Problem
In the United States alone, there are over 3.3 million wheelchair users in a global population of over 75 million. Neuromuscular disorders cause muscle weakness limiting the patient's mobility. Mobility is crucial for strengthening muscles, stimulating blood circulation, assisting with digestion, and the patient's overall mental health. However, wheelchair users may not reap these benefits due to restricted mobility. Fortunately, standing wheelchairs enable patients to move their body from a sitting to standing position. A problem with sit-to-stand (STS) wheelchair designs are that the restraints cannot be secured independently by the user. As a result, creating chest and leg restraints that can be autonomously operated is crucial for the user's overall health and autonomy.

Competitors
At present there are no restraint systems for STS wheelchairs. While a certified nursing assistant can secure the user's restraints, this creates a dependency that is inconvenient and imposes an economic burden for the patient. There are other devices that increase mobility for wheelchairs users, but none specific to the autonomous use of an STS wheelchair.

Design Process
After research into the client's condition (Spinal Muscular Atrophy), assessment of functional range of mobility and necessity for powered assistance to achieve the desired autonomy, a set of adaptations to the existing STS wheelchair were devised. They consist of a restraint system that replicates the features of a roller coaster harness that is combined with separate lower-limb stabilization that are automated and independently controlled.

Solution
The final design is based on a roller coaster harness system for the chest restraint and a corkscrew mechanism commonly found in wine openers for the leg restraints. Two controller boxes, each containing the required electronics, gears, and motors necessary for operating the designs will be mounted on the client's existing STS wheelchair. Deployment or retraction of each subsystem will occur with the push of a button. The user will engage both systems independently to secure themself within the wheelchair.

Testing
The device was subjected to three stages of testing. The first stage ensured that the microcontroller code for each restraint subsystem correctly executed the actions upon command inputs. The second and third stages of testing focused on the mechanics of the separate leg supports and chest restraint systems, respectively. This testing consisted of assessing the maximal force of restraint, accurate range of motion during deployment, absolute final position, and safety override features as well as assuring that the locking mechanisms functioned properly.

Operational Requirements
The device will allow for autonomous use of an STS wheelchair, utilizing electronically controlled restraints that will move into place via independent electronic switches and buttons.

Impact for Client
The design will have a substantial impact for the client with the most important being increased independence and mobility. This will allow the client to stand at work, reach food from higher cabinets, stretch his muscles, as well as a plethora of other daily functions and activities.