Disability Stroller Design Project

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Motivation

Transporting children can be hard for any family, especially when searching for a safe, reliable method to efficiently move their children. This project is inspired by a family with a child who requires help due to autism and other disabling disorders. The Floyd family's child has outgrown his previous stroller that allows him to go on walks and to travel unencumbered. Since not having a convenient transportation method, family activities are now difficult and limited.

Due to the family's situation, the assigned team was tasked with designing a stroller that will support the child for years to come. To complete this goal, the team's main objective includes designing and implementing telescoping elements that allow the stroller to transform and grow as the child grows. As well, the team has focused on durability to ensure the stroller's longevity and safety to ultimately improve the quality of life for the family and their son.

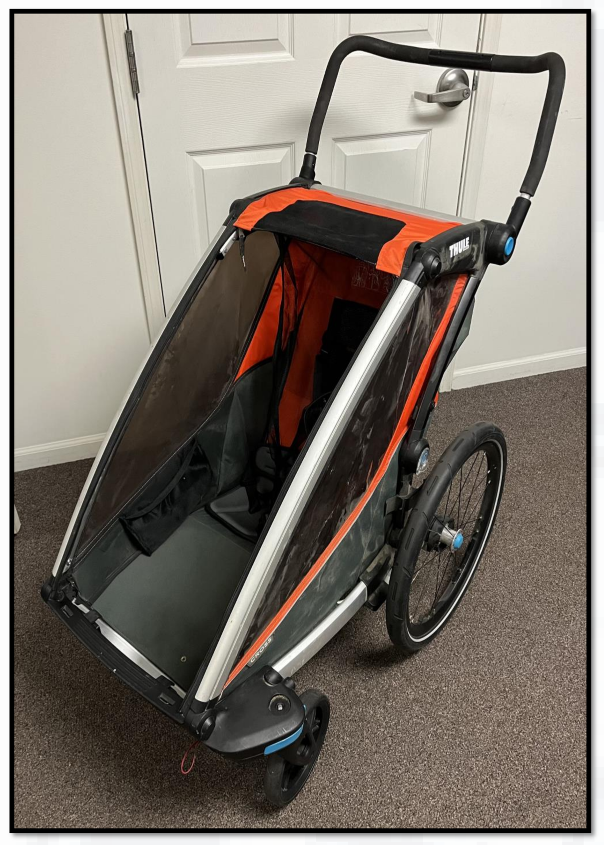
Image 1: Floyd family's previous Thule stroller

Customer Expectations

Upon meeting with the Floyds, the team discovered some design aspects the family was comfortable with from their last stroller and some which they may like incorporated into their customized stroller. Throughout the project process, durability and safety were main priorities for the team so the family could feel a sense of reliability with their child's new transportation.

- Durable
- Collapsible
- Wheel Brakes
- Suspension System
- Padding
- Rain Cover

Table 1:Project Scope Tasks

Tasks	Designation
Develop Design Concepts	A
Material Selection	A
3D Model	A
FEA Analysis	A
Material Testing	A
Manufacture Frame	A
Provide Frame to External Consultants	A
Test Fully Assembled Stroller	A

Validation

Throughout the manufacturing process, the stroller was continuously tested to ensure durability and quality between each progression. As the frame was built and new pieces were implemented, the stroller was folded and unfolded to be sure all moving pieces functioned as expected or were improved if necessary. After finalizing all components, the stroller was folded 100 times to test the product's reliability. The functionality was also validated by placing distributed weight increments in the stroller to simulate a child's weight.

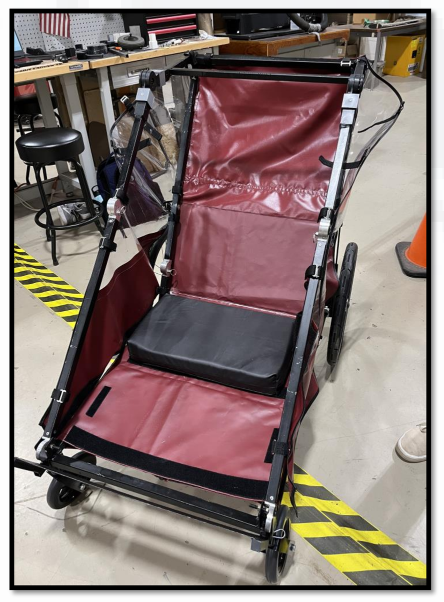
Image 2: Completely assembled stroller

Design Components

3D Modeling

The stroller was modeled using SolidWorks™ to create individual parts, which were then joined together in an assembly. The computer-aided design (CAD) assembly was used to integrate specific elements into the stroller to evaluate how these would interface with one another. The CAD ensured proper measurements were used that would feasibly allow the stroller to collapse and function as envisioned. Technical drawings were also created from the CAD for easier dimensioning and build-planning. After finalizing the stroller CAD design, finite element analysis (FEA) was used to implement realistic physical properties of the A513 material to gauge how the frame would react under load-bearing stress.

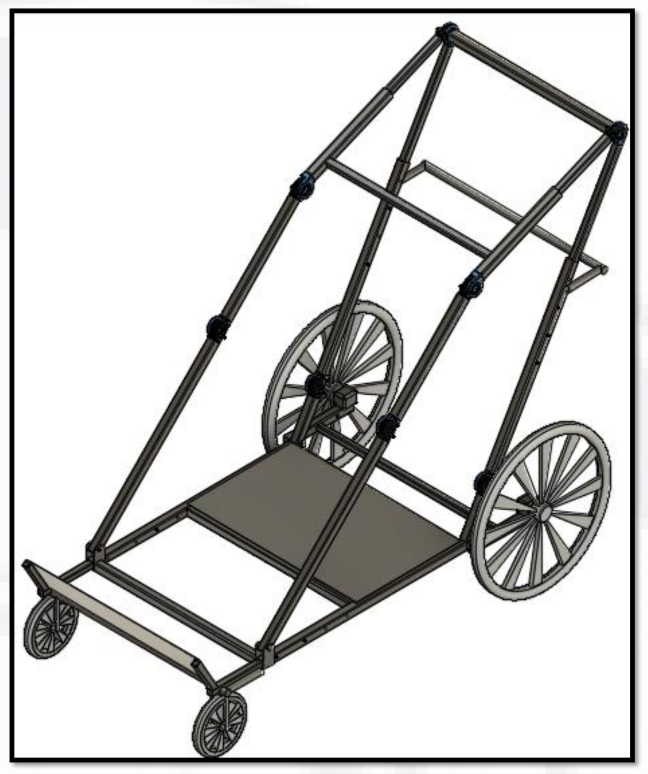
Image 3: SolidWorks™ 3D model of stroller

Building

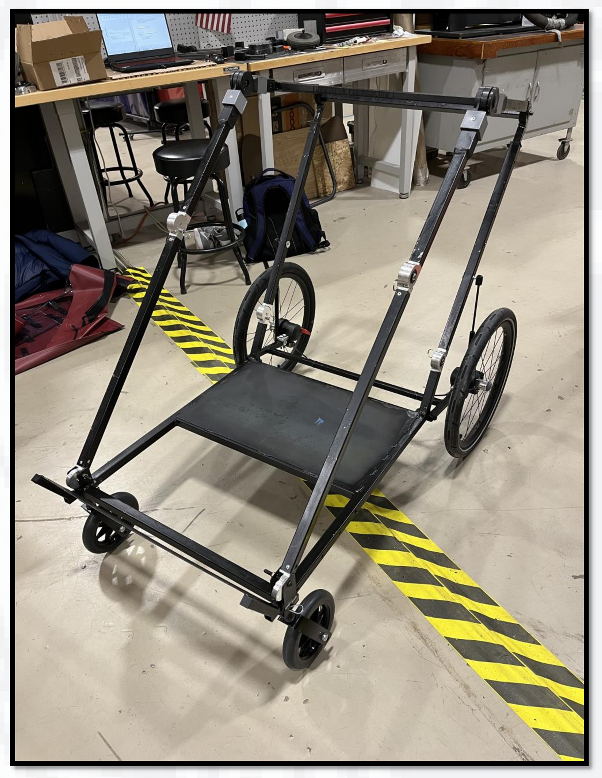
Image 4: Bare stroller frame without fabric cover

Frame Base Layout: The CAD model was used as a guideline for measurements to cut the metal tubing and sheet metal to size. Any holes were drilled using hand tools or a drill press, and the frame was welded together, which included the addition of the foot brake. 3D printed caps were created to cover the ends of exposed tubing and to insert into inner telescoping elements to permanently keep the tubing from sliding too far past its intended lengths.

Assembly: Once all parts were accounted for and prepared, the metal frame was ready for assembly. Hinges were placed into designated insertion points and secured with rivets. Telescoping elements were assembled with push buttons in place and all 3D printed caps were glued into position. The handlebar was bent and welded onto the back tubing pieces.

Fabric Body Attachment: The completed frame was given to external consultants, Angola Canvas, for the fabric covering to be customized to the build and dynamic needs of the stroller. The cover was made to be durable removable with plastic side windows, a mesh top to create a sunroof, and multiple mesh pockets.

Features

Telescoping Elements: The stroller contains telescoping elements that allow for extension in the length and height, where maximum height and length both extend 10.75 inches. These pieces involve user-friendly push button systems that aim to support the unpredictable growth pattern of a child and let the family reliably use the stroller for years.

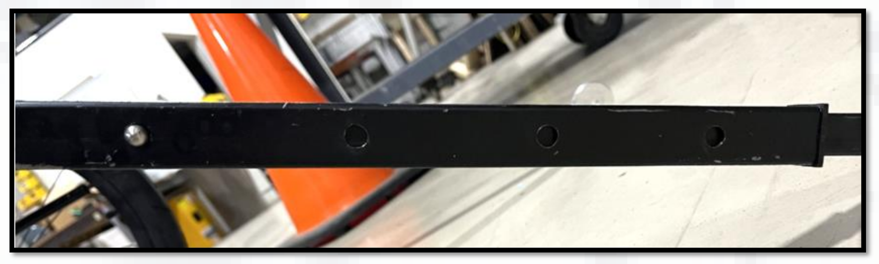
Image 5: Push button system of telescoping elements

Adaptable Hinges: The various hinges implemented in the stroller design support maximum collapsibility for convenient storage and travel capabilities. The hinges on the stroller include a set bought from McMaster Carr and sets from the team made by 3D modeling and CNC machining. The hinges selected are intended to lock at specific angle points to properly support each extension point.

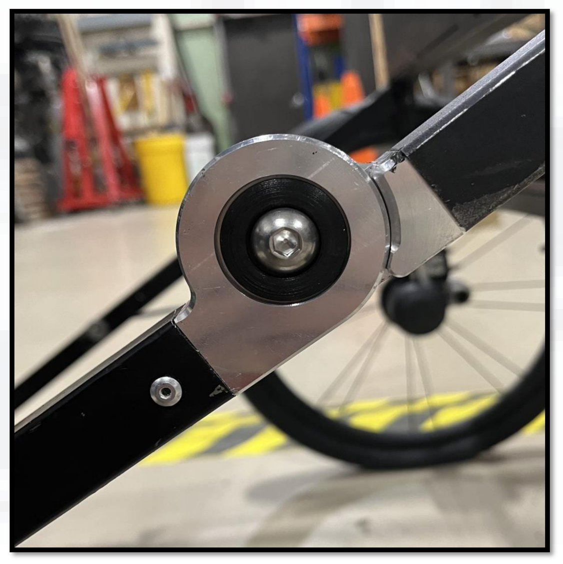
Image 6: CNC machined hinges

Testing

Fabric Yield Testing

Fabric yield testing was performed using an Instron to ensure the safety of the stroller. Standard ASTM 5034[1] protocol was referred to for testing setup and data collection. A sample size of n=30 endured tensile force until failure. Average fabric tensile strength was 19.3 ± 1.15 ksi. Using a one-sided T test, this value was calculated to be 37 SDs above the desired minimum value of 11.5 ksi.

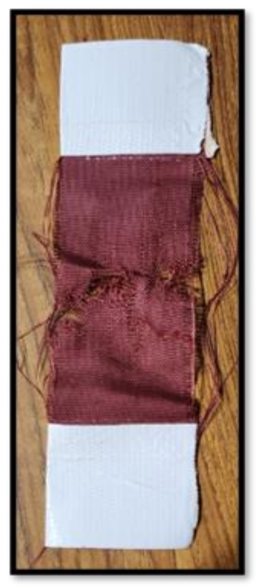
Image 7: Fabric specimen post-Instron yield test

Water Resistance Testing

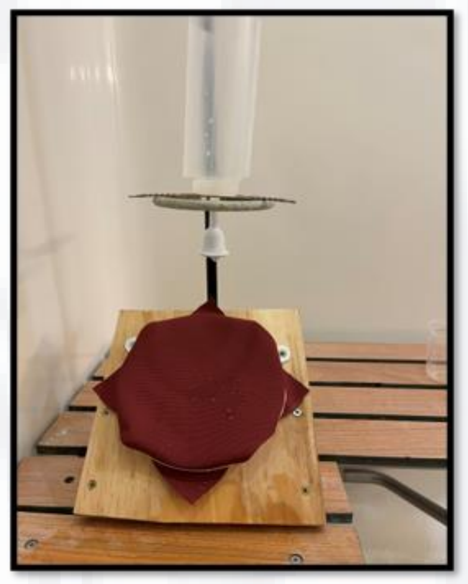
Image 8: Water resistance testing apparatus

Fabric water resistance testing was performed by simulating rainy conditions to ensure minimal water absorption by the material. Standard AATCC 22[2] was referred to as a guideline to create a testing apparatus, for testing setup, and to determine a visual scoring system. A sample size of n=30 was used to prove significance in results. Scoring was based on water particles adhering to fabric face after each test, where 0 meant complete wetting of the sample and 100 meant no wetting of the sample. The results displayed an average visual score of 94.83, which was used in a one-sided T test to determine that the average was about 29 SDs above the desired minimum value of 90.

Conclusion

Customer Requirements	Completed
Durable	✓
Collapsible	✓
Wheel Brakes	✓
Suspension System	✓
Padding	✓

Additional Features	Completed
Cupholder	✓
Snack Pouch	✓
Removable Cushion	✓
Removable Fabric	✓

References

[1] *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*, ASTM D5034 – 21, ASTM International, 2021

[2] Water Repellency: Spray Test, AATCC 22, American Association of Textile Chemists and Colorists , 2010

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