Project Statement

All-Terrain Power Chair

Team 10

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Project for Nathan Lamb

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Statement of Needs:

In the case of Nathan Lamb, there is a need for an all-terrain power chair that can traverse settings such as walking trails and beaches located around the client’s home and can be operated by Nathan, despite his medical challenges. Nathan suffers with a few limiting conditions. He is on the autism spectrum, cognitively and physically challenged, and has myelomeningocele. Due to these limitations, Nathan’s immediate and extended family find it difficult to take Nathan on any recreational activities. His family and even the Stonington school system have taken a great stride to maximize Nathan’s comfort and be able to be included him in related activities. Nathan’s family has even built a home designed for specifically for Nathan’s needs.

The client also offered some considerations to take thought of in the design of the power chair. At eleven years old, Nathan has potential to grow. After meeting Nathan, it was apparent that Nathan tends to fidget and shift positions frequently. He also tends to keep his arms near his head, and his family made it apparent that his left hand is more functional than his right. With all of these needs, the family was not able to find a power chair manufacturer that could address all the concerns; therefore, it is the task the design team to successfully build a power chair that suits Nathan’s and his family’s needs.

Introduction and Overview:

The purpose of this engineering endeavor is to create a power chair that Nathan can operate to spend more time with family and friends on recreational activities. As mentioned before, Nathan is physically and cognitively limited to where he can travel with the current mobility devices that his family and his school system has provided. His family transports him with a standard stroller with rugged wheels and foot rests. The problem with this device is that someone has to manually push, and depending on the terrain, sometimes even more people have to help propel the stroller. Also, movement becomes difficult on sandy settings. The family would like Nathan to be able to control his own movement. Another device which Nathan used is called the Standing Dani, shown in figure one.
The family has the manual Standing Dani since the powered version was not economically feasible to purchase. However, when the family demoed the powered version, they found that Nathan was easily able to control his own movement with the left-handed joy stick. This device is limited in use since the operator must be standing, it can only go on flat surfaces due to stability issues. With these devices in mind, the family wanted something that would expand upon the stroller’s mobility and the Standing Dani’s ease-of-use.

There are also other thoughts to consider regarding the design. Nathan is eleven years old. His family estimates his height to be 45 to 55 inches. As alluded to before, he fidgets a lot and has an abnormal standing position due to Myelomeningocele and possible development of scoliosis, which makes it difficult to measure his height. His growth needs to be considered in the design.

**Realistic Constraints:**

The wheelchair must be made to fit in the doorways of the house, which are a minimum of 36 inches wide. The maximum height of the wheelchair must be collapsible to 40 inches, with an overall length of 40-50 inches. Because the family does not currently own a collapsible ramp for their minivan, the wheelchair must be light enough for the father and/or mother to lift into the van by themselves.

Furthermore, any restraint devices must operate in a simple and obvious way. Anyone must be able to easily put Nathan into the wheelchair, and get him out without damaging the restraint systems.
Economic constraints are a major concern for the production of powered wheelchairs in general. Un-powered wheelchairs designed for special needs individuals can run as high as eight-thousand dollars. Most of these costs are production related and not materials-related. Because these wheelchairs tailored to the needs of individuals, costs are kept high. Fortunately, most families do not need to pay these costs directly, as health insurance is a mitigating factor. Powered wheelchairs increase the price drastically, especially if the wheelchair is designed for outdoors use. These wheelchairs can vary in price from $14,000 to over $18,000 and are likely not covered by health insurance. Being able to produce a wheelchair that is both cheap to construct and cheap to maintain will be key in supporting Nathan, and Nathan’s family.

Sustainability of this device is paramount. The family wishes to be able to use the device for years to come. Thus, the wheelchair must be robust enough to go over backwoods trails with minimal maintenance. Being able to adjust the wheelchair for Nathan as he grows is also important for sustainability of the device. Furthermore, because this is a power wheelchair, management of the batteries, specifically their disposal, longevity, and charge-capacity are important issues.

The environmental impact of our device will also be very important. While this is an all-terrain wheelchair, it will be important that the device does not destroy the environment it was created to allow Nathan to enjoy. Disposal of the batteries to power the device could also potentially produce a negative environmental impact. Educating the family themselves on how to dispose of the power source will be important in delivery of the product.

The manufacturability of this wheelchair is also important to its sustainability. If the design were put into production, then to fulfill its purpose of being a cheap, safe alternative to other powered all-terrain wheelchairs for special needs individuals, then ease of construction, selection of cheap materials, and a modular construction will be important. Modular construction will allow the individuals to tailor the wheelchairs to their specific needs and wants, while reducing price drastically. For example, every part will not need to be custom-made for the individual but can be premade in bulk.

The social implications for this wheelchair are another very important constraint. The wheelchair should not produce excessive noise. The interface should be intuitive, and the restraint system should be easy and obvious to operate. The speakers should not be so loud that neighbors or passers-by are disturbed. Furthermore, if the wheelchair can be made to bring Nathan closer to eye level, it will increase his capacity to be social and enjoy the outdoors with others.
The political and ethical constraints of this project are some of its guiding principles. The wheelchair should not put Nathan into unsafe situations via its design, e.g. the motors should not be capable of allowing Nathan to operate the wheelchair at unsafe speeds, especially considering the nature of backwoods trails in New England. Manufacturing this product has the political impact in creating a device that is affordable to families and individuals with these special needs and a desire to enjoy the outdoors, and be more mobile. As a cheap alternative, the device could provide mobility to those who may not have health insurance or would be otherwise unable to be self-mobile.

**Other Data:**

Because of Nathan’s cognitive challenges and position on the autism spectrum, considerations in the construction of the wheelchair must be made. The device must not cause him discomfiting sensory input. For example, it must not overly correct his posture, nor restrain him too much. Any excess pressure on his feet, back, or face will likely cause a behavior block against using the device.

Due to Nathan’s capacity to learn and remember music, integrated speakers with the wheelchair are recommended.

Nathan lives in a custom-built home. It has a ramp in garage and an elevator to access all the floors. The house has an open floor plan, and the power chair must be able to fit through the three feet wide doors. Outside, there are 16 acres of relatively flat land, with few gravel trails throughout. Also, he lives two miles from a small beach in Stonington, CT, where the power chair must be able to be operated.

Also, Nathan goes to Mystic Middle School in the Stonington school district. He has a Special Education teacher, named Gabrelle LaChance. His school therapist has been on a mission to find a one-armed drive mobile stander for Nathan to utilize to be able to participate more actively with his peers in a standing position. As one can see, his school has greatly helped him move on in his education.

**Questions:**

1. What is our budget?
2. Should a modular design be implemented?
3. What type of materials should be used for the wheelchair?
4. What would be the easiest way to make the wheelchair portable? Detachable parts?
5. How can the wheel chair adjust to the individual’s growth?
6. What are light, durable materials that should be used to keep the weight of the chair down?
7. What if replaceable parts are needed?
8. How can a music jack for an iPod be integrated into the wheelchair?
9. How should the individual be positioned so that they are comfortable?
10. What tires should be used that are easily filled and involve no latex?
11. What type of battery/s should be used to give optimal performance?
12. If solar panels are available, how can they be implemented into the design?
13. Should solar panels be implemented in the design?
14. How can the wheelchair be designed to make it easier for the individual to be seated?

References:
