

## **Design and Fabrication of a Motorized Stander:**

### **Increasing Pre-School Classroom Accessibility at CP Rochester's Augustin Children's Center through the Kate Gleason College of Engineering's Multi-Disciplinary Senior Design Program.**

Steven Day, Associate Professor in Mechanical Engineering, RIT

Linda Brown, Physical Therapist at CP Rochester's Augustin Children's Center

5 student Senior Design Team during Winter-Spring 2012-13

We propose to use the expertise and skill of students of the Kate Gleason College of Engineering to design and implement modifications to an existing stander device that will allow improved access to the education environment at CP Rochester's Augustin Children's Center, an AI Sigl family of agencies.

We believe that we can improve educational access and integration to students with physical disabilities that affect their ability to walk and stand with a straightforward, but completely novel modification of existing technology. Persons that are not able to walk are typically confined to a wheel chair for the majority of the day and their classroom experience. Stander devices are established devices that support a person with physical disabilities in an upright, legs straight, position. In the classroom environment, these also provide the opportunity for students to move around and interact with other children and their environment in a more natural way.

We propose to use the requested funds to purchase hardware that will be implemented by a Multi-Disciplinary team in order to build a functional motorized stander to be used by L. Brown with one specific child at Augustin Children's Center, but that has the flexibility of modes so that it may be used with other children in the future. This seems to meet the stated needs of the request for proposals as it addresses a stated need: "Improving access to educational environments, materials, and programs that build on the strengths and accommodate the needs of individuals with disabilities". And meets the particular interest of "providing near-term benefits to the Member Agencies of the AI Sigl Community of Agencies"

The requested budget will be used to purchase an off-the-shelf stander used by several children in the Rochester area and to purchase motors, controllers, switches, and electronics in order to modify this stander and make it controllable by both the student and therapist. The student team will participate in Multi-Disciplinary Senior Design and therefore will not require salary for this for-credit experience. Day and Brown are not requesting salary. We believe that this project and the team of Day and Brown as mentors to a senior design team represent a perfect use of the strengths of both RIT and Augustin Children's Center. Day is a mechanical engineer with expertise in electro-mechanical medical devices. Brown is a physical therapist with 39 years of experience.

**Design and Fabrication of Motorize Standers:** We believe that we can easily improve educational access and integration to students with physical disabilities that affect their ability to walk or stand with a straightforward, but completely novel modification of existing technology. Persons that are not able to walk are typically use a wheel chair as a means to remain mobile and recent decades have seen great improvement in the motorization and user control of motorized wheelchairs. Recent efforts to improve access to education include integration of people with physical disabilities needing a wheelchair into the classroom, but this simply does not work well in many situations, such as children standing around an activity table in the classroom or participating in a physical education exercise that involves upright or reaching positions.

Standers are established devices that support a person with physical disabilities in an upright, legs straight, position (Figure 1). These are currently used in physical therapy settings because forcing the legs to bear weight is critical to maintaining bone strength. Additionally, the use of standers allows the user to participate in activities and move about in a position more similar to their peers. In the classroom environment, these also provide the opportunity for students to move around and interact with other children and their environment in a more natural way. Typical standers do not allow for any means of mobility, other than being pushed around the room by an assistant. More recently, some include large wheelchair like wheels that may be pushed by the hands. Unfortunately many children requiring a stander do not have the strength, coordination, or endurance to manually self-propel.

We propose to use the requested funds to purchase hardware that will be implemented by a Multi-Disciplinary in order build a functional motorized stander to be used by L. Brown with one specific child at Augustin Children’s Center, but that has the flexibility of modes so that is may be used with other children in the future.

**Collaboration with CP Rochester’s Augustin Children’s Center:**

This proposal seeks to improve access to educational environments at a CP Rochester agency. CP Rochester’s Augustin Children’s Center is an accessible, modern, facility with award-winning early intervention for children with disabilities from birth to age three, as well as a preschool for children with and without disabilities form age three to five. Programs at the Center are designed to enable all children to take full advantage of their educations and growth potential, regardless of ability or disability. The center offers a universal pre-kindergarten to children of all abilities. This is the only integrated pre-school program for children with significant physical and cognitive disabilities. The classes of 12 children are fully-integrated (sig children with disability and disc children without disabilities). Physical education is offered to every child through their certified, adapted PT program. The integration of children with special needs with their higher functioning peers is central to the CP Rochester mission. Skilled therapies, (physical, speech, etc.) conduct sessions within the classroom whenever possible, in order to “integrate the child’s educational experiences and allowing he or she to maintain a presence with their peers.

Because of this uncompromising interest in fully integrating the children with disabilities into the classroom and physical education activities, CP Rochester’s Augustin Children’s Center an ideal location to develop and test this device.

**Modification of Existing Device:** There are many variations, but one of the more typical styles has large wheels on the side which are used for propulsion by the hands of the user. These wheels are, in fact, removable as the stability of the device is based on 4 smaller wheels on the frame. The modification of a commercially available device offers the clear benefit that we are not responsible for, nor duplicating, the



Figure 1: Proud young man standing in his Rabbit R82 (with propulsion wheels) stander.

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<http://www.workcompcomplexcare.com/2011/02/its-always-a-difficult-to.html>

design efforts of all of the ergonomic aspects of the device. The Rabbit R82 stander is a very well designed and highly modifiable stander so that a therapist can adjust support of the feet, knees, hips and chest of individuals. We will NOT modify this design as it is based on years of iterative improvement and input from therapist. This has the additional advantage of not subjecting the student design team to safety concerns related to the actual support of the student as this core function is performed by the stander itself. We are only adding the ability for the stander to move.

We will replace 2 or more of the passive wheels with motorized and controllable wheels. We will design and implement an onboard micro-controller capable of acquiring and processing multiple inputs from the user and therapist and controlling the motors. It is possible that additional sensors could be implemented (i.e. to detect the presence of obstacles or people) in order to provide some level of device autonomy, but our goal is not an autonomous robot, but rather a device that improves the access via mobility and autonomy of a student with disabilities.

This project proposes modify an off the shelf device with motors, a controller and some human interface so that a person could control their stander, much in the same way that motorized wheelchairs are controlled, as many people with physical disabilities also do not have the arm strength or coordination to propel themselves.

*User Interface:* Interfaces for persons with special needs come in a wide variety of mechanical switches and joysticks and are currently undergoing a revolution as a result of microcontrollers, touch screens, and even more novel methods such as eye tracking and EMG. *Semi automation and safety, such as obstacle (and people) avoidance:* A second interface and potential overrides by this 2nd operator (perhaps a therapist, teacher or parent) will be implemented. This structure of teacher-trainer is commonly used in many fields, including remote control airplanes. *Adjustability of operating modes:* The on board controller should be able to operate in a variety of modes depending on the abilities of the user and the situation. Some typical modes might include a) student uses only one switch for forward and a 2nd wireless interface controls steering and braking or b) student has full control, but the therapist has only a brake override. The design of this controller has to be selectable by the therapist so that engineering support is not regularly needed.

**Novelty, Feasibility, and IP:** After an exhaustive search, including therapists and vendors, we are not aware of any other motorized stander. Because of the lack of an available device, Day demonstrated the feasibility of this modification about five years ago. Using off the shelf stander (Rabbit) controller (BasicStamp), motors (Parallax) and Big Mac switches (EnableNet), students with cognitive and motor disabilities were able to move about the house and one typical grades of outdoor finished surfaces.

There is currently no protection of IP related to the motorization of these devices. It is certainly possible that there is a commercial niche market for these devices. It is common for assistive devices for persons with disabilities to be sold as either “off-the-shelf” or as modified products “conversion vans”.

**Multi-Disciplinary Senior Design:** We have communicated with the MSD program and plan to run this program during the Winter (MSD I) and Spring (MSD II) of the current academic year. This will *provide near-term benefits to the Member Agencies of the Al Sigl Community of Agencies*. Day will serve as the faculty guide or mentor for the team. Brown will act as the customer and consultant for the team during the design process, including visits to their facility and working with individual end users of the stander. This type of project that involves the integration of off-the shelf components into a custom system works very well with senior design. Working with a non-tech savvy customer is a very useful skill and having a project that so directly affects human quality of life will be motivating to the student team.

**Faculty Mentors:** The proposers of this project, Day and Brown have worked together some years ago when Brown was the PT to a family member of Day. They have an excellent working relationship as an engineer/therapist and personify one form of the RIT/Al Sigl relationship. Day has worked with more than 15 Multidisciplinary Senior Design teams since joining RIT as the guide (faculty who teaches/mentors the teams), customer, or sponsor of teams. More included in Biosketches below.

**Budget:**

These are approximate numbers, but I have provided the vendor used for estimation.

Rabbit Pediatric Mobile Stander (SouthwestMedical.com)	\$3,250
Motor Wheel Kits with Position Controller (Parallax)	\$600
User interface devices, including modified switches, joystick and touchscreen (Enablemart)	\$1,000
Remote control hardware (Tower Hobby)	\$250
Microcontroller (Digkey)	\$100
Amplifiers and miscellaneous electronics, wire, etc. (Digkey)	\$250
Mechanical components for modification of wheel mounting (custom)	\$500
<b>TOTAL</b>	<b>\$5,950</b>

**Student Staffing:**

The design, build and testing of this device will be done for credit during the MSD program, so no student salary will be charged. The approximate work breakdown and discipline of the MSD team members is listed below. Recently, some teams have also included a business student that was able to assess commercialization opportunities. We would be happy to include such a person with our MSD team if available and appropriate.

Discipline	How Many?	Anticipated Tasks
EE or CE	2	Implementation of control algorithms onto micro-controller. Implementation of motor control and micro-controller.
ME	1-2	Mechanical modification of device. Design of user interface and control algorithms.
ISE	0-1	Design of user interface and human factors.

## **Biosketches of PIs**

Steven Day is a mechanical engineer with a BS degree in mechanical engineering and PhD in mechanical and aerospace engineering from the University of Virginia, as well as a diploma from the von Karman Institute for Fluid Dynamics. After a post-Doctoral appointment at UC Davis from 2003-2005, he has been part of the faculty of the Mechanical Engineering Department of the Rochester Institute of Technology. His research and expertise deals with the application methods in experimental and computational fluid mechanics to a range of applied and biological flows has recently focused on electromechanical medical devices, such as implantable blood pumps. This includes collaborations with biologists, medical doctors, and industry partners and he enjoys working with non-engineers in the health sciences and addressing medical and human need based problems. At RIT, he has focused on continuing this interest in biologically and medically relevant engineering work both in the classroom and with undergraduate and graduate student projects. Steven's interest in assistive devices for persons with disabilities largely came about from fathering a disabled son (and alumnus of CP Rochester's Augustin Children's Center) and led the successful implementation of a motorized stander that both his son and daughter enjoyed driving. In addition to working with electro-mechanical systems on funded projects at work, he has enjoyed tinkering with micro-controllers, motors and remote control systems available through the hobby industry. His teaching focus at RIT is on supporting the recently launched Bioengineering option in the Department of Mechanical Engineering, as well as supporting core courses in fluid mechanics. I'm also active in guiding multi-disciplinary senior design teams and providing research opportunities to undergraduate and graduate students through co-ops, research assistantships, and advising Master's thesis projects.

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Linda Brown is a Rochester-based Physical therapist who has spent her career helping children with physical challenges to achieve independence. For 39 years she has worked with babies, preschoolers, and school-aged children in their homes and in their educational settings. She has supported their parents and educated their school districts about the children's unique abilities as well as their challenges. Linda graduated from Ithaca College in 1973 with a BS degree in Physical Therapy. As an intern in the Ithaca program she attained an internship at Blythedale Childrens Hospital in Valhalla NY, studying under clinical instructor Lois Bly, PT, who was soon to become a prominent leader in the field of Neurodevelopmental Treatment techniques for working with children with neurological impairments. After becoming licensed in NY state, Linda was hired by Winifred Fletcher, the original director of United Cerebral Palsy of the Rochester Area (UCP), to work in the agency's school-aged program at #29 school in the Rochester City School District. Linda remained there for 10 years, bridging the transition of that program from UCP to the Monroe County Health Department. She then returned to UCP (now known as CP Rochester) and has continued her employment there with the exception of several brief periods after the birth of each of her 3 children. Linda has served as Clinical Instructor for many PT students from local colleges. She has mentored a local Girl Scout who achieved her Gold Award through helping students in the CP Rochester preschool and who has recently received a doctoral degree in Physical Therapy. Through her many years as a pediatric PT, Linda has gained expertise in the treatment and management of infants and children with a variety of injuries, disorders and diseases including cerebral palsy, spina bifida, autism spectrum disorders, and developmental delays. She is skilled at facilitating developmental milestones, promoting independence, improving motor development and function, and problem-solving the challenges of daily caregiving. She considers educating, supporting, and empowering parents and families to assist their children in their quest for independence as one of the highest priorities of her job as a pediatric therapist.