Experimental Designs Inc. – The Bipedal Machine

Overview
Our project sponsor presented us with the problem of improving the existing lower body design for a 30 foot tall construction robot. The engineering applications for the project include both design and analysis components. Several existing components needed to be tested using Finite Element Analysis, the existing hip design needed improvement, and a functional pelvis structure needed to be created. Challenges included modifying models for meshing, predicting worst case scenarios for simulations, and accurately predicting forces on the full scale robot.

Objectives
The team was faced with multiple objectives including both design and analysis. The objectives included running FEA simulations on the existing calf, thigh, and rotary hydraulic, improving the hip design, developing a pelvis design, and updating the 1/10th scale prototype.

Approach
• Customer needs provided by project sponsor and previous teams
• Split FEA on existing calf, thigh, and rotary hydraulic components amongst group members
• Each team member generated concepts for both the new hip and pelvis designs
• Concept selection performed using concept screening/scoring matrices
• Patent search performed by previous teams, but additional searches were also performed
• Three meetings were held with project sponsor in addition to frequent email communication
• Models of chosen concepts were created using SolidWorks
• FEA run to show worst-case loading scenarios using the simulation package within SolidWorks
• Existing 1/10th scale prototype was provided and updated by the team to reflect changes
• Prototype was not powered or fully functional so it could not be tested
• All validation and conclusions were generated from the results of FEA simulations

Outcomes
• The sponsor now has validated structural strength of calf, thigh, and rotary hydraulic
• The hip design was improved to reduce width, increase range of motion, and improve manufacturability
• A fully functional pelvis was designed to interface with the hip and provide a mounting point for the torso
• Future teams should re-examine the hip structure to ensure that full range of motion can be achieved.
• Results indicate a stronger structural design with increased manufacturability