The Future of Motion: Technologies for Prosthetic Limbs

Robert P Weinberg
DayCon 2016
Our Roadmap

1. Normal body motion – the muscles

2. Synthetic body motion – prosthetic limbs
   a. History of prostheses
   b. Technology for prosthetic limbs

3. Daily life with a prosthesis
There are over 700 muscles in the human body
(skeletal muscles)
Muscles produce movement through contraction

Bill Geiger, Muscle and Fitness
Switchboard in brain sends electric impulse to muscle
Sarcomeres - actin & myosin filaments contract
Muscle contracting
Questions?
Roadmap

1. Normal body motion – the muscles

2. Synthetic body motion – prosthetic limbs
   a. History of prostheses
   b. Technology for prosthetic limbs

3. Daily life with a prosthesis
Evolution of limb prostheses over the centuries

Kim Norton, A Brief History of Prosthetics
Prosthetic limbs with improved function

ExploraVision Project Website
From stick to robotic limb

ExploraVision Project Website
3,000-year old prosthetic toe of Egyptian noblewoman

Alexis Douglas, Advancement of Prostheses throughout history
French Surgeon James Bertrand Ambroise Pare
Our Roadmap

1. Normal body motion – the muscles

2. Synthetic body motion – prosthetic limbs
   a. History of prostheses
   b. Technology for prosthetic limbs

3. Daily life with a prosthesis
How to engineer a prosthetic limb

• Basic parts should include:
  – Sensors – to detect intended motion
  – Microprocessor – to integrate input and output
  – Motors – to move mechanical parts
Basic parts of earlier prosthetic arm/hand

- Sensors
- Microprocessor
- Motor

Alexis Douglas, Advancement of Prostheses throughout history
Muscles generate impulses to direct robotic arm
Prosthetic sensors and microprocessor
Myoelectric prosthesis

Parts of a below-elbow myoelectric prosthesis

- electrodes
- control unit and battery pack
- friction wrist
- socket
- electric hand

© 2012 Encyclopædia Britannica, Inc.
Newer prostheses can be controlled directly by the brain

Johns Hopkins Applied Physics Lab
Artificial muscles from chemical polymers which contract with current

Drs Olazabal and Sansinena
Polymer contracting to left then to right upon application of electric current

Conductive polymers at JPL (produced by Drs. Olazabal and Sansiñena)
Questions?
Our Roadmap

1. Normal body motion – the muscles

2. Synthetic body motion – prosthetic limbs
   a. History of prostheses
   b. Technology for prosthetic limbs

3. Daily life with a prosthesis
Advanced DARPA bionic arm
Playing soccer with prosthetic legs
Running races with prosthetic legs

Chelsea Whyte, New Scientist
Paralympic sprinters running race

Chelsea Whyte, New Scientist
Rock climbing with 2 prosthetic legs!
Advanced prosthetic leg following shark attack
Champion fuzzboll player with 2 prosthetic arms

Wikipedia – “prosthesis”
Prosthetic legs from age 1 through 4 years

Hogan and Herr, Augmenting Humanity
“I’ll be back”

Arnold Schwarzenegger, “The Terminator”
Questions?
Thank you!

SITN would like to acknowledge the following organizations for their generous support.

Harvard Medical School
Office of Communications and External Relations
Division of Medical Sciences

The Harvard Graduate School of Arts and Sciences (GSAS)

The Harvard Graduate Student Council (GSC)

The Harvard Biomedical Graduate Students Organization (BGSO)

The Harvard/MIT COOP