



Trine University
Biomedical Engineering

Backpack Chair Design

Lucas Harmon, Christian Schafer, Graeme Basey, Hailey Dunham
Advisor: John Patton, Ph.D., Pe.
Trine University
One University Avenue, Angola, Indiana 46703



Opportunity:

Create a backpack chair to support the challenger/customer during long periods of walking or standing. The customer has Limb-Girdle Muscular Dystrophy, which causes progressive weakness in their limbs. This has resulted in difficulty walking and standing up from normal seating without support. The customer wants a chair which he can carry in a backpack which: deploys without removal of the backpack, with little to no set up steps, and is bar stool height so he can use it without external assistance. The chairs' purpose is to provide a seat for occasional use in city and urban environments.

Customer Specifications:

Needs	Specs	Updated Specs	New Specs
Deploy/Retract	< 10 sec	< 10 sec	< 10 sec
Adjustable Straps	Yes/No	Yes/No	Yes/No
Bar Stool Height	28" - 32"	32"	Approx. 34"
Weight	< 20 lbs.	< 20 lbs.	< 2-4 lbs.
Foam Padding	Yes/No	Firm Padding	No Padding
Water Repellant Cover	Yes/No	Yes/No	Yes/No

Materials and Standards:

- ❖ Primary materials used for the project include: 2024 Aluminum Pipe, 11 GA (1/8") Low Carbon Steel Plate, Aluminum Pack Frame, NSF Poly Pipe, 550 Paracord, and Nylon Fabric & Thread
- ❖ Primary standards and procedures used for testing and validation of various components of the project include:
 - ASTM D1683 Fabric Seam Strength Testing
 - Used for testing fabric stitch pattern
 - The Engineer's Pulse
 - Used to determine SF for PLA rollers
 - TM022-TM22-TM 22 Water Repellency: Spray Test
 - Used for testing Water Repellency
 - ASTM F2116-01 / ASTM F3410-19
 - Used for testing rope elongation
- ❖ Testing reports were written based on each test performed for the various components of the Backpack Chair

Design Process:

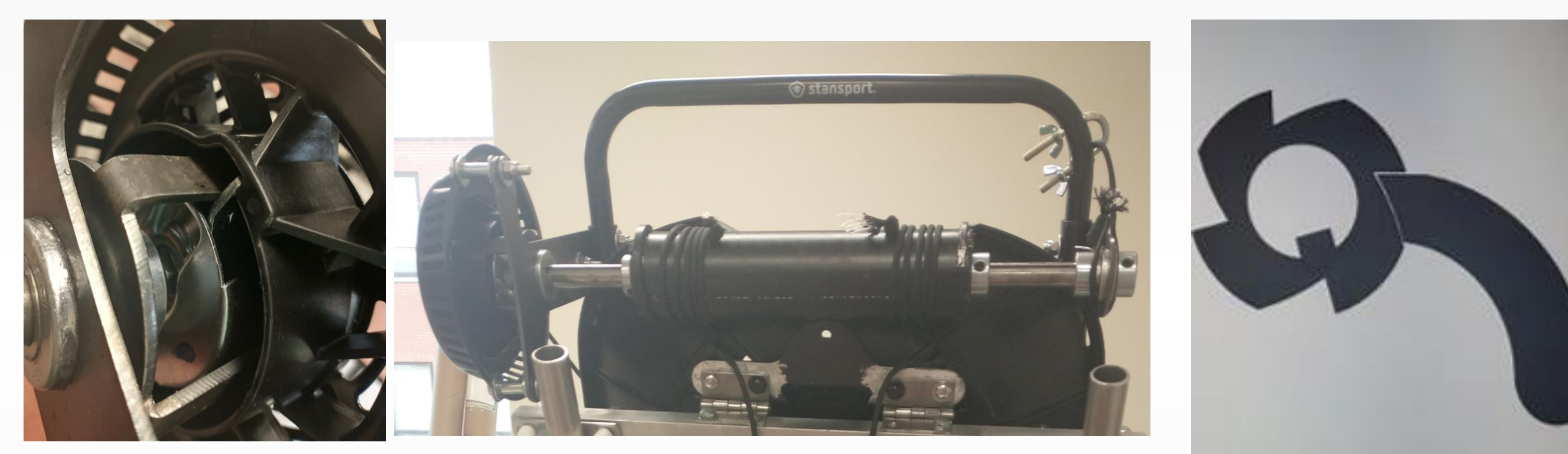
Summary of designs for the folding seat, shaft, backpack mounting arms, and joining the chair and backpack.



Original Concept Sketch

Iteration 2: Sliding Track

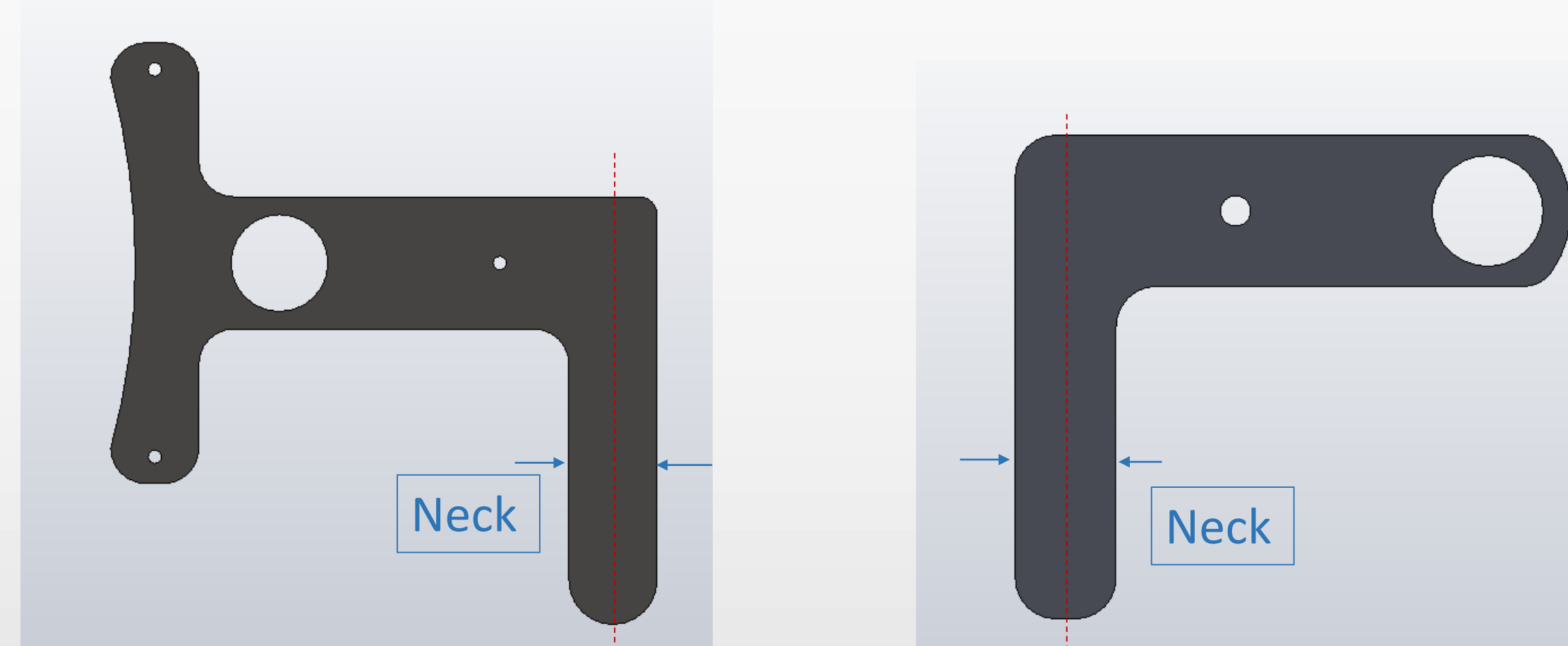
Final Design: Sliding Rail



Flywheel & recoil starter

Retraction System: Starter - Rope Spool - Ratchet

Ratchet Gear & Paw



Backpack mounting arms were bent down the middle of the necks to create two contact points on the backpack pole and were bolted on.



Assembled Chair — Backpack and Chair — Backpack with Cover

Conclusion:

- ❖ Novel backpack chair manufactured
 - Unaware of existing products on the market
- ❖ Backpack was made to initial specifications for challenger
 - Customer specifications varied over the year
- ❖ Working Prototype
 - Additional adjustments necessary, but current prototype is functional



Chair retracted (left)



Chair deployed (right)

Challenges and Future Work:

Challenges

- ❖ Difficulties w/ distance from challenger & meeting times
- ❖ Seat pivot point; ratchet weight limit; interaction btw. systems

Future Work

Dimensions

- ❖ Reduce height, width and length of chair (i.e., new chair design)
- ❖ Reduce weight of subsystems and main frames

Aesthetics

- ❖ Create plastic fabric casing
- ❖ New placement of pull cords

Functionality

- ❖ Slow or soft release of chair from pack

Acknowledgement:

The Backpack Chair Design Project would like to thank the following for their contribution, facilities, and resources:

- ❖ Dr. Patton
- ❖ Jason Whitman
- ❖ The Challenger
- ❖ Dr. Gong
- ❖ Dr. Kelly
- ❖ Joe Thompson