DEPARTMENT OF MECHANICAL ENGINEERING

Team Powerhouse
Project Title

Zachary Friedman-Hill, Ben Johnson, Cristina LiCalzi, Devin Otwell, Patrick Scott, Jordan Tripp

A. JAMES CLARK SCHOOL OF ENGINEERING

Motivation, Goal, Impact

Motivation: Millions of Americans with limited mobility rely on walkers/canes for daily movement, however these devices do not effectively support carrying everyday items.

As a result, users must improvise, balancing bags or making multiple trips, reducing stability and increasing fall risk.

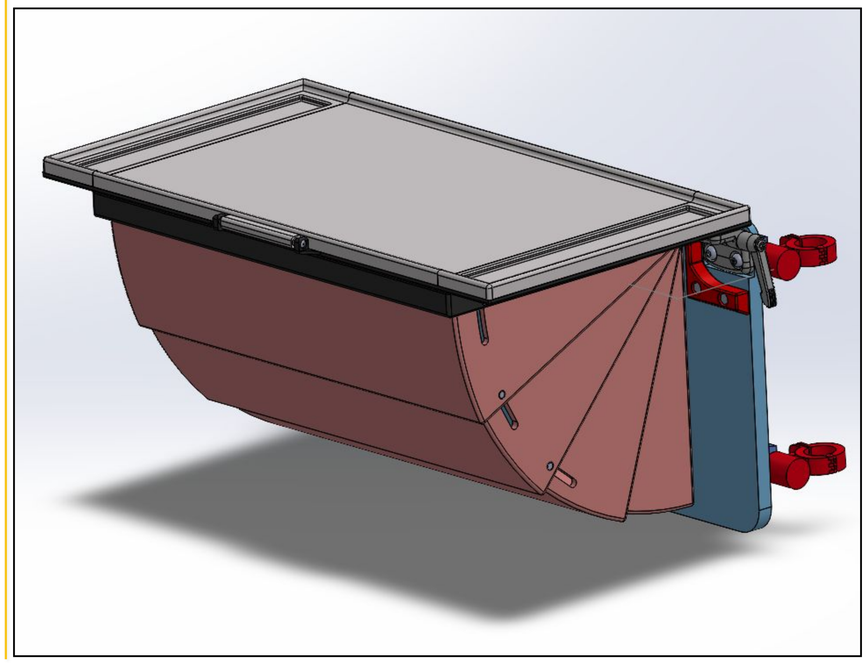
Goal: Design a fully mechanical, intuitive attachment for a walker that enables users to safely carry everyday items, including groceries, laundry, etc. without compromising balance/mobility.

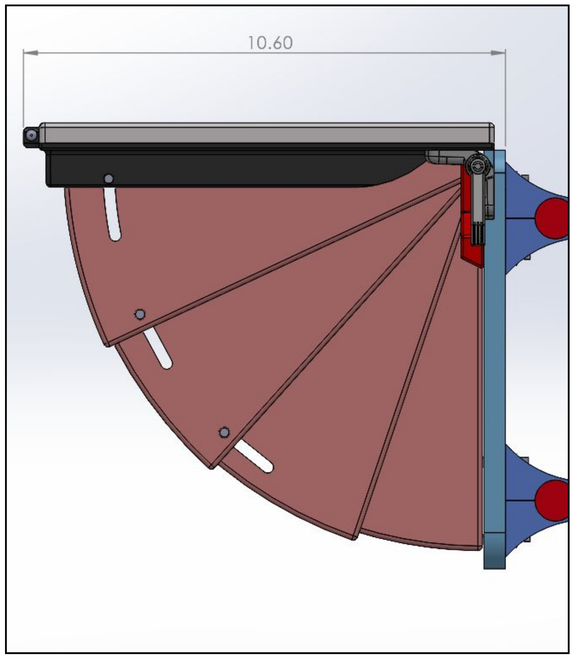
Impact: This design can reduce fall risk, increase independence, decrease caregiver burden, and improve overall quality of life.

Requirements

- Carry at least 5 kg (11 lbs)
- Have an expected cost of <$60
- Fully mechanical
- Ability to handle bulkier items, laundry, groceries, bags
- Keep items stable from swinging
- Does not impede on walking space

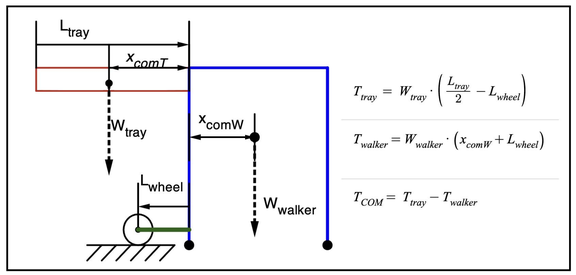
Final Design





Design Calculations & Decisions

- Length of Anti-Tipping Wheels



$$T_{tray} = W_{tray} \cdot \left(\frac{L_{tray}}{2} - L_{wheel}\right)$$

$$T_{walker} = W_{walker} \cdot \left(x_{comW} + L_{wheel}\right)$$

$$T_{COM} = T_{tray} - T_{walker}$$

To prevent forward tipping, we analzyed the combined walker-tray center of mass (COM). For a 10” tray extension, the COM is ~5” in front of the walker. To prevent forward tipping, the anti-tip wheel must extend beyond this point.

Result: A 6” anti-tip wheel attachment was selected, placing the support point ahead of the COM and maintaining stability under load.

- Diameter of Telescoping Bars

To determine an appropriate diameter for the telescoping bars as well as material, analysis of the deflection and yielding were performed.

Deflection Constraint (Material Selection)

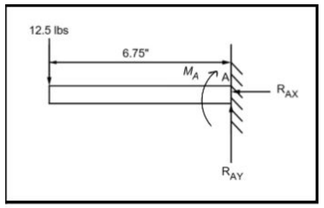


Figure: 3.43: Bar FBD

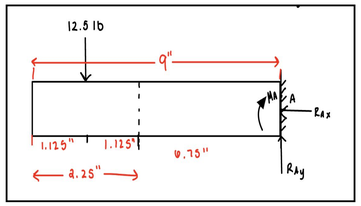
$$\delta = \frac{FL^3}{3EI}$$

$$\delta = \frac{FL^3}{3E\left(\frac{\pi d^4}{64}\right)}$$

$$\delta = \frac{64FL^3}{3E\pi d^4}$$

$$d = \left(\frac{64FL^3}{3E\pi\delta}\right)^{\left(\frac{1}{4}\right)}$$

Yielding Analysis



$$M = P_{arm}L = 12.5 \cdot 7.875 = 98.48\ lb - in$$

$$S = \frac{\pi(D_o^4 - D_i^4)}{32D_o}$$

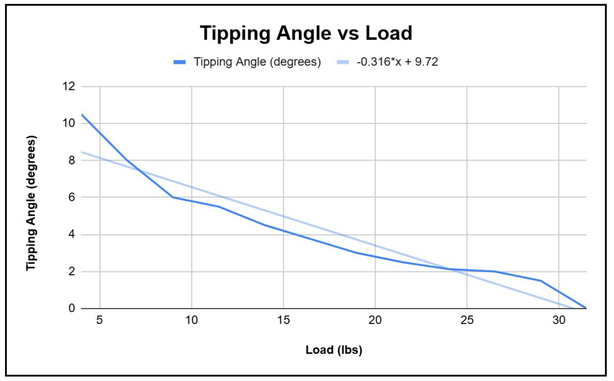
$$\sigma = \frac{M}{S}$$

$$\sigma_{allow} = \frac{\sigma}{3}$$

$$\sigma_{allow} > \sigma \rightarrow PASS$$

Results:
Material: Aluminum 6061
Outer Diamater = .625”
Inner Diamater = .40”

Prototype & Test Results



This test measured how adding weight to the attachment affects the walker’s stability by observing how the maximum angle before tipping changes with increasing load. Loads ranging from 4 to 31.5 lbs were applied incrementally to the front of the walker, and the iPhone angle measurement app attached to the rear leg was used to record the tipping angle for each trial. The tipping angle for each weight is shown in the graph above.