This is Your Brain on Computers, v. 2.0:

Present and Future Possibilities in Electronically Enhancing the Human Mind

Class I: Harnessing Output

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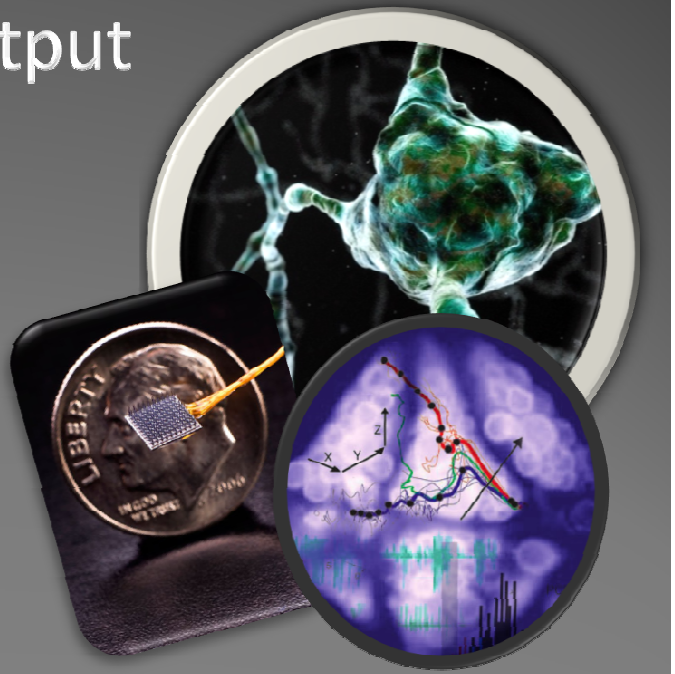
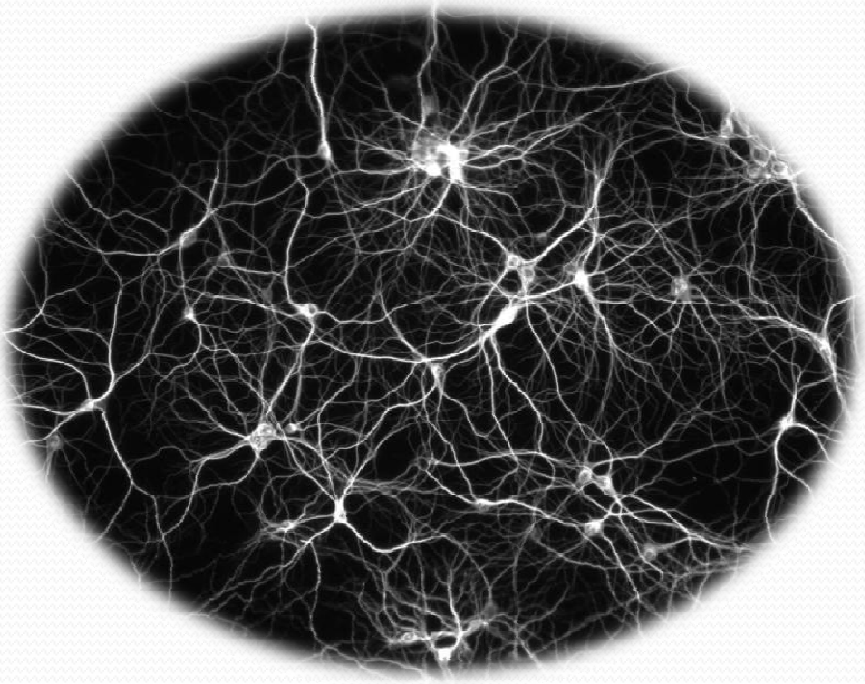
中国上海市



Introductions



- Name
- Year in school
- Why you chose this course
- Favorite future technology
- Description of your ideal virtual reality

Course Goals

- To stimulate curiosity about research and engineering techniques in the field of brain-computer interfacing
- To instill you with confidence that with sufficient research funding and human resources, virtually anything is possible
- To enhance critical thinking and debate skills
- To raise your confidence for arguing with others, especially in English

Important Vocabulary

Brain-computer interfacing: The field of scientific research investigating functional connections between the human brain and artificial computers

Neurobiology: The study of human brain structure and function using the laboratory approaches of biology

Output: Information coming out of a device (in this case, the brain)

Input: Information put into a device (in this case, the brain)

Substrate: The physical material out of which something is made (e.g., metal, wood, paper, clay)

Important Vocabulary

Prosthetic: An artificially created replacement body part

Cortex: The 3-4 mm of grey-matter neurons on the brain's surface

Electrode: A conductive device that passes electrical signals to and from the brain, peripheral nervous system, or muscles in order to record or stimulate activity in these regions

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- **Case I**
  - Proto II motorized prosthetic arm
- **Case II**
  - BrainGate neural implant device
  - Emotiv EPOC headset
  - OCZ Neural Impulse Actuator
- **Fictional technology**
  - *Natural History*: Entirely bionic bodies

Case I: Proto II Prosthetic Arm

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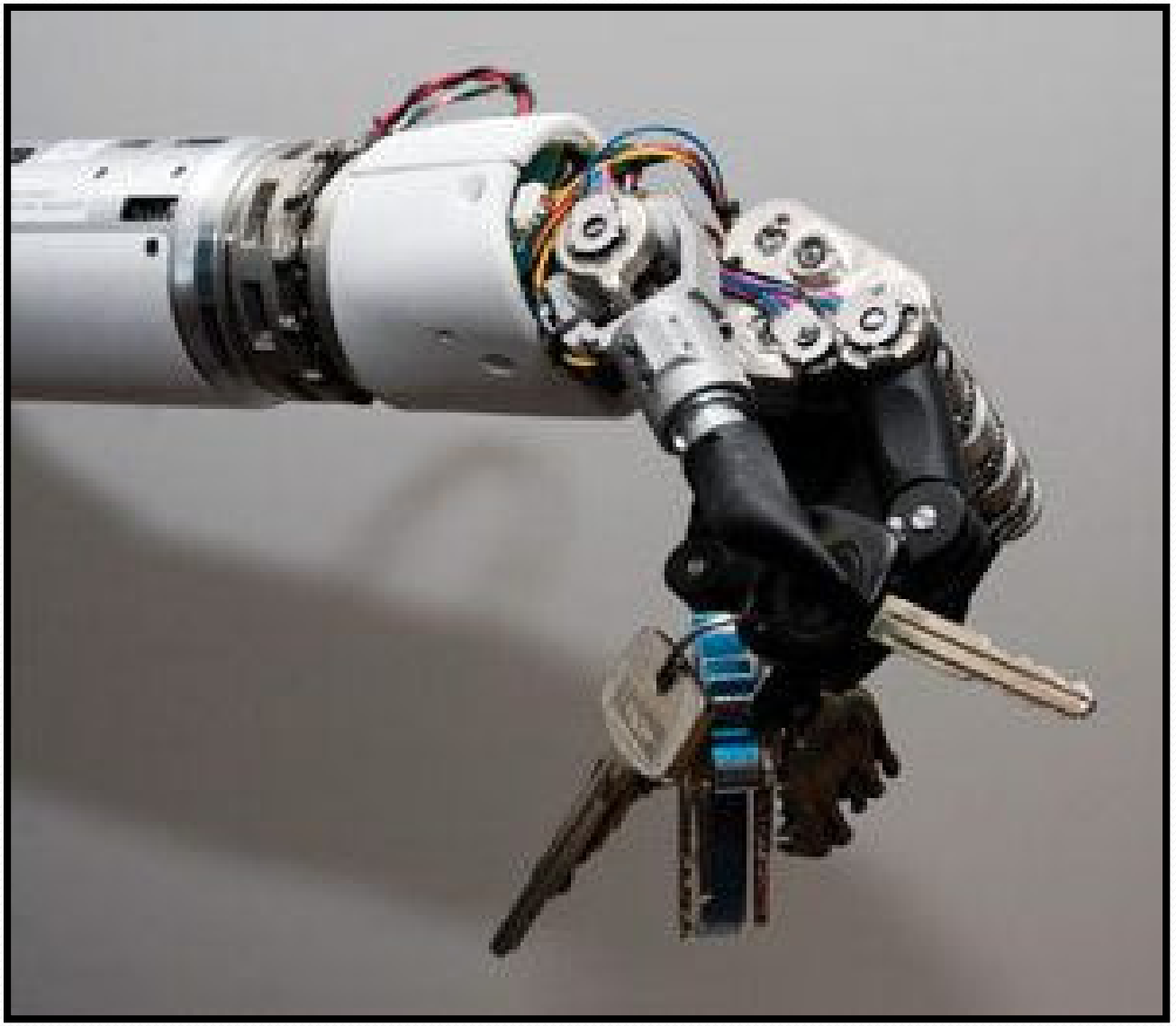
- 27 degrees of freedom
  - Proto I precursor had only 8
  - Most myoelectric prosthetics have 3
- Sensory perception
  - Fingers contain 80 receptors for sensing touch, heat, and limb position in fingertips and palm
- Strength near that of a normal limb
- > $55,000,000 in government funding
- Collaboration among >30 laboratories and private groups



Discussion Questions

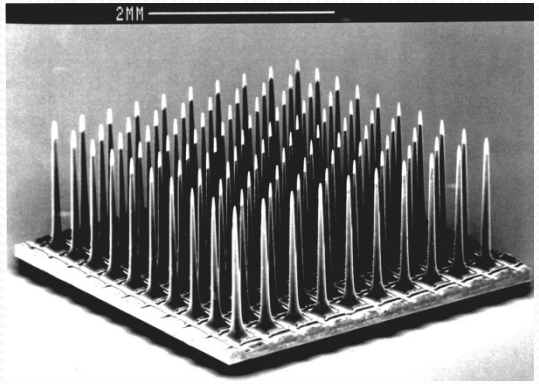
- What technical problems do you think the makers of the Proto II encountered in its development? How would you have solved them?

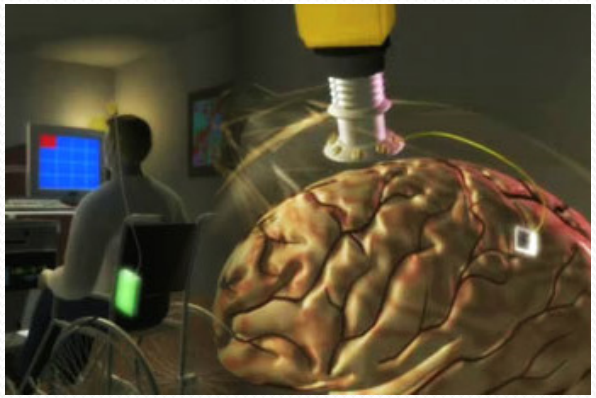
- What difficulties do you envision with the everyday use of the Proto II? How can we solve them?

- How might this technology continue to advance in the future?

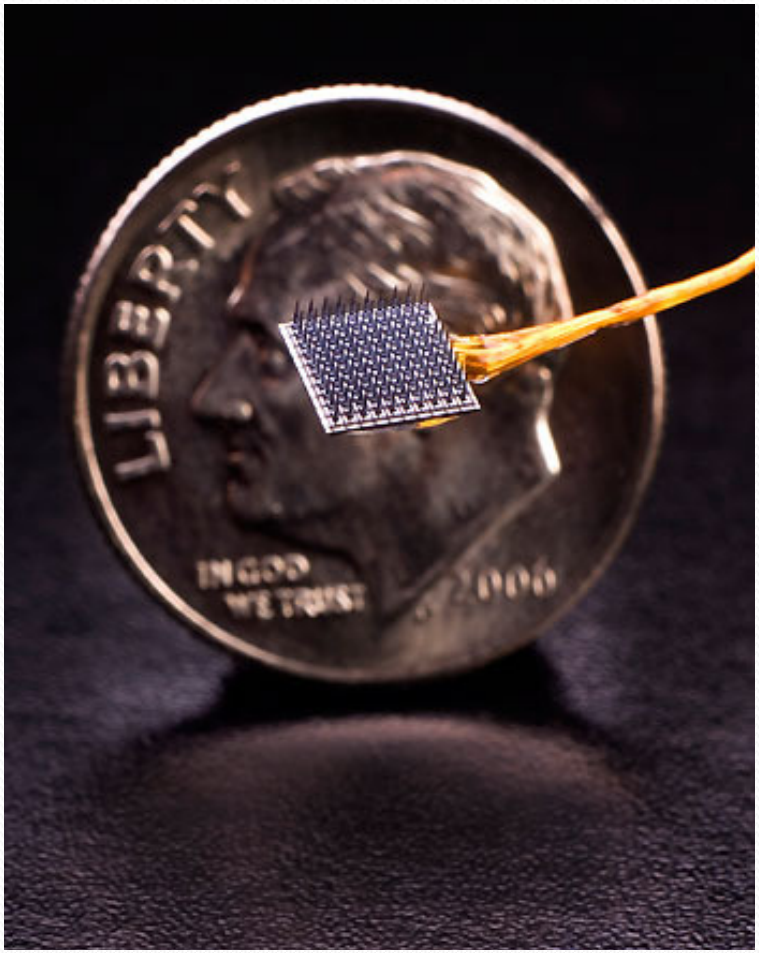
Case II: BrainGate Neural Implant

- Utah Electrode Array: 100 microelectrodes implanted into the cortex
- Uses ECoG (electrocortography) to measure brain activity for input into a computer
- Allows its user continuous 2D control of an onscreen cursor
- Developed by Cyberkinetics, a company founded by John Donoghue at Brown University
- One of several like devices funded by $25 million from the United States government



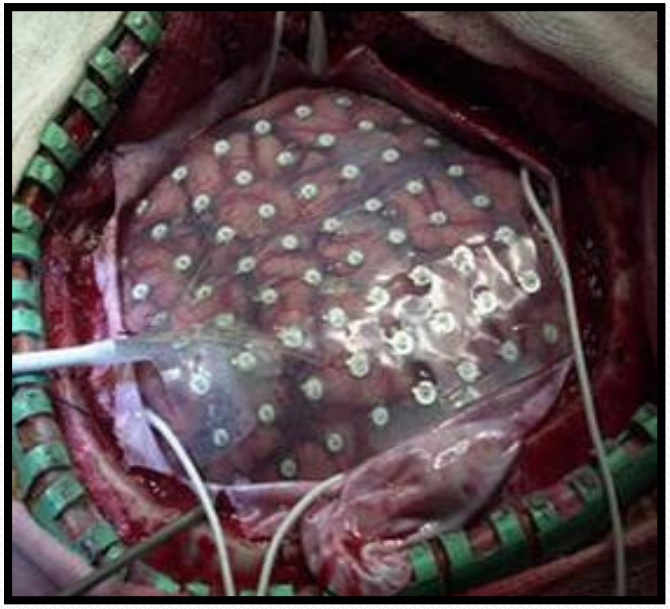


Case II: BrainGate Neural Implant

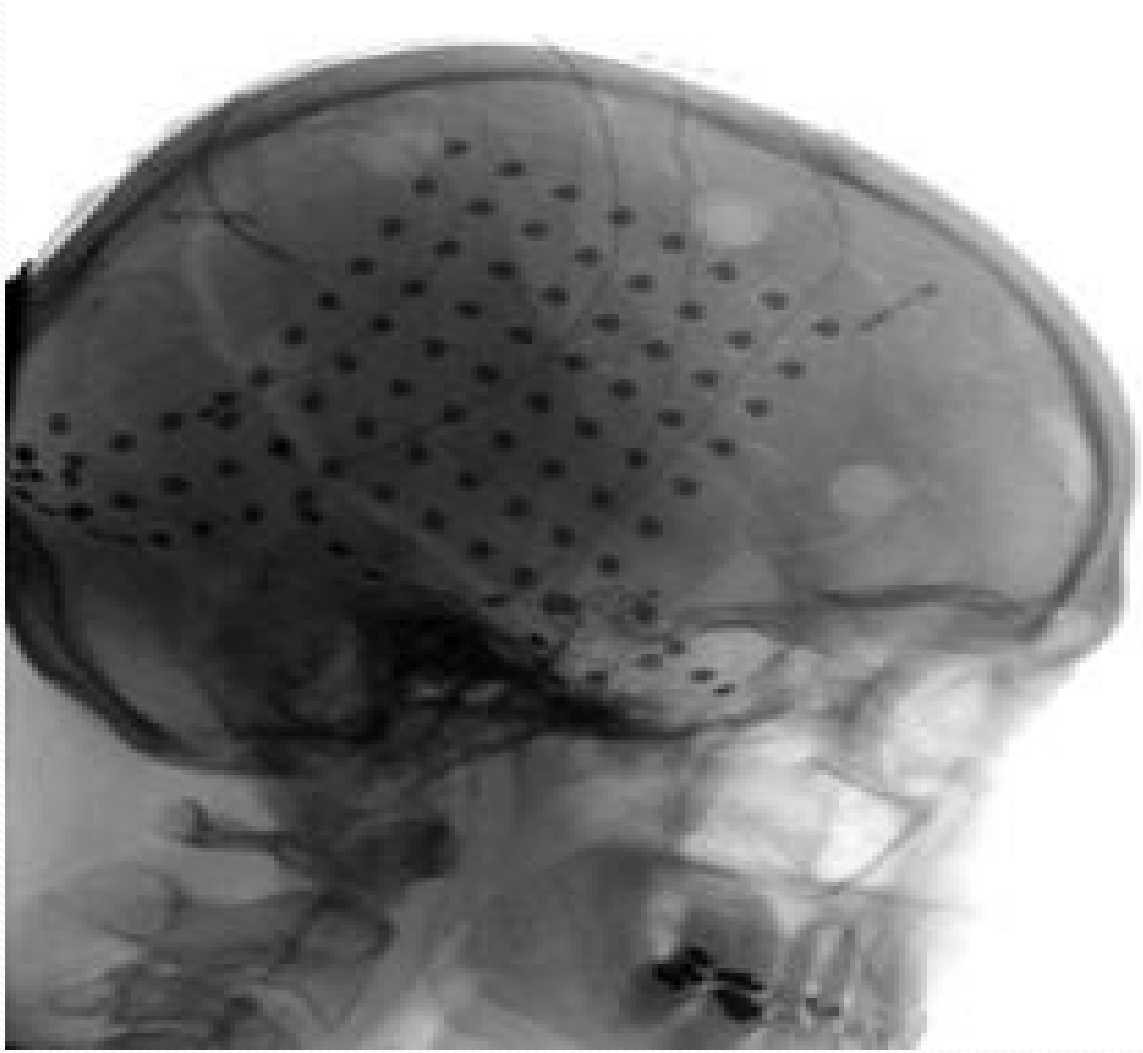


Case II: Problems of the Utah Electrode Array

- Immune reaction to foreign material
  - Signals tend to degrade over three months
  - Scar tissue forming around array?
- Brain tissue damage
  - Physical puncture
  - Overheating
- Insufficient contact
  - Shallow penetration
  - Small surface area



Case II: Surface Electrocorticography?



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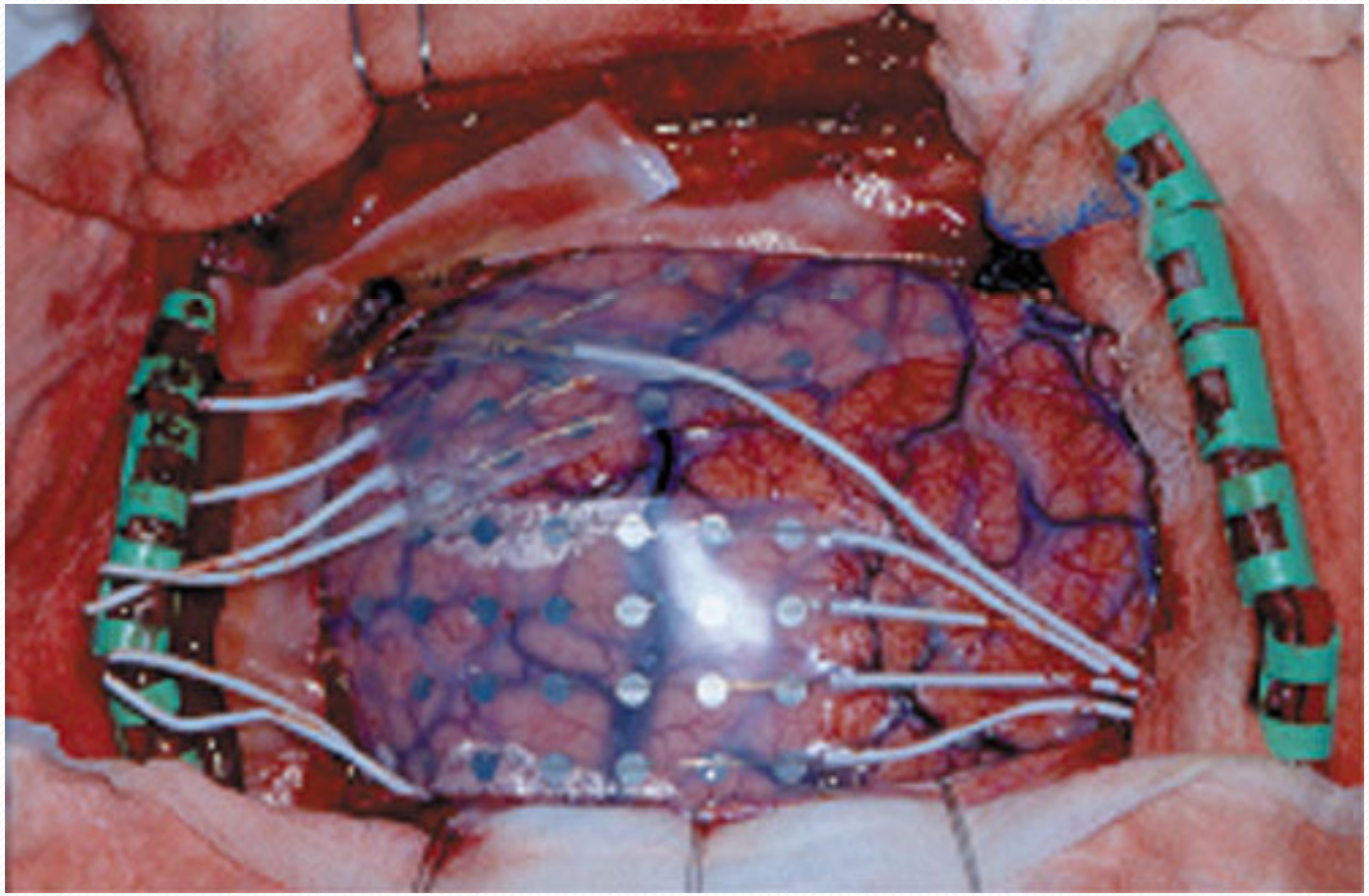

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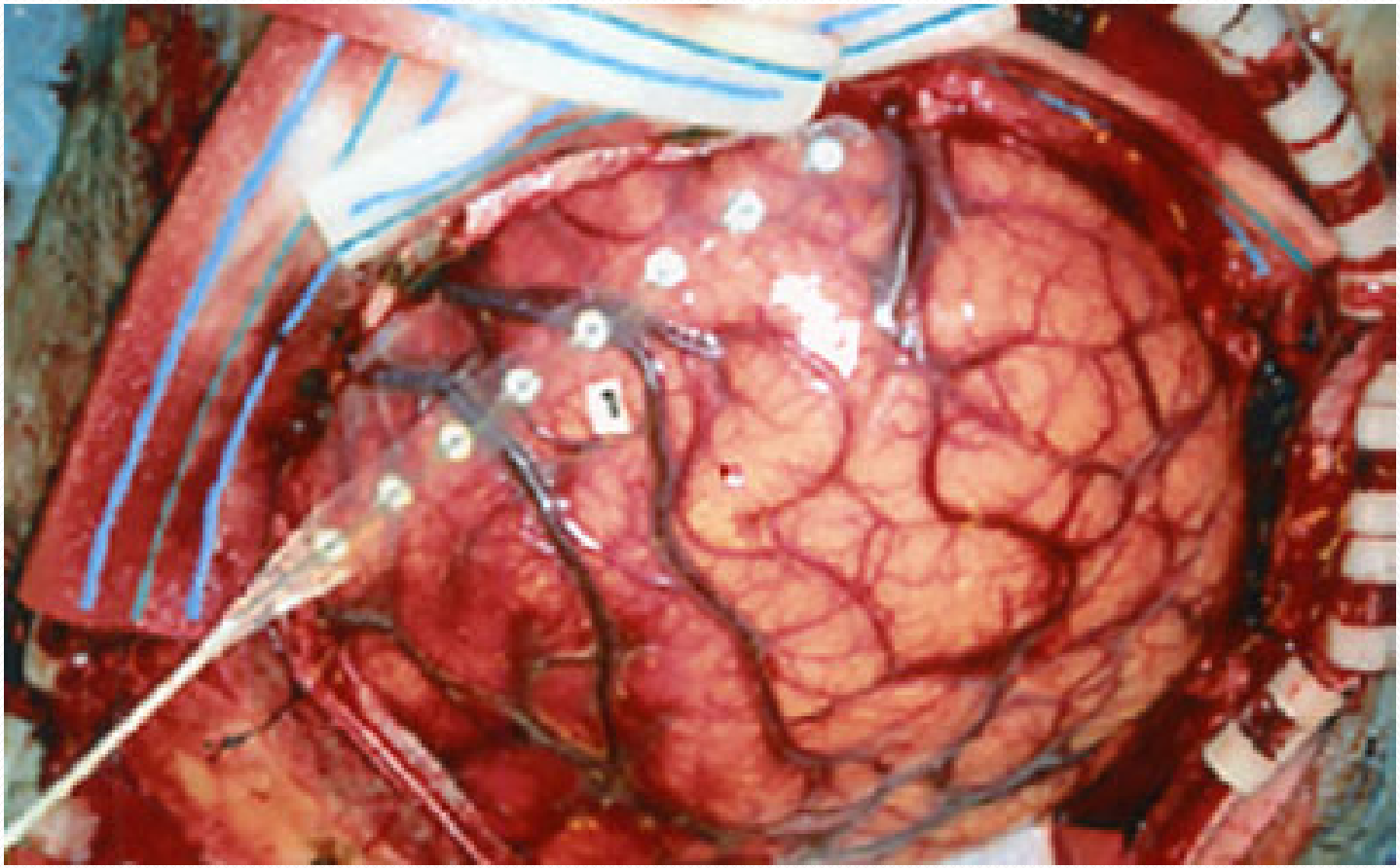
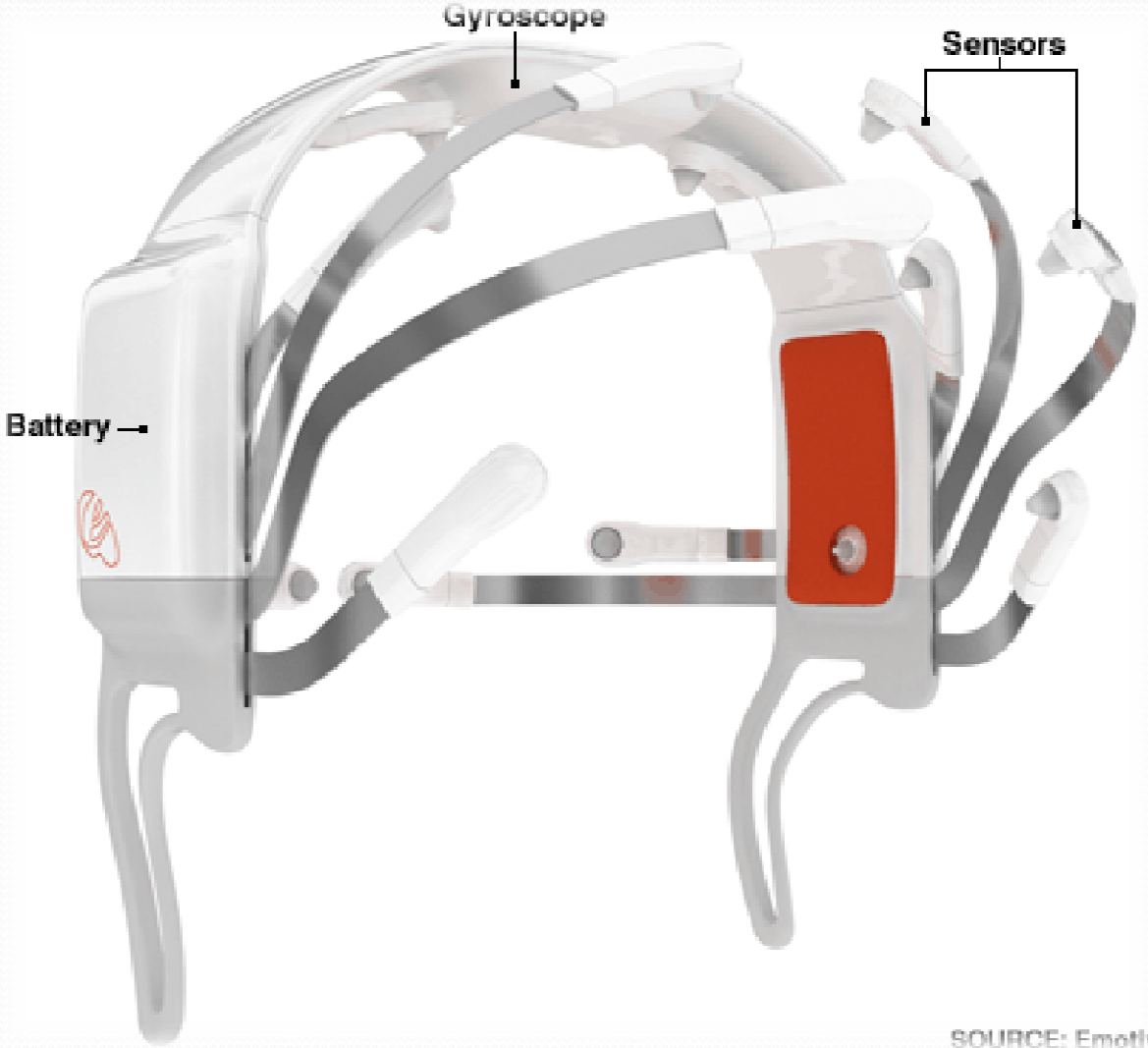


Case II: Emotiv EPOC Headset

- 16 EEG sensors
- Gyroscope for gauging head motion
- Uses brain signals and facial cues to control more than 30 movements
  - Can use EEG to push, pull, spin, delete objects onscreen
  - Translates real-life facial expressions into avatar emotions
- No technicians, electrode nets, or gel required
- On sale for $300 in the United States this autumn
- Started with a dinner-table conversation!



SOURCE: Emotiv

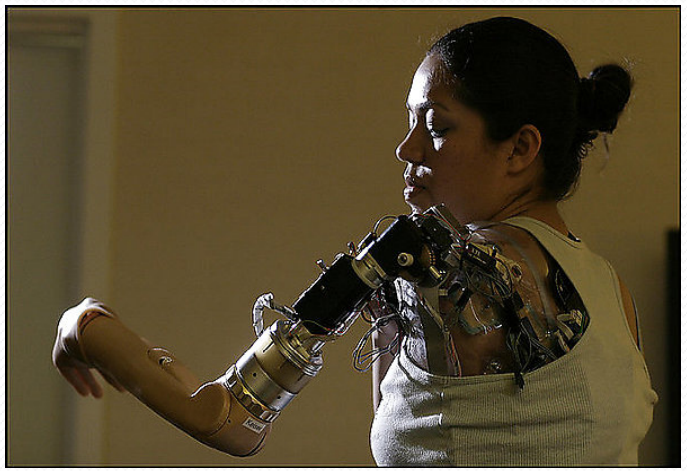
Case II: OCZ Neural Impulse Actuator

On sale for $319 starting in August!

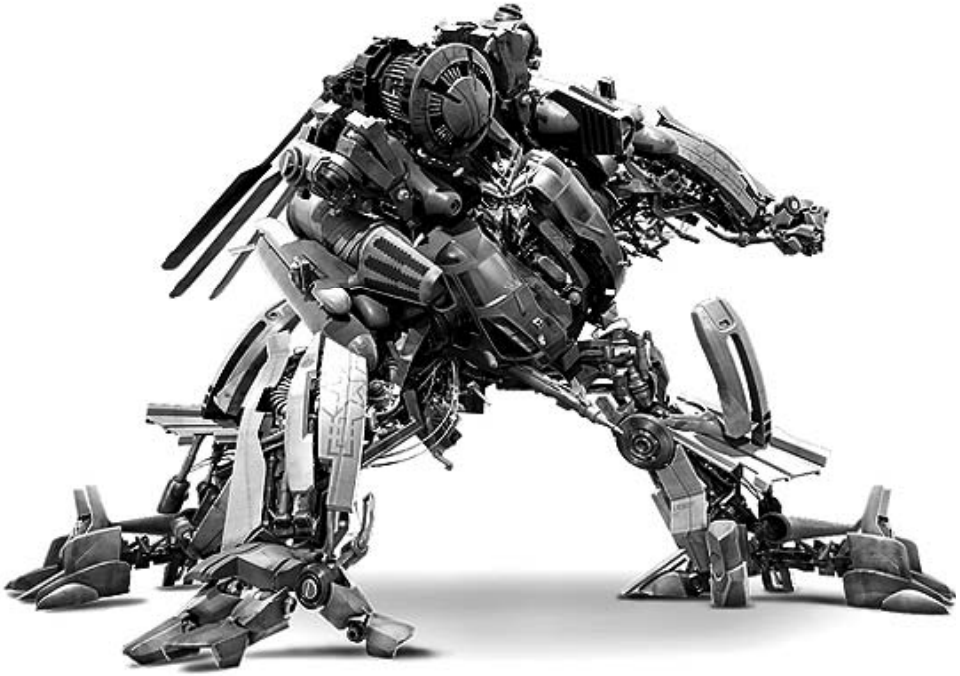
Discussion Questions

- Do you envision a world in which humans exert control over the world almost exclusively with machines and gradually lose touch with their own bodies? What might prevent such a situation from happening?

- What body parts do you feel are the easiest to replace with a machine? Why?



Fictional Technology: Bionic Bodies



Discussion Questions

- How do you think replacing the human body with a machine might change the places we can live?
- The reading selection suggests some tension between the Forged and Unevolved humans. How you feel that human society would change if such a technology as “Forged” beings existed in real life?
- What sorts of social opposition do you envision taking place against creating humans with bionic bodies?


Any questions?