

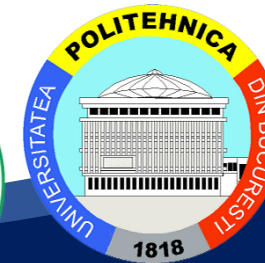


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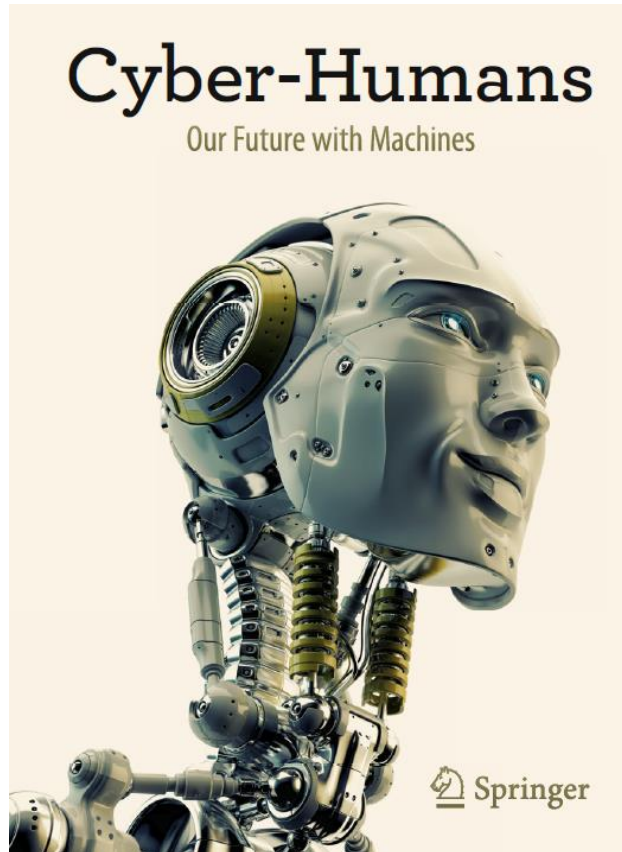
III Man-Machine Collaboration on a Shop Floor

Cyber-Human System (Cont.)



Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry

Cyber-Human System



(Barfield and Hill, 2015)

Why is Cyber Human?

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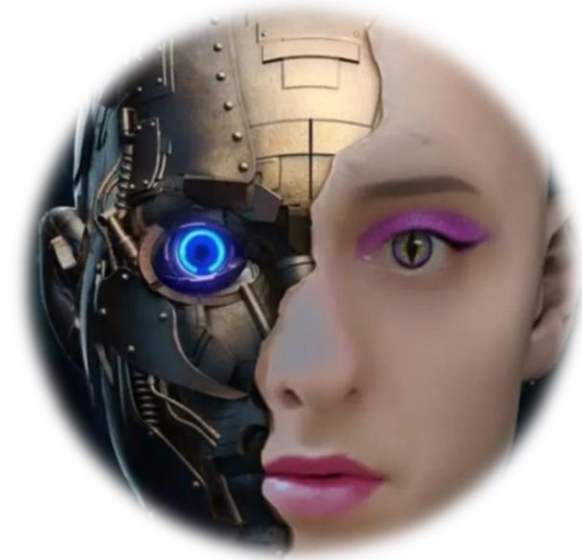
Humans, Bionics, and Cyborgs

Transhuman



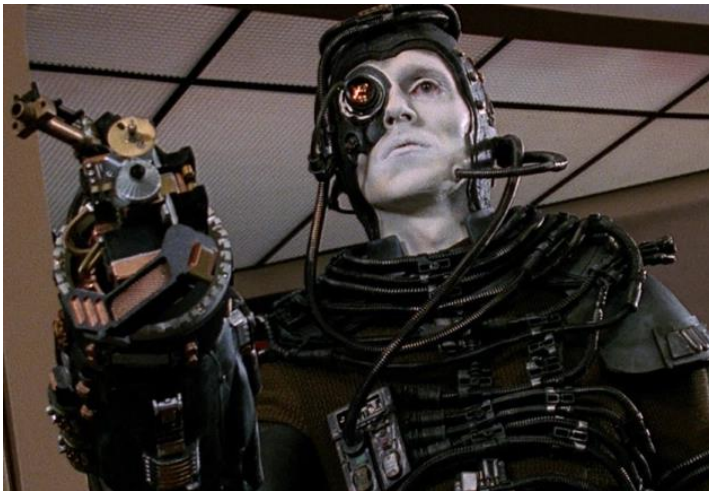
Evolutionary transition from the Human to the Posthuman

Posthuman “whose basic capacities so radically exceed those of present humans as to be no longer unambiguously human by our current standards.”



<https://www.tattoodo.com/p/350493>

The Borg, Star trek



Any organism which has synthetic hardware which interacts directly with the brain, and alters the way it functions

Cyborgs

Cyborg vs Bionic

What's the difference?



Bionics

Any organism which has mechanical or robotic hardware designed to augment or enhance the body



Darth vader, Star wars

MSE 4.0

C-3pO, Star wars



Machines designed to perform a task

Robots

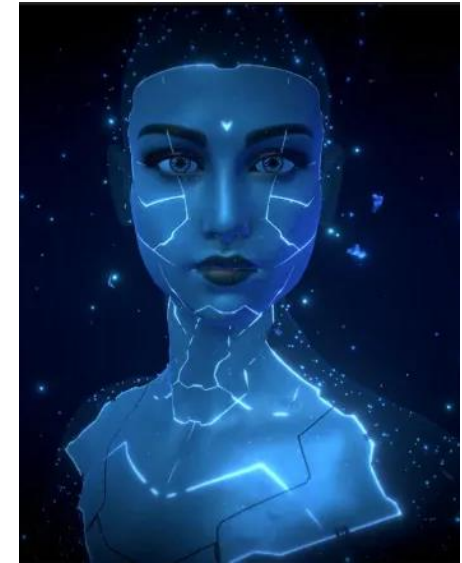
Robot vs Android
What's the difference?

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Androids

Robots designed to mimic human
behavior and/or appearance



AI, Ophelia

Center Phi
(<https://www.youtube.com/watch?v=MNoty7NdOO0>)



Cyborg and bionic systems (CBS)

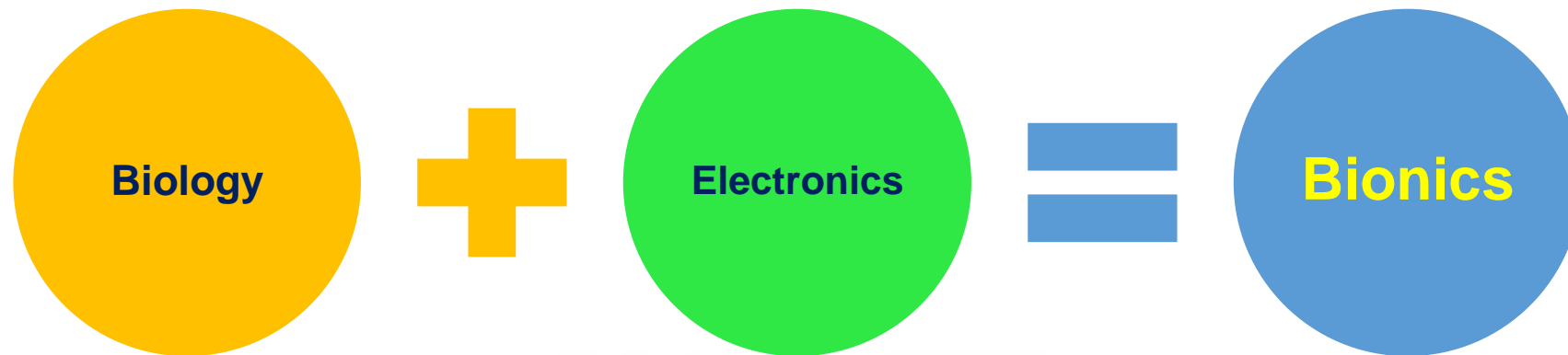
- CBS is hybrid fusion of organic and biomechatronic body parts, which integrates some artificial components or technology like bio-hybrid actuators and sensors.
- CBS aims to make an organism restored or enhanced beyond its original biological characteristics.
- CBS applications:
 - Tissue engineering
 - Individual rehabilitation treatment
 - Neuro control
 - Larger networks of communication and control

To achieve goals, we need a clear understanding of the organism mechanism, biological compatible materials, information perception and fusion, control of the implants.



Bionics

- Bionics refers to the flow of concepts from biology to engineering and vice versa.
- Bionics has been practically implemented and many people have overcome their disability to much extent by this technology since the development research in STEM CELLS, BIONICS, and SENSORY SUBSTITUTION
- The application of biological methods and systems found in nature to the study and design of engineering systems and modern technology.





Discussion and Presentation

How does the motion in human occur actually?

How does Bionics incorporate it?

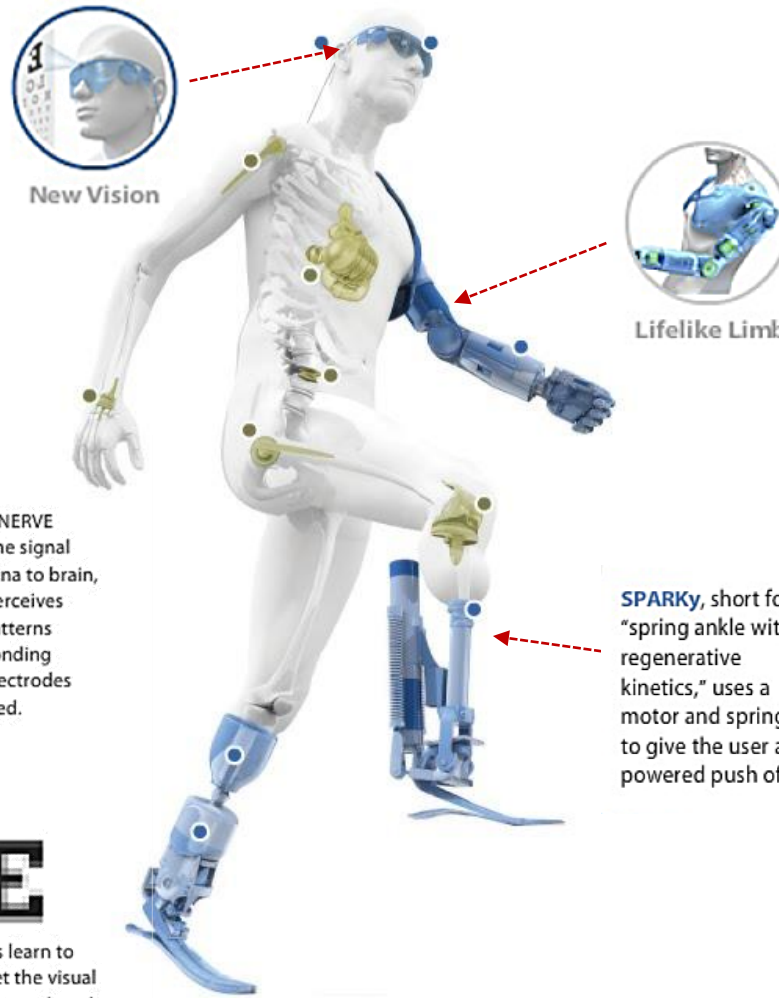


Classification of Bionics

- **Active Bionics:** The bionic part of a body that performs multiple functions.
- **Passive Bionics:** The bionic part of a body that performs single functions.

Basically, these parts are used as replacement in transplantation.

The Bionic Body



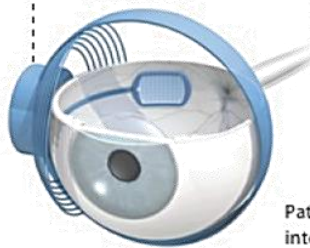
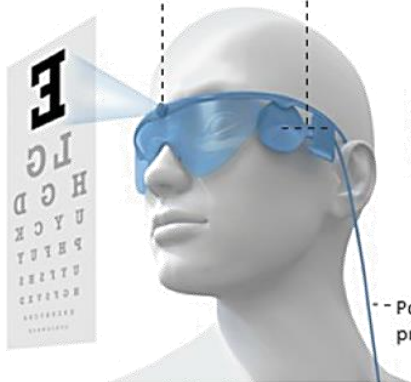
New Vision

1 VIDEO CAMERA sends images to a computer worn on a belt. The computer converts the video to a simplified signal.

2 TRANSMITTER sends the signal wirelessly to an implant in the eye.

3 RECEIVER sends the signal to the electrode array to stimulate the retina.

4 OPTIC NERVE carries the signal from retina to brain, which perceives visual patterns corresponding to the electrodes stimulated.



Power and data processing provided by belt computer.

E

Patients learn to interpret the visual patterns produced.

SPARKy, short for "spring ankle with regenerative kinetics," uses a motor and spring to give the user a powered push off.

Bionic body having Active & Passive bionic parts

Active Bionics
(Multiple functions)

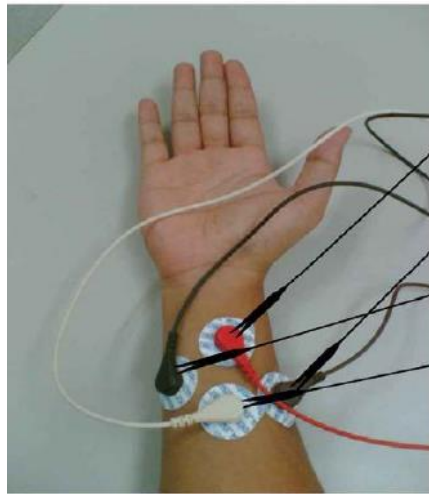
Passive Bionics
(Single function such as artificial replacements)



How does Bionics work

Amputated hand/legs or other locomotors

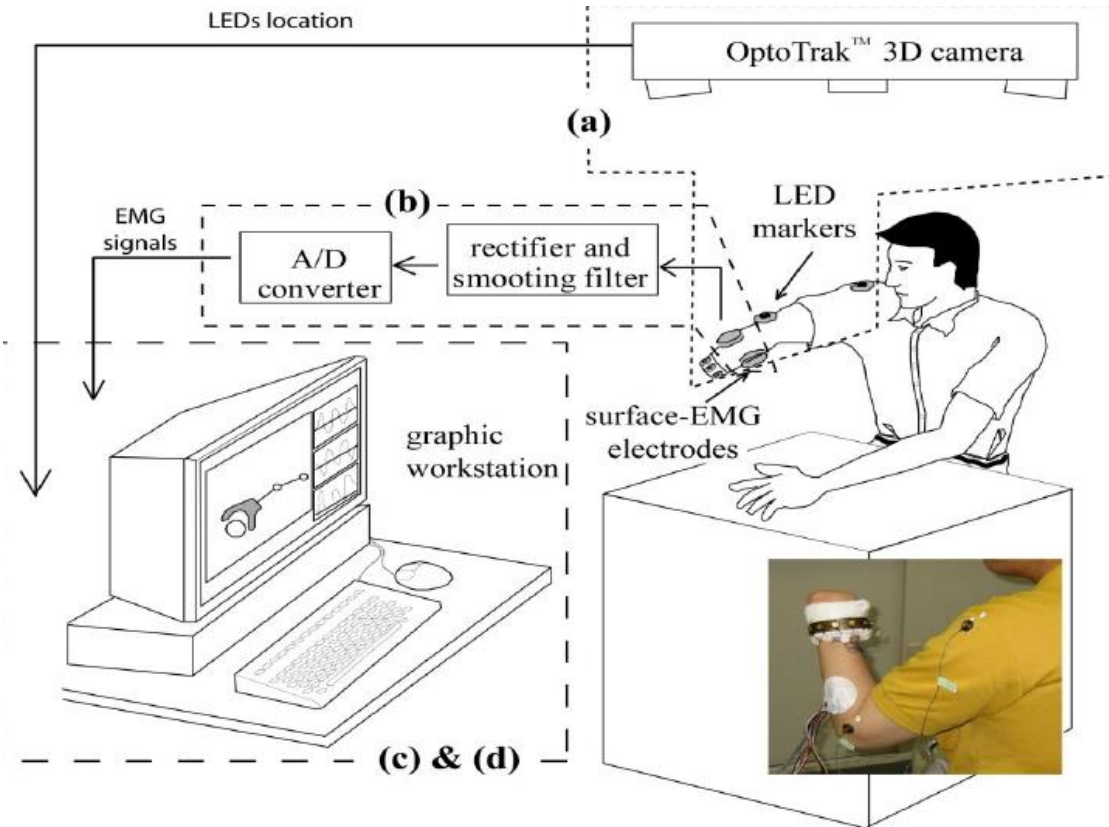
Position of the electrodes on the forearm muscles



- Red Positive = Flexor Carpi Radialis
- Brown Negative = Extensor Carpi Radialis
- Black Positive = Flexor Carpi Ulnaris
- Brown Negative = Extensor Carpi Ulnaris

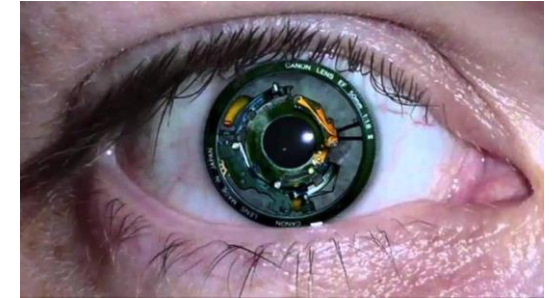
The surface electrodes are provided standard with the powerlab equipment and are disposable, with a conductive and sticky gel with adhesive ends

(ref)



Bionic Eye

Bionic eye mimics the function of retina to restore sight for those with severe vision loss. It uses a retinal implant connected to video camera to convert images into electrical impulse that activate retinal cells which carry the signal back to the brain.



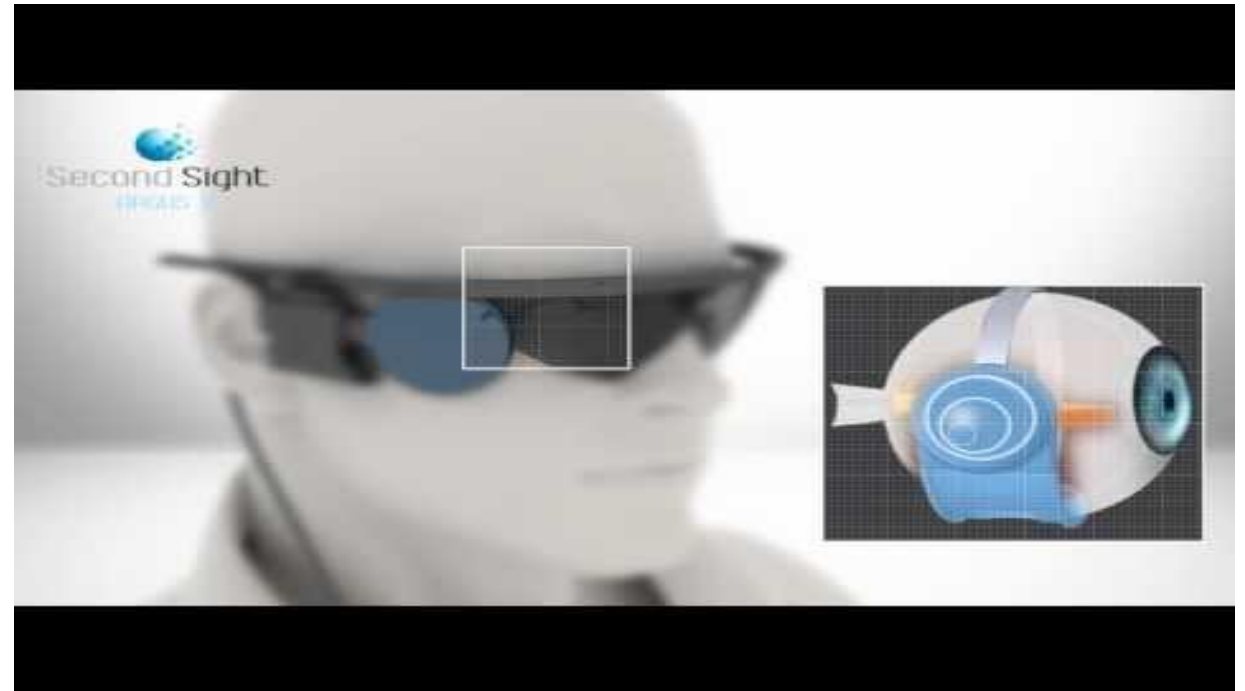
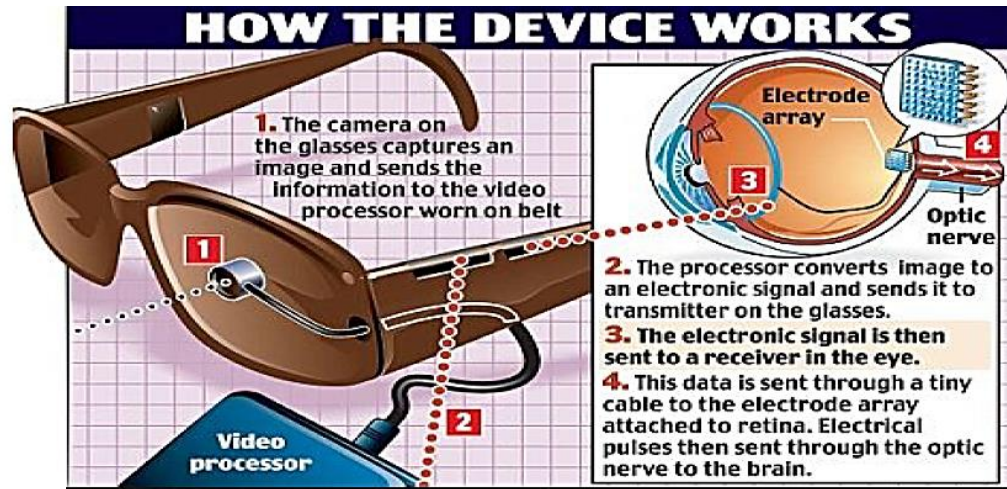
Working of Bionic Eye

- CCD Camera input – external light.
- CCD camera output – modulates laser source.
- This hits photodiode of implant.
- Provides power to chip drives current to electrodes facing retina.
- This excites the optic nerve of brain.
- Brain helps in perceiving an image.

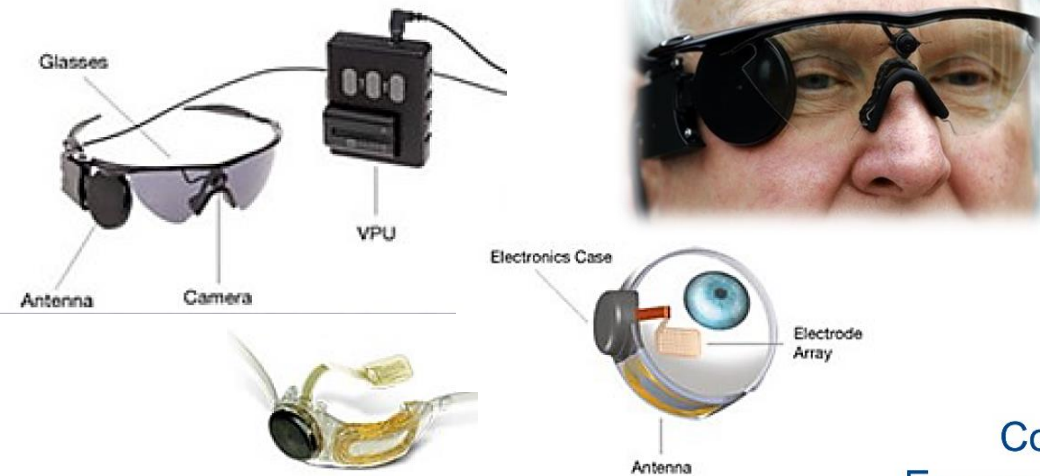


<http://emag.medicalexpo.com/the-future-for-bionic-eyes/>

Working of Bionic Eye: Argus II Retinal Prosthesis system



<https://www.engadget.com/2013-02-15-fda-clears-argus-ii-bionic-eye-for-sale-in-the-us-video.html>





Materials used in Making of Bionic body parts

- **Light weighted metals:** Titanium , Aluminium and Steel
- **Plastic polymer laminates:** Epoxy, Acrylic and Polyester
- **Reinforcement Textiles:** Nylon, Carbon Fibres, Kevlar.
- Etc.



Techniques to manufacture Bionic body parts



3D Printing

<https://www.forbes.com/sites/bernardmarr/2018/08/22/7-amazing-real-world-examples-of-3d-printing-in-2018/#320b01576585>



Casting

<https://www.amazon.com/Abu-Adiyat-STRONG-CASTING-TRIGGER/dp/B07BF6KSQN>



Plastic Forming

<https://www.amazon.com/Uvex-Bionic-Polycarbonate-Anti-Fog-S8510/dp/B001VY3ACE>

Advantages of Bionic Parts

- ✓ Improve the quality of life for those with certain disability.
- ✓ It is minimally invasive, reducing health risks to patients.
- ✓ Fewer complications from healing wounds and quicker recovery time.
- ✓ Biomaterials and biomedical devices can be used to replace damaged and diseased body parts like artificial joints, pins, screws, valves or lenses.
- ✓ Bionic parts will be everlasting in material cycle, as a result, increases material efficiency and durability.

Disadvantages of Bionic Parts



Religious groups and society believe bionics to be sinful.

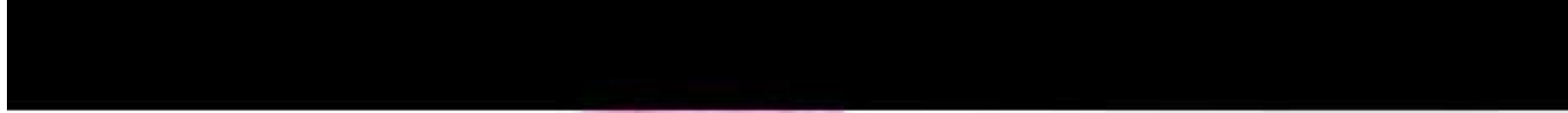


Bionic part may be operated at a lower level of effectiveness than that of blood- flesh equivalent.



It is the expensive example of advanced technology and hence deepen the gap between quality of life of poor and rich people.(cost of bionic eye is \$100,000 and bionic leg is \$150,000)

Bionic Flower – What can we learn from plants?



DidacticFesto (<https://www.youtube.com/watch?v=2BiyQlsseYI>)

Upgraded Bionic Hand Could Take over Factory Jobs: Festo – Bionic Mobile Assistant



Festo (<https://interestingengineering.com/upgraded-bionic-hand-could-take-over-factory-jobs>)

Cyborgs

- **Cyborg:** a human-machine combination that has certain physiological and intellectual processes aided or controlled by mechanical, electronic or computational devices.
- **Cyborg:** the need for mankind to artificially enhance biological functions in order to survive in the hostile environment of Space.
- **Cyborg:** Different from a robot. It used to repair or overcome physical and mental constraints.



(Manfred Clynes, 1960)

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Cyborgs

Cyborg types: Cyborgs are categorized into two types based on their structural and functional role play

- Individual Cyborgs
 - Artificial objects (e.g. prosthesis, C-leg)
 - Human with bionic or robotic
- Social Cyborgs
 - Cybernetic organism is used to describe larger networks of communication and control
 - A corporation can be considered as an artificial intelligence that makes use of replaceable human components to function



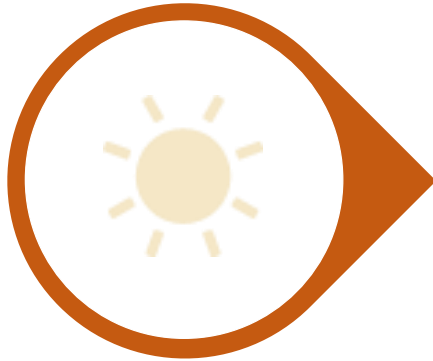


Applications of Cyborgs

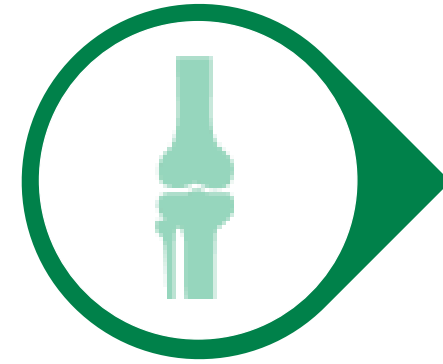
- Restorative & Enhanced
- Maximizing output and minimizing input
- BCI, provides a direct path of communication from the brain to an external device
- Limitations on speed, strength, endurance, and intelligence are overcome



Advantages of Cyborgs



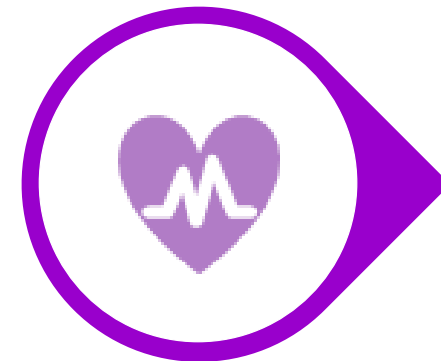
Prolongs life



Give a part of the body back



Enables one to lead a normal life



Improves the quality of life



Disadvantages of Cyborgs



Training is needed for doctors



The risk of rejection



They are all Expensive



Pain during operations



Psychological problems



Feeling different to everyone else



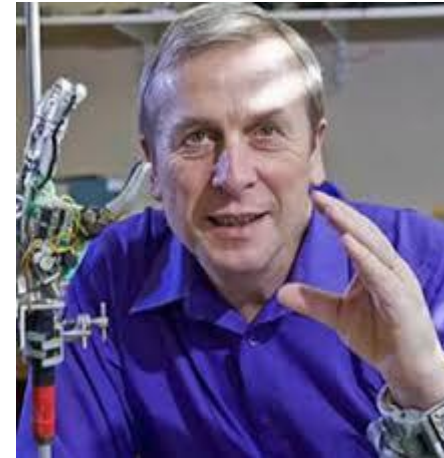
Applications of Cyborgs

- Cyborg proliferation in society in finance, military, medicine, art, sport, etc.
- Body modifications
- BCI (Brain-Computer Interface) controlled cyborg: providing a direct path of communication from the brain to an external device
- Restorative technologies: restore lost function, organ, and limbs



Applications of Cyborgs

Neil Harbisson



Kevin Warwick



Nigel Ackland

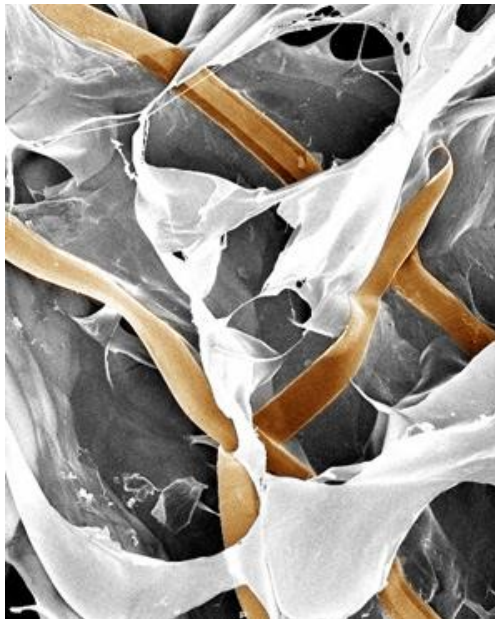


Claudia Mitchell

Applications of Cyborgs: Cyborg tissues

Cyborg tissues structured with carbon nanotubes and plant or fungal cells have been used in artificial tissue engineering to produce new materials for mechanical and electrical uses.

Wired scaffold



Researchers at Harvard University

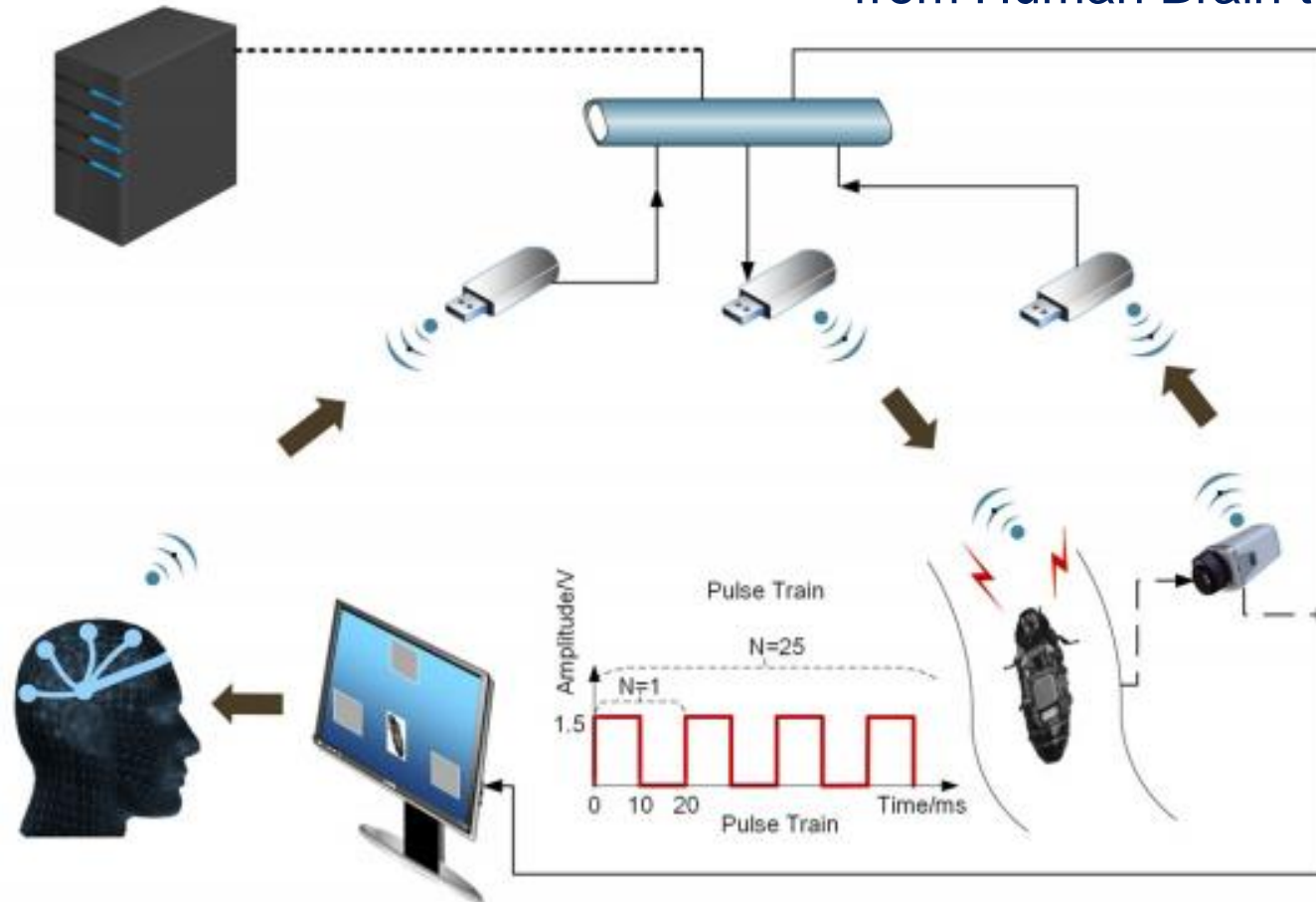
Construction of a material that merges nanoscale electronics with biological tissues → a literal mesh of transistors and cells.

Alginate (white), a seaweed-derived material used in conventional cell scaffolds, is deposited around nanoscale metal wires (**false-colored in brown**) to form a three-dimensional electronic scaffold.

<https://www.technologyreview.com/2012/08/27/184095/cyborg-tissue-monitors-cells/>

Applications of Cyborgs: BCI

BCI Controlled Cyborg: Establishing a Functional Information Transfer Pathway from Human Brain to Cockroach Brain



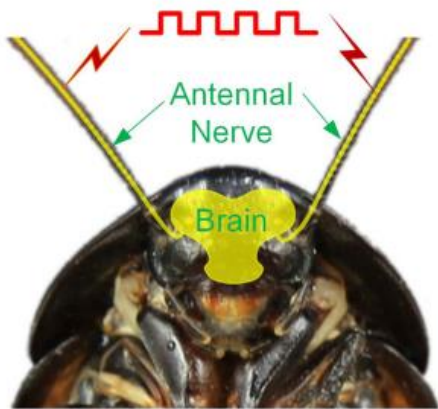
System Overview

- Entire system consists of an SSVEP-based BCI, a cyborg cockroach, and a communication sub-system.
- The communication sub-system transfers the real-time BCI commands from the host computer to the cyborg cockroach.
- The controller wirelessly steers the cyborg cockroach using his/her brain signals from the LCD screen.

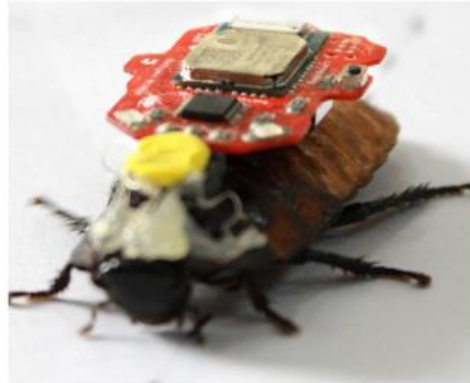
(Li and Zhang, 2016)

Applications of Cyborgs: BCI

BCI Controlled Cyborg: Establishing a Functional Information Transfer Pathway from Human Brain to Cockroach Brain



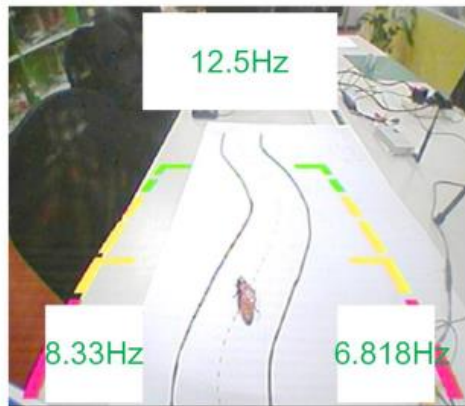
a



b



c



d

Experimental set-up

- a.** Nerve system of a cockroach and electrodes implantation.
- b.** A cyborg: a cockroach with a microstimulator on the back.
- c.** A human subject wearing an EEG headset.
- d.** Snapshot of the SSVEP user interface used in online control session

(Li and Zhang, 2016)



Factors Relating to Cyber-Human

- The Law of Artificially Intelligent Brains
- Modifying, Enhancing, and Hacking the Body
- Sensors and the Law (e.g. Sensors and Intellectual Property Law)
- The Law of Looks and Artificial Bodies



The Law of Looks and Artificial Bodies

Culture Is Important: As an example of the acceptance of androids into society

To achieve the lifelike look of

Matsuko's doppelganger

Professor Hiroshi Ishiguro's robotics lab used the latest silicon skin and state-of-the-art electronic actuators



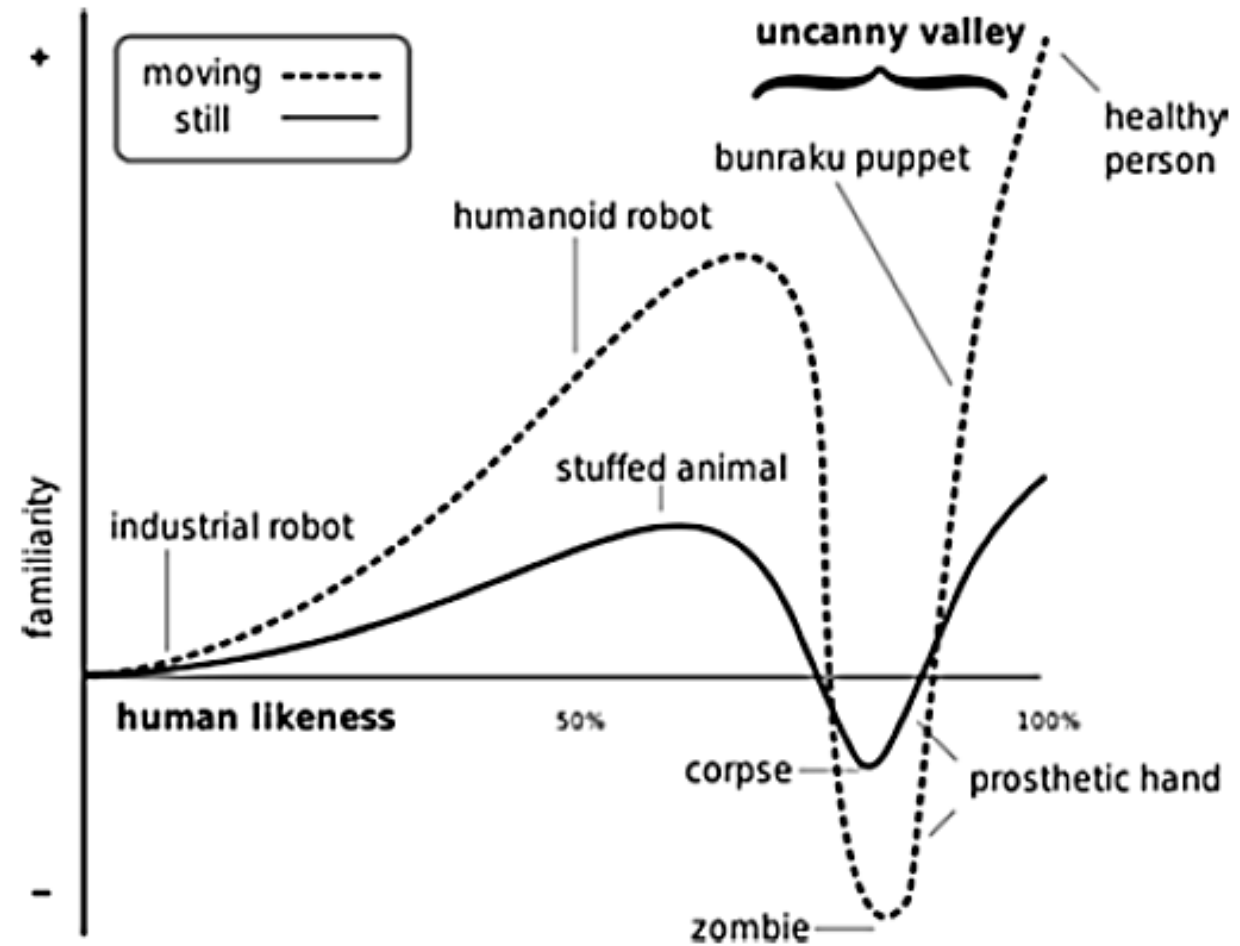
Robotics Professor Hiroshi Ishiguro and his android (Geminoid HI-4 image courtesy of Osaka University, Japan)

The Law of Looks and Artificial Bodies

The Uncanny Valley:

The concept was proposed by Mashario Mori. Image courtesy of Wikipedia Commons

The range of human expression when it comes to altering appearance is wide, and will be even more dramatic in the coming cyborg age as body and facial features for humans and androids are replaced with “cyborg” technology



The Law of Looks and Artificial Bodies

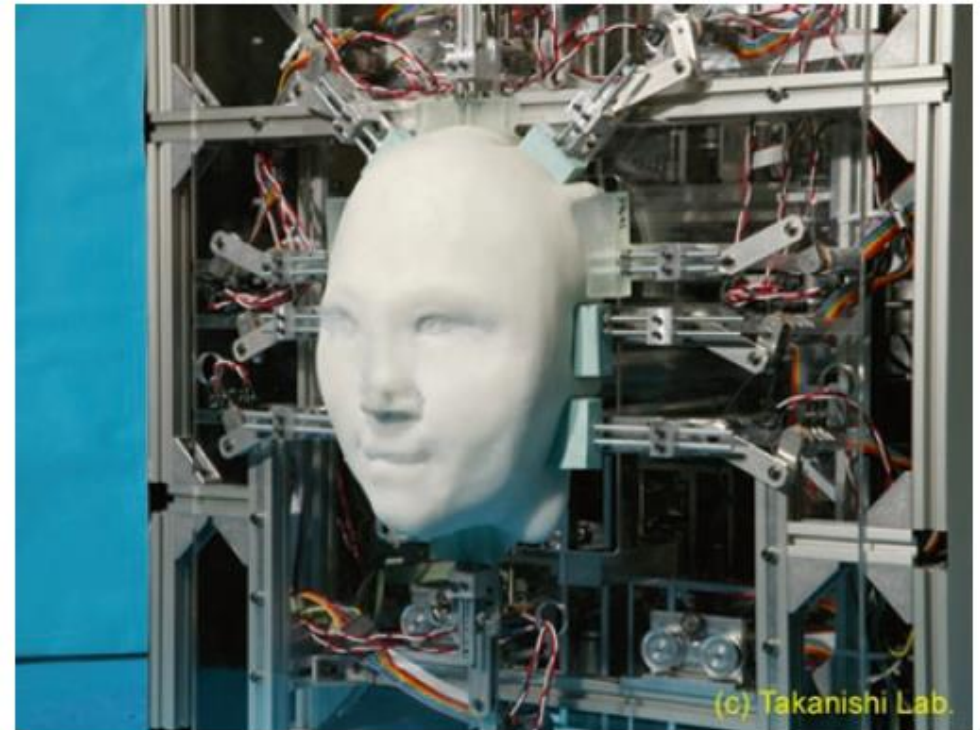
Copyright Law and Appearance:

Does copyright law offer any protection for the look, appearance, and bodies of androids and artificially intelligent machines?

Under U.S. copyright law:

Copyright protection extends to subject matter that represents “an original work of authorship, fixed in a tangible medium of expression from which the work can be perceived, reproduced, or otherwise communicated.”

(Barfield and Hill, 2015)



Meet WD-2, a robot that can change its facial expressions.
(Takanishi Lab, Waseda University, Tokyo)

Cyborgs

Cyborg Revolution: Latest Technologies and TOP of Real Cyborg



(Pro Robot: <https://www.youtube.com/watch?v=TyWohWpozp0>)

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Think to the Future of Cyber-Human?

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Thank You

Together We Will Make Our Education Stronger



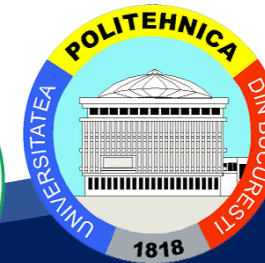
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