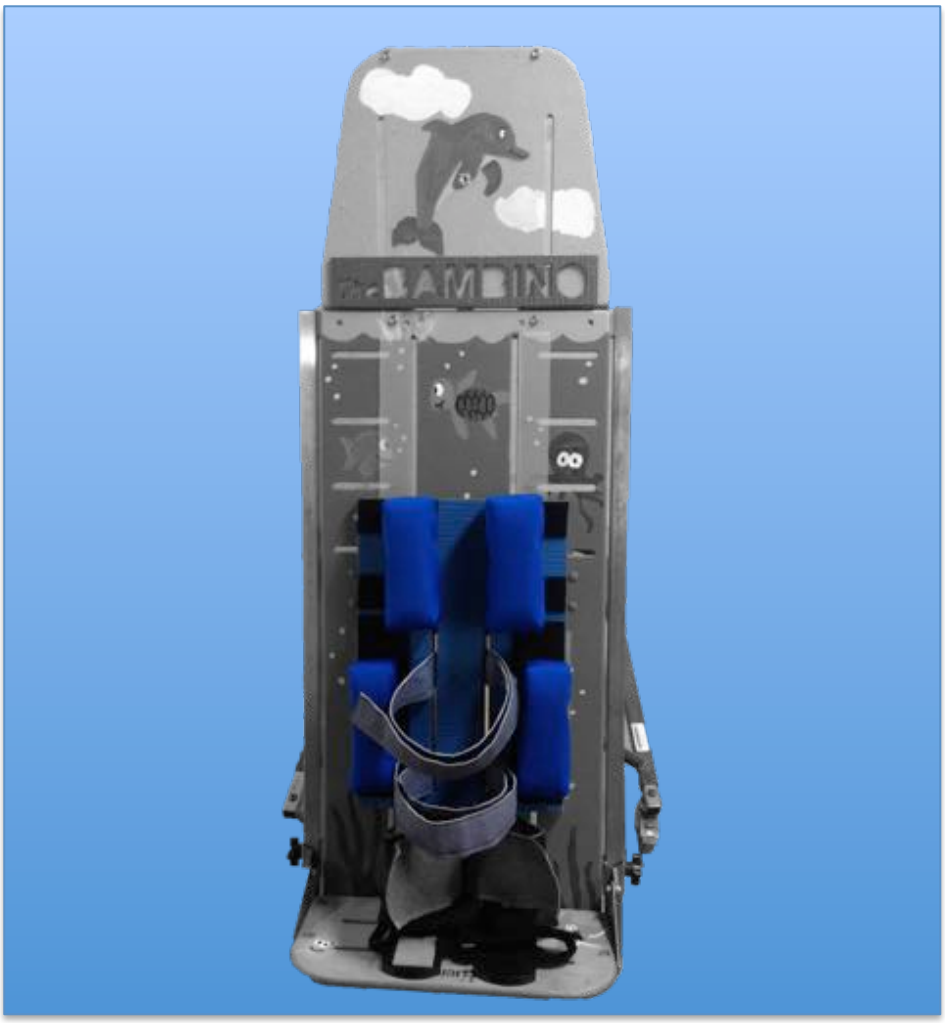
The Bambino



March 14th, 2015

Prepared For:
Rich Conti, The Misericordia Home
Chicago, IL

Submitted By:
David Chacon, Alex Friedman, Matt LoRusso, and Caitlin McMillin
Professors Emma DeCosta and John Bishop
Design Thinking and Communication Winter 2015 Section 13.4
McCormick School of Engineering and Applied Sciences
Northwestern University, Evanston, IL 60201

TABLE OF CONTENTS

Executive Summary

Problem

Due to a lack of weight on their hips, the natural stretch of gravity and the pull of gravity on their digestive tract, people with cerebral palsy develop numerous bodily problems. Many of their hips dislocate, their spine curls and they struggle with bowel movements. By stretching and raising people with cerebral palsy into an upright position, we can fight many of these problems. While standers exist for this purpose, they are only mass-produced for people over four feet in height; options in the size-range required are simply too expensive. Our client, Mr. Rich Conti, asked us to design a solution that could place children between two and four feet of height in the standing position.

Research/Testing

In order to learn more about the situation, we visited Mr. Conti at the Misericordia Home to observe the way he works with the children who will benefit from this design. Once we had a better idea of the size of the child, as well as a better grasp on the situation, we began researching existing options for ideas. Between the knowledge gained from these two steps, we narrowed our focus to three mockup of design ideas, and discussed their advantages in order to determine which option was best to move forward. After the decision was made, we then followed up at the Misericordia Home with our mockup to test it and receive feedback before returning to finalize our design, and build our final prototype.

Design Overview

Our design is a board made of one layer of polycarbonate plastic (which attaches to the original standing frame by way of screws fitting into the standing frame's pre-existing tracks) and one layer of foam (which the child will rest on for comfort). These two layers are held together by a strong bonding agent (rubber cement). On this board, we have added two slits to allow a hip strap to be attached, as well as head supports and under-arm supports (which attach by Velcro). Finally, it also utilizes the pre-existing footplate and knee straps available on the stander to better maximize efficiency.

- Adjustable: Our board is easily adjustable to accommodate the varying sizes of a child. On top of that, it ensures that, as the child grows, it will still be functional for their body. We have worked to make the product usable up until the child is large enough to use the original standing frame that our design attaches to.
- Efficient: Since the Misericordia Home already has multiple standing frames in its control (most of which go unused or are even missing one or two unimportant pieces), we have elected to create a board that utilizes these standing frames to their benefit. Using the preexisting technology, there is no

new information involved to train a physical therapist to use it, apart from learning how to attach our board to the existing standing frame.
- Easy to Clean: Our board, and the supports and straps, are covered in water-resistant material, making the cleaning process as easy as wiping down any potential spills.

Limitations

The few limitations related to our design include:
- The Velcro could potentially wear down over time, and is not easily interchangeable.

The client had specified "wants" in which a tray table, oscillating footplate, and a position that is close to the ground were evident on the design. While we did not meet these wishes, our team decided that the functionality of our design was important enough that they were not ultimately necessary to include

Introduction

Due to a lack of weight on their hips, the natural stretch of gravity and the pull of gravity on their digestive tract, people with cerebral palsy develop numerous bodily problems. Common issues include dislocation of hips, curling of the spine and struggling with bowel movements. By stretching and raising people with cerebral palsy into an upright position, we can fight many of these problems. Our client is Richard Conti, a physical therapist at Misericordia Home. He currently works with three infants, all with restricted movement, who will use the project. His project for us was to get these infants into the standing position to help prevent many of the issues that people with cerebral palsy encounter. Current solutions at the Misericordia Home only work with children who are around 4 feet tall, so we modified a current solution (a kids standing frame) to solve these problems for smaller children.

The current solution for larger children is a large board, styled similarly to a medical backboard, attached to a crank. There are adjustable head pads, side pads and straps around the knees, waist and torso. A nurse straps in the user while the board is parallel to the floor, then cranks the board until raised to the proper angle. There are tracks (long, narrow holes) in the board for the straps to slide up and down on, and there is Velcro to adjust the supports.

Our design is a modification of a current solution as it already solves the problem of safely raising and lowering users from parallel to the ground to perpendicular to the ground. It is a board, which adds head supports lower on the frame and allows the use of the current footplate and leg straps. The new side and head supports work better with the infants than the supports from the standing frame. These supports are attached to the board with Velcro. The board is easily attachable and detachable, so the original standing frame can be used for larger kids if needed. Our project attaches with wing nuts straight to the tracks on the board, for a secure fit.

The board solves the need for putting pressure on the infants hips, stretching the infants and raising them. It will also look child friendly, which was one of the requested features. The board will be covered with a yoga mat so it will be cleanable and resistant to liquids.

This report discusses the users and requirements of the design as well as the concept and rationale of the design. We also offer suggestions for how to overcome the limitations.

Users and Requirements

Main Users of the Design

Infants with severe cerebral palsy at the Misericordia Home: The main users of the design will be current and future infants at the Misericordia Home who have severe cerebral palsy. As of now, there are three infants at Misericordia with this degree of the condition. They range from around 20 inches to 40 inches tall. Cerebral palsy keeps their muscles very tight, which greatly limits their mobility. Some infants tend to curl into balls, while others are "stuck" in a more spread out position. The infants have very little head control. Many are at least partially blind and deaf. Also, some eat through feeding tubes, which are located under the ribs, around the navel area. They tend to cry more because of internal discomfort (stomach ache, sore throat) than environmental discomforts. Due to their movements being physically limited, it would be beneficial to have a device that could stretch them out and put them in a standing position.

Mr. Rich Conti: Mr. Rich Conti is the client. He is a physical therapist who works closely with the infants and will stretch them out and strap them into the device.

Other Physical therapists and nurses: These are other employees of Misericordia that work with these infants and who will possibly also be stretching out the infants and strapping them into the device.

Main Requirements

Stretches the muscles in the legs: The infants' muscles are often very tight, and their bodies are curled up. Stretching out the babies will keep their muscles looser and also help prevent their spines from bending over time. The device must be able to stretch them out to the point where their knees are almost perfectly straight, and their hips must be straight as well.

Infants need to have an adjustable amount of weight on their feet and hips: The infants have issues with their hips dislocating. Their muscles around the hips are very underdeveloped. Also, the infants have gastrointestinal, urinary, and growth issues because they are rarely in a standing position. The infants would greatly benefit from putting weight on their hips in a standing position. The device must be able to vary the amount of weight being supported from almost none of the infant's body weight to a majority of the infant's body weight. The maximum weight of an infant user would be about 40 pounds. The preferred way to vary the amount of weight being supported is to harness an infant into a device that can be inclined to specific angles.

The device looks and feels appealing to infants: The infants will have better feelings towards the device if it does not feel like another piece of medical equipment. The device must have a kid-friendly and colorful theme, such as a frog or a bear.

The physical therapist should be able to work with other children while a child is in the device: The physical therapist sometimes has to deal with all three infants at the same time. In order for him/her to be able to pay attention to the other infants, he/she must be able to leave the child unattended in the device. Also for obvious reasons it is important for the device to pose no safety threats to the child. Therefore, the straps and padding must be placed in a way that does not allow the muscles to overextend. Also, the infant must not be able to slide down the board, through the straps.

The device needs to be cleanable: Due to the fact that there are multiple infants that will be placed in the device, the board must be cleanable. The board and supports must be covered in hydrophobic materials in order to allow easy cleaning via wiping.

Design Concept

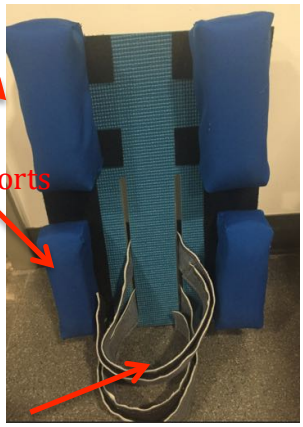
Main Idea

Our design is called the Bambino. It is a board that mounts onto the surface of the original standing frame that allows infants to use the device. The current standing frame at Misericordia for children beginning around 4 feet tall is a rigid flat board to which children are strapped and supported in a standing position (arms and legs outstretched, spine straight, knees straight, head upright, feet pointed forward and flat on the footplate). The board can lay flat in a horizontal position and rotated to a vertical position using a crank. The crank allows the board to be rotated to any angle between 0 and 90 degrees. The original standing frame has side supports, head supports, upper and lower body straps, knee straps, and a foot plate to which the feet are strapped, all sized for children around 4 feet tall (see Figure 1 * note: head supports, side supports, and body straps for original standing frame are not shown). Our design, the Bambino provides two body straps to support the infant's chest and hips, two head supports, and two side supports that are all appropriately sized for infants (see Figure 2). The body straps are vinyl fabric that wrap around the infant's body and are secured using Velcro, which also allows for the straps to be adjusted based on the size of the user. The side and head supports consist of blocks of wood covered in foam and water resistant fabric that attach to the Bambino board by means of Velcro so that they, too, can be easily adjustable. There are two long, vertical strips of Velcro along the sides of the Bambino and four smaller strips of Velcro at the top which allow the side and head supports to attach to the device. The Bambino can be removed from the current standing frame, but when it is mounted on the frame, it is securely fixed with bolts that slide into the slots of the frame. When the board is placed at the desired location on the current standing frame, the bolts are tightened using wing nuts. The device can be adjusted up and down along the length of the frame to account for the different sizes of infants.

Figure 1
Original Standing Frame

Figure 2
Bambino attached
to frame

Figure 3
The Bambino



How it is Used

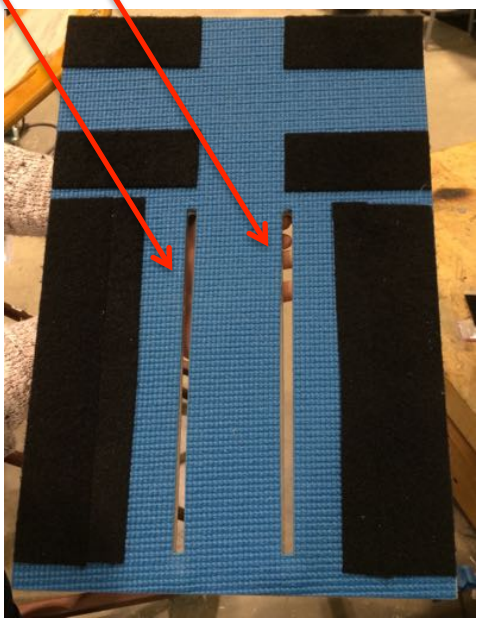
To use the Bambino, the physical therapist places the infant onto the device so that it is lying on top of the body straps, and its head is in between the head supports. Then, the physical therapist wraps the body straps around the chest and hips of the infant to secure the infant to the device. The physical therapist also wraps the leg straps around each knee of the infant to keep the knees straight and straps the feet into the footplate. After this, the physical therapist lifts the head and side supports off of the strips of Velcro on the board and places the supports back on the board at the desired locations on the Velcro so that they provide support to the infant. The supports will likely be placed snug, right up against the infant's head and side. To adjust the Bambino up and down on the original standing frame to accommodate infants of different lengths, the physical therapist is able to loosen all of the wing nuts and slide the board up and down along the slots of the original standing device. In addition, the footplate of the original standing frame can be adjusted if necessary to the position where the infant's feet rest on it at a 90° angle.

Subsystems

- The board
  - The board is 12"x18" and made out of ¼" polycarbonate. It has two 1/3" vertical slots, each 1.33" away from the center. They run from .3" from the bottom of the board to 10.33" (see Figure 4). There are also four 0.30" square holes at the top and bottom of the board that line up with lengthwise slots that are in the original standing frame. A portion of the back of the board is recessed to allow the straps to slide freely underneath the board (see Figure 5).

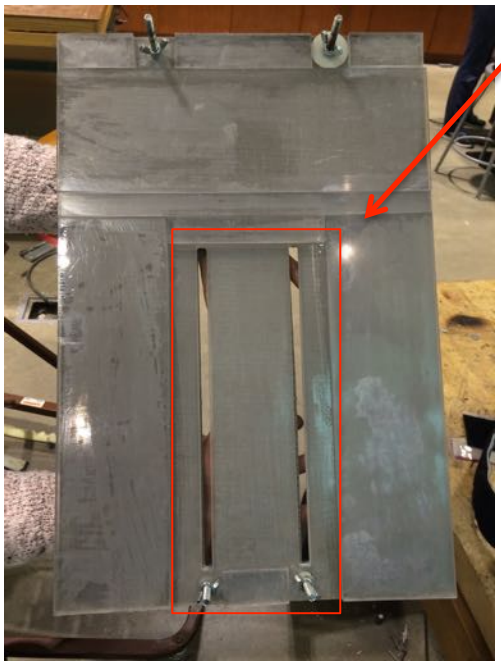
Slots that the body straps go through

Figure 4



This part of the board is recessed

Figure 5



- Leg Straps
    - The Bambino uses the leg straps on the existing standing frame. They consist of two 2" wide vinyl straps that have Velcro attached to the end. They are 3' long. The straps loop around the legs and can be adjusted to the desired tightness via Velcro, which holds the straps in place (see Figure 6). The leg straps can be raised and lowered because they are looped around the back of the original standing frame through two slots.

Figure 6

- Body Straps
    - The body straps are also vinyl with Velcro. These straps are 2" wide and 2' long. One strap goes under the arms of the child, supporting the chest, and the other strap wraps around the pelvis/hips. The straps loop around the Bambino through two 1/3" slots that are placed 3" apart from each other (see Figure 7). The physical therapist will lay the infant on top of these slits and wrap the straps around the infant from underneath. The Velcro at the ends attach when the ends are overlapped, holding the straps in place.

Figure 7

Figure 8
Front of the Bambino

- Head supports
    - The head supports consist of two blocks that attach onto the Bambino with Velcro near the head of the child. The blocks are made out of 1 3/4" x 1 3/4" x 6" blocks of wood that are wrapped in a ½" of foam and then water-resistant fabric. Strong adhesive Velcro is used to ensure the supports are secured on the device. The loops of the Velcro are placed on the device in 2" x 4.5" patches near the head to allow for adjustments. One side of each support is covered in the hooks Velcro. This allows the physical therapist to place the head support where he or she sees fit (See Figure 9 and Figure 10).

Figure 9

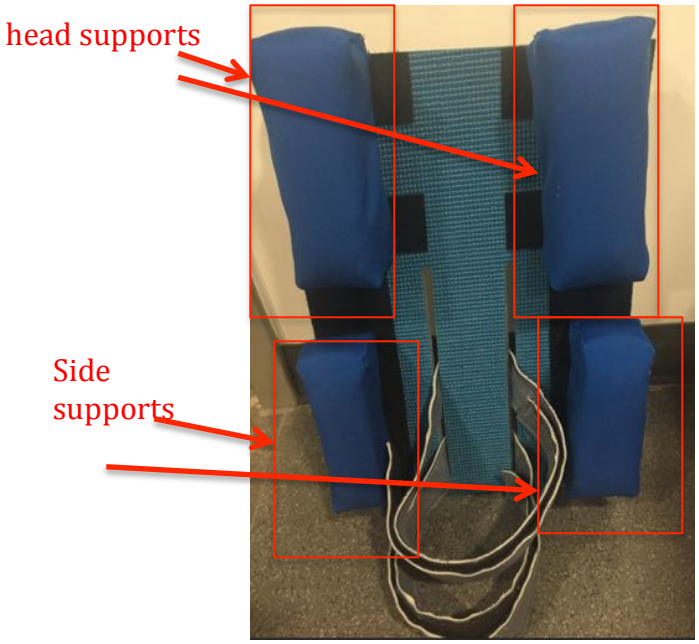


Figure 10 Velcro boxed in red

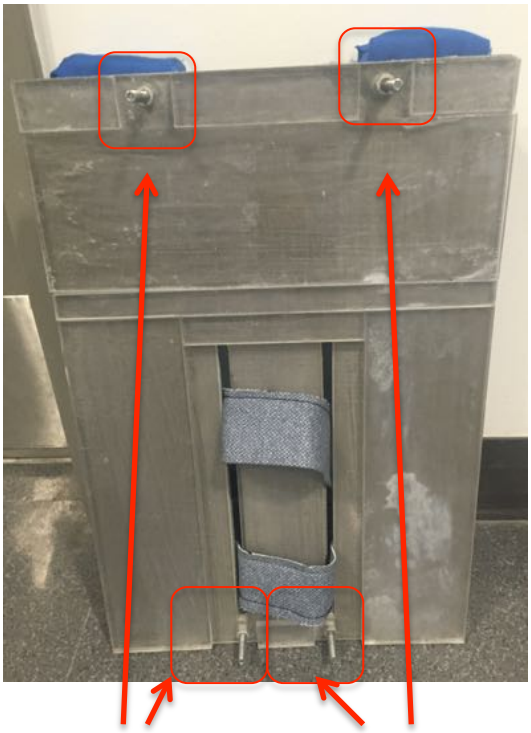
- Side supports
    - The side supports are very similar to the head supports. They are made from 1 3/4" x 1 3/4" x 6" blocks of wood that are wrapped in a ¼" of foam and then hydrophobic fabric. Strong adhesive Velcro is again used. The Velcro also allows the side supports to be easily adjusted (see Figure 10).

- Padding
    - The Bambino is padded with ¼" of colorful closed foam (from a yoga mat). This foam has vertical slots cut out of it that match the slots of the board so that the body straps and wrap around the board and the foam on top of it to secure the infant. The foam is attached with strong adhesive. This foam will make the Bambino comfortable and easy to clean.

- Attachment to the original standing frame
    - The Bambino is attached to the standing frame with ¼" carriage bolts 0.28" holes in the board and the vertical slits of the standing frame. These bolts are tightened with wing nuts. The square holes in the board restrain the square neck of the bolts from rotating, which allows the wing nuts to be easily tightened. There are two bolts at the top of the board (one to the left and one to the right) and two bolts at the bottom. The bolts are stabilized with ¼" nuts on the back of the Bambino and also with washers on the back of the original standing frame. These bolts and wing nuts securely affix the board onto the standing frame (see Figure 11 and Figure 12).

Figure 11

Figure 12



Design Rationale

Design Itself

After researching many kinds of standing frames, talking to the client, user observation, and initial user testing, our group decided that a modification to the current type of standing frame that Misericordia has for children a little bit older than the age and size of the users for our project would be the best way to achieve the needs of the client and users. We hoped to build a device that might actually be able to be used, and didn't want to have to suggest extra products to buy or additional accessories because of running out of money, so we decided that modifying the current standing frame to properly fit the size of the infant users would be the most cost efficient, usable design. The current standing frames that Misericordia has for children who are bigger than the infants work perfectly well, and so by using the base of one of the current standing frame, we can be sure that the standing frame will safely lower and raise the infants to different angles because it is already being used safely with children who are a bit bigger than the infants. Our design was a small backbone piece of sturdy, impact-resistant plastic with a yoga mat covering it that will attach to the current standing frame. The design uses the existing adjustable footplate, leg supports, and crank system, which were all proven to be safe and effective at user testing. The physical therapist helping the infants into the device will be able to adjust the insert using the tracks on the current standing frame, and the new backbone piece will have side supports and head supports that will be able to be adjusted with Velcro, which, after conferring with the shop trainers, we decided will be the safest, most adjustable and cost efficient way to provide the necessary head and side supports. The Velcro is strong enough that the supports will not wobble when supporting the infant, which was a requirement of the user. The device will also have additional chest and hip straps to increase safety and support for the infants.

Main Device Backbone Piece

After consulting the shop trainers, we decided to use polycarbonate for the backbone piece because it will not shatter, is sturdy, and is durable. We then decided to cover the polycarbonate piece with a yoga mat. The yoga mat is soft and will provide a cushion for the infant's body, so that the infant is not laying directly on the hard polycarbonate surface. Without the yoga mat, the infant might not be comfortable. The yoga mat is also easy to clean, which was a requirement of the user, and it will not easily absorb liquids that may get on it. In terms of the size of the backbone piece, we took measurements at user testing to ensure our device could accommodate for infants of a variety of sizes. The measurements showed us that the device should be 12" x 18". We decided to attach the main component of the device to the existing standing frame using screws attached to the back of the device that run along the tracks of the current standing frame and are secured with wing nuts. This ensures that the board will be firmly attached to the current

standing frame, and the physical therapist will have to unscrew the wing nuts in order to move the board at all.

Straps

We decided to use the current straps for our device, only smaller. We decided on the size of the straps based on measurements taken at user testing and will modify the existing straps to better accommodate the size of the infants. This also saves money. The current straps are used at Misericordia on larger children, so we know that they will be safe and effective to use with our device. We simply shortened the length of the straps because the infants have smaller waists than the larger children who use the current standing frame.

Supports

We chose square blocks of wood as the main structure of the side and head supports after talking to the shop trainers because they will not shatter and are durable. This is important because the user insisted that the supports be stable and firm to support the infants. We also decided to use excess super cushioning polyurethane foam from the backbone piece to add comfort for the infant users. For the size of the supports, we took measurements at user testing and got the client's opinion on the matter, and we decided that 2"x2"x6" would be best. Only having the supports two inches tall provides support to the infants, but also allows them to see over the head supports a little bit so that they do not feel like they are being smothered by the head supports. The supports will be covered in a blue sumbrella fabric for easy cleaning, and they will be attached to the backbone piece using Velcro that, according to the shop trainers, will provide enough support and stability for the supports so that they will not wobble or move when the infants are using the device. The Velcro also allows the supports to be adjusted for different users, and it will not get dirty or wear over time. This was also a requirement of the user.

Limitations and Future Work

Our design accomplishes the major requirements for the project, but does not satisfy many of the features. If we were to continue working on the project, the next steps would be adding a tray and vibrating footplate, making the entire standing frame child friendly, making the insert more adjustable and increasing the cranking speed. Ideally, this board would work with other designs of standing frames, so rehabilitation centers around the world, with different standing frames, could use it.

Adding a tray or vibrating footplate would be the next steps in the project. The current tray, used for children and adults, does not work as it is too far away for an infant, so a smaller version is needed. The current tray attaches by snapping into the holes in the adjustable armrests. The new infant friendly tray would be a piece of plastic that can also attach to the armrests on the original standing frame. This could be attached with clamps or using pegs through the holes in the arm rest.

For the vibrating footplate, the design would either use the current air pump that is used on patients at Misericordia to clear their lungs or a spring system. The machine at Misericordia pumps air into a vest (practically a bag filled with air) and vibrates the air. The setup would be placing the vest beneath the infant's feet and turn it on a low setting. Another alternative is adding a small springboard so the child can push and bounce freely.

Painting the full standing frame a bright color would make it more child-friendly. It is important to make sure not to paint into any holes and fill them up.

Currently the board only works with children up to 3 feet and with chests as wide as eight inches. The main user we worked with fits, but we were unable to get measurements on the other children, so we are unsure if they would fit. Also when the children grow, they may outgrow our product for a short while before they grow into the next product.

Mr. Conti complained about the slowness in raising and lowering the standing frame. Each turn of the handle only turns the board a few degrees, so to raise the board from zero to 75 degrees, takes a lot of work and time. Adding a gearbox of sorts to the crank would solve this issue. By changing the ratio, each crank would move the board more.

To make the board usable with any frame, we would have to research the most common standing frames and adjust it to each one. The only detail specific to this current standing frame is the location of the wing nuts as the tracks are in those locations. This could easily be fixed by adding extra tracks and holes or by making alternate designs for each popular standing frame.

The main safety concern is making sure all wing nuts are properly secured and the straps are fastened tightly. These concerns apply to the previous standing frame

design as well, so the main user, Mr. Conti, knows how to deal with these safety concerns.

Conclusions and Recommendations

The Bambino is a simple board that mounts onto a current standing frame. By attaching the board onto the standing frame with wing nuts and strapping an infant onto the board, one can raise children with severe cerebral palsy into a standing position (anywhere from 0 to 75 degrees from the ground). The rest of the features are adjusted with Velcro or by sliding the straps on tracks. This device helps solve a variety of problems.

Our boar that mounts to the current standing frame solves the main problems of stretching the infants, adding pressure to their hips and getting them into the upright position to help with their digestion. The frame also is child friendly and waterproof. The board, however, is not on the ground, nor does it have a tray, nor does it stimulate the feet. To improve the design, we would need to do more testing and get more data.

If we had access to children after we finished building a safe mockup, testing the weight distribution would be incredibly useful in determining where to add or remove support. Our board is modeled after the original standing frame, which is used on larger children. We are unsure if the design is transferable to infants. To test this we would add scales at various locations such as under the feet, under the arms and attached to the straps. We would then slowly raise the frame and see how the weight distribution changes.

It would be incredibly useful to get data on the range of weights, waist sizes, etc. of many children who would use our device. Currently, our board works with one user, but we are unsure if others would fit as we have never gotten the chance to test.

References

Bundonis, Joanne "Benefits of Early Mobility with an Emphasis on Gait Training" *Rifton.com.* Rifton Equipment, n.d. Web. 8 Jan. 2015.

"Cat 1™ Stander" *en.akces-med.com.* AkcesMed. Web. 16 Jan. 2015.

Caulton, J.M., Ward, K.A., Alsop, C.W., Dunn, G., Adams, J.E., Mughal, M.Z. "A randomised controlled trial of standing programme on bone mineral density in non-ambulant children with cerebral palsy" *Arch Dis Child* Vol. 89 (2004): 131-135. Web. 19 Jan. 2015.

Conti, Richard. Personal Interview. 15 January 2015.

"Developmental Milestones" 27 Mar. 2014. *Centers for Disease Control and Prevention.* Web. 9 Jan. 2015.

"Facts About Cerebral Palsy" 12 Nov. 2014. *Centers for Disease Control and Prevention.* Web. 9 Jan. 2015.

"Krabat Jockey Plus" *professionals.ottobockus.com.* Ottobock. Web. 16 Jan 2015.

"Leckey Totstander, Freestander and Pronestander" *professionals.ottobockus.com.* Ottobock. Web. 16 Jan. 2015.

Majd, Mohammad E. MD; Muldowny, David S. MD; Holt, Richard T. MD. "Natural History of Scoliosis in the Institutionalized Adult Cerebral Palsy Population" *Spine* Vol. 22, Issue 13 (1997): 1461-1466. Web. 20 Jan. 2015.

"Noah Goes For A Walk On The Porsche Of Walkers: The Gait Trainer" *noahsdad.com.* Noah's Dad. Web. 8 Jan. 2015.

"Physical Appearance and Growth: 8 to 12 Months" 7 Aug. 2013. *healthychildren.org.* American Academy of Pediatrics. Web. 9 Jan. 2015.

"Prone, Upright and Supine Stander for Young Children" *www.leckey.com*. British Healthcare Trades Association. Web. 16 Jan. 2015.

"Rainforest™ Jumperoo™" *www.fisher-price.com.* Fisher-Price. Web. 9 Jan. 2015.

Rempel, Gina R., Colwell, Sarah O., Nelson, Richard P., "Growth in Children With Cerebral Palsy Fed Via Gastrostomy" *PEDIATRICS* Vol. 82, No. 6 (1988): 857-862. Web. 19 Jan. 2015.

Samilson, Robert L., Tsou, Paul, Aamoth, Gordon, Green, William M. "Dislocation and Subluxation of the Hip in Cerebral Palsy" *The Journal of Bone & Joint Surgery* Jun Vol. 54, Issue 4 (1972): 863-873. Web. 19 Jan. 2015.

Schlittler, Diana X. C., Sanches, Matheus B., Carvalho, Raquel P., Barela, José A. "Ideal treadmill speed to stimulate stepping in infants" Rev. bras. fisioter. Vol. 14 No. 6 (2010): 483-490. *pubmed.gov.*Web. 8 Jan. 2015.

Sigust, Andrea "The Muscles Used to Sit & Stand" *www.livestrong.com.* The LiveStrong Foundation. 18 Dec. 2013. Web. 8 Jan. 2015.

Sochaniwskyj, AE, Koheil, RM, Bablich, K, Milner, M, Kenny, DJ. "Oral motor functioning, frequency of swallowing and drooling in normal children and in children with cerebral palsy." *Archives of Physical Medicine and Rehabilitation* Vol. 67, Issue 12 (1986): 866-877. Web. 20 Jan. 2015.

Stallings, V. A., Charney, E. B., Davies, J. C. and Cronk, C. E. "Nutrition-Related Growth Failure of Children with Quadriplegic Cerebral Palsy" *Developmental Medicine & Child Neurology* Vol. 25, Issue 2 (1993): 126-138. Web. 20 Jan. 2015.

"Understanding Cerebral Palsy -- The Basics" 10 Mar. 2014. *www.webmd.com.* WebMD. Web. 17 Jan. 2015.

Waterflow, Lucy "Harness of hope: Invention from mother of wheelchair-bound son helps him and other physically impaired children walk for the first time" 24 March 2014. *www.dailymail.co.uk.* Daily Mail. Web. 14 Jan. 2015.

Appendix A: Project Definition

Project name: The Bambino
Client: Mr. Rich Conti, Misericordia Home
Team members: Matt LoRusso, Alex Friedman, Caitlin McMillin, David Chacon
Date: March 12, 2015
Version: Three

Mission Statement: We will create a device that is sturdy, adjustable, and easy to use that will safely put infants with cerebral palsy in a standing position where their legs are fully extended. The amount of weight one the infants' feet and hips will be adjustable.

Project Deliverables:

- A working prototype that will safely put infants with cerebral palsy in a standing position where their legs are fully extended
- A full report explaining how the device works
- Instructions on how to construct the device
- Instructions on how to use the device

Constraints:

- $100 budget
- 10 weeks
- Must be lightweight

Users/Stakeholders:

- Infants with severe cerebral palsy at Misericordia Home
- Infants with severe cerebral palsy in general
- Physical therapists, such as Mr. Rich Conti, and nurses who will be placing these infants into the device

Needs	Requirements	Specifications
Stretching • Stretches the muscles in the legs • Keeps the spine upright	• Extend knees to nearly 180 degrees • Fix angle between torso and legs at around 180 degrees • Support the top and bottom of the spine with rigid supports along the majority the torso	• Infant will be strapped to a smaller board that is attached to the original youth standing frame used at Misericordia. The board will provide waist and under-arm straps. The original standing frame will provide leg straps • Side supports and head supports will prevent leaning to the left and right sides
Weight on feet/hips • Infants must have weight on their feet and hips • The amount of weight must be adjustable	• Place and hold infants in a "standing position": arms and legs outstretched, spine straight, knees straight, head upright, feet pointed forward and flat on the footplate • Weight on the feet and hips needs to be adjustable from 0% to around 90% of the infant's body weight	• The feet of the infants will be strapped into the footplate of the standing frame at a 90-degree angle • The weight will be adjusted by inclining the standing frame from 0 to 75 degrees, using the cranking system of the standing frame
Structure/Adjustability • Device must be able to account for	• The device will be able to accommodate	• The board will have two bolts at the top and two bolts at the bottom that

a variety of sizes of infants who are around 8 months old Structure/Adjustability (cont.)	infants from 20 inches to 45 inches tall • Must accommodate infants of weights from 6 lbs (5th percentile for girls at 20 inches) to 35 lbs (95th percentile for boys at 45 inches) • Must accommodate infants from 5 inches to 8 inches in width	slide through the slits of the standing frame. The board will be tightened to the standing frame using wing nuts. This will allow the board to be adjusted vertically and hold the board securely to the original standing frame • The bottoms of the side and head supports will be covered in Velcro and attached to thick strips of Velcro on the board. This will allow the physical therapist place supports at the desired locations.
Kid friendliness • The device looks and feels appealing to infants • Does not look like medical equipment	• The device will be colorful and have a developmentally appropriate theme	• The original standing frame will be painted a developmentally appropriate theme • The padding and the side supports of the device will be blue
Comfort • The child feels comfortable when in the device	• The device must be padded • The head and side supports must be padded	• The board will have a yoga mat attached on top with adhesive for comfort • The head and side supports will be covered in foam and water resistant fabric
Safety • The device should pose no danger of abrasions, suffocation, loss of circulation, or trauma • The physical therapist should feel confident leaving the infant in the frame while	• Child must not be able to slide down through the straps • Straps must not have sharp edges • Straps must be adjustable vertically and by tightness • The device must have head and side	• Straps that loop through slits in the device will be placed around the waist and under the arms. They will have Velcro so that tightness can be adjusted • There will be side supports and head supports that attach to the board with Velcro where the physical

working with the other infants	supports, as well as straps at the knees and waist, and under the arms	therapist sees best fit • Straps are made of vinyl, which does not have hard edges

Maintenance/Durability • The device needs to be easily cleanable • Needs to last at least 5 years	• Must be covered in a material that can be wiped with disinfectant wipes if necessary • Materials should be hydrophobic • Materials must be able to withstand 5 disinfectant cleanings a day for 5 years	• A yoga mat will be attached to the top of the board with adhesive • The side supports will be covered in water resistant fabric

Appendix B: Background Research

For the first week of this project, we focused our efforts on researching a small variety of sources in order to cover the broad bases set up in the project description. Before the client interview, we had only a vague idea of what the product needed to be: some sort of device that could hold a child and put them in a standing position. However, we were unsure if the device needed to be able to put them in said position on its own, or rather if the child were to just be placed in the device and then stood up. Furthermore, we were unsure if the device had some sort of end goal in mind (such as rehabilitation to the point where the child could walk on its own). Because of this, our research focused primarily on:

1. Effects of disabilities
2. Physical Characteristics of Children
3. Benefits of a Standing Position in Children
4. Competitive and Model Products

Effects of Disabilities

After meeting with the client, we learned that the children we are designing for have a form of low functioning cerebral palsy, which results in their lack of muscle control. Because of this, their ability to stand is completely non-existent, and according to Rich Conti, they will never develop the ability to stand on their own.

Cerebral palsy has no one definite cause; however, there are three main causes theorized. First is as a result of an infection during the pregnancy, which can harm the fetus' nervous system during the critical early stages of development. Second is severe physical trauma during birth, which can finish harming a child who was already suffering from complications during the pregnancy. Finally, a lack of oxygen "before, during, and immediately after birth" can cause damage in the brain. On top of the information on causes, we also learned that "about 10,000 infants are diagnosed with CP" each year, indicating that this issue is much more widespread than just the Misericordia Home, expanding our potential user base (Understanding Cerebral Palsy -- The Basics).

Due to the nature of cerebral palsy (in that it stems from brain damage in a developing brain), movement is severely impaired in the afflicted infants. Without the ability to move during such a critical point in their lives, severe growth defects are common and the effects reverberate as they continue to age. Because of their lack of movement, spines of those afflicted with cerebral palsy tend to contort, and prolonged resting in this contorted position leads to scoliosis (Majd). Hip dislocation is also common in these cases (Samilson). With the brain damage also comes an inability to eat (due to the lack of throat muscles necessary to swallow) leading to poor nutrition and growth failure (Stallings). While we can fix the nutrition and weight issues with feeding tubes implanted into the stomach, the growth defects associated with the lack of throat control are unavoidable (Rempel). Furthermore, without proper use of the throat, inefficient/infrequent swallowing is common,

leading to excessive drooling (Sochaniwskyj). This drool will most likely fall on any device we create, thus requiring it to be easily cleaned.

Physical Characteristics of Children

Based on our research findings, we believe that our target age group will be children between the ages of 8 months and 2 years. (Note: Our client interview with Rich Conti later reaffirmed this age range).

Certain developmental milestones that build up to walking began to take place by the age of eighteen months. These include: holding the head up and beginning to push upwards when laying on the stomach (two months), starting to push down when legs touch the ground and starting to roll from stomach to back (four months), rolling over in both directions and sitting without support (six months), stands while holding on to surface and can get into a sitting position on their own (nine months), pulls up to stand and walks while holding on to furniture (twelve months), and finally walks alone by the age of eighteen months (Developmental Milestones).

Many of these milestones, however, are missed in infants with developmental disabilities. In the case of cerebral palsy, babies younger than six months of age experience laggy heads when being picked up from a laying position, a stiff or floppy body, an overextended back and neck when cradling, and stiff, crossed or scissored legs when picked up. In babies over six months of age, they experience difficulty bringing their hands together or to their mouth, and are unable to roll over in either direction (Facts About Cerebral Palsy).

Benefits of a Standing Position in Children

Standing is among the most beneficial natural positions available to humans. Just in the natural position of standing, bone density is increased due to the bearing the weight of the human, foot, knee, and hip alignment is better adjusted from the proper distribution of the body's weight, the spine is stretched out and extended for healthier growth, the gastrointestinal system flows easier (as opposed to being constricted from a sitting or 'scrunched up' position), and awareness is improved in children who are now seeing the world from a slightly higher angle than they were when restricted to the floor (Bundonis).

Even in children with cerebral palsy (who have been declared non-ambulant), the standing position has been found to "reduce the risk of vertebral fractures," thus emphasizing the importance of resting in this position, even when not doing so naturally (Caulton). During our client interview, Rich Conti also mentioned his theory that placing the children in a standing position for short periods each day could help alleviate the severe scoliosis that cerebral palsy patients experience as they age.

Competitive and Model Products

Through our research, we first began to look at available toys and products designed for the general public that place children in a standing position. Our biggest find in this area was a jumper (in this case Fisher-Price's Rainforest Jumparoo, pictured in Figure 1). This toy is designed to seat one child and is attached to three springs which allow the baby to shift its weight up and down and bounce around while in the seat. Problems with this design included a lack of head and torso support for the child in the seat, and the fact that without proper use of their legs, the children would not be able to bounce themselves much.

Figure 1: Fisher-Price Rainforest Jumperoo
Source: Fisher-Price <http://www.fisher-price.com/en_US/brands/babygear/products/Rainforest-Jumperoo>

Following this, we began to look at standing tables for adults and older children. Pictured in Figure 2, you will find a diagram representing the basic structure of these standing frames. Problems included, of course, that the product is designed for

use by an older client, thus it would be useless when attempting to work with children in our specified age range and size.

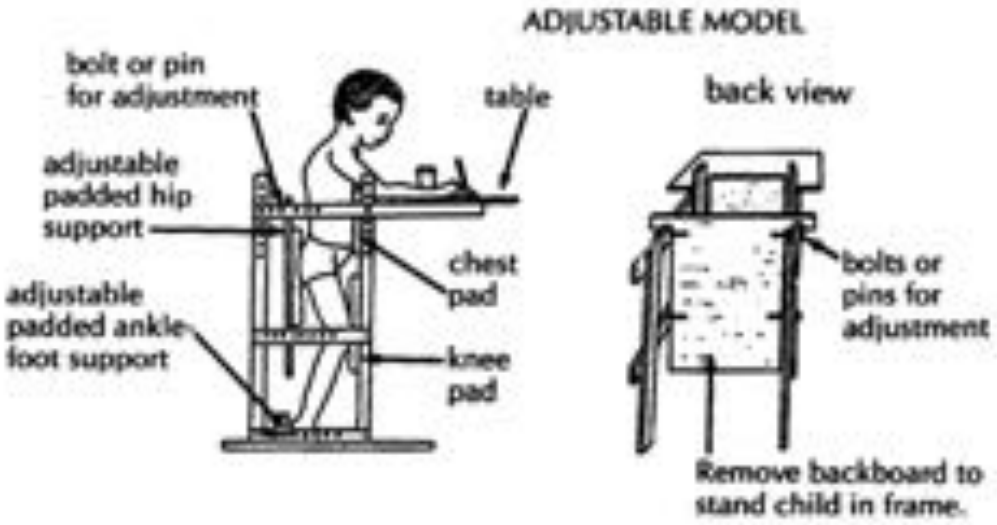


Figure 2: Design for an adjustable Standing Table.
Source:<
http://www.dinf.ne.jp/doc/english/global/david/dwe002/dwe002g/dwe00264g36.gif>

We then happened upon similar standing designs for children in our age range. Depicted in Figure 3, you will find the one example in the Leckey Totstander, which is a standing harness designed for toddlers that straps them in a vertical position. Issues with this product involve a lack of horizontal to vertical motion (described by Rich Conti as a feature necessary to allow him to place the child in the device and then gradually incline them without the need for multiple helpers) and the generally rigid nature of the device (which would only allow for standing, as opposed to perhaps moving joints and exercising the toddlers body). On top of this, similar products designed for children cost upwards of $1000 to $2000 and thus we assume are too expensive to be viable options for the Misericordia Home to consider.

Figure 3: Leckey Totstander
Source:
<http://professionals.ottobockus.com/cps/rde/xchg/ob_us_en/hs.xsl/33892.html>

Finally, we also found a harness designed by a mother of a child with cerebral palsy who was wheelchair bound. Figure 4 depicts this harness, which allows the child to walk with the assistance of an adult. This product fulfills the need for a standing position and also has the bonus of exercising the child's legs, yet does lack a head rest for those that have more limited control over their head weight.


Figure 4: "Harness of Hope"
Source: <http://www.dailymail.co.uk/femail/article-2588157/Harness-hope-Invention-mother-wheelchair-bound-son-helps-physically-impaired-children-walk-time.html>

Appendix C: Client Interview Summary

On Thursday, January 15th, 2015 at 5:00pm, we had our initial interview with our client, Rich Conti, a physical therapist at Misericordia, in the Ford Building. All members of our group (13.4) were present. The purpose of the meeting was to learn more about the problems that Misericordia is having with helping infants who have severe developmental disabilities stand. This appendix summarizes what we learned about the design problem, requirements, users, and current methods.

Problems

Our client identified several problems:

- There is currently no device to help infants stand.
- The physical therapists at Misericordia do not have enough hands to support the infants' bodies when trying to get them in the standing position.
- If their muscles do not get stretched and used to the standing position as infants, the babies will grow up to have many more problems with their muscles, bones, joints, tendons, etc.

Requirements

- Child friendly/a design that appeals to kids
    - The client does not want the product to look stiff and sterile (like adult devices used for similar reasons).
    - The client suggested making the design look like a bear.
- Portable
    - The design must be light enough to be able to be moved around the room and stored (possibly in a corner).
- Comfort
    - The product must be comfortable for the infants. The babies should be stretched out and stable, but also comfortable. There should be a little bit of space for the head to move, but not too much so it does not slouch down or fall.
- Footplate
    - There must be a footplate or something for the babies to rest their feet on.
- Horizontal start
    - The infants must start lying down, in a horizontal position, and then be slowly moved upwards.
- Different angles
    - The device must be able to be stabilized at any angle between 0 degrees and 75 degrees.
- Cost
    - The design budget is $100.

Safety

- Feeding tube

    - The product must be designed in a way that it will not interfere with the infants' feeding tubes in their stomachs (around the belly button area).
- Support
    - The design must support the infant's entire body.
        - Head, feet, legs, trunk, etc.
- Note: someone will be watching the baby during the entire time while it is in the device.

Users

- Users of the device are infants/babies beginning around 8 months old.
- Users are typically 2ft-3ft tall and will, at most, weight around 40 pounds.
- Currently, the client is working with 3 babies.
- Only one device is desired for all 3 babies.

Features

- Tray
    - The client thinks it would be nice to have a tray attachment so that the infants can rest their hands on it.
- Adjustable footplate
    - The client suggested making the footplate adjustable so that the babies can feel different pressure on their feet.
- Wheels
    - The client mentioned a design with feels for easier portability.

Appendix D: User Observation Summary

On January 22, 2015, all members of DTC group 13.4 (Alex, Matt, David, and Caitlin) visited the clients, Rich Conti and the infants at Misericordia. Rich also gave us a tour of the facilities at Misericordia, and he showed us the devices that Misericordia has to help older children with cerebral palsy stand. The purpose of the session was to understand the current way Rich stands the babies up, what difficulties and suggestions he has, and to get a better idea of what type of design will be best for the specific needs of Rich and the babies. The session lasted approximately two hours. This appendix explains the methodology used to conduct the observation, describes the current standing mechanism that Misericordia has for older patients with cerebral palsy, and summarizes the results of the observation.

Methodology

The observation took place in the babies' playroom at Misericordia, where the ifants will use the Bamboni. We were able to meet with Rich and one baby named Emma. Rich demonstrated how he typically gets Emma in a standing position. With this current method, Rich can only hold each baby in the standing position for three to four minutes at best. After meeting and observing Emma, we drew an initial product design idea, and then Rich brought out a similar device that they currently use for children a little bit older. We asked Rich what he liked and did not like about the device, and we took several measurements and pictures. Finally, Rich took us on a tour of the building at Misericordia that he worked in before we left to go back to Northwestern.

Information about users (infants)

The users are three infants at Misericordia who have severe cerebral palsy. Specifically, we interacted with Emma. She is one year old and 28 inches tall. The three babies currently at Misericordia weigh 19.89 pounds, 19.7 pounds, and 16.9 pounds. Emma has very little head control, very tense, tight muscles, and she tends to curl her arms and legs close into her body. Emma can hear, feel, and somewhat see. Rich stated that she could sense that we were in the room, nearby. He also said that he could sense when she is distressed; he said that most of the time she will cry.

Measurements of baby (Emma)

- From feet to knees: 6-7 inches
- From feet to hips: 12-13 inches
- From feet to waist: 17-19 inches
- From feet to neck: 20-22 inches

Information about device for children a little bit older with cerebral palsy

Rich's initial thought was to have us build a similar device as the one they have for older children. The current device that they have at Misericordia can begin holding children when they are a little less than 4 feet tall.

Operation of the device

- Crank system→ cranks to different angles
- Has wheels with locks
- Two feet straps
- Two foot pieces that can change angles and distance apart (feet can point different directions)
- Tray that slides on and can be adjusted
- Adjustable head support (side to side and up and down)
- Trunk support (side to side)
- Two adjustable leg straps (up and down)
- Two adjustable chest/armpit straps (side to side)
- Two adjustable trunk/core straps (side to side)
- Foot plate can be adjusted (up and down)
- Firm, yet comfortable head/pack rest
- Arms that can move out/in/up/down to hold the tray

Benefits of this device (explained by client, Rich)

- Can be adjusted and used by many kids
- Wheels
- Comfortable, supportive straps
- Tray can be taken off
- Tray has a ridge so things won't fall off/the kids can feel the ridge

Problems with this device (explained by client, Rich)

- The material that head and trunk side supports are made of isn't easy to clean and gets dirty easily
- The length of the grooves for the leg straps aren't long enough
- Some of the components of the device can be hard to adjust
    - The two components needed to move the arms for the table are sometimes a pain to move
    - Lots of different screws
- Crank is tedious and slow
- Device can't lay flat at ground level
    - If baby needs to be lifted into the device because it is on a higher level, the baby may feel separated from the group and get upset

Several Measurements of the device

- Head/trunk support pads are ~1.5 inches thick
- Wood-hard-main piece of device is 16 inches wide
- Spinal pad/main body pad is ~9 inches wide

User Observation Table

Table 1 lists the observations, opportunities these created for our design, follow-up to these opportunities, and suggestions the user (Rich) had regarding the problem he encountered.

Table 1: User observation: opportunities, follow-up, and suggestions

Observations	Opportunities	Follow-up	User Suggestions
Can take a long time to adjust all of the screws to accommodate for each specific baby	Reduce the number of screws or find a faster way to adjust them	Reduce the number of individual parts	Have one fluid head/trunk support/cushion for each side instead of two separate pieces per side
Material used for side head/trunk support easily absorbs oils/fluids and isn't easy to clean	Find another material that is much easier to clean but still comfortable and durable	Cover material in plastic/saran wrap	Material of the mat in the babies' playroom
Device can't start out laying on the ground	Think of different ways to change the angle of the device	Maybe use something along the same lines as client chairs at hair salons that can move up and down	Make the axis of rotation for the crank method at the foot plate
Some of the metal sliding pieces get stuck/are hard to slide	If we use metal sliding pieces, make sure that we create a user guide for Rich and tell him how to take care of and maintain the metal pieces so they slide smoothly	Find a different way to so what the sliding pieces do/something to replace them altogether	
The arms that the tray attaches to are difficult to adjust	Use a different method to adjust the arms on the device	Make the tray and its arms all one piece that can come off the device	

Head Support Mechanism on Current Standing Frame

Picture of Wheels on Current Standing Frame

Crank Mechanism on Current Standing Frame

Armrest for Tray Attachment on Current Standing Frame

Front View of Current Standing Frame

Close-Up Side View of Upper Portion of Current Standing Frame

Side View of Current Standing Frame

Back of Current Standing Frame

Back of Current Standing Frame Close-Up

Knee Supports on Current Standing Frame

Upper Portion of Current Standing Frame From Side

Many Standing Frames at Misericordia are Not Being Used Frequently

Tray that Attaches to Armrests on Current Standing Frame

Mechanism for Attaching Tray to Current Standing Frame

Back of Tray for Current Standing Frame

Appendix E: User Testing Summary

We will use the following testing guide when working with users in order to determine whether a mocked up solution that retrofits the existing standers to work for children will function as necessary.

The Tasks are:

1. Ensuring the mock up fits onto the existing stander and the straps and armrests can adjust accordingly to accommodate the smaller body.
2. Ensure the child fits well into the device.

The Goals are to learn:

1. Whether any new straps must be created for use with the mocked up attachment.
2. How quickly and easily Mr. Conti can attach the solution to the existing stander.
3. How well the child fits into the device.

Start Time: 2:34 pm

Introduction (For Users):
Our project is to design a solution that will allow children, under the age of four years with severe cerebral palsy, to remain in a standing position without the assistance of a nurse or physical therapist. In this user test, we will work to understand how the device will fit in to the existing stander, the ease of use to set it up on your end, as well as if the child fits securely into the device. If you are comfortable with it, we would prefer to use a real child in testing this weight, but otherwise we can simply take detailed measurements and run the simulation in a lab setting. At the end of the user interaction process, we will ask you to help evaluate your experience with the product.

Task 1:
Begin a second "Start Time" for this process to measure the set-up time for the device.
Start Time: 2:50 pm

1. Attach the prototype to the existing stander.
   a. Is the mechanism workable with only two hands?
      Yes, however, it does require a bit of multitasking on his part to place it on the board.
b. Does Mr. Conti require instruction in order to attach it? Or is the device intuitive?
   There was definitely instruction necessary. We weren't sure how it would fit on the board, so we had to move a few pads to get it to fit properly. However, on a plain board, we believe that the design will be intuitive enough to be attached with little instruction.

c. "On a scale from 1 to 10 (1 being hardest, 10 being easiest), how would you describe the difficulty of attaching the device to the stander? What changes could make it easier on you?"

4. Slide the existing straps down the stander into position for use with the device.

c. "On a scale from 1 to 10 (1 being hardest, 10 being easiest), how would you describe the difficulty of adjusting the existing straps to fit the device? Are there any straps that you would prefer not to adjust in particular?"

End Time: 3:01 pm

Task 2:

1. Make sure the stander is in its "laid down" position (parallel to the floor).
2. With the device still attached, lay the child onto it and attach the straps.
   a. How does the child fit into the device? Is any part of their body hanging over? Are the straps adjusting properly to adequately fit them in?

The child fits perfectly onto the device. The pads are also well in place to fit into her armpits for support, and the strap can be tightened to accommodate her size.

b. Does the child show any signs of discomfort when laying in the device?

She seemed to relax just fine when in the device, even when placed in the elevated position.

End Time: 3:17 pm

Feedback from Conti/Observations:

- He finds the idea intriguing
- Stander stays in the room at all times
- He is okay with taking the cushion and unnecessary straps off the existing stander
    - He's not of fan of the strings on the cushion anyway
        - Maybe we could come up with another way to detach the cushion
- Velcro will not work for the lower side supports. It is not sturdy enough.
- Lower side supports could be a little bit longer, but the height is perfect
- Need strap at pelvis and under arms
- Existing leg straps work well
    - Still it was kind of awkwardly asymmetrical
- Could be thinner
- Emma started to bow her legs while standing
    - Needs a foot plate – already available
- Side supports
    - Could make it similar to the head rest on the existing device
        - Would need tracks above the board, not carved in, which may be difficult
    - Big C-clamps
    - Could possibly use the existing tracks for the side support somehow
- Tray could be attached to the metal track along the side

- Make something that attaches to the crank to make it easier
- **How are we going to make it attach to the existing device?**
    - Straps
    - Velcro
    - Combination of the two

Pictures of user, Emma, strapped into mockup on existing standing frame

Appendix F: Bill of Materials

Item	Description	Quantity	Source	Part Number	Cost
Super-Cushioning Polyurethane Foam	Adhesive Back, 48" X 54", ¼" thick	1	McMaster-Carr	8614K72	$36.78
Wood	Four 2" X 2" X 6" Blocks of Scrap Wood	1	Shop	N/A	$0
Impact-Resistant Polycarbonate Sheet	¼" Thick, 12" X 24", Clear	1	McMaster-Carr	8574K43	$27.72
Super Adhesive Nylon Loop	2" W X 5' L, black	1	McMaster-Carr	94985K675	$8.35
Super Adhesive Nylon Hook	1" W X 5' L, black	1	McMaster-Carr	94985K667	$4.80
Sumbrella Fabric	8' X 10'	1	Vogue Fabrics	N/A	$5.00
Yoga Mat	3' X 6'	1	Walmart	N/A	$15.00
				Total:	$97.65

Appendix G: Instructions for Construction

The following table lists all materials one will need to build the Bambino.

Table 1: Materials Used for Construction

Description of Purchase	***Dimensions***
Super Cushioning Polyurethane foam	***4 x 8 ft***
Fiberglass Square tube	***1.5 in x 1.5 in x 10 ft***
Impact Resistant Polycarbonate	***2 x 2 ft***
Soft Velcro	***2 in x 10 ft***
Rough Velcro	***1 in x 10 ft***
Yoga Mat	***3 ft x 6 ft***
Shower Curtain	***8 ft x 10 ft***

Note: See Bill of Materials in report for detail on cost and part numbers.

The following tools are required to construct the device:

- Water jet
- Meter stick
- Sewing machine
- Box cutter
- Band saw
- CAD
- Scissors
- Acrylic cement

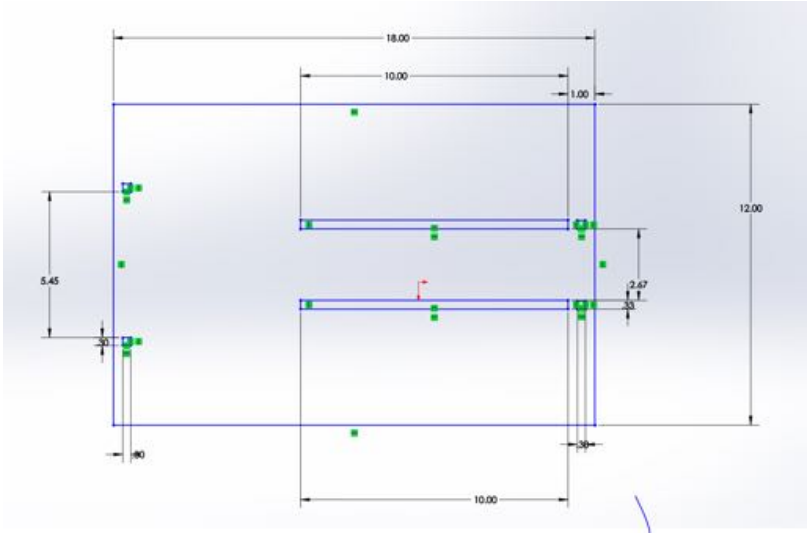
Creating the Straps

1. Cut strap in half with scissors
   5 min
2. Sew side of strap together with sewing machine (2x)
   15 min

Creating the Board

1. Finish CAD design

   30 min

   a. 

2. Water jet

   30 min

3. Put bolts in square holes

   5 min

4. Cut raisers with band saw into three 3 ½ x 10 in pieces

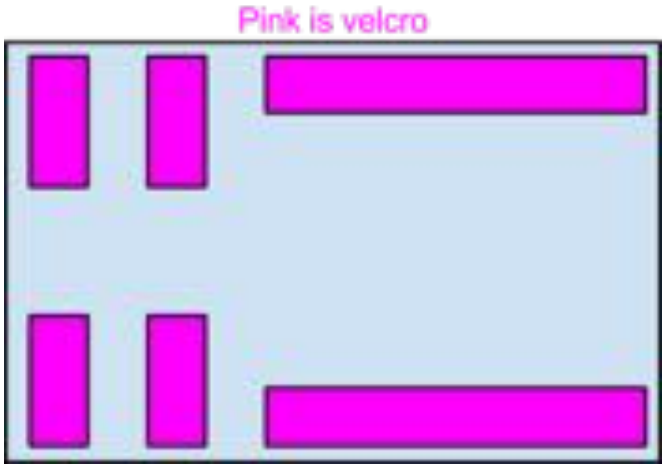
   30 min

   a. 

5. Glue raisers on back with cement
   a. Apply cement to both sides

      10 min

b. Wait 30 minutes for it to settle
   30 min
c. Attach and clamp
   10 min
d. Wait an hour
   60 min

6. Cut yoga mat with same design (w/o square holes) on water cutter
   30 min
7. Glue mat on board with cement
   a. Apply cement to both sides
      10 min
   b. Wait 30 minutes for it to settle
      30 min
   c. Attach and clamp
      10 min
   d. Wait an hour
      60 min
8. Cut four 5 in lengths of soft Velcro with scissors
   10 min
9. Attach soft Velcro onto yoga mat with adhesive back
   20 min
   a. 

Creating the Side and Head Supports

1. Cut wood into 6 in pieces with band saw
   20 min
2. Cut four 7x5 in pieces of foam with scissors
   20 min

3. Wrap/attach foam around three sides of wood (once per piece of wood)
   5 min
4. Cut eight 2x3 in pieces of foam with scissors
   20 min
5. Attach foam on ends of tube (two per tube)
   10 min
6. Cut two 8x6 in pieces with scissors
   10 min
7. Attach foam tubes on top of other foam (two times)
   5 min
8. Cut four 10x10 in pieces of sumbrella fabric
   30 min
9. Cut four 6 in pieces of rough Velcro with scissors
   5 min
10. Sew on rough Velcro with sewing machine
    60 min
11. Sew sides of sumbrella fabric together in a tube shape with sewing machine
    40 min
12. Hand sew ends of tube together around the foam block
    60 min

Ideal time: ~12 hours
Expected time: ~36 hours

Appendix H: Instructions for Use

The following are the steps to follow when using the Bambino:

Attachment to stander:

1. Slide the carriage bolts through the tracks of the original standing frame. The two upper bolts should slide into the upper tracks, and the two lower bolts should slide into the corresponding lower tracks (Figure 1).

2. Slide the ¼" washers over the bolts so that they are flat against the back of the original standing frame (Figure 2). You may have to lift the Bambino off the standing frame slightly because the wooden supports on the back of the standing frame might get in the way of the washers.

3. Screw the wing nuts back onto the bolts until the Bambino is securely pinned to the original stander (Figure 3). You may have to lift the Bambino off the standing frame slightly because the wooden supports on the back of the standing frame might get in the way of the wing nuts. Make sure the wing nuts are screwed on tightly before placing an infant into the device.

Figure 1

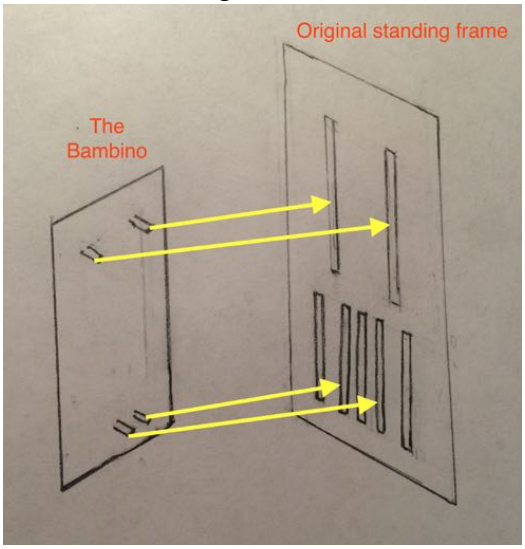


Figure 2

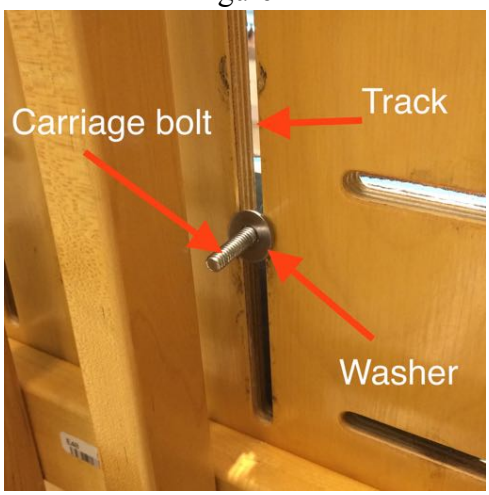
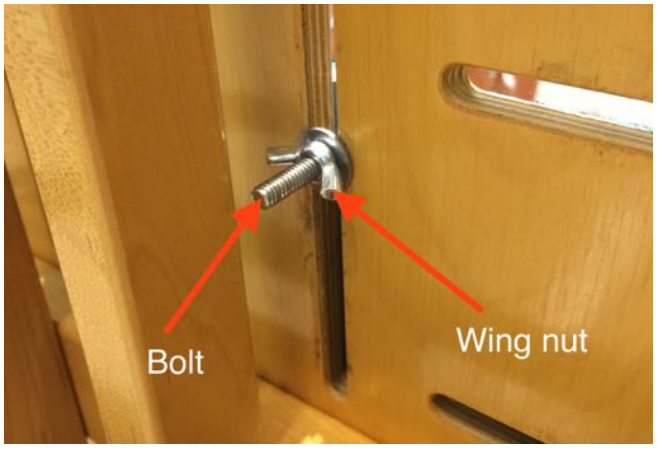


Figure 3



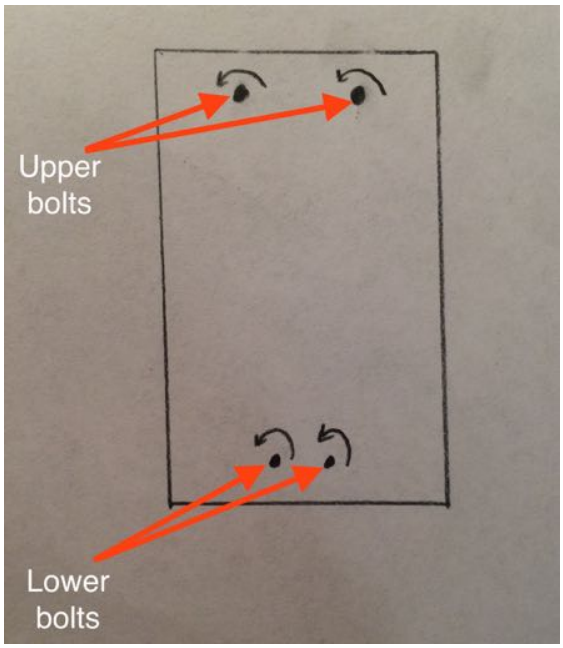
Vertical adjustment of Bambino:

1. Loosen the four wing nuts from the bolts of the Bambino. These are located on the back of the original standing frame (Figure 4).

2. Slide the Bambino up or down to the desired location.

3. Tighten the four wing nuts. Make sure the wing nuts are screwed on tightly before placing an infant into the device.

Figure 4

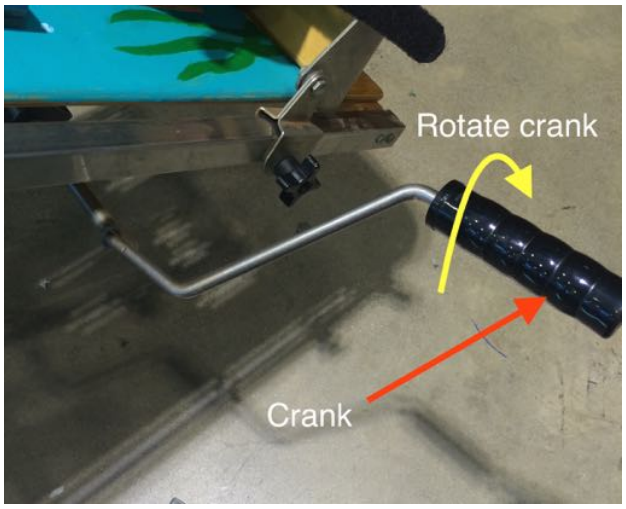


Placing infant in device:

WARNING: Make sure the wing nuts are screwed on tightly before placing an infant into the device. Failure to do so could cause the Bambino to slide down or (if wing nuts are missing) fall forward, which could lead to minor or serious injury.

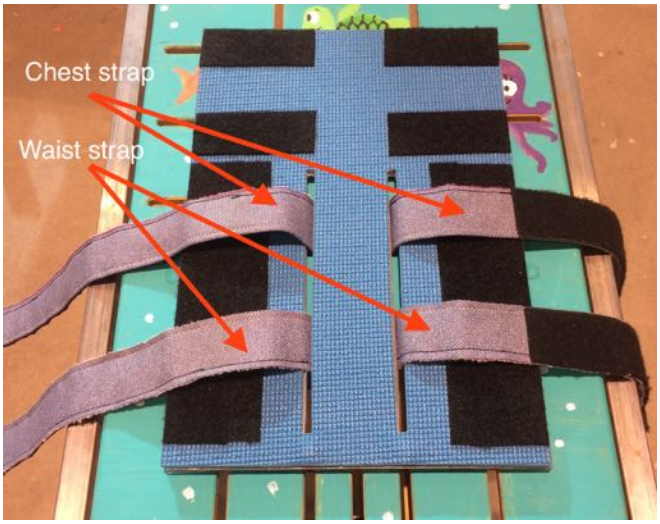
1. Rotate the crank of the original stander so that the stander is in the horizontal position (Figure 5).

Figure 5



2. Spread the straps outwards (Figure 6).

Figure 6



3. Lay the infant on top of the Bambino so that the feet are flat against the footplate and the head is in between the head supports.

4. Put the leg straps around each knee. To do this, slide each strap vertically to the position where it lines up with the knee. Then, wrap the strap around the knee. Allow the ends of the strap to overlap to the desired tightness. The Velcro on the ends will hold it secure (Figure 7).

5. Put the feet straps around each foot. Allow the ends of the straps to overlap to the desired tightness. The Velcro on the ends will hold it secure (Figure 7).

Figure 7

6. Wrap the waist strap around waist. To do this, slide the strap vertically to the desired position. Then, wrap the strap around the waist. Allow the ends of the strap to overlap to the desired tightness. The Velcro on the ends will hold it secure (Figure 8).

7. Wrap the chest strap underneath the arms. To do this, slide the strap vertically to the desired position. Then, wrap the strap around the upper body under the arms of the infant. Allow the ends of the strap to overlap to the desired tightness. The ends will hold it secure (Figure 8)

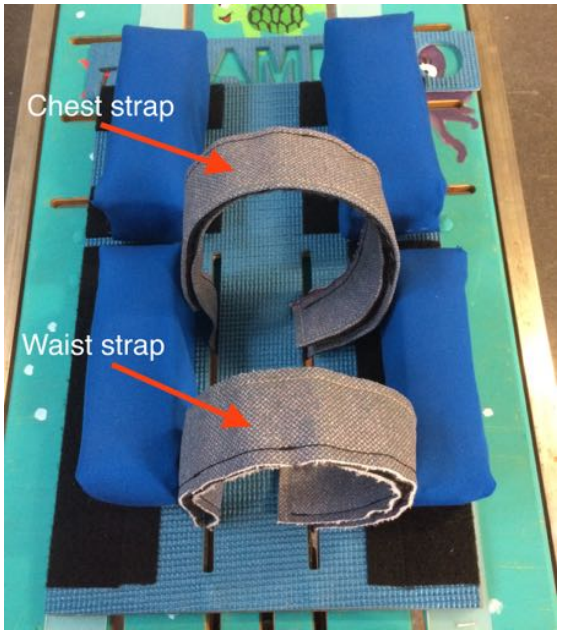


Figure 8

8. Adjust side supports by pulling them off the Velcro sections near the sides of the infant and replacing them in the desired location (Figure 9).

9. Adjust head supports by pulling them off the Velcro sections near the head of the infant and replacing them in the desired location (Figure 9).

Figure 9