Knee Joint for Assistive Leg Brace

Overview
The Team was asked to design a brace for one of the sponsor’s patients whose right leg is paralyzed from the quadriceps down to the foot as a result of an accident causing debilitating nerve damage. The patient currently wears a full leg brace that is locked at 10 degrees of knee flexion. This locked position forces the patient to walk unnaturally and uncomfortably. As a result, the patient experiences lower back and hip pain.

Objectives
The goal of this project is to design an assistive leg brace to help a patient with a paralyzed right leg walk with a more natural gait. The brace will be designed with free zero to six degrees of flexion and will contain a locking mechanism to convert from stance to sitting phases as a safety feature. Also, the brace must be able to be worn for 10 hours each day and withstand forces generated while walking.

Approach
bullet Customer needs were collected in an interview conducted during the first meeting at the Penn State Hershey Rehabilitation Center. Current problems with the existing brace were presented and ideas for improvements from the sponsor and patient were discussed.
bullet The Team then started developing concepts to address the issues with the current brace. A patent search and benchmarking was performed to help develop ideas for a brace.
bullet The Team decided to focus on redesigning the knee joint rather than altering other aspects of the brace.
bullet A Pugh chart was used to select the most practical design. Finite element analysis under an 800 pound axial load was used to look for weak areas using a computer generated von Mises stress field.
bullet Initial prototypes were machined out of aluminum to test for feasibility and verify details. Multiple iterations were used to improve the design before an actual joint was made out of titanium.
bullet A major component of testing was customer feedback for safety, functionality and comfort. The patient rated our final design a five out of five for functionality. The brace met his expectations and was exactly what was needed.

Outcomes
bullet The new brace design allows the patient to walk more naturally and therefore will aid in reducing the pain associated with the previous brace design. It also allows him to stand more comfortably. The brace has a unique design that cannot be found on the market today.