Assistive Technologies & Prosthetics

- Bioengineering as an application of traditional engineering applied to medicine
Assistive Technologies

· Assistive technology- technology used by individuals with disabilities to perform functions that might otherwise be difficult or impossible
  - Sensory & voluntary motor functions
Simple Assistive Technologies

- Glasses for people with visual impairments
- Text telephone for people with hearing impairments
- Page turner for people with movement impairments
- Wheelchair
Assistive Technologies

- Simple assistive technologies are palliative (they treat the symptom)
Prosthetic

- Prosthetic: an artificial device to replace or augment a missing or impaired part of the body
  ~ an assistive technology that goes into a person

Treat cause = more invasive
Sensory Prosthetics

- Cochlear implant

- Profound hearing loss in both ears
- Functional auditory nerve
- Desire to live in a hearing environment

http://youtu.be/_8rPD6xLB4A
Prosthetic Application - Sensory

- Retinitis pigmentosa
  - Eventually lose all vision

Eventually results in complete blindness
Functional Components of Eye

Retina - converts light into electrical signals

Cornea - some focusing

Iris - amount of light

Lens - most focusing
Rods & cones absorb light

Change electrical potential of retinal neurons

Change in electrical potential propagated to brain

Die with retinitis pigmentosa
Figure 1: Histological appearance of healthy human retina (left) and retina of a patient with retinitis pigmentosa at a mid-stage of disease (right).

The space between the retinal pigment epithelium and the outer nuclear layer in the diseased retina is a processing artifact.
Retinal Prosthetic

http://youtu.be/_8rPD6xLB4A
1. Camera captures images
2. Images are sent to hand-held device
3. Processed images are sent back to glasses and wirelessly transmitted to receiver under surface of eye
4. Receiver sends information to electrodes in retinal implant
5. Electrodes stimulate retina to send information to brain

**An Artificial Retina**
Currently in use to treat people with damaged photoreceptor cells, the device consists of a small camera, a belt-worn video processor and an implanted array of 60 electrodes. Images are converted into patterns of light and dark and transmitted to the electrodes, which send signals through the optic nerve to the brain and form a crude image of light and dark patches.

Source: Second Sight Medical Products
How does this relate to me?

- MATE – materials characterization
- IME – device manufacturing
- EE – power & electrode properties
- SE – video processing
Prosthetic Application - Movement

- Lower-limb amputation
Bones - structural support
Joints - allow movement
Muscles - apply force to bones at joints to
  • accelerate
  or
  • decelerate
Nerves - control muscles and provide sensory feedback on location of limb in space
Limb Prosthetic

- Effectively replace skeletal components (structural support)
- Deceleration effect of muscles with hydraulic piston
Limb Prosthetic

- Interface challenges
  - Excessive moisture
  - Skin irritation & sores
  - Swelling
Osseointegration
Osseointegration

Titanium incorporated within bone tissue
Improved Limb Prosthetic

Control hydraulic piston with accelerometers & strain gauges- resistance to rotation about the knee is constantly changing

Next Generation Limb Prosthetic

- Acceleration effect of muscles
  - Effectively replace skeletal components
  - Deceleration effect of muscles with hydraulic piston controlled by accelerometers & strain gauges
  - Acceleration effect of muscles with actuators controlled by accelerometers & strain gauges
Next Generation Limb Prosthetic

- PowerKnee

http://youtu.be/8_5ZauGrtjo
How does this relate to me?

• MATE – materials characterization
• IME – device manufacturing
• ME – force modeling & actuation
• EE – power & control
• SE – diagnostics
Muscle activity during imagined activities

B  Elbow flexion

C  Elbow extension
Neural-Controlled Prosthetics

http://youtu.be/Z3a5u6djGnE