BME Senior Design Projects
Ohio State University
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1. Assistive Batting Tee

GOAL: Our goal has been to design, implement, and evaluate a device that has the ability to safely and effectively improve the overall batting experience for players of Miracle League Baseball.

ABSTRACT:

The Miracle League Baseball program allows children with disabilities to actively participate in playing the game of baseball. The children who participate in this league have a wide array of impairments, which include cerebral palsy and spinal cord injuries. These conditions create physical limitations which can present challenges for the children to play independently. The batting tees currently available on the market have not been specifically designed to assist those with disabilities in hitting. As a result, children who use walkers and wheelchairs often times have difficulty positioning themselves appropriately to hit the ball. The problem that arises is that the wheels of the walker and wheelchair come in contact with the base of the batting tee, preventing the children from positioning themselves close to the ball and requiring them to lean forward. This causes them to be off balance and results in a poor swing and missing the ball frequently. Another problem with the tees currently available on the market is that the height adjustability of the ball often fails. This also inhibits the children's ability to hit the ball well because the ball is not placed at the appropriate height for the child. As a result, children often need a lot of assistance in hitting the ball. This, in turn, limits the child's independence during this activity.

2. Equine-Assisted Therapy

GOAL: The goal of our project is to design an assisted tack device to stabilize an individual's riding position and promote independence for riders with cerebral palsy and spina bifida.

ABSTRACT:

Individuals with disabilities that affect the lower extremities, including cerebral palsy and spina bifida, can experience many benefits from therapeutic horseback riding (THR). THR provides proven benefits that include improvements in physical health, mental health, and social and communication skills. Completing tasks that involve navigating the horse around the arena and listening to instructions given by the instructor help the rider become more independent. Currently, most THR students have a person walking beside them while riding to help support them and achieve the proper position on the horse. If a THR student's position could be stabilized without an extra helper on the ground, they could ride more independently and potentially benefit even more from the session. There is some existing equipment used by THR programs to address the need for limb stabilization, but students and instructors overwhelmingly agree that it does not provide adequate support. The goal of our project is to design an assisted tack device to stabilize an individual's riding position and promote independence for riders with cerebral palsy and spina bifida. In order to obtain this goal, our device will help stabilize the pelvis, thigh, and lower leg of the rider and will consequently promote independence while riding.

3. Hip Continuous Passive Motion device

GOAL: The goal of a hip CPM device is to enable patients with a repaired acetabular labrum to complete his or her treatment either in the clinic without complete supervision of a PT or in the comfort of his or her home.

ABSTRACT:

Hip continuous passive motion (CPM) is a therapy treatment used immediately following surgical repair for an acetabular labral tear. While this method is widely used and effective in aiding the healing process, the patient is dependent on the therapist for treatment, which can be physically strenuous to perform. Thus, we see a clinical need for a device that will enable the patient to receive therapy independently and eliminate the physical strain on the therapist or caregiver. We evaluated several steps in the design process in order to select a device design. These steps include identifying project requirements, developing initial concepts, and evaluating initial requirements based on our objectives for the device. These objectives include circumduction of the lower limb in clockwise and counterclockwise directions at small and large angles of hip flexion, adjustability, comfort, safety, ease of use and transport, and stability. After in-depth design evaluations based on the objectives, clinical input, and several redesigns, a design supporting the lower limb from under the patient and operating at the distal end of the patient was chosen. This design features an adjustable sling to support the patient's leg and vary the height and angle of hip flexion, two axles that translate motor power to circular motion, a programmable motor with variable speed, a stable rotation system with counterweights, and a compact, detachable design for transport.

4. Infant Mobility 1: Mobile device for child 6-9 months old

GOAL: The goal of this project is to create a motorized vehicle to facilitate independent exploration of 6-9 month old children with physical or cognitive deficiencies.

ABSTRACT:
Children who lack the physical abilities to independently explore their environment are more likely than normally developed children to have cognitive deficiencies. There are currently no commercially available devices that target the population of children between the ages of 6-12 months old who have little to no motor control of their trunk or lower limbs. Creating a motorized vehicle to facilitate independent exploration of this population is the main goal of the design. To develop an infant mobility device to serve this population of children, our team talked to clinicians, researched devices currently in use, and created a list of functional and non-functional requirements to aid in the design process. The requirements for this device were used to design multiple solutions, and these solutions were analyzed, revised, and combined into a final design which will be discussed in detail. The most important functional requirement is allowing a child in the prone position to control movement of a motorized vehicle, directing it forward, to either side or in circles. The device must also be easy for the caregiver to use and highly adjustable, so as to accommodate as many children in the clinical setting as possible. This report highlights the clinical reasons for creating a mobility device for infants, surveys existing products that aim to help at-risk infants, and explains the objectives and requirements that guided the development of the final device.

5. Infant Mobility 2: Mobile device for 12-18 month olds

GOAL: The goal of this project is to create a motorized vehicle to facilitate independent exploration of 12-18 month old children with physical or cognitive deficiencies.

ABSTRACT:
Early and self-produced mobility such as crawling and walking are important skills that are key to a child's development. Children with lower extremity disabilities such as spina bifida, cerebral palsy (CP), and spinal muscular atrophy develop independent mobility skills later in life, or might not develop them at all. Early and independent mobility is known to promote the development of other areas of maturity such as cognitive ability, social skills, fine motor skills, and peripheral vision. Since children with these lower extremity disabilities are at risk for delayed mobility they might not experience social exchanges or environmental interactions with their surroundings. The proposed device will prevent delays for infants 12-18 months old across developmental domains for infants who have lower extremity disabilities and no means of independent mobility.

Most devices researched target toddlers and are too complicated for an infant to use. Other shortcomings of these devices are a lack of adjustability, inadequate safety features, and lack of comfort for the child. Therefore, our goal is to address these limitations and develop a device that will be easy to use, comfortable to use, and adjustable. Our device aims to adapt a commercial motorized car to allow young children to move independently and safely. We hope that modifying a toy motorized car will allow the child to feel more comfortable using the device and allow the caregiver or clinician to easily adjust the settings of the device.

6. Stringed Instrument Adaptations

GOAL: The goal of this project is to design a device that will assist musicians with disabilities in playing a stringed instrument.

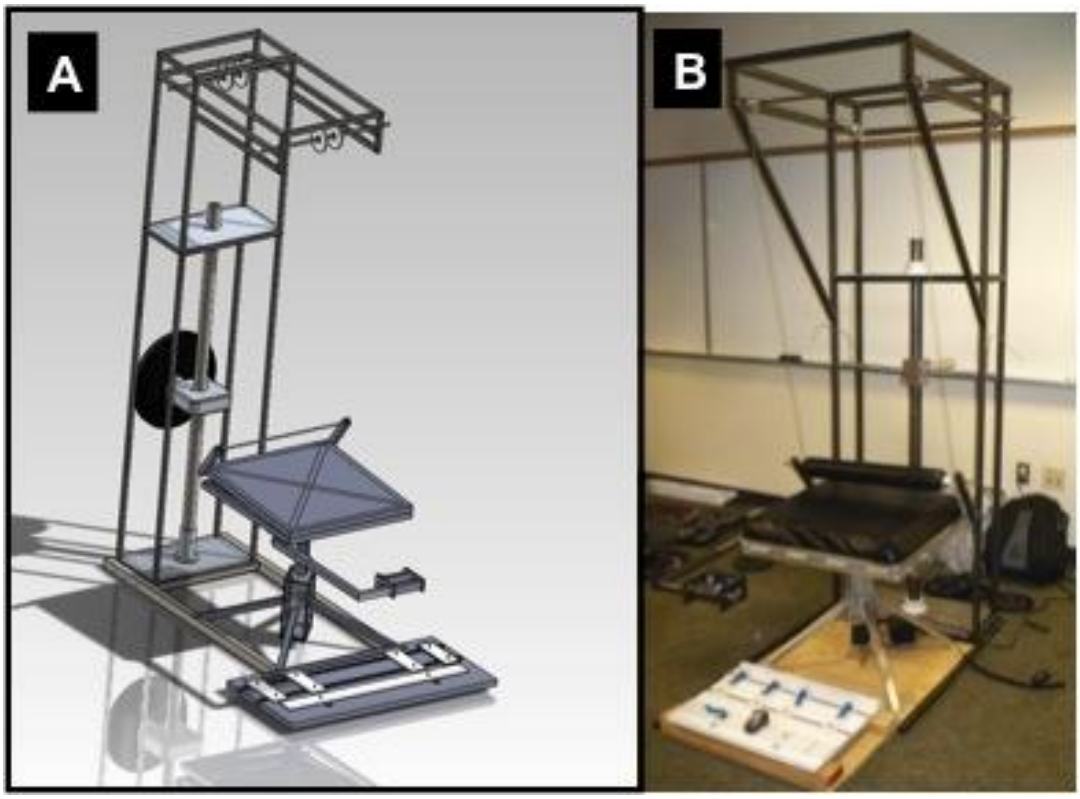
ABSTRACT:

For many, making music is an important form of expression. Therefore, the ability to make music should not be denied to anyone, especially those with disabilities. Many instruments cannot be played by anyone with limited dexterity and mobility of upper extremities, especially stringed instruments. Our team chose to address this problem by developing a mechanism to assist musicians with disabilities in playing a stringed instrument.

Having performed research on the specific limitations of certain disabilities and the available products already available, we determined the need for a new device that addresses similar limitations to the upper extremities within multiple groups. Our new device will be safe, affordable, adaptable, portable, and sturdy. The device will assist the user so that the music produced is comparable to that of an unaided musician. The device will aid individuals who have had a stroke that have been physically affected on their right side. The device will guide the user's bowing arm, assisting grip, posture, and proper wrist flexion. Our device cannot exceed a radius of three feet of distance from the user, cannot cost more than $450, and cannot weigh more than twenty pounds. Metrics have been put in place to assess our mechanism's performance, and its functional requirements have been defined. Finally, a set of different evaluations, engineering and clinical in nature, will be implemented to test our device. This report will narrate through how our group defined our problem, brainstormed ideas, decided on a final conceptual design, and will assess the effectiveness of the design.

7. Sit-to-Stand Assistive Device

GOAL: The goal of this project is to create a device that will help a patient work toward recovering the ability to sit-to-stand independently, by replicating the assistance given by physical therapists.



ABSTRACT:

Moving from a sitting position to a standing position is challenge for many people including (but not limited to) those with Parkinson's disease or those who have had a partial spinal cord injuries or stroke. Standing has both physical and psychological benefits in an individual's life. Devices exist that help a person move from sitting to standing, but do so in a passive manner. Because these devices do not encourage activation of the user's muscles and coordinaton, nor do they promote proper alignment, there is still an unmet need for a device that will help a patient work toward recovering the ability to sit-to-stand independently. The aim was replicating the assistance given by physical therapists. This goal was achieved through five sub-functions: foot alignment, leg alignment, initiation feedback, ischium lift and chair height. Ensuring proper alignment in feet and legs will be performed by a combination of a foot plate and leg braces which block improper motion and form. Initiation feedback involves audio cues given to the user if they perform proper initiation of the movement. The ischium lift consists of pulleys and counterweights which provide an easily adjustable lifting boost under the user's buttocks. Finally, the device seat is adjustable to different heights that accommodate both user height and ability, since it is easier to stand from a higher starting height. The final design would be used in a physical therapy office, enabling a physical therapist to provide quantifiable and adjustable assistance.

8. Swappable Front Ends: Wheelchair to Handcycle

GOAL: The goal of this project is to design a handcycle that allows the user to remain in their wheelchair, and to produce the device at a low cost.

ABSTRACT:
There are currently 219,000-279,000 people in the United States living with a spinal cord injury. Due to the high price of handcycles and the inconvenience of having to leave one's own wheelchair to participate, current handcycles do not make the sport readily accessible to prospective participants. The purpose of this project is to design a handcycle that allows the user to remain in their wheelchair and to produce the device at a low cost. Our objectives include that the handcycle be inexpensive to purchase, able to attach to a wide array of wheelchairs, operate safely, be easy to use, able to withstand minor collisions, and operate in a way that is comfortable to the user.

Through a design process that included research, and elimination through go/no-go, clinical input and decision matrices, we develop a detailed design which would meet our objectives. We use a sprocket and chain assembly as a method of power transmission, and a circular motion with the arms and hands as the decided input method. We also use a rotating input shaft to steer and a coaster brake to stop. On top of this, a U-shaped attachment frame is developed to attach the rest of the device to the wheelchair.

We also develop and execute a testing plan to determine if the device meets the objectives of the project. The plan includes testing for the safety associated with the attachment frame and mechanisms, and the braking and steering systems. Clinical testing is defined based two surveys: the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST) and a supplemental evaluation form. With the completion of testing we determine that the prototype is successful but requires improvements.

9. Wheelchair Transfer Device

GOAL: The goal of the project was to design a device that will assist in storing and retrieving a wheelchair from a car trunk.

ABSTRACT:

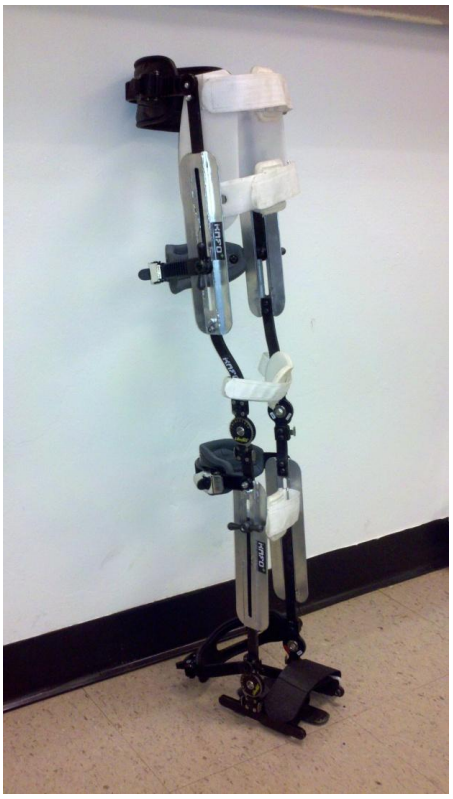
Approximately 1.5 million people in the United States use manual wheelchairs. Many of these users often have caregivers to assist them. A common obstacle for wheelchair users and their caregivers is transportation of the wheelchair itself, which is an important aspect of daily life. Caregivers risk injury when trying to load wheelchairs into their vehicles without assistance. While many devices currently exist on the market to address this issue, many of these devices have disadvantages.

We designed a wheelchair transfer device to address these problems. Our design goals were that the device must successfully transfer a variety of wheelchairs, be safe, transportable, affordable, and easy to use. We wanted our device to lift at least 50 pounds and require an input force of less than 5 pounds of force. These objectives allowed us to design and build a device that will increase the wellbeing of end users and give these users more freedom to travel unimpeded.

Through our decision matrix, brainstorming, clinical input, and testing, our group decided to design and build a winch mechanism that is capable of lifting a wheelchair into and out of a trunk while storing the device itself in the trunk. The winch device consists of a base with horizontal and vertical supports that hold the device in place, both while the device is in operation and while the vehicle is moving. The winch arm is able to be folded down into the trunk after the wheelchair is loaded, so that the trunk of the car can be shut. The winch is powered by a 12 V rechargeable battery and operated with a controller with up and down buttons.

10. Knee-Ankle-Foot-Orthosis: iKAFO

GOAL: The goal of the project was to design a device that provides ankle and foot support , and knee articulation, while helping the physical therapist make small adjustments to the fit of the device to customize it to the anatomical and physical needs of their patient.



ABSTRACT:

Each year 11,000 Americans have a spinal cord injury severe enough to cause lower extremity paralysis. This group of Americans relies on physical therapy and orthotics to facilitate their rehabilitation process. Specifically, Knee-Ankle-Foot Orthotics (KAFOs) are frequently used to assist the patient in standing and walking by externally supporting the thigh and leg. Currently these devices cost $1200-$2000, and 58-79% are abandoned by the patients due to improper fit or because they are inappropriate for their rehabilitation needs. There are few adjustable options available for patients and therapists to experiment with before buying a customized KAFO. The *Martha Morehouse* rehabilitation center currently uses a gutter splint, which offers no ankle support, or knee flexion, and offers limited size adjustability. The following paper will discuss the clinical background of paralysis as well as the background of KAFO devices. It will discuss other KAFOs currently in use and the problems associated with those devices. The paper will then discuss the project requirements including the scope of our project, functional requirements and non-functional requirements for the adjustable KAFO we are designing. It will then discuss our design process including the development of initial ideas, screening process, our selected design, and a thorough description of the entire design until the completion of the final design.

11. Knee-Ankle-Foot-Orthosis: KAir FOrce

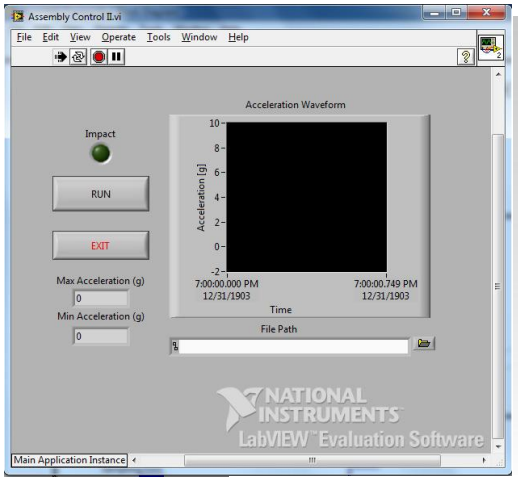
GOAL: The goal of the project was to design an adjustable KAFO for physical therapists to use as a training and diagnostic tool with patients in outpatient rehabilitation, to replace the commonly used, inefficient gutter splint..

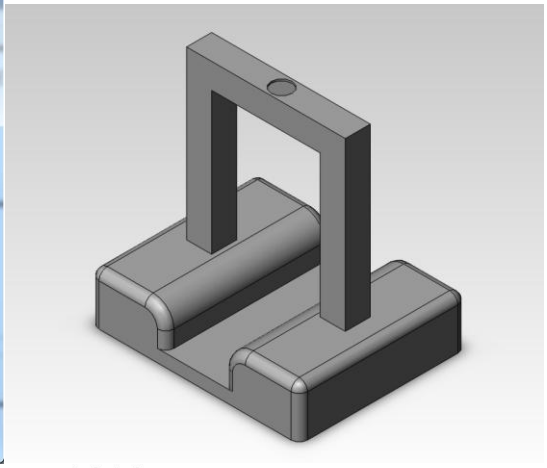
ABSTRACT:

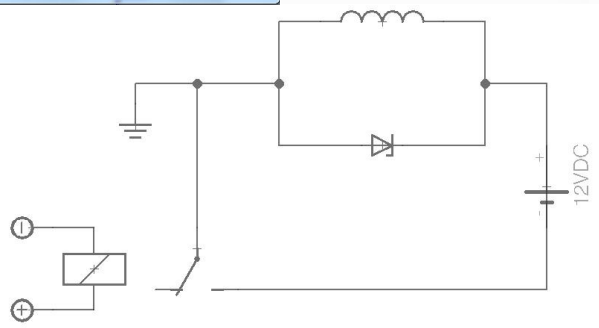
A Spinal Cord Injury involves a trauma to the vertebral column, damaging the spinal cord that controls neuromuscular and sensory function below the level of injury. SCIs affect approximately 12,000 new people each year, and cause a dramatic change in the lifestyle and mobility of these patients. Knee-Ankle-Foot Orthotics (KAFOs) are commonly used in the rehabilitation of patients with a T6 SCI or below, and promote individual mobility, and increase confidence and independence of the user. In addition, KAFOs help build and maintain muscle and bone strength, a vital part of rehabilitation. Unfortunately, 58-79% of KAFO users abandon their devices due to discomfort or lack of training, and their rehabilitation is drastically decreased. In order to increase the acceptance rate of KAFOs for patients with Spinal Cord Injuries, we developed an adjustable KAFO for physical therapists to use as a training and diagnostic tool with patients in outpatient rehabilitation, to replace the commonly used, inefficient gutter splint. This design project involved several steps. We first explored the background of the injury and the device, and then defined design requirements after meeting with patients and clinicians. Using these requirements, initial design concepts and ideas were developed, then through a screening process and building prototypes we selected a final design which was carried out to develop a final device. Our KAFO, the KAir-FOrce, contains various adjustable components for patients with different abilities, all of which can be changed according to the individual patient's needs. The device was evaluated to assess strengths and weaknesses of the design, and make future recommendations and suggestions. With this device, patients can now be more sufficiently trained for using their customized KAFO without the use of the ineffective gutter splint.

12. Traumatic Brain Injury Device

GOAL: The goal of the project was to design a device and computer interface that will quantify and report the critical parameters of a diffuse brain injury model.







ABSTRACT:

We have designed and created a novel, electromagnet-driven prototype that allows the study of diffused traumatic brain injuries by producing TBIs in animal models in a quantifiable and reproducible manner. The existing model uses a 500g weight, dropped from various heights, to inflict TBI. The new device uses an electromagnet, instead of gravity, as a force generation mechanism to inflict TBI. This solenoid-based device confers on the new model an advantage of compactness because the throw distance is reduced from two meters to a few centimeters. This new TBI device also uses an accelerometer in conjunction with a computer to precisely measure the acceleration and other relevant parameters at the time of impact. This electromagnet-driven system provides many opportunities for fine-tuning the amount of force or acceleration of the impactor at the time of contact with the target. We have also put forth many recommendations for scaling up the prototype to generate the force necessary to cause concussion-level TBI in rats.