Alternative Designs Report
Joshua’s Jumper

By
Elyssa Polomski, Michael Ballintyn, and Tianyi Xu
Team # 21

Client: Joshua Bouchard
Client Contact: Sue and Ron Bouchard, soupanony@aol.com, (508) 823-6113
Alternative Design 1

This design will be composed of three primary components: the frame, the harness and elastic straps, and the motorized platform. Each component must be fabricated and adjusted to fit Joshua’s unique body type. This device must be built especially stable and structurally sound to support Joshua’s weight and bouncing motion. To account for these factors, an aluminum frame will be constructed into a rectangular box. Horizontal aluminum bars will also be welded in approximately halfway down the frame to both increase stability, and provide a method with which to keep Joshua from bouncing too far in one direction. These bars will be padded with durable foam to prevent any injury that may result from bumping into them. One cross bar will be placed on a hinge, so as to allow for easier access when placing and removing Joshua from the harness. Another crossbar will also feature a removable control panel which will contain Joshua’s joystick control. In this way, the device can remain stationary and allow for movement only via the remote controls. The joystick for Joshua can then be attached only when he is ready to begin practicing and training towards the use of a motorized wheelchair. The frame will also be comprised of telescoping poles, allowing for easy height adjustment as Joshua grows over the next few years.

The second major component is the harness and elastic straps used to support and suspend Joshua. For this design, a suspension trauma strap will be used to help keep Joshua in the upright, standing position. As see in Figure 1, this particular strap is quite similar to that of a full-body climbing harness. With adjustable support in both the pelvic region, as well as shoulder harness, connected across the chest, this harness will be able to comfortably and safely support Joshua’s weight.

Figure 1. Suspension Trauma Strap
It is relatively inexpensive and easy to put on and adjust for his body type. Seat-belt like buckles are used to secure the harness around the person’s legs and across the chest, making it very easy to put on and remove. The other beneficial feature is that there is only one strap connected to the harness. This strap would be made of climbing-grade tubular webbing, and clipped onto the harness. The other end of the webbing would be the central point from which four separate elastic straps would meet. These straps will be attached to the external, aluminum frame, and will be spaced so as to evenly distribute the load of Joshua’s body. The elasticity of these straps will be extremely important in ensuring that Joshua is suspended at the proper height for optimal jumping and leg strengthening. These straps will also be adjustable to correct any off-center positioning of Joshua while he is in the device. It is important that the harness be adjustable, comfortable and secure, and this harness will provide all three.

Finally, both the frame and the suspended harness will be mounted on top of a motorized platform. Ideally, the frame and harness components will be able to detach from the motorized portion so that it can remain stationary in certain areas, as well as allow for easier portability. For this design, the square motorized platform will have rear-wheel drive with two supporting, swivel wheels on the front of the device. The motorized portion will attach to the rear of the device and the axel of the powered wheels will extend slightly behind the platform on which the frame will stand. To maintain stability, the front two wheels will be similar to those used on wheelchairs and will be able to swivel to allow for easier turning of the device, and will have manual handbrakes to allow for the device to be parked and remain stationary. This motor will be controlled by both a remote control and a joystick that can be used by Josh. The device will remain around walking-speed to ensure safety and controlled movement around the house. It will be a challenge to keep the motorized platform as light and portable as possible, but selecting the proper motor will play a key role in succeeding. A sketch of the design is shown below for easier visualization.
Alternative Design 1 – Front View

Figure 2. Microsoft Visio Drawing of Alternative Design 1.
Alternative Design 2

For this design, it was decided that steel would be used for the frame. It is probable that a rust-resistant galvanized steel would be used in a frame that would resemble swing-set poles. The setup would have two parallel “A” frames connected at the top of the peak with another bar. If found to be a more favorable system, the poles could be angled towards one another; this will reduce the airspace taken up by the frame and cut down on some of the metal used. Telescope poles will be utilized to account for the eventual growth of Joshua. This will also allow for the breakdown of the frame for transportation and storage. The poles will be covered and padded to make sure Josh does not hurt himself. The four poles will be set in a rectangle formation into a round base platform. This platform will also be made of metal with padding attached on top.

Suspended from the top corners of the frames with hooks will be two systems of ropes and bungee cords. A limited length of bungee cord will be used to ensure Joshua does not extend too far from the center of the device. Ropes will be used where the bungee cord is not, allowing for the necessary length from the top of the frame to Josh’s harness. The harness used will be a child’s rock climbing harness. This will provide the hooks and attachments needed to hold Josh up. Additionally, it will allow for freedom of his legs to jump and stand. Increased back supports or straps may be essential; however, this will be determined during testing. The harness will be detachable so that Joshua’s parents or caregivers can put it on in advance while he is sitting, to make for easier placement into the device. A preventative option that will be utilized is a strap that hooks from the center of the platform to Josh’s harness. This would inhibit Josh from moving too far, in any direction, from the middle of the jumper.

The motor for this system will be positioned in the middle underneath the platform. A center-driven wheel system will be employed where two larger wheels on the left and right side of the circular platform will be attached to the motor and steering. Two smaller swivel wheels will be placed on the front and back to add extra stability and movement. A brake system will be created where the device is stationary when the joystick controls are not being employed.

A joystick for Josh to use will be put on a removable tray. This tray will attach to the two front poles and can be removed when Josh strictly wants to stay in one place and jump around. The joystick will be able to simply plug into the controller when Josh wants to move around the house. The figures below are diagrams made in Microsoft Visio that display different views of this design.
Bungee Chords Attached to Harness
Rope hooked from platform to harness to prevent too much lateral movement
Joystick
Detachable Joystick Tray

Figure 3: Front View of Alternative Design #2.
Figure 4: Side View of Alternative Design #2.

Figure 5: Top View of Design #2.
Alternative Design # 3

The frame of this design will be shaped similar to the structure shown in Figure 1 below.

![Figure 1.](image)

The construction material for the frame will be carbon fiber. The advantages of carbon fiber are its high tensile strength and low density which will reduce the overall weight of the device considerably compared to metals such as aluminum or steel. However, carbon fiber is more brittle compared to metals which make it a disadvantage. The structure of the frame supports one strap attached at the peak of the frame. The strap is in the form of a metal spring. The spring will provide Joshua with more bouncing freedom. The spring is attached to a chain covered in rubber to avoid the possibility of anything getting stuck in between in holes of each chain piece. The spring and chain combination is completely capable of supporting Joshua when he is both stationary and in motion. The angle away from the vertical plane for the back arc of the frame is advantageous because the angled arc provides more spring-like stability to support Joshua while using the device.
The platform of the device cannot be detached from the device because the wheels and motor system is attached to the bottom of the platform. The platform is a square shape to match the bottom cross section of the device. The square platform allows enough area to have a motor system and four wheels all of equal size to be attached underneath the platform. The wheels are rather large to enable even proper support on different terrains such as hardwood floors, carpets, grass, or sand. Each wheel is equipped with a manual brake lever that will keep the wheel completely stopped when the lever is pushed down. The motor system is placed in the middle of the wheels and the wheels are placed at each corner of the platform. The motor system will provides four-wheel drive to further enable the maximum terrain mobility for the device.

The harness is similar to a kid’s swing seat where Joshua will slip his legs through the seat at the bottom of the seat harness. The seat of the harness raises much higher than normal swing seats would. Instead of cutting off at the hips, the harness seat will raise to just below the armpits. Joshua is properly secured into the harness seat with over the shoulder strap from the back to the front. The straps will be buckled on after Joshua is lowered into the seat. Near the small of his back there is a slightly popped out metal ring where the chain and spring suspension system will attached.

The lower section of the frame is composed of telescoping shafts. The lower shafts encompass the upper sectional shafts which allow the lengthening of the frame to prolong the useful period of the device as Joshua continues to grow. The telescope nodes will protrude from two sides on the frames (along the horizontal axis) to ensure the maximum stability as the frame extends to its full height. Clamps maybe used around the telescoping shafts to produce more strength to the frame at supporting Joshua’s weight. A remote control belt is attached to harness, it can be detached from the harness to be used be Joshua’s parents and it can be attached to the frame via clamps to make sure Joshua will not accidentally brush against it. The remote control features a joystick that controls the motor system at the bottom of the device to
reduce the effort required to move the device as needed. The remote also has a kill switch which shuts off the motor system completely in case of an emergency.

This design provides a very simple design which gives the opportunity to further enhance each component of the device. The frame is extremely sturdy and light due to carbon fiber material and the telescoping shafts. The motor system on the bottom of platform will need some covering as the device is capable of all terrain movement. The spring and chain of the suspension line needs to be inspected regularly to avoid rusting or coating need to be covered on the components. The harness seat keeps Joshua’s back straight while he uses the device and the raised seat aspect will further provide safety to Joshua should something happen.