Foot Prosthetics

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What Is A Prosthetic?

Prosthetics are devices that assist people that have suffered severe limb loss. Many soldiers and normal, everyday citizens use the art of robotics and prosthesis to regain their ability to do everyday tasks. Body parts we take for granted are taken away from people very often. In America alone, over 150,000 people suffer limb loss each year. Prosthetics are artificial body parts. Examples of prosthetics are: hands, forearms, entire arms, feet, and legs. Here at Desert Robotics, we are working to improve the prosthetic design to make prosthesis more efficient and more available.

Though it may not sound like it, prosthetics are also used for things other than human limbs. For example, an unfortunate eagle, Beauty, was struck by a hunter’s bullet and her beak was shattered. A group of mechanical engineers worked hard to develop a bionic beak for the inopportune eagle [1]. There is also another sad story about an unfortunate animal. A dolphin was swimming cheerfully when, suddenly, her tail got caught in a crab trap off the coast of Florida. Prosthetics master Kevin Carroll created a prosthetic tail for the ill-fated animal. Prosthetics can be used for more than just a limb [2].

It has also been recorded that people have created prosthetic eyes and heart valves. The FDA (US Food and Drug Association) has started to use prosthetic heart valves already. They use these to replace heart valves that leak or have thickened, hardened, or stretched. Mechanical heart valves are made of man-made materials [3].

HISTORY OF PROSTHETICS
1000 B.C. - 1899

The oldest known functional prosthetic design is a toe found on a 3000 year old Egyptian mummy. (Fig. 1) It was made from wood and leather. This toe dates back to [between] 600 and 1,000 BC, and was discovered in the year 2000 [4]. Archaeologists have also excavated a Roman artificial leg from 300 BC. The leg was excavated in Capua, Italy. During World War II, the leg was destroyed. This leg was made of bronze [5]. In 1500 B.C. Indians had written literature describing artificial legs. In 1690, Verduin constructed a transorbial prosthesis with a copper socket, leather thigh corset and a wooden foot [6]. In 1816, a prosthetic leg was developed for the First Marquess of Anglesea. He had lost a limb during the Battle of Waterloo in 1815. This leg was named the Anglesea or Clapper Leg. It was called the Clapper Leg because of the sound it made on a full extension [7].
CURRENT STATE:
Prosthetics cost from $6,000-$8,000. They can even reach a surprising $35,000 [8]. A South African paralympic runner, Oscar Pistorius, was born without a fibula in either leg. (Fig. 2) His parents made the heart-wrenching decision to amputate both of his legs when he was just 11 months old. As a child, he played rugby, water polo and tennis. He is now a great runner because of his curved, spoon-like prosthetic legs. These legs are called blades. That is one example of how important prosthetics can be. [10]

The popular sports company, Nike, has developed a Tron-style prosthetic leg designed specifically for basketball. [11] Former NFL kicker, Tom Dempsey, was born without any toes on his right foot. (Fig. 3) Dempsey wore a modified shoe with a flattened toe surface. Although he had no toes, he worked hard to reach his goal, and eventually did. He set the NFL record for the longest field goal kick. He set the record while on the New Orleans Saints, and the kick was made from 63 yards. This record still stands today. [12]

FUTURE DIRECTION:
A team of APL (Applied Physics Laboratory) workers is developing a prosthetic arm that looks, feels, and is controlled like a natural limb. The APL has been given a $30.4 million dollar contract to begin this project. Revolutionizing Prosthetics 2009 is a 4 year, $55 million program that is aiming to develop an advanced prosthetic arm. This arm is supposed to allow you to feel warmth as well as do everyday activities. (Fig. 6) This work is part of the DARPA (Defense Advanced Research Project Agency) plan to make the most advanced technologies for injured military personnel. [13]

In Star Wars: Episode V, a very good example of possible prosthetics was shown. After Luke Skywalker loses an arm, (Fig. 4) he is given a prosthetic arm which is amazingly realistic. This arm was controlled by his mind in the movie and felt exactly like a real arm to him.

A company, Otto Bock, is creating many prosthetic arms and legs using future technology. They are gathering ideas to create a prosthetic more intelligent than any other. The C-Leg is one example of that. (Fig. 6) This microprocessor-controlled leg is using designs from the past and combining it with futuristic technology. For most prosthetic legs, you have to switch legs to run, bicycle, etc. With the C-Leg you just have to press a button to switch to a different type of leg. [14]
Walking Prosthetic Design 1 “WP-1”

The WP-1 is a simple, less than aesthetically pleasing foot. It is cheap but functional. It is made with off the shelf components and any available materials. It has a swiveling, padded ankle, and a compatibility from a wide range of leg attachments.

Materials

- 1/4 inch thick PVC sheet
- Heat gun
- Bolt, and nut
- Cutter
- Optional:
  - 1/8 inch hard neoprene
  - 1/4 extra soft neoprene
  - heavy duty adhesive

Other Notes

All the parts shown can be scaled down, as long as it keeps the same ratio.

Construction

To build the WP-1, a foot shaped piece is cut out of a sheet of PVC. It is then heated and bent as seen in the design pictures. Then, two PVC trapezoids and a square are cut out of the same sheet. They are melted together as shown in the design pictures.

Then, a hole is drilled in the center of both the trapezoids. Another trapezoid box is made, but both the trapezoids are 1/4 inch larger in all directions, and the square is 1/2 inch larger. The larger box is placed over the smaller box, and another hole is drilled into the big box, aligned with the hole on the smaller box. A bolt is put in the hole, and secured on both ends. Then, two small PVC chunks are melted to the top of the bigger box, and on top of that a small plate is added.

The axle fits into a hole drilled into the small plate. After the main construction, a sandwich of 1/8 inch hard neoprene and 1/4 inch extra soft neoprene. The rubbers are adhered with heavy duty adhesive of any type and then glued with the bottom of the feet as shown in the diagram.

Current Status: Final Prototype
Difficulty to build: Moderate
Cost: under $200
Durability: Strong
Maintenance skill: Moderate
The SP Foot “WP-2” Scale Model

This is a scale model of a prototype prosthetic foot, made out of a bent IFI piece and a spring. It was a test to experiment with movement and pressure redistribution. The SP foot, (spring pressure) can be adapted to move many different ways, and is very stable.

Pictures:

* 1 notch = 1 inch
“WP-3” Prosthetic Prototype

The WP-3 prosthetic prototype is another IFI scale model that experiments with energy return. It has a different form than the SP foot, and instead of a spring, it has a rubber band.

Pictures:

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“WP-3” Prosthetic Prototype

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“WP-4” Realism Foot

The WP-4 prosthetic prototype is yet another IFI scale model that experiments with realism. It has 2 rubber bands placed to give maximum comfort and realism.

Our Philosophy

Current prosthetic technology is surprisingly oriented toward expensive, highly realistic models. Our mission is to provide cheap but functional prosthetics to people that can’t afford the higher-end prosthetics. We are not trying to make a profit, only a difference in people’s lives.
Bibliography


[6] (http://books.google.com/books?id=8byXK1cGLN8C&pg=PA6&lpg=PA6&dq=world+war+II+prosthetics&source=web&ots=oR2JaMqxIh&sig=ODJ5tg0Yg4qmSnYz-GXNL4XSVZ0&hl=en&sa=X&oi=book_result&resnum=1&ct=result#PPA5,M1)

[7] (http://www.blatchford.co.uk/company/history/history.html)


