Proposal

Wheelchair for Abby Miller

Benjamin Marcus, Katharine Guineau, Julia Olczyk
**Executive Summary**

This project involves the design and creation of a customized comfortable wheelchair for 17 year old Abby Miller, who has the condition Cerebral Palsy. The main purpose of this project is to maximize comfort and safety while maintaining freedom and functionality for both Abby and her parents. The design of this device can be divided into two categories, mechanical and electrical. The estimated cost for the construction of a new wheelchair for Abby is $2,600.

**1. Introduction**

**1.1 Background**

Abby Miller is a 17 year old girl from Clinton, Illinois that was born with Cerebral Palsy and is in need of a more comfortable wheelchair. Cerebral Palsy is a condition characterized by disorders involving the nervous system and can affect functions such as movement and posture. Some symptoms include tight muscles, muscle weakness and an abnormal gait. It is caused by abnormal development or damage to the part of the brain responsible for control of muscle tone and motor activities. Abby’s condition limits her use of her hands and arms. She has the ability to stand but needs supportive assistance because she lacks the ability to balance herself.

**1.2 Purpose**

The purpose of this project is to provide Abby with a customized wheelchair that better suits her and her family’s needs. Abby’s parents would like a wheelchair that allows Abby to sit more comfortably, but also incorporates features they enjoy on Abby’s current wheelchair including a tilt-in-space option that allows her parents to lean her backwards to help get her in and out of the chair. The Miller’s would also like to have the option to interchange the tires to better handle the terrain and weather conditions, as the chair is intended for indoor and outdoor use.
1.3 Previous Work Done

1.3.1 Products

Wheelchairs for people with cerebral palsy have been around for some time now. There are a few different types of wheelchairs, but the type of chair that we are focusing on is a tilt in space wheelchair. Tilt in space wheelchairs can be very expensive and also must be highly customized in order to be accommodating for the person using them.

Karman Healthcare makes a portable folding tilt in space wheelchair. However the price is pretty steep at $1,699.00. There are a few drawbacks to this chair, the wheels are only 14 inches which is pretty small, and the seat cushions and headrest needs to be customized for anyone who wants to use it.

Quickie also makes a tilt in space wheelchair. Their wheelchair runs for $2,825.00 and like the Karman healthcare wheelchair, this one also needs a lot of customizing to make it comfortable for any user. This wheelchair has anti-tip bars on the back which prevents the wheelchair from tipping backwards when going up ramps and other obstacles.

1.3.2 Patent Search

The tilt in space mechanism found on wheelchairs was patented by Theodore C. O’Neill Sr. in 2001. The patent is unique to the tilt in space function which keeps all of the angles of the seat as the whole seat can be tilted back and forth. The patent number for this patent is 6257609.

2. Project Description

2.1 Objective

The objective of this project is to design a customized, more comfortable wheelchair for Abby by making adjustments to the seat, foot rest, Tilt-in-Space option, headrest, harnesses and padding. Her
current wheelchair has inadequate gel padding, which she pushes through due to her exaggerated tone. The padding will be modified by layering dense and soft foam which will provide comfort yet will prevent her from pushing through. She also tends to slide out of her seat. This will be changed by making a wedge shaped seat to encourage Abby to sit back in her chair. Additional safety harnesses, including a lap belt will also be implemented. Her feet fall in between her two separate foot rests because they are too far apart. This will be replaced with a uniform single foot rest to prevent this from occurring. Due to weakness in her trunk, she leans to the left, leaving the right side of her back unsupported. Due to the specific symptoms of her condition, it is necessary to design a customized wheelchair.

2.2 Methods
The new wheelchair will be created by modifying a traditional wheelchair to meet the desired specifications. Most of the wheelchair parts will be replaced with new and improved materials to optimize comfort and function. The design of the new wheelchair is largely dependent on mechanical and electrical modifications to an existing chair.

2.2.1 Mechanical
The mechanical components of Abby’s chair are perhaps the most integral parts of the design. This category encompasses all devices that contribute to the structural stability, support and safety components of the chair.

Seat
The seat for Abby’s current wheelchair is uncomfortable and is not large enough. The back of her knees do not sit on the edge of the seat as they should. To fix this problem, the seat bottom will be replaced with a wedge-shaped design composed of a dense foam material. The wedge shape will help Abby sit back in her chair by elevating her feet slightly from her foot rest. The backrest of the seat will be redesigned to conform to Abby’s body by implementing dense foam padding onto the back of the chair.
Since Abby leans to her left side, the right side of her back is often left unsupported. This is not only uncomfortable, but tends to strain her back because she is not properly supported when seated. The shape of the chair back will be designed to be thicker on her right side and slightly thinner on the left side. A bladder pump lumbar support may also be incorporated so that the stiffness of the back of the seat can be adjusted as desired.

**Frame: Tilt-in-Space**

The frame of the wheelchair will be the chassis of a traditional, steel wheelchair that will be purchased. The frame will also incorporate a “Tilt-in-Space” apparatus that allows for the body of the chair to move independently from the frame (Figure 3). This feature enables the seat and backrest...
angles to remain fixed while tilting backwards. This is typically a desirable feature for people with complex seating needs with poor trunk and head control (www.assistireland.com)

![Figure 3. Tilt in Space Mechanics (www.assistireland.com)](image)

The mechanical structure of the “Tilt-in-Space” will ideally be motorized to allow for easy adjustment. This will allow the operator of the chair to easily adjust Abby’s chair angle by means of a button operation.

**Wheels**

The wheels of the wheelchair will be traditional tires that can easily be removed to allow for portability. It is ideal that the Miller’s have several sets of tires as spares in addition to different types of tires including those made for the outdoors. The front wheels, as illustrated in Figure 3, will be the typical wheels found on a traditional wheelchair. Depending on the condition of the purchased wheelchair, these wheels may or may not need to be replaced.

**Harnesses**

Abby has very prominent and defined tone throughout her body. Even in the sitting position, her muscles are tensed enough to lift her body off of her chair. She often pushes her feet into her foot rest which also encourages her body to lift. Therefore, it is important that there be harnesses to keep her
safely seated in her chair. She currently has a chest harness and a separate seatbelt. These harnesses provide Abby with enough comfort but do not keep her in her chair. The new safety straps will be designed to keep Abby seated back in her chair by integrating hip or leg straps. The goal will be to provide Abby with enough freedom to move without compromising her safety. Ideally, the chest harness and the lap strap will be connected with one buckle. In addition to these straps, the Millers suggested incorporating an “over the head” support that will keep Abby’s shoulders down.

![Safety Harness Ideas](image)

*Figure 4. Safety Harness Ideas*

The ultimate goal is to have a comfortable strap like those on a back pack, but with the support and functionality from other types of safety straps.

**Foot Rest**

Abby’s current wheelchair has two separate foot rests. This is an undesirable feature because Abby’s feet often slip through the opening in between. This footrest will be replaced with a uniform foot rest to prevent her feet from falling off.

**2.2.2 Electrical**

**Battery**

A battery is necessary to drive the electrical component of the Tilt-in-Space option. This battery will be selected to last all day and have the option to be recharged.
**Power Inverter**

A power inverter is a necessary component of the circuit design for the Tilt-in-Space feature of the wheelchair.

3. **Budget**

Many parts are required to make a wheelchair that fits the needs of the client. The budget below includes a preliminary list of parts needed and the approximate price of each part. Many of the pieces listed can be custom made which would change the amount of money spent making the part versus buying a product for the retail price and have it not suit the client’s needs. The majority of the budget would be used to purchase a tilt-in-space wheelchair, which retails brand new anywhere from $1200 dollars up to $3700 dollars depending on different manufacturers and different accessories. All of the parts play an integral role in the safety, comfort, and mobility that Abby requires. The proposed budget would be about $2600 to build a wheelchair that is suitable for Abby’s needs. This is about half the price of wheelchairs on the market that have all the essential equipment needed to fulfill desires of Abby’s parents.

<table>
<thead>
<tr>
<th>Parts List</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tilt in Space Wheelchair</td>
<td>$600.00</td>
</tr>
<tr>
<td>Head and Neck Support</td>
<td>$150.00</td>
</tr>
<tr>
<td>All Terrain Wheels</td>
<td>$180.00</td>
</tr>
<tr>
<td>Normal Wheels</td>
<td>$230.00</td>
</tr>
<tr>
<td>Motor</td>
<td>$250.00</td>
</tr>
<tr>
<td>Circuits</td>
<td>$100.00</td>
</tr>
<tr>
<td>Batteries</td>
<td>$125.00</td>
</tr>
<tr>
<td>Power Inverter</td>
<td>$150.00</td>
</tr>
<tr>
<td>Harnesses</td>
<td>$200.00</td>
</tr>
<tr>
<td>Foot Rests</td>
<td>$100.00</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>$165.00</td>
</tr>
<tr>
<td><strong>Total Expenses</strong></td>
<td><strong>$2,600.00</strong></td>
</tr>
</tbody>
</table>

4. **Conclusion**

The successful completion of this custom wheelchair will allow both Abby and her family to comfortably move around day to day. By designing a custom wheelchair specific to Abby, it will allow
her to spend more time in her chair and help with her posture. Issues with her current chair will be addressed and improvements will be made to accommodate the wants and needs of Abby and her family. The new wheelchair will implement many safety features such as harnesses, foot bars and interchangeable wheels for indoor/outdoor use. The safety harnesses will help to keep Abby in her seat correctly, preventing her from sliding out, and also work to help correct her posture. The foot bar would prevent Abby’s feet from falling through the space between traditional foot rests and the interchangeable wheels will help to maintain grip with the ground when moving her around. These and other features on the chair will help to keep Abby safe. A custom wheelchair for Abby will help to improve the quality of life not only for herself but also for her family. They will stop worrying constantly if Abby is seated safely and if she is sliding out of her chair because of the elements that we will include to make the chair fit Abby better. Custom wheelchairs are an expensive investment but here we will aim to make a wheelchair that suits all of the needs of Abby and her family for an affordable price.

5. References

http://www.assistireland.ie/eng/Information/Information_Sheets/Choosing_a_Standard_Self-Propelled_Wheelchair.html

www.backcountrygear.com


www.freepatentsonline.com/6257609.html