



# Off-Road Recreational Walker

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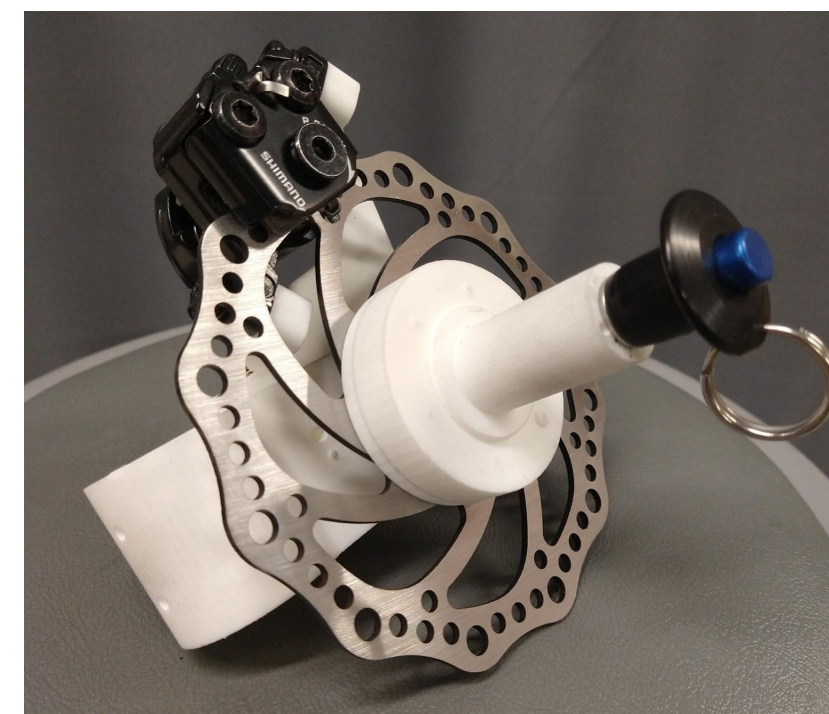
## Problem



Grace is an active seven-year-old who loves playing outside. She especially enjoys running around on the soccer field. Her current experience is limited because pediatric walkers are not well suited for irregular terrain, including grass and sand. Our team was challenged with engineering a solution to adapt existing walkers with new features that improve safety and mobility on irregular terrain.

## Proposed Solution

We designed and built interchangeable wheel hubs and a hammock seat to improve off-road performance and walker ergonomics. A user can easily install terrain-specific wheels that reduce the forces required. To ensure user safety, these hubs also have a braking and anti-rollback system.

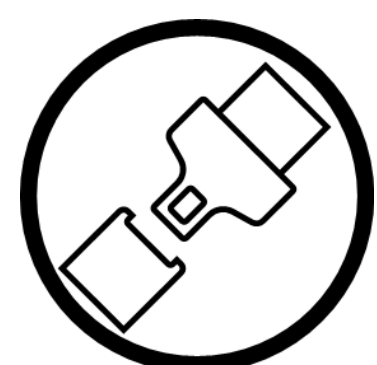


## Design Requirements



### Mobile

- Can overcome irregular terrain
- Is maneuverable



### Safe

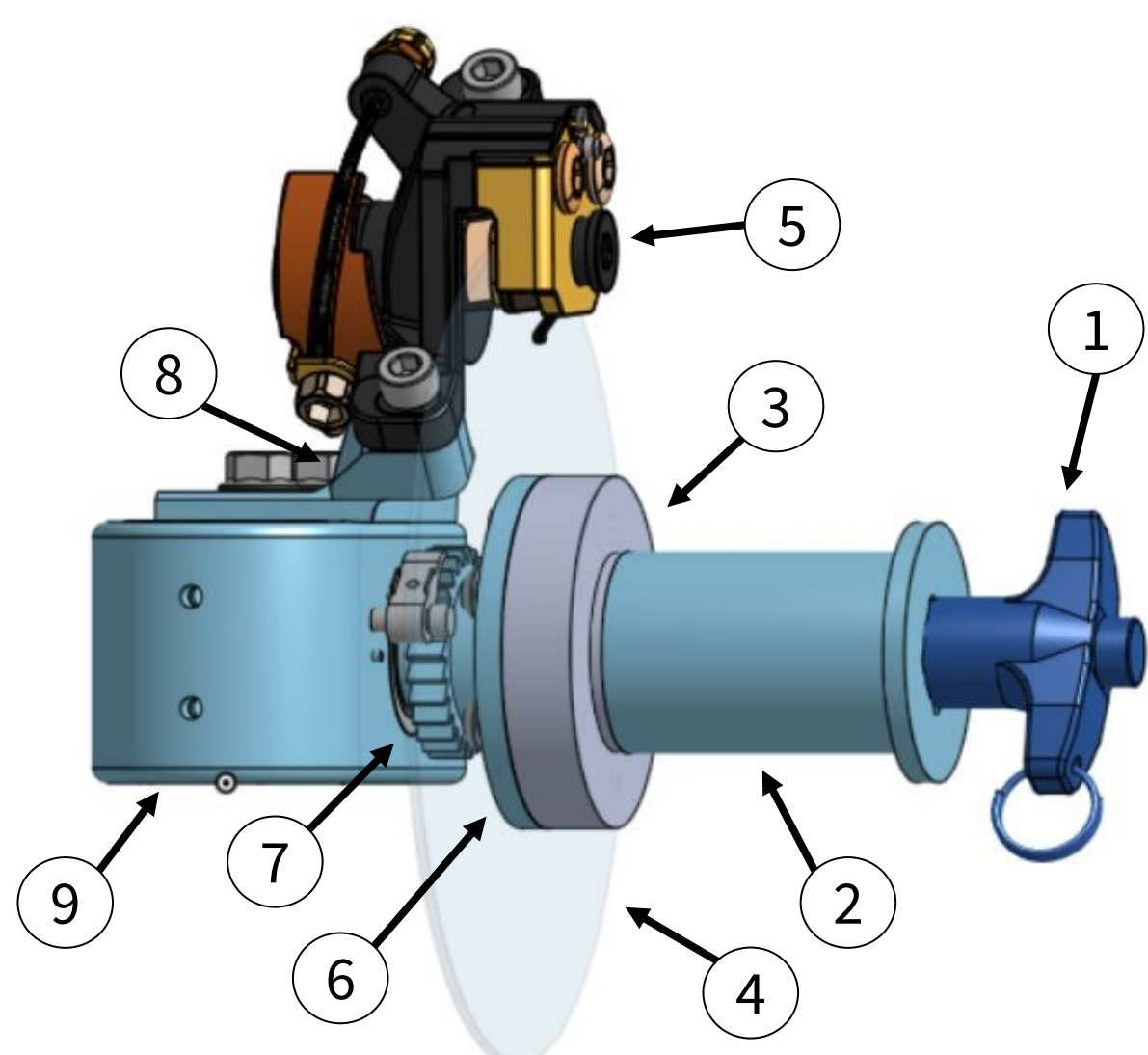
- Supports users' weight
- Is stable
- Can prevent user from rolling backward
- Has functional brakes



### Usable

- Wheel extensions are easy to install
- User can engage features
- Can be used for outdoor recreation

## Interchangeable Wheel Hub and Extension



1	Removable Axle Pin
2	Wheel Clamp
3	Brake Rotor Axle Adapter
4	Brake Rotor
5	Brake Caliper
6	Ratchet Connector
7	Anti-Rollback System
8	Brake Caliper Mount
9	Hub Mount

## Evaluation



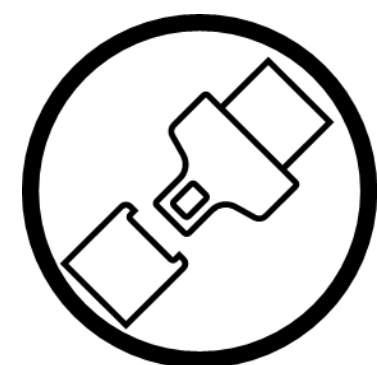
The current walker requires more force on irregular terrain than Grace is able to produce. We designed terrain specific wheel assemblies to improve performance. We conducted experiments with the walker to measure force differences with the new wheels.

**Irregular Terrain Force Test:** To be considered mobile, the walker with an installed terrain-specific extension must require less force to overcome irregular terrain than the walker with non-specific terrain wheels.

Extension Type	Peak Force with Non-Specific Terrain Wheels	Peak Force with the Terrain-Specific Extension	Force Difference
Off-Road	57.3 N	45.7 N	-20%
Beach	121.6 N	110.7 N	-9%

**Turn Radius Test:** To be considered maneuverable, the walker with an installed terrain-specific extension must have a turn radius less than 1.5 times larger than the walker's original turn radius.

Extension Type	Average Turn Radius	Turn Radius Increase
Off-Road	1010.92 mm	1.13
Beach	1084.58 mm	1.22



The user must be safe while operating the walker with off-road components. ISO standard 111999-2:2005 inspired safety tests to verify performance and safety.

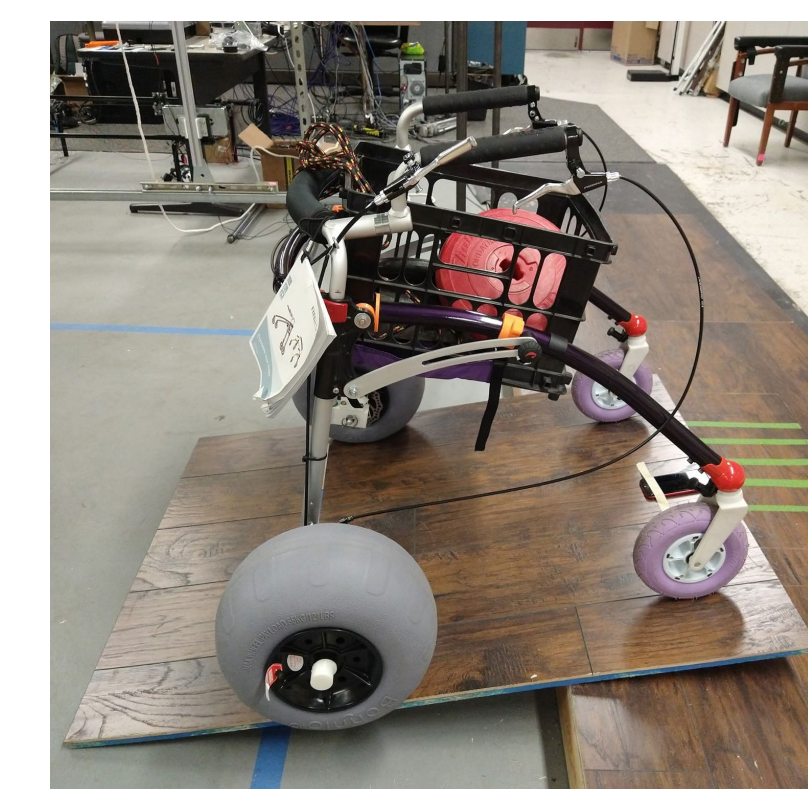
**Stability Test:** Per the ISO standard, the forward facing walker cannot tilt on inclines less than 15 degrees, the backward facing walker cannot tilt on inclines less than 7 degrees, and the sideways facing walker cannot tilt on inclines less than 3.5 degrees.

Extension Type	Walker Orientation	Angle of Instability
Off-Road	Forward	35°
	Backward	29°
	Sideways	28°
Beach	Forward	31°
	Backward	27°
	Sideways	21°



**Braking Test:** Per the ISO standard, the walker cannot move more than 10 millimeters in one minute when the brakes or anti-rollback device are engaged.

Extension Type	Brake Type	Distance
Off-Road	Running	0.0 mm
	Parking	0.0 mm
	Anti-Rollback	0.0 mm
Beach	Running	0.0 mm
	Parking	0.0 mm
	Anti-Rollback	0.0 mm



## Evaluation

**Static Loading Test:** Per the ISO standard, the extensions supporting the maximum user load cannot crack, permanently deform, or deform more than 10% under load.

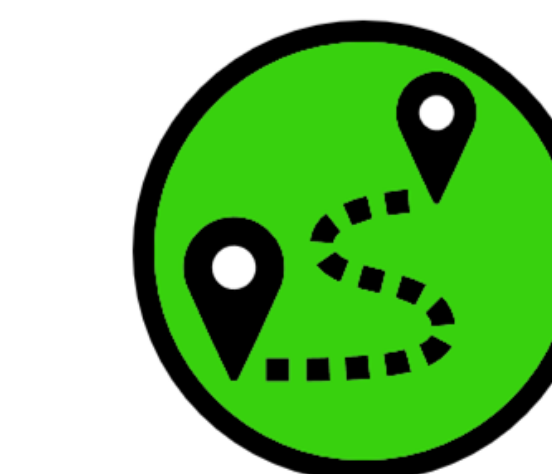
Extension Type	Deflection	Percent Deflected
Off-Road	1.587 mm	1.11%
Beach	9.53 mm	6.25%



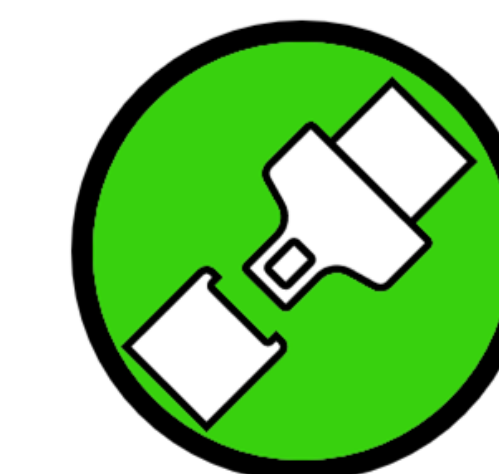
The team developed usability tests to assess walker safety and user performance.

**Pass-Fail Usability Test:** Grace and her family determined the walker's usability by completing the following checklist.

Task	Pass/Fail
Extensions can be installed and removed in under five minutes.	Pass
The off-road recreational walker does not interfere with user's ability to play soccer.	Pass
The off-road recreational walker does not restrict user's movement in any direction.	Pass
User can engage the brakes.	Pass
User can engage the anti-rollback system.	Pass



✓ Mobile



✓ Safe



✓ Usable

The off-road recreational walker was determined to be mobile, safe, and usable.

## Future Work

For other children like Grace who use technology to enable mobility every day, the off-road recreational walker enables outdoor mobility on challenging terrain. We hope that our walker adaptations and user-centered design approach will allow many more kids to recreate and exercise with others on challenging terrain. As every child's specific mobility needs are unique, our solution may need to be adapted for each user.

## Acknowledgements

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