This response was submitted to the consultation held by the Nuffield Council on Bioethics on *Novel neurotechnologies: intervening in the brain* between 1 March 2012 and 23 April 2012. The views expressed are solely those of the respondent(s) and not those of the Council.

Bob Whitcombe

1. Have you ever used a technology that intervenes in the brain, and with what consequences? Please describe your experience.

None

2. If you have not used a technology that intervenes in the brain before, would you do so if you were ill? Why / why not?

Yes - I assume that much of the technology is on a Moore's Laws path and the functionality is increasingly in software sophistication.

3. Would you use a technology that intervenes in the brain for non-medical purposes, such as gaming or improving your cognitive skills? Why / why not?

Yes – direct brain access to the World Wide Web will transform the world – but does it ignites a cognitive singularity leading to deeper collaboration and technical progress for the race or leads to a subversion of development where a few benefit and class struggles between rich and poor, young and old are destructively amplified.

4. What are the most important ethical challenges raised by novel neurotechnologies that intervene in the brain?

Who gets access, what abilities does it confer, what is the cost and will this be a vehicle that creates an even greater generational divide than exists today.

5. In what ways, if at all, should the development and use of these technologies be promoted, restricted and/or regulated? Please explain your reasons.

Priorities should be established for the basic connectivity to the brain and external compute/machines to create interface standards. These standards should partition between observational input and active input – where observation is defined as passive and benign while active input can transfer skills or knowledge – thus rewriting sections of the brain.

The market should be tasked to test multiple variations and optimizations around those standards. The benefits of connectivity, access to services for disabled; improved services for business; connected collaboration; fine coordination for global projects etc are tools that can be developed across wide ranging networks – those managing energy systems, smart grid, medical, big data and ultimately human knowledge bases and training and education systems.

I would put huge restrictions on anything that rewrites or reverses the flow of information to the receiving brains. Content needs to be isolated so the process of viewing and absorbing information.

I would put the process of capturing, mapping and remapping synaptic content into a research arena with extensive safeguards. Some mechanism should be established for encryption or other barriers to transfer across the standard Brain Machine Interfaces.

6. Have you used a BCI, and if so, with what consequences? Please describe your experience.

NONE

7. If you have not used a BCI before, under what circumstances would you do so?

Looking forward to replacing my iPAD with a BCI over wireless.

8. What are your expectations and concerns for BCIs?

I expect Mark1 versions to yield rapidly to Mark 2,3,4 etc as experience drives algorithmic sophistication and carbon based semiconductors "learn" to map physically to the brain cortex. The concern is when does a BCI create an open channel so that information is no longer static but in fact starts to impact how the receiving brain adapts to receiving signals.

9. Are there any particular ethical or social issues associated with BCIs?

My issue is whether the BCI is a one-way or two way street. If it is a one-way street where the brain is a passive receptor of information and the hurdle to creating a two way street appears consequential – then I have few ethical or social reservations. Once we start learning how to write to memory, transfer synaptic learning's from one person to another – then I have real problems and feel we need to restrict functionality of deployed interfaces. I think we all see the issues of "One Ring".

10. What would robust and effective regulation of research in this area look like? Is more or less regulation needed? Please justify your response.

I use the "Look but don't touch" as the vehicle for demarcation and guide to regulation. Look implies a one-way interface where information is transmitted, is transitory and goes to temporary memory only. Anything that involves "touch" where data transferred to the receiving brain and enters long term memory or alters behaviour or transfer of skills needs to be part of research and strictly regulated. An interface that can "reach out and touch me" is to be feared and protected against. In the case of touch with respect to a new system where the World Wide Web meets millions of innocent brains, the transmission of a computer virus takes on new potential for harm and damage that could be the ultimate "Neutron Bomb" that destroys the people and leaves the buildings behind.

The only thing that scares me more than the potential for "One Ring to Rule them all" is lots of little warring rings.

In the end it all comes down to whether we have one-way or two-way interfaces. Obviously military – and probably gamers – will want two way interfaces. If they become vehicles for rapidly advancing training, driving skills to flexible younger minds – then without clear safeguards on independence and where the point of control resides we will have created another nightmare. Having said that – I do see the potential for a future where the collective consciousness – hopefully much more sophisticated than some future neuro-facebook – will move the point of control from the individual who is able to look in today to a future where the collective decides what your participation and resource levels will be.

11. Have you used neurostimulation and if so, with what consequences? Please describe your experience.

NONE

12. If you have not used neurostimulation before, under what circumstances would you do so?

Illness or the potential for improved vision, relaxation.

13. Under what circumstances do you think it might be acceptable to use neurostimulation in non-medical context (that is to say, not for the treatment of a disease or disability)?

Web Interface – the new iPAD/communications platform

14. Are there any particular ethical or social issues associated with neurostimulation?

Promises vs returns – can TMS or an invasive procedure deliver the services without compromising quality of life. I have a neighbour using DBS for Parkinson's and it is clear how primitive our treatment modalities are.

15. What would robust and effective regulation of research in this area look like? Is more or less regulation needed? Please justify your response.

My concern is the limited pool from which to strain results. I believe we need a well regulated process – but one that is of substantially higher scale.

16. Under what circumstances would you use neural stem cell therapy?

Today – Last Resort – insufficient science

17. What do you think of the risks and benefits of neural stem cell therapy?

Mistakes by quacks selling below their knowledge levels

18. Are there any particular ethical or social issues associated with neural stem cell therapy?

Who is doing what and what results are delivered? I appreciate the need for experiments – but we need a class of individuals ready to accept the risks and need to have clear oversight to document results. Anecdotes can kill.

19. How do you feel about neural stem cell therapy being used for non-medical purposes one day, for example for human enhancement?

Inevitable – but we are moving beyond our knowledge at the moment. Ultimately we will achieve the breakthroughs and process models. I see a huge opportunity with Moore's Law enabling gene tracking and getting costs for genetic characterization down from months to weeks and from millions to a thousand dollars. I do not have a good timeframe for deliverables.

20. What would robust and effective regulation of research in this area look like? Is more or less regulation needed? Please justify your response.

My wife has multiple myeloma and I am acutely aware of the tyranny of hope vs the agony of limited capability. Hence regulation in this field is about careful characterization and documentation for well defined trials. All trials need full genetic characterization of participants and tracking of results – that can then be part of future trial to refine or update approaches. It is insufficient to run a trial with "women under 30 vs women over 30". Need more specific trials – women between 45 and 50 who have had children and carry a specific P53 genetic condition. Only with gathering of very specific data will we be able to refine models of genetic interaction that let us see how the body uses stem cell therapies and then how to optimize them.

Additional comments:

We differentiate humans from animals by the quality of our tools. The integration of silicon or carbon chips into our systems to enhance our health and other abilities is simply an extension of the application of tools. I had an epiphany while in High School some 40 years ago that mankind's role was to give birth to silicon based life forms – some years before the notion of the cyborg. It is clear we will start with ever more capable prosthetics – spurred by our need to remediate the impacts of war on our soldiers. The next step is to evolve from laughable parody to parity then dramatic improvement. With that natural evolution will come an understanding of how to integrate health benefits from specialized nanotech with our genetic structures to assist and improve our ability to combat disease.

The direction is inevitable but the ethical issue is how to enable society at large with this capability vs enabling the very few and very rich group of haves that form a distinct class overseeing a world of have nots. To me this is an issue of the technology roadmap. Do the early adopters pay a premium for Gen1 technology that is rapidly superseded by gen2,3,4 at significantly lower cost? What is the Moore's Law equivalent for hybrid carbon/silicon/organic integration? My feeling is that if the generational gap exceeds 10 years we have a real problem. If the gap and cost delta can be put on a 2-3 year timeline- we can manage.

The key will be the cost of upgrades – can a Gen1 user move to Gen2 effortlessly – or does it cost twice as much as waiting? What is lost on upgrades to memory, personality etc. What happens to memory and personality that move to the cloud for temporary storage during an upgrade? Will a person whose synapses move from chemical to optical speeds even want to go back to being a meat person?

Adoption will drive a wedge between technology luddites on one side ("Fleshies" – in support of the "pure" human) and today's youth who think nothing of body paint, tattoos and piercings as vehicles for differentiation. They will love the idea of an integrated iPhone – complete HUD on contacts, Chips inserted into the brain or ears to enable wireless access to communications and internet services. This will be the free taste – the rest of the future will be paid for by this success.

I believe our current technology has us on a trajectory to confront these issues in less than 50 years. Retirement becomes much more interesting. I am buying Apple now to reserve a place in the cloud for the fabric of my intellect before disease robs me of its vibrancy.