



Safe Shower Solution for Below-the-Knee Amputees

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Overview

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Problem Statement

The Problem:

Standard prosthetics are **not waterproof** → amputees must remove their primary limb before bathing.

Risk & Impact:

High fall risk → assistance required for basic personal hygiene.

Project Goal:

Design a **lightweight and stable support device** for safe shower entry, standing, and exit.

Background

Client Profile: Mike Degrave

- 75 year old active outdoorsman and transtibial amputee.
- Has a 10 in residual stump, a knee spacer, and ongoing volume loss.

Key Client Preferences:

- Safe solution for independently showering
- Low pressure on sensitive spots
- Lightweight and easy to use



Figure 1: Anatomy of a transtibial below the knee amputation [1]

Competing Designs



Figure 4: iWalk 3.0 Design

iWalk 3.0

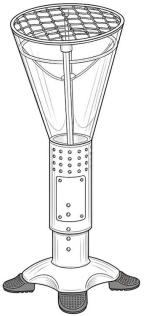
- Hands-free crutch relying on a kneeling pad and thigh straps. [2]



Figure 5: The Lytra BK Design [3]

Lytra Shower Prosthesis

- Modular design featuring a hand grip, cone-shaped socket with drainage, adjustable button leg, and rubber foot.



The Antler

- Uses netting inside a plastic frame to suspend the leg and allow water drainage. [4]



Figure 7: Collapsible Prosthetic Shower Leg [5]

Collapsible Prosthetic Shower Leg

- Four-part modular design (suspension, socket, pylon, foot) with a leg tilt to mirror natural knee positioning.

Figure 6: The Antler

Product Design Specifications

- Holds 1,069 N (1.5x user weight) for 60–70s without yielding
- < 1.8 kg overall (< 1.0 kg per component)
- DCOF ≥ 0.60 on wet, soapy tile meeting ADA non-slip standards
- Step-in socket allows independent entry/exit in < 60 seconds
- Fits 25.4 cm stump and 45.7 cm popliteal height
- Adaptability to limb volume changes
 - 15-35% loss



Figure 8: Incision Site of Stump [6]



Figure 9: Standard ADA Shower [7]



Design 1 - The Swing

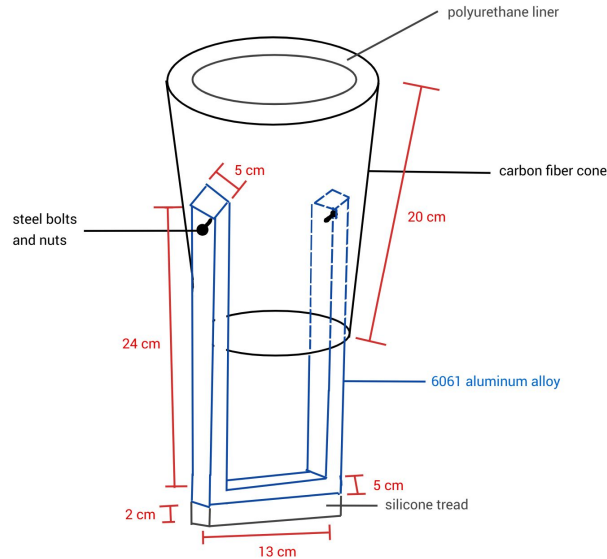


Figure 10: Design 1 - The Swing

Advantages:

- No contact on knee or nub
- Lightweight
- Can be disassembled for easy travel

Disadvantages:

- Socket is not adjustable
- Nothing to hold on to
- No security straps

Design 2 - Air Jordan

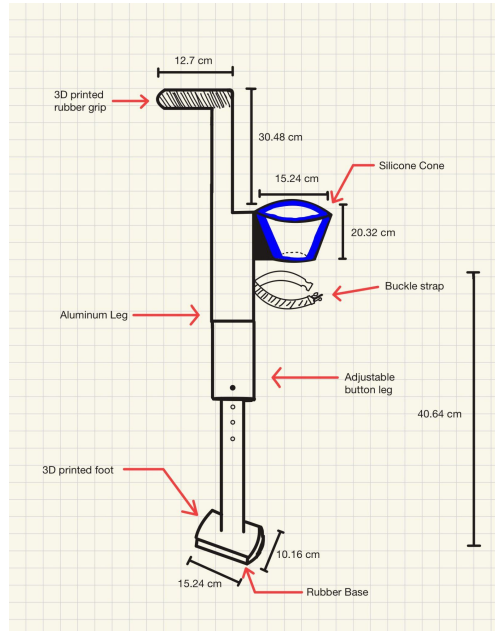


Figure 11: Design 2 - Air Jordan

Advantages:

- Strap to secure residual limb throughout volume loss
- No contact to nub
- Minimal part of residual limb covered

Disadvantages:

- Knee may contact handle
- Weight distribution not centered
- Would stick straight out if sitting

Design 3 - Larptra

Advantages:

- Hinge to prevent sticking straight out when sitting
- Drainage holes to prevent water pooling
- Thigh strap for increased stability

Disadvantages:

- Nub may contact bottom of socket
- Heavier design
- Large portion of residual limb covered

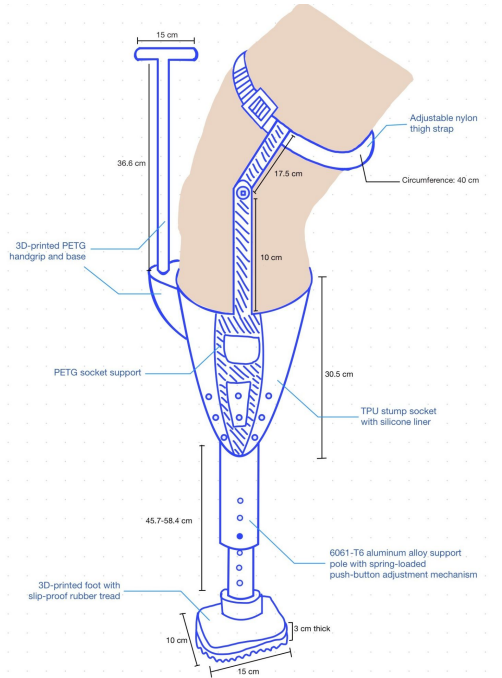


Figure 12: Design 3 - Larptra

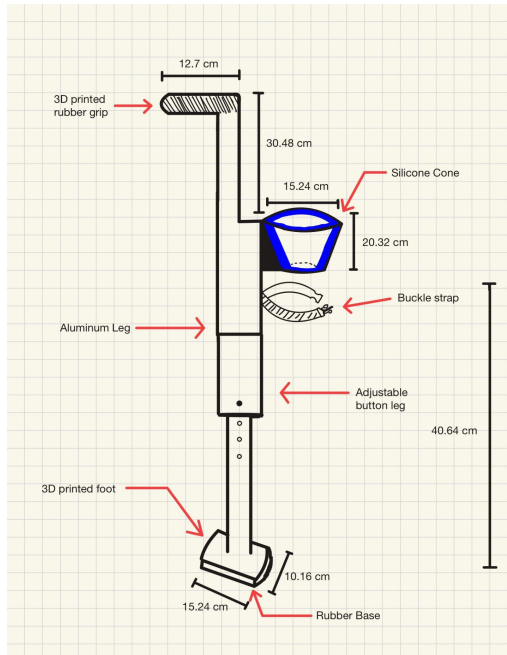


Figure 13: Air Jordan Design

Final Design

Materials and Manufacturing:

- Support leg
 - 6061-T6 Aluminum
 - Spring-loaded push button mechanism [8]
- Straps: Nylon [9]
- Cone: Silicone [10]
- Handgrip: Rubber
- 3D printed foot: PETG [11]



Figure 14: PETG filament



Figure 15: TPU Filament

Next Steps

Implement Client Feedback

- Relocation of the “cone”
- Modular & customizable handle
- Strap rework

Fabrication and Prototyping

- Finalize the materials
 - Order
- 3D print the handle grip and foot

Testing

- Safety
 - Weight bearing
 - Slip resistant
- Environmental resistance
 - Submerge
- Client Testing
 - Comfort
 - Preferences

Acknowledgements

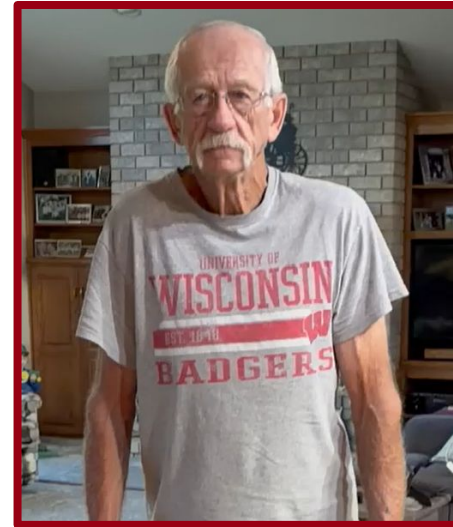
Advisor

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Client

Mike DeGrave



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Questions?

