## Advances in Biotechnology

Biotechnology over the past few years has made incredible leaps and bounds since the original Robocop. In the 80s, the concept of a powered exoskeleton was considered mere science fiction, no more than 30 years later. With the advent of technology such as Hybrid Assistive Limbs and computers able to play pong simply with a helmet, the concept is almost within the grasps of the general public.

### Powered Exoskeletons

Powered exoskeletons are designed to provide strength, protection and assistance. With the need for protection in dangerous combat environments, as well as long treks in harsh conditions, the American army has had a need for a suit that would provide the user with extra power while carrying extremely heavy gear. Companies have tried to make exoskeletons work well, General Electric, in the 1960s, attempted to design the first powered exoskeleton, it was a failure mainly due to the fact that the unit could not control its own movements. In the past 50 years, huge improvements have been made. The most notable is Cyberdyne Inc. Hybrid Assistive Limbs (HAL). The HAL can carry up to 150 kilograms of weight without the user noticing very much of the weight. It uses Electroencephalography (EEG) technology to determine how an individual may decide to move and react appropriately. The suit currently has a battery life of 2 hours, with a larger battery in the realm of possibility. The HAL has also been designed to support the weight of those who can not support their own weight. Recently, Cyberdyne began renting out the suits for $22,000.

### Brain-computer Interfaces

Brain-computer interface (BCI) research deals attempts to improve functionality and repair the functions of the brain through the use of computers. The filed is split up into 3 major research areas, invasive, partially-invasive, and non-invasive area. Each research area has advantages and disadvantages. The invasive BCI has the advantage of being the most research, but it is rather risky because it can kill the cop under the wrong circumstances. Although partially-invasive BCI research is a valid research method, it has yet to produce reliable results and as such will be ignored.

#### Invasive BCIs

Invasive BCI is mostly focused on returning sight or motor functionality to the individual. Considering how much of the brain has been mapped out, direct access would offer the greatest amount of speed across the computer and the brain.

The process of installing this interface would involve cutting open the skull of an individual and installing nodes into to brain. Nodes would mostly be installed in the frontal cortex of the brain. The frontal cortex contains the motor system allowing computer direct access to the brain and its motor function. The premotor cortex stores information on patterns, for example walking, this would allow the exoskeleton to distribute power properly. The motor cortex controls more deliberate actions allowing the computer to determine whether the Robocop needs extra power in certain areas of the suit.

With the invasive nature of this research area, there are a few major problems with this type of BCI. The biggest problem with this interface type is due to the direct connection to the brain, for example, if the computer was to have a power surge, it would also send the surge to the components in the brain causing permanent damage to the brain. Other risks involve pulling on these wires causing damage to the frontal cortex, contaminants getting inside and having full access to the grey matter. Ignoring the risks, there is also the risk of signal degradation, as the brain starts to recover from nodes on the brain, it will create scar tissue that will eventually lead to signal loss, this would mean that as the Robocop gets more use and it would be less effective as time goes on.

Unfortunately due to the risk involved and the eventual signal loss, even when considering the initial speed advantages, it is unlikely that the invasive BCIs are to be used.

#### Non-invasive BCIs

Non-Invasive BCI tries to accomplish what invasive BCIs do without the need to penetrate the skull. This offers less risk to the Robocop, but because the skull has not been penetrated leads to significantly higher amount of noise. This type of interface has allowed people to play pong as well as type messages.

The most prominent form of non-invasive BCIs is Electroencephalography (EEG); EEG has shown that with training a user is able to perform simple tasks of typing out messages. EEG analyses the electrical activity of the brain through diodes on the surface of the skin, since the skull is between the diodes and the electrical activity appears weaker, noisier leading to less accurate readings.

With the appropriate training and proper kinetic anticipation algorithms, the non-invasive BCIs are a very good system to use with Robocops, and they do not require surgery for the technology to be possible.

With the available technology, nearly within grasps, it is possible to think that fully functional Robocop suits will be available within the next 10 years. The technology for the exoskeleton suit is already available to the public, the only missing part is a fully functional BCI device, and clearly we are going to be able to create a reliable interface in the near future.