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BME Design Excellence Award Executive Summary

United Cerebral Palsy of Greater Dane County (UCP) is an organization that supports individuals with a wide range of disabilities including traumatic brain injury and cerebral palsy. Persons with these disabilities have troubles with mobility and can benefit from a therapy unit called a spider cage. Spider cages are cube shaped structures that have meshing on each face that can be attached to resistance bands which are in turn attached to a harness system worn by a patient. The resistance bands support a portion of the patient's weight and helps him or her gain stability and muscle function. Spider cages are commercially available but cost over $4,000 and are not easily transported and assembled. The members of UCP tasked the team with creating a spider cage that has the same function as the traditional cage but is also easy to assemble/disassemble and a fraction of the cost.

The team began the design process with modeling three different designs based off of using galvanized steel. It was decided that 80/20 aluminum would be the best material for the cage because it is sturdy, lightweight, and requires little to no machining for easy assembly. After discussions with Price Engineering, a final design was decided upon for less than half the cost of commercial cages. The final design consists of a 6.5ft x 6.5ft x 6.5ft cube with 1515-LS aluminum extrusions for the framework and 1in x 1in thermoplastic coated wire mesh on each face (except for the bottom and open face). To add stability, two 45 degree members were added to the top frame. Plywood flooring was added to eliminate the splaying of the front legs and the racking experienced by applying a horizontal force. For safety, a foam flooring was added to cover the exposed plywood and as recommended by the client, pool noodles were added to the aluminum extrusions.

Testing has been conducted on the wire mesh to determine how much weight is needed to produce a permanent deformation at a single point. A permanent deformation of 0.0625 inches was observed when a weight of 102 lbs was applied to the mesh. Deflection tests have also been conducted on the mesh for slip tests. The subject was connected to the spider cage via resistance bands (as would be done during a therapy session) and slipped to suspend all of his or her weight from the cage. This is considered a worst-case scenario test as it would cause a maximum amount of deflection on the mesh. The test was carried out with five subjects with weights ranging from 128 - 195 lbs which is representative of the persons who will be using the cage; a dial indicator was used to measure deflection. The client also asked the team to simulate resistance band connection points that coincide with other therapy exercises that will be used at the facility.

The client and staff at UCP have worked with a BME design team in the past and were unable to obtain a finished product. This semester, a full spider cage has been constructed as well as validated and a final product will be delivered to the client. It is modular, having 8 sections each weighing ~30 lbs and will be able to be assembled with 2-3 people without any machining. The cage functions the same as a traditional spider cage and will benefit many patients at the facility. The client has expressed how the cage will help make therapy easier for the staff and patients and how it will allow individuals who have not been able to stand on their own for years actually be able to stand alone and gain a sense of independence.