INTRODUCTION
Severe lower limb injuries can limit physical function and affect many aspects of an individual’s life (Doukas, 2013; MacKenzie, 2006). The Intrepid Dynamic Exoskeletal Orthosis (IDEO) is a custom-made dynamic response carbon fiber device, designed to restore function. The heel wedge is an integral part of the IDEO-heel wedge-shoe system (Figure 1). The purpose of this study was to determine the influence of heel wedge properties on the walking gait of individuals using an IDEO.

METHOD
Subjects: 12 unilateral IDEO users (11 male, 1 female), age 32.1±7.5 yrs, height 1.84±0.10 m, mass 96.7±23.3 kg, injuries: fracture, tendon rupture, arthritis, fusion, volumetric muscle loss

Procedures: Biomechanical gait data were collected as participants walked over level ground at a controlled speed using their IDEO with 6 different heel wedges (2 durometers x 3 heights).

Data Analysis: Outcome measures included: center of pressure (COP) velocity, ankle moment, and roll-over shape (ROS). Self-reported pain, IDEO comfort, and smoothness of gait were combined to determine wedge preference. Repeated measures ANOVA and Friedman tests were utilized with α=0.05.

RESULTS

Figure 1: The IDEO-heel wedge-shoe system. Compression of the heel wedge under the IDEO simulates plantarflexion during loading response and allows smooth forward progression.

Figure 2: Time to peak COP velocity (m/sec) was significantly greater for 1 cm wedges than 3 cm wedges. There was also a non-significant trend for greater peak COP velocity for shorter wedges. Dashed line is able-bodied.

Time to peak internal dorsiflexion moment and time of ankle moment zero crossing (moment changed from dorsiflexion to plantarflexion) were significantly earlier for shorter and softer wedges. ROS radius of curvature was significantly less for shorter wedges, and ROS center of curvature was significantly further anterior for shorter and softer wedges.

DISCUSSION
In general, shorter and softer heel wedges stopped compressing earlier. This led to an earlier and greater peak in COP velocity as the foot pivoted on the heel and abruptly transitioned to the forefoot. COP position predictably influenced ankle moment zero crossing time. Taller and firmer wedges had a more posterior ROS center of curvature, which is similar to a dorsiflexed prosthetic foot (Hansen, 2008).

CONCLUSION
Changes in heel wedge height and durometer systematically affected loading of the foot. Participants preferred wedges which produced ankle moment zero crossing time and ROS center of curvature position which were close to that of able-bodied individuals.

CLINICAL APPLICATIONS
Adjusting the heel wedge is a simple, straight-forward way to adjust the IDEO-heel wedge-shoe system. Selecting the most appropriate wedge height and durometer has great potential to improve an individual’s gait.

REFERENCES

The views expressed herein are those of the authors and do not reflect the official policy or position of Brooke Army Medical Center, the U.S. Army Medical Department, the U.S. Army Office of the Surgeon General, the Department of the Army or the Department of Defense or the U.S. Government.