TRAILS Crank Cycle

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TRAILS
TECHNOLOGY • RECREATION • ACCESS
INDEPENDENCE • LIFESTYLE • SPORTS
University of Utah Health's Global Adaptive Program

Introduction and Problem

This project aims to redesign the **Krank Cycle**, an upper body exercise bike , for spinal cord injury patients. This new design will increase **accessibility** and **adjustability** for users population with limited mobility. It includes a progress-tracking display, an adjustable frame, and dual resistance system.

Existing Krank Cycle
(No longer in production)

User Needs & Specs

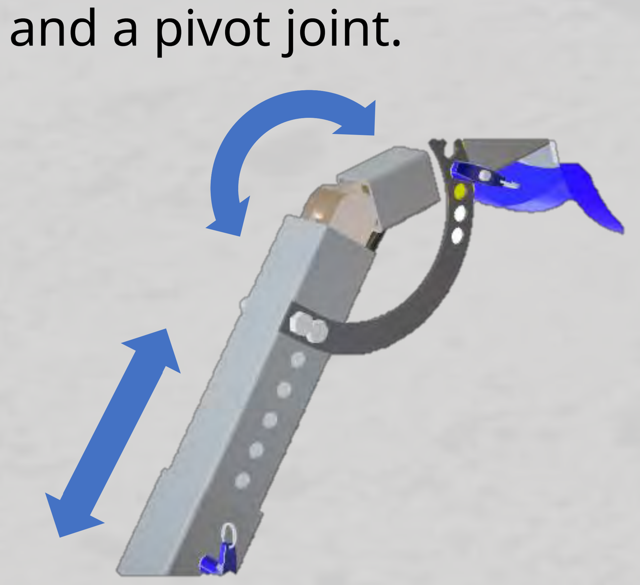
Specifications were based on user needs.

User Needs	
1.	Wheelchair Accessible
2.	Adjustable to fit a wide range of users
3.	Changing resistance
4.	Rigid enough for heavy workout use
5.	Include modern cycling resistance technology in both directions
6.	Sensors that accurately measure power, RPM/speed
7.	Portable/collapsable
8.	Create a prototype of desired design
9.	Inexpensive
10.	Design for manufacture
11.	Incorporate cooling system
12.	Add feedback for distance, calories, resistance

Specifications	
1.	The ramp platform shall not exceed **5°**
2.	The platform shall be **32-36"** wide
3.	The cycle shall interface with the TRAILS handlebars and **grips**
4.	The cycle grips shall extend out horizontally **12-15"**
5.	The device shall pivot **–20 to 60°** around a fixed axis
6.	The rider will be able to **change resistance** in a universal method adaptable for all disabilities
7.	The resistance shall range from **0 to 25 Nm**
8.	The bike will withstand max of **309 N** applied to the cycle arms without tipping over
9.	Can resist light sweat at **IPx2** rating
10.	Cycle shall accurately measure and display power within **+/- 5W**
12.	Cycle shall accurately measure and display RPM within **+/- 10 RPM**
13.	The cycle shall be **portable**
14.	The cycle shall not exceed **$3,400** in cost to prototype

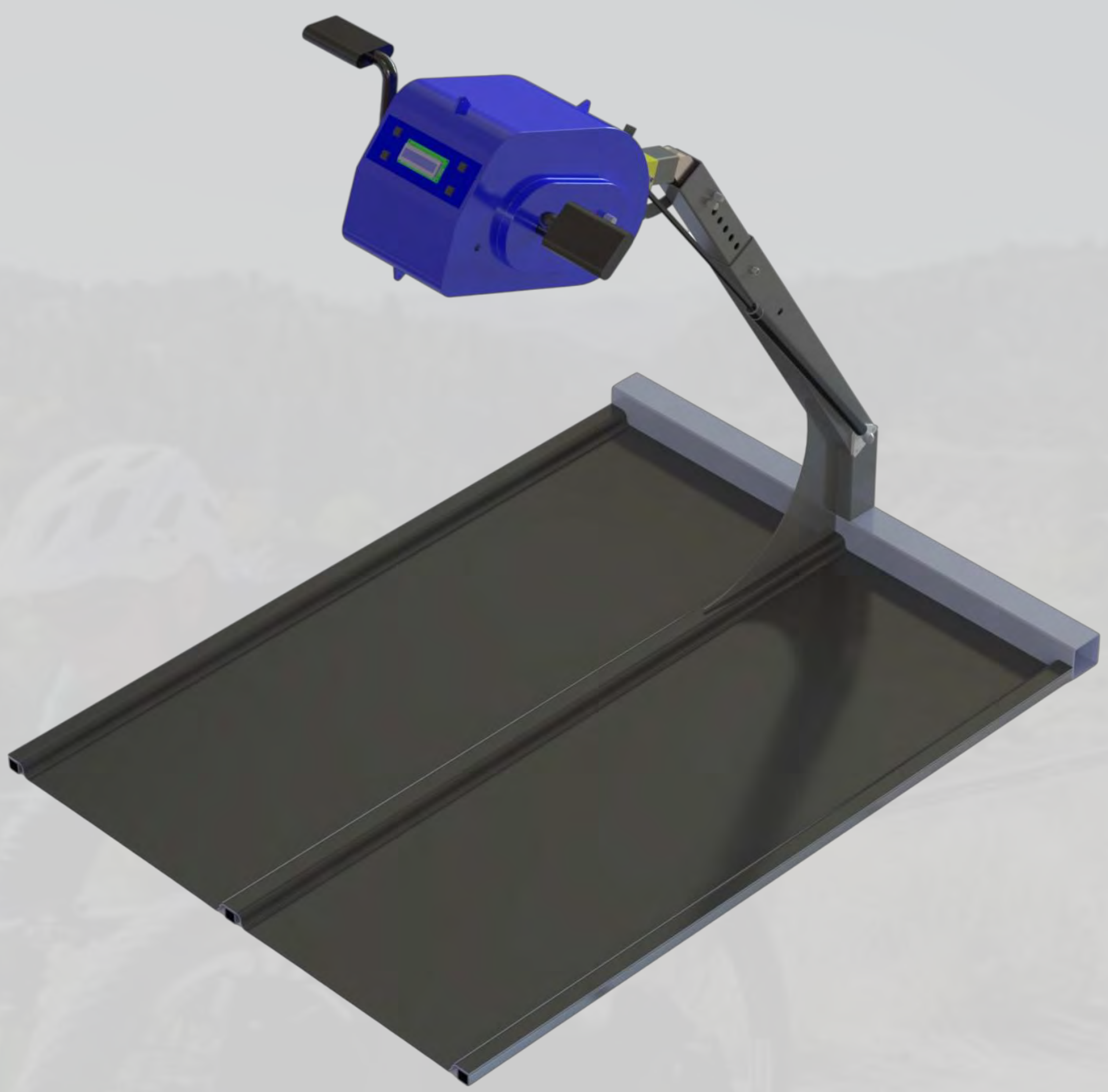
Adjustability Design

The frame was designed to accommodate the dimensions of a wide range of users as well as a variety of wheelchairs. **Two adjustable degrees of freedom** were used to accomplish this, a telescoping rail and a pivot joint.



Demonstration of the designed pivoting and extending

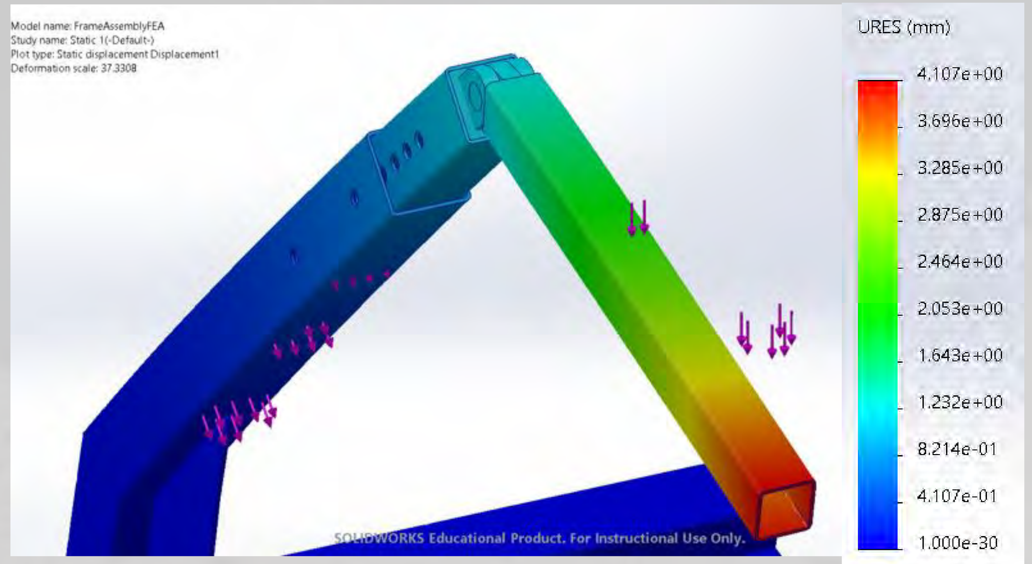
Final Design CAD Model



FEA of Frame

Finite Element Analysis (FEA) was used to evaluate our design's **structural integrity**. The results show the overall force distribution across the structure. In this case, FEA simulates forces on the top and center posts of the frame to represent the user's input.

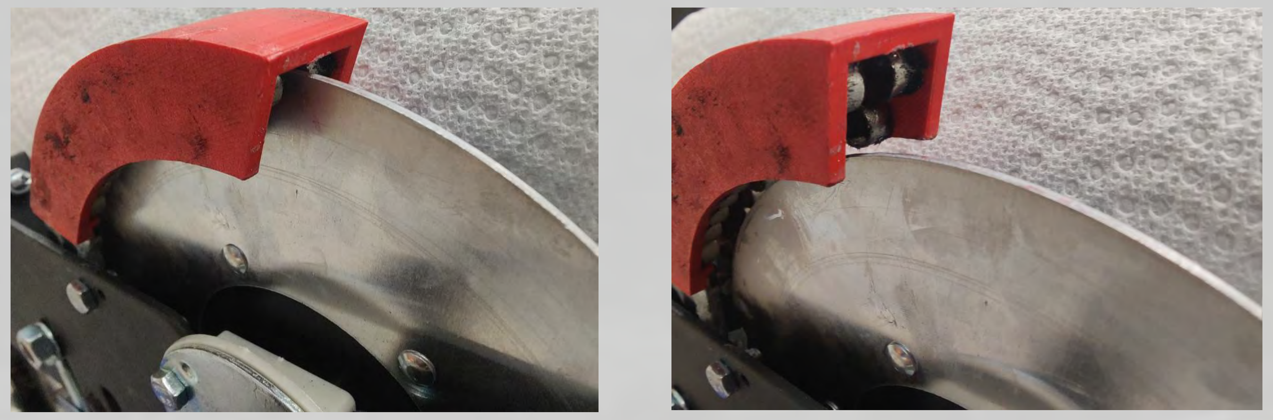
FEA Results	
Material Properties	Plain Carbon Steel Yield strength: $2.21 * 10^8\ N/m^2$ Tensile strength: $3.99 * 10^8\ N/m^2$
Applied Forces	400 N to Center Frame 444 N (100 lbs.) to Top Arm
Max Stress	$4.16 * 10^8\ N/m^2$
Max Strain	0.001
Total Vertical Displacement	4.107 mm



FEA analysis simulation done in SolidWorks

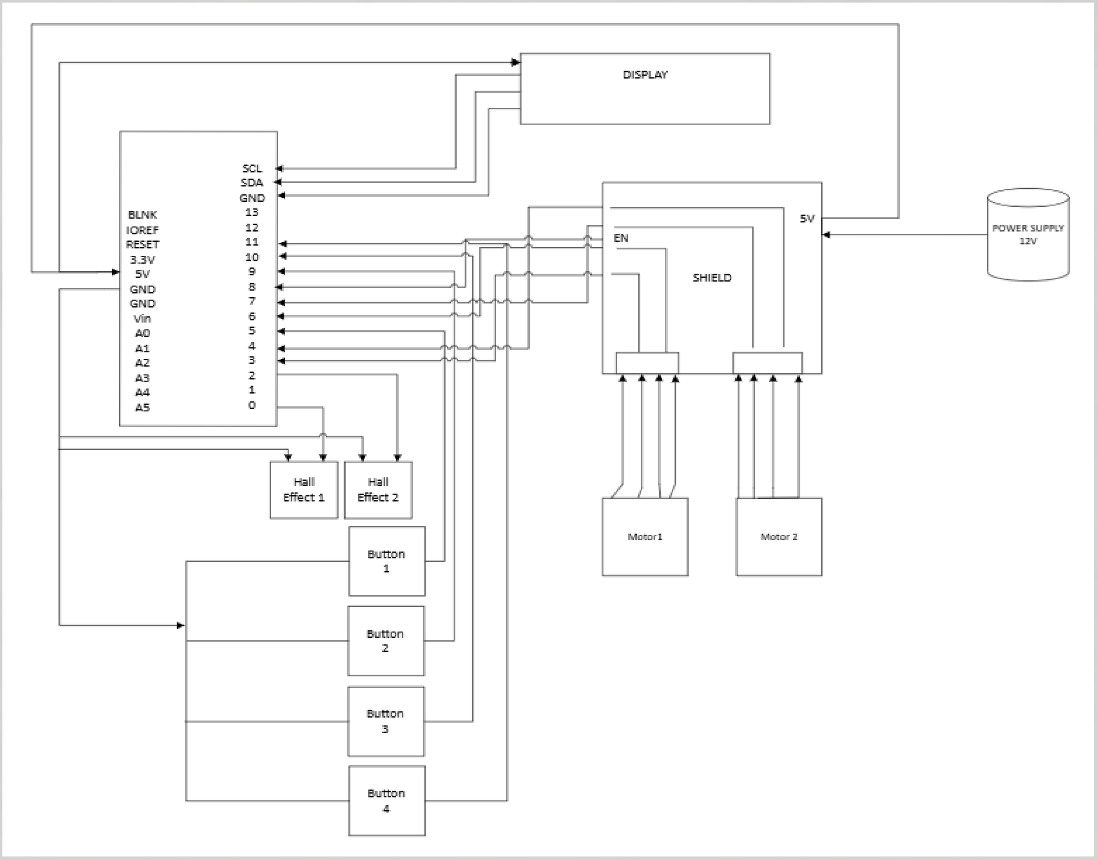
Dual Magnetic Resistance

Our design has **two independent** magnetic **adjustable** resistance systems. This allows users to exercise each arm at different intensities. **Magnetic resistance** allows for smooth and quiet operation and is created with powerful magnets. The resistance level is determined by the overlap between the magnets and the flywheel which can be adjusted by the user.



Full magnet overlap with high resistance is shown on the left and no magnet overlap with low resistance is shown on the right.

Electrical Design



Wiring Diagram showing the electrical system

The electrical system was designed to use **buttons** that control **motors** to adjust resistance, **sensors** and **display** to show user feedback.

Conclusion

All the design specifications and user needs were met. The design features allow for **adjustable dimensions and resistance.** It can be deconstructed for **portability** while maintaining **structural integrity.** Future work would mostly focus on professionally machining for higher quality parts.

Final Design Parameters	
Adjustable Stand	The frame can withstand over **42 lbs** of combined weight and force. Total length of platform: **52 inches** Width of platform: 4**0 inches** Maximum Hub Height: **49** Minimum Hub Height: **38** **11 inches** total adjustable range and can pivot from **–20 to 60°**
Resistance System	Provides **0 to 25 Nm** of resistance torque
Electrical System	Total of **8 different levels** of resistance