Portable Beach Wheelchair Optimal Design Report

Beach Wheelchair for Jack Davies

By

Maya Alfonso

Matthew Ellis

Danielle LaPointe

Kyle O’Brien

Team 13

Project for Matthew and Jack Davies

Client Contact: Thomas and Kathleen Davies, 14 Chesterwood Court, Cheshire, CT 06410.

(203) 250-7508
1. Portable Beach Wheelchair Optimal Design

1.1 Introduction

The purpose of this project is to design a beach wheelchair for use by Jack Davies, a 12 year-old boy with Cerebral Palsy. Cerebral Palsy (CP) is a disease that affects the neurological system. Usually diagnosed during very early childhood, the disease permanently affects muscular movement. Though there are varying degrees of debilitation resulting from Cerebral Palsy, Jack's condition requires the use of a wheelchair pushed from behind in order for him to be mobile. Jack's family spends time every summer in the beaches of Rhode Island. The wheelchair that Jack uses daily is not suitable for sandy terrain, which makes it very difficult for his parents to transport him around the beach. The beach wheelchair will offer the mobility Jack enjoys in his regular wheelchair, but will provide him access to the beach and allow his parents to easily transport him over the sandy terrain.

The overall purpose of this design project is to create a beach wheelchair for Jack that will offer him the security, support and comfort of his daily wheelchair, but allow him to be easily transported around sandy terrain. The current system of transportation for Jack on the beach involves using a tow cart not designed to transport children. Our aim, therefore, is to provide him with a very safe and comfortable wheelchair that will allow his parents to easily push their son across the sand. The wheelchair will have features like his normal wheelchair (Figure 1), including a reclining seat rest, a platform to attach his current...
cushioning system, neck and back supports, and a place for a feeding tube apparatus to hang. Additionally, the wheelchair will have large, rounded wheels that will travel well over sandy terrain.

The current chair that Jack uses is a “tilt-in-space” system that treats the seat and backrest as one unit, allowing them to recline and remain at a 90-degree angle. The beach wheelchair will mirror this design. One of the main differences between the chairs will be the wheels. It can be seen in Figure 1 that the tires on Jack’s current chair are not suitable for use in sandy terrain, as they do not offer enough area to disperse the weight of the chair and rider. The Portable Beach Wheelchair (Figure 2) will be equipped with large area PVC tires to keep the chair from sinking into the sand as it is pushed across the beach. Another big difference in design will be the ability to fold the Portable Beach Wheelchair down, to make it easier to fit into a vehicle. Jack’s current chair does not offer the option to fold down at all. Additionally, the Portable Beach Wheelchair will feature the ability to adapt to a larger rider, so that Jack may use it as he gets older.

Figure 2: Portable Beach Wheelchair schematic design.
1.2 Subunits

The chair that has been described is a system of many parts, all of which must work together to accomplish the creation of a successful beach wheelchair. The parts can be broken down into the following sections.

1.2.1 Frame

The frame of the Portable Beach Wheelchair is unique, because it is going to allow for the attachment and removal of a cushion system that the Davies’ family currently owns (Figure 3). This cushion system is tailored to Jack's needs, and provides adequate support for his torso. The cushion also has a harness that will be sufficient to anchor Jack in the Portable Beach Wheelchair. The frame itself will be built out of aluminum, and will consist of a seat platform, and back support and footrests. The back support and footrest will have the ability to fold down onto the seat platform, which will make the chair much more compactable.

The back support is attached to the seat on either side by a system of two locking pins (Figure 4). The bottom pin is fixed, and is the axis of rotation for the backrest. The top pin is a locking pin that can be removed to change the position of the backrest. It moves between a 90-degree angle and a 0-degree angle (folded position).

The footrests are attached to the frame by a sliding post and tube system (Figure 5). This system locks in place using pins as well, and
allows the length of the seat platform to be adjusted as Jack grows.

1.2.2 Chassis

The chassis is the weight-bearing portion of the wheelchair. Though Jack only weighs 72 lbs. now, the chassis must be able to support his weight as he gets older, and so it must be very strong. To achieve this increased strength, the chassis will be constructed from much thicker aluminum as compared to the rest of the wheelchair.

The chassis also houses the axels, where the wheels will attach to the chair (Figure 6). The large back wheels will be attached to the chair using long pins. The smaller front wheels will be attached to the chair using a swiveling axel, allowing them to spin and navigate over rough terrain more easily.

Next to the large back wheel on either side is a break. This is an important safety feature and will allow the chair to be left alone to remain stationary. The break operates on a locking pin system, and can be locked away from or on the wheel, keeping the chair from rolling.

1.2.3 Reclining system

Because the chair is utilizing an existing cushion that is fixed at a 90-degree angle at the base, the seat and the backrest must recline together. To achieve this, an arc
system (*Figure 7*) was developed to offer many different reclining positions. A small arc with a track cut out is attached to the frame of the chair on either side. This arc runs through two guides, attached to the chassis. Two fixed pins guide the arc through the track, and allow the chair to slide easily to different reclining positions. A third pin can be tightened down on the track when the desired position has been reached. This pin will safely lock the chair in place and the two fixed pins will keep the frame from tipping in either direction.

![Reclining arc system](image)

*Figure 7: Reclining arc system*

## 2. Realistic Constraints

It is important to consider any possible constraints to determine what factors may limit the construction or function of the product. The following constraints have been examined to ensure the best methods are utilized in creating the Portable Beach Wheelchair.

### 2.1 Health and Safety

The main concern of the Portable Beach Wheelchair is the safety of the client. Because the chair will be used in sand, which is very uneven terrain, it is imperative that the harness is tested to make sure that it will keep the rider locked into the chair. Additionally, it is important that the velcro adhesive used to attach the cushion to the frame of the chair is very strong and will not come apart when the rider is sitting in the chair, and tilting from side to side. Finally, all of the
components of the chair must be strong enough to support the client’s weight as he grows. In addition to the safety of the client, the safety of the workers must be considered. All metal work will be completed under the supervision of the lab supervisors, and proper safety attire will be worn.

2.2 Sustainability

Sustainability is an important restraint to consider because the client is only 12 years old, and will continue to grow for many years. To make sure that the client can use the Portable Beach Wheelchair for years to come, many adjustable features have been incorporated into the chair. These features include adjustable thigh supports, adjustable foot rests, a tall back that will support the client as he gets taller, and the option of interchanging the cushioning system so that when he grows, the chair can be adapted to support his back properly. All of these features together will ensure that the client can use the chair for a long time.

2.3 Environmental

Environmental considerations are important to make sure that the chair will operate in a beach environment. To keep the aluminum from corroding in the salty air, the frame of the chair will be coated with a high gloss paint to act as a barrier. The pins and screws will all be coated with a lubricant to keep them from locking up or rusting. This lubricant will need to be applied occasionally for the life of the chair.

2.4 Social

This wheelchair will give Jack the opportunity to interact with his family more easily at the beach, and will provide his parents with a much more manageable way to get their son onto the sand. The chair must also be assembled so that the parts are well suited and will not make any noise, which may disturb other patrons at the beach.

2.5 Economic
The price of manufacturing this chair cannot exceed the allotted budget. Parts and materials will be chosen accordingly.

2.6 Manufacturing

The main manufacturing constraint will be the experience of the workers. Individuals who are new to metalworking are creating the chair, and the main restraint will be their ability to create the complex shapes. Additionally, the tools are limited to those that can be found in the machine shop. Experienced metal workers will be available for advice and help during certain hours in the machine shop.

3. Safety Issues

Safety is a major concern in designing the Portable Beach Wheelchair. The biggest concern is the safety of the client. The chair must be strong enough to support the client's growing body, and all parts of the chair must be weight bearing and supportive. Additionally, the chair must be able to keep the client safe and upright while it is traveling over uneven, sandy terrain. To ensure that this is possible, large, wide tires will be used to absorb some of the shock of the terrain. Additionally, the client will be using a strong harness to keep his torso from slipping out of the cushioning system. To give his parents the option of “parking” the wheelchair, a strong breaking system will be incorporated so that there is no chance of the chair rolling while unattended. These components are extremely important, and will ensure that the rider is safe and comfortable when using the Portable Beach Wheelchair.

4. Impact of Engineering Solutions

The overall goal of this project is to provide the client with a portable beach wheelchair that is low cost and can be used for many years. Because the chair is not going to be marketed to be sold, the global impact is negligible. If, however, the chair ever went to market, the standard of cost and sustainability of beach
wheelchairs would be changed. Cost would be lowered and sustainability would be improved, providing many more disabled people with the opportunity to enjoy the beach.

The environmental impact of the Portable Beach Wheelchair is small, but includes disrupting the sand where the chair rolls. This disruption will be minimal, and probably will not exceed the disruption caused by patrons who walk on the beach.

Socially, if a Portable Beach Wheelchair were to be marketed, it would be more common to see disabled individuals of all ages enjoying time on the beach. The gap between society and people with disabilities would become a little bit smaller, and the stigma associated with disabled individuals would decrease.

Globally, marketing a portable beach wheelchair that is low cost would increase society’s awareness of cerebral palsy and other disabilities, weather neurological or physical, closing the gap between disabled people and the able-bodied society. It may also open up more travel possibilities for those individuals who are disabled, allowing them to see parts of the world that they would otherwise be unable to visit. Overall, the chair offers the opportunity to improve the quality of life of many disabled individuals.

5. Life Long Learning

The design team gained a lot of new knowledge and many new skills while designing this project. When the project was first started, the team learned a lot about Cerebral Palsy. As our clients Jack and Matt exhibit, there are varying degrees of CP and every individual is affected differently. Jack lacks all motor control, and so he requires a wheelchair at all times, but his brother Matthew can use a walker to get himself around.

The project has also helped the team gain important insight into working with groups. The success of the project relies on the teamwork of the entire group, and the need to communicate is imperative. The team members have all learned to
juggle multiple tasks, and to communicate with their team mates, as well as the client to achieve a product that is exactly what the client wants. These skills will translate well into many different work situations.

Understanding the functionality of typical beach wheelchairs was another important part of this project. The team examined many different types and designs to determine what would work the best for the client. They also learned how to adapt the various components to meet the needs of the client in terms of size and support level.

To create accurate drafts of the wheelchair design, the team had to learn to use a CAD program called SolidWorks. This extensive program is very detailed and is a professional program, used in many companies. Knowledge of this program will translate to any project that requires detailed 3D designs.

Finally, in order to understand what is possibly to create the team had to understand all the components of the machine shop. To learn this, all members participated in a shop class that certified they were able to operate the machines and use all of the tools available to them.
References:


