Executive Summary: Tong Biomedical Design Award, BME 301

Low Interference Wheelchair Footrest

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Background

Becker's Muscular Dystrophy (BMD) is a genetic and progressive neuromuscular disease caused by mutations in the dystrophin gene. By the age of twenty, individuals with BMD typically require an electric wheelchair due to the breakdown of muscle fibers, which limits limb mobility. Despite the progressive nature of BMD, affected individuals often maintain enough movement to transfer themselves to and from their wheelchair, highlighting the need to expand the wheelchair footrest market to cater to varying degrees of mobility.

Existing Device and Problem

Most electric wheelchairs come equipped with footrests to offer users a comfortable area. However, a common issue with these pre-built footrests, exemplified by the Sedeo Pro electric wheelchair from SUNRISE MEDICAL, is they do not adequately accommodate users with partial lower body mobility, such as those with BMD. The footrests extend too far and fail to retract sufficiently, hindering users from placing their feet on the ground. This compounds with the mechanical design of the foot plates, which is impractical to move for those with neuromuscular diseases, to cause users to forgo the footrest entirely, leading to discomfort or the continual use of an elevated seat.

Design

To address these challenges, our innovative footrest aims to enhance usability while maintaining essential support functions. The design utilizes the empty space beneath electric wheelchairs to allow for optimal retraction when not in use. Two linear actuators, connected to the footrest and the wheelchair's sides parallel to the ground, are integrated into the wheelchair's main power source and control system. This configuration enables users to effortlessly move the footrest in and out of the way using the same user interface used to control the original footrest and wheelchair. Consequently, users can enjoy the benefits of a footrest while in motion and easily retract it for seamless transfer. The footrest consists of two 11x11 inch aluminum plates welded together to form an L shape. These plates are then attached to the linear actuators via two actuator brackets, one per actuator.

Prototype Testing

In the durability and weight tolerance tests, we systematically added weights up to 250 pounds to simulate prolonged use and stress on the footrest. The testing process, recorded with cameras, facilitated the analysis of deflections using ImageJ after each increment of added weights. The approach provided a comprehensive assessment of the footrest's structural integrity and allowed the calculation of stresses and bending of the linear actuator to evaluate if requirements are met.

Marketability

Our design holds the potential to address a significant market demand, with approximately 250,000 people in the U.S. alone living with muscular dystrophy and requiring electric wheelchairs. Beyond this population, other individuals with mobility limitations, such as those with partial paraplegia, Multiple Sclerosis, or Spina Bifida, could also benefit from our product. By alleviating mobility challenges and enhancing daily independence, our innovative footrest can make a profound impact on the lives of countless individuals.