Naturalness and Neuronal Implants –

Changes in the perception of human beings

Ulrich Fiedeler, **Bettina-Johanna Krings**
Institute for Technology Assessment and Systems Analysis (ITAS)
Forschungszentrum Karlsruhe in der Helmholtz Gemeinschaft, GmbH
P.O.B. 36 40, D-76021 Karlsruhe, Germany
Tel. +49-7247-82-4644. Fax +49-7247-82-4811,
ulrich.fiedeler@itas.fzk.de

Paper presented for the EASST-Conference

23. -26. August 2006, Lausanne, Switzerland

Introduction

With our contribution we would like to refer to the debate on nanotechnology (NT) and its implications for the public discourse on the relationship of human beings and technologies. Within NT the convergence of some technologies has been considered as a crucial step towards the long term objective of "enhancing human performance".
The discussion was initiated with an US-American workshop in the year 2002, where the innovative character of converging technology (CT)[1] was strongly underlined (Roco 2002). In the final document of the workshop futuristic and far reaching scenarios on technical development based on NT and on CT were presented.

The title of the document: "*Converging technologies for improving human performance*" summarise the overall objective: to conquer the natural limits of human being. For instance, ideas are articulated that the implantation of microchips into the human brain could enlarge the capacity of memory and knowledge (foreign languages, general knowledge etc.). Or that such implants could provide new functions and new sensory abilities (see in the dark, hear in the ultra sonic region, smell like a dog etc.). In some contributions it is even assumed that with the help of NT it is possible in general to overcome illness and even death.

"*Examples of payoffs may include improving work efficiency and learning, enhancing individual sensory and cognitive capabilities, revolutionary changes in healthcare, improving both individual and group creativity, highly effective communication techniques including brain-to-brain interaction, perfecting human machine interfaces including neuromorphic engineering, sustainable and "intelligent" environments including neuro-ergonomics, enhancing human capabilities for defense purposes, reaching sustainable development using NBIC tools, and ameliorating the physical and cognitive decline that is common to the aging mind.*" (Roco 2002, p.1)

The overall idea of the whole document is that not only social problems but also human "defects" like wealth problems or even ageing should be solved by technical solutions. Therefore most contributions within the document are strongly dominated by a technological optimism, which seemed rather typical by the post war period.

[1] In this context the notion "converging technology" denotes the merger of nanotechnology, biotechnology, information technology, and cogno-sciences (NBIC).

Again human nature is perceived as incomplete and insufficient[2]. It is assumed that this incompleteness can be overcome by technical approaches, at least by implanting technical devices in human bodies. This implantation should provide new functions, new abilities and even prolong human lives (Roco 2002, Kurzweil 2002, Bostrom 2003). [3]

"Caught in the grip of social, political, and economic conflicts the world hovers between optimism and pessimism. NBIC convergence can give us the means to deal successfully with this challenges by substantially enhancing human mental, physical, and social abilities. Better understanding of the human body and developments of tools for direct human-machine interaction have opened completely new opportunities" (Roco 2002, p.3).

This document and its focus on technical solutions even for social and psychological issues and its approach to addressing problems had massive influence on the ongoing debate on NT and CT not only on the USA but also on the European discussion[4]. Although the feasibility of the presented ideas was questioned not only by the scientific community, the political and social relevance for the whole research process seems remarkable. Therefore in the following contribution we like to add some critical remarks on the normative concept underlying this debate in order to reflect on a deeper meaning of the human/machine interface.
First we address the implications of the mentioned document for research policy in general and especially of NT. Based on the example of neural implants we second qualify the normative expectations within the debate without however denying the helpfulness of these innovations especially in the field of medicine. But we third agree on a critical discussion, which consider a new quality of technological penetration into social and human processes.

(1) Relevance of CT-document and linked attitude (thinking) in NT for the Research policy

It could be argued that there are only a few prominent people who represent the normative idea of the improvement of human performance. But there are some considerations which indicate that the development mentioned above has greater importance for research processes:

- The mentioned document is an official paper of the National Science Foundation of the US-government.
- In addition the whole field of Nanoscience and NT is strongly dominated by technical optimism. In the ongoing process of the political support of NT, engineering thinking has gained influence. There are intentions to apply concepts of engineers to biological systems[5]. Cells and compartments of cells like mitochondria are perceived as chemo-mechanical machines (Jones 2004).
- A lot of funding is allocated to research on NT[6] and on CT[7].
- Founding of the *Future of Humanity Institute* in the UK, Director N. Bostrom[8]

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[2] These ideas are based on the concept of A. Gehlen, who perceived human beings as deficient by nature.

[3] Both authors are accepted as experts. (Kurzweil was asked for a testimony at the US-Congress on The Societal Implications of Nanotechnology, Wednesday, April 9, 2003, Nick Bostrom is Director of the Future of Humanity Institute at Oxford University. Bostrom founded the World Transhumanist Association in 1998 together with David Pearce.

[4]HLEG 2004, Spanish NBIC-initiative (http://nbic.org.es), Converging Technologies – Promises and Challenges, Budapest 2005 (see Coenen 2006), STOA-Project on Converging Technology 2005.

[5] In the National Institute of Health (NIH) – Roadmap it is stated: *"A key activity during this time will be the development of a new kind of vocabulary – lexicon – to define biological parts and processes in engineering terms"* (NHI – Backgronder 2003 or see for example: http://nihroadmap.nih.gov/nanomedicinelaunch/pdf/Roadmap_and_Nanomedicine_Centers_Schloss.pdf)

[6]849 million dollars have been allocated for research in the field of nanotechnology for the fiscal year 2004. In 2003: west Europe 650, Japan 800, other 800 million dollar (Roco 2004).

[7]Germany: Retina Implant Projekt (1995-2003), Founding of Bernstein Zentren für Computeral Neuroscience (2004) Budget: 34 million Euro(2004-2010) (http://www.bmbf.de/de/3063.php)

The important point with respect to our contribution is that NT and especially CT have implemented technologically driven approaches to solve general problems. This is especially obvious in the field of neuronal implants.

One crucial subject for the development of the ideas presented in the NBIC-report is the development of neuronal implants (neuronics). Together with the rise of NT the idea of a direct access to the human brain has gained new attraction. Therefore the research on this topic was intensified in the last years:

- 1990 US-President proclaims *The Decade of the Brain*.[9]
- 2000-2010 German Brain Research Foundation proclaims the *Decade of the Human Brain.*[10]
- BMBF[11] funding of Computational Neuroscience.[12]
- Imaging methods in brain (neuroimaging) and recognition research have accelerated the development in this field and have redirected attention to that field (Hüsing 2006).[13]
- European research priorities includes similar objectives (FP6 1.1.2.ii, 1.1.2.iv, 1.1.23.i, see (Knoll 2004, p.10)).
- Statements and public promises that solutions to several problems are now mature: Technical developments and research on that topic will have increasing progress (Knoll 2004, p.9, Eckmiller 2005).

There are two central reasons for the high expectations that NT could contribute essentially[14] to further developments of the brain/machine interface (BMI)[15]. The first argument is the requirement of further miniaturisation to realize a brain/machine interface. This interface should be able not only to stimulate a brain area or other areas of nerve containing tissues like the muscles of the heart by electrical pulses (peace maker, suppressing the shaking of Parkinson patients), but to connect with individual nerves and exchange signals[16]. This is especially the case for retina implants and could lead to a significant improvement of cochlea implants. Another reason for the need of miniaturisation is linked with the complex stimulation patterns neural networks are communicating with each other. These patterns must be interpreted or/and generated by the artificial implant. Therefore considerable computing power must be provided by the implanted device.
The second reason why NT is to be considered as a crucial technology for the further development of the brain/machine interface is related to the fact that brain/machine interfaces can only be realised by an interdisciplinary approach. This goes together with the consideration that NT is the new key technology which is as important for the future as

[8]FHI is an interdisciplinary research institute founded on November 28 2005, and is part of the new James Martin 21st Century School at the University of Oxford. http://www.fhi.ox.ac.uk/ (12.7. 2006)

[9]http://www.loc.gov/loc/brain/proclaim.html

[10]http://www.menschliches-gehirn.de/

[11]BMBF: Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research of Germany).

[12] http://www.bmbf.de/de/3063.php

[13]This research was accompanied by the expectation that the function of brain will be decoded soon. In addition it fuels the debate on free will and has fostered the opinion the brain is just a complex but physico-chemical determined machine.

[14] Usually, it is promised that NT will bring the „break through“ in this field.

[15] If not marked otherwise in this contribution „brain/machine interface“ termed all kinds of connections between neurons and artificial devices to read signals from the neurons or to imprint signals to the neuron.

[16] Stimulation but also reading out.

microelectronics was for the past[17]. The argument is that on the level of nm biology, chemistry and physics will merge (Rocco 2002).

(2) Neuronal implants and their effects

Generally NT can be considered as an important step in the field of the brain/machine interfaces, in so far as it has given that field new momentum. Applications of NT in the field are still at the very beginning and it seems very open, what type of technical concepts will be realised in the nearest future.

In the following we would like to present several examples for neuronal implants which should give an impression of the variety of the different approaches within this research field. It illustrates the possibilities as well as the limits of these technical applications. Many of the scientific approaches and technical applications have already been in use for a long time while some of them are still in work by progress.

Neuronal implants are artificial devices which are implanted into the human body and which have contacts to nerves or neural tissues. These devices interact with the body by electrical stimulation. Neuronal implants are also termed neuroprosthetics. In this sense a pacemaker is an example of a neuronal implant even though there is no direct connection to a nerve. The electrodes just touch the inner cardiac wall at a specific location and send out electrical pulses.

A large number of neuronal implants try to restore capabilities which have been lost due to accidents or diseases. Many of them are linked to spinal cord injuries (SPI) (see for example Pochazka 2001).

- Bladder control: In most cases SC-injured can not control the exhausting of their bladder. Usually they wear a catheter which is not comfortable and is companied by the risk of infections. There already exist implants with which the patient can control bladder exhausting by electrical devices (Prochazka 2001 p.103).
- Restore movement of a lamed hand: Another example is the attempt to restore the movement of the hand. If the injury is located at the thoracic vertebra the patient can only control muscles of the shoulder but not of the arm or the hand. Controlled by muscles of the shoulder the patient controls movements of the arm with the help of electrical stimulation. At present crude movements and simple grasping can be restored (Strauss 1999).

A huge field of investigation is the bridging of an injured nerve tract like the spinal cord. Up to now this seems to be still far from feasible. First neuroprosthesis approaches to restore walking have not produced the expected results.

- Cochlea implant: Research on cochlea implants has increased since the 1950s (Nzasanze 2005). There are now approximately 80000 deaf people with cochlea implants. For these kinds of implants electrodes are inserted into the cochlea. An external microphone records sound and the translated electrical pulses are imprinted on the cochlea by the electrodes. Usually the patients can understand speech and are even able to make telephone calls.
- Retina implant: Another example of neuronal implants is the retina implant. Loss of vision of patients who suffer from retinitis pigmentosa or from macular degeneration

[17] *"The impact of nanotechnology on health, wealth, and the standard of living for people will be at least the equivalent of the combined influences of microelectronics. medical imaging, computer-aided engineering an man made polymers in this century"* Nobel laureate Richard Smalley the 22th June 1999 to the US-Congress. http://www.house.gov/science/smalley_062299.htm (6.9.2004)

could be restored to a certain extent by implanting a light sensitive electronic device on the retina. These implants are not on the market but there exist first clinical trials (Zrenner 2002).

- Deep brain stimulation (DBS): Shaking of Parkinson patients could be reduced by inserting a long thin electrode into the brain. The electrical stimulation of the hypo campus region reduces the essential tremor movements of the extremities. Patients can even drink from a cup.
- Steering a machine by thought control: The idea of controlling a machine just by thought is very old and there are several attempts to realise it. A practical background is to enable lock-in patients[18] to communicate. There exist several attempts to control a cursor on a computer screen and therefore to compose sentences. Usually characteristic patterns of the EEG[19] are used for this purpose (Thomas 1999). But the bad signal to noise relation constrains this method. Therefore some experiments have been performed to implant electrodes in the head. The most popular experiment was performed 2001 by Nicolelis and his team (Nicolelis 2002). He implanted an array of electrodes on the surface of the brain of a monkey. He read out the signals the monkey produced while it was steering a robot arm. After training the monkey could move the robot arm in a controlled manner directly by his thought.

These examples show that the development of neuronal implants has been performed continuously[20]. Generally it has not been possible to observe a deep qualitative incision creating a new generation of technology in the last years. But because of the public promotion of these technologies, funding and research activities have been increased considerably in this field.

(3) Some critical aspects on the discourse on NT

In the last years a broad debate about NT, NBIC and its implications has arisen[4]. The vast majority of the articles discuss the societal and ethical consequences of NT and CT. These contributions mainly do not reflect the feasibility of the expected innovations but take them as given (Chen 2002, Moor 2003, Grunwald 2006b, Dunkley 2004, Mnyusiwalla 2003)[21]. Although these contributions have opened the field for new questions and doubts and put them into a wider theoretical context, the principal idea of perfecting the human body wasn’t put into question.
Therefore we would like to promote the critical debate, where the further penetration of technology into societal and cultural processes and vice versa is considered as a deep transformation process.[22] This process opens a new stage for technology with a new quality of boundaries between human beings and technology as well as the perception of technology in everybody’s life.

With a more critical perspective the public discourse in favour of NT and CT should be considered as the continuation of a single-edged understanding of technology, which can be characterised by the following aspects:

18E.g. ALS-patients

19External electrodes can be used to record the currents in the brain which are accompanied by brain activities. They form characteristic patterns depending on the mental state.

20The first heart pacemaker was implanted in 1960 (Nsanze 2005).

21It should be mentioned that there are several investigations on the rhetoric and dynamic of the debate on NT where the futuristic character is explicitly addressed (e.g. Fiedeler 2005, Coenen 2004, Schummer 2004, Grunwald 2006a).

22 Especially the Feminist Theory as well as the continuing discourse of Critical Theory focus on the transformation of the body-technology interfaces, the economic implications of new technologies as well as the domination of technology as solution for social and political problems (Scheich 1996, Knapp, G.-A., Wetterer, A. 2001, Böhme, Manzei 2003).

- The concept of technology as the central instrument for solving societal problems. With this perspective other possibilities of resolving problems are widely excluded. The technical process therefore continues with a further devaluation of social, emotional as well as communitarian needs of human beings.
- The concept of NT and especially Converging Technologies imply new interfaces between body and technology. Blurring boundaries between the corporal constitution of human beings and technological implications have been discussed intensively (especially in the field of biotechnologies). On the one hand these interfaces create legal and social insecurity and risks (Habermas 2001). On the other hand there is an extension of disembodiment of human beings as well as the further mechanisation of the world (Becker-Schmidt 1999, Krings 2002). There is a new social constellation between technology and the perception of the natural world. Obviously this process can be observed over the whole technological process. However it seems important to focus on the changing concept of responsibility and ethical values.
- NT, as any new technology, is always is embedded into a national and political context, which has to be considered seriously. Therefore “selected” technologies are introduced as a local knowledge with local interests into the public (international) discourse. The contextual framework of NT also defines the application of new technologies (resources). From the very beginning the representatives of NT have been very successful in strengthening this technology.

Scientific and technical logic of parts of NT is directed toward the change of the human condition and the living condition. The reflection of these changes should encompass not only the technical dimension but also the deeper meaning of the cultural, social and economic processes of new technological innovations. This result seems trivial, but the tremendous effects of NT in the public discourse show need for a comprehensive analysis.

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