Upgrading Humans via Implants – Why Not?

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This paper examines four different ways in which the use of implant technology opens up the possibility of upgrading human abilities, particularly in terms of mental accomplishments. In this overview of my research, I describe the incorporation of a neural implant which linked my nervous system bi-directionally with the internet. With the implant in place, neural signals were transmitted to various technological devices with the aim of controlling them directly, in some cases via the internet. Feedback to the brain was obtained from the fingertips of a robot hand, ultrasonic (extra-) sensory input, and neural signals received directly from another human's nervous system.

Prospects for the future are addressed here, both in the short-term as a therapeutic device and in the long-term as a form of enhancement, including the realistic potential, in the near future, for thought communication, an aspiration which opens up tremendous commercial potential. I consider the therapy/enhancement dichotomy here, as well as the military and medical issues. Clearly, though, an individual whose brain is part human and part machine is capable of possessing abilities that far surpass the individual who remains with nothing more than a human brain. The question arises: will such an enhanced individual exhibit different moral and ethical values to those of a human? If so, what effects might this have on society?

I
Example Number 1

The first example I wish to consider is the possession of a Radio Frequency Identification Device (RFID) implanted in the body. Such a device transmits by radio a sequence of pulses which represent a unique number. The number can be previously programmed to act rather like a PIN number on a credit card. Thus, with this implant in place, when activated, your code can be checked by computer.

Such implants are used, as a type of fashion item, to gain access to nightclubs in Barcelona and Rotterdam (the Baja Beach Club, for instance). Other uses include a high security device employed by the Mexican government, or a medical information source (having been approved in 2004 by the U.S. Food and Drug Administration which regulates medical devices in the U.S.A.).[1] In the latter case, information on your medication – diabetes, for instance – can be stored on the implant. The advantages are numerous. Because it is implanted you cannot forget it, you cannot lose it, and it will not be stolen.

An RFID implant does not have its own battery, but rather has a tiny antenna and microchip enclosed in a glass capsule. The antenna picks up power remotely when passed close to a larger coil of wire which carries an electric current. The power picked up by the antenna in the implant is employed to transmit by radio the particular signal encoded in the microchip. Because there is no battery, or any moving parts, the implant requires no maintenance whatsoever. Once it has been implanted it can be left there. How long has this been going on? The first such RFID implant was put in place on the afternoon of 24 August 1998 in Reading, England. That first implant measured 22 mm long, with a 4 mm diameter cylinder. The body selected was my upper left arm. The doctor involved, George Boulos, burrowed a hole, pushed the implant into the hole, and closed the incision with a couple of stitches.

The main reason for the selection of the upper left arm for the implant was that we were not too sure how well it would work. The reasoning was that if the implant was not working it could be waved around until a stronger signal was transmitted. It is interesting to note that most present day RFID implants are located in a roughly similar place (the upper left arm), even though there is no necessity for this. For example, in the recent James Bond film *Casino Royale* (2006) Bond himself has an implant – in his left arm!

The RFID implant allowed me to control lights, open doors, and even receive a welcome – 'Hello Professor Warwick' – when I entered the front door at Reading University.

The use of such implant technology for monitoring people opens up a considerable range of issues. Tracking individuals in this way, either by means of an RFID, or via a Global Positioning System or the cell phone network, is now a realistic concept. Ethically, though, considerable questions arise, especially when it is children, the aged, or prisoners who are being tracked.

In the case of a missing child, who might have been abducted, a tracking implant could be activated in order to enable the child to be located immediately, thereby possibly saving a life, and certainly saving a good deal of police time and parental anguish. Nevertheless, is it appropriate for small children to be given implants in this way? In many countries, children are injected with chemicals (vaccinations) that we still do not fully understand and that have several side effects. If this is deemed ethically acceptable, why not incorporate a tracking implant to keep our children safe?

II
Example Number 2

When one thinks of a robot it may be a little wheeled device that springs to mind,[2] or perhaps a metallic head that looks roughly human-like.[3] Whatever the physical appearance we suppose that the robot might be operated remotely by a human, or we imagine that it is controlled by a simple programme, or that it might even be able to learn with a microprocessor/computer as its brain. In the first case there is no blurring of human/machine boundaries. In the latter two cases we are still sure that the artificially intelligent robot is very different to ourselves. In short, we regard a robot as a machine.

In a present project at Reading University, neurons are being cultured in a laboratory to grow on and interact with a flat multi-electrode array. The neural culture, a biological brain, can be electronically stimulated via the electrodes and its trained responses can be witnessed. As long as this occurs solely in a university laboratory, it probably does not raise ethical concerns for anyone.

However, the project is now moving to enable the biological brain to form part of a robot device. In the first instance, this will be a small-wheeled robot. The input (sensory) signals in this case will be only the signals obtained from the wheeled robot's ultrasonic sensors. The output from the biological brain will be used to drive the robot around. Initially the goal of the project will be to train the brain to drive the robot forwards without bumping into any object.

What this means is that the brain of the robot will shortly be a biological brain, not a computer. All the brain will know is what it perceives from the robot body, and its only action will be to drive the robot body around. The biological brain will, to all intents and purposes, be the brain of the robot. It will have no life, no existence outside its robotic embodiment.

The question then arises: how do we treat the robot? Do we treat it as a robot or as an animal? If the robot has the same number of neurons as a dog, should we need a license for it? Who will be responsible when it does something it shouldn't do? Clearly, the ethical considerations we have given to machines change shape when robots have biological brains.

III

Example Number 3

There now exist several different types of brain/computer interfaces, employed either for research purposes or for standard medical procedures.[4] The number actually in position and operating at any given time is steadily growing, a trend that is likely to increase in the years ahead. Some of these are primarily aimed at therapeutic practises whilst others have a broader portfolio, including the possibility of upgrading and enhancing human individuals. In all cases, further implantations are at this time forging ahead with little or no consideration of the ethical issues arising. It is time that such issues were given an airing.

Perhaps, in some peoples' eyes, the use of deep-brain stimulators for the treatment of Parkinson's disease, epilepsy, or Tourette's syndrome is perfectly acceptable because of the improved standard of living it can provide for the individual recipient.[5] However, long-term modifications of brain organisation can occur, in each case causing the brain to operate in a completely different way. In other words, there can be considerable long-term mental side effects in the use of such technology. On the other hand, such stimulators, positioned in central areas of the brain such as the thalamus, can cause other results, including distinct emotional changes. Thus, the picture is not one of simply overcoming a medical problem; it is far more complex.

The use of such a stimulator raises interesting questions. For example, if an individual with such a stimulator implanted in her or his brain murdered another person and then claimed it was not her or his fault but the fault of the stimulator then who would be to blame for the murder? Would it be the individual, despite protests that the implant was overriding normal brain function? If a stray radio signal had caused the problem, could we say it was the person broadcasting at the time? Perhaps it is the surgeon who put the implant in place who is to blame, or maybe a researcher who worked on the device ten years ago. Clearly, we have a potential problem even now.

Now intelligent deep-brain stimulators are starting to be designed.[6] In such a case a computer (artificial brain) is used to understand the workings of specific aspects of the human brain. The job of the artificial brain is to monitor the normal functioning of the human brain such that it can accurately predict a spurious event several seconds before it actually occurs. Take a Parkinson's tremor. The aim would be for an electrical signal to be transmitted several seconds before, so that the spurious event does not actually occur. In other words, it is the job of the artificial brain to out-think the human brain and to stop it doing what it normally wants to do. Clearly the potential for this system to be applied across a broad spectrum of different uses is enormous. Maybe this pre-emptive system could assist in slimming or in controlling a spouse.

IV

Example Number 4

With more general brain/computer interfaces the situation is less clear. In some cases it is possible for those who have suffered an amputation, or who have received a spinal injury, to control devices via their (still functioning) neural signals.[7] Meanwhile stroke patients can be given limited control of their surroundings, as indeed can those who have motor neurone disease. Even in these cases the situation is not exactly simple, as each individual is given abilities that no normal human possesses; for example, the ability to move a cursor around on a computer screen using neural signals alone.[8] The same quandary exists for blind individuals who are allowed extra-sensory input, such as sonar (a bat-like sense). This does not repair their blindness but rather allows them to make use of an alternative sense.

Then there are ongoing experiments involving healthy individuals, in which the use of a brain/computer interface does not involve any reparative element.

Rather, the main purpose of the implant is to enhance an individual's abilities. Indeed I have been involved in such implant testing.[9] Extra-sensory input is one possibility, but there are many more as well, such as improving memory, thinking in many dimensions, and communication by thought alone. These are just some of the potential, yet realistic, benefits. To be clear: all these things appear to be possible for humans in general.

On 14 March 2002, during a two-hour procedure at the Radcliffe Infirmary, Oxford, an MEA was surgically implanted into the median nerve fibres of my left arm. The array measured 4 mm x 4 mm with each of the electrodes being 1.5 mm in length (**see fig. 1**). With the median nerve fascicle estimated to be 4 mm in diameter, the electrodes penetrated well into the fascicle. The array was pneumatically inserted into the median nerve in such a way that the body of the array sat adjacent to the nerve fibres with the electrodes penetrating into the fascicle.

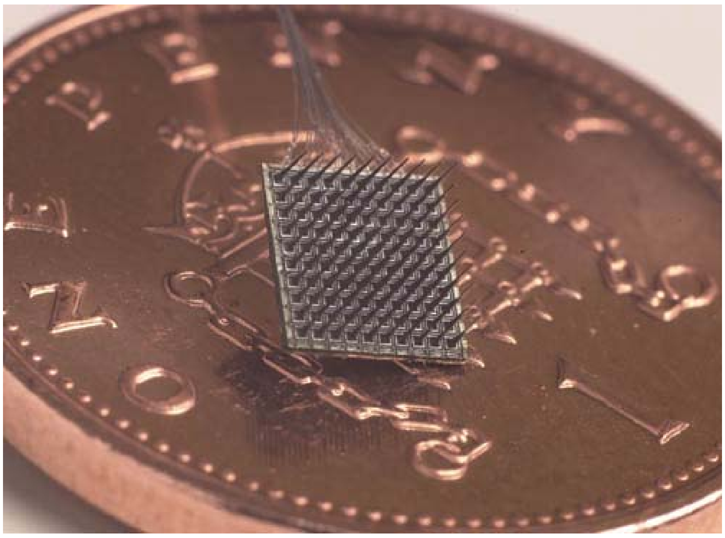

Fig. 1 A 100 electrode, 4 x 4 mm MicroElectrode Array, shown on a UK one pence piece for scale

The array was positioned just below the wrist, following a 4 cm long incision. A further incision, 2 cm long, was made 16 cm proximal to the wrist. The two incisions were connected by a tunnelling procedure such that wires from the array ran up the inside of the left arm where they exited and connected onto an electrical terminal pad which remained external. The arrangements described remained permanently in place for ninety-six days, until 18 June 2002, at which time the implant was successfully removed.

V
Nerve Stimulation

The array, once in position, acted as a neural interface. Signals could be transmitted directly from a computer, either by means of a hard-wire connection or through a radio transmitter/receiver unit, to the array, thus directly bringing about a stimulation of the nervous system.

An experiment was set up to determine if the human brain is able to understand and successfully operate with sensory information to which it had not previously been exposed. Whilst it is quite possible to feed in such sensory information via a normal human sensory route – e.g. electromagnetic radar or infrared signals are converted to visual – what we were interested in was feeding such signals directly onto the human nervous system, thereby bypassing the normal human sensory input.

Ultrasonic sensors were fitted to the rim of a baseball cap (**see fig. 2**) and the output from these sensors, in the form of a proportional count, was employed to bring about a direct stimulation of the nervous system. Thus, when no objects were in the vicinity of the sensors, no stimulation occurred, and as an object moved close by, so the rate of stimulation pulses being applied increased in a linear fashion up to a pre-selected maximum rate. No increase in stimulation occurred when an object moved closer than 30 cm to the sensors.

It was found that very little learning was required for the new ultrasonic sense to be used effectively and successfully, simply a matter of five to six minutes. This said it is important to realise that it took several weeks for the recipient's brain to recognise successfully and accurately the current signals being injected.

Fig. 2 Experimentation and testing of the ultrasonic baseball cap

As a result, in a witnessed experiment, the recipient, whilst wearing a blindfold, was able to move around successfully within a cluttered laboratory environment, albeit at a slower than normal walking pace. The sensory input was ‘felt’ as a new form of sensory input (not as touch or movement) in the sense that the brain made a direct link between the signals being witnessed and the fact that these corresponded in a linear fashion to a nearby object. The extent of this perception was also such that when an object was rapidly brought into the recipient’s line of (ultrasonic) sight, this had the effect of frightening the recipient.

Currently, to get permission for an implantation requires ethical approval in each case from the local hospital authority in which the procedure is carried out. Furthermore, if appropriate, each research procedure also requires approval from the research and ethics committee of the establishment involved. Apart from Devices Agency approval if a piece of equipment, such as an implant, is to be used on many individuals, no general ethical clearance is needed, despite the issues being so complex.

Should it be possible for surgeons to place implants which make the individual happy, sad or sexually excited? If it is acceptable for a person who is blind to receive an implant which allows them extra sensory input, then why cannot everyone have such an implant if they want one? Should we continue to develop implants that allow for brain enhancements when such research may lead to non-implanted humans becoming subservient to their intellectual (implanted) superiors?

VI
The Epilogue

In this article we have looked at four different cases in which humans and/or animals merge with technology, in the process stirring up a plethora of ethical considerations.

In example 1, the issue was tracking and monitoring. Should such technology be available for parents to ensure that their children are safe? What rights do the children themselves have? Should the same technology be used in another way to monitor the movements of prisoners?

Example 2 raised the question of robots with biological brains, ultimately perhaps with human brains. Should such a robot be given rights of some kind? If one were switched off, would this be deemed cruelty to robots?

Example 3 looked at some of the ethical issues raised by seemingly therapeutic-only implants such as those used for the treatment of Parkinson's disease, now a relatively standard procedure. Not only does the present implant give rise to possible problems concerning responsibility, but when an intelligent, predictive implant is employed is it acceptable, even for therapeutic reasons, to have a computer brain outwitting a human brain, stopping it from doing what it naturally wants to do? If you cannot do what your own brain wants you to do, then what?

Finally, example 4 looked at the potential for human enhancement. Already extra-sensory input has been scientifically achieved, extending the nervous system over the internet and enabling a basic form of thought communication. If many humans upgrade and become part machine (cyborgs) themselves, what would be wrong with that? If humans are left behind as some kind of sub-species, what is the problem? If you could be enhanced, would you have a problem witnessing the funeral of humankind?

Endnotes:

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