CYBORGS

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Abstract— Cyborgs- cybernetic organisms, hybrids of humans and machines, have pervaded everyday life, the military, popular culture, and the academic world since the arrival of cyborg studies in the mid-1980s. There has been a recurrent theme in STS in recent decades, but there are surprisingly few cyborgs referred to in the early history of cybernetics in the USA and Britain. In this paper, I analyse the work of the early cyberneticists who researched and built cyborgs. We then use that history of cyborgs as a basis for reinterpreting the history of cybernetics by critiquing cyborg studies that give a teleological account of cybernetics, and histories of cybernetics that view it as a unitary discipline. We argue that cyborgs were a minor research area in cybernetics, usually classified under the heading of `medical cybernetics', in the USA and Britain from the publication of Wiener's *Cybernetics* in 1948 to the decline of cybernetics among mainstream scientists in the 1960s. During that period, cyberneticists held multiple interpretations of their field. Most of the research on cybernetics focused on the analogy between humans and machines — the main research method of cybernetics — not the fusion of humans and machines, the domain of cyborgs. Although many cyberneticists in the USA and Britain viewed cybernetics as a `universal discipline', they created contested, area-specific interpretations of their field under the meta-discourse of cybernetics.

Keywords— **Cyborgs, Cyberneticists, Cybernetic Organisms, Medical Cybernetics, Meta-discourse of Cybernetics.**

I. INTRODUCTION

Though this technology seems science-fictional, it is no different from the state of recombinant rDNA research in the 1960s. At that point, the technology was only in its infancy, yet prescient social critics like Jeremy Rifkin were already starting to question whether all the possible dangers this technology would present were controlled for. Bioelectronics is already a real and recognized bioengineering discipline in Europe, and there are research laboratories already in place - the International Society for Molecular Electronics and Biocomputing (ISMEBC) based in Hungary and the Electronics and Biotechnology Advanced (E.L.B.A.) Research Park on the Mediterranean Island of Elba. The ELBA centre aims to produce biochips and bio computers within the next decade. Syracuse's Centre for Molecular Electronics has had some success in utilizing bacterially generated rhodopsin for the formation of optically-encoded Random Access Memory (RAM.) Other research centres have recently announced breakthroughs in utilizing DNA as the substrate for a massively accelerated supercomputing process, and replacing damaged optic nerves in blind people with electronic technology that might restore vision.

There have always been electronic medical devices available for people ever since the Civil War. People are already benefiting from pacemakers, artificial hearts, prosthetic limbs, hearing aids, and hormone-producing implants such as Norplant. However, these recent breakthroughs in bioelectronics mean new technologies that may interface with the human nervous and other biological systems at a more basic level; nanotechnology and nano-machines may be able to effect biological changes at the intracellular level, causing changes in human biological structure that might be unprecedented. During the debates over recombinant DNA research, much of the public showed at the same time enthusiasm for the possibility of gene therapy curing previously unstoppable hereditary disorders, and also *panics* toward the possibility that this might be used for eugenic purposes,

either to "cure" deficits in human attributes or perhaps "promote" improved ones. Bioethicists began to raise a host of issues pertaining to this research, ranging from the release of modified microorganisms into the environment to the disappearance of human difference. This debate has only become more confused with the addition of bioelectronics to the armory of biotechnology.

It is disturbing, but perhaps at least acceptable, for people to face the fact that they have a large degree of kinship with other forms of life on the planet, and that their genes might be interchangeable with its entire countless species. However, bioelectronics research suggests a relationship between humans and computers that is perhaps even more troubling. While cognitive scientists and artificial life researchers have alluded to this relationship in theoretical ways, bioelectronics researchers are demonstrating it in a very practical way in the laboratory. The integration of biological and electronic processes suggests that they may be very similar in their mode of operation, and only based on different physical constituents. For most people, this touches on fundamental issues of what it means to be human. Most people assume that they have attributes machines do not (free will, emotions, a soul) but will these beliefs hold up as electronic technology becomes 'hardwired' into human organisms?

Numerous arguments for bioelectronics have been advanced, from the mundane (simple medical benefits) to the grandiose (cosmic purpose). Likewise, there have been critics of the emerging field of biocomputing, whose critiques have ranged from the practical (how well will all this work) to the fanciful (science-fiction scenarios.) In this paper, these positive and negative arguments will be reviewed and weighed. Though this is a novel field for the applications of computing in modern society, it is one which humanity has been weighing in its collective imagination for a long time through literature and the arts. Ultimately, the paper aims to convince the reader that despite all the potential benefits of this new technology, there are real and substantive issues which go beyond its alleged advantages for humanity and suggest it should not proceed without social concern and control.

II. WHAT IS A CYBORG?

A cyborg is part human and part machine (robot), a hybrid of neurons and wires or circuits. It is a human being artificially transformed into a machine by providing a proper interface between man and computer. And Cyborg means “Cyber Organism”.

III. WHAT IS NEURAL INTERFACING?

The Society for Neural interfacing (SNI) actively promotes research on innovative approaches dedicated to Neural Interfacing (NIF). Evaluating current technology and its intrinsic limitations it is possible to outline an almost perfect Neural Interfacing technology, however, predictions are largely based on current visions and one's imagination. Thus, the content of this site is expected to be up dated on a regular basis. NIF techniques with the potential of significantly improving current electrophysiological approaches should display the following features:

A. Non-invasive communication with the neural tissue
B. No harming side effects
C. Spatial resolution in the range of micro- or nanometres in order to specifically target individual neuritis.
D. Temporal resolution at the millisecond level in order to capture neural processes.
E. Real-time data acquisition and processing.

An interesting concept that may ultimately merge the requirements listed is the communication with neural tissue by means of electromagnetic fields. An ideal NIF technology would enable the real-time visualization of thoughts.

IV. POSITIVE ARGUMENTS

Certainly, there have been a number of positive responses to this 'cyborg' phenomenon. There have been a number of AI researchers like Hans Moravec who have unabashedly declared that it may be time for carbon-based biological life to yield

control of the planet to its 'mind children,' silicon-based life. They claim that the phenomenon, seen from a grand evolutionary perspective, can be seen as part of the grand design of evolution. The human cyborg represents a 'transitional species' of sorts, before the human enters total post-biological obsolescence. If evolution is theorized from an abstract perspective as an attempt to increase the information-processing power hidden in matter, in the struggle against entropy, it is clear that hardware (artificial life) will eventually win out against wetware (organic life) since it is more durable and more efficient. These 'extropians' see this as perhaps bad news for the human race (although in the interim a lucky few may be able to 'download' their minds into better robot bodies or cyberspace), but in the long-term at least good news for the planet and apparently the universe.[1]

There are others who foresee perhaps a more peaceable coexistence for human beings and electronic 'life,' however. One recent theory that has been bantered about lately is that the human race may have reached the saturation point for economic growth, but this is fortunate since it has arrived in time for it to work on 'human growth,' i.e. the re-engineering of the human species.[2] We can 'graduate' from being victims of natural selection to masters of self-selection. It seems hard to argue against increasing human longevity, intelligence, or strength, since human beings seem to live too short a span, to make too many mistakes in reasoning, and to lack the physical endurance necessary to make great accomplishments. Indeed, there are those who feel that without technological modification, the human being might be simply too "short-changed" from an evolutionary standpoint to accomplish the race's greatest dreams, such as peaceful coexistence, environmental sustainability, and space exploration.[3] The search for human perfectibility is one of the oldest of utopian dreams.

Some more optimistic realists feel that human biotechnology will be an inevitable necessity in light of coming changes. Human genetic structure may be irreversibly altered for the worse as levels of radiation, chemical pollution, and so on continue to increase. Global climate is likely to change drastically due to global warming and ozone depletion. People may be forced by overpopulation and overcrowding into parts of the world previously aggressive to human settlement, whether in deserts, underground, under the sea, or perhaps even other planets. And then there are always the periodic extinctions on our planet, which many scientists now think may be due to regular collisions with asteroids or the reversal of the magnetic field. Pessimists who suspect many of these global changes may be irreversible sometimes have taken the position that the only way for the human race to avoid bitter as a species is to make some rapid technological changes in its biological adaptability.[4]

Other scientists have argued that the sort of "hyper intelligence" made possible by bioelectronics may be necessary to save the human race from itself. Just as many genetic engineers held out the possibility that human beings might soon be able to 'splice' out the genes for aggression, antisocial behaviour, and criminality in the 70s, today bioelectronics researchers suggest that augmented human beings may be able to cooperate with technology in extraordinary ways to reassert rational management of the planet and its resources, and stave off the irrational impulses of xenophobia and paranoia that might lead to its nuclear destruction. Ever since Comte (or Plato), people have argued that the best governance of the human race might be by an autocratic elite who possesses the wisdom, long-term vision, and breadth of perspective that the common man does not. Of course, to others, this danger of technocracy is a Damoclean sword hanging over the human future, and must be avoided at all costs.

Lastly, there are the postmodern theorists, normally noted for their anti-technological stance, who have taken a favourable position on the coming of the cyborg. The "cyborg anthropologists" have followed the line of Donna Haraway, who declared that she would rather be a cyborg than a goddess any day, in a sort of cynical denial of ecofeminism and the fetishizing of nature.[5] Haraway, a researcher interested in the links between humans, primates, and computers, feels that the cyborg is an important metaphorical identity for human beings in the 21st century, in that it resists essentialism (and thus racism, sexism, chauvinism, et al.) and helps to display the fluidness, hybridization, and boundary-transgression of postmodern identities. For Haraway, the cyborg is one way of the human race finally freeing itself from the culture/nature split/trap in which we have found ourselves.

V. NEGATIVE CONSEQUENCES

The critics of bioelectronics biotechnology, especially with regard to the idea of the intrinsic sanctity and integrity of human life and that human beings are created in the image of the Divine. Even those not spiritually inclined who still and biocomputing foresee numerous potential negative social consequences from the technology. One is that the human race will divide along the lines of biological haves and have-nots. People with enough money will be able to augment their personal attributes as they see fit (which is what they already do with techniques such as spas, plastic surgery, etc.) as well as to utilize cloning, organ replacement, etc. to stave off death for as long as they wish, while the majority of humanity will continue to suffer from plague,

hunger, 'bad genes,' and infirmity. It's hard not to see the biological 'haves' advocating separation and/or extinction unavoidably for their unmodified peers. Certainly, at a minimum, the two 'strains' of humanity will diverge in tremendous ways, perhaps as drastically as did Cro-Magnon and Neanderthal man in the prehistoric past, to the point where there may not be a single human species anymore. While neo-Darwinian theory suggests that such somatic adaptations are not inherited, at the level of monkeying with DNA, all bets are off. The germline is no longer behind the unbreachable 'Weismann barrier.'

It's inevitable that there will be those who see the potential of a sort of master race from this technology. Certainly, the military has already considered the possibility of the super-soldier, augmented by technology so that he has faster reflexes, deadlier accuracy, greater resistance to fatigue, integrated weaponry, and most importantly, lesser inclinations toward fear or doubt in combat[6] Such soldiers could be created through combinations of biochemical, bioelectronics, and DNA manipulation. They might have available arsenals of new biological warfare components, synthetically generated within their own bodies. But it's not clear that these 'cyborgs' would not turn on their creators. Indeed, there's no reason at all to think they would forever allow themselves to be controlled by inferiors. They could easily become a new sort of dominant caste, forcing the rest of untechnologized humanity into serfdom. Or perhaps they might decide simply to eliminate it.

For that reason, it's logical to suspect that one of the other dangers inherent in bioelectronics might be the ability to control and monitor people. Certainly, it would be easy to utilize bio-implants that would allow people to trace the location and perhaps even monitor the condition and behaviour (through observation of EEG, EKG, and other biological readouts) of implanted persons. This would be a tremendous violation of human privacy, but the creators of human biotech might see it as necessary to keep their subjects under control[7] Once implanted with bio-implant electronic devices, 'cyborgs' might become highly dependent on the creators of these devices for their repair, recharge, and maintenance. It could be possible to modify the person technologically so that their body would stop producing some essential substance for survival, thus placing them under the absolute control of the designers of the technology.

Perhaps the most cogent arguments against this technology originate from people who foresee tremendous possible risks toward human health and safety. Pointing toward the dangers already presented by technologies like Thalidomide, Prozac, silicone breast implants, steroids, and artificial hearts, these critics try to show that the autoimmune system of human beings will not so easily accommodate technological interventions and that widespread failure of organic systems may be the result. While there is widespread talk of improving the human brain through the use of 'skill chips' for implanting new knowledge, many people suspect that such interventions may be even more catastrophic because of the inability of the human nervous system to regenerate. Millions of years of evolution produced only so much capability within the human organism, and it may be lethal to technologically stretch its performance beyond those built-in limits.[8]

While all these scientific criticisms exist, there are certainly equally expressive ones coming out of the realms of traditional theology and bioethics. Many people foresee drastic consequences on religion from nevertheless possess the feeling that there is something within humanity which is not found in animals or machines and which makes us uniquely human, worry that the essence of our humanity will be lost to this technology. The idea that human beings are worth something regardless of their deficits, flaws, and infirmities, may be lost in the tide to human biotechnological improvement.[9] Those who still possess doubts that human beings are nothing but biological machines made from 'wetware' fear the consequences of the 'Brave New World' that bioelectronics makes possible.

VI. APPLICATIONS

Though cyborgs are widely used in various fields, some of the major field of cyber application and development are:

A. Healthcare
B. Augmented reality
C. Military

VII. CONCLUSIONS

As many scientists have eloquently argued, once a technology is out there, you cannot make it go away. The spirit simply will not go back in the bottle. There never was a technology that the human race ever discarded wholesale, even the hydrogen bomb or other weapons of mass destruction with the power to wipe out all life on Earth. You might eventually be able to ban the production of H-bombs, but it would take a long time to kill everybody who knew how to make one or eliminate all blueprints and specifications for the design. While scientists discussed the possibility of a ban on recombinant DNA research at the Asilomar Conference, they knew it was not feasible. Even if overt public funding for such research was cut off, covert private funding would continue to flow from various interested parties, as has happened with even disproven technologies like cold fusion.

Thus, once invented, bioelectronic technologies cannot be wished away. Once given the opportunity to improve themselves in any form, human beings rarely surrender the opportunity, whether it's "pumping iron" or exercise to raise physical fitness, so-called "smart drugs" to raise intelligence, or vitamin therapies to stem the assault of the aging process. When human beings are offered the chance to utilize computers and electronic technologies within their bodies to achieve these same results, it is almost certain they will embrace them regardless of the risks. Based on this, it would be unrealistic to try and ban such technologies, however one might worry about their ethical and social consequences. A ban would only probably force them into a large, criminal black market, as illegal drugs and weapons already have been.

A new "cyborg bioethics" may be necessary. While it cannot be possible to foresee all the consequences resulting from bioelectronics, most scientists are already aware of what some of the major dangers are. Researchers in biocomputing may be required to adopt protocols on acceptable research with human subjects, much as genetic engineers did back in the 1970s. In drafting bioethical imperatives for bioelectronics research, it will probably be imperative to consider the concerns of groups such as the religious community, since to ignore their concerns simply out of the resolve that they are merely acting out of "anti-science" ignorance will leave an important group "out of the loop" of this research. This is unexplored territory for the human race, and it is the first time in which our own "built environment" may be directly incorporated into our own sense of self and human nature. Our own bio computers (the human mind) evolved under a very specific set of evolutionary circumstances, after all, and they may not be equipped with the foresight and moral sense to keep up with the accelerating rate of technology.

Since this is the case, it is probably vital for society to assert that the scientists and engineers charged with creating this new technology exert the proper amount of social responsibility. Safeguards will have to be insisted on to prevent the possible negative impacts discussed above, and many of these things will have to be built in at the instrumental level, since they probably cannot be achieved only through policy and regulation. Critical public awareness and vigilance, of the kind already shown by Jeremy Rifkin and the Foundation on Economic Trends with regard to biotechnology, will be essential. But ultimately, bioethicists will have to struggle with the fundamental issues involved, which touch on aspects of human existence and human nature which reach to the core of what most people think is involved in what it means to be human, and this will not be an easy problem to resolve.

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