Prosthstetics

By Sam Teitler and Pedro Megale
The Egyptians were early pioneers of the idea. Toe found on a body believed to be from between the 16th century BC and the 11th century BC.
History

Middle ages

Few advance besides hand hook and peg leg. Most prosthetics were to hide deformities, Knights would wear just for fit Shield. Little attention to functionality.
The Renaissance (1400s to 1800s):

By return of medical studies prosthesis were improved and most were made of wood and metal:

Historical prosthetic arm was that of Götz von Berlichingen (1480–1562), made at the beginning of the 16th century.
History

19 Century:

Advance of medical and mechanics studies allowed articulated moving limbs.
Advance of prosthetics during Wars

As the U. S. Civil War dragged on, the number of amputations rose astronomically, forcing Americans to enter the field of prosthetics.

Samuel Decker, a Civil War veteran who built his own prosthetics, mid-1860s. With his prosthesis he was able to feed and clothe himself, picking up objects and he regained the ability to write.

Unlike the Civil War, World War I did not foster much advancement in the field. Despite the lack of technological advances.
History

Modern Prosthesis:
Need to know basics

Prosthesis: pronounced pros-thee-seez,

A device, either external or implanted, that substitutes for or supplements a missing or defective part of the body.

Legs = good

no legs = not good

bionic legs = good

For Leg Prosthesis:

Load on stump, part of body that was never meant to see load i.e. lower surface area than foot, less supportive musculature, no arch to act as spring, etc

This causes ulcers, bruising, discomfort, etc
Patella tendon-bearing style sockets (specific weight-bearing)

Anterior View
- Pressure sensitive
  1. Patella
  2. Lateral Tibial Condyle
  3. Tibial Tuberosity
  4. Tibial Crest
  5. Anterior-Distal End of Tibia
  6. Fibular Head
  7. Distal End of Fibula
  8. Distal End of Stump with Surgical Suture
  9. Medial Femoral Condyle
  10. Lateral Femoral Condyle

Lateral View

Anterior View
- Pressure tolerant
  11. Supracondylar Areas
  12. Suprapatellar Area
  13. Patellar Tendon
  14. Medial Flare of Tibia
  15. Lateral Flare of Tibia
  16. Lateral Flare of Fibula
  17. Posterior Area of the Stump
  18. Popliteal Area (Gently!)
  19. Distal End of Stump for Total Contact Socket (No Pressure, Contact Only!)

Lateral View
interfaces of prosthetics

Current dynamic: C-Leg

- Active Dampers
- Angle and force sensors connected to microprocessor

future dynamic:

- BIOM ankle
- Reads nerve and signals from electrodes

Electrical
Common Prosthetics Issues

- Socket issues or discomfort.
- Irritation and skin issues.
- General fatigue and reduced mobility.
- Poor balance, instability or fear of falling.
- Lack of sensitive foot nerves to give feedback to body.
- Current prosthesis not fitting user needs.
- Back pain.
- Intact limb pain.
Skin breakdown at socket interface

A. Corn on the distal part of the stump in a transtibial amputee.

B. Pimples (in this case, folliculitis) in the patellar region in a transtibial amputee.

C. Abrasion in a transfemoral amputee.

D. Redness > 1 min after doffing the prosthesis (in this case due to a fungal infection) in a transfemoral amputee.
Liners and Socks

- Protective cover for stump.
- Minimizes chafing rubbing.
- Can be made of silicone, polyurethane and copolymers.
- Can be filled with gels.
How to Put on a Prosthetic
Specialized Prosthesis

Climbing can even perform better than biological limbs.
Specialized Prosthesis

- Your new swiss army knife limbs
- Can even adjust your height

Golf  Swimming  Weight lifting
Kayaking  Eating  Working
3D Printed Prosthetics

- Low cost prosthetics.
- Good for kids.
The Low Cost Prosthesis

Project that aims to produce prosthesis with production cost lower than $50.
Current Fitment Process

1) stump is scanned or a positive mold is made of the stump.

2) test socket is designed around the scan or mold

3) Test socket made and worn around

4) adjustments made until it fits well

5) final carbon fiber socket is made
Current Prosthetics: Fitment Problems

- current prosthesis socket fitting takes months

- reduce contact area at stiffest parts of the stump

- apply most of load to softest parts of the stump.

- uniform material sockets have uniform stiffness, lack proper compliance
Future of Prosthetics: Fitment and Multi-Material Sockets

Multi-material socket

made from 3D printing

Body  Socket

stiff  →  soft

soft  →  stiff

Magnetic Resonance Imaging → Finite Element Analysis → Computer-Designed Socket Model
Fit Socket

14 indenters

measures stiffness

confirms FEA model of stump with precision
Hugh Herr

- stiffer socket at softer tissue for less compliance at already compliant tissue
- softer socket at stiffer tissue for more compliance at less compliant/deformable tissue
Hugh and the Dancing Prosthetic
Success Stories

Alan Fonteles Oliveira

- London 2012 Paralympic Games gold medal.
What could the world’s most impractical prosthstetic be?
References

• future of prosthetics

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• MRI


• Transfemoral Powered Prostheses

http://biomech.media.mit.edu/portfolio_page/cseaknee/
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• A Variable-Impedance Prosthetic Socket for a Transtibial Amputee Designed from Magnetic Resonance Imaging Data

https://mopro.com/amputee-resources/common-issues/

• A Variable-Impedance Prosthetic Socket for a Transtibial Amputee Designed from MRI Data


• C leg

https://www.youtube.com/watch?v=WRNkjvJUlJz

• Intelligent liner


• More sport prosthesies


• Liner and sock info