Clutch Crutch

An Alternative Hands-Free Medical Mobility Device for Lower Leg Injuries

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Problem Definition

To design and manufacture a medical mobility device to aid people with lower leg injuries which allows their hands to be free, walk upright without an imbalance in weight distribution, use stairs with ease, provide upper leg strength retention, and allow free movement of the knee joint.

Product Marketability

Assistive devices such as canes, wheelchairs, walkers, and crutches are used by 6.5 million people in the United States every day. For lower leg injuries, the most common device used for rehabilitation is the crutch, more specifically the axillary crutch. Crutches present discomfort and safety hazards for the user. A hands-free, pain-free mobility device that accounts for lower leg and knee injuries would be an ideal alternative to current market solutions.

	CRUTCHES	KNEE SCOOTER	iWALK 2.0	FREEDOM LEG	CLUTCH CRUTCH
NO WEIGHT BELOW KNEE	✓	✓	✓	✓	✓
PAIN-FREE	✗	✓	✓	✓	✓
HANDS-FREE	✗	✗	✓	✓	✓
STAIRS-FRIENDLY	✗	✗	✓	✓	✓
UPPER LEG STRENGTH RETENTION	✗	✗	✓	✓	✓
ALLOWS KNEE JOINT MOVEMENT	✓	✓	✗	✗	✓
NO PRESSURE ON KNEE	✓	✗	✗	✓	✓
EXTENDED RANGE OF MOTION	✗	✗	✗	✗	✓

Design Features

➢ **Ergonomic Movement**

A track-and-roller mechanism connects the footrest to the device without loading the injured leg with any weight. This allows a more natural walking motion and knee joint movement.

➢ **Adjustable Height & Shock Absorption**

A gas spring provides shock-absorbing functionality as well as height adjustability with the push of a button.

➢ **Fitted Comfort**

Memory foam padding is built into the seat and the footrest for a comfortable fit of the upper and lower legs.

➢ **Modularity**

Seat padding is attached to the seat by Velcro for customization. The bottom foot is also detachable by a button-and-hole mechanism for replacement.

Specifications

Maximum length: 36 in.
Minimum length: 31 in.
Seat Dimensions: 8 in. x 9 in.
Weight: 16 lb.

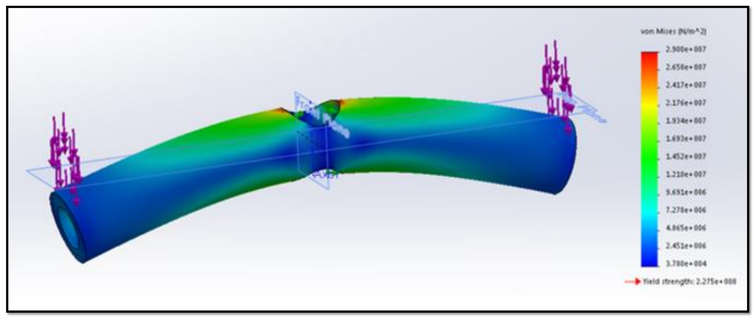
Manufacturability

Manufacturing Cost < $200

Current design consists of aluminum and wood. A more polished design would consist of advanced composites that would increase strength and durability, as well as decrease total weight.

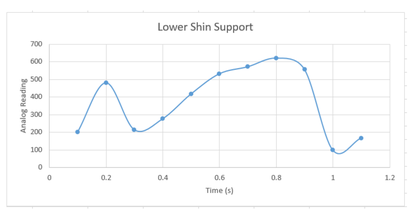
Finite Element Analysis

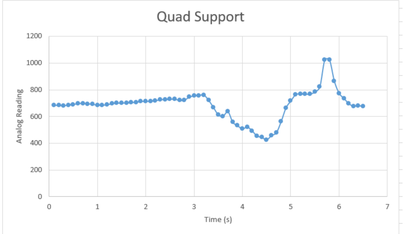
A finite element analysis was performed on the pivot rod located below the seat for potential bending failure. Stress distributions below indicate a factor of safety of 7.84.



Weight Transfer Validation

Load resistance sensors were mounted at various locations during user testing to validate weight transfer behavior to the thigh muscles and minimum load bearing of the footrest.





The data from the sensors was outputted as analog values ranging from 0-1023. The max load for the force sensing resistor is 22 lbs. which is equivalent to 1023 analog readout. From 900 to 1023 weight needs to increase exponentially for the numbers to increase linearly. From 0-900 the analog readout varies fairly linearly with a correlation of Weight = 0.000714(Analog signal). The most important observation to gain from this data is that there is very little force being applied to the injured areas of the foot, roughly a quarter of a pound.