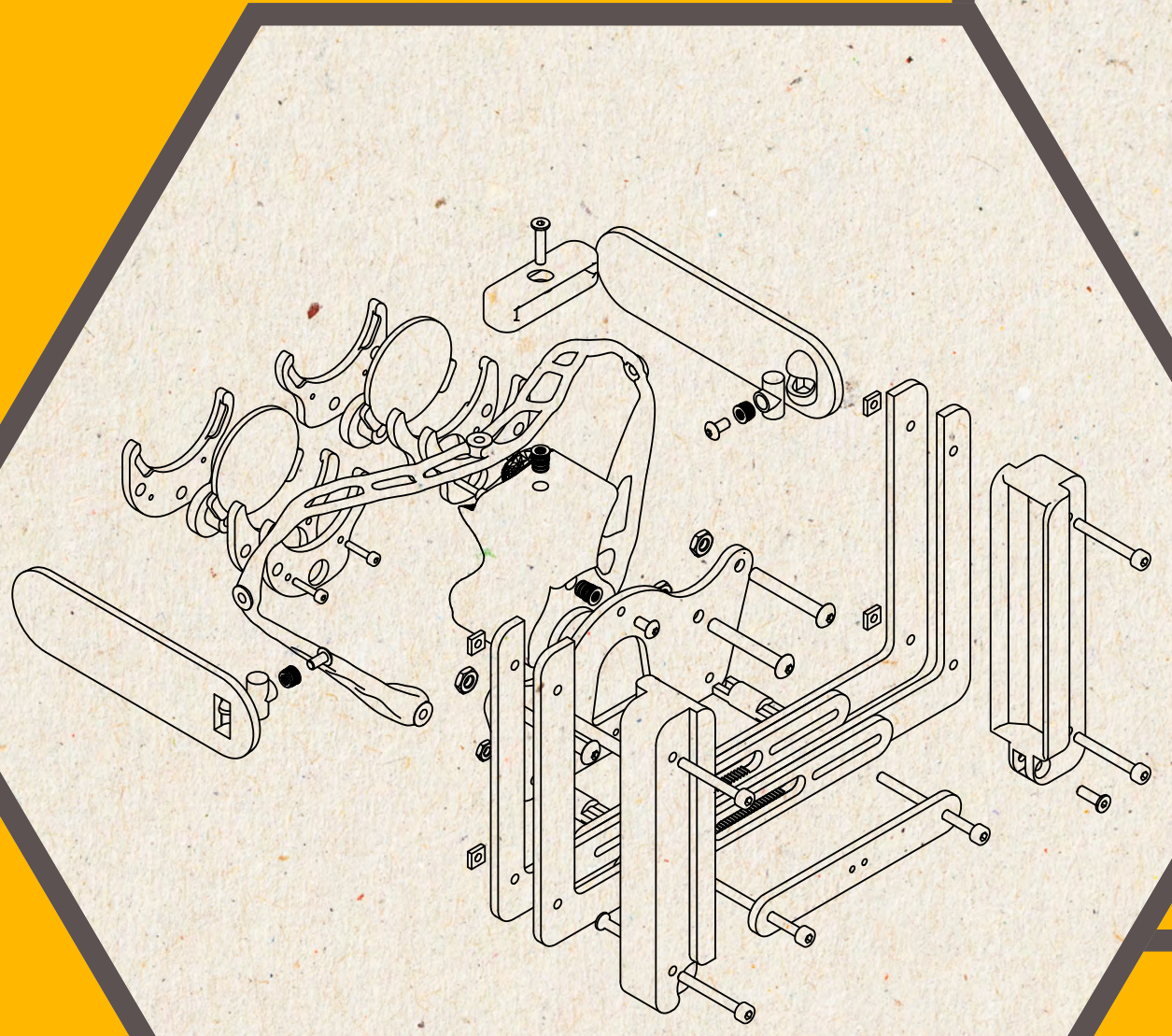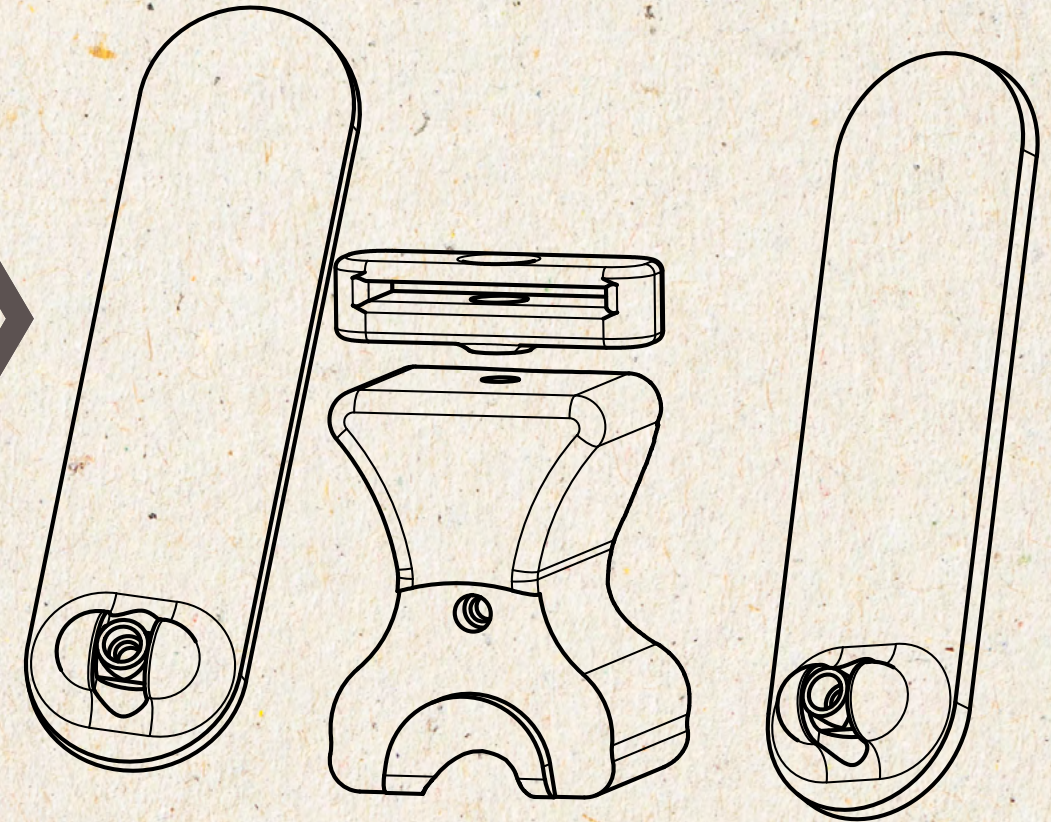
# Module Breakdown

The project was broken down into five stages to be designed and prototyped.

This allowed the project to be more easily managed – particularly as each focused on one method of production.
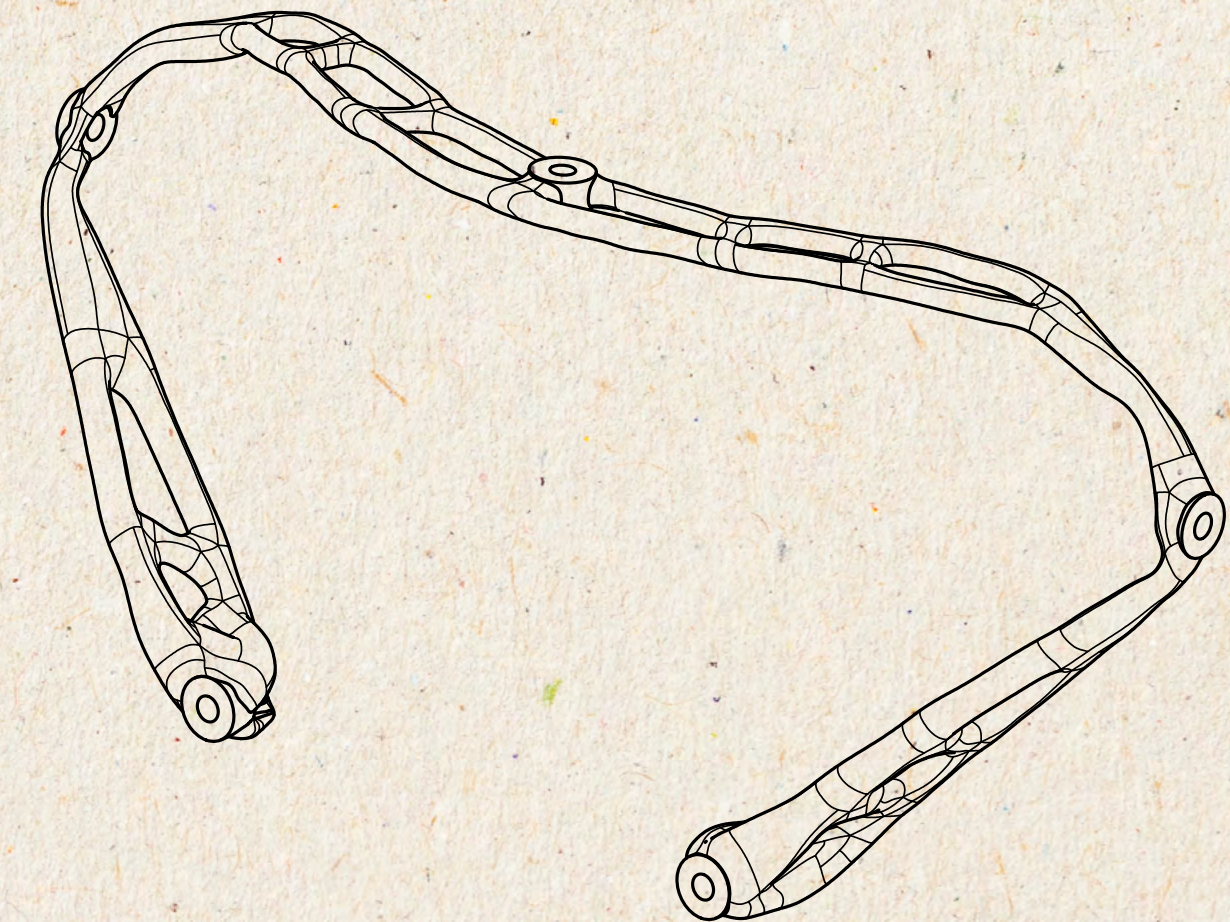
Lens Holders
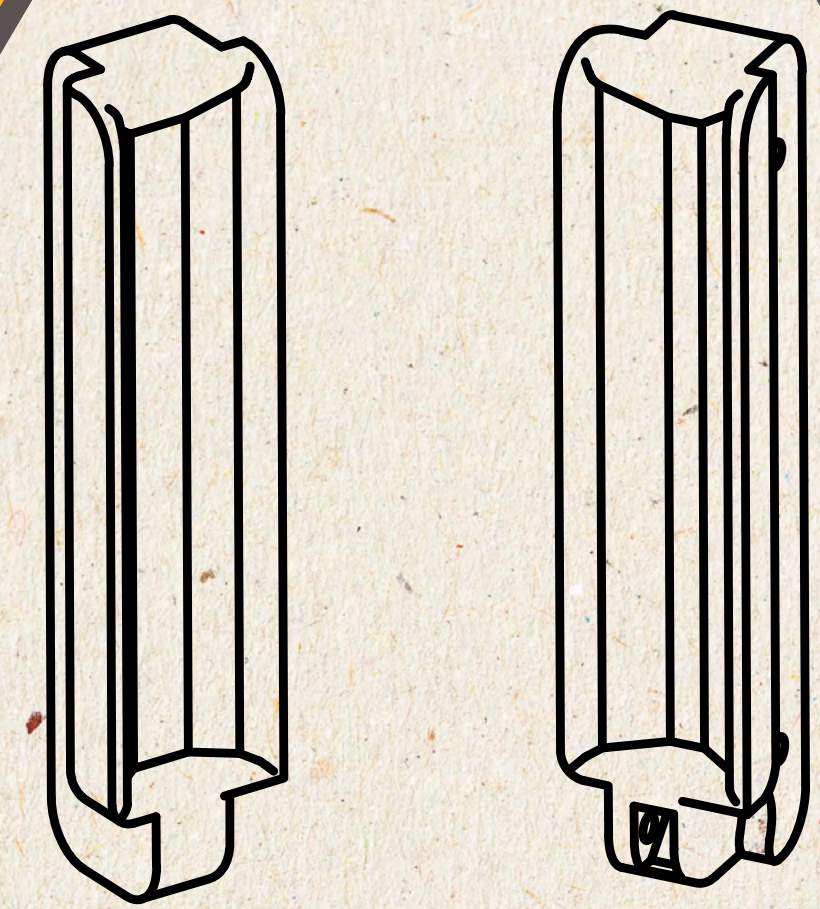


Phone Grips



Nose Interface and Head Strap Clips
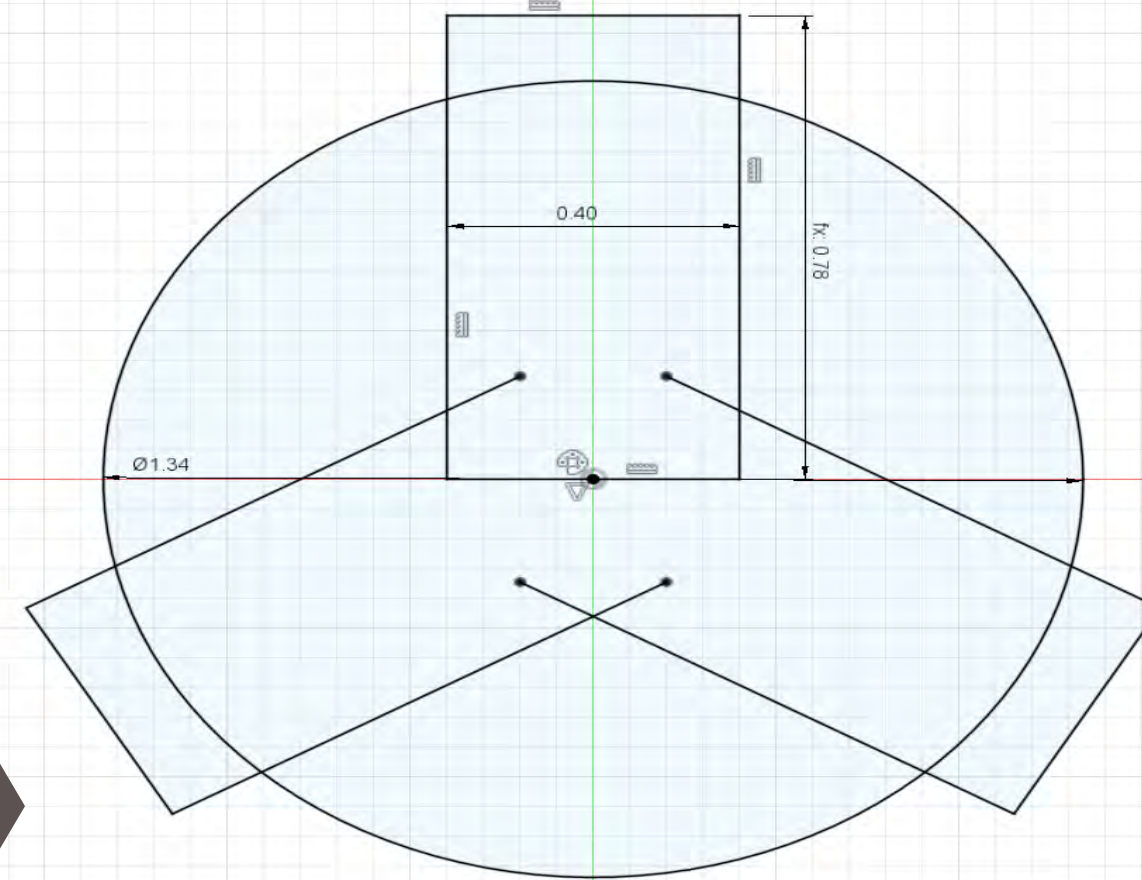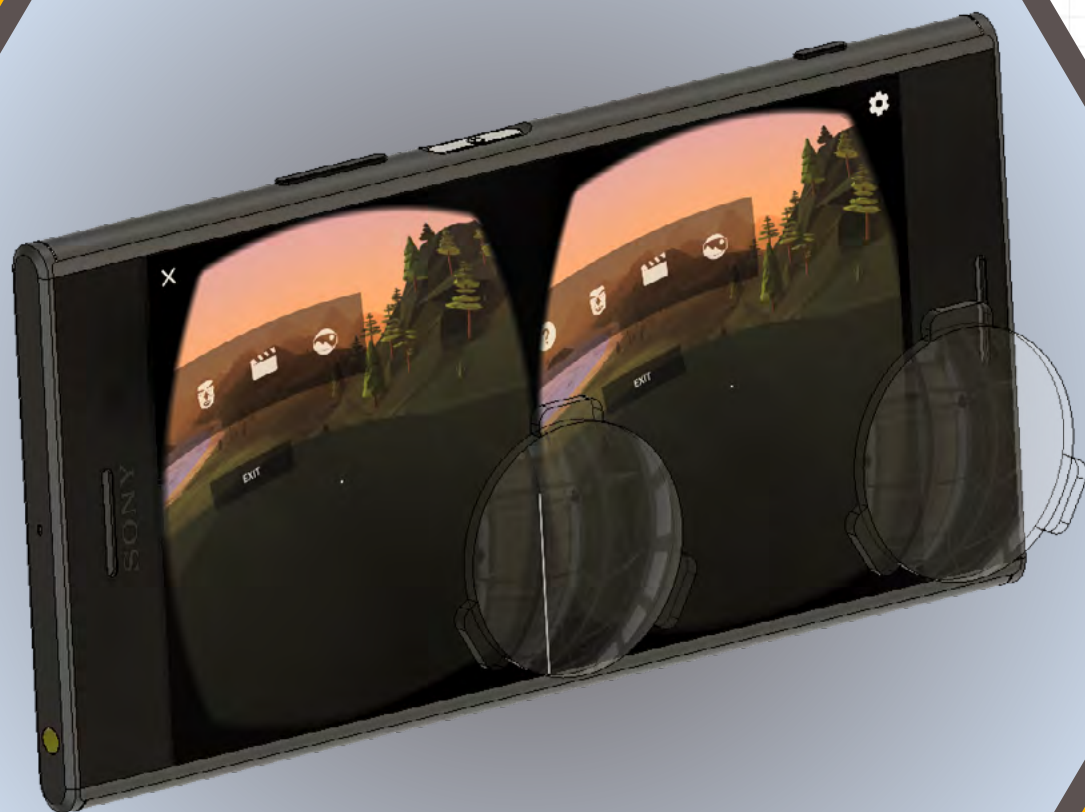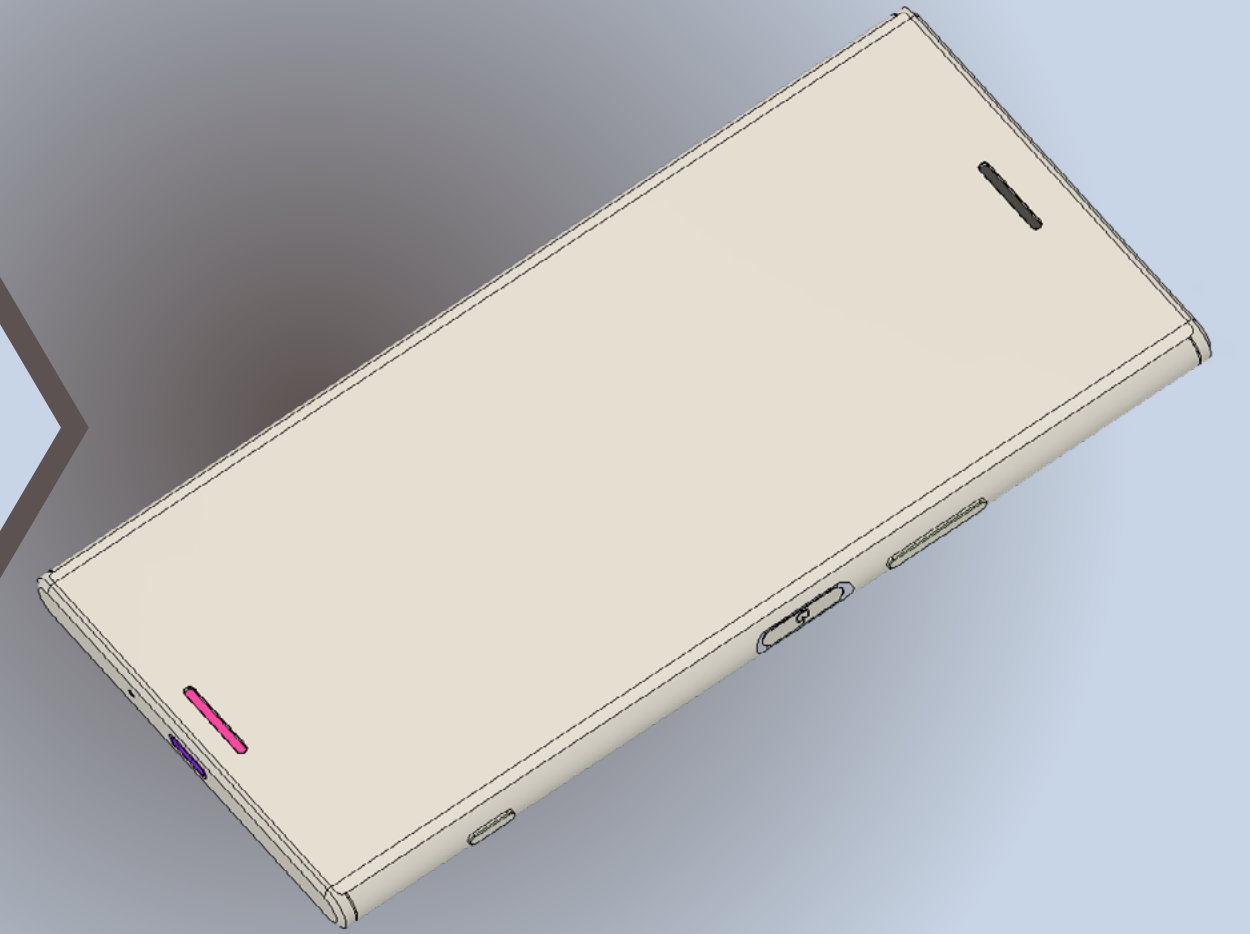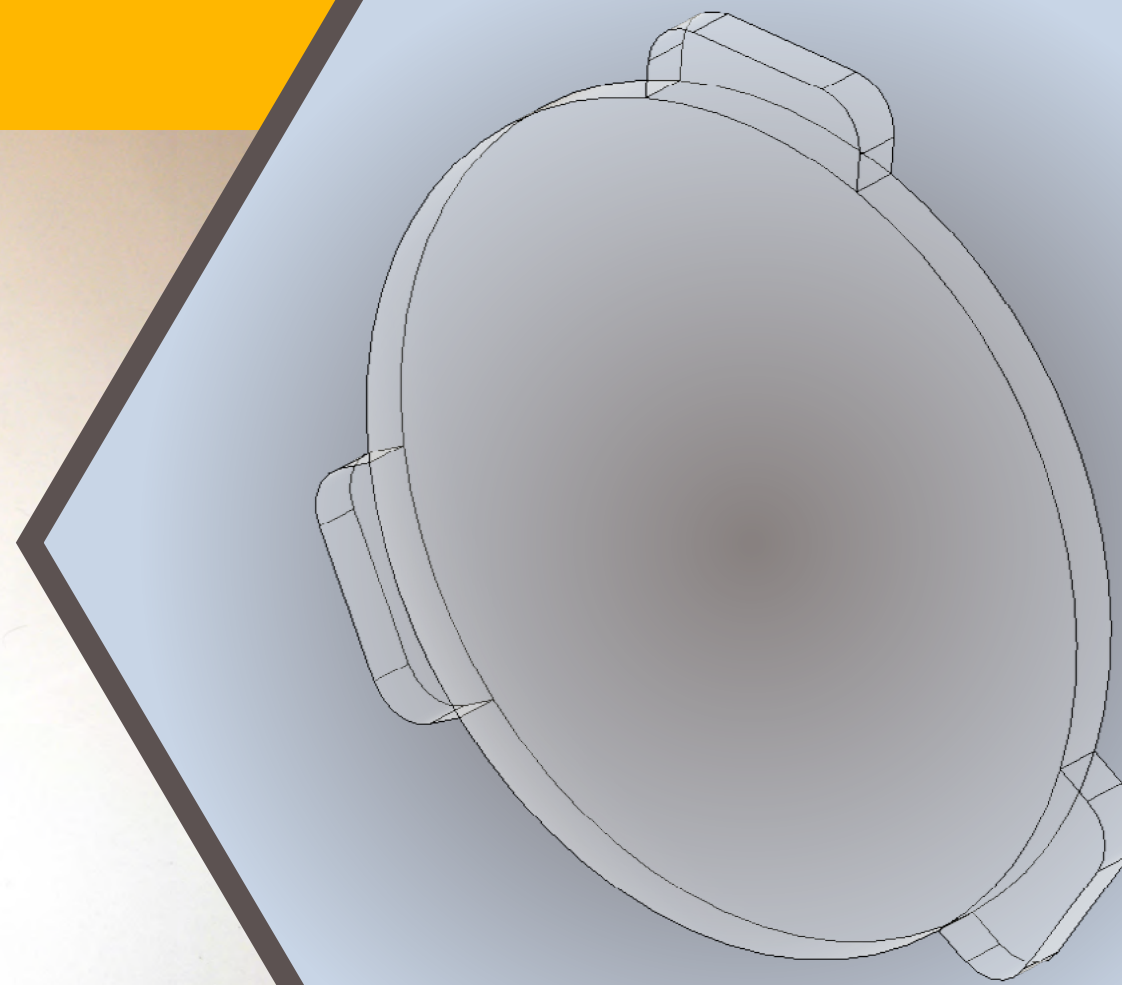


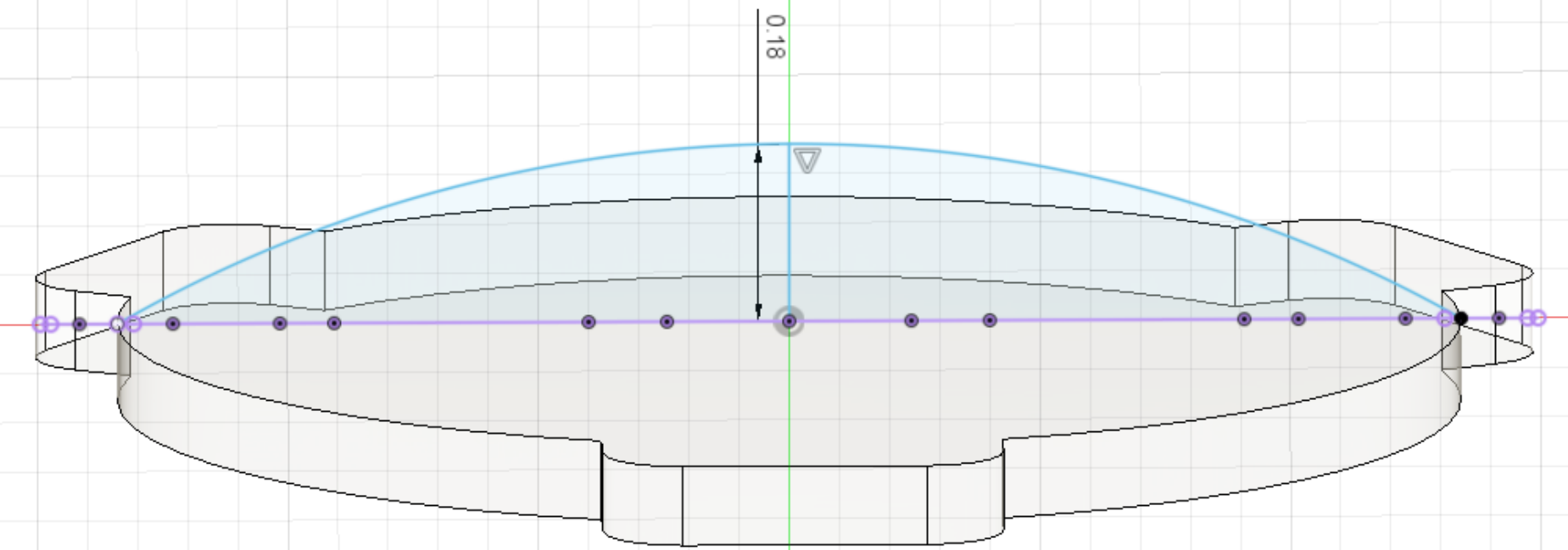Phone Sliders and Nose Plate



Head Strap Frame

# Initial CAD

The first step in CAD was to find or create models of the standard parts that would be utilised in the design.

The lenses were measured with callipers and a model of the SONY Xperia XZ from GrabCad was utilised.

The parts to be modelled



Initial lens sketch

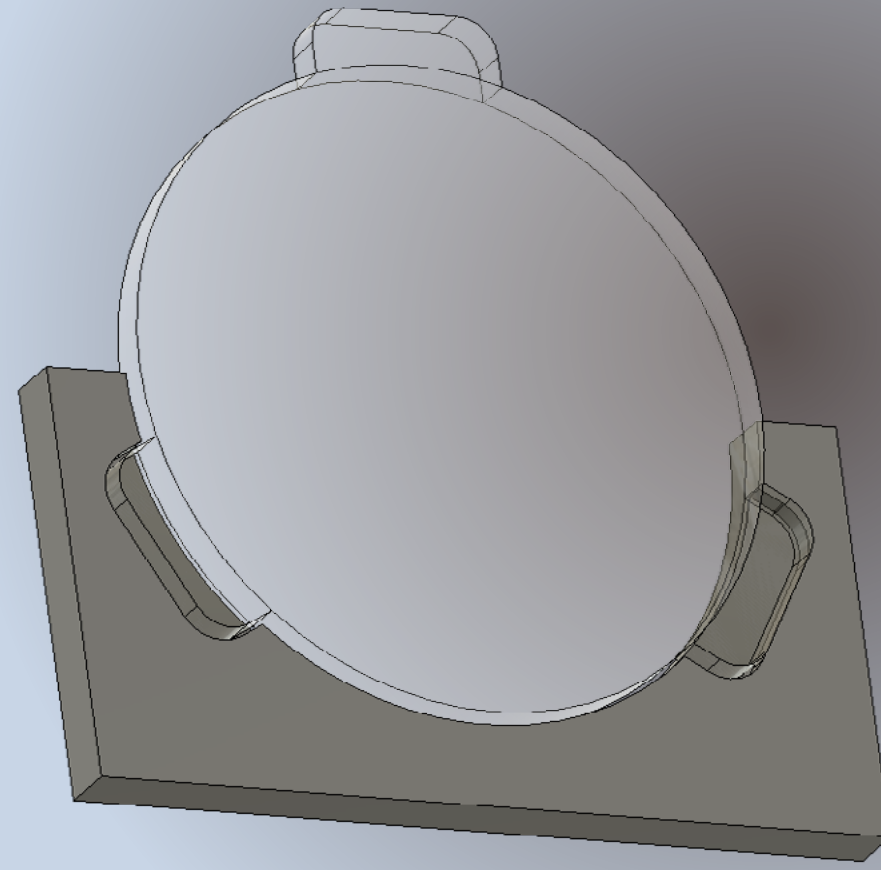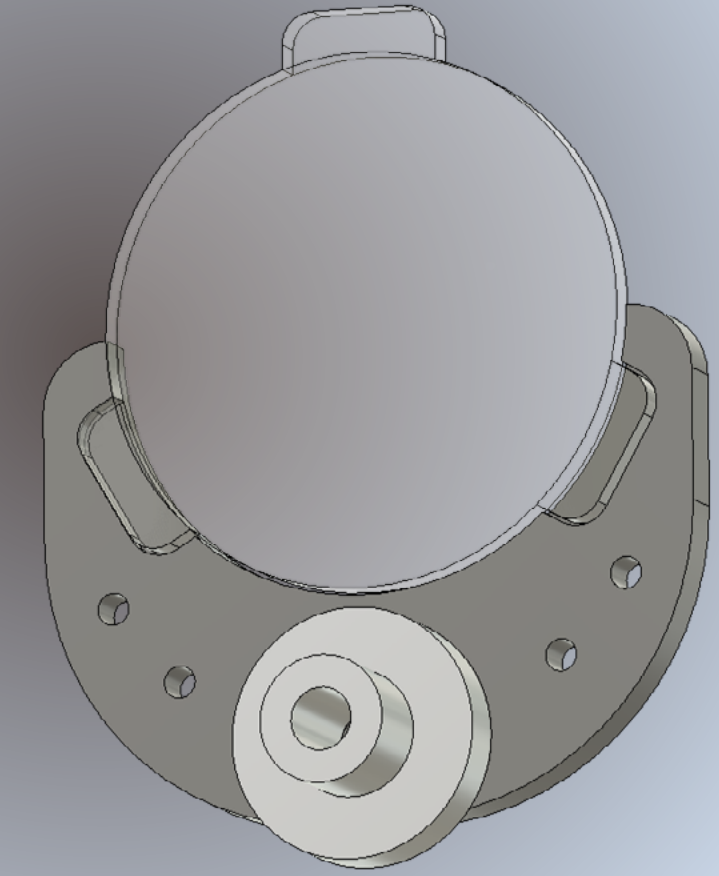The lens profile ready to be revolved

# Lens Holder CAD

This was the first part to be designed, since it was a small part and one that revolved around an unchangeable component – the lenses.

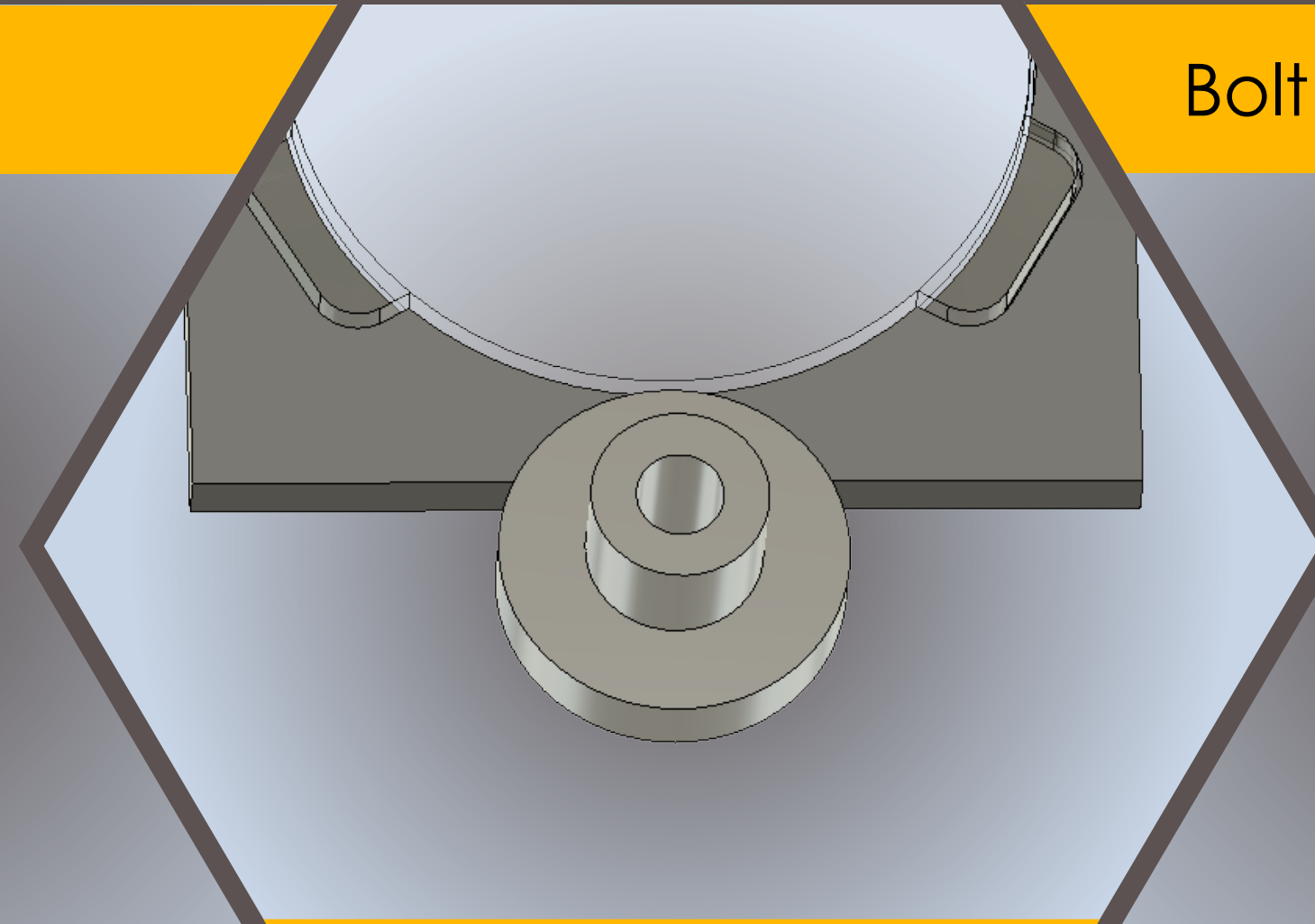As it was to be laser cut from acrylic it was build up in layers.
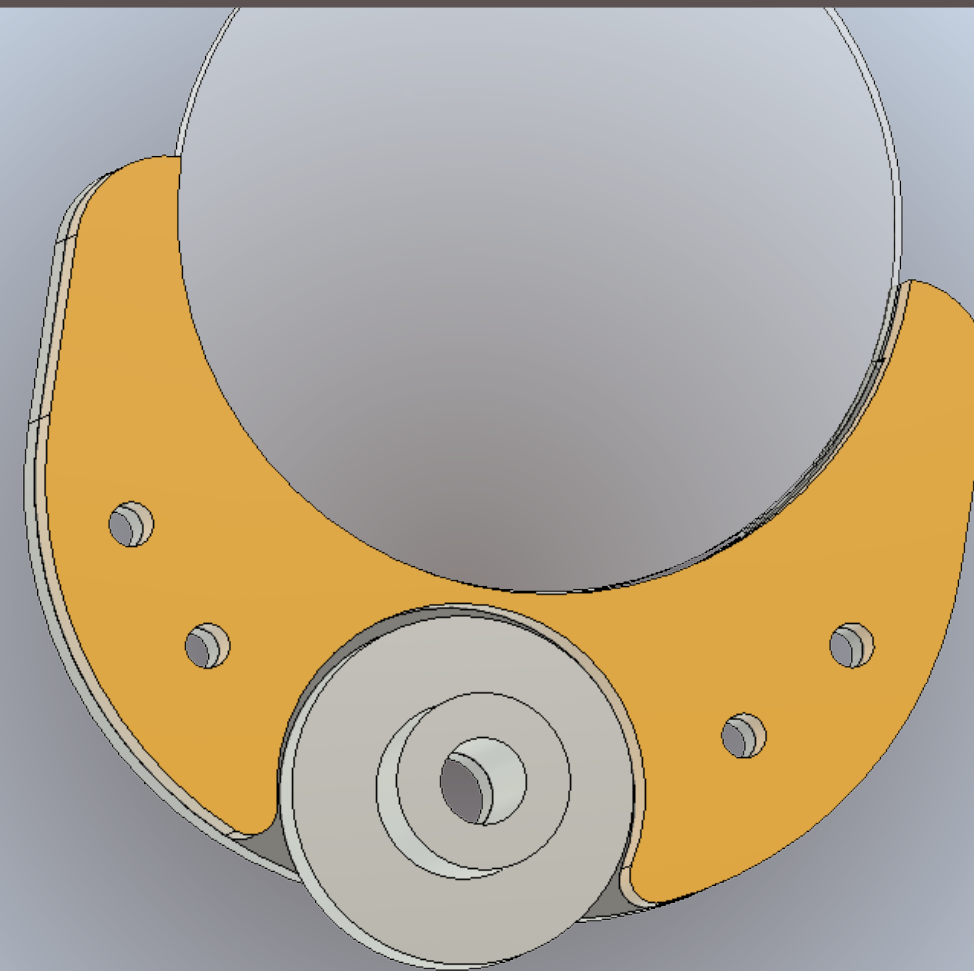
The lens in a basic holder
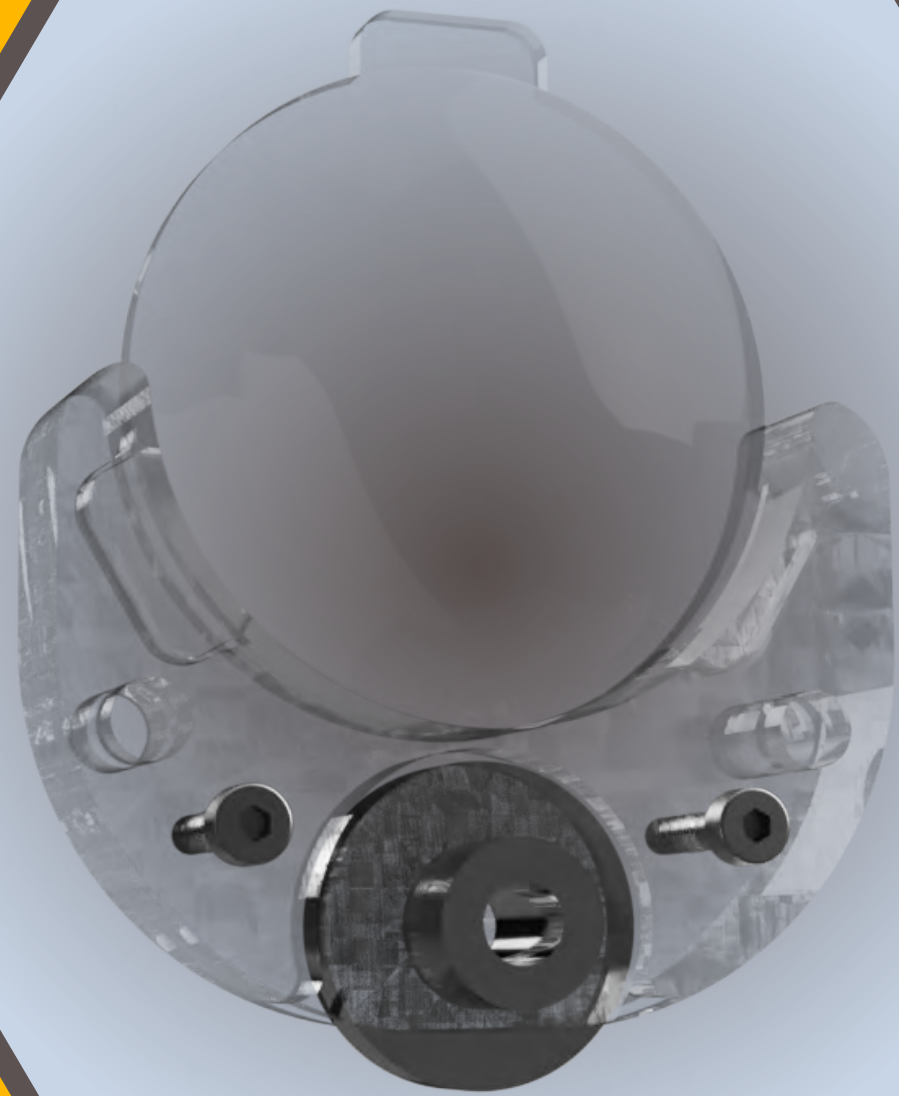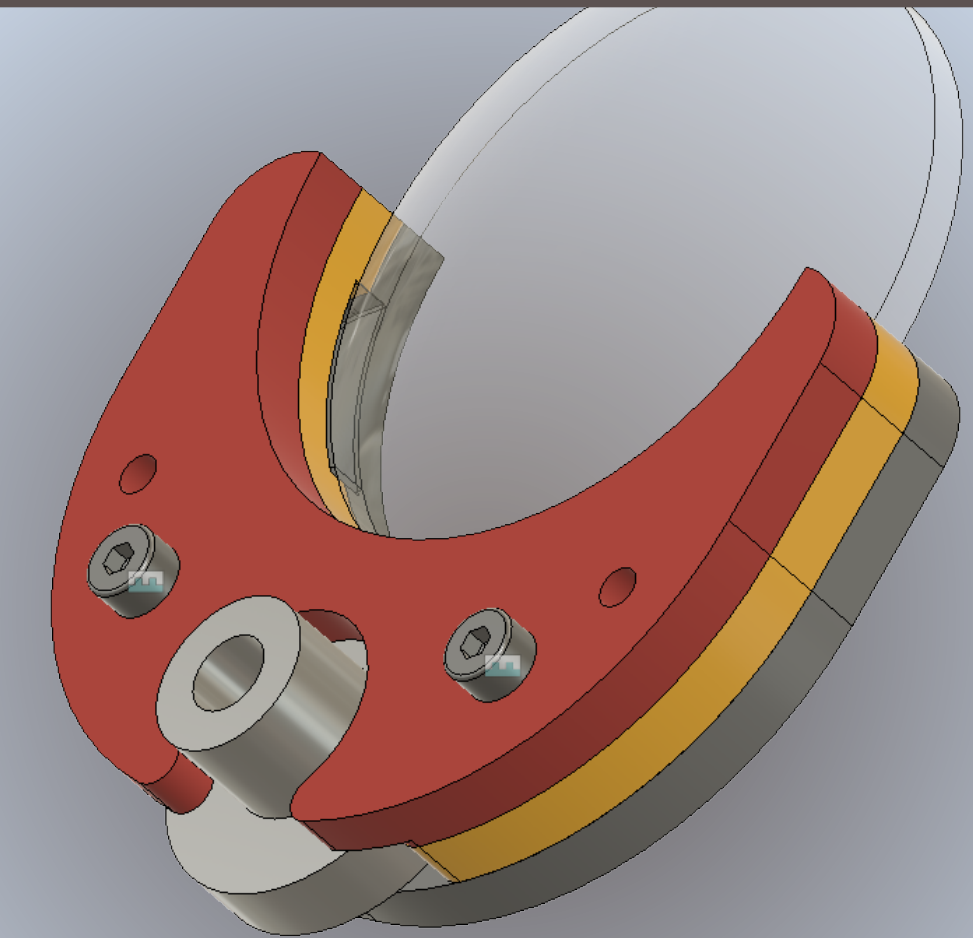
Bolt holes and bevelling

Adjustment wheel

The second layer
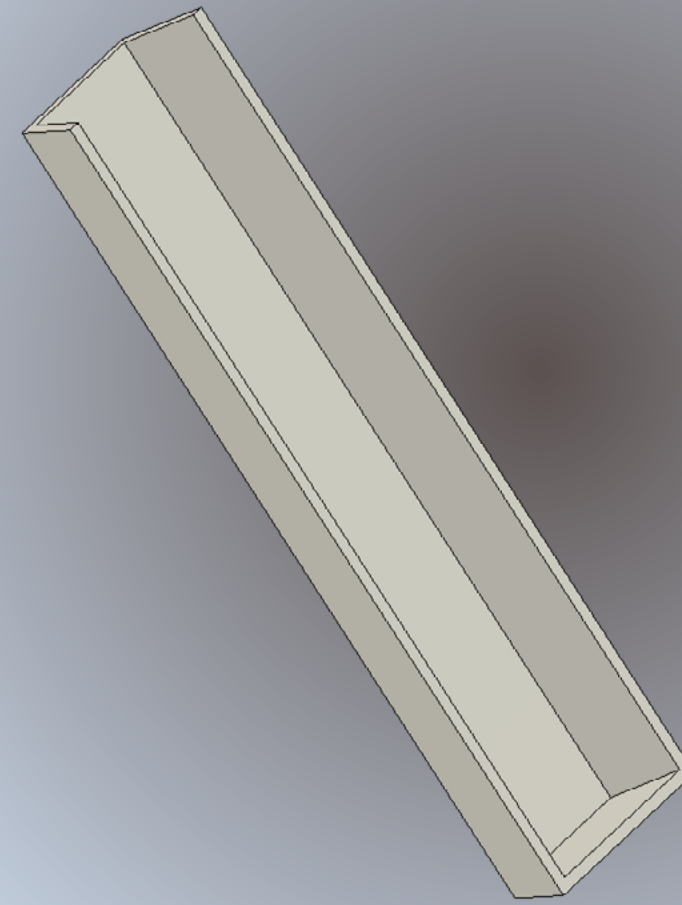
The third layer, complete with bolts

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# Phone Grips CAD

These were designed next, again due to their contact with a predefined part – the phone. Here, however, they were deliberately oversized to be compatible with alternate phones.

Loft and shell features were utilised to create a scoop shape

The part was patterned at the correct distance for the phone
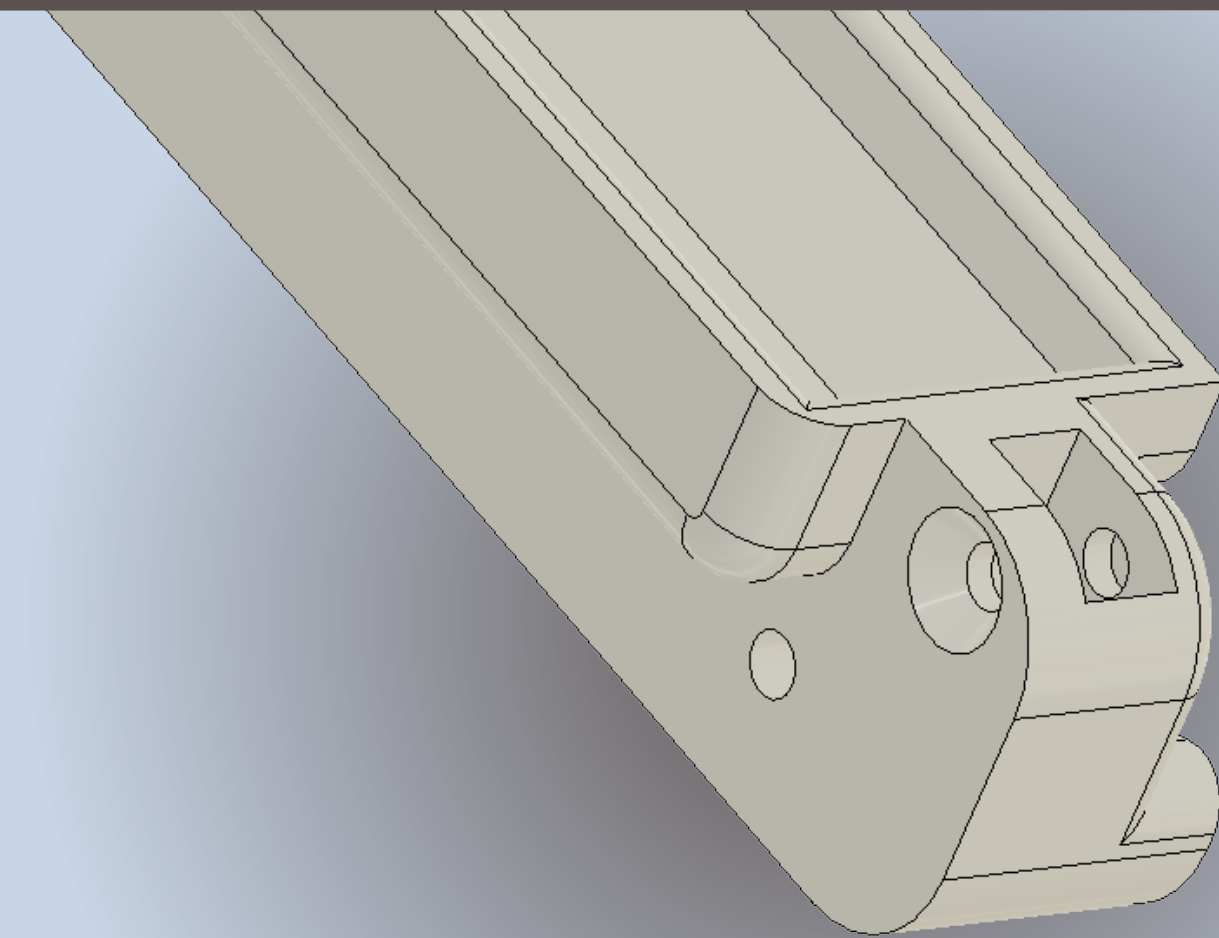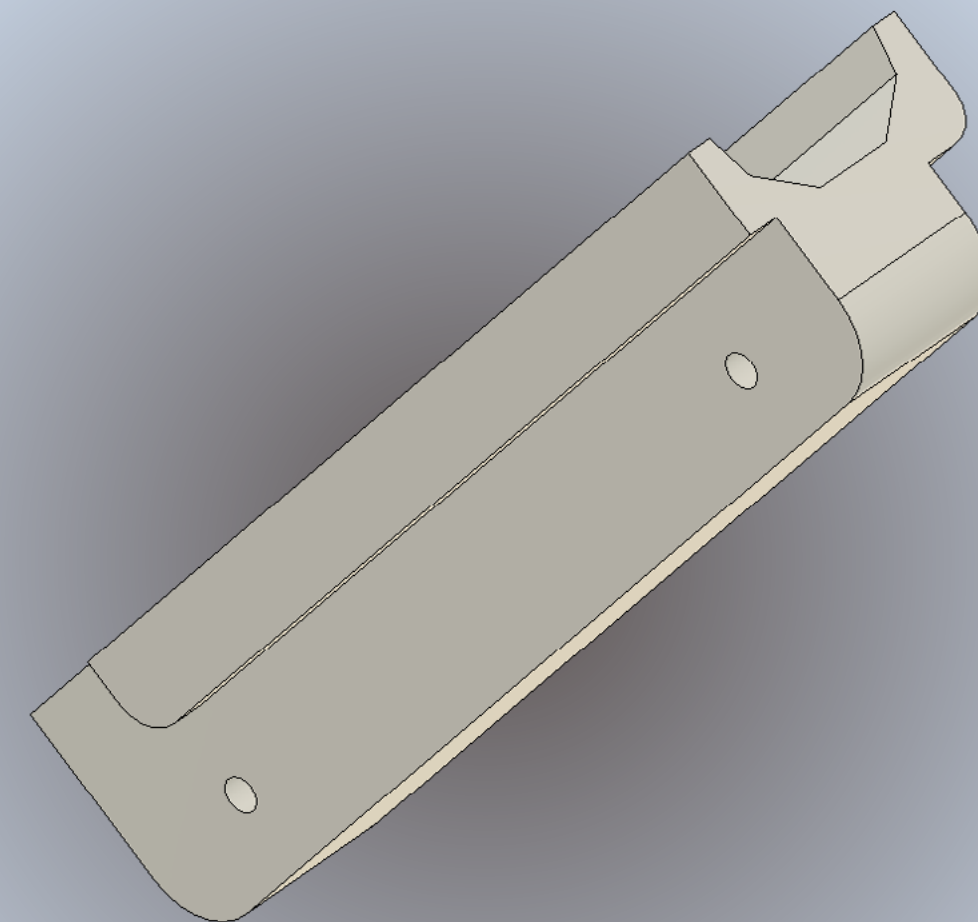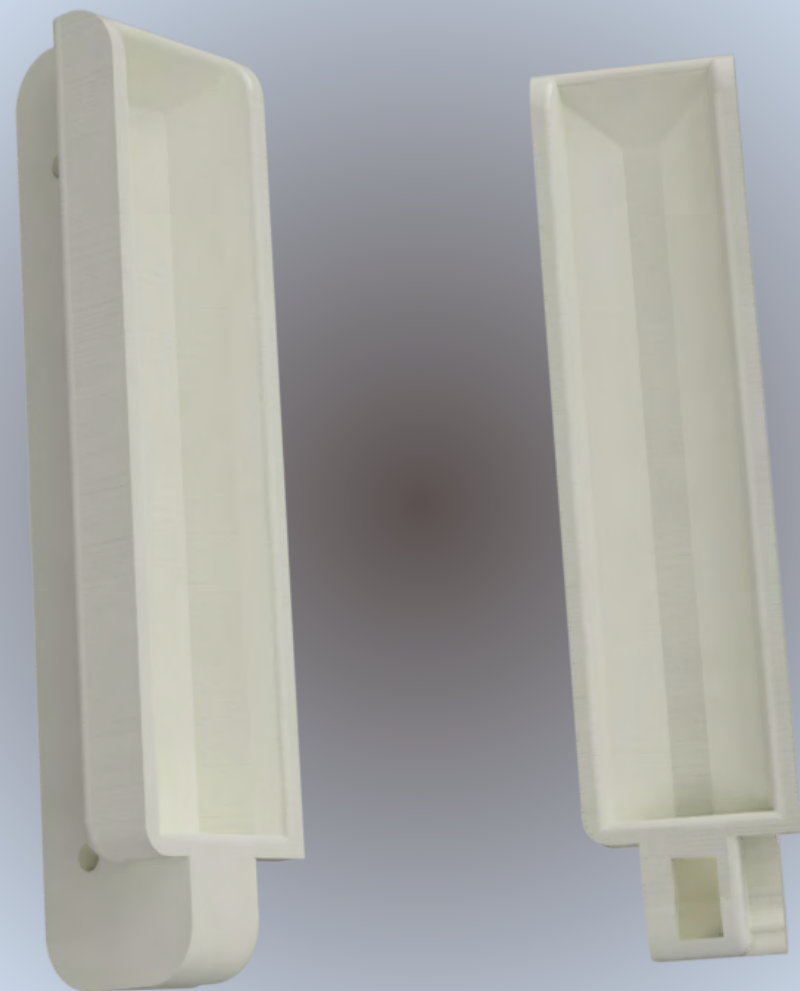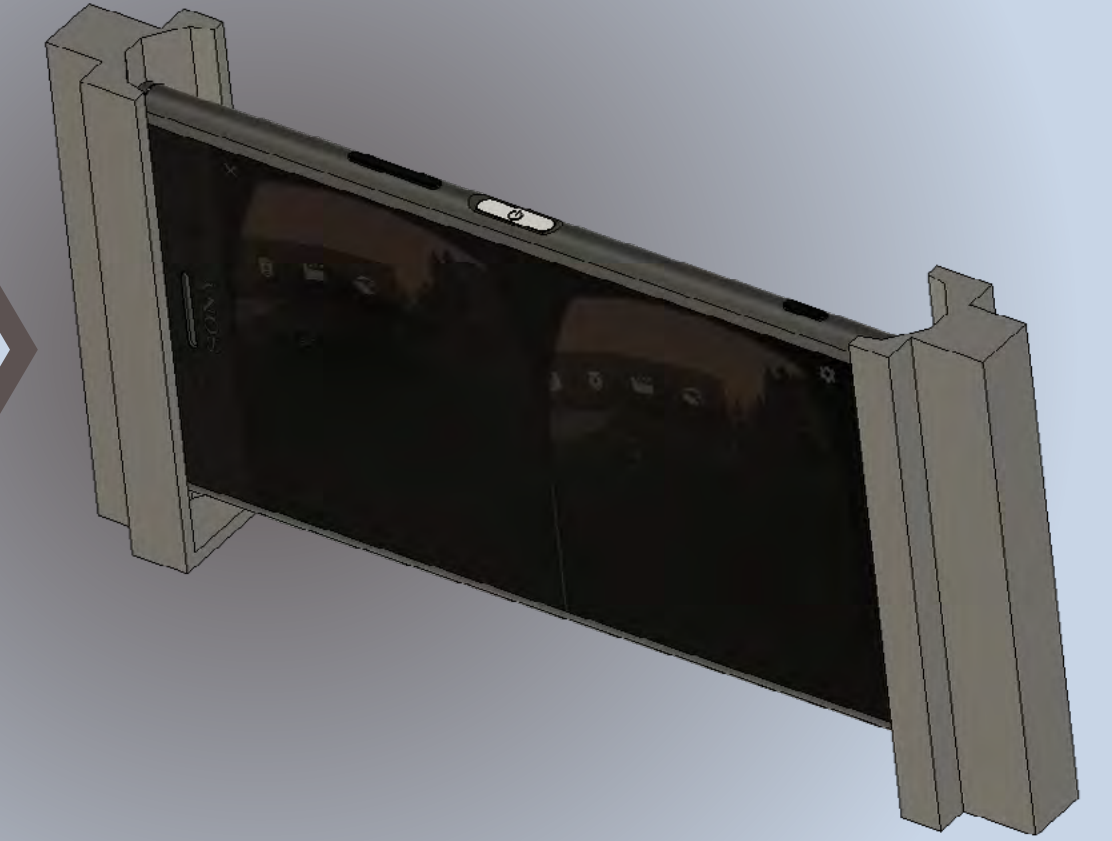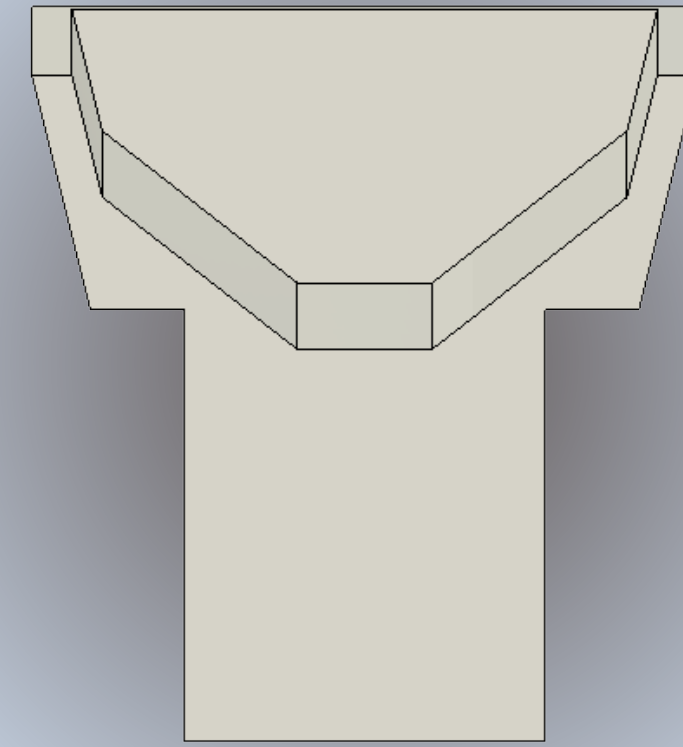
Bolt holes and bevelling were added

Final details were added

Name: Timothy Laurence Weston    Unit Number:   6E7V0016_2324_O    Year: 2023/4

# Phone Sliders CAD

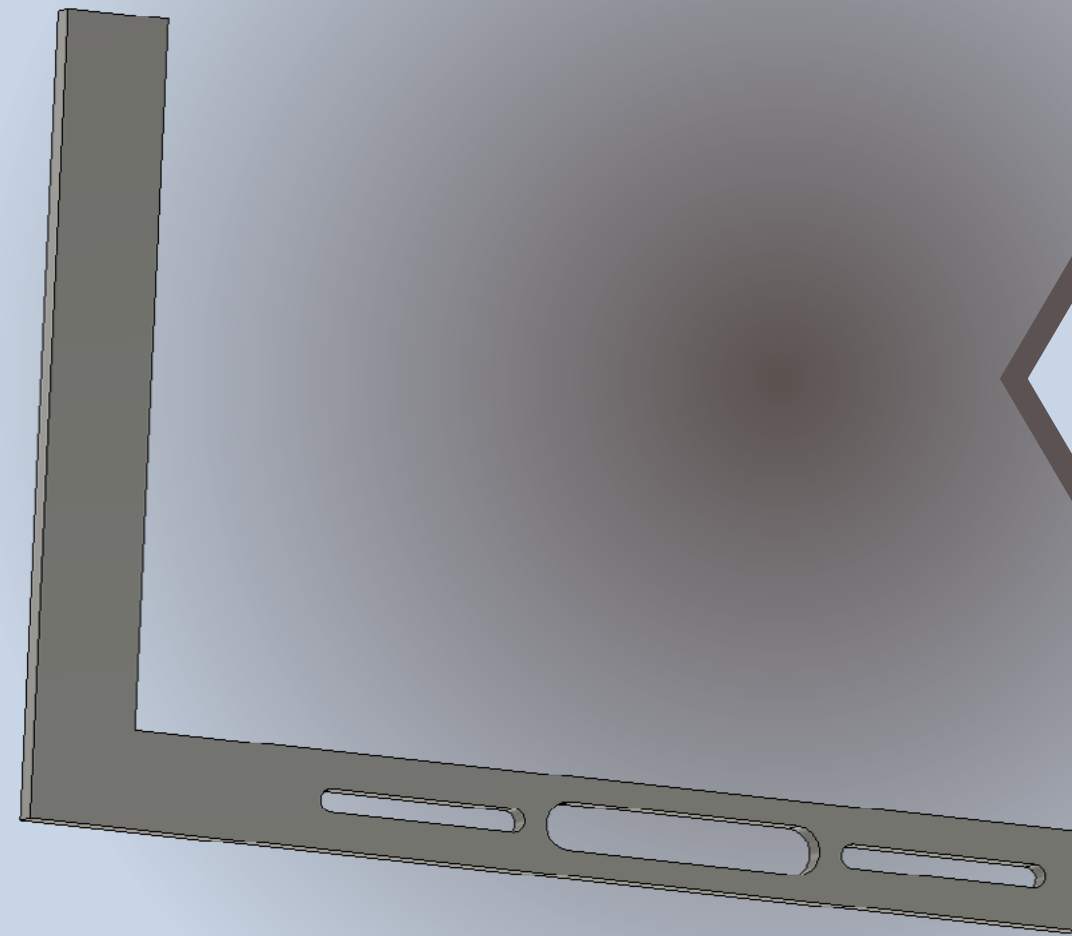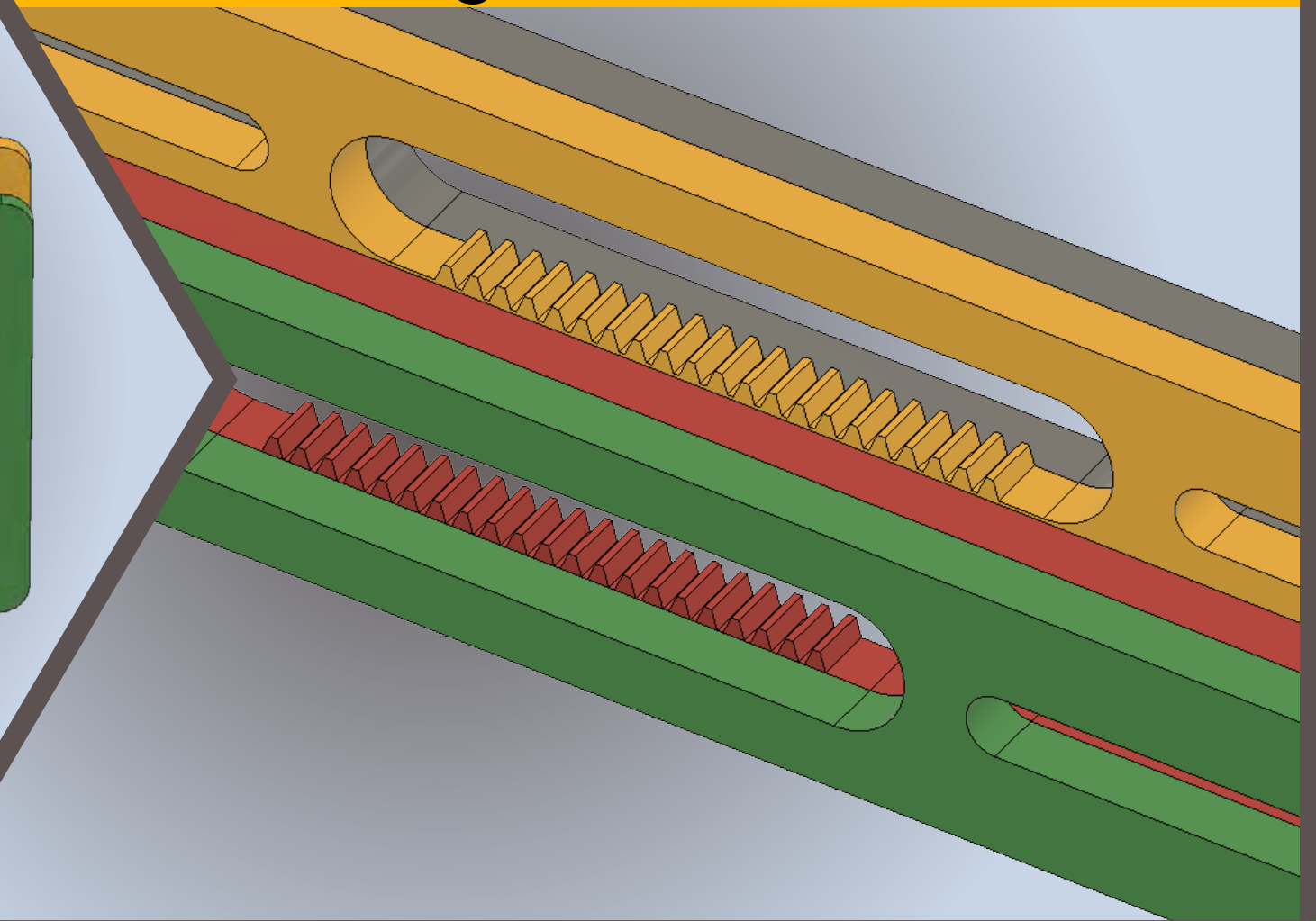These parts formed the core of the build, connecting many parts together whilst providing adjustability for differing phones.
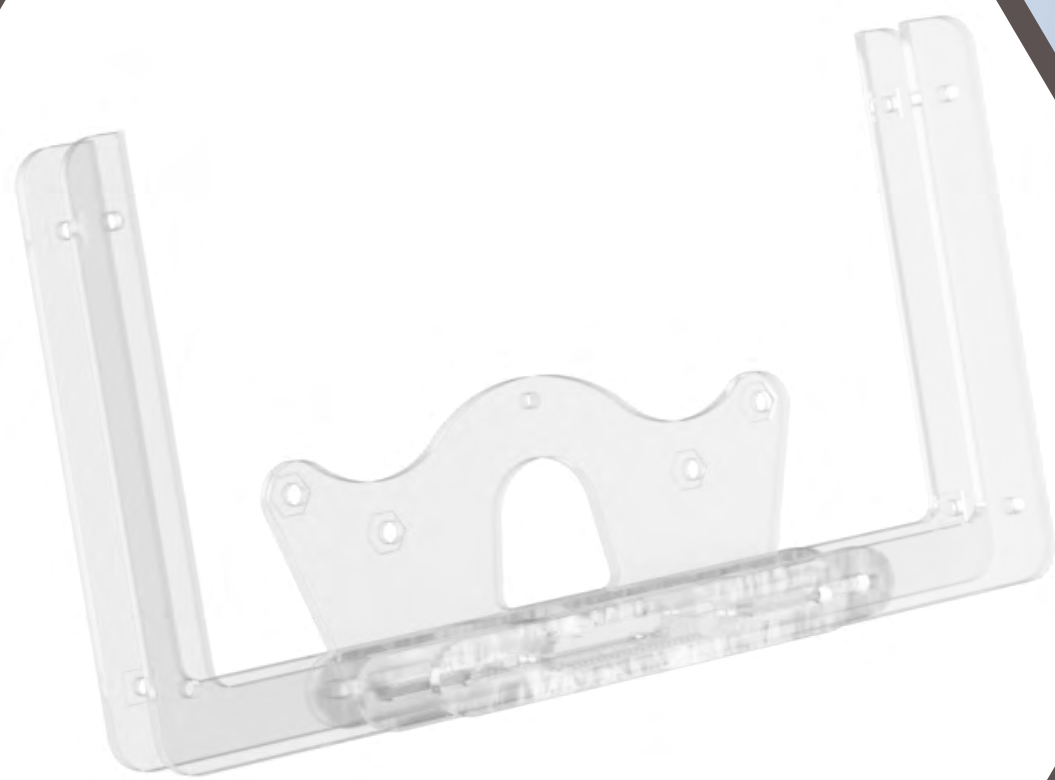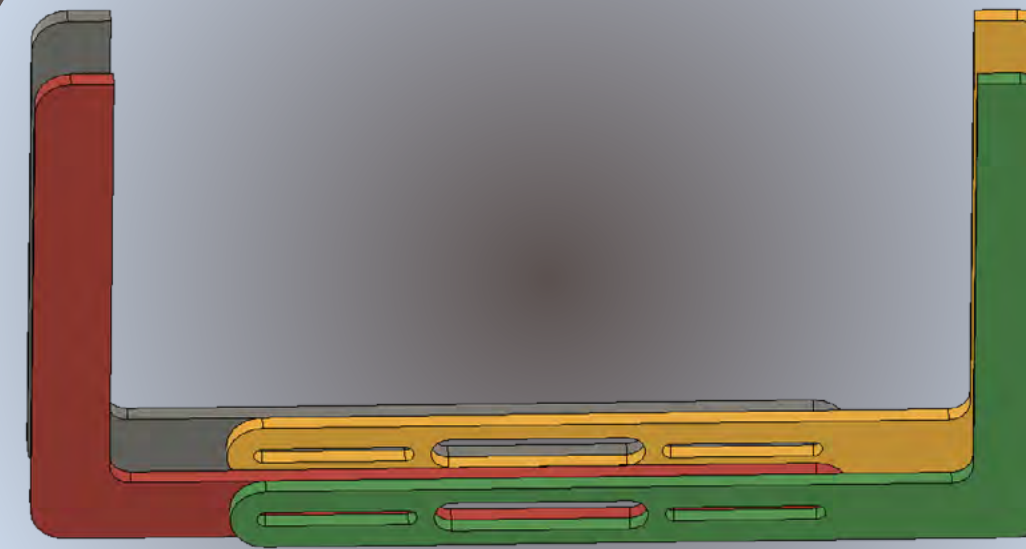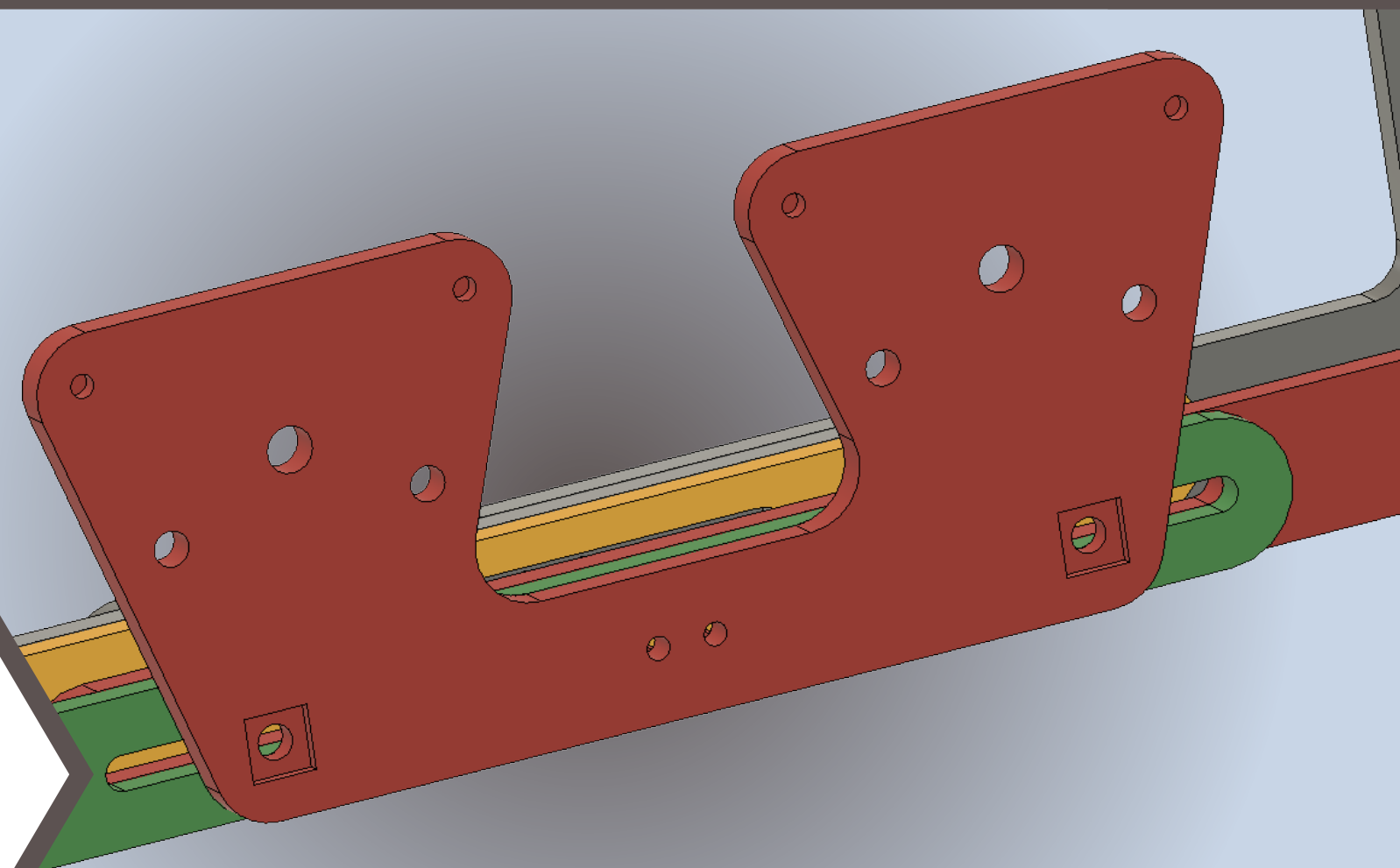
An arm was created in the sheet metal workspace

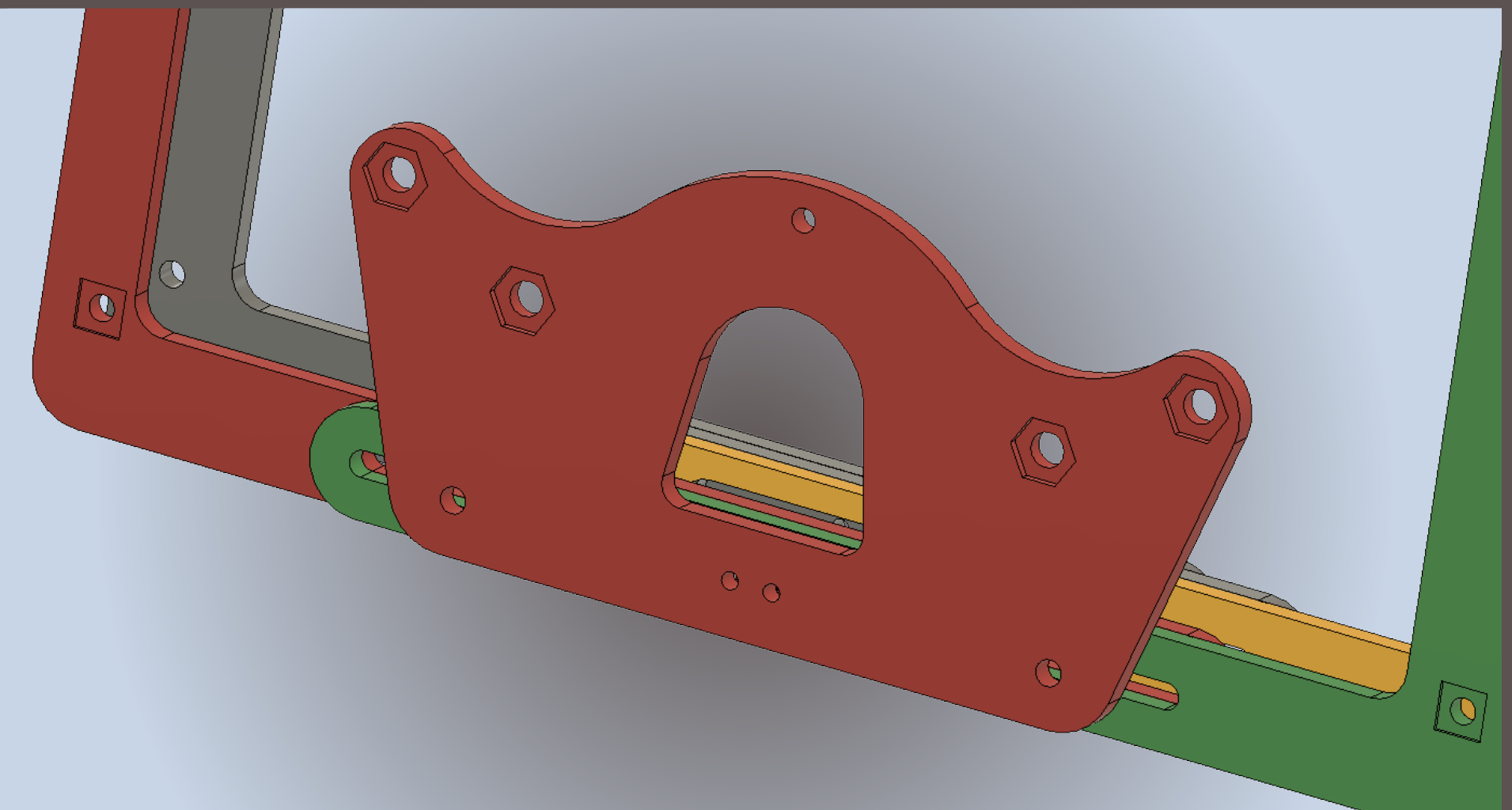Gear racks were added for centring

Filleted & patterned

A rear plate was created to support the lenses

The design was refined with engravings for captive nuts

# Laser Cut Parts

Whilst the parts were

being designed various

physical iterations were

created. The parts shown
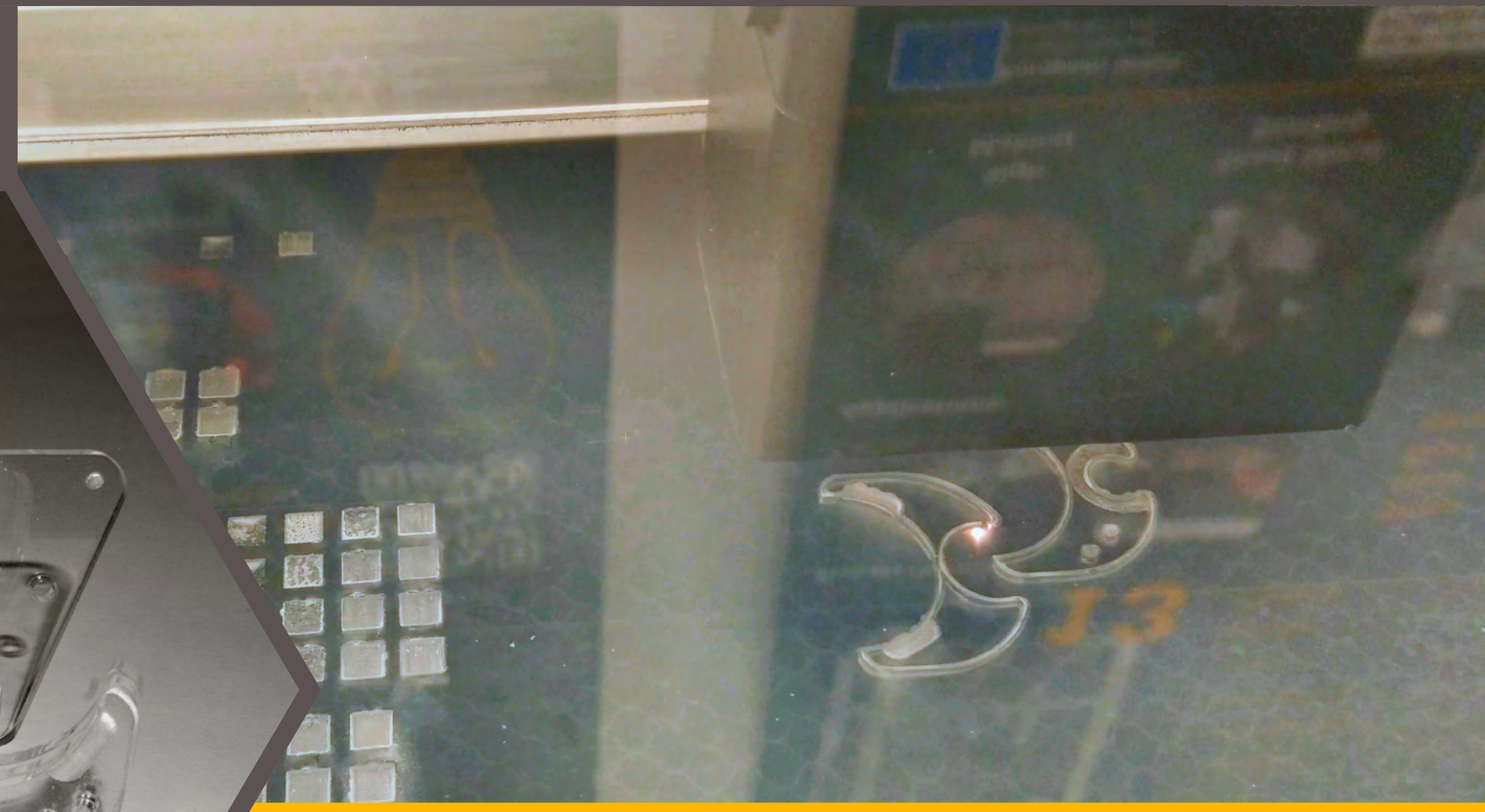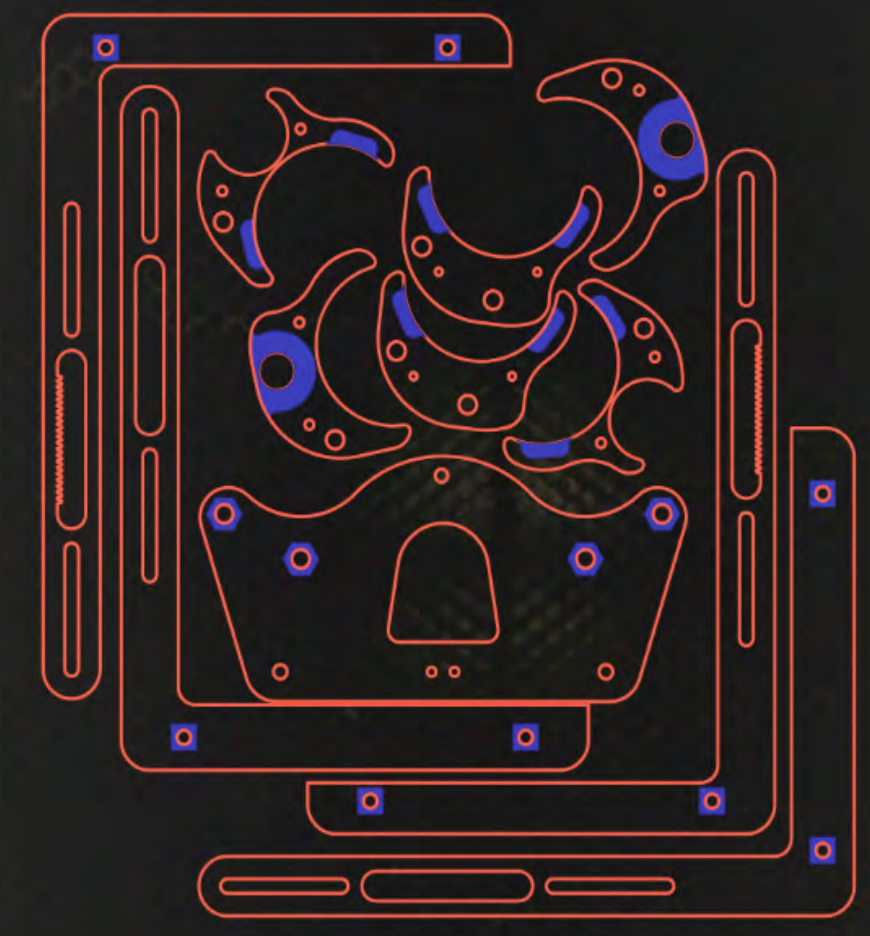
here were all laser cut.

The laser cutter was calibrated for the material & engraving depths

The parts were prepared for cutting in the Glowforge software

| | | | | | |
|---|---|---|---|---|---|
| 0.002 | 0.004 | 0.013 | 0.0 | | |
| 0.0508 | 0.1016 | 0.3302 | 0.355 | | |
| 400,20,1 | 400,40,1 | 400,60,1 | 400,80,1 | | |
| 0.008 | 0.016 | 0.017 | 0.032 | | |
| 0.2032 | 0.4064 | 0.4318 | 0.8128 | | |
| ,1,2 | 1000,20,2 | 1000,40,2 | 1000,60,2 | 1000,80,2 | 1000, |
| 0 | 0.001 | 0.002 | 0.006 | 0.01 | 0.0 |
| 0 | 0.0254 | 0.0508 | 0.1524 | 0.254 | 0.6604 |
| 800,1,2 | 800,20,2 | 800,40,2 | 800,60,2 | 800,80,2 | 800,100,2 |
| 0 | 0.001 | 0.003 | 0.012 | 0.024 | 0.032 |
| 0 | 0.0254 | 0.0762 | 0.3048 | 0.6096 | 0.81 |
| ,1,2 | 600,20,2 | 600,40,2 | 600,60,2 | 600,80,2 | 600,10 |
| 0 | 0.001 | 0.004 | 0.016 | 0.033 | 0.0 |
| 0 | 0.0254 | 0.1016 | 0.4064 | 0.8382 | |
| | 400,20,2 | 400,40,2 | 400,60,2 | 400,80,2 | 4 |

Acrylic test results were assessed

The parts were cut

Various iterations were tried

Name: Timothy Laurence Weston    Unit Number:   6E7V0016_2324_O    Year: 2023/4
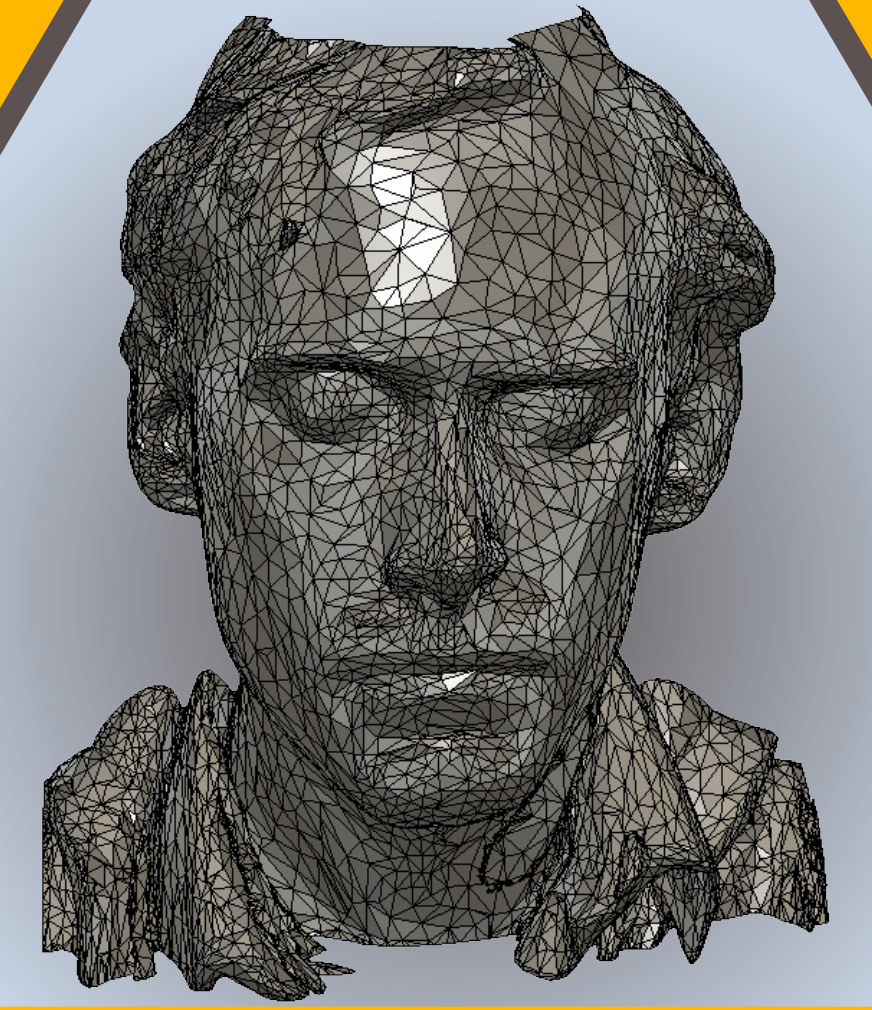
# Nose Interface CAD
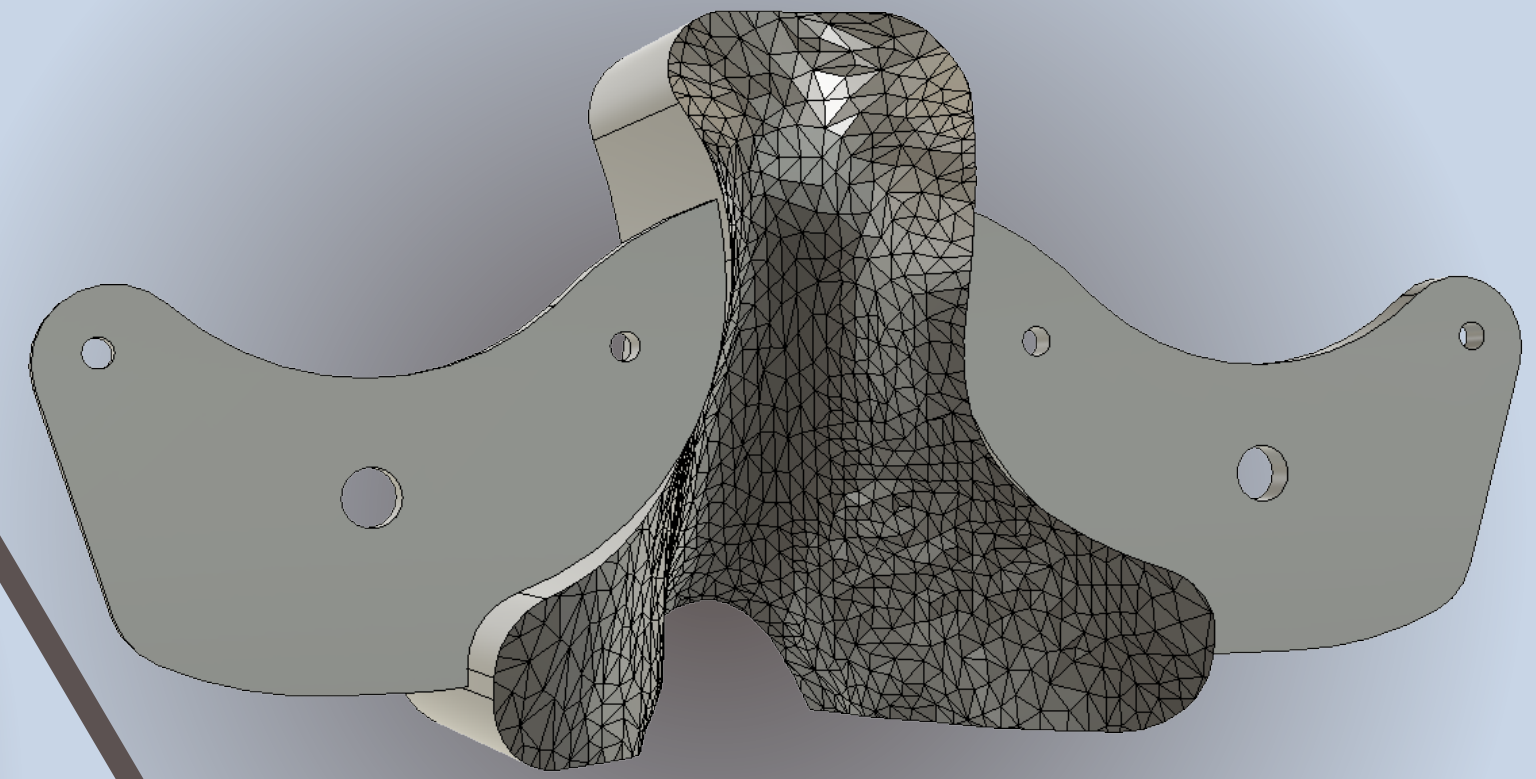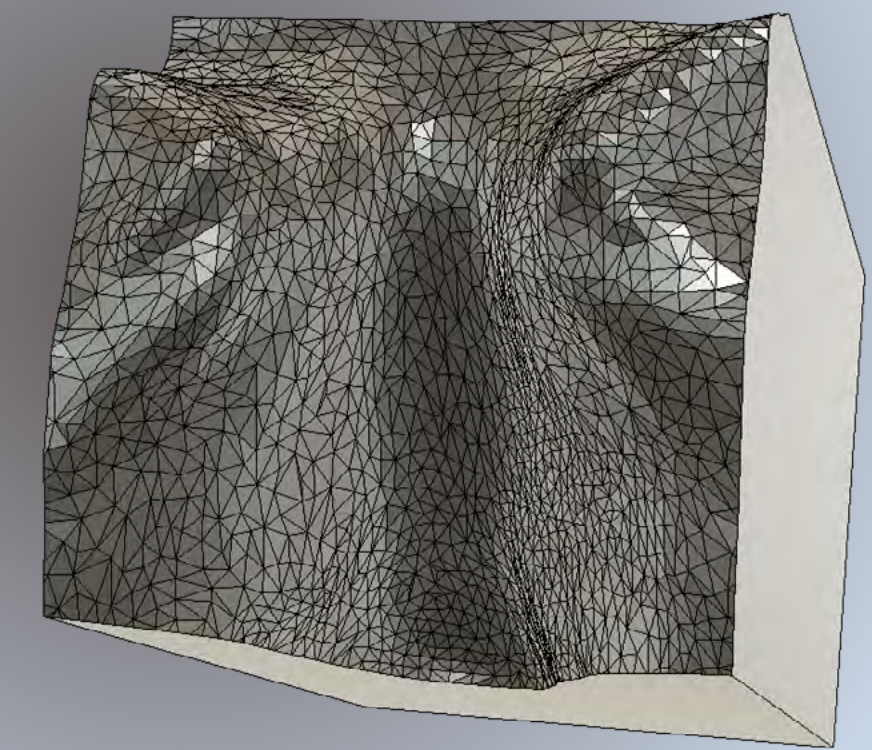
This part was designed to

be easily swappable to

allow the headset to be

customised to wearer.

First my head was 3D scanned

An impression of the nose area was created in a cube
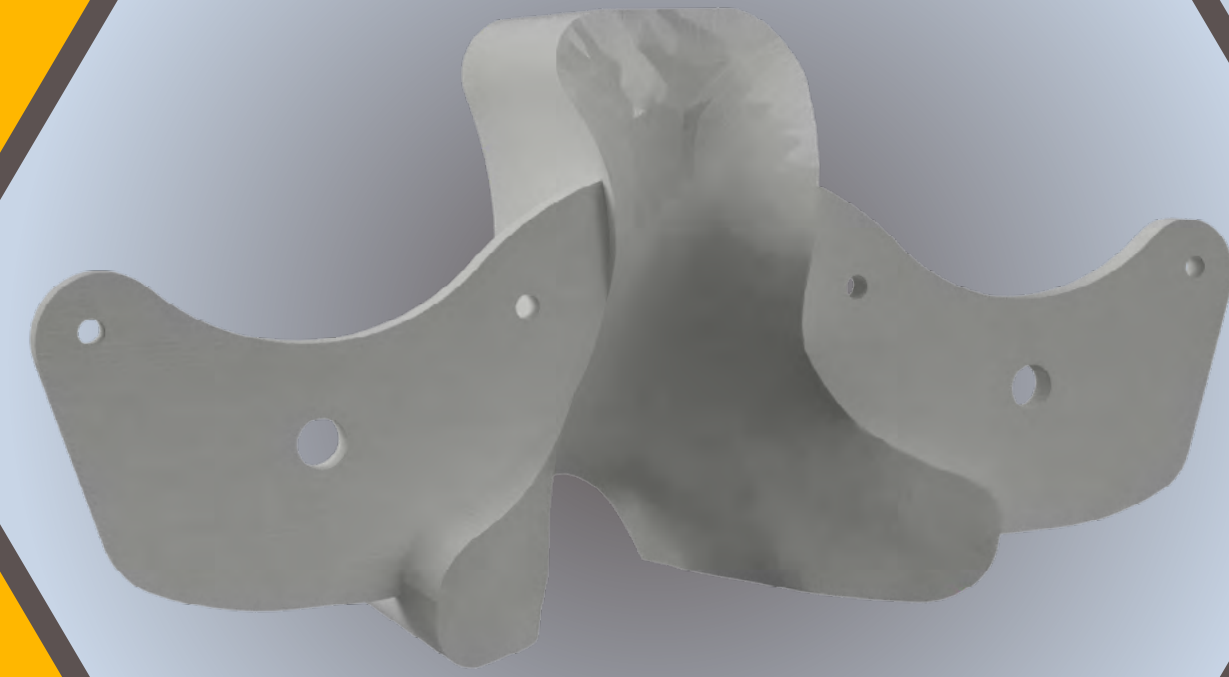
Mesh was cleaned up & simplified

The cube was trimmed back and supports for the ends added
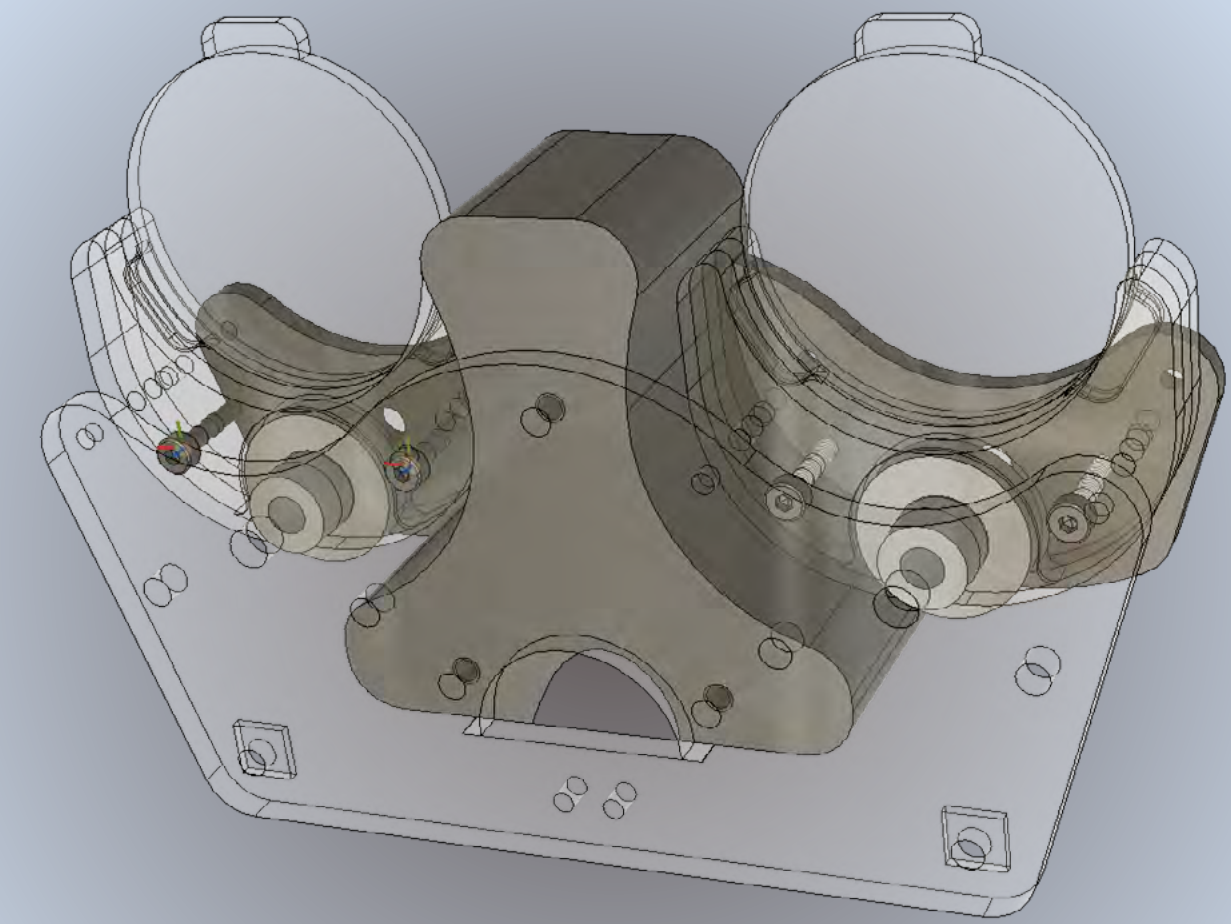
Throughout the process the parts were modelled in context

Name: Timothy Laurence Weston     Unit Number:   6E7V0016_2324_O     Year: 2023/4
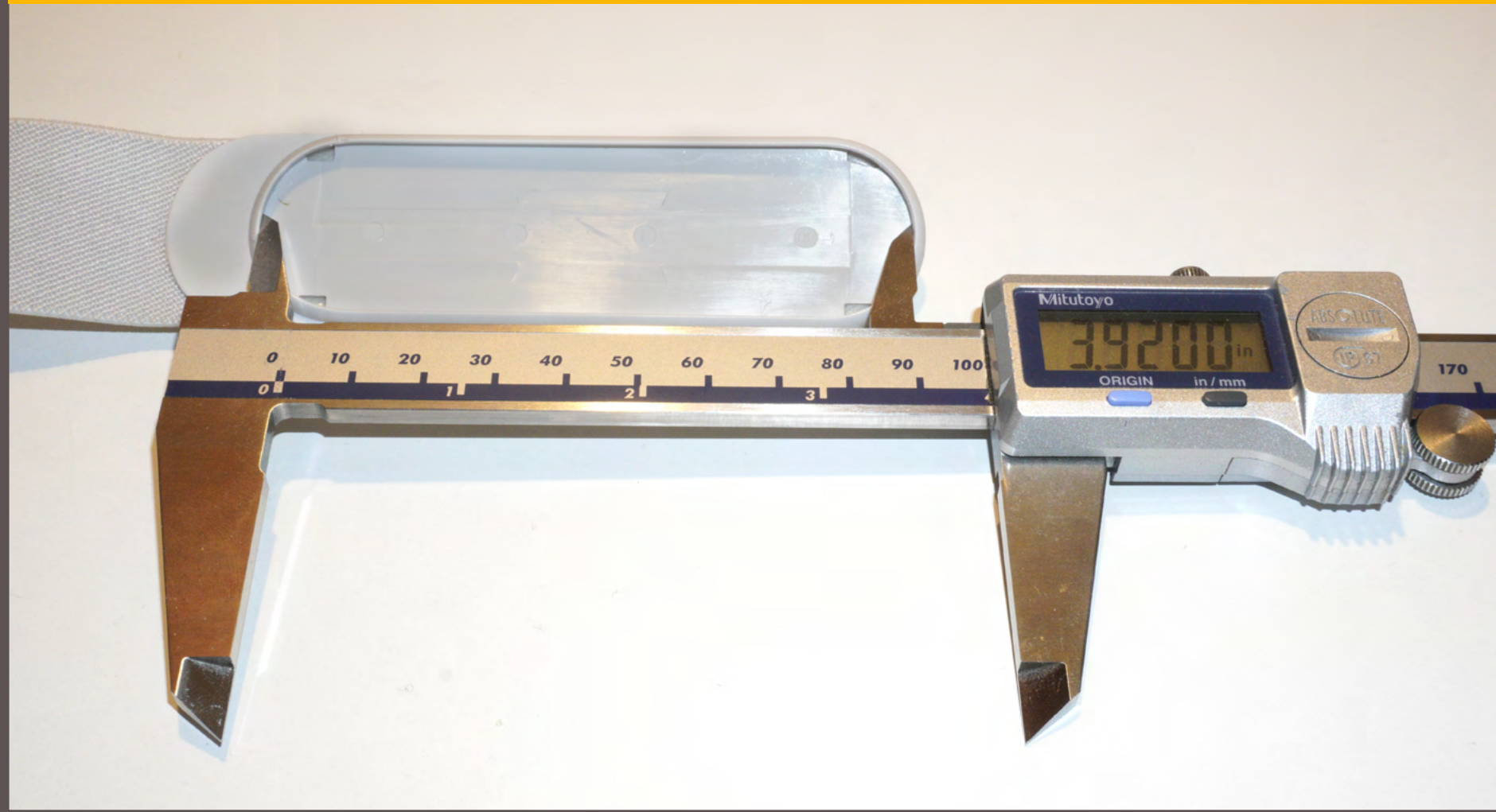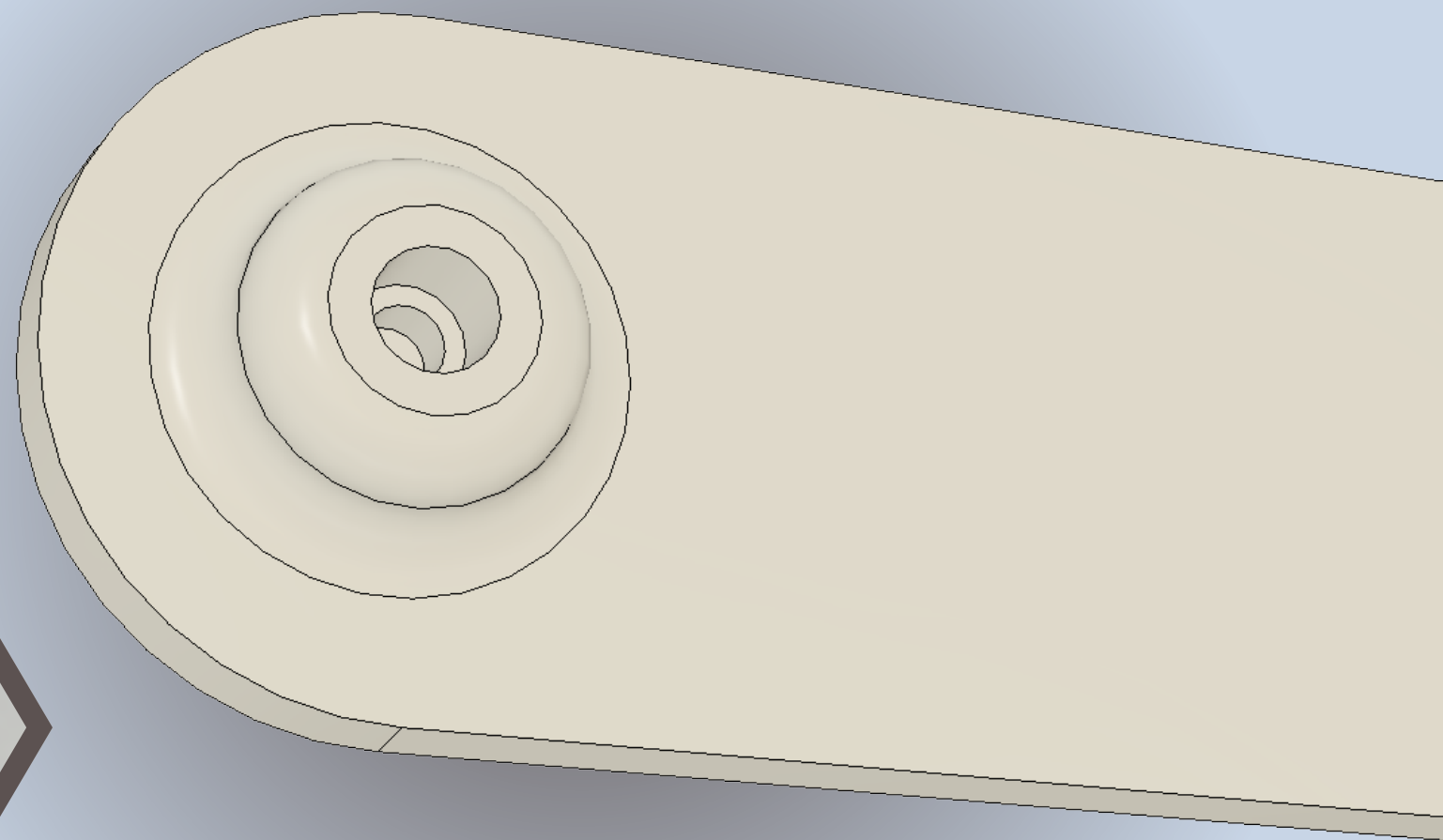
# Head Strap Clips CAD

A spare Meta Quest 2 head strap was repurposed for the headset. To utilise this a clip was designed.
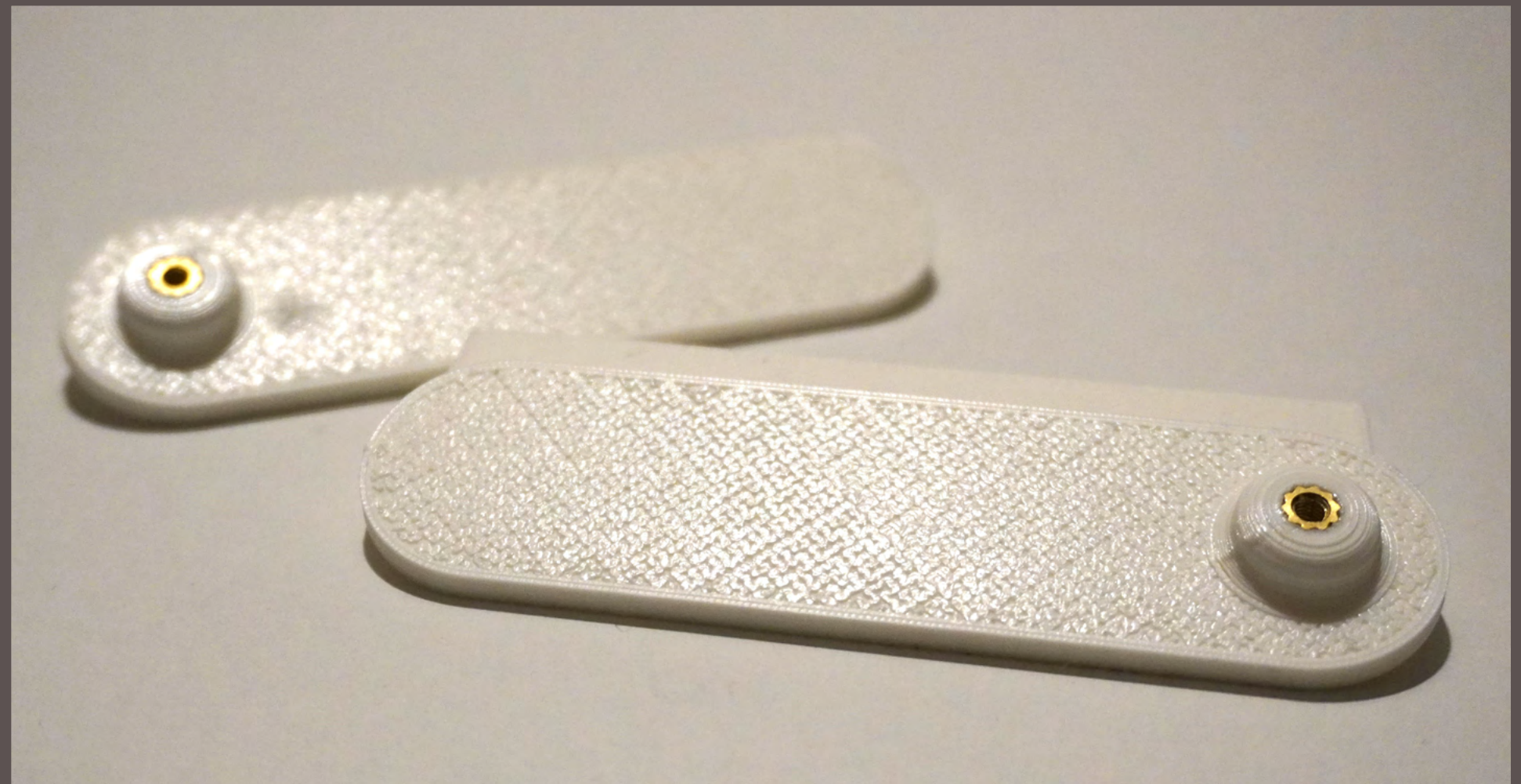
First the strap was measured



Clips were modelled and tested for fit





Holes were added for heat set inserts



The clips were printed

# FFF Parts

Concurrent with the design process parts were being printed and tested. Shown here are the prototype FFF parts.



Initially the phone grips were printed in TPU



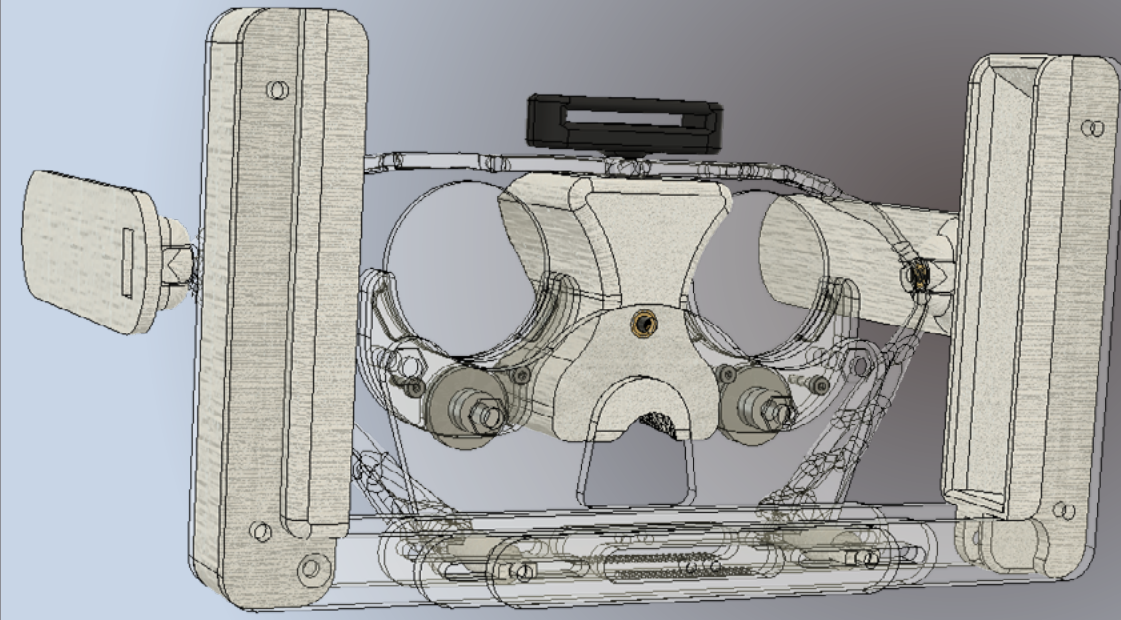The nose interface underwent the most iterations



Although the head strap clips were not far behind

# Head Strap Frame GD

This part forms the link between the headset and the head strap. It was created using generative design, which gives it an organic look and minimises material usage.
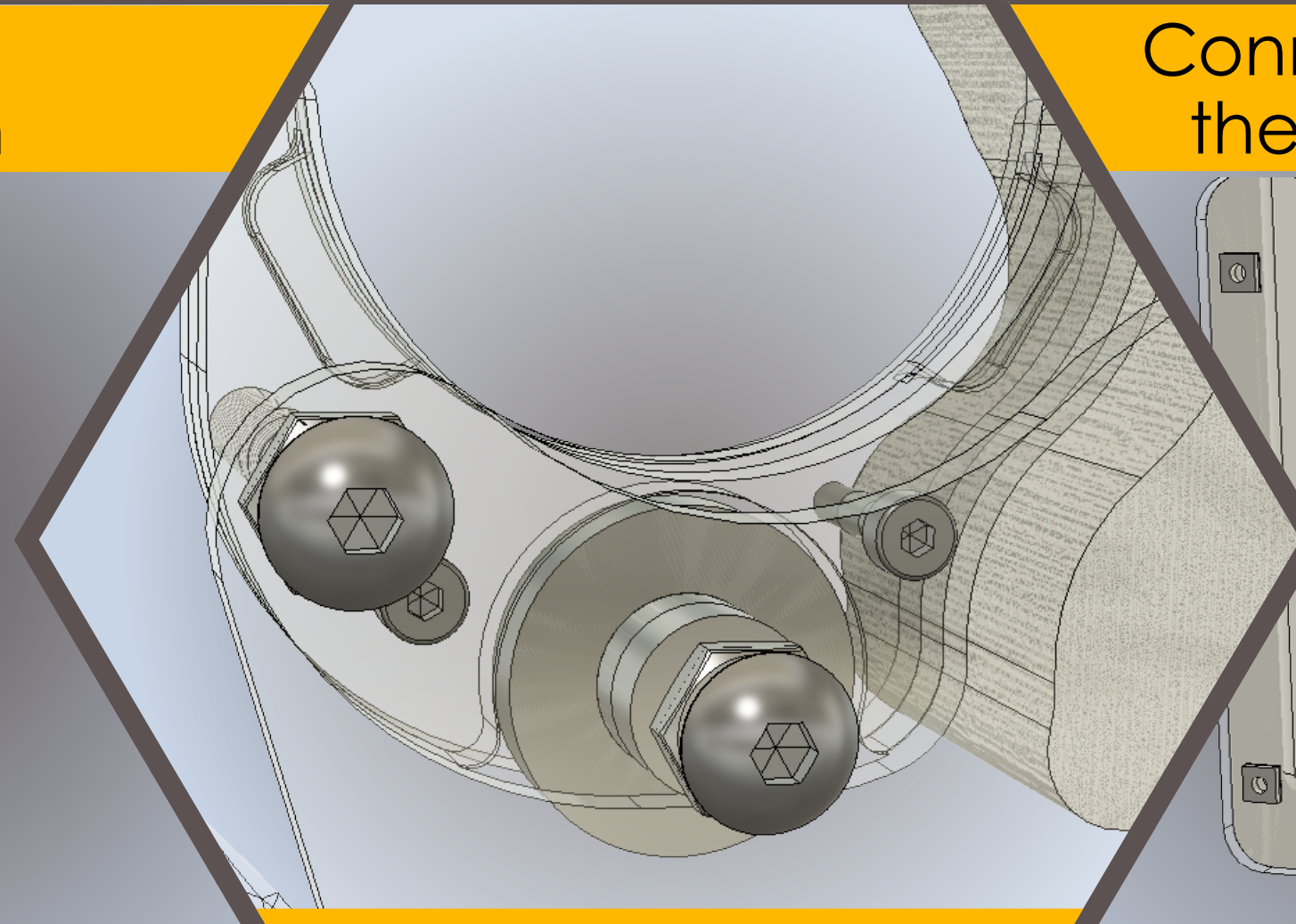

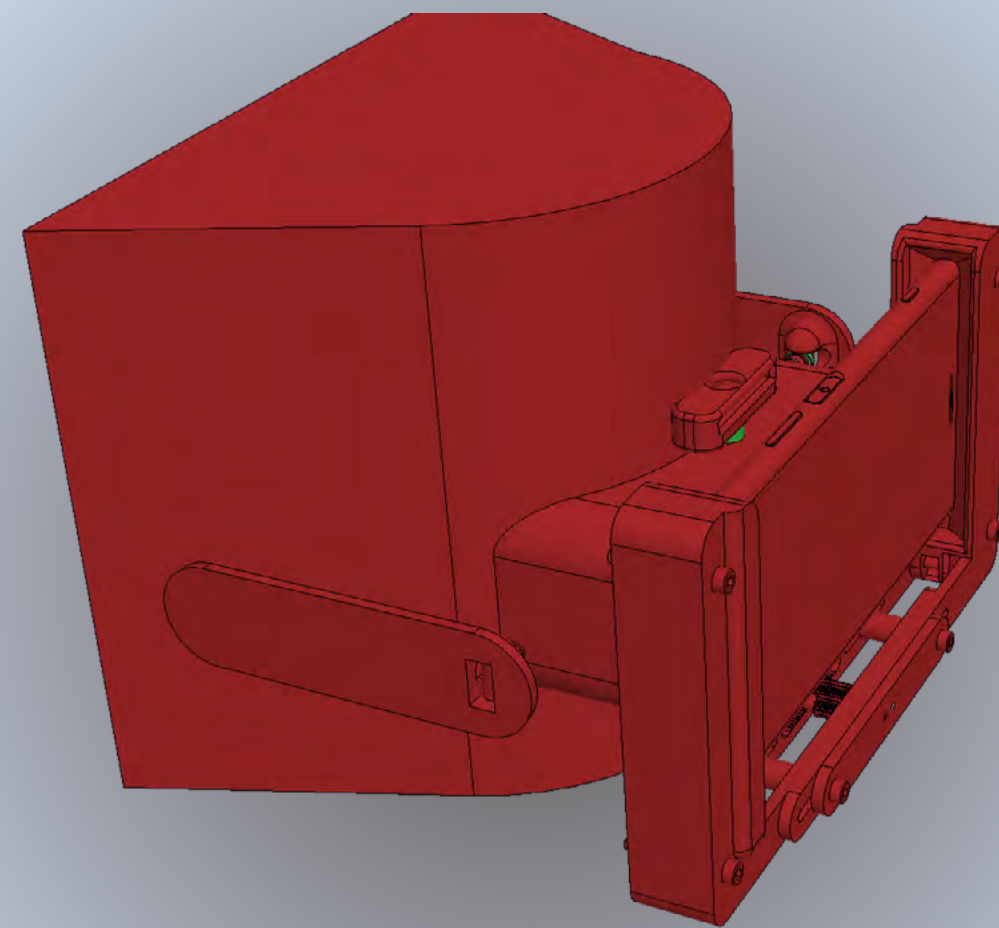All the components were assembled with joints in Fusion


Fasteners were added
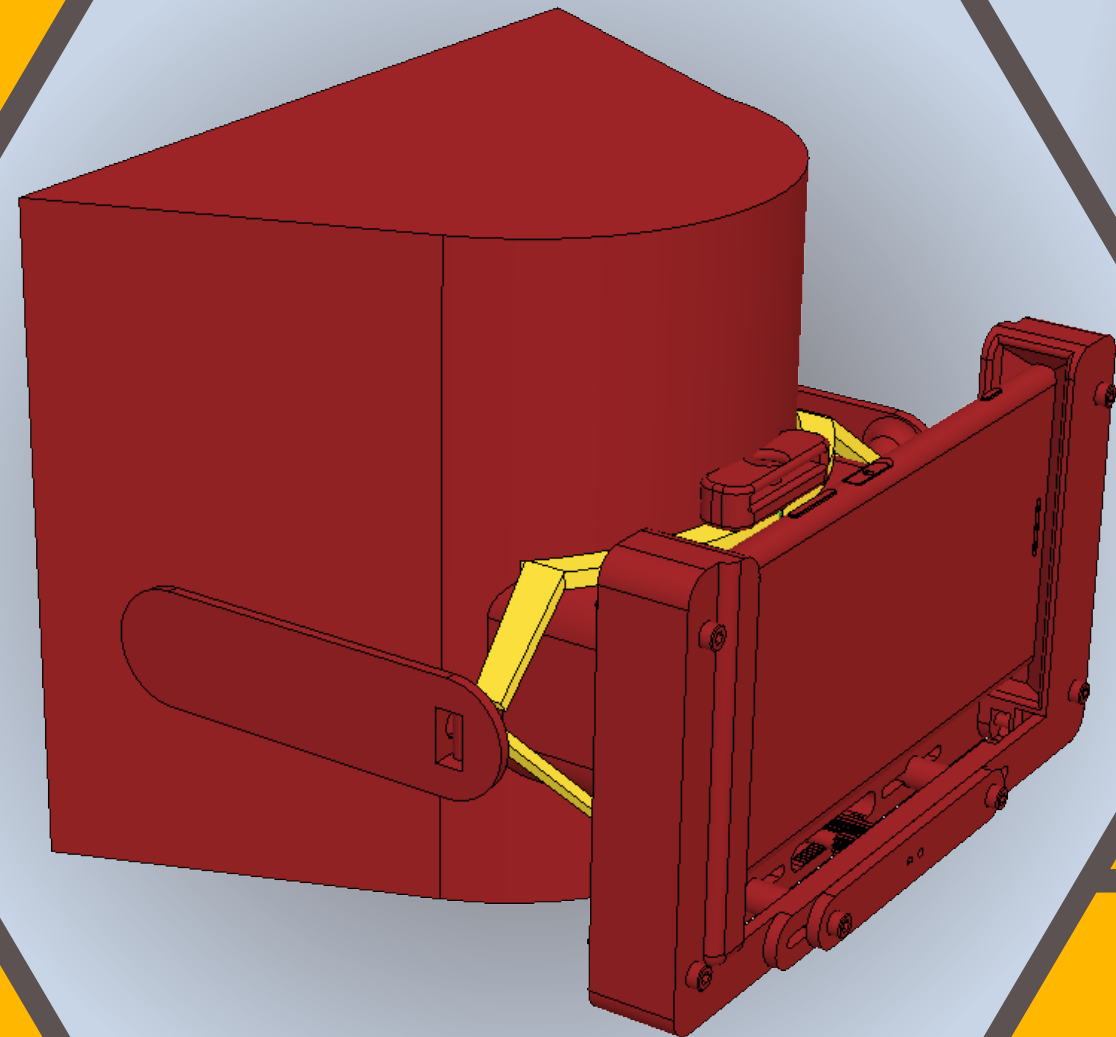

Connection points were created in the Generative Design workspace
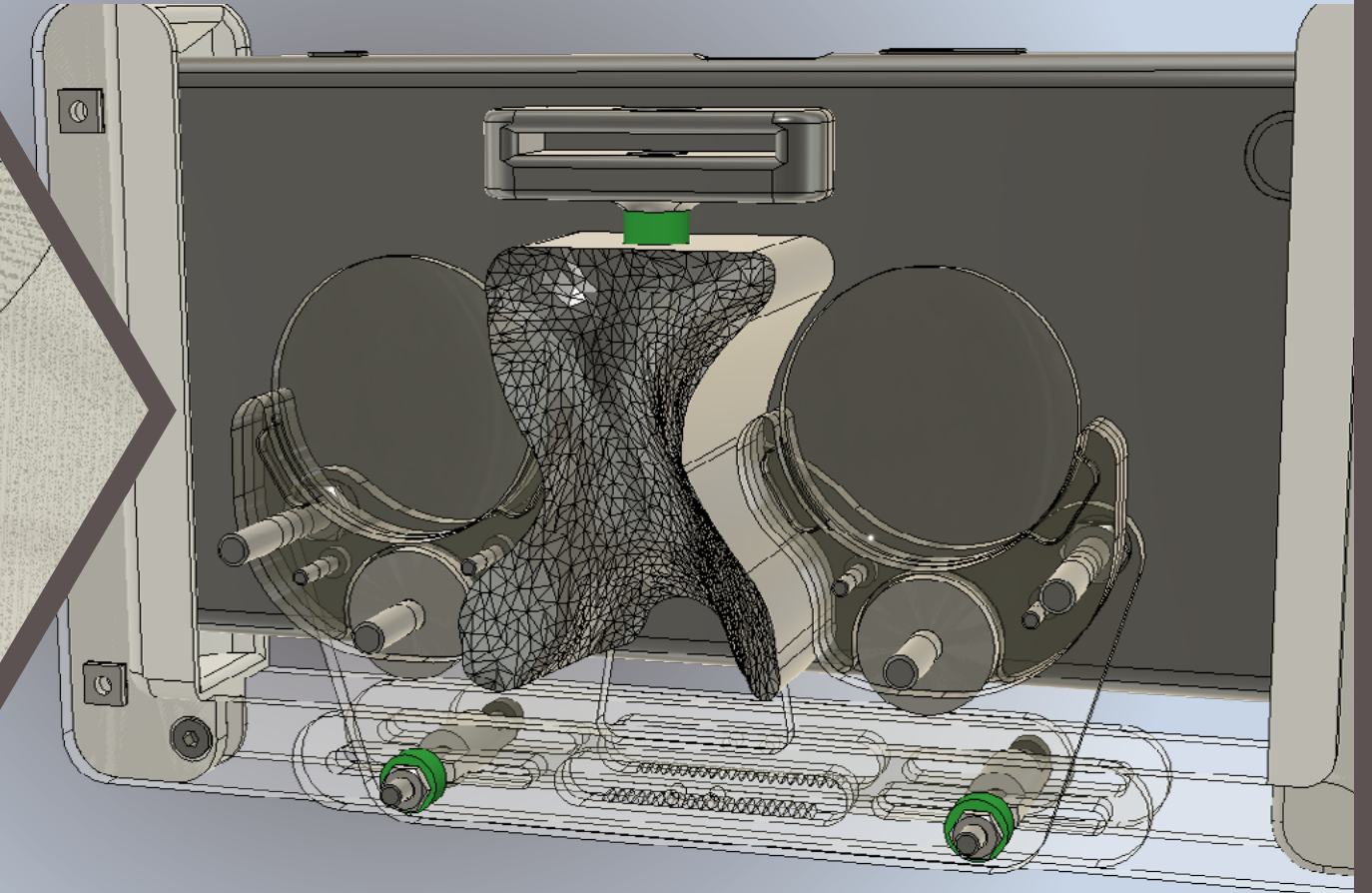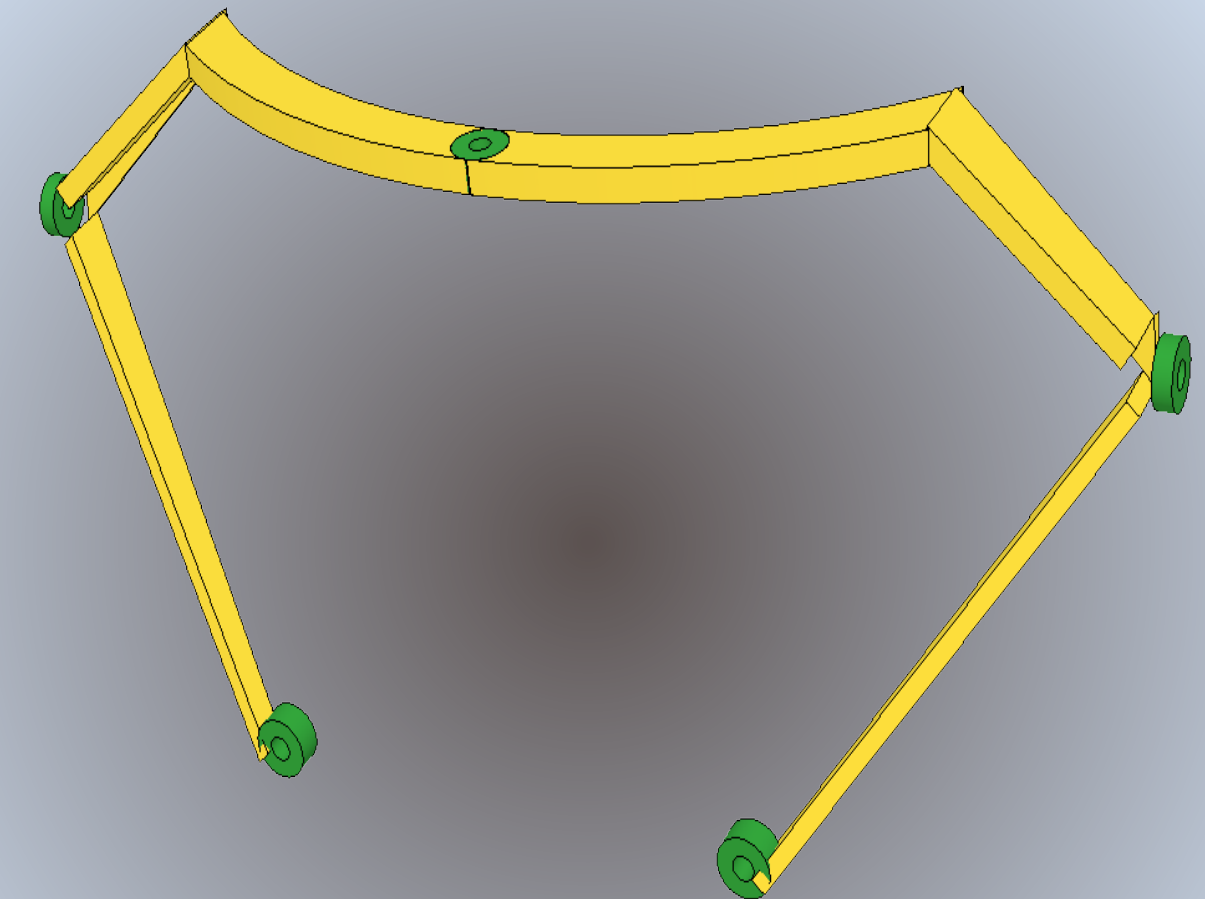

Obstacle geometry was both created and assigned


A rough starting shape was designed to guide the software

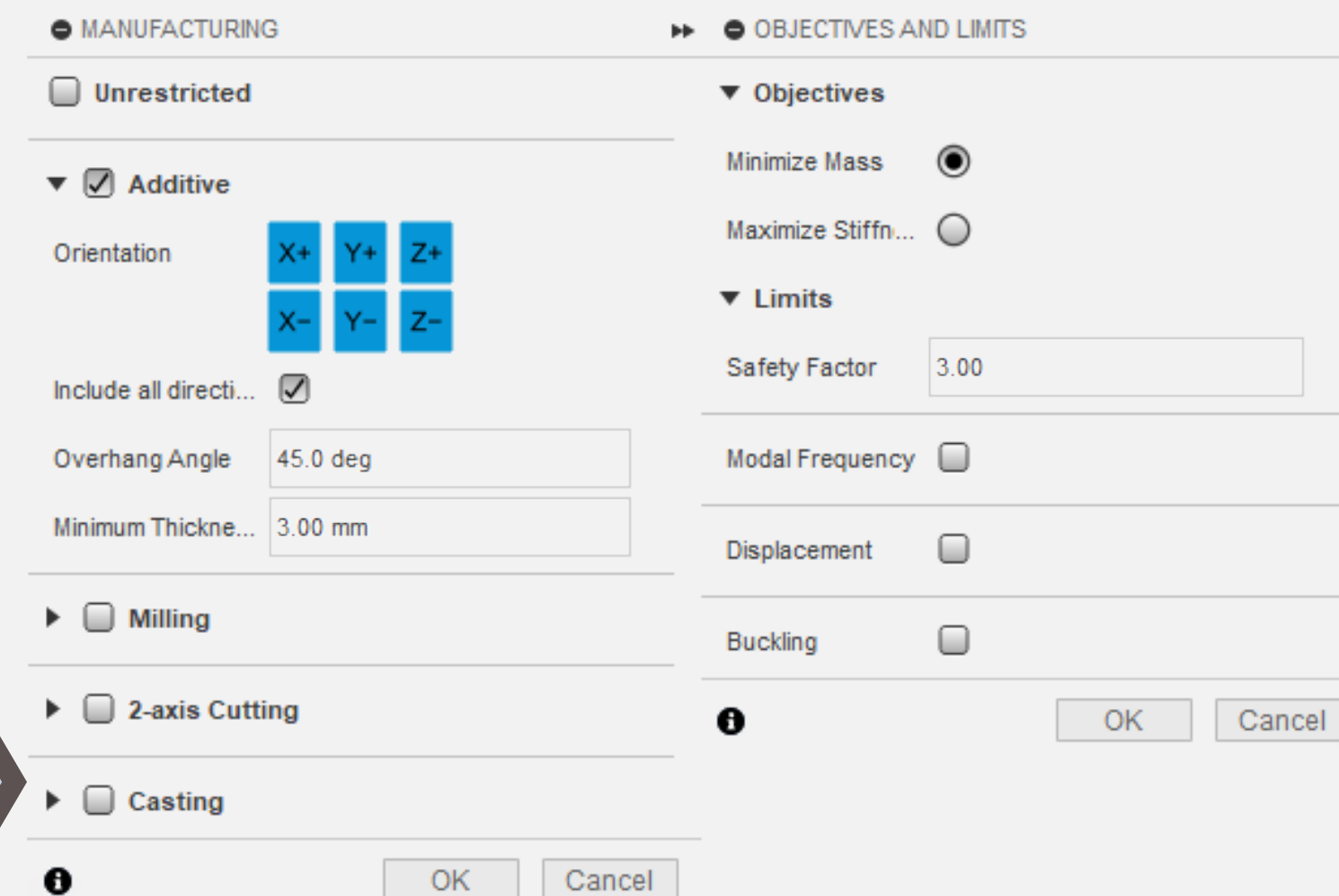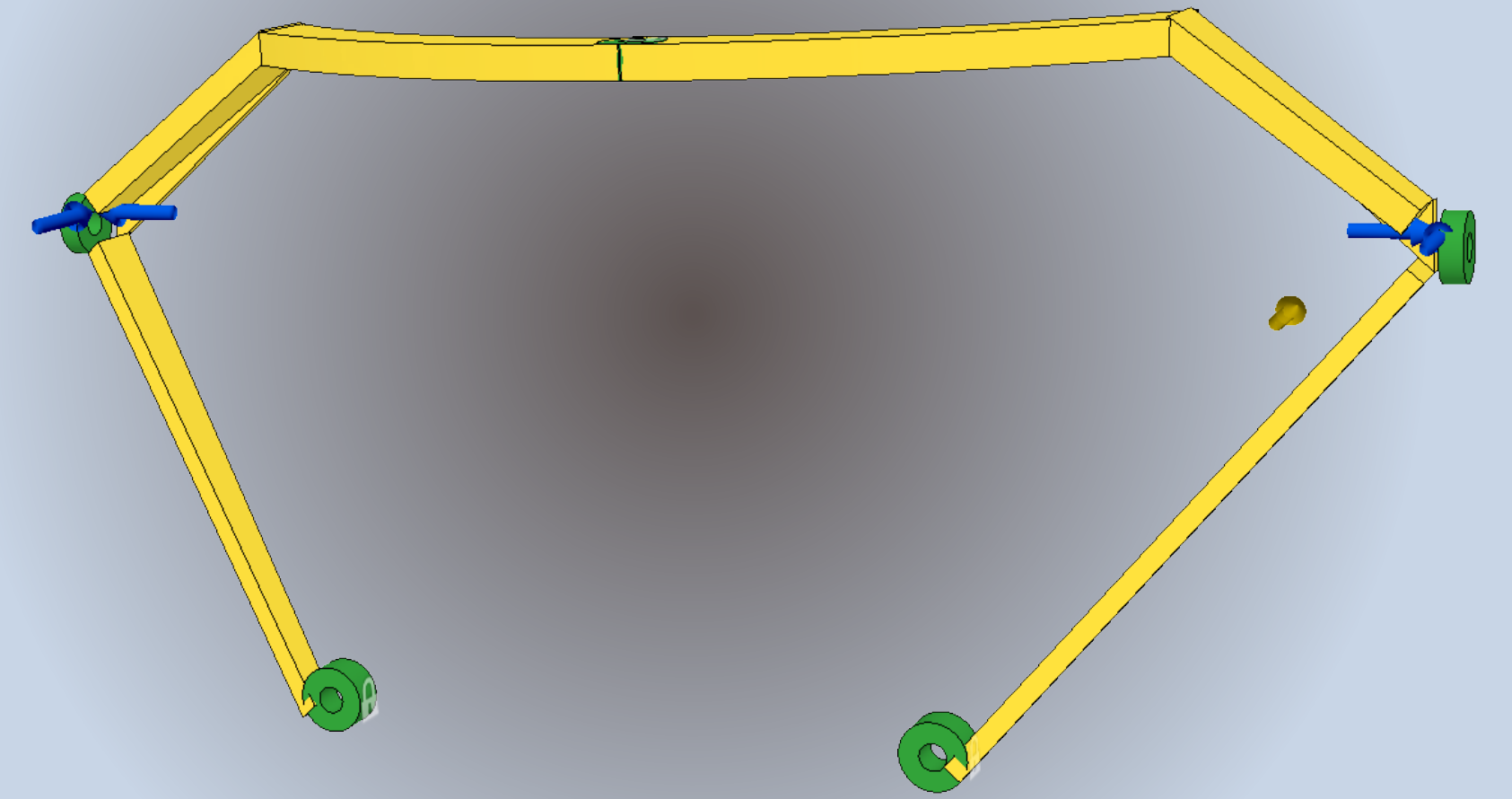Name: Timothy Laurence Weston     Unit Number:  6E7V0016_2324_O     Year: 2023/4

# Head Strap Frame GD

Constrains and

manufacturing settings

were applied.

Following processing in

the cloud, the design

was generated.



Constraints were applied to the joints at the headset



And loads were added to the strap joints



## MANUFACTURING

☐ Unrestricted

▼ ☑ Additive

Orientation  | X+ | Y+ | Z+
             | X− | Y− | Z−

Include all directi...  ☑

Overhang Angle  45.0 deg

Minimum Thickne...  3.00 mm

▶ ☐ Milling

▶ ☐ 2-axis Cutting

▶ ☐ Casting

OK   Cancel

## OBJECTIVES AND LIMITS

▼ Objectives

Minimize Mass  ⦿

Maximize Stiffn...  ○

▼ Limits

Safety Factor  3.00

Modal Frequency  ☐

Displacement  ☐

Buckling  ☐

OK   Cancel

Manufacturing criteria were specified



The design was generated (shown here with the starting shape)

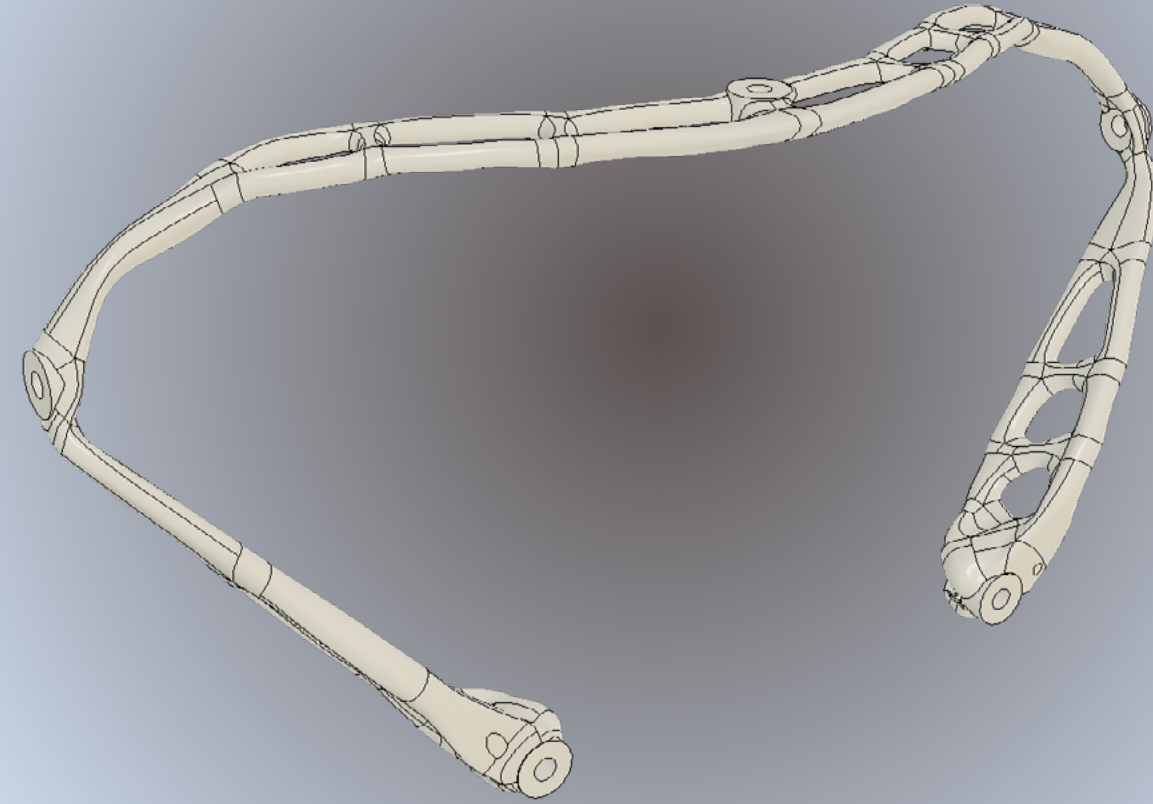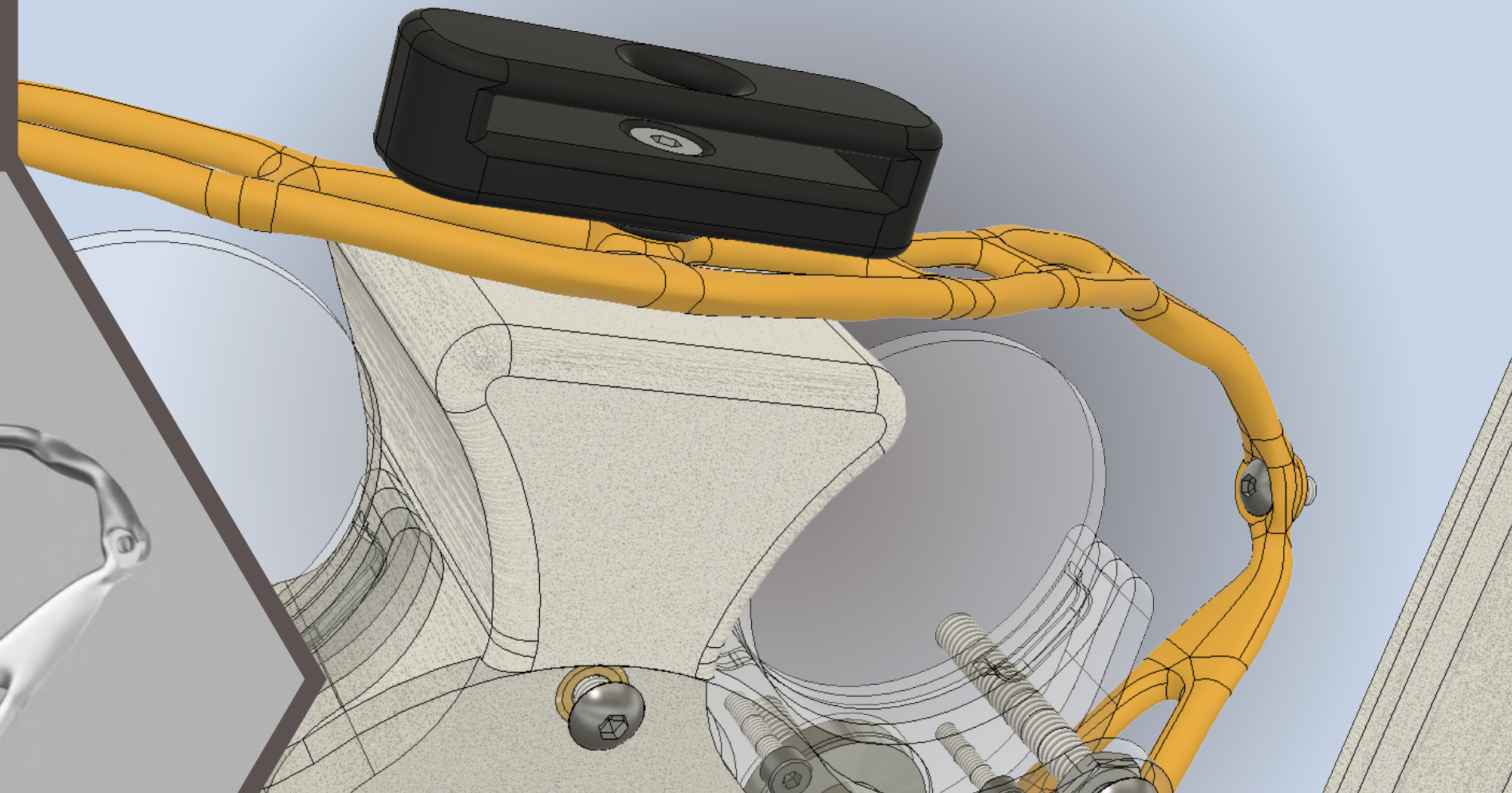Name: Timothy Laurence Weston    Unit Number:  6E7V0016_2324_O    Year: 2023/4
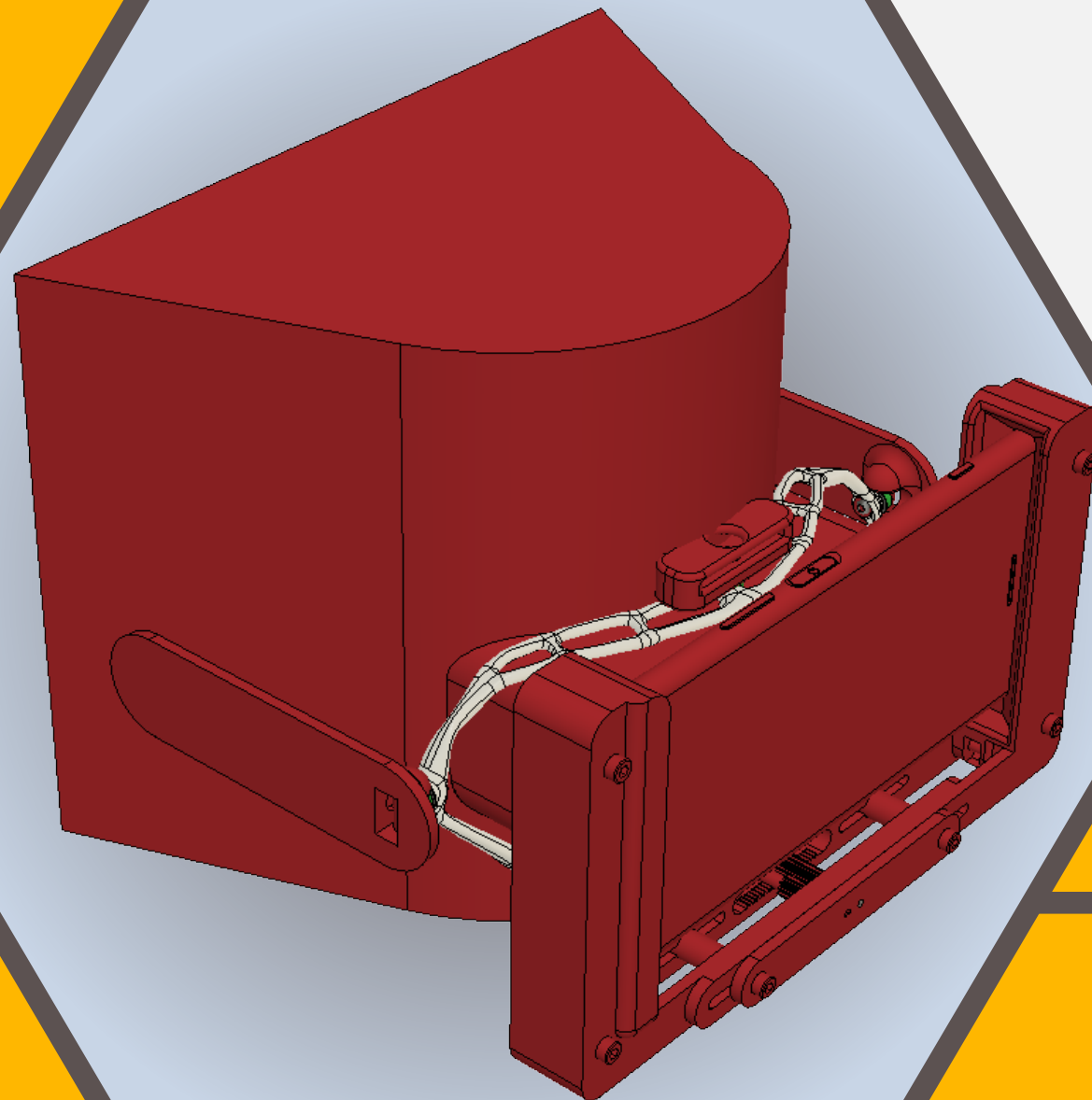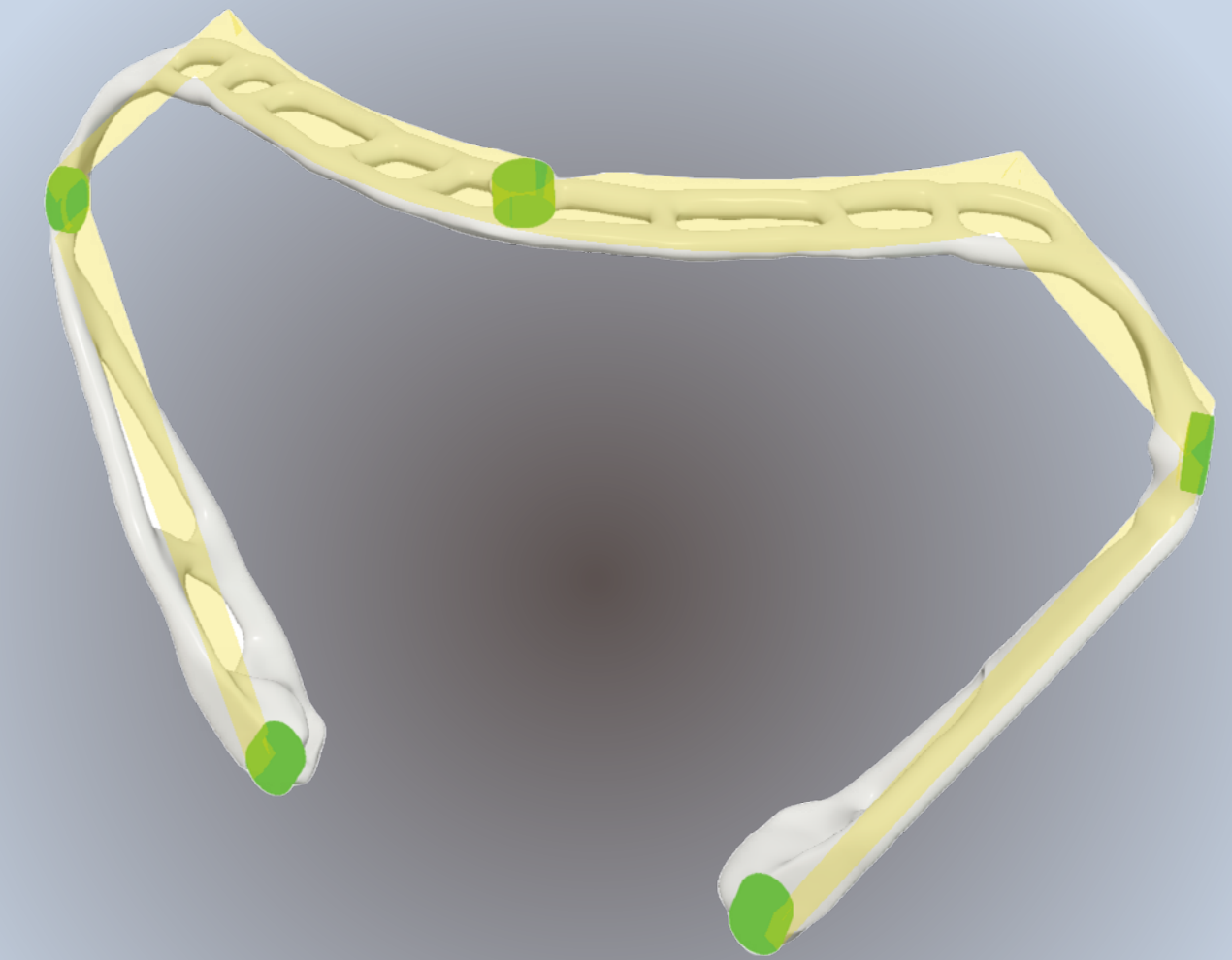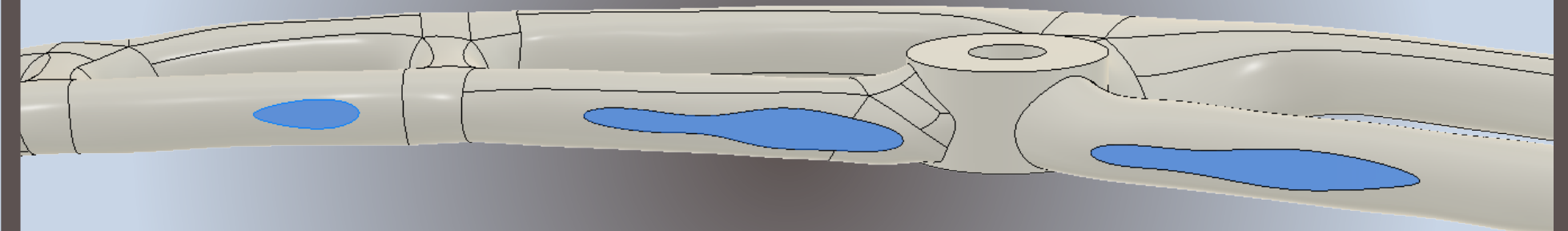
# Head Strap Frame GD

After the design was

generated it was cleaned

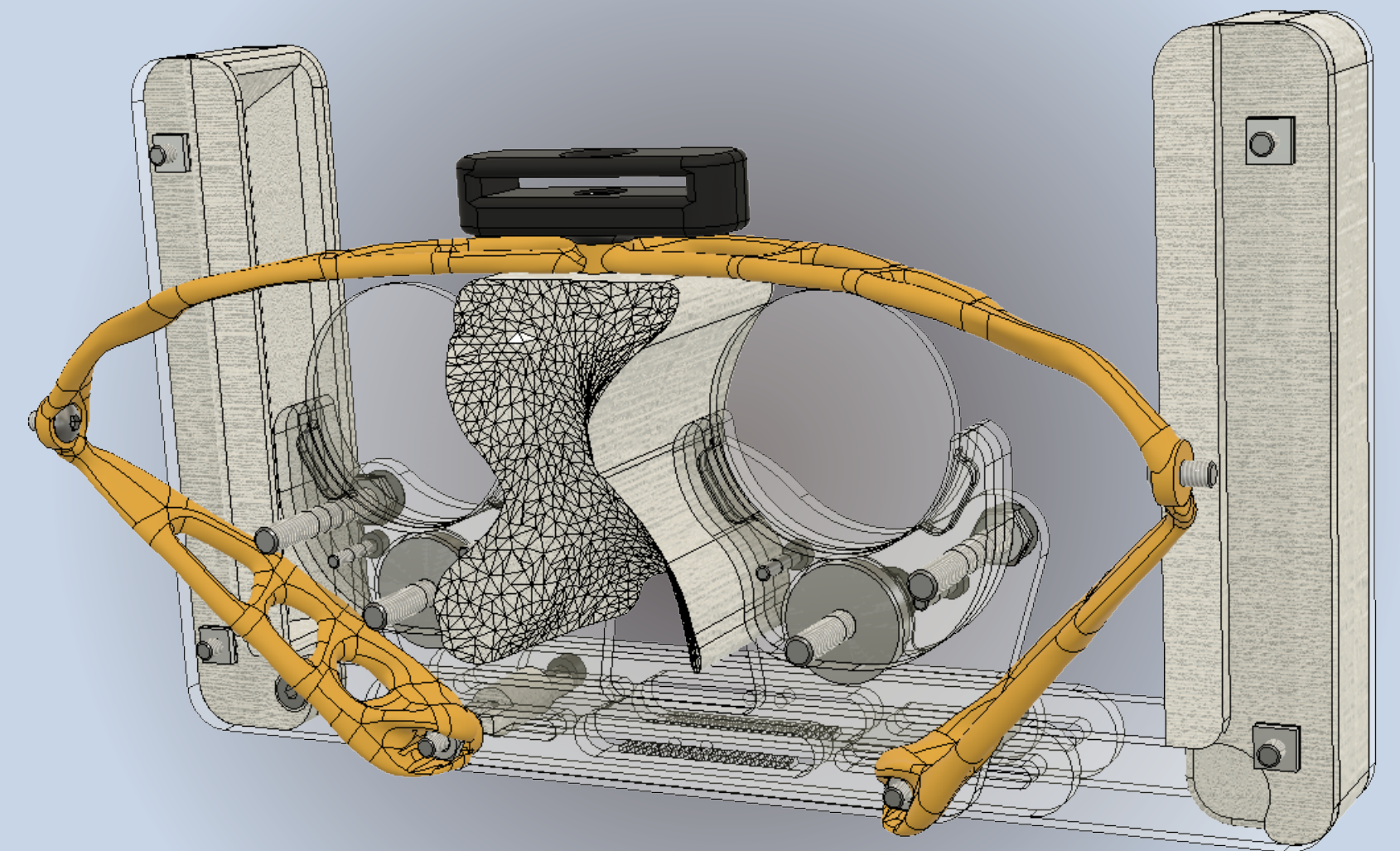up and then inserted

into the assembly.

The generated design was exported as an editable design

Excess faces were removed

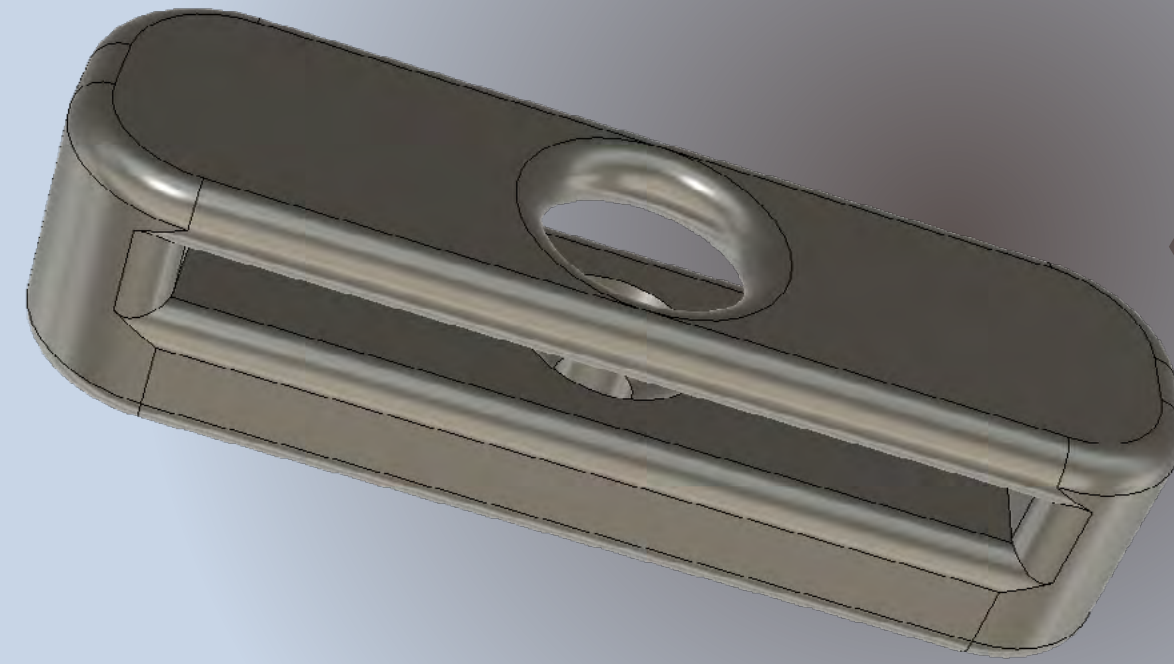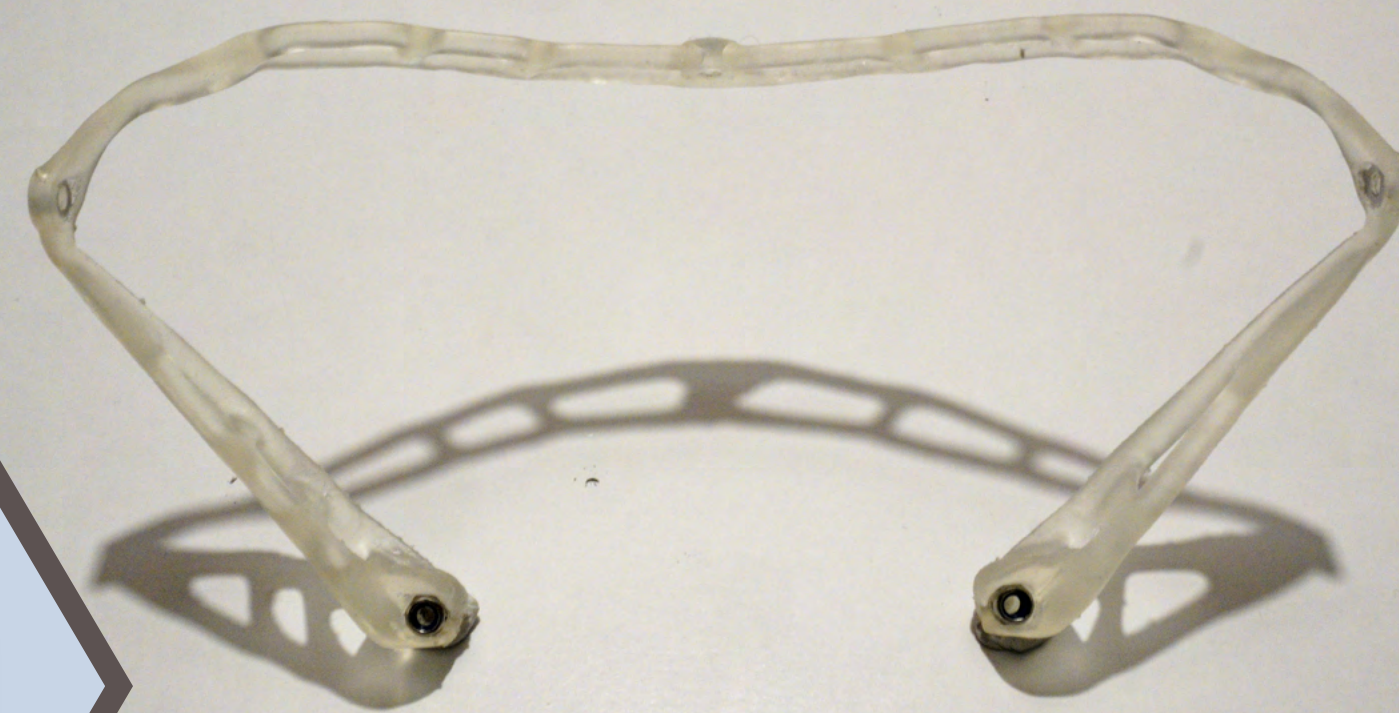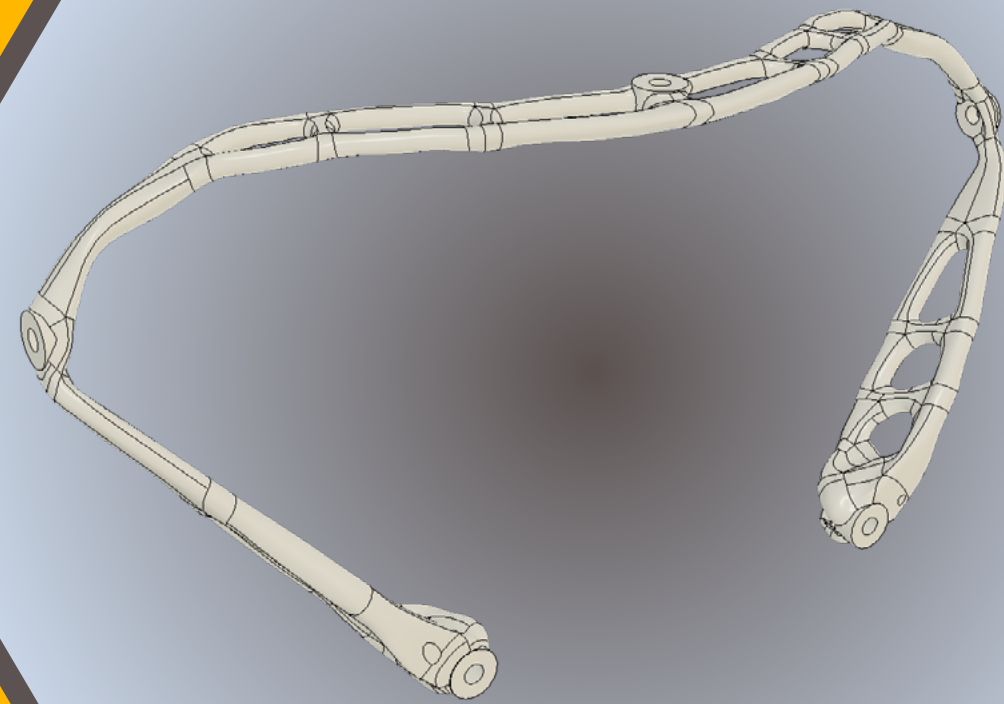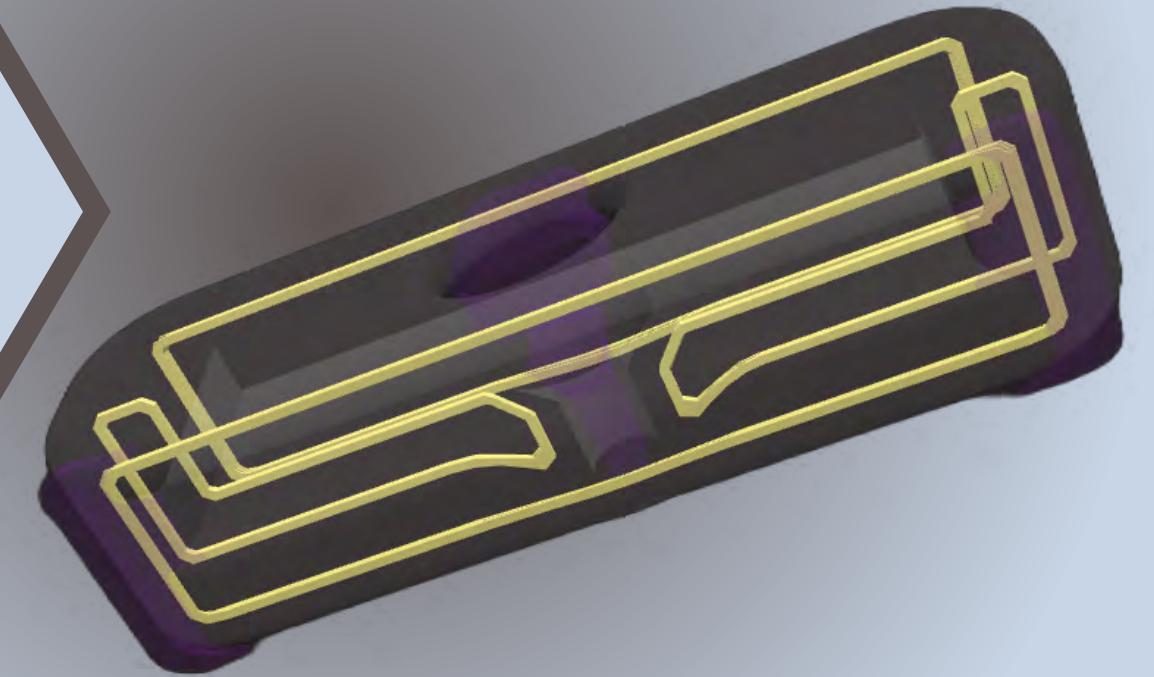The frame was imported & jointed to the other headset components

# SLA & CFR Parts

Unlike the other parts both the  SLA & CFR parts only required a single physical iteration – rather than failing fast, they succeeded fast.

The top strap mount

Fibre reinforcement was added

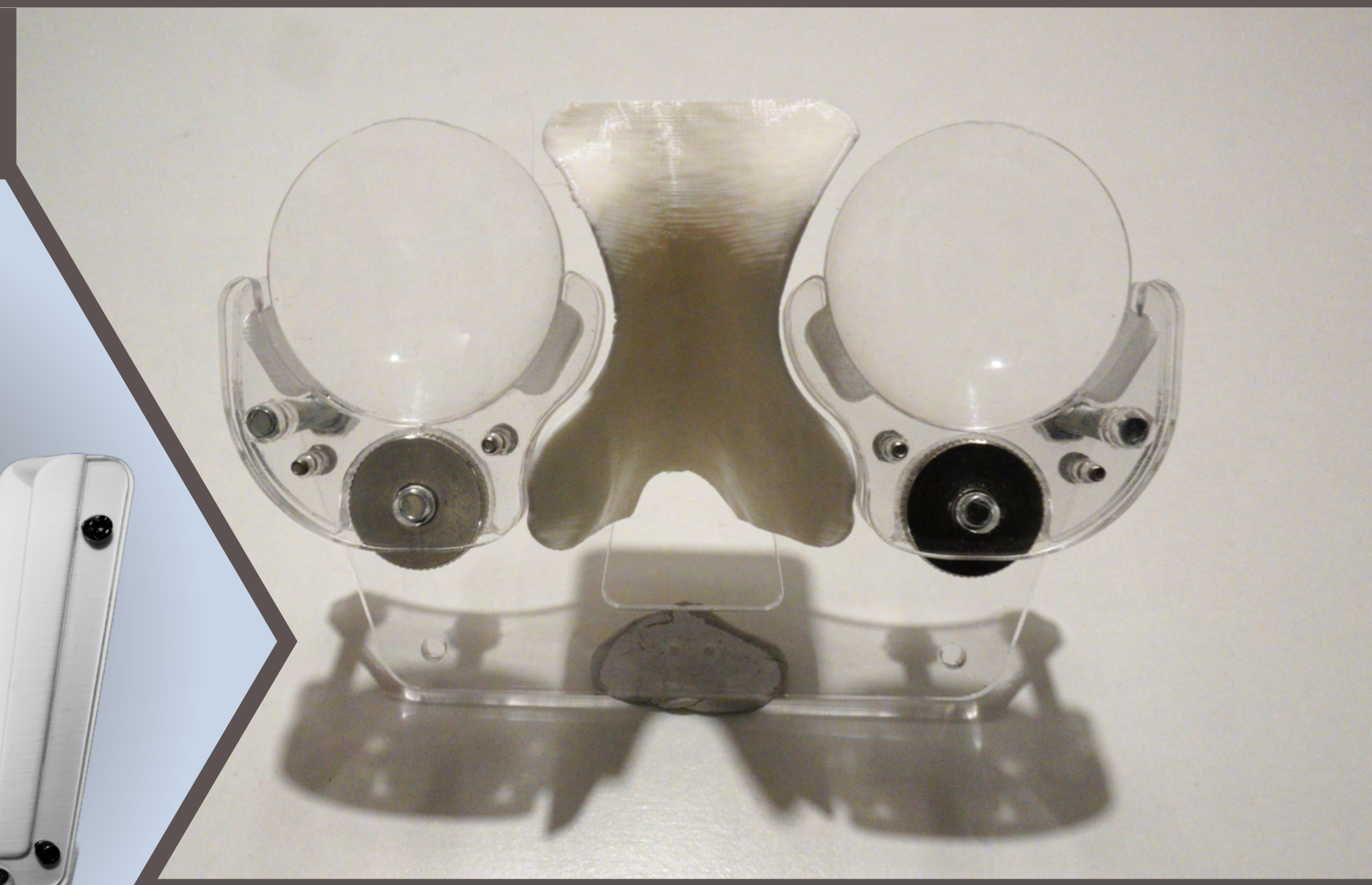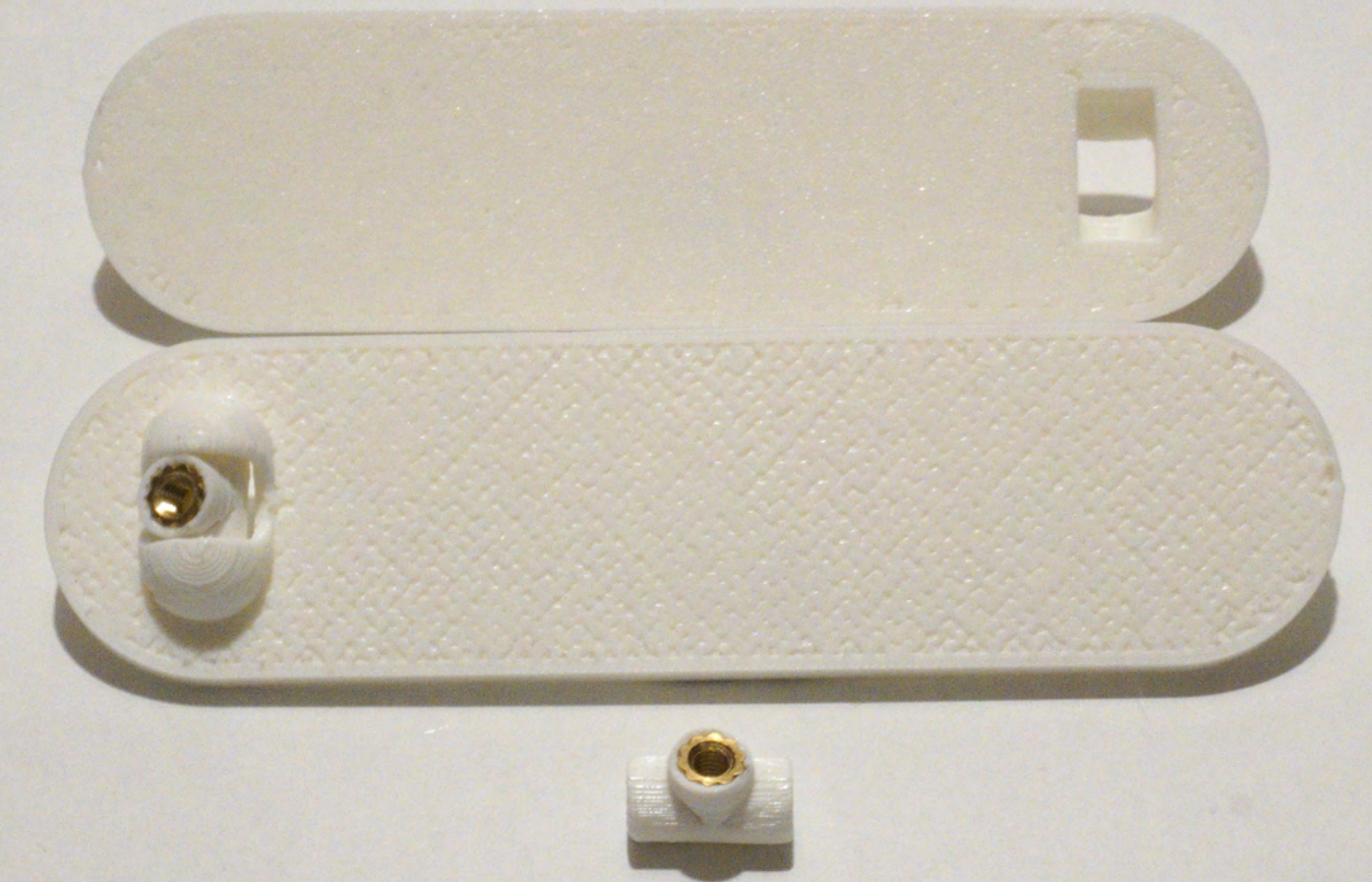The head strap frame, printed in clear resin

# Final Iterations

After multiple prototypes
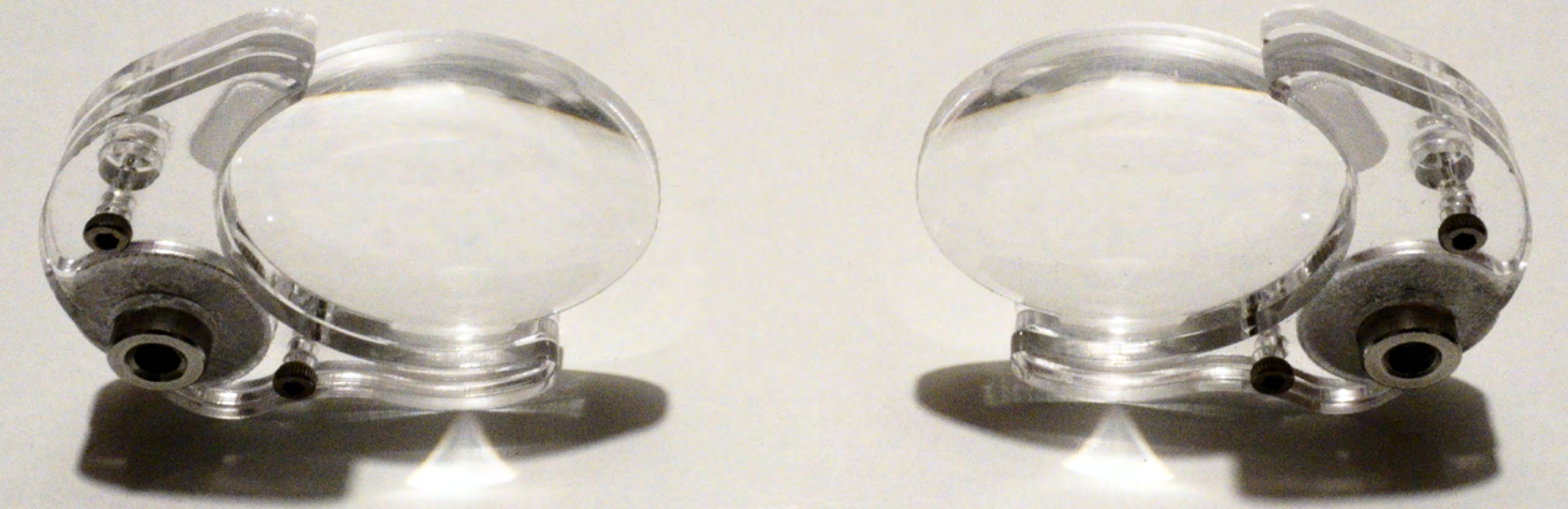
the parts were finalised.

This process had entailed

both small tweaks and

significant modifications.

The strap clips gained a hinge

The lens holders were modified to allow greater space for the nose interface
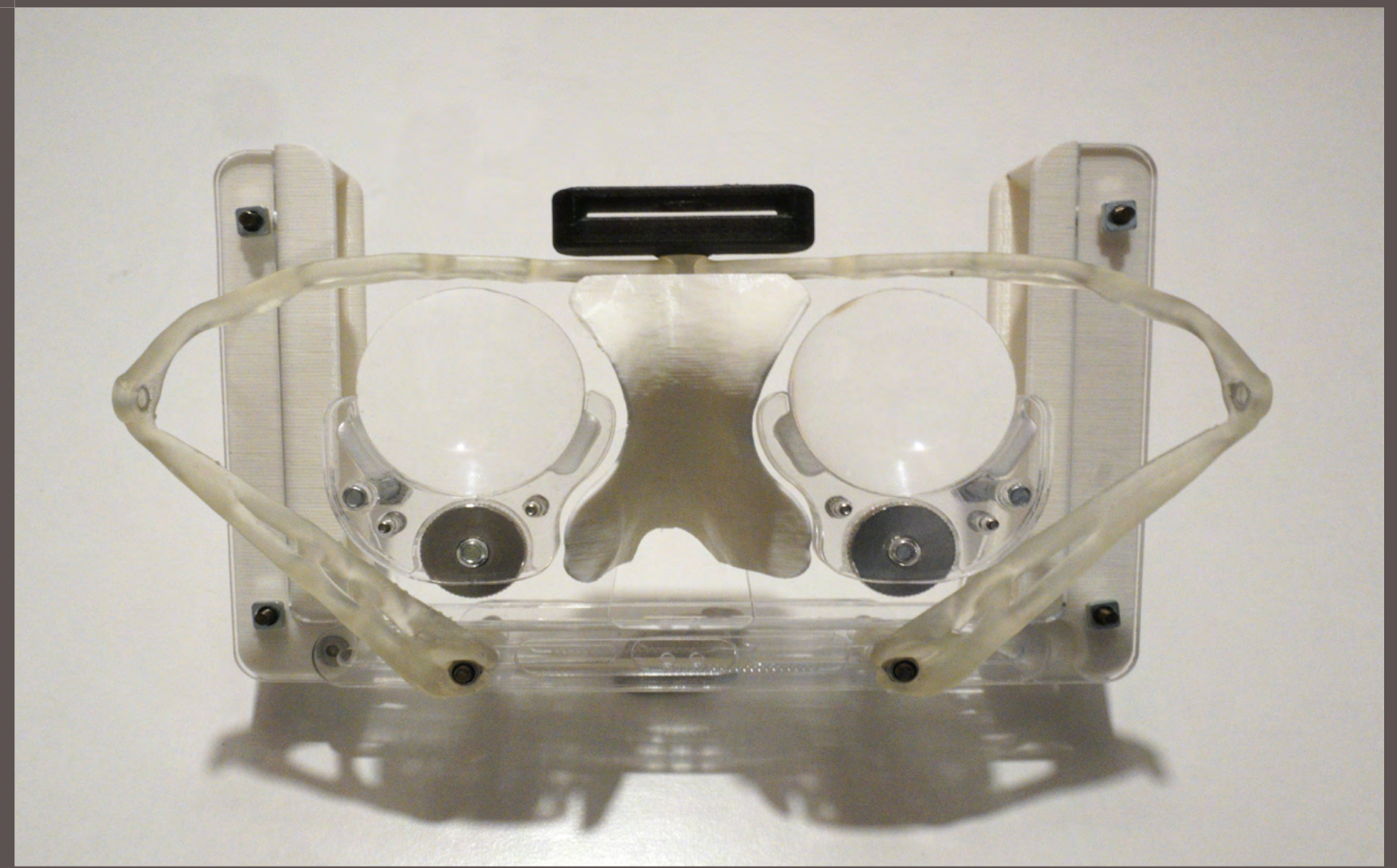
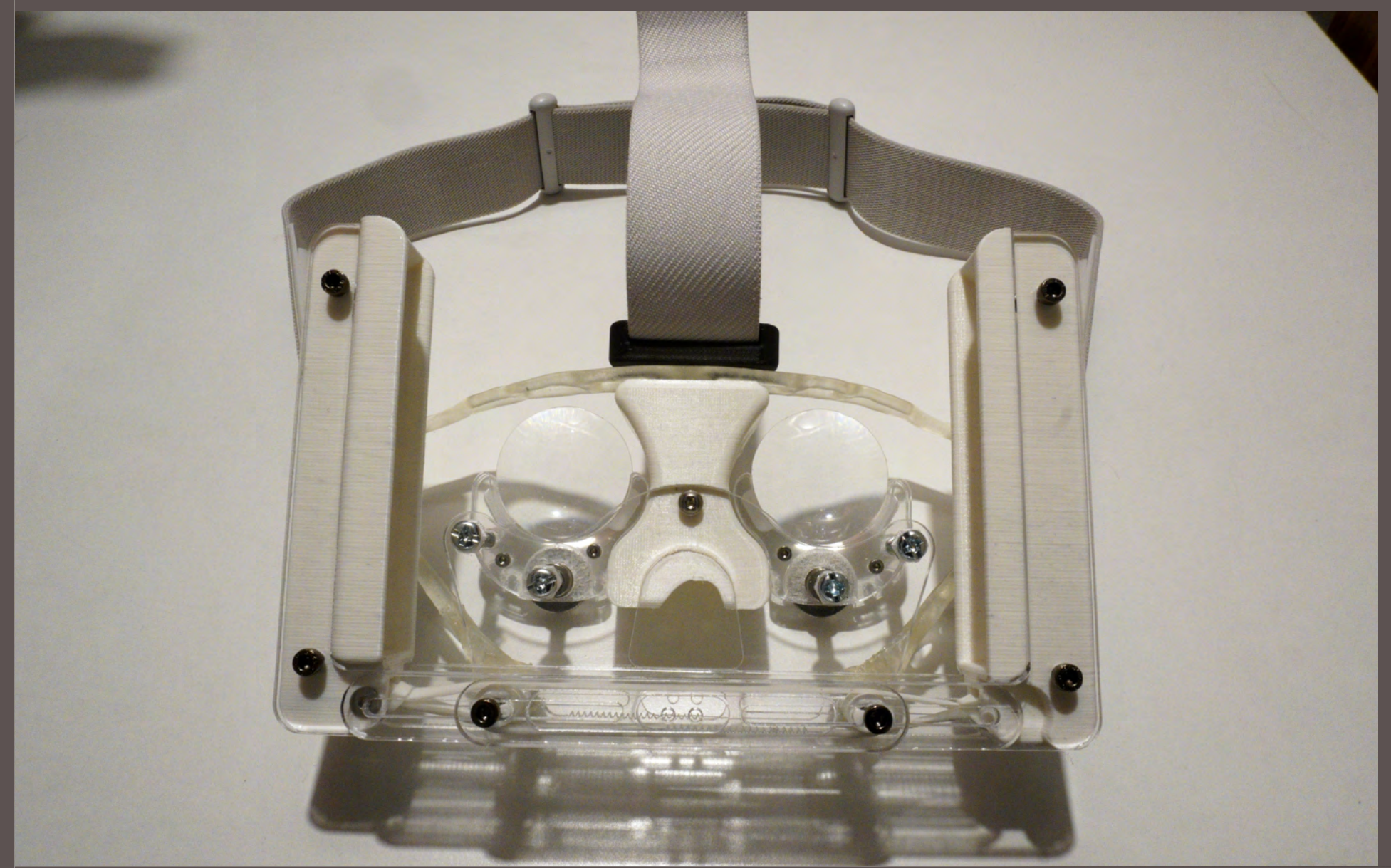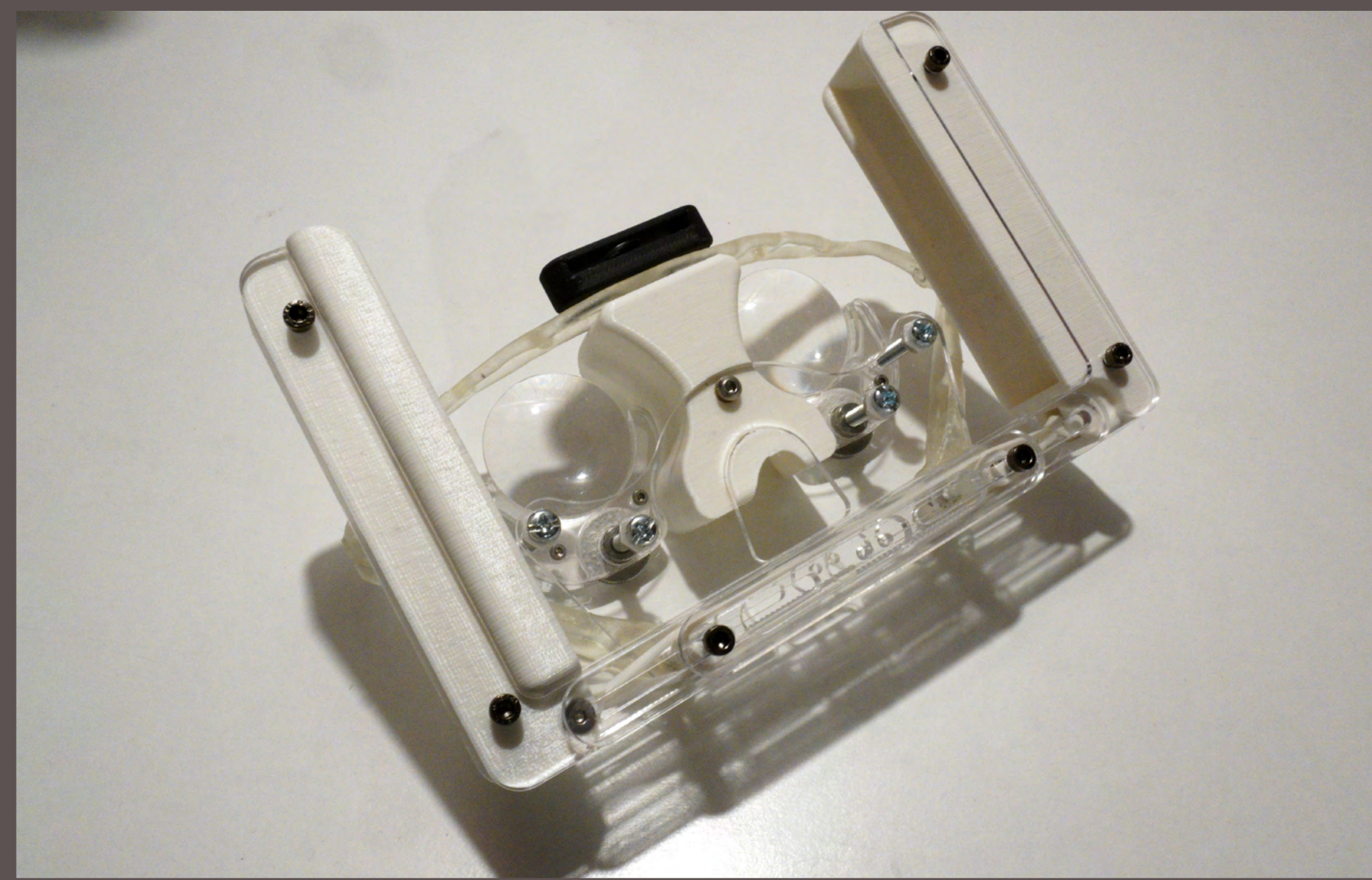Name: Timothy Laurence Weston    Unit Number:   6E7V0016_2324_O    Year: 2023/4

# Final Design

After multiple prototypes

the parts were finalised.
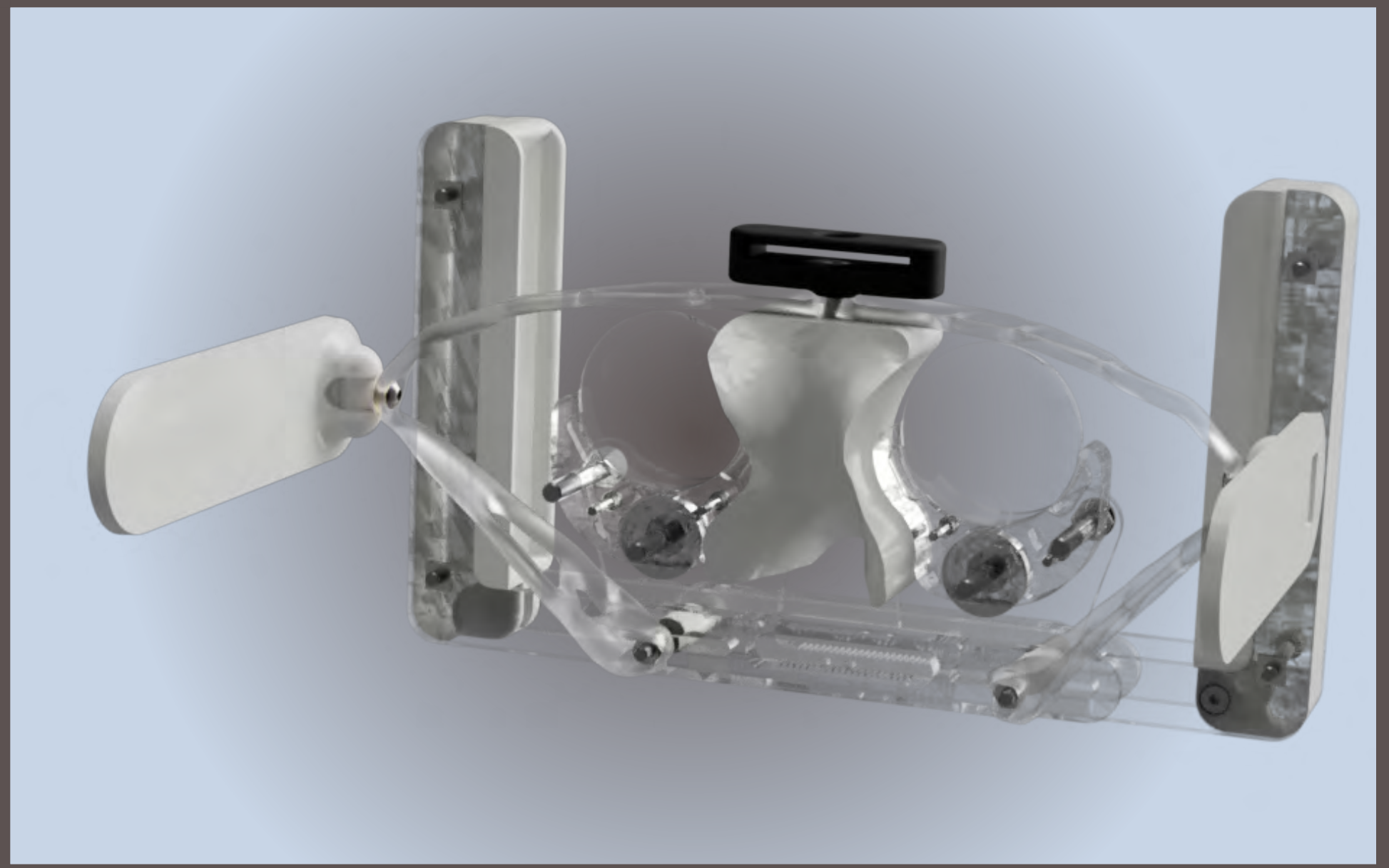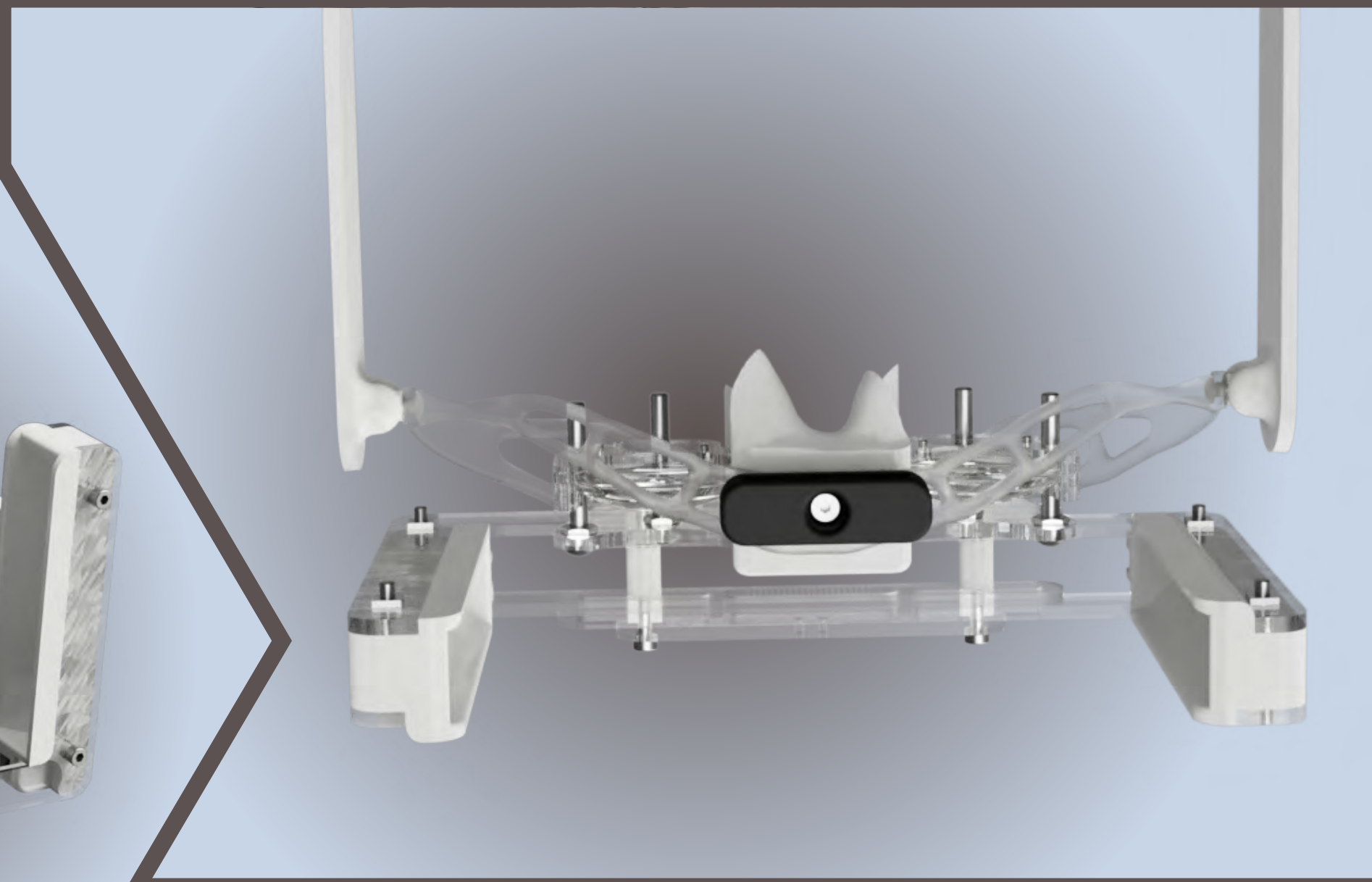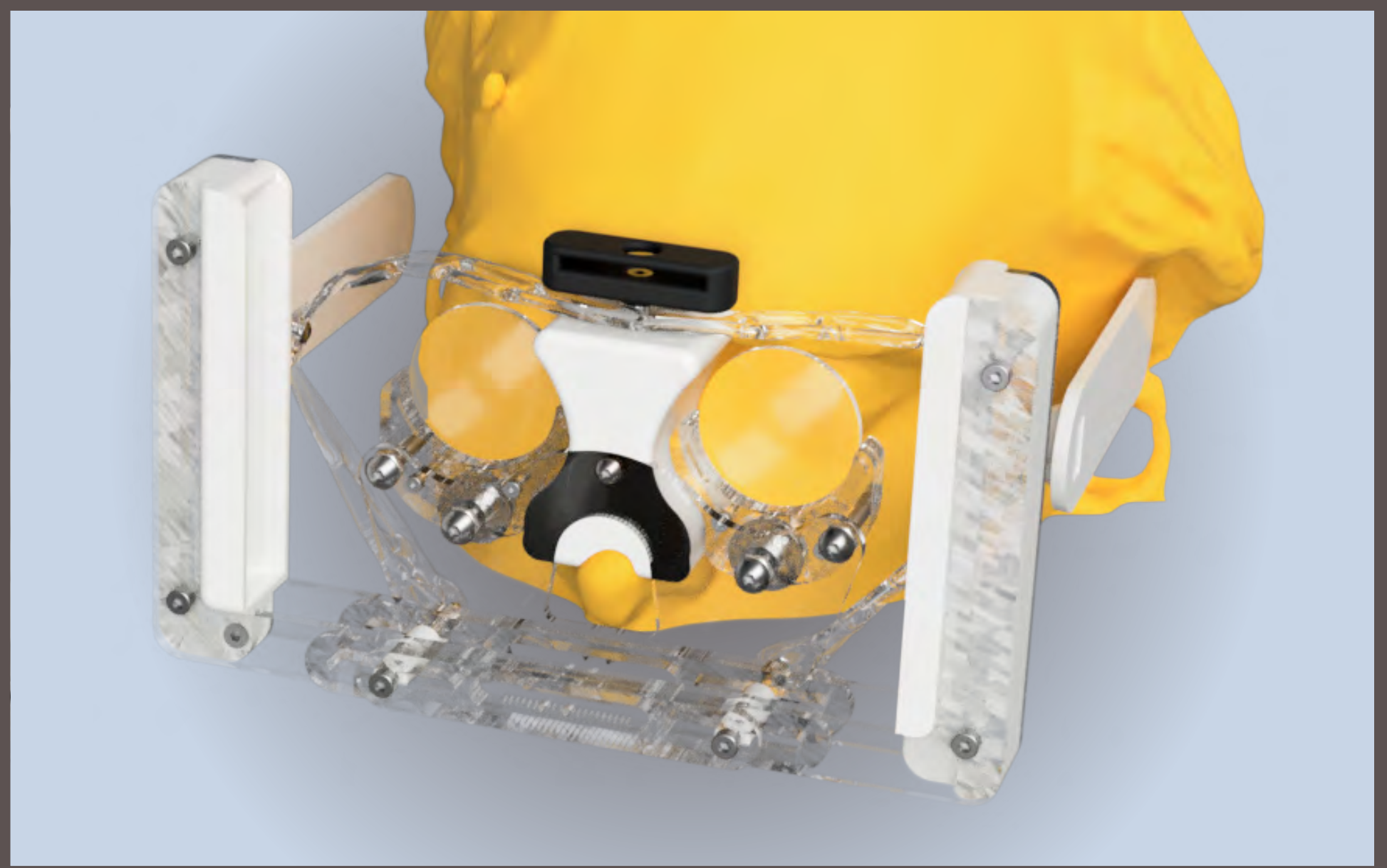
This process had entailed

both small tweaks and

significant modifications.

# Renders

3D renders of the final design were created, showing the headset from multiple angles.

UHL to 3D View:

https://skfb.ly/oTHCO

# Image References

Page 2

https://static.digitecgalaxus.ch/Files/3/9/1/5/8/7/7/1/118840383_317372616017059_796494463265948670_n.png

https://archvirtual.com/wp-content/uploads/2018/10/Envision3.jpg

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https://www.devteam.space/wp-content/uploads/2021/07/How-to-build-a-VR-Driving-Simulator-720x377.jpg

https://static1.srcdn.com/wordpress/wp-content/uploads/2023/05/pistol-whip-meta-quest-2.jpg

https://miro.medium.com/v2/resize:fit:4800/format:webp/1*6BTJYdvVyNzwoAqfLVCVtw.png


Page 3 – Task

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Page 4 – Smartphone VR Viewer

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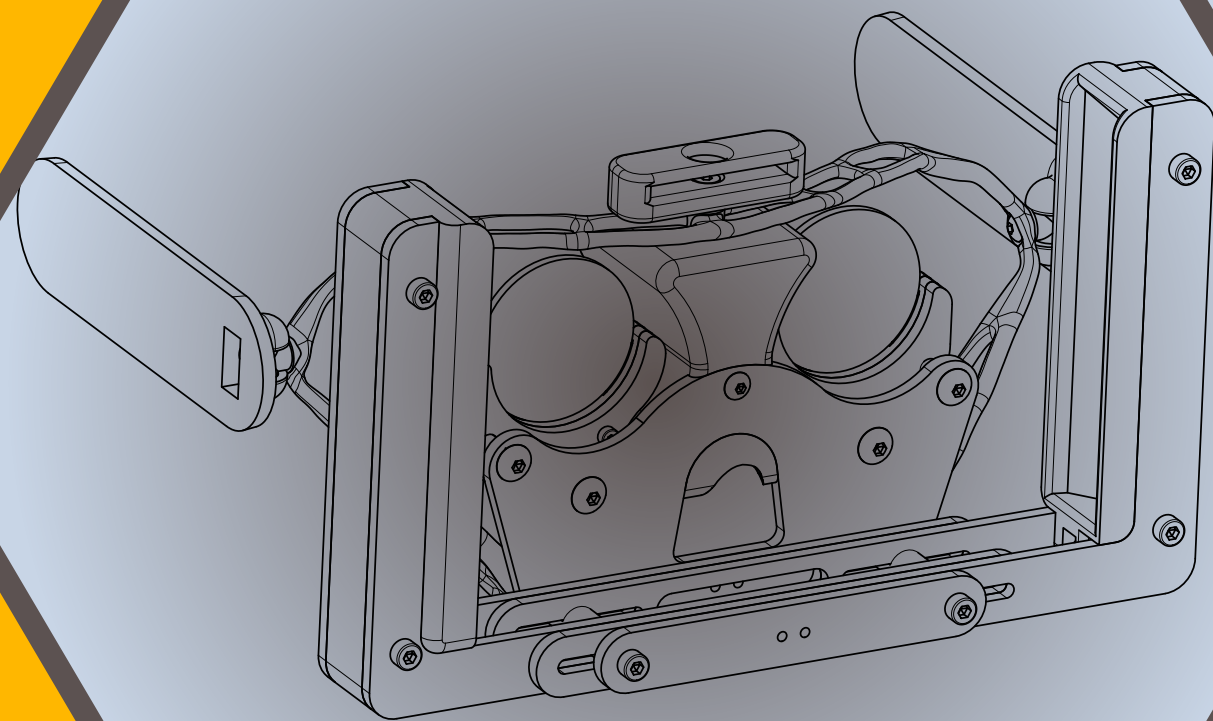
# Image References

Page 5 – Multi-Material

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https://nothingbutgeek.com/wp-content/uploads/2018/05/BASIC_CLOSED_SIDE.png

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https://cdn.simplyprint.io/i/printer_types/prusa/i3_mk3s+/product_photo_md.png

Page 6 – FFF 3D Printer

https://fabbaloo.com/wp-content/uploads/2020/05/image-asset_img_5eb0b012e6a93.jpg

Page 7 – CFR 3D Printer

https://tienda.century3d.com.mx/cdn/shop/products/reinforcingfibres_2048x.png?v=1651002227

https://uploads-ssl.webflow.com/573cd7e2103e63f747b02780/5d2cbe039934dc2c22f28a44_fiber-chart.png

Page 8 – SLA 3D Printing

https://www.suncoastscience.org/wp-content/uploads/2020/12/formlabs.png

https://formlabs-media.formlabs.com/filer_public_thumbnails/filer_public/c7/5d/c75d829e-94ed-4f8c-816c-3c72e7e57f2f/wc-mobile.png__664x0_q85_subsampling-2.png

https://eshop-3d-agency.de/storage/images/image?remote=https:%2F%2Feshop-3d-agency.de%2FWebRoot%2FStore16%2FShops%2Fe50a3f
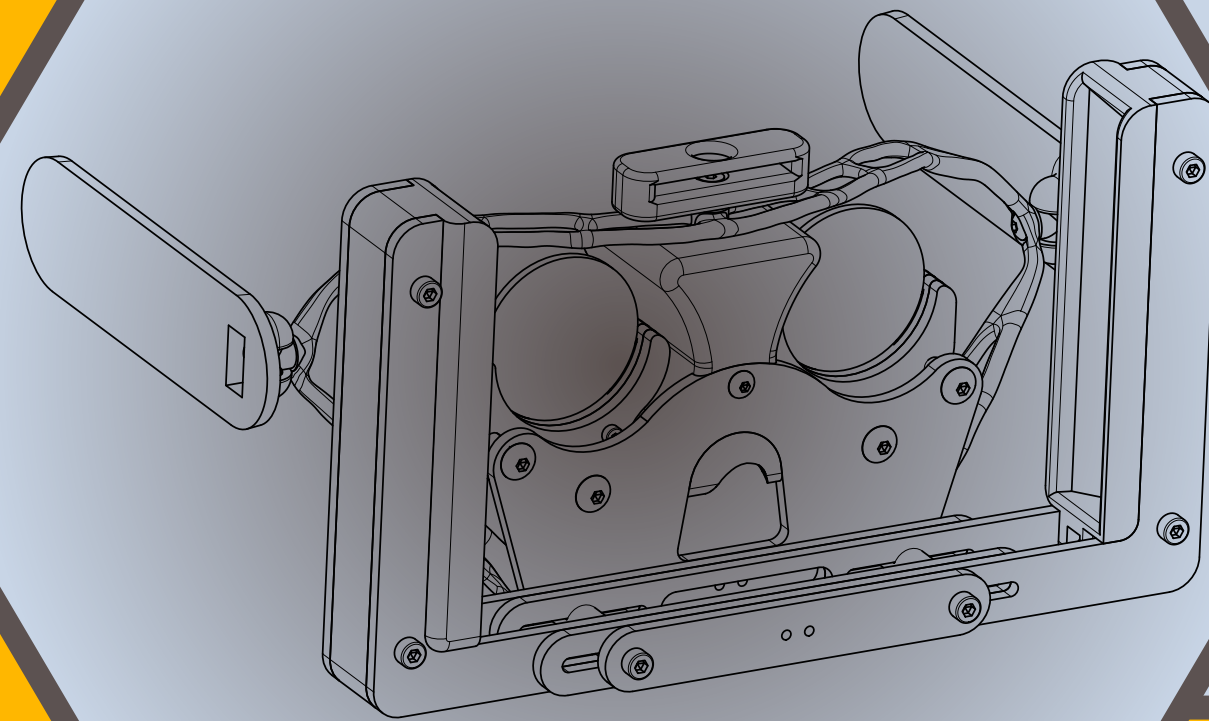
# Image References

7b-8bd4-440d-a099-1dda18a98e9c%2F5DEC%2FEEF8%2FF8EC%2F90EE%2F65B8%2F0A48%2F3548%2F0511%2F-03032019-daguerre-left_open_v1.png

https://formlabs.com/_next/image/?url=https:%2F%2Fformlabs-media.formlabs.com%2Ffiler_public_thumbnails%2Ffiler_

public%2F17%2Fed%2F17ed9b4b-2594-43c4-8386-0a101163eedf%2Fsla_tech_1.png__1354x0_q85_subsampling-2.png&w=1920&q=75

## Page 10 Laser Cutting

https://blog.glowforge.com/wp-content/uploads/2020/07/3D-Engraving_5-scaled.jpg

https://popcultpins.com/wp-content/uploads/2018/04/PopCultPins-HardDriveMagnets-001.jpg

## Page 11 – 3D Scanning

https://cdn.artec3d.com/styles/1288x888/s3/block-images/artec-leo-main.png