INTRODUCTION
Advancements in prosthetic designs could be accelerated through the use of a Prosthesis Emulating Device.

A Prosthesis Emulating Device (PED) is a special orthosis used by people without amputation that replicates the biomechanics of ambulating with an amputation. Unlike other emulators, which utilize a cast boot in conjunction with prosthetic componentry, our emulator will utilize a pseudo-socket design that consists of a plastic clamshell that encapsulates the shank of the lower limb. The distal end is opened to prevent load bearing through the foot-ankle complex and thus requires energy transfer to occur through the soft-tissues of the shank, similar to the biomechanics of controlling a transtibial prosthesis.

The purpose of this study was to create a PED to compare to uni-lateral transtibial amputee gait.

METHOD
Subjects: One able-bodied female (25 y/o, 74.8 kg, 1.75 m) and one female with a uni-lateral transtibial amputation (19 y/o, 60 kg, 1.65 m) has completed to his IRB approved study.

Apparatus: The Gait Real-time Analysis and Interactive Laboratory (Motek Medical, Amsterdam, NL) consisted of a 50 cm x 200 cm split-belt treadmill with force sensors mounted underneath both belts to measure ground reaction forces, and a 180 degree projection screen that corresponds with the speed of the treadmill to immerse the subject in a virtual reality. A lower-limb, 26 marker Human Body Model (Motek Medical, Amsterdam, NL) and a twelve-camera motion capture system (Vicon Motion Systems, Oxford, UK) will record limb kinematics (100 Hz). D-Flow control software suite 3.28.1 (Motek Medical, Amsterdam, NL) was used to define the sensory input provided to the subject. A safety harness was attached to the subjects to prevent injury.

Procedures: The participant walked at a self-selected speed wearing their typical footwear without the PED. For the second condition, the participant donned the PED uni-laterally and a shoe lift was used on the contralateral side to account for the height difference by adding a prosthetic foot (Pacifica LP, Freedom Innovations, Irvine, CA). After a habituation session which allowed the participant to acclimate to the devices, the subject walked at self-selected speed. Data on limb kinematics, kinetics, EMG, and video were collected.

Data Analysis: The Gait Offline Analysis Tool (Motek Medical, Amsterdam, NL) was used to calculate joint powers and GRF in the A-P direction. Twenty strides were time normalized to 100 datapoints and then averaged together per limb and per condition.

RESULTS
The minimum GRF in the A-P direction of the PED when normalized for bodyweight was 1.5 N/kg. The minimum GRF in the A-P direction of the transtibial amputated side when normalized for bodyweight was 1.08 N/kg. The minimum GRF in the A-P direction of the control when normalized for bodyweight was 2.2 N/kg.

PED peak ankle power was more similar to ankle power of the amputated limb in the participant with amputation (Figure 1).

DISCUSSION
The GRF of PED trials during pre-swing phase of gait (50-62%) displays decreased power absorption which correlates with a decrease in propulsive forces seen in transtibial amputee gait. (Silverstein, 2011)

Ankle power during pre-swing of the PED trial was decreased by over 300% compared to the control trial, similar to the peak ankle power of the transtibial amputee during pre-swing.

CONCLUSION
The PED produces gait characteristics similar to gait with a transtibial amputation particularly the residual limb ankle power during pre-swing and propulsive GRF during pre-swing.

CLINICAL APPLICATIONS
This improved PED can be utilized in future research to improve design of prosthetic components.

REFERENCES

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