Optimal Design Report
Beach Walker

Team 13 – Beach Walker/Beach Wheelchair

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Project for Matthew and Jack Davies
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1.1 Introduction

The purpose of the project is to design and build a beach walker for Matthew Davies, a twelve-year-old boy with spastic cerebral palsy (CP). Matthew is able to walk and is receptive, but due to his CP he requires additional support, such as a walker or quad canes, to move around. In order for Matthew to safely enjoy himself while on vacation with his family, he needs a walker that will allow him to travel easily across the beach’s terrain. The walker must also provide him with the support he needs, and be lightweight enough to be transported to and from the beach. It must account for Matthew’s expected growth, allowing for many years of use.

Three Alternative designs were constructed as options for the final product. The first was a posterior walker that will involve the use of components purchased from outside vendors. The second design was an anterior walker. The third design was a poster walker that is mainly constructed by the team members, which is ideal for a low budget. The optimal design we created involved a posterior walker, mainly because studies have shown that posterior walkers promote better posture among the user by decreasing flexion angles of the trunk, hip and knee. Some customizable parts, such as the seat (in second alternative design) and forearm platforms (in the third alternative design) were added to the final design.

The walker’s frame will be purchased from Global Industrial. The frame is made of lightweight aluminum. The walker is a posterior walker, which will provide Matthew with excellent trunk support and will help improve his balance. The walker frame to be purchased has height adjustable handle bars, but they will not be tall enough to account for Matthew’s expected height. To allow for greater height adjustability, extensions will be added.

In addition to the posterior walker frame, forearm platforms and a seat will also be purchased from Global Industrial. The forearm platforms have angle adjustable hand grips and Velcro straps to prevent arms from slipping. The seat will allow for Matthew to enable the brakes and then sit and rest whenever it’s necessary.

In order for the walker to move across the sand of the beach, the walker’s wheels will be replaced with large polyurethane balloon wheels. Due to the low pressure of these wheels, they are able to roll over challenging terrain. The wheels will be purchased from Wheeleez, Inc.
1.2 Subunits

The beach walker consists of several small subunits. Each subunit will perform a specific task, and will also be incorporated into the overall system, so that the product will function with maximum efficiency. The following section describes each subunit in greater detail.

1.2.1 Walker Frame

The walker frame is a crucial component, since it is the structure to which all other subunits will be fastened. The walker that has been selected for modification is the Nimbo Lightweight Posterior Posture Walker from Global Industrial. The frame’s most important feature is that it is posterior, which is preferred over an anterior walker frame because it is more effective at supporting proper posture and will provide the user with the maximum amount of trunk support.

The walker was chosen to be prefabricated because it will save time on building a frame, which will allow for more intricate subunits. A prefabricated frame will also eliminate the risk for any potential welding or machining errors.

The walker is made of lightweight aluminum in a midnight blue color. It weighs 14 pounds and has a 200 pound weight capacity. The height of the handlebars is adjustable between 28 and 36 inches, and the width between the handlebars is 16.5 inches. The walker folds for convenient transporting and storage. Figure 1 shows the Nimbo Lightweight Posterior Posture Walker.

Figure 1: Nimbo Lightweight Posterior Walker
1.2.1a Silicone Spray

The walker frame will be waterproofed using silicone spray, so that Matthew can use his walker in shallow water if he likes. Silicone spray can be used to waterproof and protect metal surfaces with a thin, non-corrosive, and non-staining film. It is clean, colorless, and odorless. It has a low surface tension, which allows for excellent coverage and deep penetration of surfaces.

1.2.2 Height Adjusters

The frame of the walker will be adjustable in height to accommodate for the client’s changes in height as he grows. The Nimbo walker frame that will be purchased does not have the desired height capabilities for a growing client. Instead of having the family purchase a new walker when the client outgrows the one given to him, we will manufacture additions to the frame’s adjustable range to be able to accommodate for the client now and his projected height as an adult (which will be about one foot taller). This will be accomplished by purchasing hollow aluminum tubing which will be 11 ½” long and 3/8” in diameter. Holes will be drilled into the rod and will be spaced 1” apart. These aluminum rods will replace the handle extensions that come with the Nimbo walker.

Figure 2: Hollow Aluminum Tubing 3/8” in Diameter

1.2.3 Forearm Platforms

Forearm platforms will be purchased from Global Industrial, and are made specifically for Nimbo walkers. The platforms are also made of lightweight aluminum and are height and depth adjustable. The handgrips are angle adjustable and can be adjusted individually. They can extend forward or backward, and supinate or pronate. The handgrips will have flanged endings to produce optimal grip and stability for the client. The armrest is contoured and has a flexible edge, and Velcro straps to keep arms from slipping. The forearm platforms will provide Matthew with extra support. They are shown in Figure 3.
1.2.4 Wheels

The wheels will be 49cm x 23cm PU Beach Wheels from Wheeleez, Inc. The hub of the wheel is made of polypropylene and the tires are made of polyurethane. The wheels are non-corrosive, and will not puncture. The tires have a pressure range of 2-4 psi, and due to their low pressure they are able to move across difficult terrain. Each wheel can hold a maximum payload of 264 pounds. The front two wheels will be larger in diameter than the back two (see Figures 1 and 3). This front wheels will swivel, which enhances maneuverability and ease of turning. The rear wheels will be one directional, making use of an aluminum ratchet and pin mechanism. There is an anti-reverse override bracket that disengages the one directional rear wheels and allows forward & reverse mobility. Also, a locking mechanism easily switches front wheels from swivel to non-swivel. These features are given by the frame of the Nimbo walker and will be used to promote safety and mobility for the client. Figure 4 shows a polyurethane Beach Wheel.
### 1.2.5 Seat

A seat will be added to the walker frame to give Matthew the option to sit and rest. The seat will be mounted onto the walker. It can fold up so that it will be out of the way when Matthew is standing or walking. The seat will be purchased from Global Industrial and can be seen in Figure 5.

![Figure 5: Seat for Nimbo Walker](image)

### 1.2.6 Umbrella Holder

The walker will have an umbrella holder for convenience and to protect Matthew from the sun. The umbrella holder will be prefabricated, and will be purchased from Active Forever. It folds down so that it will be out of the way when not in use, and can be positioned at different angles. The umbrella holder is shown in Figure 6.

![Figure 6: Umbrella Holder](image)

### 1.2.7 Cup Holder

A cup holder will also be added to the walker frame as an extra feature to give Matthew a place to store his beverages securely. It adjusts to hold different sized items and can be folded up when Matthew is not using it. The cup holder will be purchased from All Barstools and is seen in Figure 7.
1.2.8 Seat/Pad Covers

The pelvic stabilizer, forearm platforms, and seat will all have covers made of neoprene. Neoprene is a synthetic rubber material which is flexible and durable. It is waterproof, so it will be especially important for the seat, as it will offer protection from wet bathing suits. It is also easy to clean and static free. Neoprene can be attached to the seat and pad by either an adhesive or sewing. It is sold in a variety of thicknesses and colors, and is inexpensive. Neoprene is shown in Figure 8.
2. Realistic Constraints

One constraint of manufacturing the walker is the budget. The budget for the project will not have the ability to be increased if needed, so staying in line with the given budget is not only ideal, but necessary. In order to stay within budget and still provide a working product, donations and free parts will be taken advantage of.

As we will be purchasing the frame and wheels from an outside vendor, the other addons and features of the walker will have to be manufactured to try and lessen the overall cost. Manufacturing as many accessories for the walker as we can will allow us to stay within the budget and keep the cost of the walker as low as possible. The walker will have multiple customizations that will have to be combined and constructed properly in order for the walker to work correctly and to it’s fullest potential.

The safety features and constraints of the posterior walker are the most important part of the construction. Matthew has spastic Cerebral Palsy, which impairs his neuromuscular mobility. The walker will provide him a safe and reliable means of walking across difficult terrain. When using the walker on the beach, the safety adjustments will provide superior control when compared to posterior walkers that are available on the market.

The posterior walker will provide the client with many social advantages in that it will allow him independence while walking on the beach. As a child, the beach is seen as a place where you can relax and enjoy the pleasurable experiences that the sand and water have to offer. Matthew will be able to independently walk wherever he desires when on the beach, whether it be over difficult terrain like sand or in the shallow depths of the ocean. The independent nature of the project will allow the client to feel like a normal kid on the beach, going wherever he pleases.

3 Safety Issues

Matthew’s safety is our biggest concern. The frame of the walker must be able to support his weight without crumbling under the pressure. The joints used in the device must be strong and the material used must be sturdy and durable enough to last for many years without bending or warping. The seat must be strong enough to support Matthew’s weight and must be mounted securely to the walker frame. The wheels and all other accessories must also be secured firmly in place.

Silicone spray can be hazardous to health if acute overexposure occurs. Acute overexposure can cause eye irritation, redness, tearing and blurred vision. It can cause skin irritation, defatting, and dermatitis. If inhaled, dizziness, drowsiness, and throat irritations may occur. These hazards will be more of a risk to the designers than to the client, and using the silicone spray on Matthew’s walker should not pose any serious threats as long as the necessary precautions are taken when applying it.
4 Impact of Engineering Solutions

The main goals for the walker are to provide the client safety as well as a feeling of independence. For many physically disabled children (especially those with Cerebral Palsy), the process of growing older and more independent is altered because, while they are mentally and emotionally ready to do things on their own, their mobility impairments limits their independence. Our client, Matthew Davies, at the young age of 14 years old, desires to be independent wherever he goes, especially on family vacations to the beach. His cerebral palsy severely limits the activities he can perform when at the beach, but with the help of our project, he will be liberated to enjoy all the exciting aspects of the beach and the ocean.

This is why our beach walker is such an important project. The market has limited options for walking assistants for children with mobility and stability disabilities for use outside of normal terrain. The beach walker will have balloon wheels that allow its use over multiple difficult terrains, especially designed for use over the sand of the beach and in shallows depths of the water.

Economically, this walker could likely be brought to market at a lower price point than existing walkers. Ultimately, however, large-scale ambitions remain firmly speculative, due to the beach designed customization features of the walker. The walker, while having the ability to be used on many terrains, is specifically designed for use over the sand and in the shallow water. The specific features of the walker make it unlikely for families to purchase that do not visit the beach all that often.

5 Life-Long Learning

Our team will learn a great deal from the design process. Determining the client’s needs and expectations will help us understand the needs of disabled children and the challenges they face in daily life. We will be forced to design a walking aid that adheres to the client’s specific needs, meaning we will be in constant contact with the client and his family. This will allow us to work on our people skills and give us valuable lessons in satisfying customers in the workplace.

Building and refining the CAD model will be an extensive process involving constant communication with the client and gait research, as well as learning to utilize advanced Autodesk Inventor features such as force analysis. A virtual model of the client will be developed for this purpose, so biomechanical skills will also be learned. Gait research and consultation with the client’s physical therapist will not only provide a scientific basis for posterior walkers, but will give us important background knowledge on gait development and pathology, and the options available to assist those with mobility impairments.
Another technique learned will simply be the art of planning and coordinating groups. Microsoft Visio will be used to produce flow charts and diagrams for easy planning. We will need to learn Microsoft Project in order to keep track of project goals and deadlines. Substantial coordination will be required within our team, as well as between our team and the client’s family. All of these skills will be important regardless of each team member’s final career or educational path.

The most important skill learned during the manufacturing phase will likely be the process of revision. We will need to develop highly adjustable parts that, through repeated trials with the client, can be adjusted to build an optimal final product.

6 References- Website Links

Nimbo Lightweight Posterior Walker

http://www.globalindustrial.com/viewCart?ref=ac%2Fpd

Adjustable Frame Height


Forearm Platforms


Wheels

http://www.wheeleez.com/beach-wheels-polyurethane.php#WZ149U

Umbrella Holder


Cup Holder


Seat

Seat/Pad Covers

http://www.foamforyou.com/neoprene.htm

Silicone Spray

http://www.rainbowtech.net/products/view.php?cn=1184

Silicone Spray Safety Data Sheet

http://www.generalgraphic.com/msdssisp.htm