Subtalar Ankle Prosthetic

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Clinical Need

- 40 million amputees in developing countries have limited access to prosthetics.
- Current prosthetics only offer one axis of rotation (front to back), resulting in issues such as:
  - Energy intensive walking patterns
  - Unnatural motion
  - Excessive prosthetic wear
  - Unadaptable to outdoor terrain
- High rate of lower body amputations due to disease, trauma incidents and natural disasters.
- Many amputees don't have access to prosthetics and result in loss of: Mobility, Jobs/income, Independence.
- Prosthetics in developed countries are advanced, expensive and don't fit the lifestyle of those in developing countries.
- Prosthetics often fail to last very long due to inability to adapt to the environment and mimic human ankle functionality

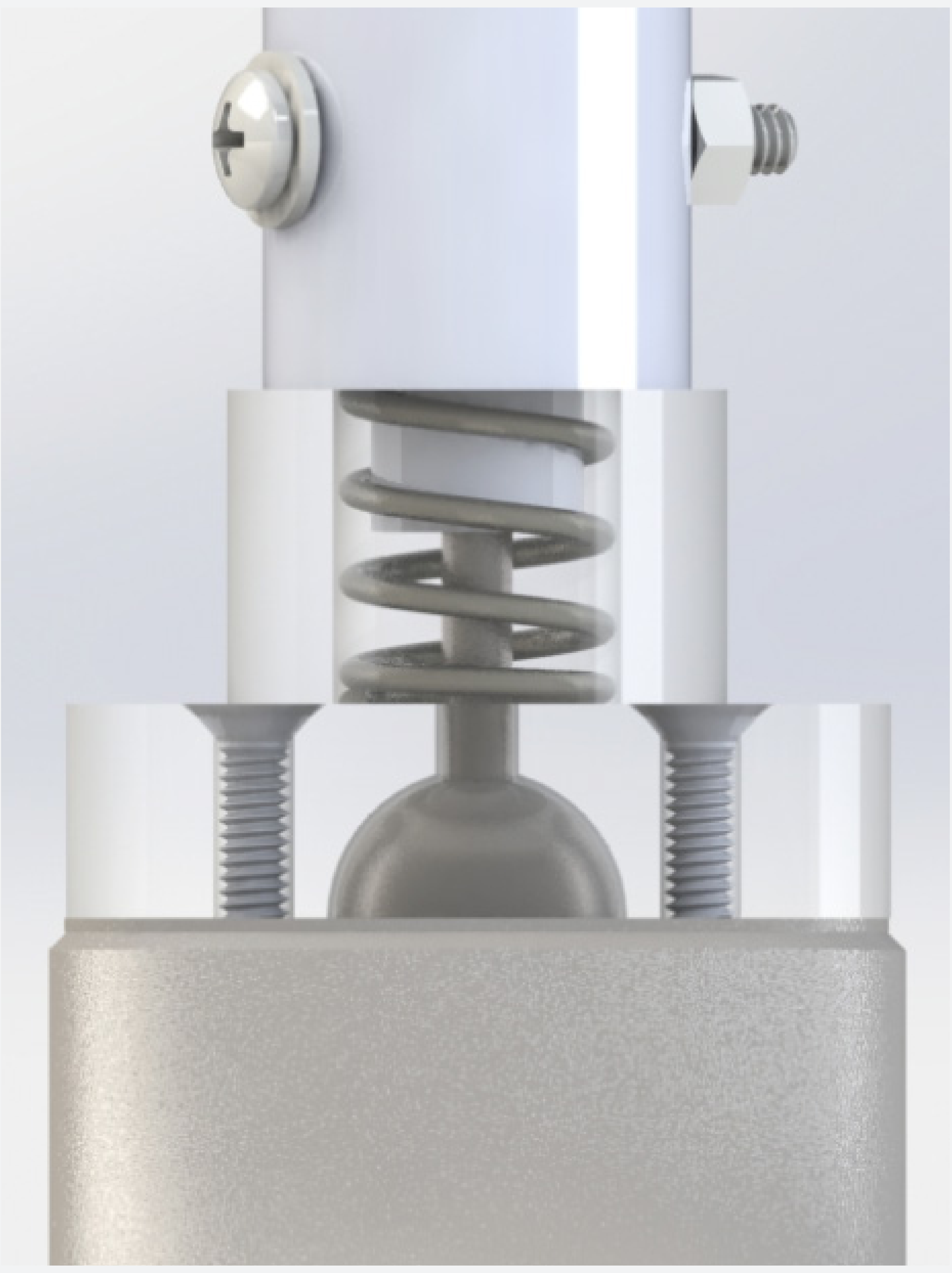
Goals

- Design and manufacture an inexpensive prosthetic that accurately imitates the human ankle function by providing multi-axial ranges of motion. This prosthetic should:
  - adapt to the environment
  - reduce the energy required to walk
  - extend the life cycle of the prosthetic
  - use materials that can be easily acquired and assembled for quick distribution

Prosthetic Design

Our overall design can be broken up into three subcomponents: the lower leg, the ankle, and the foot.

- **The lower leg** is concentric cylinders made of PVC pipe supported by a maple wood rod in the center. This material is sturdy, easy to acquire, and cheap to manufacture. The lower leg interfaces with the ankle via PVC pipe adapter connected to the threaded rod of a ball-socket joint.
- **The ankle joint** consists of a ball and rod enclosed in the hard stop and a socket built into the foot. Movement of the ball will be constrained to a specific range of motion determined by the hardstop of the joint.
- **The foot** is an injection molded component that houses the ball ankle joint and allows for attachment of the hardstop. This will be secured to the foot via flathead screws.



Engineering Analysis — Stress Analysis

stress distribution in computer animated simulations

Red represents areas of high stress
dark blue represents areas of low stress
The three images show key components of our overall design:
the outer PVC pipe (figure 1), inner maple wood rod (figure 2) and the foot (figure 3).
These images show that the components of our design are safe and unlikely to fail with high factors of safety.

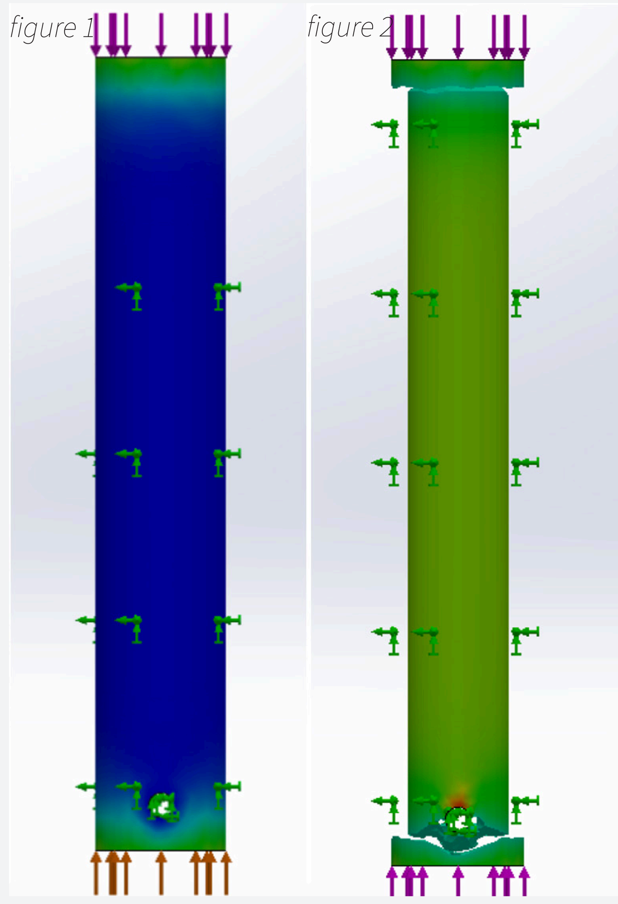
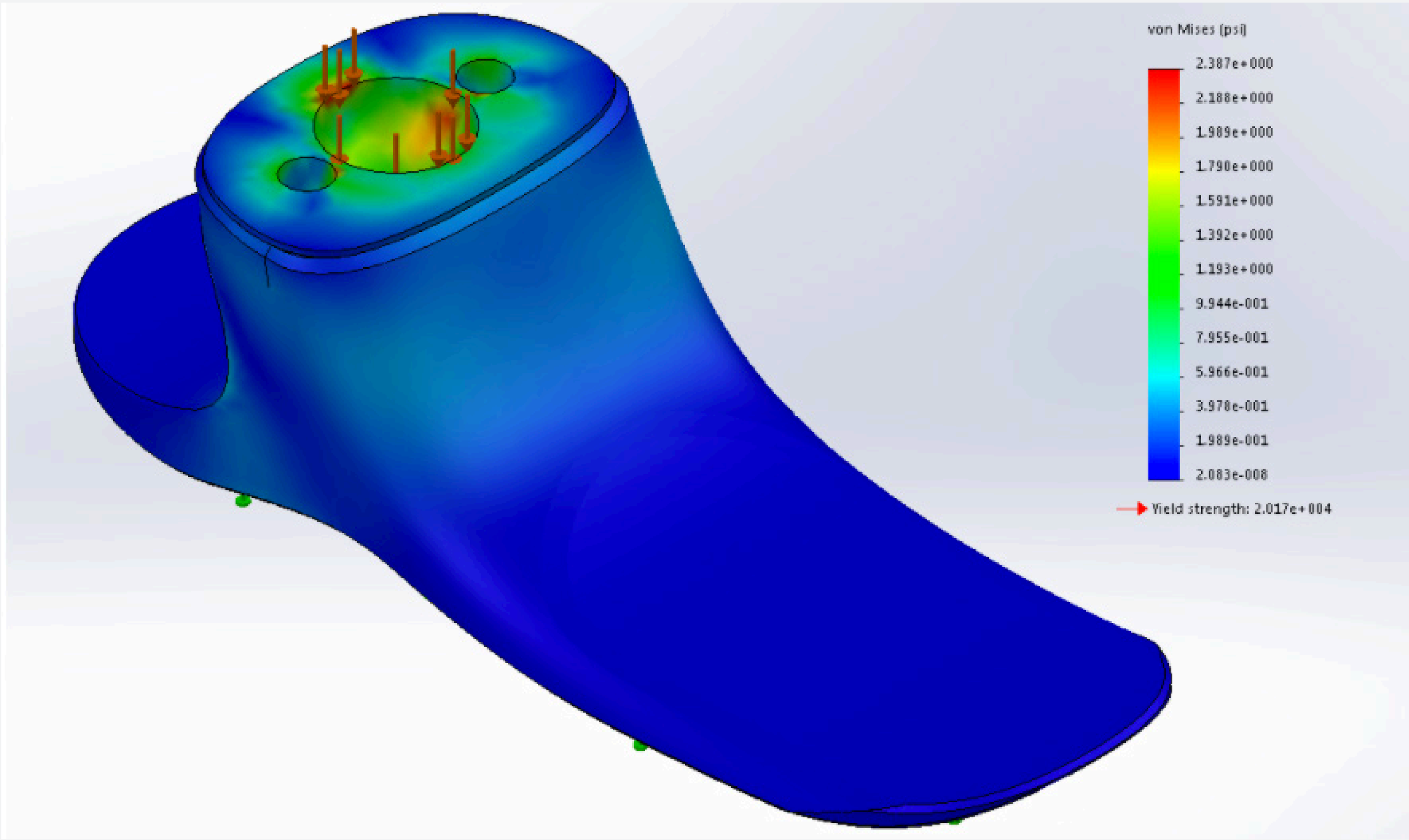


figure 3



Cost Analysis

Currently prosthetics in developing countries are inexpensive typically ranging from $12-$15. Our current multiaxial design is predicted to cost around $28 per prosthetic. We believe that we can decrease this cost by a change of supportive material (polyurethane) and in-house manufacturing of parts such as springs and ball joints.

Existing solutions

Jaipur Limb
The most popular foot in developing countries due to the resemblance to a human foot, low-cost and quick fabrication. It is made of wood, sponge rubber and heat-molded.

Niagara foot
Simple and inexpensive foot that aims to mimic the human ankle by taking advantage of material properties. It is made of delrin plastic and shaped to provide energy return like many of the advanced prosthetics in the United States.

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