

“Johnson Health Tech: Adaptive Indoor Rower for Wheelchair Users”

301 - Excellence - 2 - Adaptive Rower - Executive Summary

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Exercise is essential to maintaining a healthy lifestyle, which is why fitness centers were developed. However, the majority of exercise equipment is not designed in a manner that makes it accessible to individuals with lower extremity disabilities or injuries that require a wheelchair. In the U.S., the wheelchair user population is estimated to be around three million, making the absence of appropriate workout equipment a significant detriment to many. Physical limitations should not hinder an individual's ability to strive for a healthy lifestyle. One machine that would be beneficial to make adaptive is a rower. A rower combines both cardio and strength training, but their standard design does not accommodate individuals in wheelchairs. The British Columbia Institute of Technology has designed an Adaptive Rowing Machine (AROW). However, the modifications made to this machine are permanent, and as such are not able to be used by a non-wheelchair user. Fitness centers have limited space, so it is not often feasible to have adaptive versions and standard versions. In order to extend the versatility of the rowing machine and make it more marketable to fitness centers, a convertible design is required to allow use by all, including people with disabilities.

Research regarding the biomechanical movement of rowing was used to consider possible adaptations that could be made to the standard Matrix magnetic resistance rowing machine. After completing preliminary research, potential designs were created and evaluated based on their ability to stabilize the user during use, make the adapted rowing motion comfortable, and allow for conversion from standard to adaptive use with minimal effort. The chosen design consists of an additional pulley with supports and a wood stabilization frame for the wheelchair. The pulley is stabilized by mirroring support plates that slide onto metal support bars which hold the neck of the rower in place. Each support plate was 3D printed using Tough PLA with a high infill density to ensure rigidity. A slit was cut at the distal end of the neck, near the pulleys, to allow for the user to reorient the handlebar and rope towards the adapted side by guiding it through the additional pulley. This slit meets the most important client requirement that the machine be easily transformed from the standard to the adapted form. To stabilize the wheelchair during rowing, buckle straps were linked between the stabilizing wood frame and each of the armrests of the wheelchair to prevent backwards tipping. Simulation testing of the pulley support plates showed a maximum deformation of 1.06 mm under a maximum load of 1050 N with a safety factor of two, which ensures that the plate material and geometry will be rigid enough to support the pulley during normal rowing. Rope tensions on both the adaptive and standard sides increased as the resistance increased, thus proving that rowing on the adapted side produces a workout of similar intensity to that on the standard side. This convertible design enables the common rowing machine to be accessible to both standard and physically disabled users, granting all the opportunity to pursue an active, healthy lifestyle.