Cerebral Palsy Alliance Equipment Services Team

Presented by

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The Team

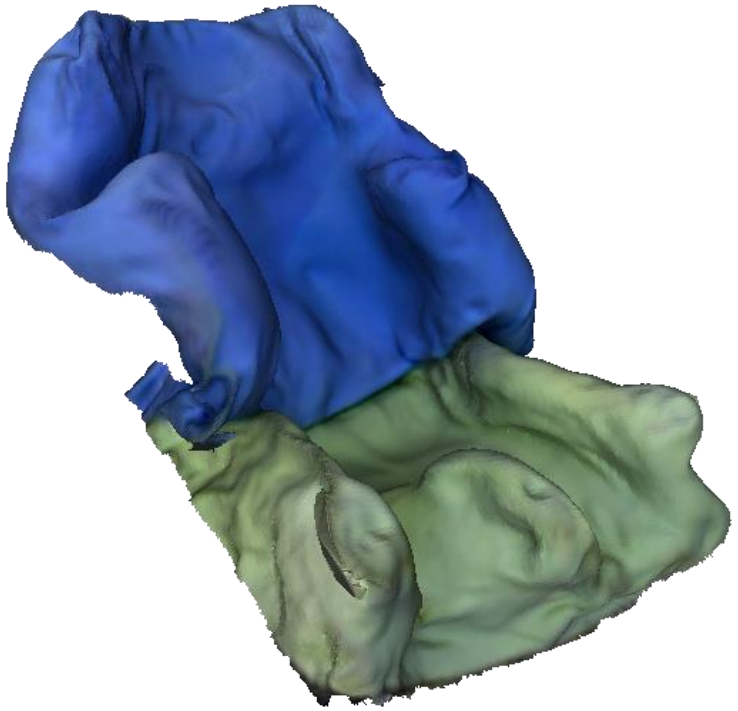
Project leader: Sithma	Liaison: Kimiko	Allen	Ben
Biomedical Engineering (3rd Year)	Biomedical Engineering (5th Year)	Civil Engineering (4th Year)	Chemical and Biomolecular Engineering (4th Year)
Phoebe	**Richard**	**Tom**	**Young**
Biomedical Engineering (4th Year)	Mechanical Engineering (3rd Year)	Aeronautical Engineering (4th Year)	Mechatronic Engineering (4th Year)

Our Project

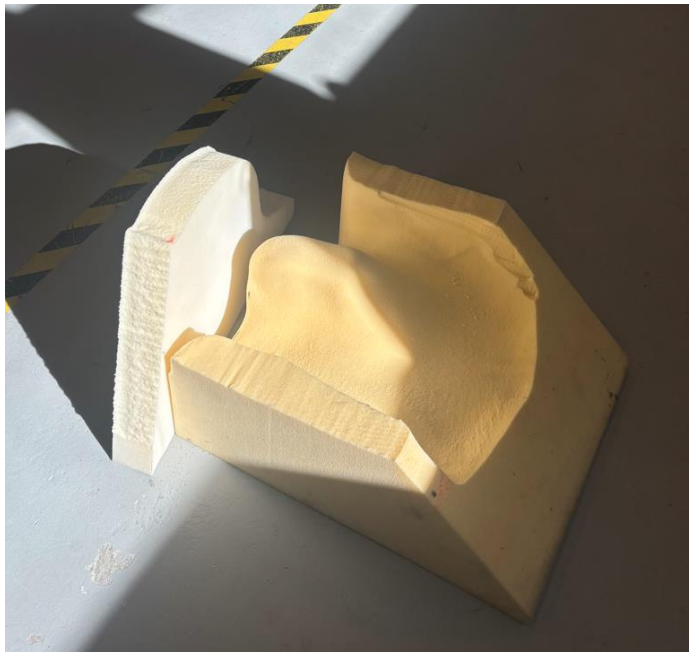
To improve CPA's manufacturing process of custom wheelchair seating for patients living with cerebral palsy

CPA's Current Manufacturing Process

1. Patient lays on bean bag to which air is removed to attain shape of their posture.
2. The bean bag is 3D scanned to attain a digital model.



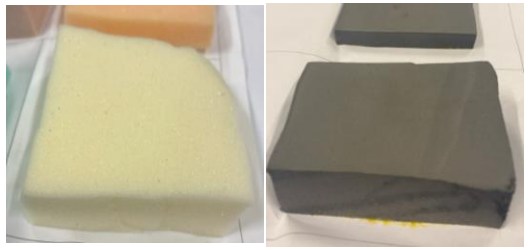
3. The scan is sent to an outsourced CNC production company that will carve the seating from medical grade foam.



CPA's Current Manufacturing Process

4. Adjustments to the seating are made including further carving and addition of other layers for support and comfort.

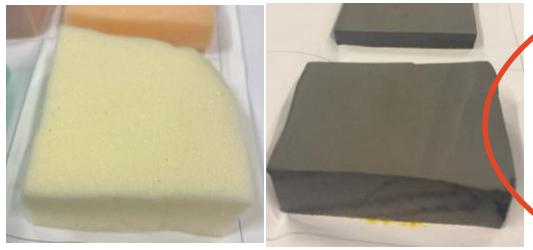
Current Materials



1. Structural base (backplate and bottom plate)
    - Wood, aluminium
2. Seat
    - PU36/130 High density polyurethane foam
    - EVA foam (waterproofing)
3. Adjustment layers for pressure alleviation and comfort
    - Gel padding (pressure alleviation, temperature regulation)
    - Vicair cell padding or hollowed air space (pressure alleviation)
4. Upholstery
    - Dartex (waterproofing)
    - Coloured, breathable, machine-washable material (aesthetics and maintenance)

Current Materials: Limitations

Wood: mould
Aluminium: heavy and difficult to manufacture



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Seat: labour intensive due to many layers, lack of recyclability, low durability (3-5 years)

Our Project

Requirements of the project brief

1. Identify and test new materials to use for the seating, where the new material must:
   - Be **lighter weight** while providing same level of **support**
   - Offer better **infection control**
   - Have improved **manufacturability**
2. Use captured 3D scanned images more skillfully and economically
   - Utilise **3D printing** in manufacturing process
3. Invest in a sustainable future by designing for end of life for our products, including:
   - Procedure to **recycle** manufacturing waste
   - Procedure to **responsibly dispose** of wheelchairs and seating systems after end of life

Project Charter

The project aims to improve the manufacturing process by recommending:

1. Alternative manufacturing processes focusing on 3D printing
2. New materials/design with improved properties
3. End-of-life program to improve CPA's sustainability

Our Solution: 3D printed Thermoplastic Polyurethane (TPU) Custom Contoured Seating (CCS)

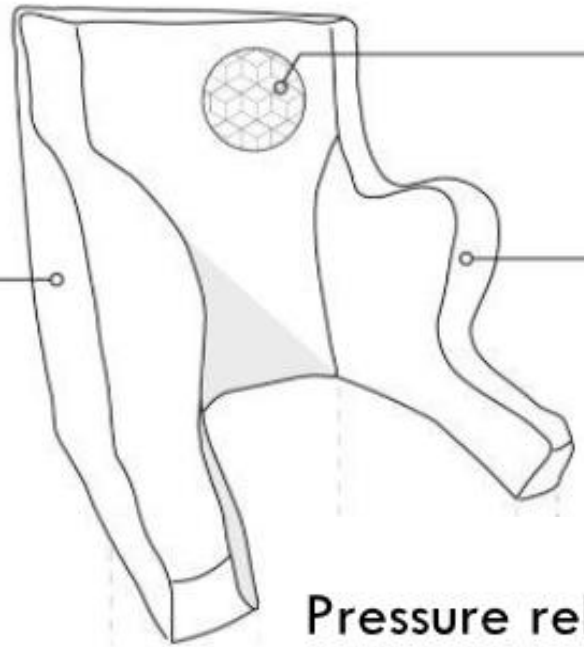
CreaTECH by CreateitREAL

- Washable (complying with EN 1021-1)
- Fire Retardant (complying with EN 1021-2)
- Resistant to bacteria, fungi and other microorganisms
- Biocompatible
- Recyclable
- Breathable
- Pressure Relief

Embrace SeatMaker

- Specialized to print wheelchair seats or cushions
- Ability to print various hardness zones with smooth transitions
- Tailored precisely to each patient's specific needs.

Our Solution: 3D printed TPU CCS

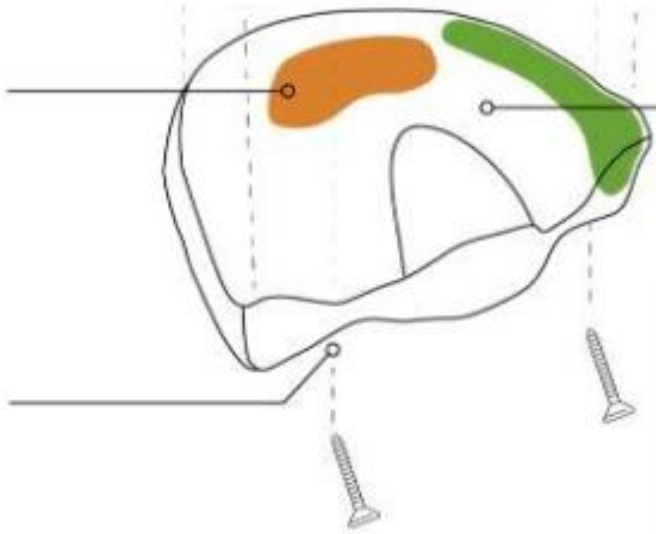


Breathable TPU Programmable Foam

Positioning supports (bodyrest)

Structural hard zones

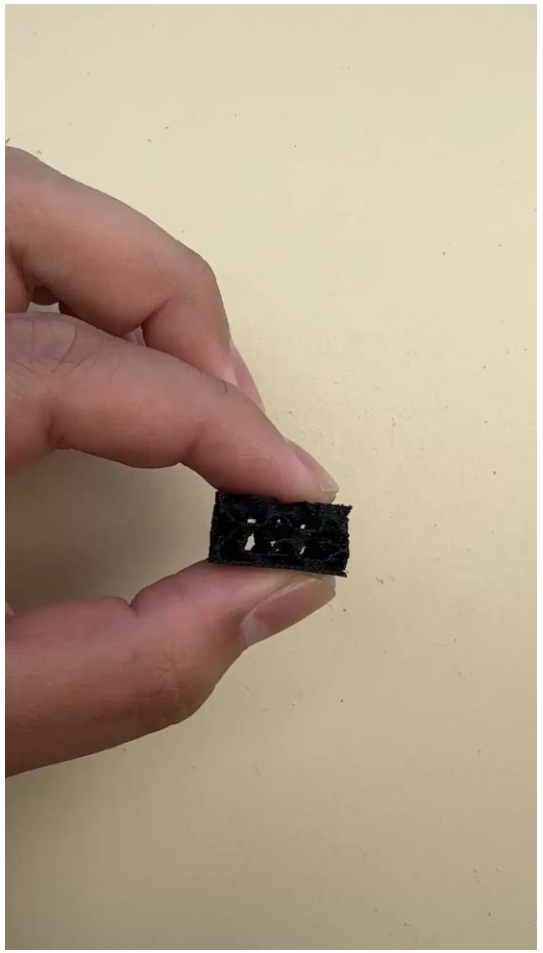
Pressure relief due to various hardness zones



Pressure distribution due to gyroid structure

Solid zones for mounting

Our Prototypes



10% infill density

12% infill density

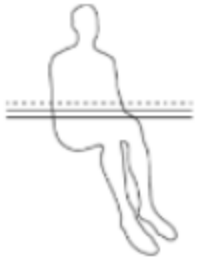
20% infill density

Our Prototypes

Honeycomb lattice structure

Scaled down seat with contours

Our Solution: 3D printed TPU CCS

1. 

BODY SCAN
Capture data

2. CAD MODEL
Define and design cushion

3. 

3D PRINTING SOFTWARE
Prepare cushion for printing

4. 

3D PRINTER
Print the cushion

5. PRODUCT
The cushion is ready right out of the printer

6. 

USE
Enjoy the customised cushion

GLIDE: Local Outsourcer

- Location : Australian Manufacturer in WA
- Registered NDIS Provider
- Manufacturer of CentroGlide Electric Wheelchair

Services	Cost per Seat($)
CAD Modeling	280 - 800
TPU 3D Printing (Approx. 72 hours)	2800
CNC Carved Foam (1 hour)	2000
CPA CNC and Shipping to Syd (10-14 Weeks from the UK)	2200

Current Issues With Wheelchair Backplate

- Moulding wood (main issue)
- Difficult repairs (wood/metal)
- Difficult to customise (metal)
- Too heavy (metal)

Our Solution: Wood Coatings

Linseed Oil
Extracted from flaxseed.

Advantages:
- Deep penetration enhances natural grain.
- Eco-friendly and non-toxic.
- Easy to repair scratches.

Drawbacks:
- Requires frequent reapplication
- Slow drying time.
- Limited water resistance

Beeswax:
Natural wax from honeybees.

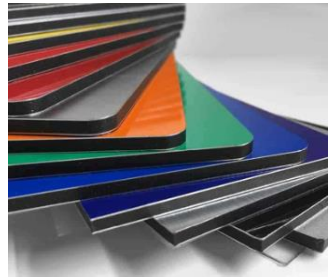
Advantages:
- Looks good on Wood
- Easy to apply
- Non-toxic and safe.

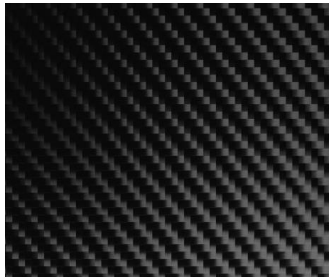
Drawbacks:
- Low durability
- Needs frequent reapplication
- Limited water resistance.

Water-based Polyurethane:
- Most durable option
- Fast drying time.
- Available in various finishes (matte, satin, gloss).
- Low VOCs

Drawbacks:
- May not penetrate as deeply as oil finishes.
- May requires additional sanding.

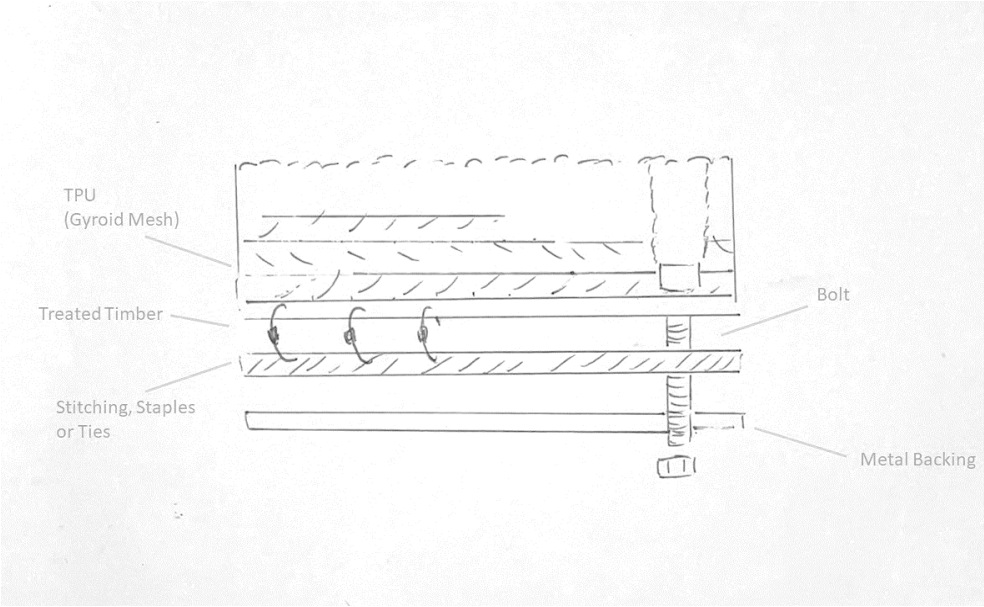
Our Solution: Alternative Backplate Materials

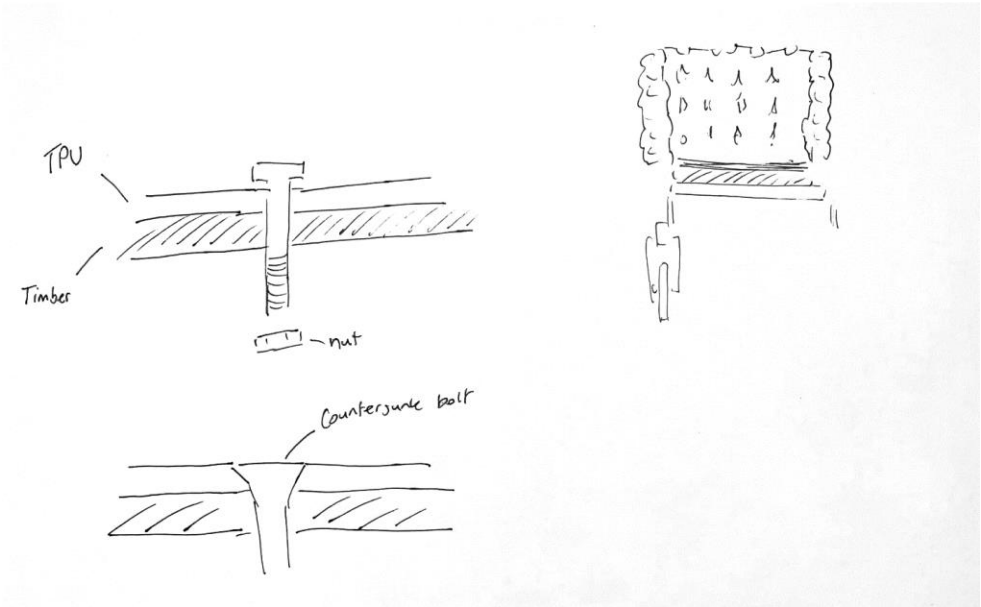




	Bamboo/Birch	Aluminium Composite	Carbon Fibre
Ignition resistant	✓		✓
Corrosion resistant		✓	✓
Contamination resistant OR can be cleaned/disinfected	✓	✓	✓
Biocompatible/non-toxic	✓	✓	✓
Lighter weight	✓	✓	✓
Similar or higher strength	✓	✓	✓
Moisture resistant	✓	✓	✓
Ease of manufacturing, maintenance and/or replacement	✓	✓	
Recyclable	✓	✓	

Our Solution: Attachment (Out of Scope)

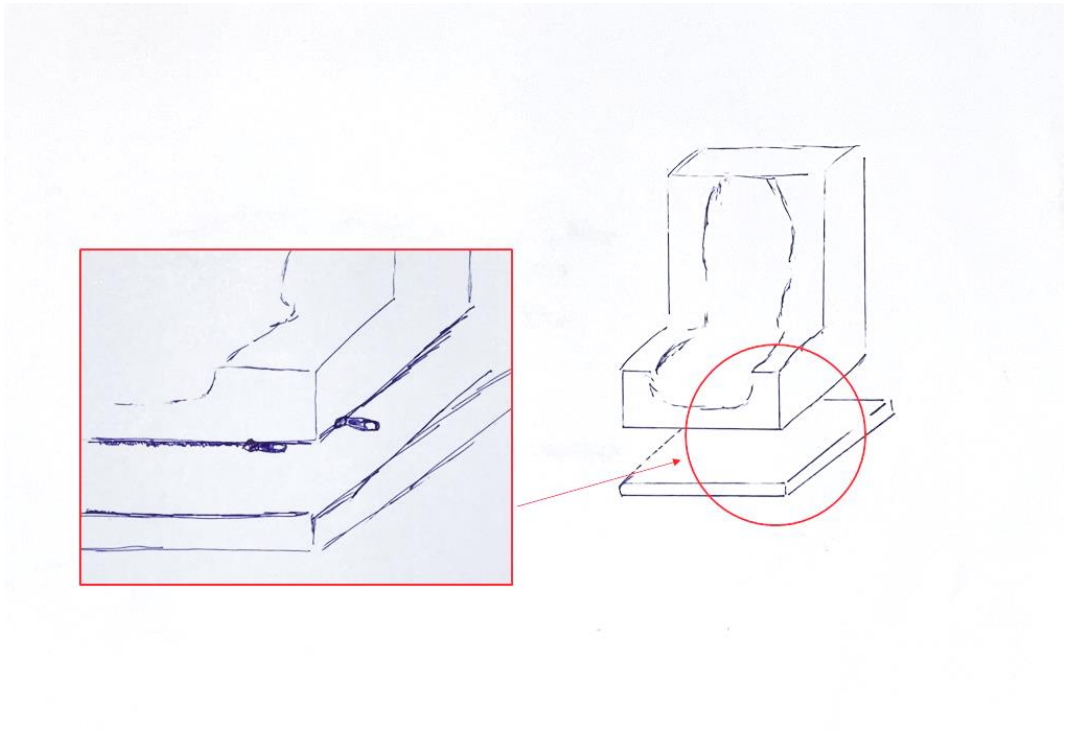


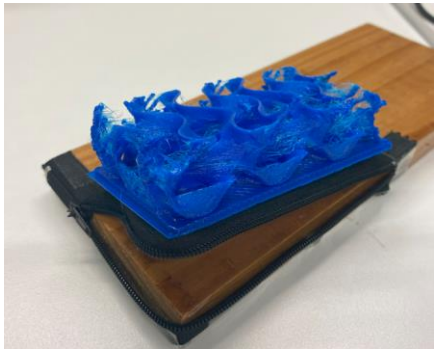


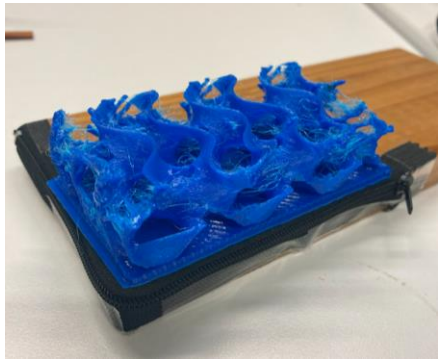
Conventional Methods

- Solid TPU material allows for varied connection methods
- Permanent attachments (stitching, ziptie)
- Semi-permanent attachment method (Bolt)

Our Solution: Attachment (Out of Scope)







Innovative Solution

- Waterproof zipper stapled onto wood backplate and solid base of TPU seat
- Allows secure attachment of TPU seat onto backplate when in use
- Enables detachment when TPU seat needs to be machine-washed

Pros: Eliminates use of glue. Positive benefits to sustainability

Cons: May introduce manufacturing complexity

Impact

Criteria	Met	Reasons
Lighter weight The wheelchair should be lighter for ease of travelling and physical management	✓	• Breathable TPU with significantly lower density with similar support
Minimal maintenance Material should be easy to clean and require minimal upkeep	✓	• TPU seat is machine washable • Backseat options are easy to clean
Recyclable material Selected material and design should have improvements in recycling method and proportion to which it can be recycled	✓	• TPU is recyclable • Plant alternatives and aluminium composite backplate are recyclable
Durability Selected material and design should have a similar or better lifespan to the currently used materials	✓	• Estimated to have similar or better lifespan compared to PU36/130
Modular design Material and design should be able to allow easy adjustments if needed	✓	• Easily customisable due to 3D printing
Pressure distribution The material and design for the seating should be designed with minimal discomfort to prevent accumulating pain and aches	✓	• Customisable hardness zones for various pressure distributions
Infection control The selected material needs to be good at providing ease at managing and handling hygiene	✓	• TPU is machine washable • Backplate materials can be wiped to easily clean/disinfect

Impact

Local outsourcing of 3D printing services:

- Reduces manufacturing expenditure by reducing number of external stakeholders
- Improves sustainability by minimising carbon emissions produced by shipping

Future work

Integrate wheelchair design into one singular 3D-printed structure

- Develop a wheelchair prototype where all parts are 3D-printed
- Use GO Wheelchair as inspiration for transition towards complete 3D printing
- Reduces overall labour within manufacturing process

Acquiring in-house 3D printer

- Allows for complete control over manufacturing process to adjust accordingly for each client
- Reduces shipping and labour costs associated with outsourcing

Criteria	Requirements	Checklist
3D Scanning & Modelling	Experience in scaling and adjusting 3D models to precise specifications.	
3D Modelling Software	Proficiency with any 3D printing software capable of importing and exporting .obj and .stl file types.	
	Expertise in converting surface models into solid bodies.	
3D Printing Capability	Access to direct-drive extruder printers capable of printing with TPU filament.	
	Experience in printing with 1.75mm standard TPU filament.	
Material and Filament Standards	Ability to source and print with 1.75mm standard TPU filament.	
	Ensures high-quality prints with fine filament for better product results.	
DESIRED		
Quality Control and Testing	Rigorous quality control processes to ensure precision and durability.	
	Testing procedures to verify the strength and functionality of the printed backplate.	
Cost & Efficiency	Competitive pricing for 3D modelling and printing services.	
	Efficient turnaround times to meet project deadlines.	
Experience	Previous experience in projects related to medical devices or assistive technology.	

Summary of Recommendation

- Implement 3D printing
- Contact Glide or other recommended company party