



DEPARTMENT OF
Biomedical Engineering
UNIVERSITY OF WISCONSIN-MADISON

Preliminary Presentation - Knee Crutch

Carmen Tanem, Katie Matheus, Meghan Hayes, Maddie, Victoria Kind, Zach Haussler

Team



Carmen Tanem



Katie Matheus



Meghan Hayes



Victoria Kind



Madeline Kramer



Zach Haussler



Overview/Background

Why Stair Mobility Matters

- Safe mobility can determine whether a patient returns home or remains in the hospital.
- Nearly 1 in 3 adults over 65 report difficulty climbing a flight of stairs [1].
- Our client frequently has patients with charcot foot, below the knee amputees, etc. Which means “hopping” is not a safe option. [2]



Figure [1]: Picture showing Charcot foot, a common injury Mr. Kutschera's patients



Problem Statement

Non-weight-bearing patients often face difficulty safely navigating stairs during lower-limb injury recovery, but current market mobility aids are not designed specifically for stair use. Our project aims to develop a lightweight, stable, and adjustable knee crutch that provides safe and easy stair mobility.

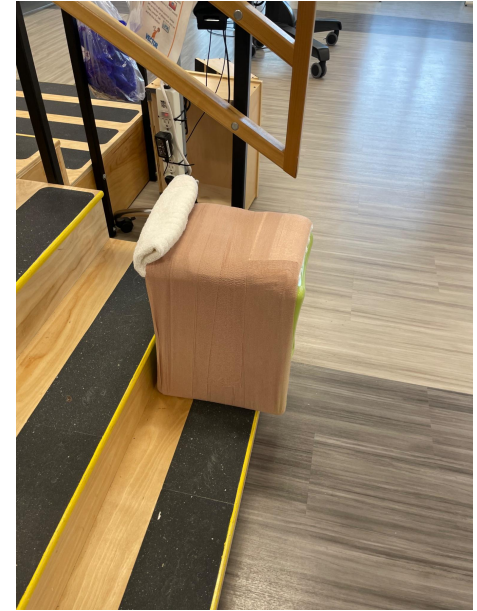


Figure [2]: Photo of clients current solution



Client

Mr. Daniel Kutschera

Physical Therapist for 33 years

- Graduate of UW-Madison
- Primarily works in neurorehabilitation
- Comes up with solutions to assist patients in overcoming physical/environmental barriers.
- Passionate in clinical expertise to assist patients as they recover after the most challenging medical crises of their lives.



Figure [3]: Photo of Dan Kutschera



Competitor

- Freedom leg
- Hands free alternative to crutches [3]
- Full leg encased
- Requires balance for stairs
- Lengthy attachment process
- High price point ~\$400



Figure [4]: Freedom Leg

- iWalk 3.0
- Can navigate stairs [4]
- Leg strapped at key points
- Uneven base
- Lengthy attachment process
- Medium-high price point ~\$180



Figure [5]: iWalk 3.0



Product Design Specifications

- Accommodate users ~5-6 ft tall and support up to 400 lbs
- Remains stable and stationary during use
- ~4 lbs or less w/ handles for portability
- Helps avoid one-legged squats
- Lasts approximately two years
- Can be easily sterilized
- Costs less than \$500
- Easily adjustable



Figure [6]: Knee angle demonstration



Design 1 - Bolt Step Design

- Adjustments locked in place via bolts
- Easily replaceable components
- Built in handles
- Five adjustable positions

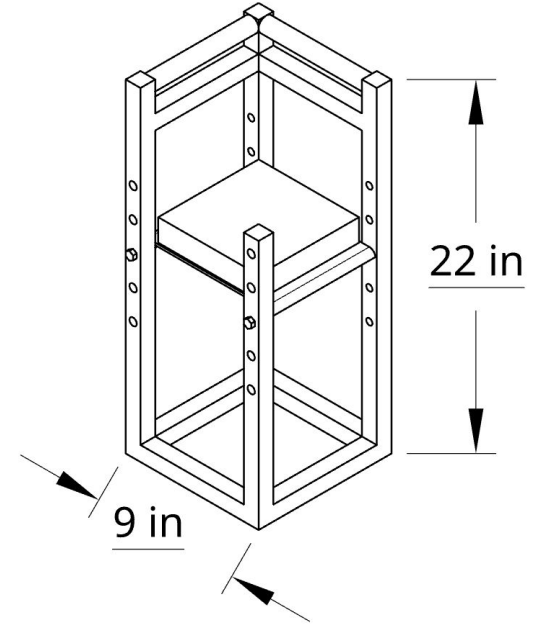


Figure [7]: Bolt Step Design drawing



Design 2

- Light Step Knee Crutch
- Reiterated previous design
- Spacer plates
- Top cushion
- Belt for stability

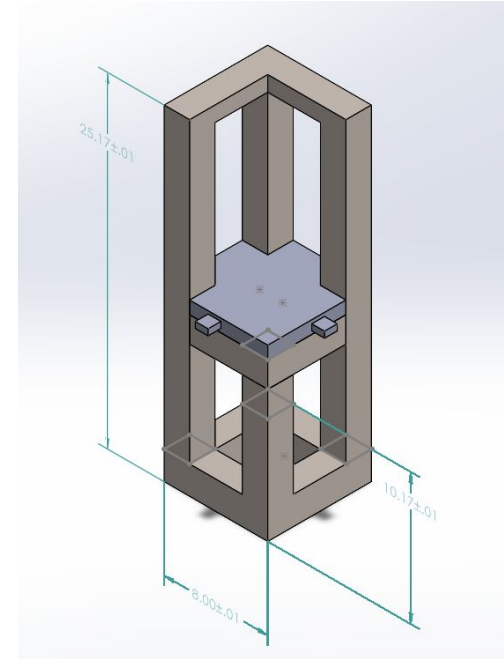


Figure [8]: Light Step Drawing



Design 3 - Screw Leg Knee Crutch

- Screw Leg Knee Crutch
- Adjustable to up to 125mm
- Rubber Feet
- Stationary cushion
- Built in handle

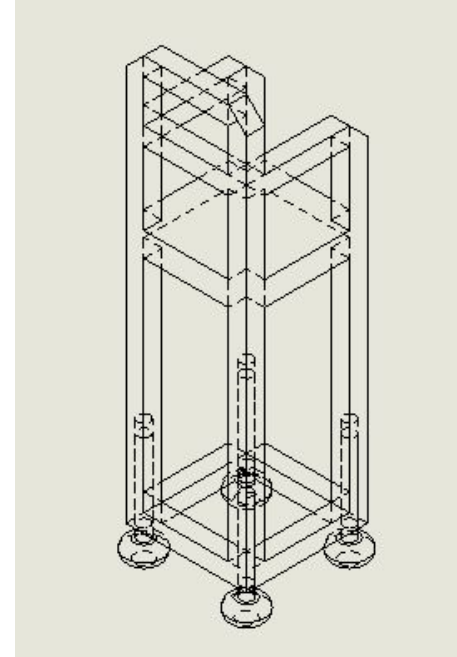


Figure [9]: Screw Leg Knee Crutch



Design Matrix

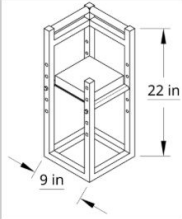
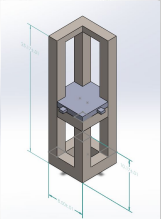
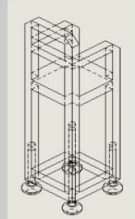
Design Criteria	Weight	Bolt Step		Light Step		Screw it	
							
Weight	20	5/5	20	4/5	16	4/5	16
Adjustability	20	4/5	16	4/5	16	5/5	20
Sterility	20	4/5	16	5/5	20	5/5	20
Ease of Use	20	4/5	16	4/5	16	3/5	12
Comfort	10	3/5	6	5/5	10	5/5	10
Ease of Fabrication	10	3/5	6	5/5	10	2/5	4
Total Score	100	80/100		88/100		82/100	

Figure 10: Knee Crutch Design Matrix



Final Design

- Made of aluminum alloy
- Foam handles and cushion added for comfort and sterility
- Three removable plates for adjustability
- Belt added around plates for security

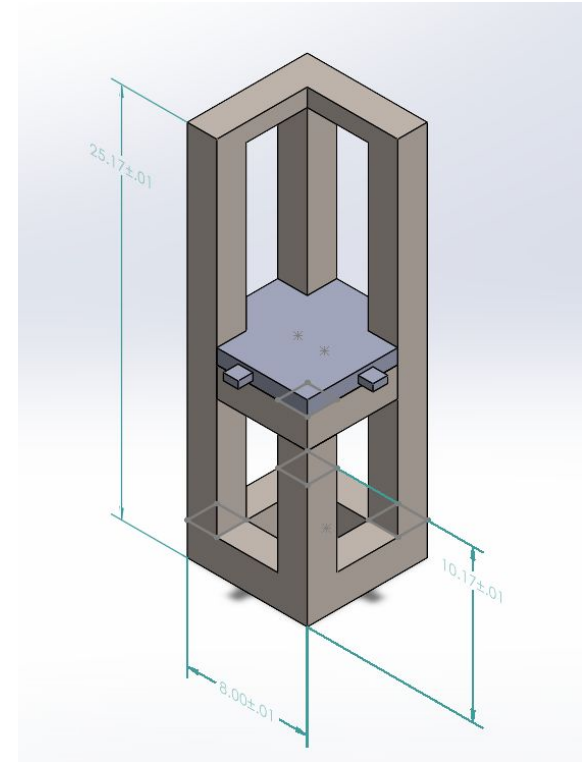


Figure [11]: Final Design of Knee Crutch



Testing and Results

- Test Various Weights and Heights of individuals [5]
- Identify how much force the aluminum and 3D prints can hold
- Test comfortability



Future Work

- Make the device very light weight
- Make the knee plate patient specific for optimal comfort
- Making the device for patients specific height
- Feasibility of mass production



Acknowledgements



Figure [12]: Photo of Duc-Huy Nguyen



Figure [13]: Photo of Dan Kutschera

References

- [1] Kondo, Kyoko, et al. "Factors Associated with Functional Limitation in Stair Climbing in Female Japanese Patients with Knee Osteoarthritis." *Journal of Epidemiology*, vol. 16, no. 1, Dec. 2005, pp. 21–29. PubMed Central, <https://doi.org/10.2188/jea.16.21>.
- [2] S. F. Jones, P. C. Twigg, A. J. Scally, and J. G. Buckley, "The mechanics of landing when stepping down in unilateral lower-limb amputees," *Clinical Biomechanics*, vol. 21, no. 2, pp. 184–193, 2006, doi: 10.1016/j.clinbiomech.2005.09.015.
- [3] "Hands Free Crutch - Crutch Alternative - Freedom Leg," Freedom Leg brace. <https://www.freedomleg.com/>(accessed Oct. 01, 2026).
- [4] "iWalk 3.0 Hands Free Crutch - Bellevue Healthcare," Bellevue Healthcare, Mar. 29, 2021. <https://bellevuehealthcare.com/product/iwalk-3-0-hands-free-crutch/>
- [5] ASTM International, "Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube," ASTM B241/B241M. The standard lists mechanical-property requirements for 6061-T6 aluminum tubing, including a minimum yield strength of 240 MPa for many extruded tube sizes.
- [6] "Daniel Kutschera | LinkedIn," LinkedIn.com, 2026. <https://www.linkedin.com/in/daniel-kutschera-239a8492>



Questions?

