IMPLEMENTATION OF A SUBTALAR JOINT IN LOW-COST PROSTHETICS

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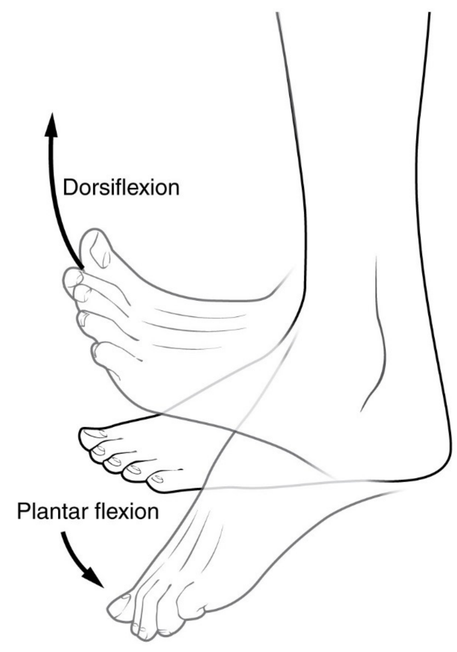
ABSTRACT

This project seeks to generate a low-cost alternative solution for patients with lower leg amputations in developing countries such as India. Existing low cost solutions focus primarily on the true ankle joint, as its range of motion is the most important to normal gait. Although an important aspect of ankle motion, low cost designs fail to address the subtalar joint because of the additional cost and complexity. As a result, the system lacks the range of motion and shock absorption inherent to the biological system. Our design explores the subtalar joint, and create a low-cost substitution that can mimic many of its properties. Allowing for further axes of rotation that better mimic the articulation of both the subtalar joint and true ankle joint will better emulate the natural movement of the ankle. Thus, this project aims to reduce the resulting stress of the prosthetic and test if this will lead to increased longevity of the device and comfort to the patient.

OBJECTIVES

01 Manufacturing costs of less than 50 USD
02 Mimics documented axes of motion
03 Ability to scale with patients of different sizes
04 Post-Processing can be completed on site
05 Factor of Safety (FoS) of all planes in motion
06 Comfortable attachment to residual limb
07 Aesthetically approachable, culturally appropriate

ANATOMY OF THE ANKLE



DESIGN SOLUTIONS

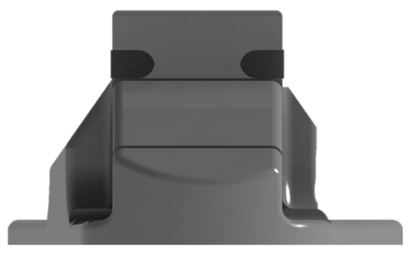
Through precise dimensions and the material properties of polypropylene, our prosthetic is capable of flexion that imitates the articulations of a human foot and ankle.

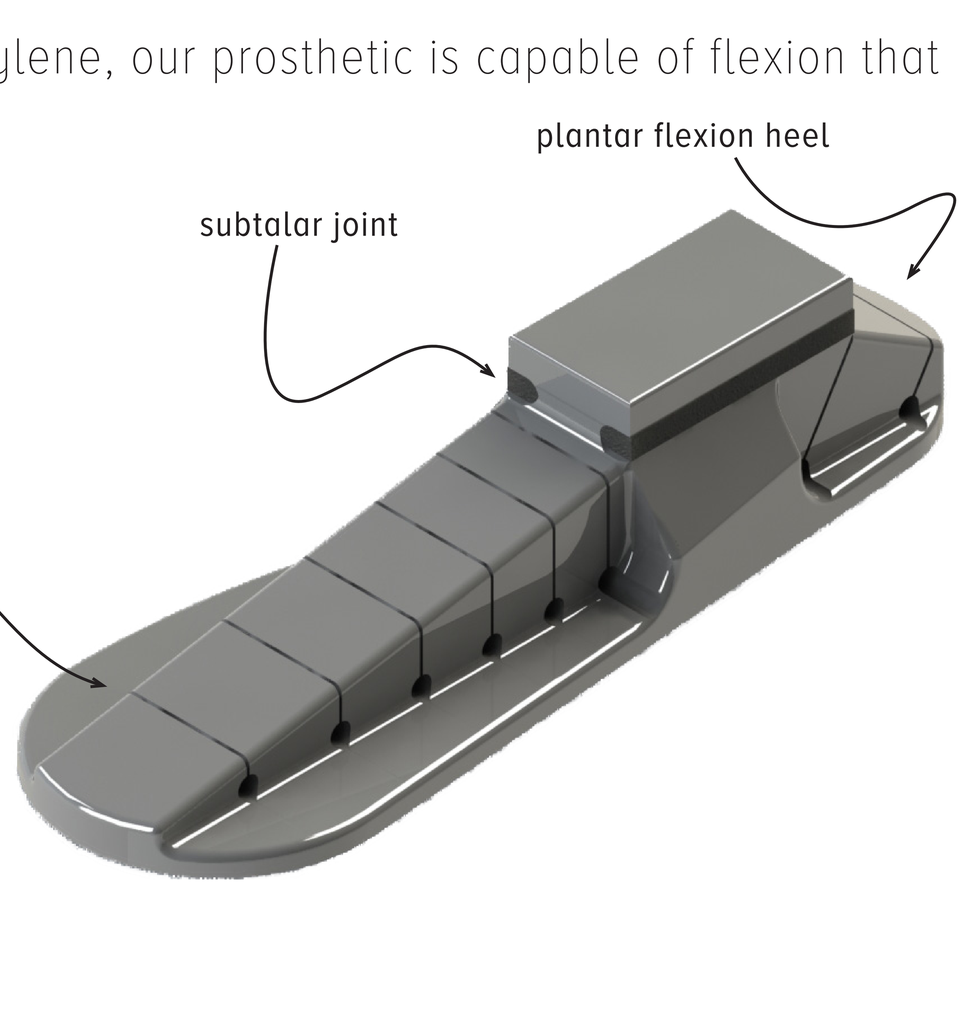
TRUE ANKLE JOINT

The kerf cuts along the middle of the foot and heel allow the prosthetic to bend in an arcing motion, creating a smooth transition from heel to toe when while walking

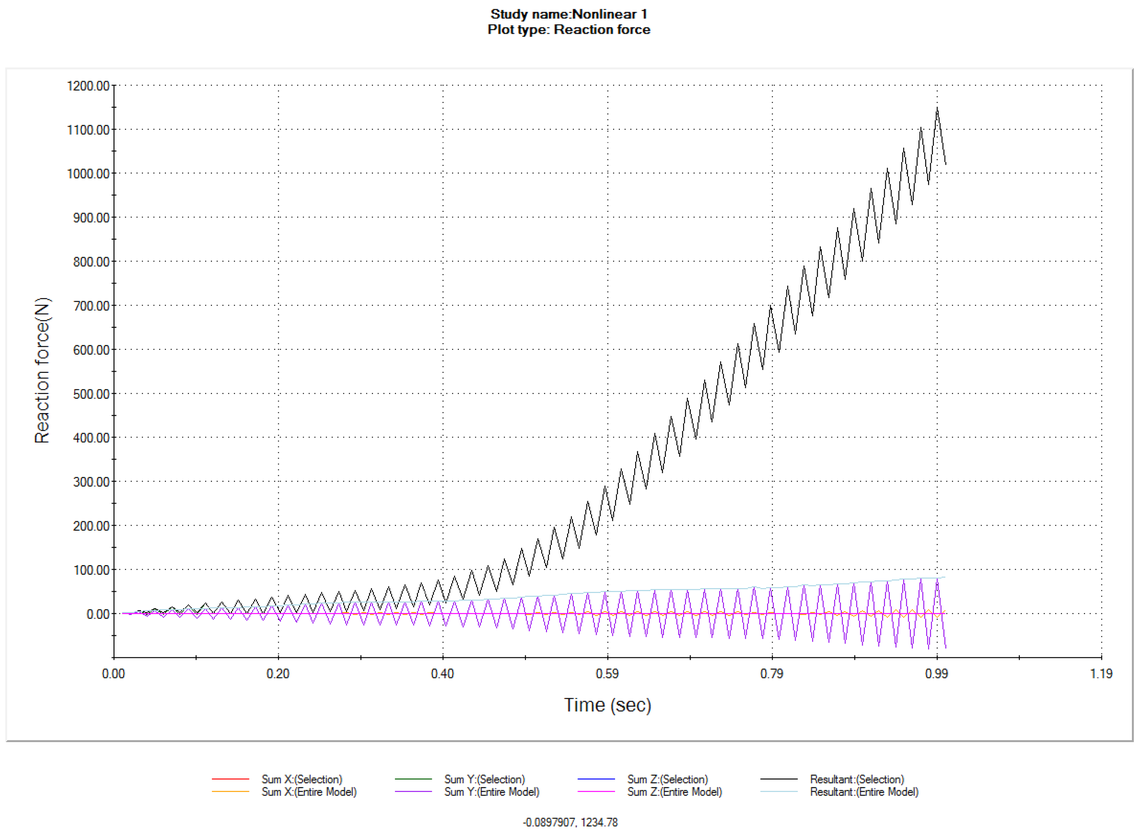
SUBTALAR JOINT

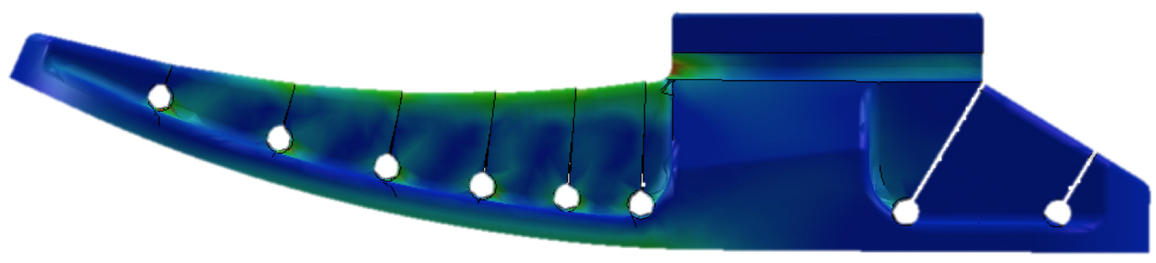
The subtalar joint feature acts to allow motions that replicate inversion and eversion, thus producing a more accurate and comfortable range of motion





ENGINEERING ANALYSIS





Above, stress distributions are represented through a color gradient, with areas in green reaching the highest stresses. The accompanying chart shows how the foot responds to the implemented flexion. The results suggest that 6 kerf cuts allow for the optimal range of motion and bending resistance, while maintaining safe levels of stress throughout the foot.