Fast and Furious: Therapeutic Modular Mobility

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Problem Statement

Children who lack the freedom of independent mobility experience resulting negative cognitive effects such as poor depth perception and cause and effect reasoning. These same children also unfortunately tend to be ostracized by their peers, preventing the development of valuable social skills.

Primary Objective

Mainly, we seek to help the children gain age-appropriate individual control of their mobility. Granting them the ability to move about on their own will help them with:

- Conceptualization of cause and effect
- Depth perception
- Cognitive development
- Social development

Needs Assessment

Patient :

- Must provide independent mobility for the child
- Needs to accommodate children of different sizes (up to 70 lbs)
- Must not startle the child during acceleration
- Needs to provide multiple options for acceleration for children with different needs

Provider:

- Must be able to easily adjust seat for child
- Must be able to easily access battery for charging
- Motor controller must be easily accessible
- Must be able to adapt car for distinct needs of child
- Must have easily switchable acceleration mechanisms
- Must be easily sanitized to prevent potential spread of germs between children

System:

- Will be a powered mobility device
- Can't compromise original outer structure
- Additional parts for the car must not cost over $200
- Time to fully charge battery should be 8-12 hours
- Total run time will be 1-2 hours
- Charge monitor to indicate battery level/when charging is needed

Solution Description

A power wheels car (6-V battery powered ride-on) with modular components and attachments which will support a variety of conditions. Our car is suited for children younger than 5 years and will have:

1. Safety Features
    a. Torso harness, foam padding, postural supports, possibly a parent handle and brake
2. Plug and Play Inputs
    a. Button to accelerate, steering wheel, handle bars, pressure controls
3. Motivational Appeals
    a. Colored inputs, music, lighting

This week:

4. Safety Feature
    a. Kill switch and steering
5. Postural Support
    a. Arm rests

Measurements/Observations to Consider

Measurement	Modification Effect
Provider can't easily access the on/off switch if the child is getting too far away	Add in an easily accessible kill switch
Some kids hunch their body over and can't properly grasp handlebars	Add lumbar support on the seat
Some kids can't keep their arms up to operate an acceleration mechanism	Add in attachable armrests
Velcro could become detached from foam headrest over time	Back the headrest with plastic for a better connection

Noteworthy Progress

- Installed motor controller
- Built and installed armrests
- Contacted Nancy about testing her kids in our car for analysis- waiting on results from chat with Dr. Walker
- Built kill switch and back steering design
    - Need to connect
- Designed 3D piece to connect steering wheel attachment and hook for unscrewing mechanism

High Hopes Study- Powered Mobility Checklist

Scoring (adapted from Furumasu 2016)

0	Task no attempted
1	Maximal hands-on assistance on switch with verbal cueing (51-75% assist)
2	Moderate hands-on assistance on switch with verbal cueing (26-50% assist)
3	Minimal hands-on assistance on switch with verbal cueing (25% or less assist)
4	Direct stand-by guarding with verbal cueing with occasional minimal assist to redirect
5	Verbal cueing only
6	Age appropriate supervision

Skills

	Score
Turns switch on and off	
Demonstrates concept of cause and effect (realizes that activating switch is causing movement of car – communicating verbally, expression, or action)	
Demonstrates "Stop" and "Go" concepts; follows directions of releasing switch at verbal cue of "stop" and pushing switch with verbal cue of "go"	
Maintains contact with switch for a minimum of 5 seconds	
Pushes switch to engage car in motion for 5 seconds	
Navigates car in forward direction for 10 seconds	
Looks in the direction of movement	
Turns a 90 degree corner to the left	
Turns a 90 degree corner to the right	
Navigates towards a toy, stops to play with toy	
Navigates towards a peer, teacher, or parent; stops to interact with individual	
Stops the car on command after engaging car in forward motion	
Stops after bumping into an obstacle	
Stops spontaneously to avoid stationary objects	

Gauging Progress and Performance

- Main benefit to modular design is the ability to accommodate wide range of potential children
- Primary quantitative scale in judging performance is High Hopes Study Power Mobility checklist
- Further observation of children currently under study at High Hopes with personalised power cars
- Assessment of children's interaction with both personalised car and modular model adjusted to ideally suit unique needs
- Success in modular design if quantitative progress made by children in modular model meets or exceeds progress made in personalised models over time

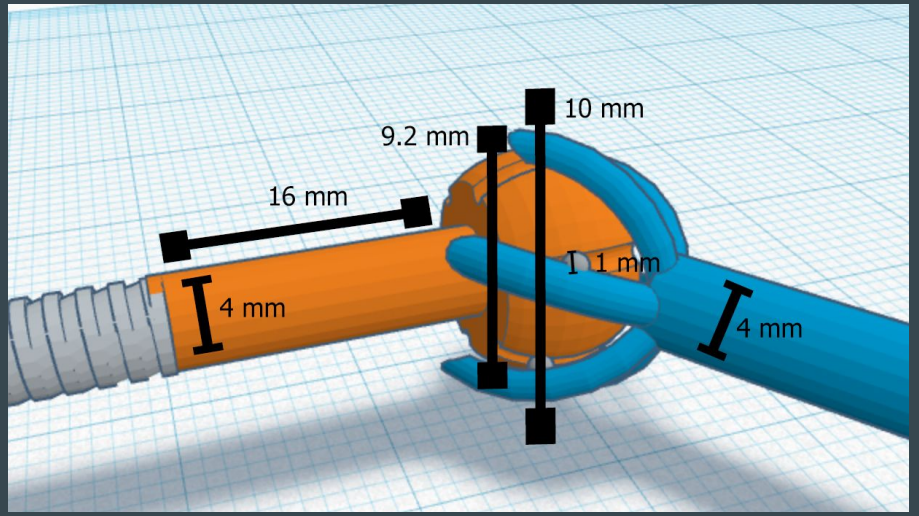
Current Goals

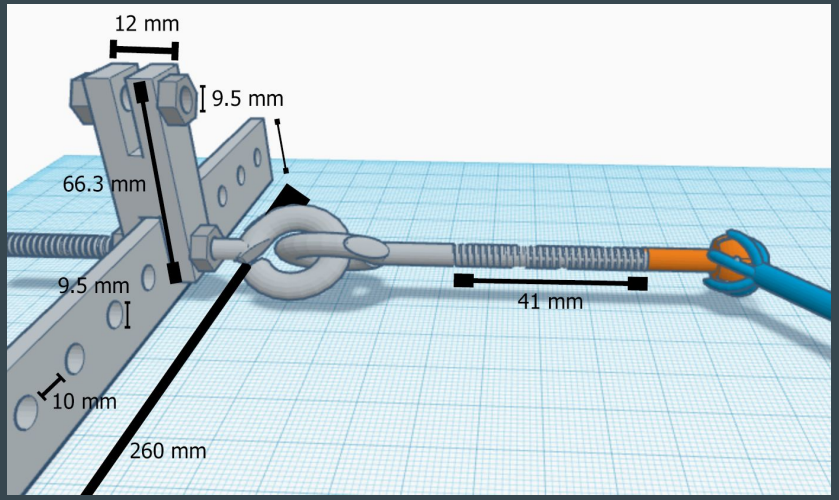
- Finish unscrewing mechanism
- Finish constructing kill switch and back steering
- Test additional saddle pieces
- Construct multiple buttons
- Make adjustments based on observations at high hopes on Friday

Milestone	Deadline	Status
Track construction- amanda and nick	Tues Feb 07	Completed
Total seat modification- amanda and nick	Tues Feb 07; Tues Feb 21 Wed Feb 22	Completed
Leg/hip padding- amanda and taylor	Tues Feb 14; Fri Feb 24 Fri Mar 3' Fri Mar 17	In progress
Steering wheel modification- taylor and nick	Fri Feb 17; Fri Mar 3 Fri Mar 17	In progress
Motor operation/wiring- will	Tues Feb 21; Thur Mar 2; Tues Mar 21	Completed
Kill switch and back handle- will, amanda, nick	Fri Feb 24; Fri Mar 17; Tues Mar 21	In progress
Headrest construction- amanda and taylor	Fri Feb 24; Fri Mar 3; Fri Mar 17; Tues Mar 21	In progress
Armrest construction- amanda and taylor	Tues Feb 28; Fri Mar 17; Tues Mar 21	Completed
Harness attachment- will	Tues Feb 28; Fri Mar 17; Tues Mar 21	Not started
Acceleration options (buttons, head, handlebars, pressure sensors)- taylor, maybe amanda and nick	Fri Mar 17; Fri Mar 24	In progress
Car test-ready	Fri Mar 24	Not started

Design Updates - Seat

- Hinged axle adaptation to be 3D printed
- Male part with 6 slots, female end with 6 arms, steel balls allow for movement
- Will allow at most 90 degrees of tilt

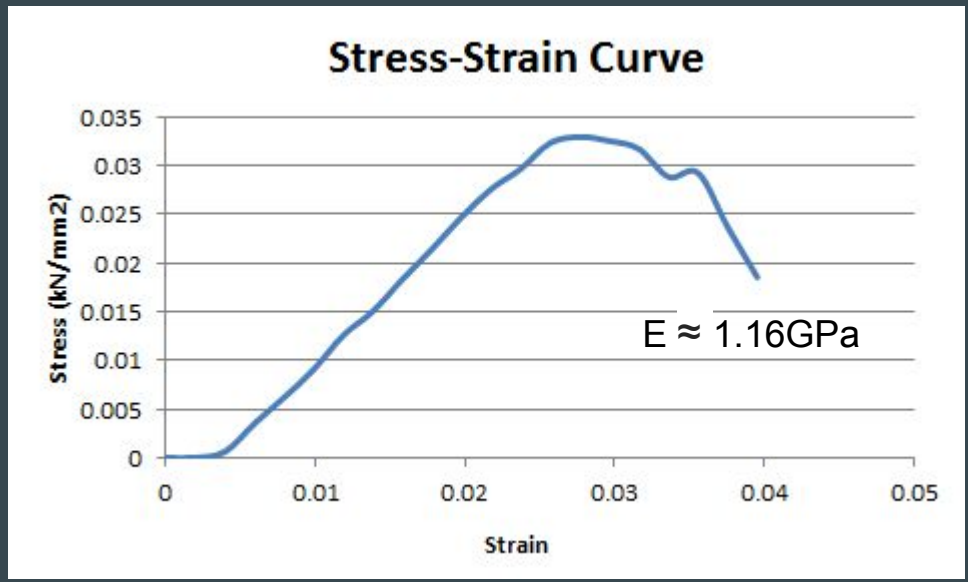




- Printed axle pieces with solid fill
- Two tracks parallel with each other
- Tracks 355 mm apart
- Designs identical and mirrored on other track

Compression Testing

Pressure (N/m2) x Minimum cross area (m2) = Force (N)

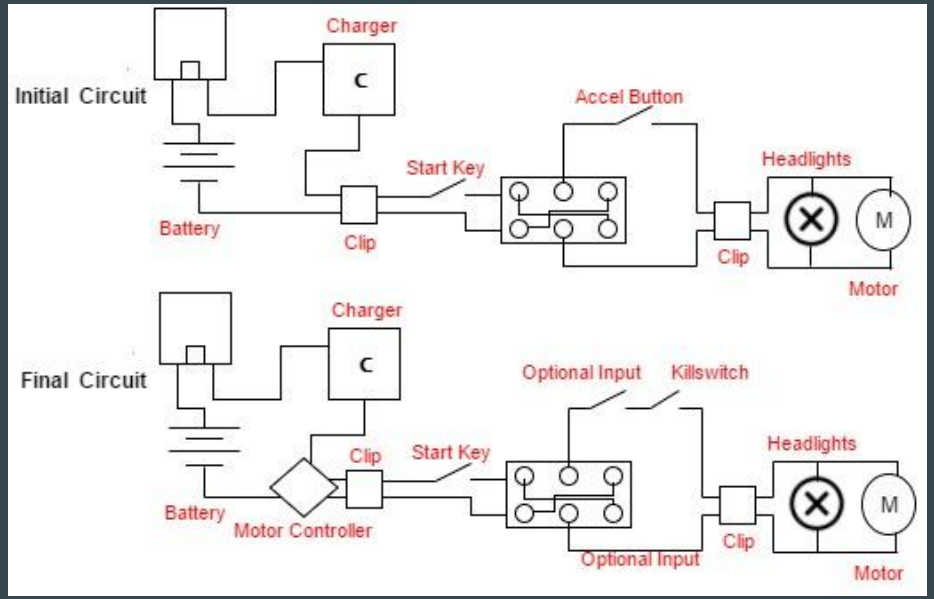


Calculated force: 2561.22 N (575.81 lbs)
Tested: 1602.25 N (360.22 lbs)

Approximate fill level for print ~62.5%

Fracture in piece follows vertical grain of 3d printed material

Design Updates- Circuit

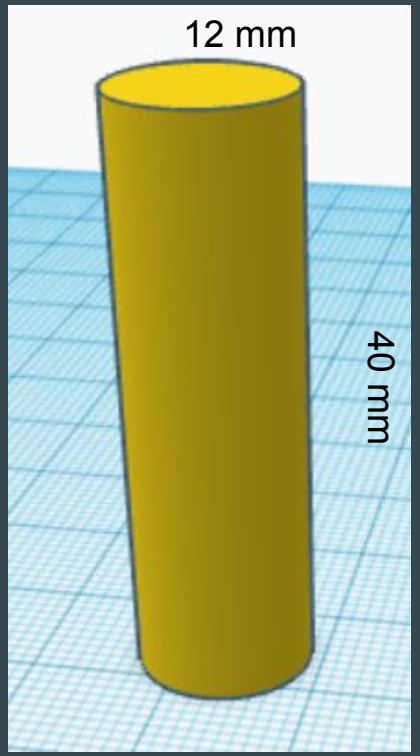


Design Update- Armrests

- 1” diameter PVC pipe
  - Noodles fit best around this size
- 24” long pipe
  - Spans length of the car but doesn’t push the dash out of place
- 15” apart
  - Enough space for child to sit while still serving its purpose

Design Update - Steering Wheel and Head Rest

- Cylindrical connector piece to be 3D printed to fit steering wheel on elevation pipe
  - 12 mm diameter to fit into both the pipe and steering wheel
  - 40 mm tall
  - Yellow to go with colors of car
- Cut out plastic backing for the headrest
  - 30.2 cm tall



Future Goals

- Final mounting of motor controller in accessible location
- Finalised circuit diagram to account for all modifications made to wiring
- Completion of foam correctional support shaping and attachment
- Printing and attachment of steering wheel adjustment mechanism
- Installation and customisation of safety harness, headrest
- Completion of back handle with embedded killswitch and subsequent connection of killswitch into car circuit

Fast and Furious: High Speeds at High Hopes Preschool Progress Presentation

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Comments

- Next week we’re meeting at noon. No progress report.
- Check notes from each slide and apply