Design of a More Efficient Walking Device for a Child With Cerebral Palsy

Project Objective

We are designing a new assistive walking device for a 6-year old child with cerebral palsy. Cerebral palsy, CP, is a neurological disorder that affects movement and posture and is characterized by, but not limited to, poor muscle tone and posture, spasticity (a tightness in muscles that is characterized by continuous and painful muscle spasms), unsteady gait, limited mobility and speech impairments. People with CP often experience difficulty controlling muscle movement, so walking, and even standing, can be a major problem for people with this disability because of asymmetrical distribution of muscle tone, poor ability to shift weight and a forward displacement of center of gravity (Thompson-Rangel et al., 1992).

The child is currently using an assistive walking device that was donated to his school. While it affords him some mobility, it does not provide him with sufficient support for walking. It is also bulky and physically impairs his ability to perform daily activities like using a computer at school. The purpose of the research project is to design and build him a more efficient walking device that is easier for the caregiver to use, provides the child with greater support during walking, and allows him to stand in front of a table or a computer. Funding from ASEE/DEED will enable us to construct the actual device, instead of this being a purely “paper based” design exercise.

1. Work Scope of Design Project

The work on the project will take place in three phases: needs assessment, mechanical design, and functional analysis.

During the needs assessment phase, the students learned about cerebral palsy and characterized the capabilities of the walker the child is using currently. This was accomplished by observing the child working on a computer at his preschool and recording his gait while in the walker (Figure 1). Concurrently, mechanical analyses were conducted on the walker to assess its stability and determine where, and how, the frame might be modified to reduce bulk but maintain structural integrity. It was determined that a new walker should have lighter frame with a lower frontal profile, a removable tray on which the child can work, a means to adjust the height of the walker, a better method to support the child’s weight, and an apparatus to guide leg motion.

![Figure 1. A: Picture of existing assistive walker at child’s preschool. B: Child using a computer with the aid of a button. C: Illustrations of shank, thigh, and HAT angles used in the gait analysis that was performed.](image-url)
During the design phase, the students are brainstorming ways to meet the identified requirements. They are drawing inspiration from the design of other, and significantly more expensive, commercial walkers, baby high chairs, and mountain climbing equipment. This information will then be used to create a solid model of the new walker with Autodesk Inventor. The students will then be responsible for constructing the walker in a student machine shop inside of Scott Laboratory, the home of Ohio State’s Mechanical Engineering Department.

The performance of the walker will ultimately be tested through interaction with the child. We will repeat the same tests that were previously performed (e.g., working in front of a computer, walking across the room, working on a table top), and qualitatively and quantitatively noting the improvements afforded by the new walker. It is our expectation that he will be able to more easily interact with his environment (e.g., have a larger workspace, able to get closer to objects, etc.) and travel across the room in less time in the new walker.

2. Schedule

This project began in February of 2007. During the spring and summer, we completed a design review and functional assessment of the existing device. During the (current) autumn quarter, we are completing the needs assessment of the device, performing an analysis of the child’s gait in the walker in an on-campus motion capture laboratory, and are brainstorming design solutions to the identified needs. During the Winter Quarter, we will finish the design of the new device and build a prototype of the new design. We then will perform subsequent mechanical and biomechanical tests during the remainder of that quarter and into early Spring Quarter, to ensure that our design solution meets the functional and occupational needs of the child. The project is anticipated to be completed by the end of Spring Quarter, in June of 2008.

3. Budget

An estimated budget for the device is below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Purpose</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel tubing, links</td>
<td>Used in the construction of the frame</td>
<td>$100</td>
</tr>
<tr>
<td>Wheels</td>
<td>Provides mobility</td>
<td>$80</td>
</tr>
<tr>
<td>Plastic Tray</td>
<td>Provides a removable work surface</td>
<td>$80</td>
</tr>
<tr>
<td>Misc. Hardware</td>
<td>Bolts, screws, washers, etc.</td>
<td>$50</td>
</tr>
<tr>
<td>Harness</td>
<td>Provides body weight support for the child</td>
<td>$40</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$350</td>
</tr>
</tbody>
</table>

4. Department Co-funding

The faculty and clinical staff on the project team are donating their time to work on the project. The cost of any materials for the project that exceed the amount provided by the grant will be paid for out of unrestricted funds from the faculty advisor.
5. Project Team
Rebecca Routson is completing her senior year in Ohio State’s Mechanical Engineering Department. She is specializing in the design of assistive devices for persons with disabilities and is performing research in the area of musculoskeletal biomechanics. Lindy Tomawis is a first year student in Ohio State’s Master’s of Occupational Therapy program. Lisa Barnett, DPT is a clinical physical therapist at Ohio State and regularly works with the child for whom this device is being designed. Dr. Jane Case-Smith, EdD, OTR/L, FAOTA is the chairperson of Ohio State’s Occupational Therapy Division and has expertise in pediatric occupational therapy and children with disabilities. Dr. Robert A. Siston, PhD is an assistant professor in the Mechanical Engineering Department and is an expert in lower extremity biomechanics and the design of medical devices.

6. External Collaboration
There will be no external collaboration on this project.

7. Faculty Advisor
This project is supervised by Dr. Robert A. Siston. His contact information is as follows:
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Reference