42-402
BME Design

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LOW-COST TRANSFEMORAL PROSTHETIC

PROTOTYPE > There are five components to the prosthetic: the band, the socket, knee, pylon, and foot. The prosthetic is modular, and each component can be replaced as needed by the user, to extend the life and lower the cost of the leg.

< BAND The band straps around the user's waist, and connects to the socket via nylon straps to secure the socket to the residual limb during parts of the gait cycle.

< SOCKET The socket is how the prosthetic attaches to the residual limb. It is comprised of three elements: the fiberglass socket, the foam liner, and the nylon straps.

< FIBERGLASS SOCKET Formed from layered fiberglass for strength and flexibility, the socket cradles and supports the residual limb.

< FOAM LINER The foam liner provides comfort for the user while using the prosthetic. The user can customize the placement and amount of padding.

< NYLON STRAPS The straps tighten and loosen the fit of the socket by contracting or relaxing the socket's slits. Multiple straps allow the user to customize their fit.

< KNEE Based off the existing Jaipur Knee, the mechanical knee will mimic normal human gait by providing stability and easy movement.

< PYLON The pylon provides structural support to the leg and connects the joints together. The pylon is comprised of a 1.5" polyvinyl chloride pipe, mechanically fastened to the knee, and fit into a rubber end cap.

< FOOT The foot is comprised of a band-seal end cap to connect to the pylon, the steel foot, and the tread.

< END CAP The band-seal end cap fastens the pylon to the foot, and can be loosened and re-tightened for access to the pylon.

< STEEL FOOT The foot is made of 1075 spring steel, stamped to form and heat-treated for rigidity. The front and back have prongs to allow for flexibility.

< TREAD The tread is made from salvaged steel-belted automobile tires, providing support, flexibility, and traction for the user.

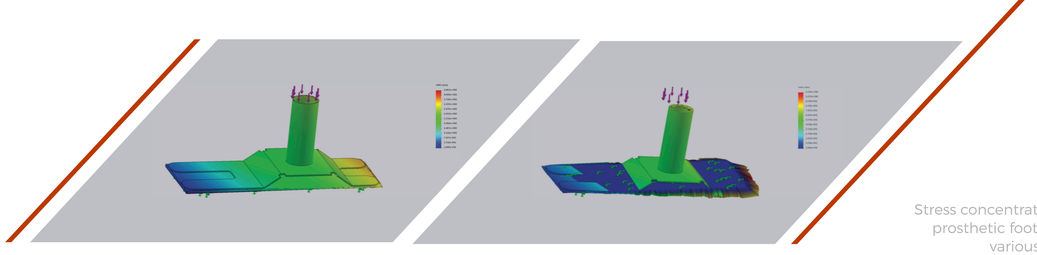
INTRO > There are approximately 5.5 million transfemoral, or upper leg limb amputees in impoverished areas worldwide. Usually caused by industrial or environmental accidents, land-mines, and the lack of public health, a leg amputation debilitates an individual in a way few other amputations do, through immobilization and an increase in their reliance on others.

The Foot Fighters created a low-cost transfemoral prosthetic leg for amputees in developing countries, at an estimated price point of $27. This project will offer users a chance to continue their day-to-day activities like caring for themselves and engaging in the workforce.

Foot Fighters Prosthetic: Pylon, calf, foot (right) band and socket (left).

TESTING RESULTS > The foot was modeled and loads were applied using Solidworks. The figures to the left depict the stress concentrations of the design. Be increasing the area of blue, the stresses can be distributed such that the foot is less likely to break. Under an 180lb load, the deformations are small, with larger deformations at the heel and pylon-steel interface.

The small deformations and areas of stress mean that the foot is capable of sustaining a person's weight. Over years of use it is possible that the sole would deform, in which case the user would replace the tire sole, instead of having to purchase an entirely new prosthetic.



Stress concentrations in prosthetic foot under various loads.

CONCLUSION > Each component of the prosthetic is designed to best fit the user and reduce complexity. Simplifying the design reduces overall costs and points of failure. In addition, the use of modular components will allow inexpensive part changes as needed over time. At an estimated total cost of $27, the prosthetic will be more accessible to those in impoverished areas.

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Team Foot Fighters building the prosthetic socket.