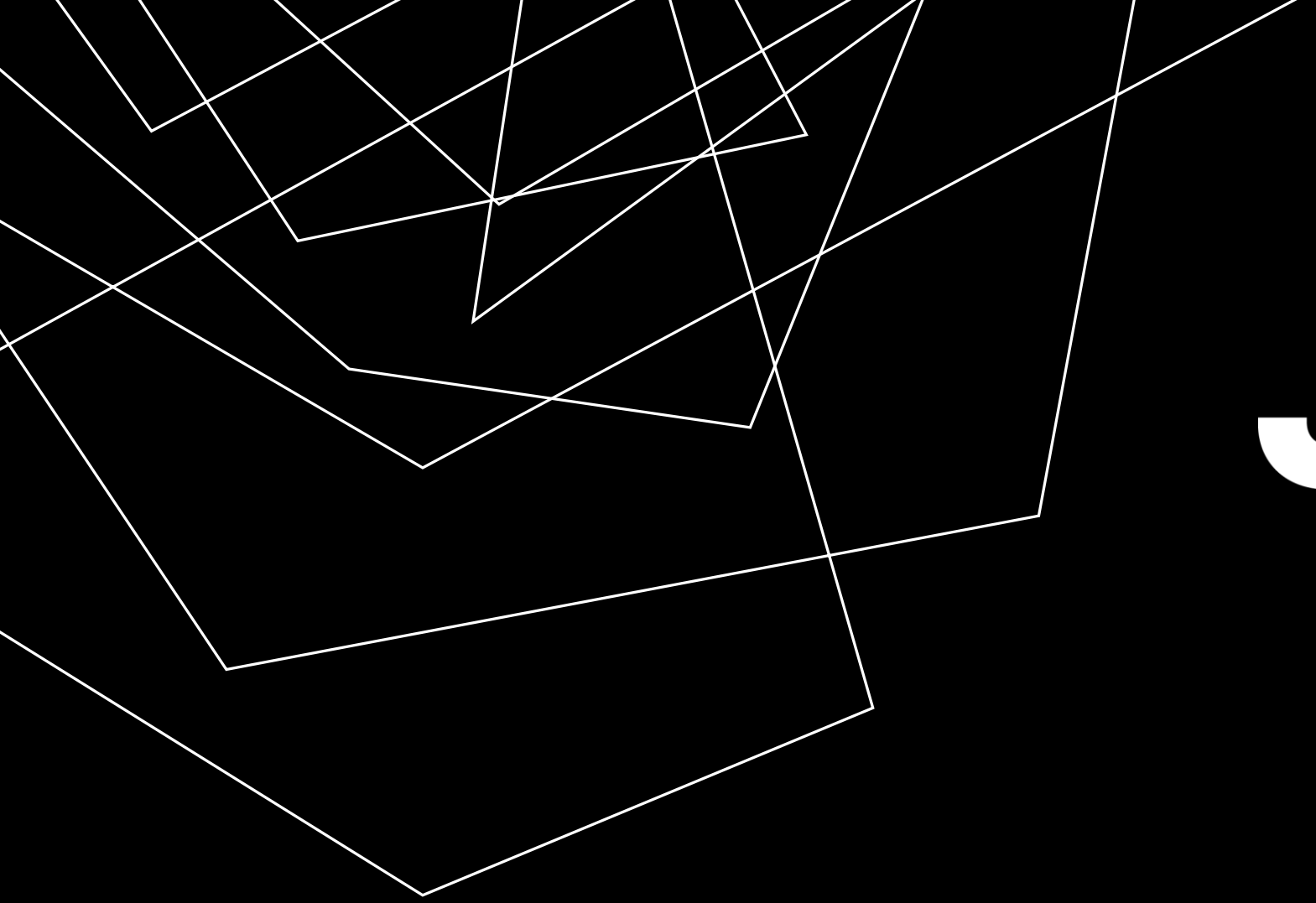


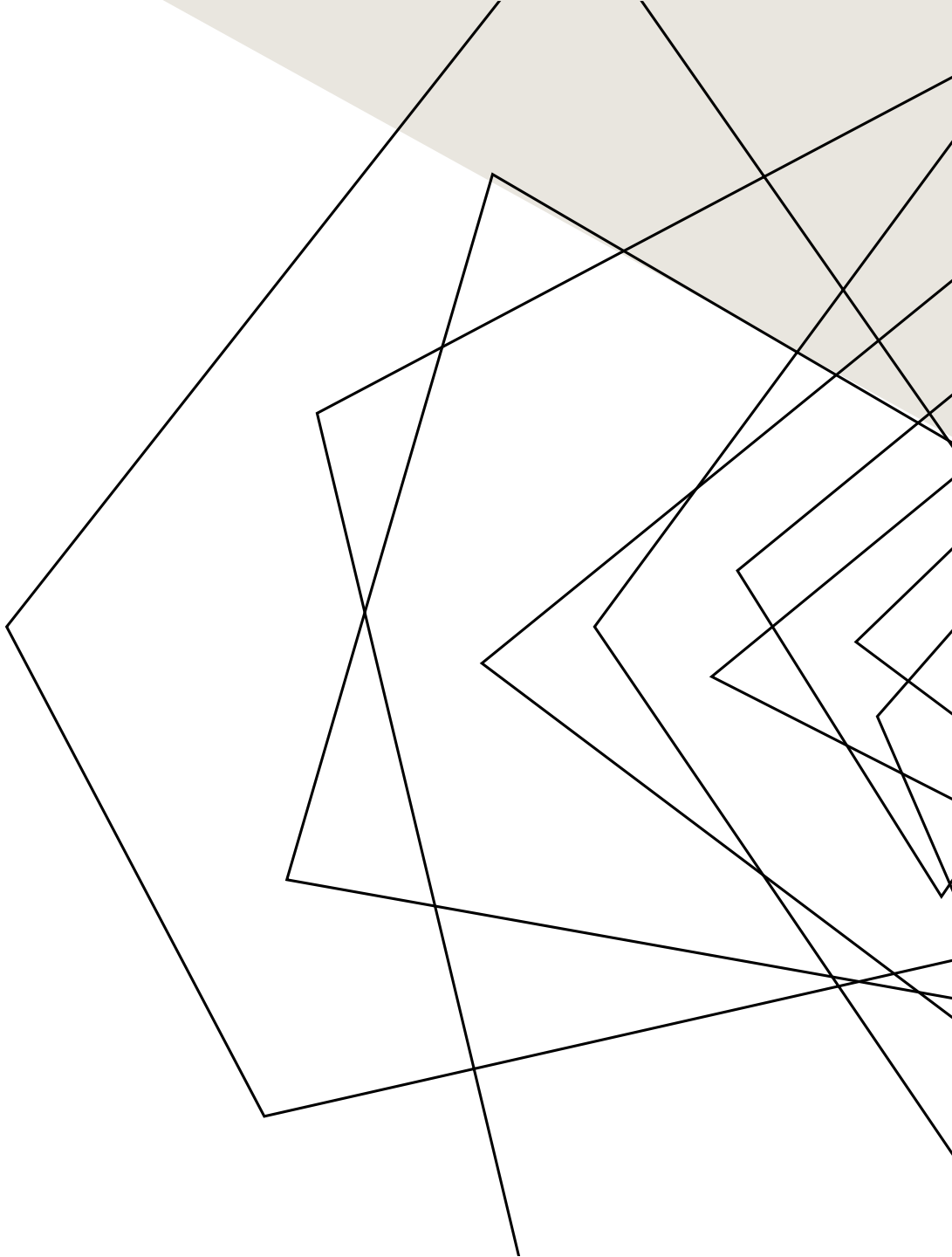
Jointly

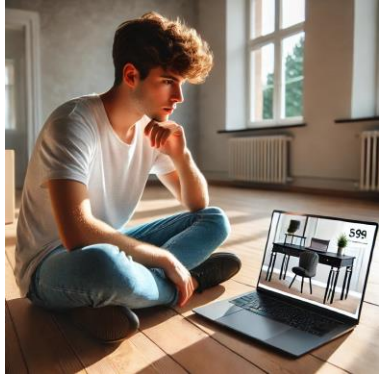
Design and Manufacturing Project

Yap Boon Pin
Ethan Gyan Singh
Lucas Goh Chen Ray
Wong Jae Hann

DISCOVER

Understanding the current situation





Exchange students | Digital Nomads | Renters

Startup / Temporary offices
Developing countries / humanitarian aid
Sustainability-driven individuals

Furnishing a temporary home

- Affordable
- Good Quality
  - Big and sturdy
- Easy transport
- Easy assembly
- Easy to resell or recycle

IKEA Furniture (cheaper product line-ups)

- ✓ Flat packed, easy to transport
- ✓ Easy to assemble
  - Minimal tools required, also provided
- × Low quality
- × Unsustainable materials

Other Furniture

- ✓ Good Quality
- ✓ Sturdy
- ✓ Features
- × Expensive
- × Difficult to assemble
- × Difficult to transport
  - Come as assembled
- × Difficult to recycle
  - × Different materials
  - × Difficult to disassemble

Cheap Furniture

Low Quality

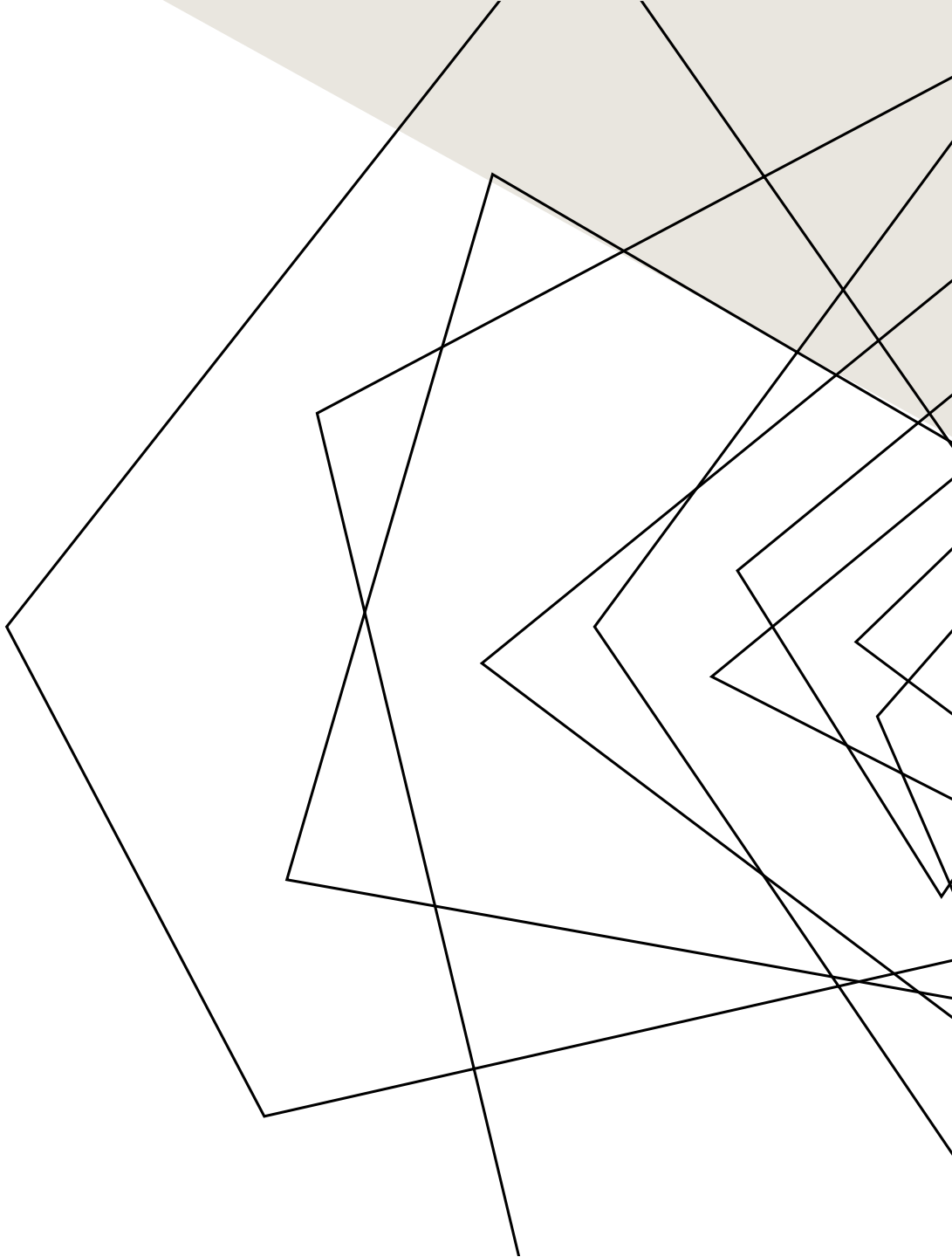
High Quality Furniture

Expensive

Multiple parts; difficult to disassemble
Difficult to recycle/dispose/resell

DEFINE

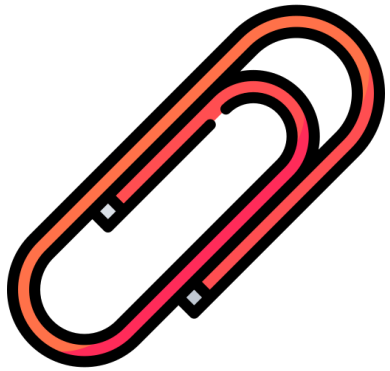
The team’s mission



FLATPACK FURNITURE LINEUP THAT CAN BE **EASILY REASSEMBLED** FOR CONVENIENT **TRANSPORTATION**, MANUFACTURED WITH **SUSTAINABILITY** IN MIND.

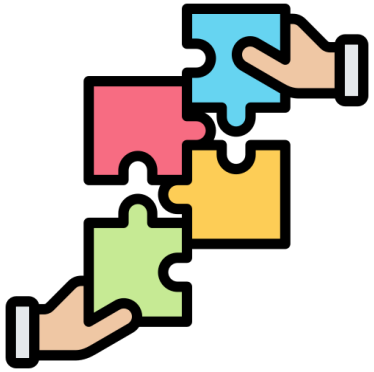
PROPOSAL – FURNITURE LINEUP

Universal Toolless Fasteners



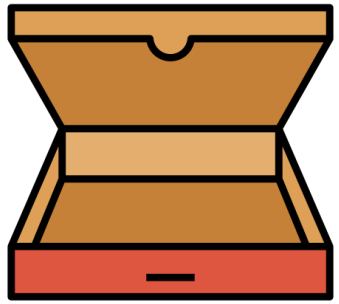
eases

Reassembly



enables

Flat packable



PROPOSED PRODUCT REQUIREMENTS

Furniture Design

- Single Material
  - easy for recycling
- Secondary material
  - must be <10% of overall composition
  - must be easy to remove
- Metals
  - durable
  - recyclable
- Use panels/sheets/plates
  - streamlined mfg process

Fastener Design

- Toolless assemble and disassembly
- Reusable
  - ideally infinite fatigue cycle
- Maximum 2 variations
  - aiming for an ecosystem of products
  - streamlined mfg process

DESIGN FOR X

DFA

Design for Assembly

- Toolless assembly
- Disassemble for convenient transportation
- Disassembly for recycling

DFD

Design for Disassembly

DF0

Design for 0 waste

- Material cut-outs to be used for other parts / fasteners
- Easily recyclable materials
- Sturdy build for long lasting

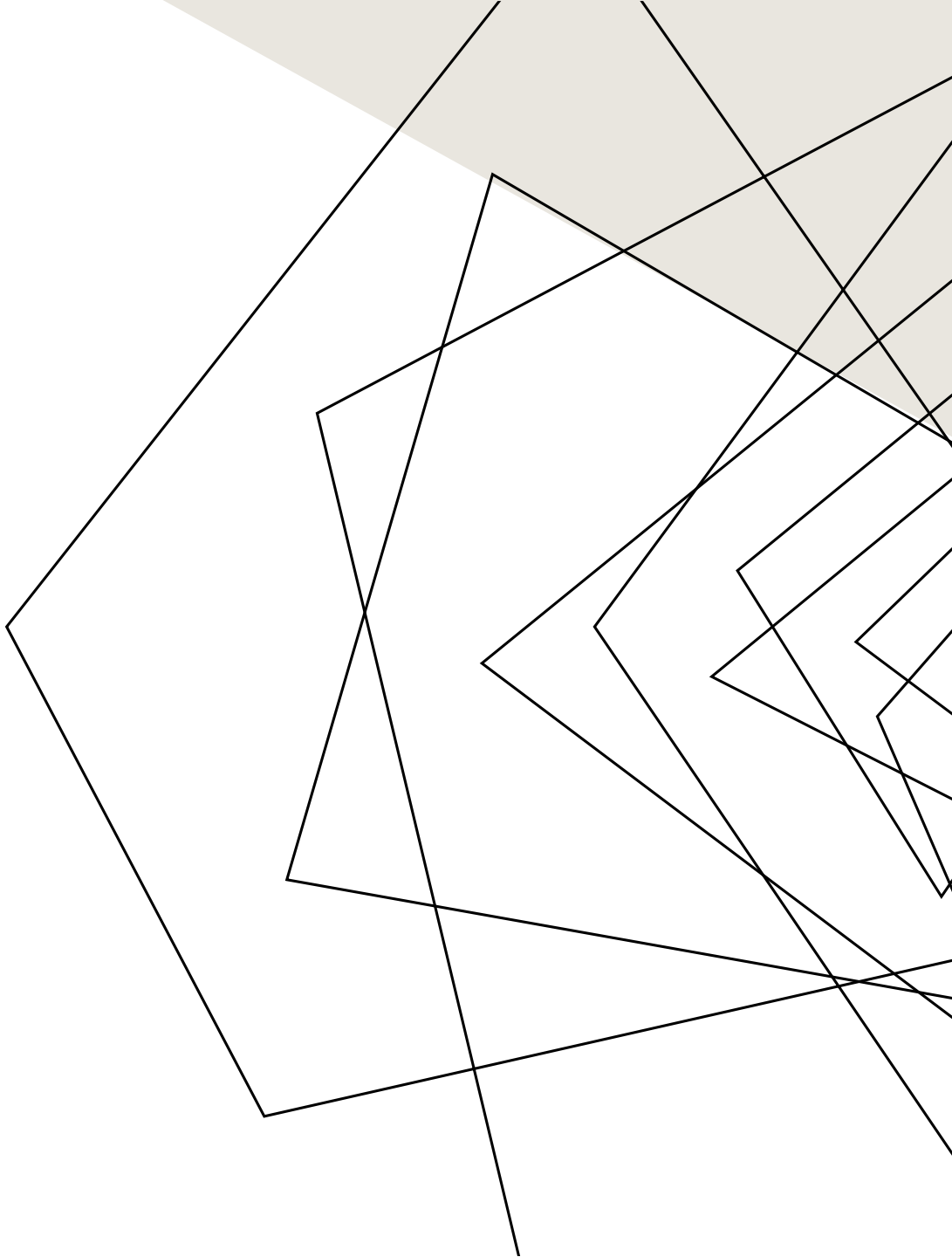
DFS

Design for sustainability

PROOF OF CONCEPT PROTOTYPE

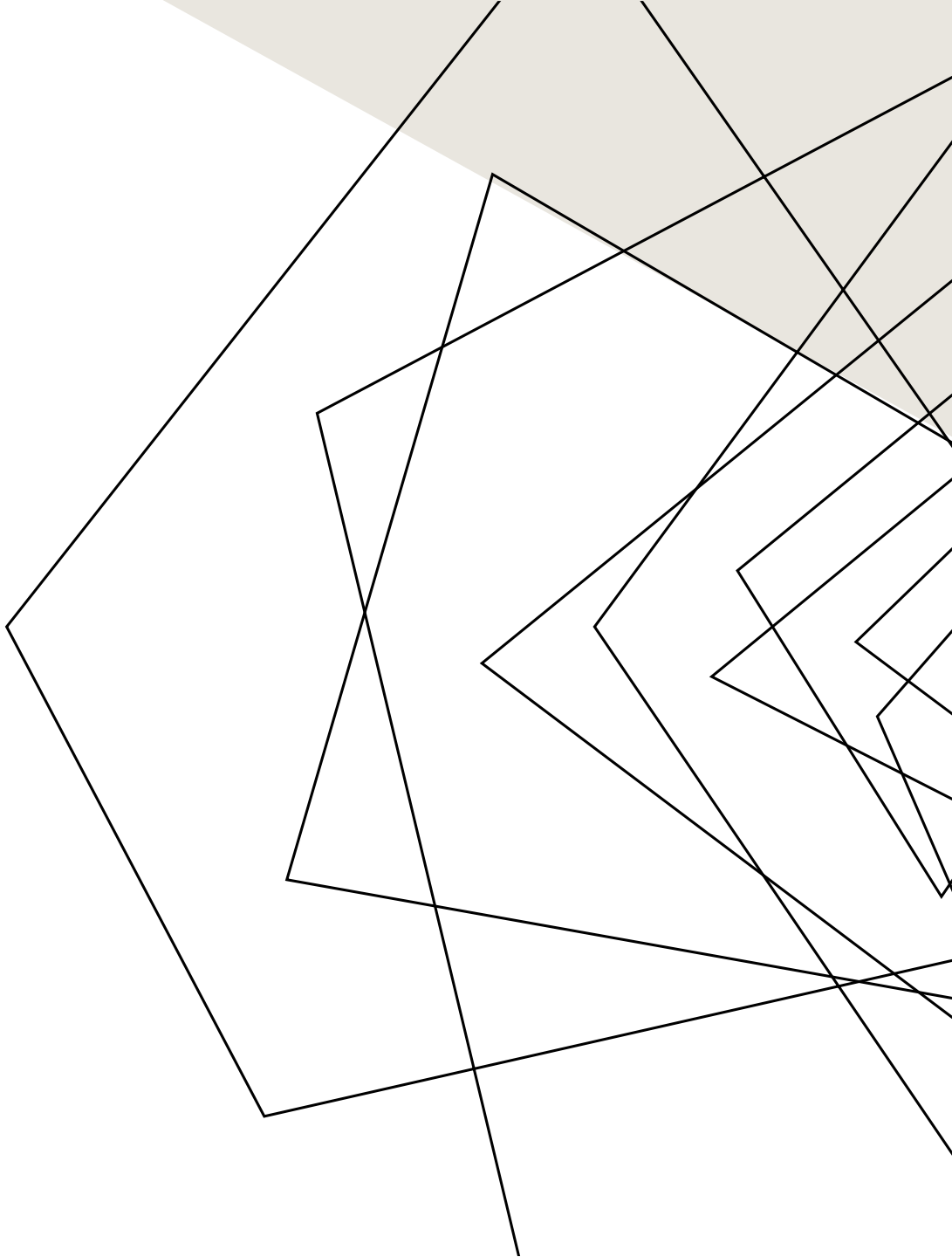
TABLE

- Essential furniture for most nomads
- Can be purposed as dining and work/study table
- Usually huge
- Relatively simple structure



DEVELOP

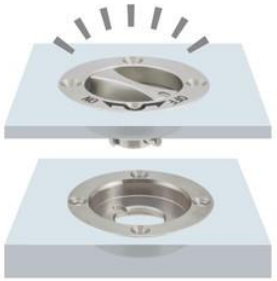
Ideating potential solutions



FASTENERS

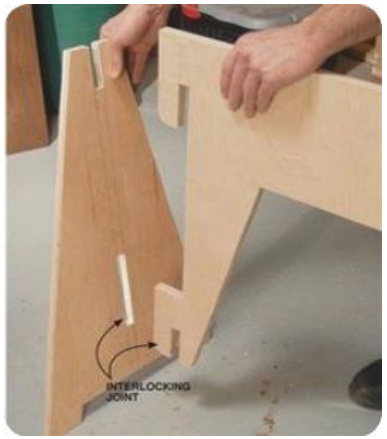

50PCS
Plastic Rivet
Fit Toyota Honda
permanent fastening
fit 6mm diameter hole
Used widely for car surface
15mm
9mm
12mm
6mm

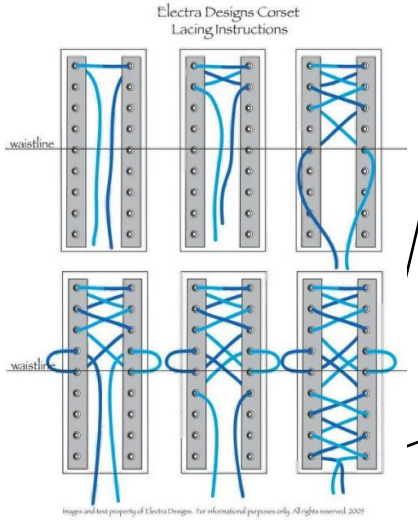

OFF
ON




OFF
ON

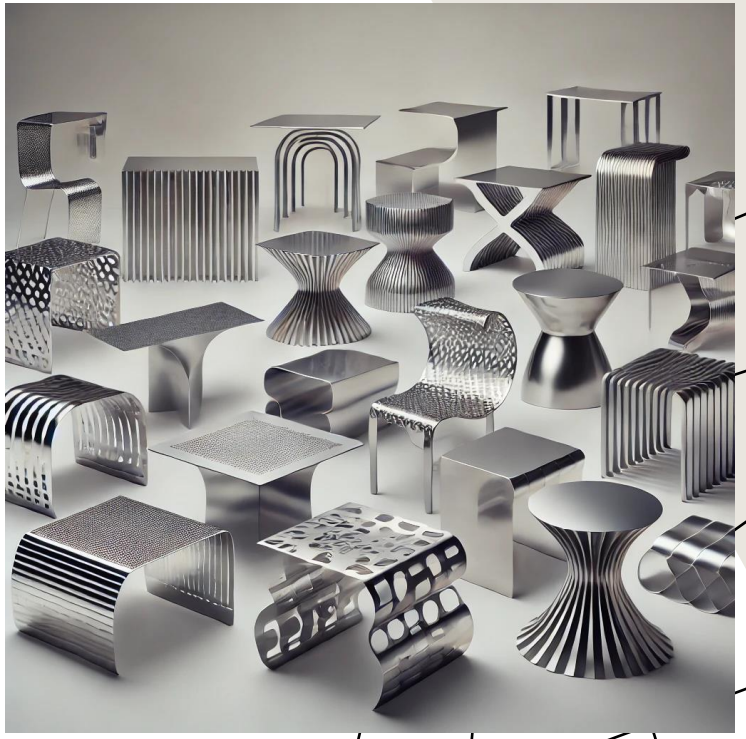
OTHER FASTENING AND ASSEMBLY TECHNIQUES





SOME TABLE DESIGNS FOUND ONLINE

(SHEET) METAL TABLE DESIGNS – GEN AI



(SHEET) METAL TABLE DESIGNS – GEN AI

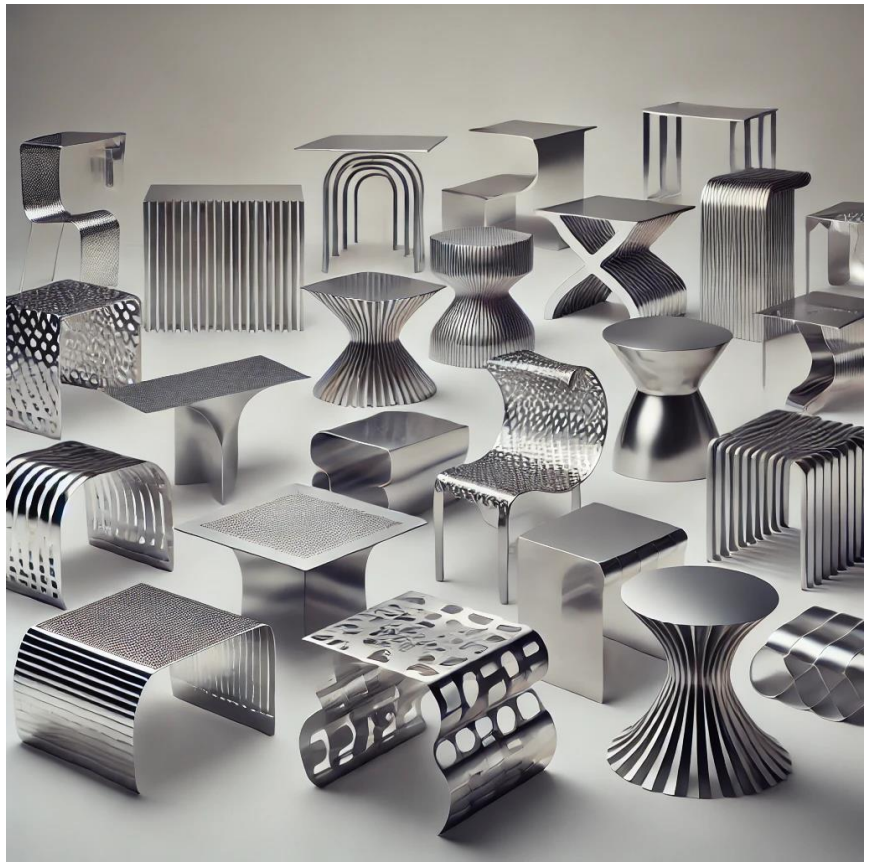
A modern study desk made entirely out of metal structures, featuring a minimalist design. The desk has a rectangular tabletop crafted from a smooth, matte metal panel, supported by distinct legs formed from flat, sleek metal panels arranged at an angular or geometric configuration. The design emphasizes simplicity and functionality, with clean lines and no excessive detailing. The setting is a neutral, well-lit study room environment, showcasing the desk's sturdy, contemporary aesthetic.

(SHEET) METAL TABLE DESIGNS – GEN AI

A collection of ultra-minimalist modern study tables featuring four metal legs and simple tabletop panels, displayed in a neutral, well-lit study room setting. The tables have a clean and practical design, with smooth, straight metal legs in a polished or matte finish. Tabletops are rectangular and made from materials like wood, glass, or matte metal, offering a spacious and functional workspace. The design emphasizes simplicity, stability, and modern aesthetics, perfect for a minimalist study environment.

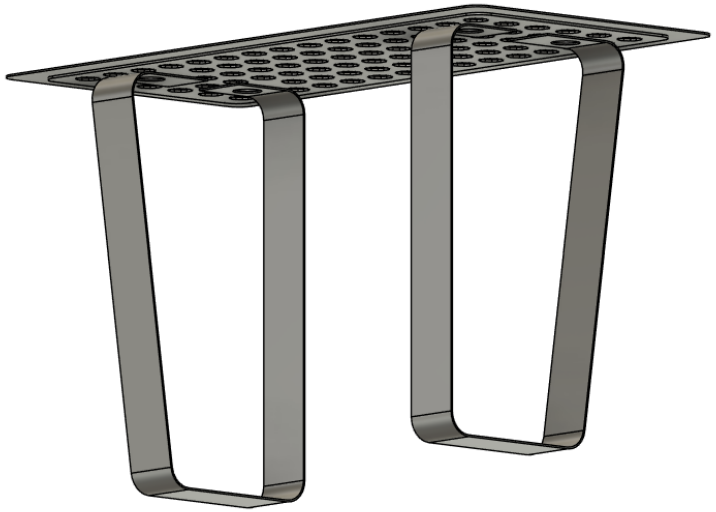
A collection of ultra-minimalist modern tables made from single-piece metal plates, displayed in a neutral, well-lit showroom. The tables feature very simple designs with as few parts as possible. One table is a single curved metal plate forming both the top and the base in a seamless flow, another is a flat plate bent at precise angles to create legs and support, and a third is a monolithic structure with a continuous, smooth surface. The finishes are polished or matte, emphasizing simplicity and modernity. The environment is clean and neutral to accentuate the minimalist aesthetic.

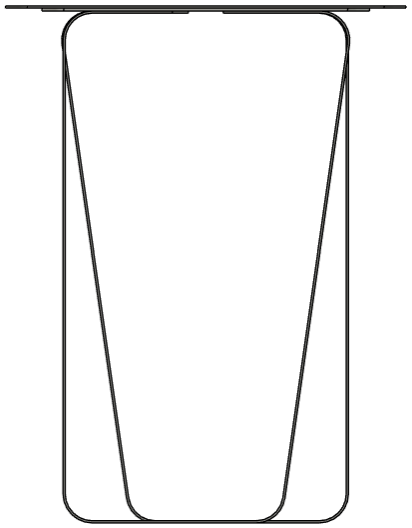
(SHEET) METAL TABLE DESIGNS – GEN AI

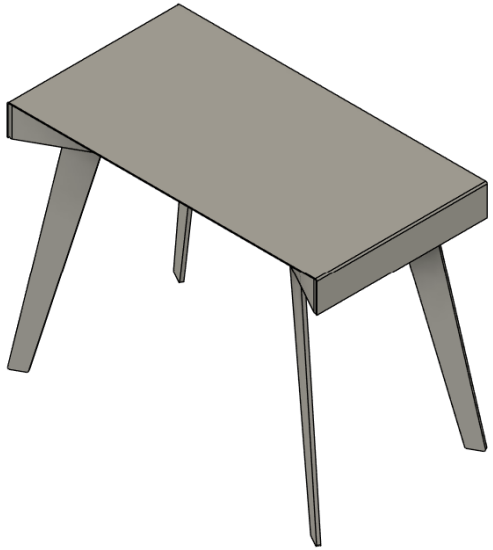


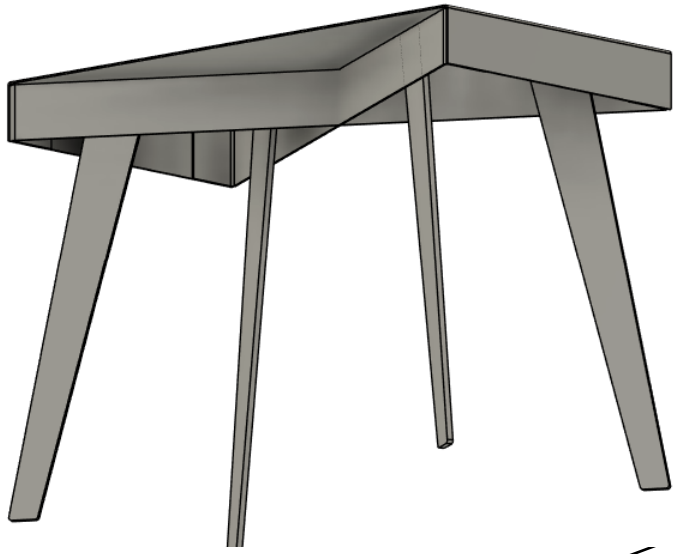
A collection of innovative and modern table designs made from metal sheets, featuring sleek and minimalist aesthetics. The tables showcase geometric forms, such as folded, perforated, or curved metal sheets, with a polished or matte finish. Some designs include interlocking elements, angled supports, or layered patterns, highlighting functionality and industrial elegance. The setting is a clean studio environment with soft lighting that enhances the metallic textures and surfaces.

SHEET METAL TABLE DESIGN ITERATIONS





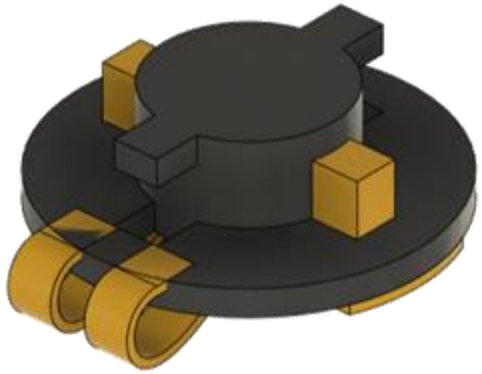


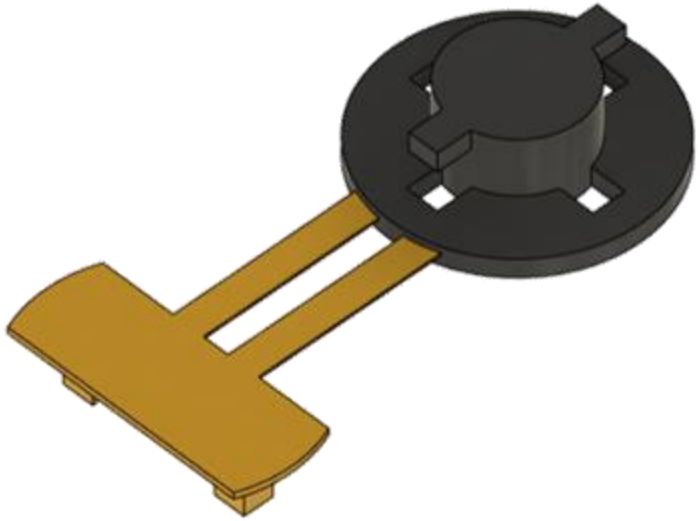


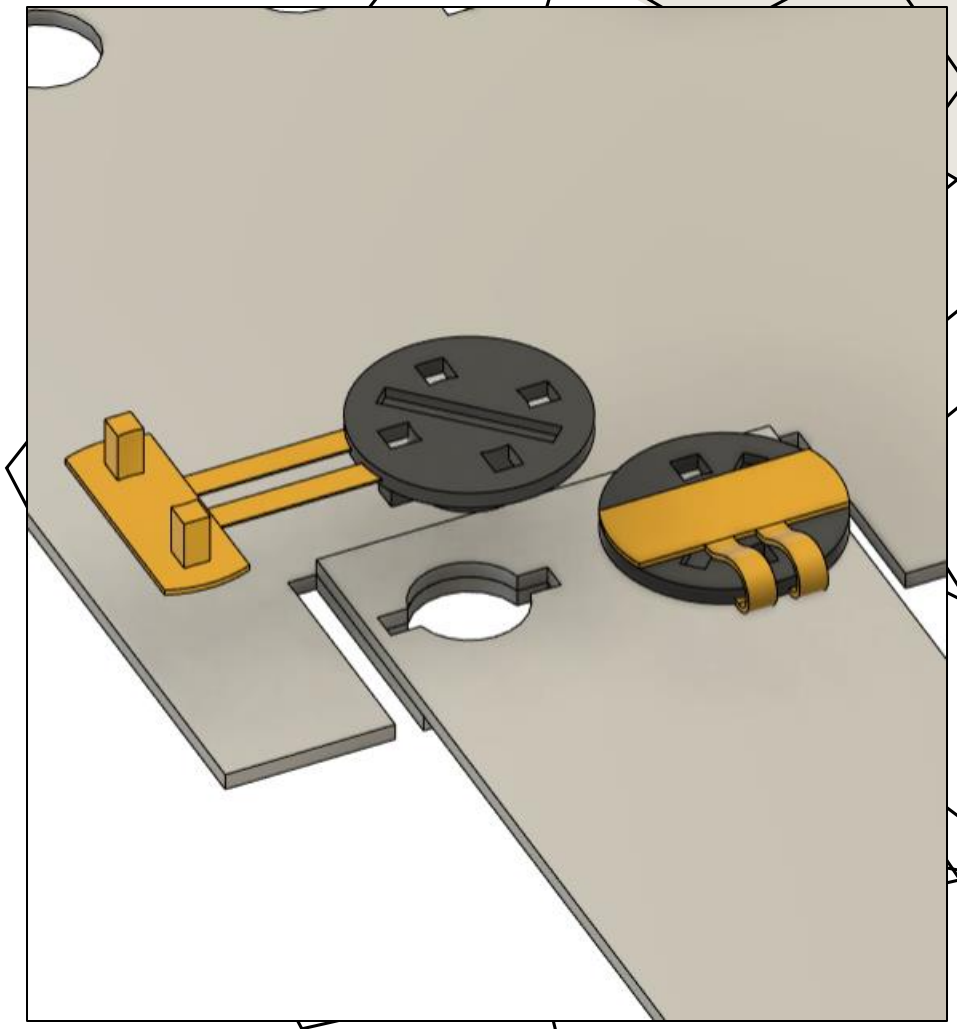
JOINT DESIGN ITERATIONS

Jointly

WITH LOCKING TAB



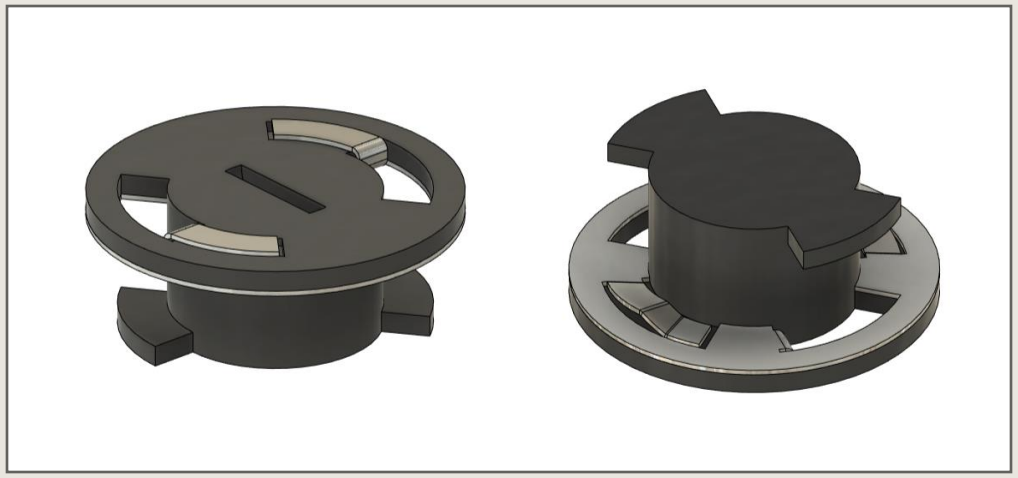


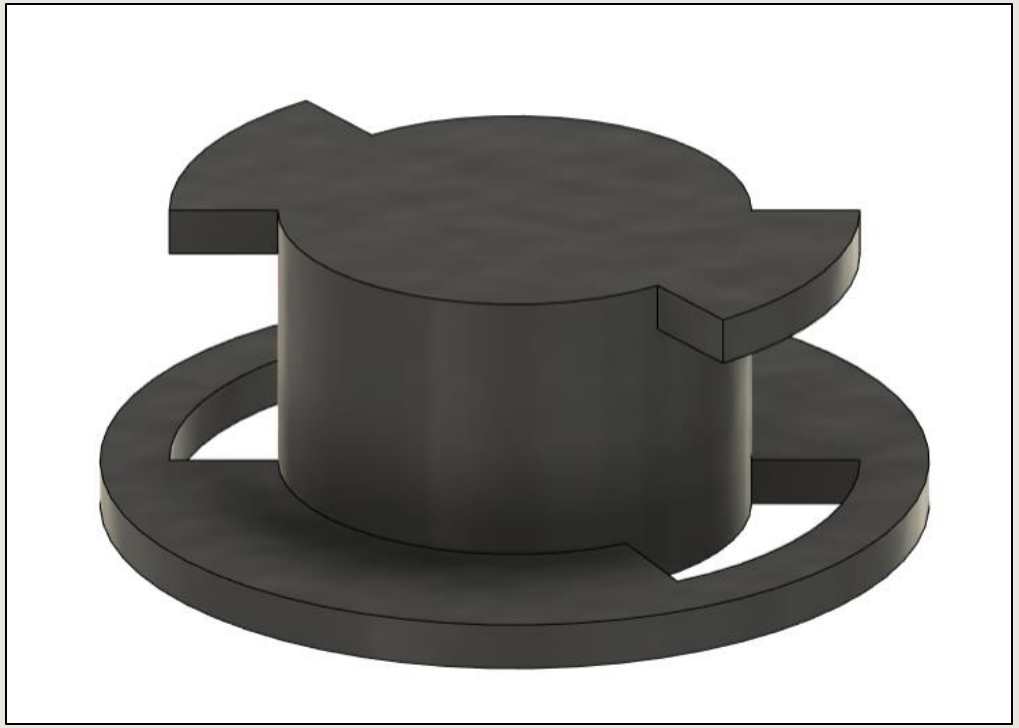


JOINT DESIGN ITERATIONS

Jointly

WITH SPRING
FRICTION FIT





Jointly

Fasteners

Part 1 – Fastener body

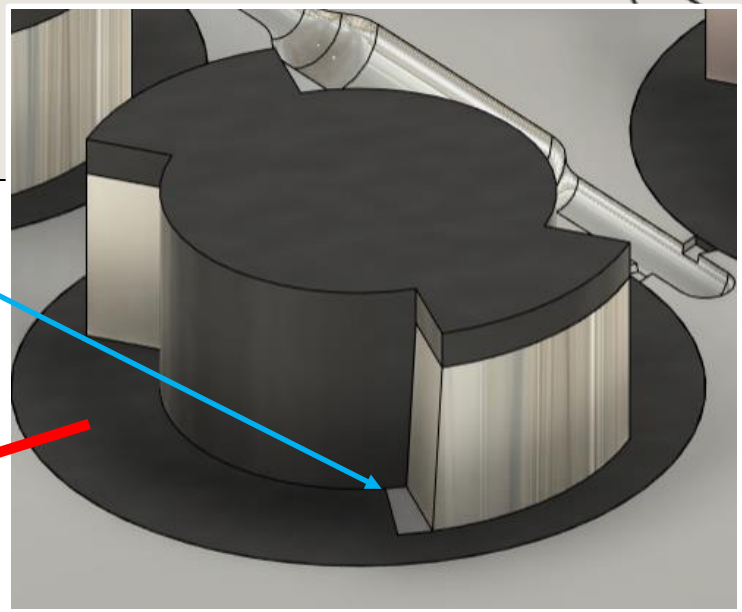
<u>Option 1</u>
Material: Nylon / ABS
MFG Method: Injection Mold / Casting

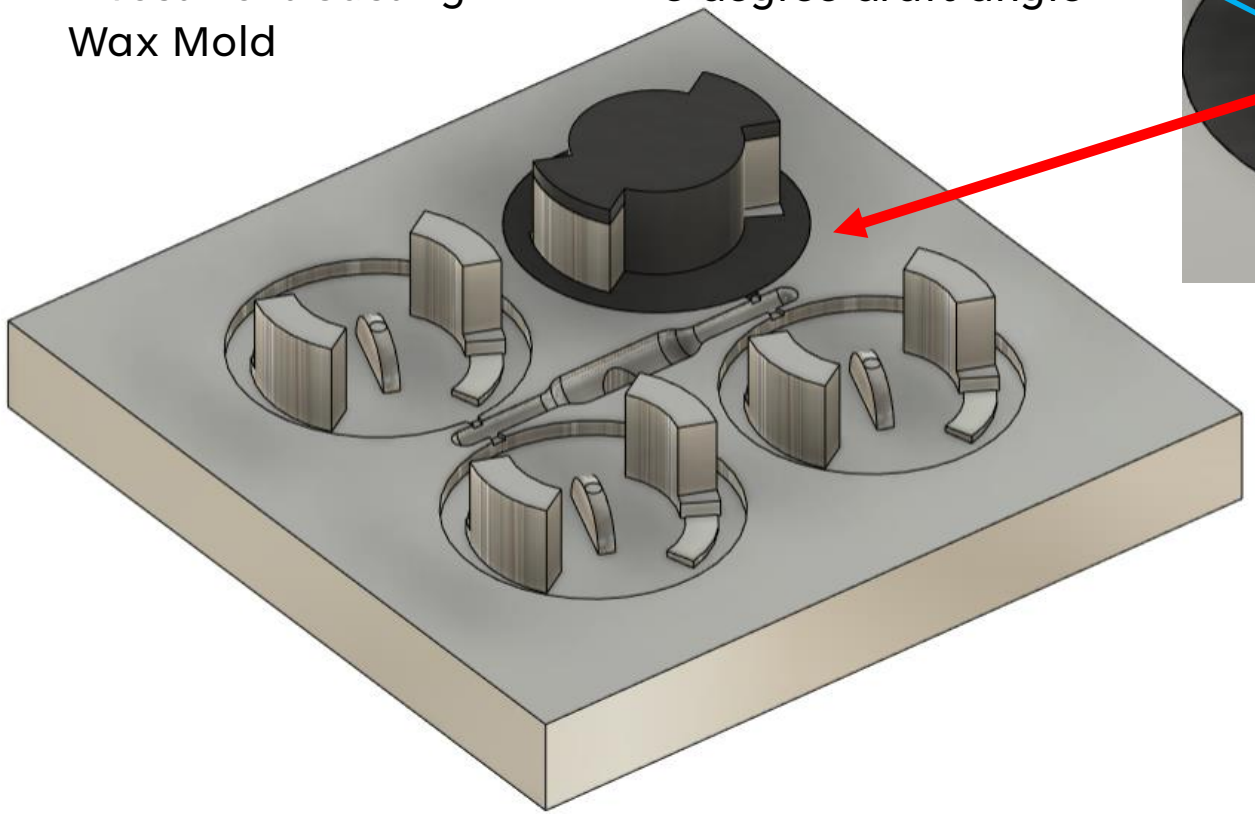
<u>Option 2</u>
Material: Aluminium
MFG Method: Investment Casting

Mold Design – Fastener body

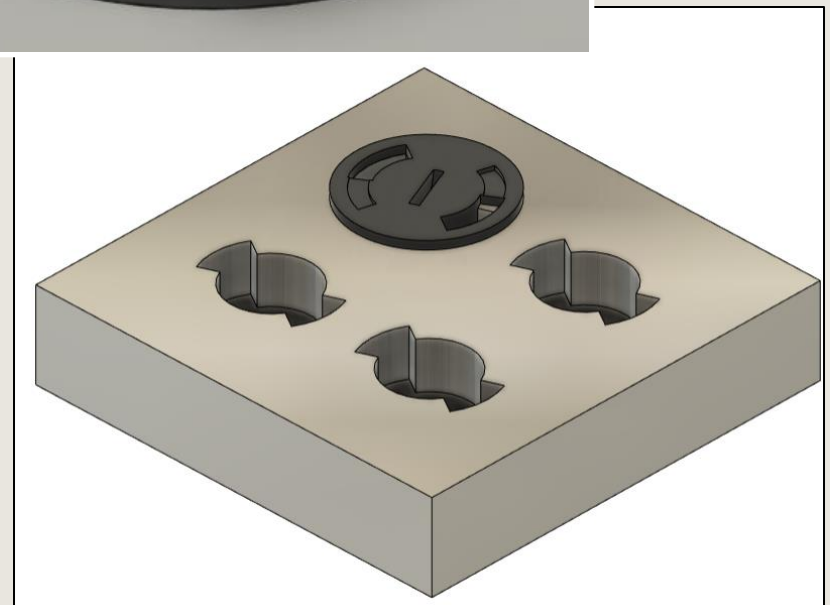
- ✓ Injection Mold
- ✓ Investment Casting Wax Mold

- Shutoffs for undercut
- 3 degree draft angle

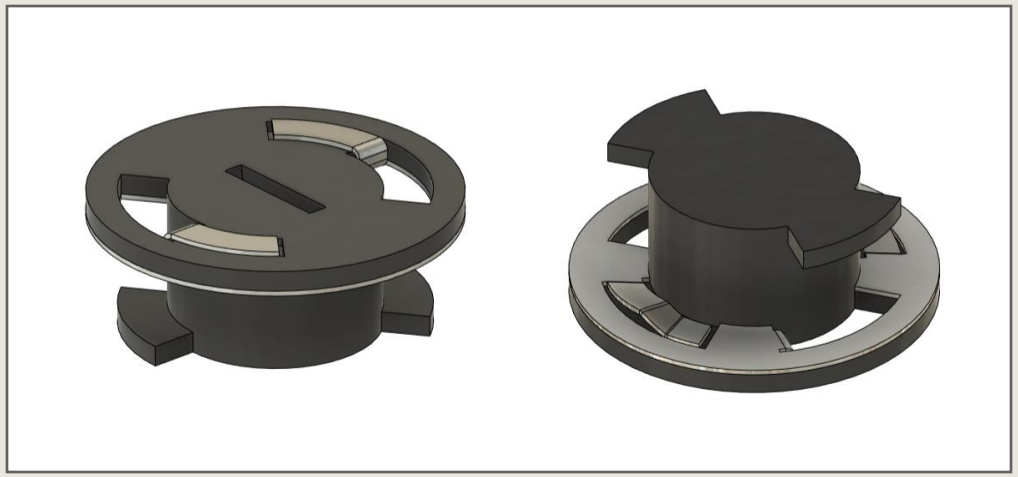


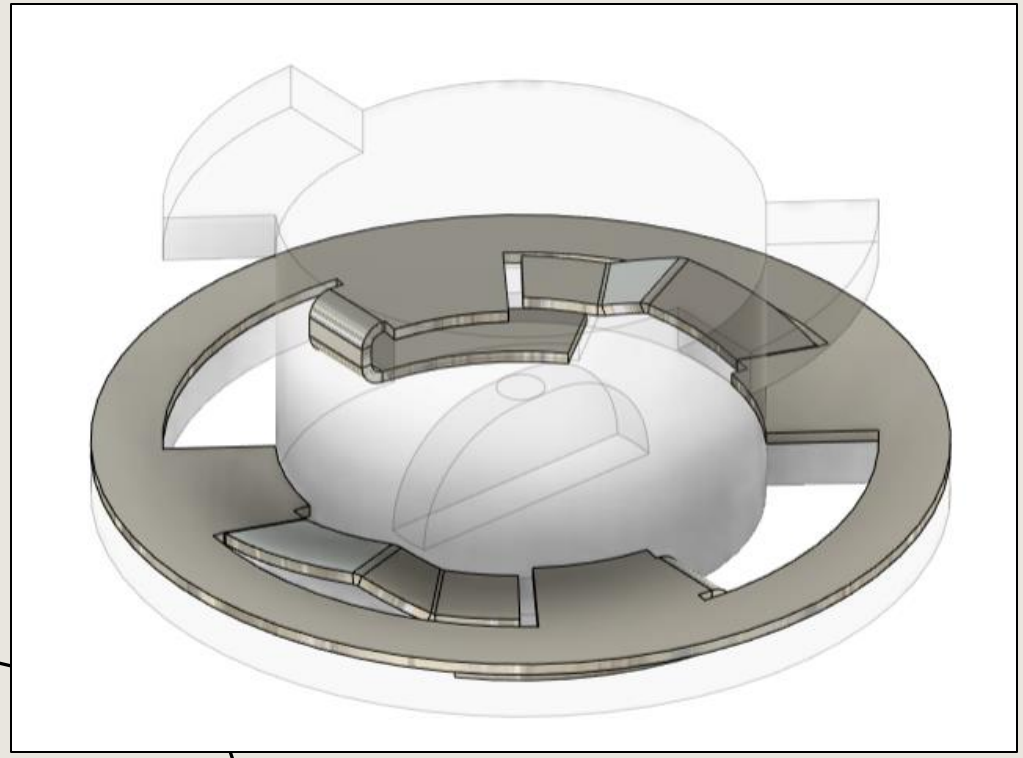


Core



Cavity





Jointly

Fasteners

Part 2 – Spring

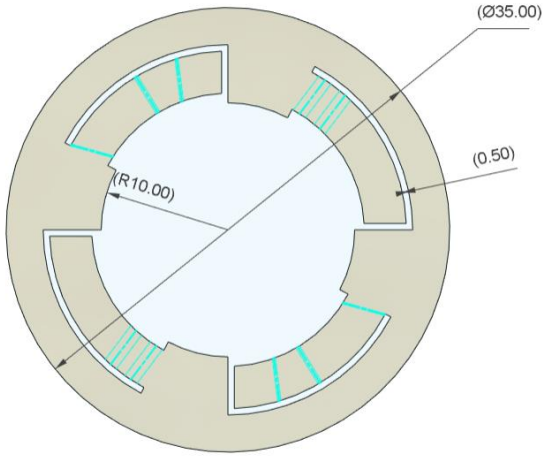
Creates friction fit

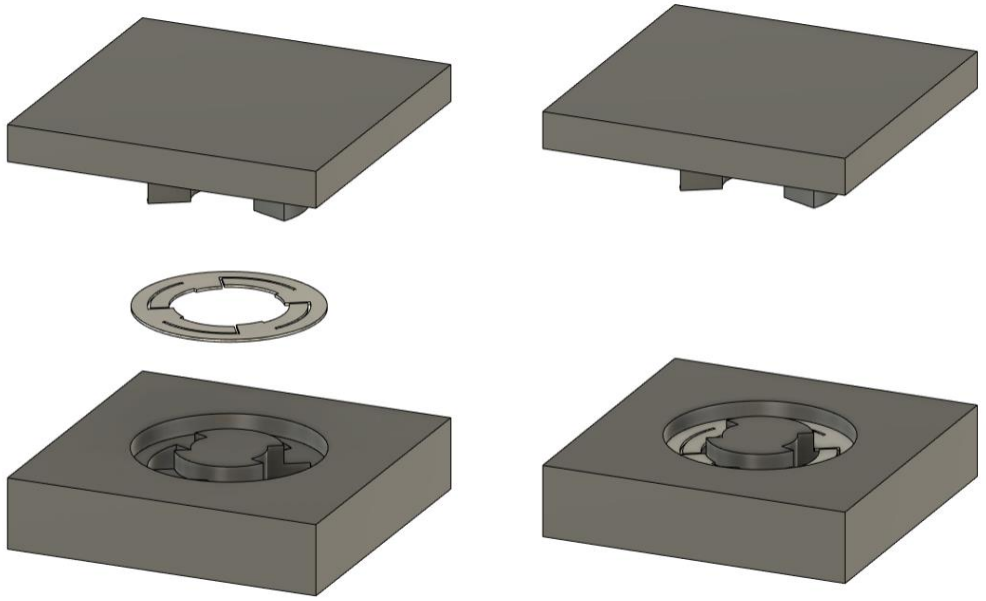
Material: 0.5mm Spring Steel

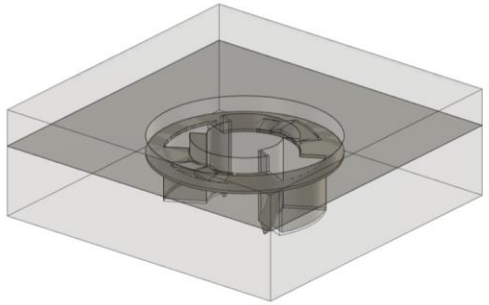
MFG Method: Shearing / Water Jet + Bending

Manufacturing Process – Spring

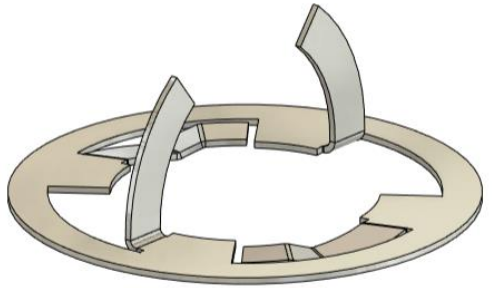
1 – Cut spring steel sheet



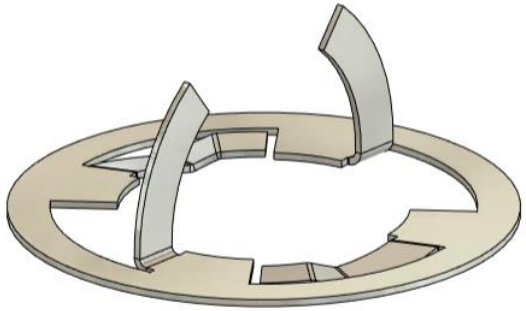


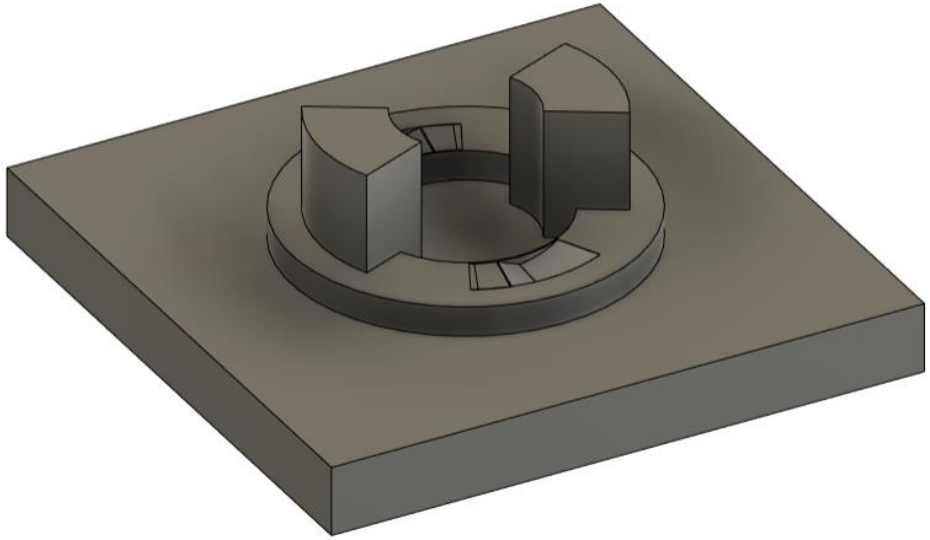


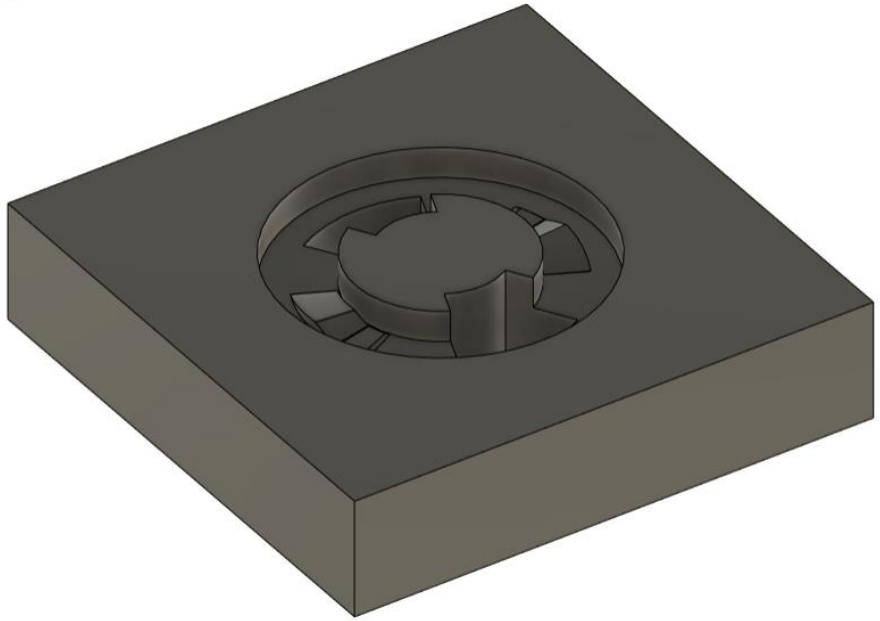
2 – Stamp / press / bend
spring steel using emboss



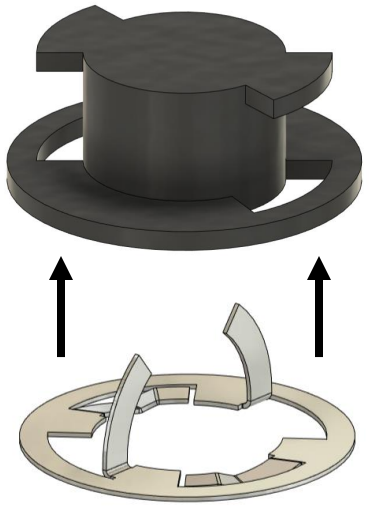
Manufacturing Process – Spring

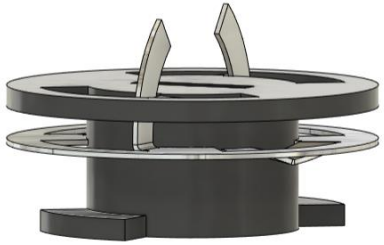


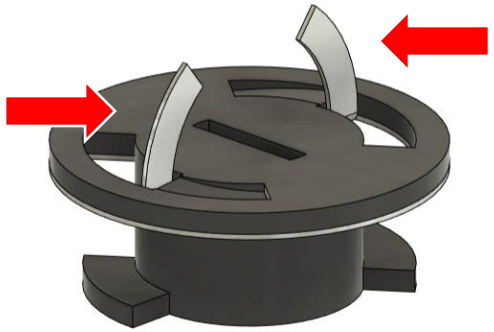


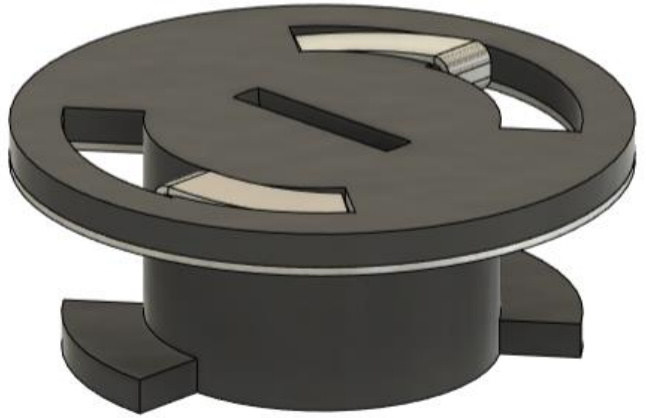


Jointly Part Assembly Process









3 – Fit spring into main body

4 – Press to bend spring and lock into place

DELIVER

Prototyping solutions

PROOF OF CONCEPT

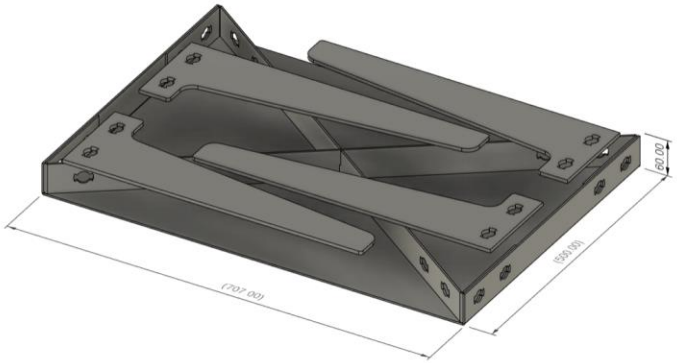
PROTOTYPE

Flat-packed

sheet metal table

Tool-free assembly using

Jointly fasteners



PROOF OF CONCEPT

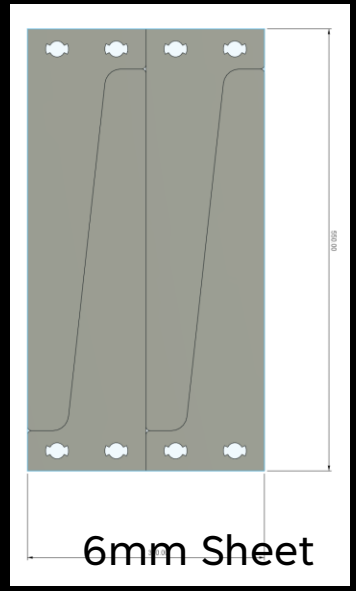
PROTOTYPE

Flat-packed

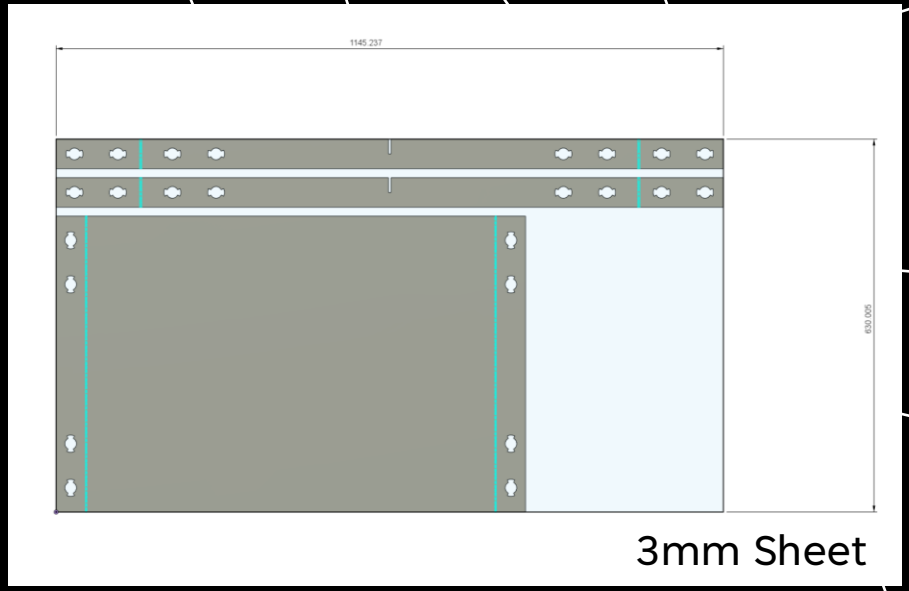
sheet metal table

Tool-free assembly using

Jointly fasteners



6mm Sheet



3mm Sheet

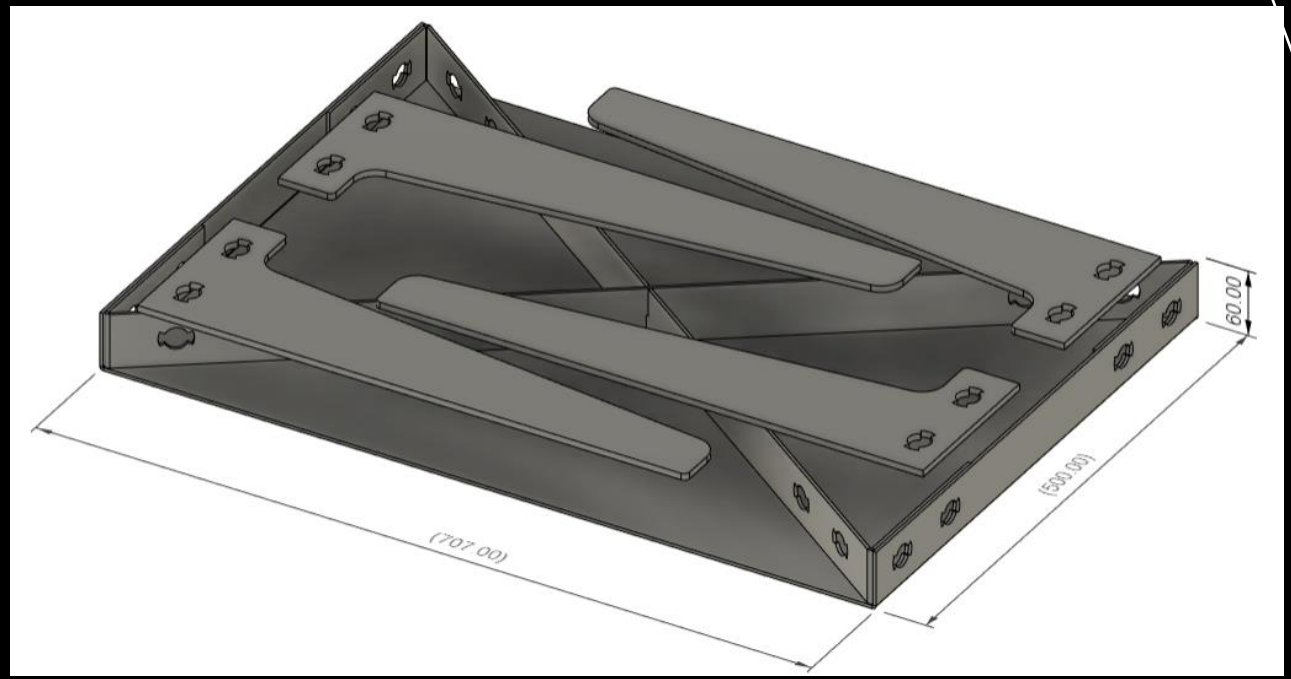


Table Design (prototype POC)

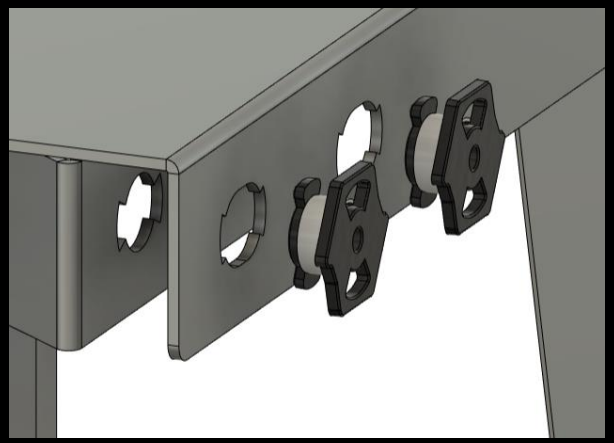
Material: Aluminium Plates (3mm, 6mm)
MFG Method: Water Jet + bending
Flatpack Size: 707mm x 500mm x 60mm
Joints Required: 16

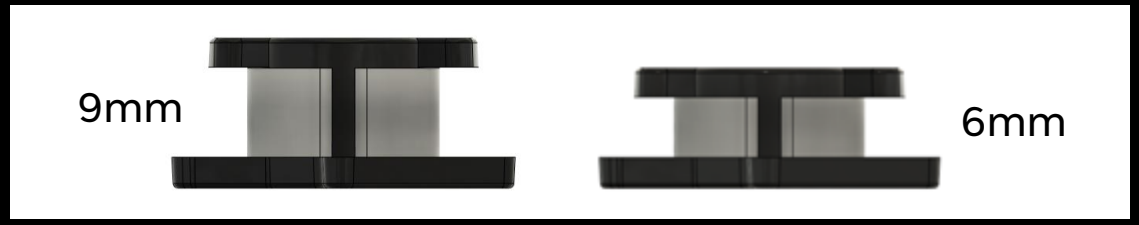
Jointly

Fasteners

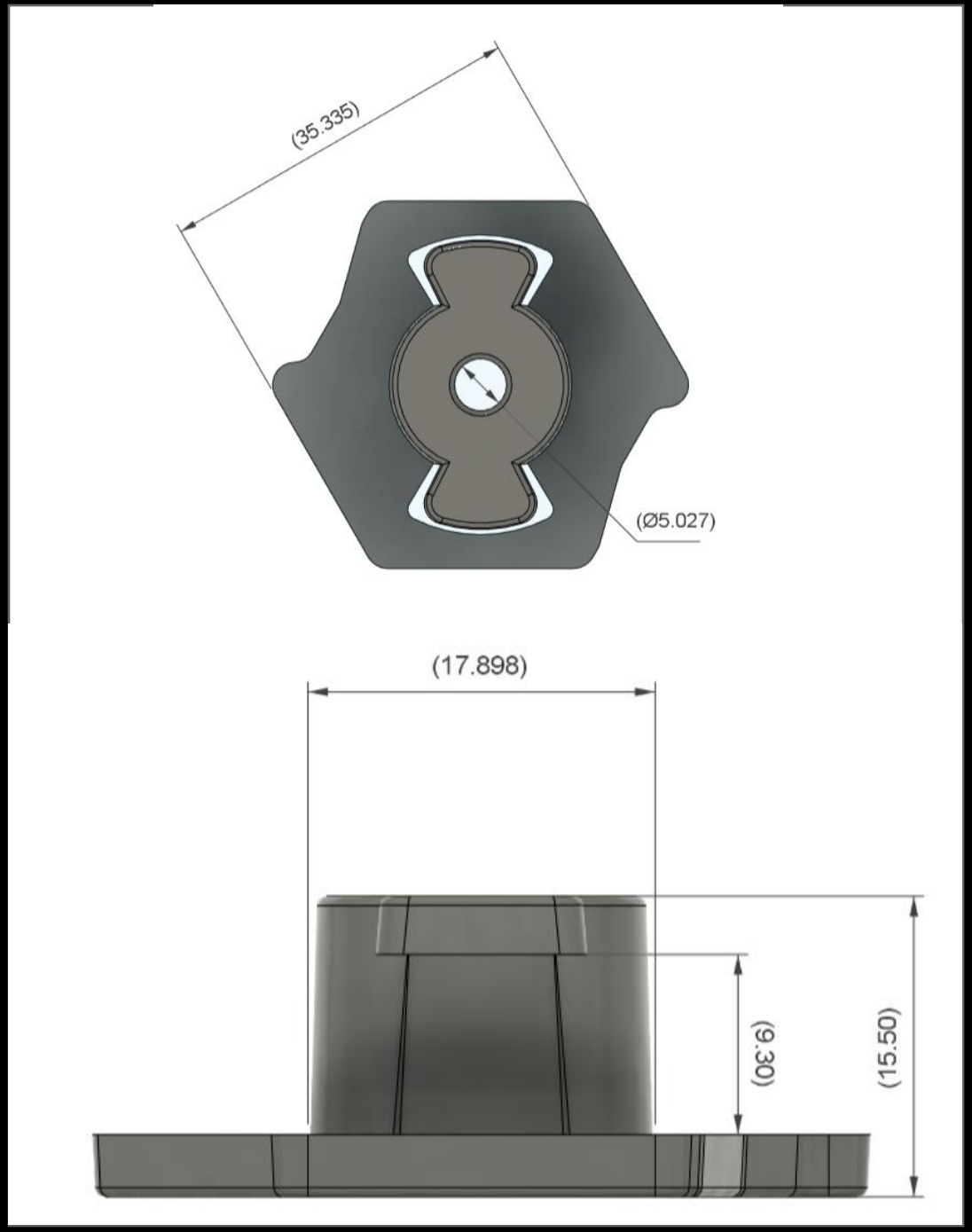
Toolless usage

2 parts
sizes
motion



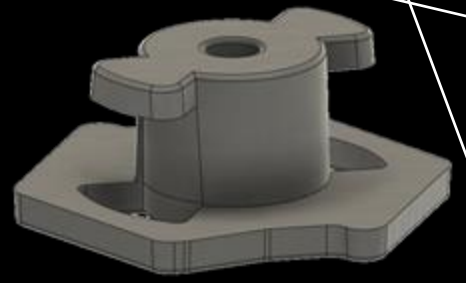


Material: Nylon/ABS



Jointly

Fasteners

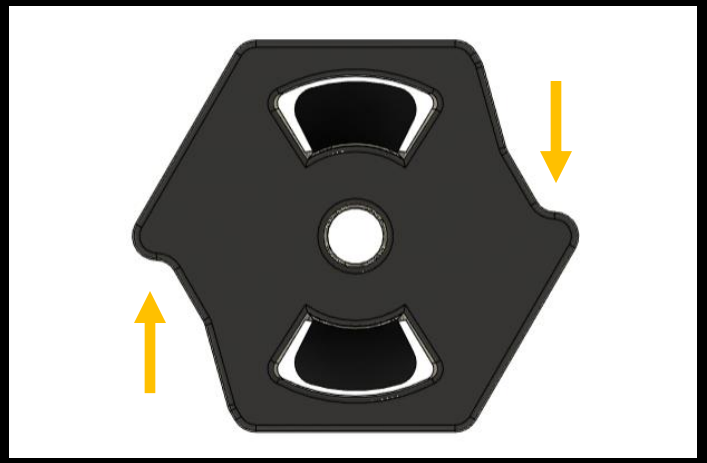


Part 1 – Fastener body

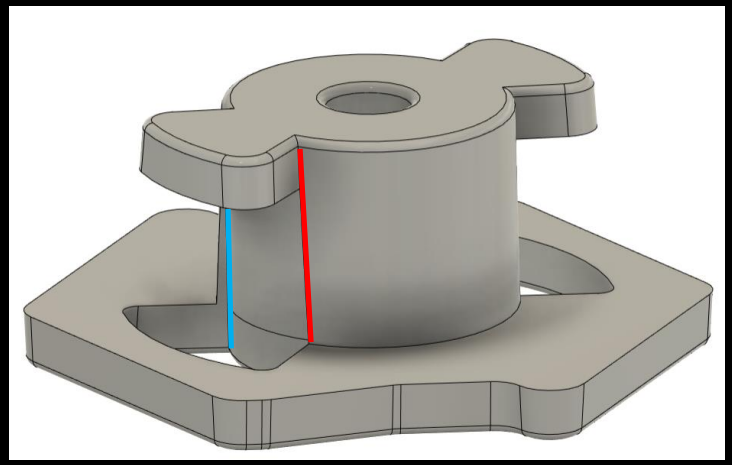
Option 1
Material: **Nylon / ABS**
MFG Method: **Injection Mold / Casting**

Option 2
Material: **Aluminium**
MFG Method: **Investment Casting**
Rejected: **tight tolerance required & cost**

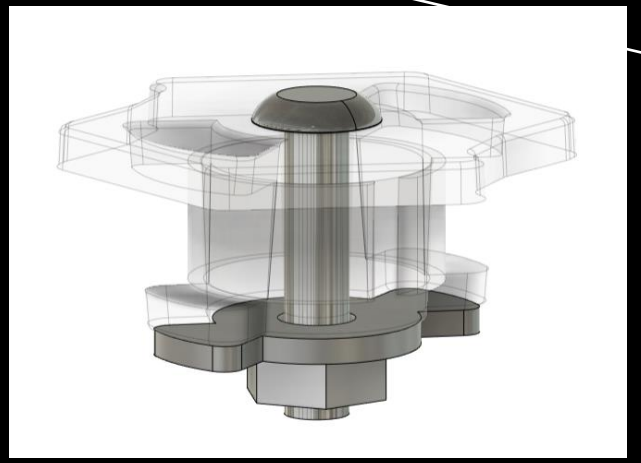
Part Features



Ergonomic design
for toolless twisting



Draft angles for
Injection moulding

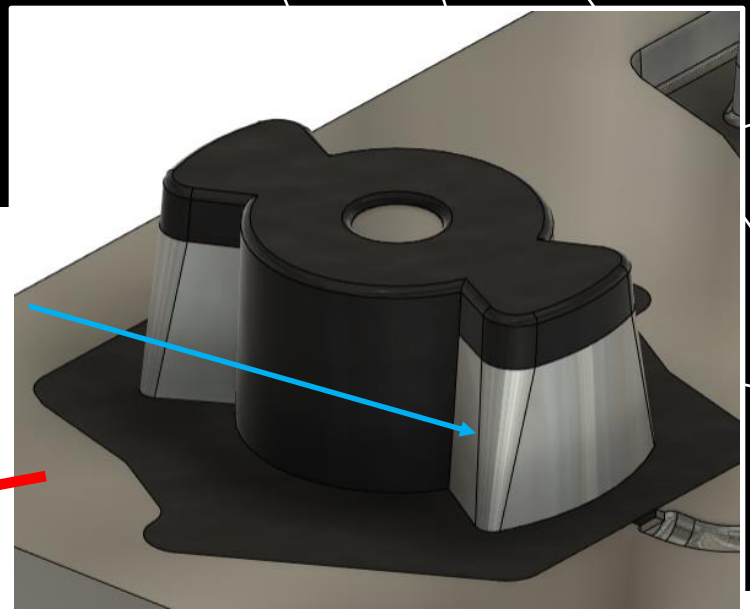


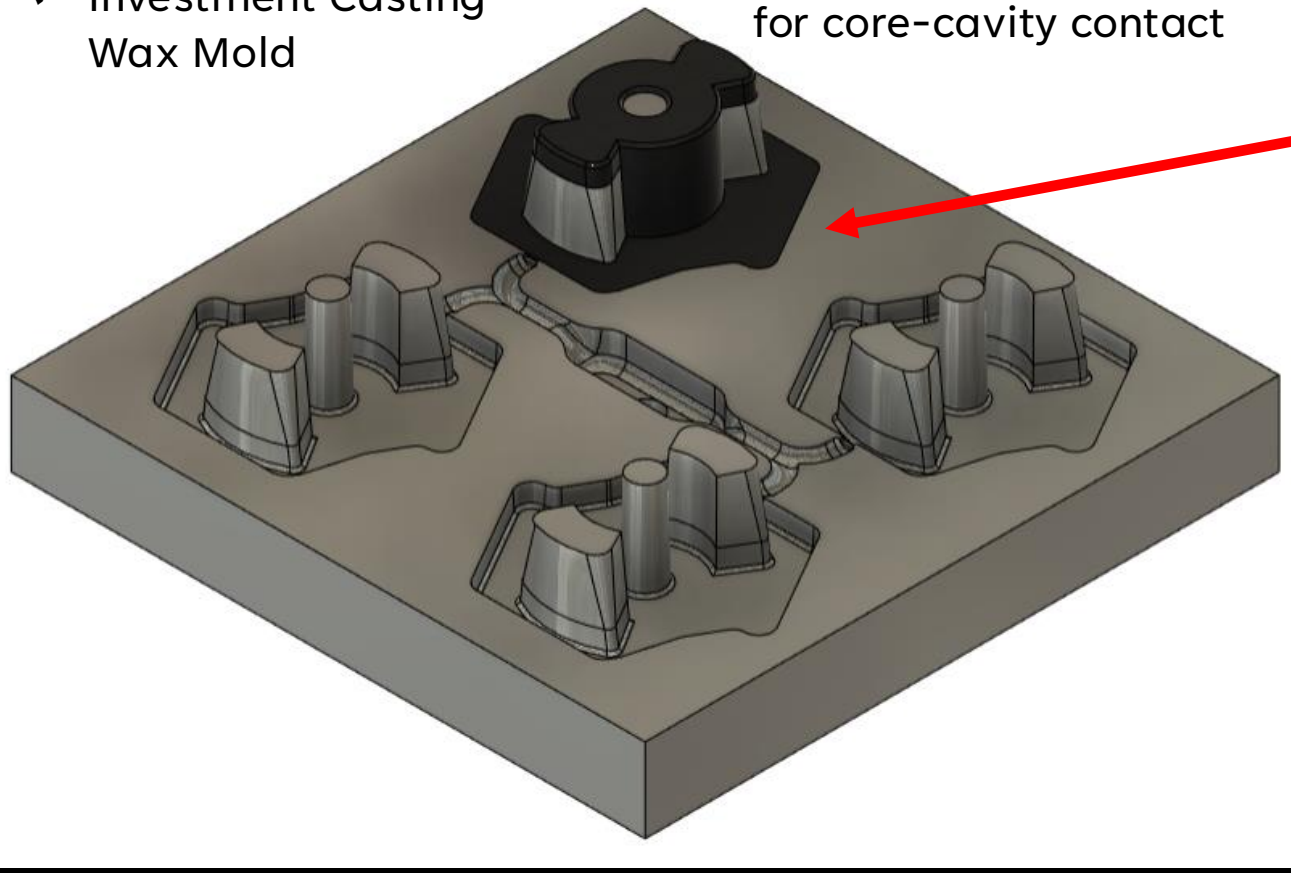
Thru-hole for M5
bolt and extra
securing plate
(optional)

Mould Design – Fastener body

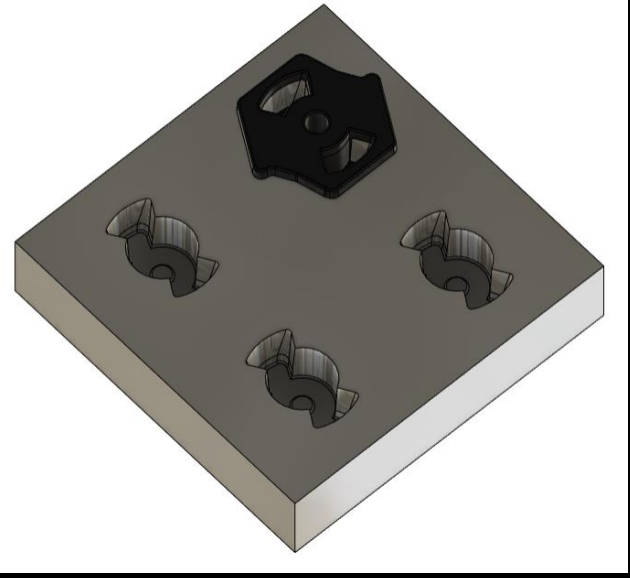
- ✓ Injection Mold
- ✓ Investment Casting Wax Mold

- Shutoffs for undercut
- min. 3 degree draft angle for core-cavity contact



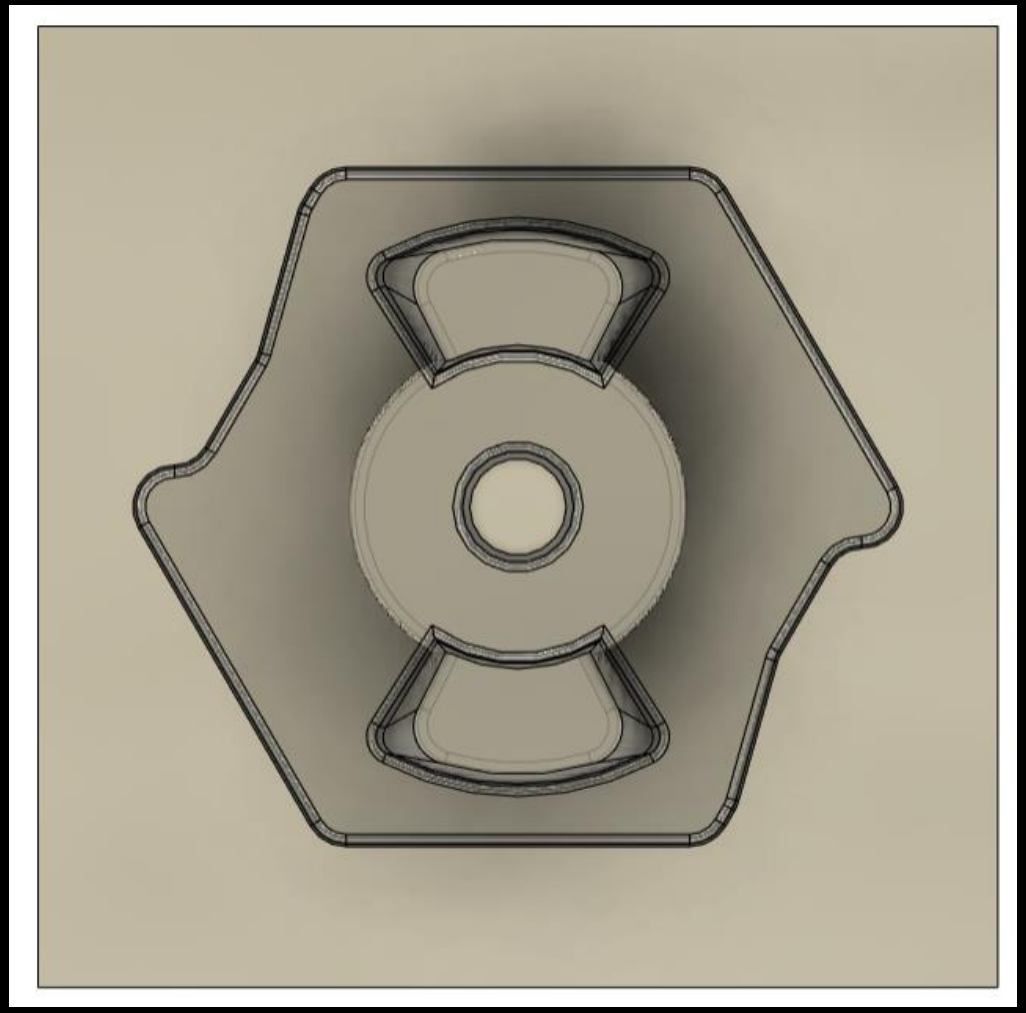


Core



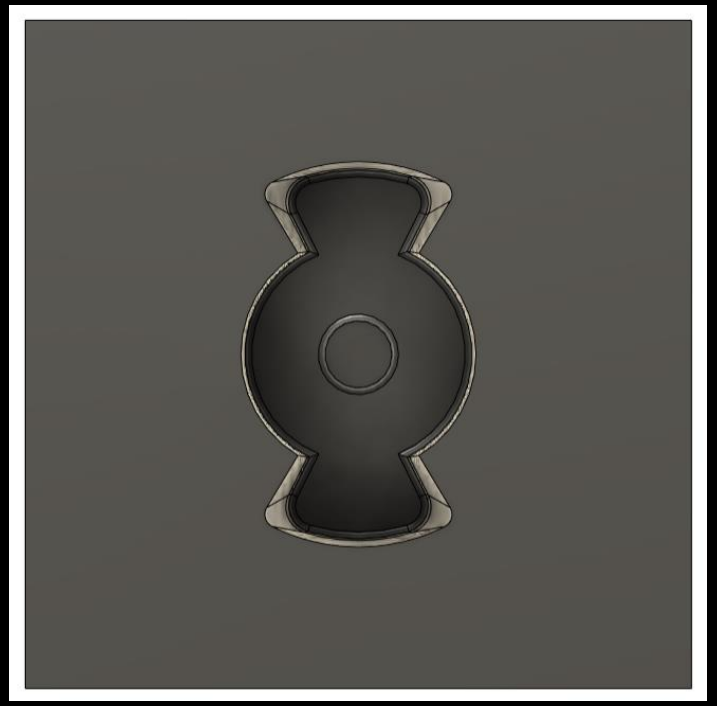
Cavity

Mould Design – Fastener body

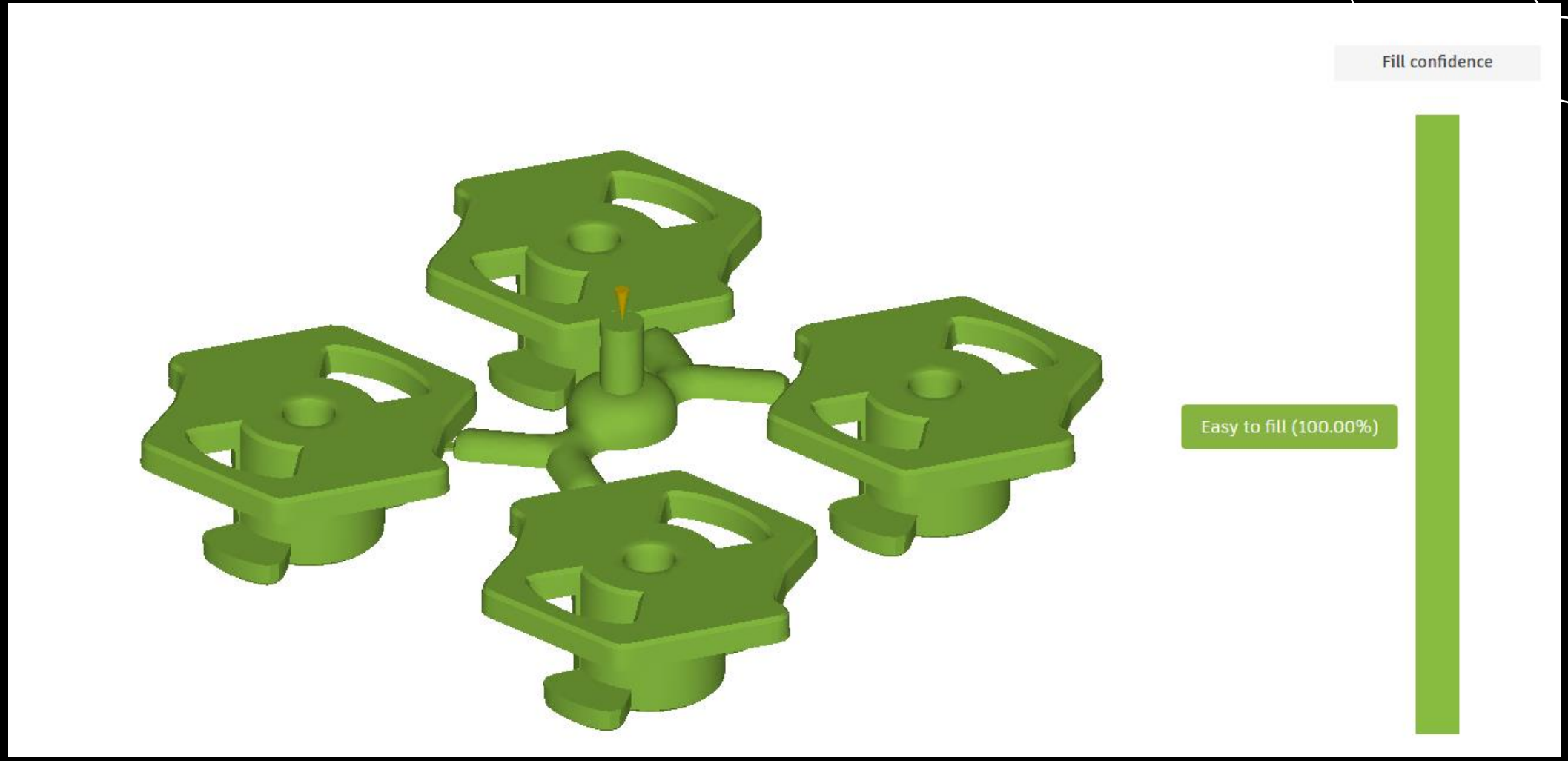


Mold Milling

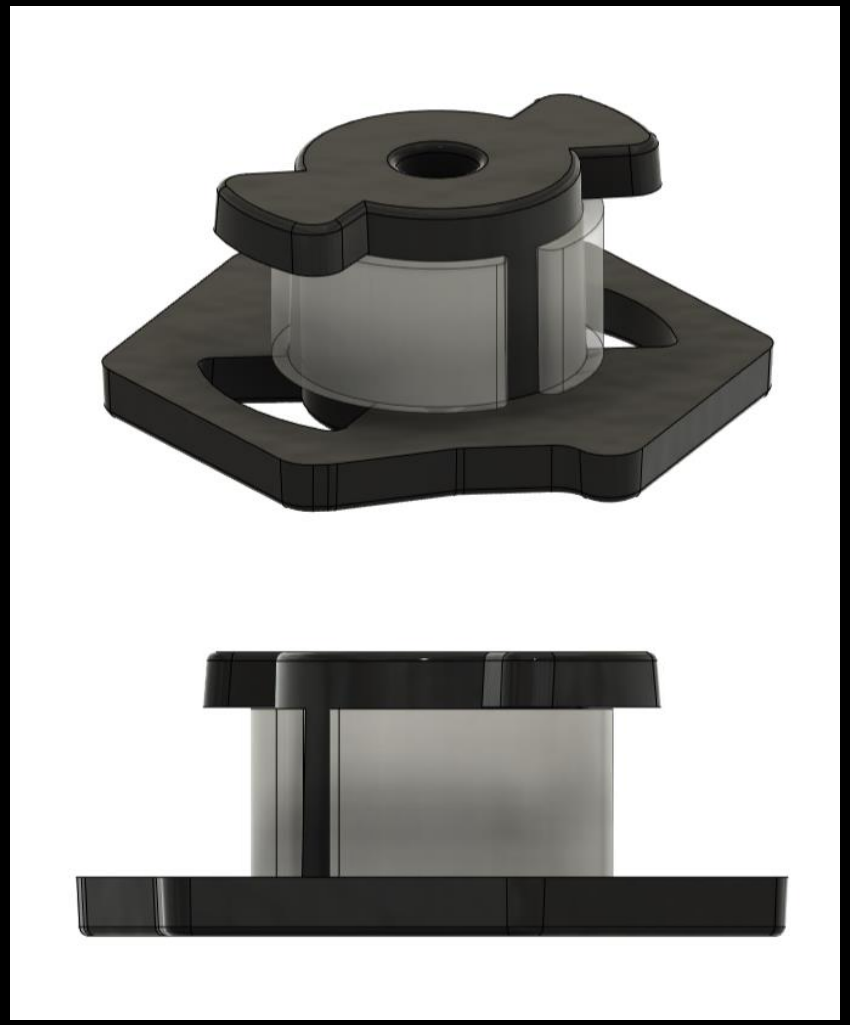
2mm radius

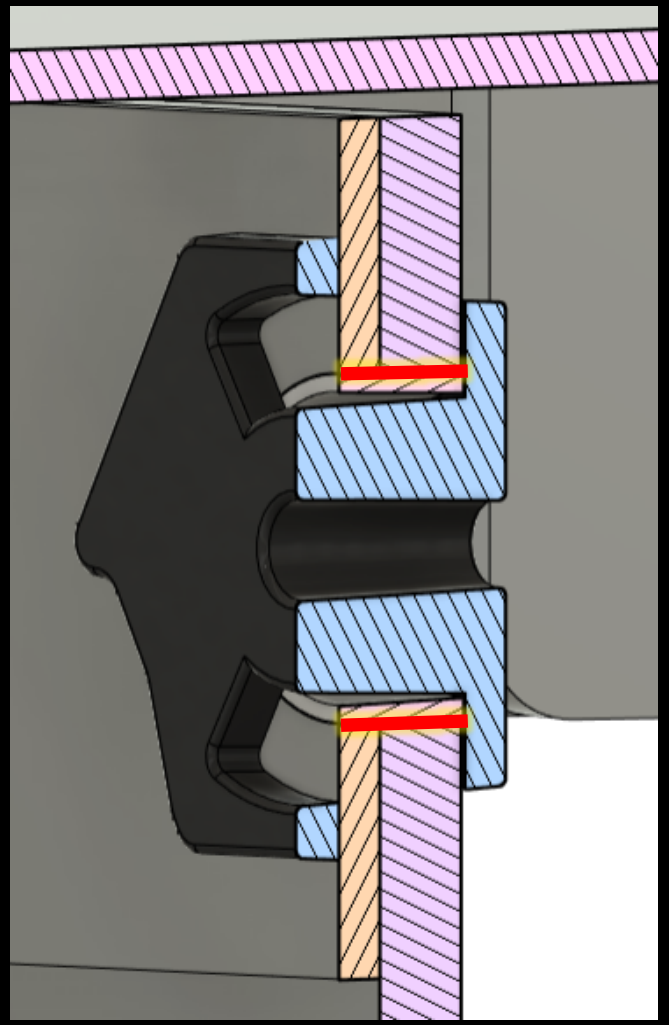


Injection Moulding – Simulation



Achieving 0 degree sidewalls - Bushing

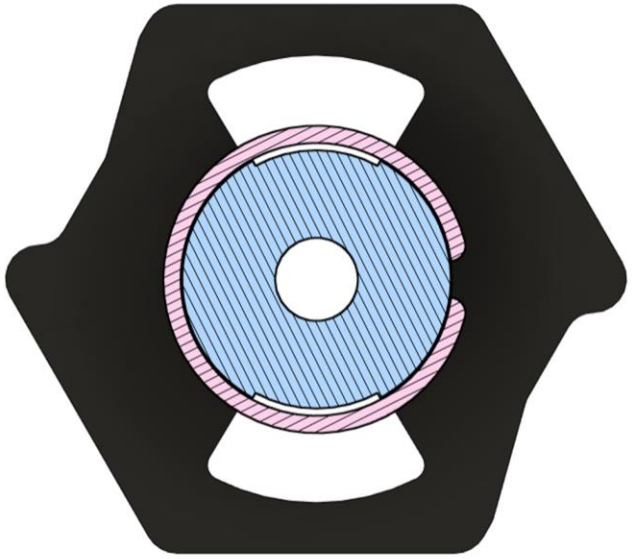


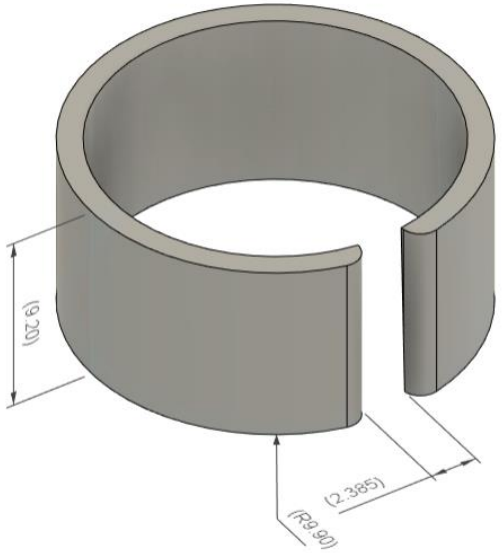


Ensuring proper fit thru plates

Acts as simple bearing

- reduces wearing against metal





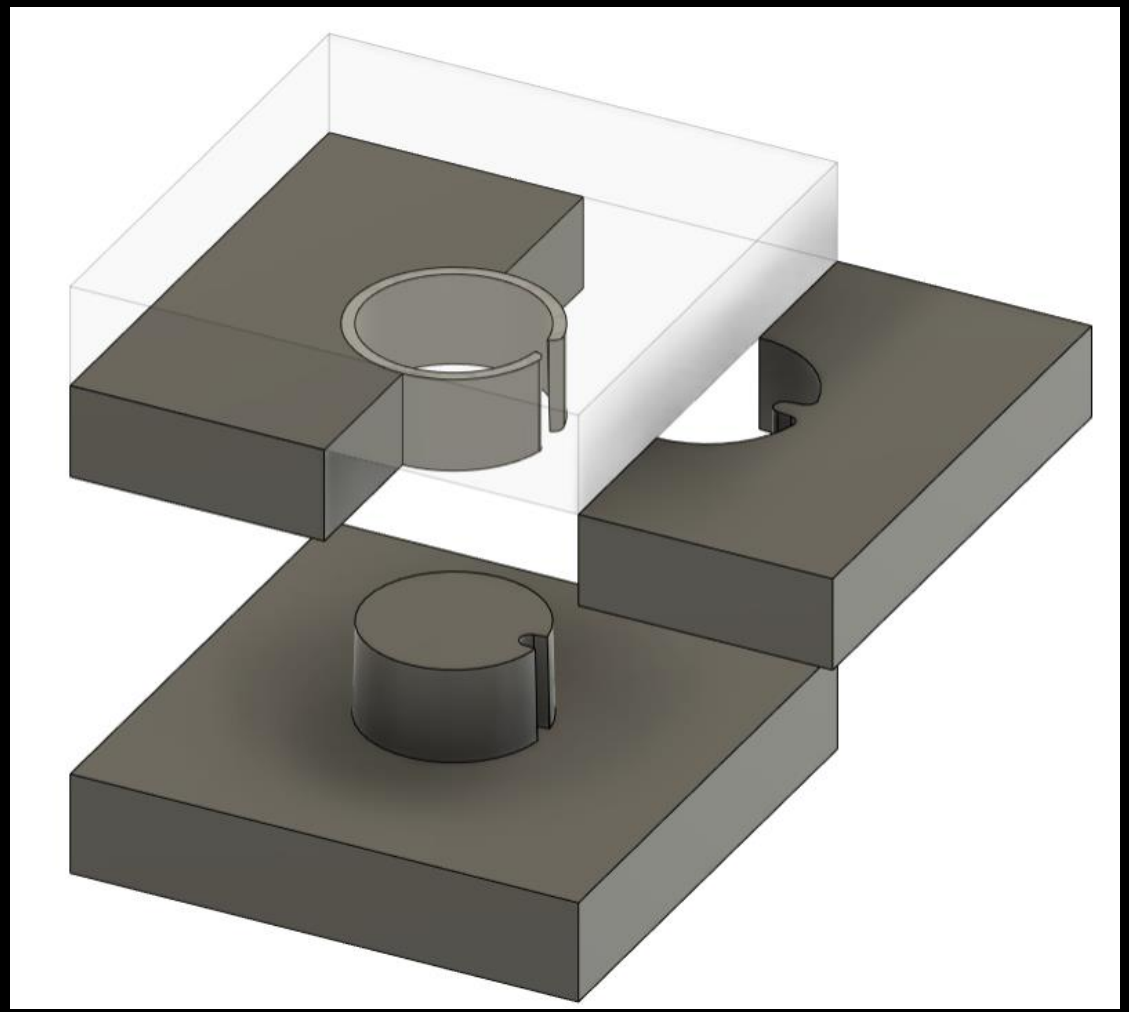
Jointly

Fasteners

Part 2 – Bushing

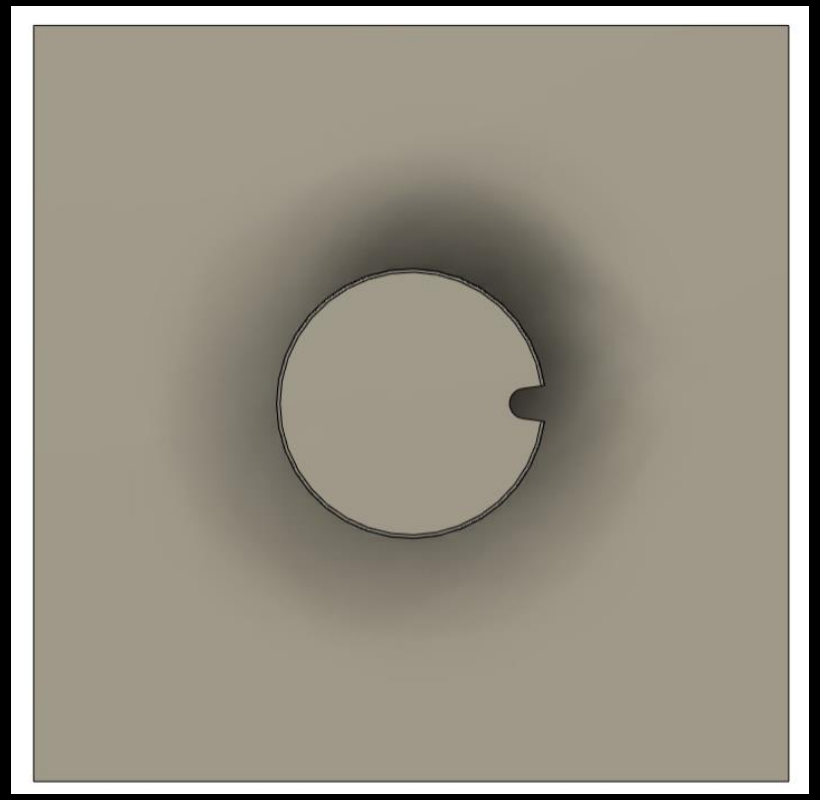
Material: **Nylon / ABS**
MFG Method: **Injection Mold / Casting**

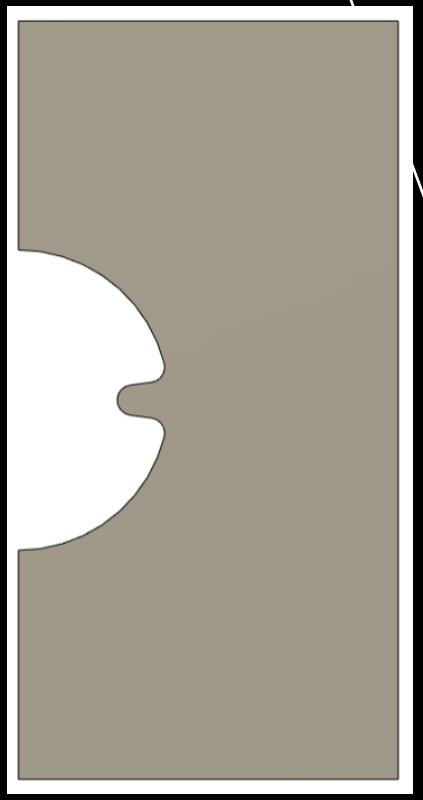
4-part Mould Design – Bushing



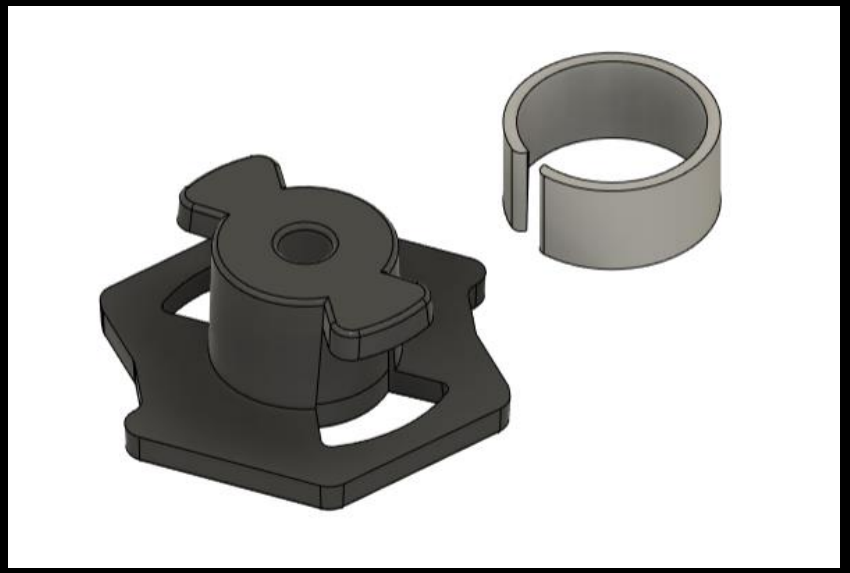
Mold Milling

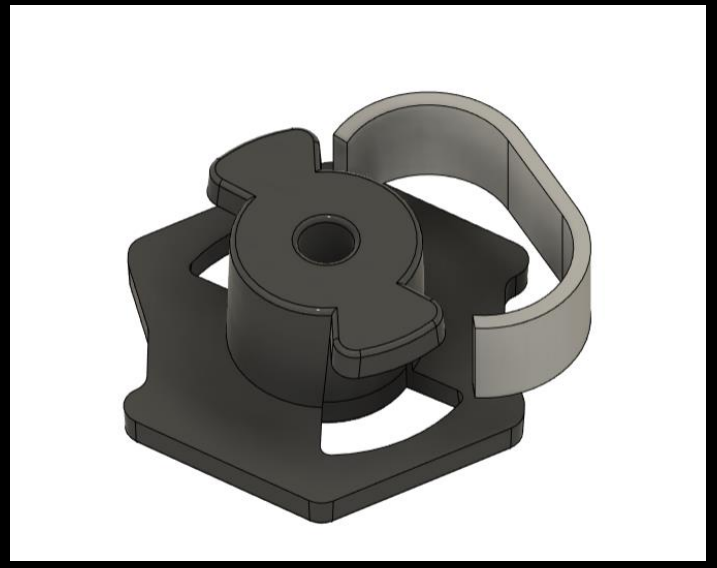
1-2mm radius

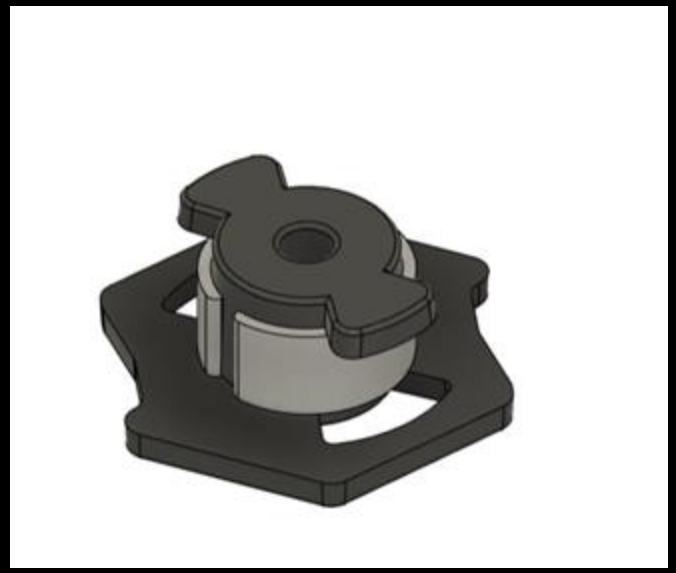




Assembly – Bushing

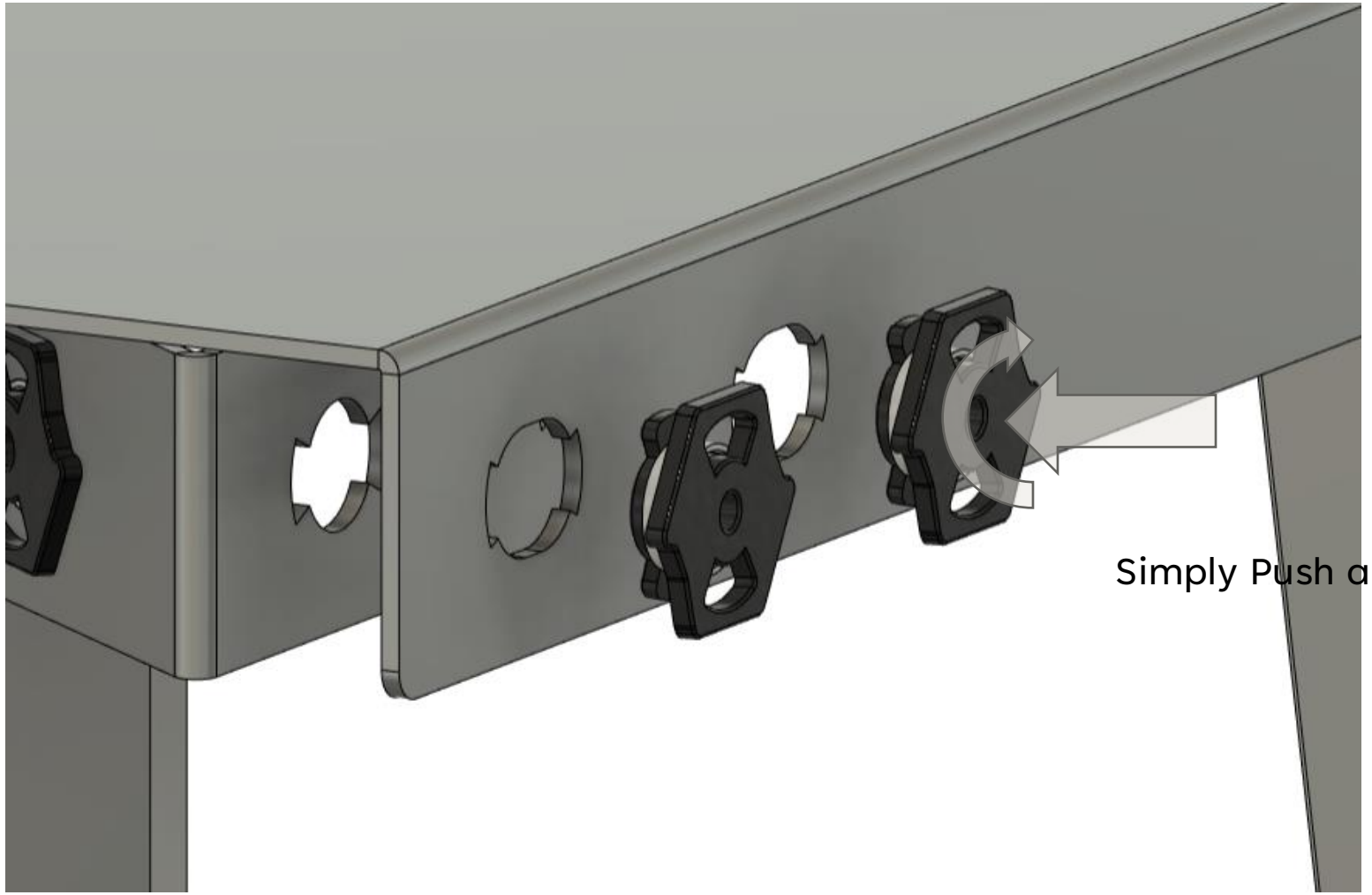






stretch and clip on

Assembly – Table using Jointly



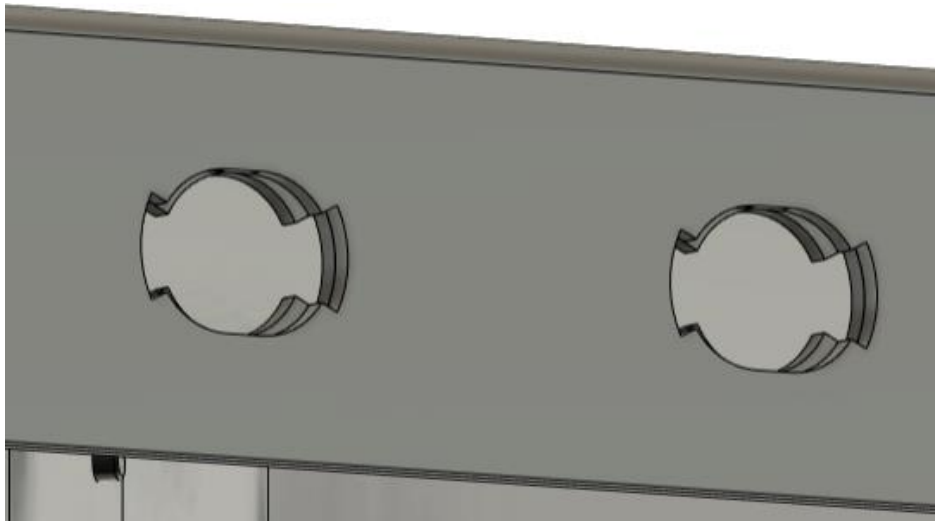
Tolerancing (cost saving)

Y-axis tolerance

Over bending allowed;
JOINTLY will pull structure back

Z-axis tolerance

Small gap eliminates interference



X-axis tolerance

Slightly wider hole in X direction for tabletop piece

PROTOTYPE TESTING

Testing the fabricated prototype in person

No injection moulding

Jointly

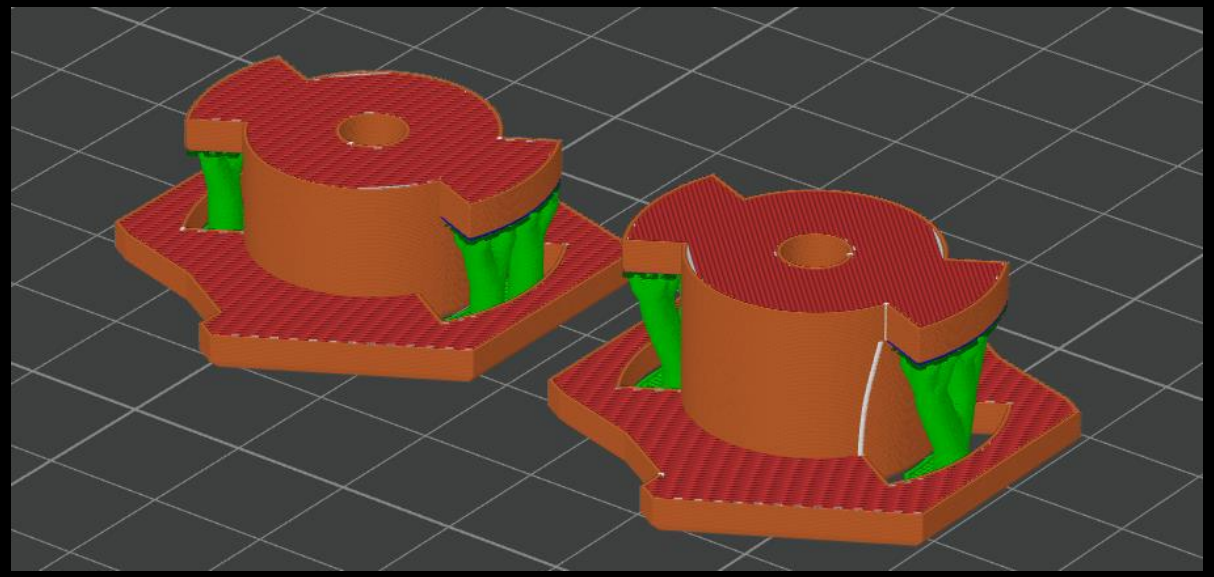
PROTOTYPE

Fastener body (1 part)

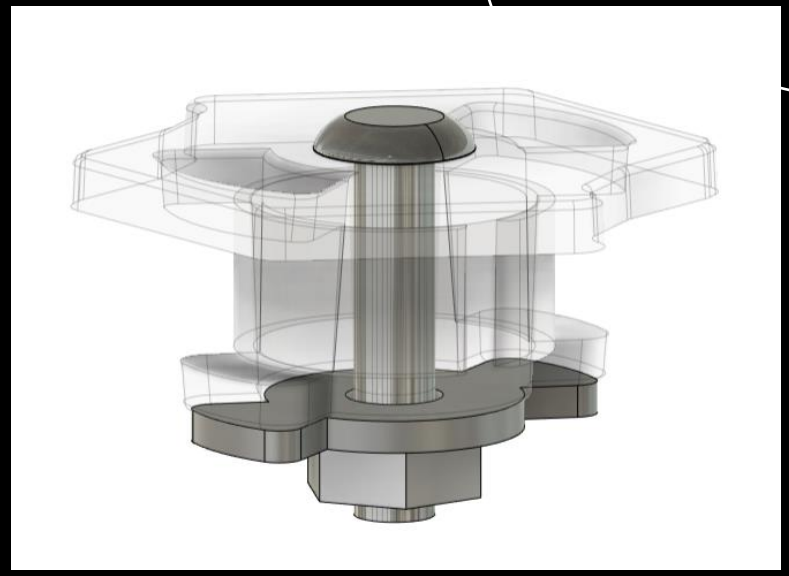
Prototyping
Material: PLA
MFG Method: FDM 3D Printing

Advantages: 0 degree draft angle; straight walls

3D Printing Prototype



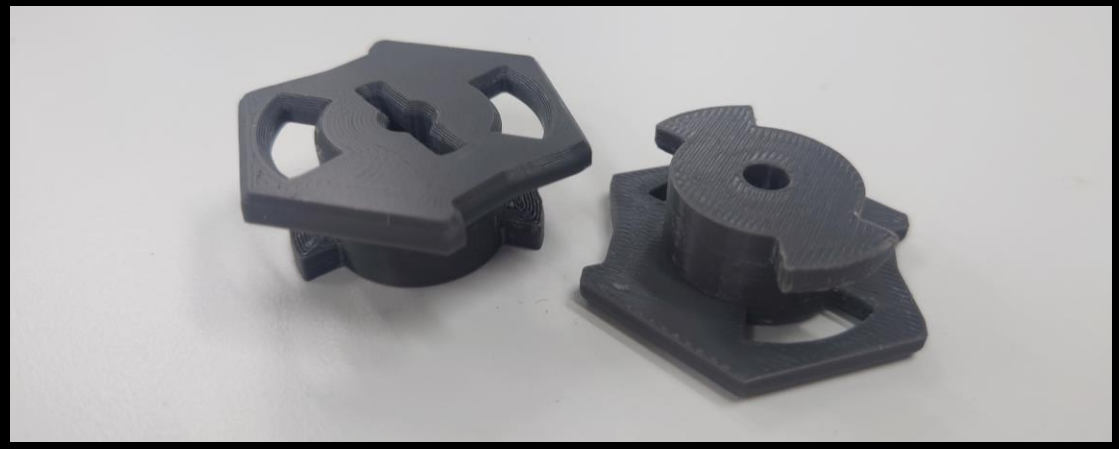
Tree supports

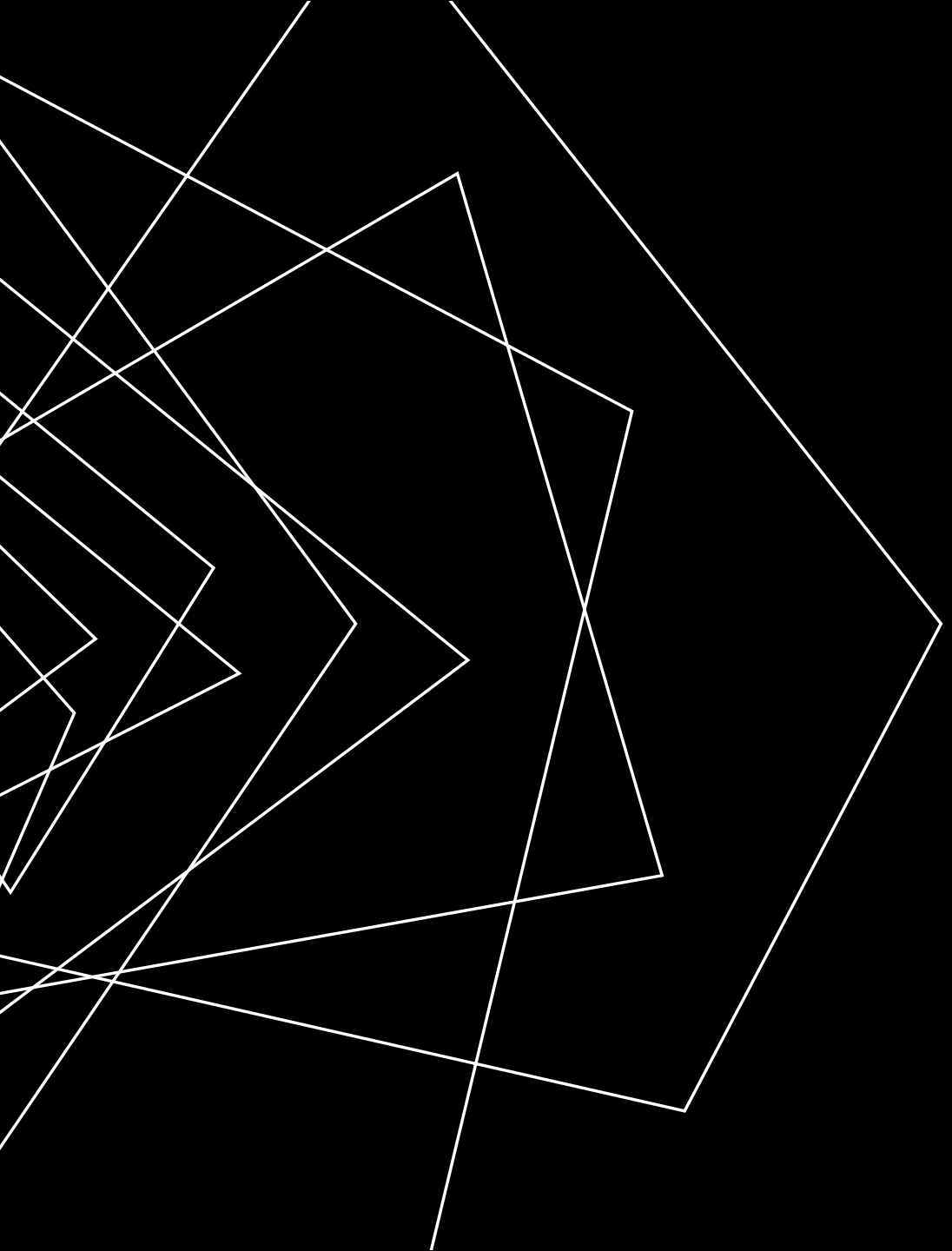


Thru-hole for M5 bolt and extra securing plate (borrowing strength)

Table (prototype) load testing

Sheet Material: Al-5052
Joint Material: **Prototype PLA FDM 3D Printed**
Joint Configuration: **no additional reinforcement**
Load: 69kg





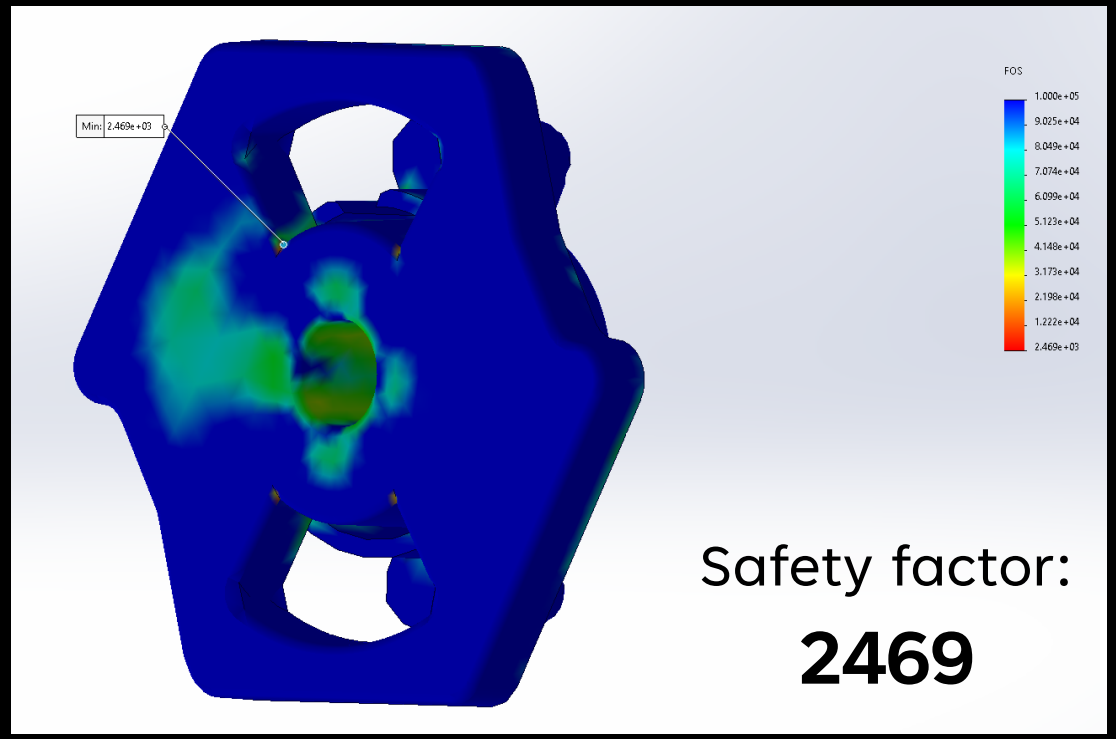
FINITE ELEMENT ANALYSIS

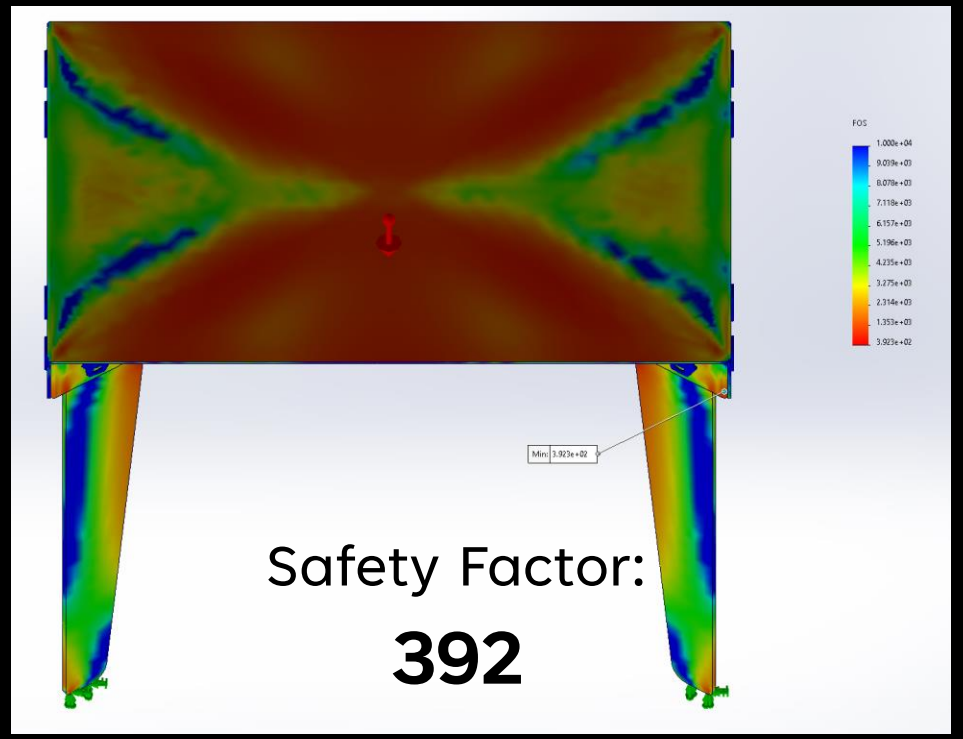
A quick study on the sturdiness of the table

Table (prototype) FEA simulation

Sheet Material: Al-5052
Joint Material: Nylon PA-6
Table legs fixed to ground
Safety Factor Plot (Jointly 6mm)

Test case:
- No external forces
- **Only gravity and weight of table**





Max Von Mises:
4.198e+4 N/m²

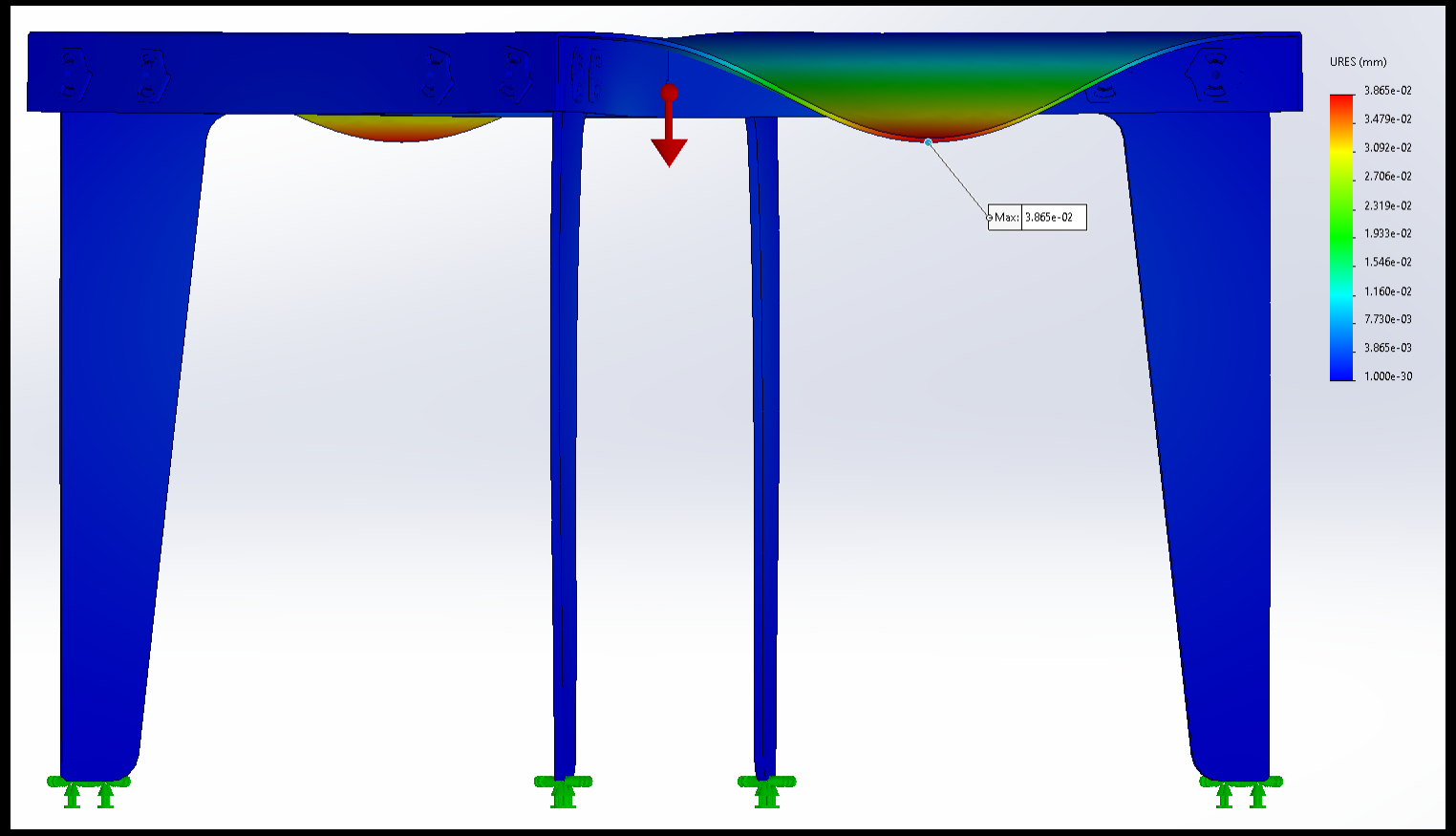
Max Von Mises:
4.971e+5 N/m²

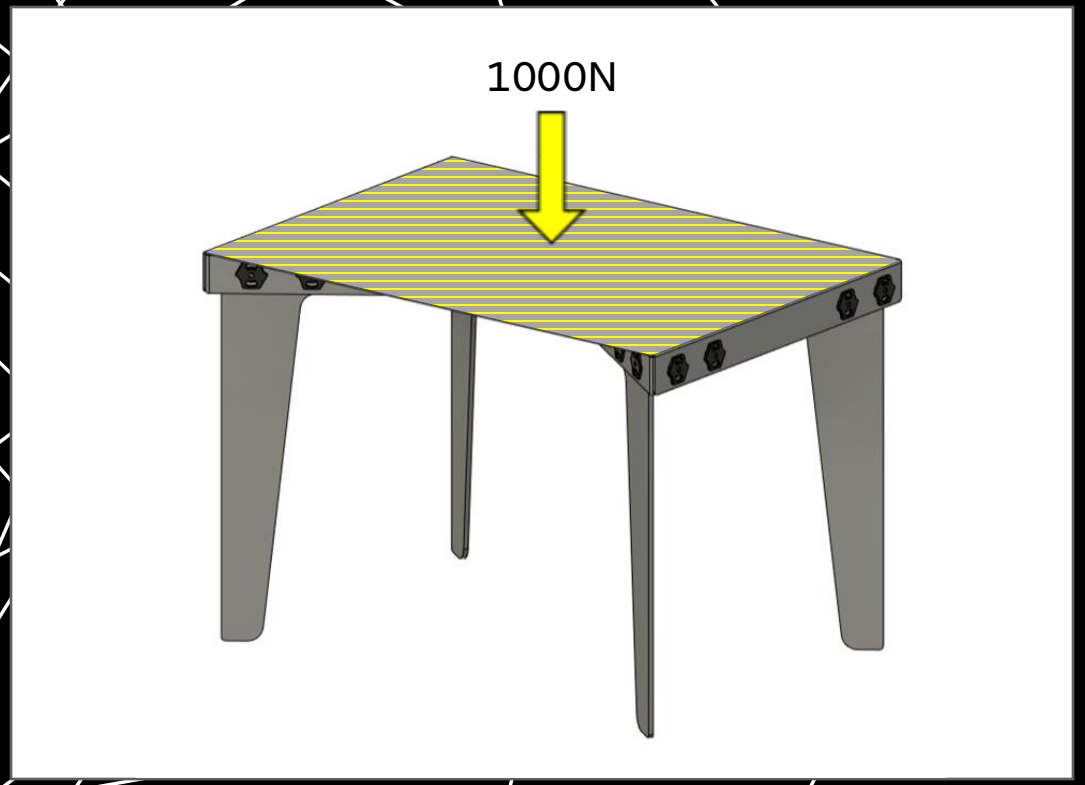
Displacement:
< 40um

Table (prototype) FEA simulation

Sheet Material: Al-5052
Joint Material: Nylon PA-6
Table legs fixed to ground
Displacement Plot (Exaggerated)

Test case:
- No external forces
- **Only gravity and weight of table**





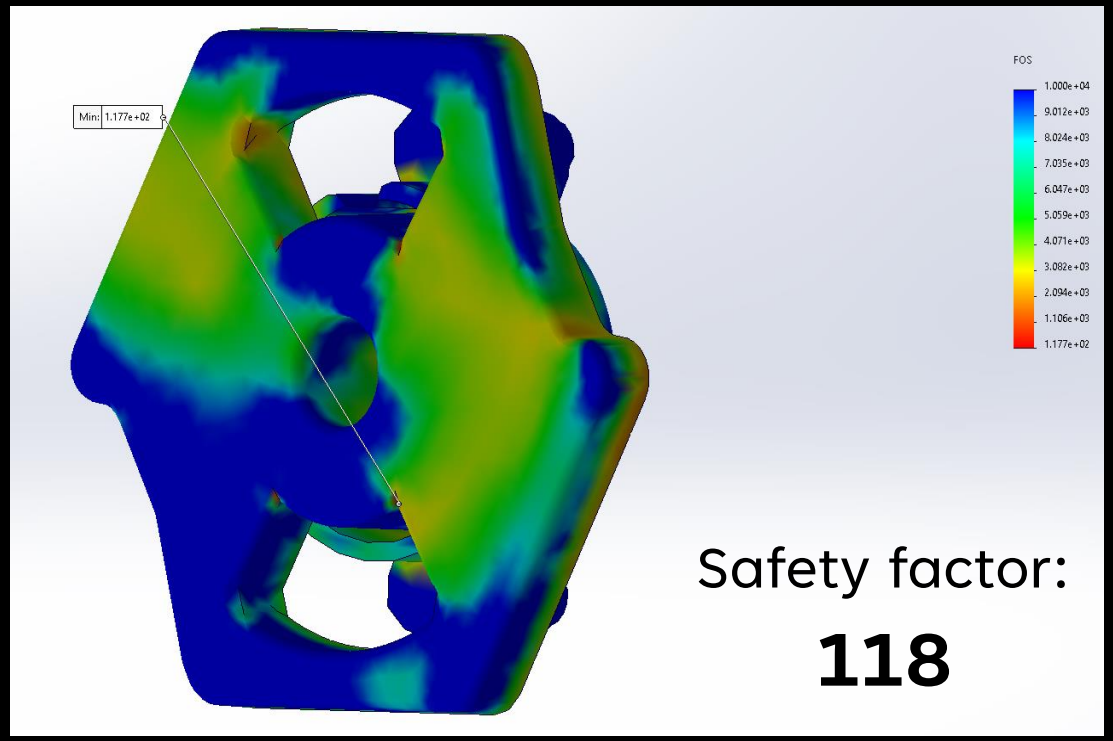
Test case

100kg uniformly distributed load on table top **downwards**

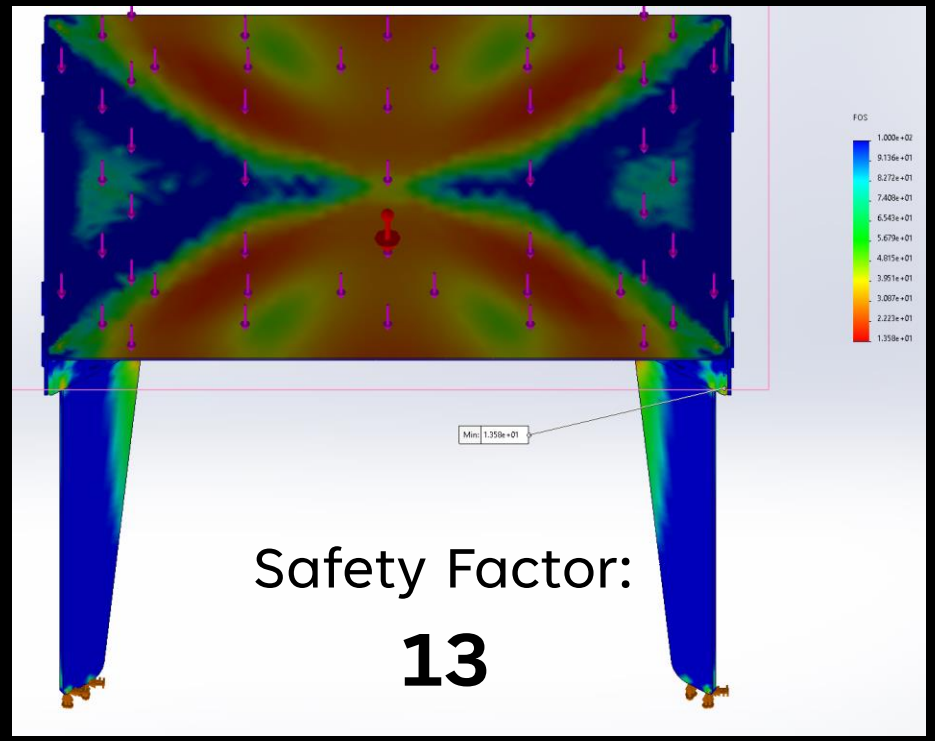
Table (prototype) FEA simulation

Sheet Material: Al-5052
Joint Material: Nylon PA-6
Table legs fixed to ground
Safety Factor Plot (Jointly 6mm)

Test case:
- 1000N UDL on table top
- Vertically downwards



Max Von Mises:
8.803e+5 N/m²



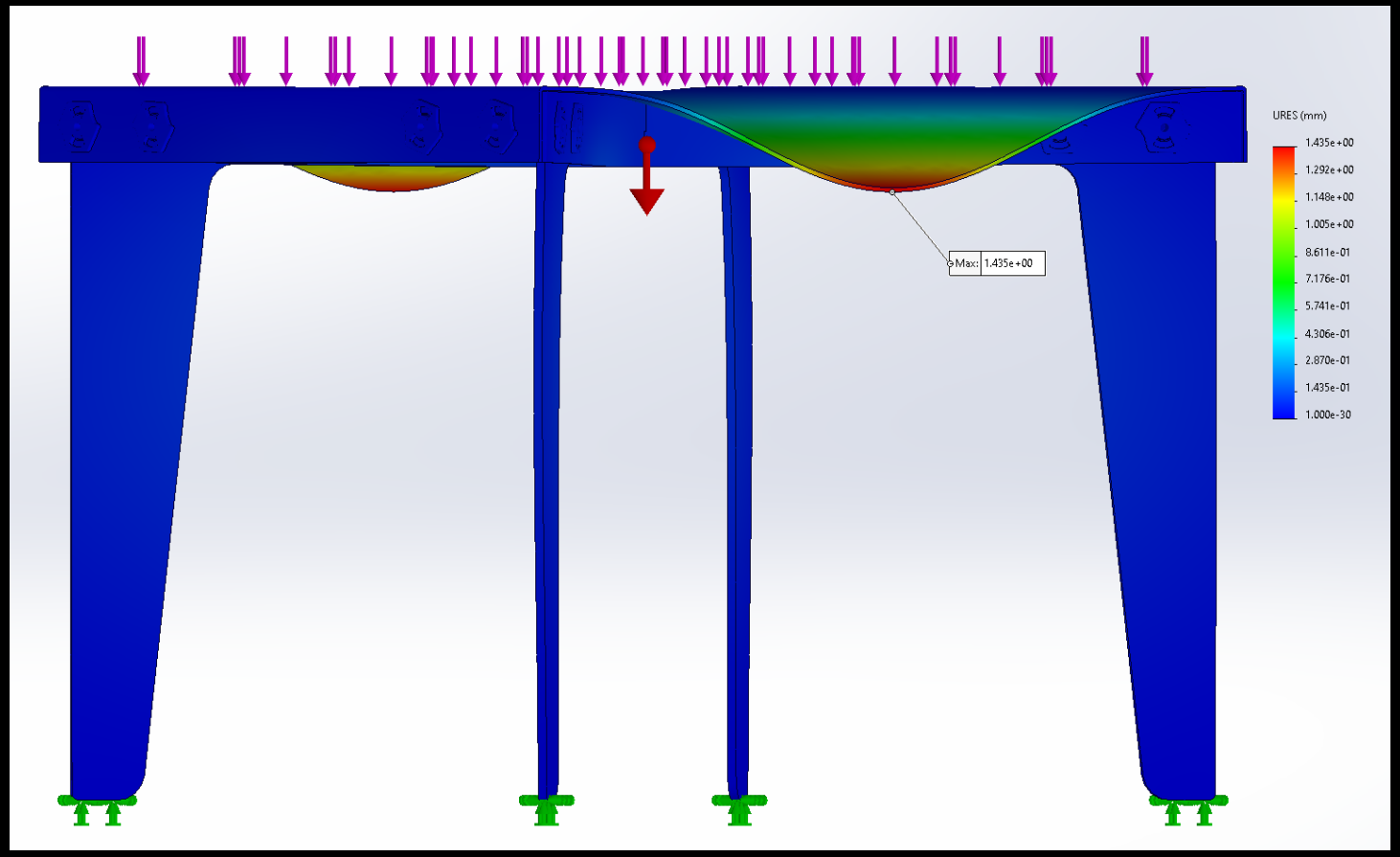
Max Von Mises:
1.435e+7 N/m²

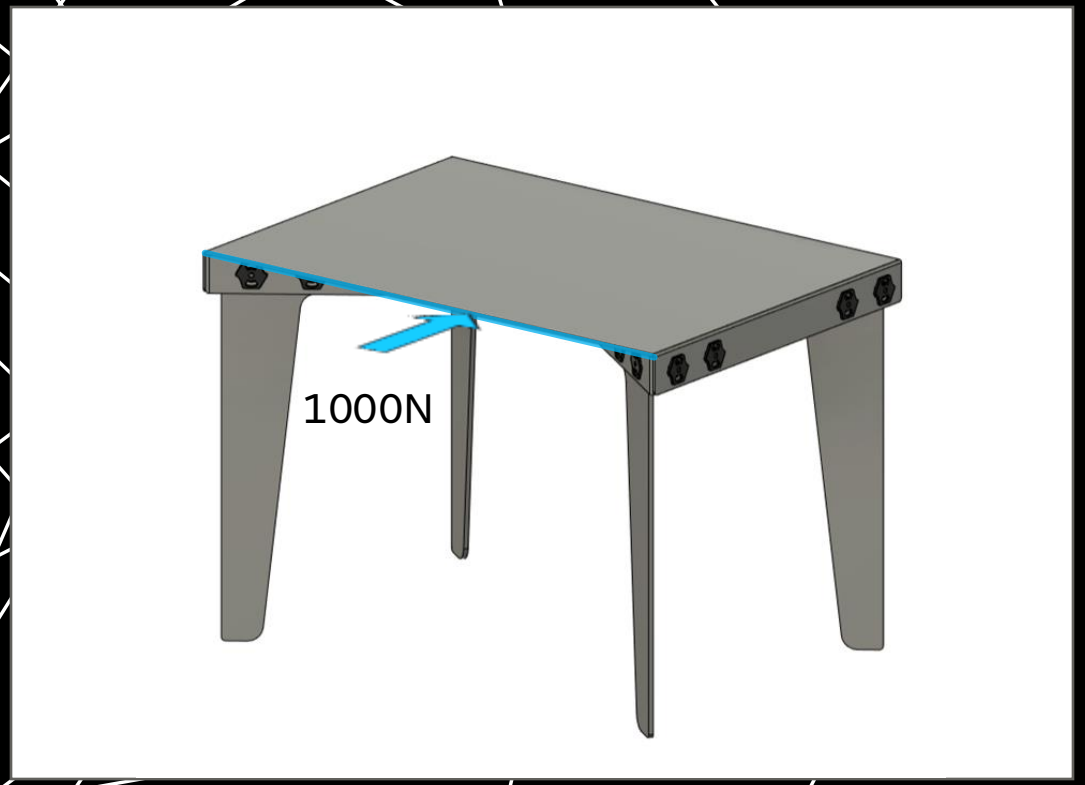
Displacement:
< 1.5mm

Table (prototype) FEA simulation

Sheet Material: Al-5052
Joint Material: Nylon PA-6
Table legs fixed to ground
Displacement Plot (Exaggerated)

Test case:
- 1000N UDL on table top
- Vertically downwards





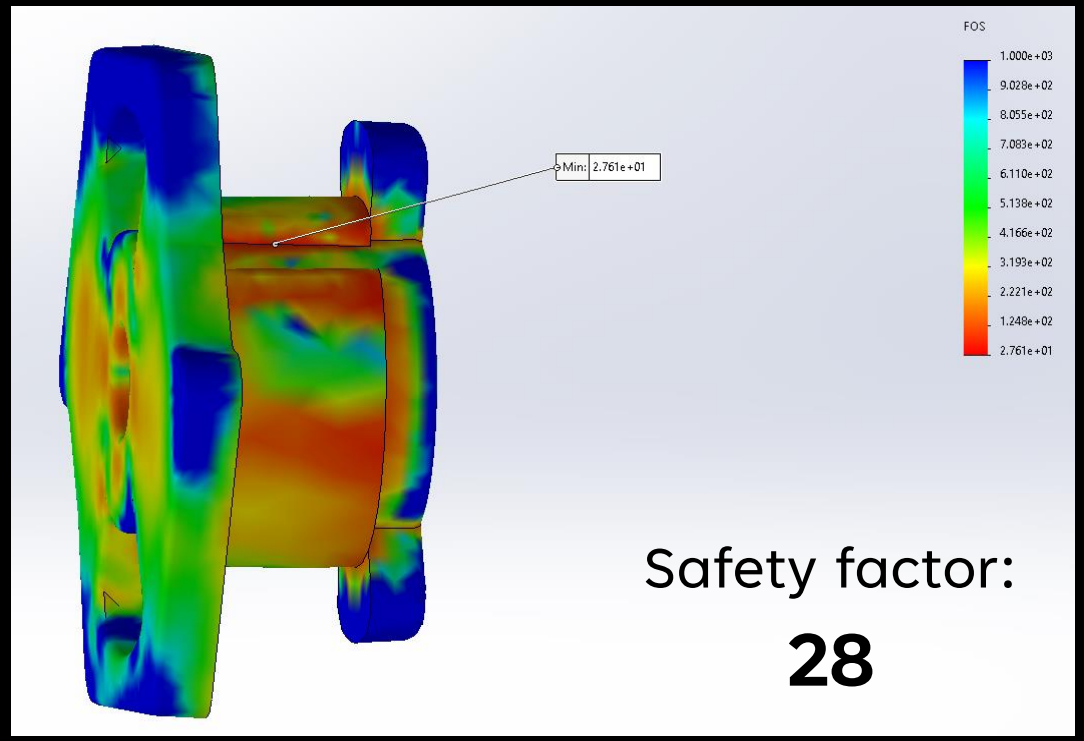
Test case

100kg uniformly distributed load on table top **sidewards**

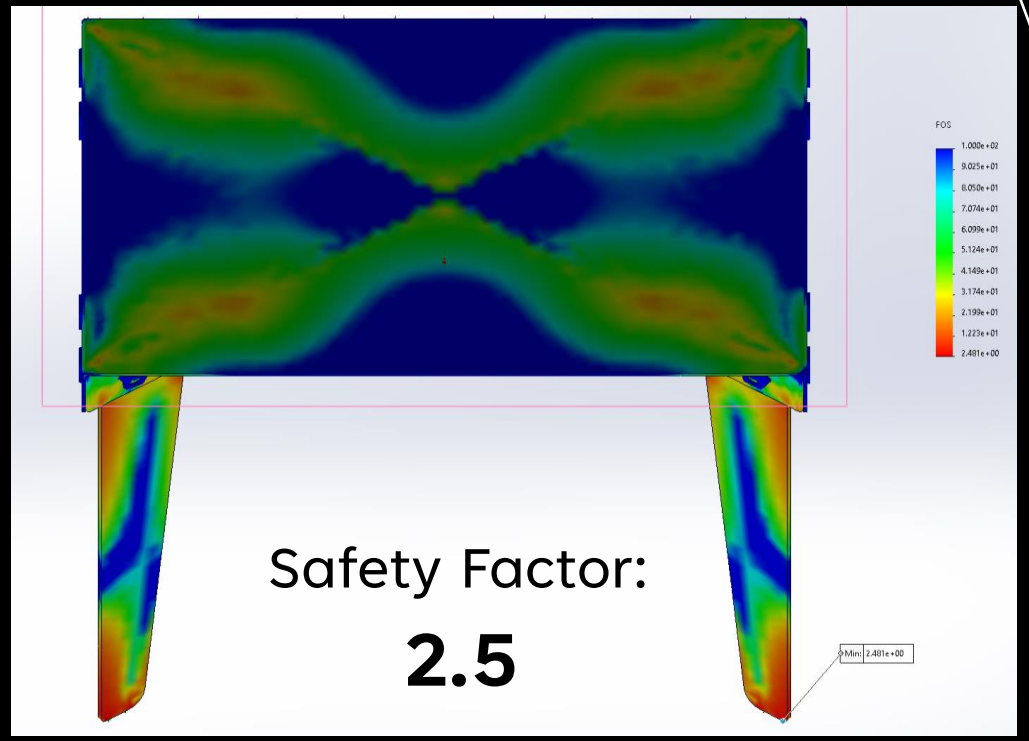
Table (prototype) FEA simulation

Sheet Material: Al-5052
Joint Material: Nylon PA-6
Table legs fixed to ground
Safety Factor Plot (Jointly 9mm)

Test case:
- 1000N UDL on table top
- Sidewards



Max Von Mises:
3.754e+6 N/m²



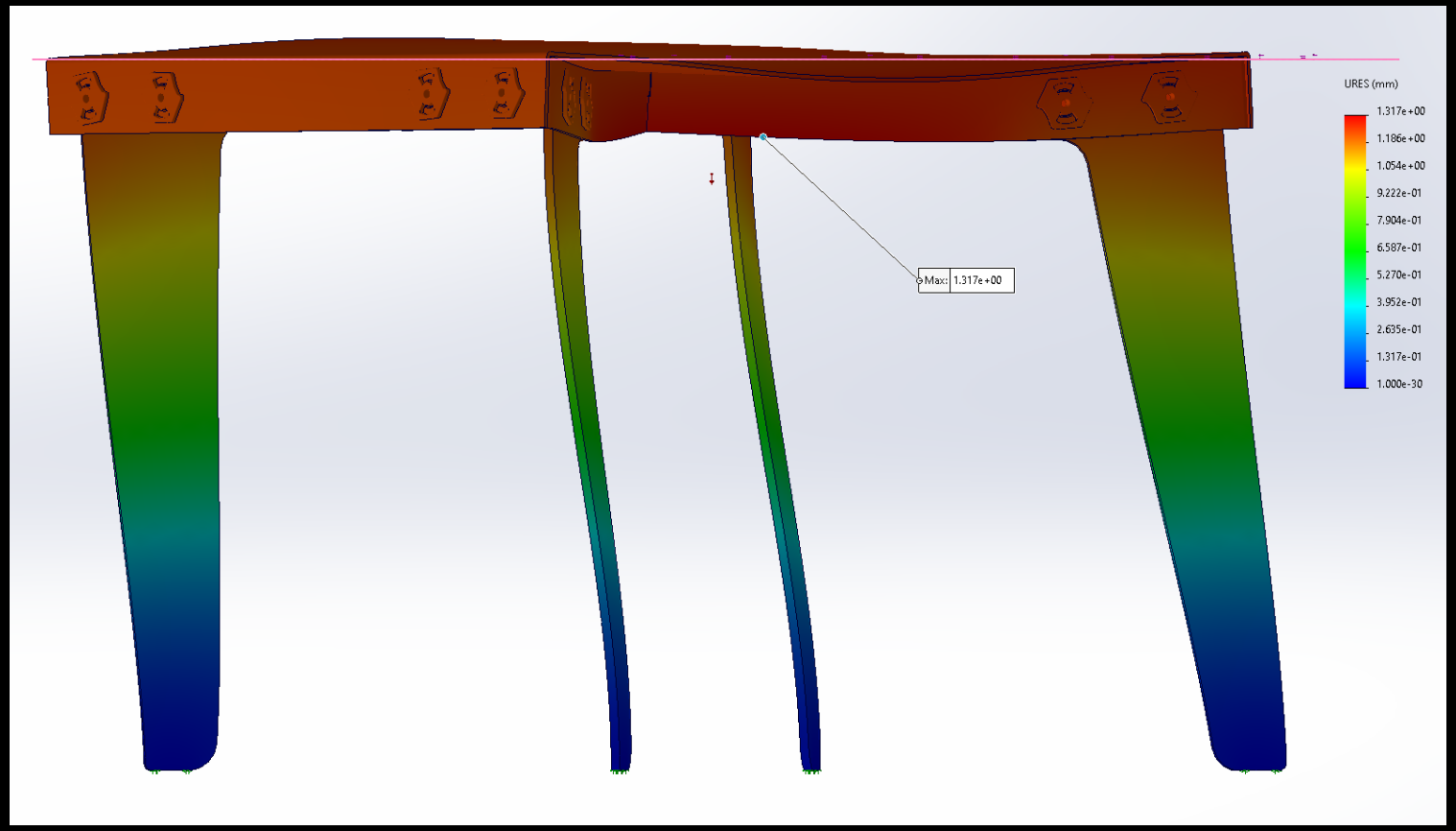
Max Von Mises:
7.858e+7 N/m²

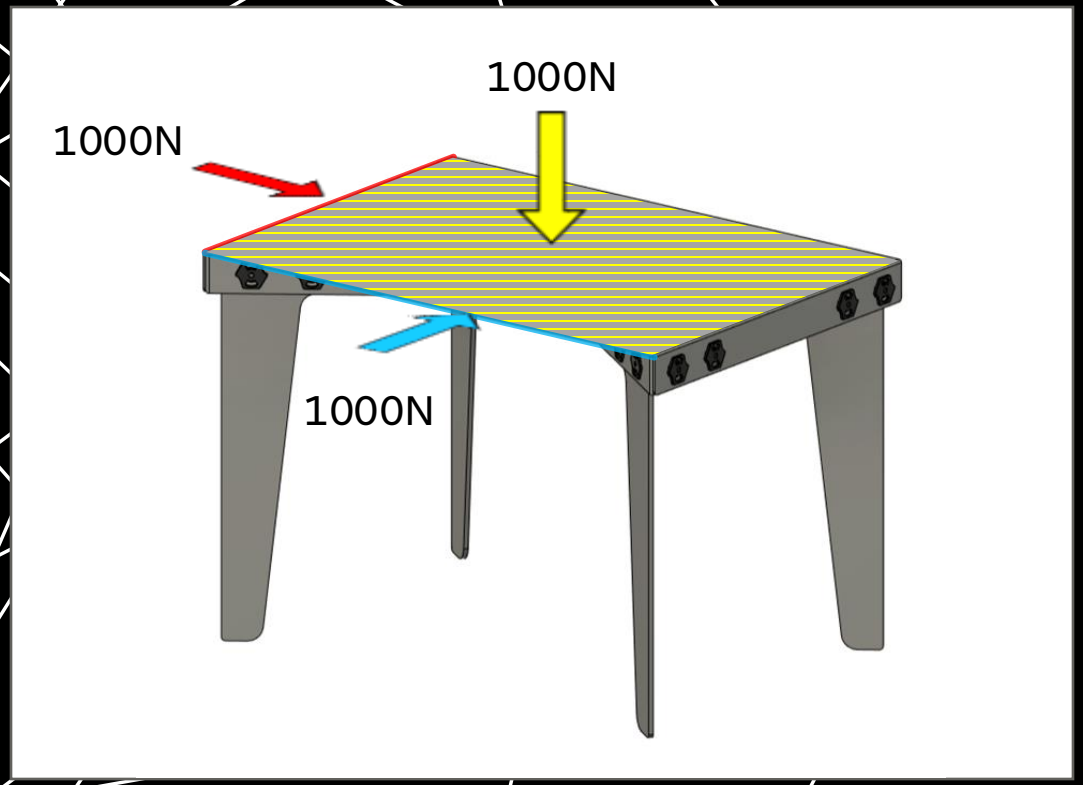
Displacement:
< 1.32mm

Table (prototype) FEA simulation

Sheet Material: Al-5052
Joint Material: Nylon PA-6
Table legs fixed to ground
Displacement Plot (Exaggerated)

Test case:
- 1000N UDL on table top
- Sidewards





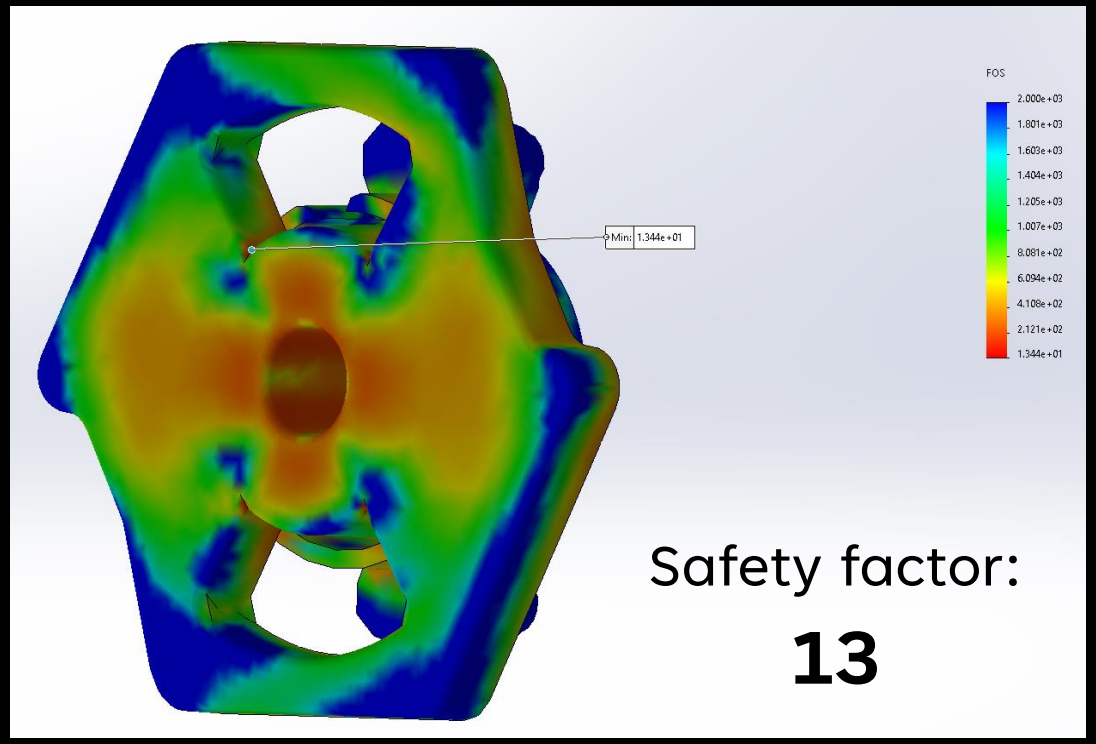
Test case

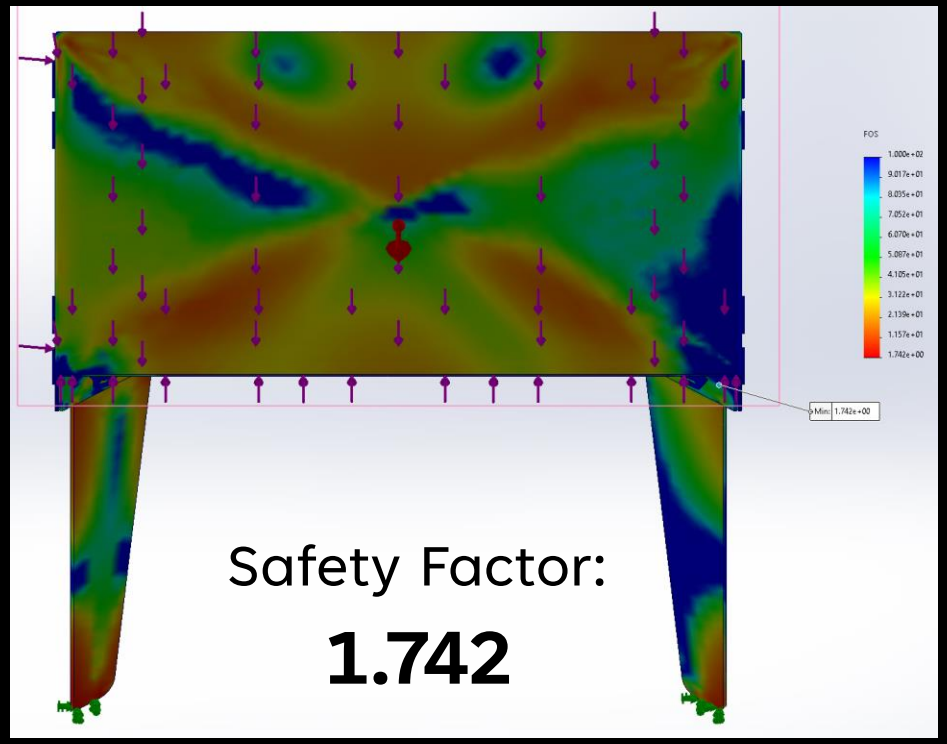
100kg uniformly distributed load from **3 directions combined**

Table (prototype) FEA simulation

Sheet Material: Al-5052
Joint Material: Nylon PA-6
Table legs fixed to ground
Safety Factor Plot (Jointly 6mm)

Test case:
- 3x 1000N UDL Combined
- Front, Left and Top





Max Von Mises:
7.713e+6 N/m²

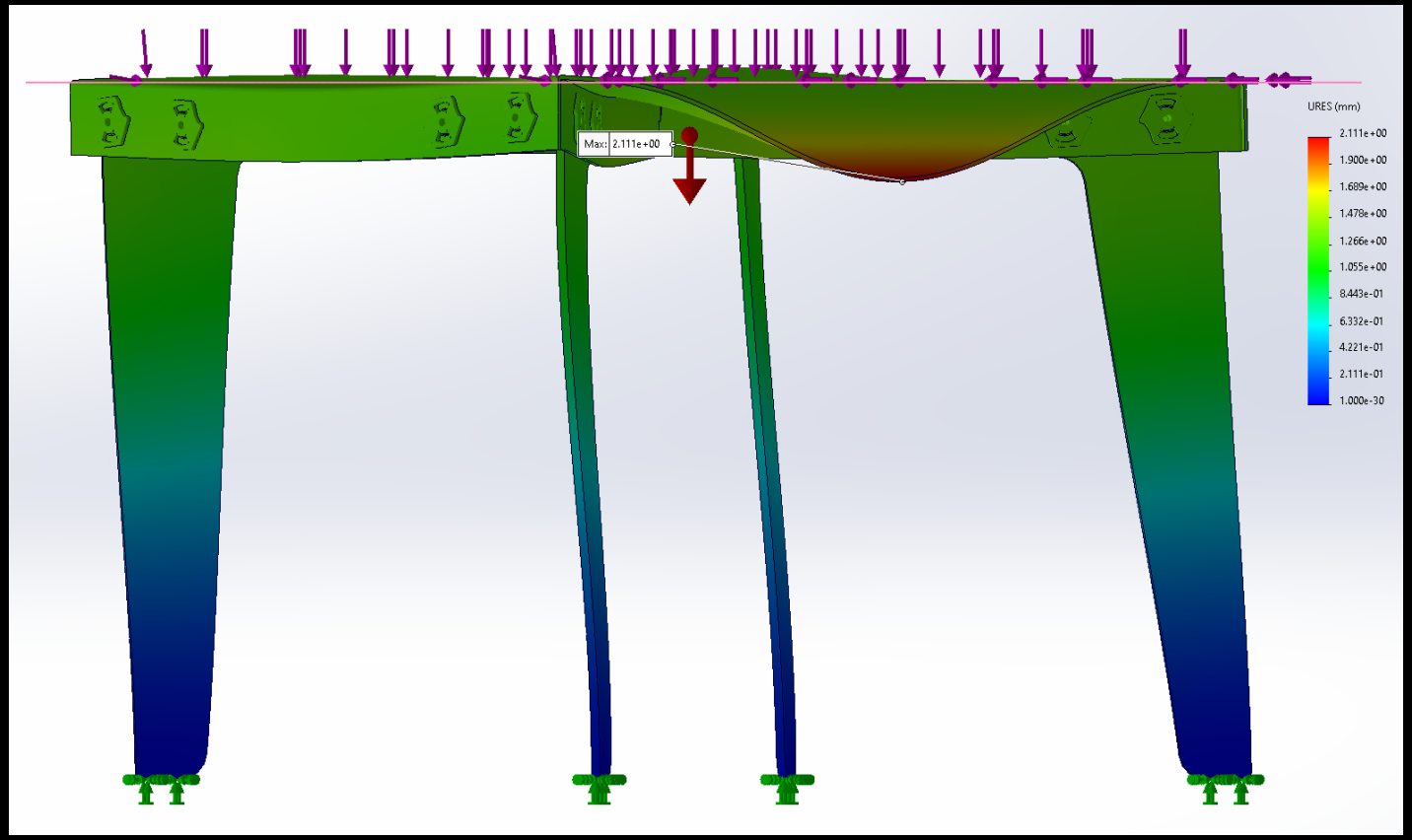
Max Von Mises:
1.118e+8 N/m²

Displacement:
< 2.2mm

Table (prototype) FEA simulation

Sheet Material: Al-5052
Joint Material: Nylon PA-6
Table legs fixed to ground
Displacement Plot (Exaggerated)

Test case:
- 3x 1000N UDL Combined
- Front, Left and Top



SPECIFICATION AND PROTOTYPE COST ANALYSIS

WEIGHT

Part	Qty	Weight per unit (kg)	Subtotal weight (kg)
Jointly Fastener S	8	0.0055	0.044
Jointly Fastener L	8	0.0068	0.054
Sheet metal tabletop	1	3.21	3.21
Sheet metal table legs	4	0.65	2.60
Sheet metal table ribs	2	0.44	0.88
		Total Weight	**6.79**

ESTIMATED MATERIAL COST

Material	Cost ($/kg)
5052 Aluminum	6
Nylon	2.5
ABS	1.5

ESTIMATED FIXED COST

Item	Cost ($)
Injection mold (2pcs)	20000
Miscellaneous / others	10000

ESTIMATED PART PRODUCTION COST

Process	Processing Cost ($/hr)
Water Jet (Labor cost + machine cost + abrasive cost)	30
Injection Molding	30

ESTIMATED COST ANALYSIS

Part	Qty	Material Cost ($)	Part Production Cost ($)	Assembly Cost	Sub totals ($)
Jointly Fastener S	8	0.014	0.25	-	2.11
Jointly Fastener L	8	0.017	0.25	-	2.14
Sheet metal table top	1	19.26	3	-	22.26
Sheet metal table legs	4	3.90	2	-	23.6
Sheet metal table ribs	2	2.64	1.5	-	8.28
				Total ($)	58.39

Cost of production of 1 table:

~$60

Retail cost of 1 table:

$180

Profit margin: 200%

ESTIMATED PRODUCT CASH FLOW

	table sales ($K)																							
Month	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
tables sold		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
fixed costs	-30 K																								
Variable costs		-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K	-1 K
Sales revenue		4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K	4 K
sales profit		2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K	2 K
cumulative cost	-30 K	-31 K	-32 K	-34 K	-35 K	-36 K	-37 K	-38 K	-40 K	-41 K	-42 K	-43 K	-44 K	-46 K	-47 K	-48 K	-49 K	-50 K	-52 K	-53 K	-54 K	-55 K	-56 K	-58 K	-59 K
cumulative revenue	0 K	4 K	7 K	11 K	14 K	18 K	22 K	25 K	29 K	32 K	36 K	40 K	43 K	47 K	50 K	54 K	58 K	61 K	65 K	68 K	72 K	76 K	79 K	83 K	86 K
cumulative profit	-30 K	-28 K	-25 K	-23 K	-20 K	-18 K	-16 K	-13 K	-11 K	-8 K	-6 K	-4 K	-1 K	1 K	4 K	6 K	8 K	11 K	13 K	16 K	18 K	20 K	23 K	25 K	28 K

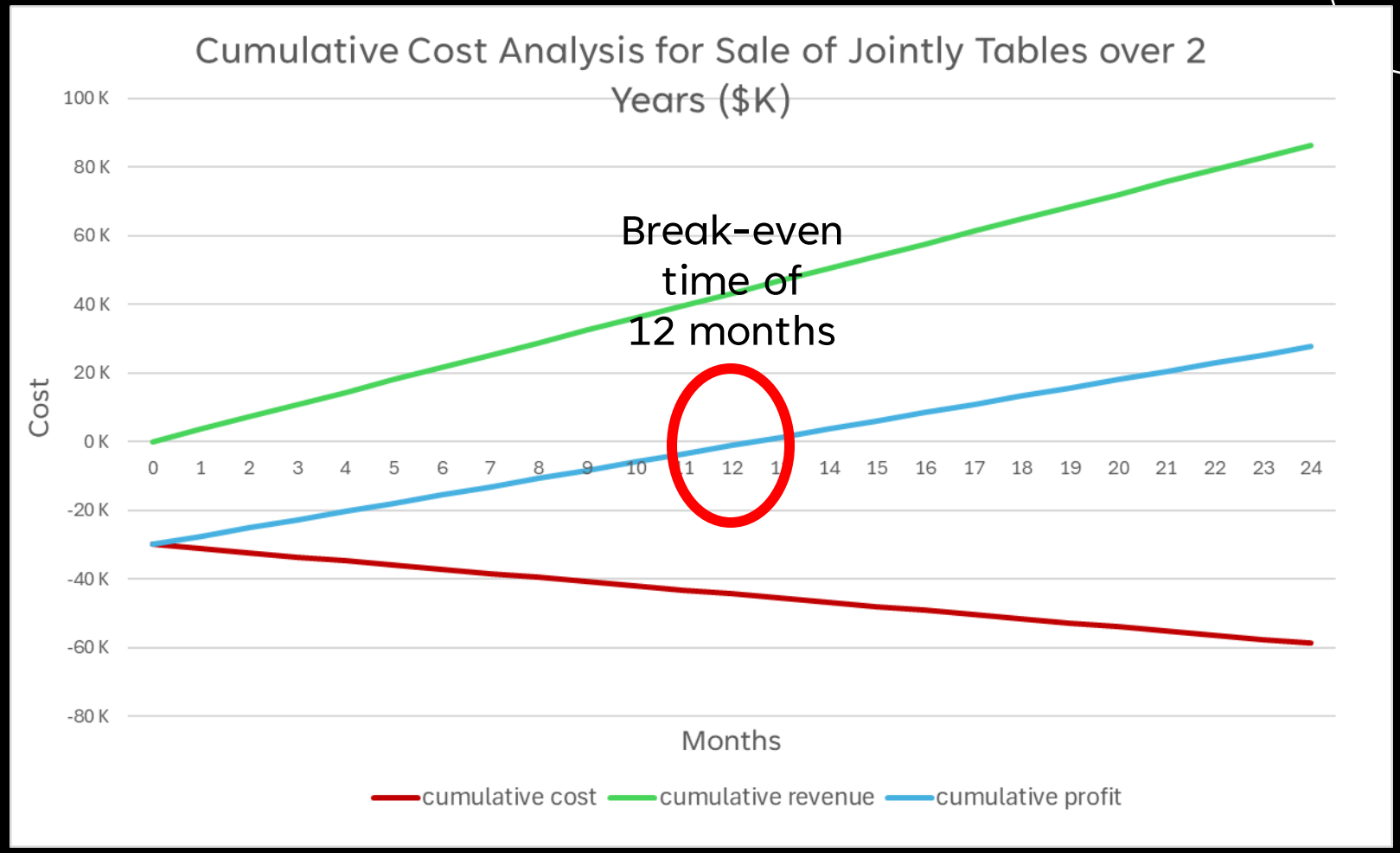
Miscellaneous costs:

- Warehouse set up (fixed)
- Warehouse rental, utilities and maintenance (monthly)
- Machinery rental (monthly)

Growth

- Conservative estimate of average 20 sales a month given the market Jointly caters to
- Jointly furniture is also designed for second hand markets is it can be reassembled

ESTIMATED PRODUCT CASH FLOW

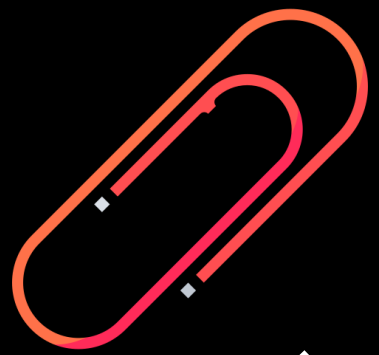


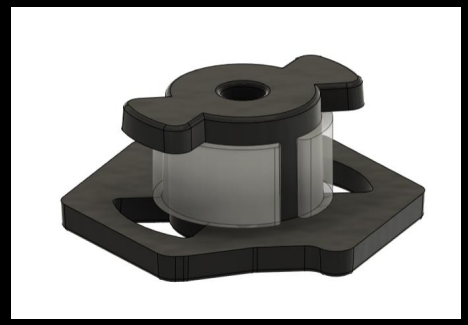
SUCCESS MATRIX

Product evaluation

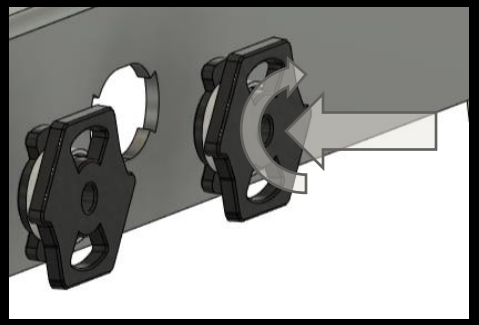
ACHIEVING PROPOSED SOLUTION

Universal Toolless Fasteners

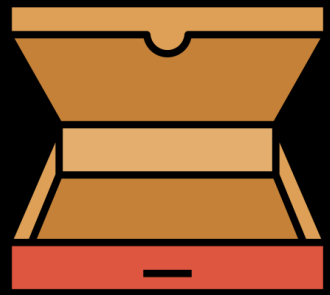


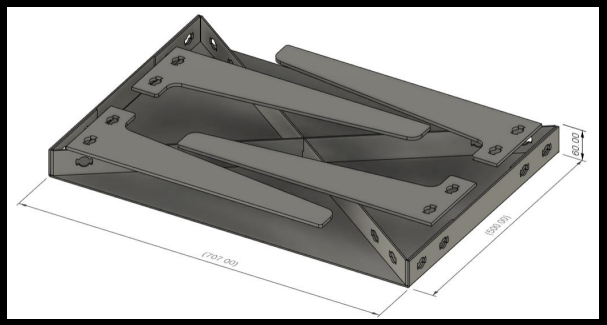


Reassembly



Flat packable





Success Factor	Criteria	Achieved?	Remarks
Easy Assembly & Disassembly	**Tool-free process**	Yes	JOINTLY does not require additional tools to fasten panels together
Designed for **Reassembly**	Can be dismantled without damage, and reassembled again with minimal wear	Yes	JOINTLY can be sold separately as replacements (since it has standardized sizes) when it wears down (long time)
Easy for **Transportation**	**Flat-packed** and can be hand carried or fit in most passenger cars Light enough to hand carry	Yes	Designing for disassembly allows for flat-packing, which reduces bulk and allows for ease of transportation compared to conventional tables
Sustainability	Easy to recycle Minimal parts of different material	Yes, mostly	Joints are reusable Metal sheets can be recycled Possibly some waste from post processes
Durability and Functionality	Support up to 100kg	Yes	Via FEA simulation Physically tested up to 69kg on a weaker 1st iteration prototype
Affordability	±$50 of similar counterpart	Yes	JOINTLY tables are priced slightly higher for their premium features and long-lasting design